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Radio-Electronics

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HX1000 HX2000 HX750 HX650

When you need to hear the action from wherever you are, Regency delivers. Our portable scanners keep you in touch with the local news. Whether it's bank hold ups, three alarm fires, weather, business, marine radio, or aircraft calls, Regency portables bring you the on the scene action. While it's happening from where it's happening . . . in your neighborhood.

PROGRAMMABILITY WITH A CHOICE

Regency offers you two new exciting keyboard programmable hand held scanners. First there's the HX2000 20 channel, no crystal scanner. It offers UHF and VHF ranges with the important addition of 800 MHz and aircraft frequencies. And with features like search and scan, priority, liquid crystal display, and selectable search increments, the HX2000 is a sure winner.

If you don't need the extended coverage, there's the HX1000. It let's you cover your choice of over 15,000 frequencies on 30 channels at the touch of your finger. No crystals are necessary. Six band coverage, search and scan, priority control, and a liquid crystal display with special programming messages and clock are all part of the package. And with the sealed rubber keyboard and die-cast aluminum chassis, the HX1000 is the most rugged and durable hand held on the market.

CRYSTAL-CLEAR

If you don't need all the features of programmables, but you want the convenience of portability, we've got you covered. Our two crystal controlled hand held scanners, the HX650 and HX750, offer six channels, individual channel lock outs, LED channel indicators, step control, two antennas and an adaptor/charger. Both cover VHF high and low, UHF and "T" public service bands, with the HX750 offering the additional coverage of VHF aircraft band.

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Your Regency Scanner dealer would be happy to give you a free demonstration of these and other new Regency Scanners. Stop in today. Or, write Regency Electronics, 7707 Records St., Indpls., IN 46226.

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Scanners

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NEW! Regency‡ MX7000-G

List price $699.95/**CE price $449.00**
10-Band, 20 Channel • Crystalless • AC/DC
Frequency range: 25-550 MHz. continuous coverage and 800 MHz. to 1.2 GHz. continuous coverage
In addition to normal scanner listening, the MX7000 offers CB, VHF, and UHF TV audio, FM Broadcast, all aircraft bands (civil and military), 800 MHz communications, cellular telephone, and when connected to a printer or CRT, satellite weather pictures.

NEW! Regency® MX5000-G

List price $599.95/**CE price $354.00**
Multi-Band, 20 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Selectable AM-FM modes • LCD display
World's first continuous coverage scanner
Frequency range: 25-550 MHz. continuous coverage.
Never before have so many features come in such a small package. The *Regency* MX5000 mobile or home scanner has continuous coverage from 25 to 550 MHz. That means you can hear CB, Television audio, FM broadcast stations, all aircraft bands including military and the normal scanner bands, all on your choice of 20 programmable channels.

NEW! Regency® MX4000-G

List price $629.95/**CE price $394.00**
Multi-Band, 20 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Selectable AM-FM modes • LCD display
Bands: 30-50, 118-136, 144-174, 440-512, 800-950 MHz.
The *Regency* MX4000 is gives coverage in the standard VHF and UHF ranges with the important addition of the 800 MHz. and aircraft bands. It features keyboard entry, multifunction liquid crystal display and variable search increments.

Regency® MX3000-G

List price $319.95/**CE price $182.00**
6-Band, 30 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Bands: 30-50, 144-174, 440-512 MHz.
The *Regency* Touch MX3000 provides the ease of computer controlled, touch-entry programming in a compact-sized scanner for use at home or on the road. Enter your favorite public service frequencies by simply touching the numbered pressure pads. You'll even hear a "beep" tone that lets you know you've made contact.

Regency® Z30-G

List price $279.95/**CE price $166.00**
6-Band, 30 Channel • No-crystal scanner
Bands: 30-50, 144-174, 440-512 MHz.
Cover your choice of over 15,000 frequencies on 30 channels at the touch of your finger.

Regency® C403-G

List price $99.95/**CE price $62.00**
5-Band, 4 Channel • Crystal scanner
Channel indicator LED • AC only • Low cost
Bands: 30-50, 148-174, 450-470 MHz.
Regency's basic scanner, the C403 gives you the excitement of police, fire and emergency calls at a budget price. It can tune in to any of five public service bands and brings the signal in loud and clear...on any of four possible channels. It comes with detachable telescope antenna and AC power cord. Order one crystal certificate for each channel you want to receive.

Regency® HX1000-G

List price $329.95/**CE price $209.00**
6-Band, 30 Channel • No Crystal scanner
Search • Lockout • Priority • Scan delay
Sidelit liquid crystal display • Digital Clock
Frequency range: 30-50, 144-174, 440-512 MHz.
The new handheld *Regency* HX1000 scanner is fully keyboard programmable for the ultimate in versatility. You can scan up to 30 channels at the same time. When you activate the priority control, you automatically override all other calls to listen to your favorite frequency. The LCD display is even sidelit for night use. A die-cast aluminum chasis makes this the most rugged and durable hand-held scanner available. There is even a backup lithium battery to maintain memory for two years. Includes wall charger, carrying case, belt clip, flexible antenna and nicad battery. Order your *Regency* HX1000 now.

Regency® R106-G

List price $159.95/**CE price $92.00**
5-Band, 10 Channel • Crystal scanner • AC/DC
Frequency range: 30-50, 146-174, 450-512 MHz.
A versatile scanner, The *Regency* R-106 is built to provide maximum reception at home or on the road. Rugged cabinet protects the advanced design circuitry allowing you years of dependable listening.

NEW! Regency® R1050-G

List price $179.95/**CE price $109.00**
6-Band, 10 Channel • Crystalless • AC only
Frequency range: 30-50, 144-174, 440-512 MHz.
Now you can enjoy computerized scanner versatility at a price that's less than some crystal units. The *Regency* R1050 lets you in on all the action of police, fire, weather, and emergency calls. You'll even hear mobile telephones.

Programming the R1050 is easy. Merely touch the keyboard and enter any of over 15,000 frequencies on your choice of 10 channels.

Regency® HX650-G

List price $129.95/**CE price $79.00**
5-Band, 6 Channel • Handheld crystal scanner
Bands: 30-50, 146-174, 450-512 MHz.
Now you can tune in any emergency around town, from wherever you are, the second it happens. Advanced circuitry gives you the world's smallest scanner. Our low CE price includes battery charger/A.C. adapter.

NEW! Regency® HX-650P-G

List Price $189.95/**CE price $104.00**
Now, Communications Electronics offers a special packaged price on the *Regency* HX-650 scanner and the following items for only $104.00. You get the *Regency* HX-650 scanner, a set of 4 AAA ni-cad batteries, the MA-506 carrying case, six crystal certificates, AC adapter/charger and flexible rubber antenna for only $104.00 per package plus $10.00 shipping/handling. To order this special package, use CE special order number HX-650P-E.

QUANTITY DISCOUNTS AVAILABLE

Order two scanners at the same time and deduct 1%, for three scanners deduct 2%, four scanners deduct 3%, five scanners deduct 4% and six or more scanners purchased at the same time earns you a 5% discount off our super low single unit price.

NEW! Regency® HX2000-G

The World's First 800 MHz. Handheld Scanner
List price $569.95/**CE price $359.00**
7-Band, 20 Channel • No-crystal scanner
Priority control • Search/Scan • AC/DC
Sidelit liquid crystal display • Memory backup
Bands: 118-136, 144-174, 440-512, 800-950 MHz.
The new *Regency* HX2000, handheld scanner covers thousands of frequencies including the new 800 MHz. band. Although this scanner does *not* have low band, you can scan up to 20 channels at the same time. Selectable AM/FM reception modes on all frequencies. With the included AC/DC transformer, the HX2000 can be operated on either 120V AC or 6 VDC. Scans 15 channels per second. Size 3" x 7" x 1½." Includes wall charger, carrying case, belt clip, flexible antenna and nicad batteries.

NEW! Regency® RH250B-G

List price $699.95/**CE price $379.00**
10 Channel VHF synthesized transceiver
Built-in scanner with programmable priority
Fully programmable CTCSS on every channel
If you're a fireman, policeman or a person on the go and it's essential that you stay in touch with headquarters, you need the *Regency* RH250 transceiver. You can program simplex or semi-duplex frequencies including CTCSS tones.

OTHER RADIOS & ACCESSORIES

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B-4-G 1.2 V AAA Ni-Cad batteries (set of four)	$9.00
A-135C-G Crystal certificate	$3.00
A60-G Magnet mount mobile antenna	$35.00
A70-G Base station antenna	$35.00

Add $3.00 shipping for all *accessories* ordered at the same time.
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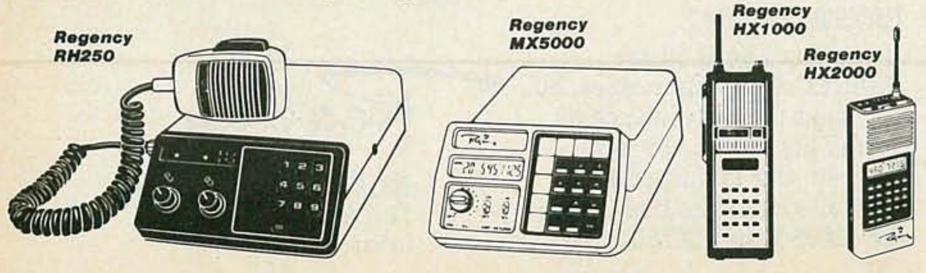

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COVER 1

Robots are here to stay! In the next year or so, there's going to be a personal-robot explosion just like the personal-computer explosion we've just witnessed. Well, here's where you can get started!

We'll show you how to convert a commercially available toy robot arm by adding computer control to it. It's a whole lot easier than building a robot from scratch, and you can learn just as much—and you can have at least as much fun! Whether you put your robot to work or just use it to play with, it's sure to attract a lot of attention. The story starts on page 49.

NEXT MONTH

ON SALE MAY 9

INSTALLING SATELLITE TV
One article will cover the decisions you have to make before you set up a TVRO. A second will show you how to set things up once you've made your decisions.

TURN YOUR DVM INTO A THERMOMETER
Why just measure voltage?

BARGRAPH VOLTMETER FOR YOUR CAR
Keep tabs on your electrical system with this easy-to-read meter.

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How electronics technology is used to aid the blind.

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An indepth look at flip-flops.

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Microfilm & Microfiche editions are available. Contact circulation department for details.

Advertising Sales Offices listed on page 138.

WHAT'S NEWS

Four countries join for direct broadcast

The Nordic Council of Ministries of Culture, Communications, and Industry has decided on a new transmission system for Nordic direct broadcasting satellites. Denmark refrained from joining the decision by the Ministries of Finland, Iceland, Norway, and Sweden. The Danish Communications Administration, however, supports it.

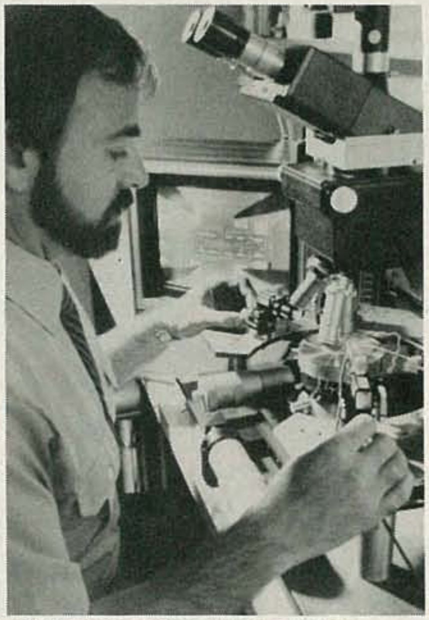
In one satellite channel, the new system, C/MAC/PACKET, can send television pictures, TV sound, commentator channels, and two sound radio channels in stereo. It also improves sound and picture quality.

England has also chosen the C/MAC/PACKET system, and it is recommended by the European Broadcast Union as the only form for satellite broadcasting in Europe.

World's fastest circuit developed at Bell Labs

The fastest, most efficient semiconductor circuit ever made has been developed at AT&T Bell Labs. A frequency divider using the new technique operated at 10 billion cycles per second when cooled to 70 degrees Kelvin, and did it with about one tenth the power dissipation of the equivalent silicon device. That is about twice the speed of present-day circuits. (At room temperatures, the best silicon circuits approach its speed, but use 20 to 30 times as much power.)

The new circuit is based on a Selectively Doped Heterostructure Transistor (SDHT), a multilayer sandwich of aluminum gallium arsenide and gallium arsenide (AlGaAs-GaAs) in which the



AN SDHT FREQUENCY DIVIDER IC is examined by J.V. DiLorenzo, head of the Bell Labs Electronic Materials and IC department. It was developed by Raymond Dingle, Horst Stormer, and Arthur Gossard at Bell Labs.

electrons are able to move faster than up to now was considered possible. That is accomplished by placing the silicon donor impurities in the AlGaAs layer and forcing the electrons to migrate to the GaAs layer. Thus, the electrons can move without being impeded by collisions with donor impurities in the crystal. They move at twice the "normal" speed at room temperatures—twenty times as fast at liquid-nitrogen temperatures.

The first of the many applications of the new technology are expected in the supercomputer field, where speed of operation is a critical factor.

Electronics taught by videodisc

Eastman Kodak Co. has licensed J.A.M. Inc., a maker of video and computer training software, to produce and market an interactive videodisc course: *New Electronic Technologies*. Subjects include electronic displays, electronic imaging, magnetic and nonmagnetic recording, integrated circuits, and electronic transmission.

The package will consist of six laser discs, with the corresponding computer-interface card and computer program (stored on flexible diskettes). It is designed for use with a laser-disc player and either an IBM or IBM-compatible personal computer.

Kodak anticipates that the course will appeal to business and industrial organizations, colleges, and government agencies. J.A.M. expects to market the course for $6,750.

New standard announced for tape recorders

The Electronic Industries Association (EIA) has announced the availability of a new Interim Tape Recorder Measurement Standard (IS-12). It is the result of an industry-wide effort to standardize the measurement of high-fidelity analog tape recording and reproducing equipment.

An important feature of the new standard is the establishment of reference levels to which such specifications as signal-to-noise ratio, maximum recorded-level, and meter calibration are referred. Ambiguities due to the choice of reference input and output levels have also been addressed, so that products can be compared.

Copies of IS-12 are available from the Electronic Industries Association, Standards Sales Office, 2001 Eye Street, N.W., Washington, D.C. 20006 at the price of $18.00 per copy. R-E

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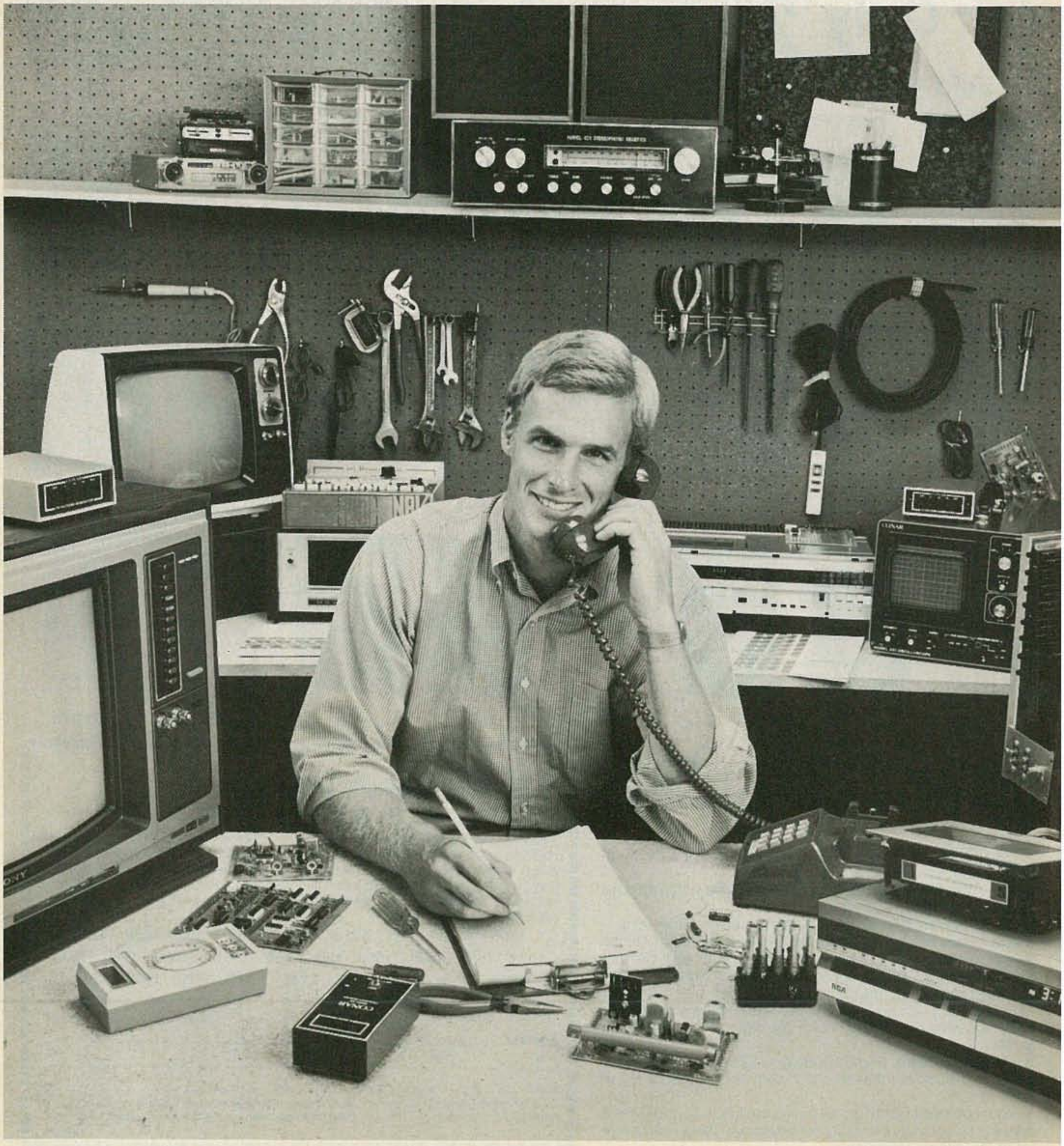

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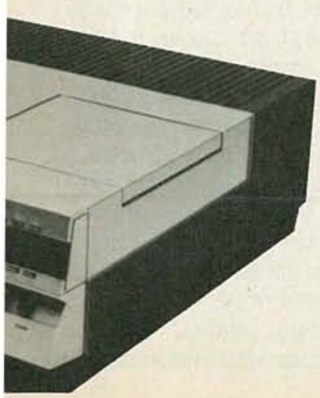

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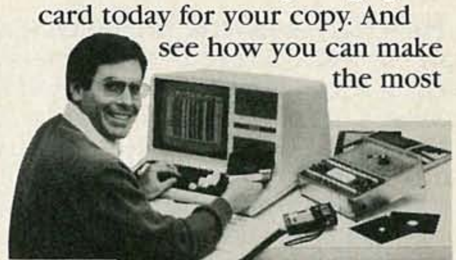

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VIDEO NEWS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

• **VCR's hottest year.** Videocassette recorders became a true mass-market product in 1984, EIA's official sales figures prove. Dealers in the United States bought 7,615,791 VCR's last year, up 86.1% from the 4,091,321 sold in 1983. In fact, 1984's sales exceeded the total for 1981, 1982, and 1983 combined. And the momentum continued into 1985, with sales in January eclipsing those of January 1984 by more than 64%.

• **New videocassette products.** Since many people buy VCR's solely to watch pre-recorded cassettes, why not make a play-only videocassette machine? That question has come up repeatedly, and the answer always has been that hardly any savings is made possible by eliminating the record function, especially since production of record-and-play machines is so high. But apparently the demand is there, and the videocassette player, or VCP, could be a hot product this year.

VCP's are now being imported by Funai of Japan, mainly for the rental market, selling at around $260. Another version could be designed to retail for less than $200. Funai's initial offerings have aroused enough interest to encourage big Matsushita to enter the market, and it is exploring bringing them to the United States. As reported last month, Quasar and General Electric are considering offering these VCP's (although at a much higher price than the Funai machine). Korea's Gold Star, Samsung, and Daewoo have developed VCP prototypes, as has Sampo of Taiwan.

Another videocassette product—which isn't on the market here and might not ever be—is stirring up plenty of excitement nevertheless. That is a double-deck VCR, being offered by Sharp in the Middle East only. The reason it has raised a furor here is that it can easily be used for copying cassettes—just put a recorded cassette in one slot and a blank one in the other. The Motion Picture Association of America, which has been pressing for legislation to levy a fee on VCR and tape sales (to be paid to copyright owners) has hailed the existence of the two-cassette machine as proof that one of the main purposes of VCR's is to make illicit copies of copyright material.

• **New video products.** Pioneer has introduced its combination laser videodisc and digital audio compact disc player. Priced at $1,200, it can play the 4½-inch CD audio discs as well as 12-inch and 8-inch videodiscs, including the new ones with digital soundtracks.

General Electric, Magnavox, Panasonic, and Quasar around midyear will market camcorders that use full-sized VHS videocassettes and weigh just over seven pounds, with batteries; they were unpriced at press time, but are expected to list between $1,600 and $1,800. They can play back as well as record.

The Beta Group—including Sony, NEC, Sanyo, and Toshiba—will soon market the third version of the record-only Betamovie camcorder. This one has a solid-state CCD pickup in place of a camera tube, and has automatic focus.

Hitachi is introducing a filmless still camera, using the standard 1.85-inch micro-floppy disc to store 25 pictures; it will be priced around $2,000 (including TV playback system and dye-transfer color printer) in Japan.

• **Korean VCR's coming.** The first VCR's from Korea are scheduled to start arriving this spring and summer. They had been kept off the export market previously under the terms of license agreements with Japanese developers of the VHS and Beta formats; but beginning this year, export is permitted. The major effect of the new source for video recorders is expected to be lower prices. The first Korean VCR's—both VHS models—have been announced by Samsung and Gold Star, their lowest suggested list prices being $349 and $399, respectively. However, list prices don't necessarily represent true "street prices," and there is conjecture that the units will settle down to $299 or less. **R-E**

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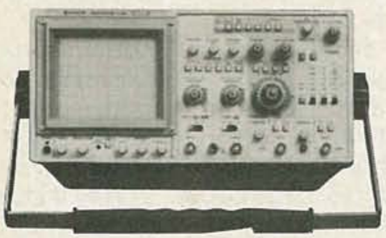

• Quad channel (Ch. 1,2,3,4) with independent position controls • 8 trace with alternate sweep • 18kV-6" rectangular CRT • Minimum deflection factor 1 mv/dlv, maximum sweep time 2ns/div • TV-sync • X-Y operation up to 1 MHz (3° or less), variable hold-off • Gate output for A and B sweep • CH 1 signal output to 100 MHz (-3db)... plus much more.

HITACHI 100 MHz QUAD TRACE DELAYED SWEEP SCOPE

Model V-1050F
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• Use of low halation dome mesh and large 6" rectangular CRT with internal graticule • 500 uV/div high sensitivity design • Alternate and single sweep functions • TV sync separator circuitry with one touch synchronization • Automatic focus circuits • Variable hold-off circuitry • X-Y operation • Delayed sweep function with one touch control 10X magnification

HITACHI 60 MHz DUAL TRACE DELAYED SWEEP SCOPE

Model V-650F
$995.00
(Reg. $1195.) Probes included.

• 6" rectangular CRT with internal graticule. • 1 mV/div high sensitivity design • Triple trace for checking synchronous signals and relationship and timing between observed waveforms • TV sync separator circuitry • Automatic focus circuitry • Variable hold off circuitry • X-Y operation • Delayed sweep function with one touch control 10X magnification • Signal output: CH1 output terminal to frequency counter, etc.

HITACHI PORTABLE OSCILLOSCOPES 1 mV/div DUAL TRACE

Model V-222 (20 MHz)
$549.95
(Reg. $715.) Probes included.

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$699.95
(Reg. $895) Probes included.

• Thin, light and compact design • Large 6-inch rectangular, internal graticule CRT • Autofocus circuit and scale illumination • DC offset function • Voltage and frequency reading outputs • Alternate magnify function • 8 divisions of displayed dynamic range • TV sync separation circuit • X-Y operation mode

HITACHI PORTABLE OSCILLOSCOPE DC TO 20 MHz, 1 mV/div DUAL TRACE

Model V-212
$499.95
(Reg. $615.)
Probes included.

• Thin, light and compact design • Large 6-inch rectangular, internal graticule CRT • High accuracy - +3% • High sensitivity −1 mV/div • Stable, low-drift design • 8 divisions of displayed dynamic range • TV sync separation circuit • X-Y operation mode

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SATELLITE TV

BOB COOPER, JR.,
SATELLITE TV EDITOR

What's new in TVRO systems

WHAT'S SMALLER THAN A 10-FOOT DISH, but bigger than a bread box?—a PD™, or *Personal Dish*™. A Personal Dish is a small C-band (4 GHz) satellite terminal, like that shown in Fig. 1. (It is also a registered trademark of PD, Inc., 3 Claremont Road, Bernardsville, NJ 07924.)

FIG. 1

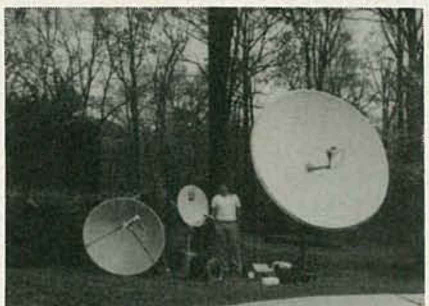

FIG. 2

About five years ago, a 10-foot dish was a form of a PD; two years ago, it was the 8 footers; one year ago, the 6 footers. But now you can't be a respectable PD supplier unless you have a 4-foot dish.

Are dishes getting better and better? Is TVRO electronics getting better and better? (So much so that a 4 foot dish today works like a 10 foot dish of yesteryear?) Without qualification, the answer is no! In fact, that would be a resounding NO! Still, dishes are getting smaller and more and more firms are offering the miniature C-band terminal systems. So what's the story here?

What's happening

There are actually two and a half stories. All are true and we'll be brief. For one, dish designs have improved, but not that much. Besides, as dishes get larger and larger, more and more of their surface area (or gain-ability) is thrown away in the manufacturing or assembly process by sloppy tolerances.

A bigger dish, with inaccurate surfaces, is no better (no more sensitive) than a smaller dish with an accurate surface. It is far easier to maintain good surface accuracy, and therefore maximize gain, with a smaller surface. That's basic.

Second, satellites have become more powerful. In particular, the present generation Galaxy (Hughes built) satellites are nearly 9 watts per channel. That's nearly 3 dB better than the older, original SATCOM and Westar birds! More signal from the satellites allows you to back-off on the ground system, and reduce the dish size for the equivalent picture detail.

Finally the half-story: Satellite receivers perform more efficiently. By reducing the receiver's (IF) bandwidth, greater receiver sensitivity has been achieved. Of course, there is some sacrifice; you lose some of the crispness of the picture when you chop out some of the satellite-transmitted information. But that's generally considered an acceptable trade-off.

So we have smaller dishes today than we had in 1980 or even 1983 because they are of better quality (by a 10% factor), receiver circuits about 20% more sensitive, and satellites stronger by a 50% factor. That adds up to 80% better quality, not quite 100%.

Because there are trade-offs involved in the smaller dishes, you never really get you back to the 100% you started with when using a quality 10-foot dish system to begin with. You can never regain the extra signal margin—for example, to compensate for system aging—nor can you put back the picture detail sacrificed with the narrow-banded receiver (IF).

In spite of those negatives, PD's are here and selling well, in sizes from 4 feet to 6 feet. And if you are thinking about selling or servicing new TVRO systems, or simply buying one for yourself, you need to understand what this "smaller is better" mania is all about.

The smaller units have several obvious advantages: size is one, of course. Many people wouldn't have a dish on the roof or in the yard if it had to be 10 feet in diameter. Many roofs can't stand the wind loading of a 10-footer or even an 8-footer. (Figure 2 will give you some idea about the differences in dish size. Shown are a 4-foot C-band, left; 2-foot Ku-band, center, and a 10-foot C-band dish.) That's a plus in favor of four to six foot dishes.

Another advantage is the price:

* Publisher, CSD magazine

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If you are into electronics, operating or working for an electronics sales or service center, and are interested in learning more about the business opportunities offered by the rapidly growing TVRO industry, Bob Cooper has a special data-packet for you. And it is free of charge! Simply send your name and address, preferably on a company letterhead or with a company business-card attached to: TVRO Starter Kit, P.O. Box 100858, Ft. Lauderdale, FL 33310 and ask for your kit.

You will be sent a complete packet of current information on the TVRO dealer world, including valuable reprinted articles from CSD magazine outlining the start-up problems associated with becoming a TVRO dealer in the 1985 TVRO industry. There is no obligation, of course.

A popular dealer-net price on a well known 6-footer is under $250, including the mount. That's a hard number to argue with when 8 to 10 foot dishes are twice as much (or more) in the dealer-distribution line.

At least two East Coast firms have made a science of 4 to 5 footers and their experience to date is instructive. Personal Dish, Inc. has created a series of 4- and 5-foot dishes with special side-of-building and roof-top mounts intended for the often over-built northeastern corridor.

Their concept is that people who live in townhouses, condos, and apartments should not be shut off from satellite-TV service just because they don't have a suitable backyard in which to "plant" a 10-foot dish. But that's not all; they have another marketing direction as well: Personal-Dish-fed mini-cable systems.

A look at the system

By placing a single antenna on a fixed mount, anchored on just a single satellite such as Galaxy 1, customers can be provided with between 10 and 12 satellite-delivered channels. The dish feeds a *B*lock *D*own *C*onverter (BDC), which outputs a wide spectrum of signals in the UHF range.

Those UHF-range signals, all from a single satellite, are then amplified and cable-fed to individual apartments from the master dish antenna. It's cable-TV with a satellite twist. With proper planning and proper equipment, you can serve 2 or 200 individual outlets in that way. Each home has independent access to all the signals on one satellite through one or two cables from the PD.

People can subscribe or simply pay into a cost-sharing "kitty." In that way individual homes have access to the same programming that regular cable-TV customers have, when and where regular cable is not available, typically for under $600 per home. Not a bad trade. But is it really satellite TV? Think again.

Until recently, you couldn't be a satellite TV person unless you were equipped with the latest dish, LNA, receiver, and motor drive. That's fine; there has been a market of at least 500,000 such people to date and more undoubtedly will be found with the same instincts. But there is another market developing as well.

That market is made up of people who live where cable-TV has not reached, but would like the finer things that the premium programming of cable offers. In fact, that market may turn out to be far more significant and lasting than the present TVRO market. That's because you are selling entertainment, not technology, and we all know that technology is always a hard sell.

Blair A. Gilbert, of StarTrak Satellite Systems (GBS, Lamplighter Plaza, PO Box 349, Kulpsville, PA 19443), thinks it's the trend of the future. Operating out of a suburb of Philadelphia, he put 50 of his 4-foot terminals on trial this past summer. It was a marketing test to determine how many people would be willing to pay $30 per month for a dozen or so channels from a single satellite.

He found out that more than 80% of the homes—after being exposed to his *GBS* system—kept it. Many paid him $1495 for the installation after the trial. The balance went on a 48-month credit program he had arranged.

Gilbert didn't mess up his marketing by selling satellite-TV. His literature and sales presentation barely mentioned satellite-TV. What he sold was entertainment: 12 channels of it, with a small 4-foot dish for $30 a month. Since he completed his test, he has launched a national distribution network for his dish package, his electronics, and his marketing expertise.

Gilbert got his original idea by watching the growing pains of USCI, the 12-GHz DBS firm that launched the mini system with great fanfare (followed by financial chaos) just over a year ago. He saw that people were interested in the USCI 5-channel package, but he also saw that USCI was making, in his judgment, errors in "pitching" their home systems.

For one thing, he found that USCI was pushing too hard on the satellite-delivery part of the package. He felt that if you're limiting your customers to something less than the 100 "sky-channels" of true TVRO service, you shouldn't make a big thing of the satellite-connection.

The "plain vanilla" truth is that smaller dishes are with us, although their sales success has been spotty to date. The equipment suppliers selling those compromise antenna-systems have made the same mistake that USCI apparently made. They are trying to pretend that you can do the same thing with a 4- or 6-foot antenna that you can do with a 10-foot antenna. Gilbert has proven, and Personal Dish, Inc. is proving, that if you concentrate on the product and soft-sell the vehicle, you can be a very, very busy businessman.

Businesspeople exposed to Gilbert and PD, Inc. are wising up. They've realized that really small antennas won't perform all over the USA—in south Florida, for example, a 6 footer is still not enough even on the hotter satellites. But they will work adequately (if not flawlessly) over more than 85% of the continental 48 states. And you can sell them if you don't try to represent them for being something they are not.

There is a trend here; perhaps an entirely new marketplace that's driven not by technology, but purely by the entertainment value of a dozen channels or so. As Peter Sutro of Personal Dish notes, "We tried to sell the 5- and 6-foot antennas as *junior* TVRO's and that was a mistake. People invariably would look at the performance and channels available on a fully motorized 6-footer and compare that to our standard 10-footers.

"The 6-foot system was not a fair match for the 10-footers. We sold very few 6-foot units that way. And even as loss leaders for advertising, we created a certain amount of buyer resentment and resistance. That's when we decided to take away the motor drive and offer the 6-foot package only as a dedicated system intended for sharing between two or more residences. When we did, we discovered an entirely new market."

So, are smaller dishes just toys? Not if you recognize that they are not TVRO system pieces, but rather that they have a market identity all their own. **R-E**

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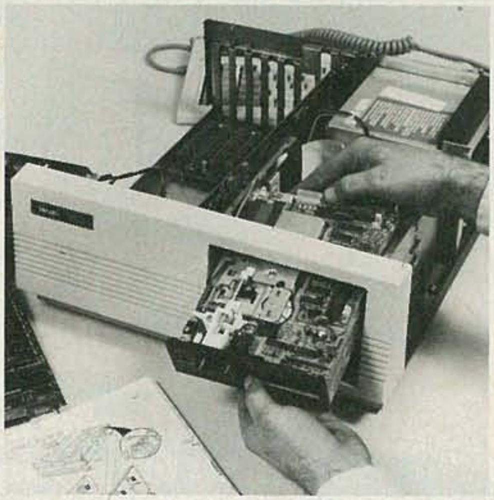

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LETTERS

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BANDWIDTH ACCURACY

I take exception to the text in the October 1984 article, "Satellite Stereo Demodulator," by Roger Cota and Lloyd Addington. The authors unfortunately have confused baseband modulating frequencies with broadband uplink/downlink bandwidths.

Their contention that the "effective bandwidth of a satellite transponder is about 10 MHz" is in error. To be accurate, the effective bandwidth of the modulated carrier is 36 MHz, which is centered in the satellite's transponder bandwidth of 40 MHz.

The 36-MHz bandwidth is comprised of at least three composite elements:

1. The peak video deviation of a 4.2-MHz baseband video signal that modulates the carrier ranging from 8.46 MHz to 13.8 MHz, (depending on the up-linking operator and the number of audio subcarriers and their modulation index.)

2. The peak deviation of the energy dispersal waveform, which is usually 1 MHz.

3. The peak deviation of the carrier by any audio subcarrier.

A mathematical manipulation of all those peak deviations must fit Carson's rule where the bandwidth, in this case 36 MHz, will be two times the sum of the composite deviation of the carrier and the instantaneous modulating frequency.

The deviation of the carrier has nothing to do with a baseband adaptation of the NTSC 6 MHz TV-channel bandwidth (which is derived from the FCC's in-channel bandwidth for VHF television stations) and the placement of the audio subcarriers in the spectrum of 6-10 MHz.

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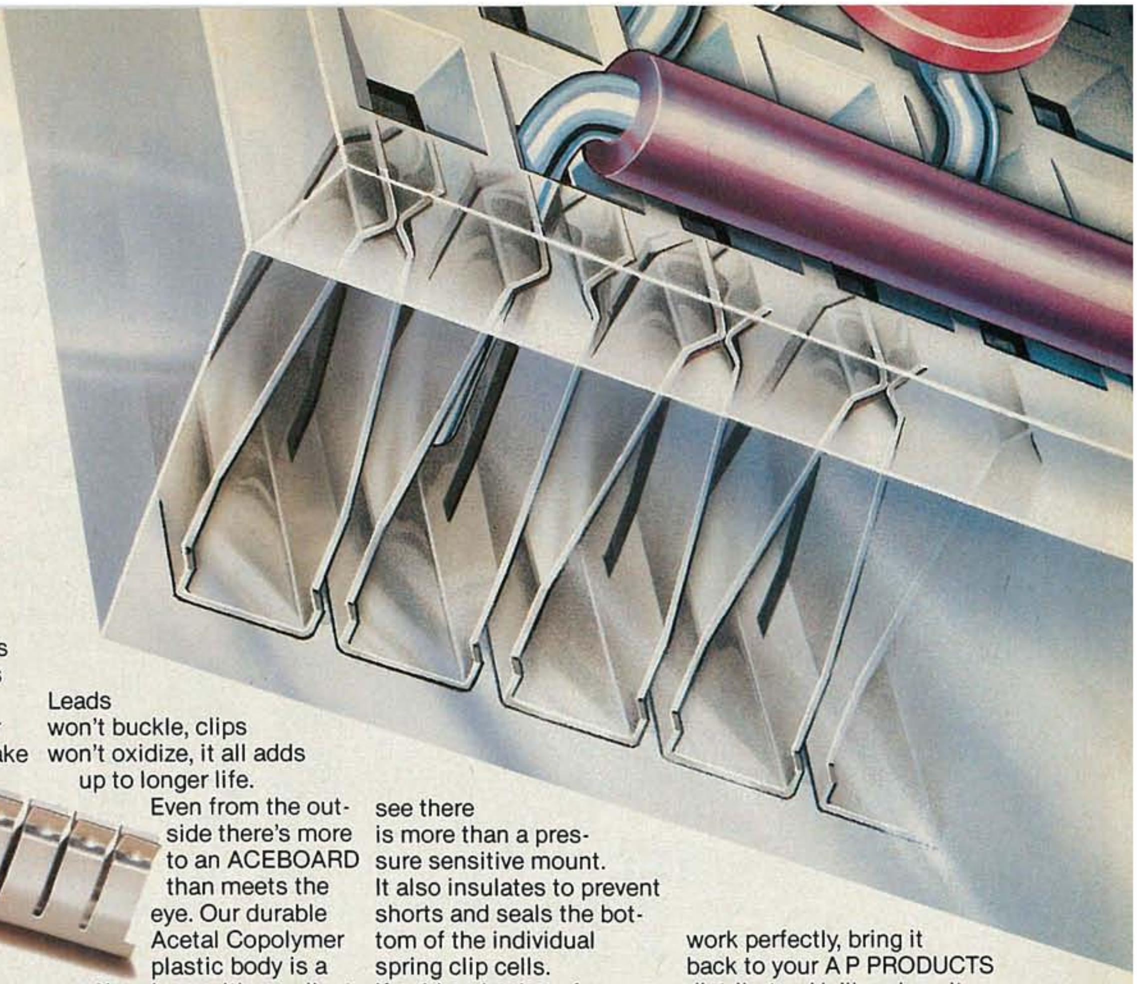

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Since one bad connection can ruin a whole circuit, we pay close attention to how well our spring clip terminals sit within the insulator cell areas. Spring clip edges are never exposed at the insertion window. Leads won't buckle, clips won't oxidize, it all adds up to longer life.

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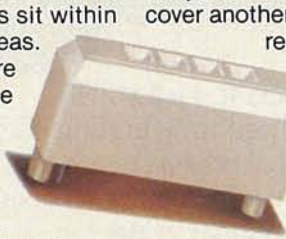

Turn our breadboard body over...and you'll discover another key to it's reliability. The double-sided adhesive foam you'll see there is more than a pressure sensitive mount. It also insulates to prevent shorts and seals the bottom of the individual spring clip cells. If solder shavings from resistors or component leads drop into the cell, they can't spread into other cells to short them out.

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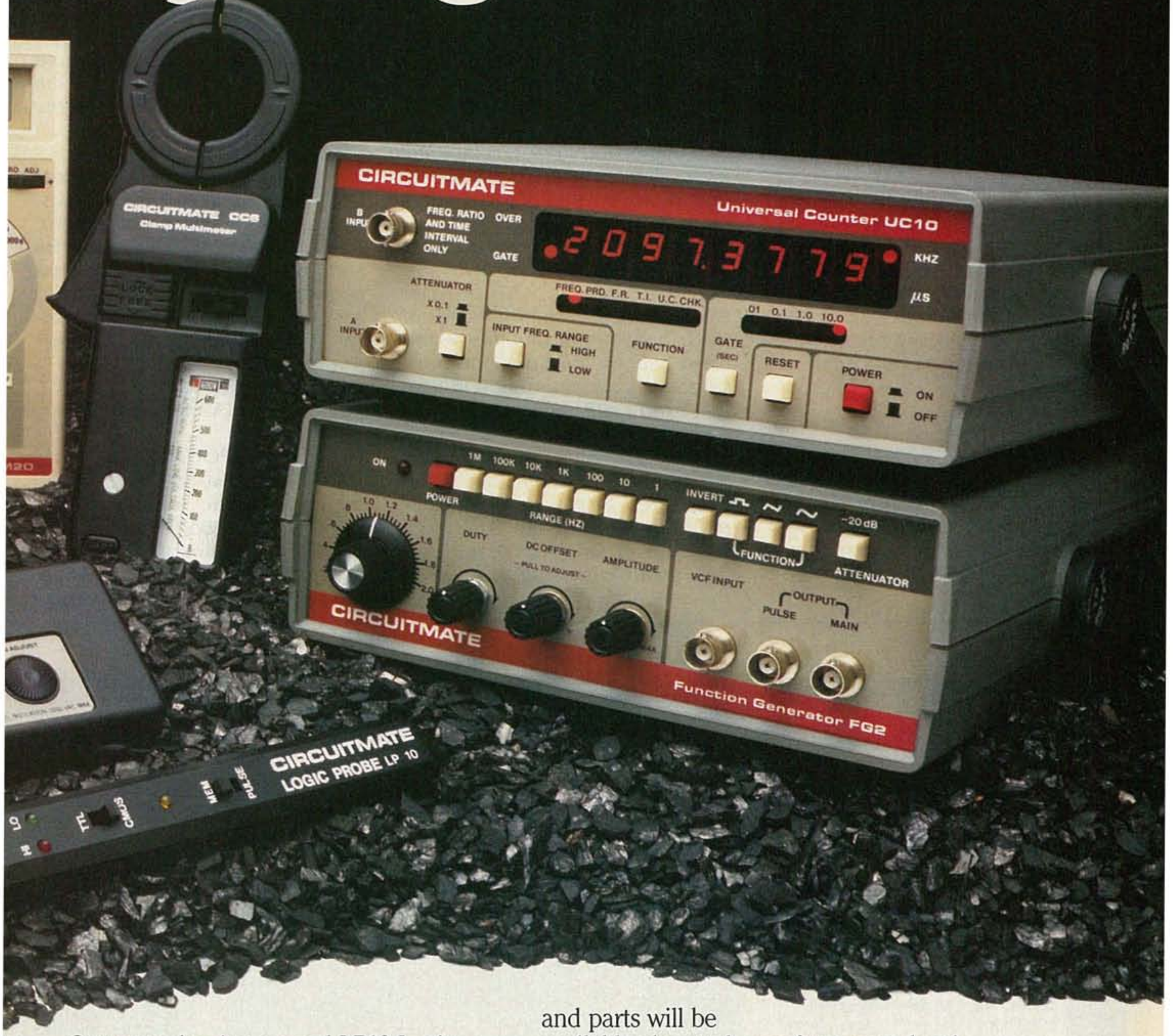

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LETTERS

continued from page 22

In addition, the R7-C14 (R23-C27) combination used for de-emphasis has a time constant of 100 μs—that is not widely used. To accommodate the more widely used 75 μs pre-emphasis curve, R7 (and R23) should be changed to 7500 ohms.

Also, the R10-R9 (R26-R25) resistors for IC5-c (IC5-d) will give that non-inverting amplifier a gain of 7.7, not 6.6.

Finally, demodulating in the matrix mode will produce audio levels twice as high as in the discrete mode according to the circuit diagram.

TOM BENTSEN
Upper Montclair, NJ

We did not mean to mislead readers on the technology of modulating satellite transponders. Apparently the letter writer has some confusion about the word "effective".

For the letter writer to assert "to be accurate the effective bandwidth of the modulated carrier is 36 MHz," demonstrates a fundamental misunderstanding of how FM modulation is molded mathematically and the intent of Carson's rule.

To be even more accurate, performing the derivation of the spectrum bandwidth for FM is typically a very difficult task. Strictly speaking, the bandwidth of a frequency modulated signal is infinite. Since frequency modulation of a carrier results in the generation of an infinite number of sidebands. However, at the extreme edges of the bandwidth, the amplitude and consequently the power of those sidebands become negligible so that bandwidth can be defined by considering only those sideband signals that contain significant power. The acceptable power ratio is dictated by the particular application of the system. Accepting some distortion in satellite transmission and throwing away 2% of the bandwidth power then:

$$BW \approx 2(\text{DEVIATION RATIO} + 1) \times (\text{MAXIMUM MODULATING FREQUENCY.})$$

That expression for bandwidth is generally referred to as Carson's rule. But that is not fully descriptive of what is happening. A more accurate derivation involves the tabulated Bessel functions and the Fourier series:

$$e^{jB\sin\omega mt}$$

The purpose of the article was not to get hung up on semantics, but to present a fun and useful kit. I am glad that all this bandwidth stuff works out, however, for it has allowed me to enjoy stereo movies for over a year. As for other matters, we apologize for the misprints.

DR. ROGER COTA,
Video Control Vancouver, WA

APOLOGY

I feel that I owe Mr. Grossblatt an apology; I tender it herewith.

In his June, 1984, article on the CD4018 sinewave generator he stated that "We are not using the Q_5 output of the 4018 because it's a quick and dirty way to make the waveform conform more closely to a sinewave." On the basis of symmetry considerations I jumped to the conclusion that the circuit would not work with that output. (See "Letters," Nov. 84.) I was wrong. It will function better with than without it.

Fourier waveform analysis reveals that even harmonics are absent from both waveforms; odd harmonics (particularly the third) are higher for the flat-topped waveform, which will make it unsuitable for many applications.

This application of his "common sense" approach reminds me of a proverb: Nothing is obvious unless you have seen it before. I wonder if he has seen this before? I have, so I have no excuse; I just allowed myself to be carried away in the heat of the moment.

L.D. SMITHEY
Pacific Palisades, CA

MORE ON ANTENNAS

The "Communications Corner" column on phased VHF vertical antenna arrays (**Radio-Electronics**, October, 1984) was a good article, except for a couple of items that should be added.

The antennas are going to have definite driving point impedances, which will include mutual impedance, that can be calculated from knowledge of the antenna's length and spacing. Those driving point impedances will then be *transformed* to different values at the other end of the phasing lines (lines other than one wavelength long), that can easily be determined from a Smith chart. The transmitter will then see the parallel combination of those two transformed impedances, and that number will most likely be a mismatch to the standard 50-ohm resistive termination.

Varying the length of the phasing lines and/or the antennas slightly can help in neutralizing the reactive components, and thus bring the VSWR down; also keep in mind that if the feed-point impedances of the lines are different, the antenna currents will be different, and the radiation pattern will be affected. An excellent introductory book on such things is the *ARRL Antenna Book*.

MARTIN E. GASPAR
Salt Lake City, UT

APPLAUSE

I'm not much for writing—but after saying amen to many reader's letters asking you not to become a computer magazine, now I'm applauding your construction articles on the Timex/Sinclair *1000*.

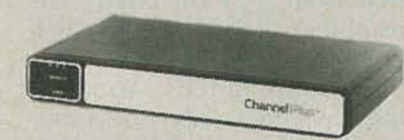
I own a number of computers, but would not attempt to modify most of those. An exception to that is the *1000*. Thanks to your articles on using that computer as a controller (**Radio-Electronics**, July, August, and September 1984), I am making the *1000* into a dedicated controller for my solar heating system, and learning a lot about how computers work in the process. So, keep providing your readers with good construction articles of all types.

O.R. HERMAN
Williamsport, PA **R-E**

EQUIPMENT REPORTS

Multiplex Technology ChannelPlus Video Multiplexer

Here's a video "switcher" that's not a switcher!



CIRCLE 5 ON FREE INFORMATION CARD

AS YOU ADD MORE VIDEO-ENTERTAINment equipment to your TV, the need for some type of switcher grows. That usually means more knobs to turn, more required set-up time, and more intimidation for the "electronic-shy" in your family. But that doesn't *have* to be true, thanks to *ChannelPlus* from Multiplex technology (251 Imperial Highway, Fullerton, CA 92635).

ChannelPlus works to give your home-video sources their own UHF TV channels. It accepts your video and audio inputs and it outputs an RF signal. Three sets of inputs and outputs are available. And although it come preset to certain channels, you can select other UHF channels for your output. (Those between Channels 20 and 40 give the best results.)

Using *ChannelPlus*

Let's look at how you would use *ChannelPlus* to connect your VCR,

continued on page 32

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EQUIPMENT REPORTS

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videodisc player, and your home computer to your TV. The first thing to do is to hook your present TV antenna to *ChannelPlus*. It's antenna output can then be fed to your TV—or to a splitter if you have more than one TV. (We'll see where that can come in very handy.) You can even daisy-chain the antenna output to the antenna input of another *ChannelPlus* if you want to expand your system at a later time.

Once you have your antenna connections made, you can hook up your video sources. The video and audio outputs of your VCR, videodisc player, and computer would go to the video and audio inputs on *ChannelPlus*. When everything's turned on, the antenna output that is fed to your TV will contain three signals that it previously didn't—the UHF TV signals that are modulated with your video and audio inputs.

Advantages of *ChannelPlus*

The main advantage of *ChannelPlus* is that once you set it up, you never really have to worry about it. That can be seen by the front panel—it has no controls (except those under a decorative cover). There are 4 LED's however. One indicates that power is supplied. (There is no power switch—the unit is always left plugged in.) The other 3 indicate that an acceptable video signal is being input to the device.

ChannelPlus is attractive but, since you never have to touch it, you can position it somewhere out of sight. As long as you remember, for example, that your VCR is on channel 25 and your personal computer is on Channel 35, all you have to do is turn to one of those channels to watch the appropriate source. And you can even use your remote control to tune it in.

If you have several TV's presently wired to the same antenna, you'll be able to use *ChannelPlus* to watch different video sources throughout the house. For example, even if all your video equipment is in one central location, the VCR could be watched on one TV, while a videodisc is watched on another. Using that feature another way, you could watch a single source on all the TV's in the system at the same time.

That would come in very handy for a home-security system that uses several video cameras. You could assign, for example, the cameras in the nursery, and at the swimming pool to different channels. And you could watch those cameras simply by turning to the appropriate channel *on any TV in the house*.

You might wonder why you would want to use *ChannelPlus* with your VCR—after all, the VCR has an output on Channel 3. Unfortunately, there is a very good reason: As a cost-cutting measure, the RF modulators used in many VCR's—even some of the most expensive—are not of the best quality. So bypassing the VCR's own modulator and using one in

continued on page 36

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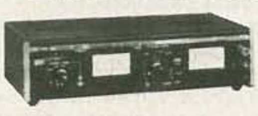

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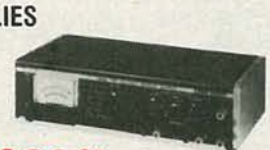

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- Functions as three separate supplies
- Exclusive tracking circuit
- Fixed output 5VDC, 5A
- Two 0 to 25VDC outputs at 0.5A
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EQUIPMENT REPORTS

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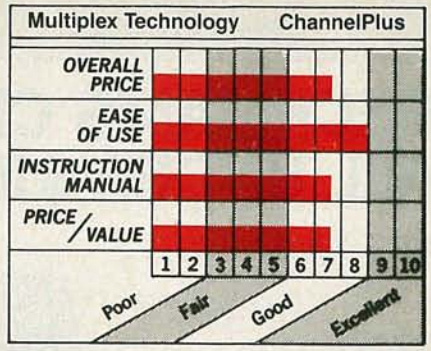
ChannelPlus can result in a sharper picture.

ChannelPlus is well constructed, well shielded, and does everything it claims. The isolation between video inputs is greater than 70dB, and its maximum power consumption is only 7 watts. Our only objections are minor. For example, no cables are supplied with the unit.

The manual serves its intended interest well—it tells you how to set up the unit. But it did have some shortcomings. For example, there is no power switch on the *ChannelPlus*. But there is no mention of leaving the unit on all the time.

If you are a cable-TV subscriber, you can still use *ChannelPlus*, but you'll have to order the "CR" or cable-ready model. You can still output signals on UHF, but you can also output signals on cable channels 57–64.



There are several models of *ChannelPlus* available. The two main types are the "V" series and the "R" series, which accept composite-video (and audio) signals and RF (Channel 3 or 4) signals respectively. In each type, models with one, two, or three sets of inputs and outputs are available. We examined the model *H3V*, which accepted 3 video and audio inputs. That model is priced at $269.95. The one- and two-input models are priced at 129.95 and 199.95 respectively. The one- two- and three-channel RF-input models are priced from about $160 to $360. For cable-ready models, you must add $10 per output.

If you have only one TV and just need a way to switch between video sources, then *ChannelPlus* may be more than you need. But if you have several TV's tied into the same system, *ChannelPlus* becomes a worthwhile addition. **R-E**

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continued on page 42

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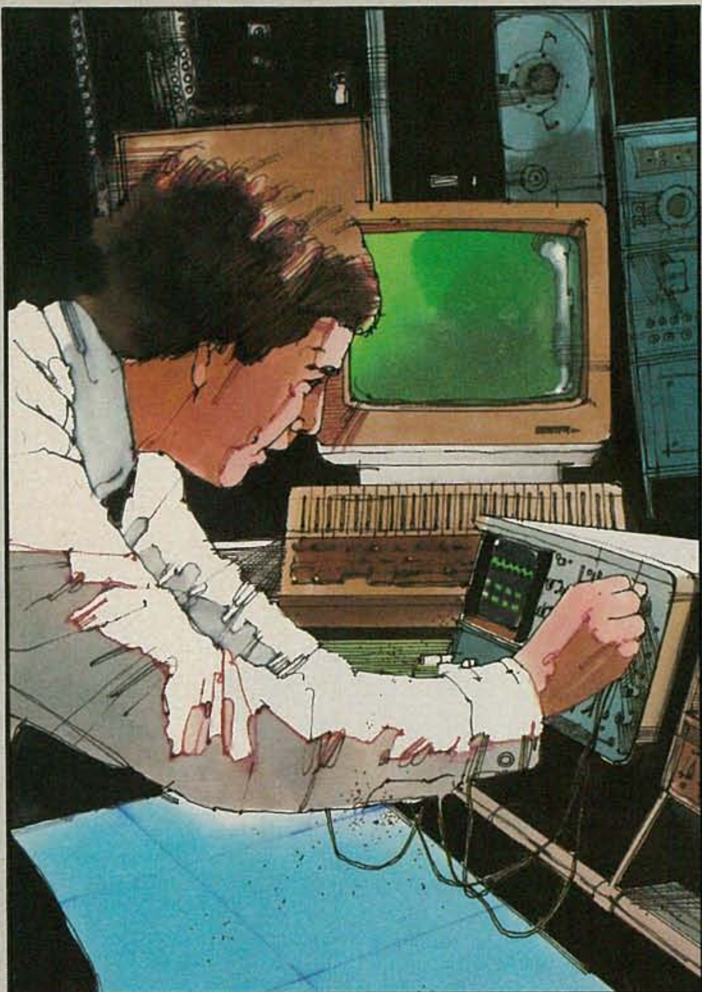

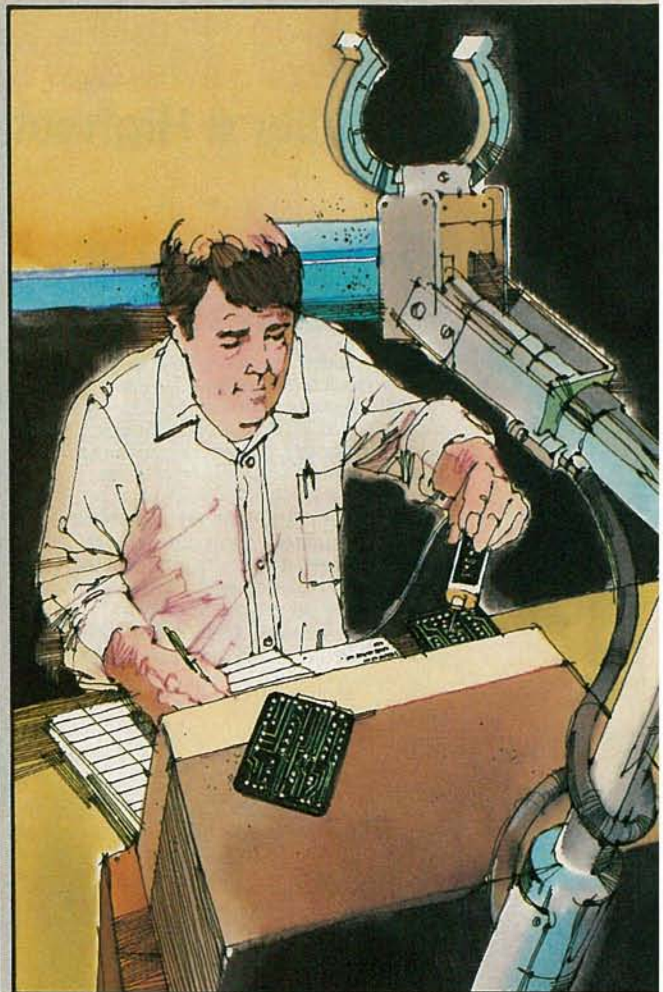

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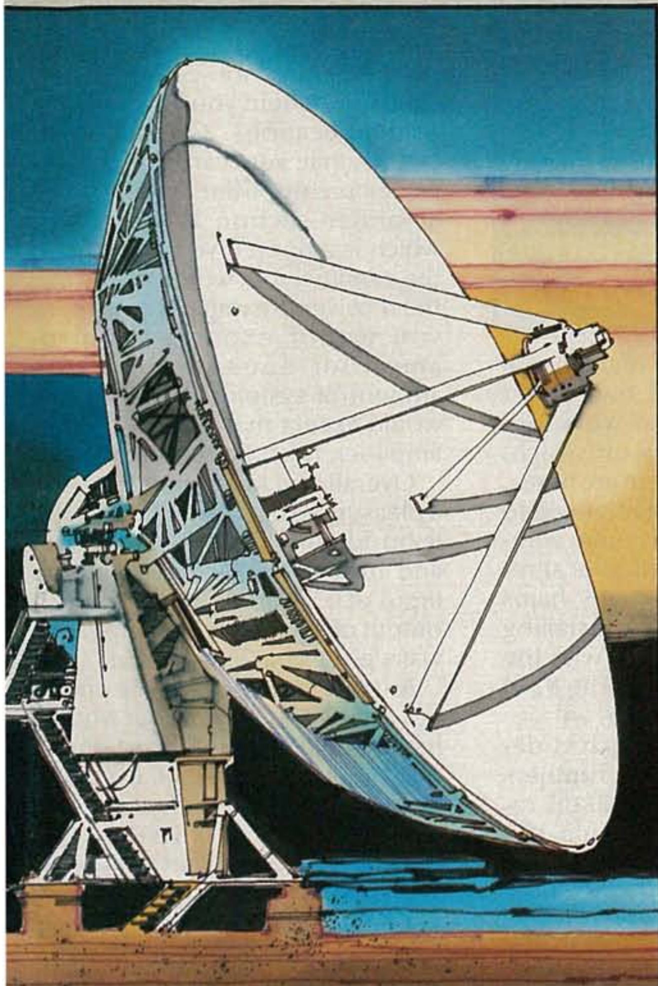

EQUIPMENT REPORTS

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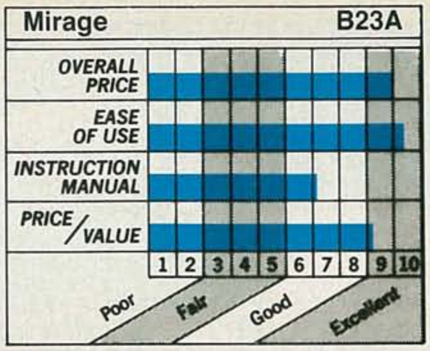
pecially if you use a handheld radio for mobile VHF work—is a small radio frequency (RF) amplifier. If you rely on the handheld for reliable communications through a local repeater, an amplifier can become especially important as you move out of your prime coverage area.

We recently came across an amplifier that is simple to use, reliable, and one which effectively turns a simple two-watt handheld radio transceiver into a high-output 30-watt mobile amateur transceiver: the *B23A* from Mirage Communications (PO Box 1000, Morgan Hill, CA. 95037). The *B23A* is a multimode VHF amplifier that can provide you with up to 30 watts of output for both single sideband and FM communications.

The *B23A* ($89.95 suggested retail) is an updated version of a 4-year-old offering. Originally, the Mirage *B23* was designed to sit in



series with the output of the handheld or low-powered transceiver and was designed to work full time—there was no on-off switch. It worked well, but there are times, of course, when you don't need to output 30 watts (when you're within a couple of miles of a local repeater, for example). Many hams solved that problem by installing an on-off switch in series with the hot lead from the battery. The *B23A* includes an on-off switch.

The new package, which is designed to look like its big brothers in the line, also adds a 10-dB receiver preamplifier to help the mobile operator "dig out the weak ones." The preamplifier does work well and helps turn many situations that are non-copyable into situations where you have reliable communications. One nice feature is that you can use the receiver preamplifier whether the amplifier section is on or off, which is a boon if you don't need the amplifier, but would like to use the receiver preamp. Of course, as you would expect, the preamplifier does increase the amount of system noise, but you would expect that with a VHF preamplifier. It isn't a problem at all.

Overall, the KLM-Mirage *B23A* is a pleasure to use. You simply hook it up to your car's 12-volt system and turn it on. With a minmum input of 0.5 watt of RF, you find an output of 5 to 7 watts. An input of 2 watts gives you 28 watts out.

As you would expect, the amplifier can get rather hot. But Mirage has included a more-than-ample heat sink to radiate that excess heat away. Over-temperature protection, as well as VSWR protec-

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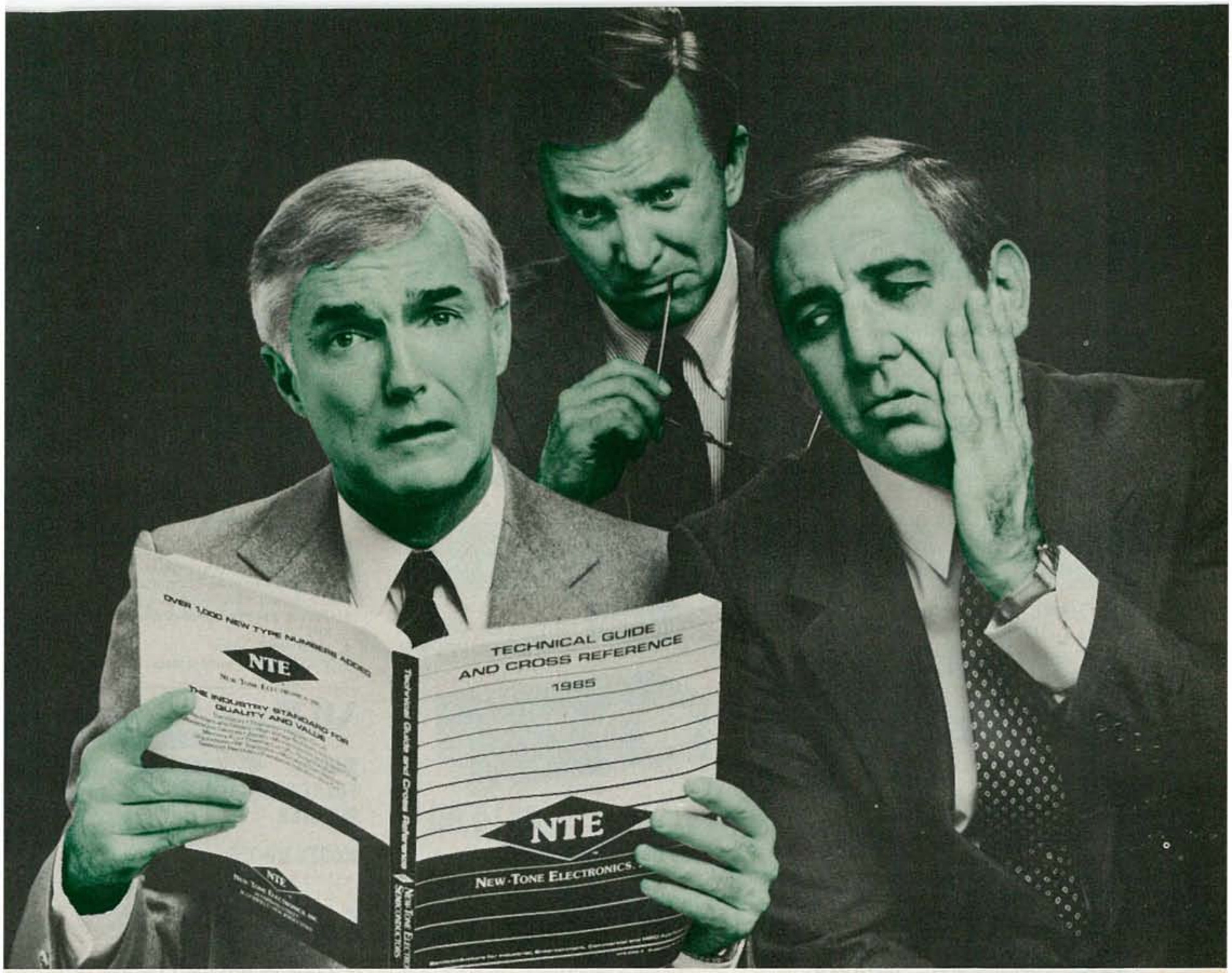

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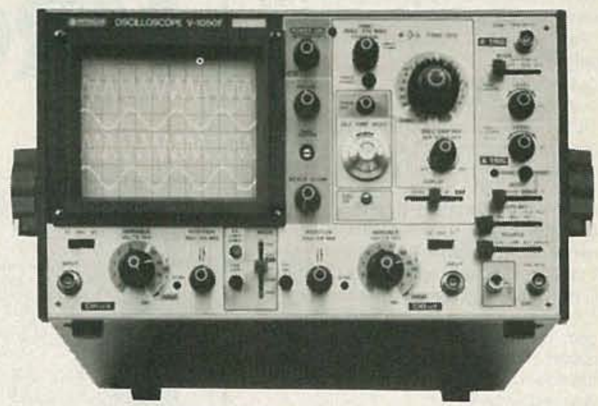
Model V-212 shown



Model V-1050F shown

MODEL V-212 **$461.00**
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Features 6" Rectangular CRT
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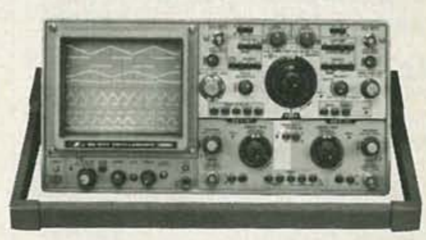
- Beam finder
- Delayed sweep
- Alternate time base
- 2 ea. X1/X10 Probes



MODEL 5711 **$1695.00**
DC to 100MHz (typically over 120 MHz), 5 mV/div, True 4 channel input, eight trace, Delayed sweep, alternate time base, CRT acceleration voltage 20 KV, (w/saddle bag, front cover, 2 ea. X10 probes).

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(5711 with counter and DMM).

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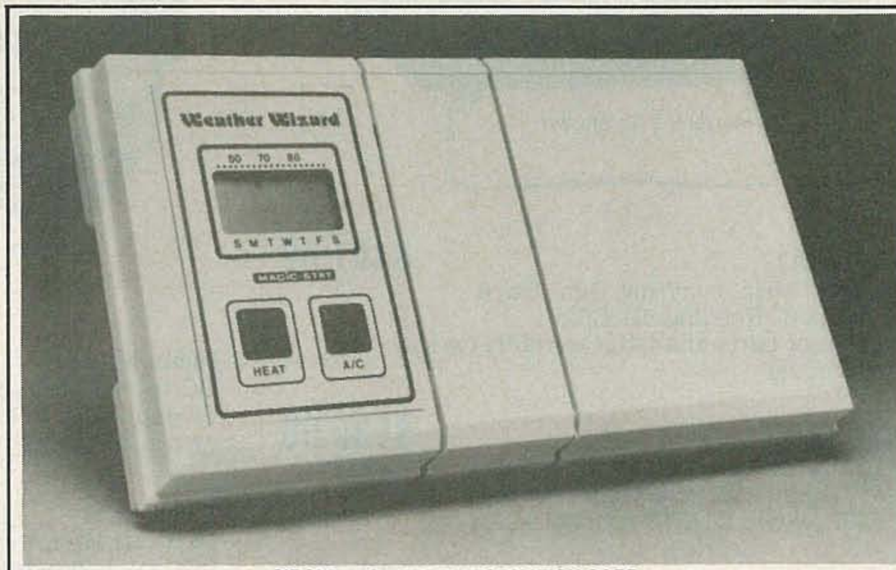

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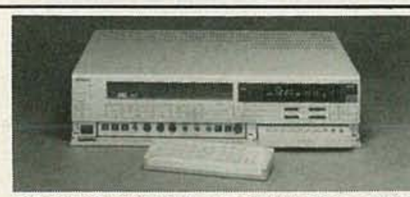
THERMOSTAT, the *Weather Wizard,* can be programmed for the entire year in five to ten minutes (and can be reprogrammed at any time, in one sitting). The user can program in his or her lap, or at a table, before installing the thermostat on the wall.

Both heating and cooling temperatures can be programmed simultaneously. The unit retains both heating and air-conditioning settings in its electronic memory, so that the desired room temperature can be maintained without needing to reprogram the thermostat when the weather changes.

Users may have different programs for each day of the week, and up to six heating/cooling settings per day. There is also a vacation-setting feature that holds an economical temperature while the user is away, and allows him or her to specify the temperature desired upon return.

The *Weather Wizard* is priced at $99.95.—**Quad Six, Inc.** 3753 Plaza Drive, Ann Arbor, MI 48104.

VIDEO CASSETTE RECORDER, model *AVS-6200,* offers hi-fi stereo and three playback speeds: SP, LP, and EP. It incorporates such video features as a signal-to-noise ratio of >45dB and horizontal resolution at 240 lines, with audio features that include audio-frequency modulation—permitting distortion-free wide dynamic range—and Dolby B noise reduction.



CIRCLE 12 ON FREE INFORMATION CARD

The model *AVS-6200* has remote control, and provides easy-to-use record-playback functions on the

VHS format. It comes with double-gap integrated 4-head configuration; noise-free field-still frame advance and slow-motion playback, and dynamic aperture control for picture clarity. It also provides stereo-simulcast recording capability, and two separate stereo outputs.

The model *AVS-6200* is priced at $1,399.00.—**International Jensen,** 4136 N. United Parkway, Schiller Park, IL 60176.

INTERFACE DEVELOPMENT SYSTEM, the *eZ System,* is a hardware-development system that provides an easy solution to the designer, test engineer, student, or experimenter who needs quick access to a personal computer's bus-expansion slot for rapid circuit development. The system features three major components:

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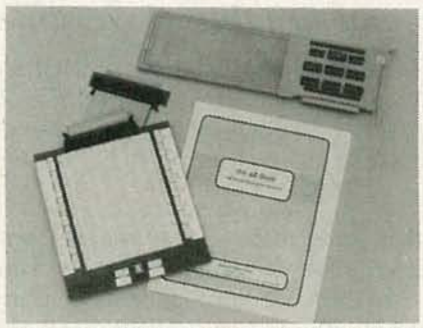

CIRCLE 13 ON FREE INFORMATION CARD

(2) The *eZ Card* is a prototyping board for the IBM *PC/xT* that features a fully buffered address, data, and control bus. All buffered signals are conveniently accessible for use in the large prototyping area, which consists of over 2,300 holes on a 0.1" × 0.1" grid and can accommodate over 60 sixteen-pin DIP sockets for wire-wrapping. Circuits developed and debugged on the *eZ Board* can be permanently transferred to the *eZ Card.*

(3) The *eZ Book* features technical information on the computer system and contains several practical and useful project circuits, such as A/D conversion, parallel port, joystick interface, etc.

The *eZ System* is available direct from the manufacturer at $225.00 plus $10 S&H. Delivery is from stock.—**Sabadia Export Corporation,** 3920 Coronado Street, Suite 206, Anaheim, CA 92807.

AC/DC CURRENT CLAMP, model *CT233,* is designed for applications requiring DC- or AC-current measurement without breaking wires or electrical connections to divert the current through the meter. A Hall-effect device measures magnetic flux, which is converted to a current measurement by the circuitry in the clamp.

The model *CT233* may be used with most DMM's, or an oscilloscope may be susbstituted, allowing the user to see the signal. Maximum current capacity is 600 amps AC, DC, or AC on DC. Also, the AC frequency response extends to 400 Hz; that is useful for aircraft-maintenance operations.

CIRCLE 14 ON FREE INFORMATION CARD

A flashing battery indicator and a three-position power and range switch are also featured. When the power is on, the battery indicator blinks; no blinking means that a change of batteries is needed. The power and range switch turns on the unit, selecting 0-200 amp or 0-600 amp operation.

The model *CT233* is priced at $150.00.—**Beckman Industrial Corporation,** 630 Puente Street, Brea, CA 92621. **R-E**

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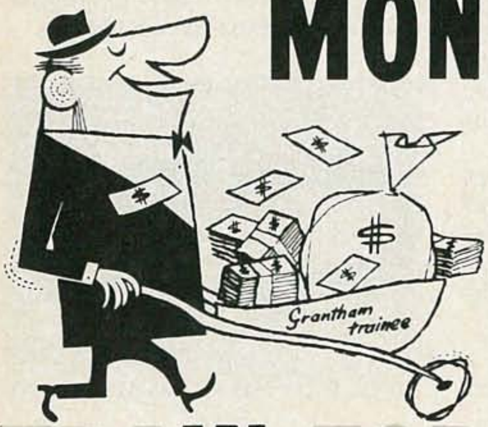

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Computer-Controlled ROBOT ARM

You can experiment with computer-controlled robotics without a lot of cash and without most of the mechanical headaches that usually accompany robot construction.

JIMMY BANAS

ROBOTS NO LONGER EXIST ONLY IN SCIence fiction—they're quickly becoming a part of everyday life. Robots are being used to manufacture cars, assemble electronic circuits, and even to build other robots! They are also helping to eliminate the need for humans to do tasks in dangerous chemical or radioactive environments.

Robots like the ones we mentioned above usually cost thousands of dollars. But you don't have to spend that much if you want to get started experimenting with robots. And you can avoid a lot of the headaches with mechanical construction that robots usually bring to mind.

We'll show you how to add computer control to a commercial toy robot-arm—the *Armatron*. There's a big advantage to not building the robot from scratch: You can avoid the problems of getting parts, and many of the mechanical

problems that usually accompany robot construction and experimenting. That's not to say there's no mechanical work involved—you will have to modify the *Armatron*. But the work is nothing like what you'd have to do to build a robot from scratch.

What is a robot?

Even though humans have dreamed about robots for centuries, the word "robot" is a relatively new one. It was first used in Karel Capek's 1923 play *R. U. R.* (Rossum's Universal Robots) and means "slave worker."

Early attempts at making robots were mechanical endeavors only. The results were basically dolls that looked human but ones that could perform special functions (like writing or playing music) based on a mechanical design of levers and gears.

The advent of the computer and electronic components brought robots the capability to perform much more sophisticated tasks. Some robots can "see" and others can make decisions about their actions. Even so, today's robots—although complicated machines—can perform only relatively simple tasks like pick-and-place operations. It's expected that someday—but not in the very near future—robots will perform much like those made famous in *Star Wars*. Rest assured that we won't be giving our robot that much power. But if you are interested in such endeavors, and make your robot more "intelligent," then we'd like to hear about it.

Robots used in industry are usually defined as programmed manipulators that automatically perform useful work. They can move in different ways; the *anthropomorphic-type* closely simulates the movement of a human through six degrees of freedom—with motions similar to those of the waist, shoulder, elbow, wrist, and fingers. A computer is generally used to command the robot to move to the desired positions.

The *Armatron*

For an investment of about $32, you can be the owner of a robot that is capable of the same maneuvers as industrial robots costing many thousands of dollars. Tomy Toy Company copied the design of industrial robots and built their *Armatron* robot arm. Radio Shack (Tandy) bought the exclusive rights to it. Of course, the *Armatron* robot arm doesn't have the accuracy and repeatability of industrial robots. But we don't think that it's a toy, either.

As purchased, the *Armatron* is controlled by two mechanical joysticks. By pushing the joysticks forward or back and left or right you can rotate the entire arm about its base, raise and lower the arm, bend the elbow, and raise and lower the wrist. By rotating the joysticks you can rotate the wrist and open and close the gripper.

A single motor powers all six joints of the *Armatron* through a cleverly designed planetary gearing system. The joysticks actuate levers that engage gears, giving forward, neutral, and reverse operations for each joint. Despite the clever design, we will remove and discard the joysticks, planetary gearing system, and the motor. We will replace them with six computer-controlled motors that will power the six joints.

The computer/robot system

Figure 1 shows a block diagram of the computer-controlled robot arm. Any computer that has at least a 4-bit output port can be used for control—the author used a Commodore *VIC-20*. Although the programming examples we'll discuss were written for that computer, they can be easily altered to run on other computers.

A 4-to-16 line decoder is used to decode the 4 bits from the computer port into 16 output lines. We need only 12 of the lines—there are six motors, and each needs a forward and a reverse control line. That means that you have 4 lines left over for your own experimentation. How about using those extra lines to control a movable platform?

The twelve outputs of the decoder interface with six motor-controller switches. Figure 2 shows one of those circuits, which are basically transistor switches that turn the motors off or on in either direction.

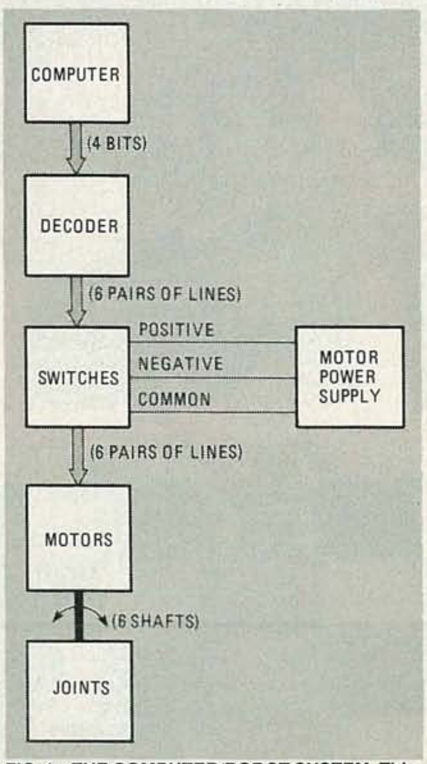


FIG. 1—THE COMPUTER/ROBOT SYSTEM. This block diagram shows us the basic components that make up our computer-controlled robot.

Small DC motors were selected to control the *Armatron* joints because they proved most practical. The motors are inexpensive, small, and don't require large amounts of power. They are also easy to work with. By POKE-ing a number from 1 to 12 to the output port we can drive any of the six joints either forward or reverse. We'll get to the details on that shortly. But now that we have a basic idea of how the system works, let's look at the mechanical interface in detail.

The mechanical interface

The hardest part of converting the *Armatron* into a computer-controlled robot is making the mechanical modifications. But as long as you're careful, you really shouldn't have any problems. The first thing we'll do is remove the existing joystick mechanism, the planetary gearing system, and the motor drive so that our motors can control the arm.

To start, remove the seven screws from the bottom of the *Armatron* and carefully separate the arm and top cover from the bottom tray. Figure 3 shows what you should see. Discard all components on the gear cover except the ring gears, which interface to the arm.

When you remove the gear cover (it's held on by five screws), you will expose the motor, the joystick parts, and the gears that interface with the ring gears. Remove the three screws that hold on the joystick cover. At this point, you can discard the joystick cover and all the joystick components. But do not throw any of the gears away. Next clip the wires at the ends of the battery holder. After you've done that, you should be left with the base and the the planetary gears as shown in Figs. 4 and 5.

The bearing blocks

After all unnecessary parts have been removed, you have to make preparations to interface control motors to the *Armatron* gears. The motors will be mounted outside of the *Armatron* case, so shafts have to be brought out from the gears to the motors. Those shafts are supported by two bearing blocks.

Each bearing block has three holes drilled through it to support three shafts. Each bearing block also has three vertical slots that hold gears that engage with *Armatron* gears.

A bearing block, along with its associated shafts and gears, is shown in Fig. 6 prior to installation in the *Armatron*. Figure 7 shows the dimensions of the bearing blocks. The author arrived at the design by trial and error; the dimensions are fairly critical and should be followed closely.

The bearing blocks can be made from a variety of materials. The author's were made from maple wood. But you can use any material that's easy to drill and cut and yet hard enough for accurate dimensioning. Wood is probably the least ex-

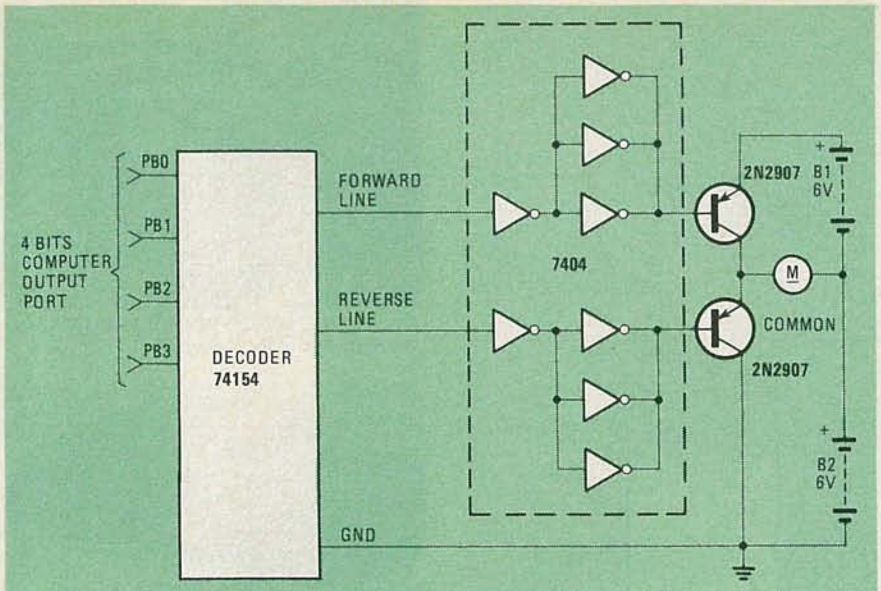


FIG. 2—MOTOR-CONTROLLER CIRCUIT. To control all of the *Armatron*'s joints, you will need six motors. Even so, you will still have 4 unused outputs from the 74154 decoder.

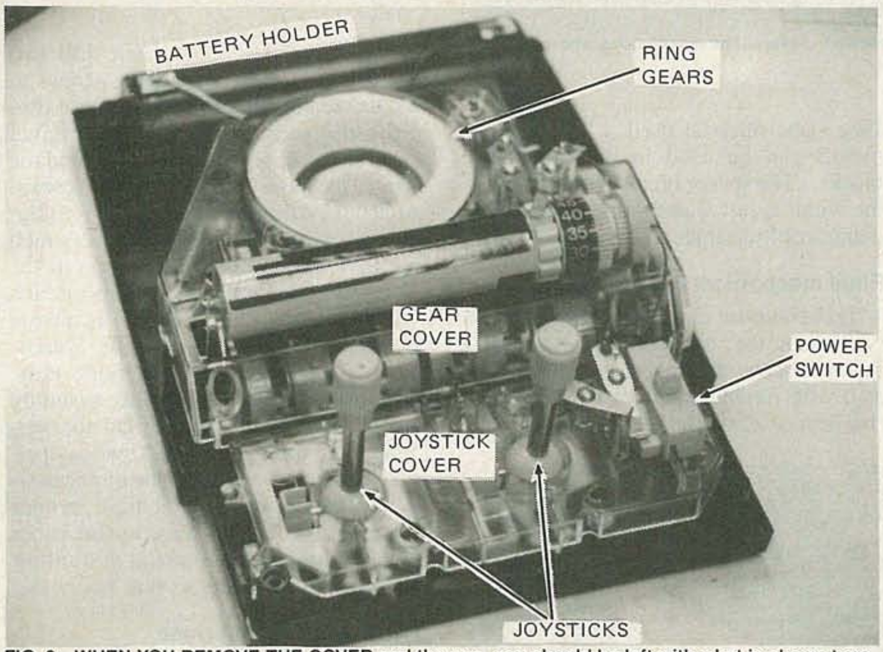


FIG. 3—WHEN YOU REMOVE THE COVER and the arm, you should be left with what is shown here.

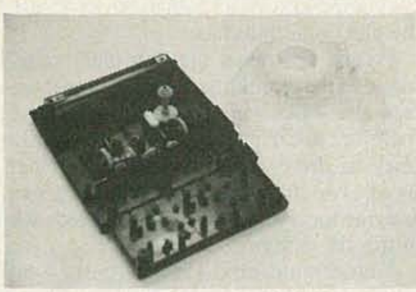


FIG. 4—THE BASE AND GEAR COVER are what are left when the mechanical joystick components are removed.

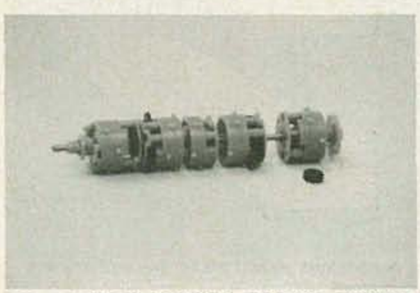


FIG. 5—THE PLANETARY GEARING SYSTEM. Don't throw this out! You'll need six ⅜-inch gears from the system.

pensive way to go. For example, the author purchased a 2 × 2 × 24-inch piece of raw stock maple for about $3 at his local lumber store. A table saw was used to cut the slots; a #29 drill bit was used to drill the holes for the shafts.

Shafts and Gears

Six shafts are needed to transfer power from the motors to the gears. Those shafts must connect with the short motor shaft and must fit tightly through the gear that will interface to an arm gear. After much experimentation it was found that plastic rods, found at a local hobby store, made the best shafts. One of the key advantages of plastic rods is that they can bend slightly without breaking. That means that, even if everything is not in precise alignment, they will still work and they won't bind. The rods, with nominal outside diameter of ⅛ inch, have a hole down the middle that allows them to be easily press-fit onto the motor shafts. The lengths of the shafts, as shown in Fig. 8, are determined by the arrangement of the motors next to the *Armatron*. You may want to make yours longer or shorter. For clean cuts on the plastic shafts, use a small tubing cutter.

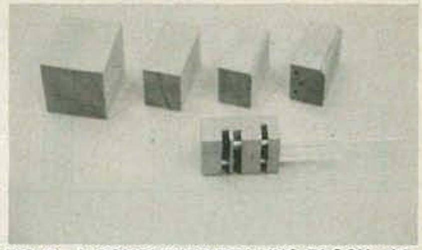


FIG. 6—A COMPLETED BEARING BLOCK with shafts and gears is shown in the foreground. The background shows the progression of fabrication steps.

The gears that fit on the shafts and interface with the *Armatron* gears are were obtained from the planetary gearing system that you removed earlier (Fig. 5). The ability to use these gears is an advantage because they are already sized to mesh with the other gears. The ⅜-inch diameter gears must be removed from the planetary gearing system. You will have to modify the gears slightly by redrilling the center hole to a size just under the diameter of the shaft so that the gear can be press-fit tightly onto the shaft. For best results, use a series of drills of increasing diameter up to ⅛ inch so that you won't offset the hole from the center of the gear as you drill.

The next step is to assemble the shafts and gears in the bearing blocks. The longest shaft belongs in the middle hole and is press fit into a gear in the deepest bearing block slit; the top shaft is press fit into a gear in the middle, shallow slit and the bottom shaft is press fit into a gear in the remaining shallow slit.

Motors and mounting blocks

Each of the six joints is powered by an individual small DC motor. Small motors are necessary because the shafts exiting the *Armatron* must be spaced close together—otherwise they will not be able to fit the bearing-block gears.

To hold the motors, we need five mounting blocks on each side of the *Armatron*. Figure 9 shows the dimensions for the mounting blocks. Use those di-

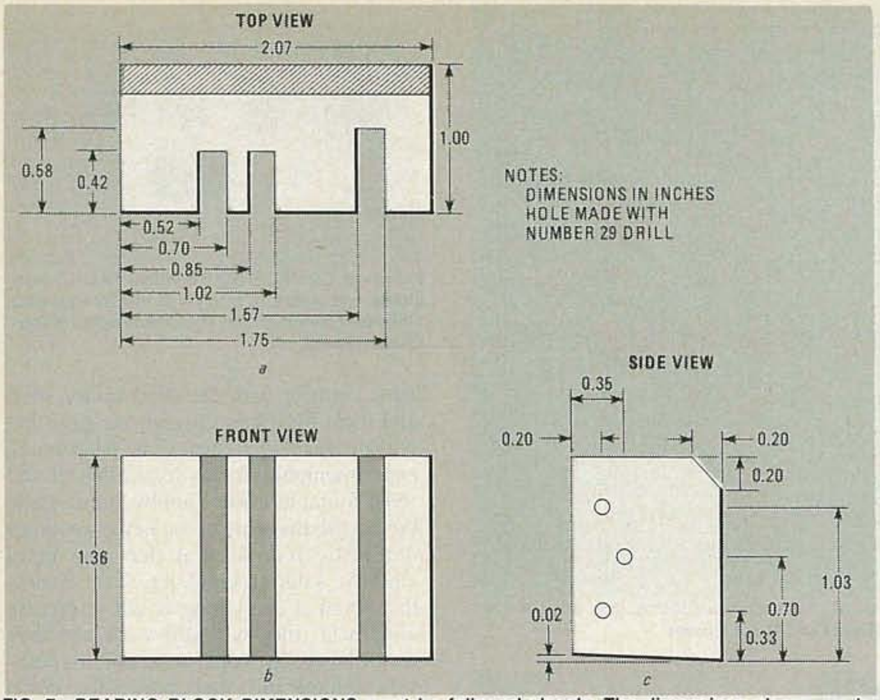


FIG. 7—BEARING BLOCK DIMENSIONS must be followed closely. The dimensions shown are in inches. All holes are made with a #29 drill.

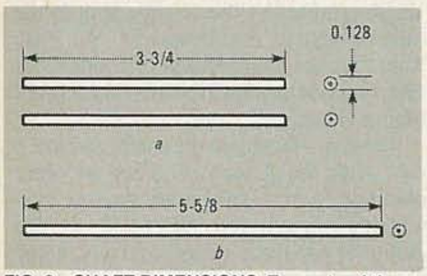


FIG. 8—SHAFT DIMENSIONS. Two sets of three shafts are required.

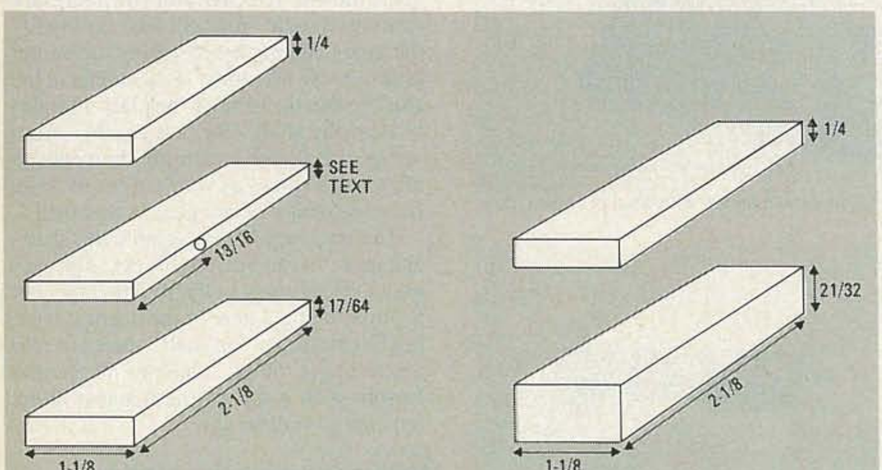


FIG. 9—MOTOR-MOUNTING BLOCK DIMENSIONS. The dimensions shown are for the author's system. You may have to change the dimensions to fit your motors.

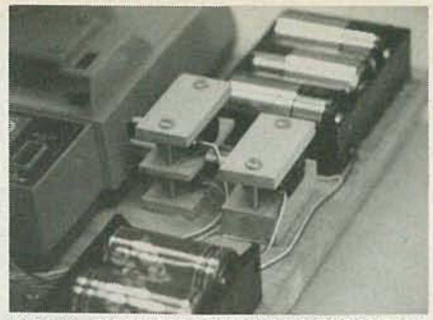


FIG. 10—THE MOTOR-MOUNTING BLOCKS on the right side of the *Armatron*.

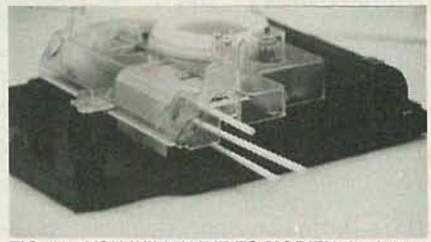


FIG. 11—YOU WILL HAVE TO MODIFY the base and gear cover to accommodate the shafts.

mensions only as a guide—you may have to change your dimensions to fit the motors that you use. The critical block is the spacer between the two motors closest to the *Armatron* (see Fig. 10). That spacer block is made by first drilling a hole using a #29 drill bit through a piece of wood. (The same material used in the bearing blocks can be used in the mounting blocks.) The spacer block is sanded until the width is just slightly thicker than the diameter of the shaft.

Final mechanical modifications

The *Armatron* must be modified to accommodate the bearing blocks and shafts. Figure 11 shows the right side of the *Armatron* with modifications to the base and ring gear cover/holder. A slot must also be cut in each side of the outer cover so that the shafts can protrude. A thin hacksaw blade and file can be used to cut away the plastic to make the modifications.

Final assembly of the mechanical components starts with mounting the bearing blocks in the base. Place each bearing block in the base and match drill two holes; use ½-inch self-tapping screws to secure the bearing blocks to the base. Replace the gear cover with the original screws. Assemble the outer cover and the arm to the base with the original screws. Attach the *Armatron* to a ½ × 12½ × 12½-inch plywood base with four 2¼-inch screws located in the four corners of the *Armatron*. Mount the two motors on each side closest to the *Armatron*. The motors are press fit into the plastic shafts. Finally, mount the third motor on each side of the *Armatron*. To hold down the mounting blocks, use 2¼-inch screws. Do not overtighten the mounting blocks; when operated, final adjustments to the motor positions can be done to achieve proper alignment. You may want to use paper spacers under the bottom mounting blocks so that the motors turn freely.

The electronic interface

Now that the mechanical modifications are complete, we can turn to the easy part: the electronic interface.

Figure 12 shows the complete schematic of the circuit that's required to interface the motors to a computer. As we mentioned earlier, we need 12 control lines to drive the six motors. In other words, two lines—one for forward control and one for reverse—are required for each of the six motors.

Your computer must have at least a 4-bit output port to operate the interface. Those four lines are fed to IC5, a 74154 4-to-16 line decoder. That decoder takes an input and selects one of sixteen lines as an output. (That output depends on the value of the 4-bit word. (If you are familiar with binary numbers, you'll realize that there are 16 possible combinations of 4 bits. The selected output line is driven low,

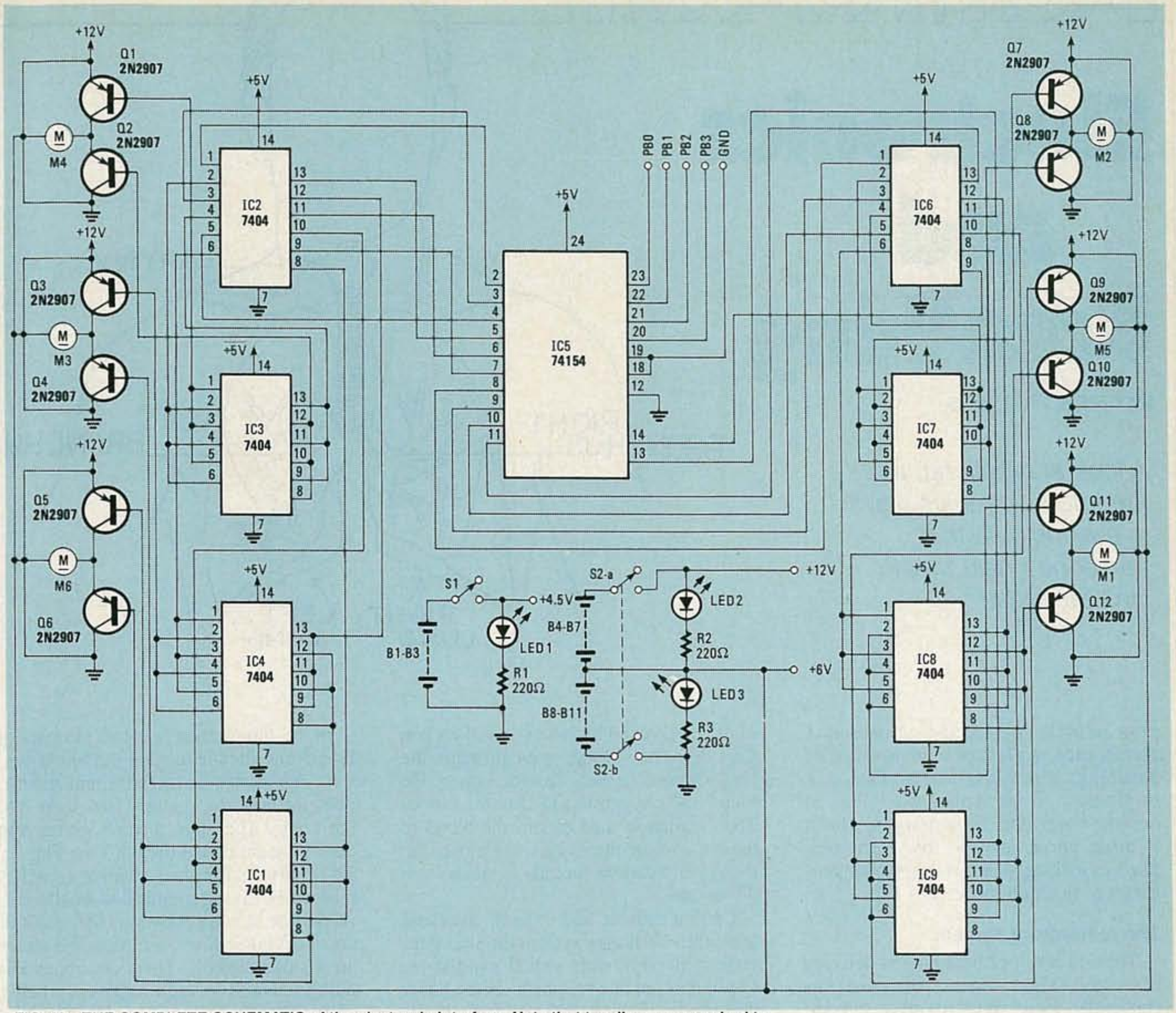


FIG. 12—THE COMPLETE SCHEMATIC of the electronic interface. Note that two lines are required to control each motor. One will cause the motor to go forward, the other will cause it to go in reverse. Motors M1–M3 correspond to the bottom, top, & center of the right side; M4–M6 correspond to the top, bottom, & center of the left side.

while the other 15 lines remain at a high logic level.

Each output line is first connected to a single 7404 inverter and then to three 7404 inverters arranged in parallel. That not only boosts the output current to sufficient levels, it also returns the control signal back to its original logic level. The inverter outputs are fed to the bases of 2N2907 transistors, which act as simple switches and determine the direction of the flow of current through the motor.

For example, if the forward line is low and reverse line is high, then the forward transistor conducts turning the motor in the forward direction. If both inputs are high then neither transistor conducts and the motor remains off. Note that if somehow both lines go low the entire loop is connected putting 12 volts across the two transistors. That will quickly burn them out. Fortunately, using a decoder like the 74154 should prevent that from ever happening.

Two separate switches are used to turn the power supplies on and off. Three LED's are used to show that the power is on. During system operation the switch for the electronic circuit should be turned on before the switch for the motor controllers to insure that the transistors are properly biased. Similarly the switch for the electronic circuit supply should be turned off last.

Circuit layout and final assembly

Circuit layout is not critical and you should feel free to use the construction technique you're most comfortable with. The author's circuit, shown in Fig. 13, was built using a pre-drilled "universal PC board."

A 12/24 pin card-edge connector was used to interface the electronic circuit with the VIC-20 computer. Of course, the connector you use will depend on the computer you use.

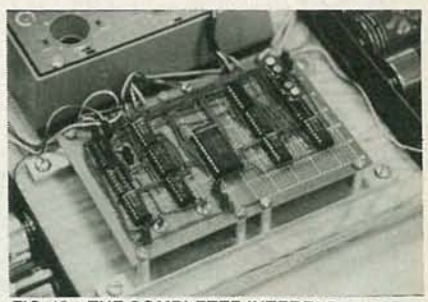
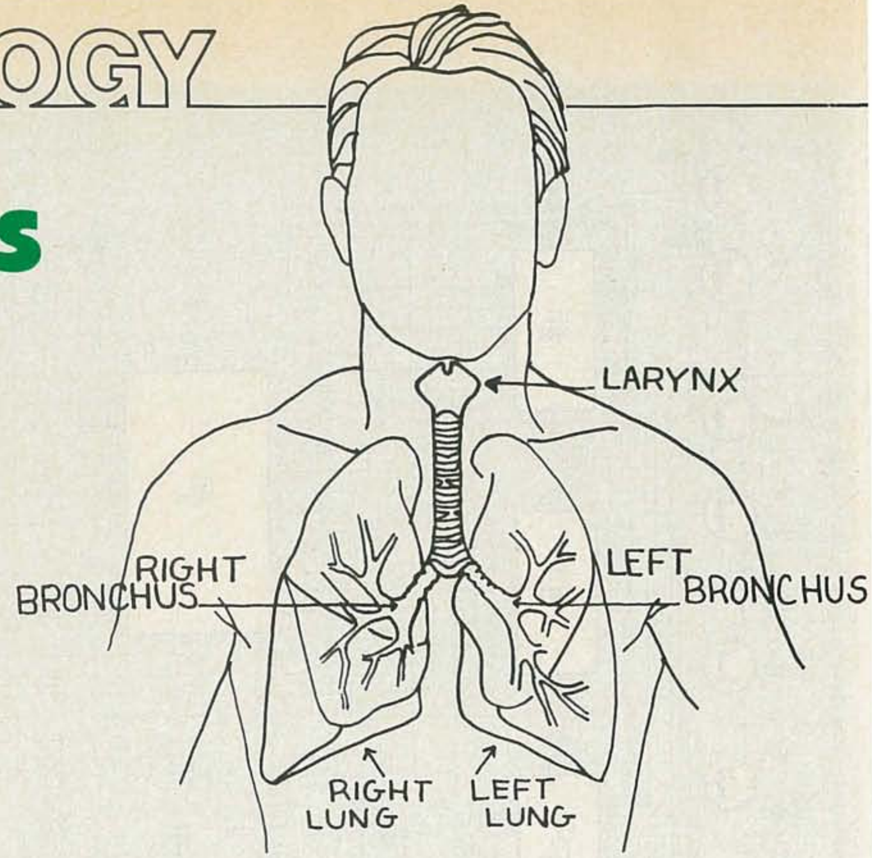


FIG. 13—THE COMPLETED INTERFACE. Universal PC boards were used. Note how the transistors are mounted in IC sockets.

Three separate battery packs, using D-cells, are used for power supplies. Two 6-volt supplies are used for powering the motors; a 4.5-volt supply is used for the integrated circuits.

continued on page 117



Electronics and Breathing

RAY FISH, Ph.D., M.D.

A look at breathing, and the role electronics plays in making sure that someone's next breath isn't their last!

THIS MONTH, OUR LOOK AT MEDICAL electronics will focus on the act of breathing, which is otherwise known as respiration. In particular, we'll look at how the *respiratory* system works, what it is made up of, and the role electronics plays in making sure that everything continues to function properly.

The respiratory system

The end result of breathing is delivery of oxygen to body tissues. The same process is also used to remove carbon dioxide from the body. A "block diagram" of the respiratory system is shown in Fig. 1.

One of the main functions of blood is to carry oxygen to, and remove waste products (such as carbon dioxide) from all of the cells in the body. Blood that has circulated through the body has given up much of its oxygen and has an excess of carbon dioxide. That blood goes through the lungs where carbon dioxide leaves the blood and oxygen is added to the blood. The circulation then carries the blood to the body where the oxygen is given to the tissues and carbon dioxide is taken from the tissues.

Carbon dioxide and oxygen enter and leave the circulatory system through thin-walled blood vessels called capillaries. Capillaries are one cell thick. In the body, the arteries branch repeatedly until the capillaries are reached. At that level, oxygen and carbon dioxide (as well as nutrients and other chemicals) can diffuse across the walls of the blood vessels quickly enough to be of use to the tissues. The capillaries join to form veins, which return blood to the heart.

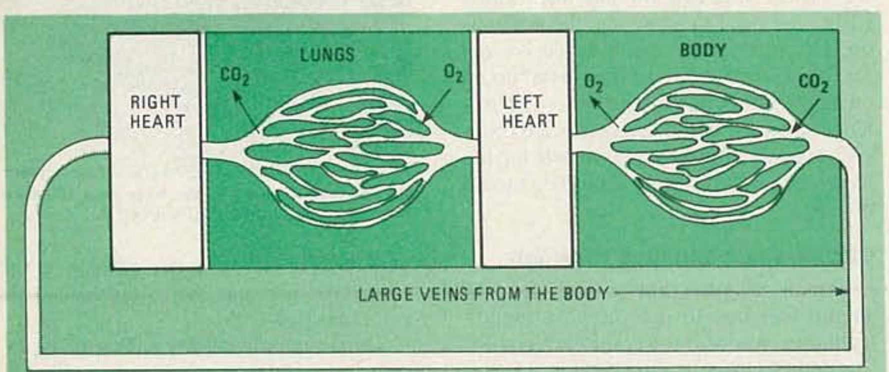


FIG. 1—"BLOCK DIAGRAM" of the respiratory system. Oxygenated blood from the lungs is pumped through the body. In the body, oxygen is removed from the blood and carbon dioxide is picked up. Blood is then pumped back to the lungs, where the carbon dioxide is removed and oxygen is picked up. The process is then repeated.

In the lungs, there are two systems of branching: the airway and the blood vessels. Air comes in the nose and mouth, goes through the trachea, and then into the lungs. The large airways going into each lung are called bronchi (see Fig. 2). Those divide into two smaller branches repeatedly, giving smaller and smaller airways. The smallest airways, the result of about 20 branchings, are roundish structures called alveoli. There are about 150 million alveoli in each lung, each being 75 to 300 microns in diameter (one million microns equal one meter). The total surface area of the lungs is about 70 square meters.

Some of the medium sized airways are surrounded by muscular walls that can contract to make the airway smaller. Mucous glands in the walls of the airways provide mucus secretions that can catch foreign particles and debris. Cells with moving hair-like projections, called cilia, wave the mucous toward the mouth to carry the foreign particles out.

Ever wonder why cigarette smokers seem to cough a lot? It is because cigarette smoke paralyzes the cilia. It is then up to the cough mechanism to bring up the mucus, and any debris that it has caught. Cigarette smoke also increases mucous production and ties up 5% to 10% of the oxygen carrying capacity of the blood with carbon monoxide.

Blood to be oxygenated comes from the heart through the pulmonary arteries. In each lung, those arteries divide repeatedly down to the capillary level. Those capillaries line the walls of the alveoli. Thus the blood stream is carried within one cell thickness of the air in the lungs (about 0.1 micron). Air in the lungs can then diffuse into the blood stream, while carbon dioxide can diffuse out of the blood stream into the lungs.

Although you can consciously control the rate and depth of breathing, it is usually an automatic function. The brain controls breathing in such a way as to maintain the carbon dioxide content of the blood at normal levels. Actually, centers in the brain sense the acidity (pH) of the cerebrospinal fluid. That acidity depends on the carbon dioxide content of the blood. (Rapid or deep breathing will decrease the carbon dioxide content of the blood; shallow breathing will increase it.)

Some diseases and conditions cause the blood to be acidic. Those include kidney failure, diabetic ketoacidosis, and aspirin overdose. Individuals suffering from those conditions are said to be suffering from a metabolic acidosis and will be breathing rapidly or deeply. That's because the brain senses the abnormal acid level and causes the respiratory system to compensate with the rapid or deep breathing.

While it is sensitive to changes in carbon-dioxide levels, the normal respiratory control system is relatively insensitive to oxygen levels. But in persons who have chronic lung disease, the normal carbon-dioxide level cannot be maintained, and the body learns to ignore the higher carbon-dioxide levels that result. Instead, those persons do have their breathing controlled by the content (partial pressure) of oxygen in their blood. If given a high concentration of oxygen, their breathing will slow, the carbon dioxide level will rise so high as to change the blood pH and affect brain and heart function, and they may die. Those persons are called carbon-dioxide retainers and are recognized by the elevated partial pressure of carbon dioxide in their arterial blood gases.

Arterial blood gases

When blood is exposed to air in the alveoli, various gases diffuse into and out of the blood. The partial pressures of carbon dioxide and oxygen, which are measured in millimeters of mercury (mmHg), in the blood will depend on the concentrations of oxygen and carbon dioxide in the lungs. Those concentrations depend on the composition of the inhaled air and also upon gases released into or taken up from the lung by the alveoli. Gas exchange in the lung will decrease the oxygen content and increase the carbon dioxide content of air in the lung. Breathing very rapidly or deeply will lead to more oxygen and less carbon dioxide in the lungs and therefore in the blood.

Electrodes can be placed in samples of blood to determine the blood gases. An electrode may simply consist of a wire. More commonly, an electrode consists of a wire placed in a solution-filled thin-walled container or membrane. The membrane allows the passage of certain molecules or ions.

When a wire is placed in a solution, a voltage will develop between the wire and solution. The voltage depends on the types of metal in the wire and the types and concentrations of ions in the solution surrounding the wire.

Indicating electrodes develop voltages in response to the the presence of a certain compound or ion. Electrodes have been developed that indicate the concentration of hydrogen ions; such hydrogen ion-sensitive electrodes can be used to measure pH.

As we said previously, changes in the carbon-dioxide content of blood will change the pH of blood. Therefore, if a pH-indicating electrode is surrounded by a membrane that allows only carbon dioxide to pass, the pH-indicating electrode will become a carbon-dioxide indicating electrode.

There are several types of oxygen-indicating electrodes. Small assemblies containing all the electrodes needed to measure pH, carbon dioxide, and oxygen have also been built.

Monitoring respiration

Carbon dioxide strongly absorbs infrared light with a wavelength of 4.26 micrometers. Use has been made of that fact to build respiration monitors that measure the efficiency of the breathing process. Such monitors place a sample of the exhaled breath between an infrared light source and detector (see Fig. 3). Light filters are used as shown so that only the absorption of light by carbon dioxide is monitored.

The model shown in Fig. 3 is a simplified one. Depending on components used and system design, the temperature of the sensor, detector, and gas analyzed may need to be controlled or taken into account if any readings taken are to be useful. In addition, the barometric pressure and the presence of other gases can affect readings and need to be accounted for.

When a person depending on a machine gets insufficient oxygen, the results are sometimes disastrous. Therefore, the oxygen concentration in inhaled gases is often monitored when a person breathes gases from a respirator or other machine. An alarm will sound if there is inadequate oxygen in the inhaled gases. Such problems arise when the wrong tanks are connected to a respirator or anesthesia machine, the tank runs out, a line is cut, or a valve malfunctions. Many precautions are taken to prevent such problems, and the number of accidents is relatively small. Nevertheless, monitoring the inhaled oxygen concentration can indicate when something is wrong.

Sometimes measuring the concentration of oxygen being pumped to the

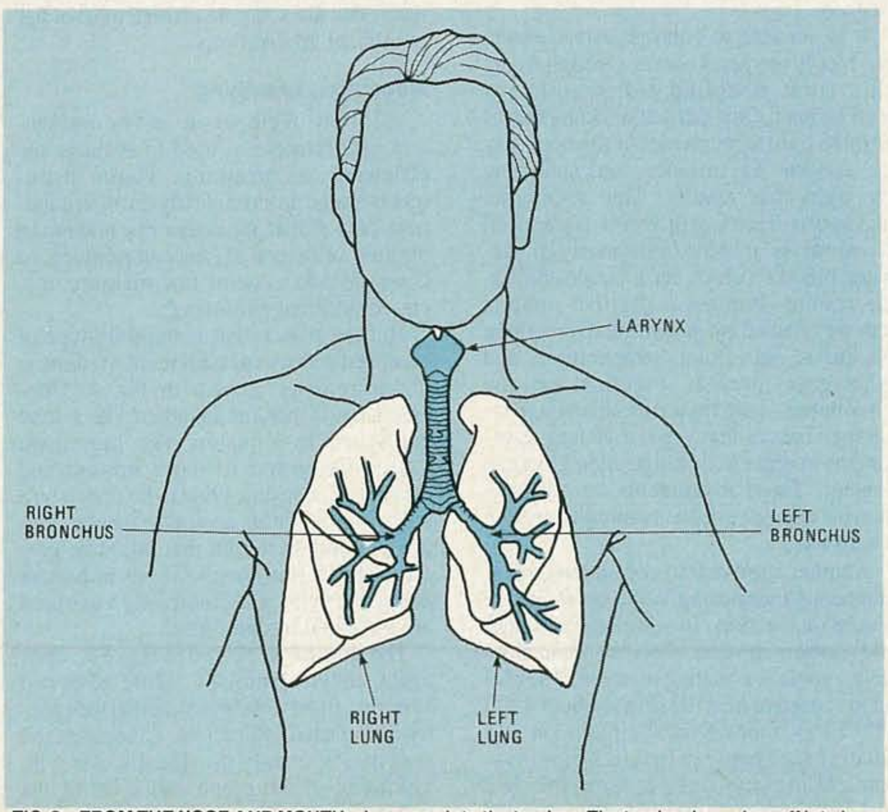


FIG. 2—FROM THE NOSE AND MOUTH, air passes into the trachea. The trachea branches off into large airways, called the left and right bronchus, which in turn enter the lungs.

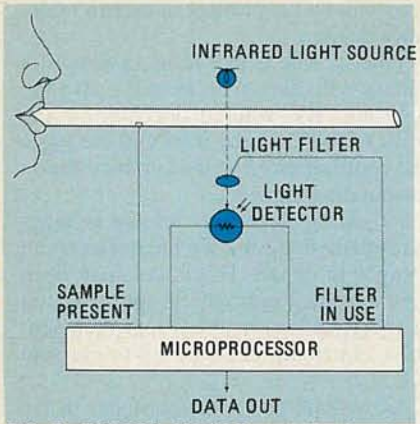


FIG. 3—CARBON DIOXIDE strongly absorbes infrared light. That fact has been used to make exhaled carbon-dioxide monitors similar to the one shown here.

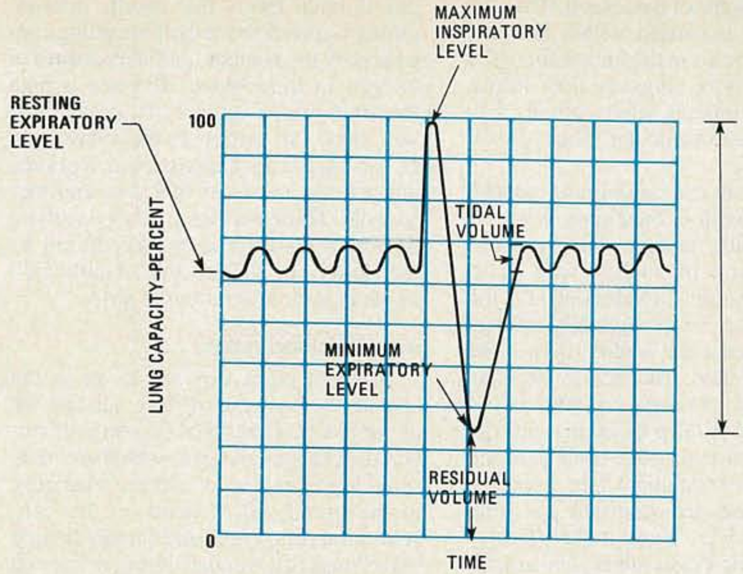


FIG. 5—THE OUTPUT produced by a simple spirometer. Note the parameters shown; today's computerized instruments can provide even more detailed measurements.

patient may not be adequate. That may occur, for instance, if tubing to the patient is kinked so that the oxygen does not get to the patient. Another possibility is that the tubing may accidentally be placed into the esophagus (the pathway which carries food from the mouth to the stomach) instead of the trachea. Pumping air into the esophagus may or may not distend the stomach. If it does, the chest will move a little with air movement into the stomach, which may appear similar to the movement caused by normal breathing. In addition, the sounds heard when listening to the "lungs" with a stethoscope will instead be caused by air moving through the esophagus; the sound produced will be very similar to that produced by normal breathing.

Thus, it is not always obvious when oxygen is not getting to a person. If the person is unconscious, anesthetized, or an infant, the problem may not surface until brain damage occurs.

Because of those problems, it would be desirable to continuously measure blood oxygen content in persons receiving oxygen via a machine. The normal procedure of testing blood gases is not fast enough for that. Drawing a blood sample often takes 5 minutes, and it is another 5 or 10 minutes before the sample can be analyzed. Brain damage occurs in 5 minutes or less when a person does not receive oxygen.

It is possible to continuously measure the blood oxygen content through intact skin (that is called *transcutaneous monitoring*). One method of doing that is to shine light through part of the body, say the earlobe, for instance, and analyzing the light that results. That technique makes use of the fact that well oxygenated blood varies in color from poorly oxygenated blood (blue vs. red). Unfortunately, the results obtained using that method may be affected by factors such as earlobe thickness, skin color, temperature, and other gases present. Practical earlobe "oximeters" take light transmission measurements at as many as 8 different wavelengths in order to calculate blood oxygen content. Those instruments are thus expensive and not used as commonly as one would like.

Another approach to continuous transcutaneous monitoring is via an electrode placed on the skin. In addition to oxygen and carbon dioxide sensors, skin electrodes contain a heating element. The element is used to heat the skin to about 43°C (109°F) to improve local circulation and gas exchange between the circulatory system and the skin surface. From the skin surface, gases from the blood further diffuse across an artificial membrane into the electrode and are then analyzed.

The measurements obtained at the skin surface are not as accurate as those obtained by taking blood samples. The electrodes must be kept clean and firmly attached to the skin. Calibration every few hours is commonly needed. However, repeatedly taking blood samples is undesirable, especially in very young children. Commercially available instruments can provide analog and digital readouts of oxygen and carbon dioxide levels that are accurate enough to be of use in clinical applications.

Measuring breathing

A variety of electronic and/or mechanical instruments are used to evaluate the efficiency of breathing. Those instruments range in complexity from a hand-held device that measures the maximum air flow velocity a person can produce, to computerized systems that measure dozens of different parameters.

But the device that is the prototype of most respiratory measurement systems is the spirometer, shown in Fig 4. Conceptually, a person breathes via a tube connected to a piston. Air movement causes the piston to move upward and downward, causing a line to be drawn on a strip chart recorder or similar device. Figure 5 shows an output that might be produced by a spirometer. Some important parameters that are commonly measured are indicated in that figure.

The spirometer shown in Fig. 5 is, once again, only a prototype. More advanced systems, most notably computerized systems, are used in practice. Computerized systems commonly provide the user with a printout of the graph and a list of the measured parameters. One commercially

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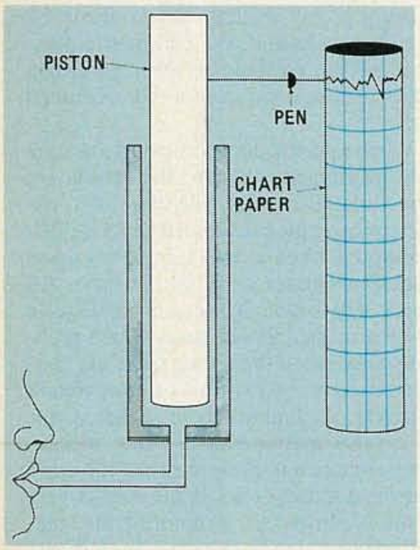
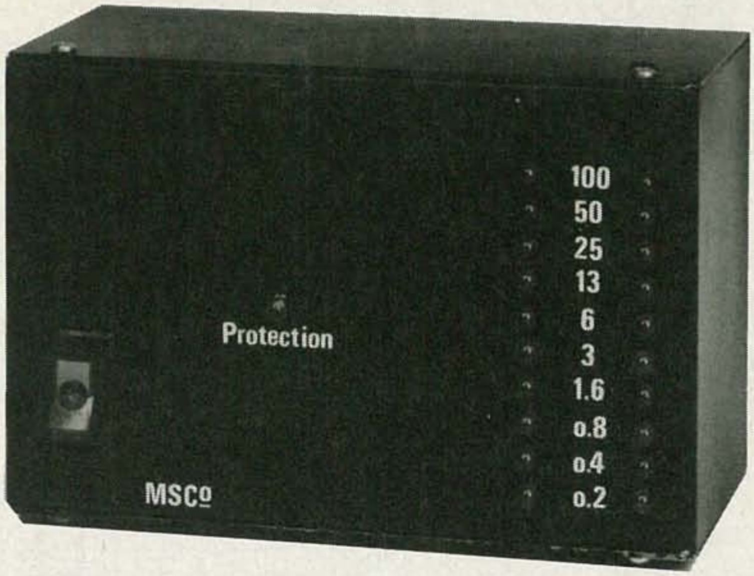


FIG. 4—BREATHING EFFICIENCY can be measured by a device called a spirometer. The model upon which almost all spirometers are based is shown here.

POWER METER for your STEREO



More than just a peak-reading power meter, this easy-to-build project disconnects your speakers before your amplifier does the job—permanently!

MARK S. COHEN

IT'S NOT UNCOMMON TO see loudspeakers with power ratings of 500 watts or more. Now, you might think it safe to connect such speakers to any amplifier of 500 watts or less, and expect that combination to comfortably run at full power. Unfortunately, that's not so!

While some speakers may be able to handle instantaneous peaks of that magnitude, they can also be destroyed by continuous operation at substantially lower power levels. For example, the author's speakers are rated at 680 watts but are only capable of handling *30 watts* in continuous operation!

While most amplifiers have some sort of built-in protection circuitry, that circuitry does nothing, of course, to protect the speakers. That circuitry is designed to protect the amplifier *only*, and therefore will not kick in until long after the speakers have begun to smoke!

Here's something else to consider: Many of today's otherwise fine power amplifiers have no turn-on delay. At power up, the output may swing briefly to the positive or negative supply rail. (We've all heard that loud, dull thump at turn-on.) Even if that doesn't destroy the speakers outright, it certainly does nothing for their performance.

From what we've seen it is clear that a proper speaker-protection device must pass large power levels for musical peaks, but disconnect the speakers if the amplifier produces a sustained high-level output. The circuit described here does that, and also provides a turn-on delay.

If that doesn't peak your interest, included in this circuit is a peak-reading LED dot display that shows the output level being fed to your speakers. Not only is the circuit helpful in protecting speakers, but it also provides a fascinating demonstration of the power required to handle musical transients. The power monitor is designed so that successive LED's are turned on by a each 3-dB increase. That allows high resolution at low power levels.

Circuit description

Figure 1 is a schematic diagram of our circuit. It consists of four parts: an input buffer and peak detector, power-metering circuit, relay-control section, and, of course, the power supply.

Let's see how the circuit works. The left- and right-channel inputs are independently rectified and their peaks sampled. That information is sent to the metering circuits for display, and to the relay-control section. That section disconnects the speakers from the amp when the continuous power level is above a user-defined level (which is determined by the rating of your speakers). The relay-control section also contains the turn-on delay.

Let's take a closer look at the individual sections. **Note:** From here on, we'll only discuss the left channel as both left and right are identical. At the input, resistors R1 and R3 form a voltage divider to attenuate the input signal. Those resistors are selected to yield an output of 10 volts when the amplifier is delivering its maximum rated output. Table 1 is provided to help in the selection of R1 (R7 for the right channel) for various amplifier power and speaker impedance combinations.

Transistor Q1 is configured as a voltage follower. The Q1 output is rectified by diodes D1 and D2, which conduct only when the emitter voltage exceeds that at capacitor C1.

The parallel combination of R5 and C1 produces an extended time constant for the peak-reading operation of the meter. Capacitor C1 charges rapidly through resistor R4 (at the Q1 collector) and discharges slowly through R5. That allows easy viewing of peak power-levels.

The speaker protection circuit is formed by comparators IC3, IC4, relay RY1, and a few discrete components. Potentiometer R24 is used to set the circuit trip point, which is equal to your speakers' continuous power-handling rating (we'll explain just how that's done in a moment). That trip voltage is applied to pin 2 of IC3-a.

TABLE 1
ATTENUATION RESISTOR VALUES

Speaker Impedance	50W	100W	200W	400W	800W
2 ohms	*	3.9K	10K	18K	30K
4 ohms	3.9K	10K	18K	30K	47K
8 ohms	10K	18K	30K	47K	68K
16 ohms	18K	30K	47K	68K	100K

(*To read a maximum power level of 50W into 2 ohms, R1 and R7 should be replaced by a piece of wire between the appropriate printed circuit board pads.)

The voltage from the input section is fed to pin 3 of IC3-a via the series combination of R6 and C2. The values of the components in that R-C circuit are selected so that the capacitor charges almost instantaneously for high voltages, but slowly for lower voltage levels.

Should the voltage at pin 3 exceed the voltage at pin 2, the comparator outputs a high. When that happens, the voltage at pin 2 of IC4 rises above that at pin 3,

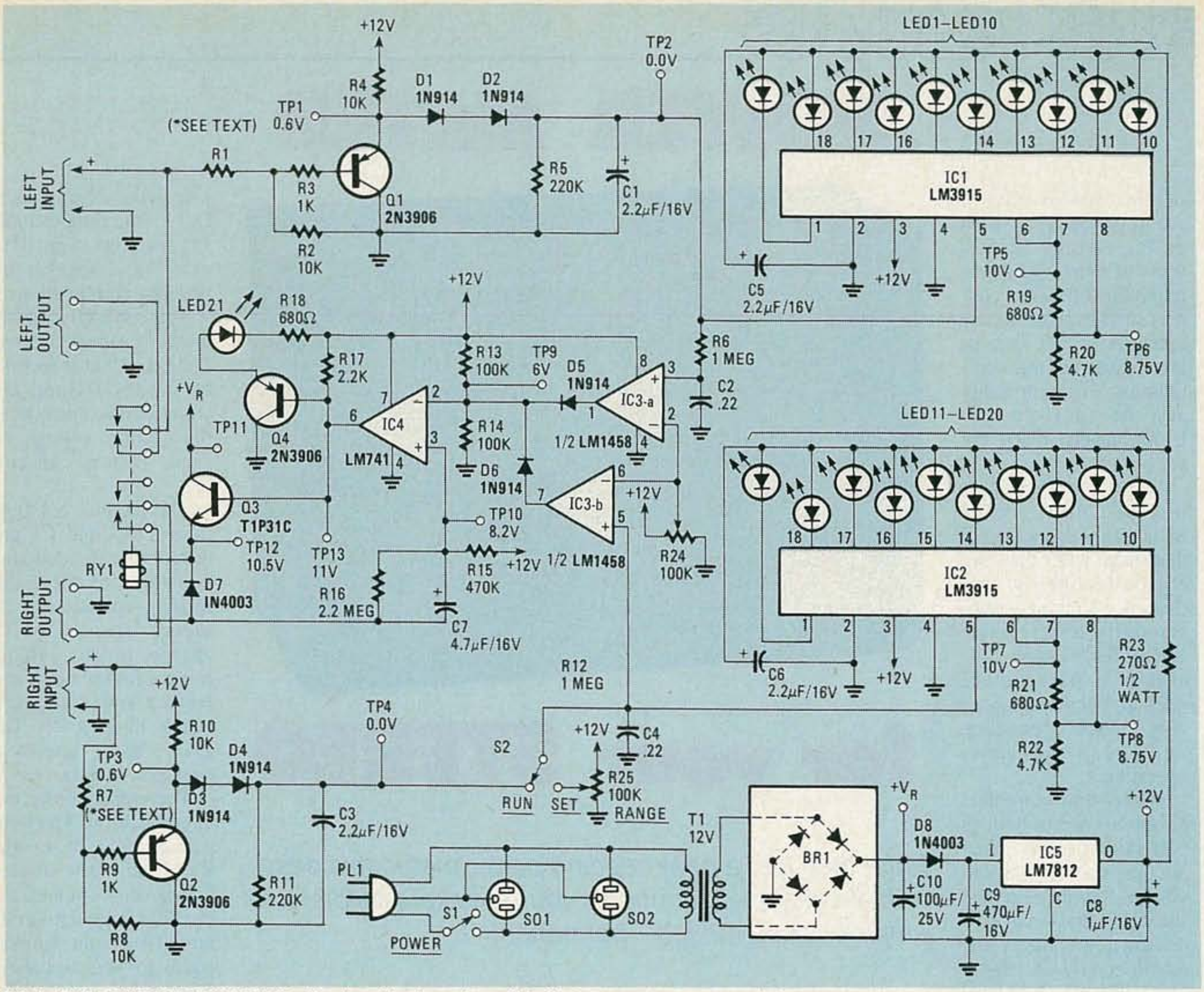


FIG. 1—THE SCHEMATIC DIAGRAM for the circuit is shown here. Note that a separate power supply is provided for transistor Q3.

causing that comparator's output to go low.

When the output of IC4 goes low, Q3 stops conducting. That, in turn, cuts of the current flow through RY1 causing the relay to open, disconnecting the speakers.

Also, when IC4 goes low, transistor Q4 begins to conduct. That causes LED21 to light, indicating that the protection circuit has been tripped.

Diode D7 protects Q3 against energy stored in the relay that might otherwise damage the transistor when the relay is turned off. Also, note that transistor Q3 is fed from a separate 16-volt power supply, $+V_R$. We will see later that $+V_R$ is designed to turn off rapidly so that the relay quickly opens when power is removed from the circuit, to protect the speakers from both turn-off and turn-on transients.

A six-second turn-on delay is provided by C7 charging through R15. At power up, the voltage at pin 2 of IC4 is set to 6 volts by a voltage divider made up of resistors R13 and R14. Diode D5 is included to ensure that the reference voltage at pin 2 of IC4 is not affected by a low at the output of IC3-a.

Pin 3 of IC4 is initially at ground; therefore, its output is low and the relay is turned off. At power up, capacitor C7 charges slowly through R15. When the charge on C7 (tied to pin 3) exceeds 6 volts, IC4 outputs a high, turning on Q3. That closes the relay contacts, connecting the speakers.

The display portion of the circuit is made of an LM3915 LED display driver (IC1). That IC can produce either dot or bargraph outputs. As shown in the schematic, it is wired as a dot-display driver. Successive LED's are turned on when the input voltage is increased by 3 dB (power doubled). Table 2 lists the peak power level at which each LED lights. As that table shows, those power levels depend on the maximum rated output of your amplifier, assuming that R1 has been selected as described earlier. For instance, if the maximum output of your amplifier is 50 watts, then LED's 1 and 11 light at 0.1 watt, and so on. Resistors R19 and R20, tied to pins 6 and 7 of IC1, control the brightness of the display and set the voltage level needed to light LED10. Resistors R19 and R20 are chosen so that a 10-volt input lights LED10.

TABLE 2
PEAK POWER DISPLAYED

LED	50W	100W	200W	400W	800W
1,11	0.1	0.2	0.4	0.8	1.5
2,12	0.2	0.4	0.8	1.5	3
3,13	0.4	0.8	1.5	3	6
4,14	0.8	1.5	3	6	13
5,15	1.5	3	6	13	25
6,16	3	6	13	25	50
7,17	6	13	25	50	100
8,18	13	25	50	100	200
9,19	25	50	100	200	400
10, 20	50	100	200	400	800

If preferred, a bargraph display may be selected by connecting pin 9 of IC1 to the power supply; appropriate holes for a jumper wire are provided on the PC board. If you chose the bargraph mode, R23 (270 ohms ½ watt) should be replaced with a 39 ohm, 5 watt unit. Note that the LM3915 has a nasty tendency to oscillate under some conditions; C5 is included to protect against that.

The power supply is straightforward—a simple bridge rectifier and a single LM7812 regulator (IC5) gives a constant 12-volt output. The $+V_R$ supply is filtered only by C10, which is isolated from C9 by D8. That produces a fast turn-off of the relay when power is removed.

The power switch, S1, also turns convenience outlets SO1 and SO2 on and off. Those outlets are intended to be used as power connections for the rest of the stereo system. Using those outlets ensures that power is applied to all components simultaneously, and that all transients have ended before the speakers are connected. Thus, S1 acts as a master power switch.

Finally we come to S2 and R25. Switch S2 is a SPDT unit that is used to disconnect the right channel input and instead connect potentiometer R25 to the comparator and display circuitry. With S2 in the SET position, R25 is used to set the trip point (which is determined by R24 and your amplifier's maximum rated output) so that the speakers are disconnected at the desired power level.

Construction

The circuit is straightforward enough to be built on perfboard, but it is strongly recommended that a PC board be used. PC board minimizes construction errors and saves time in the long run.

A few factors had to be taken into account in the circuit layout. Capacitors C5 and C6 should be placed as close to the LED's as possible. All ground connections on the left and right input and display circuits should be returned directly to pin 2 of IC1 and IC2 respectively. That's done to prevent oscillation of the LM3915, which may occur under some circumstances. When LED's 1–20 are all turned on, R23 may have to dissipate as much as 5 watts; so it's a good idea to put some space between it and any other components.

The first step is to etch your own PC board or acquire one from the supplier given in the Parts List. The PC-board pattern is shown in Fig. 2; the corresponding parts-placement diagram is shown in Fig. 3.

First note that the IC's are not socketed (see Fig. 4), although sockets may be used if desired. Also note that some resistors and diodes are mounted vertically (like radial lead capacitors).

Turning to the resistors first, the holes on the board are spaced for ¼-watt units with their leads bent flush to the resistor body. Install all fixed resistors, making sure they are in their proper positions. Once that's done finish up by installing potentiometers R24 and R25.

The capacitors should be the next components installed. Observe capacitor polarities and be sure that all units are

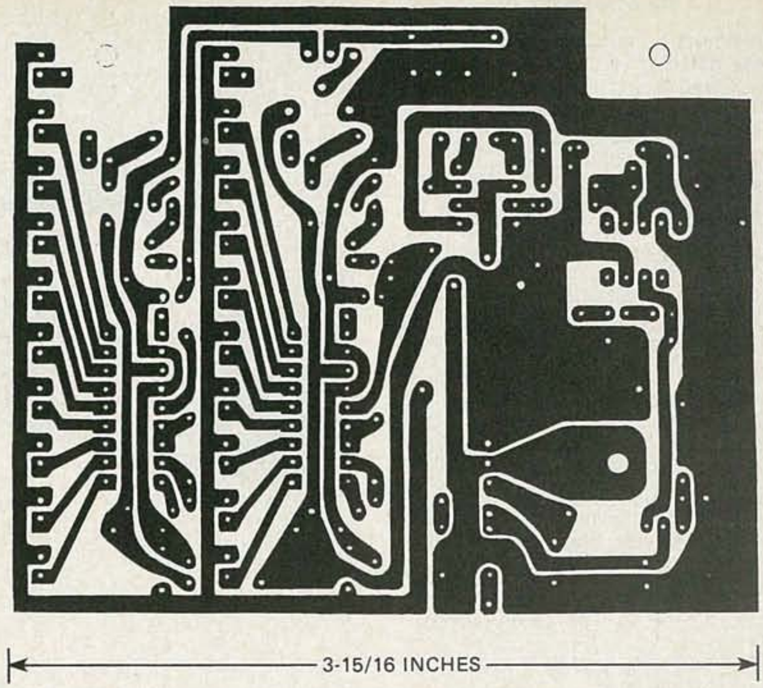


FIG. 2—THE FOIL PATTERN for our speaker-protection device/power meter is shown here full size.

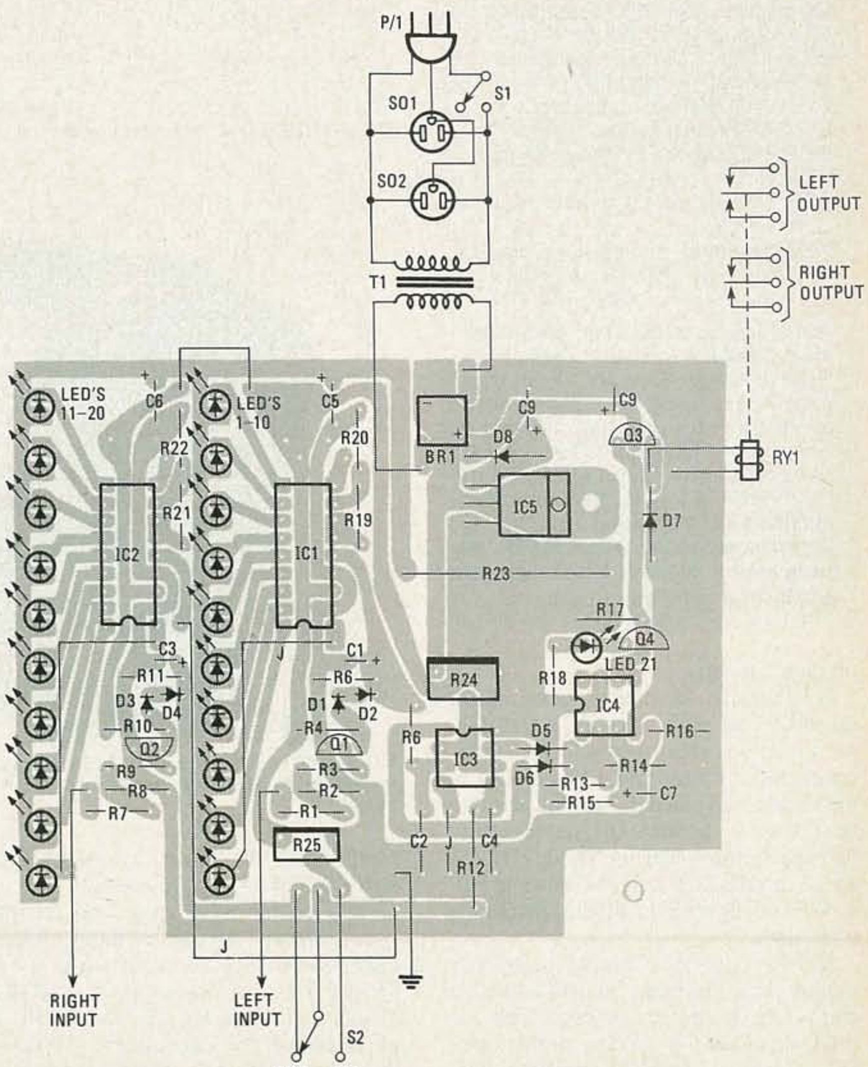


FIG. 3—PARTS-PLACEMENT DIAGRAM for the foil pattern given in Fig. 2 is shown here. Note that several of the holes are not used.

PARTS LIST

All resistors ¼ watt, 5% unless otherwise noted.
R1, R7—see Table 1
R2, R4, R8, R10—10,000 ohms
R3, R9—1000 ohms
R5, R11—220,000 ohms
R6, R12—1 Megohm
R13, R14—100,000 ohms
R15—470,000 ohms
R16—2.2 Megohms
R17—2200 ohms
R18, R19, R21—680 ohms
R20, R22—4700 ohms
R23—270 ohms, ½ watt
R24, R25—100,000 ohms, trimmer potentiometer

Capacitors
C1, C3, C5, C6—2.2μF, 16 volts, tantalum
C2, C4—0.22μF, ceramic
C7—4.7μF, 16 volts, tantalum
C8—1μF, 16 volts, tantalum
C9—470μF, 16 volts, electrolytic
C10—100μF, 25 volts, electrolytic

Semiconductors
IC1, IC2—LM3915 LED dot/bar display driver
IC3—LM1458 dual op-amp
IC4—LM741 op-amp
IC5—LM7812 12-volt regulator
Q1, Q2, Q4—2N3906 PNP transistor
Q3—TIP31C NPN transistor
BR1—50 PIV, 500-mA bridge rectifier
LED1–LED21—jumbo LED's
T1—12-volt, 500-mA transformer
S1—SPST, rocker switch, 15 amps
S2—SPDT submini PC mount switch
RY1—DPDT 12-volt DC relay
SO1, SO2—grounded convenience outlets (see text)

Miscellaneous:—case, 3 conductor line cord, strain relief, PC board, jacks for input and output, screws, solder, wire, etc.

The following is available from Clearview Designs, Inc., 217 East 85 St., Suite 467, New York, NY 10028: complete kit including wire, solder, step-by-step instructions, and all components except case for $59.95, plus $3 postage and handling; circuit board only available for $10. New York State residents add 8¼% sales tax. Other selected components available by arrangement, contact Clearview Designs, Inc. for details.

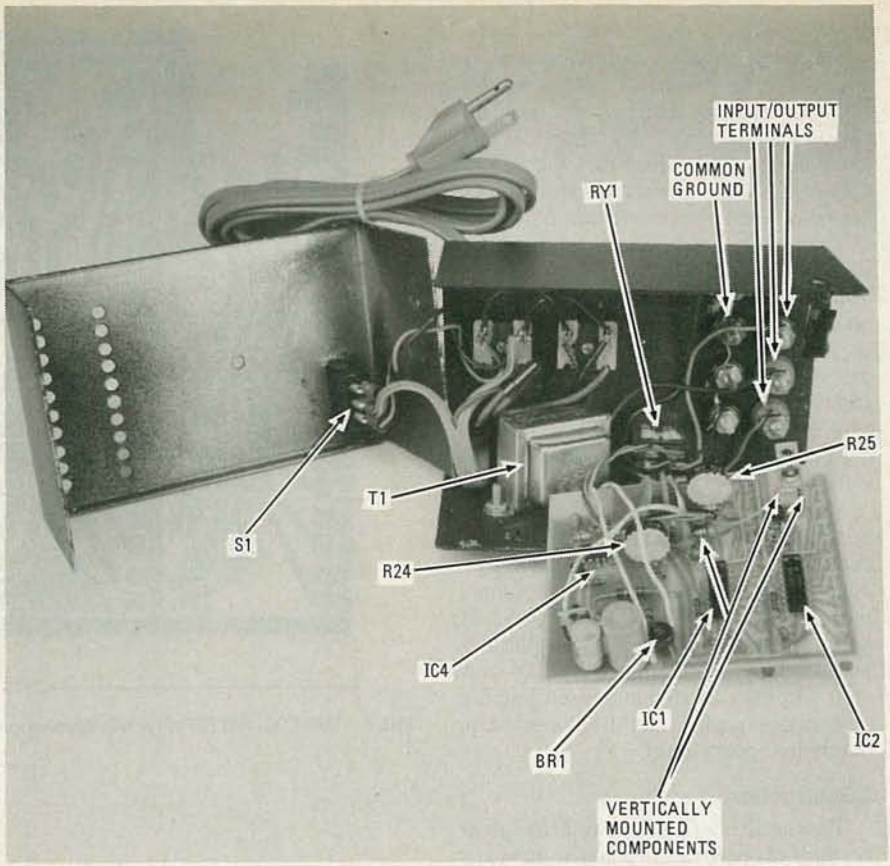


FIG. 4—INSIDE THE UNIT. Note that several components are vertically mounted on the PC board.

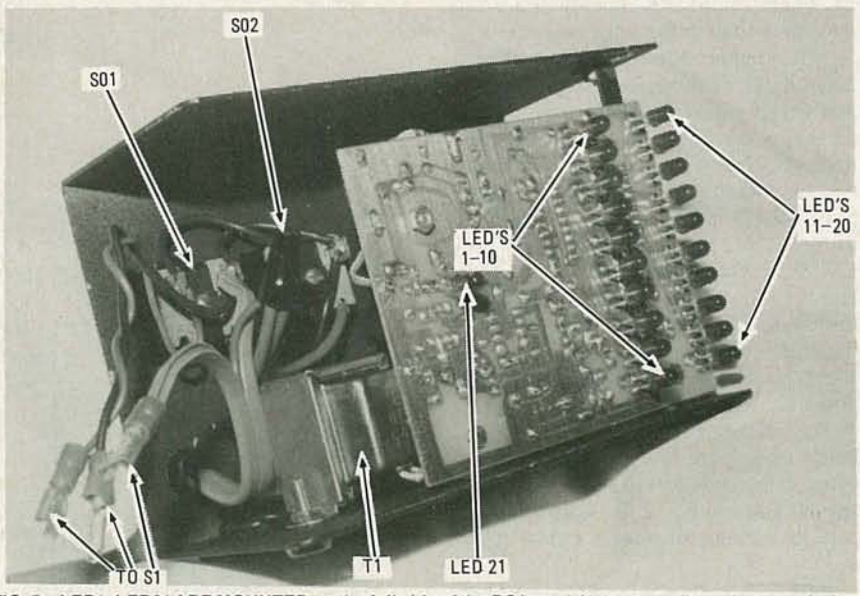


FIG. 5—LED1–LED21 ARE MOUNTED on the foil side of the PC board. Using a cardboard spacer during installation as described in the article helps ensure that all of the LED's are mounted at the same height.

oriented properly.

Next, install the diodes. Once again, carefully note their orientation (see Fig. 3). It is a good idea when soldering semiconductors to attach an alligator clip to the lead being soldered. The clip acts as a heat sink to protect the device from damage during soldering. Diodes D1–D4 are all installed vertically as shown in Fig. 4. When done with the diodes, install the transistors.

Install the IC's next, noting the orientation of pin 1. Pin 1 may be marked with a painted band, notch, or dot. With the marked end on top, pin 1 is in the upper left corner. The LM7812 regulator, IC5, should be installed so that when bent back, its flat side is flush with the board. Next install the bridge rectifier, BR1, again noting the proper orientation.

Next solder S2 in place on the PC board. Then install the five jumper wires; either bare or insulated wire may be used. The LED's, which mount on the foil side of the board (see Fig. 5), should all be positioned at the same height. To make the task easier, insert a cardboard spacer, about ¼-inch wide, beneath the LED's during soldering.

As the circuit does not require any special shielding, it can be placed in any appropriately sized cabinet. Prepare the cabinet by drilling carefully spaced holes into the front panel for each LED. Or you may cut out a single block and use a bezel with lens to improve the unit's appearance. The relay, transformer, power switch, AC outlets, and input/output jacks are mounted on the cabinet as shown

continued on page 119

HOW TO

Servicing Cordless Telephones

A cordless telephone, like any other piece of electronic equipment, is bound to break down sooner or later. This article will show you how to troubleshoot and repair the problem.

CHRISTOPHER KITE

CORDLESS TELEPHONES ARE FAIRLY COMplex pieces of electronic equipment that in addition to containing all of the circuits of a standard telephone, also include two FM transmitters and receivers. If you've ever done any troubleshooting of communications equipment, you should have little trouble servicing cordless telephones. The radio portion is pretty straightforward, once you understand the frequency scheme and modulation technique used. However, telephone circuit operation and testing techniques may be somewhat new to you, and as such, special attention will be given to that area of servicing in this article.

Of course, an article like this cannot cover all the variations found among the numerous brands and models of cordless telephones available. However, the basic operation of all cordless telephones is the same. The examples cited in this article can be readily adapted to the particular make and model you are servicing to help you track down specific problems in most cordless telephones.

How they work

Before we jump into our look at troubleshooting, let's learn a bit more about how a cordless telephone works. Basically, a cordless telephone contains all the circuits and functions of a conventional telephone, plus a two-way radio communication link. The two-way radio link must handle not only voice communications, but also some method of dialing, ringing, and controlling the hook switch.

Cordless telephones are made up of two

separate units: a base unit and a portable unit. Communications between the base and portable units are full duplex: that means that both the base-to-portable link and the portable-to-base link can operate simultaneously. Both the base and portable units have a transmitter and a receiver. The base unit is connected directly to the telephone line and serves as a link between the portable unit and the telephone line. Figure 1 shows how a typical cordless telephone system works. A block diagram of a cordless phone is shown in Fig. 2.

Cordless telephone base-to-portable links use a carrier signal in either the 1.7-MHz or 46-MHz frequency band. Earlier cordless telephone base-to-portable links use the 1.7-MHz band and use the AC power line as an antenna. That is necessary because a relatively long antenna is required at that low a frequency. Newer cordless telephone base-to-portable links use the 46-MHz band and a telescoping antenna. The base unit contains a power supply (operating from the AC line) that is used to power the transmitter and receiver and also to charge the batteries of the portable unit.

Cordless telephone portable-to-base links use a carrier signal in the 49-MHz frequency band. That signal is transmitted using a telescoping antenna. In addition to the transmitter and receiver, portable units contain a speaker, microphone, dialing keypad, and rechargeable batteries.

There are 10 pairs of carrier frequencies available for cordless telephone operation. Each base-to-portable channel has a specific corresponding portable-to-base channel. The frequency pairs are listed in Table. 1. Initially only the 1.7/49-MHz bands were allocated by the FCC. The 46/49-MHz bands were added after January 1, 1984.

Because of the limited number of cordless telephone frequencies, the same channels are used over and over again. With the relatively short range of cordless telephones and the use of the following techniques, a minimum of interference, false ringing, and security problems (i.e. unauthorized capturing of a telephone line) occur.

False ringing is reduced by using several specific ring frequencies for the base-to-portable link. In that way, two cordless telephones with overlapping range and operating on the same channel, but with different ring frequencies, will not cause ringing of the neighboring unit.

Similarly, use of several specific guardtones (pilot signals) for the portable-to-base link reduces unauthorized use of a telephone line. The base unit will not respond to a portable unit unless the proper guardtone is sent. That prevents capture of a base unit by a nearby portable unit on the same channel, but with a different guardtone.

Earlier cordless telephones used only

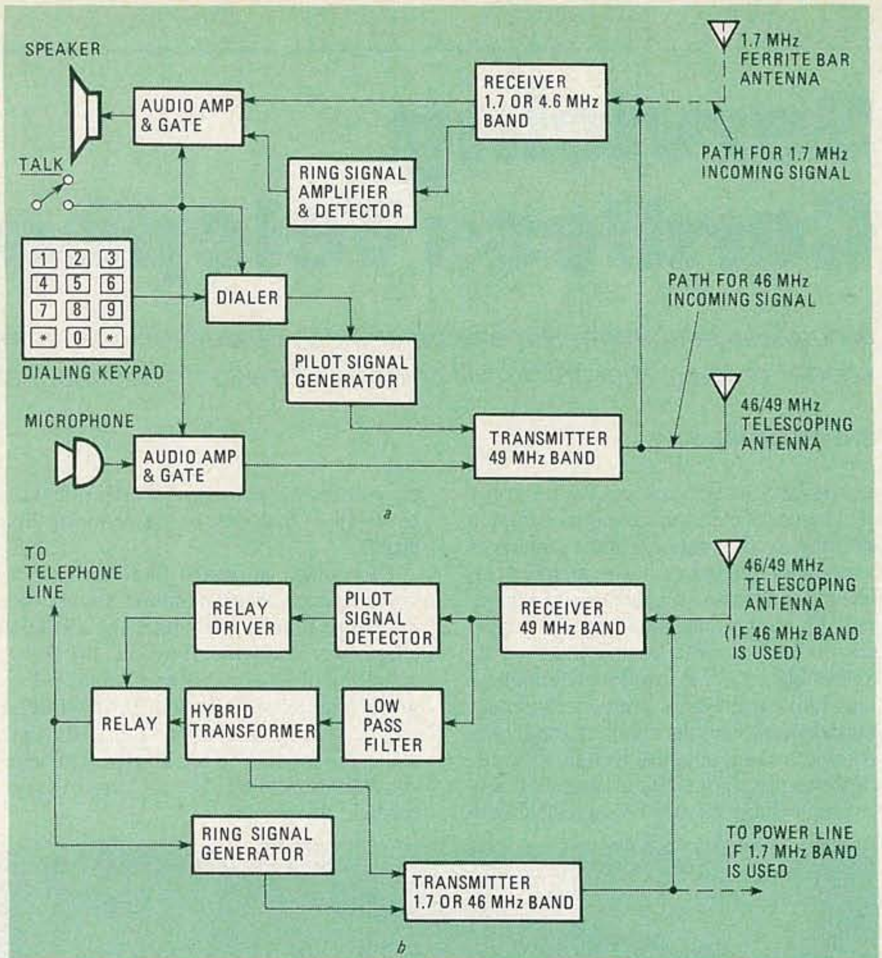


FIG. 2—HOW A CORDLESS TELEPHONE WORKS. A block diagram of a portable unit is shown in *a*, while the block diagram of the base unit is shown in *b*.

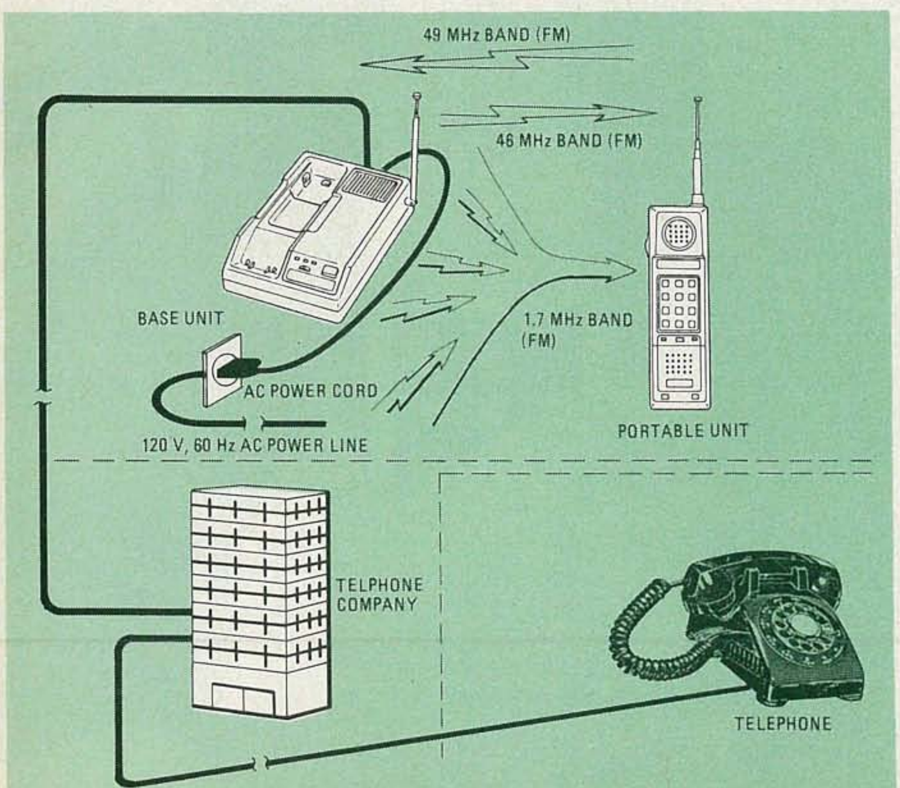


FIG. 1—THE BASE UNIT'S TRANSMITTER in a 1.7-MHz unit uses the base's AC power line as an antenna. That can pose some additional complications when servicing the cordless phone.

TABLE 1—CORDLESS TELEPHONE FREQUENCIES

1.7 MHz Band Frequencies	49 MHz Band Frequencies	46 MHz Band Frequencies
1.665 MHz	49.670 MHz	46.610 MHz
1.690 MHz	49.770 MHz	46.710 MHz
1.695 MHz	49.830 MHz	46.770 MHz
1.710 MHz	49.845 MHz	46.630 MHz
1.725 MHz	49.860 MHz	46.670 MHz
1.730 MHz	49.875 MHz	46.730 MHz
1.750 MHz	49.890 MHz	46.830 MHz
1.755 MHz	49.930 MHz	46.870 MHz
1.770 MHz	49.970 MHz	46.970 MHz
	49.990 MHz	46.930 MHz

guardtones and ring frequencies to help prevent unauthorized capturing of telephone lines and false ringing. New cordless telephones use digital coding. With digital coding, ringing, dialing, and disconnecting are usually caused by a frequency shift of the carrier. That frequency shift is digitally encoded, and the encoding techniques vary from one manufacturer to another.

Incoming calls

Between calls, the cordless telephone is in a "standby" mode; that is, both the base and portable transmitters are turned off and both receivers are awaiting incoming signals.

When a 20-Hz ringing signal is received by the base unit from the telephone line, a 20-Hz ring detector turns on the base-unit transmitter and a ring-signal generator circuit that feeds a ring signal to the transmitter. Typically, that ringing signal has a frequency in the 700-Hz to 1500-Hz range. Different frequencies are used for ring signals in different cordless telephones to help prevent false ringing (i.e. the ringing of portable units that use the same channel when the ring signal does not originate from that portable unit's base unit). At the transmitter, the ring signal is used to modulate a carrier signal (either in the 1.7- or 46-MHz band). That modulated carrier is then transmitted to the portable unit.

The receiver section of the portable unit has power if the the portable unit is in either the talk or standby mode, as long as the power is turned on and the batteries are charged. The incoming signal is demodulated by the receiver and fed to the ring-signal detector. The ring-signal detector is a filter that only passes a ring signal of a certain frequency. If the ring frequency transmitted by the base unit is correct (i.e. is passed by the filter), the ring signal is passed to an audio amplifier. There the signal is amplified and fed to the speaker.

When someone answers the call, the portable unit is switched from the standby mode to the talk mode. That disconnects the ring signal from the amplifier and turns on the RF transmitter, pilot-signal generator, and both of the audio-amplifiers-and-gates. The pilot signal (guardtone) and audio (from the microphone) are fed to the transmitter where they modulate a 49-MHz band carrier. That modulated signal is then transmitted over the telescoping antenna to the base unit.

The base unit receives the signal, demodulates it, and feeds it to the pilot-signal detector and a low-pass filter. When the pilot signal (guardtone) is of the correct frequency, the pilot-signal detector energizes the relay into an off-hook condition through the relay driver. The off-hook relay turns on the base-unit transmitter. The low-pass filter blocks the guardtone and feeds voice audio (300 Hz to 3 kHz) to the hybrid transformer. The hybrid transformer feeds the audio signal to the relay where it is sent out over the telephone line when the relay is in the off-hook state. The hybrid transformer also feeds a low-level audio signal to the transmitter for sidetone in the portable unit.

Incoming audio (from the telephone line) is fed through the relay to the hybrid transformer when the relay is in the off-hook state. That audio signal is fed to the transmitter where it is used to modulate a carrier signal in either the 1.7- or 46-MHz band. That modulated signal is transmitted over the antenna to the portable unit.

The portable-unit receiver demodulates the signal and feeds it to the audio-amp-and-gate. When the portable unit's switch is in the TALK position, the demodulated audio signal is amplified and fed to the speaker (earpiece).

Outgoing calls

When a telephone call is initiated from a cordless telephone, the portable unit is switched from the standby mode to the talk mode. That turns on the transmitter and pilot-signal (guardtone) generator. The guardtone or pilot signal is typically a frequency tone in the 4- to 7-kHz range. The pilot signal modulates a 49-MHz-band carrier, and is transmitted to the base via the telescoping antenna.

That signal is demodulated by the base unit's receiver and fed to the pilot-signal detector and the low-pass filter. The pilot-signal detector energizes the relay to an off-hook state (through the relay driver) if the pilot signal is at the correct frequency. The cordless telephone is now off-hook and a telephone number can be dialed. The low-pass filter only allows signals below 3 kHz to pass, so the guardtone signal is rejected by the low-pass filter, while dialing and voice signals are allowed to pass.

When a digit on the keypad (located on the portable unit) of a pulse-dial cordless telephone is pressed, the pilot signal is interrupted a certain number of times for each digit. The relay goes from off-hook to on-hook each time the pilot signal is interrupted. That on-hook/off-hook change at the relay causes dialing pulses to go out over the telephone line. Those pulses are decoded by the telephone exchange in the same manner as the pulses from an ordinary pulse-dial telephone, and the telephone call is routed to the telephone number dialed.

Turning to a DTMF (tone dial) cordless phone, when a digit on the keypad of the portable unit is pressed, the dialing tones and guardtone are used to modulate the carrier signal. Dialing tones have frequencies in the 300–3000 Hz band, and guardtones have frequencies above 3000 Hz. The modulated signal is received by the base unit, demodulated, and then (if the guardtone frequency is correct) the tones are sent out over the telephone line, decoded, and used to route the telephone call just as with a standard telephone.

As we said earlier, when in the off-hook state, both transmitters operate in a full-duplex mode to permit talking and listening simultaneously. Incoming and outgoing audio are handled as described in the previous section. When the call is completed, the cordless telephone portable unit is set back to the the standby mode and the pilot signal is discontinued. That causes the base-unit relay to go back to an on-hook state and incoming calls can now be accepted.

Test equipment

The proper test equipment is essential for effective cordless telephone troubleshooting. General-purpose test equipment such as a multimeter, oscilloscope, and audio generator will fill part of the requirements, but some special-purpose telephone test equipment is also needed. First, we must either tie up a telephone line (for some tests two lines are needed) or use a telephone line simulator. A 48-volt DC power supply fed through a 1.5 kilohm series resistance will suffice for the basic telephone-line simulator, with input/output jacks for applying ring voltage and test tones, and measuring dialing and audio signals.

A 20-Hz ring generator is also needed; it should provide an output that is variable from 45- to 100-volts RMS. A ring generator is a special-purpose device used only for telephone testing. Ideally, the ring generator should shut off automatically when the telephone is taken off-hook. If not, you must be very careful never to take the telephone off-hook when the high-voltage (45–100-volts RMS) signal is applied. Applying such a high voltage to an off-hook telephone may damage the telephone.

Another special-purpose device is a dial decoder. It is used to determine whether the telephone is dialing the correct digits.

For RF testing, we need a method of measuring transmitter RF-level. The simplest method is to use an RF probe and a multimeter. The RF probe can be touched to the antenna for RF level measurements. That technique is not useful for 1.7-MHz band transmitters that use the AC power line as an antenna. For those, a special tester is required.

A deviation meter is needed for measuring FM modulation and an FM-modulated, RF signal-generator is needed for receiver testing. A frequency counter is good for measuring transmitted RF carrier-frequency and setting the RF-signal generator on frequency. It is also needed for measuring guardtone and ring-signal frequencies, whether generated by the cordless telephone or by an audio signal generator for injection into a cordless telephone. Note that once again, 1.7-MHz transmitters may prove to be a problem in that sometimes the radiated signal level is insufficient to drive a frequency counter.

One piece of equipment that the author has found useful is the B&K-Precision model *1050* telephone analyzer (see Fig. 3). It includes many of the specialized test instruments required in cordless telephone repair. Among those are a telephone-line simulator, 20-Hz ring generator, pulse- and DTMF dial-decoder, FM-deviation meter, RF-signal generator (for cordless-telephone frequencies only), a dummy load for measuring 1.7-MHz RF levels, two audio generators, and other convenience features. A general-purpose oscilloscope, multimeter, frequency counter, and service manual for the telephone being serviced complete a well-equipped test bench for cordless telephone servicing.

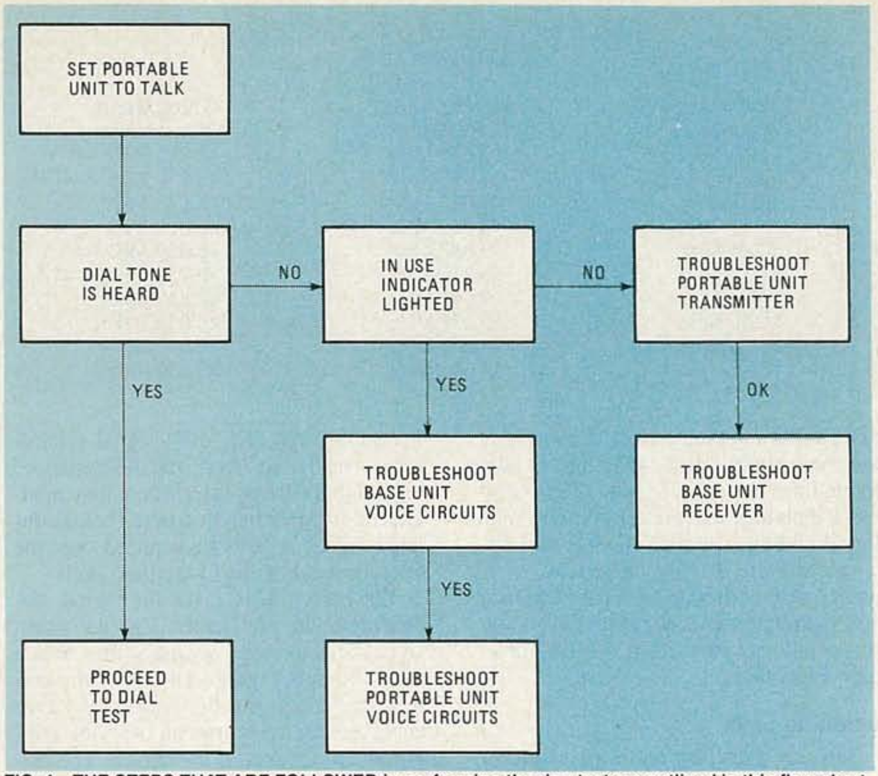


FIG. 4—THE STEPS THAT ARE FOLLOWED in performing the ring test are outlined in this flow chart.

Operational tests

Let's start our cordless telephone tests with a ring test, dial-tone test, dial test, and voice test. Even if you have a complete description of the symptoms, and have a fairly good idea of where the problem lies, it is a good idea to verify those symptoms and performing the above operational checks will usually do it. They take very little time to perform, no more than 10 or 15 seconds for the entire sequence. If problems are encountered during any of the tests, you will have at least isolated the problem to a particular section and a few additional tests will narrow it down to a specific circuit or component.

FIG. 3—THE B+K *1050* telephone analyzer contains many instruments and features required to adequately service a cordless telephone.

If the cordless telephone passes those tests, we know that it will operate at short range. We can then proceed to check more subtle symptoms such as short range, interference, etc.

To perform a ring test, apply AC power to the base unit and connect it to a telephone jack. Leave the portable unit in standby (on-hook). Apply a 100-volt, 20-Hz ring signal to the telephone line and see if the portable unit rings. If the telephone does not ring, ring-test troubleshooting is needed. If the telephone rings, check further that the ringing threshold is below 45 volts. If not, troubleshoot that problem. If so, proceed to the dial-tone test.

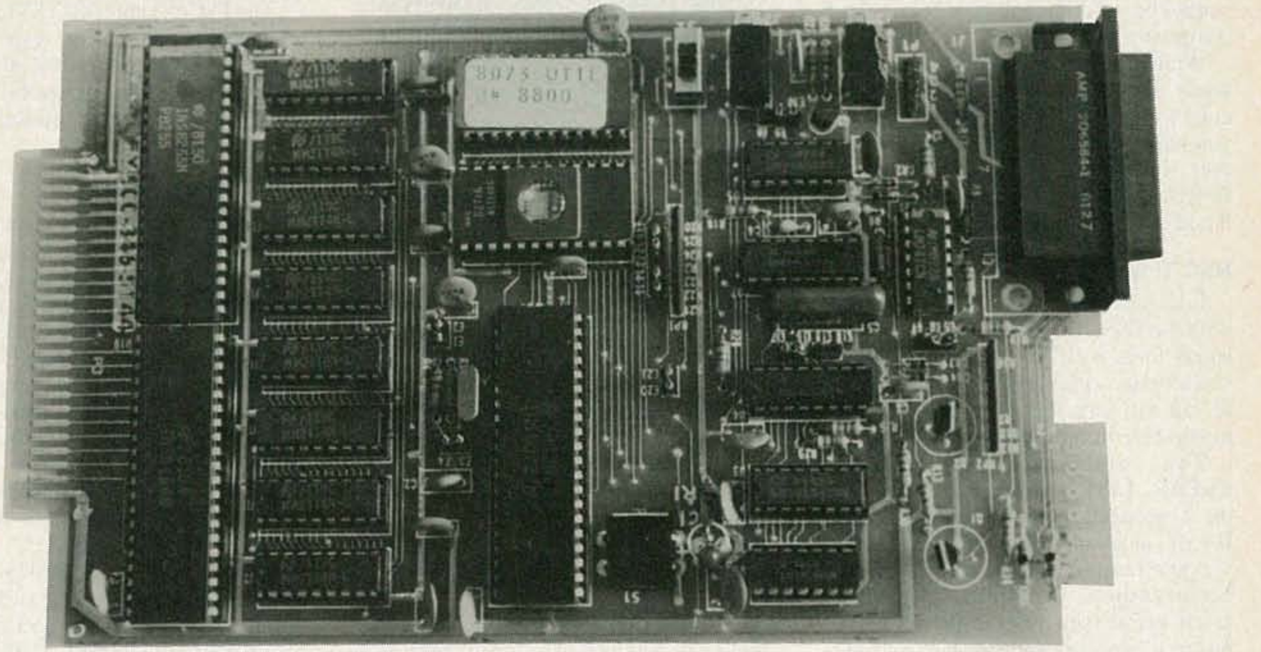
To perform a dial tone test, first remove the 20-Hz ring signal. Then simply set the portable unit to TALK and listen for the dial tone. If the dial tone is not heard, dial-tone-test troubleshooting is needed. If everything is working, proceed to the dial test.

To perform the dial test, dial each digit, 0 through 9, and observe whether the correct digits are shown on the dial decoder. If not, dial-test troubleshooting is needed. If dialing is normal, proceed to the voice test.

To perform the voice test, speak into the mouthpiece and listen to the earpiece for correct sidetone level and overall voice quality. If satisfactory, the cordless telephone is operational. If not, voice-test troubleshooting is needed.

Let's now see what the above tests show us, and how they can be used to help

continued on page 118



How to Design Microprocessor-based Projects

Make your next project "intelligent." Use a single-chip microcomputer to control it.

TOM FOX

Part 2 LAST MONTH, WE INtroduced National Semiconductor's INS8073 microinterpreter and described, in detail, its pin connections and their functions. In this second part of the series we will look at a handy demo/development board as well as introduce the language of the 8073, NSC Tiny BASIC.

Before we get started with that, we should mention that National Semiconductor has, unfortunately, discontinued production of the INS8073. However, many suppliers still have stocks of that IC, so you should be able to find it rather easily. Even if you can't, don't worry. There are many other single-IC computers available. You may even learn more if you try to use another microinterpreter.

Even if you don't want to pore over data sheets and design interfacing circuits, you can still put the power of a microinterpreter to work by using development and demonstration boards. Several manufacturers offer such boards. For example, we'll look at a demonstration board for the INS8073 that is available from Digi-Key Corp. (Highway 32 South, PO Box 677, Thief River Falls, MN 56701). That board, shown in Fig. 5, sells for $250. A user manual is $10.

The demonstration board makes designing with the 8073 so simple it seems as if you're cheating! After you receive the board, all you have to do to start programming in NSC Tiny BASIC is to connect up power (+5 and −12 volts). If you use an RS-232 terminal, you have to add a jumper to the board, and use a standard male-male cable to connect the D-type connector on the board (J1) to your terminal's RS-232 connector. Of course, you can also use your computer along with communications software to emulate a smart terminal. Baud rates (110, 300, 1200 4800 baud) can be set by adding jumpers on the board.

After you turn on the power, a prompt (>) should appear on your terminal screen. You are then ready to start programming in Tiny BASIC.

Besides being easy to hook up and get running, the development board contains 4K of RAM, a 8255 programmable peripheral interface IC, an 8154 RAM-I/0 that provides 128 bytes of scratch-pad memory for use in assembly-language subroutines, and has 16 I/0 lines that can be individually programmed.

Perhaps the nicest features of the board is that it has an EPROM-resident utility program as well as an EPROM programmer (which is controlled by the utility program). The utility program allows you to store and retrieve programs on cassette tapes and download programs from a "host" computer. It also has a variety of other features such as the DUMP command, which allows you to "display" part of memory in both the hexadecimal and converted ASCII format. However, for our purposes (the design of smart machines), its greatest feature is that it makes the programming of EPROM's easy and nearly foolproof. All you need is a single-supply 2716 EPROM and a +25-volt source. The built-in program does all the rest. One caution: the S (setup) command is not mentioned in the manual, but it should be used immediately before the P (program) command.

While the demonstration board is definitely helpful if you want to design circuits using the 8073, it is not essential if you have access to an EPROM programmer. However, if you don't have an EPROM programmer available, then the board is recommended.

NSC Tiny BASIC

Like most tiny BASIC's, that supplied with the INS8073 allows only signed integers from −32767 to +32767 and 26 single-letter variables (A to Z). However, as you will soon see, this Tiny BASIC is remarkable in most other respects.

The commands RUN, CONT, CLEAR, LIST, and NEW are similar to the commands used by many standard BASIC languages. The command NEW<expr> resets the program pointer to that of the <expr>. That command should be given before you enter a program. For instance, say you want to start your program at 1100H. (The "H" indicates that the number is in hexadecimal). You should type: NEW#1100<return> and then type: NEW<return>. NOTE: In NSC Tiny BASIC "#" is used as a prefix to indicate to the interpreter that the number is in hexadecimal. Numbers that do not have that prefix will be treated by the interpreter as if they are decimal.

The following NSC Tiny BASIC statements and operators are similar to those of other BASIC's and will be listed without comment: REM, LET, PRINT, IF–THEN, FOR–NEXT, GOTO, GOSUB, RETURN, INPUT, STOP, +, −, ×, /, >, <, =, AND, OR, NOT, and MOD.

The DO–UNTIL, statement is used to program loops and has been borrowed from PASCAL. That statement is rare in the BASIC language, although the proposed ANSI standard BASIC contains it.

The LINK statement is used to transfer control to machine language subroutines, which can be used where speed is important.

The DELAY statement causes a delay in the program execution up to a maximum of just over 1 second. The number following the DELAY statement gives the time in milliseconds that the program will be delayed. DELAY 100 causes a delay of about 100 milliseconds (1/10 of a second) and DELAY 0 gives the maximum delay of about 1040 milliseconds. (Note all times are only approximate and depend on the frequency of the clock.) The DELAY command is used extensively in our example project.

The function RND (random) is also used frequently in our example project.

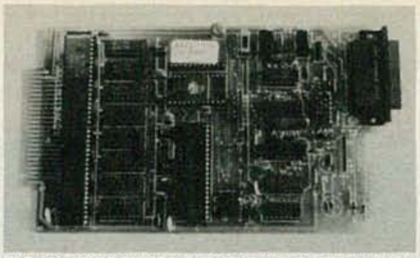


FIG. 5—THIS DEMO/DEVELOPMENT BOARD is not necessary if you want to use the 8073, but its on-board EPROM programmer and utility program makes it easy.

The statement LET A=RND(1,10) assigns a pseudo-random number between 1 and 10 (inclusive) to the variable A.

Let's take a look at a short program segment that will give us a delay in program execution between 1 and 5 seconds:

```
310 LET L=0
320 LET M=RND(1,5)
330 DELAY Ø
340 LET L=L+M
350 IF L<5 GOTO 330
```

The TOP function gives the address of the top of memory. (The top of memory is the first memory location in external RAM that is not used by the NSC Tiny-BASIC program.)

The following is an example of how the TOP function is used. (Note that this example is printed here exactly as it would appear on your terminal.)

```
>NEW#1100
>NEW
>10 PRINT TOP
>RUN
4366
```

The number displayed on the terminal after the program has run (4366) is the first address of unused RAM. Note that like all numbers displayed on the terminal under the control of the INS8073 microinterpreter, 4366 is in decimal. While the interpreter "understands" numbers given to it in hexadecimal (with a "#" prefix), it only displays decimal numbers on the terminal.

The STAT function allows you to monitor and set the 8073 status register. For details on that register, refer to the *National Semiconductor Tiny BASIC User Manual* and/or the INS8070 data sheet.

The ON statement is used for processing interrupts. It has two formats; ON 1 <expr> and ON 2 <expr>. Notice there are two interrupts, 1 and 2. Number 1 interrupt occurs when there is a high-to-low transition at pin 38. Interrupt number 2 occurs when there is a high-to-low transition at pin 39. After the 8073 senses the interrupt, the interpreter will execute a GOSUB beginning at the line number given by <expr>. It is important to note that the statement, STAT="odd number" (where the odd number is often 1), should be used before an ON statement in order to enable the interrupts.

The INC(X) and DEC(X) functions increment and decrement, respectively, the memory at the locations given by X. Those functions are useful in multiprocessing. For our purposes, however, we will ignore them.

The indirect operator

One of the most important features of NSC Tiny BASIC, especially for those who look to the 8073 to provide "brains" for "brainless" machines, is the indirect operator "@." That operator is simpler to use than the PEEK and POKE commands found in most BASIC languages. For instance, to store a 4 (decimal) at location C000H, simply make the following statement; @#C000=4. The statement "LET B=@#6000" sets the value of the variable B equal to the value stored at the hexadecimal address 6000.

Be aware that the INS8073 is an 8-bit device and it can only store an 8-bit binary number (0 to 255 in the decimal system) at any memory location. Thus, if you use the @ operator to attempt to store a two-byte (16 bit) number or larger at any memory location, you might experience sleepless nights trying to debug your program. The interpreter will only "see" the least-significant byte. For instance, the statement "@#C000=260" (260=100000100) would actually store "4" (00000100) at location C000.

Putting the microinterpreter to work

Now that we've introduced you to the INS8073 microinterpreter and taken a quick look at a demo/development board and the NSC Tiny BASIC language, it's time to design a project that is based on the 8073. In particular, we will describe, in detail, how to build a "burglar outwitter."

The first step in the design of any project should be to decide exactly what you want the project to do. As the name of this project suggests, we would like to fool or outwit a burglar into thinking that someone is in the house, even when it is empty. The circuit we'll describe is fairly simple—it's meant simply to be a demonstration of what you can do with the INS8073. If you decide to build such a device, you'll learn a lot more if you customize the circuit and/or program to better meet your needs. We'll give you some hints on how to do that.

The burglar outwitter

We want our demonstration circuit to control three lights: The living-room light (called light A), the hallway light (light B) and the bathroom light (light C). When it gets dark, we want light A to go on for random length of time between 10 and 60 minutes. We want light B to go on about a second after light A goes out. Light B will stay on for 1 to 5 seconds. About a second after light B goes out, we would like light C to light for a random length of time that is no greater than 20 minutes but no less than 5 minutes. About a second after this light goes out light B should go on and stay lit for 1 to 5 seconds. After a second pause let's have light A go on again, but only if it is still dark.

That completes the first cycle. After 5 such cycles, we would like the controller to go into a "sleep" phase for the rest of the night. During that "sleep" phase, light C (the bathroom light) will go on every 1½ to 5 hours for between 1 and 10 minutes. That should continue until sunrise, when the controller will be reset and prepared for the next night.

If possible, we would like to use a 2716 EPROM to store the software. And we would like to design the system so that it is easy to expand. After all, we'll probably want to add another light—or maybe a dozen appliances.

Now that we know what we want our controller to do, we have to design an actual circuit to do the job. First, however, let's look at some input and output details. Let's pick address C000H for both our output and input port address. Note that C000H is equal to 1100 0000 0000 0000 in binary notation. To decode that address, address lines A15 and A14 (the two most significant bits) must be high while A13 and A12 are low. (We don't care about the other address lines here since there is no memory at those locations.)

The NSC Tiny BASIC statement LET B=@#C000, assigns the value at address C000 to the variable B. (Remember the prefix "#" stands for "hexadecimal" in NSC Tiny BASIC.) We have to design a circuit that places information on dark/light at input-port location C000. When its dark, let's make D0 "one" (high) and when its light, let's have D0 "zero" (low).

For the output port, we will use the same address, C000. We can do that because the 8073 has READ and WRITE control lines that tell external circuits (such as address decoders) whether the 8073 is inputting information (reading) or outputting information (writing). TTL latches will be used to temporarily store output information. We'll use one latch for each light controlled.

The output circuit will be designed so that the statement @#C000=1 will set latch 1. Also the statement @#C000=2 will set latch 2 and @#C000=4 will set latch 3. All latches will be reset by the statement @#C000=0. (Note that those statements work because a decimal 1 = 00000001 (binary), 2=00000010 (binary) and 4=00000100 (binary).

A buffer/driver/relay circuit will be connected to the latches' output to actually control the lights. But we're getting a little ahead of ourselves. We'll go into specific detail on how to wire real-life parts. But first, let's look at a program that will accomplish our objectives.

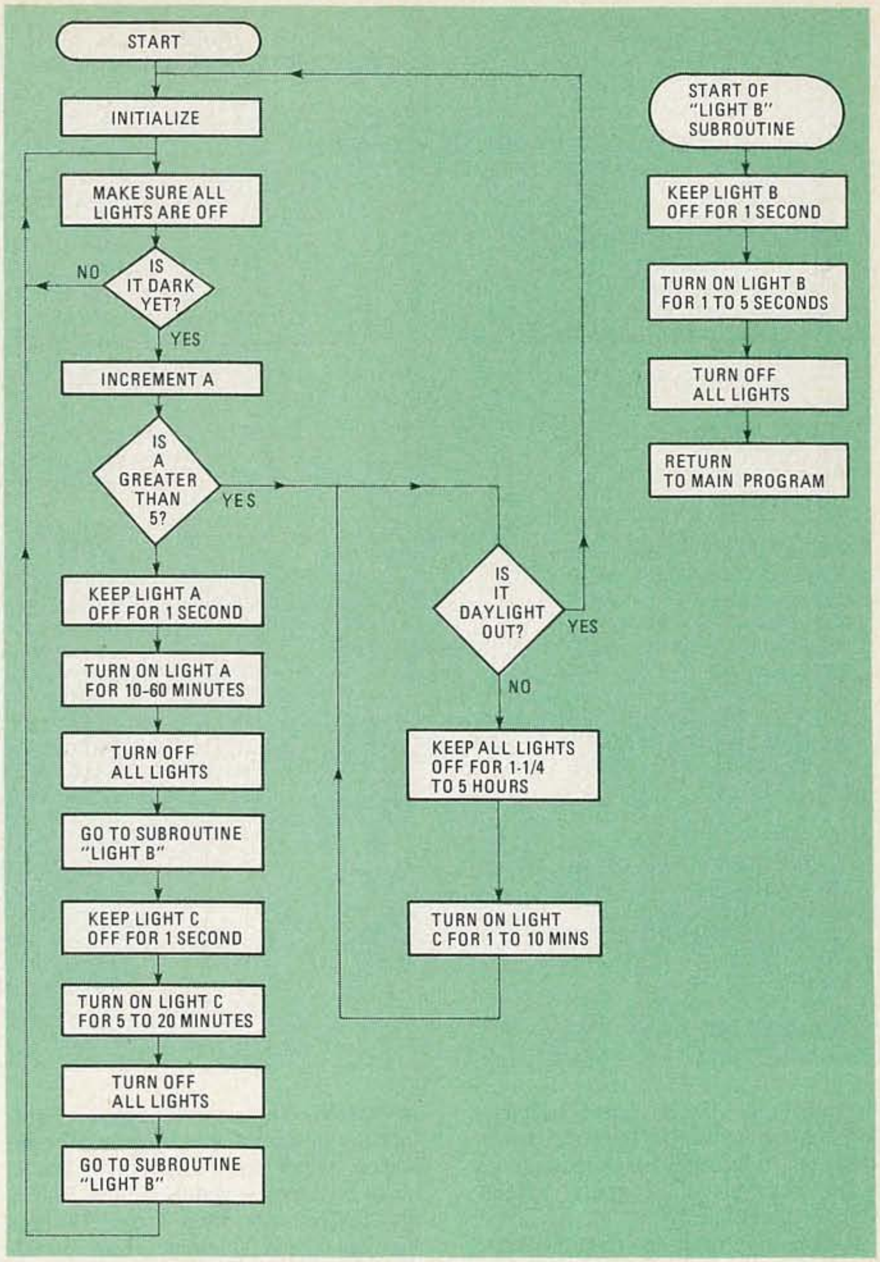


FIG. 6—THE FLOW CHART FOR the burglar outwitter. The actual program could have been written more compactly, but then it wouldn't have been as valuable a learning tool.

The control program

The first step in writing any non-trivial program should be the sketching out of a flow chart. Figure 6 shows a simplified flow chart for our BASIC program. Although this project has a definite practical application, it also provides us with the opportunity to explain the basics of designing with the INS8073. You may find that the program (and circuit itself) was not designed to be especially compact. The primary objective is to have something that's easy to understand. You might like to write a shorter and more elegant program that accomplishes the same task.

The wordy program shown in Table 1 is allowable here since there is plenty of memory space in the 2716 EPROM. Longer, more complicated programs may not fit in a single 2716.

While we could go through the program line-by-line to explain its operation, it is probably less confusing to study the flowchart. There are some lines that we should describe, however.

The program statement in line 20 turns off all lights, while the statement in line 30 places information on dark/light into variable B. In line 40, all data bits are masked except the least-significant bit of data (D0). The variable "C" has the value of 1 when it's dark and 0 when light.

When it's dark, the statement on line 60

TABLE 1
BURGLAR OUTWITTER PROGRAM

```
  1 REM GHOSTLY BURGLAR OUTWITTER PROGRAM
  5 REM SET ALL VARIABLES TO ZERO AND INITIALIZE
 10 CLEAR
 20 @#C000=0
 25 REM TEST FOR DARKNESS
 30 LET B=@#C000
 40 LET C=1 AND B
 50 IF C=0 GOTO 20
 55 REM ITS DARK SO INCREMENT A
 60 LET A=A+1
 70 IF A>5 GOTO 500
 80 GOSUB 200
 90 GOSUB 300
100 GOSUB 400
110 GOSUB 300
120 GOTO 20

200 LET J=0: DELAY 0
205 REM TURN ON LIGHT A
210 @#C000=1
220 LET K=RND(1,6)
225 REM KEEP LIGHT A ON FOR 10 TO 60 MINUTES
230 DELAY 0
240 LET J=J+K
250 IF J<3600 GOTO 230
255 REM TURN OFF LIGHT A
260 @#C000=0
270 RETURN

300 LET L=0: DELAY 0
305 REM TURN ON LIGHT B
310 @#C000=2
320 LET M=RND(1,5)
325 REM KEEP LIGHT B ON FOR 1 TO 5 SECONDS
330 DELAY 0
340 LET L=L+M

350 IF L<5 GOTO 330
355 REM TURN OFF LIGHT B
360 @#C000=0
370 RETURN

400 LET N=0: DELAY 0
405 REM TURN ON LIGHT C
410 @#C000=4
420 LET P=RND(1,4)
425 REM KEEP LIGHT C ON FOR 5 TO 20 MINUTES
430 DELAY 0
440 LET N=N+P
450 IF N<1200 GOTO 430
455 REM TURN OFF LIGHT C
460 @#C000=0
470 RETURN

500 LET A=0: LET D=0: LET F=0
510 LET E=RND(1,4)
515 REM TEST FOR DAYLIGHT
520 LET H=@#C000
530 LET I=1 AND H
535 REM IF ITS NOW LIGHT OUT BRANCH TO START
540 IF I=0 GOTO 10
545 REM IF STILL DARK WAIT FOR 1¼ TO 5 HOURS
550 DELAY 0
560 LET D=D+E
570 IF D<18000 GOTO 520
575 REM TURN ON LIGHT C
580 @#C000=4
590 LET G=RND(1,10)
595 REM KEEP LIGHT C ON FOR 1 TO 10 MINUTES
600 DELAY 0
610 LET F=F+G
620 IF F<600 GOTO 600
625 REM TURN OFF LIGHT C
630 @#C000=0
640 GOTO 500
```

increments the "sleep-phase variable," A. After that has been incremented past 5, statement 70 instructs the program to go to the "sleep phase" program segment, which starts at line 500.

If there have been less than 5 passes, the program jumps to the subroutine at line 200, which controls light A. First, the subroutine clears the variable J and delays the program for about a second (DELAY 0). Next, the subroutine turns on light A (@#C000=1). The statement on line 220 sets K equal to a pseudo-random number between 1 and 6. The statement "DELAY 0" delays further program execution for about a second and is the first part of the loop, which consists of the statements in lines 230, 240, and 250. The statement in line 240 increases the value of the variable J by the amount of K. (Remember "K" is between 1 and 6.) Line 250 causes a branch to line 230 if J is less than 3600. Note that if K=1, this program loop will cause a delay of about 3600 seconds (60 min.). When K=6 the delay is about $3600/6 = 600$ seconds (10 min). Notice that with this program shorter delay times are more likely than longer ones. That fact has nothing to do with an inherent defect in the RND command. Rather, it is built-into the design of the program. For instance, when K=2, the delay time is about 30 minutes, with K=3 the delay is about 20 minutes. There is no delay time between 60 and 30 minutes. Can you figure out the approximate delay times for K=4 and K=5?

The other light-control subroutines work the same way, but take the time to read through them to make sure you understand.

The statement at line 120 causes a branch back to line 20. After making sure all lights are off, the program checks to see if it's still dark out and if it is, variable "A" is incremented. When A reaches 6, the program branches to line 500. The program segment from lines 500 to 640 is the sleep phase. Lines 520, 530 and 540 check to make sure it's still dark. If it is light, the program branches back to the beginning. If it's still dark the program proceeds. Lines 550, 560 and 570 causes a delay of between 4,500 seconds (1¼ hours) and 18,000 seconds (5 hours).

When that "rest" time is over, the next statement, @#C000=4, turns on light C. The delay loop formed by the statements in lines 600, 610 and 620 keeps light C on for a period of time between about 1 and 10 minutes. The statement "@#C000=0" turns off all lights and the program branches back to line 500.

The controller circuit

The schematic of the complete burglar outwitter is shown in Fig. 7. The first thing we'll look at is photodarlington transistor Q1, which monitors the light level. When hit by light, the photodarlington conducts current. That produces a voltage drop across R4. That voltage also appears at pin 3 of IC5-a, the op-amp's non-inverting input. When the voltage at that input exceeds that at the inverting input (pin 2), the op-amp output of jumps to almost 5 volts. That triggers IC6-a (a Schmitt trigger NAND gate), whose output jumps low.

The output of IC6-a is fed to the input of the three-state buffer, IC7-a. This buffer is enabled only when a READ operation is taking place on location C000. (When a three-state buffer is not enabled, it is basically disconnected from the circuit.) The decoding for that buffer is provided by IC6-b, IC9-a and IC10-a.

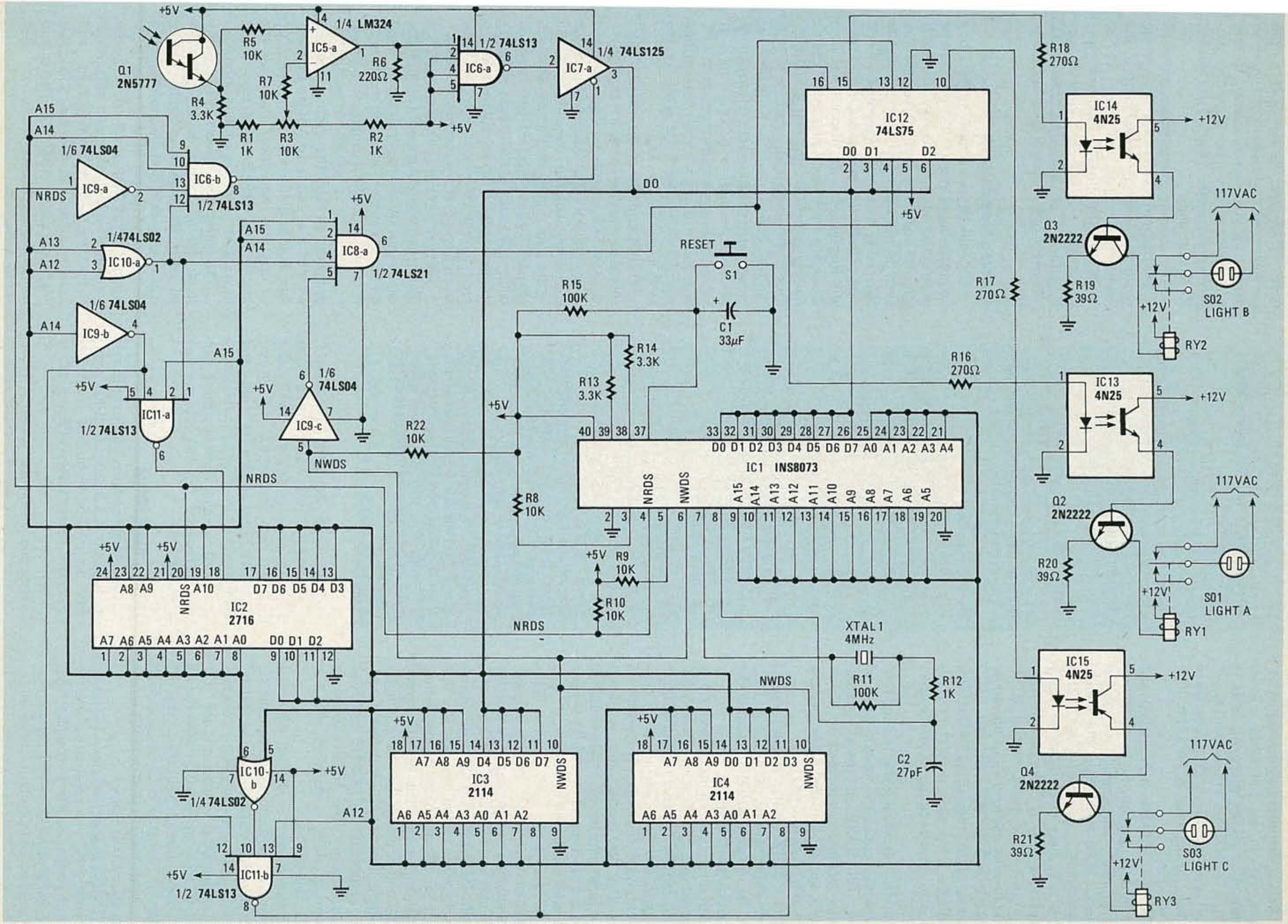


FIG. 7—THE BURGLAR OUTWITTER. Note that, although not shown in the schematic, bypass capacitors (about .1 µF) should be installed at each IC between the power lead and ground.

The output of IC7-a is fed to data-line DØ. Pulling the previous discussion together, we can see that when a READ operation is taking place on address C000, IC7-a's output will be low (DØ will be Ø) when it is light out. Of course, when it's dark, the output of IC7-a will be high (DØ will be 1).

The 2716 EPROM, IC2, contains our Tiny BASIC program. As far as the microinterpreter is concerned, it is located at addresses 8000 to 87FFH. The address decoder for IC2 consists of IC9-b, IC10-a and IC11-a. Since the EPROM's OUTPUT ENABLE pin (20) is connected to IC1's NRDS (READ DATA STROBE) output, IC2 is ENABLED only during a READ operation. Note that with the 8073, the first ASCII character of the program in EPROM must be located at hex address 8000 if the circuit is to be self-starting at power up or reset.

Two 1K × 4 static RAM's, IC3 and IC4, provide the scratch-pad memory required by the Tiny BASIC interpreter. The decoding required is provided by IC9-b, IC10-b, and IC11-b. That RAM memory starts at hex address 1000.

The 4-MHZ crystal and associated lowpass filter network (R11, R12, and C2) form the frequency-control network for the on-chip oscillator.

Start-up (initialization) of the 8073 is achieved with the R-C network consisting of R15 and C1. The RESET pin of IC1 (pin 37) goes low for about a second after power-up and then gradually rises to +5 volts. That slow rise in voltage is allowable as input since the RESET pin is buffered with a TTL-compatible Schmitt trigger. (The first instruction to be fetched, after pin 37 goes high, is at location 0001. Unlike microprocessors, which only understand machine language, the designer who uses an 8073 need not know this specific information since the on-chip interpreter takes care of these details. That is just one example of the savings in time microinterpreters provide to the designer.)

The output circuit that controls lights and appliances consists of the quad-latch IC12, optocouplers IC13–IC15, and associated circuitry. The address-decoding network for IC12 is made up of IC8-a, IC9-c, and IC10-a.

The quad latch is enabled when IC1 attempts to write to location C000H, Once a latch is enabled it can store data. Thus the statement @#C000=1 enables IC12. Since DØ is connected to the "D" input of latch one (pin 2), it also causes latch one to store a 1. The result is that pin 16, the "Q" output of latch one, goes high and stays that way at least until IC1 writes to location C000 again.

When pin 16 goes high, the LED inside optocoupler IC13 is energized causing the internal phototransistor to conduct. That turns on transistor Q2, which causes relay RY1 to close and thus turn light A on.

PARTS LIST

All resistors ¼ watt, 5% unless otherwise specified

R1, R2, R12—1000 ohms
R3—10,000 ohms potentiometer
R4, R13, R14—3300 ohms
R5, R7, R9, R10, R22—10,000 ohms
R6—220 ohms
R11, R15—100,000 ohms
R16, R17, R18—270 ohms
R19, R20, R21—39 ohms

Capacitors

C1—33 µF, 10 volts, electrolytic
C2—27 pF ceramic disc
C3–C13—0.1 µF bypass capacitors (not shown on schematic)

Semiconductors

IC1—INS8073 microinterpreter
IC2—2716 EPROM (properly programmed, see TABLE 1 and the text)
IC3, IC4—2114 1K × 4 RAM
IC5—LM324 quad op-amp
IC6,IC11—74LS13 dual NAND Schmitt trigger
IC7—74LS125 quad buffer
IC8—74LS21 4 input AND gate
IC9—74LS04 hex inverter
IC10—74LS02 quad NOR gate
IC12—74LS75 4-bit bistable latch
IC13, IC14, IC15—4N25 or equivalent optocoupler
Q1—2N5777
Q2,Q3,Q4—2N2222

Other components

RY1,RY2,RY3—6-volt DC relay with 50 ohm coil, (Calectro D1-973 or equivalent)
S1—SPST momentary type switch
XTAL1—4 MHZ crystal
Miscellaneous: PC or prototyping board, two-conductor cable (for Q1), 14-gauge U.L. approved wire (for wiring the light circuits to the relays), hook up wire, solder, etc.

The INS8073 demo/development board (Part No. DB10-ND), is available from Digi-Key Corporation, Highway 32 South, P.O. Box 677, Thief River Falls, MN 56701-9988 (1-800-346-5144) for $250.00.

Similarly, the statement @#C000=2 causes D1 to go high, which turns on light B. The statement @#C000=4 will cause D2 to go high and light C will go on. Notice that by connecting D3 to pin 7 and adding another optocoupler/transistor/relay circuit, another light/appliance can be controlled by the statement @#C000=8.

Burning the EPROM

As we mentioned previously, the demo/development board from Digi-Key contains an on-board burner for 2716 EPROM's. A brief review of how to use it follows.

After you obtain the prompt (>) on your terminal, type: NEW#1100<return>. Then type: NEW<return>. You are now ready to enter the program in Table 1 (or your own program). To save time (and memory space for longer programs), you might want to leave out the REM statements.

After entering your program, connect a +25 volt source to pin 3 of "P1" on the board and insert an erased 2716 in the empty socket. Now type: NEW#8800<return> and then type: S<return>. Switch S2 to P and then type: P<return>. If everything goes well, "DONE,CMD?" should show on the display.

Building the outwitter

Since this project is fairly simple (for a computer-based project, that is) it can be put together on a solderless breadboard. If you use such a system, make sure you keep all the wires that are connected to IC1 and IC2 as short as possible. While such a breadboarding technique isn't suitable for permanent installations, it is ideal for design work since the circuits can be quickly constructed and easily modified. This is also an economic method of testing your design, since the parts from the breadboard can be used in a different project or can be used in the final circuit. If you do make a permanent version on a PC board or wire-wrap board, be sure that you use IC sockets—at least for the EPROM.

The photodarlington transistor, Q1, should be mounted so that it is facing out a window. Make sure that you don't locate it near an indoor light. When it starts to get sufficiently dark out, carefully adjust R3 so that light A goes on. The relays listed in the parts list are Calectro D1-973 and can control 200 watt (120-volt) light bulbs. By connecting the contacts of those relays in series with the coil circuit of a power relay, much larger currents can be controlled.

The beauty of using microinterpreters is that the program contained in the EPROM can be quickly and easily changed—short programs can be modified in less than an hour. As a real-life example, let's look at our circuit. It is possible to modify the program so that the circuit can tell whether it is summer or winter. One way that could be done is by writing a program so that the "outwitter" measures the length of day. The circuit can then modify its behavior according to the season.

The output circuit itself can be easily modified to control more lights/appliances. The addition of light D has already been touched upon previously. By adding an additional 74LS75 quad-latch, 4 more lights/appliances can be easily controlled. With the use of a suitable decoder to the output of these 8 latches (and a modification of the program) 256 lights/appliances can be controlled. That should be nearly enough for everyone! **R-E**

All About OPTOCOUPLERS

Interfacing digital signals to real-world devices has always been a difficult task. But optocouplers can help make it easy!

DANIEL M. FLYNN

HOW OFTEN HAVE YOU WANTED TO INTERface a logic circuit to real-world devices that operate from an AC source or a high DC voltage? That interfacing problem can be overcome in many ways. But perhaps the best way is to use an *optocoupler*. Optocouplers have a lot to offer: electrical isolation, logic-circuit compatibility, small size, and high reliability.

Optocouplers can be used in applications that require electrical isolation—when the low DC output of a logic circuit is used to control an AC motor. Since a logic circuit is incapable of delivering an AC voltage, and AC induced in the logic circuit can cause all kind of trouble, the motor and the logic circuit must be electrically isolated. And that's where the optocoupler really comes in handy.

An optocoupler might be used in applications where the high-level output of a metering device is fed to a microprocessor-controlled circuit to automatically start or stop operation at a predetermined point. (Consider a robotic assembly line, for example.)

In this article, we'll look at several optocoupler circuits that may be used to interface logic circuits to the "real world," or to interface any low-voltage circuit to one that operates on higher voltage. But before we do that, we should first take a closer look at what optocouplers are and discuss their parameters.

Optocoupler basics

The optocoupler (also called optoisolator or photocoupler) is a single component consisting of a light source and photodetector. The two elements are isolated from each other by a transparent insulator, and the assembly is completely enclosed in an opaque package.

The light source for most optocouplers is a gallium arsenide (GaAs) IRED (*In*fra*Red* *E*mitting *D*iode). The detector, or output element, may be a phototransistor, photodarlington, light-activated bilateral switch, or light-activated SCR. Figure 1 shows the schematic symbols for those types. Although other types are available, those shown are the most common.

Signals are transmitted between the two electrically isolated elements by means of a light path, or light source. The two elements cannot reverse their roles. And since there are no electrical connections between them, a signal passes through the unit in one direction *only*.

Optocoupler parameters

To successfully design with optocouplers, a clear understanding of their parameters is required. Because we'll be dealing only with low-frequency circuits, we'll define only the DC parameters of those devices. The DC parameters are divided into input, output, and current-transfer ratio.

The *C*urrent *T*ransfer-*R*atio or CTR is the ratio of the input current to output current of an optocoupler (at a specified bias). It is often represented by η. That value depends on the efficiency of the IRED and the spacing between input and output elements. The area, sensitivity, and gain of the detector also play a role.

The DC input parameters define the electrical parameters of the IRED. They are: I_F, diode forward current; V_F, diode forward voltage, and V_R, maximum reverse voltage. (See Fig. 2.)

Because the DC output and transfer parameters differ depending on the type of detector element used by the optocoupler, we'll list and define them separately according to the detector.

Phototransistor- and photodarlington-type optocouplers work on the same principle. The collector-to-base junction is enlarged and works as a reverse-biased photodiode controlling the transistor. That is, radiation striking the junction generates electron-hole pairs, which are swept across the junction by the field developed across the depletion region. The parameters for the photodarlington and phototransistor types are:

- I_C, maximum continuous collector (output) current
- $V_{(BR)CBO}$, maximum collector to base breakdown voltage
- $V_{(BR)CEO}$, maximum collector to emitter breakdown voltage
- $V_{(BR)ECO}$, maximum emitter to collector breakdown voltage

Optocouplers that use light-activated bilateral switches in the output are de-

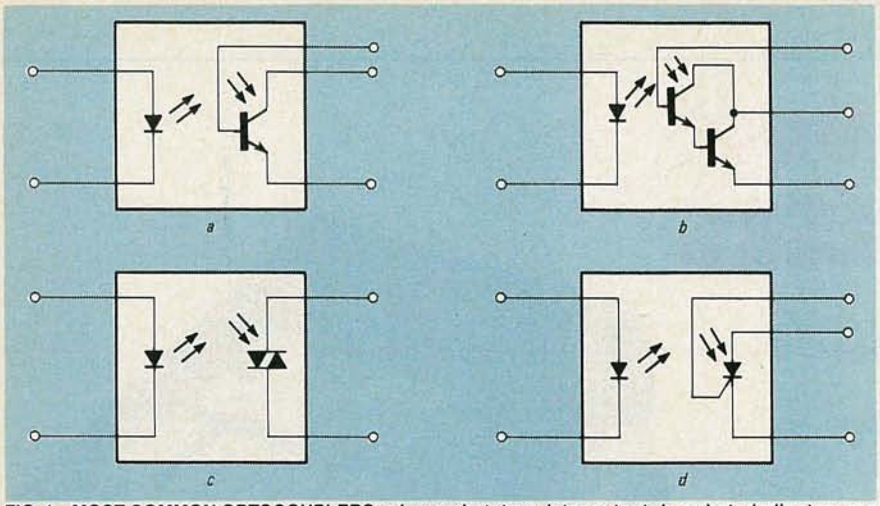


FIG. 1—MOST COMMON OPTOCOUPLERS: *a* has a phototransistor output; *b*, a photodarlington; *c*, a light-activated bilateral switch, and *c* has an SCR output.

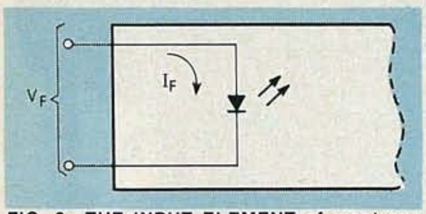


FIG. 2—THE INPUT ELEMENT of most optocouplers is a gallium arsenide (GaAs) IRED.

signed for applications that require isolated triac triggering, low-current isolated AC switching, and high electrical isolation. For that type of device the parameters are:

- $I_{T(RMS)}$, maximum on-state RMS current
- V_{DRM}, maximum repetitive off-state output terminal voltage
- V_{TM}, peak on-state voltage.

Light-activated SCR optocouplers are designed for applications that require high electrical isolation between low-voltage circuitry (like those using IC's) and the AC line. The parameters for the SCR devices are:

- $I_{T(RMS)}$, maximum on-state RMS current
- V_{DRM}, maximum repetitive off-state output terminal voltage
- V_{RM}, maximum reverse voltage

The transfer parameters of an optocoupling device (as mentioned above) is the measure of the ratio of current transmitted between the input and output elements. For phototransistor and photodarlington type units, the parameters are:

- CTR (η), ratio (in percent) of the minimum high collector output-current to diode current at a given V_{CE} and I_F.
- $V_{CE(sat)}$, the collector-to-emitter saturation voltage

For light-activated bilateral switch and SCR types:

- I_{FT}, maximum IRED trigger current required to latch (trigger) the output
- I_H, holding current required for the output to remained latched

The specifications for three optocoupling devices—4N33, 4N26, and MOC3010—are given in Table 1, Table 2, and Table 3 respectively.

Voltage level shifters

When a logic circuit is required to accept inputs from the real world, it is often necessary to shift the voltage level of an input signal to 5-volt logic levels. If the input is a DC signal, it can be interfaced to the logic circuit using an optocoupler without electrically tying the two together (i.e., the two circuits do not share a common ground.)

The advantage to that is that any noise or voltage spikes on the signal-circuit ground are not directly impressed on the logic-circuit ground. An optocoupler can also be used to convert AC signals to 5-volt logic levels, while isolating the logic circuit from the high AC voltage.

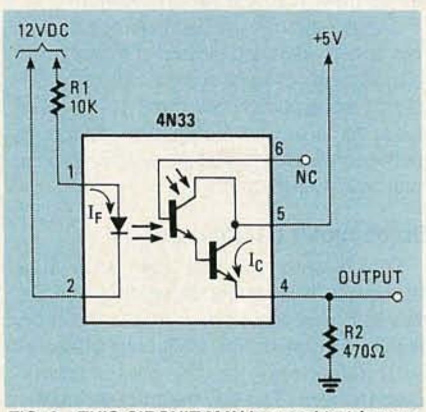


FIG. 3—THIS CIRCUIT MAY be used to trigger a TTL gate input.

Figure 3 shows one optocoupler application where a 12-volt DC (V_{IN}) input is converted to 5-volt logic levels. Here we see a circuit using a 4N33 optocoupler. (Specifications for that device are given in Table 1.) The 12-volt input causes the output of the optocoupler to go to a high logic level. In addition, any common-mode noise is rejected because of the optocoupler's diode input.

When a 12-volt signal is presented to the input, current flows through R1 and the IRED. That current lights the IRED, and the light striking the photodarlington's collector-to-base junction causes it to turn on. The photodarlington output is used here because its large CTR value allows enough current to pass through resistor R2 to develop the required voltage at the output for a logic 1. The output signal can now be used to drive a logic-gate input.

Removing the 12-volt DC signal turns the photodarlington off, and R2 pulls the output low. (In low-speed switching circuits, the base input of photodarlingtons and phototransistors typically remain unconnected. However, high-speed circuits use the base input to increase the switching speed of the device.)

When designing similar circuits for various DC-input levels, remember that

GLOSSARY OF OPTOELECTRONIC TERMS

Bandgap (electronic)—the potential difference between the valence and conduction bands, which determines the forward voltage drop and frequency of light out of a diode.

Current transfer ratio (electronic)—the ratio of input current to output current at a specified bias of the optocoupler.

Dark current (electronic)—the leakage current of a photodetector with no incident light, usually I_{CEO}.

Detector (radiometric)—a device that changes light energy (radiation) to electrical energy.

Effective irradiance (electronic)—IR perceived by a detector.

Emittance (radiometric)—power radiated per unit area from a surface.

Emitter (radiometric)—a source of radiation.

Infrarad (photoelectric)—radiation of longer wavelength than normally perceived by the eye; i.e., 78 to 100 micron wavelengths.

Irradiance (radiometric)—radiated power per unit area incident on a surface, broadband analogy to illumination.

Isolation voltage (electronic)—the dielectric withstanding voltage capability of an optocoupler under defined condition and time.

Light current (electronic)—current through a photodetector when illuminated under specified bias conditions.

Optocoupler (electronic)—a single component that transmits electrical information between a light source and a light detector, which are not electrically connected; also called optoisolator or photocoupler.

Photoconductor (electronic)—a material whose resistivity is a function of the radiation level falling on it.

Source (radiometric)—a device that provides radiant energy.

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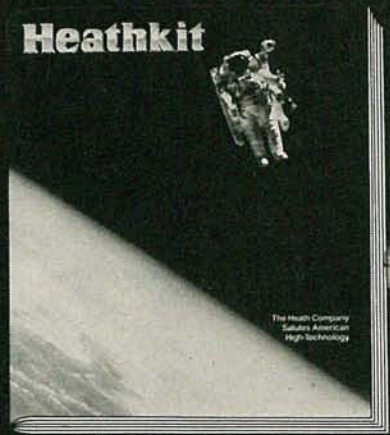

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the value of R2 is determined by the input parameters of the logic gate being fed. The value of R2 given by:

$$R2 < V_{IL}/I_{IL}$$

where V_{IL} is the low-level input, gate voltage and I_{IL} is the low-level input, gate current.

The value of R1 is found by first solving for I_C (collector current):

$$I_C = V_{IH}/R2$$

where V_{IH} is the high-level input to the driven gate and R2 is resistance in ohms. Next, solve for I_F (diode forward current):

$$I_F = I_C/\eta$$

where η is the CTR of the optocoupler. To find the CTR, go to the specification sheet in Table 1 and look under the heading I_C for the coupled parameters. From that we get:

$$\eta = I_C/I_F = 50/10 = 5$$

Now the nominal value for R1 is given by:

$$R1 = (V_{IN} - V_F)/I_F$$

As an example, let's calculate the values of R1 and R2 for Fig. 3, assuming that the driven logic gate is a standard 7400 series. For that type of device, the input parameters are: V_{IL} = .8 volt, V_{IH} = 2 volts, and I_{IL} = −1.6mA. Therefore, the value of R2 is given by:

$$R2 < V_{IL}/I_{IL} = .8/(1.6 \times 10^{-3}) < 500$$

Now it can be seen that R2 is chosen to be the largest common resistor value that is less than 500, which is 470 ohms. Using the value of R2, solve for the collector current:

$$I_C = V_{IH}/R2 = 2/470 = 4.3mA$$

where 2 is the high-level gate input voltage and 470 is the value of R2 in ohms. The value of I_F is found from:

$$I_F = I_C/\eta = 4.3/5.00 = 1.0mA$$

Now look up I_F under the input heading and I_C under output. Since neither of the calculated values exceed the maximum ratings of the 4N33, we can now solve for R1:

$$R1 = \frac{V_{IN} - V_F}{I_F} = \frac{12 - 1.2}{1 \times 10^{-3}} = 10.8K$$

The closest common resistor value to the one calculated for R1 is 10K.

Decreasing the value of R1 increases the loading effect on the signal source and decreases the transfer efficiency. For instance, in a similar circuit with R1 chosen to yield a I_F of 20mA, the current-transfer ratio is only 46%.

TABLE 1
4N33 SPECIFICATIONS

		Minimum	Typical	Maximum	Units
Input	I_F			80	mA
	V_F (I_F=10mA)		1.2	1.5	V
	V_R			3	V
Output	I_C	30		100	mA
	$V_{(BR)CBO}$	30			V
	$V_{(BR)CEO}$	30			V
	$V_{(BR)ECO}$	5			V
Coupled Parameters	I_C (I_F=10mA, V_{CE}=10V)	50			mA
	$V_{CE(sat)}$ (I_F=8mA, I_C=2mA)			1.0	V

TABLE 2
4N26 SPECIFICATIONS

		Minimum	Typical	Maximum	Units
Input	I_F			80	mA
	V_F (I_F=10mA)		1.1	1.5	V
	V_R			3	V
Output	I_C			100	mA
	$V_{(BR)CBO}$	70			V
	$V_{(BR)CEO}$	30			V
	$V_{(BR)ECO}$	7			V
Coupled Parameters	CTR (I_F=10mA, V_{CE}=10V)	20			%
	$V_{CE(sat)}$ (I_F=50mA, I_C=2mA)		.1	.5	V

TABLE 3
MOC3010 SPECIFICATIONS

		Minimum	Typical	Maximum	Units
Input	I_F			50	mA
	V_F (I_F=10mA)		1.2	1.5	V
	V_R			3	V
Output	$I_{T\ (RMS)}$			100	mA
	V_{DRM}			250	V
	V_{TM} (I_T=100mA)		2.5	3.0	V
Coupled Parameters	I_F		8.0	15	mA
	I_H		100		µA

The circuit in Fig. 4 converts a 24-volt input, V_{IN}, to an inverted 5-volt output. That is, a high input causes the output to go low. When a 24-volt signal is present, current flows through the IRED, and the phototransistor conducts. Because the output of the device is taken at its collector, the input to the logic gate is low.

When the input signal is removed, the phototransistor turns off and R2 pulls the output high. The 4N26 is used here instead of the 4N33 because of its lower $V_{CE(sat)}$ value. Table 2 shows the specifications for the 4N26.

The resistance of for R2 is not critical. A nominal value for R1 for any input voltage (V_{IN}) level is given by:

$$R1 = (V_{IN} - V_F)/I_F$$

where $I_F = (V_{CC} - V_{CE(sat)}/R2 - I_{IL})/\eta$.

The I_F value guarantees that the phototransistor will saturate. The value of R1 when V_{IN} is 24 volts is easily found. Let's say that the driven gate is once again a 7400 series TTL. Since R2 is 10K and the gate requires an input current, I_{IL}, of −1.6mA, then:

$$I_F = \frac{5 - .4}{10{,}000} + \frac{.0016}{.20} = 10mA$$

Using that value, you can now find the resistance of R1:

$$R1 = 24 - 1.1/10 \times 10^{-3} = 2.3K$$

The closest standard value is 2.2K.

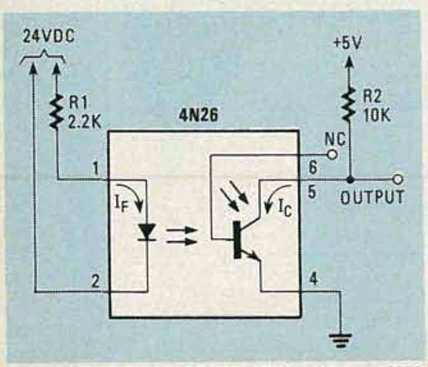


FIG. 4—THE BASE CONNECTION OF the 4N26 is used to increase switching speed.

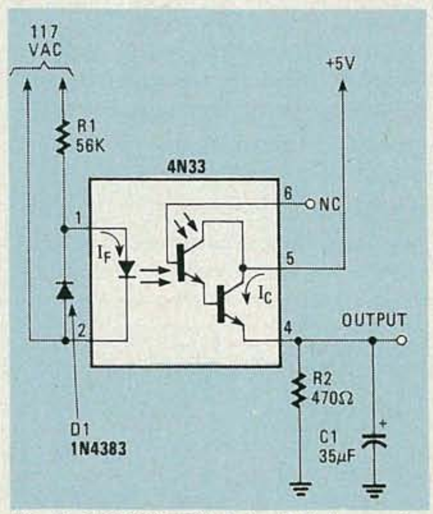


FIG. 5—NON-INVERTING circuit that converts 117 volts AC to to 5-volt logic levels.

A non-inverting circuit that converts a 117 volts AC to a 5-volt logic level is shown in Fig. 5. With a 117-volt input applied, current flows in the IRED for one-half the AC cycle and in diode D1 during the other half.

During each positive half-cycle, the photodarlington conducts. That causes a pulsating DC voltage to develop across R2, which is then filtered by capacitor C1. The voltage across C1 forces the gate input high. When the AC input is removed, the photodarlington turns off. The voltage across C1 drops as the capacitor discharges through R2. Now, R2 pulls the gate input low.

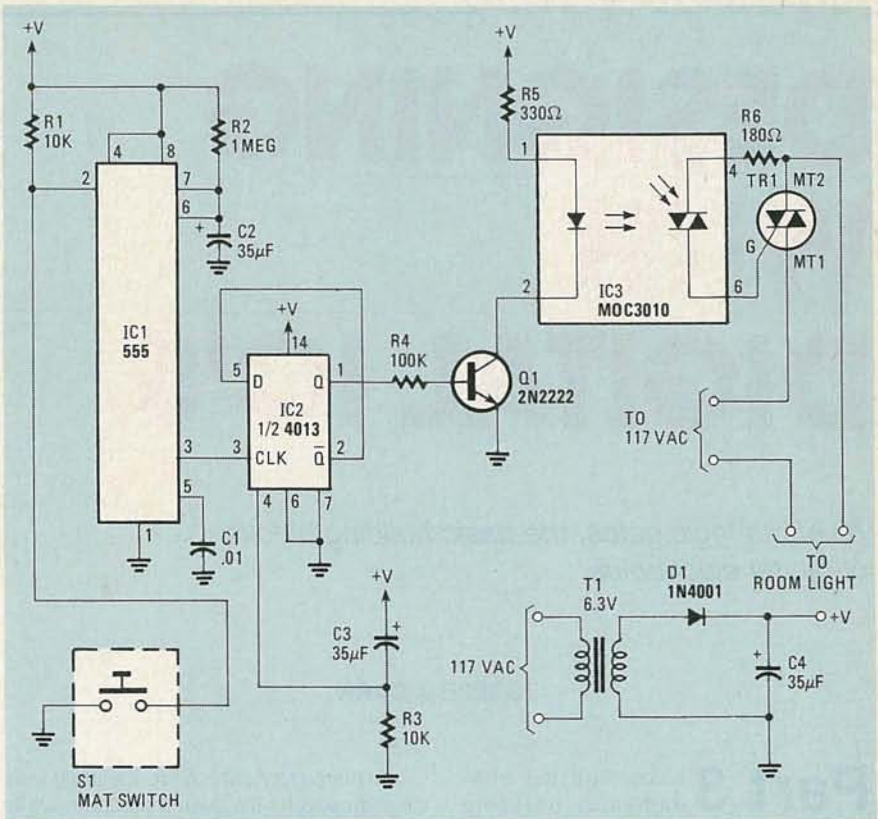


FIG. 9—THE OPTOCOUPLER is triggered by a one-shot to turn on room lights when some one steps on the mat switch, S1.

Load control

When interfacing logic circuits to the real world, a logic gate output is often required to control a 117-volt AC load. The relay circuit of Fig. 6 can be used in such applications. However, many circuit design requirements may *exclude* the use of a relay.

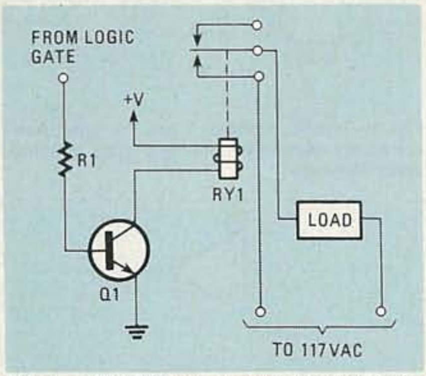


FIG. 6—A RELAY can be used to interface logic gates to real world devices, but circuit requirements may exclude its use.

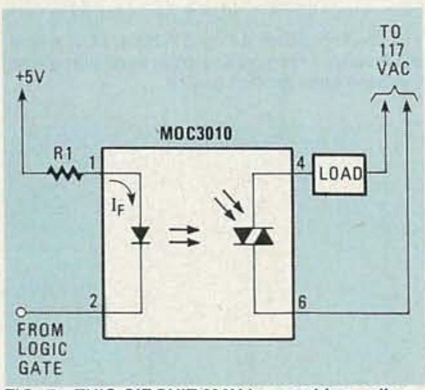


FIG. 7—THIS CIRCUIT MAY be used in applications that have small AC power requirements.

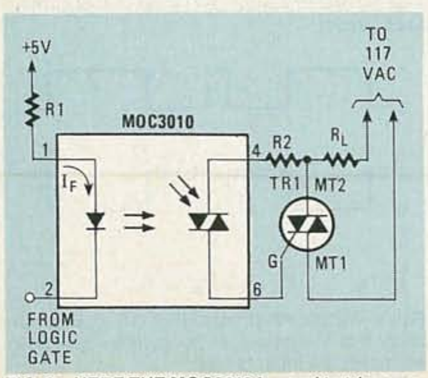


FIG. 8—HERE THE MOC3010 is used to trigger a triac to accommodate larger load requirements.

The optocoupler designs shown in Fig. 7 and Fig. 8 provide electrical isolation and control without the disadvantages of the relay-circuit design. The control circuit of Fig. 7 may be used to drive loads with small AC power requirements. Here a MOC3010 optocoupler is used; its parameters are shown in Table 3.

When the logic-gate output is low, current flows through the IRED of the optocoupler. If I_F is equal to I_{FT}, the bilateral switch output is triggered into conduction. Since the bilateral switch conducts in both directions, power is delivered to the load during the positive and negative halves of the AC cycle. As the output of the logic gate that's feeding the optocoupler goes high, I_F is reduced below I_H of the MOC3010 and the bilateral switch turns off.

The maximum value for R1 is given by:

$$R1 \leq \frac{V_{CC(MIN)} - V_{F(MAX)} - V_{OL}}{I_{FT}}$$

where V_F and I_{FT} are parameters of the optocoupler used and V_{OL} is the low-level output voltage of the logic gate.

Choose the largest resistor value available that's less than the calculated value. Remember, the logic gate must be capable of sinking a current of I_{FT} with some margin of safety. The largest load that the MOC3010 can handle is 12 watts.

The circuit in Fig. 8 overcomes the power switching limitation of the MOC3010. Now we see that the output of the MOC3010 is used to gate a power triac. The value for R1 is calculated in the same way as done for R1 in Fig. 5.

The minimum current required to trigger the triac determines the maximum value for R2, while the power dissipation of the triac gate determines the minimum value for R2. The maximum value of R2 is given by:

$$R2 = (2V_S - V_{TM} - R_L)/I_{GM}$$

where V_{TM} is the output parameter of the optocoupler, I_{GM} is the maximum gate trigger current of the triac, and V_S is the AC supply voltage.

Load control application

Figure 9 shows a circuit that can turn room lights on and off as the pressure-mat switch, S1, is activated. The 555 timer, IC1, is configured as a monostable (one-shot) to de-bounce S1 and allow time for the person to step off the mat.

The output of IC1 at pin 3 is fed to half of a 4013 dual, D-type flip-flop, IC2-a, so that it is triggered on each clock pulse. When the Q output of IC2-a is high, transistor Q1 conducts. That provides a path to ground for the diode current, and that, in turn, causes the IRED to conduct. The light from the IRED striking the photodetector causes it to turn on triggering TR1, delivering power to the load. **R-E**

DESIGNING WITH DIGITAL IC'S

All about logic gates, the basic building blocks of digital electronics.

JOSEPH J. CARR

Part 3 GATES ARE THE FUNdamental building blocks of digital circuits. From the simplest devices to the most complex computers, digital circuits are ultimately no more than collections of the basic gates described in this article. Those gates include the NOT, AND, OR and, EXCLUSIVE-OR. In addition, two other gates are considered basic, although they are essentially formed by marrying two other gates. Those are the NAND (formed from a NOT and an AND) and the NOR (formed from a NOT and an OR).

Circuit symbols

Over the years there have been several different sets of schematic symbols used for digital devices. As a result, at times, the industrial and military/aerospace segments of the electronics industry have had difficulty reading each others' drawings. More recently, however, the set of symbols shown in Fig. 1 has become more or less accepted by all. Those are the symbols that we will use in the remainder of this series.

The NOT gate

The NOT gate, or inverter, is the simplest form of gate, and, indeed, some do not even consider it a gate. Figure 2-*a* shows the circuit symbol for that device, while its truth table is shown in Fig. 2*b*. The equivalent circuit for the inverter is shown in Fig. 3.

An inverter inverts. That is, its output signal is the complement of the input signal, as is shown in Fig. 4, and is always the opposite of the input.

In our equivalent circuit, the input state is indicated by the switch position, while the output state is indicated by the bulb. With the input low (switch open) the power supply is connected to the bulb through a current-limiting resistor, so the output is high (bulb on). But when the input is low (switch closed), the output is low (bulb off). Symbolically, if the input is A, the output is $\overline{A}$, and if the input is $\overline{A}$, the output is A.

There are several TTL and CMOS IC's that contain inverter stages. The most common form are hex inverters, which are integrated circuits that contain six independent inverters in one package. Examples of hex inverters include the 7404, 7405, 7406, 7407, 7416, and 7417. Of these, all but the 7404 use open-collector outputs.

At this point, it might be prudent to digress a little and mention noninverting buffers. Those also come in hex form (such as the 4050B). Those devices have fanout ratings of 10 and up, and do not invert the input signal. They are used to provide isolation between circuits and to increase the drive capacity of certain device outputs. Microprocessor outputs typically have fan-outs of 2, so they will not drive the heavily loaded lines normally found in personal computers. Devices with fan-outs to 100 are available.

An indication of the influence of personal computers is that IC manufacturers now offer octal buffers and inverters (devices with eight independent buffers or inverters). Those devices match the 8-bit data bus typically used by many popular personal computers.

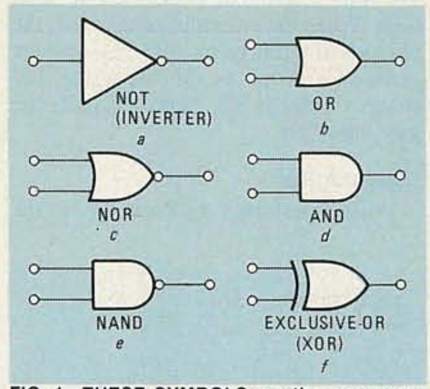
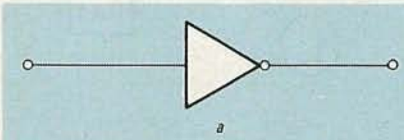


FIG. 1—THESE SYMBOLS are the ones now commonly used to denote logic gates in schematic diagrams.



INPUT	OUTPUT
0	1
1	0

b

FIG. 2—THE SCHEMATIC SYMBOL FOR a simple inverter, or NOT gate, is show here, along with the truth table for that device.

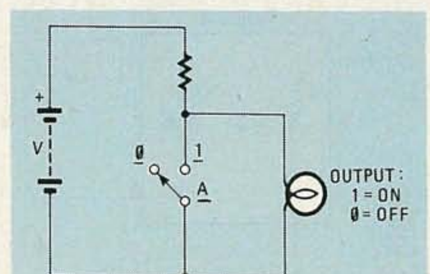


FIG. 3—THE OPERATION of an inverter can be seen by examining the operation of this equivalent circuit.

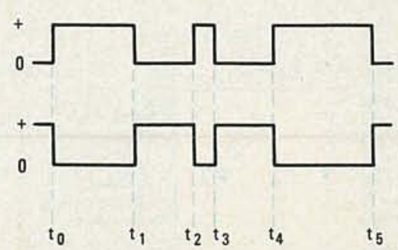


FIG. 4—THESE INPUT AND OUTPUT waveforms show that the output of the inverter goes low whenever the input is high.

The OR gate

Figure 5 shows an OR gate. Its schematic symbol is shown in Fig. 5-*a*, its equivalent circuit in Fig. 5-*b*, and its truth table in Fig. 5-*c*. The input/output waveforms for the device are shown in Fig. 6. For our example, we've chosen to show a two-input device, although OR gates with three, or more inputs are available.

The equivalent circuit can help us understand how an OR gate operates. Once again, the switches are used to represent the inputs, while the light bulb is used to represent the output. If either switch is closed, then the output lamp lights. In other words, if either A OR B is closed, then the lamp is on. Both A and B must be open for the lamp to be off.

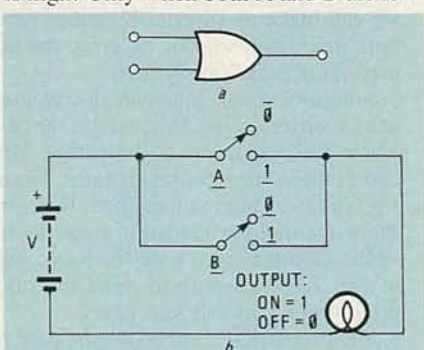
That operation is also seen by examining the truth table. Note that a 1 on either input, or on both inputs, will result in a 1 output. The only situation where the output is Ø is when both A and B are also Ø.

The NOR gate

A NOR gate is a combination gate made from an OR gate followed by a NOT gate. As seen in Fig. 7-*a*, the NOR gate symbol is an OR symbol with a small circle indicating inversion at the output terminal. The equivalent circuit for the NOR gate is shown in Fig. 7-*b*, while the truth table for that device is shown in Fig. 7-*c*.

Let's see how that gate works by examining its equivalent circuit and truth table. When either switch is closed (logic 1), the lamp is shorted out so that it will be off (logic Ø). Both switch A and B must be open (logic Ø) for the lamp to be on (logic 1).

We can see graphically the operation of the NOR gate by examining its input and output waveforms shown in Fig. 8. The waveforms labeled A and B are applied to inputs A and B, respectively. As is shown, the output is low if either A or B, or both, is high. Only when both A and B are low



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

c

FIG. 5—THE OR GATE. The schematic symbol, equivalent circuit, and truth table for that device are shown here.

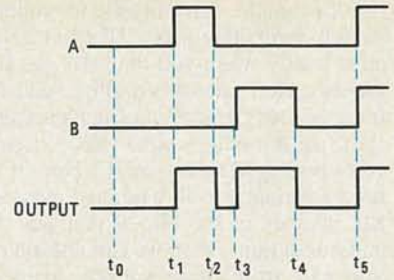
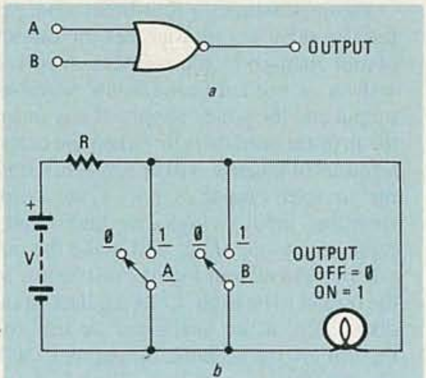


FIG. 6—THE OUTPUT of an OR gate goes high whenever either, or both, of the input are high.



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

c

FIG. 7—THE NOR GATE. The schematic symbol, equivalent circuit, and truth table for that device are shown here.

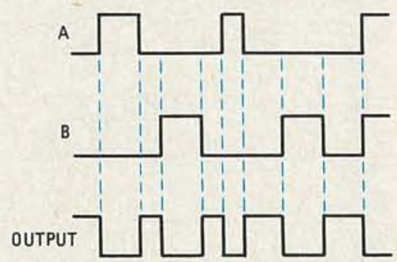


FIG. 8—THE NOR gate—output is high only when neither input is high.

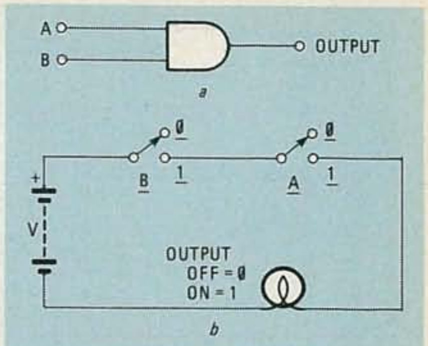
is the output high.

An example of the NOR gate is 7402. That TTL device is a quad two-input NOR gate, so there are four independent two-input gates in the same IC package.

The AND gate

The AND gate is shown in Fig. 9; the circuit symbol is shown in Fig. 9-*a*, the equivalent circuit is in Fig. 9-*b*, and the truth table is in Fig. 9-*c*. The input and output waveforms for the device are shown in Fig. 10.

As you can see in the truth table and the waveform diagram, for the output of the AND gate to be high, all of the inputs must be high; otherwise the output is low. That operation is further illustrated by the equivalent circuit. That circuit consists of



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

c

FIG. 9—THE AND GATE. The schematic symbol, equivalent circuit, and truth table for that device are shown here.

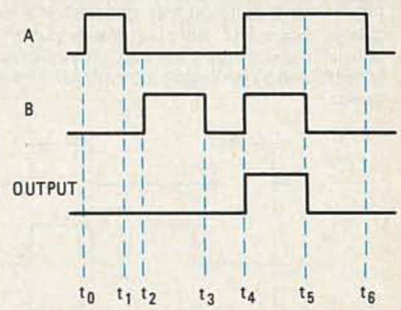


FIG. 10—ONLY WHEN BOTH INPUTS are high, is the output of the AND gate high.

two series connected switches, labelled A and B. Those switches correspond to the inputs of a two-input AND gate. Note that the lamp will not be on, indicating a high, unless both switches are closed (in the logic 1 position).

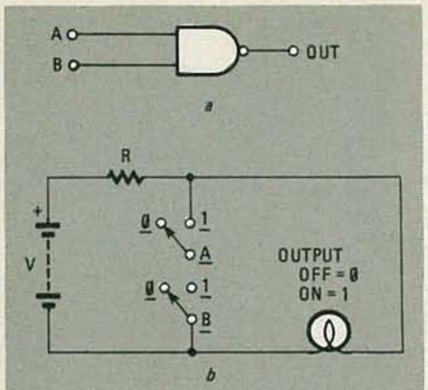
In some older manuals on digital logic, they call the AND gate by a very appropriate name: "coincidence detector." In other words, a circuit that generates an output indicating the coincidence of input pulses.

The NAND gate

The NAND gate is another example of a composite gate. In this case, the NAND gate is essentially an AND gate followed by an inverter (NOT-gate). Figure 11-*a* shows the schematic symbol for a NAND GATE, Fig. 11-*b* shows the equivalent circuit, and Fig. 11-*c* shows the truth table. Figure 12 shows the input/output waveforms for that device.

In operation, as is shown in the waveform diagrams and the truth table, if either input sees a low, the output is high. The only way that the output can be low is if both inputs see a high.

It is instructive to compare the operations of NAND and NOR gates, keeping in mind that a positive-logic NAND is also a negative-logic NOR, and vice-versa.



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

c

FIG. 11—THE EQUIVALENT CIRCUIT of a NAND gate is shown in *b*. Note that the output is low only when both inputs are high. That operation is confirmed by looking at the truth table for that device.

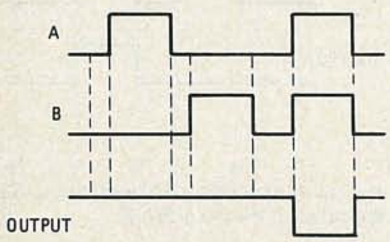


FIG. 12—THE INPUT AND OUTPUT waveforms for a NAND gate. Note, once again, that the output is low only when both inputs are high.

In the equivalent circuit for a NAND gate, the two switches that represent the inputs are connected in series with each other, and the series pair is in parallel with the lamp. Thus, both switch A and switch B must be set to 1 for the output to be 0.

The EXCLUSIVE-OR (XOR) gate

The EXCLUSIVE-OR (XOR) gate is a like an OR gate in that it will produce a high output if either input A or input B are high. It differs in that it will not produce a high output if both inputs are high. Figure 13-*a* shows the circuit symbol for the XOR, Fig. 13-*b* shows the equivalent circuit, and Fig. 13-*c* shows the truth table. Figure 14 shows the input/output waveforms for that device.

In operation, a high on either input will produce a high output, but if either both inputs are high, or both are low, then the output is low.

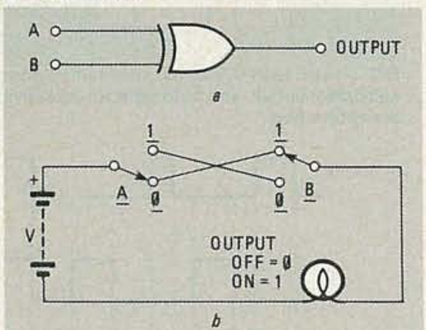
Simple digital circuits

Digital logic gates can be more flexible than they appear at first glance, especially when two or more are used in a combination circuit. In this section, we will see a few such circuits.

For example, it is possible to combine gates to form other gates. That fact can be quite handy when you have designs that use only a few gates on a multiple-gate IC. Inverters, for instance, are often packaged six to an IC, while NAND and NOR gates come packaged four to an IC. Now, if we need a two input NOR gate, and there is a hex inverter in the circuit that has two unused sections, then we can fashion our NOR gate from those unused inverters, thereby avoiding the need to use another IC.

Figure 15 shows a four-input NOR gate fashioned by wiring together the outputs of four open-collector inverters. A pull-up resistor is needed between the wired-OR output and the power supply. If any one of the inverter outputs is low, then the output terminal of the gate will be low also. Since the inverter output is low if the corresponding input is high, we know that a high on any one input will make the output low, and all four inputs must be low for the output to be high. Looking back at our discussion of the NOR gate, we find that the circuit we've built functions exactly like that gate.

The use of wired-OR outputs to form an N-input NOR gate is normally limited to cases where extra inverters already exist in the circuit.



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

c

FIG. 13—THE EXCLUSIVE-OR GATE. The schematic symbol, equivalent circuit, and truth table for that device are shown here.

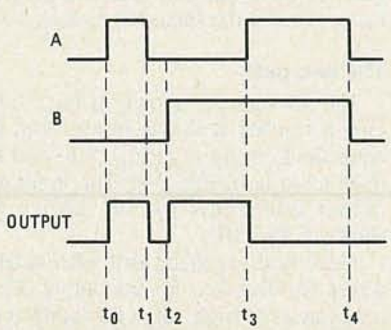


FIG. 14—IN THE EXCLUSIVE-OR, the output is high only when either input, but not both, are high.

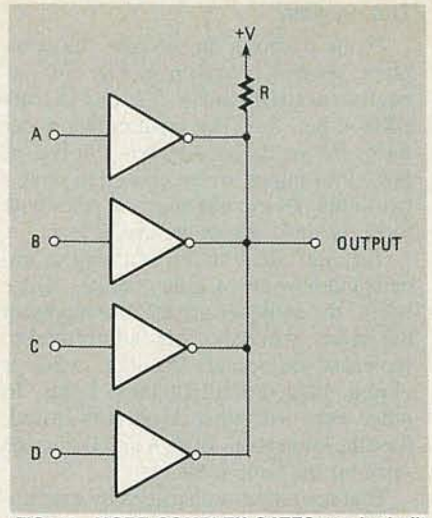


FIG. 15—MORE COMPLEX GATES can be built using simple inverters. Here four inverters are configured as a four-input NOR gate.

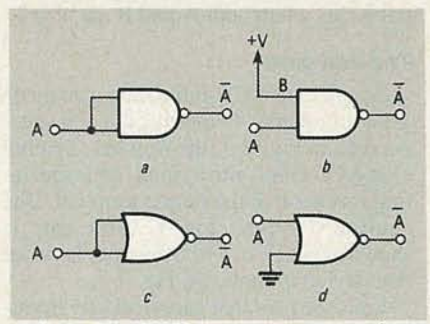


FIG. 16—BY WIRING NAND or NOR gates as shown here, they can be used as simple inverters.

Figure 16 shows the opposite case—the use of more complex gates to form a simple inverter. Again, the purpose in doing that is to make efficient use of extra gates in the circuit. If, for example, you need an inverter and find that one or more NAND sections are otherwise wasted, you can make the NAND work as an inverter and thereby avoid using another IC.

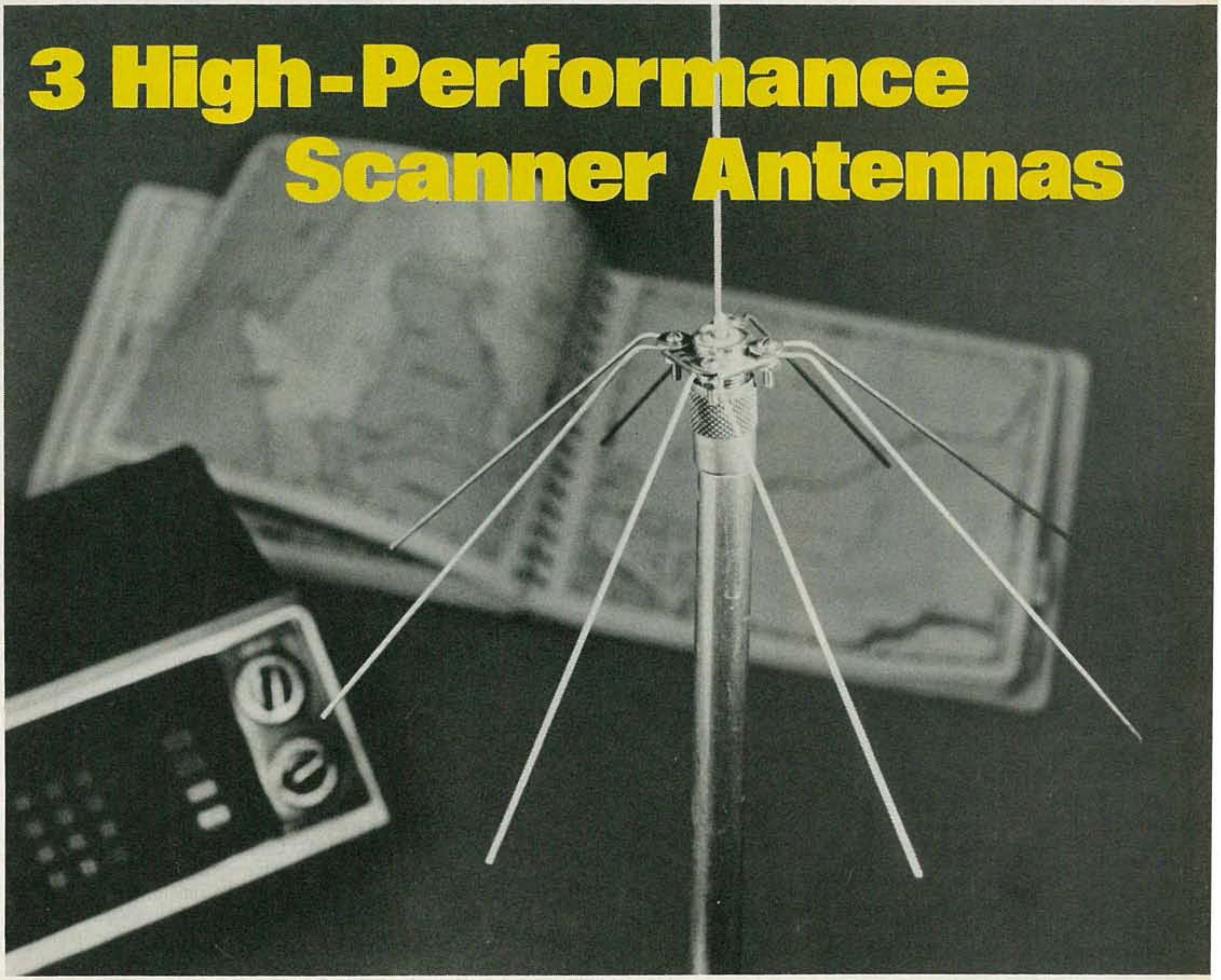
From NAND gates (Figs. 16-*a* and 16-*b*), we can make an inverter by either tying both inputs together or by tying the unused input permanently high.

Similarly, a NOR gate can also be used as an inverter. In Fig. 16-*c*, we see the case where both inputs are tied together. That case is the same as for NAND gates. Figure 16-*d* shows an alternate method. Here, we show one input grounded to form the inverter. Compare that with the NAND gate of Fig. 16-*b*, keeping in mind the rules governing NAND and NOR gates.

The properties of the XOR gate give us the ability to build a circuit that is either an inverting or noninverting buffer, depending upon the setting of a switch. Figure 17 shows such a circuit. Switch S1 is connected between ground and one input of the XOR gate. Also connected to the gate input is a pull-up resistor to the power supply. When S1 is open, the resistor will ensure that the gate input is high. When S1

continued on page 120

3 High-Performance Scanner Antennas



Are you still using your scanner's built-in antenna? Build one of these custom antennas and pull in those weak signals you've been missing!

LOREN FREBURG

Part 2 WHEN WE LEFT YOU last time, we were discussing the extended double-Zeppelin antenna. As mentioned then, the antenna is made of ¾-inch tubing, as shown in Fig. 8, which allows the feedline to be run down the center where it cannot affect the antenna's performance.

The center (phasing) stub is made from brass brazing rods; 3/16-inch diameter for a VHF-low, and 1/16 inch for the VHF-high or UHF bands. Calculate the length of each section using Fig. 9 as a guide. Then correct the length for the diameter of the material used in each section according to Table 3. The calculation for the stub length must include the length of the leads on the transformer, see Fig. 10, which should be cut as short as possible.

If the antenna is intended for the VHF-low band, 30–50 MHz, each element will be from 12- to 20-feet long. That means that you'll need more than one length of tubing. Use two sizes, maybe ¾ and ⅞-inch diameters, so that one fits inside the other. Use the larger size for the portions nearest the feedline connection. Cut two one-inch long slots lengthwise on the outside end of larger tube, and insert the smaller one. Use a hose clamp to hold them together.

Drill two 3/32-inch holes in each element to mount the antenna on the mast and hold the phasing stub: one ¼-inch from the end and the other about 4–6 inches from the end. Bend the brazing rod to form the stub. That's easily done by temporarily inserting the bolts into the tubing and then bending the rods around them. Cut to the final length after forming the bends.

Mount the antenna and phasing stub near the top of the mast (see Fig. 8) with No. 10 machine screws and washers. Run the coaxial feedline, preferably RG-8/M, through the lower tubing before inserting the screws. The RG-58/U has higher losses, but will fit easily. (If you've chosen RG-8/U, either solid or foamed dielectric, there's will not be enough space for the machine screws and the larger cable.) Secure the tubing to the mast with U-bolts.

Although not necessary, the phasing stub may be bent into a semicircle around the mast. That streamlines the appearance and reduces the stress slightly because the stub does not have to support as much feedline. That's particularly advantageous for the VHF low-band antenna. Solder the transformer leads to the end of the phasing stub, and connect it to the coaxial cable with the appropriate connector.

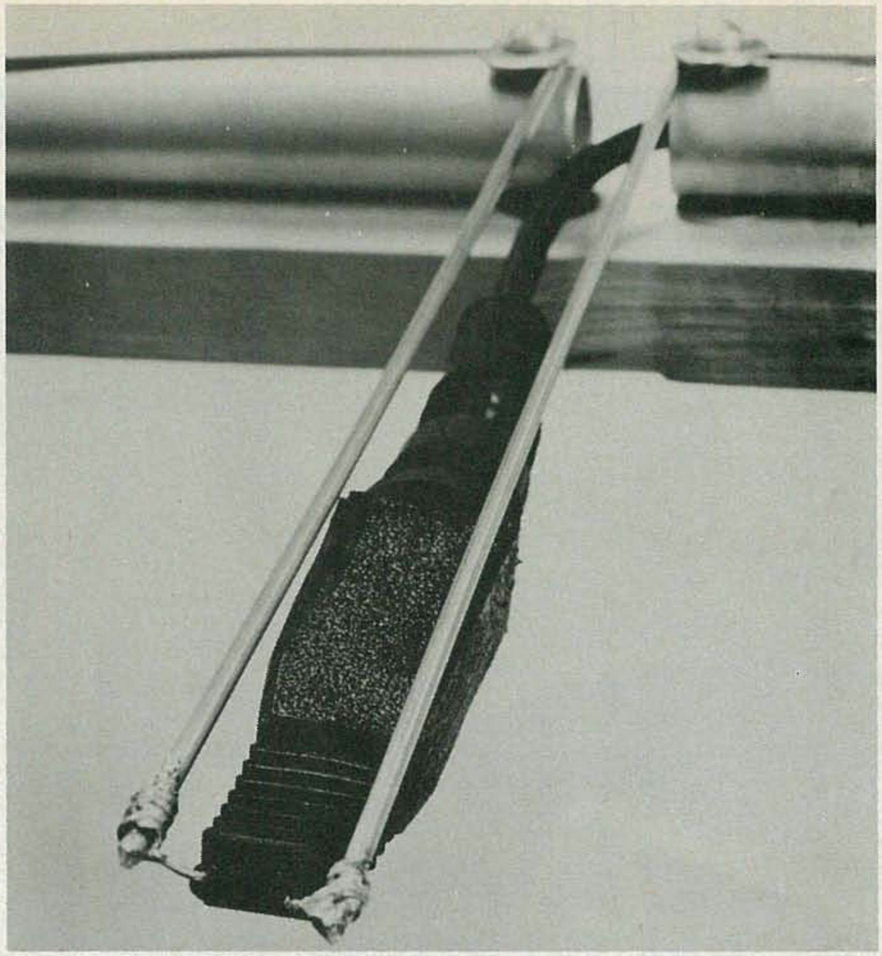


FIG. 10–EXTENDED DOUBLE-ZEPP with balun transformer connected; the transformer leads should be cut as short as possible.

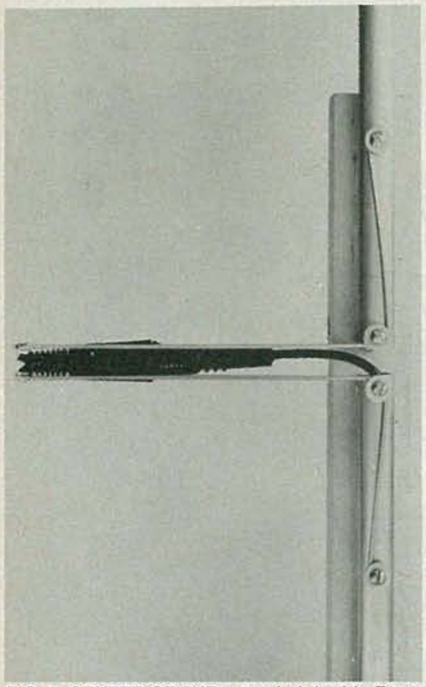


FIG. 8–CENTER OF THE extended double-Zepp antenna. Note the orientation of the balun transformer and phase reversal stub.

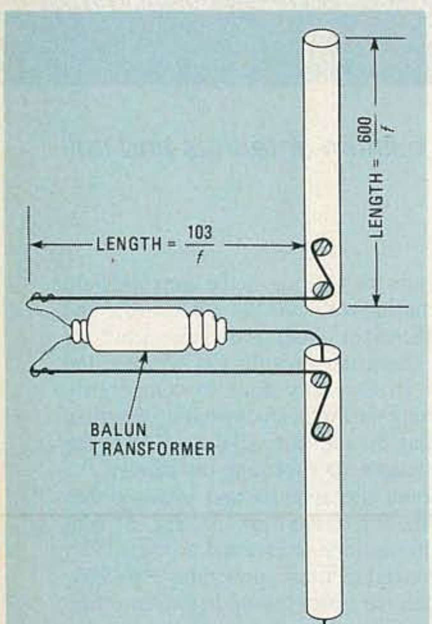


FIG. 9–EXTENDED DOUBLE-ZEPP. Calculate the length of the elements as shown.

The mast material must be a non-conductor. Wood that has been weatherproofed with two coats of varnish or polyurethane is a good choice. Shorter antennas for UHF or VHF-high band are easily supported on 2 × 2-inch lumber, but for VHF low, use a 2 × 4 or even a 4 × 4, depending on the height the mast will be. Before raising the mast, cover all the electrical connections with silicone rubber cement to prevent oxidation.

The upper element of the extended double-Zepp does not have to be made of tubing since there's no coaxial cable to shield. For UHF and VHF high band, you may prefer to use brazing rods, very small diameter tubing, or even heavy-gauge copper wire for smaller sections. The lower element is, of course, all tubing. The very top of the upper element is an 8½ -foot fiberglass, CB whip antenna.

The whip antenna is bolted to a metal cap, which is then bolted to a lower 5½-foot aluminum tubing. That reduces both wind resistance and weight for this tall, effective antenna. The total length of the antenna will be about 14 feet.

Coaxial-collinear antenna

This antenna is a modification of the stacked-dipole. It is made of coaxial cable and all the elements lie on the same line, hence the name, *coaxial-collinear*. (Refer to Fig. 11.) One side of the dipole is the center conductor of the coaxial cable and the other side is the outside braiding as shown in Fig. 11-*a*. The feedline is connected to the center of a half-wave dipole. Figure 11-*b* shows the dipole folded on itself and Fig. 11-*c* is the folded dipole with the center conductor extended.

Additional half-wave sections are stacked on with the center conductor of each section connected to the outside braid of the next as shown in Fig. 11-*d*. The braid acts as a shield, preventing a signal from reaching the center conductor.

The results is that every other half-wave section is exposed to the incoming signal and the induced current is in phase, thus providing gain. The configuration at the top of the antenna array makes each leg of the series of dipoles equal in length. The feedline is therefore connected at the very center, where the impedance is lowest and comes closest to matching the feedline.

The basic design can be modified for more or less gain. Eight half-wave sections provide about a 6-dB gain over a simple dipole, and sixteen sections give about a 9-dB gain. Because of its length, the design is most applicable for VHF high-band and UHF signals.

The coaxial cable used should have a 50-ohm impedance with a solid dielectric. (RF travels slower in solid polyethylene, thus the antenna can be made shorter.) Use either RG-8/U or RG-58/U. The RG-8/U is heavier and stiffer, but has lower losses. The RG-58/U is easier to solder with a small soldering iron.

The single most important requirement for a good coaxial-collinear antenna is patience. The work is not difficult, but it can be time consuming, especially if you're not comfortable with coaxial cable. Concentrate on only one joint at a time. Be careful when connecting the sections; an accidental short circuit can turn your carefully engineered antenna into just a random length of wire.

Calculate the lengths of the sections according to Fig. 12. Then correct for the velocity factor of the coaxial cable you're using, usually 0.66 for the solid dielectric. For example, a half-wave section designed for 155 MHz:

$\lambda = 984/115 = 6.348$ feet
$\lambda/2 = 6.348/2 = 3.174$ feet
$3.174 \times 0.66 = 2.094$ feet

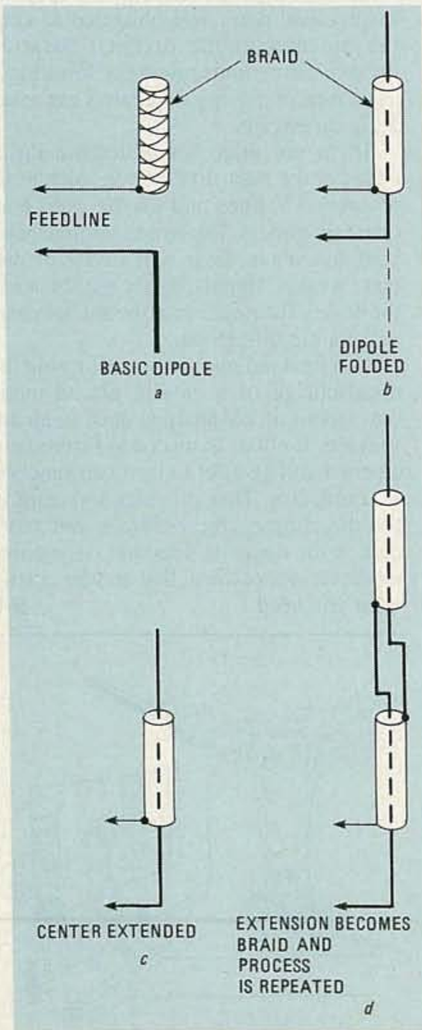


FIG. 11–COAXIAL-COLLINEAR antenna made from coaxial cable: *a* is a basic dipole; *b* shows the dipole folded on itself; in *c*, the center conductor is extended, and *d* shows two stacked coaxial sections.

After determining the dimensions, begin by preparing one end of your coaxial cable as shown in Fig. 13. Do *not* cut to length until after the end is properly prepared. That way, if you make a mistake you lose only an inch or so rather than the entire section. Do the same for each of the eight sections, preparing one end and then cutting to length. (By the time you return to complete the other end of each section you'll be an expert!)

Prepare the coaxial cable by stripping away some of the insulation according to Fig. 13; a tubing cutter or knife work well, but be careful if you use a knife. It is a good idea to tin the copper braid before joining the sections, but be careful not to overheat the polyethylene core. If the core melts, it runs over the braid making further soldering almost impossible.

If you use high-quality coaxial cable with a closed braid, you will not experience the difficulty of molten plastic oozing through the spaces, as you would with the cheaper stuff.

After preparing the individual sections, begin connecting them (see Fig. 14). Note that at the joint, the center conductor of each section is joined with the shielding of the next. Be careful that you leave no frayed ends of braid that might short the joint. The best way to handle that is to lay the center conductor of one section on the braid of the next and wrap the braid end around the joint as shown in Fig. 14.

Seal each joint with silicon rubber cement and wrap it securely with electrical tape to protect it from moisture and make it stronger. Slide the completed antenna into a length of heavy-walled (Schedule 40) PVC plastic tubing about ¾ inch in diameter. The thicker RG-8/U coaxial will easily slide through the tubing. But the lighter RG-58/U needs some help: For support, use a small nylon cord about ⅛ inch in diameter cut a foot longer than the antenna. Tie knots in the cord every foot or so and tape to your antenna, starting at the bottom.

Put the tape on the top side of the knot to prevent it from slipping when the entire assembly is in position. Slide the cord through the PVC tubing and pull the assembly through using the cord for support. With the antenna inside the tubing, there will be about a foot of nylon cord protruding from the top. Tie a large knot an inch beyond the end of the top wire section and then cap the end of the tubing, with the knot just outside.

If the cap fits too tightly, file a notch on the outside of the tubing to accommodate the cord. Glue the cap in place and dab a little glue on the knot so it won't come loose. Your antenna is now ready to be taken to its final location.

Depending on the antenna's length, you may want to brace it with lumber. And if it is exceptionally long, you may have to use guy wires as well. Non-stretching polypropylene clothesline is fine. The guy wires don't have to go to the very top because at least 5 feet will be self-supporting even in extremely high wind.

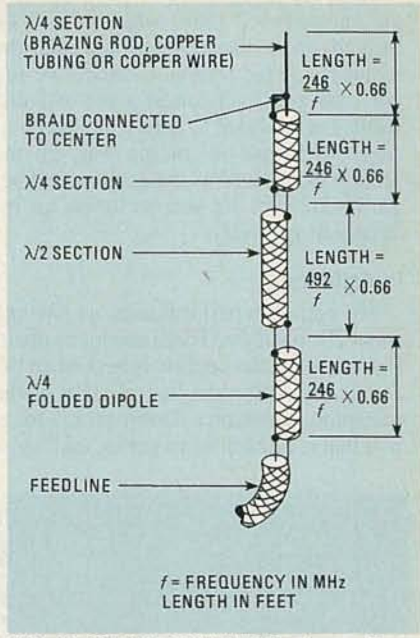


FIG. 12–COAXIAL-COLLINEAR antenna dimensions are shown here. Note that the center conductor of each λ/4 section is connected to the braid of the next.

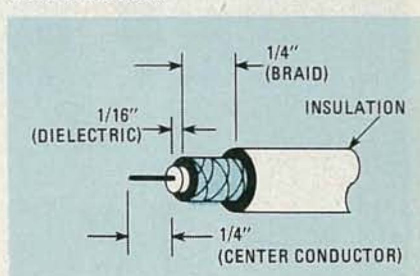


FIG. 13–PREPARE THE COAXIAL cable sections by stripping off some insulation and peeling back the braided sheilding.

Which antenna is best?

The three different antennas described varying in size, complexity, performance, and appearance. Begin designing your antenna by choosing the type that best suits your needs. In making your decision, you must consider all the variables. You can be assured that any choice made is an improvement over your monitor's built-in antenna system.

First, pick the band for which the antenna will be used. If you are lucky, all frequencies used by your local services will be in one band, and close together in frequency. Use Table 1 to help make that selection.

Often you will be interested in frequencies in all three bands; therefore you must decide which is most important to you. That choice should not be too painful. Your new antenna will probably outperform the built-in one on all frequencies solely because it is mounted higher and away from interfering objects.

After choosing the band, consider how the antenna will look, where it will be located, and is there enough room for the radials; will the coaxial-collinear be too tall?; do you really need a lot of gain? Table 4 is provided to help with that decision. With that out of the way, go the section that describes the antenna and begin building it. Be sure to follow all instructions carefully.

TABLE 4
ANTENNA SELECTION GUIDE

Band	Ground Plane	Extended Double-Zepp	Coaxial-Collinear
VHF-low	Shortest antenna Radials may need support Good Choice	Fairly tall but no radials	Excessive length
VHF-high	Short Easy construction	Reasonable length Neat installation	Highest gain Neat installation Good choice
UHF	Tiny Easy construction	Small size is difficult to build	Highest gain Neat installation Good choice

Installation

For optimum performance, an antenna should be positioned high and in the open. Remember that reception is best when the antenna is within the line of sight of the transmitting antenna. Don't pick a location that is hazardous to get to, and *never* place an antenna near any electrical line before, during, or after installation. And do not mount near metal objects.

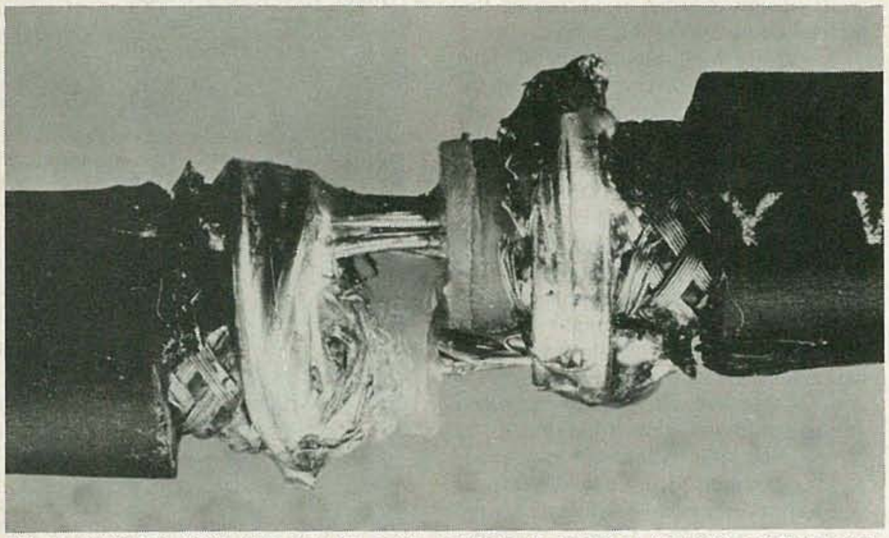


FIG. 14–FINISHED JOINT: Note that the center conductor is placed on the braid and braid ends wrapped around to secure conductor in place before soldering.

Other than the obvious shock hazards presented by power and telephone lines, nearby metal objects can change the effective inductance of the antenna and, thereby, reduce its performance. Also, before installation, ask yourself: "If the antenna falls or is blown down during a storm, where will it land?" It might also be a good idea to ask: "If I fall during installation, where will I land?"

Try to pick a location where you'll need only the minimum amount of feedline. In other words, don't place the antenna 200 feet away from the receiver's location simply to gain 10 feet in height. The height advantage will be overshadowed by additional losses due to the extra feedline. Also try to keep as much of the feedline vertical as possible.

Use coaxial cable to connect the antenna to your monitor. It is rugged, flexible, and the shielding allows you to place it in any convenient location. Running the cable along metal gutters will have no effect. Coaxial cable is available in a wide variety of sizes and efficiencies, with corresponding costs. Pick one that has a nominal 50-ohm impedance.

An important difference between cables is the structure of the dielectric material. If it's foamed it will have significantly less loss at radio frequencies than the solid core. RG-58/U, about ¼ inch in diameter, with a foamed-dielectric is an excellent cable for our purposes. Try to avoid RG-8/U. It is larger in diameter, less flexible, and costs more.

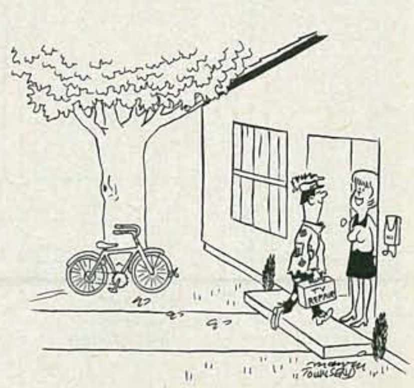
If you can find RG-8/M (miniature RG-8/U) it is also a good choice. It's only slightly thicker than RG-58/U and exhibits a good balance of flexibility and low loss at a reasonable cost. Remember when choosing your cable that signal loss increases with frequency and feedline length. For long runs at high frequencies, it is an excellent idea to use the best cable that you can afford. You'll also need a Motorola-type plug to connect the feedline to your scanner.

The simplest place to bring the feedline into the house is usually in the vicinity of a window. Drill a small hole through a nonmovable part that can be easily patched later if necessary. The window frame, top or bottom is best for that. Some houses allow easy access through a basement vent and then up through the floor.

When running coaxial cable, avoid sharp bends and be certain that the external connections are weather sealed. The foamed-dielectric cable in particular can absorb moisture, which increases feedline losses. And don't feel obligated to keep the antenna in the original location chosen. Sometimes raising or lowering it a few feet, or moving it sideways can make a big difference.

There are often unpredictable influences in the area, like power, telephone, or cable TV lines and maybe even your own rain gutters. Regardless of how good your antenna is, there will always be distant, weaker signals barely audible over the noise. The position of the antenna may make a big difference.

As a final thought, consider turning the disadvantage of a closely placed metal downspout or TV-antenna mast to an advantage. If either is spaced $\lambda/4$ from your antenna and parallel to it, it can function as a reflector. That provides less gain in the direction of the reflector, but more gain in the opposite direction. If you live on the far side of town, that may be exactly what you need. **R-E**



"I understand that you're the only TV service man in the area who still charges $10.00 an hour."

HOBBY CORNER

EARL "DOC" SAVAGE, K4SDS,
HOBBY EDITOR

Power-surge protection, and more!

A SURGE ON THE AC POWER LINE CAN cause you all kinds of problems. Don Maxwell (OK) has had a couple of line-voltage monitors blown by surges induced in the line during electrical storms. R. Fortier (Ont) just wants to protect his equipment from "normal" surges caused by power company switching or by an industrial user.

Well, fellows, one of the easiest ways to protect your equipment from most varieties of power-line surges is to install an MOV (*M*etal *O*xide *V*aristor) or two.

A MOV is a small component that looks like a fat disc capacitor. It is inexpensive and you can get one from many sources, including Radio Shack.

The MOV is connected across the AC line and simply shorts to ground the spikes that exceed the rated voltage. Of course, you could install an MOV in each piece of equipment, or in an outlet box or strip, to protect all the equipment.

That's it, fellows—nothing could be simpler. And, Don, good luck with those storms!

Headphone adapter

Bob Thorsen (CT) sent in a circuit for installing a headphone jack on your radio or TV. That is a handy feature to add to any radio, TV, or record player, and it can be used to connect an additional speaker as well as a headphone.

With a couple of minor changes, Bob's hook-up is shown in Fig. 1. In Fig. 1-*a*, one of the leads to the built-in speaker is broken. Figure 1-*b* shows a 2-conductor, single closed circuit jack; the numbered points shown in the figure are connected to the like numbered points in Fig. 1-*a*. Note that points 1 and 3 are disconnected when the phone plug is inserted into the jack. Normally, that would mean that no sound comes from the speaker when using the headphones. By adding the SPST switch, it is possible to choose between routing the signal to the headphones only or to both the headphones and speaker at the same time. Do not wire that switch any other way or you may end up with either a short across the amplifier or no load on the amplifier. Either or both conditions can be fatal to some amplifiers.

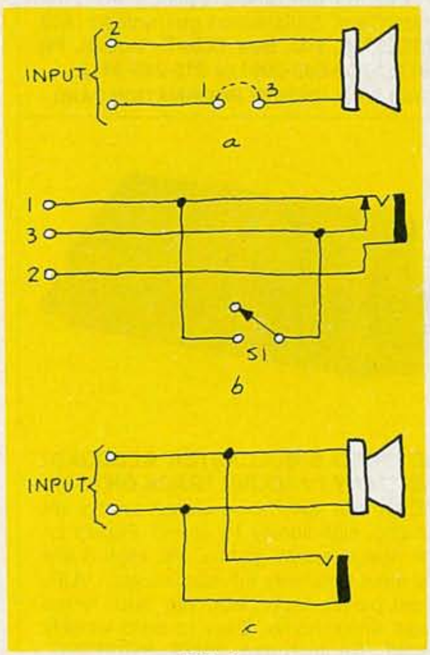


FIG. 1

If you want sound from the speaker whether the phones are plugged in or not, just wire an open-circuit jack as shown in Fig. 1-*c*.

Questions without answers

I wish it were possible to answer every one of your questions. Unfortunately, that cannot be done because time just will not permit it (to say nothing of the fact that the answers to some to them cannot be found).

Don't let that stop you from sending your questions. We will get to as many of them as we can. There are a couple of types of questions, however, that get put aside as soon as they come in. To save you time, here are two examples of questions that will not or can not be answered.

We won't knowingly tell you how to get yourself in trouble. That's why one reader did not get a circuit to shock anyone who touched his car and another did not find out how to increase the power of a CB transmitter. For the same reason, we just set aside a letter from a gentleman in NY who wanted a device to disrupt the reception of his neighbor's too-loud TV.

Secondly, you know, of course, that special circuits can't be designed to your specifications. Most of you are very understanding about this restriction and we appreciate it. But some are not.

For instance, there is a fellow in PA who has become insistent about a circuit design using the components he has on hand. Such service is not available here! We suggest that you study until you can design it yourself.

Crossed signals

C. W. Sturgeon (NY) has built a multiple-input device that controls several relays. When individual sections are tested, they function perfectly. A problem shows up when the several sections are connected. In that event, there is interaction between the sections, which, in turn, causes some unforeseen and undesirable consequences.

On the basis of the information sent by CW, he has a classic case of stray signal paths. I won't try to show you CW's entire complex circuit, but will instead demonstrate the problem and solution with a simple example.

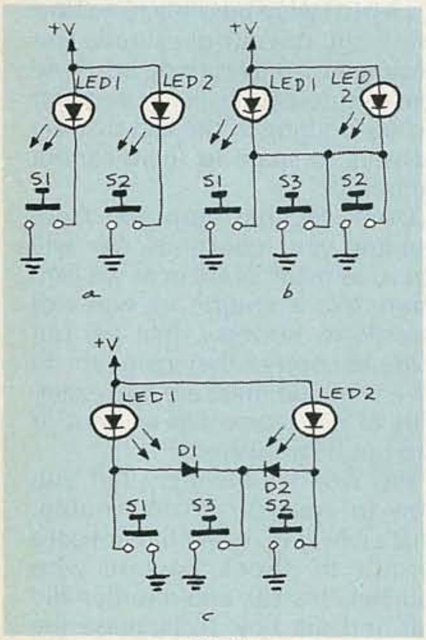


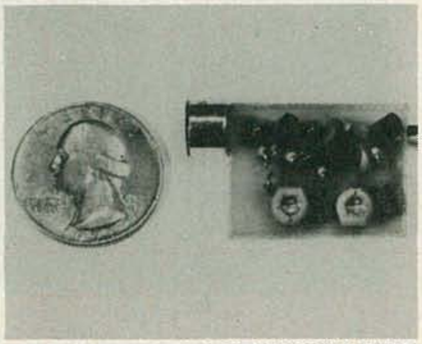
FIG. 2

Suppose you have two LED's, labeled A and B in Fig. 2-*a*, controlled individually by momentary switches S1 and S2. Now, you want to add a third switch to light both LED's.

You might be tempted to wire S3 as shown in Fig. 2-*b*. If you did so, however, all three switches would light both LED's. Trace the signal paths and you will see the interactions. That certainly makes the device worthless but you can save the day.

The signal paths can be isolated

Radio-Electronics mini-ADS



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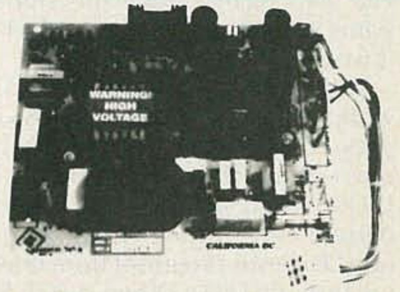

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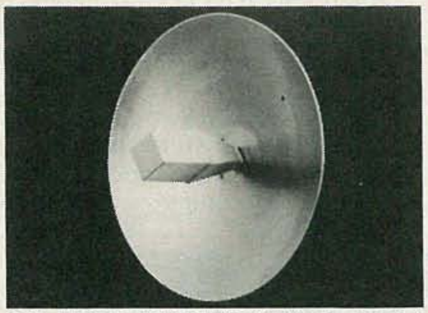

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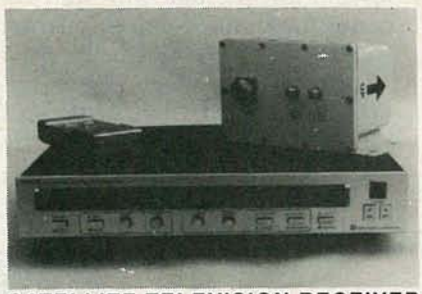

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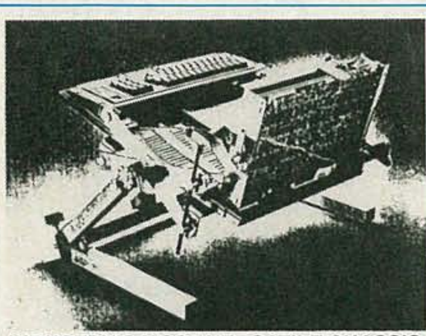

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with two diodes wired as shown in Fig. 2-*c*. Again, trace the signal paths to understand how and why it works.

Let's look at how the circuit works together. When switch S3 is pressed, diodes D1 and D2 permit current to flow through both LED's. When switch S1 is pressed, current flows through LED1 but diode D1 prevents current from flowing through LED2. When switch S2 is pressed, current flows through LED2 but diode D2 prevents current from flowing through LED1.

Thus, the device functions properly: You can light one LED or the other or both. The switches do not interact—they have been "isolated" by the diodes.

Now, CW, put some diodes in your device and cut out those stray signal paths. I suspect that your circuit will work properly with them installed.

AC-powered clock

It is much more convenient to have some types of devices powered by batteries than by the AC line. When purchasing or building, each of us has to make the power-source decision considering relative costs, convenience, and other factors.

Walter Quick (FL) wants to build a 1.5-volt AC-powered DC supply to put into a battery-operated clock.

Well, Walter, I really can't understand why you want to change a cordless clock into one tied to the AC line. Of course, you wouldn't have to replace a battery every year or so, but, on the other hand, your clock would stop with each power outage.

But, if you really want to do that, just build a regular half-wave power supply using the physically smallest components you can find. Lacking a transformer with a lower output, use one-half of a center-tapped 6.3-volt AC filament transformer. Probably, you will have to use a voltage divider or a dropping resistor to get down to 1.5 volts. The final result will look like the circuit in Fig. 3.

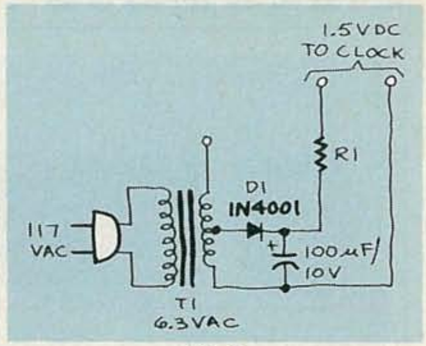

FIG. 3

You can determine the value of R1 by trial and error or by calculation. To do the latter, measure the clock current when using a battery; subtract 1.5 from the supply voltage to determine V (the amount of voltage to be dropped across the resistor), and then, use the R = V/I formula to determine the resistance necessary to get the supply voltage down to the 1.5 volts that is required.

But, I suggest that you not change the clock so that you can't go back to a battery supply when, as is bound to happen, you get tired of resetting it. **R-E**

COMMUNICATIONS CORNER

The talking heads

HERB FRIEDMAN,
COMMUNICATIONS EDITOR

A SURE-FIRE WAY TO TELL WHEN SOMEthing has become trendy is when you find university professors and professional seminarians hitting the lecture circuit glorifying both the virtues and evils of the most recent technologies. The latest subject for their learned papers, discourse, and expensive seminars is "communications." In the past few weeks, I've listened to the largest collection of old ideas described as "new technology" that one can imagine!

One expert, for example, dwelt at length on the "new directions" created by a TV network's recent three-way satellite hookup so three political pundits could discuss the latest developments in yet another third-world conflict. And what was so spectacular about the program? A satellite relay transmission that permitted each analyst to see the others on a TV monitor. (For this we need a seminar?)

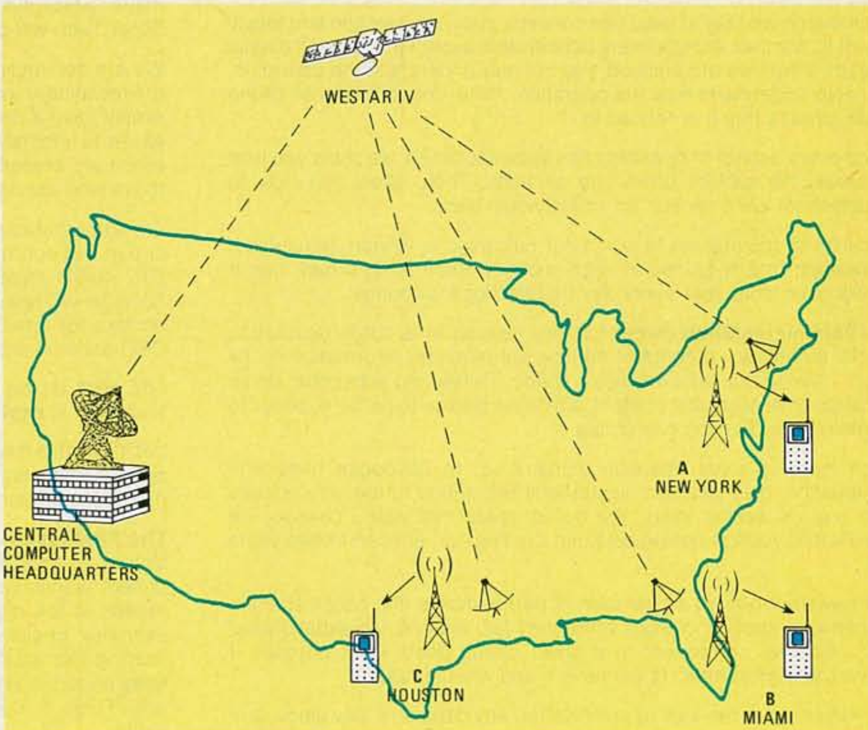

FIG. 1

Many years ago, the legendary Edward R. Murrow wrote about the first live three-way transatlantic broadcast between the U.S., Europe, and Africa as World War II unfolded. It was no big deal; simply a straight telephone interconnect that allowed each commentator to hear the others. The circuit terminated at the CBS broadcast transmitter.

Here we are some 40-years later, and what took a real communications *pro* only three paragraphs to describe has now become the subject for a half-day seminar. It's really the same old thing with a different "twist;" instead of low-cost telephone circuits we are now using multi-million dollar satellites to end up with "talking heads"—radio with pictures. (Sorry, I will not buy "talking heads" as state-of-the-art, even if it sells on the lecture circuit or packs a communications seminar at $250 a throw.)

High-technology serves no useful purpose if the best it can do is to require mega-bucks to only marginally improve something we have been doing all along at reasonable cost and effort. To have value, high-tech must add a new concept to communications; it must give us something important that was not previously available or attainable. Or it must so sharply reduce the overall cost of a service or product that it becomes generally affordable.

Let me use something called *QuoTrek* as an example. QuoTrek is a service that uses a pocket receiver—a handheld receiver terminal—to display trading and instant updates on selected stocks and commodities. The receiver has a 40-character LED display, and an alphanumeric keyboard for selecting the specific stock quotes desired.

While you might have no interest in the stock market (preferring to do your gambling in Las Vegas),

VOL. 2 No. 5 May 1985

COMPUTER DIGEST

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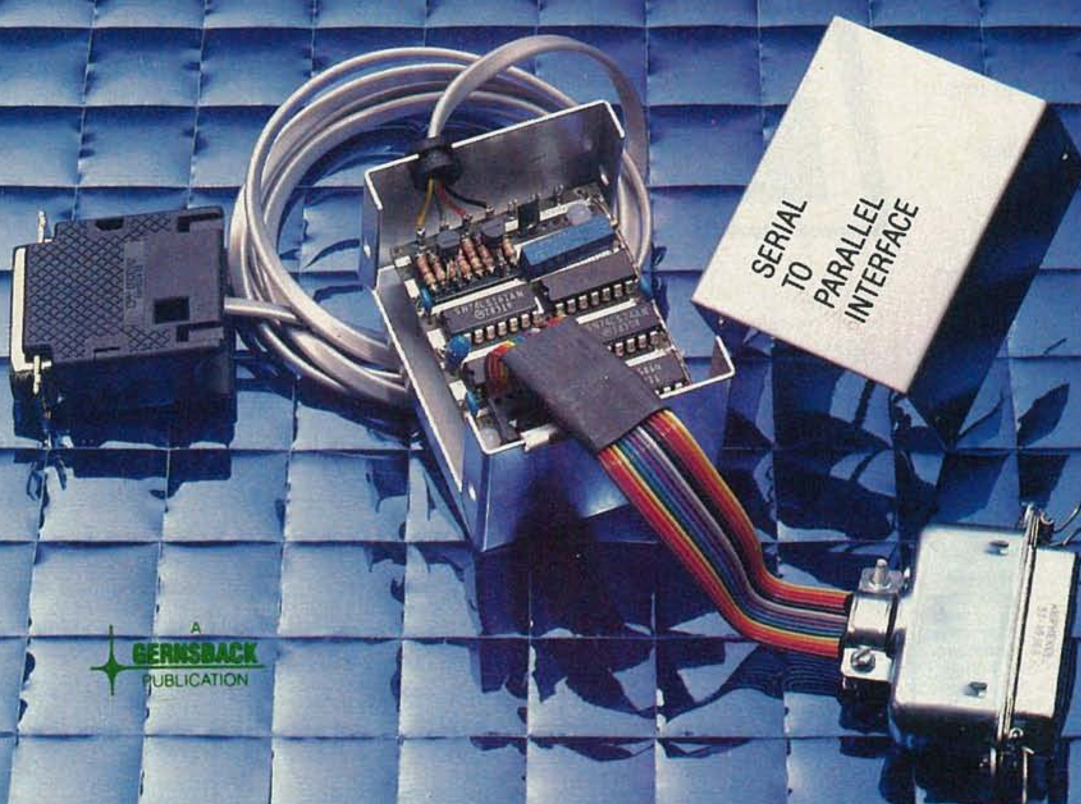

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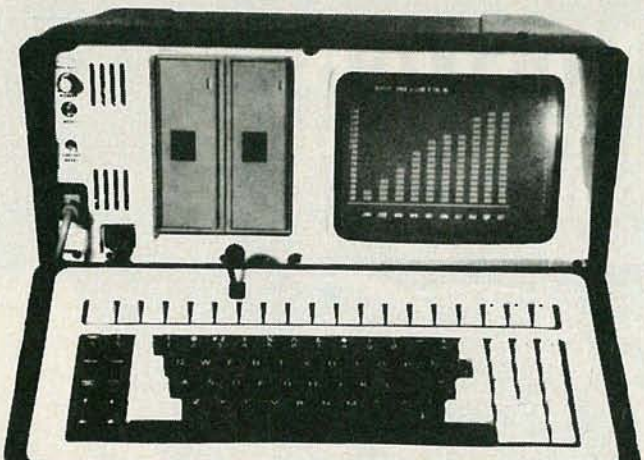

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General Specifications

ZORBA is the lowest cost full featured portable computer. This light weight computer is ruggedly packaged in a convenient carrying case. The case surrounds a strong inner chassis which further protects the Z80A based computer with its two double sided double density disk 400K drives, large easy to read 9" display screen and well designed detachable keyboard.

ZORBA uses CP/M, the industry standard operating system, which means that a wide range of existing software is readily available to the user.

The ZORBA users manual covers operation of the unit, all suppllied software and all interface and internal information. A system diskette is supplied with all system files and utilities. A second diskette contains the sources for all ZORBA software including BIOS, SETUP, FORMAT, and PATCH.

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Keyboard communicates serially with CPU
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95 keys in standard QWERTY format
13 Key Numeric pad
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55 Software programmable function keys
All keys auto-repeat after 1 second delay
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Controller:	WD1793
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Built-in disk interchange formats: Xerox 820 (SD, DD), Kaycomp (DD), DEC VT-180 (SD), Osborne (SD) and IBM-PC (eg. CPM/86) and Televideo 802 (Read/Write and Format compatibility) (Expandable to 61 Formats)

Specifications
General Mechanical and Electrical

Width	-17.5 inches (44.45 cm)
Height	- 9.0 inches (22.86 cm)
Depth	-16.0 inches (40.64 cm)
Weight	-24.6 pounds (11.1 Kg)
Power	-80-130 VAC or 190-245 VAC 50/60 Hz 170 watts max

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Display Tube:
9" diagonal, Green or Amber
High resolution display circuitry
60 Hz refresh rate

Display Format:
25 lines x 80 columns
5x7 Character Font with full descenders
128 ASCII Characters
8x9 32 Characters Graphic Font
2K Memory Mapped Display Buffer

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Z80A CPU running at 4 Mhz with no wait states
64K bytes of 200 ns RAM (58K after CP/M loaded)
16K bytes of EPROM (2732) can be switched in and out by software
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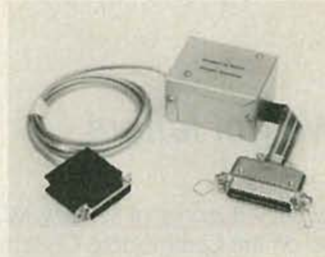
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Vol. 2 No. 5 May 1985


Page 11.

Radio Electronics YOUR OWN Computer

ON THE COVER

More and more, people are collecting equipment that may be very useful, but not compatible. If you have a Centronics output on the computer you want to connect to a printer with an RS232 connector, this interface device will make it all possible. See page 8.

EDITORIAL

We get letters...

■Charley Buehner of Scobey, MT, wrote to say that he liked the piece we did on the Commodore Cassette Interface, but that he has an Atari. His friend has a Commodore *Plus/4* which has a din port connector, and Charley wants to know if there's anything that they can do.

Charley, it's a problem.

There are so many varieties of computer out there, and we have only 16 (count'em) pages each month! The name of the game, of course, is "standardization" which would put us all back in the game. It all really began when the resistor manufacturers decided on a standardized color-coding system that really worked out well for everybody. The capacitor manufacturers *tried* to follow suit, but the result was utter chaos, with ramifications, ifs, and's and but's.

In the world of computers, standardization was attempted with interconnects, the RS-232 being the biggest bug-a-boo of all. Still, it's *called* a "standard," and we have to live with it. So non-standard is this standard, that hundreds of articles have been (and still are) written about it. At least one manufacturer offers a cable that lets you interconnect regardless of deviations from that so-called standard!

We attempt to aim articles at the various types of computers, but no magazine can be all things to all men. What's needed, we feel, is an organization of computer manufacturers that will sit down like rational people and try to sort things out with an eye toward simplification.

It seems that they're all willing to adopt standards, provided that the methods and systems they now use themselves, are adopted as the "standard." And chances are that even if that *were* to happen, they'd claim a proprietary interest and stop it all with a law suit!

There doesn't seem to be a simple solution, if solution there is at all. We can only hope for that Utopian day when there will be peace on Earth, no more crime, no more famine, love will once again prevail, and all computers, regardless of manufacture, can use any software or peripherals without complicated and devious rework.

But if you think the Peace Talks get bogged down, just try getting computer manufacturers to talk to each other. Kissinger could have a field day with those people! But until the time that happens, we're all going to have to suffer with non-standard standards.

Byron G. Wels

Byron G. Wels
Editor

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LETTERS

Glitch!

There seems to have been a slight glitch in the program listed in the March, 1985 issue in the story on Morse Code Practice On Your Commodore. Have you heard from others? Have you located the problem?—P. Childers, Orlando, FL.

Yes. Here are the corrections: Line 30 should have a comma, not a decimal point; Line 290 should read: EL (1)=R:For I=2 to N. Line 300 should read P=N-I and line 480 should read GOTO 210. Other than that, Bob Woods, our author, assures us that everything else is O.K.

Bottom line

I went to a "computer store" recently, more to window shop than to buy, but I did get to talk to a salesman. Actually, he did the talking, I listened. He was obviously trying to fast-talk me into buying a product I neither needed nor wanted, but which carried a heavy price tag, and I assume, a heavy commission for him. He steered me around the aisles to the equipment *he* wanted me to see, I couldn't get a word in edgewise, and he got more and more insistent as I got angrier and angrier. How do you handle a situation like that?—B. Pettigrew, Seattle, WA.

The way I handle that kind of situation is simply to walk out and let him stand there and talk. Then go back to the same shop a month later. Chances are he won't be there any more.

Seiko Misses The Mark

After reading your article by Marc Stern in the February Issue, (Seiko's Datagraph System) I feel I must comment. The article, though an excellent promotion for Seiko, did not point out any of the system's obvious failings. Perhaps the author did not have the opportunity to use one. I did, and found sufficient reason to return the product to the place of purchase.

The first failing was a distinct lack of contrast in the display. The viewing angle was more critical than an ordinary LCD watch. As there is no provision for use at night (no back lighting or light) the watch functions (much less the data functions) are unusable at night or in dim light. The actual computing and recording utility, from a practical standpoint, is diminished by having to carry the keyboard module (which does not appear to be too sturdily built). The alarm function could have been enhanced by having multiple alarms tagged to different messages, but as it currently stands, it is limited to one.

In a nutshell, Seiko's wrist "computer," despite its excellent technology, fails to provide sufficient utility as either a watch or a computer to merit its price tag. It is a good step in the right direction, but falls short of the mark.—C. N. Austin, TX

C. N., I can assure you that Marc did indeed test the system, and liked it. I guess differences of opinion are the reason that we hold elections!

Worried

I like the idea of computers being made smaller and more portable, but this also makes them more susceptible to theft. They're easily negotiable, and make fine targets for burglars. What's the best way to protect a computer against robbery?—C. Simpson, Ft. Lauderdale, FL.

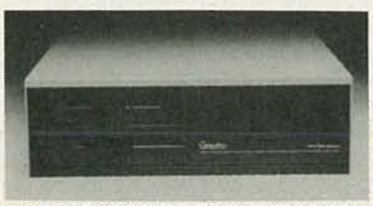
You'll find a wide variety of devices to protect a computer from theft. But don't forget, when you buy a computer, to notify your homeowner's insurance agent so you can get it covered under your regular policy.

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

SUBSYSTEM OPTION, has been designed by the Viasyn Corporation (formerly known as CompuPro) as a mass storage option for its *System 816* microcomputers that allows the user to tailor a disk system to fit his or her particular application needs.

The new *Tri-Disk Subsystem* offers combinations of either one 8-inch and one 5.25-inch floppy disk drive, or two 8-inch floppy drives, and a 5.25-inch hard disk available in choices of 20 or 40 Mbytes.



CIRCLE 21 ON FREE INFORMATION CARD

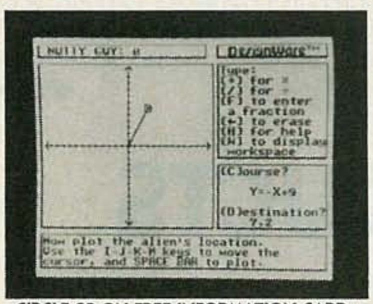
The *Tri-Disk System* featuring either the 8- and 5.25-inch floppies, or the dual 8-inch floppies, is priced at $4,995, with the 20 Mbyte hard disk. With the 40 Mbyte hard disk, the price is $5,495.—**Viasyn Corporation,** 450 Newport Center Drive, Suite 200, Newport Beach, CA 92660.

COMPUTER SYSTEM, the *Integral Personal Computer,* comes in a 25-pound transportable package with a built-in ThinkJet printer, a 3½-inch double-sided disk drive, a 9-inch electroluminescent display, and a full-size keyboard. It is based on the Motorola 68000 16/32-bit processor and a 16-bit HP graphics processor. Standard memory is 800 Kbytes, which can be expanded by the two standard input/output (I/O) slots. Also standard is the HP-IB expansion interface (IBEEE 488); and there are five interface options that can be plugged into the I/O slots.

CIRCLE 22 ON FREE INFORMATION CARD

The Integral Personal Computer is priced at $4,995.00—**Hewlett Packard Company,** 1020 N.E. Circle Boulevard, Corvallis, OR 97330.

EDUCATIONAL GAME, *Mission: Algebra,* provides kids age 13 to 18 with an entertaining, educationally sound way to practice solving linear equations. The game features a random generator that creates thousands of problems for endless practice in coordinating pairs on a graph, determining the equation of a line and solving for "x" and "y" coordinate pairs.



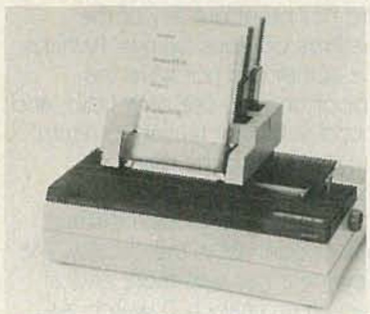
CIRCLE 23 ON FREE INFORMATION CARD

The object of the game is to recreate the course of your lost sister ship to locate its present position. In the process, you must learn to solve linear equations. Problems flash on the screen above a large workspace. The valiant reconnaissance scout must solve for "y" before plotting the x,y coordinates on a graph to locate the ship that's gone astray. Incorrect answers are identified, requiring reevaluation of tracking tactics and the selection of another approach.

"Mission: Algebra" is priced at $44.95.—**Designware,** 185 Berry Street, San Francisco, CA 94107.

INK-JET PRINTER, model *PT-90,* is a dot-matrix printer with an ink-jet printing system (32 nozzles) for letter-quality printing and graphics. It is particularly designed for use in final text preparation and processing.

The model *PT-90* has an overall resolution of 240 dots per inch, both horizontally and vertically. Its letter-quality mode offers a character resolution of 96 × 32 dots (at 10 cpi), indistinguishable from fully-formed characters. Its draft mode offers a character resolution of 48 × 16 dots, comparable to the best high-density impact printers.



CIRCLE 24 ON FREE INFORMATION CARD

The *model PT-90* offers almost universal compatibility with popular systems and software.The suggested retail price is $3495.00.—**Siemans,** 186 Wood Avenue South, Iselin, NJ 08830.

COMPUTER FURNITURE, the Oak 170 Series, includes a desk, hutch, printer stand, corner connector, and monitor/printer platform, all in oak with a hand-rubbed finish.

The desk, model *CT-170,* has a dual-level top with adjustable keyboard and CPU shelves. The entire lefthand surface can be lowered to a typing height of 27", 28", or 29". Detachable keyboards can be tilted at 5°, 10°, or 15° for user comfort. The desktop's fixed half can hold a cassette or disk drive, and even a printer. A pencil drawer slides below. The model *CT-170* is priced at $329.95.

The add-on hutch, model *CTA-171,* includes a monitor shelf and two adjustable storage shelves. The monitor shelf can be raised or lowered to put the video monitor at the proper eye-level, and can also be tilted to reduce glare. The model *CTA-171* measures 28" × 49" × 13" and is priced at $219.95.

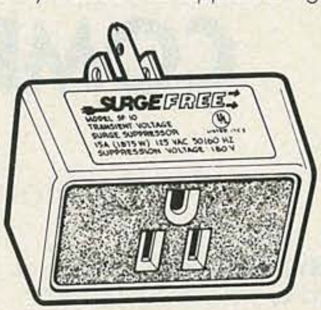
CIRCLE 25 ON FREE INFORMATION CARD

The printer stand, model *CT-175,* has two top paper slots to accommodate either rear- or bottom-feed printers, and two interior storage shelves. The forms receiving shelf on the back can be raised or lowered depending on the user's needs or office location. The model *CT-175* measures 29" × 25" × 28" and is priced at $229.95.

The trapezoid corner connector, model *CTA-173,* can join the desk and printer into a complete work center. It can be attached to either the right or left side of the desk, as the user prefers. It is priced at $79.95.

The monitor/printer platform, model *CTA-172,* can be used with the desk to hold a monitor or micro printer. It also has a tilting feature to reduce monitor glare, and measures 9" × 22½" × 11¾". It is priced at $49.95.—**Bush Industries, Inc.,** 312 Fair Oak Street, Little Valley, NY 14755.

SURGE SUPPRESSER, the SurgeFree model *SF-10,* is a single-socket electronic power center for residential use. It features fail-safe, solid-state, surge-clamping electronic circuitry. Rated at 15 amps (1875 watt) 125-volts AC, it instantly detects and suppresses high-



CIRCLE 26 ON FREE INFORMATION CARD

voltage spikes and surges, protecting such electronic equipment as personal computers, color-TV, and microwave ovens or any sensitive devices. It is priced at $12.95.—**Ultima Electronics, Ltd.,** 21 Central Drive, Farmingdale, NY 11735.

SOFTWARE REVIEW

Telecommuter—Integrated word processing and communications for PC-compatibles and lap computers.

HERB FRIEDMAN

■*Telecommuter* is an integrated word processing and communications package specifically designed for the users of IBM-compatible and Radio Shack lap computers (and the NEC 8201A lap computer). The program is based on the concept that most persons using an IBM-compatible personal computer at the office and a lap computer in the field don't want to become computer scientists in order to integrate the two. By making the office computer emulate and support the lap computer, *Telecommuter* creates a totally integrated word processing and communications environment that employes the same functions: Except for the word processor, both IBM-IBM-compatibles and the lap computers function the same way for communications and text creations: The difference in the word processor is that the IBM is a full-fledged word processor, not a text editor: It is intended for the creation of business documents or for the reworking of text, data or even BASIC programs that originated in a lap computer's text editor.

Host and cable transfer too.

In addition to the word processing and communications functions, *Telecommuter* provides HOST and CABLE TRANSFER modes. In the HOST mode the disk drives of the office Computer can be accessed directly from the field by the lap computer—or any other remote computer—and data, documents, or whatever, can be exchanged between the disks and the remote computer. For example, consider the field technician who might need to know the availibility of spare parts, but the home office is closed for the day. By using a remote computer to access the office *PC* he could check inventory files, even start the office printer and leave a message telling the first person in the next morning to pull the parts and ship them express. Or, he might write a complete report of his efforts using the lap computer's text editor and then upload the report directly into the office *PC*'s "electronic mailbox."

All this may sound complex. It's not. When the lap computer accesses the office *PC* the commands seen at the remote site appear almost exactly as they do at the *PC* itself; the user actually works in PC-DOS when using the *PC's* functions from the remote site. He can call for a DIR of either drive, ERASE, COPY, WRITE and READ files, even start and stop the office printer. It functions the same way on both ends.

Telecommunter is intended for use with a Hayes Smartmodem, a Radio Shack Modem II, or a Tandy 1000. The HOST mode can easily accommodate the small business having one phone line because *Telecommuter* allows a Smartmodem's bell (ring) pickup to be programmed by the user through a configuration menu. Instead of having to put up with an automodem answering on the first or second ring, a Smartmodem can be programmed to pick up on, the fifth ring so the computer can be left on-line at all times. Someone will usually answer before the fifth ring; if not, the computer answers the line. With this feature, the user doesn't have to wonder whether the computer and modem are turned on or off, they can be left on, or turned on by a time clock because *Telecommuter* can be set to cold boot directly into the HOST mode. For those who are into serving as a HOST for other computer systems and users, *Telecommuter* comes with a special FILTER program that converts *WordStar's* word processor.

It's safe.

Meddlers and other unauthorized users can be kept out of the HOST computer by using an optional password of up to 14 characters. If the correct password isn't entered by the fourth try *Telecommuter* automatically disconnects from the telephone circuit.

The *Telecommuter* package includes a special null modem cable that permits direct cable transfer—UPLOAD and DOWNLOAD—between the office and lap computers, or any other computer. If the user returns to the office, the material in the lap computer can be directly transferred into the office PC at speeds up to 9600 baud. However, 9600 baud assumes the computers are close to the same tolerance. We have not found that to be so, and generally run direct cable transfers at 2400 baud.

Virtually every parameter is user-programmable through installation and configuration menus: This includes color or monochrome screen display, password selection, communications default drive, communication parameters, individual selection of COM1 or COM2 for the RS232 and modem I/O's, individual baud rate, stop bit and parity for all communications modes, modem set and reset control codes, even printer selection. *Telecommuter* automatically plugs in the correct boldface, underline and optional control codes for commonly-used Radio Shack, Epson, IBM, Itoh, NEC and Diablo printers.

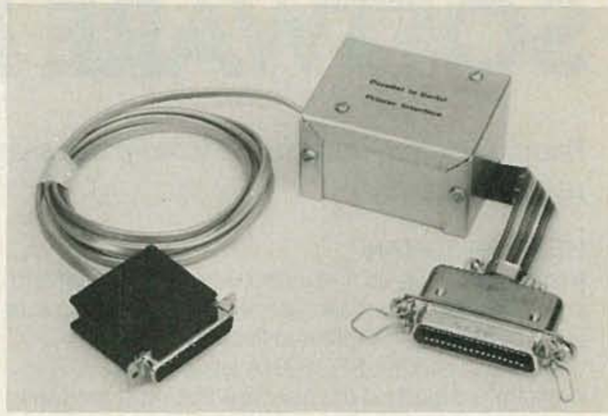
The one thing *Telecommuter* cannot do is protocol (binary) transfers. The program is specifically intended for communications and the preparation of text and documents. In these areas its performance is superb.

Telecommuter Integrated Word Processing Communications Software, Sigea Systems, Inc., 19 Pelham Rd., Weston, MA 02193. For IBM *PC* and *PC/XT* compatibles and Tandy 2000, 1200, 1000. computers with internal or external modem. Price: $200 postpaid, includes postage and handling.

PARALLEL TO SERIAL INTERFACE

Interface a Centronics parallel output to an RS232 serial printer.

R. L. L. Hu



■If you built your computer system using boards and peripherals from different manufacturers, you have probably experienced the frustrations and confusion of mixing and matching interfaces. This project meets the real need to interface a Centronics parallel output to an RS232 serial printer.

How the circuit works

Refer to the schematic diagram, Figure 1. Parallel data from the printer controller is loaded into IC1, a 74LS165 shift register by the STROBE signal if the BUSY line is low. This STROBE signal also clears IC2, a 74LS161 binary counter and presents IC3-a, a 74LS74 flip-flop. On the positive edge of the STROBE1 pulse, IC3-b is clocked and the BUSY line to the printer controller goes high. Since most parallel interfaces found today use only the STROBE1 and BUSY lines for handshaking, the ACK signal was not implemented in this design. The BUSY line will be kept high for a minimum of 10 clock cycles for each byte transferred. During this interval, the parallel data loaded will be clocked out serially through IC3-a: first the start bit, then followed by 7 data bits and ending with 2 stop bits (total of 10 bits). The

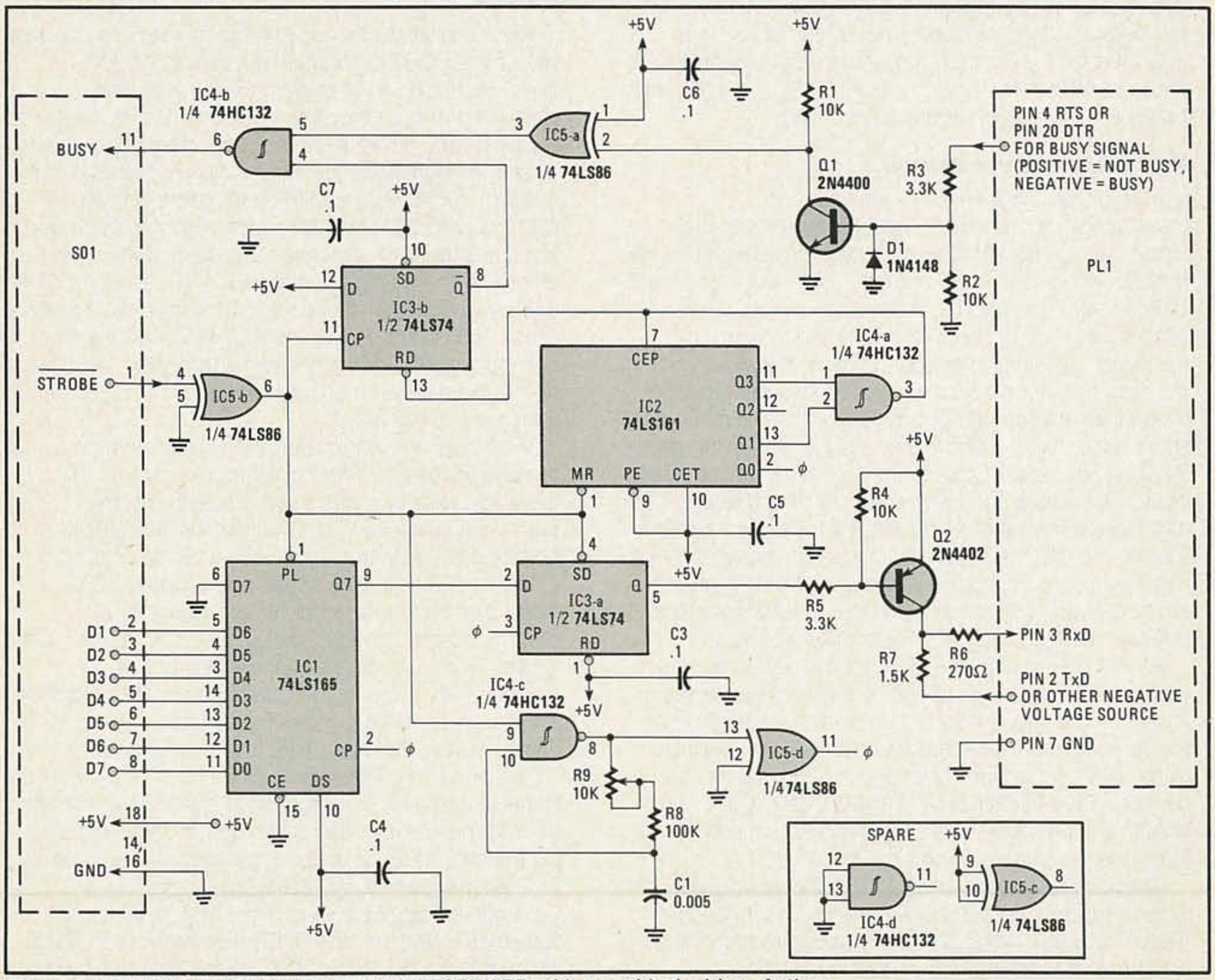


FIG.1—SCHEMATIC DIAGRAM IS STRAIGHTFORWARD with no critical wiring. Author used wire-wrap method, on ordinary perfboard. For better understanding, refer to the schematic while reading "How it works" section.

BUSY line can also be held high by the serial printer if the printer buffer becomes full, that holds off any further data transfer from the printer controller. Many serial printers use either pin 4 (RTS *Request To Send*)) or pin 20 (DTR *Data Terminal Ready*) to signal this buffer-full condition.

To keep the overall parts count low, the 74HC132 (high-speed CMOS) Schmitt-trigger was used for IC4. That IC lends itself well to operating as an oscillator simply with the addition of a resistor and a capacitor. The oscillator runs at 2400 Hz or 2400 baud with the values of R and C shown.

Since the STROBE pulses occur asynchronously (when the BUSY line is low), it is possible to have the positive edge of a clock pulse arrive just at the instant the STROBE pulse goes high. Unfortunately, that would result in an unpredictable outcome. However, with the clock circuit shown, which is not the same as gating the output of the oscillator, a setup time is ensured between the last STROBE pulse and the next clock pulse. Pull-up resistors were not used in interfacing LS TTL to this CMOS, since with CMOS gates as the only load on the LS TTL outputs, the LS TTL outputs will generally rise up to one Vbe below Vcc.

Transistors Q1 and Q2 serve as voltage trasnslators, and diode D1 keeps the base of Q1 from going into negative or reverse breakdown.

Construction.

The layout of the components is not critical. The prototype was built using wirewrap technique. The RS232 receiver and driver components were all mounted on a single 16-pin component header and plugged into a wirewrap socket. The whole circuit board fits into a small chassis box (Radio Shack 270-235), with one end of the box for the parallel interface connections and the other end for the RS232 interface connections. It is best to keep the parallel interface cable short and extend the RS232 interface cable to the length desired.

Do not substitute the 74HC132 with 74LS00, unless you plan to design your own oscillator. The baud rate of this interface board can be changed to suit your printer or your inclination. However, not much can be gained by running at a baud rate greater than 2400, unless you have a very fast printer (240cps) or a print spooler, since data transfer occurs concurrently with printing anyway.

Note that some serial printers use an active-low BUSY signal, in which case, pin 1 of IC5 should be tied to ground instead of Vcc.

Powering-up the interface

The 5-volt supply needed to run this board can usually be obtained from the Centronics end of the interface. Check your printer controller documentation to see if it is available at one of the connector pins. If not, it would be a simple matter to install a jumper from the 5-volt source on the printer controller board to one of the connector pins. The negative supply (-9, -12, -15V. etc.) may be obtainable from the serial printer end of the interface. Check the documentation for the printer; if pin 2 (TxD *Transmtted Data*) is unused and remains at a negative RS232 voltage level when operating, then it may be usable as the negative voltage source to drive the RxD (*Received Data*) line.

Apply power to the interface board. Check and adjust VRl for oscillator frequency of 2400 Hz. This frequency does not have to be accurate, since each start bit synchronizes the receiver clock of the UART/ACIA in the printer. Timing errors are non-cumulative.

Troubleshooting.

If the printer prints the correct character each time, then the baud rate is set correctly. If you get garbage, check the baud rate. Now try writing a string of characters to the printer. If the printer worked in the single character mode but now it prints garbage, check and make sure the number of data bits, parity bit and stop bits on the printer are set as follows: 7 data bits, no parity bit and 2 stop bits, which is the same as setting for 7 data bits, mark parity bit and 1 stop bit.

PARTS LIST

Resistors
R1, R2, R4—10,000 ohms
R3, R5—3300 ohms
R6—270 ohms
R7—1500 ohms
R8—100,000 ohms
R9—10,000 ohm, 10-turn potentiometer

Capacitors
C1—0.005uF
C2-C6—0.1uF

Semiconductors
IC1—74LS165 shift register
IC2—74LS161 counter
IC3—74LS74 flip-flop
IC4—74HC132 Schmitt trigger
IC5—74LS86 quad OR gate
Q1—2N4400 transistor
Q2—2N4402 transistor
D1—1N4148 diode

The number of stop bits sent by the interface board can be increased from 2 to 4, if your printer lacks the flexibility in data format settings, by simply moving the wire from Q1 to Q2 on IC2.

If the printer prints okay initially, but starts to drop characters after a while, it is likely that the printer buffer overflowed due to improper handshaking. Check the busy line from the printer to the printer controller. If the problem is still not resolved, set up a scope loop by disconnecting the printer and issuing continuous print commands, remembering to tie up or down, depending on your particular printer, to the printer busy line. Now is a good time to pause and reflect, before you become too deeply involved in troubleshooting, on a couple of things which should have been verified before hooking up the interface: that the Centronics controller itself works, and that the RS232 printer itself works also. This interface has been tested and used with Cromenco printer controller board, Heathkit H14 dot-matrix printer (256-character buffer) and Smith Corona TPI serial daisy wheel printer (32-character buffer). Both have been working.

ECG® LED Lamps

Philips ECG has LED lamps in shapes and sizes for virtually any application. They're available in round, rectangular, triangular and square shapes. They come in red, yellow, green, or even in two colors. And there's a choice of clear and diffused reds. Some have jewelled lenses. And some are even available as flashing LEDs with the flasher circuit built in.

In addition, long-life, shock-resistant, vibration-resistant, LED replacements for incandescent cartridge indicator lamps are also available in red, yellow or green.

Common applications: All LED indicator applications. LED cartridges are ideal replacements for cartridge-type incandescent lamps.

CIRCLE 297 ON FREE INFORMATION CARD

ECG® High-Voltage Rectifier and Voltage Divider Network

Philips ECG's ECG568 is a high-voltage rectifier used in Sanyo and Sears TV sets to supply high voltage to the picture tube. It also contains a voltage divider network which supplies focus voltage to the picture tube.

Common applications: For use in television service and repair.

CIRCLE 298 ON FREE INFORMATION CARD

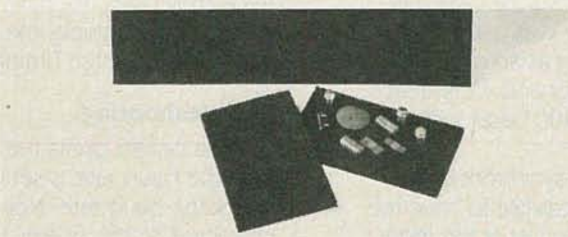
EMF® Transient Voltage and RF Interference Suppressors

EMF transient voltage surge suppressors by Philips ECG clamp voltage spikes on 120 VAC line to levels safe for all electronic equipment. They can handle up to 40% greater surge current than other suppressors. Single outlet suppressors are available in both two- and three-prong versions.

The multiple outlet EMF315 incorporates both a spike suppressor and a PI filter to suppress RF interference on the AC line. RF interference causes audio and video degradation and causes digital equipment to function imperfectly.

Common applications: Electronic equipment such as hi-fi and television, stereo, computers or other line-operated electronic equipment subject to voltage surges and radio frequency interference from the AC line.

CIRCLE 299 ON FREE INFORMATION CARD



ECG® A-STAT Material

Philips ECG has two sizes of anti-static foam that will prevent damage to semiconductors from static electricity. The A-STAT 12 measures 12" x 12" and is perfect for bench use. The A-STAT 2 measures 3" x 5" and can be carried in the tool box. When semiconductors are kept in A-STAT foam, static electricity is shunted through the foam instead of into the semiconductor, where it could have caused damage.

Common applications: Essential for semiconductor protection on the workbench or in the field.

CIRCLE 274 ON FREE INFORMATION CARD

BUILD THE MODEM MINDER

You don't have to sit there watching and waiting...

KIRK VISTAIN

■Like many computer users, I enjoy communicating with remote CP/M and bulletin board systems. And like many, I've spent much of my time hearing busy signals and redialing. That's why I was so happy to get a copy of MEX, the public domain Modem Executive program. With it, I could tell the computer to keep dialing a number until it connected, without my intervention. But, I ran into a slight problem. The computer is supposed to make life simpler by eliminating the need for human intervention in mundane, repetitive tasks. Yet there I was, sitting by the terminal, watching a number being dialed over and over again. Why? Because I had to know when a connection was made. Perhaps like many of you, I have a computer which does not support a terminal bell. So the only way to know when I had reached a remote was to watch the screen. I know what you're thinking. Turn the volume up and go do something productive while you're waiting. High volume? That doesn't help your concentration. That's why I designed the Modem Minder (Fig. 1).

FIG. 1—WITH UP-FRONT CONTROLS and a small footprint, the Modem Minder fits nicely just about anyplace.

How the Modem Minder works.

When your computer attempts to ring up a remote, it waits until it hears the answering computer's acknowledgment tone of 2225 Hz and responds with its own 1270 Hz signal. It is this tone that the Modem Minder senses acoustically.

When used with a direct-connect modem, such as the Hayes Smartmodem, it monitors the speaker output, which can be set to an unobtrusive level, and sounds a piezo buzzer when it detects the 1270 Hz tone from the originating computer. You can go about your work while the computer tries to connect, and be notified when it does, without being distracted by the dialing tones.

Design.

I designed the Modem Minder to meet several goals. First, it had to be as isolated as possible from the circuitry of both the modem and computer. This is good practice whenever you build an add-on device. Modifying commercial designs is a risky business, and will generally void any warranty you might have. The idea of hard-wiring an unproven circuit to a $250 modem just isn't appealing, unless you're a fireworks buff. So I opted for acoustic coupling. This means that the modem must have an internal speaker. All the stand-alone Hayes models and many others do, so this seemed a valid approach.

Parts availability and ease of construction constituted the second criterion (Fig. 2). This meant using off-the-shelf devices and a simple circuit. Since the Modem Minder would probably not be used for extended periods of time, the complexity of an AC supply seemed excessive, so battery power was chosen.

Because it would be sitting close to the computer, Modem Minder would have to reject noise and speech. More importantly, it would have to distinguish between the desired 1270 Hz tone and the other tones it would be likely to hear on the phone line, especially the uncomfortably proximate 1209 Hz touch-tone signal used with numbers 1, 4, and 7.

The circuit shown in the schematic, Fig. 3, satisfies these requirements. IC2-a is configured as a non-inverting amp with a gain of approximately 30. The acoustical transducer is a ceramic microphone chosen mainly for economy and its limited frequency response, which helps reduce noise problems. C4 eliminates the DC offset component of the amplified mike signal and feeds the input (pin 3) of a 567 tone decoder IC. Since the detection bandwidth of this IC is amplitude sensitive at signal levels below 200mV, the preceding preamp stage provides signal above this level.

The approximate detection frequency of the circuit is determined by the series resistance of R1 and R8, and C1, according to the formula $f = 1.1/((R1 + R8) \times C1)$ where f is the center frequency of the internal current controlled oscillator (CCO). R8 is used to compensate for component tolerances, and to allow precise adjustment of the detection frequency. Capacitors C2 and C3 set the detection bandwidth at about 4% (1219-1320 Hz) at input levels of greater than 200mV.

The combination of R2 and D1 provides a feedback path which causes the output of IC1 to latch until disabled by a positive pulse at pin 1 from RESET switch, S1.

Pin 8 of IC1 is an active low output. This means it goes from near the positive supply rail to ground when it detects a tone. This signal is fed to IC2-b, which is wired as a comparator. R6 and R7 set the voltage at pin 12 to approximately 1V. As long as pin 13 remains above this level, the output of the comparator is negative, which disables piezo buzzer, PB1. D2 protects the buzzer from reverse polarity.

When a detected tone causes the output of the decoder IC to drive pin 13 below the level of pin 12, the output snaps up to the positive supply rail and causes the buzzer to sound, until RESET is pushed.

Construction.

I tested the design of the Modem Minder on a Heath Digital Design Console, a handy device for the experimenter. The prototype was built on an etched board, (see Figs. 4 and 5), although, for one-time construction, wiring the device on perfboard would be quicker.

Most of the parts are readily available at electronic supply stores, or maybe even in your junk bin. A few parts need explanation. The type of ceramic microphone you use may determine the amount of gain required in the preamp. The design goal is to provide the input of the 567 tone decoder with a minimum of 200mV at 1270 Hz, with the modem's speaker output set to an unobtrusive level. If you need to adjust gain, change the value of R3. A higher value means more amplification, a lower one less. At gains above 500, offset might become a problem, but you'll probably never need to go that high.

Microphone and case.

One important consideration is how the modem's speaker is mounted. If it is on the bottom of a stand-alone design, such as the Hayes Smartmodem, you can cut a hole in the Modem Minder case, just slightly smaller than the microphone module. The module is then mounted from inside the case, facing up, that is, toward the modem's speaker. The modem sits atop the case with its speaker over the microphone opening on the Modem Minder. This allows it to block most extraneous noises, as well as keep phone line signals to an unobtrusive level.

The size of the case will be determined by the type of modem you are using and the way you mount it in your system. If you are dealing with an outboard device the box should be big enough to support it, but small enough to fit between the feet. That way, intimate contact is maintained and audio leakage from the speaker is minimized.

For those of you with Hayes Micromodems, or other types, which are mounted inside the computer, or have unusual speaker locations, it may be necessary to place the microphone, in its own enclosure, over the speaker, and connect with shielded cable to the separately mounted Modem Minder electronics.

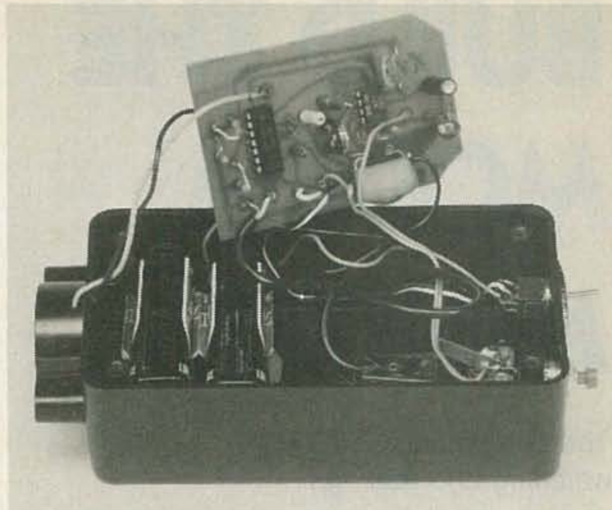


FIG. 2—INSIDE THE BOX, compact parts placement and easy wiring is revealed. Nothing super-critical makes this a comfortable project.

Adjustment and use.

There are several ways to adjust the 567 to the correct frequency. The most obvious is to connect a frequency counter to pin 6 of the 567 and adjust for a 1270 Hz output. If you don't have a frequency counter, you can simply dial up a remote computer and wait for the modem to answer back with the 1270 Hz signal. This will likely require several tries, since the tone doesn't last long.

When you first power up, the Modem Minder's

PART LIST

RESISTORS

All resistors ± 5% unless otherwise specified.

R1—2200 ohms
R2—18,000 ohms
R3—15,000 ohms
R4—470 ohms
R5—1 megohm
R6—8200 ohms
R7—1000 ohms
R8—2500 ohms linear trimpot*

CAPACITORS

C1—.22μF
C2—10μF
C3—22μF
C4—.01μF

SEMICONDUCTORS

IC1—LM567 Tone decoder
IC2—LM324 Quad Op Amp
D1, D2—1N4148 Didoe

MISCELLANEOUS

MIC—Microphone element
BZP1—Piezo buzzer
SW1—SPST, N.O., Momentary contact
B1, B2—9-volt battery
Enclosure, perfboard or printed circuit materials, hardware.

*A 2500 ohm potentiometer is preferred but a 5000 ohm will work adequately.

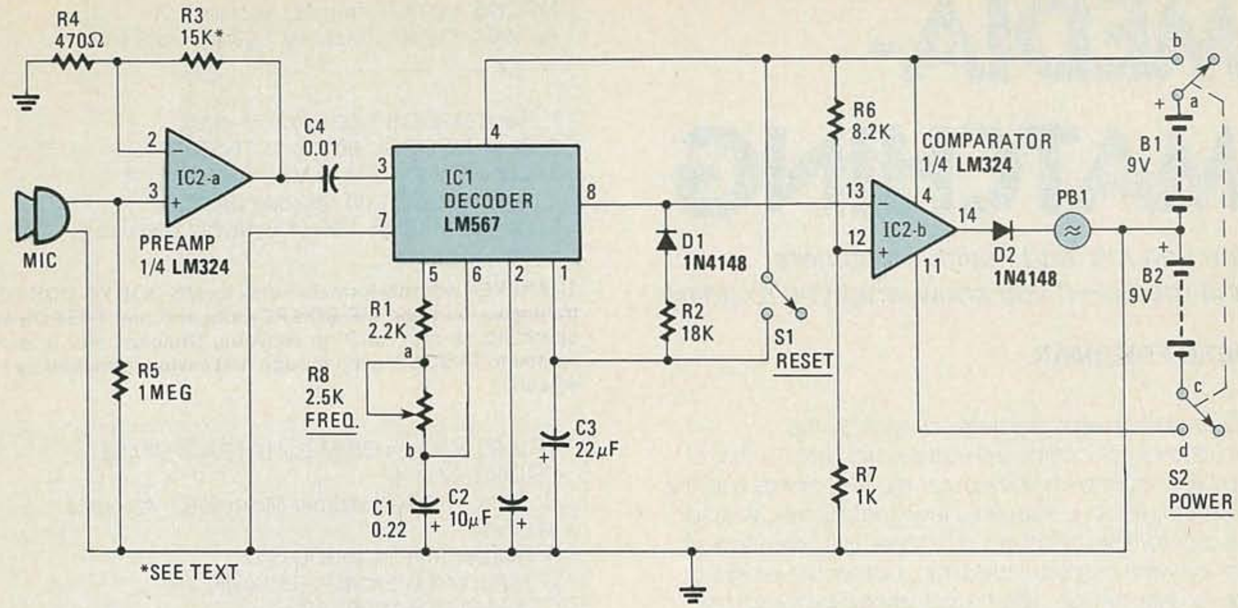


FIG. 3—SCHEMATIC DIAGRAM holds no secrets. It's easy to follow, and should be referred to while reading the text. For more information on R3, the 15K resistor, refer to the text.

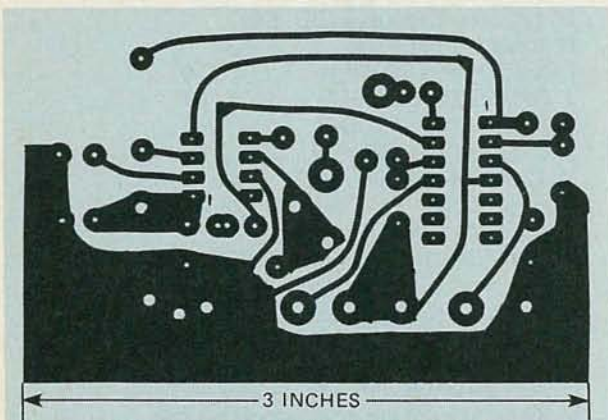


FIG. 4—FULL-SIZE CIRCUIT BOARD LAYOUT is provided here, looking at the circuit side.

buzzer will latch on. Pushing RESET will stop it. You could probably use the remaining two opamps in the LM324 to devise some sort of automatic-reset-at-power-up circuit, but I prefer the beep, because that tells me the batteries are good and most of the circuitry is operational.

Just a quick word about computer etiquette: It's best to be certain you're dialing the right number before you leave the terminal unattended. Imagine how you'd feel if someone's computer got your number by mistake and kept calling every two minutes, early some Sunday morning!

The Modem Minder is one of those unusual devices that you might look at and decide to build because there's nothing much on television that night, and you've got most of the parts in your junk box anyway, and besides, it's raining out. It is, after all, an interesting project, and the building doesn't take all that long to complete. What makes it unusual, is that after you've built it and installed it, you check it to see that it's operational, and then you start using it. And before

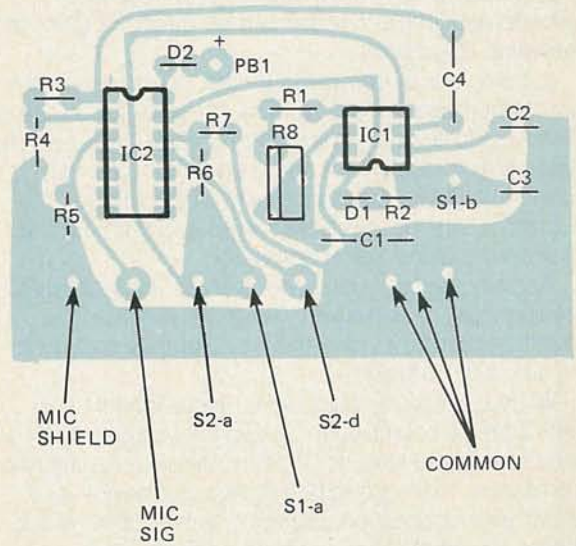


FIG. 5—PARTS PLACEMENT is shown in the above diagram.

long, you wonder how you ever got along without the thing! My own unit is in constant use and if I've got any regrets at all about it, it's only that I wish I had built it a long time ago. If you're using a computer, and using a modem, the Modem Minder is one ancillary device you've got to have.

Computer databases, bulletin boards, and remote systems are fun to use, but for that very reason you're likely to run into a lot of busy signals. To make your time more productive, let the Modem Minder sit around waiting for a connection, while you go about your business. You can trust it to buzz you as soon as the connection is made. I'll be glad to answer any questions you might have about this device. Just send your mail in care of this magazine, or leave me a message on Compuserve, EMAIL box 72356, 1355.

MEDIA-MATCHING

You can mix and match computers and media—If you know what you're doing.

HERB FRIEDMAN

■One of the major problems caused by the proliferation of computer models and types is that of media compatibility. Except for the IBM clones and the IBM-compatible computers, few computers can read the disk formats of other computers, and even though the software might be the same, neither the program nor its data can be directly exchanged between two different computers.

For example, the same version of *WordStar* is available for Osborne, KayPro and Radio Shack computers (among many others) yet neither the program itself or its text file can be directly exchanged between computers.

It is this lack of compatibility that normally prevents you from preparing a document in the office on say, an IBM-*PC*, and then polishing it at home on your personal Radio Shack *Model III*. It also works the other way round in that you cannot prepare a data disk for *SuperCalc* on your portable KayPro and then use the disk on the office Xerox computer.

Actually, the text, data, and even the program files are identical, or at the very worst not identical but interchangeable; it's only the way that they are written to disk that's different.

While it is entirely possible to exchange text and data between computers by using a modem, doing so requires either a telephone connection—meaning two computers, two locations, and two operators—or a direct wire connection through a null modem, which means having the two computers adjacent or physically near each other. Either way, it's a very incovenient way to do things.

The simplest and most convenient way to exchange software between computers is to move the disks from computer to computer regardless of the manner in which the disk was electrically formatted by the originating computer. While this was almost impossible to do several years ago, today there's a seemingly endless list of low-cost programs (utilities) that allows almost any professional computer to read, and sometimes write in the format of most other computers.

In practical terms this means that you can prepare a *SuperCalc* spreadsheet on the Office IBM-PC, and then directly use the data disk on your Osborne; or at worst, you'll have to exchange the data to a disk formatted for the Osborne. Either way, all you're carrying from location to location is a disk, not a full computer.

```
MSDOS 1.00 File Transfer Version 1.00
(c) 1984, Purves Computer System Software
________________________________________

1. Read MSDOS 1.00 Disk Directory
2. Copy MSDOS 1.00 File to TRSDOS Disk
3. Copy TRDOS File to MSDOS 1.00 Disk
4. Sort MSDOS 1.00 Diskette Directory
5. Format MSDOS 1.00 Compatible Diskette
Enter Selection:
```

TRANSFER not only formats a disk for MS-DOS/PC-DOS 1.0, it translates between ME-DOS/PC-DOS and any TRSDOS-like operating system such as Newdos, Dosplus, etc. It is not limited to TRSDOS, even though that's what is implied by the screen.

```
TRS-80 Model 4 CP/M 2.2 INTERCHANGE
PROGRAM vl.42
Copyright (c) Montezuma Micro 1983. All rights
reserved.
A. Montezuma Micro (DD,SS)
B. Hurricane Compactor I&II (DD, SS)
C. IBM PC CP/M-86 (DD,SS)
D. Xerox 820-1 (SD, SS)
E. Xerox 820-2 (DD, SS)
F. Osborne-1 (SD, SS)
G. Osborne Executive (DD, SS)
H. Kaypro-2 (DD, SS)
I. Zenith H-89 (SD, SS)
J. Zenith Z100 (DD, SS)
K. Zenith Z100 (DD, DS)
L. Cromeco Z-2 (SD, SS)
M. Cromeco Z-2 (DD, SS)
N. Eagle 80trk. (DD, SS)
O. Lobo MAX-80 (DD, SS)
P. LNW Computers LNW80 (DD, SS)
Q. MM Shuffle Board (DD, SS)
R. Holmes VID80 (DD, SS)
S. Omikron Mapper I (SD, SS)
T. Morrow Micro Decision (DD, SS)
U. Access Matrix (DD, SS)
V. Radio Shack Mod.4CP/MPlus(DD,SS)
W. Televideo 802 (DD, DS)
X. HP-125 (DD, DS)
Y. DEC VT-180 (DD, SS)
Z. NEC PC-8001A (DD, SS)
Select disk formnat by pressing [A-Z]
Press "BREAK" to exit to the CP/M operating system
```

INTERCHANGE for the MODEL 4 CP/M is one of the most flexible and powerful translators, because it permits an alien disk to be run on the host computer. About the only thing it can't do (at least at the time of this writing) is translate to MS-DOS/PC-DOS.

Different formats.

The reason for disk incompatibility is the way in which the information is stored on the disk. For whatever reasons—greed, or an honest belief that their system is better—manufacturers store data in different ways. Even the directory track—the list of disk files and where they are located on the disk—varies from manufacturer to manufacturer. For example, some computers have the directory on track 17, others have the directory on track 20, or track 2, or track 3. Obviously, if a computer is looking at track 17 for a list of files it won't find anything if a particular disk's directory is on track 2.

Then there's the way in which the data itself is recorded. The directory listing for each file contains information as to which tracks and sectors used for the files, the amount of space used, etc. The file itself has assorted block markers, pointers, and checksums in addition to the data itself. Even if a computer could locate a file on an alien disk, it most likely won't understand the markers, pointers, checksums, and other bits and pieces of control information that must be interpolated before it's possible to read the data. (Alien means a disk from a different kind of computer.)

Similarly, even if the computer could write to an alien disk the file probably could not be located or used by the computer for which the alien disk was intended.

Media compatibility.

The way out of this seemingly impossible morass is to use translation software that reads and interpolates an alien disk's data to the host computer's format. Actually, the best translators can read and write most of the commonly used disk formats. Though most translation software accommodates a broad range of computers—a few specifically translate for only two or three computers—at the worst it requires two different translators to accommodate all the most popular disk formats. The major exceptions are the Apple, Atari and Commodore disk formats, for which there is presently no direct translator.

Disk translation programs are designed for computers with at least two disk drives, one of which must be a 5¼-inch floppy (the other can be a floppy or a hard disk). The program itself can be on a 5¼ diskette or on a hard disk; the alien disk, however, is always a 5¼-inch diskette: there is no such thing as an alien hard disk.

The translator causes one disk drive of the host computer to read (and sometimes write) the alien format. Once the translator is installed the alien format drive can no longer read or write in the host format.

Some of the older translation programs can only read from the alien disk. For example, if the host computer is an Osborne and the alien disk is from an IBM-*PC* the translator will read the IBM disk and copy the files directly to an Osborne-format disk. The more modern translators can exchange data in both directions; meaning data can be read from the IBM disk and written to the Osborne disk, or read from the Osborne disk and written to the IBM disk. Another difference between the older and more modern translators is that many of the older translators processed all files, the user could not pick and choose. The modern translators allow the user to select one or more files for translation.

The most modern translators such as Media Master, Uniform, and TRANSFER can even format an alien disk, which means you don't have to carry disks back and forth. For example, assume you have a document created on a Radio Shack *Model III* using the *TYPITALL* word processor and you want to use the document on the office IBM clone. The program TRANSFER first allows you to format a blank disk in the IBM format, and then it will copy the document from the Radio Shack

```
MEDIA MASTER V1.02 (4/18/84) -- Osborne I and
Executive
(c) Copyright 1984 MDG and Associates
1. COPY file(s)
2. PRINT directory
3. DISPLAY directory
4. LOG in a new diskette
5. ERASE file(s)
6. VERIFY or write toggle (VERIFY is ON)
7. FORMAT a diskette
8. EXIT to CP/M
Press selection followed by <return>

Single Sided Formats Available
_______________________________________________
A. Osborne (DD)
B. Osborne (SD)
C. DEC VT180
D. IBM PC CP/M
E. IBM PC-DOS 1.0
F. IBM PC-DOS 2.0
G. TI Professional CP/M
H. TRS-80 I w/Omikron
I. TRS-80 III w/Mewm Merch
J. TRS-80 IV CP/M
K. LNW-80
L. Xerox 820 I (SD)
M. Xerox 820 II (DD)
N. NEC PC-8001A
O. Actrix
P. Cromeco w/Int'l Term
Q. Cromeco CDOS (SD)
R. Cromeco CDOS (DD)
S. Lobo MAX-80
T. Morrow MD2
U. Kaypro II
V. Zenith Z90
W. Heath Z100 CP/M
X. Heath w/Magnolia
Y. Systel II CP/M
Press selection followed by <return>
```

MEDIA MASTER does not support running a programming but it is most efficient at handling translation. The supported formats are the most modern and extensive for CP/M computers, and they include translation to/from IBM PC-DOS and PC CP/M.

host disk to the newly-created IBM disk.

Run time.

While the ability to read and write alien formats is by itself spectacular, some of the translation programs even allow a computer to run directly from the alien disk. For example, Montezuma Micro's translator called *Interchange*—which is supplied with their version 2.2 CP/M for the Radio Shack *Model 4* computer—will run a generic CP/M program directly from the alien disk. ("Generic" means a program that isn't hardware dependent for a specific computer—a program that will run on any conventional CP/M computer.) If you have, say, the word processor *WordStar* and the spelling checker The Word Plus on a Kaypro disk, *Interchange* allows you to run them directly on the Radio Shack *Model 4*. In fact, *Interchange's* transfer is so effective that you can write data to either the alien disk in the alien format, or to the Radio Shack format disk located in the A: drive.

While it is often possible to run a program directly from the alien disk, it can only be done if both the host and alien computers use the same CPU and the same operating system. The reason we can run KayPro programs on the Radio Shack *Model 4* is because both use the Z80 microprocessor and both employ the same version of CP/M. If we had CPM-86 or MS-DOS/PC-DOS programs on the alien disk they could not be run because the Z-80 op codes are different than those for the 8088 microprocessor, for which CP/M-86 and PC-DOS is written. In fact, unless the CPU's and operating system is the same there is really no point in translating binary encoded disk files because they won't run on an alien computer.

Translators are most effective when exchanging ASCII-encoded text and data because ASCII is directly transferable between computers. For example, if you have a document created with an MS-DOS version of *WordStar* it will work directly with a CP/M version of *WordStar* if transferred to a CP/M machine. Similarly, ASCII *Peachtext, SuperCalc, dBase II* and *VisiCalc* files can be transferred between various computers and operating systems. If a program cannot process ASCII files directly it will have some way to convert the files to ASCII so they can be interchanged between different implementations or operating systems.

```
IBM-PC SINGLE SIDED          MORROW MICRO D                 ----------------------
IBM PC DOUBLE SIDED          MORROW MICRO D SS              ----------------------
OSBORNE DOUBLE DENSITY       DEC VT-180 SS 9 SECTOR         ----------------------
KAYPRO II                    NEC PC 8000 SS                 ----------------------
ZENITH CPM-85 DS DD          ACCESS MATRIX 8 SECTOR SS      ----------------------
OTRONA SPM-80                TELEVIDEO 803                  ----------------------
SANYO MBC-1000               NCR DECISION MATE V            ----------------------
KAYPRO-IV DS DD              EPSON QX-10                    ----------------------
HP-125                       ---------------------------------------------------
HP-9138                      ---------------------------------------------------
---------------------------------------------------------------------------------
                             CUSTOM DISK TYPE SELECTION
      USE CURSOR ARROWS TO MOVE BETWEEN FIELDS
RETURN SELECTS ENTRY
   F1 ENTER THE DISK TYPE BY NAME FOR SELECTION
                -------------------------

                                             F10  DONE  RETURN TO PRIOR MENU
                                             ESC  ABORT  ABNORMAL TERMINATION
SELECT FUNCTION KEY                                      Jan-1-1980     0:24 am
CROSSDATA (C) COPYRIGHT 1983 AWARD SOFTWARE INC. ALL RIGHTS RESERVED IBM 2.OD
```

CROSSDATA translates many of the most common "commercially-used" CP/M computer disks to whatever IBM DOS you're using in either single or double-sided.

BASIC.

It is often difficult to transfer BASIC programs even if written in ASCII. The reason for what is apparent incompatibility is due to what is sometimes very subtle differences between the various versions of BASIC, even though the most commonly used BASICs are Microsoft BASIC. For example, Radio Shack's implementation of Microsoft BASIC uses a form of space compression to save RAM. While Radio Shack's BASIC can use the statement:

```
10 FORX=1TO10
```

Microsoft's BASIC won't process the statement because most implementations require that commands be framed by spaces on either side. For Microsoft BASIC the statement must read:

```
10 FOR X=1 TO 10
```

Some translator programs can convert BASIC statements into other BASIC dialects. Generally, they accommodate only the most commonly-used statements; the user must then manually correct the unconverted statements when they are indicated as syntax errors. Usually, it's more trouble than it's worth.

Summing up.

Translation software is what prevents your old computer(s) from becoming obsolete. Unless you have need for a new software that can run only on the latest computers—such as *Multimate*--you'll find that much of your software can run on both the old and new computers.

As example, because I work in several locations I must use several computers. This article originated on a NEC-8201 lap computer. It was dumped to a Radio Shack *Model I* for processing by *Typitall* whose files are non-ASCII. The *Model I* disk was carried to my home and spelling checked by *Hex Spell* on a *Model 3/4* (yes, there is a way to run *Model I* disks directly on a *Model 3/4*). A converted ASCII text file was finally translated using *TRANSFER* for the *Model 3/4* to an IBM-*PC* because my high speed modem is on the *PC*. The file eventually wound up in R/E's computer. The article went from something new, to something very old, and back again to something new. And it was all made possible by software that translates different disk formats.

consider the same system being used to immediately disseminate the license-plate numbers of stolen cars, descriptions of missing persons, delivery schedules, traffic conditions, etc. Figure 1 illustrates the various technologies used by QuoTrek to put fast-breaking information into your pocket almost within seconds.

How it works

The information that eventually ends up on the display of the pocket receiver originates at several stock and commodity exchanges. That information is then relayed by RCA to QuoTrek's central computer, which is located in California, via redundant satellite or landline circuits. (RCA uses the best available circuit as determined by computerized transmission-monitors.)

The central computer forms the data concerning 8000 stocks and commodities into a packet, and then dumps the packet into the top of a RAM (memory) stack. Data compaction—which is technical jargon for "gets rid of the unnecessary spaces"—maximizes the amount of data that can be squeezed into the packet.

A continuously reading microprocessor scans the RAM stack and uplinks (transmits) the data to the Westar IV satellite. Because of limitations at the final output stage of the system, the computer is programmed to loop or repeat the entire stack—all 8000 items—every two minutes.

Turning our attention once more to Fig. 1, it shows several local FM stations spread across the country receiving the downlinked data packet from Westar IV. The station, in turn, rebroadcasts the data at 4800 baud on its FM subcarrier. (It's the 4800 baud transmission rate that requires the 2 minute loop for 8000 stocks and commodities.) Individual subscribers access the data through the pocket receiver that is purchased outright, but the user still has to pay a monthly fee for the service.

The receiver has a keypad-programmable microprocessor, a 40-character display, and 40 memories to store the selected data. Any of the 40 memories can be programmed or instantly reprogrammed by the user for any of the 8000 stocks or commodities. There is also an additional manual memory (41) that allows the user to direct-access data on any stock or commodity without changing the programming of the basic 40 memories.

Of the 8000 items received every 2 minutes or so from the FM station, the receiver's computer strips off the data on the 40 user-selected items and stores it in one of the memories.

To view the latest data on a particular stock on the receiver's display, the user "punches" in the code for that stock. (If you're overwhelmed by all the high-tech that's taken us this far, there's more to come.)

Though the data on the 8000 items is downlinked from the satellite to the FM stations in a loop that repeats every 2 minutes or so, information on trading is instantaneous. The moment there is a trade at the stock exchange, the information is relayed by RCA to the West Coast where it is immediately inserted into the data stream at the output of the RAM stack. And everyone's pocket receiver updates instantly, as the central computer strips the old quote from the RAM stack and the new information is uplinked to the satellite.

It's a never-ending process of updating, instantly inserting the latest trades into the data stream and removing the old. But even with the shuttling of data back and forth across a continent, the information is barely seconds old by the time that it reaches the receiver because there is no transmission delay at the exchange.

To those who live or work in big cities, getting the latest stock and commodity information is no big deal; but consider a trader in "upper outback" Wisconsin. There is no way he's going to know what's happening unless he spends plenty of time on the long-distance telephone. But if the local FM-station provides QuoTrek, even though he's out in the boondocks, he'll be as up to date on the latest action in the market as a Wall Street Banker...and that's what communications is all about. **R-E**

DRAWING BOARD

ROBERT GROSSBLATT

Making our demonstration circuit do double duty

IF I HAD TO MAKE A LIST OF THE MOST difficult things to do in electronics, understanding someone else's design would have to top the list. Sitting down and studying a complex schematic is a time-consuming task. The drawing has to be broken down into individual sections, each of which has to be gone through by itself.

In effect, you're doing the opposite of designing. The reward you get for the work you put in is learning something new. And, if you're lucky, you may pick up a few tricks and shortcuts that can be filed away for use in your own designs.

Using the extra latch

When we left off last time, I asked if you could think of any slick tricks we could do with the extra latch we had left. Now I don't know if you've come up with anything since then, but I threw the question out to you because I already had something in mind.

One neat way to simplify a design and cut down the parts count is to make components do double, triple, or even quadruple duty. A standard place to find that sort of thing is in the design of keyboards. All computers, some calculators, and even the typewriters use that technique to keep their keyboards down to a manageable size.

Can you imagine what a typewriter would be like if there was no shift key? Or a computer without a control key? In any event, there's no reason we shouldn't use the same sort of trick ourselves. Figure 1-*a* lists the four control pins of the 5101, the memory we're using in our demonstration circuit. Figure 1-*b* is the truth table for the IC (which we'll look at later).

5101 CONTROLS

PIN	FUNCTION	COMMENTS
17	STANDBY CONTROL	HIGH FOR NORMAL OPERATION LOW FOR STANDBY
18	OUTPUT ENABLE	LOW TO ENABLE OUTPUTS HIGH THREE STATES OUTPUTS BUT LEAVES INPUTS ENABLED
19	CHIP ENABLE	LOW FOR NORMAL OPERATION HIGH DISABLES ENTIRE CHIP
20	R/$\overline{W}$	HIGH CAUSES A READ LOW CAUSES A WRITE

a

TRUTH TABLE

PIN 17	PIN 18	PIN 19	PIN 20	OUTPUTS	OPERATION
X	X	H	X	THREE STATE	DISABLED
L	X	X	X	THREE STATE	STANDBY
X	H	X	H	THREE STATE	OUTPUTS DISABLED
H	H	L	L	THREE STATE	WRITE
H	L	L	L	THREE STATE	WRITE
H	L	L	H	DATA	READ

*X = DON'T CARE

b

FIG. 1

How it works

Since the circuit we're using has a four-bit wide bus, what we're going to do is arrange things so that our keyboard serves two purposes. The first is keying in the information to be presented to the memory, and the second is actually telling the memory what we want it to do.

Since there's a separate line on the bus for each of the memory's control pins, we have the ability to select any one of the the sixteen possible combinations. That sounds a lot better than it really is—being able to do it doesn't mean it's worth doing.

Obviously some of our choices are junk. Doing things like triggering a write is a pretty useless if we put the memory to sleep at the same time! Let's take the control pins one at a time, see what they do, and decide what we want to do with each of them.

Looking at Fig. 1-*a*, we see that pin 17 switches the memory between normal operation and the low-power standby mode. If you bring it low, you'll be putting the IC to sleep, while holding it high sets the IC up for normal operation. The 5101 and other members of the *low-power* family can remember data for a cost of only a few microamps.

Since so little power is required, the life of the battery you choose to power the IC during standby will be close to its shelf life.

There are certain timing requirements for reliably switching over to standby operation. And if it's not handled properly, the memory will glitch and you'll wind up with garbage instead of data. If you want me to spend some time on the subject, drop me a line and I'll devote a couple of columns to it.

Pin 18 is the $\overline{\text{ENABLE}}$ control for the outputs. If it's made low, the IC operates normally and data appears at its output pins. Making it high causes the outputs to go to its three-state mode. Notice that pin 18 *only* controls the outputs. You'll still be able to write to the memory regardless of how you have that pin set.

Disabling the entire IC is accomplished by bringing pin 19 high. That disconnects the inputs as well as the outputs. However, a low will enable them. Read and write operations are controlled by pin 20; read is done with a high and write is done with a low. There are very strictly defined timing needs whenever you read or write to memory.

Even though the 5101 only needs a write pulse that's 250 nanoseconds wide, the total write cycle time is 450 nanoseconds. And that's fast as far as the 5101 goes. The slower (cheaper) IC's can have minimum write-cycle times as long as 800 nanoseconds!

You'll remember from some of our earlier discussions of memories in general that a whole series of operations have to happen when you do a read or write. The address you put on the bus has to be internally decoded by the memory and the particular cells in the matrix have to be accessed. Generating a write pulse before the addresses have stabilized will result in writing to an indeterminate location and glitching whatever was there before.

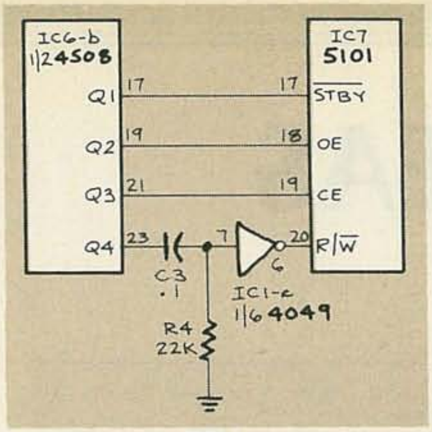


FIG. 1

The same sort of analysis applies to a read operation. The only way to be sure you're getting valid data from the IC is to design your circuit with an eye to the minimum setup times needed by the IC you're using. Since the circuit we're designing is going to be manually operated, most of those restrictions can be ignored.

If you go through all the possible configurations you can have with the control pins, you'll realize that there are very few of them that serve any useful purpose. Therefore, we can immediately cut them out. In fact, if you study the truth table in Fig. 1-*b*, you'll see that there's only one set of conditions that will produce data at the outputs.

Both of the enable pins (18 and 19) disconnect the outputs when they're made high. The outputs are also disconnected during a write operation. To keep the circuit as simple as possible, let's say that we want the outputs of the IC to be enabled all the time (except, of course, during a write) since we want to see the results of reads and writes as soon as they happen. Let's further say that we don't ever want to put the IC to sleep.

Our choices have been reduced considerably because all we're left with is the ability to read and write to the memory. In fact, you've probably realized by now that you can explore as many of the possibilities as you want by simply connecting the control pins to the output of the latch. If you're satisfied with losing some choices, you can hard wire the enable pins to ground and only deal with pin 20, the READ/$\overline{\text{WRITE}}$ control.

Circuit additions

In order to give you as many choices as possible, we'll draw the schematic connecting all the control pins of the memory to the latch outputs. You can select or eliminate as many options as you want. There are a couple of things to keep in mind, however, when you're making your choices. If you look over the truth table on the data sheet, you'll see that putting a high or low on one pin will set the memory in a particular mode regardless of what you do to the other pins. If, for example, you put a low on pin 17, the IC goes into the standby mode and won't respond to anything until you wake it up again.

There's one more problem we have to deal with. No matter how you decide to deal with the control pins, we can't allow the latch alone to control the READ/$\overline{\text{WRITE}}$ pin. If we leave things the way they are, the memory will lock in the write mode every time we select a write. The output of the latch has to be used to trigger some other circuit that generates the actual write pulse. The circuit has to have a normally high output that can be triggered into producing a low pulse wide enough to meet the timing needs of the memory.

There are loads of ways to accomplish that, but since we already have a couple of spare inverters in the circuit, we can use one of them to do the job. Figure 2 is a partial schematic of our demonstration circuit showing how to connect the extra latch from our last discussion to the 5101 memory IC.

The control pins are connected to the latch and the READ/$\overline{\text{WRITE}}$ pin is controlled by a half monostable. (That half monostable is made from an inverter leftover from the 4049 that formed the basis of the clocking circuit used for our keyboard.) Remember that the pulse generated by the 4049 is inverted. The circuit produces a negative pulse when it's triggered by a positive going pulse at its input.

The values of the resistor and capacitor are chosen for an output pulsewidth of about one millisecond. That's long enough for any

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NEW IDEAS

Electronic heat sniffer

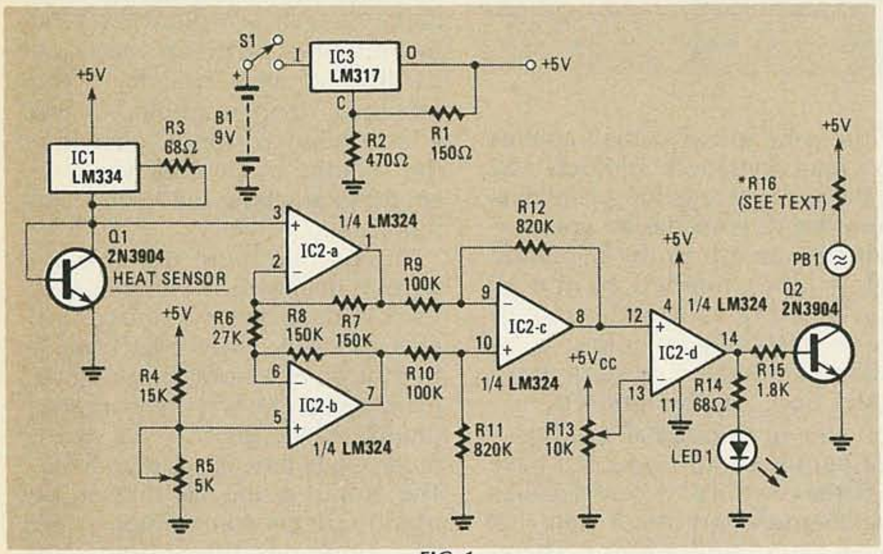

FIG. 1

MANY ELECTRONICS EXPERIMENTERS and servicemen have a habit of using their built-in heat sensors—fingers—to determine whether semiconductors are alive and well, or if they're just plain dead! While using your finger gets the job done (sometimes), you can also wind up with a pretty painful burn. Having become tried of toasting my fingers on overheated IC's and transistors, I set out to find a better way.

The result of that quest is shown in Fig. 1, the schematic of a heat-sensing circuit. Unlike fingers, that circuit can also be used to track down heating and cooling losses around windows and doors, or even around electrical outlets.

Heat-sensing circuit

The sensing element, Q1, is a 2N3904 general-purpose NPN transistor, although any general-purpose NPN unit in a TO-92 style case will do. That small plastic unit was chosen simply because larger units take longer to heat. Also, metal-cased transistors dissipate heat too rapidly, so that the silicon substrate may not have enough time to react to the heat.

IC1 (LM334) supplies Q1 with a constant current that is independent of temperature. An LM324 quad op-amp, IC2, forms a high input-impedance differential amplifier (IC2-a, IC2-b, and IC2-c) with a gain of about 99. IC2-d is used as a voltage comparator.

When Q1 senses an rise or fall in temperature, the base-to-emitter voltage decreases. That decrease in voltage causes the input to IC2-a at pin 3 to deviate from the reference voltage that's fed to IC2-b at pin 5 (which is set by potentiometer R5).

The difference between the input and the reference is amplified by IC2-c. That amplified voltage is fed to IC2-d where it is compared to a control voltage set by potentiometer R13. The setting of R13 determines the threshold and is set at a point that's equal to the ambient temperature.

The output of IC2-d at pin 14 is fed to the base of transistor Q2. When the output of IC2-d is high, LED1 lights and Q2 turns on. With Q2 turned on, a ground path through the transistor is provided for the buzzer (PB1).

The value of R16 depends on the type of LED and buzzer used. If a 3–12 volt buzzer is chosen, R16 may not be necessary. The proper operation of the circuit is heavily dependent on the supply voltage (ie., the two reference voltages), so the LM317 (IC3) programmable regulator is used. The values of R1 and R2 set the regulator output to 5 volts.

The circuit may be built on perforated construction board using point-to-point wiring. All components, except Q1, are mounted on the board. Transistor Q1 is mounted at the tip of the heat-sensing probe.

Prepare the probe by first bending the leads of Q1 to a 90° angle. While keeping the leads separated, encapsulate them in epoxy, making sure that enough lead is protruding so that wires may be attached. Solder one piece of wire across the base and collector of the transistor, and a second wire to the emitter. Leaving Q1 sticking out, cover with flexible tubing. Now connect the probe to the circuit board.

To calibrate the circuit, simply adjust R5 (while monitoring with a voltmeter) for a reading of between 2.25 and 1.2 volts at pin 5 of IC2-b. After that's done, the circuit is ready for use.

Using the unit

To use the heat sniffer to determine if a CMOS IC is working, for example, bring the probe close to the IC. Then adjust R13 until LED1 goes out. Now touch the flat side of Q1 to the IC. If the IC is working, the heat that it produces will cause LED1 to light and PB1 to sound. (Of course, some malfunctioning IC's will also produce a good amount of heat.)

With a little practice, you should be able to test any semiconductor in 5 seconds or less. Since resistors produce much more heat in operation than do semiconductors, they are easier to check. But, the test only shows whether the resistor is passing current—it does not indicate whether the resistor is still in tolerance and passing the *correct* current. If the resistor is open, it passes no current, so it will produce no heat, and all indicators will be off.

Testing for heating and cooling losses is accomplished in the same way. But don't forget that R13 must first be adjusted for ambient temperature.

All parts for the heat sniffer are common components, and should all be available from local electronics supply stores or through mail order.—*Robert Pham*

DRAWING BOARD

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memory you can find. If you want to change it, the period of the output pulse can be determined by this formula: T = .77RC.

It's generally a good design practice to make the write pulse as narrow as you can without making the operation of the memory any less than completely reliable. Since we're building a demonstration circuit, there's no reason to cut things that close, but by all means change the values. The pulse can't be too long.

Given the connections shown in Fig. 2-*a* binary 8 (1000) will generate a read, 9 generates a write, 10 (a binary A) disables the entire IC, and 13 (a binary D) disables only the outputs. All the keys up to 7 will put the IC to sleep, but be careful! To put the IC into the standby mode, things have to be done in a certain order. We'll cover that and other mysteries, and finish up next time. **R-E**

STATE OF SOLID STATE

ROBERT F. SCOTT,
SEMICONDUCTOR EDITOR

A light dimmer

ELECTRONIC LIGHT DIMMERS HAVE BEEN used in the home and industry for a couple of decades. Typically, they are relatively simple devices with which the operator controls the level of illumination by using a potentiometer to vary the triggering angle of a triac or SCR that is wired in series with a lamp. The newest development in electronic light dimmers uses a "touch switch" to control the light—both to turn it on and off, and to select the brightness level.

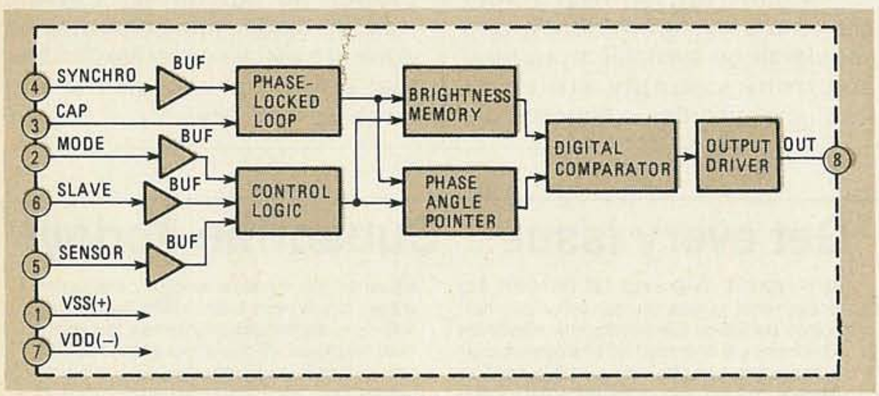

FIG. 1

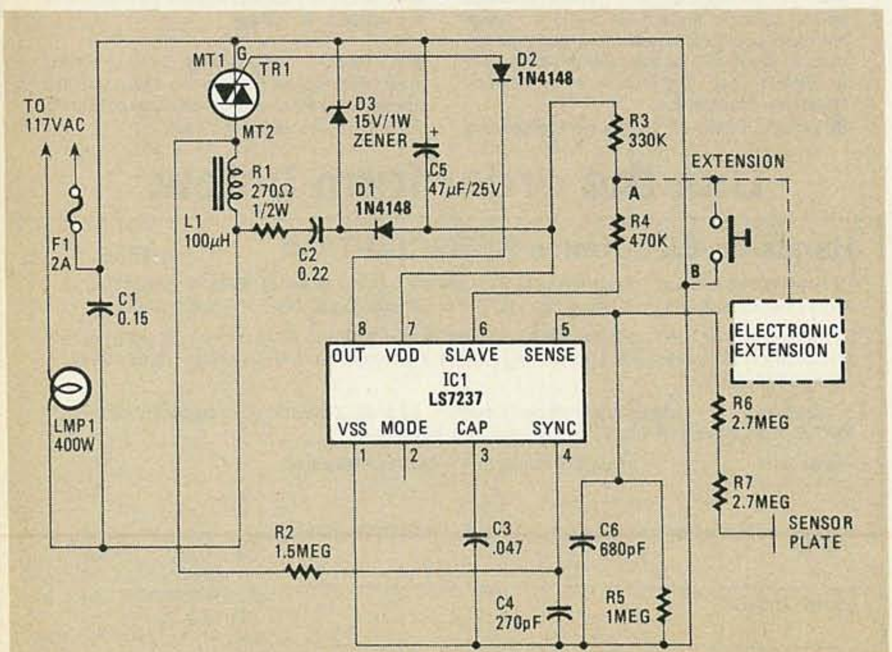

FIG. 2

The heart of the new circuit is the LS7237 monolithic PMOS touch-sensitive light dimmer and switch developed by LSI Computer Systems. The block diagram of the device is in Fig. 1, and a practical circuit using the device is shown in Fig. 2.

The output at pin 8 of the LS7237 is used to trigger a triac. The lamp brightness is, in turn, controlled by varying the output phase angle (triac triggering angle) with respect to the phase and frequency of the AC line.

The output at pin 8 is a low-level pulse of fixed duration (40 to 55 μs) occurring every half-cycle of the AC line voltage. The phase angle (θ) of that pulse, with respect to the AC line, controls the lamp brightness. The phase angle can be varied by applying a low-level pulse to the SENSOR input (pin 5) or a high-level pulse to the SLAVE input (pin 6). That's done by touching the appropriate sensor plate. (When using the SLAVE input, you can use a mechanical push-button or the electronic switch and sensor plate as shown in Fig. 3).

The relationship between output pulse phase angle, light level, and brightness as a percentage of rated wattage is shown in Table 1. The circuit can be set up to operate in one of three different sequences of brightness by tying the MODE pin (pin 2) to a specific voltage level as shown in Table 2.

When power is first applied, the output comes up in the OFF state. Then each time the sensor plate is touched, the output steps to the next brightness level.

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SERVICE CLINIC

JACK DARR

Resurrecting a dead TV

ONE OF THE MOST COMMON PROBlems that a TV serviceman runs into is the dead set—no sound, no video...nothing. Many of us have a habit of thinking that the dead-set condition was a lot easier to correct in the "old days." In a sense, it was. But, if the right approach is taken, the newer sets are no more difficult to repair than the old tube-types were.

Repairing modern TV's

In the old days, a completely dead set usually meant that there was a fault of some kind in the power supply. But, what about the newer solid-state sets? Nothing has changed: When a set quits cold, it almost certain that some important power-supply component has packed it in. (Now, doesn't that sound just like the older ones?)

Of course, you'll find new things in the power supply, like pulse-width modulated circuits, but they're just as easy to service as any other circuit. By using the same testing procedure that you used for tube-type sets, you can find the trouble in no time at all. The only essential thing is to make sure that the horizontal oscillator is running.

Figure 1 is a block diagram of the *S*witched *M*ode *P*ower *S*upply (SMPS) found in the Sylvania C3 color TV. The SMPS processes the horizontal signal for the sweep system, and drives high-voltage stages. It also drives a separate stage that provides all the low DC voltages for operation of the chassis.

In troubleshooting the SMPS, all you need to do is make a few quick checks to see if the low voltages are present. If they are missing, first find out if the horizontal oscillator is running. (Here is where a scope comes in handy.) A malfunctioning or dead oscillator can cause all kinds of trouble.

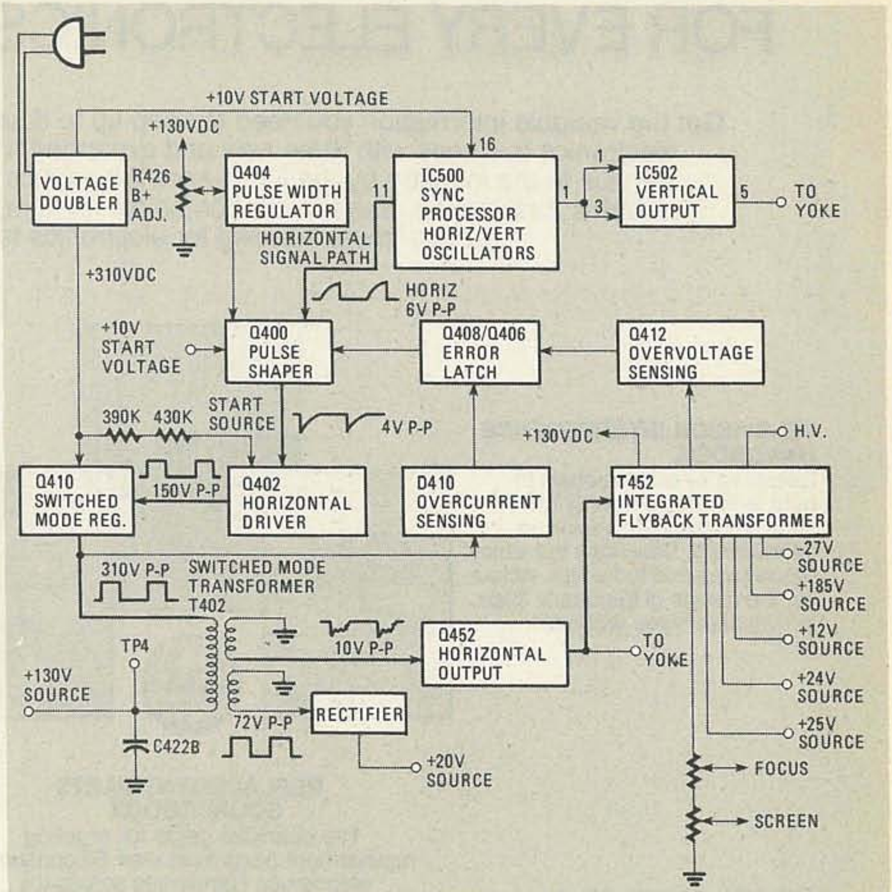

FIG.1

The oscillators in pulse-width modulated supplies are usually fed a start voltage that "kicks" the oscillator into action. Once started, it keeps on going until a short pulse is applied to stop its operation. If you find that the oscillator is not doing its job, the problem may be in the start circuit.

If you're unsure whether the problem is in the oscillator or the start circuit, there are two ways to check. First, you can monitor the start voltage at turn-on. If the pulse is missing, you have to trace it back to its source and find out why.

The other way of determining the cause of the malfunction is to try to start the oscillator with a battery; about 15–20 volts is sufficient. If you don't have a battery of the right voltage handy (which I never do), a bias box can be used. A bias box is simply a small DC power-supply.

Using the external supply, check to see that the horizontal oscillator starts to run when the proper voltage is applied to it. And be sure that it continues operating after the start voltage is removed. If the oscillator performs properly, your start circuit is *not* working. Although you may find several variations of the start circuit, they are generally not complicated. Some of them simply charge a capacitor, and discharge it across the oscillator to provide the start voltage.

If there is a malfunction in the start circuit, you'll have make sure that the DC voltages derived directly from the AC line are present. Usually there will be a half-wave or full-wave rectifier along with other components connected directly across the AC line.

In addition, many of the newer sets are not chassis types, so an isolation transformer should always be used.

Dead set causes

Perhaps the most common cause of a dead set is lightning. Solid-state sets are extremely vulnerable to sudden power surges in the AC line. If lightning strikes the power line anywhere within a mile of your home, large instantaneous peaks will be generated in the power supply. That's almost certain to damage transistors and any other solid-state device in the set.

Those surges can blow out several transistors at the same time. So, if you find a shorted transistor in the circuit, there is a good chance that there are several others nearby. Often a shorted component causes the next in the series to go down the tubes. (I think my record is eight at once, but one good jolt of lighting can do a lot more damage than that.)

Also look for signs of arcing around the AC line plug, antenna terminals, etc. If you find any indication of arcing you may be in for a never-ending search for damage of all kinds. But, fortunately (for city dwellers, that is) that type of damage is more often found in rural areas. That's because the power lines are in the open and are longer, so they make a much better target for lightning.

One thing that can be done to provide some degree of protection from power-line surges is to put a fast-acting *M*etal *O*xide *V*aristor (MOV) across the line. By placing an MOV across the AC-line connection on the chassis, fairly-severe power surges can be attenuated before they get into the set.

Also, don't be lulled into thinking that *lightning arresters* stop lightning. Plenty of damage can be done in the few split microseconds before an arrester opens up.

When repairing any electronic device (not just TV's), always check the DC power supply first, since it's the stage where a part is most likely to be damaged. Also, it is a good idea to get used to checking everything: individual stages, components, and even the line cord. **R-E**

STATE OF SOLID STATE

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All input timings for the LS7237 are synchronized with the AC line when this 50/60-Hz source is tied to the SYNCHRO terminal (pin 4) through a suitable lowpass filter network (R2-C4).

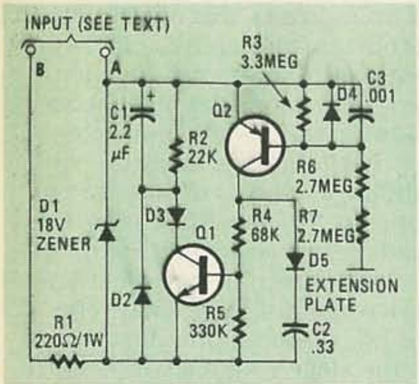

FIG. 3

Low-level negative-going pulses applied to pin 5 of the LS7237—the SENSE input—cause the circuit to step the lamp through the sequences of brightness as determined by the voltage on the MODE terminal. Output stepping occurs on the trailing edges of the input pulses.

The function of pin 6, the SLAVE input, is similar to the SENSE input except that it operates on positive-going pulses instead of negative ones. It is to be used when long extension cables are used between the sensor plate and the dimmer circuit. In such a case, the electronic extension and extension plate circuit, whose schematic is shown in Fig. 3, should be used.

A practical circuit

Let's now return to Fig. 2 and see how the components of the basic circuit function.

- Diode D1, R1, C2, C5, and Zener diode D3 deliver a regulated +15 volts to the V_{ss} terminal of the device.
- Network R2-C4 feeds a filtered 60-Hz signal into the device to synchronize the internal phase-locked loop (PLL) with the line frequency.
- Resistors R3 and R4 limit current in the event that the extension circuit is incorrectly polarized. When the extension touch plate is not used, tie pin 6 directly to ground at pin 7.
- Resistor R5 sets the sensitivity of the sensor input. Select a value between 1 megohm and 5 megohms.
- Capacitor C3 is the filter for the internal PLL.
- Diode D2 limits the positive swing of the triac gate to V_{SS} + 0.5 volt. That positive swing may occur in some triacs when they are triggered.
- Inductor L1 and C1 form an RF filter to suppress RFI developed by the triac.

TABLE 1

Output phase angle (θ)	Brightness levels	Percent rated wattage
No output	Off	0
45°	Night light	9%
70°	Mood light	29%
105°	Medium	66%
159°	Maximum	99%

TABLE 2

Mode	Mode input	Brightness sequence
0	V_{SS}	Off—Max—Off
1	V_{DD}	Off—Mood—Med—Max—Off
2	Floating	Off—Night Light—Mood—Med—Max

The LS7237 IC is available from the manufacturer, **LSI Computer Systems, Inc.**, 1235 Walt Whitman Road, Melville, NY 11741 at $3.40 each in lots of 1 to 24 pieces. Be sure to add $5.00 for shipping and handling. New York state residents add sales tax. A data sheet is available from the manufacturer upon request.

Semiconductor data book

The *RF and Power Semiconductors Data Book* from TRW contains over 600 pages of electrical specifications, performance parameters, and photographs of nearly 400 semiconductor devices. The semiconductor devices covered in the data book include Zener and Schottky diodes, microwave transistors, and hybrid amplifiers for CATV and VHF-UHF linear applications. A valuable aid in selecting a suitable device for a particular application. Available from Marketing Services, RF Devices Div., **TRW Electronic Components Group,** 14520 Aviation Blvd., Lawndale, CA 90260. **R-E**

EQUIPMENT REPORTS

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tion is also built into the unit.

About the only complaint we have with the *B23A* is its brief documentation. Mirage supplies a short pamphlet that describes how to set up the amplifier, but it treats you as if you were an appliance operator, as opposed to a radio amateur who might want to get inside the piece of equipment and work on it. There is a schematic diagram included, but there is no other technical information available. We only wish that they would include in the manual a section dealing with the theory of the *B23A*'s operation.

Still, the Mirage *B23A* is a good unit. It has a one-year warranty on the final transistor package and a five-year warranty on the rest of the unit. So if you're an amateur in search of a good amplifier, take a look at the Mirage *B23A*, you'll like what you see. Oh, by the way, our first *B23,* which has a *very* low serial number is still working well after 4½ years. **R-E**

ROBOT ARM

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To finish assembly of the system, mount the electronic interface in front of the *Armatron* on the base. Connect the motor leads to the interface. Finally, mount the battery packs to the base.

Software for control

The demonstration program, shown in Table 1, was written to direct the computer to move the robot arm automatically—first rotating the entire arm (joint 1), raising the shoulder (joint 2), bending the elbow (joint 3), bending the wrist (joint 4), rotating the wrist (joint 5), and closing the gripper (joint 6). After the robot does those steps, it will do them again—but in reverse. The demonstration program is written in BASIC. Pressing "D" from the keyboard will exercise the joints in sequence. Pressing "J" will result in the computer asking for a joint number from one to six. Pressing "F" or "R" will cause the joint to move forward or reverse respectively. Finally, pressing 'S' stops the program.

That program, as well as the other to follow, uses the user port of the VIC-20 at memory location 37136. Since we are not inputting information, we must POKE the number 255 into memory location 37138 (POKE 37138,255). Each joint must be turned on for a different length of time in order to perform the demonstration. Those on-times are stored in arrays DF and DR and can be changed if you desire. Because the order in which the motor controllers were wired to the decoder was different than the order of the joints, a software transformation had to be made as indicated in data statement 3010.

The second program, shown in Table 3, controls the joints through the keyboard. Key "J" will ask for a joint number. Pressing keys "F" or "R" will move a joint forward or reverse as long as the key is being pressed. Pressing "S" will end the program.

PARTS LIST

Resistors
R1–R3—220 ohms, ¼ watt, 10%

Semiconductors
IC1–IC4, IC6–IC9—7404 hex inverter
IC5—74154 4-to16 line decoder.
LED1–LED3—Standard red LED
Q1–Q12—2N2907

Other components and materials
S1—SPST switch
S2—SPDT switch
M1–M6—DC motors (6 volts)
B1–B11—1.5 volts, "D" cells
Armatron robot

Miscellaneous: Battery holders, motor shafts, IC sockets, breadboard, edge connector for your computer port, etc.

TABLE 1—AUTOMATIC DEMONSTRATION

```
0 REM * AUTOMATIC
  DEMONSTRATION OF ARM JOINT
  MOTIONS *
1 N=10
2 DIM F(6),R(6),L(6)
3 FOR J=1 TO 6:READ F(J):NEXT J
4 FOR J=1 TO 6: READ R(J):NEXT J
5 POKE 37138, 255:POKE 37136,0
6 FOR J=1 TO 6:READ L(J):NEXT J
9 INPUT A$:IF A$="D" THEN 100
10 PRINT"INPUT JOINT NUMBER"
11 INPUT J
20 GET A$:IF A$=""THEN 20
21 IF A$="D"THEN 100
25 IF A$="F"THEN
   KF=L(J)*2-1:GOSUB 1000:
   GOTO 20
30 IF A$="R"THEN
   KR=L(J)*2:GOSUB 2000:GOTO 20
35 IF A$="J"THEN 10
40 IF A$="S"THEN END
45 GOTO 20
100 FOR I=1 TO 2
101 FOR J=1 TO 6
105 IF I=2 THEN 120
110 KF=2*L(J)-1:GOSUB 1000
115 GOTO 130
120 KR=2*L(J):GOSUB 2000
130 NEXT J
135 NEXT I
140 GOTO 10
1000 FOR T=1 TO N
1005 POKE 37136,KF
1010 FOR Z=1 TO F(J):NEXT Z
1015 POKE 37136,0
1020 FOR Z=1 TO 1:NEXT Z
1025 NEXT T
1030 RETURN
2000 FOR T=1 TO N
2005 POKE 37136,KR
2010 FOR Z=1 TO R(J):NEXT Z
2015 POKE 37136,0
2020 FOR Z=1 TO 1:NEXT Z
2025 NEXT T
2030 RETURN
3000 DATA 12, 12, 15, 15, 75, 75
3005 DATA 12, 12, 15, 15, 75, 75
3010 DATA 4, 5, 2, 1, 6, 3
```

The programs we've showed you so far have moved one joint at a time. However, it is possible to move more than one joint simultaneously. That's of interest to us because we, as humans, move our joints in what is known as *coordinated motion*. You can experiment with different combinations of joints to see what kind of overall motion can be achieved.

The controller circuit we showed you before would be of no use because only one line of the decoder can be active at a time. However, if your computer has an output port with 12 output lines, you can control the motors directly without the decoder. Remember, however, that if both the forward and reverse control lines for a motor go low at the same time, the transistors will be burned out. The circuit shown in Fig. 14 is a simple interface between the computer and motor controller that prevents that from happening.

TABLE 3—KEYBOARD CONTROL

```
0 REM * KEYBOARD CONTROL OF
  ARM JOINT MOTIONS *
1 POKE 37138,255:POKE 37136,0
2 DIM F(6),R(6)
3 FOR J=1 TO 6:READ F(J):NEXT J
4 FOR J=1 TO 6:READ R(J):NEXT J
5 PRINT"INPUT JOINT NUMBER"
10 INPUT J
11 IF J=4 THEN L=1
12 IF J=3 THEN L=2
13 IF J=6 THEN L=3
14 IF J=1 THEN L=4
15 IF J=2 THEN L=5
16 IF J=5 THEN L=6
17 KF=2*L-1:KR=2*L
20 GET A$:IF A$=""THEN 20
25 IF A $="F"THEN GOSUB 100
26 IF A $="R"THEN GOSUB 200
30 IF A $="S"THEN END
35 IF A $="J"THEN 5
40 GOTO 20
100 IF PEEK(197)<>42 THEN 111
106 POKE 37136,KF
107 FOR Z=1 TO F(J):NEXT Z
108 POKE 37136,0
109 FOR Z=1 TO 1:NEXT Z
110 GOTO 100
111 POKE 37136,0
115 RETURN
200 IF PEEK(197)<>10 THEN 211
206 POKE 37136,KR
207 FOR Z=1 TO R(J):NEXT Z
208 POKE 37136,0
209 FOR Z=1 TO 1:NEXT Z
210 GOTO 200
211 POKE 37136,0
215 RETURN
300 DATA 7, 7, 15, 15, 75, 75
310 DATA 12, 12, 12, 12, 75, 75
```

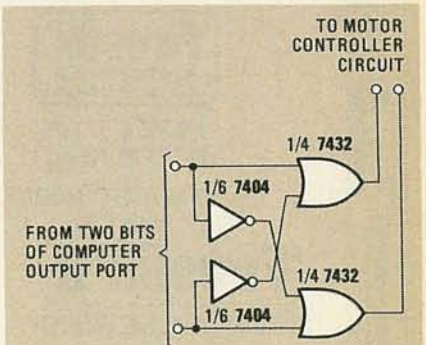

FIG. 14—IF YOUR OUTPUT PORT has enough lines to control the motors, then you can bypass the decoder. This circuit will make sure that you don't burn out your transistors. It should be wired between the output port and the inverters that drive the transistor switches.

Using your robot

When putting your robot to work, keep in mind the following rules that were proposed by Isaac Asimov, in 1950. 1) A robot may not harm a human being or allow a human being to be harmed. 2) A robot must obey the orders given it, unless the orders violate the first rule. 3) A robot must protect itself as long as it does not violate the first and second rules. Keep those rules in mind and have fun with your robot! **R-E**

CORDLESS PHONES

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narrow down the cause of a failure.

Ring test analysis

The ring test is performed by first inserting the telephone line into the telephone line simulator with ring generator attached (and plugging the cordless telephone power cord into an AC receptacle). Leave the portable unit in standby (on-hook). Next, set the ring generator-voltage to 100 volts RMS. The ringer (buzzer or speaker) on the portable unit of the cordless telephone should sound.

Let's see what that test shows us. In ringing, the 20-Hz ring generator applies a 20-Hz ring signal to the telephone line. The 20-Hz ring detector recognizes it and turns on the base-unit RF transmitter and modulates the RF carrier with a ring signal (typically, a frequency in the 700- to 1500-Hz range). The portable unit receiver detects the RF signal. A narrow-band filter detects the correct ring frequency and feeds an audio tone to the speaker. Many cordless telephones use the same speaker used in voice communication. However, some cordless telephones actually use a separate buzzer. If the telephone rings, all of those circuits are operating.

If the ring test is successful, gradually reduce the ring voltage and note the approximate voltage at which ringing stops. Some cordless telephones may ring with the ring voltage set below 45 volts, which is excellent. Most cordless telephones will stop ringing below about 45 volts, and should be considered normal. If the ringing threshold is higher that 45 volts, some additional troubleshooting checks should be made in the 20-Hz ring detector circuit of the base unit.

Most base units have a CALL button that can be pressed to ring the portable unit without the 20-Hz ring signal applied to the telephone line. If the ring test was not successful, press the CALL button on the base unit and note whether the ringer in the portable unit now sounds. The CALL button normally activates the base-unit RF transmitter and applies ring-signal modulation, causing the portable unit's ringer to sound. In that case, there is no ring signal applied to the telephone line and the ring detector circuit is not used.

If the ringer now sounds, we have isolated the problem to the telephone cord or the 20-Hz ring detector. If the ringer does not sound, we know that the base-unit RF transmitter or portable-unit receiver are probably the cause. The ring test procedure is summarized in Fig. 4. That's all we have room for now. Next time, we'll continue our look at troubleshooting cordless telephones by examining the rest of the operational tests. **R-E**

BREATHING

continued from page 56

available spirometer makes use of a popular home computer and gives a printout of normal and measured values for over a dozen parameters. Many spirometers are portable and microprocessor controlled.

Artificial respiration

Electronically controlled respirators are available in most hospitals in this country to assist the breathing of persons who are unable to breathe on their own. Conditions that sometimes make artificial or assisted respiration necessary are head injury, drug overdose, heart failure, severe asthma attacks, pneumonia, chest injury, and anesthesia.

A respirator must provide a controlled volume of air over a reasonable time. Modern respirators allow you to control the volume of air, inspiratory time, expiratory time, maximum allowable pressure, percentage of inspired oxygen in the air, temperature, and humidity.

If the patient is breathing fairly well and just needs a little help, the respirator may "assist" breathing by adding a little extra volume to each breath taken. Or, the respirator may add an occasional deep breath. In other cases, the respirator may need to take over breathing completely.

The device known as the "iron lung" is not used much anymore. It caused inspiration to occur by applying a negative pressure to the outside of the chest wall. Exhalation was caused by the natural recoil force of the lungs when the pressure was returned to normal (normal, in this case, is the local atmospheric pressure). Taking of blood pressure, washing of the skin, and doing anything else that required contact with the body was done during exhalation when the pressure on the body surface was normal. That made any procedure difficult.

In the 1940's and 1950's "positive pressure ventilation" (blowing air into the lungs under pressure) became popular in anesthesia. That development paved the way for modern respiration techniques.

Most respirators in use today are attached to a tube that is inserted through the patient's nose or mouth and into the trachea. Positive pressure is applied to inflate the lungs. The pressure normally returns to normal during exhalation.

Respirators can be set so that the pressure does not drop all the way to atmospheric pressure, but instead returns to some positive pressure during exhalation. That allows more oxygen to be absorbed by the lungs and is called CPAP (*C*ontinuous *P*ositive *A*irway *P*ressure) or PEEP (*P*ositive *E*nd *E*xpiratory *P*ressure). CPAP and PEEP requires less oxygen to be inspired to achieve a given level of oxygen in the blood. **R-E**

POWER METER

continued from page 76

in Fig. 4.

Dry-transfer lettering may be used to mark power levels associated with each LED and give a professionally-finished appearance. It's also a good idea to mark the left and right output and input connectors as well.

Now run a single lead between all ground terminals of the output and input connectors to a ground point on the PC board. The "hot" terminals are connected as shown in Fig. 3.

The convenience outlets are wired together in parallel. The neutral terminals are connected to the green wire of the power cord; under no circumstances should neutral be connected to the PC board or chassis ground. Check the wiring and make sure all diodes, capacitors, and IC's are in the proper place and correctly oriented. Be especially careful about the power connections.

Test and calibration

With the power switch turned off, set S2 to the RUN position and plug in the power cord and turn on the power. LED 21, the protection lamp, should come on for a few seconds and then go out. As the LED goes out, you should hear the relay click as it closes.

Place S2 to the SET position. One left-channel LED should light. Adjusting R25 should change which LED is on. If the unit doesn't operate as expected, remove power immediately. To aid in troubleshooting, nominal operating voltages at various test points through out the circuit are shown in Fig. 1.

The only calibration necessary is done using R24 and R25. Note: For calibration, it is important that you know the continuous power-handling capability of the speakers to be connected; contact the manufacturer for that information.

Set R25 to about mid-range and turn R24 all the way in one direction until the relay opens and LED21 lights. Now rotate R24 all the way in other direction (the relay should close). With S2 still in the SET position, adjust R25 until the LED corresponding to the power handling capability of your speakers just turns on.

Wait several seconds and turn R24 until you hear the relay click open and you see LED21 turn on. Waiting several seconds ensures that the protection circuit turns on *only* after sustained high-power levels and not during large transients. Now set S2 to the RUN position, and the unit is ready for connection to your system.

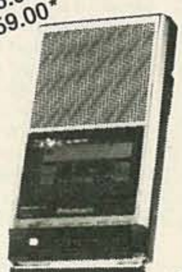
Using the device

First, determine which speaker-output terminals are common between the left and right channels of your power amplifier (usually the ground terminals). An ohmmeter may be helpful here. Then connect the common terminals of the amplifier to the ground terminals of the protection circuit. Caution: The circuit should not be used with any amplifier that cannot accept common connection of the left and right speaker grounds. For most commercial amplifiers that's not a problem; but if you are unsure, consult your owner's manual or the amplifier's manufacturer.

Connect the positive (+) outputs of the amplifier to the left and right inputs on the unit. Occasionally the bottom-most LED on one or the other channel will remain lighted with no input to the speakers. If that happens, first disconnect the amplifier and ground the unit's inputs. If that turns the LED off, there may be a small amount of DC at your amplifier's output terminals.

Should that be the case, have your amplifier serviced immediately to save wear and tear on your speakers. If the LED stays on with the inputs grounded and S2 set to RUN, there may be a problem with Q1, Q2, or any one of diodes D1–D4. Normal variations among inexpensive components may cause that condition; the simplest solution is to replace those components in the affected channel.

While the unit should prevent most forms of speaker damage, *please* do not use it as an excuse to abandon all caution in using your stereo. **R-E**



DIGITAL IC'S

continued from page 96

is closed, however, the gate input is low.

Figure 18 shows the input/output waveforms for that circuit. From time t_1 to t_5 the switch is closed, so the circuit operates in the inverting mode. Thus, the output pulse is high when the input is high, and low when the input is low. From t_5 to t_9, however, the switch is open, so the circuit operates in the inverting mode. Here, we see a high output for low inputs and vice-versa.

Figures 19, 20, 21, and 22 show two forms of electronic digital switch and

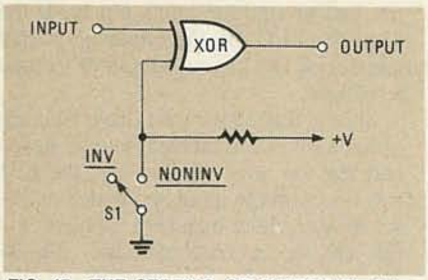


FIG. 17—THE SETTING OF SWITCH S1 determines whether this buffer is inverting or noninverting.

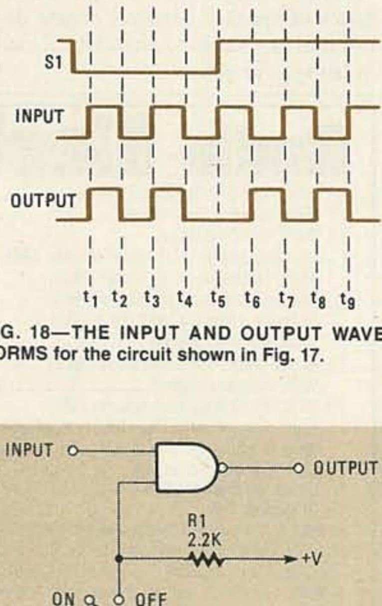


FIG. 18—THE INPUT AND OUTPUT WAVEFORMS for the circuit shown in Fig. 17.

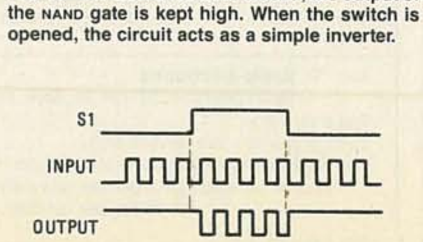


FIG. 19—AS LONG AS S1 is closed, the output of the NAND gate is kept high. When the switch is opened, the circuit acts as a simple inverter.

FIG. 20—THESE waveforms show the operation of the circuit shown in Fig. 19.

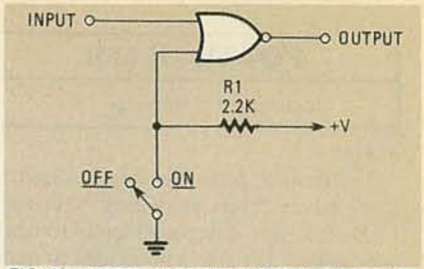


FIG. 21—HERE, when the switch is closed, the output of the circuit is kept low. When it is opened, the circuit acts as a noninverting buffer.

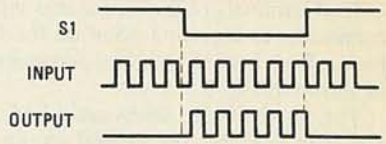


FIG. 22—NOTE THE DIFFERENCE in "polarity" between the output of this NOR-gate circuit, and the NAND-gate circuit of Figs. 19 and 20.

their associated input/output waveforms. The circuit in Fig. 19 is based on the NAND gate and is inverting, while that in Fig. 21 is based on the NOR gate and is noninverting. In both cases, one input of the gate is controlled by a switch, while the other serves as the signal input. In some cases, the switch and pull-up resistor are replaced by a logic level from some other circuit. Thus, our electronic switch can be controlled either manually or digitally.

The inverting circuit shown in Fig. 19 is based on the two-input NAND gate (such as the 7400). One input is connected to a grounding switch and a pull-up resistor. When S1 is closed, the NAND input is kept low so the output is held high. But when S1 is opened, the input is high and the output will follow the signal input in the manner of an inverter. Its operation can be seen by examining the input/output waveforms shown in Fig. 20.

Figure 21 shows a similar circuit using a NOR gate. Note that the "polarity" of the signals is reversed (reflecting the difference between NAND and NOR), but otherwise the operation is similar. The operation of the circuit can be seen by examining the input/output waveforms in Fig. 22.

Next time, we'll turn our attention to how to interface digital circuits to each other, and to the "outside world." **R-E**

"All right, what wise guy that fed it that sex program.

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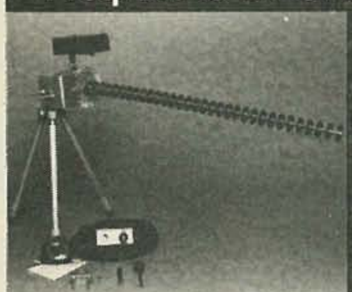

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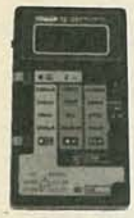

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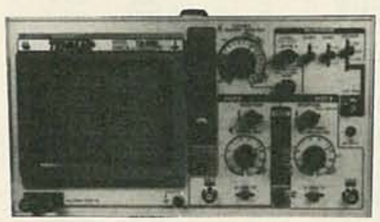

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7400

ACT #		Pkg'd Qty	Pkg. Price
05500	7400	3	1.10
05502	7400	5	1.80
05504	7401	3	1.10
05506	7402	3	1.10
05508	7403	3	1.10
05510	7404	3	1.10
05512	7404	5	1.85
05514	7405	3	1.10
05516	7406	2	1.00
05518	7407	2	1.00
05520	7408	3	1.10
05521	7409	3	1.10
05522	7410	3	1.10
05526	7414	2	1.00
05528	7416	2	1.00
05530	7417	2	1.00
05532	7420	3	1.10
05534	7422	3	1.20
05536	7423	3	1.20
05538	7425	3	1.10
05540	7426	3	1.10
05542	7427	3	1.10
05546	7430	2	1.00
05548	7432	3	1.10
05550	7438	2	1.00
05552	7439	2	1.30
05554	7440	3	1.35
05556	7442	2	1.10
05562	7445	1	.90
05564	7446	1	1.00
05566	7447	1	1.00
05568	7447	5	4.75
05570	7448	1	1.00
05572	7450	3	1.10
05574	7451	3	1.10
05578	7454	3	1.10
05586	7473	10	4.10
05588	7474	2	1.00
05590	7474	5	2.50
05592	7475	2	1.00
05594	7476	3	1.40
05602	7485	1	.80
05604	7486	2	1.00
05606	7489	1	2.39
05608	7490	2	1.00
05610	7490	5	2.50
05612	7491	2	1.40
05614	7492	3	1.29
05616	7493	3	1.29
05618	7493	5	2.15
05622	7495	2	1.10
05624	7496	2	1.30
05626	7497	1	2.60
05628	74100	1	1.65

ACT #		Pkg'd Qty	Pkg. Price
05630	74104	1	1.00
05632	74105	1	1.00
05634	74107	2	1.00
05636	74109	2	1.00
05638	74116	1	1.45
05640	74121	2	1.00
05642	74122	2	1.25
05644	74123	2	1.00
05646	74123	10	5.00
05648	74125	2	1.25
05650	74126	2	1.25
05652	74132	2	1.30
05654	74136	2	1.20
05656	74141	1	1.20
05658	74142	1	3.75
05660	74143	1	4.60
05662	74144	1	4.00
05664	74145	1	.90
05666	74147	1	1.65
05668	74148	1	1.10
05670	74150	1	1.60
05672	74151	2	1.20
05674	74153	2	1.20
05676	74154	1	1.35
05678	74155	2	1.10
05680	74156	2	1.40
05682	74157	2	1.20
05684	74160	2	1.20
05686	74161	2	1.50
05688	74162	2	1.55
05690	74163	2	1.50
05692	74164	2	1.50
05694	74165	2	1.65
05696	74166	1	1.25
05698	74167	1	3.20
05700	74170	1	2.00
05702	74172	1	5.00
05704	74173	1	1.10
05706	74174	1	.74
05708	74175	2	1.30
05710	74176	1	1.00
05712	74177	1	1.00
05714	74179	1	1.30
05718	74181	1	2.40
05720	74182	1	1.00
05722	74184	1	2.36
05724	74185	1	2.36
05726	74190	1	.90
05728	74192	2	1.45
05730	74193	2	1.45
05732	74194	1	.90
05734	74195	2	1.40
05736	74196	1	1.00
05738	74197	1	1.00
05740	74198	1	1.50
05742	74199	1	1.50
05744	74221	1	.90
05746	74251	1	1.00
05748	74276	1	2.50
05750	74279	1	1.50
05752	74283	1	1.30
05756	74285	1	3.05
05758	74365	2	1.30
05760	74366	2	1.30
05762	74367	2	1.30
05764	74368	2	1.30
05766	74390	1	1.50
05768	74393	1	1.50

74LS

ACT #		Pkg'd Qty	Pkg Price
05770	74LS00	4	$ 1.20
05772	74LS00	10	2.75
05774	74LS01	4	1.20
05776	74LS02	4	1.20
05778	74LS03	4	1.20
05780	74LS04	4	1.20
05782	74LS04	10	2.85
05784	74LS05	4	1.20
05786	74LS08	4	1.20
05788	74LS08	10	2.85
05790	74LS09	4	1.20
05792	74LS10	4	1.20
05794	74LS10	10	2.85
05796	74LS11	4	1.20
05798	74LS12	3	1.00
05800	74LS13	3	1.00
05802	74LS14	2	1.05
05804	74LS15	2	1.05
05806	74LS20	4	1.20
05808	74LS21	4	1.20
05810	74LS22	3	1.00
05812	74LS26	3	1.00
05814	74LS27	4	1.20
05816	74LS28	3	1.00
05818	74LS30	4	1.20
05820	74LS32	4	1.20
05822	74LS33	3	1.00
05826	74LS37	3	1.10
05828	74LS38	3	1.10
05830	74LS40	3	1.00
05832	74LS42	3	1.30
05834	74LS47	2	1.40
05836	74LS48	2	1.60
05838	74LS49	2	1.30
05840	74LS51	4	1.20
05842	74LS54	3	.90
05844	74LS55	3	.90
05846	74LS73	3	1.10
05848	74LS74	3	1.00
05850	74LS75	3	1.15
05852	74LS76	3	1.10
05854	74LS78	3	1.10
05856	74LS83	2	1.10
05858	74LS85	2	1.50
05860	74LS86	3	1.00
05862	74LS86	5	1.80
05864	74LS90	3	1.30
05866	74LS92	3	1.30
05868	74LS93	3	1.30
05870	74LS95	2	1.05
05872	74LS96	2	1.10
05874	74LS107	3	1.30
05876	74LS107	5	1.90
05878	74LS109	3	1.20
05880	74LS112	3	1.20
05882	74LS113	3	1.10
05884	74LS114	3	1.10
05886	74LS122	3	1.05
05888	74LS123	2	1.30
05890	74LS123	5	3.10
05892	74LS125	3	1.20
05894	74LS126	3	1.20
05896	74LS132	2	1.20
05898	74LS132	5	2.85
05900	74LS133	2	1.00
05901	74LS136	3	1.10
05902	74LS138	2	1.00
05903	74LS138	5	2.35
05904	74LS139	2	1.00
05905	74LS139	5	2.35
05906	74LS148	1	1.50
05907	74LS151	2	1.00

ACT #		Pkg'd Qty	Pkg Price
05908	74LS151	5	2.35
05909	74LS153	2	1.00
05911	74LS155	2	1.30
05912	74LS156	2	1.15
05913	74LS157	3	1.35
05914	74LS158	2	1.00
05915	74LS160	2	1.30
05916	74LS161	2	1.30
05917	74LS162	2	1.30
05918	74LS163	2	1.30
05919	74LS164	2	1.30
05920	74LS165	2	1.40
05921	74LS166	1	1.35
05922	74LS169	1	1.00
05923	74LS170	1	1.30
05924	74LS173	2	1.05
05925	74LS174	2	1.15
05926	74LS174	5	2.70
05927	74LS175	2	1.15
05928	74LS181	1	1.75
05929	74LS190	2	1.45
05930	74LS191	2	1.45
05931	74LS192	2	1.45
05932	74LS193	2	1.45
05933	74LS194	2	1.00
05934	74LS195	2	1.00
05935	74LS197	2	1.40
05936	74LS221	2	1.69
05937	74LS240	1	.95
05938	74LS240	5	4.50
05939	74LS241	1	.90
05940	74LS241	5	4.25
05941	74LS242	2	1.59
05942	74LS243	2	1.59
05943	74LS244	1	.95
05944	74LS244	5	4.50
05945	74LS245	1	1.10
05946	74LS245	5	5.25
05947	74LS247	2	1.40
05948	74LS248	1	.90
05949	74LS249	1	.90
05950	74LS251	2	1.69
05951	74LS253	2	1.00
05952	74LS257	2	1.10
05953	74LS258	2	1.10
05954	74LS259	1	1.00
05955	74LS266	3	1.00
05956	74LS273	1	1.00
05957	74LS279	3	1.15
05958	74LS283	2	1.15
05959	74LS290	2	1.20
05960	74LS293	2	1.30
05961	74LS298	2	1.50
05962	74LS323	1	2.99
05963	74LS352	2	1.40
05964	74LS353	2	1.40
05965	74LS365	3	1.29
05966	74LS366	3	1.29
05967	74LS367	3	1.29
05968	74LS367	5	2.00
05969	74LS368	3	1.29
05970	74LS373	1	1.00
05971	74LS373	5	4.75
05972	74LS374	1	1.00
05973	74LS375	3	1.29
05974	74LS386	3	1.00
05975	74LS390	1	.85
05976	74LS393	2	1.50
05977	74LS399	1	.95
05978	74LS624	1	1.29
05979	74LS629	1	2.25
05980	74LS640	1	1.44
05981	74LS670	1	1.44

74S

ACT #		Pkg'd Qty	Pkg. Price
05S00	74S00	2	$1.00
05S04	74S02	2	1.00
05S06	74S04	2	1.00
05S08	74S08	2	1.00
05S09	74S10	2	1.50
05S10	74S20	2	1.00
05S12	74S32	2	1.10
05S35	74S38	1	1.00
05S40	74S51	2	1.00
05S13	74S64	2	1.50
05S14	74S74	2	1.10
05S15	74S85	1	1.75
05S16	74S86	2	1.35
05S17	74S109	1	1.50
05S19	74S112	2	1.39
05S45	74S124	1	2.49
05S18	74S138	1	1.25
05S50	74S157	1	1.15
05S20	74S158	1	1.15
05S21	74S163	1	2.69
05S55	74S169	1	3.89
05S60	74S174	1	1.25
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05S65	74S189	1	3.69
05S70	74S201	1	4.99
05S75	74S225	1	4.99
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05S27	74S244	1	2.25
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05S26	74S373	1	2.25
05S32	74S374	1	2.25
05S28	74S387	1	2.00

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ACT #		Pkg'd Qty	Pkg. Price
05F01	74F00	2	$1.00
05F03	74F02	2	1.00
05F05	74F04	2	1.00
05F07	74F08	2	1.00
05F09	74F10	2	1.00
05F10	74F11	2	1.50
05F11	74F20	2	1.00
05F15	74F32	2	1.20
05F16	74F64	2	1.50
05F17	74F74	2	1.10
05F19	74F86	2	1.40
05F20	74F109	1	1.40
05F22	74F112	1	1.25
05F24	74F113	1	1.25
05F26	74F114	1	1.25
05F28	74F138	1	1.25
05F30	74F139	1	1.25
05F32	74F148	1	1.35
05F34	74F151	1	1.25
05F36	74F153	1	1.25

ACT #		Pkg'd Qty	Pkg Price
05F38	74F157	1	1.25
05F40	74F158	1	1.25
05F42	74F160	1	2.99
05F44	74F164	1	1.95
05F46	74F174	1	1.95
05F48	74F175	1	2.55
05F50	74F181	1	3.85
05F52	74F182	1	1.95
05F54	74F189	1	4.85
05F56	74F190	1	3.00
05F58	74F191	1	3.00
05F60	74F192	1	3.50
05F62	74F193	1	3.50
05F64	74F219	1	4.65
05F66	74F240	1	2.20
05F68	74F241	1	2.20
05F70	74F244	1	2.20
05F72	74F245	1	4.75
05F74	74F251	1	1.25
05F76	74F253	1	1.25

ACT #		Pkg'd Qty	Pkg Price
05F78	74F257	1	1.25
05F80	74F258	1	1.25
05F81	74F280	1	1.45
05F82	74F283	1	2.60
05F83	74F350	1	2.69
05F84	74F352	1	1.20
05F85	74F353	1	1.20
05F86	74F373	1	2.95
05F87	74F374	1	2.95
05F88	74F378	1	1.80
05F89	74F379	1	1.70
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05F91	74F382	1	4.15
05F92	74F384	1	9.50
05F93	74F385	1	8.60
05F94	74F398	1	3.20
05F95	74F399	1	1.75
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2N2219A	.45	TIP31A	2/1.25
2N2905	.45	TIP32A	2/1.25
2N2907	.25	1N4148	25/1.00
2N3055	.69	1N751	5/1.00
2N3565	4/1.00	1N4002	10/1.00
2N3638	4/1.00	1N4004	10/1.00
2N3772	1.69	MPQ2232	1.49

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8088	29.50	8238	4.25	8286	6.45
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8155	8.75	8250	10.50	8288	14.95
8156	8.75	8251	4.25	8289	44.95
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LM311CN	.62	LM733	.98	CA3023	2.75
LM312H	1.75	LM739	1.85	CA3039	1.25
LM318CN	1.45	LM741CN	.33	CA3046	1.25
LM318H	1.55	LM741H	.40	CA3059	2.85
LM319N	1.19	LM741N	.29	CA3060	2.85
LM320 (see VRs)		LM747	.65	CA3065	1.69
LM324N	.55	LM748	.55	CA3080	1.10
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LM358CN	.65	MC1330	1.65	CA3086	.80
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LM392N	.69	ULN2003	1.49	TL071CP	.79
LM723N	.48	XR2206	3.75	TL072CP	1.35
LM723H	.55	XR2207	2.90	TL074CN	1.90
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NE556	.65	LM2877P	2.00	TL494	4.10
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LM567	.85	LM2917	2.85	MC3459	3.75
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7403	.19	7450	.19	74128	.49	74180	.75
7404	.19	7451	.19	74132	.45	74181	1.75
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7406	.49	7454	.19	74141	.65	74184	2.25
7407	.49	7459	.25	74142	2.95	74185	2.25
7408	.24	7460	.37	74143	3.70	74190	.67
7409	.19	7470	.29	74144	2.95	74191	.67
7410	.19	7472	.29	74145	.59	74192	.67
7411	.24	7473	.33	74147	1.49	74193	.67
7412	.38	7474	.34	74148	1.19	74194	.67
7413	.34	7475	.38	74150	1.09	74195	.67
7414	.49	7476	.34	74151	.55	74196	.75
7416	.49	7479	4.60	74152	.67	74197	.86
7417	.49	7480	.69	74153	.53	74198	1.15
7420	.19	7482	.95	74154	1.19	74199	1.15
7421	.35	7483	.45	74155	.69	74221	1.19
7422	.45	7485	.55	74156	.59	74251	.75
7423	.58	7486	.35	74157	.59	74273	1.65
7425	.29	7489	1.95	74158	1.65	74276	1.89
7426	.29	7490	.35	74159	1.58	74279	.75
7427	.25	7491	.65	74160	.79	74283	1.40
7428	.55	7492	.45	74161	.69	74284	2.90
7430	.18	7493	.35	74162	.69	74285	2.90
7432	.29	7494	.85	74163	.69	74290	1.49
7437	.25	7495	.50	74164	.69	74298	1.49
7438	.29	7496	.69	74165	.69	74365	.55
7439	.58	7497	2.70	74166	.85	74366	.55
7440	.19	74100	1.50	74167	2.75	74367	.55
7441	.79	74107	.24	74170	1.25	74368	.55
7442	.45	74109	.37	74172	4.75	74390	1.45
7443	1.15	74116	1.45	74173	.69	74393	1.33
7444	1.15	74121	.29	74174	.69	74490	2.25
7445	.68	74122	.44	74175	.69		

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74LS01	.25	74LS114	.39	74LS248	.98
74LS02	.25	74LS122	.45	74LS249	.98
74LS03	.25	74LS123	.95	74LS251	.59
74LS04	.33	74LS124	2.75	74LS253	.59
74LS05	.25	74LS125	.49	74LS257	.59
74LS08	.27	74LS126	.49	74LS258	.59
74LS09	.28	74LS132	.59	74LS259	2.95
74LS10	.25	74LS136	.39	74LS260	.59
74LS11	.33	74LS138	.59	74LS261	2.49
74LS12	.33	74LS139	.59	74LS266	.55
74LS13	.39	74LS145	1.19	74LS273	1.45
74LS14	.59	74LS148	1.36	74LS275	3.29
74LS15	.33	74LS151	.55	74LS279	.59
74LS20	.26	74LS153	.55	74LS283	.68
74LS21	.29	74LS154	1.49	74LS290	.88
74LS22	.29	74LS155	.69	74LS293	.78
74LS26	.29	74LS156	.69	74LS295	.98
74LS27	.29	74LS157	.69	74LS298	.88
74LS28	.29	74LS158	.69	74LS324	1.75
74LS30	.25	74LS160	.69	74LS347	1.95
74LS32	.33	74LS161	.69	74LS348	1.95
74LS33	.63	74LS162	.69	74LS352	1.25
74LS37	.35	74LS163	.69	74LS353	1.25
74LS38	.39	74LS164	.69	74LS363	1.29
74LS40	.25	74LS165	.90	74LS365	.48
74LS42	.44	74LS166	1.90	74LS366	.48
74LS47	.74	74LS168	1.15	74LS367	.45
74LS48	.74	74LS169	1.15	74LS368	.45
74LS51	.25	74LS170	1.40	74LS373	1.39
74LS54	.29	74LS173	.67	74LS374	1.33
74LS55	.29	74LS174	.67	74LS375	.69
74LS73	.39	74LS175	.67	74LS377	1.38
74LS74	.34	74LS181	1.95	74LS385	1.95
74LS75	.39	74LS190	.85	74LS386	.45
74LS76	.39	74LS191	.85	74LS390	1.15
74LS78	.39	74LS192	.78	74LS393	1.15
74LS83	.59	74LS193	.78	74LS395	1.15
74LS85	.69	74LS194	.69	74LS399	1.47
74LS86	.39	74LS195	.69	74LS424	2.95
74LS90	.54	74LS196	.79	74LS668	1.75
74LS92	.54	74LS197	.79	74LS670	2.29
74LS93	.54	74LS221	.89	81LS95	1.45
74LS95	.75	74LS240	.95	81LS96	1.45
74LS96	.89	74LS242	.95	81LS97	1.45
74LS107	.39	74LS243	.95	81LS98	1.45
74LS109	.39	74LS244	1.25	25LS2521	2.65
74LS112	.39	74LS245	1.45	25LS2569	3.50

CMOS

4000	$ .29	4028	$ .65	4059	$7.90	4505	8.95
4001	.24	4029	.75	4060	.85	4506	1.10
4002	.24	4030	.39	4066	.39	4507	1.10
4006	.79	4031	3.25	4069	.28	4508	1.90
4007	.25	4032	2.15	4070	.35	4510	.79
4008	.95	4034	1.91	4071	.28	4511	.79
4009	.39	4035	.79	4072	.28	4512	.79
4010	.39	4037	1.95	4073	.28	4514	1.18
4011	.24	4040	.75	4075	.28	4515	1.79
4012	.24	4041	.75	4076	.75	4516	1.19
4013	.35	4042	.65	4077	.35	4518	.85
4014	.75	4043	.85	4078	.35	4520	.75
4015	.39	4044	.69	4081	.29	4555	.95
4016	.35	4046	.80	4082	.29	4556	.95
4017	.65	4047	.89	4085	.95	4566	1.35
4018	.79	4048	.99	4086	.95	80C95	1.50
4019	.39	4049	.35	4093	.45	80C97	.49
4020	.69	4050	.34	4094	2.95	MC14408	12.95
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4024	.59	4055	3.95	4502	.95	MC14412	12.95
4025	.25	4056	2.95	4503	.49	MC14419	4.95
4027	.45	CALL FOR 74HC					

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74S00	$.35	74S74	$.55	74S158	$.99	74S260	$1.19
74S02	.35	74S85	1.89	74S160	2.49	74S280	1.95
74S03	.35	74S86	.55	74S161	1.89	74S287*	1.95
74S04	.45	74S112	.55	74S174	1.19	74S288*	1.95
74S05	.45	74S113	.55	74S175	1.19	74S373	2.09
74S08	.39	74S114	.55	74S188*	1.49	74S374	2.09
74S09	.39	74S124	2.69	74S194	1.49	74S387*	1.95
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74S11	.35	74S133	.45	74S196	1.49	74S472*	4.95
74S15	.35	74S134	.50	74S240	1.99	74S473*	4.95
74S20	.35	74S135	.69	74S241	1.99	74S474*	4.95
74S22	.35	74S136	1.39	74S242	1.99	74S475*	4.95
74S30	.35	74S138	.89	74S243	1.99	74S570*	2.95
74S32	.45	74S139	.89	74S244	1.99	74S571*	2.95
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74S64	.39	74S157	.99	74S258	1.19	74S941	2.49
74S65	.39	CALL FOR 74HC					

74C00

74C00	$.35	74C74	$.65	74C161	$1.15	74C373	$2.35
74C02	.35	74C85	1.89	74C175	1.15	74C374	2.35
74C04	.29	74C90	1.15	74C240	1.89	74C901	.59
74C08	.35	74C93	1.15	74C244	1.89	74C922	4.45
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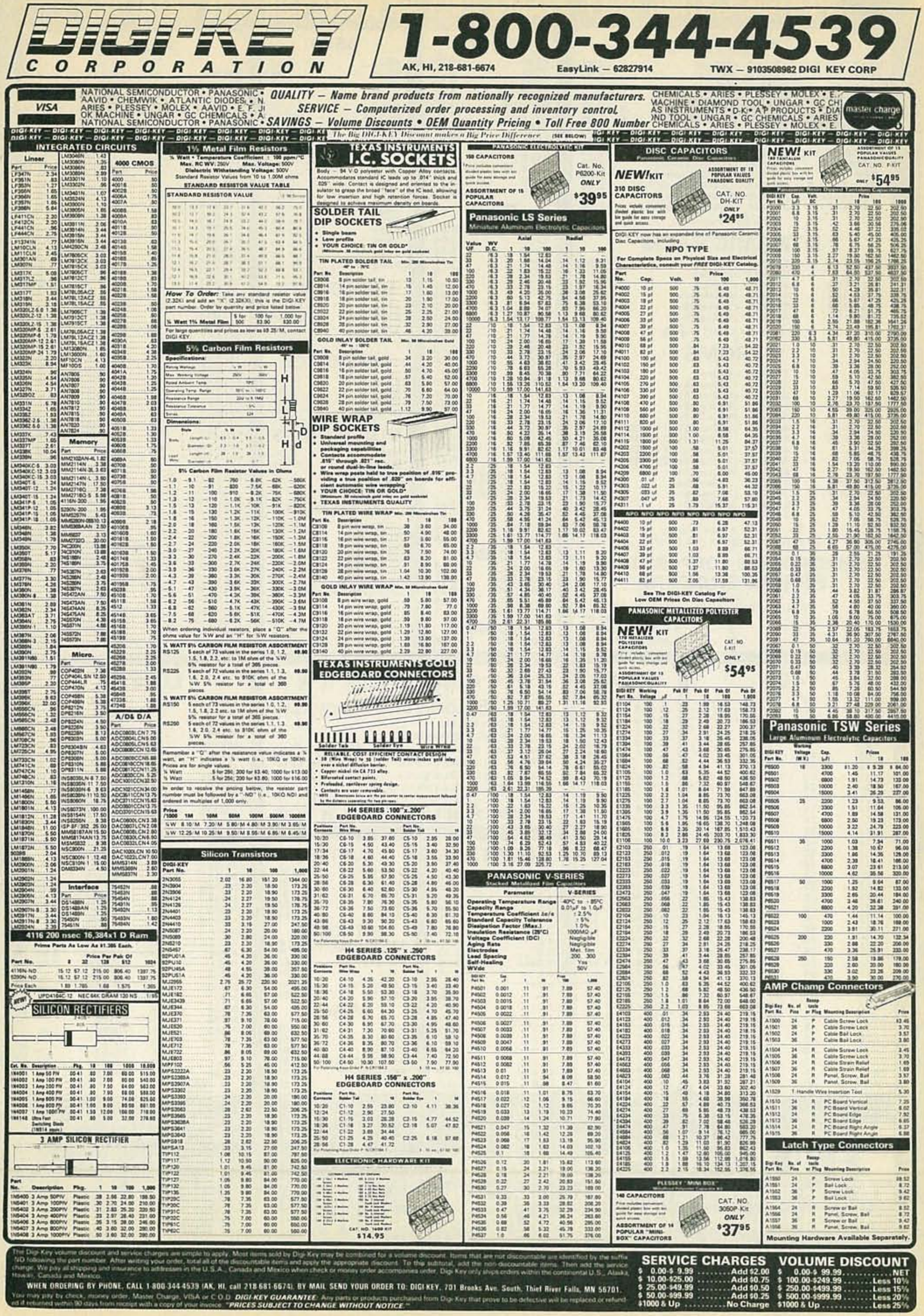

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HM6116LP-4	2048x8	(200ns)(cmos)(LP)	3.95
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LP = Low Power

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2732	4096x8	(450ns)(5v)	4.25
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2732A-35	4096x8	(350ns)(5v)(21vPGM)	4.95
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2764-250	8192x8	(250ns)(5v)	5.25
2764-200	8192x8	(200ns)(5v)	8.95
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5v = Single 5 Volt Supply
21vPGM = Program at 21 Volts

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PE-14T	X	9	8,000	119.00
PE-24T	X	9	9,600	175.00

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8216	1.75
8228	3.49
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8250	10.95
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8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8259	6.90
8259-5	7.50
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6551	9.95
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6551A	11.95

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74LS00

74LS00	.24	74LS157	.65
74LS01	.25	74LS158	.59
74LS02	.25	74LS160	.69
74LS03	.25	74LS161	.65
74LS04	.24	74LS163	.65
74LS05	.25	74LS164	.69
74LS08	.28	74LS165	.95
74LS09	.29	74LS166	1.95
74LS10	.25	74LS169	1.75
74LS11	.35	74LS173	.69
74LS12	.35	74LS174	.55
74LS13	.45	74LS191	.89
74LS14	.59	74LS192	.79
74LS20	.25	74LS193	.79
74LS21	.29	74LS194	.69
74LS26	.29	74LS195	.69
74LS27	.29	74LS197	.79
74LS32	.29	74LS221	.89
74LS33	.55	74LS240	.95
74LS37	.35	74LS241	.99
74LS38	.35	74LS242	.99
74LS40	.25	74LS243	.99
74LS42	.49	74LS244	1.29
74LS47	.75	74LS245	1.49
74LS51	.25	74LS251	.59
74LS73	.39	74LS253	.59
74LS74	.35	74LS257	.59
74LS75	.39	74LS258	.59
74LS76	.39	74LS259	2.75
74LS85	.69	74LS260	.59
74LS86	.39	74LS266	.55
74LS90	.55	74LS279	.49
74LS92	.55	74LS280	1.98
74LS93	.55	74LS283	.69
74LS107	.39	74LS290	.89
74LS109	.39	74LS293	.89
74LS112	.39	74LS299	1.75
74LS122	.45	74LS323	3.50
74LS123	.79	74LS365	.49
74LS124	2.90	74LS367	.45
74LS125	.49	74LS368	.45
74LS126	.49	74LS373	1.39
74LS132	.59	74LS374	1.39
74LS136	.39	74LS377	1.39
74LS138	.55	74LS390	1.19
74LS139	.55	74LS393	1.19
74LS145	1.20	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS670	1.49
74LS153	.55	74LS682	3.20
74LS154	1.90	74LS688	2.40
74LS155	.69	81LS95	1.49
74LS156	.69	25LS2521	2.80

7400

7400	.19	7492	.50
7401	.19	7493	.35
7402	.19	74100	1.75
7403	.19	74107	.30
7404	.19	74116	1.55
7405	.25	74121	.29
7406	.29	74122	.45
7407	.29	74123	.49
7408	.24	74125	.45
7409	.19	74126	.45
7410	.19	74132	.45
7411	.25	74145	.60
7413	.35	74148	1.20
7414	.49	74150	1.35
7416	.25	74151	.55
7417	.25	74153	.55
7420	.19	74154	1.25
7421	.35	74155	.75
7425	.29	74157	.55
7427	.29	74159	1.65
7430	.19	74161	.69
7432	.29	74163	.69
7437	.29	74164	.85
7438	.29	74165	.85
7442	.49	74166	1.00
7445	.69	74173	.75
7447	.69	74174	.89
7448	.69	74175	.89
7473	.34	74185	2.00
7474	.33	74192	.79
7475	.45	74193	.79
7476	.35	74194	.85
7483	.50	74259	2.25
7485	.59	74367	.65
7489	2.15	74368	.65
7490	.35	74393	1.35

74S00

74S00	.32
74S02	.35
74S04	.35
74S05	.35
74S08	.35
74S10	.35
74S11	.35
74S20	.35
74S32	.40
74S37	.88
74S74	.50
74S86	.50
74S112	.50
74S124	2.75
74S132	1.24
74S133	.45
74S138	.85
74S139	.85
74S140	.55
74S151	.95
74S153	.95
74S157	.95
74S158	.95
74S161	1.95
74S163	1.95
74S174	.95
74S175	.95
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100	16v	.18	100	15v	.20
220	35v	.20	150	25v	.25

50v MONOLITHIC

.01uf	.14	.1	.18
.047	.15	.47	.25

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10pf	.05	470	.05
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47	.05	.0015	.05
56	.05	.0022	.05
68	.05	.005	.05
82	.05	.01	.07
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14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call

ST=SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
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RED	.10	.09	MAN-72	CA	.3"	.99
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YELLOW	.18	.15	FND-500	CC	.5"	1.49
			FND-507	CA	.5"	1.49

D-SUBMINIATURE

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RT. ANGLE PC SOLDERS	MALE	DBxxPR	1.65	2.20	3.00	4.83
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	FEMALE	IDBxxS	3.25	4.29	5.25	7.95
HOODS	BLACK	HOOD-B	---	---	.99	---
	GREY	HOOD	.89	.99	.99	1.09

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FOR ORDERING INSTRUCTIONS, SEE IDC CONN. ABOVE.

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4 position	.85
6 position	.90
7 position	.95
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PN2222	.10	2N3055	.79
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2N2907	.25	2N3906	.10

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1N759	12.0v zener	.25
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7815T	.75	7912K	1.49
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7905T	.85	79L05	.79
7912T	.85	79L12	.79

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4012	.25	4040	.75	4071	.29	4584	.75		
4013	.38	4042	.69	4081	.29	74C00	.35		
4015	.39	4046	.85	4082	.29	74C04	.35		
4016	.39	4047	.95	4093	.49	74C14	.59		
4017	.69	4049	.35	4503	.65	74C74	.65		
4018	.79	4050	.35	4511	.85	74C906	.95		
4020	.75	4051	.79	4518	.89	74C922	4.49		
4023	.29	4053	.79	4520	.79	74C923	4.95		
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PPF1.......Plans.......$15.00 **PPF1K**....Kit/Plans....$175.00

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BLS10..............ASSEMBLED..............$89.50
BLS1..PLANS..$10.00 **BLS1K**..KTI/PLANS..$69.50

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SNP2........Plans........$9.00 **SNP2K**.....Plans/Kit.....$59.50

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3PDT RELAY, 12VDC coil, 10A contacts $1
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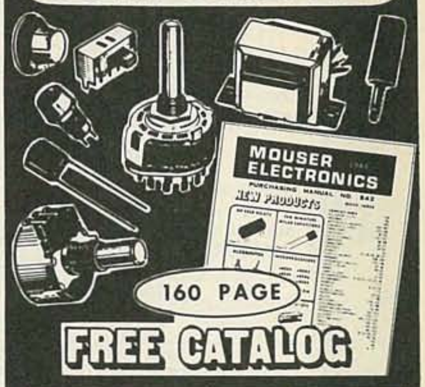

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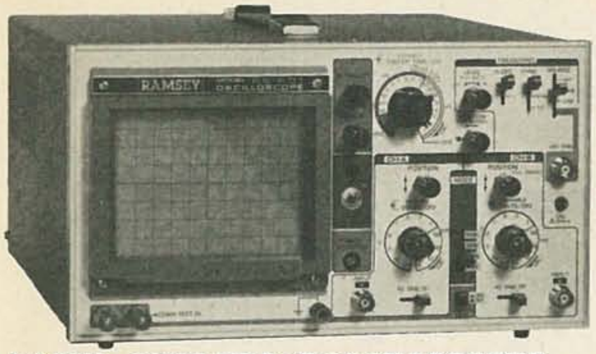

20 MHz DUAL TRACE OSCILLOSCOPE

Unsurpassed quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a component testing circuit for resistor, capacitor, digital circuit and diode testing. • TV video sync filter • wide bandwidth & high sensitivity • internal graticule • front panel trace rotator • Z axis • high sensitivity x-y mode • regulated power supply • built-in calibrator • rock solid triggering

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NEW

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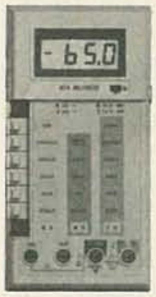

RAMSEY D-3100 DIGITAL MULTIMETER

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CT-70 kit $99.95
BP-4 nicad pack 8.95

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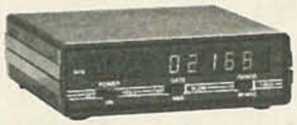
CT-90 kit $129.95
OV-1 0.1 PPM oven timebase 59.95
BP-4 nicad pack 8.95



CT-125 9 DIGIT 1.2 GHz COUNTER

A 9 digit counter that will outperform units costing hundreds more. • gate indicator • 24mV @ 150 MHz typical sensitivity • 9 digit display • 1 ppm accuracy • display hold • dual inputs with preamps

$169.95 wired includes AC adapter

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A versatile lab bench counter with optional receive frequency adapter, which turns the CT-50 into a digital readout for most any receiver • 25 mV @ 150 MHz typical sensitivity • 8 digit display • 1 ppm accuracy

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Professional quality at a hobbyist price. Features include 26 different ranges and 5 functions • 3½ digit, ½ inch LED display • automatic decimal placement • automatic polarity

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DM-700 kit $99.95
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RAMSEY
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CIRCLE 70 ON FREE INFORMATION CARD

CIRCLE 75 ON FREE INFORMATION CARD

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