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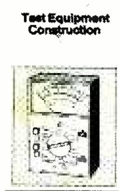

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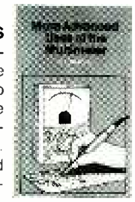

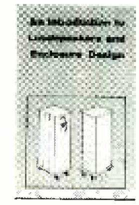

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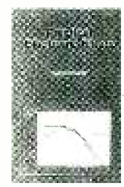

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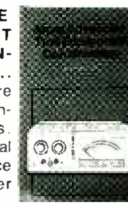

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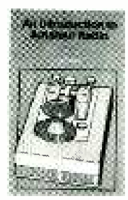

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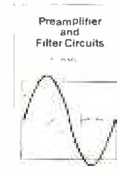

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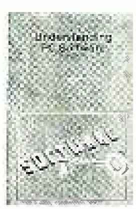

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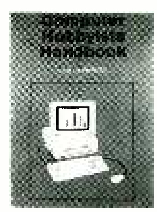

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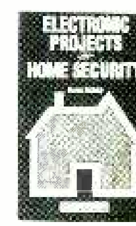

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JUNE 1992, VOLUME 9, NO. 6

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EDITORIAL

ELECTRONICS AND THE AUTOMOBILE

It's getting more and more difficult to think of the car as a mechanical device. Six years ago, the car contained about $500 worth of electronics. Today cars—which have computers faster and more powerful than those in the Apollo rockets that went to the moon—contain about $1000 worth of electronics. At the turn of the century, that figure should double to $2000.

Despite the dramatic improvements that electronics has brought to our cars—from anti-lock brakes to increases in fuel economy—there's lots more to come. Electronics doesn't have to be limited to the automobile itself; it can dramatically improve our roads, too. That's the idea behind IVHS or Intelligent Vehicle Highway Systems.

IVHS promises several benefits. Imagine always knowing where you are even on unfamiliar roads. Imagine never having to worry about collisions with other vehicles because of IVHS collision avoidance systems. Imagine travelling at speeds higher than today's speed limits—during rush hour.

Building IVHS will take a great deal of engineering know-how. But engineers can't build IVHS by themselves. In fact, much of the technology that could make our roads and vehicles far safer and far more efficient—and more intelligent—already exists. But unless the government is willing to invest in an IVHS infrastructure, simply having the technology won't help.

In 1990, a mere $4 million was invested in IVHS. Although that jumped to $20 million last year, it's simply not enough. Even with the current recession and our huge budget deficit, we should spend more. Why? Because the return on the investment will be so great.

Intelligent highways will save time. Saving time will, of course, save money. (It's estimated that delays caused by highway congestion costs each of the 12 largest metropolitan areas more than $1 billion each year.) But IVHS doesn't stop at saving time and increasing productivity. Efficient highways also save energy and reduce pollution. And those, in turn, save money, too.

It seems to us that spending money on IVHS is a smart investment. Not only will we get an efficient transportation system out of the deal, we'll also have a way to put to work all of the talented engineers who are now out of a job because of reduced defense spending. If there was ever a true win-win situation for the U.S., IVHS is it.

Chris F. O'Brian

Chris F. O'Brian
Gizmo Editor

LETTERS

PA-SYSTEM PRIMER CORRECTION

Sam Allen's article, "A PA-System Primer" (**Popular Electronics**, February 1992) brought back memories of years past. I have worked on many systems such as the Miami Beach Convention Hall (on the original construction), the Edenroc Hotel, several schools, hospitals, power plants, and even an insane asylum.

There was a big error in the article, which said that connecting a load between the 4-ohm tap and the 16-ohm tap would find an impedance of 1.4 ohms. Wrong! The 4-ohm tap of the transformer is the center point of the 16-ohm winding, so the impedance between those two taps is 4 ohms. Connecting a 2-ohm load there would result in a great loss of power, distortion, and, on a solid-state amplifier, possible overload and damage to the output transistors. An older, tube-type amplifier would distort, but would probably not be damaged.

D.E.
Hendersonville, NC

Thank you for taking the time to share your thoughts about my article. And thank you for spotting the error that slipped past my proofreading. The connection should be made between the 8-ohm and the 16-ohm tap. The connection was shown correctly on an illustration that I submitted with the original article, but that illustration unfortunately was left out of the printed version due to lack of space.—Sam Allen

WHAT MAKES AN ENGINEER?

Although I missed the September 1991 issue of **Popular Electronics** in which Harry Treitley's article "What Do Electrical Engineers Do?" appeared, I'm compelled to write after reading the commentary about it in the February 1992 *Letters* column.

Frankly, I couldn't believe JDS of Seaford, NY. Either he's unhappy with his career or with some aspect of his work. As well-tenured as he says he is, it would seem he regrets his past 14 years, and for that I am truly sorry.

It's my experience that there is something inherent in what's needed to master any profession, including engineering. For example, one doesn't invest many years to earn an MFA and then say he's an "artist." He may know what art is and its value, but to say that knowledge results in "artisanship" stretches the truth. Many of us have the training, but how many the *talent*? How many tinkered with junked TV sets (and repaired them) before puberty? Clearly, there are psychological factors at work.

Unfortunately, some "institutions" capitalize on this, and the result is that we have "graduates" with little talent calling themselves engineers simply because they have a diploma. Recent educational statistics show that about 60% of graduates have poor reading and math skills. The numbers are discouraging to the engineering sciences and those seeking a career there.

I agree with Mr. Treitley on several points. If anything could be added, I'd say that engineers must have not only solid educations but also elements about them that were fostered and supported long before college. The letter from that 14-year-old in Canada is one such example. But it is both sad and frightening that JDS is supporting that interest in his own children.

While we are faced with a recession and other fiscal woes, most engineers and managers are aware that salaries have fallen short of inflation. At the same time, good engineering *talent* has always been hard to find and keep. There is, in fact, a shortage—despite the fact that engineering positions have become over-specialized.

My point is, if you've gained some notoriety for the finely-honed skills you possess, the matter of salary ceases to be an issue. Of course it will take hard work and maybe years of experience, but talent always bypasses the leveling-out of salaries. But that also requires use of your imagination, intuition, sense of creativity, and problem-solving abilities, which are stretched to their limits. Those qualities are what many employers pay top dollar for.

So if you want to enter this field, keep those things in mind. Be careful about the schools you choose. Above all, learn all that you possibly can about the world around you.

P.J.S-E
San Diego, CA

SPEAKER-PROTECTOR CORRECTION

In the article "Build a Speaker Protector" (**Popular Electronics**, March 1992) there is a mistake in Fig. 1. In the schematic, relay K1, right-channel contact set the connections to the common (wiper) and normally closed (upper) contact are shown reversed. As drawn, as soon as K1 pulls in you have a dead short across the right output.

R.D.A.
Hialeah, FL

OHM, MIGOSH!

I recently broke a small variable resistor accidentally, and I noticed that the resistance element greatly resembled the ohm symbol (Ω). I thought that was an interesting, and useless fact. Thanks for a great magazine!

D.C.
Temple, TX

WHERE'S THE BEEF?

I have a beef I would like to share: I'm finding more and more projects in the popular press that require the purchase of a special part from a particular company in order to be completed. The fact that most readers can accomplish the project only after an outlay of cold cash to "Z Company" detracts significantly, in my view, from the value of the article.

Also, the current plethora of static-electricity machines in several electronics magazines gives me the feeling that authors are trying to reinvent the wheel.

To end on a positive note, I find many interesting and useful articles in **Popular Electronics**. I guess I'm just old enough to find some of the current material to be old hat.

W.T.R.
Seattle, WA

We strive to present projects that use only readily available parts. However, some projects require the use of special purpose IC's to either function properly or to keep construction costs down. Unfortunately, while such parts are readily available through industrial channels, they can be nearly impossible to find through those few companies that are still willing to sell one IC at a time to a hobbyist. Rather than scrap an otherwise worthwhile circuit, in those instances arrangements are made to secure a reliable source of those parts at a reasonable cost.

In a few much rarer instances, we have published projects that use either a proprietary component or proprietary software. That's done when the project does something at a far lower cost, or in a far better way, than other similar projects or products. It is not something we are comfortable with, but we feel it is better than not publishing the project at all.—Editor

WE WANT LETTERS

We want your opinions about what appears in these pages and what you would like to see. Please write to us at: **Popular Electronics,** 500-B Bi-County Blvd., Farmingdale, NY 11727. ■

JUNE 1992

GIZMO®

A CHRONICLE OF CONSUMER ELECTRONICS

VOLUME 5,
NUMBER 6

The Road to Tomorrow

A look at where electronics in the automobile will take us.

A couple of summers ago, while on a West Coast vacation, we happened upon the Oregon Country Fair. Not your typical cattle judging and bake-sale type of fair, the annual event is a free-flowing collection of arts and crafts booths; demonstrations of solar devices, geodesic dome living, and various ecologically friendly technologies; chemical-free foods; and plenty of long hair, bell bottoms, incense, and, of course, music. The fair is organized by an extended family of hippies, living in a commune. For anyone who lived through the 1960's, and particularly those of the "Woodstock" generation, it was a trip down memory lane. On the long walk back to our car, we even spotted one of those old school buses, painted in "psychedelic" flowers and peace signs and obviously serving as someone's home as well as transportation. After a moment, we noticed a satellite dish mounted on the back! That dish jerked us abruptly back to reality. We were entering the 1990's, and we were reminded how much had changed since the 60's.

While you might not see many vehicles sporting satellite dishes, there have been significant automotive advancements in the past few decades. There are cars and vans on the road today that boast all the electronic comforts of home—televisions, VCR's, phones, and incredible audio systems—and others with all the electronic necessities of the office—PC's and fax machines. Soon to come to these shores (translate: already available in Japan) are voice-controlled audio and navigation systems, and sunroofs that are actually transparent solar cells that provide power to top off your battery charge or to drive a vent to keep the car cool when it's parked in the sun.

Car stereo has taken on a life of its own. Although AM/FM/tape decks are virtually standard equipment on new cars, the aftermarket autosound industry is going strong even in a recession. You can equip your car, truck, or van with CD changers, receivers with built-in karaoke, digital signal processors, DAT players, power amplifiers, subwoofers, and extra speakers. In fact, enough people have boosted the decibel levels of their auto sound systems that several states have enacted noise-control legislation. (In New York, repeat offenders face increasingly steep fines and possible license suspension or revocation.)

Car manufacturers, noting the strength of the automotive aftermarket are now offering very competitive systems. Ford has teamed up with JBL, General Motors (Delco) has teamed up with Bose, Chrysler with Infinity. The same holds true for foreign manufacturers.

Even cars that boast no add-on electronic gadgets carry an average of almost $1000 worth of electronic gear, an amount that's expected to double by 2001. In today's car, even analog dials depend on information obtained electronically, as do digital displays, air bags, automatic climate controls, antilock brake systems, and cruise control systems. Seats, windows,

TURN PAGE FOR CONTENTS

This month in GIZMO®

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door and trunk locks are all electronically controlled in luxury cars, and as option packages in most other cars.

The electronics in tomorrow's cars will go beyond comfort, convenience, and safety controls. The "smart" cars of the not-too-distant future are expected to be able to sense, and warn drivers about, dangerous obstructions and annoying traffic jams on the road ahead, to be able to adjust their suspension according to road conditions, and even to help drivers parallel park. In a sense, the evolution of electronics in the car may mimic the changes that the airplane went through as it changed from a mechanical device with some electrical parts to more of a solid-state device whose mechanical parts are useless without electronics.

This month, **GIZMO** takes a look at what's new, and what's upcoming, in car electronics. We'll describe some of the latest advances and preview things to come—traffic warning systems, anti-collision radar, voice control, and electric cars. Then we'll take a look at several gadgets that you might want to have installed in your car today.

While airbags, which rely on sensors to trigger the bag's inflation, and anti-lock brakes, which sense when a wheel is about to stop too abruptly, are becoming standard in an increasing number of cars, new safety features are being introduced. One is traction control, which works in the opposite way as anti-lock brakes, activating when the tire is about to spin too fast. It's intended to prevent your car from skidding out, or "fishtailing" on slippery surfaces, and to provide smooth acceleration even on icy roads. Designed particularly for rear-drive vehicles, a traction-control system senses when a rear wheel is turning faster than the front wheels and automatically applies enough braking force to bring it back under control. If it senses that both rear wheels are spinning, it actually reduces engine power by throttling it back or by changing its spark timing. Although limited-slip differentials, which have been around for some time, tried to do the same thing, electronic control promises to do it much better. Several luxury cars currently offer traction control, but it's still priced too high for the mass market.

A different type of sensor is used in BMW's electronic "curb feelers." Object sensors mounted in the bumpers recognize when you come too close to a curb, a pole, or another car, and sound an alarm. Available only in Germany, the system costs about $650.

A horrible traffic accident that occurred in California last autumn—when a sudden dust storm totally obscured drivers' vision on a major highway and resulted in a huge car and truck pileup and several fatalities—might have been avoided if collision-warning systems were available.

Why not put that sunroof to work? Here Sanyo demonstrates their see-through solar-panel sunroof that helps to keep your car cool by powering vents while you're parked.

Several such warning systems are under development. One, expected to be marketed later this year by VORAD Safety Systems Inc. of San Diego for about $1500, is a radar system that operates on the same band as police radar guns. A small, domed antenna, mounted in the car's grille, scouts road conditions ahead and a compact computer evaluates the data to determine if a collision seems imminent. Both an alarm and a dashboard light warn the driver of the danger. The idea is that in many cases even a one-second warning can prevent an accident. The VORAD systems also acts as like an airplane's "black box" to provide an event recorder that can be used by police to reconstruct an accident.

GM is working on a "near proximity warning system" that mounts on the rear bumper and detects the presence of moving objects. It not only helps when backing out of the garage, but should also monitor the driver's "blind spot."

Another warning system depends on "smart streets:" Intelligent Vehicle/Highway Systems, or IVHS's are traffic-management systems that keep track of cars on the road, perhaps showing drivers the least-congested routes.

One vision is an automatic-guided highway system that would send signals to the car's computer via a metal track embedded in the highway. The car would be under complete computer control. Inter-vehicle spacing would be maintained for both safe and efficient travel, and expected speeds would be high. Planners theorize that because the computer-controlled highway would be so efficient, a single lane in each direction would be all that is necessary.

Other visionaries see an approach where the car, instead of the highway, is intelligent. "Vision steered radar" would process images from a camera to find lane boundaries and curvature.

Don't expect to see any of those scenarios soon. A better idea of what our cars and highways will be like at the turn of the century might be gleaned by looking at some of today's IVHS test projects.

In Germany, Sieman's Ali-Scout system handles traffic management and navigation. The systems relies on infrared transceivers in the car and mounted along the highway. The "beacons" along the road pick up information from a car as it passes—its speed, direction, destination, etc.

Here in the U.S. several IVHS projects are being tested. One is California's Smart Corridor Demonstration project, which integrates traffic sensors, computers, and communications links to coordinate traffic and give drivers information for the Santa Monica Freeway and five major arterials between downtown Los Angeles and the San Diego Freeway.

Keeping up with the aftermarket. Ford offers DSP technology—the latest craze in car audio—in the epitome of the American familiy car, the Taurus.

The most ambitious project in the U.S., also in California, is the Program on Advanced Technology for the Highway or PATH. It's envisioned that, eventually, conductors embedded in the roadway would inductively couple energy to the vehicle either to drive it directly or to recharge its batteries.

The largest obstacle to IVHS isn't the technology—much of the technology already exists. Rather it's the immense costs of building the necessary infrastructure. It's not that such spending wouldn't buy any tangible benefits. It's estimated that delays caused by highway congestion costs each of the 12 largest metropolitan areas more than $1 billion each year. The reduced pollution would also have economic benefits, as would the reduction in consumed fuel. Even so, U.S. government funding for IVHS was a mere $4 million in 1990 and $20 million in 1991. Now that the Cold War has ended and the world has changed so dramatically, perhaps a public-works project of this scale would be the perfect place to put to work all of those highly qualified engineers and technicians who have lost their defense-industry jobs.

Digital mapping technology—essential to IVHS—is used on a much smaller scale in car-tracking systems. The Lo-Jack system, available for about $600 in select areas of the country, places a small radio beacon in a car. If the car is reported stolen, the police can use special tracking equipment to trace the vehicle. Of course, the widespread use of this type of system depends on police departments' ability to buy the necessary gear. Another such system, marketed by International Teletrac Systems (Inglewood, CA) also features radio transmitters hidden in cars, but uses its own network of receiving antennas to automatically track any car that is started without its normal ignition key. Hot-wiring or other tampering with the ignition causes the transmitter to alert the Teletrac center, which uses a computerized grid system of maps to track the car's location, and passes that information on to the local police on a minute-to-minute basis. Teletrac, which carries an initial cost between $600 and $700 and a monthly fee of about $15, also provides a "roadside assistance"

(Continued on page 89)

Let Blaupunkt be Your Copilot

TRAVELPILOT VEHICLE NAVIGATION SYSTEM. Manufactured by Blaupunkt Bosch Telecom, Robert Bosch Corporation, Mobile Communications Division, 2800 South 25th Avenue, Broadview, IL 60153; Price: $2495.

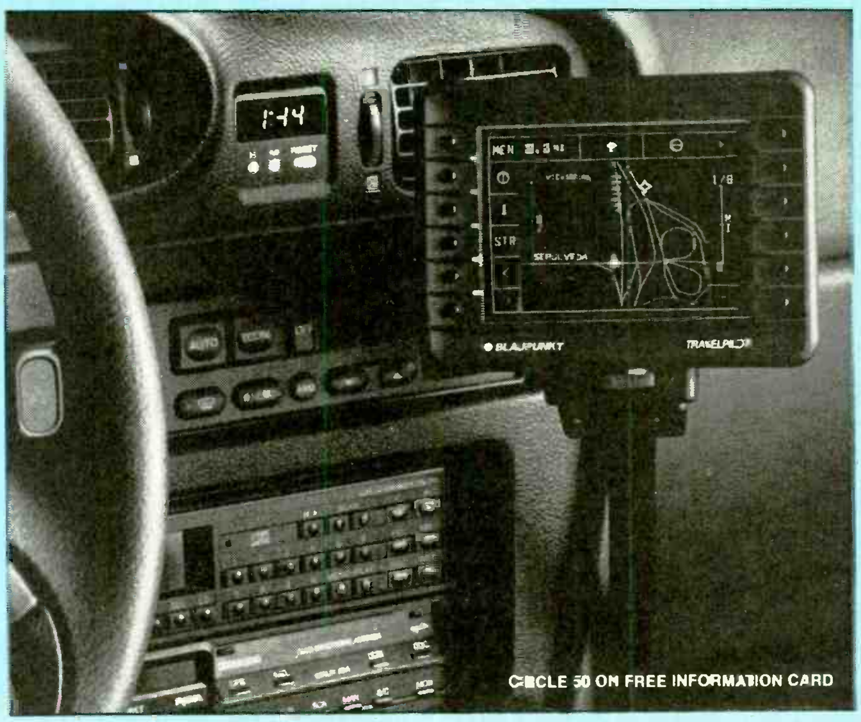
Your last service call took twice as long as expected, and now you're running late for the next one—a new customer, to make matters worse. The directions you were given are convoluted at best, and it's in an unfamiliar part of town. Now you're driving around in circles, teeth clenched, way behind schedule, worried about bad first impressions, and trying to simultaneously read the directions, a crumpled road map, and street signs simultaneously.

Your cousin is getting married in a candlelight ceremony in his bride's parent's home, 300 miles away. Despite delays from road construction, you've made it to the town with a couple of minutes to spare. Now you're headed down the main thoroughfare (speed limit 50 mph), from which the directions instruct you to "make a left turn onto Williams Street after about a half a mile." Unfortunately, the only street signs are unlit, too small to read from more than 10 feet away, and located directly at the intersections. The odometer says you've already traveled 6/10's of a mile—have you missed your turnoff? (And the wedding ceremony?)

Anyone who drives, for a living or just to get from place to place, has experienced moments like those. Whether you're lost on the way to a doctor's appointment, a job interview, or a social engagement, it's a stressful situation—and the traditional "helps" often cause still more frustration. Well-marked streets are a rarity, fold-out maps are unwieldy to use while driving, and books of maps require frequent page-turning to follow your course. And straining to read the small print on a street sign—or trying to determine both where you are and where you're headed on a printed map—while driving is a dangerous proposition.

Blaupunkt offers a safe, convenient, self-contained solution to all of those problems. Their *Travelpilot* navigation system not only places detailed local street maps or long-distance road maps on an LCD screen, but also displays the location and direction of your vehicle, the location of your selected destination, and the distance between the two. The moving-map display changes continuously as you drive—the entire map actually rotates in response to any turns you make. That means you can clearly see precisely where you are at any given moment—an arrow-shaped cursor represents your car—and how much further you must travel. The display can be mounted in the dash or on a goose-neck swivel base so that it can easily be viewed by the driver or the passenger.

The Travelpilot uses a "dead-reckoning" system, in combination with CD-ROM-stored maps and map-matching software, to keep itself, and you, on the



CIRCLE 50 ON FREE INFORMATION CARD

right course. A small computer equipped with a CD-ROM player is stashed in the trunk or under a seat. Digital data is supplied by Etak, Inc. of Menlo Park, CA. Each of their CD-ROM disks contains detailed maps of the specific metropolitan area as well as a complete map of all U.S. interstate highways. An electronic flux-gate compass mounted in the rear window and sensors mounted in the vehicle's wheels (one on each side of the car) are used to plot the vehicle's movement in relation to those digital maps. As the car makes a turn, sensors detect that one wheel has traveled farther than the other; from that information, both the distance and the direction are obtained. The direction and distance data from the compass and sensors are compared with digital data on the map discs, and the results are shown on the 4.5-inch, monochrome, moving-map display.

The Travelpilot is self-contained; it is not dependent on satellite signals, LORAN equipment, or radio transmitters and does not entail any user fees. It is also quite sophisticated. You can opt between maps of different scales. The screen can zoom into a ⅛-mile close-up or out to a 30-mile wide view. Other map scales are ¼, ½, 1, 2, 4, 8, and 15 miles. The Travelpilot allows you to input the general vicinity or exact address of your destination, which is then indicated on the map by a star. Can't make out the words on a street sign? The Travelpilot displays street names on command.

But before you run out to buy a Travelpilot, keep in mind the system's two major requirements—you must live near one of the major metropolitan areas for which maps are currently available and you must have deep pockets to afford almost-$3000 (including installation) price tag for the system. The locale requirement is getting easier to meet all the time: Etak recently introduced four new CD-ROM maps covering East Coast cities (New York, Boston, Philadelphia, Providence, Baltimore, Washington DC), Southwestern cities (Albuquerque, Houston, Dallas/Ft. Worth, New Orleans), Southeastern cities (Atlanta, Memphis, Jacksonville, Tampa/St. Petersburg, Orlando, Miami/Ft. Lauderdale), and Midwestern cities (Chicago, Milwaukee, Springfield, Detroit, Lansing, Minneapolis/St. Paul, Cleveland, Cincinnati, Columbus, Lexington, and Louisville). Their original West Coast cities disc covers San Francisco, Oakland, Los Angeles, San Diego, Las Vegas, and Honolulu. Each $100 disc also covers the surrounding suburbs and rural areas (although there is not always full coverage of some outlying areas) and includes a complete map of all U.S. interstate highways—a truly impressive amount of data. In terms of cost, Blaupunkt is quick to

The Blaupunkt Travelpilot looks deceptively complex. It's actually surprisingly easy to use.

point out that the first cellular phones had higher price tags than the Travelpilot. At this point, as far as consumers are concerned, the Travelpilot is still a rich man's toy. However, for such businesses as trucking companies and limo services, or for any individual who depends on a car for his living, it could pay for itself in no time. And the Travelpilot is being used in several cities by fire departments, electric companies, and ambulance services. Of course, prices are expected to drop as sales increase.

Here at **GIZMO**, we had no problem with the first requirement: Long Island, our home base, is covered by the East Coast cities disc. Price is another matter. Fortunately, we were able to borrow a Travelpilot-equipped Jaguar from Tom Sunkin, owner of Audio Mobile, an authorized Travelpilot installer located in Deer Park, NY.

Limited to four hours, our test drive route took us from the middle of Long Island out to the end of the North Fork, about 130 miles round trip. That short jaunt included travel in towns, on highways, in rural areas, and even on dirt roads.

The system is quite easy to use. In fact, we had a harder time getting used to the climate and radio controls in that unfamiliar car than we had using the high-tech Travelpilot. We didn't have a manual on hand during our test drive. A short demo before leaving Audio Mobile got us started. When we got into trouble, built-in on-screen help got us back on track.

For safety's sake, the help screens and several other functions reached via the main menu can be accessed only when the car is stopped. To enter a location (which is one of those things you can't do while driving), you can select either region/city, single street, intersection, or street address, depending upon how much you know about where you're going. By typing in the first four or five letters of the street—for example, "W-A-S-H"—a list of possibilities is generated: Washburn Ave., Washington Ave., Washington Street, etc. After the correct one is selected, the numerical address can also be entered. The destination (as long as it is within 30 miles) appears on the map as a star symbol, and the distance and direction is displayed at the top of the screen. At least 32 destinations can be stored in memory; previously stored destinations can be recalled at the touch of a button. (The first time you use the Travelpilot, you might also want to select the type size in which street names will be displayed, the language to be used, and whether distance should be displayed in miles or kilometers.)

The Travelpilot comes on automatically when the ignition is turned on, and the map shows the location of the vehicle when it was last turned off. Six buttons running down each side of the screen are used to control all functions; on-screen icons serve to remind us of their functions. We weren't quite sure about the "?" icon, but soon discovered that it stood for "information": When it's we pressed, the present position and the destination are automatically shown on a map selected for optimum scale for the distance, and the name of the destination is displayed for a few seconds at the bottom of the screen.

By the time we'd gotten nominally acquainted with the controls, we were raring to go. We struck out on the Long Island Expressway, and were amazed to see every exit appear in real life just as the on-screen cursor reached it on the map. Actually, for accuracy's sake, we should say "when the on-screen intersection reached our cursor" because it's the map, not the cursor, that moves. At each bend in the road, the map shifts so that the top of the map is always the direction in which we're headed. There aren't many twists or turns on the LIE, however. We'd heard that the system, which relies on information about turns to keep on track, sometimes gets hung up a bit on long, straight stretches of highway, but we didn't experience any difficulty at that point.

Since it's difficult to get lost on the LIE, we decided to exit at a road we'd never driven before, even though it meant going away from our intended destination—and even though that sort of maneuver inevitably gets us hopelessly lost. That wasn't the case with the Travelpilot. Not only could we see exactly where we were in terms of both the LIE and our ultimate destination, but we could track our progress as each street we passed was clearly marked on our display. (To avoid crowding the screen, not every street on the map is labeled at once; pressing the *str* button calls up different sets of street names.) We immediately realized what that could mean at rush hour on the LIE, a road that's been nicknamed "the longest parking lot in the world." We'd be able to take side roads without worrying about getting lost, and then find our way back to the main road at some (according to radio traffic reports) less-crowded point.

We opted instead to turn off on a different road heading northeast (back on the trail to our North Fork destination). As the surroundings became increasingly rural, we were quite impressed to see that even dirt roads were displayed (with dotted lines and without street names) on the Travelpilot map when it was in one of its local (small-scale) modes. When we switched to the 30-mile map, the result was disconcerting. At that scale, only highways and their exits are shown. Out on the eastern end of Long Island, that meant that the area between the LIE and I-95 in Connecticut was blank, except for the arrow representing our car! There was no indication of the Long Island or Connecticut shoreline or the Long Island Sound.

Switching back to a smaller scale, we realized that the system had gotten slightly off track and needed to be repositioned. That problem is known to occur when the vehicle is transported by tow truck or ferry or is driven for long periods in areas not covered by the map database, on ("invisible") side roads when the map is in its 30-mile mode, on long stretches of straight roadway, and in large parking lots. Whatever caused our mistracking, setting it right was easy enough, particularly considering that we didn't know previously how to do it. We simply drove to an intersection, stopped the car, used the help menu, and then moved the cursor to that position on the ⅛-mile map, using the arrow keys on the "reposition" help screen. Smaller corrections can be made while driving and are sometimes necessary to keep the system on track.

We have heard reports of 15-year-old housing developments that were missing from the map database, but we didn't encounter anything like that during our admittedly short test drive—except that the six-year-old street on which the main **Popular Electronics** offices are located wasn't included. Otherwise, even developments that appeared new were shown.

Etak plans to make upgrades available as needed, and has much more in store for Travelpilot users. Starting this year, EtakMaps will include business-listing information for hotels, restaurants, service stations, and points of interest. By the end of 1993, the company plans to introduce enhanced map databases that will cover the road network of 40 major metropolitan regions (an area whose combined population is more than 100 million) and will include such tourist and traffic information, such as one-way streets and no-left-turn intersections. They're also expecting to include Yellow Pages listings, so you could locate a restaurant on the map and on your way there use your cellular phone to make a reservation. We wouldn't be surprised if the potential advertising reduced the cost of the disc to essentially free. In addition, the Travelpilot's built-in RS-232 interface—which now allows the system to be connected to radio-dispatch systems—will in the future allow it to be integrated to navigation and traffic-avoidance systems based on Global Positioning Satellites (GPS) or intelligent vehicle/highway systems (IVHS) technologies. That should eliminate the need to ever manually reposition the vehicle—and the fear of spending a lot of money on a technology that will soon become obsolete.

Even without all those future promises, the Travelpilot is a worthwhile device simply for stress reduction and peace of mind. For anyone whose livelihood depends on traveling from place to place, it could be invaluable. Having extremely poor senses of direction, we would *love* to have one in our car. Maybe, one day, we will—when the price comes more in line with our bank accounts, that is. ■

Electronic Car Keys

REMOTE KEY CAR-CONTROL SYSTEM. Manufactured by: RACE, Inc., 5310 Finch Avenue East, Unit 8, Scarborough, Ontario, M1S 5E8, Canada. Price: $800 plus installation.

CIRCLE 51 ON FREE INFORMATION CARD

Even though the cover date on this issue makes us think of the beach, flowers, and even mosquitoes, we're writing this in the middle of winter. We don't complain too much about the cold weather. But that's because, as a rule, we don't have to be out in it if we don't want to be. There are only two times when cold weather really gets to us. One is when our home heating-oil bills arrive. The other is when we have to get into our car on a cold morning and head off to work.

On the worst of those cold mornings, we'd run out of the house a little ahead of schedule to start the car and turn on the defroster to make it a little easier to scrape off the windows when we were ready to go. Doing that had a couple of drawbacks. First, we'd get pretty cold just running out to the car to start it. Second, we needed a second key for the car so that we could keep the doors locked, to avoid having it stolen out of our driveway while the engine ran.

Imagine, though, if you could start your car on a cold winter morning as you have a last cup of coffee and finish reading the paper at your breakfast table. Imagine that you could turn on the heat and rear-window defroster so that by the time you were ready to go, the car would be, too. Imagine that a would-be thief would not only set off your alarm system and "page" you to alert you to a potential problem, but also would cause the engine to shut off.

We don't have to imagine any longer. We just had the *Remote Key* installed in our 1988 Mazda 626. The Remote Key is manufactured by a company called *RACE, Inc.*, a clever acronym for Remote Automation and Control Electronics. By adding a convenience that neither Detroit or Tokyo has yet addressed, we instantly updated our car to something that is the envy even of people driving their new '92 models. It almost feels like we're driving a new car.

The Remote Key can be installed in almost any car with automatic transmission. (But putting it in a car without a healthy amount of power accessories doesn't make much sense.) Installing the Remote Key is not a simple matter, however. RACE says that it should take about four to six hours to install it in our Mazda. But since no RACE dealer was located in our area, we had to find an alarm shop that was willing to do it. Our installer, Mike Barnes of Speaker Street Sound and Security (Commack, NY), estimated that the installation would take more than twice that long—at least the first time around.

We certainly weren't going to attempt to install the Remote Key ourselves. Even though we've had some experience installing car stereo systems, we didn't feel competent enough to handle the Remote Key installation. After watching the system being installed, we know we made the right choice. Finding a qualified installer is essential. The base unit—that is, the part of the Remote Key that mounts inside the car—needs to be connected to up to 38 points in the car. Virtually every electrical device in the car is affected. That includes the horn, power trunk latch, power windows, headlights, ignition switch, air conditioner, brake switch, door locks, and more. It's easy to do a lot of damage if you don't have full knowledge of your car's electrical system.

Our installer, a car security and audio professional who has a great deal of experience with Mazdas, mounted the base unit under the front driver seat, which was essentially the only place it would fit. Longer wire harnesses, which are available as an option, would have allowed us to mount the base unit in the trunk. The installation went relatively smoothly, if slowly. But it was not free of problems.

The manual was reasonably well written. But it was not as thorough as it should have been, and didn't take into account all possible configurations. We'll give a couple of examples.

The locks on all four doors are controlled by the driver-side door. When the key is turned, or the lock is manually operated, all four doors are locked or unlocked. In either case, the system depends on the actual movement of the driver-side lock. Remote Key, however, puts out a momentary signal to lock or unlock the door, which is compatible with the many cars that use a momentary switch for door control. We had to add an actuator to control the lock. The installation manual made no mention of that possibility.

For similar reasons, we also had to add a window-control module and three relays to complete the installation. Again, those possibilities aren't mentioned in the manual. For qualified installers, such customizing doesn't present much of a problem. But a less experienced installer would undoubtedly run into trouble, even though RACE offers help by telephone.

Although the system installation is difficult, using the Remote Key is rather straightforward. The controller is about the size of a pocket calculator, but with its spring-loaded pop-up lid, it looks something like the communicator used on the old *Star Trek* TV series. Under the lid is a twelve-button keypad and eight LED indicator lights.

To start things off, you first press the ON button, then enter a 7-digit security code and press the enter key. If you're within range of your car, the green ON LED will flash. If not, the red RANGE LED will blink. Turning the car on is as easy as pushing the ENG and ON keys in sequence. A push of the STAT key will give you the status of the engine, air conditioning, defroster, locks, and alarm.

It's likely that you'll leave the door locked when you start your car so that no one will simply get in and drive away. Even if you don't, however, you don't have to worry too much. First, without the key in the ignition switch, your steering column will remain locked. If someone still tries to drive away without putting the key in the ignition, they will be stopped the first time they step on the brake, for instance, when they try to put the car in gear. If you leave the alarm on, they won't even get that far—the engine will shut off as soon as they open the door.

The alarm has several operating modes. Fully armed, it will blow the horn, flash the headlights, and page the transmitter. If you like—since no one pays attention to blaring alarms anyway—you can turn off either the light or the horn function, and just keep the paging feature operational.

Regardless of how you set the alarm, you can control the horn and headlights from the keypad. You can blow the horn to help you find your car or to frighten away potential thieves. You can flash the lights to help you find your car, or hold the LHT button down to keep the headlights burning to light your way.

The range of the remote key is claimed to be 1000 feet, extending to 2000 feet under ideal conditions. We apparently never found ideal conditions—our maximum range in an unobstructed area was less than 750 feet, a little more than 1/10 mile. That was certainly more than adequate between our kitchen and our driveway. It also allowed us to start the car before leaving a local restaurant—as long as we were sitting at a table in the front and were lucky enough to have found a good parking spot, that is.

The toughest real-life test we put it through was when we went to a mid-winter hockey game. We figured that the remote key would help us at the end of the game by letting us get out of the parking lot not only faster, but in a warmer car. Things didn't work as we expected, however.

We parked the car in the large, quickly filling parking lot, got out, and started walking toward the Nassau Coliseum, intending to lock the doors and set the alarm on the way. But by the time we had entered our security code and locked the doors, we were out of range. We had to walk back toward the car to finish arming the alarm.

Installing the Remote Key is not a job for amateurs. Here our installer routes wires through the firewall. Note that the dashboard is partially disassembled and that the door panel has been removed to work on the power door locks and power windows.

We also had to alter the alarm functions because we knew that the paging feature wasn't going to do us much good from inside the building if it couldn't make it halfway across the parking lot! Apparently, the other cars and vans in the lot reduced the range dramatically. On the way out of the game, we started to head in the general direction of our car. We purposely didn't pay too much attention to where we parked on the way in because we wanted to see if the Remote Key really could help us find our car.

That, too, didn't work out well. As we walked, entering our code, the red RANGE light would flash telling us we were not in range. So we'd enter the code again. And again. (Nine key presses each time.) By the time we were both close enough, and had entered our code, we had walked past our car. In effect, the range was roughly equivalent to the other, one-way remote starters on the market, nowhere near the 1000 feet we were expecting.

The requirement of entering seven digits is a big drawback in convenience. RACE did it to increase security. (Would-be thieves often use 3-digit scanners to quickly find the codes of less-secure systems.) And seven digits aren't necessarily difficult to remember—phone numbers are also seven digits. Yet we would prefer to have the ability to set internal switches to automatically send out a personalized security code, perhaps along with three additional key presses. Such a set up would keep the system just as secure, while making it much faster and also more convenient to use.

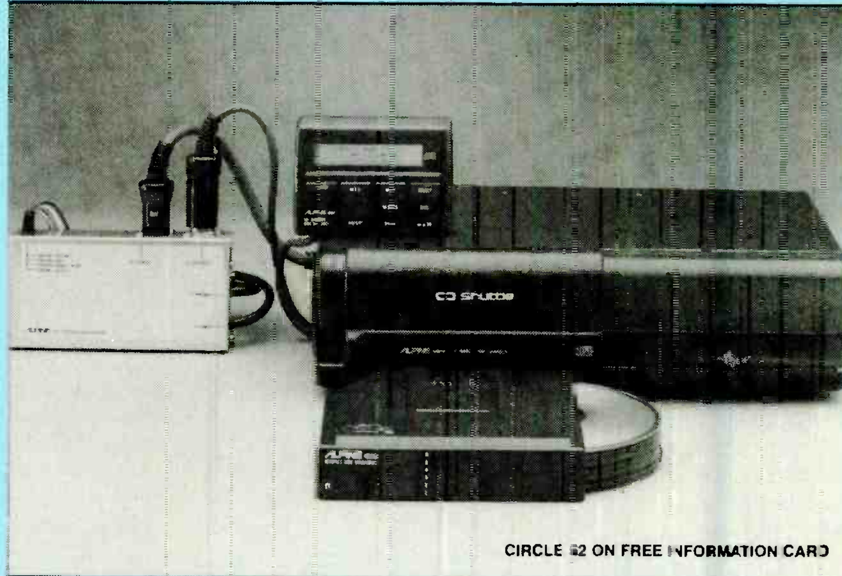
We'd also like to see a smaller controller. RACE says that their market research showed that people don't want a small controller because they're easier to lose. Well, our car keys aren't too big, and we don't lose them very often. And if the Remote Key were smaller, we'd be able to attach it to our keychain.

One other potential weak link in the system is that the security features can be overridden by the ignition switch. That's good in some respects. If you walk to your car without the handheld controller, you can still use your car key to operate the car as normal. The disadvantage is that a thief can bypass the Remote Key's security features by replacing the ignition switch. But then again, no security system that we've ever seen is going keep a determined thief from getting what he wants. And a security system that isn't convenient to use is the worst kind you can have because you're less likely to use it.

Despite our complaints, Remote Key is, indeed, an innovative product. That's why it won a Design and Engineering Award at the 1991 Summer Consumer Electronics Show. It has a host of features that we haven't yet mentioned. For example, it includes circuitry to protect the starter motor from accidentally re-engaging when you insert your ignition key. If the motor idles too high (3000 rpm) the engine will be automatically shut off. It will also shut off after a maximum idling time of 15 minutes—and page you to let you know. It has a safety function that doesn't allow you to start the engine if the hood is opened, and will automatically shut off the engine if it's opened.

But whether you'll be happy with it depends on what you need it for. To start your car from your breakfast table in a suburban area, it will probably do fine. In urban areas or in large, crowded parking lots, its range decreases. RACE offers an optional trunk-mounted external antenna that might eliminate our major complaint with the system. We hope to have the opportunity to try the antenna out for ourselves and report on its performance in a future issue of **GIZMO**.

In the meantime, we're looking forward to summer, when we can use the Remote Key to control our air conditioner instead of our defroster. At this time of year, it's a nice thought. ■



CIRCLE 82 ON FREE INFORMATION CARD

Alpine CD'ing

ALPINE 5951 CAR CD REMOTE CHANGER SYSTEM. From Alpine Electronics of America, Inc., 19145 Gramercy Place, Torrance, CA 90501. Price: $620.

Although the compact disc has been around for a full decade and is by all accounts a dramatic success, it's been slow to penetrate the automotive world. That's not to say that it hasn't made a dent. Even Detroit offers in-dash CD players. (Ford was the first, in 1985, with a limited quantity in luxury cars.)

As we see it, in-dash CD has its problems. We like our cassette player in the dash—and we don't have room to mount both a cassette unit and CD player. Cassettes are a sensible format for the car. They're easy to handle, they're not affected by vibration, and, in the car, we don't find their limited dynamic range or tape hiss to be a serious problem—regardless of what some purists say.

CD's, on the other hand, are difficult to handle—it's virtually impossible to open a jewel box using only one hand—and vibration can lead to problems. Even so, we do love CD's. We buy virtually all of our pre-recorded music on disc, and we love the fast access time of the discs. But can the cassette, the CD, and the car cohabit sensibly and conveniently? After having the opportunity to put *Alpine's 5951 CD Shuttle* remote changer system through its paces, we know that the answer is a resounding "yes!"

The 5951 gives everyone who currently has an AM/FM stereo in his car the ability to upgrade to CD-changer capability with a relatively simple installation. The 5951 can be added to virtually any car-audio system because it modulates the audio from your favorite CD's onto an FM frequency of either 88.3 or 88.7 MHz—it becomes, in effect, another radio station. That means that it doesn't require a line-level input, a feature missing on many older car receivers. The changer is intended to mount in the trunk or other remote location; you pre-load it with up to six discs before you set off on your drive.

The "unfortunate" result of translating CD audio to FM is that the result is only as good as your current FM audio system. And the quality of FM at its best is a distant second to CD. But we do most of our automotive listening when we're driving—not at a sound-off competition, or while parked outside the 7-11 on the strip trying to show off for our buddies. We don't want to imply that there's no truth to the claims of car-audio enthusiasts and high-end advertisers, but if there's any place we can put up with a compromise in frequency response, it's in our car.

The factory-installed audio system in our Mazda 626 is a fairly mediocre one. Its tuner-and-cassette portion is as good or better than most OEM units, although its amplifier portion could use improvement. Although stock sound systems are unquestionably getting better each year, many of you probably have a similar sound system in your car, but don't want to spend the big bucks required to upgrade to top-notch sound. But we saw a couple of advantages to adding the 5951 to our system. First, the upgrade gave us CD compatibility—the feature we wanted most. Second, it let us upgrade our system piece by piece, which let us keep the apparent cost down. We can, at a later date, add a new, compatible head unit that will not only control the CD Shuttle, but will also let us connect the changer directly to the amplifier, instead of through the FM tuner.

The 5951 consists of two main units. The first is the 5952V CD Shuttle, Alpine's entry-level 6-disc changer. The 5952V uses 8 × oversampling. The DAC's used in the changer are hybrid 18-bit/1-bit converters. The combination of multi-bit and 1-bit technologies is said to take advantage of the best qualities in each, while overcoming the disadvantages of each. The results are CD changer specifications that include a dynamic range of 95 dB, a total harmonic distortion figure of 0.01% (1-kHz test signal), a frequency response of 5 Hz to 20 kHz (±1 dB), signal-to-noise ratio of 98 dBA, and channel separation of 85 dB (1-kHz test signal).

The second component of the 5951 system is Alpine's 5955 CD controller with FM stereo modulator. The modulator takes the audio output of the changer and feeds it directly into the existing system's FM antenna input. The FM antenna, in turn, plugs into the modulator unit, and is fed to the radio when the CD changer is switched off. A small control panel is used to power the system up and to control the functions of the changer. Because of the limitations inherent in FM radio, you are not able to take advantage of the changer's excellent specifications.

We chose to mount the changer in our trunk, under the rear deck, because it used our trunk space most efficiently. We don't want to give the impression, however, that the changer is large. It's actually one of the smallest on the market, measuring about 3 × 11 × 7 inches. The location we chose certainly wasn't our only option. Although it would certainly have fit with ease under a seat, we preferred not to mount it in the car's interior. In the trunk, we could have mounted the changer vertically, rather than horizontally. But in our car, the trunk floor isn't as rigid as we'd need to do so. Although we had a horizontal surface to which we could attach the changer, we could have tilted the unit as far as 30 degrees off the horizontal axis. The same goes for vertical mounting. Now *that's* mounting flexibility!

The changer connects to the modulator unit through a single, fairly bulky, cable with DIN connectors on either end. Our installer routed the cable under the rear seat, and under the door channels up to the modulator unit, which he tucked invisibly behind the glove box, securing it with wire ties. Since the modulator measures only 4¾ × 1¼ × 2⅜ inches and weighs just 7 ounces, that wasn't a difficult feat.

The modulator must be connected to the power and ground, and between the car's antenna and the receiver's antenna input. Other than that, setting two switches completes the installation. The first switch selects the output frequency of either 88.3 or 88.7 MHz. The other is a three-position (L, M, H) level switch, which is used to adjust the output level of the modulator. The idea is to set the level to sound like a good FM station, without distorting. The final step is to set the selected output frequency in our radio's station memory.

The "control panel," or controller, for the CD Shuttle plugs into the modulator with another DIN cable. We mounted it to our center console, using a supplied strip of Velcro. The controller measures about 2⅜ × 3¼ inches and is about ¾-inch thick. Unfortunately, our dash didn't offer any convenient, flat surface on which to mount the controller. The center console was a compromise that didn't provide the easiest access.

With the CD changer's power off, the radio operates as normal. We didn't notice any signal degradation with the modulator in-line. When you hit the POWER button on the controller, the modulator disconnects the external antenna and inserts its own signal. The controller's back-lit LCD is easy to read in all lighting conditions. The buttons, which light up when the power is turned on, were also easy to see.

Besides the power button, there are three other rocker buttons that perform two functions each. One selects which disc you want to hear and also serves as a pause/play control. A second rocker is used to search for the next or previous track, and also serves as an audible fast forward or reverse control. The third button lets you repeat either a single track or an entire disc, as well as play tracks in a random order. After all the tracks on a disc have been played once, the changer will play the tracks on the next disc in a random sequence. You cannot play tracks randomly across all discs, however.

When you turn the changer's power off, the radio returns to normal operation. If you're lucky, there will be a local station on the frequency that you've chosen for the modulator. If you're really lucky, the station is one that you enjoy. We were lucky on both counts. If there is no station in your area on either 88.7 or 88.3, you'll have to remember to lower the volume on the radio before you power down the CD changer, or you'll be rudely met with inter-station noise. When you turn the power back on, the changer picks up right where it left off—even in the middle of a song.

The changer mechanism uses air suspension, spring suspension, and rubber damping to protect the player mechanism from road vibrations. To say that it works would be an understatement. We could not make the changer skip, even with deliberate, repeated drives over railroad tracks.

Track-to-track access time was very rapid; disc-to-disc access was about 10 seconds, equivalent to many home cartridge-style changers. Even though we'd like to see all manufacturers adopt a single cartridge style as standard, Alpine's proprietary cartridge has some features that we liked quite a bit. First, there are no fold-out disc leaves to damage; discs are inserted simply by slipping them into slots in the cartridge. Second, discs are inserted label side up—now that makes sense!

We were interested in CD for our car primarily for its convenience. We were impressed, however, by how much it improved the sound of our factory-installed, stock sound system. And now that we've gotten a taste for car CD, we're beginning to wonder how good a non-modulated system would sound. ■

Alpine's 5952V changer not only makes installation easy—requiring only a single cable between the changer and modulator. It also can be mounted vertically or horizontally, or at angles as much as 30 degrees from perpendicular.

The World in your Car

PHILIPS DC777 AM/FM/SHORTWAVE STEREO CASSETTE RECEIVER. Manufactured by Philips Car Stereo International, 9600 54th Avenue North, Minneapolis, MN 55442; Tel: 1-800-328-0795. Price: $499.

The trend in car audio today is high-powered, multi-source head units that combine AM/FM reception with cassette decks and CD changers. Options abound in terms of add-on speakers, amplifiers, subwoofers, and digital signal processors. But one thing that isn't readily available is shortwave car receivers.

That's a direct result of the drive for hi-fi car audio. Back in the 1930's and '40's, shortwave wasn't all that uncommon in a car. As we became more interested in—and accustomed to—good audio, shortwave took a back seat to fidelity. With the problems inherent in shortwave reception—fading, interchannel interference, manmade noise, and unpredictable propagation conditions—there were better choices available.

At home, we're reasonably frequent listeners to the shortwave bands. Over the last couple of years, we've been joined by a lot of other people. Last year, shortwave radios saw record sales of more than 1.4 million units. A lot of that was a direct result of events in Eastern Europe, the Persian Gulf War, and the disintegration of the Soviet Union. Soon after the war ended, sales took a decided turn for the worse. Even so, growth appears to be slow but stable, thanks to new consumer awareness. Unfortunately, recent comers to the medium won't appreciate how strange it sounds to hear Radio Moscow talk about how many Russian citizens are in serious economic trouble. Seasoned listeners (like us) are still used to them telling us how the Soviet government guaranteed everyone not only a job, but a place to live. An unemployment rate of 0% was pretty tough to beat!

Having shortwave radio in our car is an idea that never really seemed practical to us. That is, until we got the opportunity to try the *Philips DC777* cassette receiver. The DC777 is no throwback to the 1940's. Besides being a shortwave receiver, it's also an AM/FM cassette receiver. It provides such features as an auto-reverse tape transport, automatic station-storing, and a 50-watt (total power into 4 ohms) amplifier. (Line-level outputs are also provided.) The unit, with its red backlit LCD and fold-out keypad, looks modern too, and has the features to prove it.

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Besides receiving the FM and AM (to 1700 kHz) bands, the DC777 receives shortwave frequencies from 3170–21,910 kHz. That broad range is broken down into eleven shortwave bands from 90 meters to 13 meters. To enter the shortwave mode, you press the front panel SW button. Each successive press of the button moves you up in frequency to the next band.

Because of the nature of radio-wave propagation, different bands are viable at different times of day. In the afternoon, for example, the 19-meter band (15,100–15,600 kHz) will generally provide good listening conditions. At night, however, you'll have better luck on the lower frequencies, for example, the 31-, 41-, or 49-meter bands. When you're in a given band, you can automatically search for stations in either direction.

Although the search function is certainly convenient, it's a good example of where the DC777 is not as user-friendly as it should be. Because of the nature of shortwave broadcasting, many of the stations that the tuner stopped at were either strong interference sources or foreign-language broadcasts. We found ourselves constantly leaning over to push the search buttons to find a station that we wanted to hear. If there ever was a radio that could really benefit from *scan* tuning, where the tuner stops for a few seconds on successive new stations, it's this one.

You may find yourself doing a limited amount of search tuning on the shortwave bands, however, because the DC777 offers 20 memory presets for shortwave. On the AM and FM bands, five memory buttons are used to store preset frequencies. On shortwave, however, four of the five memory buttons can store 5 frequencies each. The fifth button is used to switch between the different locations on each button.

Unfortunately, storing a shortwave frequency in memory was not as easy to do as it should have been. When you're driving and find a new station, you can't necessarily store it in memory without overwriting another location—unless you planned ahead of time.

If you're interested in tuning to frequencies between the major shortwave bands, you can enter a frequency directly. A fold-out keypad gives you two rows of buttons to do just that. The two-row keypad is not convenient to use, and we wouldn't recommend using it while driving. The keys are somewhat mushy, and if you mis-enter a key, you can't clear it or backspace over your error.

The AM and FM bands also offer a mix of user-friendly and user-unfriendly features. The front panel of the radio sports a single rotary control. Normally it's a volume control. But subsequent pushes of an AUDIO button allows it to control balance, front-to-rear fading, treble, and bass. Although it keeps the front-panel clutter down, that sort of control isn't the sort that's easy to use when you're driving. Fortunately, it's not likely that you'll have to use it often. The bass and treble settings for FM, AM and shortwave, and the cassette are stored independently, a great feature.

The DC777 also features an auto-store feature in which the five strongest stations on either the FM or AM bands are stored in memory—a convenience when travelling. When you use auto-store, you do not delete your other presets!

When we're driving through different areas, we have to admit that we don't normally use auto-store. We'd rather find a good but weak station than a strong lousy one. Philips has an interesting way of let-

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ting us find weaker stations, but one that we don't like. On AM and FM, search tuning starts off with a low sensitivity level. That is, it stops at only strong stations. Once you've scanned the entire band, the next pass will be at a higher sensitivity level. The third pass will be at the highest sensitivity level, meaning it will stop at weak stations. Even though it would mean an extra front-panel button, we would prefer to see a front panel LO/DX switch or something similar.

Using manual tuning to find stations isn't too convenient, either. First you have to hold down both search buttons until you hear a beep—about 2 seconds. Then each push of the button moves you either up or down in frequency. But, because the radio is built for European markets as well as for North America, each push of the tuning button steps the frequency only .05 MHz on FM or 1 kHz on AM. Because FM stations in the U.S. are spaced 0.2 MHz apart, you have to press the button 4 times to move to the next possible station. That increases to ten button pushes on the AM band.

The cassette portion of the DC777 is a fairly bare-bones auto-reverse transport. No noise-reduction circuitry is offered. One feature that we do like very much is that the radio becomes operational during fast-forward and rewind operation.

The DC777 does offer one feature that we've never seen before in a car radio: three timer memories. You can set the radio (assuming that it is turned on) to tune in up to three different stations every day at different times. The timer will switch stations or interrupt cassette playback at its appointed time.

This is a radio for people who truly appreciate that medium, and enjoy the variety of programming that is found only on the shortwave bands. Although we have a number of complaints about its ease of use, we don't want to give a negative overall impression of the receiver. Before we listened to the DC777, we had no idea that shortwave could sound so good. And using the shortwave portion of the DC777 was straightforward, even while driving. Anyone who enjoys shortwave should seriously consider putting it in his car. And anyone who finds himself driving anywhere there's a dearth of AM and FM stations will be able to feel in touch with the world with the DC777.

The DC777 is not a DX-er's radio, but that's just as well for its intended use. A car's ignition system will present trouble to any weaker station. And the effort and concentration that's required for DX-ing doesn't mix very well with driving. But its ease of use and exceptional shortwave sound might serve to introduce a new group of listeners to the pleasures of shortwave listening. ■

Stealthy Road Warrior

TRAPSHOOTER SOLAR STEALTH RADAR DETECTOR (RD-6000). Manufactured by Cobra Electronics Group, Dynascan Corp., 6500 West Cortland Street, Chicago, IL 60635. Price: $319.95.

The battle lines are drawn when it comes to radar detectors. On the one side you have a natural alliance of law-enforcement and highway-safety agencies and insurance companies, who would like to see all radar detectors banned outright. They argue that the devices are bought and used solely to break the law, and that their use causes dangerous driving maneuvers (abrupt decreases in speed) and an increase in traffic accidents. Insurance companies have even tried—unsuccessfully—to deny coverage to people who own radar detectors!

On the other side is a more eclectic group consisting of champions of personal freedom to monitor the airwaves, drivers who have been unfairly ticketed by police using inaccurate radar guns—and, of course, people who speed, and the radar-detector manufacturers (who are the founding members of the Radio Association Defending Airwave Rights, or RADAR). The radar-detector advocates adamantly support the use of radar detectors, defending their right to monitor all the radio bands. They argue that actual travel speeds are rarely within legal speed limits, that traffic fines are simply another form of state taxation, and that the radar guns used by police are unreliable.

It's that last argument that carries the most weight. One of the most dramatic demonstrations of traffic radar's drawbacks was a television program that showed Florida viewers footage of a radar gun "catching" a banyan tree moving down the road at an impressive—and illegal—85 miles per hour, and a house moving along at a more sedate 28 mph (and it wasn't even hurricane season!). It's been estimated that as many as 30% of the speeding tickets issued by radar-equipped police are wrong. In fact, the first radar detector, the "Fuzzbuster," was created by Dale Smith after he was erroneously ticketed at a radar-equipped speed trap in 1968. Radar-gun standards, which addressed the problem of inaccuracy, were proposed in 1981 by the National Highway Traffic Safety Administration but have yet to be adopted.

When most of us think of radar, what comes to mind is the sort of sophisticated military radar system that uses a rotating dish to sweep an area and then clearly displays the speed, distance, and shape of objects on a screen. In comparison, the radar guns used by police are quite simplistic. Instead of a sweep, they use a constant (straight-line) beam that can't distinguish between more than one moving object. Instead of a screen, traffic radar has a digital readout that simply displays a number. The Doppler principle is used to measure the speed at which a car is moving: That is, the difference between the transmitted frequency and the frequency reflected by the car is used to determine the speed.

That all sounds pretty straightforward, but there are plenty of problems with the approach. First, the constant-beam traffic radar, with its rather wide beam, has a

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difficult time indicating precisely which car on a crowded highway is the one that's speeding. Second, radar guns are susceptible to interference from several sources—among those are moving vehicles, other radio and microwaves, reflections from buildings or road signs, and even the rear-view mirror inside the patrol car! Finally, the reader's accuracy is affected by weather conditions, terrain, and operator proficiency.

Radar detectors "listen" for microwaves transmitted by traffic radar, at 10.525 GHz for X-band radar and 24.150 for K-band, and beep when such frequencies are encountered. With a much greater range than the guns, the detectors can alert the driver in plenty of time to slow to the legal limit.

The radar-detector battle is being fought not only in the legislative and judicial systems—Connecticut, Virginia, and Washington DC have banned the use of radar detectors and several other states are considering adopting similar laws—but also in electronics labs. The law-enforcement camp countered X- and K-band radar detectors with systems operating on the 34.36-GHz Ka-band, including "Photo Cop," which photographs speeders and sends them, via the U.S. Mail, a print that's stamped with their speed and, of course, a speeding ticket.

In response, radar-detector manufacturers offered "tri-band" models, with the added capability to also pick up Ka-band radar. What the tri-bands can't detect, however, is the new "Stalker" gun, which is said to be much more accurate and less prone to false readings. You guessed it—wideband radar detectors are now beginning to hit the market in response to these units. If laser guns are ever adopted in large enough numbers by police departments, we're sure we'll see a whole new breed of detectors.

Meanwhile, police in those states that have banned the devices have started to use radar-detector detectors (RDD's); now they can ticket you for owning and using the detector as well as for speeding. Naturally enough, manufacturers have responded with anti-radar-detector-detector radar detectors. (Whew!)

Cobra is one of the main advocates of "undectable" radar detectors. While not entirely transparent to RDD's, Cobra's *Stealth* line of radar detectors use a "dielectric resonant oscillator" (DRO) circuit that eliminates microwave leakage, reducing the chance of external detection. Besides the DRO circuitry, the *Trapshooter Solar Stealth* has a pulsed power-supply system that uses 98% less power than traditional 12-volt radar detectors by sending power to the unit only once every 1/50 of a second. That reduces the unit's exterior signal leakage to "negligible levels," making it the company's least detectable model.

As you've probably guessed from its name, the *Trapshooter Solar Stealth*'s anti-detection capability is not its main claim to fame—that would have to be its status as the first solar-powered, cordless radar detector to hit the market. The unit features a photovoltaic panel that is more sensitive to low-light levels and offers more output per lumen than conventional solar arrays. Molded to the top of the compact Solar Stealth—which is about the size and shape of a computer mouse—is a nine-segment photovoltaic cell that continuously charges a ni-cad battery system while the unit is in daylight. The batteries, which are in an airtight pack designed to withstand the wide range of temperature and humidity conditions found in cars, can maintain a full charge from the solar-power system. The radar detector can theoretically operate on internal battery power for up to 30 hours without the benefit of daylight.

To extend battery life, the Solar Stealth has a motion-detection system that shuts the unit off after three minutes of no movement. The detector automatically turns itself on as soon as it detects movement again, for instance, when a car door is opened. Again theoretically, you should—once the unit is charged either from sun exposure or using the supplied 12-volt power/recharging cigarette-lighter cord—never have to turn the power switch off. The motion detector is so sensitive, however, that you may occasionally hear and see a low battery indicator that reminds you to recharge it. How sensitive is it? Well, when we set the detector on our kitchen table, we couldn't walk into the room without causing it to power up. In a car parked outdoors on a windy day, the Solar Stealth would surely keep switching itself on. Fortunately, there is a rather simple solution to that problem: Shut off the unit's power switch.

The radar detector can be mounted either on the dashboard, using the supplied Velcro strip, or on the windshield, using a mounting bracket with suction cups. Of course, it must be located in a spot that lets the sun hit it. It must also be horizontal and be placed so it can have an unobstructed "view" of the road.

The manual accompanying the Solar Stealth provides, in plain English, full details on how to use it and how to interpret its visible and audible warnings. Five LED's arrayed across the front of the unit act as a signal strength meter, lighting in a flashing pattern from left to right to indicate the strength of the received radar signal (weak signals on the left and strong signals on the right side). A red lamp on the left front corner and an amber lamp on the right front corner flash when K-band and X-band radar, respectively, are detected by the unit. (The Solar Stealth is not a tri-band radar detector. It detects only the X- and K-band signals. Those two are still by far the most commonly used radar bands, however, and probably will remain firmly entrenched in speed traps for the next several years at the very least.)

The Solar Stealth used different audio cues to alert you to the type of radar being used: It "beeps" to indicate X-band radar, and "braps" when it sniffs out K-band radar signals. It also "chirps" to indicate a low battery condition. There is a volume control on the side of the unit, and both a mute button and a dim switch on its top, so you can opt for either audible or visual warnings, or both.

Also located on the top of the unit is the city/highway mode switch. In highway mode, any radar signal will set off the alarms. In towns or cities, where there are many sources of false (out-of-band) radar signals (microwave relay towers for telephone and TV signalling, surveillance and alarm systems, and anti-shoplifting systems, for instance), the city mode is preferable. Instead of reducing the Solar Stealth's operating range and sensitivity, switching to city mode mutes the audible alarm until the signal is analyzed and verified as most likely to be caused by police radar. The unit has lock-out circuitry that guards against false alarms caused by interference from such out-of-band signals. In addition, "no false" circuitry reduces the chance of false alarms triggered by spurious signals from, of all things, poorly designed radar detectors.

In our driving tests, we were alerted to several speed traps. Otherwise, we hardly noticed the Solar Stealth was there—which is precisely how a radar detector should behave, at least as far as we're concerned!

It's difficult to argue with a driver's right to use a radar detector as protection against possible false arrest due to inaccurate radar-gun technology. Of course, those false readings can work in one's favor on occasion. We were recently pulled over and told we'd been clocked doing 72 mph in a 55-mph zone. Because it was our first day driving a brand new car, and with no previous moving violations on our driving record, we were "let off" with a $50 ticket for a moving violation that wouldn't go on our license or be reported to our insurance carrier. Had the radar gun clocked our actual speed—over 80 mph (it really is quite easy to lose track of speed when you are driving a new car!)—there's not much of a chance we'd have met such leniency. Of course, if we'd had our Solar Stealth back then, we'd have been reminded to check our speed; we would have slowed to the legal limit and probably wouldn't have been stopped at all. ■

ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.


Citizen Personal Color LCD TV/Stereo

Portable LCD TV

Providing portable audio as well as video, *Citizen's* (CBM America Corporation, 2020 Santa Monica Blvd., Suite 410, Santa Monica, CA 90404) *T530* 2.9-inch LCD TV has a built-in AM/FM stereo receiver. It can be used as a TV with stereo sound or as a separate TV and stereo. Weighing just over one pound, the sleek unit features a pop-up screen with the controls and tuning system located inside and around the base. The color TV is compatible with both NTSC and PAL, and has automatic on-screen tuning. The radio is manually tuned. The T530, which runs for about three hours on five "AA" batteries, has A/V, earphone, DC, and external antenna jacks and a three-way power supply. A carrying case is included. Price: $299.99.

CIRCLE 60 ON FREE INFORMATION CARD


Sansui Portfolio Style Personal CD Stereo System

Portfolio-Style Personal Stereo System

Sansui USA Inc. (1290 Wall Street West, Lyndhurst, NJ 07071) has packed a lot of audio into a notebook-sized package. Its portfolio-styled *Audio A-4* includes a CD player, an auto-reverse cassette deck, a digital AM/FM stereo tuner, and fold-out speakers in a compact 12¼ × 8⅜ × 3⅛-inch package that weighs less than five pounds. A top-mounted control panel allows operation even when the unit is closed. The tuner has 20 FM and 10 AM presets and features manual and automatic tuning, a digital clock, a 24-hour timer, and a sleep timer. The CD player has 20-track random-access programming automatic dubbing to the built-in cassette deck, which features a "karaoke" mode that allows users to replace the vocals on recordings with their own voices. Microphone inputs are provided, along with a separate volume control. The speakers are mounted in fold-out doors that are vented to allow operation whether they are open or closed. Other features include a telescoping antenna, AC or battery power, and extension-speaker jacks. Best of all, you can carry it around and everyone will think you're a hard-working executive with a notebook computer, not someone looking for a party about to happen. Price: $499.95.

CIRCLE 61 ON FREE INFORMATION CARD

Thrilla's Surfari Video Game

Everybody's surfing with *Town & Country II: Thrilla's Surfari*, the Nintendo video-game sequal to the popular Town & Country from *LJN Ltd.* (1 Spring Street, Oyster Bay, NY 11771). Players enter the world of a gorilla called Thrilla—"the ultimate surfer dude"—as he skateboards through jungles, boogie-boards down rivers, windsurfs across the desert, and hangs ten on an active volcano. All that, not to mention battling two-headed "lavabeasts" and sharks, in an attempt to rescue Barbie Bikini, Thrilla's sweetheart. Price: $47.95.

CIRCLE 62 ON FREE INFORMATION CARD

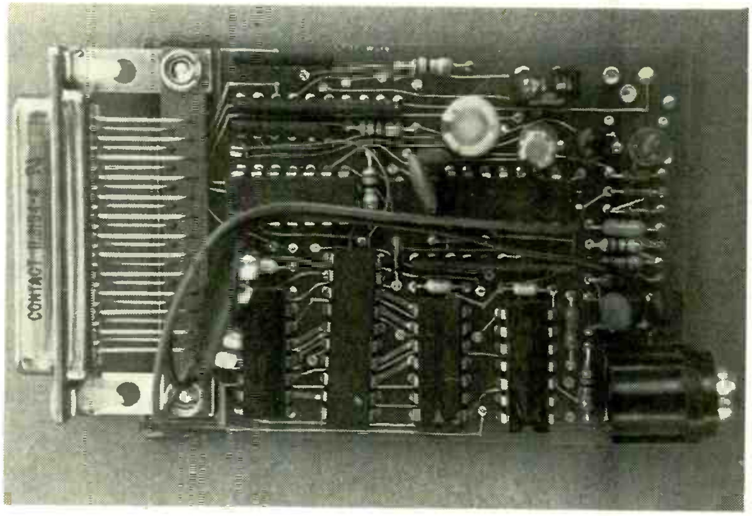

CD/Mate 10-Disc Carrier

CD Carrying Case

It's easy to take your portable or car CD player and ten of your favorite discs on the road with the *CD/Mate* 10-disc carrier from *Sunstone Enterprises, Inc.* (19215 Parthenia St., Suite C, Northridge, CA 91324). The ten discs are stored in soft, semi-rigid, anti-static-nylon, fleece-lined, half-height pockets that allow the discs to be easily accessed, but prevent them from rubbing against each other when the case is closed. In fact, the CD/Mate is guaranteed not to damage CD's. A "hook-and-loop" closure keeps the discs securely enclosed, while a zippered compartment holds a portable CD player. The case is made of a durable, leather-like material over resilient, impact-resistant foam padding. Other versions of the case (disc-only, for example) are also available. Price: $18.95.

CIRCLE 63 ON FREE INFORMATION CARD

A Hands-on Electronics REPORT



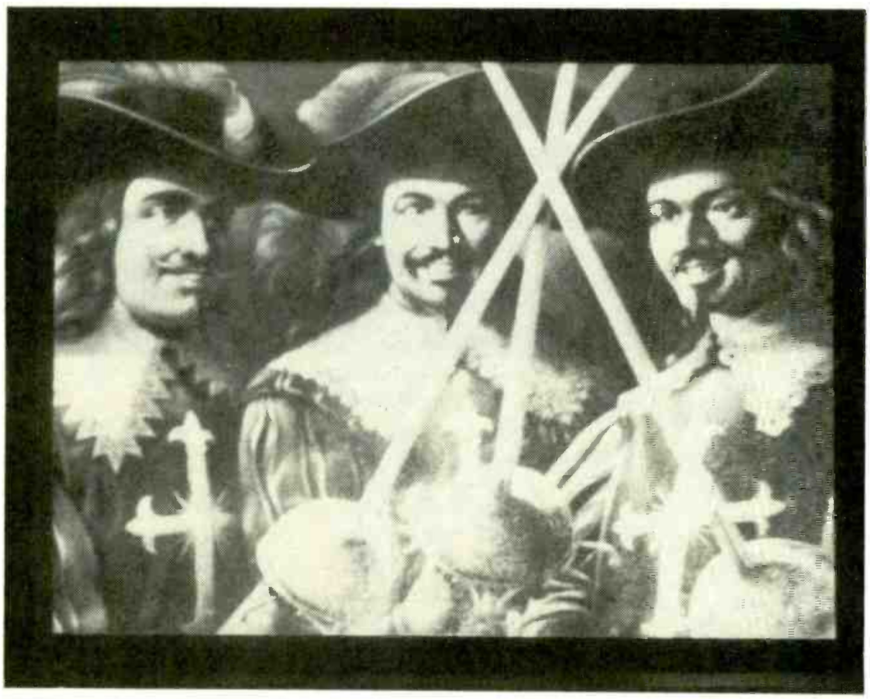
CIRCLE 119 ON FREE INFORMATION CARD

COLORBURST SV1000 VIDEO DIGITIZER

Grab frames of video with your computer and an inexpensive interface.

Would you like to be able to take a static picture with a video camera or camcorder, digitize it, then display it on your VGA monitor? Especially if you could then "grab" it for use with your desktop-publishing program, or display it as an illustration within a database. Well, you can do all that with the $90 SV1000 Video Digitizer from Colorburst (PO Box 3091, Nashua, NH 03061; Tel. 603-891-1588).

To illustrate the usefulness of the gadget, suppose you were a real-estate agent that kept all the local listings on a computer. You could scroll up data regarding a home, and also show a picture of it on the screen! Or, if you're in manufacturing or sales, you could use the SV1000 to capture a "picture" of a product. Then you could import it into your sales literature using a desktop-publishing program. There are countless applications for digitized pictures.



This is a digitized high-resolution picture as seen on a VGA monitor. Note the excellent clarity of the image.

Hardware Requirements. The SV1000 unit is a compact 2.4-inch by 3.8-inch board with a DB-25 male connector and an RCA jack. To use the SV1000 you'll need a computer, a source of composite video, and a 9-volt transistor-radio battery for power.

The computer should be an IBM PC/XT/AT or compatible, with minimum requirements of an 8-MHz motherboard with 512K of RAM, a VGA card, monochrome VGA monitor, 360K floppy drive (a hard drive is also recommended), a parallel-printer port, a BASIC interpreter (such as BASICA or GWBASIC), and DOS 2.0 or higher.

The SV100 does not need a slot in your computer, since it simply plugs into your computer's parallel-printer port via the DB-25 connector. That permits it to be used with lap-top and notebook computers as well as full-size PC's. If, like some models of the Tandy 1000, your printer port does not

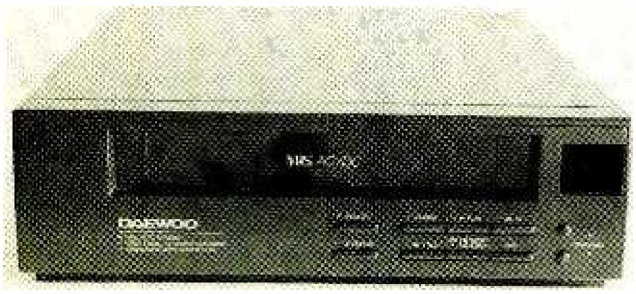
(Continued on page 87)

PRODUCT TEST REPORTS

By Len Feldman

Daewoo Model DVP-1060N Video Cassette Player

Electronics industry statistics reveal that a substantial percentage of people that own VCR's rarely, if ever, record anything for themselves. In the past, "time shifting" (recording a broadcast for later viewing) was the primary use to which people put video recorders. In recent years, however, the availability of thousands of motion pictures and other material on pre-recorded videotapes for purchase or rental has altered the primary use of VCR's. It made sense, therefore, for some companies to produce play-only video-cassette machines—units that play tapes but have no recording capability. Clearly, such a machine can be manufactured at considerably less expense than a video recorder/player.



CIRCLE 120 ON FREE INFORMATION CARD

This Daewoo Model DVP-1060N Video-Cassette Player has a few creature-comfort features even though it is, for the most part, a basic play-only unit.

Daewoo is a company based in Korea that has come up with just such a machine. With their American division based in Carlstadt, New Jersey, Daewoo offers a six-month warranty on both parts and labor for their Model DVP-1060N. The unit is quite small compared with full-blown VCR's, measuring only 11 inches in width by 3½ inches high by 13⅛ inches deep. It weighs just over 10 pounds. The player operates on either 117 volts AC or 12 volts DC. The unit can be powered from a car's cigarette lighter socket with a supplied cable. Other accessories supplied with this player include an RF cable and a remote control complete with a pair of AA size batteries for power.

Operating features include a motorized front-loading cassette system, auto rewind and auto repeat, shuttle search in both directions for quick location of particular segments at 21 times normal playing speed in the SLP mode, connectors for separate audio and video outputs, and an "encore" feature that rewinds a tape at high speed for 8 seconds, and then plays.

When a cassette is inserted into the slot on the front panel of this player, power is automatically turned on and playback begins automatically. When it reaches the end of a tape, the unit automatically rewinds it to the beginning, ejects the tape, and turns off. In addition to the usual RF-output (for watching playback via TV channels 3 or 4), there are audio- and video-output jacks to accommodate TV sets having external audio and video inputs. That type of connection usually results in better picture quality.

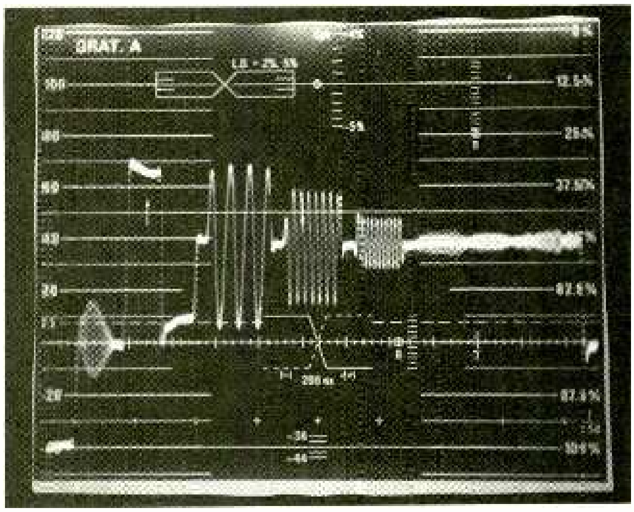
CONTROLS

Since only playback functions are available with this unit, the number of front panel controls needed is relatively small. Soft-touch buttons along the lower right section of the panel, below the cassette slot, include a power switch, an auto-repeat switch, rewind, play and fast-forward switches, a pause/still-frame button, a stop/eject button, and a button labeled "N/C" that is used to reduce or eliminate noise bars that often appear when trying to view a single frame. Further to the right are two small circular buttons that can be used to adjust tracking.

The rear panel of the DVP-1060N is equipped with RF type-F input and output connectors, a channel 3/4 selector switch, standard phono-type video- and audio-output jacks, and a DC terminal for use when powering the player from a 12-volt DC source.

One minor criticism of the rear-panel layout is in order: The power cord is permanently attached to the machine, so if you want to operate the player from a DC source, you will need to tie up the power cord with one of those familiar plastic-bag ties if you don't want it dangling all over the place.

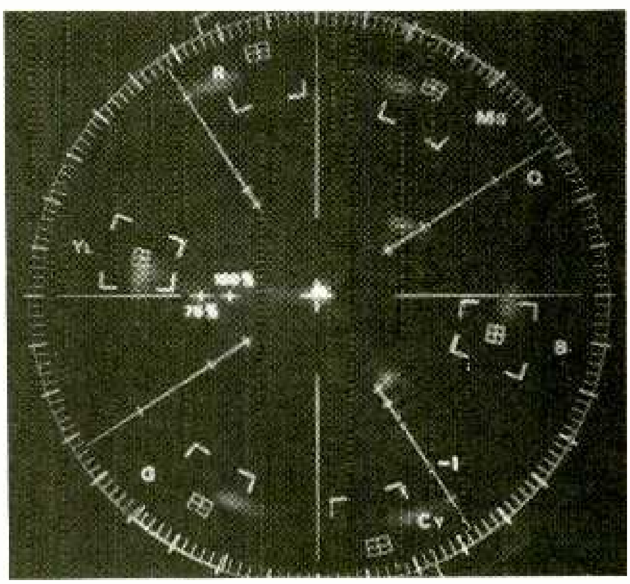
The remote control supplied with the player



Video frequency response at 2 MHz was off by some 8.94 dB, which is poorer than what's obtained with most VHS video recorders we have tested in recent years.

TEST RESULTS—DAEWOO DVP-1060N

Specification	PE Measured
Video frequency response	
At 2.0MHz	−8.94 dB
At 3 0 MHz	−19.4 dB
Video signal-to-noise ratios	
Chroma AM	46.2 dB
Chroma PM	39.4 dB
Luminance, 100-IRE reference	47.7 dB
Luminance, 50-IRE reference	47.6 dB
Luminance, 10-IRE reference	46.4 dB
0-dB audio reference level	0.58 Volts
THD at 0 dB reference level	3.0%
THD at −10 dB reference level	0.57%
Audio frequency response (−3 dB)	96 Hz to 12 kHz
Power requirements (watts, AC/DC)	14.5/8.8
Weight	10.8 lbs.
Fast forward time (T-120 tape)	3 min. 59 sec.
Fast rewind time (T-120 tape)	3 min. 58 sec.
Dimensions (H × W × D, inches)	3½ × 11 × 13⅛
Price:	Unavailable



Color accuracy and levels of color saturation were good on the play-only deck.

duplicates the major controls found on the front panel and adds a few of its own. For example, the previously described encore feature is accessible only from the remote control, and two buttons are provided on the remote for the stop and eject functions instead of one as found on the player's front panel.

TEST RESULTS

As usual, lab tests were performed on this product by Advanced Product Evaluation Labs (APEL), under the direction of Frank Barr. The results of those tests, along with the sample actually tested were then sent to our lab where further subjective testing and hands-on evaluations were done. In the case of this player, APEL had to use a pre-recorded test tape that they prepared, using an industrial-quality VCR whose specifications exceed those of VCR's typically found in peoples homes. All measurements were made at the SP speed, although it should be noted that the player will play tapes at any of the popular VHS format speeds (SP, LP, and SLP). While tests were made with the player operating from AC line current, APEL indicated to us that the player operates correctly with DC voltages as low as 9.2 volts.

Video frequency response at 2 MHz was off by some 8.94 dB, which is poorer than what's obtained with most VHS video recorders we have tested in recent years. This measurement was made using a multiburst test signal, and results are shown in a photo accompanying this article. The amplitude-modulation (AM) red-field chroma signal-to-noise ratio measured an excellent 46.2 dB, while phase modulation (PM) chroma S/N was about average with a reading of 39.4 dB. Luminance (brightness) signal-to-noise ratio was excellent, ranging from 46.4 dB to 47.7 dB depending upon the reference luminance level used when making the measurement. Color accuracy and levels of color saturation were good.

As for audio performance, the output level for a 0-dB reference recorded signal was 0.58 volts at a total-harmonic-distortion level of 3.0%. Signal-to-noise ratio for the monophonic linear edge track was 47.1 dB, which is about normal for this type of audio reproduction system. Frequency response during the playback of audio signals extended from 96 Hz to 12 kHz between the two −3 dB cutoff points. Harmonic distortion for a 1-kHz test signal recorded at −10 dB with respect to the reference level was an acceptably low 0.57%. All of the video- and audio-performance measurements made by APEL are summarized in the table accompanying this report.

HANDS-ON TESTS

We played several of the video tapes we own—both those made by us on other VCR's and a few commercially available pre-recorded tapes from our video library. While tracking adjustment was necessary for many of these randomly selected tapes, there was sufficient range of the tracking controls to bring each tape into proper synchronization. As suggested by the rather poor video frequency response, the picture detail was not particularly outstanding. In fact, Daewoo, in their rather complete operating manual, only claim a horizontal resolution of 230 lines,

(Continued on page 88)

Build a Miniature Tracking Transmitter

This little circuit can help you to find your car in a packed parking lot; locate a child who has disappeared in a crowd; or reunite you with a dog that has escaped the confines and safety of your yard.

BY VINCENT VOLLONO

When we need to locate an object, the first sense that we use is sight. Well, with the *Tracking Transmitter* described in this article, you can also use your hearing. The Tracking Transmitter outputs a series of short, tone-modulated pulses that can be picked up on almost any FM receiver, as a recognizable beep. Using an FM receiver (either mobile or portable), one can scout areas where you might expect the object to be located.

When the transmitted signal is detected, simply varying the position of the receiver will cause the received signal strength to increase or decrease, enabling you to determine the general direction of the signal. By continuing to scan the area, you should soon be able to pinpoint the location of the object.

Circuit Description. The Tracking Transmitter (see the block diagram in Fig. 1) is a fairly simple circuit consisting of four distinct sub-assemblies; a free-running multivibrator, a transmit switch, an audio-tone generator, and an FM transmitter. The multivibrator is used to control the transmit switch, which turns both the audio generator and the transmitter on and off at a given rate. That helps to reduce power consumption to a bare minimum. The output of the audio generator is fed to the FM transmitter, which puts out a periodic beep in the 88- to 108-MHz range that can be detected using an ordinary FM receiver.

A schematic diagram of the Tracking Transmitter is shown in Fig. 2. The multivibrator is comprised of components Q1, Q2, C1, C2, and R1 through R4. The values of R2 and R3 have been chosen to produce a pulse width of 300 milliseconds with a pulse separation of 1500 milliseconds. The output of the multivibrator, which is taken from the collector of Q2, is coupled through R5 to the base of Q3. The output of Q3, taken at its emitter, is used to drive Q4. Together those two transistors (Q3 and Q4) form the transmit switch.

When the output of the multivibrator swings positive, Q3 turns on, which then turns Q4 on. With Q4 on, the emitter of Q6 is pulled to ground, causing it to conduct. With Q6 conducting, any signal applied to its base is transferred to the antenna, which is connected to the junction formed by C8 and C9. Components Q5, R6, R7, R8, and C3 make up the audio-tone generator, whose output is coupled to the base of Q6 through C4 and R8.

During the negative alternation of the multivibrator output, Q3 and Q4 turn off, which also turns off the transmitter. Components Q6, R10, R11, R12, L1, L2, and C5 through C9 comprise the circuit's transmitter section, which operates from below 88 MHz to above 108 MHz.

Capacitor C7 is used to coarse tune the transmitter, while C6 (which is optional and can be left out of the circuit) is used to fine tune it. The antenna for this project is nothing more than a 6- to 12-inch length of stranded insulated wire attached to the appropriate point in the circuit.

The Tracking Transmitter is designed to operate from a 9-volt battery; however, it will also operate from voltages ranging from 5 to 18 volts. The higher voltages would produce the most powerful output signals.

Circuit Construction. The layout for the Tracking Transmitter is fairly compact. The circuit board measures only 2½-inches long by 13⁄16-inches wide (see Fig. 3). When building the Tracking Transmitter, it is important that all leads be kept as short as possible to avoid any unwanted capacitances. You must also avoid any looping of the component leads to limit unwanted inductances.

All of the components, with the exception of the battery supply, are mounted on the printed-circuit board. Install all of the board-mounted components using Fig. 4 as a guide. Be sure to double-check all transistor pinouts before mounting those units.

Note that all of the axial-lead components (R1 through R12 and L1) are vertically mounted. The electrolytic capacitors should be miniature radial-lead units. If axial-lead electrolytics are used, they must also be mounted vertically and be miniature types.

Note that inductor L2 is a hand-wound, air-core coil, consisting of seven turns of #22 solid magnet wire.

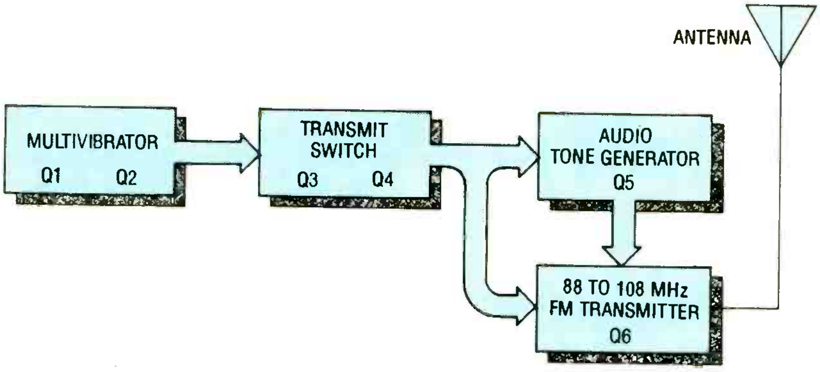


Fig. 1. The Tracking Transmitter consists of four distinct subassemblies; a free-running multivibrator, a transmit switch, an audio-tone generator, and an FM transmitter.

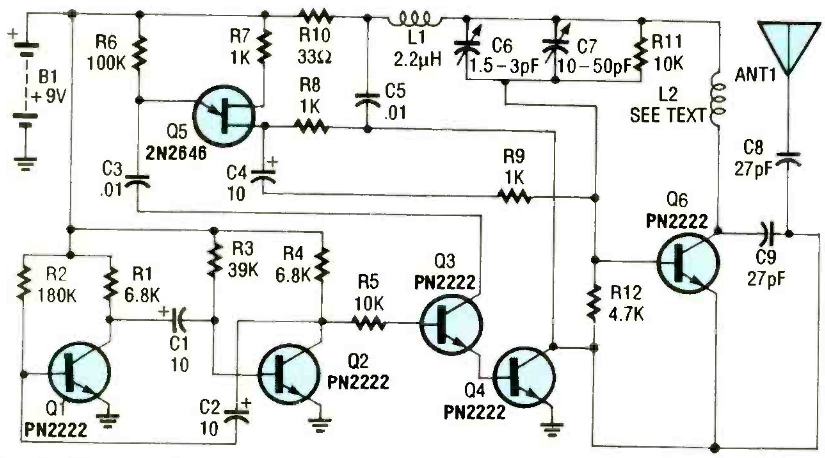


Fig. 2. The multivibrator (which produces a pulsewidth of 300 milliseconds with a pulse separation of 1500 milliseconds) is built around Q1 and Q2. The multivibrator output is coupled through R5 to the base of Q3, whose emitter feeds Q4, which controls the circuit's transmitter section.

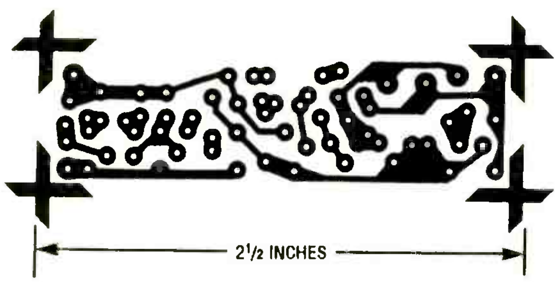


Fig. 3. The Tracking Transmitter was assembled on a small printed-circuit board, measuring only 2½-inches long by 13/16-inches wide. Because of its size, the axial-lead components (all resistors and L1) must be mounted vertically.

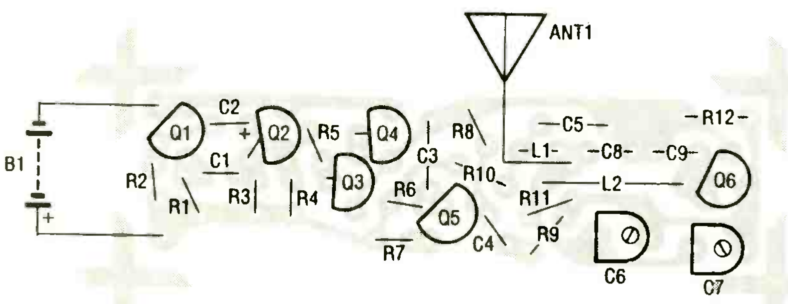


Fig. 4. All of the components, with the exception of the battery supply are mounted on the board. Install all of the board-mounted components using this diagram as a guide.

PARTS LIST FOR THE TRACKING TRANSMITTER

SEMICONDUCTORS

Q1–Q4, Q6—PN2222 general-purpose NPN silicon transistor
Q5—2N2646 N-channel unijunction transistor

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1, R4—6800-ohm
R2—180,000-ohm
R3—39,000-ohm
R5, R11—10,000-ohm
R6—100,000-ohm
R7–R9—1000-ohm
R10—33-ohm
R12—4700-ohm

CAPACITORS

C1, C2, C4—10-μF, 16-WVDC, miniature radial-lead Electrolytic
C3, C5—.01-μF, ceramic-disc
C6—1.5- to 3-pF miniature variable
C7—10- to 50-pF miniature variable
C8, C9—27-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

L1—2.2-μH coil
L2—See text
ANT1—See text
Printed-circuit board materials, #22 magnet wire, 5/32-inch drill bit (see text), 9-volt transistor-radio battery, battery connector, enclosure (optional), on/off switch (optional) wire, solder, hardware, etc.

Note: The following items are available from Xandi Electronics, P.O. 25647, Tempe, AR 85285-5647; Tel. 602-829-8152 (catalogs and general information) or 800-336-7389 (orders only). A complete parts kit (#XTR100KB) for $28.90 + $3.00 S/H, containing an etched and drilled printed-circuit board, all resistors, capacitors, inductors, transistors, and battery snap. COD orders, add $6.00. Arizona residents add 6.7% sales tax.

That coil is made by carefully wrapping 7 turns of the specified wire on a 5/32-inch drill bit. Once wound, scrape the insulation off of each end of the coil and insert the ends into the appropriate holes in the printed-circuit board, and solder it into place; make sure that you have a good electrical connection. Once the coil is formed and installed on the circuit board, you must be careful not to move the coil, or the windings may accidentally

(Continued on page 94)

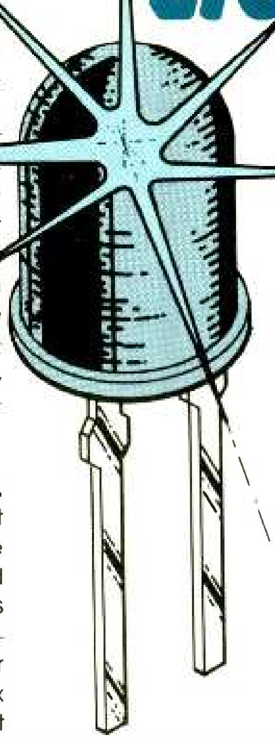
SOLID-STATE LIGHT SOURCES

LED's can really dress up a project as well as provide a user with necessary information, so learning to use them properly is important to the look and use of your circuits.

BY JOSEPH J. CARR

Most people (whether technical or non-technical) like projects that light-up more than ones that just sit there. Apart from just our simple fascination with light, blinking indicators give us a feeling that "something" is going on.

On a more serious level, illuminated indicators can provide the user with important information about a circuit's operation, or even its lack of operation. The most popular indicator on hobbyist-built and commercial electronic devices today is probably the LED or light-emitting diode. So it behooves the hobbyist to know about how to use them wisely and to full advantage, and that is why this article was written: To share some basic design techniques for LED-driver circuits, and provide a few useful LED applications.



A Variable-Brightness Circuit. Figure 1A shows a graph of LED output for various levels of diode current. The two curves in Fig. 1A were created from data taken from the test set-ups shown in Figs. 1B and 1C. When building those circuits each silicon solar cell was mounted in a light-tight box that had its interior painted with flat black antireflection paint. A common red LED was mounted in each box such that its light fell directly on a solar cell less than 1 cm away.

A solar cell becomes somewhat more linear when it is heavily loaded. So to linearize the cell and provide an indication of output current, it was shunted with a milliammeter resulting in the circuit in Fig. 1B. The resulting output current gives us a relative measure of LED light output.

The scheme shown in Fig. 1C also uses a milliammeter as the output indicator. However, the solar cell is loaded by a 47-ohm resistor, so the meter reads the relative voltage across the resistor. This can also be used as a relative measure of the LED's intensity.

Since the resulting curves are nearly linear for most of their range, the light intensity can obviously be controlled by varying the current flow through the LED. In other words, we can make a variable-brightness control by controlling the current through the LED. Figure 2 shows the use of a variable resistor, R2, for that purpose. The LED current (I) in amps is equal to:

$$I = ((V+) - V_{LED})/(R1 + R2)$$

The voltage drop across an LED is typically around 1.8 volts, so you can use that value for V_{LED} in your calculations.

The value of fixed resistor R1 should be selected so that current I does not exceed its maximum allowable value when V+ is at its maximum value or when the resistance of R2 is zero. For example, assume that the maximum value of V+ is 11.8 volts DC, and I_{MAX} is 20 mA. The value of R1 is found by setting R2 to zero and solving the previous equation for R1:

$$R1 = ((V+) - V_{LED})/I_{MAX}$$
$$R1 = (11.8 - 1.8)/.02 = 500 \text{ ohms}$$

As a practical matter, 500 ohms is not a standard value for composition or metal-film resistors, so use a 510- or 560-ohm resistor instead.

The minimum power rating of resistor R1 can be found by calculating as follows:

$$P = I_{MAX}{}^2 R1$$
$$P = (.02)^2(500)$$
$$P = 0.2 \text{ watts}$$

Because only 0.20 watts are dissipated by the resistor, a ¼-watt resistor can be used, and it will provide a 20% safety margin. If you prefer an even wider safety margin opt for a ½-watt rating for R1.

The value of R2 is found by solving the first equation for R2 when R1 is set to the selected value (*e.g.*, 510 ohms in our example), and I is at the minimum value that corresponds to the minimum desired brightness (I_{MIN}). That manipulation yields:

$$R2 = ((V+) - V_{LED})/I_{MIN} - R1$$

Assume, for the sake of our example, that the minimum current value is 1 mA (*i.e.*, .001 amperes):
And, solving for R2:

$$R2 = (11.8 - 1.8)/0.001 - 510$$
$$R2 = 9490 \text{ ohms}$$

The calculated value for R2 is close enough to 10,000 ohms to make a 10k potentiometer a good choice.

Note in Fig. 2 that R2 uses only two terminals. Use either the middle terminal and either end terminal, or short the middle terminal and one end terminal together and use this joined terminal and the remaining terminal as the variable resistor.

Driving LED's From Digital Circuits. Light-emitting diodes are often used as indicators in digital circuits. There are four common digital-driver circuits: two are transistor-transistor-logic (TTL) drivers, and the other two are Complementary Metal-Oxide Semiconductor (CMOS) drivers.

The circuit in Fig. 3 shows one form of TTL driver. Such TTL drivers are called open-collector devices because the output terminal is the collector of an internal transistor (shown in the inset).

The inverter's output state is always opposite its input state. So, if the input is low, then the output is high; if the input is high, then the output is low. Under the output high condition there is no path to ground for the LED, so no current flows and the LED is off. But when the inverter output is low, the internal transistor is turned on hard, so its collector terminal is grounded. The cathode end of the LED is grounded through the inverter's output transistor, so it turns on.

Although the power terminal on the inverter chip must be +5 volts ±0.15 volts (the standard for all TTL devices), the open-collector output of some TTL units can operate at considerably higher potentials. For example, in some devices (*e.g.*, 7405) no output can come in contact with a voltage greater than +5 volts, while the voltage presented to 7406 and 7407 devices can be as high as +30 volts DC. In such devices, output currents up to 30 mA are permitted.

The collector-to-emitter voltage of the inverter's output transistor is typically very low (< few hundred millivolts), so it is usually ignored in calculating the value of the series current limiting resistor, R1. The value of R1 should be:

$$R1 = V+/I_{LED}$$

where I_{LED} is the current allowed to flow through the LED.

Other TTL outputs (see inset to Fig. 4) may be series "totem pole" circuits, but they also act as current sinks. When transistor Q2 is turned off, no current can flow between ground and the output. But if Q2 is turned on hard, a current path is completed between ground and the output terminal.

The typical amount of current needed by one regular TTL input, (called "fan in") is 1.8 mA. The number of standard TTL inputs that one output can drive is called the "fan-out." A standard TTL output has a fan-out of ten, so it can drive ten standard 1.8 mA TTL inputs. Thus, a TTL output can also handle a current load of 10 × 1.8 mA, or 18 mA (which is sufficient for most common LED's).

The normal LED driver is naturally a current source, so one can be connected directly to a TTL output as shown. If resistor R1 is selected to limit the LED current to 18 mA or less, then it

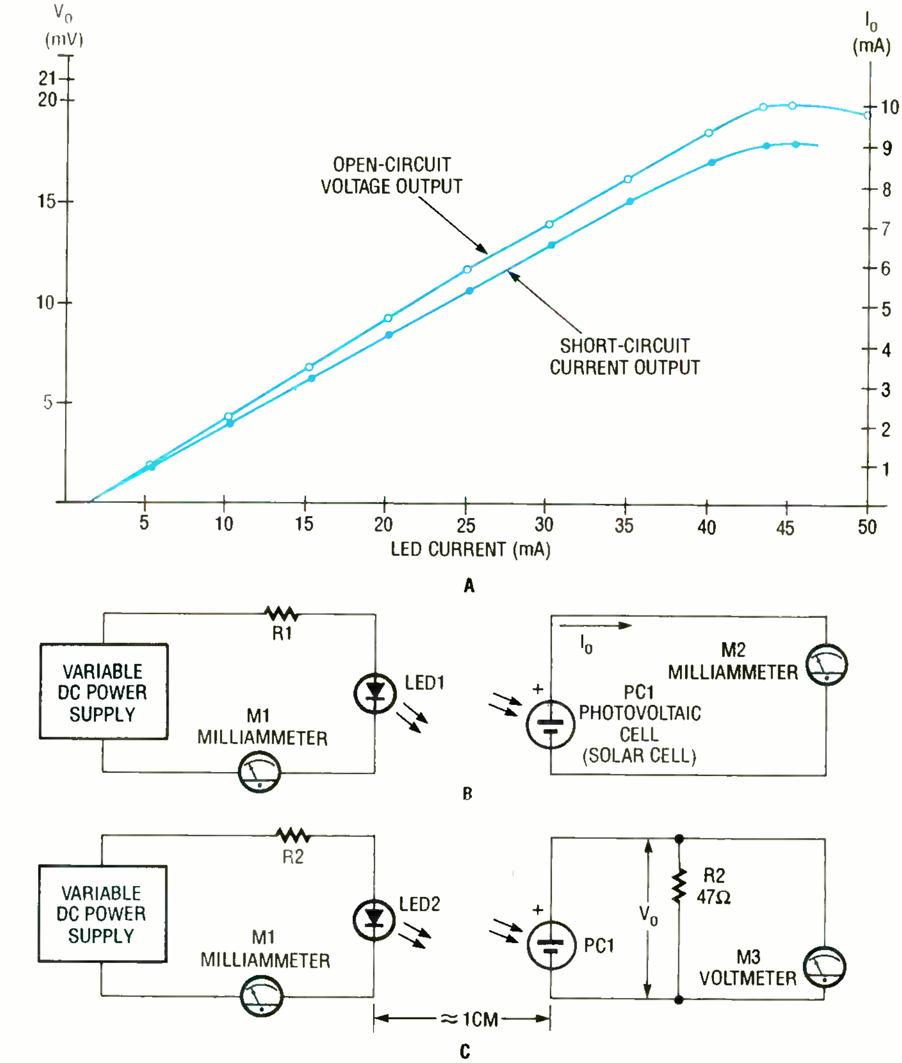


Fig. 1. In A we show two LED output curves derived by experiment. The circuit in B was used to get the data for the short-circuit current plot, while the circuit in C yielded the data for the open-circuit voltage plot.

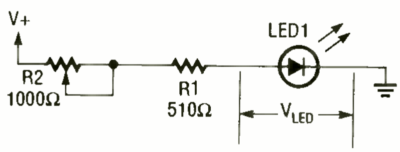


Fig. 2. Since LED intensity is linearly related to the input current this circuit can be used to vary the LED's brightness via R2.

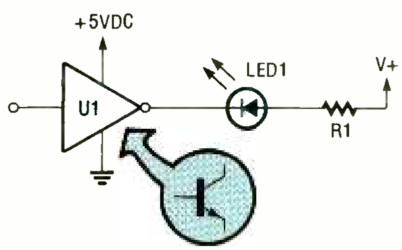


Fig. 3. You can drive an LED with an open-collector TTL inverter. The inverter shown must ground the LED to turn it on.

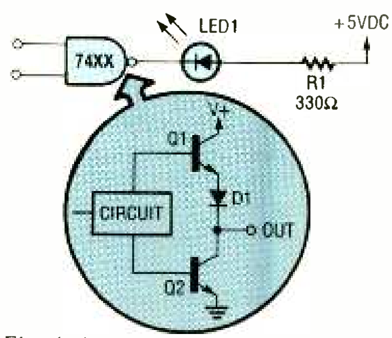


Fig. 4. A totem-pole TTL output can drive an LED by grounding the LED's cathode, much like the open-collector driver.

will function well with the TTL device. Using 15 mA to allow for a margin of safety against both resistor tolerance and voltage variations, the value of R1 should be:

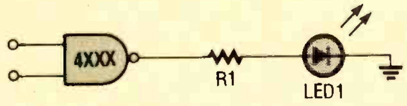


Fig. 5. Unlike TTL devices, integrated circuits made with CMOS technology can source enough current to power an LED as shown here.

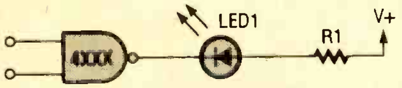


Fig. 6. A CMOS-based gate can sink current much like a TTL gate in order to activate an LED.

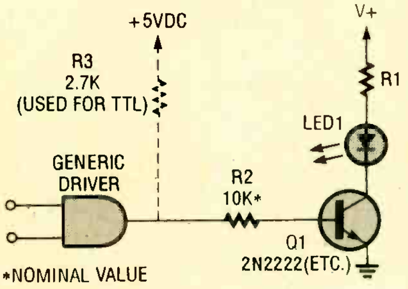


Fig. 7. This driver circuit will work for either CMOS or TTL gates, but you don't need R3 in a CMOS-driven circuit.

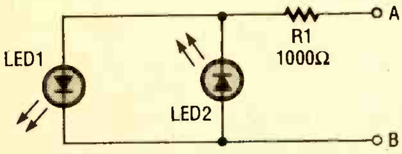


Fig. 8. This simple polarity checker is easy to build and can be of help if you don't know much about a circuit's wiring or grounding convention.

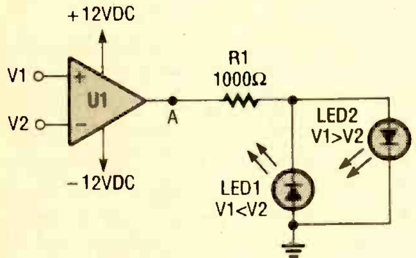


Fig. 9. This is a bipolar output indicator that lets you know if one voltage is greater than, less than, or equal to another.

$$R1 = 5/0.015 = 333 \text{ ohms}$$

That value is very close to the standard value of 330 ohms, so one would ordinarily select 330 ohms as the correct value.

The other major class of digital devices is the CMOS family, which often carry 4xxx and 45xx part numbers. The output of a CMOS device is a current source when high and a current sink when low. A CMOS output can drive an LED in either condition. Figure 5 shows a CMOS LED driver that turns the LED on when high. Under this condition, the CMOS output is connected to the V+ power supply through internal circuitry. In that way electrons flow through the LED, the current-limiting resistor, and the CMOS device output terminal to V+.

Figure 6 shows the opposite condition—the LED turns on when the CMOS output is low. Under this condition, the CMOS output is connected to ground through internal circuitry. Electrons flow from ground, through the CMOS output to the LED, R1, to V+.

A generic LED driver circuit is shown in Fig. 7. That configuration can be used with almost any digital or other form of DC signal source. The LED is turned on and off by switching transistor Q1. When the gate is high, Q1 is biased hard on and the collector-emitter path is a near-short circuit. In this way, the LED's cathode is grounded and the LED turns on. If the gate source is a CMOS device, then the circuit will work without R3, however, if the gate is a TTL device, then that pull-up resistor is needed to provide enough current to activate Q1.

The transistor selected for Q1 should have sufficient collector current and collector power dissipation ratings to sustain the full LED current indefinitely. It should also have sufficient beta gain (H_{fe}), to turn on hard when the base is at a potential of 1 volt less than V+. The value of R1 can be adjusted to ensure Q1 turn-on without exceeding the base-current rating of the device.

Checking Polarity and Voltage.

There are many cases where you need to know the polarity of a DC voltage source. When installing or servicing automobile electronics, for example, it is necessary to know whether the car's ground is positive or negative.

The circuit of Fig. 8 is a simple polarity tester consisting of a pair of back-to-back LED's in series with a current-limiting resistor. If point "A" is positive with respect to point "B," then LED1 will turn on. On the other hand, if point "B" is positive with respect to point "A,"

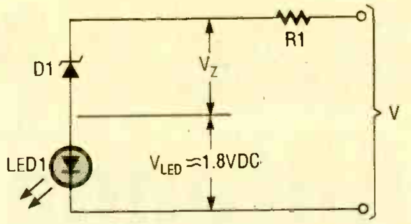


Fig. 10. This is a simpler voltage-level sensor than that shown back in Fig. 9. To use it you have to know the polarity of the voltage it is to monitor.

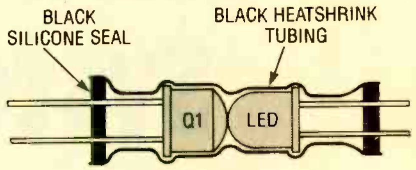


Fig. 11. You can "roll your own" optocoupler by using some heat-shrink tubing, an LED, an optical transistor, and silicon sealant as shown here.

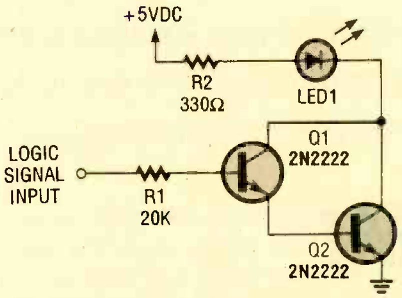


Fig. 12. This high sensitivity Darlington LED driver circuit can be used as a simple logic probe. You may have to vary the value of R1 to suit the circuit under test.

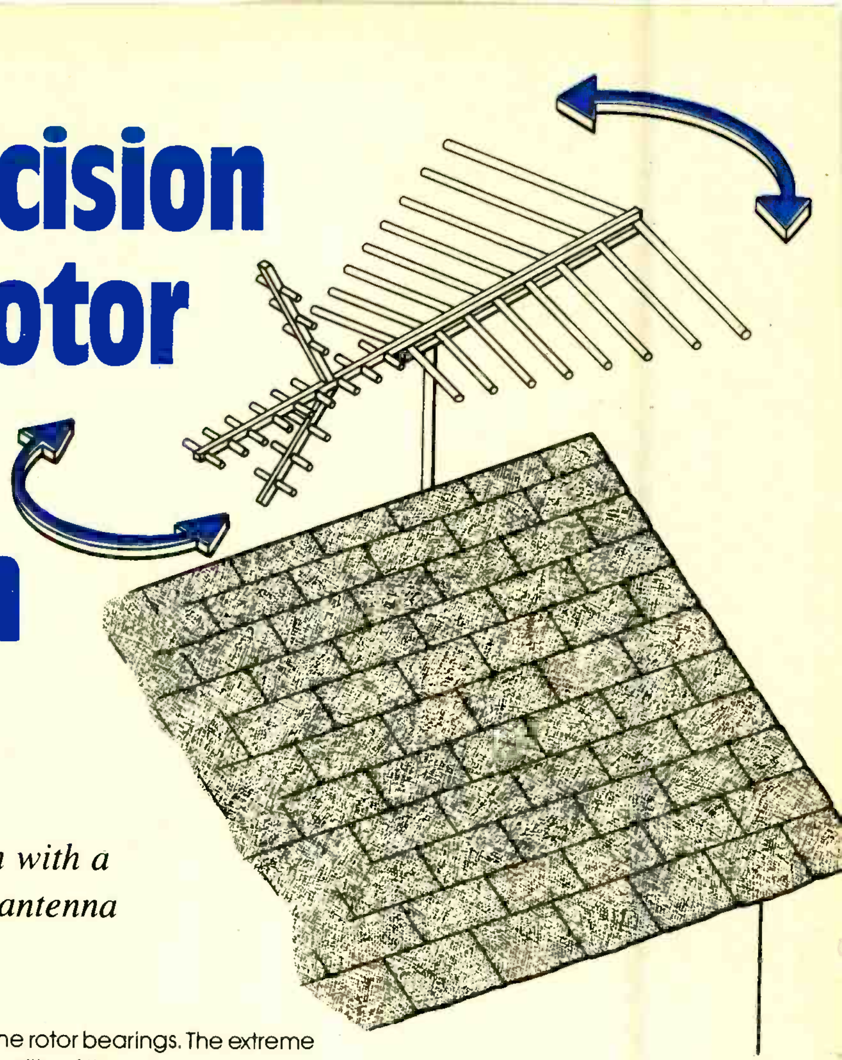
then LED2 turns on. In other words, the polarity of the voltage across the two points determines which LED lights. An AC source causes both LED's to turn on.

This technique can be used to build some more interesting circuits. For example, Fig. 9 shows an op-amp voltage-comparator circuit that uses the polarity tester circuit as the output-state indicator. The output of op-amp A1 (point "A") will be close to 12 volts when V1 < V2, close to −12 volts when V1 > V2, and zero when V1 = V2. By connecting the LED's back-to-back as shown, we obtain an indicator of which state exists.

One application for the voltage-comparator circuit of Fig. 9 is as a voltage level indicator. If the non-inverting input (+), or V2, is set to a

(Continued on page 93)

Build a Precision Antenna-Rotor Control System



BY GUY E. HOCKING

Augment your antenna-rotor system with a circuit that allows you to aim your antenna with pin-point accuracy.

When cable television came to our town, our home was connected on a "special introductory" basis. After paying the tab for several months, the expense appeared greater than the benefits. I felt the money would be better spent on a new antenna system, so I canceled my cable service and purchased the necessary hardware. In fact, over time I purchased a few antennas, amplifiers, and the like.

One antenna (a stacked-Yagi UHF antenna I use to receive San Diego's "Movie Channel" 120 miles away) was very directional, so a strong VHF signal in the area often swamped the UHF amplifier (even in spite of a filter placed in the line). Repositioning the antenna by hand worked, but soon became an irritating task: The wind would sometimes move the antenna, and certain weather conditions seemed to shift the location of the strongest signal.

I eventually purchased an antenna-rotor system with the expectation that it would accurately aim the antenna and indicate its direction. However, wind became an even larger problem due, at least in part, to the play in the rotor bearings. The extreme directionality of the antenna required numerous small corrections to aim it for the best reception. To make matters worse, the direction indicator on the control box and the antenna quickly went out of sync. All this lead me to design and build my own rotor-control system which is described here.

Circuit Operation. The system consists of a store-bought antenna rotor and a home-made rotor-control unit. If you already own a rotor-control unit, you can salvage some of its parts to use in the home-made control circuit, or you could augment it with the additional parts used in the home-made unit.

The system has a home-made direction sensor that "tells" the control circuit the position of the antenna and the control circuit then compares that with the desired direction. The control circuit will activate the rotor to reposition the antenna as necessary.

The direction sensor is shown keeping tabs on an antenna mast in Fig. 1. It consists of a potentiometer (R7) in a sealed enclosure and capped with a control knob fitted in a roll of tape. As the mast rotates, a drive cord wrapped around it and the tape spool causes the potentiometer to rotate as well. (Note the position of the terminal marked "CW" for clockwise as you will need to know which terminal that is.)

To see how the potentiometer works in the system, take a look at the control circuit in Fig. 2. The control circuit contains a three-voltage power supply comprised of T1, D3–D6, and U2. The negative voltage (−V) is held to −10 volts or less by the voltage divider action of R15 and R17, and is filtered by C1. The positive 18-volt source (+V) from D3 and D4 is filtered by C2 and C3. The maximum difference between +V and −V is limited to about 28 volts. The positive voltage is regulated to 5 volts by U2 for use in the signal-processing portion of the circuit. Resistor R16 limits the current of the 5-volt supply to 5 mA in the event of a short.

The remainder of the circuit is responsible for comparing the antenna

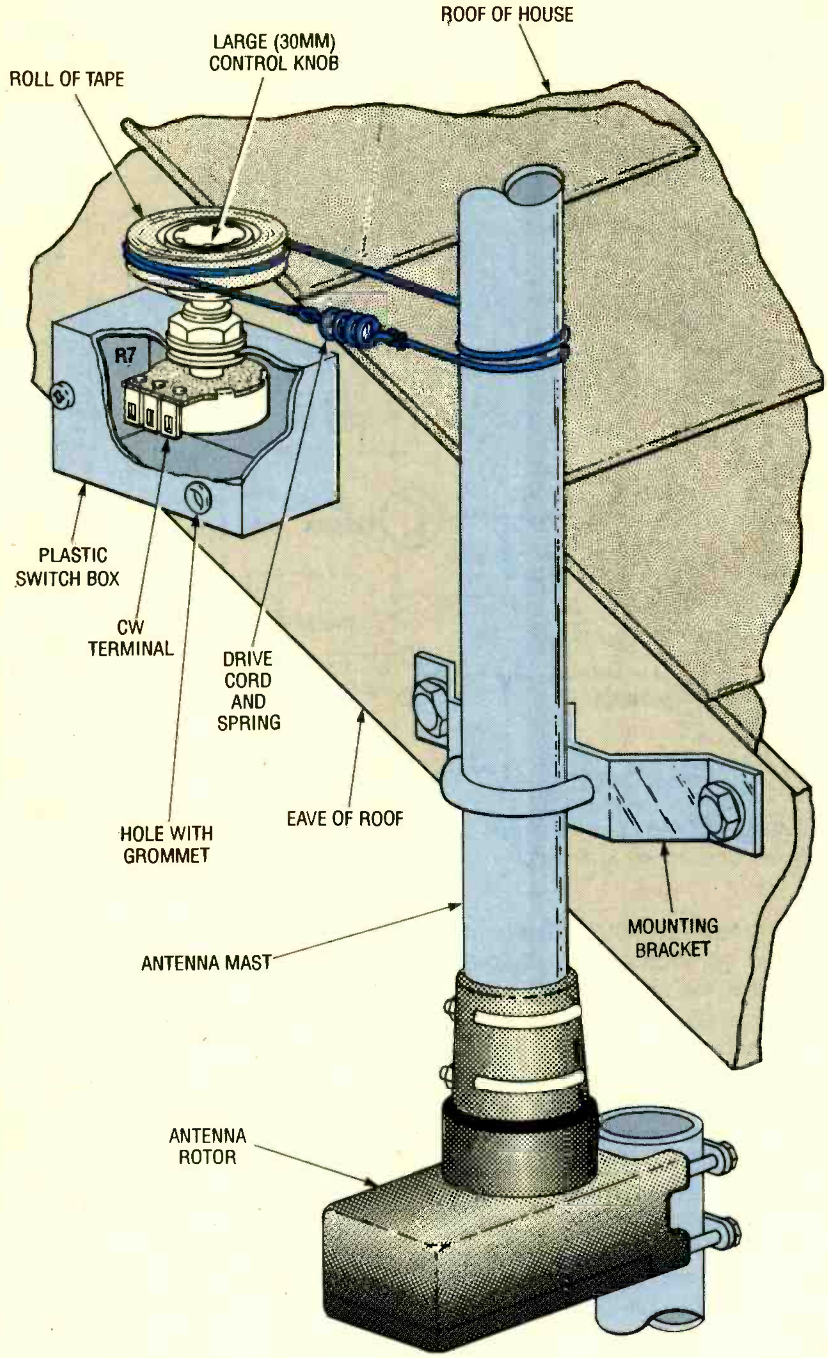


Fig. 1. An enclosed potentiometer keeps tabs on the antenna direction via a drive cord and spring made from a radio-dial cord. As the antenna rotates the potentiometer rotates as well.

position to the user-requested position and operating the rotor accordingly. As mentioned, the circuit senses the antenna position via the antenna-direction potentiometer (R7). The desired position is set by the user through the direction-control potentiometer, R12.

Both of those potentiometers are in series with R13. That resistor ensures that the signals from the potentiometers will always be above ground. However, potentiometer R12 is also wired in series with R14. That limits its voltage range to about 4% less than R7. The reduced voltage range helps to ensure that the voltage from the antenna-direction potentiometer will be able to equal the buffered direction-adjust voltage, thus allowing the control-circuit to enter its quiescent state, as you'll see.

Potentiometers R7 and R12 are connected through isolation resistors R5 and R10 to pins 12 and 10 of U1, respectively. Those pins are the non-inverting inputs of two amplifiers wired as voltage followers. The followers prevent the remainder of the circuit from loading the potentiometers. That is important since even a few microamps of current would develop a significant voltage across the 5k units.

The buffered antenna-direction voltage is sent to a meter circuit. In the meter circuit a current proportional to that voltage flows through R9, M1, R11, and R13 to ground. In that fashion, the circuit displays the antenna position via M1. North is represented by both the full-scale and zero positions of the meter's needle. Trimmer R11 is adjusted to limit the maximum meter current to 50µA (the full-scale deflection value for M1).

The antenna-direction voltage-follower output is also sent to the inverting input of U1-d, an op-amp configured as a comparator that controls clockwise rotation of the rotor. Some of that voltage is tapped off trimmer R8 to provide U1-b—a comparator that controls counterclockwise rotor operation—with hysterisis. The trimmer is adjusted to a value slightly clockwise of the point where the circuit stops "hunting." At that setting the circuit will give the greatest directional sensitivity with a minimum of motor reversals. In a manner similar to the antenna-direction voltage, the buffered direction-adjust signal is sent to U1-b and U1-d.

The action of those two comparators is as follows: If the direction-adjust voltage at pin 5 is higher than the antenna-direction voltage at pin 6, the output at pin 7 goes high (to the positive rail). That causes current to flow through LED1 (which lights up), D7, R4, and the base of Q2. Current also flows through R3 and the base of Q1, so Q1 and Q2 are both turned on.

Those transistors activate relays K1 and K2. Relay K2 applies line current to T2, the transformer used to power the rotor. Relay K1 causes the rotor to spin clockwise by connecting the appropriate rotor terminal to T2. Capacitor C7 takes the applied AC, shifts it by 90°, and applies that phase-shifted voltage to the remaining terminal of MOT1. In that way, C7 provides the rotor with a voltage that compliments

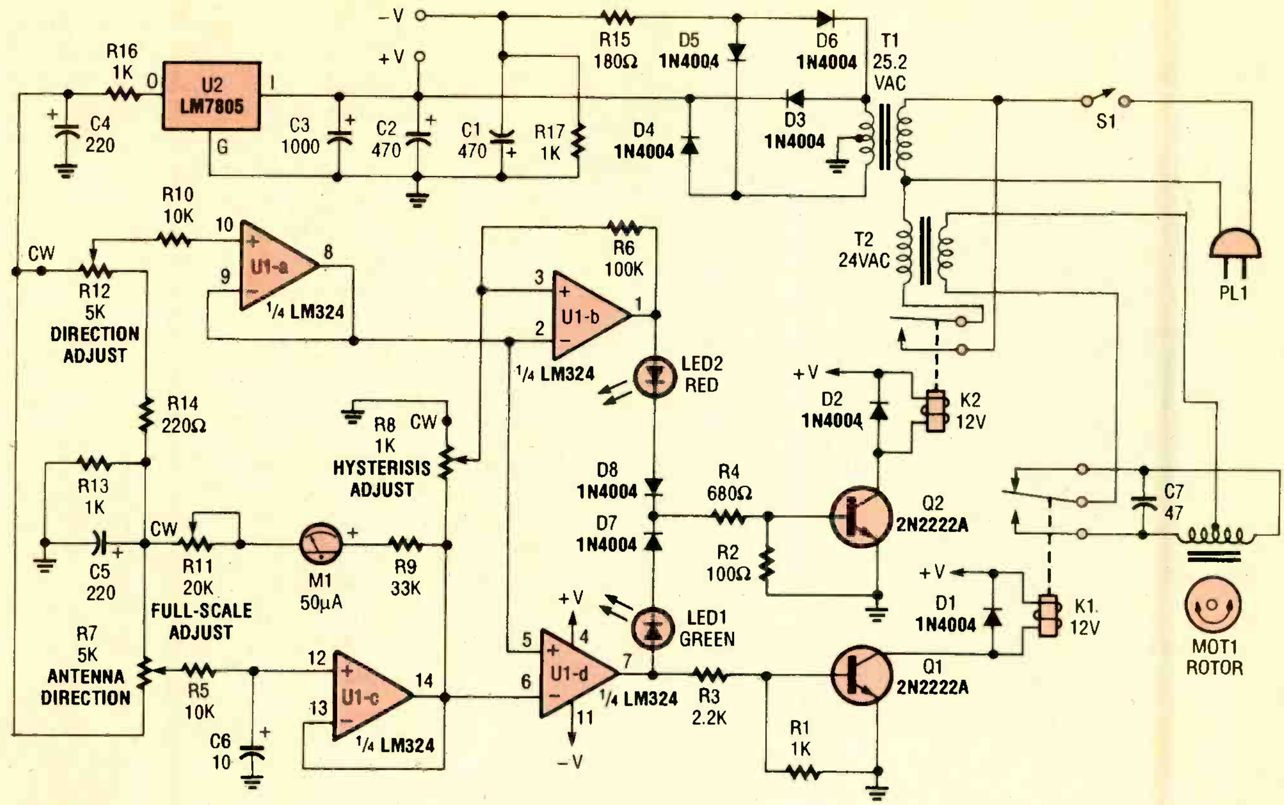


Fig. 2. The circuit monitors the position of the antenna and compares it to a user-set position and automatically activates the rotor to make adjustments as necessary.

the voltage from T2 so both coils in the motor are under power for maximum torque. While the capacitor/rotor arrangement might seem odd, the design is typical for antenna-rotor systems and a rotor will not function without the capacitor.

At the same time, output pin 1 goes low (to the negative rail). That output is held low by the reduced voltage at pin 3 caused by current flowing from R8 through R6.

As the antenna rotates clockwise, R7 is turned clockwise as well, increasing the voltage representing antenna direction. As the antenna-direction voltage becomes equal to the direction-adjust voltage, pin 7 goes low and the base bias current to Q1 and Q2 is reversed. Transistors Q1 and Q2 turn off, as do LED1, K1, and K2. Power to the rotor is interrupted and rotation ceases.

If the direction-adjust voltage at pin 2 is lower than the antenna-direction voltage (minus the hysterisis) at pin 3, pin 1 goes high. Voltage is applied to pin 3 via R6 to provide positive hysterisis to the comparator. Transistor Q2 is turned on by current through LED2 (which lights), D8, and R4, activating K2 and thus powering T2. The normally closed contacts of K1 then provide power to the rotor so it rotates counterclockwise.

At the same time, pin 7 goes low and that output is held low by the difference in input voltages. As the antenna rotates counterclockwise, R7 is turned counterclockwise as well, decreasing the voltage representing antenna direction. When the antenna-direction voltage (plus hysterisis) at pin 3 becomes equal to the direction-adjust voltage at pin 2, pin 1 goes low applying negative voltage to R8 and negative hysterisis to U1-b via pin 3. Further, LED2, Q2, and K2 turn off. Power to the rotor is interrupted and rotation ceases.

Construction. The author's first prototype consisted of a rewired, store-bought control box (which had PL1, S1, T2, and C7 already in it) connected to the rest of the circuitry (built on a piece of perfboard) via some ribbon cable. However, if you wish to use this method of construction, or if you will gut the control box for its parts, be sure you use it to position the antenna due North first.

A second prototype was built entirely on perfboard. Either method of construction is suitable, and point-to-point soldering or wire-wrapping will work well.

Begin by installing the resistors and diodes. Of course, two potentiometers (R7, the antenna-direction potentiometer, and R12, the direction-adjust potentiometer), M1, LED1, and LED2 should not be mounted to the board. Instead, R12, M1, LED1, and LED2 need to be mounted on the cabinet for the circuit, and R7 will be mounted near the antenna mast.

Mount the socket for U1 next. A socket is necessary so you can perform some tests on the circuit prior to installing U1. Now install U2, the transistors, the relays, and the capacitors. Note that the normally closed contact of K2 is not used and can be bent out of the way. Remember that the contacts of K2 are switching line power, so insulate those terminals.

The leads to the off-board components (excluding the rotor), should now be added. With the exception of R7 and R12, connect the off-board components to the circuit using plain small-gauge, stranded hookup wire.

Connect R12 to the circuit using shielded twisted-pair to limit noise pickup. Make sure you solder the shield to the negative (the counterclockwise) terminal of the potentiometer, and the ground side of the circuit (the connection to R14).

The last component to connect is R12. Of course, you'll need to know how much shielded twisted-pair to use, so measure that off at this time. Connect the cable to the circuit making sure the shield is connected on the ground side (toward the junction of R13 and R14) of the circuit. Before you can connect the potentiometer to the cable, you must install it in its housing, so let's discuss that now.

In the author's prototype, R7 was mounted in a standard wall-mount switch box, but you can use any box that you can water-proof. Drill two 1⁄8-inch holes near the center of the closed end of the box. One hole will be used for the potentiometer's shaft and the other for its locking tab, so space them accordingly. Enlarge the hole for the shaft to 13⁄32-inch but don't mount the potentiometer in it just yet.

Drill a hole in the side of the box large enough for the shielded cable and a grommet (look back at Fig. 1). Place a grommet in the hole and snake some of the cable though it. Solder the cable leads to the potentiometer with the shield running to the counterclockwise terminal and mount the potentiometer in place. Check the polarity of the connections one more time and seal the enclosure with silicon caulk.

The drive pulley can be constructed from a large diameter (30mm) control knob, some epoxy, and a roll of plastic tape. Since the potentiometer is only active over about 275°, a 4:3 drive ratio was chosen. To achieve that ratio, unravel tape from the spool until its outside diameter is equal to 4⁄3's of the mast's diameter. For example, if your mast is 2 inches thick, you should adjust the tape diameter to 2⅔ inches. Now secure the knob to the potentiometer shaft and cement the tape roll to the control knob. With that done, the rotor left unconnected, and the IC socket empty, the circuit is ready for testing.

PARTS LIST FOR THE ROTOR CONTROL CIRCUIT

SEMICONDUCTORS

U1—LM324 quad op-amp, integrated circuit
U2—LM7805 5-volt, 1-amp, voltage regulator, integrated circuit
Q1, Q2—2N2222A NPN Silicon transistor
D1–D8—1N4004 1-amp, 400-PIV rectifying diode
LED1—Green light-emitting diode
LED2—Red light-emitting diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R13, R16, R17—1000-ohm
R2—100-ohm
R3—2200-ohm
R4—680-ohm
R5, R10—10,000-ohm
R6—100,000-ohm
R7, R12—5000-ohm linear carbon potentiometer
R8—1000-ohm linear carbon trimmer potentiometer
R9—33,000-ohm
R11—20,000-ohm linear carbon trimmer potentiometer
R14—220-ohm
R15—180-ohm

CAPACITORS

C1, C2—470-µF, 35-WVDC, electrolytic
C3—1000-µF, 35-WVDC, electrolytic
C4, C5—220-µF, 35-WVDC, electrolytic
C6—10-µF, 35-WVDC, electrolytic
C7—47-µF, 35-WVDC, non-polarized electrolytic

ADDITIONAL PARTS AND MATERIALS

K1—SPDT 12-volt relay with 10-amp, 125-VAC contacts
K2—SPST 12-volt relay with 1-amp, 125VAC contacts
M1—50µA meter
MOT1—Antenna rotor
PL1—AC line cord and plug
S1—SPST switch
T1—120 to 25.2-VAC, 2-amp, center-tapped transformer
T2—120 to 24-VAC, 2-amp transformer

Perfboard, silicon caulk, radio-dial cord and spring, 30mm control knob, spool of plastic tape, grommet, hardware, project enclosure, enclosure for a potentiometer, 14-pin IC socket, shielded twisted pair, solder, wire, etc.

Circuit Checkout. Before you begin checking the circuit, verify that the socket for U1 is empty. As you proceed, you'll need to use the socket terminals to activate the transistors and relays, and to take voltage measurements. You will also need a multimeter with at least a 10-megohm input impedance to take those readings. Throughout the procedure be very cautious around the line-current wiring in the project; remember that the contacts of K1 carry 117 VAC.

Start by connecting your multimeter to the circuit ground, which is readily available from the tab of U2. The voltage readings you'll take in the following steps are referenced to the circuit ground, so leave that lead in place to take those measurements. If at any point you find anything out of the ordinary, investigate and correct the condition before you proceed further.

To start, plug-in the AC line cord and switch S1 on. Read the voltage at pin 4 of the IC socket. It should fall between 17 and 19 volts. Measure the voltage at pin 11 on the socket to verify that it is between −9 and −11 volts.

Now measure the voltage at the junction of R16 and U2; it should be between 4.9 and 5.1 volts. The voltage on the other side of that resistor should be between 3.8 and 4.0 volts. Also check the junction of R13 and R14 for a voltage of from 1 to 1.2 volts.

Adjust R7 to get a 2.5-volt reading (±.01-volt) from its wiper. Also put R11 in its full counterclockwise position and R8 to its midrange position. Both LED's should be off at this point. Set your meter to perform continuity tests and check the contacts of K2, which should be open. Check the normally open and normally closed contacts of K1 to ensure it is not engaged or wired improperly.

Now turn off S1 and jumper pin 4 to pin 1 on the IC socket. Turn S1 on and verify that LED2 is illuminated while LED1 is extinguished. Perform continuity checks to ensure the normally open contacts of K2 have closed, and that K1 is also engaged. Turn S1 off and remove the jumper from the IC sock-

(Continued on page 94)

Infrared remote controls transmit an invisible beam of light. Not only is their operation a mystery to many people, they can also be difficult to troubleshoot when they're not working properly. This article will describe how they work, and in addition show you how to build a device that will allow you to display a remote control's demodulated signals on your oscilloscope.

Infrared Light. Infrared remote controls are quite commonplace these days. Virtually anything that has controls on it can now be purchased with a remote control. Devices with remote controls aren't any more expensive than devices without remotes.

As you probably already know, with the exception of universal or similar units, the remote control from one device usually will have no effect on another device. Have you ever wondered how that is accomplished? Well, it's actually quite simple, but before we begin our discussion, let's first be sure that we understand what infrared (IR) is. IR is actually light, so it is very similar to the light you see emitted by a light bulb. However, what's different is the wavelength, or the frequency, of the emitted light. The wavelength, by the way, is what gives light its color. You've probably noticed that you can't see any light coming from your IR remote control. That's because the wavelength of IR is such that it's invisible to the human eye. But keep in mind that just because *you* can't see IR light, that doesn't mean that you can't construct a device that can see it.

IR is used for remote controls for many reasons, but the main one is you don't have an annoying beam of light exiting your remote control every time you press a button. Now let's see how many different functions, as well as device-specific codes can be sent using a beam of "invisible light."

The Language of Remotes. For you computer fans (no pun intended), remote controls act very much like modems, transmitting data in a serial fashion. Refer to Fig. 1 as the process is explained. Figure 1A shows a series of digital pulses (intelligence) to be transmitted by the remote control. The length of time between pulses (not the pulses themselves) is used to represent bits of information. For example, if the time between pulses that represents a binary zero is T seconds, the time between pulses to represent a one is 2T. The digital information is encoded on a carrier (usually 40-kHz), and serially transmitted as a signal that resembles the waveform shown in Fig. 1B.

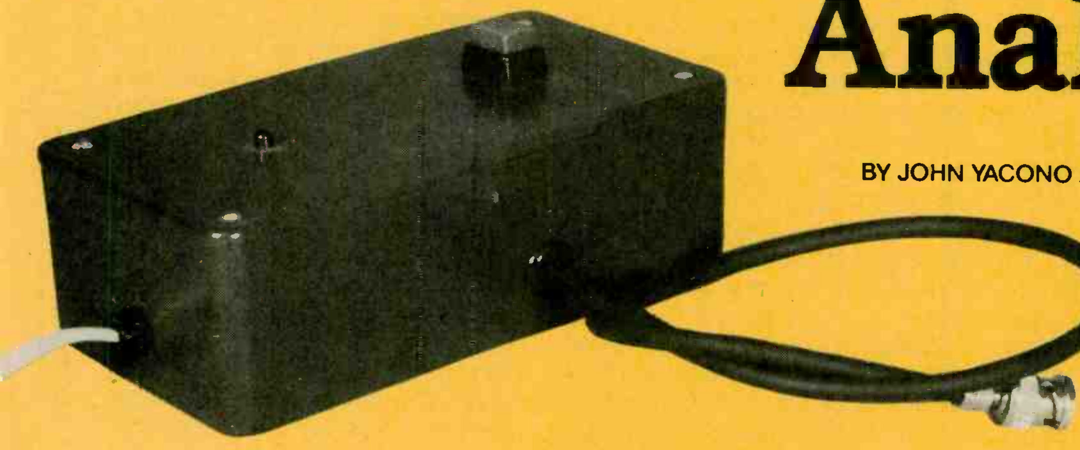
Referring back to Fig. 1A, the first pause between pulses, labelled "start," is actually 3T long and is used to tell the receiver (a TV, VCR, tuner, or whatever) to prepare to receive the incoming data. That "start bit" also helps the receiver to synchronize itself with the remote transmitter. If the receiver is not synchronized, it could misinterpret some bits along the way.

After that, the transmitter sends a device ID. That allows the receiver to check the ID of the transmitter to make sure the received signal is coming from a compatible remote. If the ID is incorrect, the receiver's microprocessor ignores the rest of the pulses. If the ID is correct, the remaining pulses tell the receiver which function (play, fine-tune, channel up, etc.) is being requested. If the function is a valid one, the microprocessor places the function bits in a special memory location (more on that later) and proceeds to perform the specified task.

A Simple Remote-Control Analyzer

Uncover the secret language of infrared remote controls using a device that displays their invisible signals on your oscilloscope.

BY JOHN YACONO AND MARC SPIWAK



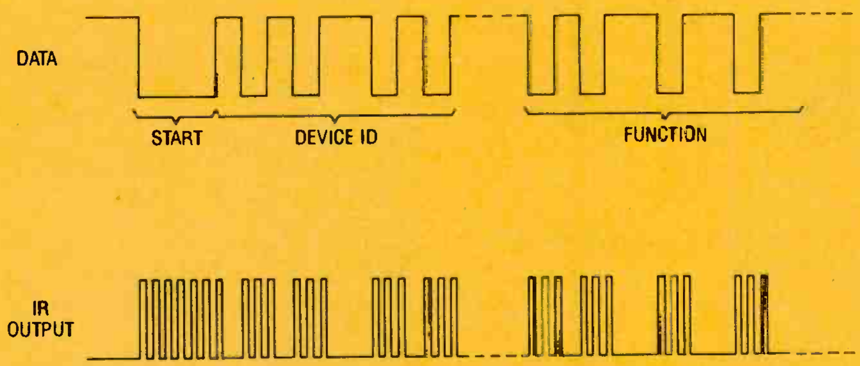


Fig. 1. The encoded data transmitted by a remote can be broken down into three major parts—start, device ID, and function—as shown in A. That data is transmitted (see B) as a series of infrared bursts.

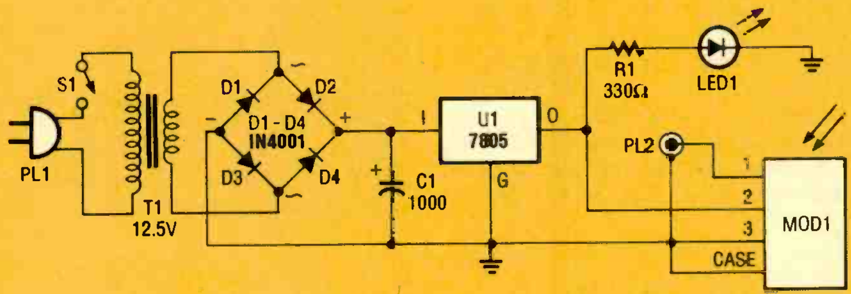


Fig. 2. The Remote Analyzer is so simple because all of the signal processing is performed by the infrared detector/demodulator module, MOD1.

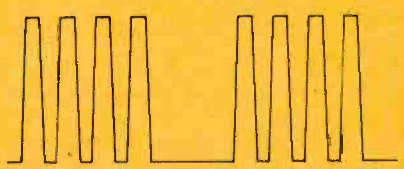


Fig. 3. Ideally, this is what the IR output from a remote would look like if it was trying to transmit two pulses.

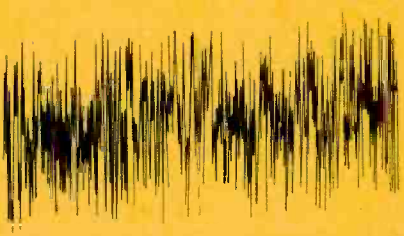


Fig. 4. In the real world, there is a lot of ambient noise in a room. It can be generated by the walls, the furniture, a human, a light bulb, and just about anything that's at room temperature. Note how the trace shifts upward as it moves right due to a light bulb increasing the ambient light in the room.

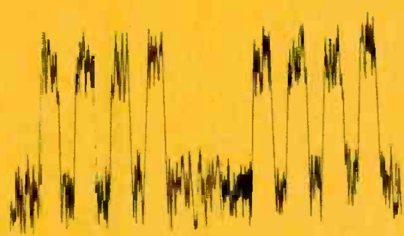


Fig. 5. The transmitted bursts with superimposed noise (at the top of the bursts) might look like this. Actually, most environments aren't that noisy.

Two examples of invalid sequences are selecting channels outside a tuner's range, or requesting a function that contradicts what the unit is doing (such as rewinding during a recording session without first stopping).

If you keep your finger on a remote button, the remote doesn't keep repeating the same string of bits over and over. Instead it transmits a special "repeat" command. The microprocessor then fetches the last valid command from its memory. The repeat signal contains very few bits, so by using a repeat command, the remote can get the microprocessor to respond quicker. That's very useful if you want to scan through channels rapidly, or alter volume quickly.

Circuit Theory. A schematic diagram for the Remote Analyzer is shown in Fig. 2. The circuit is powered from a simple 5-volt supply, consisting of PL1, S1, T1, a bridge rectifier (comprised of D1 through D4), capacitor C1, and a common 5-volt regulator, U1. Switch S1 is the on/off control and is optional. The power-supply transformer used in the prototype is a 12.6-volt AC unit, but any transformer that can supply at least 5.6-volts AC will do. The 12.6-volt unit was used solely because of its availability.

The output of T1 is full-wave rectified by diodes D1 through D4 and filtered by C1. The bumpy DC output from the capacitor is regulated down to 5-volts by U1, a 7805 integrated regulator. LED1 acts as a power indicator that lets you know the circuit is active.

The 5 volts DC powers a GPIU52X infrared-detector module (MOD1) that single-handedly demodulates the 40-kHz carrier used by most infrared remotes. After demodulation, the resulting logic pulses are sent to an oscilloscope via PL2, a BNC connector. Now let's discuss the operation of the tiny module in depth.

Module Operation. When infrared light is received by MOD1, it processes the light to determine if it contains valid control signals. The best way to understand how the IR-detector module works is to take a simple pulse train and follow it through the stages of the module. Let's start with a simple two-pulse remote transmission, like that shown in Fig. 3. Note that it appears as two bursts of infrared turned on and off at 40 kHz.

That trace is not true to life, however. In an average room, plenty of infrared noise is generated by light bulbs, the sun, and home-heating radiators. The ambient noise would look something like Fig. 4. Note that the graph slowly rises as it moves to the right. That simulates the effect of a light bulb in the room. The light bulb would increase and decrease in brilliance at 60 Hz, thus raising and lowering the amount of ambient infrared in the room. The module would actually receive a combination of the remote signal and the noise. A graphic representation of that signal is shown in Fig. 5.

Refer to Fig. 6 (the module's functional block diagram) as we describe the module's operation. The IR would be received by an IR photodiode, which is operated in its reverse-bias mode. The amount of reverse-bias current that the diode passes depends upon the intensity of the received infrared light.

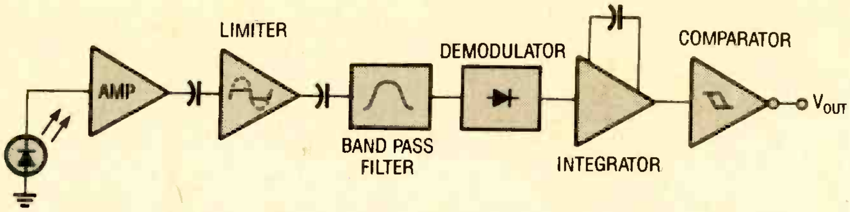


Fig. 6. The module stages look something like this. Together they process infrared light to extract any pertinent waveform and then demodulate it.

PARTS LIST FOR THE REMOTE ANALYZER

SEMICONDUCTORS

U1—LM7805 5-volt, 1.5-amp voltage regulator, integrated circuit
D1–D4—1N4001 1-amp, 50-PIV silicon rectifier diode
MOD1—GPIU52X IR detector/demodulator module (Radio Shack 276-137)
LED1—Light-emitting diode (red)

ADDITIONAL PARTS AND MATERIALS

R1—330-ohm, ¼-watt, 5% resistor
C1—1000-µF, 16-WVDC, electrolytic capacitor
T1—12.6-volt, 0.5-amp power transformer
PL1—Molded AC plug with line cord
PL2—BNC connector
S1—SPST switch
Perfboard, enclosure, coaxial cable, wire, solder, hardware, etc.

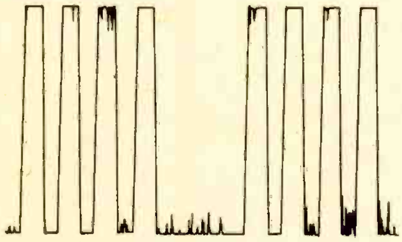


Fig. 7. Amplifying and limiting the incoming waveform helps remove a lot of the noise. The noise remaining is not likely to pass through the remaining stages.

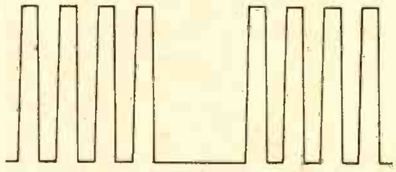


Fig. 8. The bandwidth-limiting filter eliminates the rest of the noise. In fact, the only way that any noise could successfully get through the filter is if its amplitude was so large that the amplifier and limiter stages could not help get rid of it.

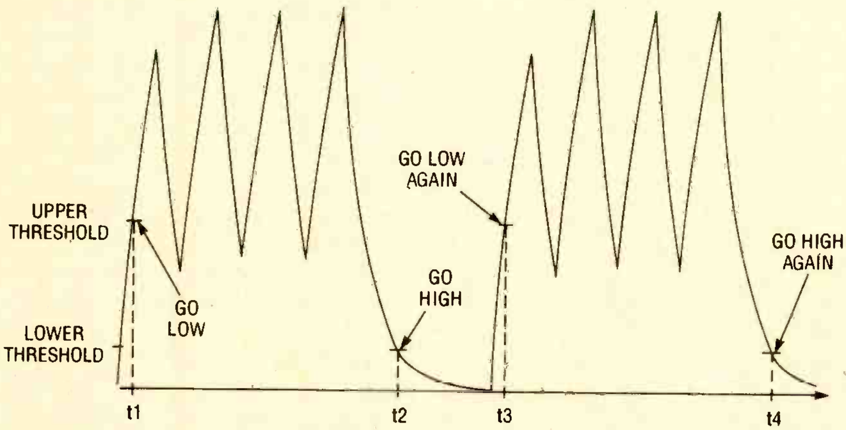


Fig. 9. When the wave is integrated, it doesn't make transitions very quickly, so it only goes completely low after a burst has finished.

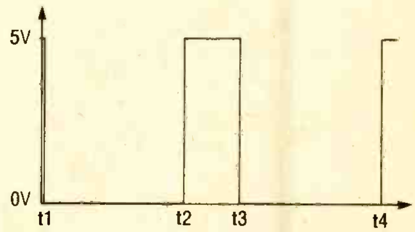


Fig. 10. This is the output from the Schmitt trigger and the module as a whole. If you compare it with Fig. 9, you'll see the trigger's output is normally high, and goes low only when the incoming wave surpasses the upper threshold (t1), and only goes high again when the integrated wave drops below a lower threshold (t2).

The fluctuations in current are amplified by a high-gain stage, and the output of the amplifier is then "limited" by the next stage. The limiter chops the extreme highs and lows off the incoming signal, resulting in a quasi-digital pulse train, much like that shown in Fig. 7. Note how much of the noise has been disposed of by the limiter stage.

The simplified wave then passes through a bandpass filter that is centered at 40 kHz and has a bandwidth of ±4 kHz. The filter removes even more noise and also prevents sources of infrared operating at the wrong frequency (60 Hz, for example) from causing false activation.

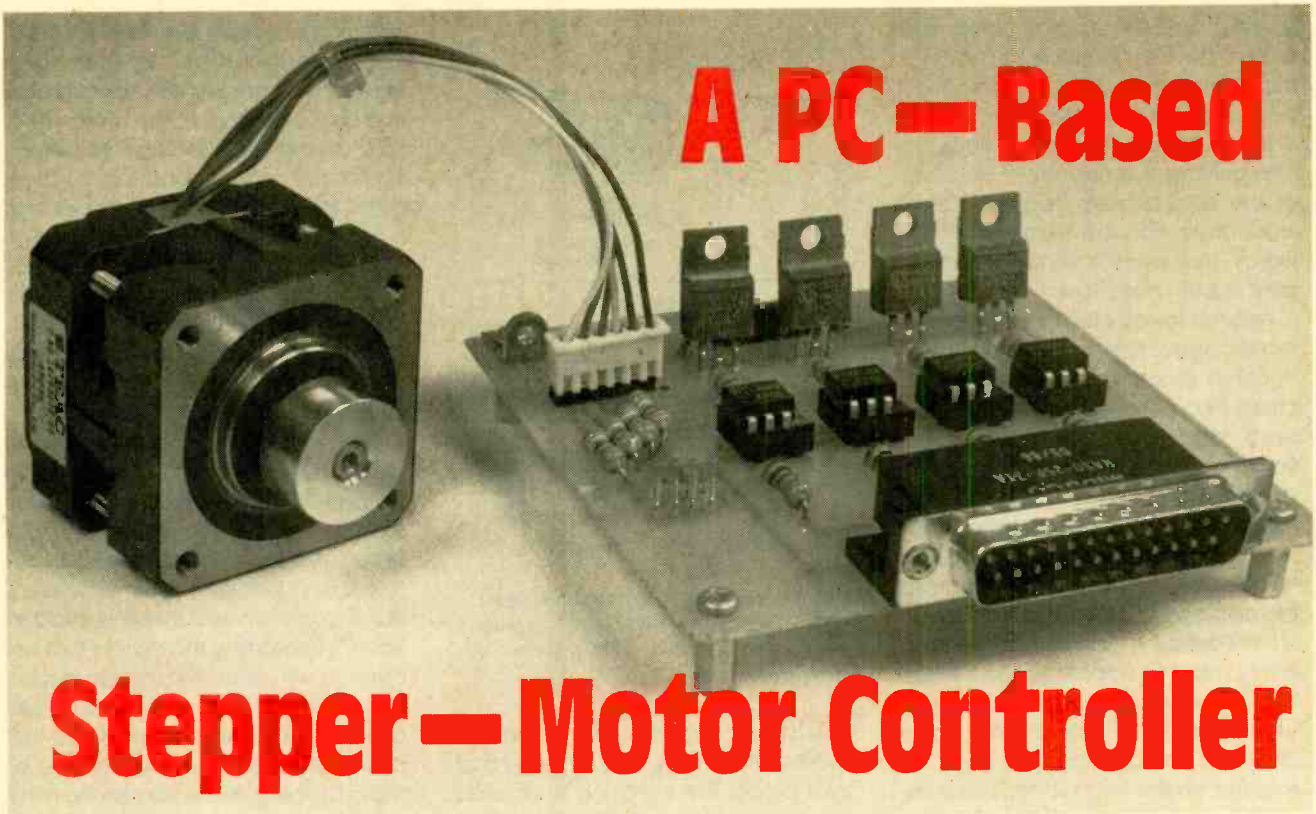
The filtered signal is then demodulated, thereby producing a signal that resembles that shown in Fig. 8. Although the circuit has effectively retrieved the remote transmission, the processing does not end here. The final stages demodulate the signal so that the module can output the pulses represented by the bursts. The demodulated signal is then integrated—meaning that it is sent through a filter that responds slowly to the changing signal. The result of that is shown in Fig. 9. Note that the wave doesn't have enough time to go to zero during a burst. The individual pulses just occur too fast. However, the integrator's output does have enough time to go to zero between bursts.

The entire circuit is built on a piece of perfboard, and it all fits inside a small plastic project case. A BNC connector is used to connect the device to an oscilloscope.

The next stage—an inverting "Schmitt trigger" comparator—takes advantage of those characteristics. Its output will not go low unless the input signal exceeds a certain amplitude, and will not go high again until the signal drops below a certain mini-

(Continued on page 93)

A PC-Based Stepper-Motor Controller



Learn about the single most important component of robotic systems by building a PC/stepper-motor interface.

BY LARRY R. ANTONUK

The electronic hobbyist who wants to expand his knowledge and extend his skills has several options: Night courses are available at many colleges and "tech" schools, but the schedules are inflexible. Home-study courses are another option, but they often cost hundreds of dollars. The last and perhaps best choice for many is a simple self-styled project/study program. For the motivated individual that is often the ideal approach. Using available texts and documentation, the self-taught student can design and build his own lab-type courses, saving hundreds of dollars.

In this article, we'll present enough information for you to build a simple PC/stepper-motor interface, which can be used as an excellent springboard into the world of automation. Building and using the interface will give the hobbyist an excellent introduction to stepper-motor theory, not to mention a taste of BASIC programming.

In addition to its use as an instructional tool, the interface board may also be used to control relays for any general-purpose computer control of the "outside world." Let's start off with a little background information on stepper motors.

Why Stepper Motors? Few products have revolutionized industrial-control technology as much as the simple stepper motor. Widely used for moving and positioning products in the machining and manufacturing industries, steppers are the foundation of the whole applied robotics field. Stepper motors are found in disk drives, printers, and even in children's toys. Familiarity with these motors and their drive systems is a prerequisite for anyone hoping to enter the industrial-electronics field. In fact, their are even some special vocabulary words and catch phrases applicable only to stepper motors (see the boxed text entitled "Glossary" for some examples).

At this point, you might be wondering what's so special about a stepper motor to make it so important. Well, while a stepper motor resembles a standard DC motor, its operation is quite different: A stepper is designed to rotate its armature one "step" or portion of a rotation at a time rather than making complete rotations at a given speed.

The number of degrees in each step varies from motor to motor, but a typical value might be 1.8 degrees per step. That means that for each "signal" (which we'll discuss in detail later) sent to the motor from the controller, the motor shaft will rotate 1.8 degrees, and stop. If a shaft movement of 18 degrees is desired, 10 signals must be sent to the motor. If "continuous" rotation is desired, the motor must be sent a continuous stream of signals.

As an example, the printhead on some printers rides on a carriage that is connected to a belt. The belt is driven by a stepper motor. The software (or firmware, to be exact) in the printer knows that a given number of stepper-motor steps corresponds to a given number of spaces on the platen. So the firmware commands the printhead to print a letter, then sends signals to the motor to move the carriage the right number of steps before printing the next letter. Because of the special way stepper motors work, they can be stepped backwards. That permits some printers to print in both directions.

Another special feature of stepper-motor operation is their ability to "lock" in place. That allows them to brake in a precise position. With forward, backward, and braking functions available, it's possible to use a stepper motor to drive a threaded rod that mates with a nut mounted to a movable carriage (see Fig. 1). This "lead-screw" drive assembly causes the carriage to move back and forth a fixed distance that is proportional to the number of steps the motor takes. Two motor/lead-screw assemblies positioned at 90° to one another could allow the carriage to move in an X-Y manner, similar to a plotter. Three assemblies would permit three-dimensional motion; that configuration is widely used in computer-controlled machining operations.

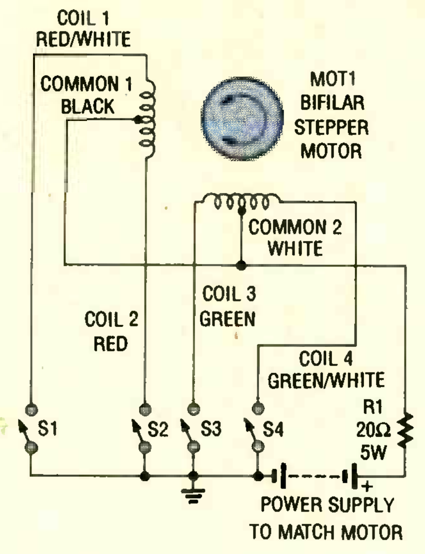


Fig. 2. A stepper motor contains two center-tapped windings. If you actuate those windings in the right sequence the rotor will rotate.

In a standard, motor some type of "commutation" (or switching) must take place. The switching is required to change the polarity of the field windings so that the magnetic field always forces the rotor into motion. In a typical motor, the commutation process is accomplished through the use of brushes and a commutator—a segmented cylinder mounted on the rotor shaft. As the rotor and commutator spin, different segments of the commutator touch the brushes. The brushes and commutator segments complete the circuit containing the coils so that current will flow through the right coils in the right direction to keep the rotor in motion.

In a stepper motor, on the other hand, the commutation takes place in a circuit external to the motor itself. Typically the field windings are switched on and off with transistors. Furthermore, in a stepper motor, the idea is not to *oppose* the magnetic field of the rotor to cause it to spin—the coils in a stepper *attract* the rotor to pull it to a specific position and hold it there. To move the rotor to the next step, you have to energize the right coils to coax it to that step.

Figure 2 contains a schematic for a typical stepper motor. By applying voltage to the four coils in a prescribed manner, the motor will step. Different stepper designs require different sequences of coil activation, but a common sequence is listed in Table 1. Energizing the coils in that sequence will cause the rotor to step in one direction; reversing the sequence will cause it to step in the opposite direction. Keeping any two of the coils energized will cause the rotor to brake. Many times the rate at which the coils are switched is varied to slowly bring the motor up to speed, or to gradually slow it down. This acceleration/deceleration process, known as "ramping," is often used when a motor has a very heavy load.

The circuitry used to produce the train of data needed to step the motor can be simple or complex. The proper sequence of pulses can be produced with logic gates, single-board microprocessor systems, or PC-based controllers. PC controllers will usually make use of a card that plugs into an expansion slot. This card will often be able to drive several different motors at once. In more complex systems, an optical encoder is often used to keep tabs on the shaft position.

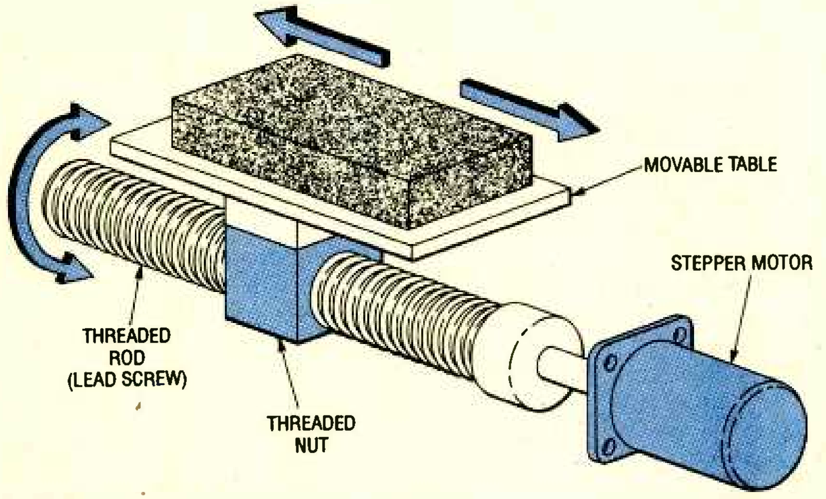


Fig. 1. Stepper motors can perform a number of tasks where precision is important. Here one is shown moving a work table back and forth.

What Makes it Step? A stepper motor is similar to a permanent-magnet DC motor. Both types use a permanent-magnet rotor or armature, and a coil or series of coils that make up the field winding. Current flowing through the field winding produces a magnetic field that opposes the magnetic field of the permanent magnets, causing the rotor to move.

Finding a Motor. Surplus stepper motors are available from a variety of sources. Mail-order catalogs, electronic parts shops, and computer/amateur-radio flea markets are good places to start looking. Junked disk drives will often yield a usable motor, as will old printers. There are several different types of stepper motors, each requiring a different type of drive circuitry. The simplest configuration (from the driver standpoint) was shown back in Fig. 2. That is known as a bifilar-wound, six-lead hybrid motor, and is the type to use with our controller. That type can be identified by checking the coil continuity with an ohmmeter—look for two center-tapped windings. Also, many of these motors were produced with standard color coding on the leads. If the colors match the ones in the diagram, you can be fairly sure that you have the correct type of motor.

Once the "common" leads are located, it becomes necessary to determine which of the other coil leads is which. The easiest way to do this is by connecting the motor as shown back in Fig. 2. Adjust a power supply to the voltage value stated on the motor's nameplate and connect it as shown. Switches S1 through S4 don't need to be actual switches—two clip-tipped leads will work just fine. The 20-ohm resistor is used as a dropping resistor in most motor circuits. It prevents the motor from overheating when braking.

Arbitrarily name one pair of coils (coils that share a common center-tap) 1 and 2, and the other pair 3 and 4. Fasten a piece of paper to the motor shaft, to help you see what direction the rotor is turning. When the hookup is complete, connect the two clip leads to the first and third coils (close S1 and S3), then the first and fourth coils (S1 and S4 closed), and so on, simulating the signals that will be sent to the motor by the controller as indicated in Table 1. If the motor rotates a step at a time, in the same direction each time you change the clip leads it means that you randomly picked the proper coil designation on the first try.

More likely, the motor will step in one direction, then step back, then step forward, etc. The task at this point is to re-designate the wires so that when you move the clip leads through the sequence the motor rotates in only in one direction. When you reach this stage the motor leads will be arranged in the order that matches Table. 1. (The procedure is fairly simple, but so are many Chinese puzzles. The job is best approached with a fresh cup of coffee.)

TABLE 1—STEPS AND BIT VALUES

Step	Coil 1	Coil 2	Coil 3	Coil 4	Decimal Equivalent
1	1	0	1	0	10
2	1	0	0	1	9
3	0	1	0	1	5
4	0	1	1	0	6
Note: 1 = Energized; 0 = Not Energized					

Our Controller. Rather than relying on a large quantity of logic gates or a dedicated microprocessor, our controller board (see Fig. 3) is simply a "dumb" interface between the computer and the motor. That means that the computer will do all the "thinking," and the controller board will simply drive each coil in the motor based on the output from the computer. There are several ways to get information into and out of a personal computer, but for our purposes the printer port is the easiest. That is because the printer port is a parallel port, meaning that eight bits are available on eight different lines, all at the same time. We simply pick four of these lines, assign each one to a coil in the stepper motor, and instruct the computer to send data to the port that corresponds to the bit sequence we desire.

The board performs two simple functions. First, it uses power transistors (Q1–Q4) to sink the high current required to run the motor under the di-

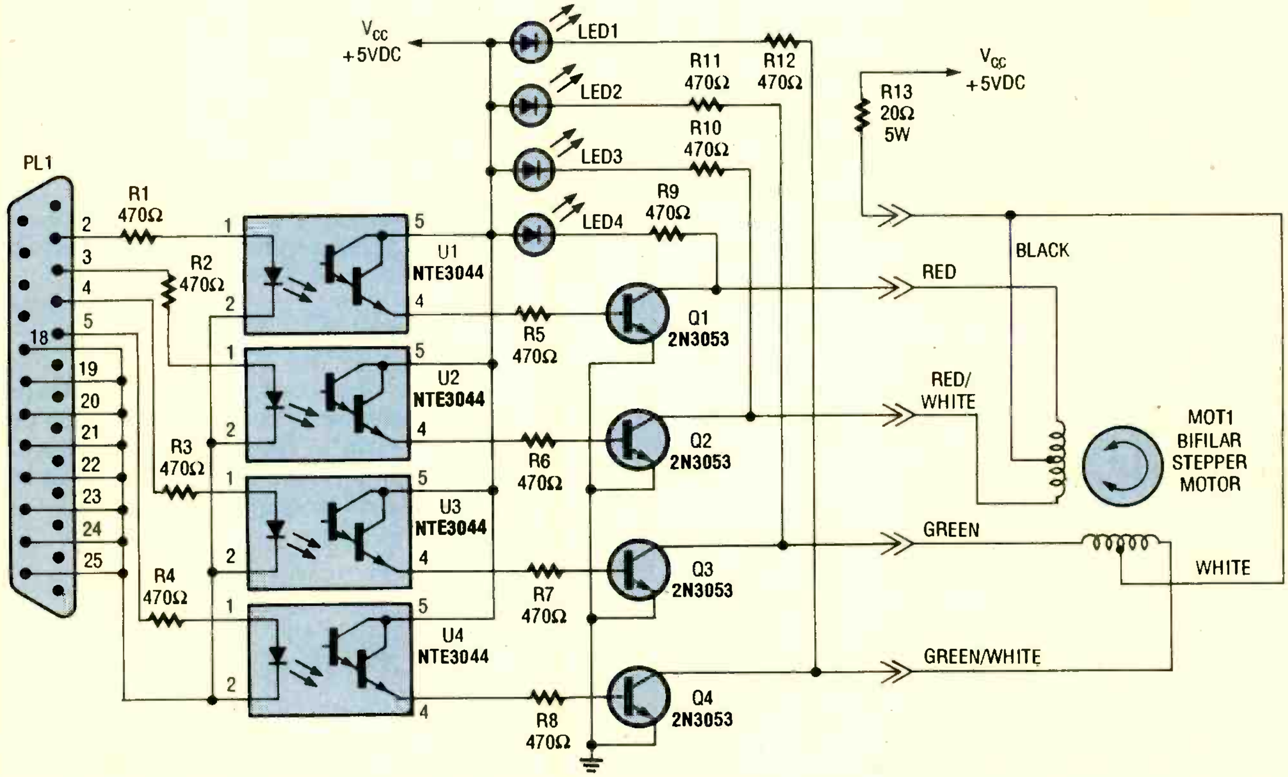


Fig. 3. The motor-control interface is really an isolating circuit. It isolates the computer port from the motor.

rection of the low-current outputs of the printer port. Second, since it uses optoisolators to help perform that task, it provides the printer port with electrical isolation. That means that any unwanted noise generated by the motor will not be able to make its way into the computer. In addition, if a device on the controller board should fail, there is no path for any destructive currents to damage the printer port. For both these reasons optoisolators are worthwhile, yet inexpensive, insurance.

Due to the small number of parts, construction of the board is very straightforward. The unit may be assembled using the PC board foil pattern shown in Fig. 4 and the parts-placement diagram shown in Fig. 5, but perfboard or even a solderless prototype board will work just as well.

If you plan to use the foil pattern, please note that it is designed to accomodate 8-pin IC sockets for U1–U4 although those IC's have only 6 pins. That is because 8-pin IC sockets are more readily available than 6-pin sockets. So when installing U1–U4 be sure to position them so that pins 1 and 6 on those IC's are in holes 1 and 8 of the socket.

Before you start acquiring your parts, please note that the resistor values in the transistor-driver portion of the circuit were chosen for a given stepper-motor voltage, and may

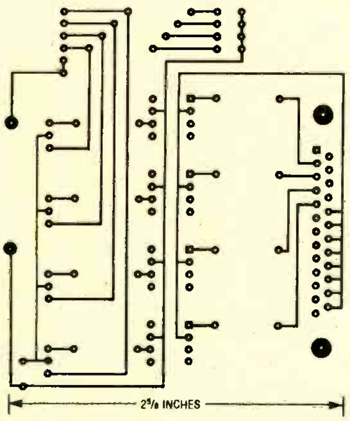


Fig. 4. If you wish to make a PC-board, use this solder-side foil pattern. Note that it is shown here smaller than actual size.

need to be altered slightly for the best performance. If your motor rotates, but doesn't have the torque you think it should, check to make sure you are using the optimum resistor values. Once the board is assembled, connect it to the PC printer port via the 25-pin connector, making use of a DB-25 male-to-female extension cable if necessary. Connect the power supply and motor, and you're ready to go.

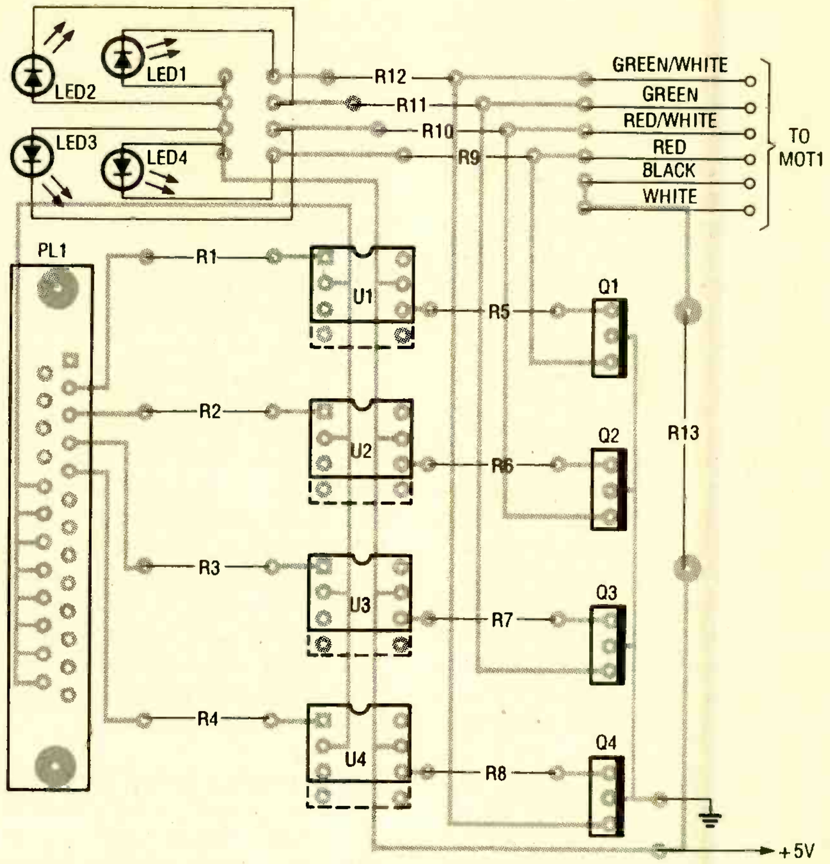


Fig. 5. Stuff the printed-circuit board using this parts-placement diagram as a guide. If necessary, alter the connections to the motor to suit the one you use.

The Program. Getting the computer to talk to the motor is perhaps the easiest part of the project. If we refer back to Table 1, we can see that the coils that need to be energized change with each step of the motor. If we think of the coils as binary digits (the bits) of a four-bit word, we simply need to send this word to the printer port each time we want the motor to step. Converting the binary information to decimal, we see that we need to send the sequence 10-9-5-6 (in regular decimal numbers) to move four steps, and we repeat the sequence to keep the rotor rotating. Accomplishing that is fairly simple. The simplest way to send information directly to the printer port is via BASIC. Load BASIC, and type in the following:

OUT 888, 10 <return>

That command sends a decimal value of 10 (which is 1010 in binary) to the first four lines of the printer port. The LED's corresponding to the first step sequence will light, and the motor will step. Now enter:

OUT 888, 9 <return>

The LED's will change, and the motor will step to the next position. Try it with the next two lines:

OUT 888, 5 <return>
OUT 888, 6 <return>

That works well, but it's difficult to get the motor to go very fast since you have to enter each line. To resolve that problem create the following short program, and run it:

```
10 OUT 888, 10 <return>
20 OUT 888, 9 <return>
30 OUT 888, 5 <return>
40 OUT 888, 6 <return>
50 GOTO 10
```

Until you hit the control-break key, the program will send a stream of step sequences to the motor. Depending on the speed of your PC, two things

(Continued on page 91)

Build the "Tiny Tuner"

If you've been having problems with your QRP equipment, this tuner may be just what you need to optimize your rig for the frequency of interest

BY PHIL SALAS, AD5X

Low-power amateur-radio operation is challenging and fun. The thrill of making international contact using a rig of less than five watts is really something to experience. Low-power (or QRP) equipment tends to be small and light, making it perfect to carry along on vacations. Unfortunately, some of the peripherals needed for a QRP station can be as large or larger than a complete QRP transceiver. For example, commercially available antenna tuners are often designed to handle upwards of 200 watts, which means large inductors and capacitors. Because of that, the tuners are much larger than needed.

But that needn't be because of the *Tiny Tuner* described in this article. The Tiny Tuner is small enough to fit in the palm of your hand, and it is flexible enough to match almost any piece of wire that you might use for an antenna. That's accomplished through an L-type filter network.

L-Type Filters. In its basic form, the L-type filter—so named for its resemblance to the letter L—is built around two components; either an inductor and capacitor (LC-type) or resistor and capacitor (RC-type). Such circuits can be used for impedance matching, selecting a band of frequencies from among many, etc.

Two L-type LC filters are shown in Fig. 1. Figure 1A shows an L-network configuration that can be used to match a low-impedance output to a 50-ohm load (the antenna). Figure 1B shows an L-network configuration that can be used to match a high-impedance output to a 50-ohm load.

Those filter circuits, in addition to their impedance matching properties, also provide low-pass filtering, which in our application, is well suited to the suppression of harmonics in the transmitted signal. A low-pass filter will pass all frequencies that are at or below its design parameters, while attenuating all others.

Although the two circuits shown in Fig. 1 are configured for low-pass operation, they can easily be converted to high-pass operation by reversing the positions of the inductor and capacitor. The high-pass type filter would, of course, pass only signals at or above the design frequency, while attenuating all others.

Now let's take a look at our tuner circuit, which uses both of the circuits in Fig. 1.

The Tuner. The schematic diagram for the Tiny Tuner is shown in Fig. 2. As can be seen, the tuner is little more than a tapped inductor (L1), variable-capacitor (C1), L-type LC filter. The capacitor is connected to the inductor through a center-off DPDT switch (S1), which allows the capacitor to be connected to either the input or output of the circuit. The switch enables the Tiny Tuner to provide *either* a step-up or a step-down impedance transformation (depending on which extreme the switch is set to).

When S1 is set to "I" (input), the capacitor is connected to the input (transmitter) side of the antenna tuner. That configuration matches the low-impedance to a 50-ohm circuit in Fig. 1A, and therefore permits you to tune short antennas. When the switch is flipped to the "O" (output) position, the variable capacitor is connected to the load side of the antenna tuner (matching the high-impedance to a 50-ohm circuit of Fig. 1B), permitting you to tune long antennas.

Tuning is handled through the inductor/switch combination. The inductor's 12 taps are connected to the contacts of a 12-position rotary switch, S2. That switch is used to select the number of turns that will be included in the circuit. The number of turns included in the circuit determines the electrical length of the antenna; *i.e.*, the S1/L1 combo is used to electrically lengthen or shorten the antenna. In that way, the antenna can be made resonant at the frequency of interest.

When S1 is in the off position (which takes the capacitor out of the circuit) and the inductor is set to zero inductance, a direct path to the output is provided through switch S2, thereby bypassing the antenna tuner.

Construction. Because the Tiny Tuner is comprised of so few parts, there is nothing difficult about building the circuit. In fact, the most difficult aspect of the circuit's assembly lies in winding the inductor, L1—and even that is really quite simple. Inductor L1 was made from #24 enamel-coated wire hand-wound on an Amidon Associates (12033 Otsego Street, North Hollywood, CA 91607) T130-6 (yellow core) torroid coil form. When winding the coil, leave an extra length of wire at the beginning of the coil; that will serve as the zero (0) tap. Then wind 21 turns of the wire on the coil form. As you wind, make loops (which will form the taps) at turns 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19. As the loops are made, give them a twist close to the toroid body (see Fig. 3) to hold the turns in place. The taps should be equally spaced around the coil form. That helps to place the taps in good position to be soldered to the contacts of the rotary switch. At turn 21, again leave an extra length of wire, which will also serve as a tap.

Once all 21 turns have been wound, snip off the ends of each loop, scrape the enamel from the leads, individually twist the pair of wires from each loop, and then tin them. After tinning

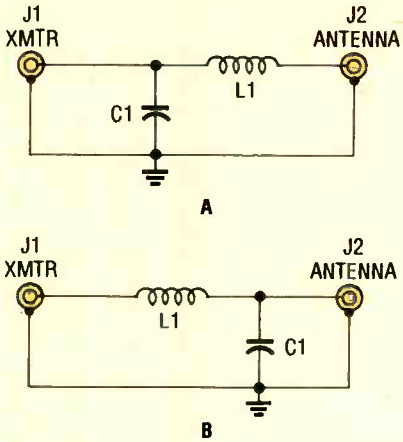


Fig. 1. Here are two L-type, LC filters; the one in A can be used to match a low impedance to a 50-ohm load, while the one in B can be used to match a high impedance to a 50-ohm load. Those filter circuits, in addition to their impedance matching properties, also act as a low-pass filter.

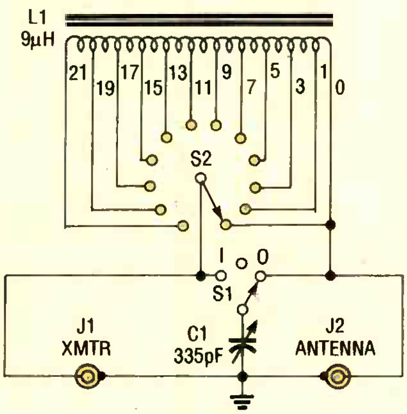


Fig. 2. The Tiny Tuner is comprised of a tapped inductor (L1) and a variable capacitor (C1), which is connected to the inductor through a center-off SPDT switch (S1). That switch arrangement permits the capacitor to be connected to either the input or output of the circuit, thus allowing the circuit to emulate both of the circuits in Fig. 1.

all the taps, solder the inductor to a 12-position rotary switch. Assuming a clockwise rotation of S2, the turn-21 tap should be connected to the first switch contact (making the first switch contact the position of maximum inductance); The turn, 0 tap should be connected to contact 12. Connect lengths of insulated hook-up wire to contact 12 and the wiper terminal of S2. They will be used to connect the switch/inductor assembly to switch S1. Place the switch/inductor assembly to the side, and begin preparing the enclosure to accept the tuner.

The author housed the prototype unit in a 3 15/16 × 2 1/16 × 1 5/8-inch plas-

PARTS LIST FOR THE TINY TUNER

C1—335-pF tuning capacitor
L1—See text
S1—DPDT center-off toggle switch
S2—SP12T rotary switch
J1, J2—BNC chassis-mount jacks

ADDITIONAL PARTS AND MATERIALS

Amidon Associates T130-6 yellow-core toroid coil form, 3 15/16 × 2 1/16 × 1 5/8-inch plastic enclosure, knobs, #24 enameled wire, miniature microphone cable or RG-174 coax, hook-up wire, solder, hardware, etc.

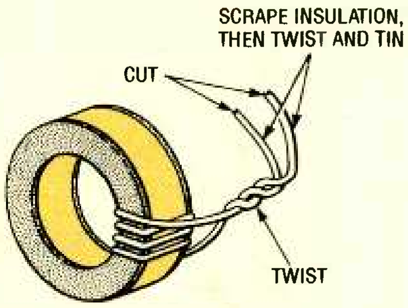


Fig. 3. Inductor L1 is comprised of 21-turns of #24 enamel-coated wire handwound on a T130-6 (yellow core) toroid coil form. When winding inductor L1, taps are made at turns 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19, with turns 0 and 21 serving as the first and twelth taps.

tic project box. The metal lid of the box was used as the front panel of the unit. Prepare the lid by first drilling holes for the unit's controls. A full-scale template of the Tiny Tuner's front panel is shown in Fig. 4. The template can be copied or cut from the page, and used as a combination drilling guide and panel label.

If the template is to serve as a label, it should first be covered with clear plastic laminating film (the type used to protect wallet ID's) and glued to the lid; if not, all that is needed are a couple of strips of tape to hold the drill guide in place. In any case, drill holes at the three crosshairs. The center and left holes (for the DPDT center-off switch and variable capacitor, respectively) should be 1/4-inch in diameter; the right hole should be 3/8-inch in diameter (for the 12-position switch).

Once the front panel has been prepared, mount S1, S2 (with inductor), and C1. The center position is reserved for S1; the capacitor and inductor (S2) positions are indicated on the front panel by "C" and "L," respectively. Unfortunately, C1 (the 335-pF variable capacitor) is not easily mounted. That unit is one of those flush-mounted jobs that have flat tuning knobs—that's the type used in portable radios. Thus, it was necessary to mount that unit, and outfit it with a conventional knob, in an unconventional manner. To mount the variable capacitor, first place the unit flush against the back side of the lid at the proper location. While holding it firmly in place, apply a bead of hot-melt glue around the unit; allow the glue to cool before releasing it.

Once cooled, mount the flat knob to the capacitor's tuning shaft. The flat knob will be used as a base for mounting a more conventional knob. Turn the capacitor fully counter-clockwise

(Continued on page 90)

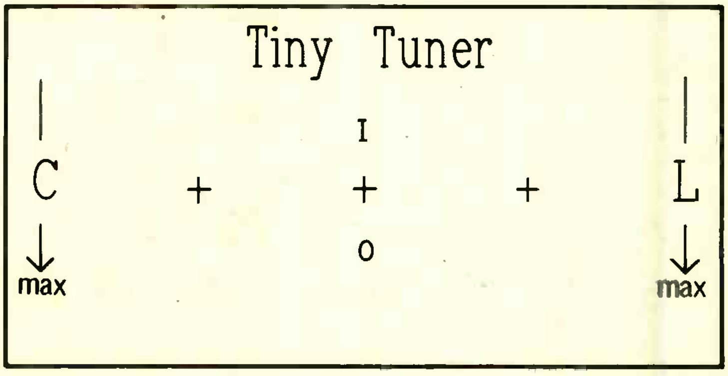
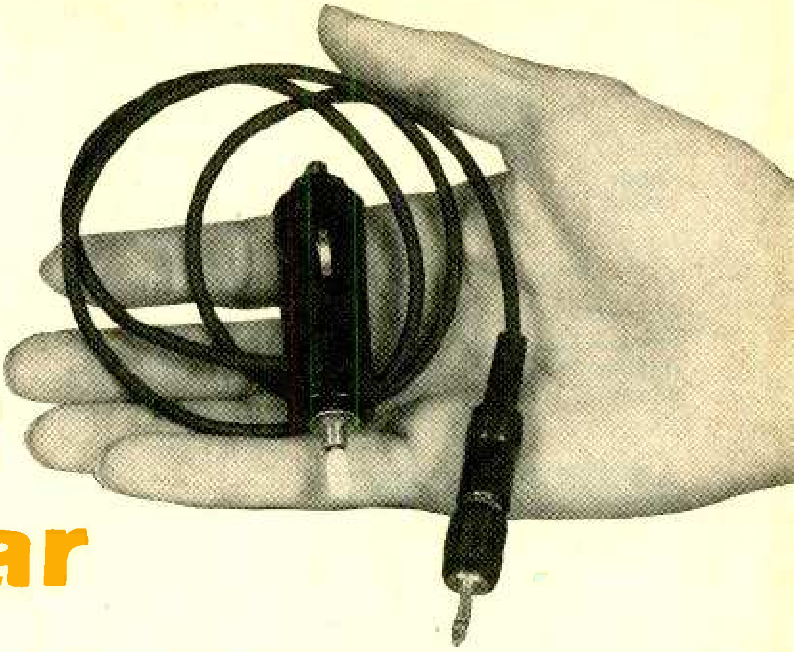


Fig. 4. The author's prototype unit was housed in a 3 15/16 × 2 1/16 × 1 5/8-inch plastic project box with a metal lid. If the same size enclosure is used to house your unit, this template can be used as a combination drilling guide and panel label.



Build a VOLTAGE ADAPTER for your car

In just one evening, you can build a device to power your Discman, boombox, portable fridge, laptop computer, or any other device that requires 3, 6, or 9 volts, right from your car's cigarette lighter. It can even provide almost any DC voltage!

If you've got an older car without a tape player or, more commonly, without a compact-disc player, you might feel that you're missing out on something. And even if you've got those gizmos in your car now, your tastes in music might not be the same as those of your passengers. The most cost-effective and diplomatic answer to both dilemmas is to use a portable, perhaps personal, sound system in your car for you or your passenger. (Of course a driver should not use headphones; there are speakers on the market that can plug into a personal audio system and I strongly recommend using them in such circumstances.)

By now you're probably saying "Cost effective? *Batteries* for portables aren't cost effective." That's very true, and that's where the *Car-Power Adapter* described in this article comes in. It's a small, unobtrusive device that converts the 12 volts available via your car's cigarette lighter into 3, 6, or 9 volts. I'll also show you how to modify the device to provide any DC voltage up to almost 12 volts.

The Car-Power Adapter can be used for many more things. My favorite use is as a power supply for my garage-door opener transmitter. (I'll never get stuck opening my garage door in the rain because the little battery went dead.)

Of course there are devices like the Car-Power Adapter on the market, but they're pretty noticable in the dashboard and can get in the way of other stuff there. They're also more expensive and, of course, not configurable.

What's in It?. The Car-Power Adapter contains an LM317 adjustable-voltage regulator. Its output voltage is determined by the resistor network accompanying it. Take a look at the example circuit in Fig. 1. Resistors R_A and R_B set the regulator's output voltage according to the following equation:

$$V_{OUT} = V_{ref}(1 + R_B/R_A) + I_{adj}R_A$$

In most applications, V_{ref} (which is the voltage across R_A) is 1.25 volts and I_{adj} is about 50 µA. Those values make the equation:

$$V_{OUT} = -1.25(1 + R_B/R_A)$$

which is the equation that you should use if you want different output voltages than the ones presented here.

The Car-Power Adapter circuit is shown in Fig. 2. In the circuit, the role of R_A is played by R2. Resistors R1, R3, and R4 perform the function of R_B and act as follows: If the single-pole double-throw center-off switch (S1) is in the center position, only R2 and R1 are in the circuit. They program the regulator to output 9 volts. Switching S1 to put R3 in the circuit causes the resistance between the adjust terminal and ground to drop. The effective resistance of the R1/R3 parallel combination sets the regulator to output 3 volts. Similarly, with R4 in parallel with R1, the output voltage is 6 volts.

Circuit Construction. Although the Car-Power Adapter is not a critical circuit, you should pay special attention to the following instructions because of the compactness required. One other thing that deserves mention is that the instructions are for negative-ground car wiring. If you've got a positive-ground vehicle, switch all the connections between the lighter plug's ground clip (mentioned later) and its center contact.

Start by sawing the heat sink off of the LM317 regulator. The heat sink will not be necessary because of the low currents required by most low-voltage devices. The heat sink will only make the device impossible to fit in the lighter plug, so carefully get rid of it.

For the rest of the assembly take a look at Fig. 3 (which, with the exception of the plugs and the switch, represents the physical, layout of the circuit). Wrap one lead of R2 around the LM317's center terminal as shown. Lay the resistor directly on the regulator leaving room for R1 as shown.

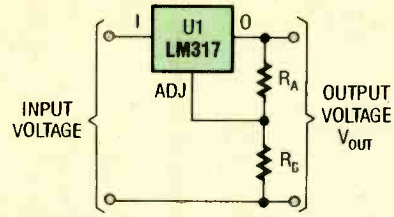


Fig. 1. This is the standard way of wiring an LM317 adjustable-voltage regulator. The output voltage is determined by the values of R_A and R_B.

yet.

Wrap a piece of electrical tape over resistors R2, R3, R4, and the long lead of R2. The tape will insulate R2's long lead from R1. Now place R1 next to R2. Wrap another piece of tape over the end of the regulator where the heat sink was to cover that sawed-off terminal. Now its time to bundle up the assembly with some wide heat-shrink tubing. Make sure that it's long enough to wrap around the edges of

PARTS LIST FOR THE CAR-POWER ADAPTER

RESISTORS (All resistors are ¼-watt, 5% units.)
R1—1500-ohm
R2—240-ohm
R3—470-ohm
R4—2400-ohm

ADDITIONAL PARTS AND MATERIALS
U1—LM317 1-amp adjustable-voltage regulator, integrated circuit
PL1—Cigarette-lighter plug
PL2—See text
Heat-shrink tubing, stranded wire, coax, electrical tape, solder, etc.

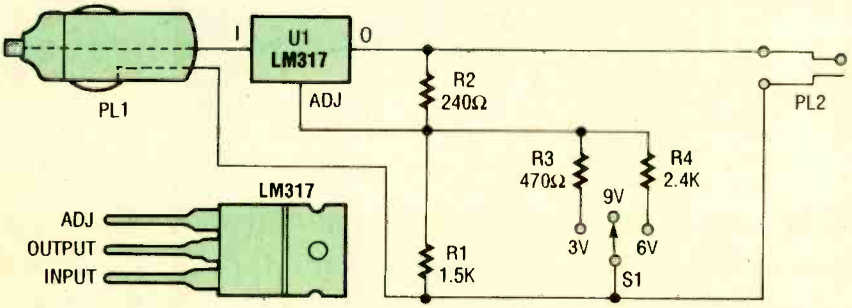


Fig. 2. In the schematic diagram for the Car-Power Adapter, note how the value of R_B (which is R1 with S1 in the center position) is changed by putting R3 or R4 in parallel with R1.

Wrap the remaining lead around the adjust terminal leaving no slack in the lead. Solder both ends of R2 to their respective terminals.

Take six pieces of stranded wire about ⅝-inch long, strip off 1/16-inch of insulation from one end of each, and tin that end. I suggest you use different colors for easy identification. Solder one of them to the LM317's center terminal, close to the regulator's body, and trim the terminal as short as possible. Use a small piece of heat-shrink tubing to insulate the connection. (Don't worry if you do not have a heat-shrink gun; a blow dryer will do.) Take another piece of prepared wire and solder it to the input terminal, again trimming the terminal short and using heat-shrink tubing.

Take another piece of tinned wire and solder it close to the body of R3. Use a piece of heat-shrink tubing to insulate the connection, but don't slip it over the end of the resistor—that will make it too bulky. Repeat the procedure for R1 and R4, but use two pieces of wire on one end of R1.

Lay R3 next to R2, wrap its free lead around the lead of R2 as shown, and solder the connection. Follow the same procedure to connect R4 to R3. Now connect the free end of R1 to R2 as shown, but don't lay it next to R2 just the regulator. Shrink the tubing and trim the excess. You should have a compact package with wires coming out one side.

Strip 1/16-inch of insulation off the ends of the wires from R3, R4, and one of the wires from R1. Strip ⅛-inch off the remaining ends of the other three wires and tin them all.

Final Assembly. Before putting everything together, you must first prepare the switch and case (which is the cigarette-lighter plug). You have to expand the hole in the back end of the cigarette-lighter plug for the switch to fit through it. You can do that easily by twisting a triangular hand file around in the hole until it's large enough to accommodate the switch's threads.

You also have to grind down the plastic sides of the switch to fit it in the cigarette-lighter plug. You can use a hand file or power grinder. If you use a power grinder, go slow—the plastic turns to powder very quickly. Your goal is to take enough off of the sides of the switch to allow it to enter the plug and seat firmly against the rear. Be sure to leave enough plastic around the outside terminals to prevent them from breaking off.

Now you must determine where to drill the hole for the power cord, which should be a coax type to prevent inductive pickup of noise. Put the switch in position inside the cigarette-lighter plug and measure the distance from the front of the case (the end that is inserted into the dashboard) to the terminals on the switch. Use the measurement to help you drill a hole for the power cord so the cord can enter without interference from the switch. About ½-inch from the end with the switch worked well for me. Remove the switch and drill the hole for the power cord large enough to loosely accommodate the coax power line that you use.

Connect the wire with the 1/16-inch lead from R1 to the spring clip that connects the cigarette-lighter plug to ground. Connect the remaining wire from R1 to the center contact of S1. Connect the wires from R3 and R4 to the remaining terminals on the switch, as indicated in Fig. 3.

Solder the wire from the regulator's input terminal to the center terminal on the cigarette-lighter plug. Run the power-cord coax through the hole you made for it and solder its shielding to the ground clip. Slip a small piece of heat-shrink tubing over the wire from the regulator's center terminal and solder the coax's center conductor to the wire. Position the tubing over the joint and shrink it.

Position the ground clip so that it surrounds the regulator. As a final touch, you might want to slip some heat-shrink tubing over the wires soldered to the clip to provide some strain relief. The tubing should be positioned to hold a bit of the wire's insulation tightly against the clip.

(Continued on page 90)

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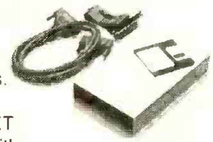

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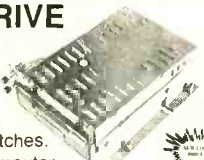

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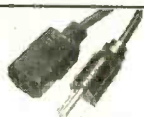

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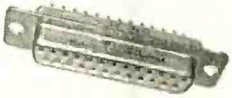

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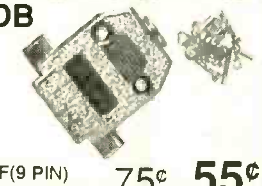

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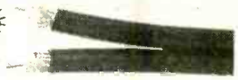

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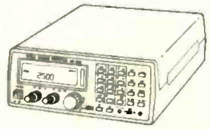

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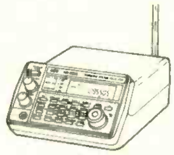

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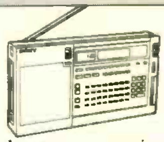

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BC549C	.30	NPN	30	100	0.5	300	TO-92
BC557	.20	PNP	45	100	0.3	150	TO-92
BC558	.20	PNP	25	100	0.3	150	TO-92
BC639	.45	NPN	80	1000	1	130	TO-92
BC640	.45	PNP	80	1000	1	50	TO-92
BD139	.55	NPN	60	1000	8	250	TO-126
BD140	.55	PNP	80	1000	8	75	TO-126
BD681	1.05	NPN	100	4000	40	1	TO-126
BD682	1.05	PNP	100	4000	40	1	TO-126
BF199	.95	NPN	25	25	0.23	550	TO-92
BF469	.95	NPN	250	50	1.8	60	TO-126
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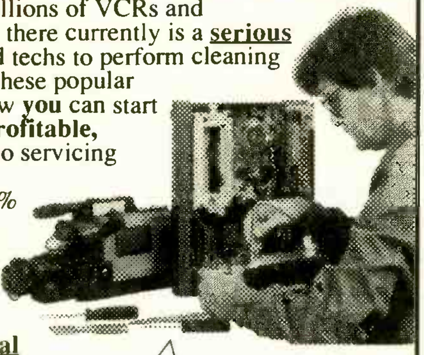

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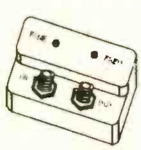

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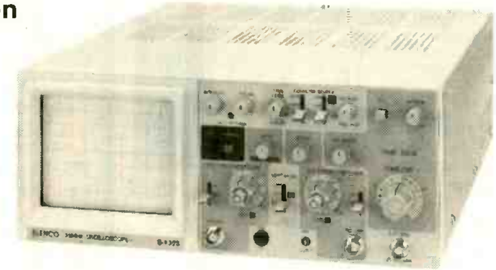


S-1325 25MHz
Dual Trace Oscilloscope

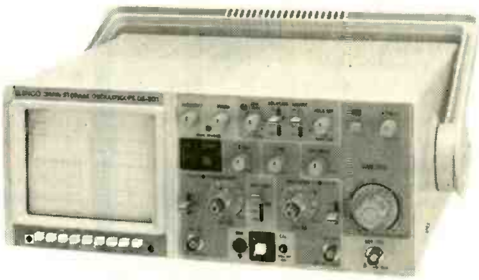
$349

S-1340 40MHz
Dual Trace Oscilloscope

$495

$795

DS-203 20MHz, 10MS/S
Digital Storage Oscilloscope



- 2K word per channel
- Plotter output
- 8 bit vert resolution
- 2048 pts hor. resolution
- Much more

All scopes include probes, schematics, operators manual and 3 year (2 years for Elenco scopes) world wide warranty on parts and labor. Many accessories available for all Hitachi scopes. Call or write for complete specifications on these and many other fine scopes.
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2 Channel
Includes probes

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V-522 - 50MHz, DC Offset	$875
V-422 - 40MHz, DC Offset	$775
V-223 - 20MHz, Delayed Sweep	$695
V-222 - 20MHz, DC Offset	$625

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V-1060 - 100MHz, Dual Trace	$1,395
V-1065 - 100MHz, DT, w/cursor	$1,649
V-1085 - 100MHz, QT, w/cursor	$1,995
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V-1150 - 150MHz, Quad Trace	$2,695

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(Portable Real-time Digital Storage Oscilloscopes)

RSO's from Hitachi feature roll mode, averaging, save memory, smoothing, interpolation, pretriggering, cursor measurements. These scopes enable more accurate, simplier observation of complex waveforms, in addition to such functions as hardcopy via a plotter interface and waveform transfer via the RS-232C interface. Enjoy the comfort of analog and the power of digital.

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VC-6025 - 50MHz, 20MS/s	$2,195
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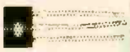
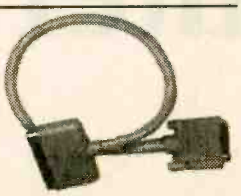


"N" channel JFET: analog switch, etc., with spec sheet.

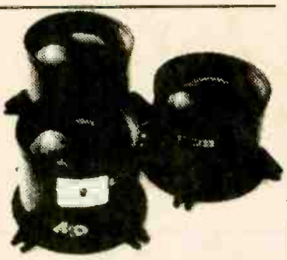
12 for $9.95

18"PC SCSI I/O CABLE



Not for Macintosh!

$3.99 each



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High quality light weight plastic lenses originally used in projection TV's.

Blowout Special - 3 for #19.95

ASTEC DC/DC CONVERTER

+12 VDC in, -5 VDC out @ 200 mA. With spec sheets.

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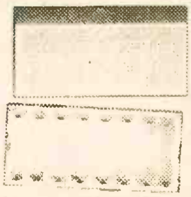

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HLMP 2685 - Red
HLMP 2885 - Green

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RCA SOLDERLESS PLUG

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Model LV341T
- 24-hour timer.
- Operates up to eight eleven-Watt lamps.
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0.35 mm dot pitch. 174 x 230 mm viewing area. Full technical specifications.

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Five pounds of assorted electronic hardware: fasteners, nuts, bolts, screws brackets, springs, standoffs, arms, gears, pulleys and indescribable metal stuff from Silicon Valley's surplus to complement anyone's hardware hoard.

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STEPPER MOTOR ASSORTMENT

Ten for $16.95

3 mW HeNe LASER

Power supply diagrams included.

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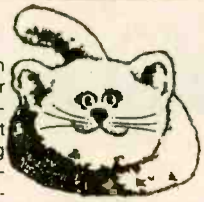
ROBOT KITTY



This fun feline with an internal microprocessor control system is a marvel of state of the art technology, featuring DUAL DC DRIVE MOTORS with GEAR REDUCTION and two-inch diameter RUBBER TREAD DRIVE WHEELS that provide excellent mobility and traction. Special integrated sound analysis and recognition circuitry allow you to command your Robot Kitty with simple hand claps. When your Robot Kitty hears your commands, it moves, meows and purrs, and its eyes light up! If you ignore it, it will "go to sleep" and then awaken at your command. Original retail price over $100.00!

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10 Ω, 9.76 Ω
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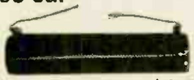

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200 gauss neodymium magnet mounted on a frame with ball bearing pivot.

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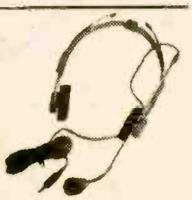
BOOM MIKE



Electret condenser type. This versatile microphone may be wired for Handy Talkie, telephone, base station, aircraft radio, CB radio, motorcycle intercom, etc. A transistor radio type earphone may be installed in either or both muffs. The microphone unit can be easily removed and installed on another headset or helmet.

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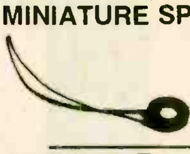

This 1" speaker is an ideal companion for installation in our boom mike featured above.

$1.49

Attention: Entrepreneurs!

These mikes and speakers are easily assembled into a product that will retail for $20.00. The Boom Mike will work on nearly any radio: aircraft, ham, CB, etc. We are now offering a 100-lot price on speakers and mikes for those who would assemble and resell at hamfests, flea markets, etc. Call (408) 943-9773 for details.

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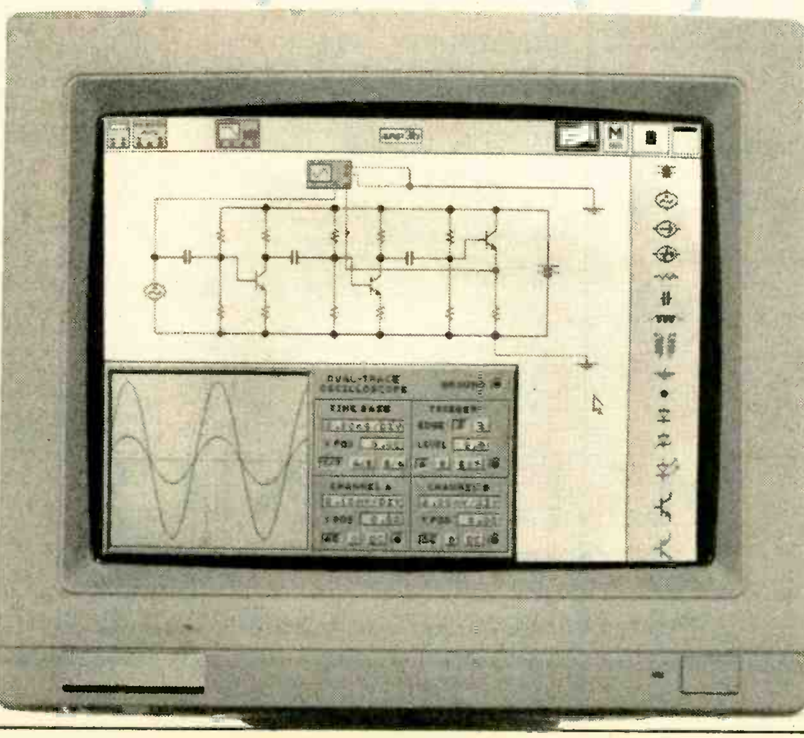

Testing an analog three-stage amplifier with the simulated oscilloscope.

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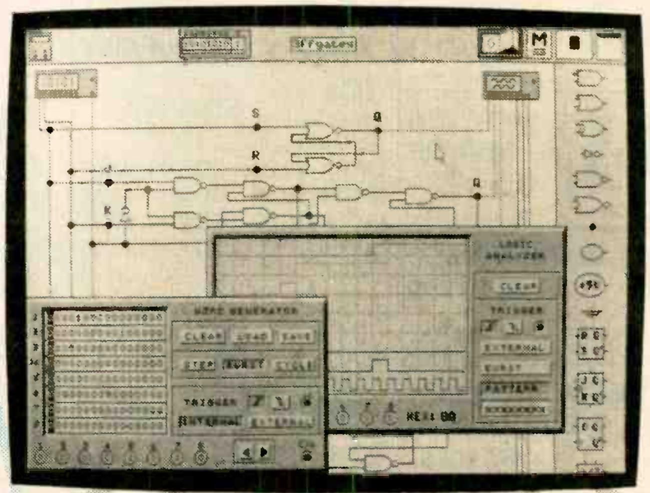
Powerful software to build and simulate analog and digital circuits.

Building and testing circuits is fast and easy with *Electronics Workbench*. Just click-and-drag with a mouse to add parts, run wires, and adjust instruments. The traces on the simulated instruments are the same as you'd get on real equipment.

Electronics Workbench really *is* an electronics lab in a computer. It's ideal for learning about electronics, experimenting, and prototyping circuits.



Testing a gate implementation of three different flip-flops.

"Electronics Workbench is pretty amazing."
– Jerry Pournelle, Ph.D., InfoWorld

". . . Electronics Workbench is a marvelous learning and teaching tool for the study of electronics."
– Art Salsberg, Editor-in-Chief, Modern Electronics Magazine

"Building a circuit is simple and intuitive."
– Jeff Holtzman, Computer Editor, Radio-Electronics Magazine

". . . if you're trying to learn electronics, you can do 10 times as many experiments with Electronics Workbench . . ."
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Includes:

- ***Analog Module*** with passive and active components including transistors, diodes, and op-amps; a function generator, an oscilloscope, a multimeter, and a Bode plotter.
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Electronics Workbench Professional Version runs on any IBM AT or PS/2 or true compatible with 640 kB RAM; Microsoft-compatible mouse; EGA/VGA graphics; hard disk; MS-DOS 3.0 or later. Monochrome version also available. Macintosh Version (monochrome only) runs on Macintosh Plus or greater. All trademarks are the property of their respective owners. Prices are in US dollars. Offer valid in the USA and Canada only.

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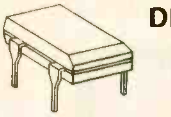
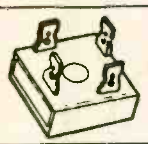


DIP BRIDGE
50V/1A
$0.40ea / 5pcs
$0.27ea / 50+



400V/25A BRIDGE
$2.60 each
$2.20ea / 10+

BLINKING LED
T1 3/4 RED
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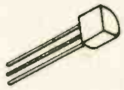
$0.70ea /100+

KESTER SOLDER
SN60/40 .031DIA
$7.50ea
1 Lb ROLL



PN2222A
PN2907A
2N3904
2N3906
2N4401
2N4403
7¢ ea / 50pcs
6¢ ea / 100+
no mixing

TANTALUM CAPS

15¢ each
20pcs min
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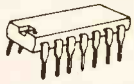
1uF/35V 2.2uF/35V

ICs



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LM311	$0.20	CD4001	$0.25
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24 PIN MACHINE

$0.30ea / 10pcs
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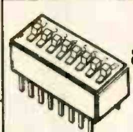

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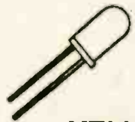

3mm or 5mm
RED LED
$0.09ea / 10pcs
$0.07ea /100+

YELLOW or GREEN
no mixing
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$0.08ea / 100+

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no mixing
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CERAMIC DISC CAPS

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25pcs min
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20pF/50V	100pF/50V
27pF/50V	1000pF/50V
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1N4148	0.05	0.03	0.02
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CIRCLE 147 ON FREE INFORMATION CARD

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- ***Forms Protective Coating!***
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__PreservIT__ (Blue) seals the metal surface and provides superior lubricating and preserving qualities for long-lasting protection from oxidation and contamination. For use on clean surfaces or ones precleaned with __DeoxIT__. Non-flammable, non-toxic, non-corrosive, non-gumming, ozone-safe.

__DeoxIT™__ and __PreservIT™__ contain active ingredients that do not rely on solvents (freon, alcohol, etc.) for performance. Both have excellent migration properties that coat the metal surfaces and protect them from future oxidation and contamination. On moving connectors/contacts, they re-coat the moving metal surfaces, providing continued protection and reduced wear & abrasion.

Use on similar and dissimilar metals, stationary and moving connections/contacts. Reduces Intermittent Connection Failures, Reduces Arcing and RFI, Reduces Wear & Abrasion.

DustALL Dt3 *quickly and safely removes dust, lint and particles from sensitive electronic equipment, computers, lab equipment, optical grade surfaces and other mechanisms and equipment.*

FreezALL Fz7 *quickly and safely cools circuits to -54°C. Locates intermittent components (capacitors, resistors, transistors, etc.) due to heat failure, hairline cracks on printed circuit boards and provides low temperature testing of electronic circuits.*

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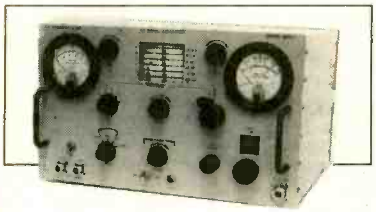
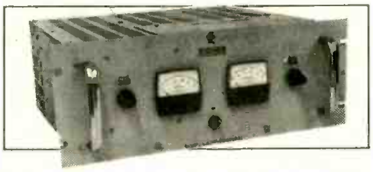


AN/USM 44C

Signal Generator: General purpose, solid state, high frequency generator which provides radio frequency (rf) signals used to test, evaluate and align radio receivers, rf equipment and amplifier. Direct replacement for HP 608 series. Frequency: 10 MHz to 480 MHz ±0.5% in 6 bands. Modulation: Internal AM: 400 and 1000 Hz +10%, 0 to 95% with 0.5 volt RF output. External AM: 0 to 95%, 0.5 volt output, 1.0 volt RMS input @ 20 to 200 KHz. Pulse Modulation: 40 to 200

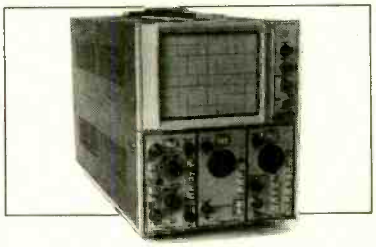
Price: $200.00



HYPERION POWER SUPPLY MODEL HY T1-36-30C

Solid state output 0-36 VDC, 0-30 amps. Input 115 vac 55 to 60 cps. Current limit adjustable. Dual meters to monitor voltage and current strapped connections in back to allow remote control.

Price: $250.00



TEKTRONIX MODEL 5110N (also known as 5103N/D10)

General purpose, 2 MHz plug-in oscilloscope. Includes 5B13 Time-Base, 5A18 Dual-Trace vertical amplifier and 5A23 Horizontal amplifier. 6½ inch rectangular display. Sweep rates from 5 microseconds to .5 second per division. Vertical sensitivity from 1 mV to 5 V per division. Add, alternate or chopped operating modes. X-Y mode, within 1 degree from dc to 100 kHz.

Price: $225.00

MODEL HP 180A

Oscilloscope: Mil Spec AN/USM-281A, 8 x 10 CM display, 100 MHz response which accepts standard 1800 series Plug-Ins. Includes Vertical Plug In: 1801A (PL-1186), frequency BW 50 MHz, maximum sensitivity 5mV/DIV. Horizontal Plug-In: 1821A (PL-1187), triggering to 100 MHz, minimum sweeptime 100 NS/DIV, has delayed sweep capacity.

Price: $250.00

TS-723A/U

Spectrum Analyzer: Frequency range 20 Hz to 20 KHz. Fundamental frequency rejection, -80 dB. Inherent distortion <0.1%, sensitivity 0.3% full-scale. Useable to 0.1%. Input impedance 200K ohms 40 pf. Meter frame 0.3 to 300 volts fullscale. VTVM frequency range 10 Hz to 100 kHz + 3% flatness. VTVM input impedance 1M ohm, 3M ohm, 2.4M ohm, 37 pfs dependent on range selected. Noise measurement—full scale 300 microvolts, minimum—75 dBm, frequency—10 Hz to 20 KHz. Power Supply—115V/230V, 50 to 100 Hz, 90 watts.

Price: $100.00

R-1051B/URR SYNTHESIZED HF RECEIVER

2-30 MHz LSB-USB-ISB-AM-CW-FSK radios. Tunes in 0.1 KHz increments plus vernier for virtual continuous tuning: 500 KHz IF. 50 ohm antenna input: 600 ohm audio out. Highly stable frequency control: rugged shipboard design. 7x17.4x18.9. 84 lbs sh. Used—checked.

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I.R. TANK PERISCOPE

Type M-24. Rugged military construction. Contains two independent infrared image converter tubes plus correction lenses, prisms, and eyepieces. The binocular viewing system is directly connected to a prism-type periscope. The image tubes have dynamic focus provided by a built-in adjustable voltage divider. This unit requires 10 to 15 KV at low current for operation. Unable to supply power supply. (Dimensions: 18" high × 9" wide × 4½" thick. Weight 17 lbs.)
Stock #OP 9001 Price: $200.00

A.C. POWER SUPPLY STACO MODEL E1010VA

This unit has been designed and constructed for rigorous industrial, classroom or laboratory applications. These power supplies are brand new. Current list price $750.00. Specifications: Input: 120 VAC 50/60 HZ. Output: 0-120 VAC 10 amps. Includes manual with schematics. Features: Ammeter, voltmeter, convenience outlet, power indicator and circuit breaker. Dimension: 10" × 15" × 6". Weight: 22 lbs.

Price: $165.00

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This popular unit has been the standard of the industry for many years. Features dual trace input, DC to 100 MHz response, and 5mV/div sensitivity. Sweep rates of 0.05 µsec/div to 0.5 sec/div (Timebase A) and 0.05 µsec/div to 50 msec/div (Timebase B). X10 magnifier extends maximum sweep rate to 5 nsec/div. Versatile triggering capabilities. 8 x 10 cm CRT display. Weighs only 22¾ lbs. Price: $800.00
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EXOTIC TECHNICAL INFORMATION: Electronic spying & countermeasures, computer hacking, power meter & telephone phreaking, cable & satellite phreaking, investigative electronics, alarms, locks, chemistry, and much more. Free brochure: Mentor Publications, Box 1549-P, Asbury Park, NJ 07712.

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BUILD OR buy assembled, four digit SWR & power meter, with alarm & set points. Plans available. **Free Information.** Rupp Electronics, 5403 Westbreeze, Fort Wayne, IN 46804. (219) 432-3049.

PASSIVE DEVICE sends VCR signals over existing telephone wires in home. How-to guide, $19.95, **JZO RESEARCH,** Box 28131, Minneapolis, MN 55428.

BUILD YOUR own neighborhood radio station with our high quality FM stereo transmitter kit, with case $42.95. Also available, two meter 144 MHz power amplifier kit 10X power gain $29.95. Add $3.75 S&H. Send $1.00 for complete catalog. **Sunset Electronics,** 12145 Alta Carmel Court, Suite 250-139, San Diego, CA 92128.

BUG DETECTORS, plans $5.00; kits $25.00. FM transmitter, phone devices, more plans and kits available. Catalogs $2.00. Free S.H. Send check or money order to: Greg Larsen, Rt. 1 Box 231-C2, Interlachen, FL 32148.

FM STEREO BROADCASTER kit. This kit outperforms the competition. Transmitter will broadcast any audio signal from a CD player, VCR, or cassette player to FM stereo radios throughout your home and yard. All the complex circuitry is in the unique BA1404 integrated circuit. Tunable across the FM band, runs on 1.5 to 12 volts DC. Complete kit of PC board and components for $24.00. **TENTRONIX,** Dept. PM692, 3605 Broken Arrow, Coeur d'Alene, ID 83814.

INSTRUCTION FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for the additional ads (a photocopy of this form works well). Choose a category from the list below and write that category number into the space at the top of the order form. If you do not specify a category, we will place your ad under Miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is 40¢ per word. Minimum charge is $6.00 per ad per insertion (15 words). Any words that you want set in bold or caps are 10¢ each extra. Bold caps are 20¢ each extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

CONTENT

All classified advertising in the **PE Market Center** is limited to electronics items only. All ads are subject to the publisher's approval. We reserve the right to reject or edit all ads.

DEADLINES

Ads received by our closing date will run in the next issue. For example, ads received by April 14 will appear in the August, 1991 issue that is on sale June 18. Market Center ads will appear Aug., Oct., Dec. etc. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS. advertising credit only. No phone orders.

AD RATES: 40¢ per word, Minimum $6.00.

Send your ads with payment to:
Popular Electronics Market Center, 500-B Bi-County Blvd. Farmingdale, NY 11735

CATEGORIES

100 — Antique Electronics
130 — Audio-Video Lasers
160 — Business Opportunities
190 — Cable TV
210 — CB-Scanners
240 — Components
270 — Computer Equipment Wanted
300 — Computer Hardware
330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
450 — Ham Gear Wanted
480 — Miscellaneous Electronics For Sale
510 — Miscellaneous Electronics Wanted
540 — Music & Accessories
570 — Plans-Kits-Schematics
600 — Publications
630 — Repairs-Services
660 — Satellite Equipment
690 — Security
710 — Telephone
720 — Test Equipment

CLASSIFIED AD COPY ORDER FORM

Ad No. 1—Place this ad in Category # ____

1 - $6.00	2 - $6.00	3 - $6.00	4 - $6.00	29 - $11.60	30 - $12.00	31 - $12.40	32 - $12.80
5 - $6.00	6 - $6.00	7 - $6.00	8 - $6.00	33 - $13.20	34 - $13.60	35 - $14.00	36 - $14.40
9 - $6.00	10 - $6.00	11 - $6.00	12 - $6.00	37 - $14.80	38 - $15.20	39 - $15.60	40 - $16.00
13 - $6.00	14 - $6.00	15 - $6.00	16 - $6.40				
17 - $6.80	18 - $7.20	19 - $7.60	20 - $8.00				
21 - $8.40	22 - $8.80	23 - $9.20	24 - $9.60				
25 - $10.00	26 - $10.40	27 - $10.80	28 - $11.20				

Ad No 1—Total words ____ × .40 per word = $ ____

All Caps words ____ × .10 per word = $ ____

Bold words ____ × .10 per word = $ ____

Bold Cap words ____ × .20 per word = $ ____

TOTAL COST OF AD No. 1 $ ____

Total classified ad Payment $ ________ enclosed.

[ ] Check [ ] MasterCharge [ ] Visa ($15.00 minimum credit card order)

Card # __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ Expiration Date __ __ / __ __

Signature ____________________

Name ____________________

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WORLD'S ONLY CALLER I.D. ELECTRONICS KIT

SEE WHO'S CALLING BEFORE ANSWERING PHONE. DESIGNED FOR IBM-LIKE COMPUTERS, OUTPUTS RS-232 SERIAL TO COM1 OR COM2 (1200,N,8,1). INTERFACES TO COMPUTER/PRINTER - DOES NOT HAVE ITS OWN DISPLAY.

DECODER & CABLES - KIT. IMPC-CID-1K $39.95
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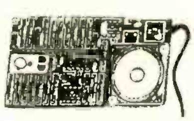

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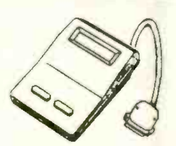
VISUAL RF FIELD-STRENGTH CHECKER, ADJUST YOUR TRANSMITTER FOR BRIGHTEST LED OUTPUT. IMPC-RFV-1 $24.95

AUDIO-VISUAL VERSION, ADJUST YOUR TRANSMITTER FOR BRIGHTEST LED OUTPUT OR HIGEST PITCH TONE. IMPC-RFA-1 $29.95

Caller I.D. not yet available everwhere. Check with your local phone company.

WE ARE THE SOURCE FOR CALLER I.D.



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INTERNATIONAL MICROPOWER CORP.
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CIRCLE 35 ON FREE INFORMATION CARD

PE MARKET CENTER CLASSIFIEDS

NI-CAD ZAPPER can rejuvenate those unrechargeable NI-CAD batteries. Instructions, schematic and parts list to construct the NI-CAD Zapper: $5.00. **TENTRONIX,** Dept. PM692, 3605 Broken Arrow, Coeur d'Alene, ID 83814.

HAM RADIO KITS & ASSEMBLIES for various QST & 73 construction articles. For catalog, send legal size SASE w/52 cents postage to A & A Engineering, 2521 W. LaPalma #K, Anaheim, CA 92801.

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IBM PC and laptops video digitizer. Connects to camcorder. 640 by 480 resolution. 256 gray levels $89.98. Demo disk $3.00. Information $1.00. Colorburst, Box 3091, Nashua, NH 03061. Phone (603) 891-1588.

3.5" DISKETTE PUNCH. 1.44MB from 720K diskettes! 3.5" DD and HD diskettes are made from the same media. Punch sensing hole to make drive operate in HD mode. Heavy duty construction! 30 day money back guarantee! $17.95. We pay shipping! **COMPUCRAFT,** 9391 Mentor Ave., Suite 113, Mentor, OH 44060. Call (216) 255-7027 Ext. 113 for information.

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TV NOTCH filters. Brochure $1.00. Micro THinc, Box 63/6025, Margate, FL 33063. (305) 752-9202.

IMPOSSIBLE CABLE systems. New user programmable units authorize any or all features of Pioneer or Jerrold descramblers. Take Control (800) 968-4041.

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Looks and functions like a common outlet; uses power line for power and antenna (no batteries needed ever)!

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CALL IDENTIFIER displays callers phone number, stores phone number with date & time of call...$59.95ppd.

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Test chips for JERROLD, TOCOM, ZENITH, S.A. & more. Fully activates units in just minutes. Easy installation. Zenith only $39.95ea. Most others only $50ea.
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HV CAPACITORS, parts, kits. $1.00 brings catalog and coupon. Two Fox, POB 721, Pawling NY 12564.

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LET THE Government finance your small business. Grants/loans to $500,000. Free recorded message: (707) 448-0270. (KJ8)

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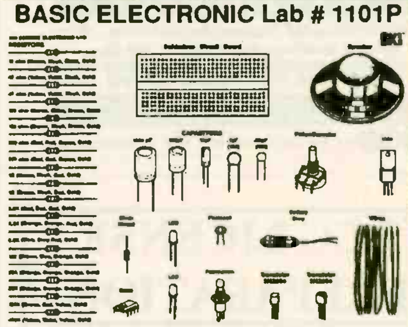

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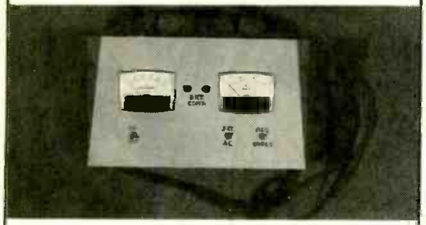

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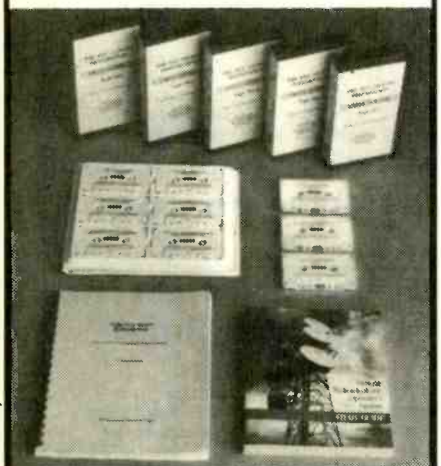

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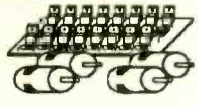

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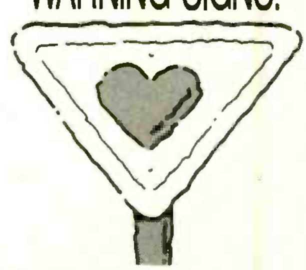

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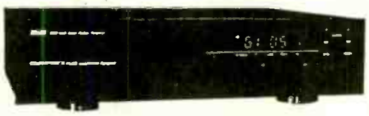

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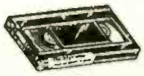

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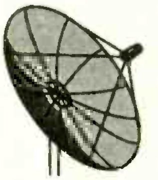

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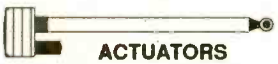

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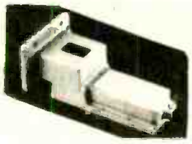

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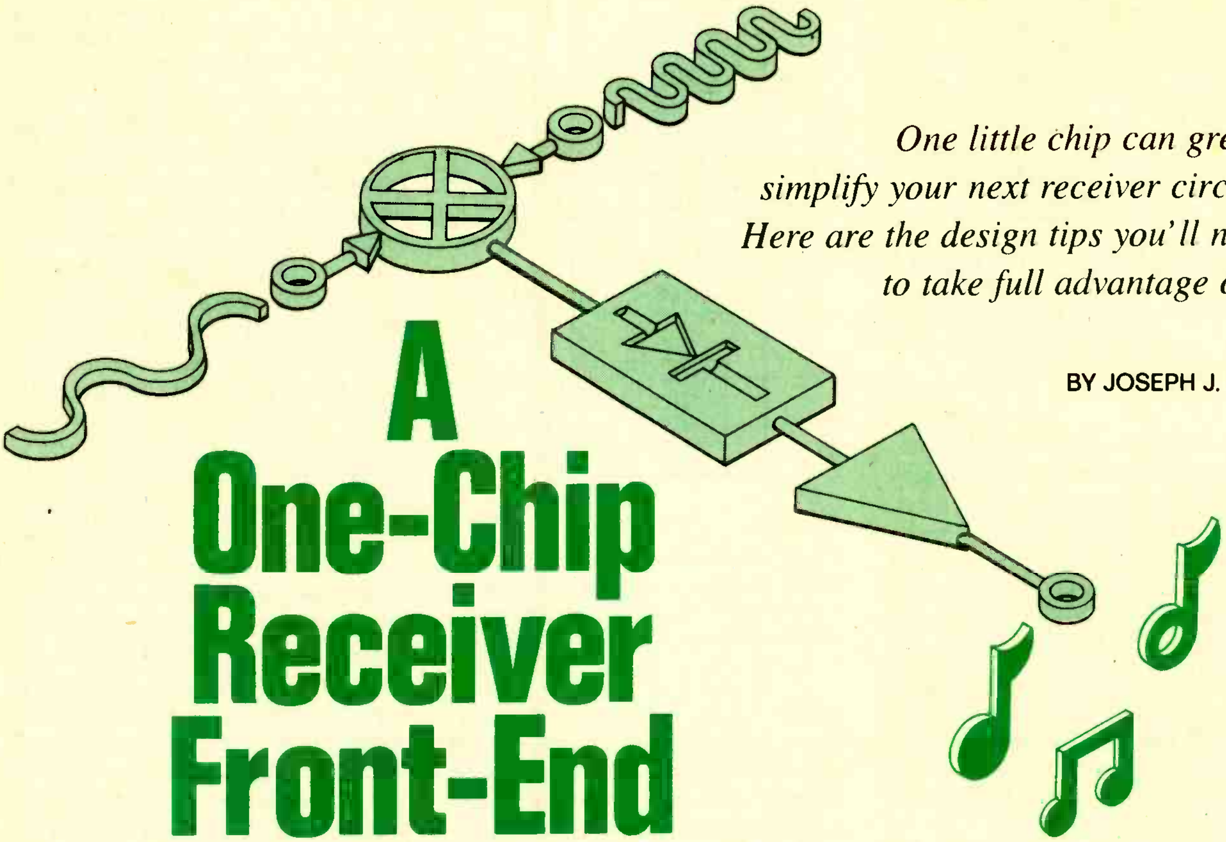


One little chip can greatly simplify your next receiver circuit. Here are the design tips you'll need to take full advantage of it.

A One-Chip Receiver Front-End

BY JOSEPH J. CARR

Every now and then chip manufacturers come up with a truly neat new product. Old timers in electronics fondly remember the introduction of the Signetics 555 chip as one of those breathtaking devices, and that chip is still a "best-seller." The Signetics NE602 single-chip frequency converter also falls into that "stellar" class. Depending on the circuit configuration, it can be used as a frequency converter in receivers or transmitters, a spectrum analyzer, a complete receiver front-end from very low frequencies up to the mid-VHF region, or even a complete receiver. Furthermore, the NE602 chip is, unlike many radio-frequency (RF) devices, in that it's relatively easy for hobbyists to tame and use with limited test equipment.

The basis for the NE602 is the heterodyning process used in most modern radio receivers, and in other products. In heterodyning, two signals are mixed together in a nonlinear mixer circuit (see Fig. 1) to produce a collage of output frequencies including both the input signals (f_1 and f_2), plus the sum ($f_1 + f_2$) and difference ($f_1 - f_2$) frequencies. In point of fact, the harmonics of f_1 and f_2 also mix, so the output of a frequency mixer can be characterized by:

$$f_O = mf_1 \pm nf_2$$

where n and m are integers (1, 2, 3, etc.).

In a radio-receiver mixer, one of the frequencies (say f_1) will be an RF signal from a distant station, while the other frequency (f_2) is generated by an oscillator in the receiver (called the "Local Oscillator," or "LO"). The purpose of making the frequency conversion is to selectively translate any incoming frequency to a single Intermediate Frequency (IF). This is advantageous since the rest of the receiver need only supply the bulk of its gain and selectivity at the intermediate frequency. That keeps the receiver's cost low and its design simple. Nearly all modern broadcast radio, communications, and television receivers use this process, and are thus called superheterodyne receivers.

The NE602. The Signetics NE602 chip provides mixer and local oscillator stages in a single package. The NE602N is the eight-pin DIP package, while the NE602D is the Surface-Mounted Device (SMD) version. The NE602AD and NE602AN are improved versions of the basic NE602 units.

The mixer in the NE602 is a Gilbert Transconductance Cell (GTC), so it qualifies as a Double-Balanced Mixer (or DBM). GTC's are so useful that they are used in various analog multipliers and amplitude modulators. When you explore the arithmetic of the process they perform, you find that they are all multiplication circuits (*i.e.*, the functions of the two input signals are multiplied to get the output signal), so it is not surprising that the GTC finds its way into mixer service.

Unlike other DBM circuits, which are usually made with diodes, the GTC is based on active devices such as transistors. The principal advantage of transistor construction is that the circuit has very good sensitivity (down to the microvolt level), while at the same time (unlike other mixers) it suppress the LO and RF signals in the output. Other mixers pass those signals along to the output, so the circuit design must incorporate some means for selecting the desired sum or difference signal. Furthermore, by not passing the high amplitude local-oscillator signal to the output, the NE602 can directly drive another receiver stage without overdriving it.

The sensitivity of the NE602 is truly startling for a device that does not

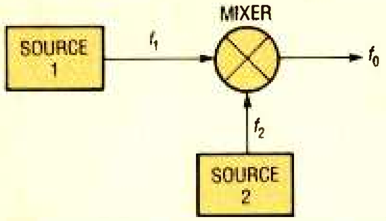


Fig. 1. In the heterodyning process two signals (f_1 and f_2) are combined by a nonlinear mixer circuit to produce the sum ($f_1 + f_2$) and difference (f_1-f_2) output frequencies plus their harmonics.

include an RF amplifier. Since the device is quite capable of handling signals down to the microvolt level, it is a candidate for use as a receiver front-end without any additional circuitry. The NE602 will handle signals up to −15 dBm, and prefers to see signals at −25 dBm or less. These signal levels are neither terribly high nor terribly low (in a 50-ohm load, −25 dBm equates to about 12.5 millivolts, which is high for a received radio signal, but low for other frequency-translation applications).

The NE602 devices seem to trade-off dynamic input-signal range (*i.e.*, the difference between lowest and highest signal amplitude that can be accommodated) for spectrally purer output. The GTC mixer in the NE602 is capable of operation to about 500 MHz.

The internal oscillator consists of a single, high-frequency NPN transistor that will oscillate to 200 MHz or so. The base and emitter terminals are available to the outside world, so the transistor can be incorporated into the external-circuit design. The collector circuitry and DC-bias network are built into the chip, so the circuit designer does not have to bother with the "housekeeping" chores of circuit design.

The pinouts for the NE602N, shown in Fig. 2, are as follows: pins 1 and 2 are the differential RF inputs, pin 3 is ground, pins 4 and 5 are the push-pull outputs (either alone will also serve as a single-ended output), pin 6 is the oscillator-transistor base terminal, pin 7 is the oscillator-transistor emitter terminal, and pin 8 is the power-supply terminal.

Power Connections. The NE602 is a low-voltage, low-current device. It requires a DC supply voltage of be-

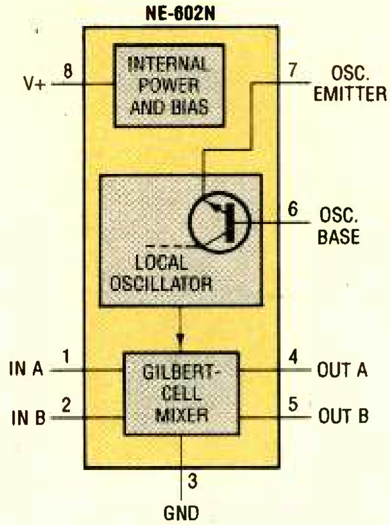


Fig. 2. This block diagram of internal NE602 circuitry reveals the two basic sections of the chip. Note that the local oscillator section is just a transistor.

tween 4.5 to 8 volts DC and will generally draw less than 3 mA. It works well with a 5-volt supply, but may be stressed if a 9-volt battery is used without precautions. Figure 3 shows several different popular DC-power configurations.

In Fig. 3A, we see the use of a simple RF choke to decouple the power supply from the NE602. The RF choke and the decoupling capacitor (C1) prevent RF from the NE602 from reaching other stages, or vice-versa. The RF choke should be 2.5 mH if the frequencies are under 3 MHz, 1 mH from 3 to 30 MHz, and 30 to 100 µH for VHF signals. As always in such situations, the decoupling capacitor and RF choke should be mounted as close as possible to the body of the NE602. The supply voltage in this instance must be strictly limited to 4.5 to 8 volts.

The circuit of Fig. 3B is somewhat more popular, and more practical. In that circuit, DC power is supplied to the NE602 through a 100-ohm resistor while C1 acts as a decoupling capacitor. A variant of the same theme, shown in Fig. 3C, allows an NE602 to operate from a 9-volt battery or other 9-volt power source. The resistor provides a small voltage drop to reduce the voltage received by the NE602.

In some circumstances, it is prudent to provide some voltage regulation to the NE602 device. In automotive applications, for example, the voltage can normally range from 11 to 14.5 volts and can run as high as 18 volts if the car's voltage regulator fails. Further, regulation is good for projects that rely on household current for power, as the AC-line voltage can range from 105 to 127 volts.

In such circumstances, the circuit in Fig. 3D can be used to regulate and reduce the voltage from a 12-volt (or higher) DC supply. In Fig. 3D, the voltage is regulated by a 400-mW or 1-watt Zener diode that limits the voltage applied to pin 8 of the NE602. Use

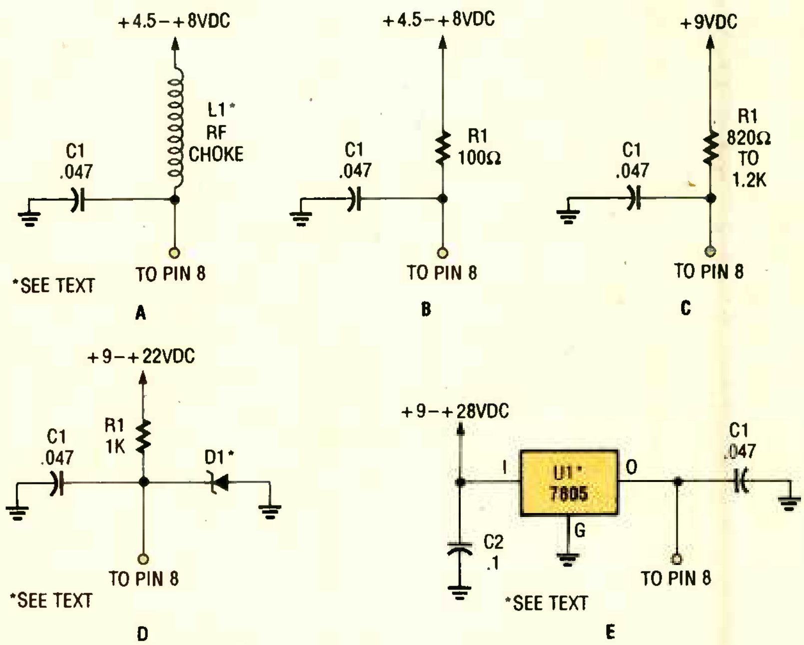


Fig. 3. These are just some of the DC power-circuits suitable to drive the NE602. Note that all of them contain at least one capacitor to suppress RF noise.

a 5.6-volt, 6.8-volt, or 8.2-volt Zener diode for D1.

Alternatively, use a circuit such as the one in Fig. 3E. There we see the use of a 7805 three-terminal IC voltage regulator. The 7805 is a bit of overkill because it can handle 750 or 1000 mA (depending on the package), so you can use the TO-5 or TO-99 low-power version, or a 78L05. You can also use 7806 or 78L06, but the output voltage will be 6 volts not 5. As in the other cases, the decoupling capacitor, C1, should be placed near the NE602. Note that a noise-immunity capacitor (C2) is also used at the input of the voltage-regulator chip.

Input Circuits. The NE602 uses differential inputs called IN A (pin 1) and IN B (pin 2). However, either one can be used alone to serve as a single-ended input. The input impedance of the NE602 is on the order of 1.5k at lower frequencies, and is somewhat lower than that in the VHF region. Keep in mind that AC circuits tend to work best when the source and load impedances are matched. An implication of this requirement is that 50- or 75-ohm antenna inputs have to be transformed to 1,500 ohms for best efficiency.

Figure 4 shows several different basic input configurations for the NE602. Those circuits are not the only ones that will work, but they are popular. The circuit in Fig. 4A can handle a high-impedance (1.5k), single-ended input, such as when the NE602 is used as a frequency converter in some project other than a radio receiver, or when the receiver design uses an RF amplifier or RF preselector ahead of the NE602. The signal is coupled through C1 (which is used for DC blocking) to pin 1 on the NE602. The alternate input, pin 2, is unused so it is bypassed to ground through a decoupling capacitor.

Figures 4B, 4C, and 4D are used for cases where the source impedance is lower than the NE602 input impedance, for example in a radio receiver where the standard antenna impedance is either 50 or 75 ohms (the former predominates). In Fig. 4B the impedance is matched by the split capacitor circuit composed of C_A and C_B. The series combination of those two capacitors must resonate inductor L1 at the desired frequency.

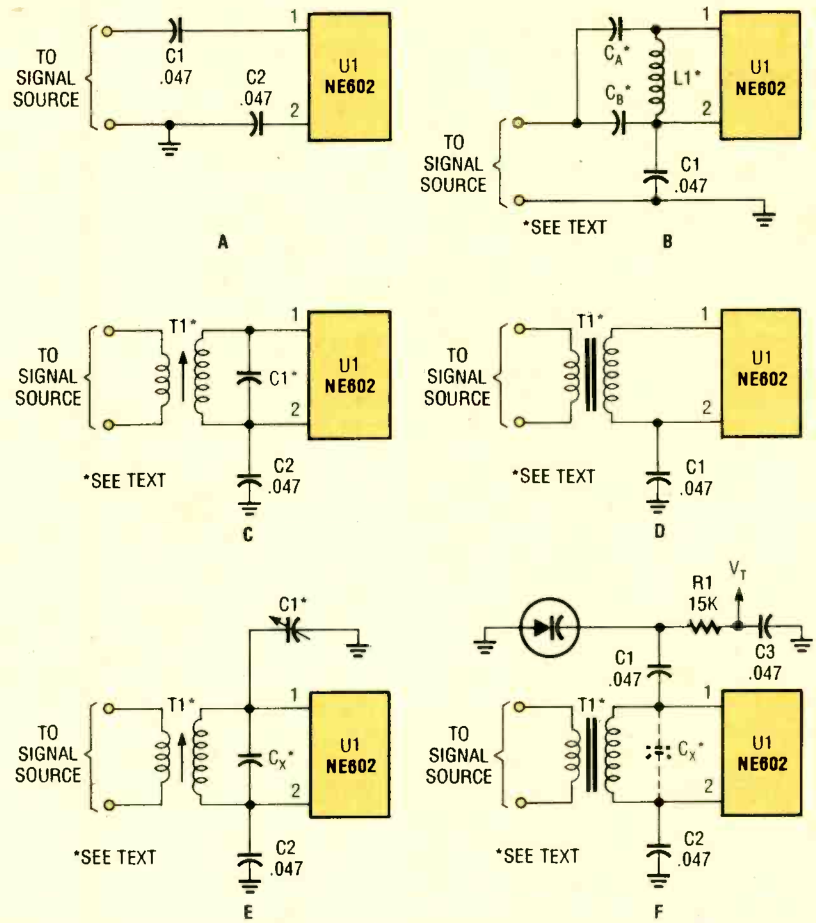


Fig. 4. Here are a few of the many possible RF input circuits for the NE602. Just about any tuned or broadband circuit will work.

Thus, that circuit is most useful in single-frequency, applications. The coil and the transformers used in the circuits that follow can be wound on coil forms or on torroidal ("doughnut" shaped) cores.

Another version is shown in Fig. 4C. There the impedance is matched by the turns ratio of the input transformer, T1. Capacitor C1 is used to resonate the secondary of T1 at the desired frequency. If C1 is made variable, then the input can be tuned over a frequency range that is determined by the range of C1.

The circuit of Fig. 4D has an untuned, broadband RF transformer at its input so it can handle a wide band of input signals. These transformers are typically built on torroidal cores with bifilar-wound turns. The turns ratio of T1 determines the impedance ratio according to:

$$N_P/N_S = \sqrt{Z_P/Z_S}$$

where N_P is the number of turns in the primary, N_S is the number of turns in the secondary, Z_P is the impedance reflected to the primary of T1, Z_S is the impedance connected across the secondary of T1. If you work the arithmetic for 50 ohms and 1.5k, the values turn out such that N_P/N_S is 0.183, so inverting, we find that (to make the impedance transformation) the secondary needs 5.5 turns for every turn in the primary.

Figure 4E shows the use of a different sort of tuned input transformer. In that circuit, the main tuning capacitor for the secondary is connected between the junction of pin 1 and one end of T1's secondary and ground. As long as capacitor C2 is also in the circuit, this connection effectively places the capacitor in parallel with the secondary winding of the transformer, but is a little more amenable to most variable capacitors (which are mechanically designed to be grounded when mounted). A padder capacitor, C_X, may be connected either across C1, or directly in shunt with the transformer winding as shown. That capacitor will set the minimum capacitance of the circuit, and helps

C1 resonate with the inductance of T1. In typical applications, C_X will set the frequency of the bottom of the band when C1 is fully meshed (*e.g.*, at maximum capacitance), and then C1 "bandspreads" across the desired band as it is tuned.

A modern variation on Fig. 4E is the voltage-variable scheme shown in Fig. 4F. There the variable capacitor is replaced with a voltage-variable capacitance diode, also called a "Varactor." Such diodes have a junction capacitance that is a function of the applied reverse voltage. When the tuning voltage (V_T) is changed, it will change the capacitance of D1, and in turn changes the resonant frequency of the circuit.

NE602 Output Circuits. The output impedance of the NE602 is typically 1.5k (the same value as for the input impedance). The output terminals (labeled OUT A and OUT B back in Fig. 2) are a push-pull pair, but can be operated in a single-ended fashion simply by placing a DC blocking capacitor on the output you wish to use (either pin 4 or 5) and ignoring the remaining one (as shown in Fig. 5A). Unlike the equivalent input circuit, the unused output terminal does not need to be bypassed to ground.

The output circuit in Fig. 5B uses a broadband RF transformer (similar to that used back in Fig. 4D). The turns ratio of the transformer should be set to reflect 1.5k back to the primary as a function of the load impedance. Again, if the 50-ohm standard impedance is used, then a 5.5:1 turns ratio is required. A tuned version of that circuit is shown in Fig. 5C.

Another single-ended circuit is shown in Fig. 5D. That one is based on a ceramic IF filter or a crystal filter (FIL1). The filter is one of the standard very low cost 455-kHz or 10.7-MHz IF filters used in broadcast radios. One can also use a 5.5-MHz, 8.83-MHz, or 9-MHz crystal filter, or 455-kHz, 260-kHz or 500-kHz mechanical filters (if you want to spend big bucks).

Local-Oscillator Circuits. For a superhetrodyne receiver to work properly, the local-oscillator frequency must be set so that mixing it with the desired RF will produce the desired intermediate frequency (which can be either the sum or difference of the two). For example, in an AM superheterodyne radio designed for a 455-kHz IF, when the user wants to receive a station on 1240 kHz, the local-oscillator signal must be either 1695 kHz (because 1695 minus 1240 is 455) or 785 kHz (because 1240 minus 785 is 455). Usually the LO is selected to be above the operating frequency (but that's not a requirement), so the sum of RF and IF is used. In direct conversion "autodyne" receivers, the LO is on or very near the radio frequency.

In an NE602 circuit the LO can be either internal or external, as required. In Fig. 6A, we see the connection scheme for an external LO circuit. The LO signal is coupled to pin 6 through a DC blocking capacitor. The signal should have an amplitude on the order of 700 mV peak-to-peak.

Internal variable-frequency oscillators (VFO) are shown in Figs. 6B and 6C. The circuit in Fig. 6B is a Hartley oscillator, as indicated by the feedback being obtained from a tap on the tuning inductor, L1. The version shown in Fig. 6C is a Colpitts oscillator, which is identified by the feedback network being a tapped capacitive voltage divider consisting of C2 and C3. A parallel-mode crystal oscillator

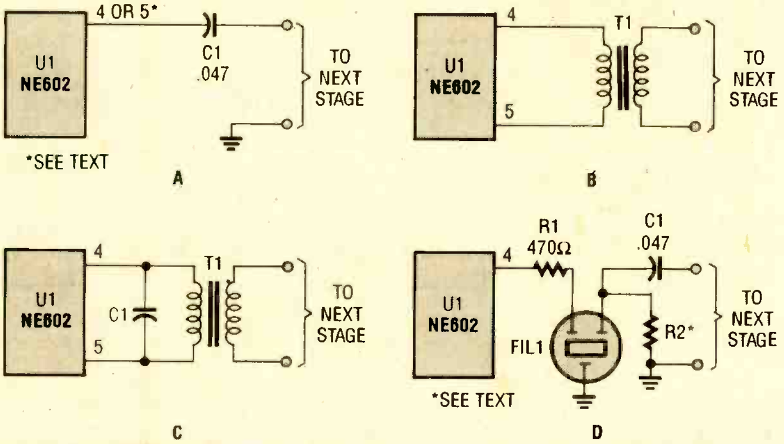


Fig. 5. If the NE602 is used as a mixer, its output must be tuned to the desired intermediate frequency. If the IC is used for direct conversion, you only need to AC couple its output.

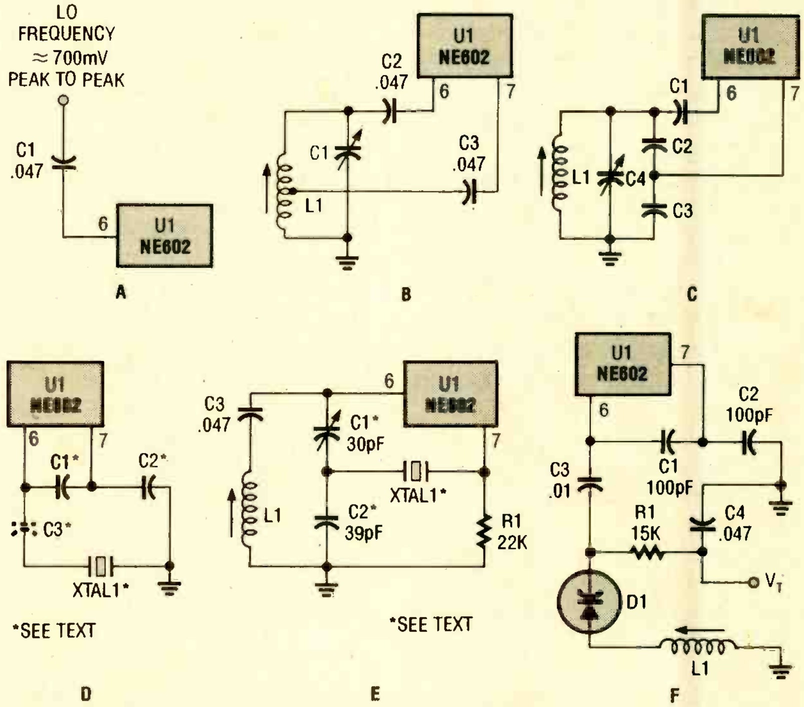


Fig. 6. Just about any standard oscillator (such as a Colpitts or Hartley configuration) can be used to generate the LO frequency needed by the NE602.

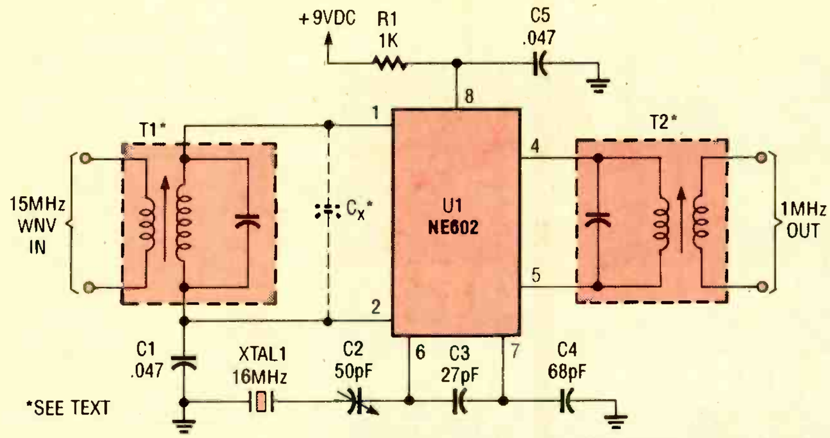


Fig. 7. This simple frequency converter mixes the 16-MHz WWV/WWVH signal with a 15-MHz signal from the LO to convert it down to 1 MHz so it can be heard on an AM-band receiver.

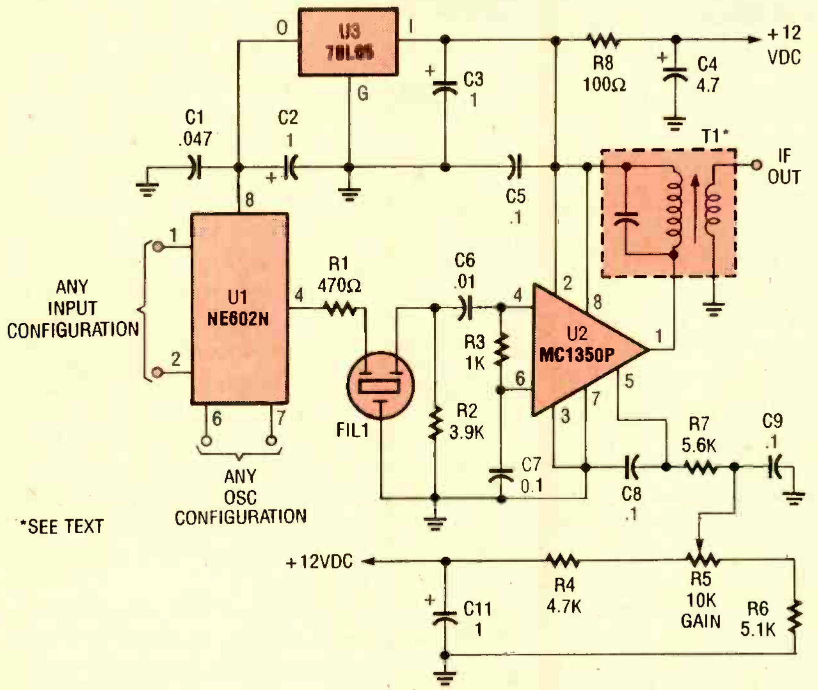


Fig. 8. This superheterodyne-receiver front end shows how valuable the NE602 can be in an RF circuit. By combining this circuit with any of the input and LO circuits presented earlier, you'll be well on your way to having a complete receiver.

for fundamental frequencies (0.8 to 20 MHz) is shown in Fig. 6D. The values of the capacitors are approximately:

$$C1 = 100/\sqrt{f}\ \text{pF}$$
$$C1 = 1000/f\ \text{pF}$$

When specifying crystals for this application, ask for parallel-mode operation on the desired frequency, with a load capacitance of either 20 or 30 pF. The optional variable capacitor shown (C3) will allow you to fine-tune the circuit's resonant frequency. This method is typically used on fixed-frequency radios.

A circuit for an overtone oscillator is shown in Fig. 6E. This circuit is used for low-VHF applications. The inductor must be set to resonate at the overtone frequency (*i.e.*, the desired LO frequency) with the series combination of C1 and C2. The crystal is a third-overtone type, so be sure to specify the overtone frequency desired, not the fundamental frequency or the circuit won't work as you desire or as you expect it to.

Finally, a voltage-variable LO circuit is shown in Fig. 6F. In the circuit, a varactor diode is used to tune coil L1 to the desired frequency. Capacitors C1 and C2 are connected to make this circuit into a Colpitts circuit not too unlike the one in Fig. 6C.

Applications. This article would not be complete without a few applications for the NE602. The ones we'll discuss are not exhaustive, but are selected to be representative of the different jobs the chip can do.

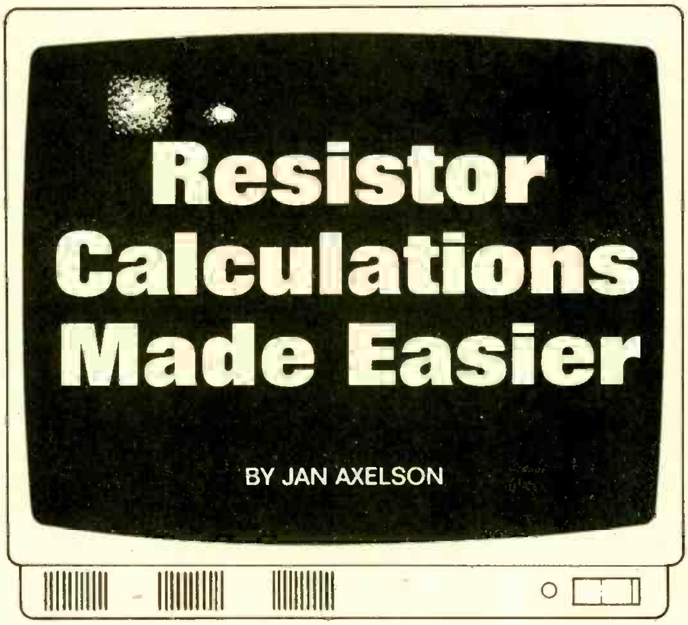
A basic frequency converter is illustrated in Fig. 7. The circuit is a WWV/WWVH-to-AM-broadcast-band converter. The circuit converts the 15-MHz WWV/WWVH frequency to 1 MHz—the middle of the AM-broadcast band. The 16-MHz local oscillator is a fundamental crystal type. A 16-MHz LO frequency was selected because 16-MHz crystals are used in personal computers, and as such are sold by a wide variety of mail-order and local parts distributors.

The input circuit is tuned by an RF transformer who's secondary resonates at the RF. Either a regular cylindrical coil form or torroidal form may be used. Alternatively, a 10.7-MHz IF transformer—the sort that has the resonating capacitor in a hollow space in its base—can be modified for this use. The capacitor must be crushed, and the debris cleared out, so that an external capacitor (C_X) can be used. These same tips apply to the output transformer, T2. Although designed for one particular application, the circuit can be used for any number of receiver needs.

Figure 8 shows a combination of IC's that can be used to make a conventional superheterodyne receiver. In the circuit, frequency conversion is performed by an NE602 augmented with any of the standard input and LO configurations presented. The output circuit is the ceramic filter type shown earlier. The IF amplifier is a 60-dB gain circuit based on the MC1350P IC, operating at 455 kHz. Potentiometer R5 acts as a sensitivity or gain control by providing an adjustable DC bias to pin 5 on the MC1350P.

Because of the high frequencies involved there are two basic rules to follow when building the circuits. First, keep all leads and wire between components short. Second, if you'll be using printed-cirtcuit board construction, create a ground plane around the circuit to use for all ground connections.

The NE602 is a unique device that makes a wide variety of RF projects open to those who are not deeply skilled in RF design. Try it, you'll like it. ■



Resistor Calculations Made Easier

BY JAN AXELSON

Use our simple program to find out what real-world resistor values will give you the resistor ratios you need.

Whether you design, construct, or repair electronic circuits, you've probably noticed that resistors are commonly available only in specific values. For example, it's easy to find a 5%-tolerance resistor of 470 or 510 ohms, but a simple ¼-watt, 500-ohm resistor is hard to find. In 1% tolerances, you can get more precise values like 4.99 and 6.04 ohms, but many round values like 4, 5, or 6 ohms are unavailable.

The values commonly available are called standard or preferred values, and they offer a compromise between practicality and precision. Imagine a set of resistors containing every value from 1 ohm to 1 megohm—1,000,000 different values. It would be easy enough to choose any value you desire from this selection, but keeping this many different values on hand would be a chore and an expensive one at that.

By using only preferred values, your selection *is* more limited (a set of 5%-tolerance resistors from 1 ohm to 1 megohm has just 145 different values), but the choices aren't as restrictive as you might think, since the values are selected so that you can always find a resistor that is within a few percent (or less, for 1% tolerances) of any desired value.

If you need a resistor of a specific value, you can select the closest match from the preferred values. However, many circuits, including voltage dividers, linear amplifiers, and others, require pairs of resistors in specific ratios in order to achieve a desired gain or attenuation. For these circuits, it's not always easy to see which combination will give the closest match to the desired ratio.

To help you find resistors to fit desired ratios, this article contains a computer program called RESISTOR.BAS that finds and displays resistor values to achieve any desired ratio, using preferred values for 5%- and 1%-tolerance resistors. Several examples will show you how to use RESISTOR.BAS to help you design circuits.

Preferred Values. Tables 1 and 2 show the first two digits (the first two color bands) of common resistor values with tolerances of 5% and 1%, respectively. Five-percent-tolerance resistors are fine for general-purpose use, while 1% tolerances are normally reserved for circuits where exact values are essential, as in critical measuring circuits, linear amplifiers, or other precision analog circuits.

Each 5%-tolerance value is about 10% higher than the previous value, while each 1%-tolerance value is about 2% higher than its previous one. That explains why most of the values are clustered at the lower values (with many values between 1 and 2 ohms) and fewer at the high end.

In practical terms, this arrangement means that you can find a 5%-tolerance resistor that is within about 5% of any desired value, or a 1%-tolerance resistor that is within about 1% of any desired value. Of course, depending on the tolerance, the actual resistance of a component may vary up from the rated value, and that must be taken into account as well.

Many suppliers offer special prices on resistor sets containing several of each preferred value for several decades, making it easy to supply a workshop with a wide range of resistor values with a single purchase.

Using RESISTOR.BAS. Listing 1 shows the program RESISTOR.BAS, which determines and displays preferred resistor values to fit the ratios you request. The program displays all resistor pairs that exactly match the desired ratio. If no exact match exists, the values that give the closest match are displayed. In addition, when doing calculations for 5%-tolerance resistors, the program also displays other resistor pairs that yield ratios within 2% of the desired ratio. That allows you to find a combination close to what you want, even if you don't have the first-choice values on hand.

The program was written in Microsoft's GW-BASIC for IBM-compatibles, but you should be able to run it in other BASIC dialects with few modifications if any.

One typing tip: in line 310, be sure to type "\", for integer division, not "/" signifying floating-point division.

I'll first describe how to use RESISTOR.BAS. At the end of this article I'll give a a description of how the program works, for those who want all the details.

When you run RESISTOR.BAS, you are asked to enter a number representing a resistor ratio, or 1 to toggle the resistor tolerance between 5% and 1%, or 0 to exit the program (see Fig. 1). If you enter a ratio—any positive number other than 0 or 1—the program finds and displays the preferred values that best match your desired ratio, using the selected tolerance. The smaller of R1 and R2 is a value between 1 and 10, with the larger value scaled as necessary. In Fig. 1, the program was asked to recommend 5%-tolerance resistor pairs to get a ratio of 17. The program has found

TABLE 1—COMMON 5% RESISTOR PREFIXES

1.0	2.2	4.7
1.1	2.4	5.1
1.2	2.7	5.6
1.3	3.0	6.2
1.5	3.3	6.8
1.6	3.6	7.5
1.8	3.9	8.2
2.0	4.3	9.1

TABLE 2—COMMON 1% RESISTOR PREFIXES

1.00	1.47	2.15	3.16	4.64	6.81
1.02	1.50	2.21	3.24	4.75	6.98
1.05	1.54	2.26	3.32	4.87	7.15
1.07	1.58	2.32	3.40	4.99	7.32
1.10	1.62	2.37	3.48	5.11	7.50
1.13	1.65	2.43	3.57	5.23	7.68
1.15	1.69	2.49	3.65	5.36	7.87
1.18	1.74	2.55	3.74	5.49	8.06
1.21	1.78	2.61	3.83	5.62	8.25
1.24	1.82	2.67	3.92	5.76	8.45
1.27	1.87	2.74	4.02	5.90	8.66
1.30	1.91	2.8	4.12	6.04	8.87
1.33	1.96	2.87	4.22	6.19	9.09
1.37	2.00	2.94	4.32	6.34	9.31
1.40	2.05	3.01	4.42	6.49	9.53
1.43	2.10	3.09	4.53	6.65	9.76

that the resistor values 51 and 3 give an exact match, and six other close matches are displayed as well.

In selecting actual components, you can scale the values by multiplying both R1 and R2 by the same factor of 10. For example, instead of 51 ohms and 3 ohms, you may substitute 510 and 30, or 5,100 and 300 ohms, and so on. How large you scale the values depends on the magnitude of the impedance you desire.

The practical limits of the components you use will limit the size of the ratios you calculate. In other words, just because you can calculate resistor values for a ratio of 500,000 doesn't mean that the op-amp you use will be capable of a gain this high in your circuit. As always, you are responsible for knowing the limits of your circuits.

Example Uses. Figure 2 shows four example circuits where RESISTOR.BAS would come in handy. Figure 2A shows an op-amp configured as an inverting amplifier. The ratio R1/R2 equals the absolute value of the op-amp gain, or V_{OUT}/V_{IN}. So, for a gain of -35:

$$R1/R2 = 35$$

When you type that into the program, RESISTOR BAS will tell you that the 5%-tolerance values 56 and 1.6 fit this ratio exactly. For higher impedance (and lower current consumption), you could scale the values to, say, 56,000 ohms and 1,600 ohms.

Figure 2B shows an op-amp configured as a non-inverting amplifier, where:

$$R1/R2 = Gain - 1$$

For a gain of 15:

$$R1/R2 = 14$$

and again using 5%-tolerance values, RESISTOR.BAS would recommend a best match of R1 equal to 18 and R2 equal to 1.3. Again, you may scale the values as desired by multiplying both values by the same factor of 10.

Figure 2C is a comparator that compares input V_{IN} to reference voltage V_{REF}. V_{OUT} is low when V_{IN} is greater than V_{REF}, and high when V_{IN} is less than V_{REF}. To set V_{REF} to a specific voltage, you substitute your desired V_{REF} and V+ into this equation:

$$R1/R2 = V_{REF}/(V^+ - V_{REF})$$

and ask RESISTOR.BAS to find values to match the resulting ratio. For example, if:

$$V_{REF} = 8 \text{ volts}$$
$$V^+ = 15 \text{ volts}$$

then:

$$R1/R2 = 1.1429$$

Using 1%-tolerance values, the closest match is with R1 at 10.7 and R2 equal

LISTING 1

```
10 CLS
20 PRINT "                                        RESISTOR.BAS"
30 PRINT "                                       by Jan Axelson"
40 PRINT
50 PRINT "Finds pairs of preferred (standard) resistor values to match desired
ratios."
60 PRINT "Enter ratios (R1/R2) as single, positive numbers.  Examples:  250,
1.8, .45"
70 PRINT "Enter 1 to toggle resistor tolerance (1%-5%), enter 0 to quit."
80 PRINT
90 T=5:N=24                'default=5% tolerance
100 DR=2                   'initialize DR (desired ratio) to begin WHILE loop
110 WHILE DR<>0
120 PRINT "Current resistor tolerance = ";T;"%"
130 INPUT "Enter desired resistor ratio (or 1 to change tolerance, 0 to quit):
",DR
140 IF DR=1 THEN IF T=5 THEN T=1:N=96 ELSE T=5:N=24  'on request, toggle
tolerance
150 PRINT
160 IF DR>0 AND DR<>1 THEN GOSUB 200
170 PRINT
180 WEND
190 END
200 '****************************find resistor values**************************
210 INVERT=0:EXACTEXIST=0:MINERROR=100:C=.5
220 IF DR>1 THEN RATIO=1/DR:INVERT=1: ELSE RATIO=DR
230 FOR I=1 TO N
240 EXACTMATCH=0
250 R1=10^((I-1)/N)                        'calculate sample R1 from formula
260 IF T=5 THEN M=10 ELSE M=100            'allow 2 or 3 significant digits in R1
270 IF T=5 THEN IF I>10 AND I<18 THEN C=1.5 ELSE C=.457 'correction for 5% R's
280 R1=INT(R1*M+C)/M                       'round off
290 J=INT(N*(LOG(R1)/LOG(10)-LOG(RATIO)/LOG(10))+1.5)
300 R2=10^((J-1)/N)                        'find best match R2 for sample R1
310 M=10^(1-((J-1)\N))                     'allow 2 significant digits in R2
320 IF T=1 THEN M=M*10                     'add 3rd digit if 1%
330 IF T=5 THEN IF (J MOD 24)>10 AND (J MOD 24)<18 THEN C=1.5 ELSE C=.457
340 R2=INT(R2*M+C)/M                       'round off
350 IF INVERT=1 THEN R1A=R2:R2A=R1 ELSE R1A=R1:R2A=R2 'if inverted, swap back
360 E=ABS(DR-R1A/R2A)/DR                   'calculate error
370 IF E<=.0001 THEN PRINT "*Exact match:  ","R1 =";R1A,"R2 =";R2A:EXACTEXIST=1:
EXACTMATCH=1:MINERROR=E
380 IF T=5 AND E<=.02 AND EXACTMATCH=0 THEN PRINT " Close match:",INT(R1A/R2A*
1000+.5)/1000, "R1 =";R1A,"R2 =";R2A,"Error =";INT(E*10000+.5)/100;"%"
390 IF E-MINERROR<0 THEN MINERROR=E:R1BEST=R1A:R2BEST=R2A 'save if best so far
400 NEXT I
410 IF EXACTEXIST=0 THEN GOSUB 430      'print best match if no exact match
420 RETURN
430 '*****************************print best match*****************************
440 PRINT
450 PRINT "Best match =",INT(R1BEST/R2BEST*10000+.5)/10000,
460 PRINT "R1 =";R1BEST,"R2 =";R2BEST,
470 PRINT "Error =";INT(ABS(R1BEST/R2BEST-DR)/DR*10000+.5)/100;"%"
480 RETURN
```

```
                        RESISTOR.BAS
                       by Jan Axelson

Finds pairs of preferred (standard) resistor values to match desired ratios.
Enter ratios (R1/R2) as single, positive numbers.  Examples:  250, 1.8, .45
Enter 1 to toggle resistor tolerance (1%-5%), enter 0 to quit.

Current resistor tolerance =  5 %
Enter desired resistor ratio (or 1 to change tolerance, 0 to quit):  17

 Close match:  16.667        R1 = 20        R2 = 1.2        Error = 1.96 %
 Close match:  16.923        R1 = 22        R2 = 1.3        Error = .45 %
 Close match:  16.875        R1 = 27        R2 = 1.6        Error = .74 %
*Exact match:                R1 = 51        R2 = 3
 Close match:  16.97         R1 = 56        R2 = 3.3        Error = .18 %
 Close match:  17.222        R1 = 62        R2 = 3.6        Error = 1.31 %
 Close match:  17.333        R1 = 130       R2 = 7.5        Error = 1.96 %

Current resistor tolerance =  5 %
Enter desired resistor ratio (or 1 to change tolerance, 0 to quit):
```

*Fig. 1. This is a sample session of **RESISTOR.BAS**. Here it yielded the 5%-tolerance resistor values that give a nice match for a ratio of 17.*

to 9.31.

Finally, 2D shows an LM317 adjustable voltage regulator. The equation for the resistor ratio to achieve a desired V_{OUT} is:

$$R1/R2 = (V_{OUT} - 1.25)/1.25$$

For a V_{OUT} of 21 volts, the ratio is 15.8. Using 1% tolerances, RESISTOR.BAS recommends any of four resistor pairs, including R1 = 15.8 and R2 = 1, which may be scaled to 1,580 ohms and 100 ohms.

These are four common applications where RESISTOR.BAS can be helpful. Any time you can express two desired resistor values as a ratio, RESISTOR.BAS will find values to fit.

About the Program. You can use RESISTOR.BAS without understanding *how* it works, but for those who are interested, here are some details:

Lines 110–180 form the main program loop that asks for your response and decides what to do next. If you enter "1," line 140 changes the value of T (tolerance) from 5 to 1 or from 1 to 5, and changes the number of preferred values per decade to 24 or 96, as appropriate. If you enter "0," the program ends at line 190.

If you enter a positive number other than 1, line 160 branches to subroutine 200 to calculate resistor values to match the ratio you've entered. If your desired ratio (variable DR in the program) is greater than 1, line 220 inverts it. This ensures that all calculated resistors will be 1 ohm or greater.

Lines 230–400 form a loop that steps through one decade of resistor values, finds the resistor value that best matches the desired ratio for each value, and compares each calculated value to the desired ratio.

The preferred resistor values may be calculated with this formula:

R = 10 ^ ((I – 1)/N)

where R is the resistor value, N is the number of values in one decade (24 or 96), and I is the number of the value in the series (from 1 to 24 or 96).

Line 250 uses the above formula to calculate the first value in the decade, and calls it R1. In line 260, the variable M determines the number of significant digits in the value (2 digits for 5% values and 3 for 1% values).

Line 270 sets a correction value (denoted C) for 5% values. The 5% values require this extra step, since some of the preferred values vary slightly from the values calculated by the formula. Line 270 sets the value of C according to the count (I), so that the rounded-off value in line 280 will equal a preferred value. (The values to accomplish this were determined by experimentation.) The 1% values follow the formula exactly, and line 280 sets C = 0.5 for those values.

The rounded value in line 280 is the first of 24 or 96 sample R1's. Lines 290–340 find the value of R2 that gives the closest match, along with the current sample R1, to the desired ratio. Line 290 uses logarithms to solve the following equation for J, the count of R2:

desired ratio = R1/(10 ^ ((J – 1)/N))

Line 300 calculates the value of R2, and lines 310–340 round the value and adjust it if necessary.

Lines 350–390 compare the ratio of the sample R1 and R2 to the desired ratio. If the ratio was inverted in line 220, line 350 swaps R1 and R2 for the comparison. Line 360 calculates the error (denoted E) as the percent difference between the sample and desired ratios.

If the sample ratio is within 0.01% of the desired ratio, line 370 displays the values and calls them an exact match. If the selected tolerance is 5% and the sample ratio is within 2% of the desired ratio, line 380 displays the values, calling them a close match. If the sample ratio is the closest one so far to the desired ratio, line 390 saves the values as R1BEST and R2BEST.

The program then loops back to line 230 and repeats the process until all 24 or 96 R1's in the decade have been sampled.

When all of the sample ratios have been calculated, if no exact match was found, line 410 branches to subroutine 430 to display the best match. The program then loops back to line 110 and asks for another ratio. ■

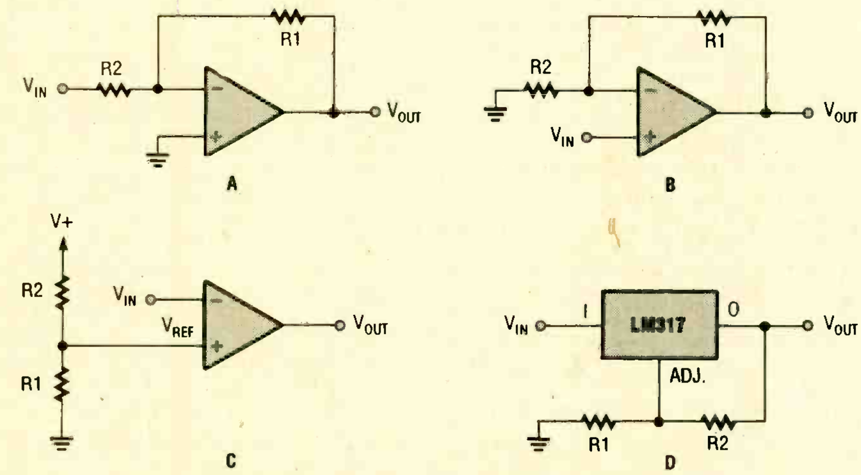
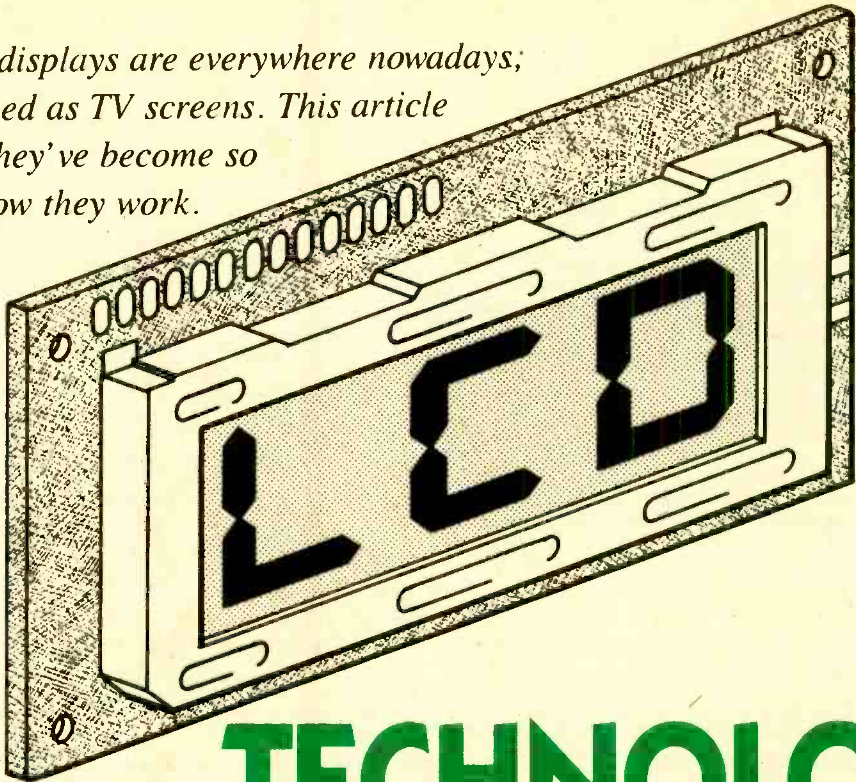


Fig. 2. Shown here are a few of the circuits that require resistor-ratio calculations. They are an inverting amplifier, a non-inverting amplifier, a voltage comparator, and a programmable power supply.

Liquid-crystal displays are everywhere nowadays; they're even used as TV screens. This article explores why they've become so popular and how they work.



TECHNOLOGY

BY DANIEL KATZNELSON

The liquid-crystal display or LCD made its commercial debut in the early 1970's. It represented a quantum leap in display technology that manufacturers of digital watches were quick to exploit. Today the LCD is the most widely used display type except, of course, for the ancient CRT, which might be phased out before long: The introduction of color, combined with constantly improving resolution and speed has brought about the development of highly portable flat-screen TV's and lap-top computers. We are undoubtedly heading toward an age of tubeless consumer goods.

How LCD's Work. LCD's are amazingly efficient at performing their jobs. The smallest LED (light-emitting diode) display consumes a few milliwatts, while an LCD uses power measured in microwatts. For electronic enthusiasts the implications are obvious—a project's display-current requirements can practically be ignored. Frequently, circuits that use LED's must be designed around the display because a glowing diode demands over 1000 times more power than a crystal segment.

The physical arrangement of an LCD is totally different from other display devices because it does not produce light. Instead it modifies available ambient light to produce digits and characters.

Liquid crystals have some of the characteristics of a liquid and a solid. The liquid-crystal particles can be visualized as twisted ribbons that can be moved around. The crystalline medium in an LCD is an organic compound that is scientifically referred to as being "dielectrically anisotropic." That means the properties of the crystals change when an electric field is present. If unenergized (*i.e.*, with no potential present) the crystals "rotate" any incoming light around (which we'll explain in a little bit); when under the influence of a field, any passing light remains unaffected. As you'll see, that's a very important property.

For simplicity, you can imagine light as a wave moving up and down as it travels forward. But in the real world one light wave might be traveling at you while moving up and down, while another wave wiggles left to right, and a slew of others have every orientation in between.

A polarizing filter allows only the light waves traveling with a particular orientation to pass through. If you place one polarizing filter behind another and position them so one permits only light wiggling up and down to pass, and the other will only accept light wiggling left and right, then light will not be able to pass both filters. But, if you take the "up-and-down" oriented light passing through the first filter and "rotate" it so when its reaches the second filter it wiggles left and right, it could then pass through the second filter. You can do just that by placing an unenergized liquid crystal of the right thickness between the filters. Light will travel through the first filter and be rotated by the crystal through 90° so it can pass through the second filter.

Then if we energize the crystals in a certain area, they will not rotate any light getting past the first filter, causing that light to slam into the second filter, which won't allow it to pass. Thus if you try to look through the three layers (the first filter, the liquid crystal, and the second filter), the energized region will appear dark. That is how LCD's work—each segment forming a digit is an energized region. A reflective coating is placed behind the second

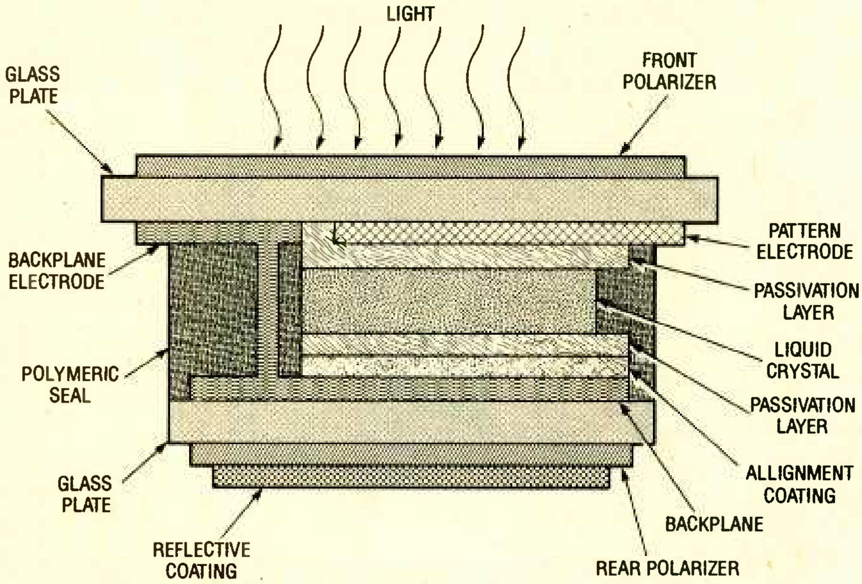


Fig. 1. This is the layout of a typical LCD. In the position shown, the unit would be read from above.

filter so no light has to be generated behind the display to make the dark area apparent. The coating reflects any light making it through the assembly back out again.

How LCD's Are Built. Figure 1 illustrates a single cell from the most common type of LCD called a *T*wisted *N*ematic *L*iquid-*C*rystal *d*isplay or TNLCD.

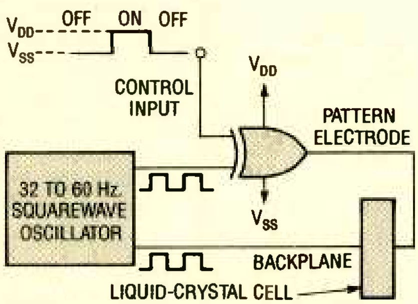


Fig. 2. This is the most popular drive circuit for an LCD. The gate's control input determines whether it inverts or buffers the oscillator signal.

Ambient light of the correct orientation passes through the front polarizer and the front glass. It then passes through a transparent pattern of information electrodes. Each electrode is in the shape of a display segment and consists of a grid of fine wires composed of indium tin oxide. They are etched into the glass by a process called photolithography.

Another electrode (to the rear of the display) is the backplane or common connection. As the name implies, it is electrically common to all segments in the display. The external connection for that electrode is brought to the front of the display to be level with the connection points for the front pattern electrodes.

Note the *passivation layer* next to both electrodes. It acts to prevent current from flowing through the liquid-crystal layer, which would limit its life.

The light waves continue their journey, penetrating the liquid-crystal layer and the second passivation layer. Finally it passes through the alignment coating. That coating ensures that the crystals will line up properly when energized.

The light continues to pass through the component parts of the rear glass subassembly, which are essentially the same as the front half of the display. Light that has not been rotated because it passed through energized regions of the liquid crystal doesn't make it though the rear polarizer. The rest of the light passes to the reflector at the back, which is often a coating of highly luminescent material or may be provided with some kind of backlighting. The polymeric seal prevents the crystalline compound from leaking out. In multi-cell displays, it also separates the liquid in each cell.

LCD Drive Considerations. Many of our readers have undoubtedly built devices that use LED displays. When LED's are included as part of an overall design, the prime consideration is DC power consumption. If the regulator can handle the load, your problems are over.

That is definitely not the case with LCD's. In fact, any DC voltages over 25 mV will quickly lead to a chemical meltdown. To make matters worse, you may not be immediately aware that something is wrong until a critical measurement fails to materialize on the display. To keep from taxing the display, an LCD should be driven by an oscillator producing a clean squarewave with a 50% duty cycle.

Figure 2 shows a widely accepted method used to drive LCD's. The basic idea is to apply a squarewave (with a frequency between 32 and 60 Hz) to both the pattern electrodes and backplane of an LCD. When the pulse train delivered to a pattern electrode is the same as the signal received by the common electrode (*i.e.*, the control input of the XOR gate is low), they have the same potential, thus the segment controled by the pattern electrode does not appear. If you make the gate's control input high, it inverts the oscillator's output. Thus the pattern electrode is at some potential relative to the backplane (regardless of whether the clock is high or low), the crystals align, and a segment is darkened. The signal action for that is shown in Fig. 3. LCD's are typically operated at between 3- and 5-volts rms.

(Continued on page 93)

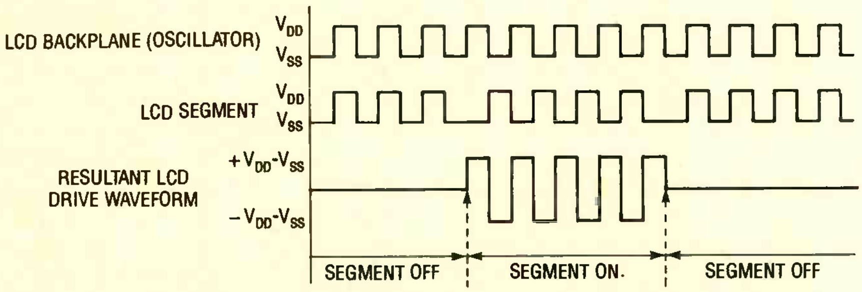
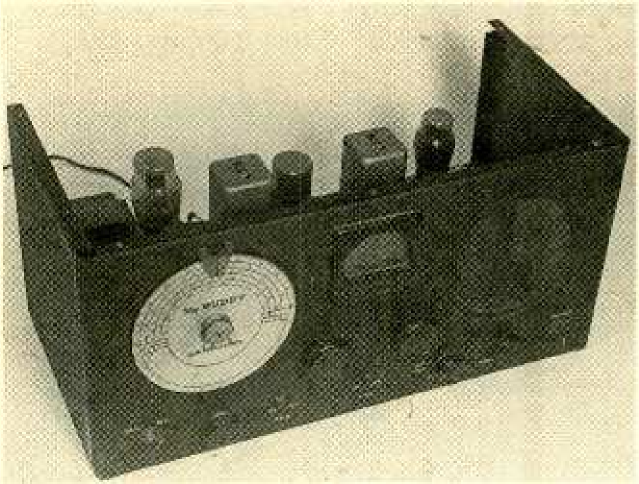


Fig. 3 These LCD drive waveforms should give you an idea of how the circuit works. You can subtract the top wave from the one in the middle to get the bottom waveform.

By Marc Ellis

Getting Started on the Sky Buddy

Last month, we talked a little bit about the history and evolution of the Hallicrafters Sky Buddy receiver (Model S-19R), our current restoration project. Introduced in 1939, this bottom-of-the-line model was a popular starter set for teenage hams and shortwave listeners in the quiet years just prior to the onset of World War II. The set sold for $29.50, which sounds like a pittance to our modern ears. But in an article in *The Golden Years of Radio* (Ham Radio Publishing Group, 1978), John J. Nagle, K4KJ, tells us that he worked almost an entire semester in the school cafeteria to come up with the money to buy a Sky Buddy.



Front view of the model S-19R Sky Buddy with its covers removed for inspection and cleaning. The front panel has a very neat, attractive, and businesslike appearance.

The set we're going to be working on is one I picked up at a flea market a few years ago. I'd never before seen an old "silver dial" Hallicrafters up close, let alone had the opportunity to purchase one. So I was quite happy to add the S-19R to my collection for the princely sum of fifteen bucks. After getting the set home, I put it away without working on it because I thought the restoration would someday make a good project for this column. And now the time has come!

CRACKING THE COVERS

One gains access to the S-19R Sky Buddy by unscrewing and removing the heavy-gauge metal covers forming the top and bottom of the cabinet. That exposes both sides of the chassis for inspection and repair. My first official act was to remove those covers so that I could make a complete visual assessment.

With the covers off, I could see that the set is evidently complete and in reasonable condition. Except for a missing tube (an easy-to-replace 6SK7), all of the parts seem to be present. I couldn't see (or smell) any burned components and none of the wiring appears to have been modified or tampered with.

About the worst thing I can say about the appearance of the radio is that it definitely has a tired look. The finish is dirty and scuffed; the chassis is covered with a sticky grime and—here and there—shows signs of corrosion; the bright metal parts, including the IF transformer cans and dial, have coatings of that varnish-like yellowish deposit often found on old radios (maybe it's grease from cooking or tar from cigarette smoke). Finally, the presence of some neatly opened seed hulls suggests that a small rodent may once have made a comfortable home under the chassis.

The removal of the covers has also exposed an odd constructional quirk. The chassis can't be separated from the cabinet, but is permanently attached—apparently by spot welding.

TESTING FOR LIFE SIGNS

Though the Sky Buddy's zip-cord power lead was brittle and cracked, I decided that it was probably still safe enough to carry power for a few initial checks. Accordingly, I plugged it into the isolation transformer/variable voltage source that I use for set testing.

The variable voltage feature allows me to apply power gradually. This is a must for restoring the electrolytic filter capacitors in the power supplies of long-unused sets. Such capacitors may well short out with sudden application of full power, but *gradual* application of power promotes an electrochemical rejuvenation or "forming" process.

Electrolytic capacitors are not permanent components; eventually the moist electrolyte inside dries out to the point where the unit will not function. After that, the only cure is replacement. However, if a long-unused electrolytic has any potential life left at all, an initial "forming" will probably keep it going.

For my initial "signs of life" test, however, I usually pull the rectifier tube so that the DC power supply is not functioning. Hence, there is no voltage on the electrolytic. With the Sky Buddy's type-80 rectifier removed and full line voltage applied, I snapped on the power switch and was gratified to see the set's pilot light come on, illuminating the bandspread dial. I could also see the filaments of the two glass tubes light up.

That meant the power transformer's 6.3-volt filament winding was OK. I used my multimeter to check the other windings, and was happy to observe that five volts was present at the filament pins of the type 80's socket and that well over 700 could be measured across the plate pins. So the power transformer seems to be in good shape.

Now it was time to check the state of the electrolytic. I connected my multimeter to monitor the power supply's DC output, plugged in the type 80, and powered up the set with a line voltage of about 60. My eyes were glued to the meter, because if no DC voltage were to appear, or if it appeared and suddenly dropped to a low value, the electrolytic would probably be shorted.

At first I was worried because, even after several seconds of warm-up, no DC voltage appeared. But after quickly shutting off the set and thinking for a moment, I realized what was wrong. The S-19R's "send-receive" switch was in the "send" position, which cuts the DC power in order to silence the receiver during periods when the operator is transmitting.

With the switch reset to "receive," I tried again. This time, I watched the DC voltage climb smoothly to 60 or 70 and hold there with no sign of fluctuation.

The rear view of the opened-up Sky Buddy shows the dirt and grime that has settled into this set. The chassis is not a separate unit, but a shelf-like assembly spot-welded to the cabinet front and sides.

SOUNDS FROM THE SPEAKER

Apparently the audio stages and loudspeaker were also working, because I could hear crashes in the speaker when rotating the set's very noisy volume control. Increasing the line voltage to about 90 caused a further increase in DC voltage, and now I was able to hear a rush of static in the speaker as the radio's RF circuits began to function.

The S-19R requires an external antenna, and I didn't have one connected. But since the DC voltage was still holding steady, I tried tuning for broadcast-band stations with my finger on the antenna terminal. I also turned on the BFO (beat-frequency oscillator) switch to help me detect any faint signals that might come in.

For those who may not know, the BFO generates a low-power radio signal that mixes with incoming signals to create a heterodyne, or whistle. That is normally used for reception of Morse-code (CW) signals, which are formed by interrupting a radio "carrier wave." The pure carrier wave does not carry any sound. So without the BFO, CW signals would be heard only as patterns of hisses.

As I tuned, I did hear some faint whistles, indicating that stations were being picked up. With the BFO turned off, however, the signals disappeared, being too faint to hear on their own. The set's DC voltage was still holding steady, so I decided to boost the line voltage to the full 120. Now one broadcast station was coming in fairly loudly.

What I heard, believe it or not, was our local nostalgia music station—which at the moment happened to be playing that moody '40's favorite *Tangerine*. The sound was distorted, and eventually faded to a very low level. But for a brief moment, I seemed to be living out that science-fiction writer's fantasy: picking up antique-radio programs with an antique radio. It was a neat experience!

This comfortable restoration shop belongs to Shayne Trowsse of Ontario, Canada. Note the TV set atop the oscilloscope at the left end of the bench, not to mention the adjoining hi-fi tuner and amp!

TAKING STOCK

So now we know that the power supply is in good shape and that the electrolytic probably won't have to be changed. We also know that the audio stages and speaker are functioning. The latter is quite a relief, because the S-19R has a dynamic speaker (one requiring a source of DC power in order to function). These are subject to burn out with failure of the electrolytic capacitor, and exact replacements are hard to come by.

The major components in the RF section of the set are probably OK, too, since we

(Continued on page 77)

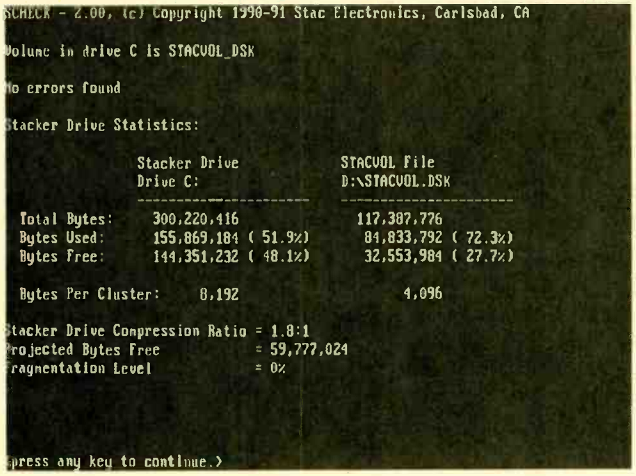
COMPUTER BITS

By Jeff Holtzman

The Secret Life of a Computer Products Reviewer

The story you are about to read is true. Only the names have been changed to protect the innocent. Part of my job involves evaluating new computer hardware and software. It's a fun job—one that many people covet. Most of the time I love it. Sometimes, though, it drives me to the brink of violence. Here's why.

Have you ever thought about how product reviewers do their jobs? At one end of the scale, some collect vendor press releases and rewrite them without ever puncturing the shrink wrap. At the other end are testing laboratories that perform scientifically rigorous, statistically valid testing. In between are the rest of us, those who roll up their sleeves, take a deep breath, install the product, and use it in a realistic manner.



Stacker is the answer to the disk-space crunch. Simple installation, transparent operation, and easy on-the-fly configuration make it a winning product. Its low cost makes it a must-have item.

Doing so can be perilous, however. Why? Because the reviewer is continually caught in a Catch-22. Experienced reviewers know full well that early releases of products tend to have bugs, occasionally very nasty bugs that destroy data. Trying to safeguard yourself against data loss while using a pre-release product to do real work is akin to doing crash testing for an auto company with real people instead of dummies.

Another problem is that some vendors have adopted the pernicious habit of sending shrink-wrapped—*i.e.*, supposedly final, stable, totally debugged—review copies of their products, when they in fact know the code is not final. Nor do they bother to inform the reviewer of that fact. So the reviewer blithely goes about his or her business, first dipping a toe gradually, so to speak then a foot, then the legs, and perhaps finally attaining enough confidence to jump in headfirst.

Things may proceed smoothly for awhile, in some cases even months. Suddenly, though, strange things start happening. Files are corrupted, initialization information is lost, software refuses to run and must be reinstalled. Tracking down those types of problems is an unrewarding and sometimes futile activity. Call a technical support line, and they cannot reproduce your problem, even though the version number, file size, and time/date stamp of your product and theirs are all identical. Do a file compare between your version and a commercial release, however, and you're likely to find differences. I have.

It's also worth pointing out that I've seen publicly published reports of the same types of things happening to paying corporate customers.

CASE IN POINT

Recently I installed a new version of a popular Windows font manager. Things seemed to be working just fine; then I started to run my spreadsheet program. Lo and behold, the text in all system dialog boxes was nearly illegible. I called the font vendor, who naturally couldn't reproduce the problem, but who pointed out that the vendor of the spreadsheet program had surreptitiously released a "maintenance" version of the program. Knowledge of the availability of that maintenance version has not been widely disseminated. I called the vendor's sales line without identifying myself as a member of the press, and was told that there was indeed an upgrade available, at no cost, and that it would arrive in four or five working days.

Actually, it arrived the next day; when I saw it, I assumed that the vendor's haste in shipping it amounted to a tacit confession of guilt. Wrong. After installing the new software, I expectantly started it up, and the sign-on dialog box looked just as bad as before. Then I started thinking that something was screwed up in one of the initialization files. I examined WIN.INI and the font manager's INI file as well. Things seemed to be in order, but I also noticed that there was a lot of junk in WIN.INI that had been left behind by some software packages that I had at one time tested but long since deleted.

> **VENDOR**
>
> Stac Electronics
> 5993 Avenida Encinas
> Carlsbad, CA 92008
> 619-431-7474

I deleted the junk, restarted Windows, and the problem recurred. In fact it was worse. When I started the word processor, it would not display anything right. In addition, the file manager/launcher I used seemed to have lost its configuration information as well. Then I thought it might be a virus. I ran several virus scanning utilities; nothing.

At last, I remembered that the file manager had lost its configuration information once before—and that the only solution I'd found then was to reinstall it. So I disabled the file manager, returning to Windows' own Program Manager. Fired up Windows, then the word processor; everything checked out. Fired up the spreadsheet; it too now seemed to work just fine.

LESSONS LEARNED

There are several lessons here. One concerns vendor indifference toward reviewers. The other concerns product security as related to install and uninstall procedures. Vendor indifference is a tough one. Some companies go out of their ways to accommodate reviewers; others take a positively hostile attitude. Most, however, fall somewhere between those extremes; it is to them that these words are addressed: Please remember that those of us who try to do a conscientious job use your products to do real work. In the interest of fairness, you should ship upgrade/bug-fix disks automatically. Remember that most of us do face-to-face consulting and are liable in that situation to report bugs that are uncovered subsequent to published reviews.

Product security is even tougher. For years, users have stood for awkward and destructive installation procedures that wantonly change system files, ignore system configuration, and don't clean up after themselves. A general solution to the problem is required, one that is enforced by the operating system. Then application vendors would have to conform to standards.

Vendors would be among the first to benefit from such an arrangement. By adopting a secured database approach to configuration and initialization information, system files could not be changed in unspecified ways by unwitting (or even malicious) users. That would translate directly into lower technical-support costs. It would also translate directly into better product quality, better press coverage, and greater customer loyalty.

STACKER REPRISE

Stacker (mentioned last time), from Stac Electronics, continues to amaze me. After several months of moderate use, I have double the disk space and have had no problems with compatibility or reliability. A friend has been using the software only version on a sexy little 386SX notebook, and he loves it. I've seen the software version for about $80, and the hardware version for about $140 by mail order. ■

CIRCUIT CIRCUS

By Charles D. Rakes

Filter Circuits

Listen up fellow circuiteers because this time around we are going to share a few audio-enhancement circuits. Just about anything that we listen to that's not "in person" can often be electronically improved. Here are just a few examples of where shaping and filtering audio signals can improve our ability to understand and interpret what we hear:

If you are an avid shortwave listener or amateur-radio operator, the difference in receiving or contacting a rare DX station greatly depends on the IF-bandwidth and audio-filtering capabilities of your receiver. Most receivers that don't have a selectable AF filter can be improved immensely by using an add-on filter at the receiver's audio output.

The success of audio surveillance with a long-range shot gun or parabolic microphone is greatly enhanced by using one or more bandpass filters to select and amplify only the desired signals.

BANDPASS FILTER

Our first entry, see Fig. 1, is a variable-frequency, audio bandpass filter. Two 741 op-amps are configured as identical RC active filters and are connected in cascade for better selectivity. The filter's tuning range is from 500 Hz to 1500 kHz. The overall voltage gain is slightly greater than one and the filter's Q is about 5. The circuit can handle input signals of 4 volts peak-to-peak without being overdriven. The circuit's input impedance is over 200k and its output impedance is less than 1k.

The filter can be connected as shown in Fig. 2 to offer a variable bandpass to an existing amplifier by inserting the filter circuit between the amp's preamp and output stage. The circuit's frequency-determining capacitors, C3, C4, C5, and C6 should be good quality 5% polystyrene, and all resistors should be 5%.

SUPER BANDPASS FILTER

The filter circuit in Fig. 1 is an excellent building block that can be expanded into a super bandpass filter. Such a circuit is shown in Fig. 3. The circuit, which is

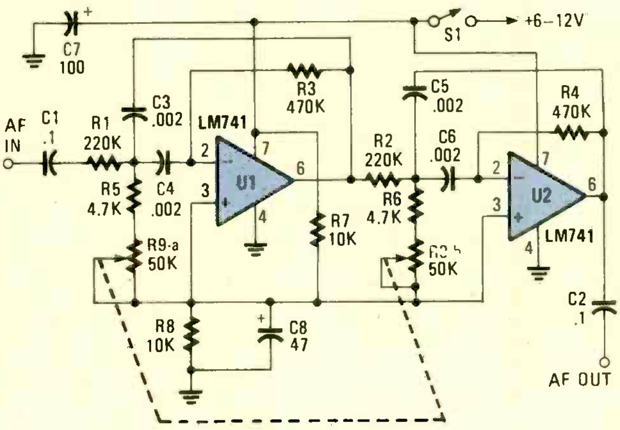


Fig. 1. This variable-frequency, audio bandpass filter is built around two 741 op-amps that are connected in cascade.

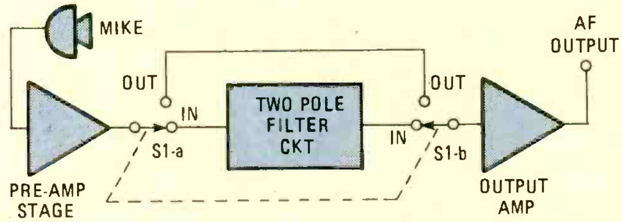


Fig. 2. The filter can be wired into an existing amplifier by inserting the filter circuit between the amp's preamp and output stages as shown here.

PARTS LIST FOR THE BANDPASS FILTER

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1, R2—220,000-ohm
R3, R4—470,000-ohm
R5, R6—4700-ohm
R7, R8—10,000-ohm
R9—50,000-ohm dual potentiometer

CAPACITORS
C1, C2—0.1-µF, ceramic-disc
C3–C6—.002-µF, 50-WVDC, polystyrene or similar
C7—100-µF, 16-WVDC, electrolytic
C8—47-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
U1, U2—741 op-amp, integrated circuit
S1—Power switch
Perfboard materials, IC sockets, 6–12-volt power source, knob, wire, solder, hardware, etc.

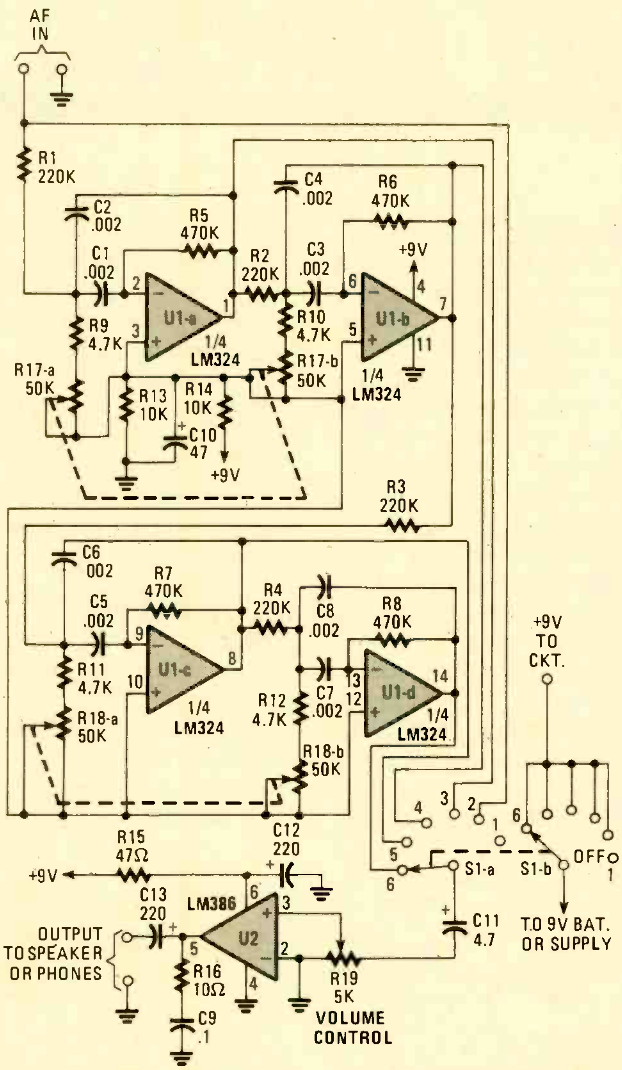


Fig. 3. The filter in Fig. 1 can be expanded as shown here, by adding an audio power amplifier and a filter-selector switch.

built around an LM324 quad op-amp and an LM386 low-power audio amplifier, consists of two cascaded filter circuits, an audio power amplifier and a filter-selector switch.

Two 50k dual potentiometers allow a wide adjustment of the filter's bandpass and bandwidth. An LM386 boosts the filter's audio to drive a speaker or headphones. A six-position switch allows the selection of the number of filter circuits inserted in the audio chain. With the selector switch in position 2, the filter circuit is bypassed and the audio is fed directly to the input of the LM386.

In position 3, the audio input is passed through the first filter stage, providing minimum selectivity, which offers a good degree of filtering for single-sideband signals or to pull a weak AM station out of the RF mud. The 3-dB bandwidth of the filter in that position is about 30%, which is broad enough for speech.

In position 4, two filters are cascaded, as in our first circuit in Fig. 1, and offer a bandwidth of about 20%. That position is also usable for speech in a limited way, but is better suited to single-signal audio tone or CW reception. By switching to position 5, three filters are in the audio loop and if the two dual potentiometers are adjusted alike, the bandwidth will be about 15%. That is too narrow for speech. However, if one of the dual potentiometers is tuned to a slightly higher frequency and the other dual potentiometer is tuned to a slightly lower frequency, the filter can be used for enhanced speech reception. But, as the bandwidth is increased in that manner, the overall circuit gain goes down. The loss may be made up by adjusting the volume control, R19.

With all four filters switched in (position 6) and tuned to the same frequency, the bandwidth is about 10%. The bandwidth of the filter can be tailored by shifting the position of the two dual potentiometers. Greater tuning versatility can be

PARTS LIST FOR THE SUPER BANDPASS FILTER

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1–R4—220,000-ohm
R5–R8—470,000-ohm
R9–R12—4700-ohm
R13, R14—10,000-ohm
R15—47-ohm
R16—10-ohm
R17, R18—50,000-ohm dual potentiometer
R19—5,000-ohm potentiometer

CAPACITORS

C1–C8—.002-μF, 50-WVDC, polystyrene
C9—0.1-μF, ceramic-disc
C10—47-μF, 16-WVDC, electrolytic
C11—4.7-μF, 16-WVDC, electrolytic
C12, C13—220-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

U1—LM324 quad op-amp, integrated circuit
U2—LM386 low-voltage audio-power amplifier, integrated circuit
S1—DP6T rotary switch
Perfboard materials, enclosure, sockets, cabinet, knobs, power source, wire, solder, hardware, etc.

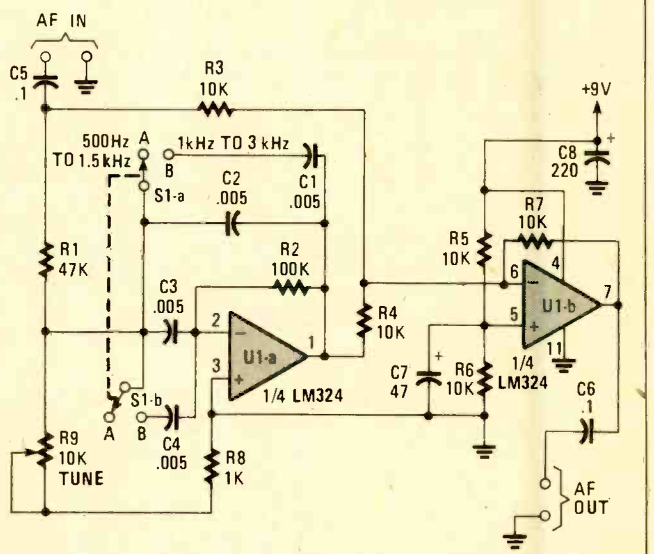


Fig. 4. The notch filter can be added to just about any receiver to attenuate a single frequency by more than 30 dB.

PARTS LIST FOR THE NOTCH FILTER

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—47,000-ohm
R2—100,000-ohm
R3–R7—10,000-ohm
R8—1000-ohm
R9—10,000-ohm potentiometer

CAPACITORS

C1–C4—.005-µF, 50—WVDC, polystyrene (see text)
C5, C6—0.1-µF, ceramic-disc
C7—47-µF, 16-WVDC, electrolytic
C8—220-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

U1—LM324 quad op-amp, integrated circuit
S1—DPDT switch
Perfboard materials, enclosure, IC sockets, power source, wire, solder, hardware, etc.

had by replacing the two dual potentiometers with four separate 50k units.

NOTCH FILTER

The bandpass filter is a big asset in selecting signals that we want to hear but can do little in removing a single frequency tone that we don't want to hear. If you do a lot of shortwave listening, there's little doubt that at least some of your favorite stations have been plagued by an interfering heterodyne tone. Some of the better shortwave receiver's have a built-in notch filter that can be used to tune out or at least reduce an annoying heterodyne tone without significantly reducing the desired signal.

The notch filter shown in Fig. 4 can be added to just about any receiver and will reduce a single frequency tone by more than 30 dB. The filter circuit as shown can be connected to a receiver's internal circuitry; or externally by adding the LM386 audio-amplifier portion of the circuit shown in Fig. 3 to drive an external speaker. The second option might be more convenient.

The notch filter tunes from 500 Hz to over 3 kHz in two ranges. The tuning range can be changed by either increasing the values of C1 and C4 or C2 and C3 to lower the frequency or by decreasing the values to increase the frequency. The capacitors should have a 5% tolerance or better and be a good quality polyester-, polystyrene-, polypropylene-, or mylar-type capacitors.

The circuit's input impedance is about 10k and will handle a maximum input signal of 1-volt peak-to-peak with a 9-volt power supply (which can be a 9-volt battery if you wish). The filter's voltage gain is about 1 and the output impedance is less than 1k. An additional notch filter circuit can be formed from the two remaining op-amps in the LM324 package and used to assist in removing two interfering tones. Just cascade the two filters by connecting the output of the first notch filter to the input of the second.

Looks like it's time to close for this visit. So until next month, when I return with more circuits for your work bench and soldering iron, I hope you enjoy better reception and happy listening. ■

THINK TANK

By John J. Yacono

More Tips

This month, I will continue to present some of the helpful tips provided by some of you readers. First, however, I would like to clear up a couple of errors that have crept their way into this column.

The first one appeared in the January 1992 issue. To refresh your memory, that was one of the *Think Tank* columns devoted to op-amp operation. While the column was being prepared for publication, an "R" was dropped from some of the equations. To amend this error, all the equations presented in the column have been listed in their correct form in the boxed text entitled "Op-Amp Equations."

By the way, I have received some favorable response about presenting a little math in the column. If you have an opinion about whether or not I should do more derivations, write-in and let me know. If you want to see more circuit theory, let me know what you would like covered.

I have been more or less flooded with letters regarding an error in the March 1992 *Think Tank* column, which was dedicated to automotive electronics. (Apparently, I did not over estimate the importance and interest people invest in cars.) Figure 5 that month lost a ground symbol on the way to these pages. It should have been attached to the unconnected terminal of the relay in the figure. See Fig. 1 for the corrected schematic diagram.

Since the automotive-electronics topic seemed so popular, I will try to do another column on it in the future. To help me out, please send your car-related (or other) circuits to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. All the submissions used will receive a "Think Tank II" or other book.

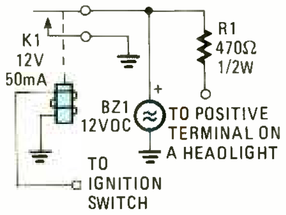


Fig. 1. This is how the headlight-reminder circuit should have looked. Note: The ground connection is important for the device's operation.

Now let's get to those helpful hints. As usual, I'll kick things off.

A CABLE RACK

I have quite an assortment of cables in my workshop, all with various connectors on the ends. The large number and variety makes interconnecting equipment quick and easy, but wading through the assortment, looking for just the right cable, is a chore in itself. There are commercially sold cable racks that are designed to solve that problem by neatly suspending the cables from one end, but they are expensive (or perhaps I'm just too cheap to buy one).

So, in the true hobbyist spirit, I made one of my own (see Fig. 2) out of a screen-door spring. The springs are readily available from hardware and home-care stores, and can be prepared for use in a matter of minutes.

Start by securing a flat-head nail, head-up in a bolted-down vice. Loop one end of the spring over the head of the nail, and insert a screw driver in the loop at the other end. Grip the handle of the screwdriver with one hand and the stem with the other. Pull the screwdriver firmly toward you tilting it slightly so that the loop of the spring slides down toward the handle. The tilt will keep the spring away from the hand you placed on the stem. Firmly stretch the spring until the space between windings is about equal to the thickness of most of your cables. To accommodate

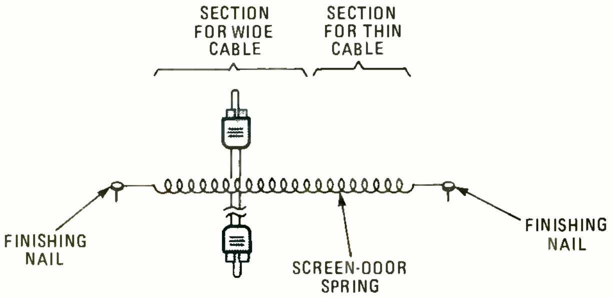


Fig. 2. A quick and easy cable rack can be made from an inexpensive screen-door spring. All it takes is a little muscle.

thicker cables you can make a section of the spring larger by altering the loop you attach to the nail so that you stretch only a portion of the spring.

I recommend that you mount the spring to a convenient surface in your workshop by placing a finishing nail through the loop at each end. Angle the nails slightly away from the spring to prevent it from escaping. By using finishing nails in that fashion, you can always take down the rack (spring) and drop it, cable and all, into your tool box for field work. Now let's get to the helpful tips provided by you readers.

SOCK IT AWAY

I have a helpful tip for auto-stereo enthusiasts. Before installing car speakers, I have always covered them with panty hose. The hose provides the speakers with protection against dust, bugs, sand, etc., which usually fall on them causing distortion and reducing speaker life. It just takes a little work to slip them over; once you get them on, you will need to cut a little slot for each wire connection. I have taken that tip for granted for a number of years, but lately I have been surprised to find that a number of people have never heard of it.

—Scott Partridge, Vicksburg, MS

That's a pretty nice way to recycle used panty hose. You can also use them as dust screens in projects requiring a cooling fan. They really keep the lint out. The plastic eggs that some of them come in can be used as unusual project cases, too.

BATTERY CLIPS

Most of the circuits that I build require 9-volt transistor-radio batteries, so I never seem to have enough suitable battery clips on hand. Instead of making more trips to the store, I have found a way to make them for myself. To start, take a dead 9-volt battery and pry off the metal casing. Then lift off the terminal assembly at the top of the battery (as shown in Fig. 3) and cut the wires that connect it to the cells of the battery.

You can easily solder wires to the back of the terminal's connector and use the assembly as a battery clip. Just remember to

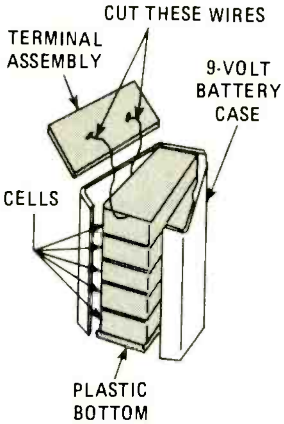


Fig. 3. This is an internal view of a 9-volt battery. Note that the separate cells in the battery are wired in series by stacking them on top of one another.

solder a red wire (or other positive lead) to the terminal that used to be the negative terminal of the battery so that the polarity is correct. The resulting battery clips are stronger than store-bought ones and you should have no trouble finding the raw materials.

—Jim Tschanz, Libertyville, IL

Definitely a neat idea, but one that should be tried with caution. If you want to try that trick, be careful not to cut yourself on the metal of the battery case. And be sure to wash your hands and work surface thoroughly when done. Also be sure never to dismantle a rechargeable battery, they might contain very hazardous chemicals.

There is something else you can make out of old batteries: oxygen! Before you discard the battery entrails, remove the black powder from each of its cells. The substance is called manganese-dioxide. If you sprinkle some of that powder in a glass containing hydrogen peroxide, the mixture will produce bubbles of oxygen. A word of caution is in order however: **never** deliberately try to concentrate the oxygen produced. Remember oxygen is the key ingredient for combustion; having too much of it in one place invites disaster. For that same reason, do not try the experiment near an open flame.

If that experiment and the battery-clip tip don't seem like good enough reasons to rip an old 9-volt battery apart, then what about this next idea?

OP-AMP EQUATIONS

$$V_O = A_{OL}\,(V_{in+} - V_{in-})$$
$$V_{in-} = V_O\,R2/(R1+R2)$$
$$V_O = A_{OL}\,(V_{in+} - V_O\,R2/(R1+R2))$$
$$V_O/A_{OL} = (V_{in+} - V_O\,R2/(R1+R2))$$
$$1/A_{OL} = (V_{in+} - V_O\,R2/(R1+R2))/V_O$$
$$1/A_{OL} + R2/(R1+R2) = V_{in+}/V_O$$
$$R2/(R1+R2) = V_{in+}/V_O$$
$$(R1+R2)/R2 = V_O/V_{in+}$$

A TRIMMER TOOL

If you build projects that contain trimmer capacitors, adjusting them can be really frustrating without the right tool. But don't fret; if you have a dead 9-volt battery around, you can make an insulated adjustment tool out of it.

First check the bottom of the battery to make sure it is not metal. Then carefully use a pair of pliers to remove the battery's metal casing without cutting yourself. Discard all but the insulating bottom of the battery. Cut two notches into the insulating material

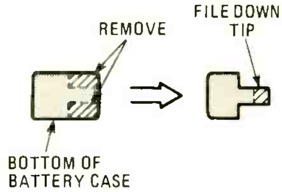


Fig. 4. If you need a trimmer-capacitor adjustment tool, don't throw out those old 9-volt batteries. They have a plastic part that can easily be modified for the job.

so it looks like Fig. 4. Finally, file down the tip so that it can fit into the slot on a trimmer capacitor—don't file too much or the tip will break off.

—Unsigned, Sapulpa, OK

Anyone attempting to make one of those adjustment tools should observe the same cautions mentioned for building the battery clips (beware of sharp metal, don't use rechargeable batteries, etc.)

I'm sorry I couldn't provide a name with that last letter, but it was received unsigned (it contained only the address) and the envelope for the letter was misplaced. Nonetheless, the author's Think Tank II book is on the way to him/her.

THE CUTTING EDGE

Most of us don't give our *(Continued on page 88)*

DX LISTENING

By Don Jensen

Brazilian DX On A Rollercoaster Ride

Brazil for years has been one of the most active countries on the shortwave bands. Although some stations have shifted to medium-wave AM and VHF-FM bands, there remain more than 150 shortwave outlets in this, the largest of the South American nations. For SWL's, the best known Brazilian SW'er is government-operated *Radiobras.*

In 1958, two years before Brasilia, a planned city carved out of the Amazonian wilds to be the country's new capital, was even completed, the equally new shortwave station went on the air. *Radio Nacional de Brasilia* aired its first official broadcast on May 31 of that year.

In earlier years, Radio Nacional de Brasilia, the forerunner of today's International Service Radiobras, directed much of its shortwave effort to reaching audiences in the Brazilian Amazon.

Programs during the early years focused on public service to those who had flocked to the frontier area. The radio helped to link the settlers to their families elsewhere in Brazil. Several years later, Radio Nacional de Brasilia was merged with *Radio Nacional de Rio de Janeiro*, which was one of the nation's oldest and best known broadcasters.

International shortwave programming, on an experimental basis, started in June 1972, with English test broadcasts to Europe. An International Service officially began several months later, with four one-hour programs in English, German, Portuguese, and Spanish. French and Italian programs were added. That early effort to reach overseas listeners wasn't successful, since Radio Nacional de Brasilia's shortwave transmitter was only a 10-kilowatt unit, far too weak to compete with other international broadcasters.

But that changed in 1974, when a "world-class" 250-kilowatt transmitter came on line. But by then, RNB was facing financial problems, forcing a cutback in broadcasting hours and services. In fact, in June 1977, the foreign broadcasts were suspended entirely, as the focus shifted to a new internal SW-radio service directed to Brazilians living in the vast Amazon region.

The International Service was resumed in 1979, with a one-hour daily English program to North America. Shortly therafter it was expanded again with additional English broadcasts to Europe and Portuguese programming to southern Europe and Africa. In the early 1980's, some Spanish- and German-language programming returned. In addition, the station leased air time to other countries, such as Germany and neighboring Surinam, allowing those broadcasters to relay their programs to western-hemisphere audiences over the Brazilian facilities.

The International Service of RNB—which by then stood for Radio Nacional de Brasil—resumed a full-fledged service in July 1990, with 80-minute daily programs in its four programming languages. But in a baffling move, the station later shifted the timing of its 11.745-kHz English program to North America from a prime-time evening slot (0200 UTC) to the early morning (1200 UTC) when there are fewer listeners. Instead, you might try the European beam from Radiobras on 15,265 kHz, 1800 to 1920 UTC.

Your reception reports may be sent to Radiobras, Caixa Postal 04/0340, 70323 Brasilia, Brazil.

IN THE MAIL

Larry Martinson writes from Spartanburg, SC: "Strange as it may seem, over the last couple of years, I've become something of a fan of *Radio Moscow.* What is going to happen to this venerable shortwave service?"

I wish I knew, Larry. For longtime SWL's, the changes—and most of them were improvements—in Radio Moscow's programming during the *glasnost* era were nothing short of amazing. So I, too, found myself tuning in far more frequently than in the earlier Cold-War years.

Already there have been some significant programming changes, notably the loss of the North American Service. Budget constraints, which doubtless will continue to be a problem, last

December resulted in the folding of that service into Radio Moscow's World Services. Fortunately, some of the better programs survived; shows like Joe Adamov's Mailbag, Russian by Radio, Culture and the Arts.

Station staffers, reportedly, still have concerns about the future and possible additional cutbacks. But I expect that Radio Moscow, or something like it, will continue to broadcast on shortwave to English-speaking listeners.

Brad Davies lives in the Pacific Northwest, one of the best areas in the U.S. for DX'ing Indonesia. And our reader in Yakima, WA, has found that out himself. "I've really become hung up on listening to the Indonesian stations. During the spring, I logged quite a few of the home-service *Radio Republik Indonesia* outlets on the lower shortwave frequencies. Some are real DX'ing challenges!"

Although often difficult to hear (especially in parts of eastern North America), Indonesia's RRI home-service SW stations, located from Sumatra to Irian Jaya, the western part of New Guinea, are favorite targets of experienced, serious DX'ers.

Perhaps the best bet for listeners in most parts of the U.S. and Canada is the RRI station at Ujung Pandang, in Indonesia's Celebes Islands (Sulawesi). Look for it just before dawn on 4,753 kHz. I also recommend a couple of reference books. The 25-page *Survey Of Broadcasting Activity In Indonesia* is a highly accurate listing of 280 different SW stations, their frequencies, and observed schedules. A companion book is *The Dx'ers Handbook: Indonesia*, which includes a profile of this Asian island nation and its broadcasting, a guide to Indonesian language station identifications, tips on obtaining QSL's, detailed maps to help you locate the stations you hear, and much more.

These publications are offered as a special package for $12, postage included, by FT Special Publications, C/O Bryant, Rt. 5, Box 14, Stillwater, OK 74074.

That's mail call for this month. Remember that your letters are always welcome. Write if you have questions or comments about shortwave listening. Or drop us a note telling the rest of us what you're hearing on SW these days. The address, as always, is *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

DOWN THE DIAL

Here are some SW listening choices:

HONDURAS—*Sani Radio* has been heard on 6,300 kHz with Spanish-language programming until sign off at 0000 UTC.

HONG KONG—If you come across English-language *British Broadcasting Corporation* programs on 11,820 kHz during the 1430 to 1500 UTC time block, the signals actually are coming from a BBC relay transmitter at Hong Kong.

INDIA—*All India Radio* is heard in English on 9,950 kHz with a health program from 2215 until 2230 UTC sign off.

IRAQ—*Radio Baghdad* operates on 15,601 kHz in Arabic at 2120 UTC.

PHILIPPINES—*Radio Filipinas* is relayed on 21,580 kHz by a *Voice of America* transmitter at Tinang in the Philippines. It has been noted in English at 0230 UTC. The programming also can be found on a parallel frequency of 17,760 kHz.

RUSSIA—One of the new Russian SW broadcasters that has gone on the air in recent months is *Radio Ala*, which operates from St. Petersburg, the former Leningrad. It has been logged on 7,400 kHz by east-coast U.S. listeners signing on, in Russian, shortly after 0700 UTC.

SWEDEN—*Radio Sweden International* is heard on 11,705 kHz, broadcasting in English, with "60 Degrees North," during the 0200 UTC program block.

UKRAINE—*Radio Kiev* has been logged on 11,790 kHz after 0100 UTC with English-language news, commentary, and "top 10" music.

USA—Shortwaver *WWCR* now has a two hour block of programming especially for the DX'ing enthusiast. It is called "Signals" and it is heard Sundays, beginning at 0430 UTC.

VENEZUELA—How about some good Latin music? Try listening for *Radio Rumbos* on 4,970 kHz at around 0430 UTC.

VIETNAM—7,417 kHz. Another tip for listeners on the western coast of North America is the *Voice of Vietnam*, noted ending a program in the Lao Language at around 1425 UTC. After a brief silence, programming continued in Chinese at 1430 UTC. The station is on 9,732 kHz at the same time. ■

*Credits: D.J. Prisco, PA; Gerald Hart, MN; Bob Brown, PA; John Carson, OK; Jerry Berg, MA; Doug Robertson, CA; Harold Levison, PA; George Vadino, WA; Brian Alexander, PA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057; World DX Club, North American Representative, Richard D'Angelo, 2216 Burkey, Wyomissing, PA 19610.

HAM RADIO

By Joseph J. Carr, K4IPV

Receiving Loop Antennas

Loop antennas are used for a variety of purposes, ranging from limited-space transmitting to radio-direction finding to low-QRM receiving, especially on 30-meters and below (160-meter to 20-meter ham bands, plus adjacent shortwave-broadcast bands). Shortwave listeners are very familiar with small loop antennas for receiver QRM reduction, but hams don't use such antennas very often. It's a shame because the receiving loop has some charming attributes, particularly ferrite-core loopstick antennas.

Palomar Engineers LA-1 loop antenna is intended for the AM broadcast band (550 to 1630 kHz). Other models, which will mate with the LA-1 loop amplifier, are available for the shortwave amateur-radio and international-broadcast bands.

Unfortunately, using such receiving antennas demand either a separate receiver and a separate transmitter (as opposed to a transceiver), a separate receiver for monitoring the band with a transceiver for operating, a transceiver with an extra *receive-only* antenna jack (several models have that feature), or an antenna-switching scheme that is keyed to the transmit/receive relay. Many hams use two receivers, especially when tracking DX.

LOOPSTICK ANTENNAS

A loopstick antenna (refer to Fig. 1) consists of a ferrite rod wrapped with wire and then covered with tape to keep the wire in place. The wideband variety of loopstick does not resonate the loop. A loopstick antenna can be made by, first, wrapping a ferrite rod (such as an Amidon Associates—PO BOX 956, Torrance, CA 90508; Tel. 213-763-5770—FB-43-101 ferrite rod) with a single layer of either black electrical tape, or the white Teflon tape used to waterproof plumbing-pipe threads. After that, two coils of enameled or Formvar-covered wire (#24 or #26, for example) are wound onto the insulated rod. From the center, the ferrite rod is wrapped with about three feet of the wire in each direction (leaving about ⅛ to ¼ inch of rod free at the ends). The excess is then cut off, and the wire is covered with an additional layer of tape to keep the wire in place.

The two windings (A and B, in Fig. 1) are connected together, and then soldered to the center conductor of a length of coaxial cable or a coax connector. In some cases, the shield of the coax is not grounded. You can experiment with it to see which way works best for you. I've found that connecting the shield to ground at the receiver end sometimes reduces signal levels, but at other times it did not; the effect of grounding seems to be frequency related.

Loopstick antennas suffer from a malady known as *antenna effect*, i.e., the interaction of the loop with local conductors and ground. That can be overcome by using an open U-shaped shielded enclosure, like that shown in Fig. 2. In making my shortwave loopstick antenna, I used a cover salvaged from a large (about 9 inches) LMB chassis box that had been used in another project some years ago. When the

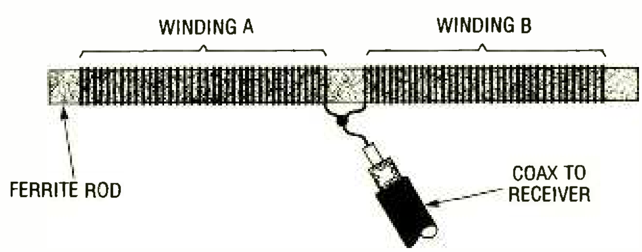


Fig. 1. A loopstick is comprised of two coils (A and B) wound on a ferrite rod. The two windings are connected together, and then soldered to the center conductor of a length of coaxial cable.

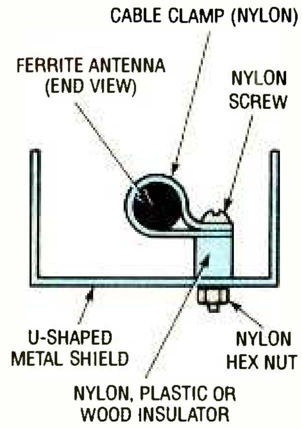


Fig. 2. To counteract the interaction with local conductors and ground, loopsticks can be mounted in an open U-shaped shielded enclosure.

U-shaped chassis is used, the rod is mounted to an insulated stand-off with nylon machine screws and hex nuts. The loop is held to the stand-off using a plastic or nylon cable clamp.

WHY USE A LOOPSTICK?

Perhaps the best reason to use a loopstick antenna is that it is capable of nulling interfering signals. That feature is due to the nulled patterns associated with loops. A single loop antenna manifests a figure-8 pattern, like that shown in Fig. 3A. The two directions of maximum reception are perpendicular to the loopstick rod, while the null directions are off the ends.

Figure 3B shows a case where the antenna pattern is a cardioid (*i.e.*, heart shaped); the antenna pattern has been altered from the figure-8 pattern by using a *sense* antenna. The sense antenna is an omnidirectional whip, about 14 to 24 inches long, that is connected to the antenna circuit through a phasing potentiometer (see Fig. 4). A portable-radio replacement whip or homemade whip will suffice for the sense antenna. The sense antenna is used to reduce one lobe and make the antenna essentially monodirectional (see Fig. 3B). That configuration is needed for direction finding, but for amateur-radio receiver-antenna applications, it is unnecessary.

The idea when using a loopstick antenna is to place the null in the direction of an interfering signal. By nulling out the strong QRM, one will often expose underlying weaker signals that would otherwise be obscured. You may be surprised at how that effect improves your operating pleasure.

Of course, if you're not into building loopstick antennas, then there are commercial models available. I've used the Palomar Engineers (P.O. Box 455, Escondido, CA 92033; Tel. 619-747-3343) model LA-1 loop amplifier and frequency-selective loop. That

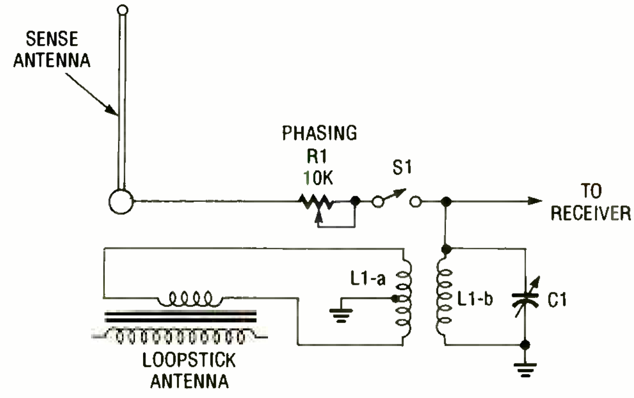


Fig. 4. The sense antenna is an omnidirectional whip, about 14 to 24 inches long, that is connected to the antenna circuit through a phasing potentiometer, as shown here.

particular loop is intended for the AM-broadcast band (550 to 1630 kHz). Other models, which will mate with the LA-1 loop amplifier, are available for the amateur, shortwave-radio, and international-broadcast bands.

The Palomar loop is a resonant type. A tuning control on the LA-1 allows the operator to resonate the loopstick to the received signal frequency. The loop can be adjusted for azimuth by rotating it in the horizontal direction. It can also be rotated 90 degrees in elevation. The latter ability is useful on most bands because the skywave may arrive at an angle other than horizontal.

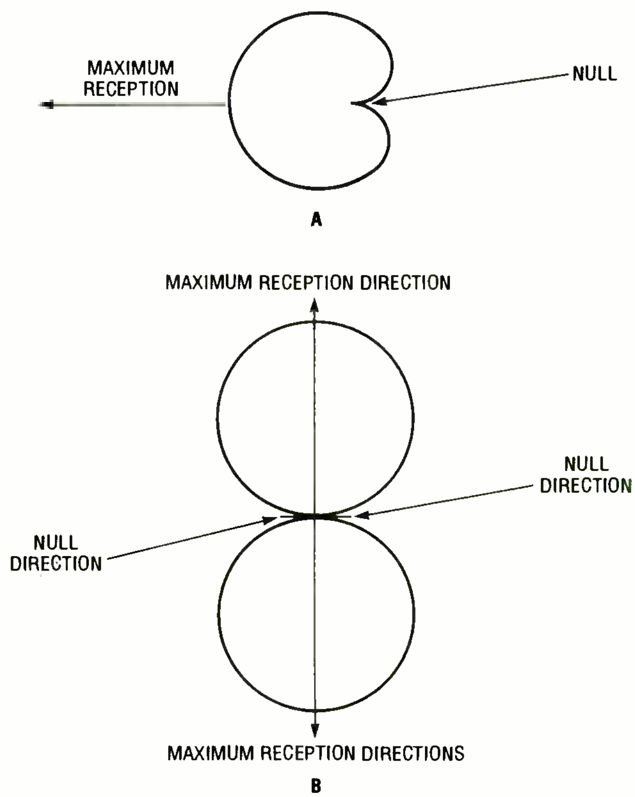


Fig. 3. A single loop antenna exhibits a figure-8 pattern (A), which can be altered (B) by using a sense antenna.

THANKS MUCH

Many readers have responded to my offers of a schematic for the digital sawtooth generator (see the May, 1992 column) and the BASIC program listing for the loaded dipole design problem. Some readers noted that I failed to tell them the dialect of BASIC that the program is written in, so here goes. It was written in GW-BASIC, and tested using MS-DOS BASICA as well. However, most of the variable names and BASIC commands are common to other BASIC dialects. I still have some program listings, and it's also available on the RE-BBS (516-293-2283; 8, N, I). Readers who want both listable and executable versions, as well as around twenty other MS-DOS programs that are of use to radio buffs, can write to me at P.O. Box 1099, Falls Church, VA, 22041. The price is $20. Specify 3.5-inch or 5.25-inch diskettes. ■

SCANNER SCENE

By Marc Saxon

Give Your Handheld a Boost!

If you're like me, now that good weather has arrived upon the land, you'll carry your handheld scanner from place to place. And you might also be disappointed when signals fail to be loud and clear because you've moved out of range of the stations you want to copy. Your local Radio Shack store may have a quick, simple, inexpensive, and effective solution to this common problem, and it's not a solution that might readily come to mind.

Give your scanner a big "boost" without spending big bucks, with Radio Shack's Amplified VHF/UHF/FM Portable Antenna.

Radio Shack recently introduced the *Archer Amplified VHF/UHF/FM Portable Antenna* (Cat. No. 15-1607) that retails for $24.95 and is intended to improve reception on pocket-sized, small-screen TV receivers or FM portables. What it was designed to do, it does well. It looks good, too, with its black matte finish. Slightly larger than a deck of playing cards, the twin nine-section telescoping antennas can be folded down along both sides of the amplifier. The device operates on two "AA" batteries, or with the AC-power adapter that is supplied with the unit. When the AC is connected, the battery is disconnected. The unit is lightweight and can be carried in a shirt pocket.

The specifications advise that the frequency range of this signal-boosting antenna is 50 to 900 MHz, which is ideal for most scanners. Extending the twin antennas mounted on the amplifier produces highly directional reception, and when extended parallel to one another, the antennas act like an omnidirectional ground plane. In either mode, the device behaves like an expensive active-antenna system.

The device can be easily matched to most handheld scanners using the *Archer RF Adapter* (Radio Shack Cat. No. 278-254) for the BNC (scanner) end, and the ⅛-inch (3.5-mm) *Mini Phone Plug to Phono Plug* (Cat. No. 274-326A) to accept the 3.5-mm cord and plug that feeds signals from the amplifier. These two connectors add about $4 to the package. If your scanner doesn't use a standard BNC antenna connector, Radio Shack offers a wide enough assortment of adapters to fill your needs.

The Archer Portable Antenna has a bypass switch that allows you to use the antenna without the amplifier, and it can be switched into "boost" position when you want to increase reception. For those who would like to use it at a fixed location, or with a regular desktop scanner, the amplifier was designed with an adjustable stand so that it may be used flat on its back or in an upright position.

By slightly adjusting the lengths of the twin antennas, you can maximize signal pickup in specific bands. A little experimentation will show you the best length for each band.

The gain of the amplifier is 10 dB (minimum) from 50 to 470 MHz, and 8 dB (minimum) above 470 MHz. Add to that a maximum power-output level of 89 dBu plus more than 50 hours of continuous battery life and you'll quickly recognize this as a handy scanning accessory.

The amplified antenna was brought to our attention by James E. Tunnell, of Silicon Technologies, Walnut Creek, CA. James tells us that, using this unit with his handheld scanner, he has monitored naval vessels operating 100 miles offshore. Near Nellis AFB in Nevada, he was able to pick up stations deep within the facility (which occupies almost 3,000 square miles).

James writes that the real

satisfaction of using this unit is when you set your scanner to a known active frequency but hear nothing because of the distance. Then, you switch to "boost" and your scanner suddenly becomes alive with chatter on that frequency.

FREQUENCY MATTERS

In North Carolina, the Cary Towne Center mall increased in size about fourfold and is now a gigantic complex. The security frequency there is 467.1125 MHz. Also in North Carolina, the Raleigh Beltline (Route I-440) is being rebuilt and widened. This major project is scheduled to take about another six years to complete. Most of the construction takes place at night, and 461.50 MHz is where to scan to hear them putting the road together. This information came in from Sam Cederas, of Cary, North Carolina.

A commonly asked reader question concerns the so-called UHF-T band (470 to 512 MHz), and how it differs from the regular UHF communications band (450 to 470 MHz). When the FCC established the 450–470-MHz band, it appeared that the amount of spectrum set aside would be adequate to meet the needs of two-way users. As technology improved, the UHF channels began to fill with stations. In metropolitan areas, there was an actual shortage of frequencies for use by new licensees, without reaching an over-saturation point.

Around 1970, the FCC decided to allow limited use of a few UHF-TV channels in some areas for two-way users. Those channels were between 470 and 512 MHz and became known to communications people as the UHF-T (for television) band.

Two-way licensees in this band operate only on selected UHF-TV channels in the 470–512-MHz range in thirteen specific metropolitan areas, and on the condition that they don't cause interference to TV broadcast licensees on those frequencies in other cities. That means that two-way licenses there are subject to power and antenna height/gain restrictions more stringent than in the regular UHF communications band in order to limit their signal coverage.

As an example, communications in Chicago in the 470–476-MHz range (TV Channel 14) can't cause interference to Channel 14 in Jacksonville, IL.

SOMETHING FISHY

Here's a helpful hint to those who like to take a scanner along during fishing trips in small boats. Maybe you have a fear that the scanner will get splashed, or become covered with the kinds of yicky stuff encountered while pursuing fresh- or salt-water fish. No problem.

Get some large-size sealable vinyl freezer or sandwich bags. Cut a hole for the antenna, and then seal the handheld right inside the bag. You can open the bag to get at the controls, and some controls can be accessed right through the bag. The bag protects the set from splashes and gook. To be extra safe, you could also put a little clear plastic tape at the hole for the antenna.

MAIL CALL

We would like to hear from you with frequencies, clippings, comments, and questions. Write to us at *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

ANTIQUE RADIO

(Continued from page 64)

were able to hear some kind of a signal. Finally, I did run all the tubes through a tube checker without uncovering any serious problems. The 80 rectifier did show somewhat low emission on both plates, but I doubt that the condition is serious enough to affect the radio's performance. Eventually, however, I'll probably substitute a better one.

The next step for the Sky Buddy will be a serious housekeeping and deep-cleaning job. It doesn't pay to troubleshoot a set as neglected as this one because dirty contacts at switch terminals, tube pins, and potentiometer wipers can cause mysterious symptoms that make the real problems hard to find. Once that's done, we can get serious about any major problems that may remain.

I plan to remove all the tubes, as well as certain other chassis-mounted components. Those include the speaker (which is a separate housekeeping project all by itself) and the subchassis holding the tuning capacitor and dial drives. The latter disassembly is necessary to replace the four hardened shock-mounting grommets intended to cushion the tuning assembly, as well as to restring the dial cords.

Since the main chassis can't be separated from the cabinet, removal of this subchassis is about the only way to obtain access to pulleys and shafts for restringing. Though the dial cords are OK now, sad experience has taught me that these old cords will probably snap soon after the set is put back into service. Better to replace them while the set is already disassembled for cleaning rather than later, after the project is completed.

Following this partial disassembly, I'll wash the grime from the cabinet and chassis, clean the speaker and tuning-capacitor assembly, and restore the latter as outlined. I'll also treat all switches, controls, and tube pins with contact cleaner. Then we'll reassemble the set, connect it to a good antenna and see what problems still remain.

MORE CONTEST RESULTS

When I reported on the results of our "With The Collectors" contest (February, 1992 issue), I was only able to award five of the eight prizes because I had received only five entries! For that reason, I offered to extend the contest cutoff date until at least three more people could write in to tell me about their antique-radio collections, display methods, collecting habits, and interactions with the rest of the family. I'm happy to announce that I now have three more entries in my hands, all with good pictures included. Those folks will receive the three unawarded prizes.

We'll get into their stories next time, when we have the room to do them justice. But, as a sneak preview, I'm running a shot of the well-organized workroom of one of our new winners. He's Shayne Trowsse of Casselman, Ontario, Canada. More about Shayne and the other two winners, next time. Thanks for your entries, folks. We're all going to enjoy them!

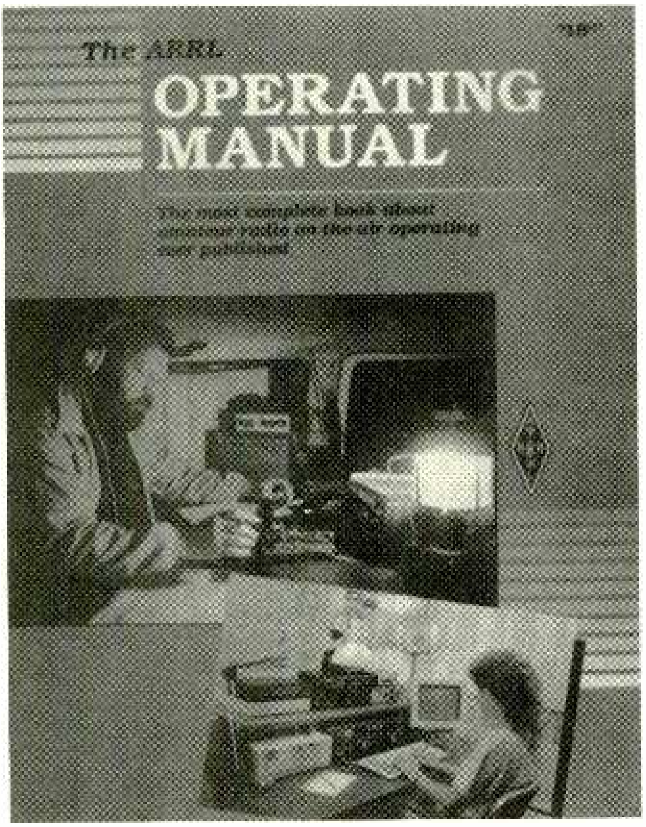
In the meantime, I'll be waiting to hear from *you*. Write me c/o *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

ELECTRONICS LIBRARY

The ARRL Operating Manual

edited by Steve Ford, WB8IMY

Subtitled "The most complete book about amateur radio on-the-air operating ever published," the book tries to fill the need for a single volume that encompasses the wide variety of on-the-air activities, and provides a wealth of information for experienced hams as well as beginners. The fourth edition offers current information, written by authors who are experts in their fields, on such subjects



as shortwave listening, basic operating techniques, antenna orientation, DX'ing, DXpeditions, contests, operating awards, RTTY and AMTOR, packet radio, FM and repeaters, VHF and UHF operating, satellites, emergency communications, traffic handling, slow and fast scan television, and fax. In addition, a comprehensive reference section includes call-sign outline maps, sunrise/sunset tables, ARRL award applications, azimuthal equidistant maps, and more.

The ARRL Operating Manual costs $18.00 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111.

CIRCLE 90 ON FREE INFORMATION CARD

EVERYMAN'S DATABASE PRIMER Featuring dBASE IV 1.1

by Robert A. Byers & Cary N. Prague

This "official guide" to Ashton-Tate's dBASE IV provides an in-depth introduction to relational database software. Its professional advice is presented in easy-to-understand text, useful program examples, and sample screen shots intended to help beginners to quickly become proficient. The book begins with a tutorial demonstrating how to plan and create a small-business inventory system, and goes on to explain how to use the Control Center menus, master queries and query-by-example, generate reports with the new dBASE IV report writer, set and use relations, and produce mailing labels and mail-merge documents. In addition, the book explains how to create forms for data entry; enter, change, and delete data; access valuable information; and import and export data between programs. The book's last section is an introduction to programming and applications. It also explains the difference between applications and programs and explains how to create a complete menu-driven system using the Applications Generator.

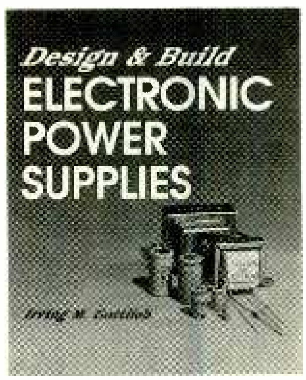
Everyman's Database Primer Featuring dBASE IV 1.1 costs $24.95 and is published by Sams, 11711 North College Avenue, Carmel, IN 46032; Tel: 800-257-5744

CIRCLE 95 ON FREE INFORMATION CARD

DESIGN & BUILD ELECTRONIC POWER SUPPLIES

by Irving M. Gottlieb

Due to recently developed techniques that allow higher switching rates with no significant loss in performance, power-supply technology has come a long way in the last few years. This practical guide to modern power-supply design and new construction techniques, written for technicians, engineers, and hobbyists, provides a complete overview of those important changes. Its emphasis is on practical, real-world applications rather than mathematical theory. And rather than present a bunch of "how-to-build" projects, the book provides guidance and insights to encourage those who are technologically knowledgeable to



experiment in the design and construction of their own power supplies.

The book includes full coverage of the older 20-kHz power-switch standard, and also brings readers up to date on today's most advanced power-supply circuits, components, and measurement procedures. It includes discussions of electronic and synchronous rectification, resonant-mode switching, sine-wave power supplies, current-mode control, IGBT power switches, and MCT thyristors.

Design & Build Electronic Power Supplies costs $17.95 and is published by TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-822-8138.

CIRCLE 104 ON FREE INFORMATION CARD

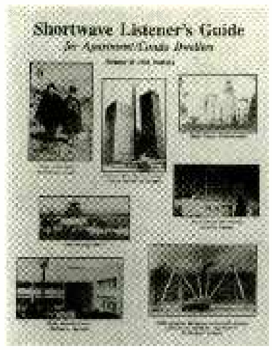
SHORTWAVE LISTENER'S GUIDE FOR APARTMENT/ CONDO DWELLERS

by Edward M. Noll, W3FQJ

Written for the beginner shortwave listener and broadcast-band listener—and, in particular, those who have been stymied by poor results using indoor antennas—this book provides an introduction to shortwave program listening and specific advice on the proper use of indoor antennas. In most cases, results can be improved with a more effective indoor antenna. The book also discusses such devices as tuners, switches, and amplifiers that can help improve reception. The information can help readers to plan their installations and to take the best advantage of indoor situations.

While the book is aimed at those who live in the worst listening situations—high-rise apartment or condo buildings with their high metal content, or row houses hemmed in by such high-rises—the material covered can also benefit SWL's in better (but still difficult) listening situations, such as a mobile-home park or a housing development with a no-antenna restriction.

A large portion of the book covers shortwave programming, including SW broadcast frequencies and their characteristics, English-language listening from around the world, US shortwave stations, some station profiles, and



organizing your listening. The book explains how to tell UTC time and offers tips on DX tuning, QSL'ing, and medium-wave broadcast DX'ing. Information is presented about the characteristics and use of a wide variety of antennas and accessories, including a starter random-length wire antenna, a random-length wire shortwave tuner, antenna bridges, loop antennas and variations, signal intensifiers, active antennas, ferrite loop antennas, noise and interference filters, and medium-wave antennas. The books appendices include antenna dimension tables and equations and time-zone charts.

The Shortwave Listener's Guide for Apartment/Condo Dwellers costs $9.95 (plus $3 shipping) and is published by MFJ books, P.O. Box 494, Mississippi State, MS 39762.

CIRCLE 93 ON FREE INFORMATION CARD

MONITORING NASA COMMUNICATIONS: How to Tune in the National Aeronautics & Space Administration on Shortwave, VHF, UHF, and Satellites

by Anthony R. "Tony" Curtis, K3RXK

The major media doesn't devote much time to coverage of NASA and the space program, but space enthusiasts can stay up to date with information direct from the source, by monitoring NASA's communications on the ground and in space. This book, which includes what its author calls "the world's largest list of NASA radio frequencies," provides all the information needed for such monitoring. NASA stations are broken down by usage, and there are tips on the equipment needed to receive the transmissions. The book offers a quick-tuning guide to space-shuttle and amateur-radio shuttle retransmissions. In addition, it includes a history of rocketry and how NASA came into existence, as well as discussions of space satellites in general and communications satellites, space shuttles, deep-space probes, and navigation satellites.

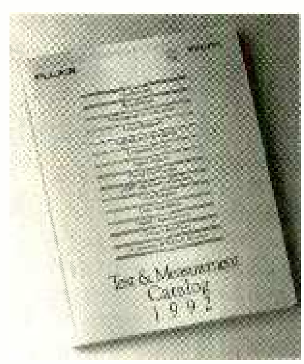
Monitoring NASA Communications costs $14.95 (plus $2 shipping) and is published by Tiare Publications, P.O. Box 493, Lake Geneva, WI 53147; Tel: 414-248-4845.

CIRCLE 103 ON FREE INFORMATION CARD

TEST & MEASUREMENT CATALOG 1992

from Fluke and Philips

Integrating the product lines of John Fluke Mfg. Co. and Philips Test and Measurement into 17 major categories, this 440-page catalog includes descriptions, photos, specifications, and ordering information for more than 600 products and customer-support services. A full-color in-



troduction section highlights new products such as digital multimeters, oscilloscopes, ScopeMeters, reference standards, board-test systems, timers/counters, power supplies, and software. Listings of application literature, sales offices, technical centers, and distributors are also included.

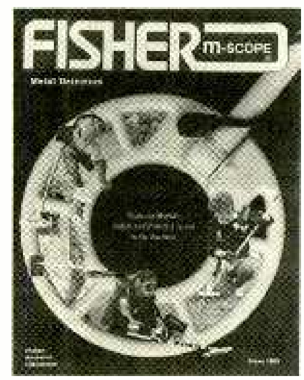
The Test & Measurement Catalog 1992 is free upon request from John Fluke Mfg. Co., Inc., P.O. Box 9090, Everett, WA 98206; Tel: 800-44-FLUKE.

CIRCLE 100 ON FREE INFORMATION CARD

METAL DETECTORS CATALOG

from Fisher Research Laboratory

This 16-page, full-color catalog features metal detectors for treasure hunting, underwater searching, prospecting, relic hunting, and competition hunting. Four new models include an improved entry-level metal detector, a QuickSilver target-ID machine, the deep-seeking 1266-X, and a break-down version of the 1266-X that can fit in a small carrying case. The cata-



log also includes a full-page "Fisher Features" chart that compares 82 features ranging from optical search coils to pushbutton pinpoint controls. A selection of accessories is also described.

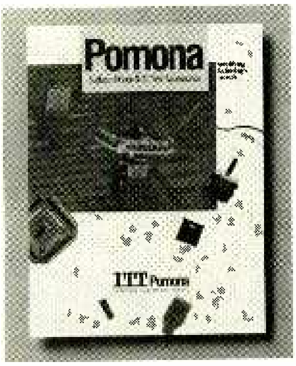
The Metal Detectors Catalog is free upon request from Fisher Research Laboratory, Dept. PE, 200 West Willmott Road, Los Banos, CA 93635; Tel: 209-9826-3292; Fax: 209-826-0416.

CIRCLE 102 ON FREE INFORMATION CARD

SURFACE MOUNT & IC TEST ACCESSORIES

from ITT Pomona

This 14-page brochure describes Pomona's complete line of SMT/IC test accessories, kits, and probe sets. Highlights include the company's new DIP/ SOIC, PLCC, QFP, and SMD micro test clips and assemblies; miniature pincer and hooked test clips; standard hooked test clips; alligator test clips; coaxial cable assemblies; test-lead kits; and adapters, breakouts, and interfaces. The products are ar-



ranged in fifteen major categories and are presented with an easy-to-use index.

The Surface Mount & IC Test Accessories catalog is free upon request from ITT Pomona Electronics, 1500 East Ninth Street, P.O. Box 2767, Pomona, CA 91769; Tel: 714-469-2900; Fax: 714-629-3317.

CIRCLE 91 ON FREE INFORMATION CARD

PASSIVE COMPONENTS: A User's Guide

by I.R. Sinclair

Although the use of integrated circuits has increased dramatically over the past ten years, passive components—including any component that is incapable of power amplification, and not just resistors and capacitors—continue to be the mainstay of the electronics industry. With most educational courses strongly emphasizing semiconductors, the subject of passive components has been neglected to the point that many technicians wouldn't know how to wind a 10-µH coil without consulting an amateur-radio handbook. That lack of knowledge can also lead to such time- and money-wasting problems as resistors of an incorrect dissipation rating being used in servicing and capacitors of high-loss factor being put into oscillating circuits. Furthermore, the use of passive components in feedback loops and bias chains means that the overall performance depends on the passive components. To remedy that lack of information this book focuses exclusively on passive components. It discusses their fundamental action, parameters, variation with temperature, tolerances, stability, reliability, manufacturing methods, and standards. The book includes chapters on fixed resistors; variable resistors, potentiometers, and diodes; capacitors; inductors and inductive components; inductive devices; transducing components; and hardware, including terminals, connectors, knobs, switches, fuses, and circuit boards.

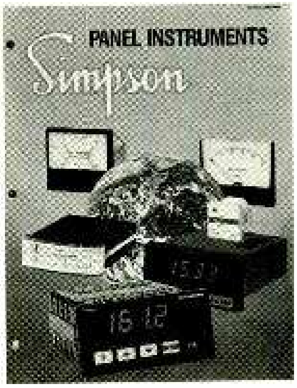
Passive Components: A User's Guide costs $21.95 and is published by Butterworth-Heinemann, 80 Montvale Avenue, Stoneham, MA 02180; Tel: 800-366-BOOK.

CIRCLE 101 ON FREE INFORMATION CARD

PANEL INSTRUMENTS CATALOG

from Simpson Electric Company

Simpson's wide selection of analog and digital panel meters, meter relays, and controllers are described in this 32-page, fully illustrated catalog. A special section is devoted to the recently introduced Hawk series of digital on/off controllers/indicators for start, stop, or limit control of a wide range of process variables. Both AC and DC digital panel meters are described in the catalog, which also includes descriptions of analog AC and DC panel meters including Wide-Vue, Century, designer, segmented scale, and round and rectangular models. Analog Pyrometers, "Rugged Seal" controllers, edgewise instruments, and accessories are also featured. The catalog provides users with ranges and specification charts and dimensional drawings and photographs for each unit.



The Panel Instruments Catalog is free upon request from Simpson Electric Company, 853 Dundee Avenue, Elgin, IL 60120-3090; Tel: 708-697-2260; Fax: 708-697-2272.

CIRCLE 92 ON FREE INFORMATION CARD

INTRODUCTION TO PERSONAL COMPUTERS 2nd Edition

by Katherine Murray

Even though computers have become commonplace, almost indispensable tools in offices and homes, they can still be intimidating to newcomers. Part of the cause stems from their versatility—they can be used for jobs involving words, numbers, pictures, sounds, or combinations of those elements. Selecting a computer depends to a large extent on what you plan to use it for.

Introduction to Personal Computers is aimed at two groups of people: those who are planning to buy their first computers, and those who recently "inherited" a computer at the office or at home. Providing a non-threatening introduction to the workings and capabilities of various personal computers, the book answers such questions as: What can a computer do for me?; What equipment will I need?; How do I set up a system?; and What software will I need? Readers are lead through a basic course in computers, beginning with general information and progressing to specifics about various components and software programs. Divided into four sections, the book begins with a discussion of computer basics in which the different types of computers (IBM-PC, Apple, Amiga, Macintosh, and clones) are briefly described, basic terminology is explained, and the tasks that computers can do are outlined, and computer components and their functions are covered.

The second section is devoted to purchasing considerations, and is intended to help the reader determine his computing needs and make a wise decision within his budget. Part three provides quick-start tutorials for PC's, Macintosh, and Apple IIG's, and includes information on setting up a computer, learning to use the operating system, and using the computer. Software for IBM, Apple, Macintosh, and Amiga computers is discussed in the fourth section, which includes reviews of spreadsheets, word processors, data management programs, desktop publishing, integrated software, graphic programs, communications packages, and games, and educational software. A glossary contains clear definitions of common computer terms.

Introduction to Personal Computers; 2nd Edition costs $19.95 and is published by Que, 11711 North College Avenue, Suite 140, Carmel, IN 46032; Tel: 1-317-573-2500.

CIRCLE 105 ON FREE INFORMATION CARD

FULL PRODUCT-LINE CATALOG

from Sencore Electronics

This 68-page color catalog includes the latest test equipment for analyzing VCR's, computer monitors, televisions, and cable systems. Specifications are provided for all products, along with application information, and detailed descriptions of the features and functions of each item.

The Full Product Line Catalog is free upon request from Sencore Electronics, 3200 Sencore Drive, Sioux Falls, SD 57107; Tel: 1-800-SENCORE. ■

CIRCLE 106 ON FREE INFORMATION CARD

NEW PRODUCTS

Shielded Bookshelf Speakers

Designed specifically for video and home-theater applications, *Signet's SL240B/U* compact loudspeaker is magnetically shielded so that it will not distort the television picture even when placed close to the set. That means that a single SL240B/U speaker can be placed on top of a TV receiver to serve as the center channel for a video surround-sound system. A pair of the speakers, placed on top of a stereo television, will enhance the sound-staging capabilities of stereo-TV broadcasts.

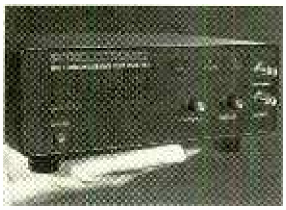
The speaker features a ¾-inch metallized polycarbonate ferrofluid-cooled dome tweeter for handling the high-impact, high-frequency transients of music and soundtracks. A 5¼-inch long-throw paper-cone woofer, treated to damp resonance and reduce distortion, offers accurate bass response, and a foam surround is used to provide wider dynamic range and to minimize distortion and sound coloration. The 7 × 10¼ × 6-inch loudspeaker is finished in wood-grain black vinyl.

The SL240B/U bookshelf loudspeaker costs $120 each. For more information, contact Signet, 4701 Hudson Drive, Stow, OH 44224; Tel: 216-688-9400.

CIRCLE 108 ON FREE INFORMATION CARD

SELF-TUNING TEST RECEIVER

A self-tuning radio from *Optoelectronics*, the *Model R-10* communications test receiver, finds and demodulates signals. As an easy-to-use, inexpensive alternative to costly modulation meters, the R-10 can be used to test the modulation quality of mobile voice transmitters, to verify the accuracy of audio signaling tones including DTMF (dual-tone multi-frequency) and CTCSS (continuous tone-coded squelch systems), and to search for "bugs" in countersurveillance operations.



The R-10 can automatically accommodate the enormous difference ratio between an unknown carrier of up to 1000 MHz and a modulating frequency as low as 50 Hz; no manual tuning is necessary. The test receiver automatically determines and locks onto the strongest carrier signal in a 100-foot range, and then demodulates whatever FM audio is present on the carrier. That audio is output to an internal power amplifier/speaker and to the BNC output jack. A frequency counter or oscilloscope can be used to evaluate the audio output for DTMF and CTCSS testing. The user can determine by simply listening to the demodulated audio if a surreptitious transmitter is nearby.

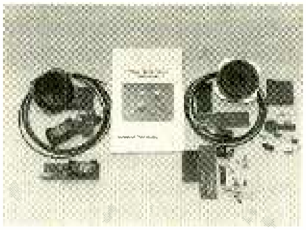
The unit has two modes of operation: search and lock-on. Other features include a sensitivity control and audio-gain, power, and low-battery indicators.

The model R-10 communications test receiver costs $359. For more information, contact Optoelectronics Inc., 5821 NE 14th Ave., Ft. Lauderdale, FL 33334; Tel: 800-327-5912 or 305-771-2050; Fax: 305-771-2052.

CIRCLE 109 ON FREE INFORMATION CARD

OPTICAL VOICE LINK KIT

The *Optical Voice Link* kit from *Industrial Fiber Optics* provides a fun and easy introduction to the mysteries of fiber-optic light transmission while teaching the scientific principles behind it. Once assembled, the kit has a transmitter module for converting voice signals into light that is coupled into the optical fiber. The receiver module collects the light from the fiber and converts it to audio signals that can be heard from the speaker. The kit, which was designed for a variety of educational, commercial, and industrial applications, contains printed wiring boards, switches, electronics, a microphone, an 8-ohm speaker, 10 feet of plastic fiber cable, a tutorial guide, and step-by-step assembly instructions. No special tools or prior experience with fiber optics is required to use or build the kit. The Optical Voice Link runs on two 9-volt batteries. A fully assembled version is also available.



The Optical Voice Link costs $49.95 in kit form (order number *P/N IF-OVL10*) and $79.95 assembled (order number P/N IF-OVL10A). For additional information, contact

Industrial Fiber Optics, P.O. Box 3576, Scottsdale, AZ 85271; Tel: 602-731-8459.

CIRCLE 110 ON FREE INFORMATION CARD

CAPACITANCE METER

With nine ranges that measure from 0.1 pF to 20,000μF, *Extech's Model JAC380123* is a handy tool for measuring capacitors. The capacitance meter is fast and accurate, with a 0.5-second sampling time and 0.5% accuracy on low ranges. Excitation voltage is 2.8 volts peak maximum. The compact meter measures 7.3 × 3.4 × 1.5 inches

and weighs just 10 ounces. It is packaged in a safety-yellow case with a large LCD readout. The capacitance meter comes with alligator test clips, a spare 200-mA fuse, a 9-volt battery, and instructions. Available options include test leads and a carrying case.

The model JAC380123 capacitance meter costs $99; test leads cost $10; and the carrying case costs $15. For further information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154; Tel: 617-890-7440; Fax: 617-890-7864.

CIRCLE 111 ON FREE INFORMATION CARD

STANDBY POWER SYSTEMS

The first two models in the *Patriot* line of standby power systems from *Best Power Technology* feature enhanced power-protection capabilities, small size, and low cost. Both the 250-VA and 450-VA models provide full-time lightning and surge protection. The Patriot is UL-1449 listed—a rating normally reserved for quality surge protectors—and also passes ANSI/IEEE C62.41 for both Category A and the higher Category B impulses. The power system protects computers, LAN's, and other electronic equipment against high-voltage conditions by switching the load from line to inverter. Even when it is not operating on inverter, Patriot filters noise from incoming power. Its advanced, multistage filter provides 33 dB normal-mode noise isolation. Two audible alarms and a triple-mode status indicator light warn users of overloads or a low battery.

The 250-VA model supports small, single-user PC's, for a Macintosh SE/30 up to an IBM PS/2 Model 55 with VGA monitor. It can support an IBM PS/2 Model 30 with VGA for 22 minutes. The 450-VA model can support a PS/2 Model 55 with VGA for 18 minutes, or a Sun 3/60 system for 12 minutes. It features an interface port that lets it trigger a safe, orderly shutdown on many popular

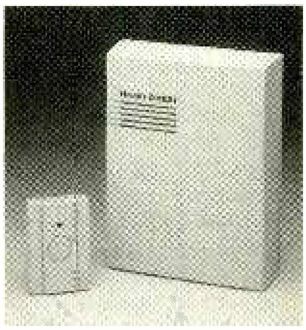
computer systems. Optional CheckUPS software and shutdown kits are available for DOS, OS/2, AS/400, RS/6000 AIX, Novell NetWare, LAN Manager, UNIX/Xenix, Lantastic, Banyan VINES, Prime, and more.

The Patriot 250-VA and 450-VA cost $169 and $279, respectively. For further information, contact Best Power Technology, Inc., P.O. Box 280, Necedah, WI 54646; Tel: 800-356-5794; Fax: 608-565-2929.

CIRCLE 112 ON FREE INFORMATION CARD

WIRELESS DOORBELL

Installing a conventional doorbell can be both time-consuming and inconvenient, but *Heath Zenith's Reflex SL-6153 Wireless Doorbell* makes easy work of adding or replacing a doorbell. The battery-powered unit looks and acts like a real doorbell, but takes only a few minutes to install. Instead of wires, the device uses radio signals to transmit between the pushbutton and chime. The signals



have an effective range of up to 50 feet, and pass through doors, walls, and floors.

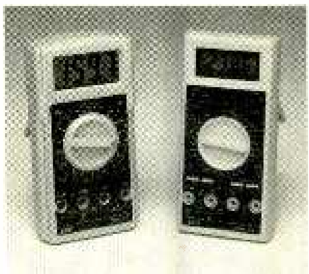
The weatherproof transmitter can be mounted outdoors with screws or with double-faced tape included in the package. The chime, which can be mounted on a ceiling or a wall, has a 2½-inch magnetic speaker. Users can select either a single- or a double-chime tone and can select from among three different transmission channels, to permit more than one Wireless Doorbell to be used in the same home—for instance, at the front and back doors.

The SL-6153 Wireless Doorbell has a suggested retail price of $29.97. For more information, contact Heath Zenith, Reflex Brand Group, 455 Riverview Drive, Benton Harbor, MI 49022.

CIRCLE 113 ON FREE INFORMATION CARD

DIGITAL MULTIMETERS

Two new digital multimeters from *Philips ECG* are each designed to fill a particular electronic-servicing need. The *DM-37* combines an extra-large (0.9-inch) 3⅓-digit display, drop-proof construction, and all primary functions in one compact meter, making it well-suited to industrial plant and field maintenance. Its functions include voltage to 750 VAC/1000 VDC,



current to 20 amps AC/DC, resistance to 20 megohms, plus diode and continuity tests. Its basic DC accuracy is 0.5%.

The *DM-38* is a multifunction meter that combines the nine most frequently needed functions and ranges in one dependable handheld instrument. It offers such features as a 3¾-digit LCD readout, peak data hold, and rugged construction. The DM-38 measures capacitance up to 40 μF, frequency to 4 MHz, TTL logic levels, transistor hFE, voltage to 750 VAC/1000 VDC, current to 20 amps AC/DC, resistance to 400 megohms, semiconductor junctions, and continuity (audibly). Ideal for field, lab, and shop use, the dependable DM-38 provides 0.5% basic DC accuracy.

The DM-37 and DM-38 digital multimeters, which are supplied with test leads, cost $48.95 and $88.95, respectively. For more information, contact Philips ECG, 1025 Westminster Drive, Williamsport, PA 17701; Tel: 800-526-9354.

CIRCLE 114 ON FREE INFORMATION CARD

MOBILE ANTENNA ADAPTOR

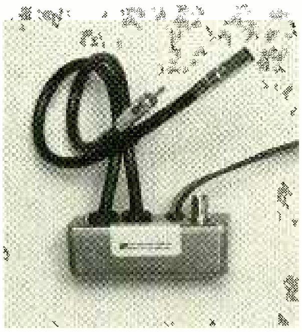
Getting good shortwave and scanner reception while driving in your car can be difficult, but your existing car radio antenna can make a fine receiving antenna if it's connected to *Electron Processing's MSW-1* antenna interface. The antenna connector covers all frequencies from 0.5 to 1000 MHz and has an internal 10-dB amplifier. Using the supplied Motorola-type connectors, the MSW-1 can be quickly and simply installed in the antenna line of your car-radio antenna. You need only plug the unit into the antenna line and attach a 12V

(Continued on page 86)

NEW PRODUCTS

(Continued from page 82)

DC power supply. The car radio's reception is not affected by the addition of the MSW-1. A female BNC jack is provided for connection to your receiver.



The MSW-1 mobile antenna adaptor costs $70, plus $5 for shipping and handling. For additional information, contact Electron Processing, Inc., P.O. Box 68, Cedar, MI 94621; Tel: 616-228-7020.

CIRCLE 115 ON FREE INFORMATION CARD

CLAMP-ON CURRENT METERS

With the increased use of personal computers, adjustable-speed drives, and other non-linear loads—devices that can draw high-peak currents in short pulses, causing harmonics to appear in the current—harmonics have become a major concern for electrical professionals. Harmonics, which can cause such problems as overheated transformers, neutral conductors, and unexplained

tripping of circuit breakers, can only be accurately measured with a true-rms measuring tool. The *30 Series Current Masters* from *John Fluke Mfg. Co.* can solve the complicated current-measurement and power-quality problems associated with non-linear loads. The clamp-on meters measure true-rms current up to 700A and frequency to 10 kHz to help technicians track down the hot spots before they become major problems.

Both the *Fluke 31* and *33* offer such current-troubleshooting features as manual and autorange modes, display hold, sleep mode (for battery conservation), and a power-up self-test. A combination analog/digital display includes real-time current, even while reading frequency or in the hold mode. Their rugged, angular design makes them compact enough to easily maneuver in crowded breaker boxes yet large enough to surround large-diameter conductors. A protective holster that can be attached to a work belt is included with each unit.

The Fluke 31 offers both true-rms frequency and current readings, making it well-suited for use in the measurement of traditional and non-linear loads. When used with a digital multimeter, it allows simultaneous current measurement while the DMM is used for voltage. The Fluke 33 adds features that enable the technician to perform more in-depth current testing and to automatically record data for up to 24 hours. The min/max feature records the minimum and maximum and calculates the average for both rms current and frequency. Its "smoothing" feature calculates and displays a three-second running average reading for both frequency and current, which is useful when working on circuits with fluctuating currents. A crest measurement detects the half-cycle peak, and can be used to determine the crest factor, showing if the waveform is distorted or sinusoidal.

The Fluke 31 and 33 cost $179 and $249, respectively. For more information, contact John Fluke Mfg. Co., Inc., P.O. Box 9090, Everett, WA 98206; Tel: 800-44-FLUKE.

CIRCLE 116 ON FREE INFORMATION CARD

THIRD HAND

Recognizing that some jobs require more than two hands, *Jensen Tools* is offering the *Third Hand*. The device has two adjustable arms anchored in a heavy base to prevent movement, and firm alligator jaws to hold small parts. The versatile

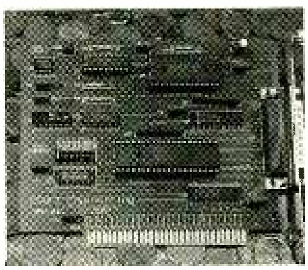
tool can be adjusted to almost any position, freeing the user's hands for soldering and fine adjustment work.

The Third Hand costs $13.92. For additional information, contact Jensen Tools, Inc., 7815 South 46th Street, Phoenix, AZ 85044; Tel: 612-968-6231.

CIRCLE 117 ON FREE INFORMATION CARD

DATA-ACQUISITION BOARD

Its combination of small size, low cost, and high performance makes *BSOFT Engineering's ANA100* attractive to engineers, educators, hobbyists, and students who need a high-speed bus data-acquisition I/O PC board. Available for IBM-PC/XT/AT and compatibles in either 8-



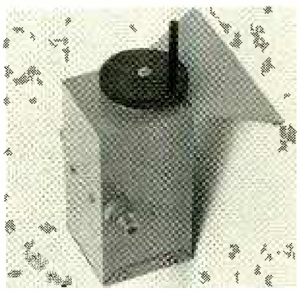
or 16-bit half or full slots, the board offers single-channel conversion speeds as fast as 2.5 microseconds. The ANA100 features an on-board 8-bit analog-to-digital "Flash" converter; 14 TTL digital I/O lines that can be used for activating relays, reading logic status, etc.; and a single-channel, analog-output, 8-bit D/A converter that can be jumpered for a full-scale range of 2.5, 5, or 10 volts. That provides a resolution of 9.8, 19.5, or 39.1 mV. Each board comes with a user's manual including hardware description, and a disk containing programming examples, written in BASIC, for controlling the ANA100. Typical applications include waveform and pattern generation, automated testing, speech digitizing, robotics, audio instrumentation, and high-speed data-acquisition and process control.

The ANA100 analog I/O board costs $99. For more information, contact BSOFT Engineering, 444 Colton Road, Columbus, OH 43207; Tel: 614-491-0832; Fax: 614-497-9971.

CIRCLE 118 ON FREE INFORMATION CARD

TVRO SINGLE RECEIVER NOTCH FILTER

The multi-tuning knob on *Microwave Filter Company's model 8976* single-receiver notch filter lets you tune the entire blockband to notch out terrestrial interference while removing minimum signal bandwidth. The filter operates over the bandwidth of 900–1450 MHz. The single knob tunes a



narrow 15-dB notch through the entire band to suppress any downconverted 4-GHz carrier.

The model 8976 TVRO single-receiver notch filter has a list price of $275. For further information, contact Microwave Filter Company, Inc., 6743 Kinne Street, East Syracuse, NY 13057; Tel: 1-800-448-1666 or 315-437-3953 (in New York, Hawaii, and Alaska); Fax: 315-463-1467. ■

CIRCLE 129 ON FREE INFORMATION CARD

VIDEO DIGITIZER

(Continued from page 22)

use a DB-25 connector, you will probably not be able to use the SV1000 on your machine.

Colorburst also offers their SV1500, which permits you to conveniently switch between the SV1000 digitizer and your printer. It has the SV1000 inside an A-B switch box. (Check with Colorburst for price.)

With either unit you can use any composite NTSC video source that can provide a *still* frame of video (such as a camcorder or 4-head VCR). A still video image is required because the units are not "frame-grabbers" that capture a single video frame. Instead, images are captured by scanning the video input over a period of time—10 seconds for low-resolution (320 × 200 pixel) images or 20 seconds for high-resolution (640 × 480 pixel) images. Pictures are captured in black and white with 256 gray levels in either resolution. The video source plugs into the RCA jack.

Documentation and Software. Documentation is supplied with your purchase, unfortunately, it's only five pages long, and somewhat difficult to follow. However, free technical telephone support (see the phone number for Colorburst elsewhere this article) is available directly from Frank Lyman III, the designer of the SV1000.

The necessary software for initial capture, display, and re-display of images is included with the SV1000 board. It comes on either a 5.25-inch 360K or a 720K 3.5-inch floppy disk. It is menu driven, and includes some diagnostics to check both the SV1000 board and the video source. It allows juggling of gray levels so the brightness and contrast of the displayed picture can be varied. The software saves digitized pictures as BSAVE-formatted disk files. Having a hard-disk drive is a good idea, as mentioned before, because a single high-resolution picture uses 320K of disk space. A low resolution file, on the other hand, takes only 64K of disk space. Furthermore, low resolution images are easier to print out and convert to other formats (more on that in a moment).

A software-demo disk is available for $3 postpaid. It has an abbreviated menu and some samples of both low and high resolution digitized pictures. While the demo will not capture new pictures, you can use other software to capture and convert the sample images to see how they look in your application.

Additional Software. The bundled software does a lot, however, it's up to you to provide display-capture and file-conversion software to suit your application. Colorburst recommends two software packages from other vendors to enhance or print the picture produced by the SV1000. The first, the PC Image-Processing Package for $58 from ImTek (7088 Wiltshire Drive, Lambertville, MI 48144; Tel. 313-856-2200) enhances digitized images to bring them greater clarity, in the same manner that JPL software processes NASA pictures from space. The software performs 25 operations, such as filtering, edge detection, histogram equalization, dilate, shrink, histogram display and image combining operations. Special programs are also provided to process SV1000 images, to generate TIFF- or PCX-compatible files.

Alternatively, you can have ImTek make file-format conversions for you. You can call them to get a quote for doing exactly what you want. That is important as there are dozens of incompatible screen-capture formats, even though they have the same extension. ImTek also provides a service to digitize 35mm slides at a cost of $6 each. Contact them for more details.

Colorburst also recommends EGAD for capturing a screen and printing it out. This is a $35, highly flexible screen-print package from Lindley Systems (4257 Berwick Place, Woodbridge, VA 22192-5119; Tel. 703-590-8890). It allows you to crop, enlarge, reduce, and print CGA, EGA, or VGA color screens with color-on-color printers. For black-and-white printers, eight shades of gray are available. It supports most popular printers.

The SV1000 Video Digitizer is available for $89.98 (postpaid) from Colorburst. They accept payment by check or money order. C.O.D. orders must add $5. Please specify whether you need a 5.25- or 3.5-inch disk. For more information, contact them directly, or circle No. 119 on the Free Information Card. ■

DAEWOO DVP-1060N

(Continued from page 27)

which is at the low end of the scale for typical VHS machines. Color accuracy seemed very good, however, and the few special effects and features provided on this player worked as they should. We particularly liked the encore feature. How often have you missed a small portion of a taped program because of a phone call, the need to get some refreshments, or other factors that require you to leave your viewing seat. At the slowest SLP speed, the 8-second rewind resulted in a repeat playback of about 3 minutes of programming—which is just long enough to take care of a typical interruption.

We used the player, hooked up to a small portable TV monitor, in an automobile, powering it with the supplied DC cigarette-lighter cord. Daewoo was smart enough to make the DC power cord long enough so that the machine could be placed on the back seat of the car.

If you really aren't interested in making your own video recordings and only want to rent or buy prerecorded video tapes, using a compact, inexpensive video player such as this Daewoo unit makes sense. For more information on the DVP-1060N Video Player, contact Daewoo (100 Daewoo Place, Carlstadt, NJ 07072) directly, or circle no. 120 on the Free Information Card. ■

THINK TANK

(Continued from page 71)

common tools much thought, but the next time that you cut the leads off a component, you should think a bit about the tool you are using. What does it matter? Well, wire cutters have three classifications: true-flush, semi-flush, and shear-cut. When you cut a lead off a component using true- or semi-flush cutters, the blades of the cutter pinch the lead in such a way that it snaps off and flies dangerously away. Note that the same force that turned the lead into a projectile was also transmitted in the opposite direction, into the component.

To prevent that from happening, cutters with shear-cut blades are recommended. Instead of focussing all the pinching force in one small area, they spread it out, reducing the snap action. Even when you use shear-cut cutters, it is highly recommended that you wear eye protection and use wire-stub retainers (available from Snap-on Tools). The retainers slide right onto your cutters and eliminate the risk of flying leads.

Shear-cut cutters might not only save semiconductors, but your eyes. Let's keep our hobby safe.

—*Mike Giamportone, Yale, MI*

That's good advice. I know, for example, that oscillating crystals can be very easily damaged by shock during cutting.

ALL-PURPOSE INSULATION

For those of you who need a good insulator at a very reasonable price, here is a tip that I have picked up in my career as an instrument-control technician: Common household silicon caulk (available at almost any home-supply store like K-mart or Wal-mart, or hardware store) works quite well. It insulates and lasts for quite a substantial amount of time (around 35 years).

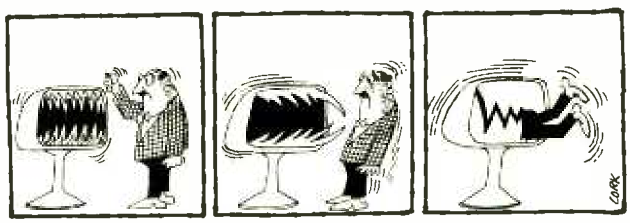
In the industry, it is known as RTV or room-temperature vulcanizing material because it cures at room temperature. However, it can withstand temperatures of around 500–600°F, and it even acts as a heat sink to a good degree. It works very well even on high-voltage components.

One thing you should know about RTV is it won't stick to plastic wrap, so you can use the wrap to help mold the silicon into any shape desired and it can be easily peeled away when it cures. Use caution though, as RTV will stick to just about anything else.

—*Scott Partridge, Vicksburg, MS*

I share your respect for the material. It is the insulator of choice in research involving high voltage. One thing to keep in mind, though, use pure silicon caulk. Stay away from the stuff with hardening agents like epoxies, they become brittle and flake away and have few of the good qualities of pure silicon caulk.

Well, that brings us to the end of another one. Until next time, keep the wheels of invention turning. ■



ROAD TO TOMORROW

(Continued from page 7)

feature. If you experience car trouble, a push of a button lets the command center know that you need help and precisely where to send the tow truck.

As sophisticated as car electronics have become, the automobile has remained the same, gas-powered, combustion-engine machine. Now, however, the electric car is making its debut, spurred by legislation like that passed recently in California, requiring that a certain percentage of cars sold in the state emit no airborne pollutants, and even requiring new commercial buildings to provide charge stations in their parking lots. The benefits of electric cars are obvious: less air pollution and reduced dependence on foreign oil sources. But, until recently, there have been problems that outweighed those advantages: short range and long recharging times. Who'd want to stop every couple of hours to recharge the family car for several hours while on vacation? Especially if that car also was slow to accelerate and had trouble keeping up with the gas guzzlers on the highway.

Automotive manufacturers have been working on those problems. Ford, Chrysler, and General Motors have teamed together in the United States Advanced Battery Consortium, whose goal is to develop a better energy source for electric cars. Nissan claims to have developed a battery that requires only a 15-minute recharge. GM's Impact is powered by a lead-acid battery similar to those used in gas-powered cars. While boasting an 8-second 0–60-mph acceleration rate, a top speed of 75 mph, and a 100-mile range at 55 mph, the Impact still requires eight hours of recharging on a standard 220-volt household outlet and is expected to cost more than similar sized GM cars. Ford is developing a small electric truck powered by a sodium-sulfur battery, and Chrysler is working on a minivan that uses a nickel-iron battery.

Although the car of the tomorrow will undoubtedly be exciting, today's car can be pretty exciting itself. Following are reviews of some current products that might make you feel as if you're driving a car of the future. ■

VOLGAGE ADAPTER

(Continued from page 48)

Put an "S"-shaped kink in the wires to the switch to allow them to fold over once they are put in the lighter plug. Now insert the assembly, switch-first, into the lighter plug. As you do so, fold back the wire that goes to the center contact of the lighter plug. Make sure that the switch's body is perpendicular to the hole for the coax. That allows the switch to slide over the coax without pinching it. Once the switch is all the way in, turn it to align it with the coax. Push the clip the rest of the way in and screw on the cap containing the center contact.

The plug you connect at the far end of the power cord (PL2) and its polarity is up to you. I chose to use an RCA phono plug because I have a few adapters that can convert it for use with the devices I have. Once you have connected PL2 you're all done.

Testing. Before plugging the unit into your car, take a resistance reading across the lighter plug's contacts. It should read about 6000 ohms. If you get zero or an off-scale reading, check for an open or short in the circuit, respectively. If all is well, plug the unit into your car's cigarette-lighter socket and measure its output with a voltmeter. Unless you've redesigned the unit for different outputs, with the switch in the center position, the device should yield 9 volts. The other positions should give 6 and 3 volts.

If you get nothing out, check the ground and V_{out} connections. If you get three incorrect voltages, check the connections to R1 and R2. If the maximum voltage (9 volts for the authors model) is correct, but one or both of the other voltages are wrong, check R3 and/or R4 as necessary.

Once ready, your Car-Power Adapter should bring you many hours of listening pleasure. As you'll probably discover, it can be used for more than just audio and is perfect for working on a laptop by the shore, or to give yourself a quick shave before an important appointment. You're bound to come up with more uses on your own. ■

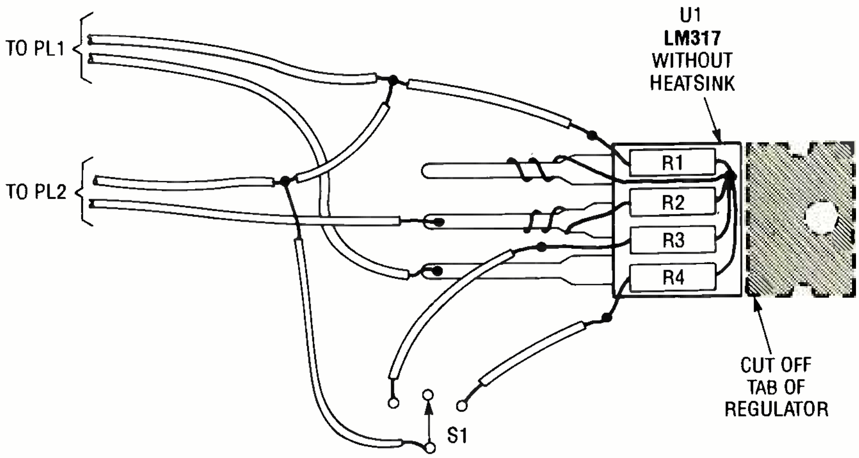
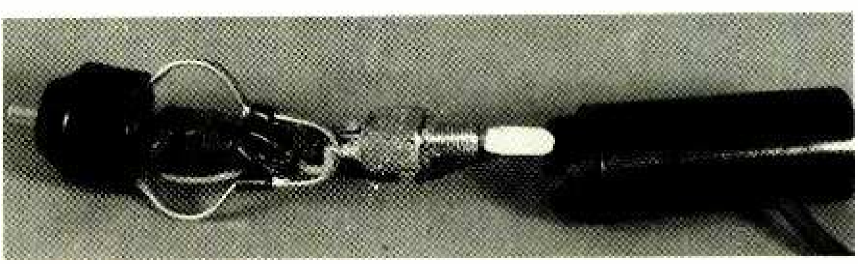


Fig. 3. Here is the best way to lay out the parts to form a neat, compact package. You should use heat-shrink tubing to insulate all the connections.



The inside of the Car-Power Adapter is laid out like this. As you can tell, the compact design requires precise lead lengths to fit properly in the plug.

TINY TUNER

(Continued from page 46)

(maximum capacitance), then apply a few drops of quick-setting epoxy to the flat knob, and mount a conventional knob, centering it over the flat one. The right knob will fit perfectly over the capacitor's flat knob. Make sure that the conventional knob is positioned so that its pointer is oriented where you want the maximum capacitance position to be. Next, mount S1 and the switch/inductor assembly to the front panel, and place a matching knob on the shaft of S2 (the inductor/switch combo), making sure that the zero-inductance position is where you want it.

After that, mount J1 and J2 (two BNC jacks). Those connectors can be mounted at any location on the plastic portion of the enclosure. In the author's prototype, the jacks were mounted opposite to the front panel, one on top of the other. Once all of the components have been mounted, it is time to interconnect them. The physical wiring is shown in Fig. 5. Miniature shielded microphone cable should be used to connect the circuit's input and output to J1 and J2. Make sure the shields of the two coax cables are connected together (in

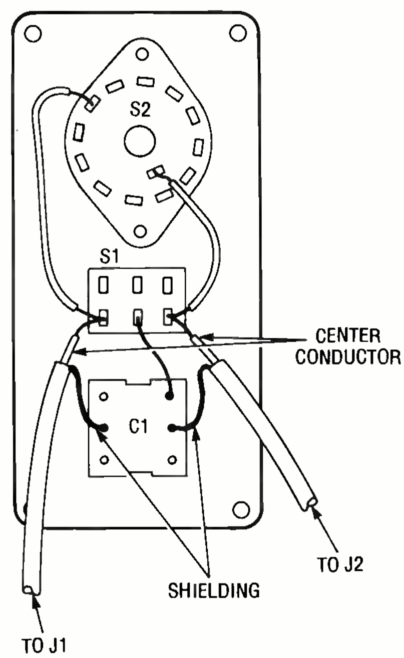
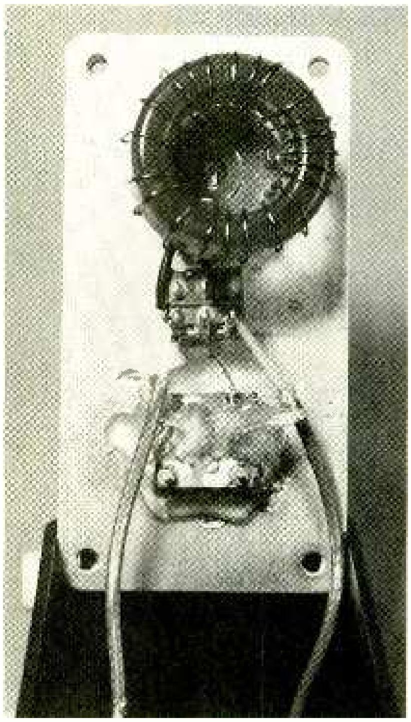


Fig. 5. Once all of the components have been mounted to the enclosure, use this diagram as an aid is the final wiring of the circuit.

the author's unit, that was handled through the capacitor's ground terminals) and to the shell of the BNC connectors.

While the circuit is very simple and nothing should go wrong, its a good idea to check your work for wiring errors anyway. If all appears okay, your tuner is complete and you can close up the enclosure.



Here is the fully wired Tiny Tuner prior to the sealing of its enclosure. Note that L1 obscures the rotary switch to which it is mounted.

Conclusion. Now you have an antenna tuner for QRP operation that is small enough to literally fit in your pocket. The Tiny Tuner can be left permanently in the line since it is bypassed when the inductance switch is set to minimum, and the center-off toggle switch is in the center position. With the inductance set to zero, you can tune out inductive reactances with the variable capacitor. With the switch set to off, you can tune out capacitive reactances with the tapped inductor. You electrically reverse the tuner by flipping the capacitor switch from "I" to "O;" thereby, permitting you to match high or low impedances. And while the power-handling capability is not very high, it is certainly high enough for almost any QRP rig that you might wish to use. ■

STEPPER MOTOR

(Continued from page 44)

might occur: your motor might go spinning merrily on its way, or it might sit there chattering at you. The reason for that is that the speed at which the step sequences are being sent to the printer port depends on the speed of your computer. If the pulses arrive at a speed that is faster than the maximum rate the motor is designed for, the motor will be unable to remain in sync with the incoming pulses. At best, this means that the "step integrity" of the system is lost (*i.e.*, there is no longer a one-to-one correspondence between the signals sent to the motor and the steps the motor takes). At worst, the motor is so confused that it just sits there and groans.

If that is the case for you, your program needs to pause between each output command. Modify the program so it reads like this:

```
10 OUT 888, 10
15 GOSUB 100
20 OUT 888, 9
25 GOSUB 100
30 OUT 888, 5
35 GOSUB 100
40 OUT 888, 6
45 GOSUB 100
50 GOTO 10
100 FOR X = 1 to 10
110 NEXT X
120 RETURN
```

Glossary

Step Angle—The motion of the shaft, in degrees, for each input signal applied to the motor windings.

Holding Torque—The maximum braking torque available from a motor at standstill, with rated current applied to the windings.

Dynamic Torque—The torque developed by the motor while stepping at low to normal speeds.

Detent Torque—The torque developed by an unenergized motor, due to residual magnetism.

Start-Stop Region—The speed at which the motor can still instantly stop or start, without losing synchronization with the controller signal.

Slew Mode—High speed rotation, beyond the start-stop region. The motor is still running in sync with the controller pulses, but can no longer instantly start or stop.

PARTS LIST FOR THE PC/ STEPPER-MOTOR INTERFACE

SEMICONDUCTORS

U1–U4—NTE3044 Darlington-output optoisolator/coupler, integrated circuit
Q1–Q4—2N3053 NPN power transistor
LED1–LED4—Subminiature light-emitting diode

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise specified.)
R1–R12—470-ohm (see text)
R13—20-ohm, 5-watt

ADDITIONAL PARTS AND MATERIALS

PL1—Male DB25 connector
MOT1—5-volt stepper motor (see text)
Printed-circuit board or perfboard materials, 5-volt power supply, solder, etc.

Now, rather than simply dropping down to the next line after each output, our program flow is interrupted by a GOSUB. The only function of the GOSUB is to waste a little time between each step. By varying the value in line 100, we can change the amount of the inter-step pause, tailoring the system to our own computer. By using an initial INPUT statement, the program could ask for left or right rotation, and then branch to a 10-9-5-6 sequence for clockwise rotation, or a 6- 5-9-10 for counter-clockwise.

With a little bit of imagination, it's fairly simple to create a BASIC program that simulates a machining operation. The computer can prompt the user for ten different movements, each one having a different direction and length (number of signals). This can be seen as moving a carriage back and forth in a milling operation. Pauses could be inserted between movements (say, five seconds for a drilling operation.) Ramping could be optional with each movement, if a high-inertial load was being moved.

In fact, practically any real-world job can be simulated (or actually performed) with this controller. Once you work through the above process, your knowledge of stepper motors will be greatly increased, allowing you to design, maintain, and troubleshoot real systems. ■

SOLID STATE LIGHT SOURCES

(Continued from page 33)

predetermined value, then LED1 will turn on as long as V1 < V2, and LED2 will turn on (and LED1 turns off) when V1 > V2. The reference voltage for V2 can be provided by a potentiometer, resistive voltage divider, a Zener diode, or a voltage regulator.

A simpler voltage-level indicator is shown in Fig. 10. This circuit consists of a Zener diode (D1) and an LED. As long as the applied voltage (V) is less than the sum of the Zener-diode potential of D1 (V_Z) and the forward bias potential of LED1 (about 1.8 volts as mentioned earlier), then the LED is off. But once V is greater than $V_Z + V_{LED}$, the Zener begins to conduct and the LED turns on.

Some Other Interesting Circuits. An optocoupler is a device that allows one device to control another while providing current isolation between the two circuits. For example, a circuit might operate at a high DC voltage that is incompatible with the low-voltage operation of the other circuits. The optocoupler will permit an optical signal to pass from one side to the other without there being an electrical connection.

Figure 11 shows a method for making one of these devices at home. An LED is positioned so that it touches the optical window of a phototransistor. Both of the components are placed inside a piece of black heat-shrink tubing, which is then heated until it shrinks. The assembly is then sealed at the ends with black silicone sealant.

You could also make a simple digital-logic probe. That is a device that allows a circuit troubleshooter to determine whether a logic output is high or low. In TTL circuits, a logic high is represented by a signal of +2.4 to +5.2 volts; a logical-low is represented by 0 to 0.8 volts. In CMOS circuits, the high level may be the same as in TTL, or it may be different. For example, 0 volts for low and +12 volts for high, or −12 volts for low and +12 volts for high. Troubleshooting these circuits makes it necessary to know which level is present at any given point.

Figure 12 shows the circuit for a simple logic probe based on an LED indicator and a pair of 2N2222 NPN transistors. The two transistors are connected in a Darlington-pair configuration. The result of the Darlington configuration is a circuit with an extremely high gain. The overall gain of a Darlington pair is the product of the gains of the individual transistors. For example, if two transistors each with a gain of 100 are connected in a Darlington configuration, the overall gain is 10,000. The Darlington pair can be treated as if it were a single transistor with a gain equal to the product of the gains of the two transistors.

The circuit of Fig. 12 shows the Darlington pair being used as a transistor switch. The transistors are turned on by applying a high logic level to the input, and when the transistors are turned on hard, the LED is grounded so current will flow through the LED. Although the value of R1 is shown as 20 kilohms, it can be anywhere between 18 to 24 kilohms.

As you can see, LED's can be used to create many interesting circuits. By now you should understand how LED's can be used to dress up your own projects. ■

LCD TECHNOLOGY

(Continued from page 62)

There are many specialized IC's designed to drive LCD's. Two such CMOS chips are readily available from most component catalogs: The CD4543, called a BCD-to 7-segment latch/decoder/driver for LCD's, sells for under $1; the high speed version, the 74HC4543, costs around $1.50. I suggest you experiment with one of those IC's as a good starting point.

Finally, although TNLCD's are mass produced in huge quantities and can be purchased at rock-bottom prices, they are by no means the only display type that uses liquid-crystal material. Stricter requirements, such as for color-reproduction and faster response time, have contributed to the expansion of the LCD family. Better contrast ratios combined with wider viewing angles have made necessary other LCD formats besides the twisted nematic. Some of those other types are *T*hin-*F*ilm *T*ransistor (TFTLCD), *M*etal-*I*nsulator-*M*etal (MIMLCD), Dynamic Scattering, and Smectic LCD's. ■

REMOTE-CONTROL ANALYZER

(Continued from page 40)

mum. What that means is that the rising edge of the first pulse in the first burst causes the Schmitt trigger output to go low. The Schmitt trigger is designed so that its output will not go high again until the signal drops close to zero. So the remaining pulses in the burst have no effect on the circuit's output.

When the first burst is complete, the integrator has enough time to go to zero, and the Schmitt trigger goes high again. The entire process is repeated for the second burst, and the demodulated signal (which is shown in Fig. 10) is output at pin 1 of MOD1 in Fig. 2.

Construction. Building the project is very easy because it uses very few components, which can all be purchased from Radio Shack. Also, because you won't be looking to win any awards for the device's appearance, it can be installed inside any kind of project case.

The prototype circuit was built on a piece of perfboard using point-to-point wiring according to the schematic shown in Fig. 2. Both the IR-detection circuit itself, as well as the 5-volt power supply, including the transformer, mount on the same board. There are only a few things that you must keep in mind when assembling the unit: The IR module must be positioned on the board so that a remote control can be aimed at it, that the connector the you use for PL2 mates with whatever connector or adapter you plan on connecting it to, and last remember to ground the module's case. The authors used a BNC connector for PL2 because that type would easily mate with the input connectors on their oscilloscope. The project's circuit board was housed in a plastic project box, but any case can be used.

Using the unit couldn't be simpler. Plug in the unit, turn on the power, and connect the circuit to your scope input via PL2. Then all you have to do is point a remote control at the IR detector and shoot. Provided that your scope is on and set properly, you should see the pulse train on the oscilloscope's screen. ■

TRACKING TRANSMITTER

(Continued from page 30)

spread. Spreading the windings will alter the inductance of the coil, thus changing the frequency range of the transmitter. That could make it impossible to tune in the designed FM range.

Once all of the on-board components have been mounted, connect the antenna. The antenna is nothing more than a 12-inch length of #22 stranded insulated hook-up wire. At this point, connect a 9-volt battery snap to the circuit. If you wish, you can add an on/off switch to the circuit by connecting the switch in series with one of the battery leads.

Although the Tracking Transmitter is designed to be used without a chassis box, you can house the unit in a small plastic or metal box (recommended if you will be including an on/off switch in the circuit). A metal box is the preferred enclosure; it will make the transmitted frequency much more stable and easier to set.

Checkout. Check over your work for proper assembly and short circuits. Make sure that each transistor is correctly oriented and in its proper place. Check each resistor and make sure the resistor values are in the proper location as well. Connect a 9-volt battery to the circuit.

Use an oscilloscope to look at the signal at the collector of Q2. You should see a pulse train with a peak-to-peak amplitude of approximately 8 volts. The positive-going pulses should be approximately 300-milliseconds wide and should be separated by approximately 1500-millisecond spaces. If you don't have an oscilloscope, connect the ground lead of an analog (non-digital) voltmeter to the negative terminal of the battery. Set the voltmeter for 10 volts or higher. Connect the positive lead of the voltmeter to the collector of Q2. The meter reading should repeatedly pulse from about 1 to about 9 volts.

Next, turn on an FM receiver and set it to a clear (unused) frequency between 88 and 108 MHz. Using a non-conductive alignment tool adjust C7 and C6 until you hear the transmitter on the receiver. You may have to squeeze or spread L2 to insure that the Tracking Transmitter tunes from the low end to the high end of the band. ■

BUILD A PRECISION ANTENNA

(Continued from page 37)

et. Turn S1 to on again and perform continuity checks to make sure the relays are disengaged (test all contacts to be sure).

Turn S1 off and this time jumper pin 4 to pin 7 before applying power. Verify that LED1 is illuminated while LED2 is extinguished. Continuity tests should reveal that K2 is engaged. Switch S1 off and remove the jumper.

Turn S1 back on, and verify that each IC socket pin voltage is between 0 and 5 volts with the exception of pins 4 and 11 (which are at +V and −V, respectively). Make sure both LED's are out and turn off S1.

Install U1 and flip on S1. Turn R12 (close to its center position) until both LED's go dark. Rotate R12 ¼-turn clockwise. LED1 should light (if not, try rotating R8 counterclockwise to decrease the circuit's hysterisis.) LED2 should be extinguished. Now turn R7 clockwise (about a ¼ turn) until LED1 goes out. Make sure LED2 is still off. Rotate R12 a ¼-turn counterclockwise (back to center). At this point LED2 should be illuminated while LED1 is extinguished. Now turn R7 counterclockwise (about ¼ turn) until LED2 is extinguished. LED1 should still be extinguished.

Adjust R8 to a comfortable level of hysterisis. Position its wiper so that the LED's do not light-up at the same time or toggle on and off.

Position R12 fully counterclockwise. LED2 should be lit while LED1 is off. Turn R7 counterclockwise until LED2 goes out. LED1 should still be extinguished and M1 should indicate a zero reading. Move R12 fully clockwise and make sure LED1 is on and LED2 is off. Rotate R7 clockwise until LED1 goes dark and make sure LED2 is still out. Adjust R11 for a full-scale reading on M1. Turn R12 and R7 fully counterclockwise. Check to see that LED2 is off (you can ignore LED1). If all has gone well, you can install the circuit in an appropriate case and mount the assembly for R7 near the antenna mast.

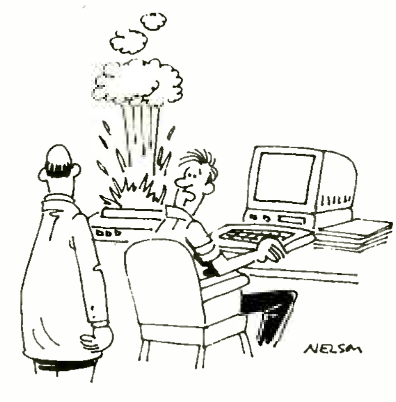
Installation. If you must snake the cable for R7 through walls and ceilings, disconnect it from the circuit, run the cable, and reconnect it to the circuit. If you have not already done so, use the standard rotor control box to rotate the antenna all the way counterclockwise to North. When done, attach the control circuit to the rotor leads (with the power off).

Secure the switch box to the roof near the antenna mast. Make the drive belt from waxed cotton and a spring similar to that used for radio dials. It should be long enough to provide a full turn around both the antenna mast and the drive pulley. Wrap the drive belt accordingly, and tie its ends to the spring, which should be stretched slightly to provide some drive-belt tension.

Turn R7 fully counterclockwise, turn R12 90° away from its fully counterclockwise position, and turn on S1 for ten seconds. Go back to the antenna and confirm that there has been some clockwise rotation (as viewed from above); if not, swap the leads running from K2 to the rotor. It should work now.

If the rotor seems to hunt back and forth too much, tweak R8 to augment the hysterisis. Letter and index all station locations on the meter's dial and you're all done.

The author placed a different version of the unit in operation as a freeze-protection circuit on his solar water heater. A recent cold spell froze the draindown system. I came home one night and found a note tacked to the front door telling me the city had turned off the water feed after the pipes burst. A collector-mounted resistor/thermistor pair replaced R7 in the antenna-control circuit and the pump is now activated by K1 to keep that from happening again. There may be numerous other applications for this sensitive control circuit, but I'll leave it up to you to discover what they are. ■



The computer ordered the laser printer to fire photon torpedoes.

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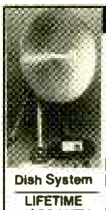

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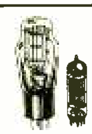

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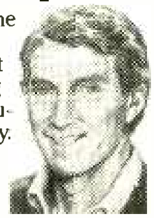

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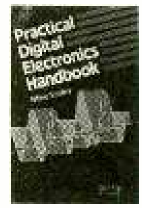

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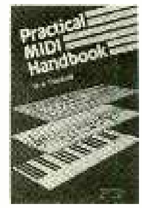

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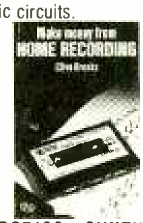

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There is a thriving professional service steeped in high-tech techniques that you can become a part of! But first, you must know and understand Countersurveilance Technology. Your very first insight into this highly rewarding field is made possible by a video VHS presentation that you cannot view on broadcast television, satellite, or cable. It presents an informative program prepared by professionals in the field who know their industry, its techniques, kinks and loopholes. Men who can tell you more in 45 minutes in a straightforward, exclusive talk than was ever attempted before.

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Discover the targets professional snoopers seek out! The prey are stock brokers, arbitrage firms, manufacturers, high-tech companies, any competitive industry, or even small businnesses in the same community. The valuable information they filch may be marketing strategies, customer lists, product formulas, manufacturing techniques, even advertising plans. Information thieves eavesdrop on court decisions, bidding information, financial data. The list is unlimited in the mind of man—especially if he is a thief!

You know that the Russians secretly installed countless microphones in the concrete work of the American Embassy building in Moscow. They converted what was to be an embassy and private residence into the most sophisticated recording studio the world had ever known. The building had to be torn down in order to remove all the bugs.

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The open taps from where the information pours out may be from FAX's, computer communications, telephone calls, and everyday business meetings and lunchtime encounters. Businessmen need counselling on how to eliminate this information drain. Basic telephone use coupled with the user's understanding that someone may be listening or recording vital data and information greatly reduces the opportunity for others to purloin meaningful information.

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The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of voice scrambling telephone communications. In fact, do you know how to look for a bug, where to look for a bug, and what to do when you find it?

Bugs of a very small size are easy to build and they can be placed quickly in a matter of seconds, in any object or room. Today you may have used a telephone handset that was bugged. It probably contained three bugs. One was a phony bug to fool you into believing you found a bug and secured the telephone. The second bug placates the investigator when he finds the real thing! And the third bug is found only by the professional, who continued to search just in case there were more bugs.

The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

The professionals viewed on your television screen reveal information on the latest technological advances like laser-beam snoopers that are installed hundreds of feet away from the room they snoop on. The professionals disclose that computers yield information too easily.

This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

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