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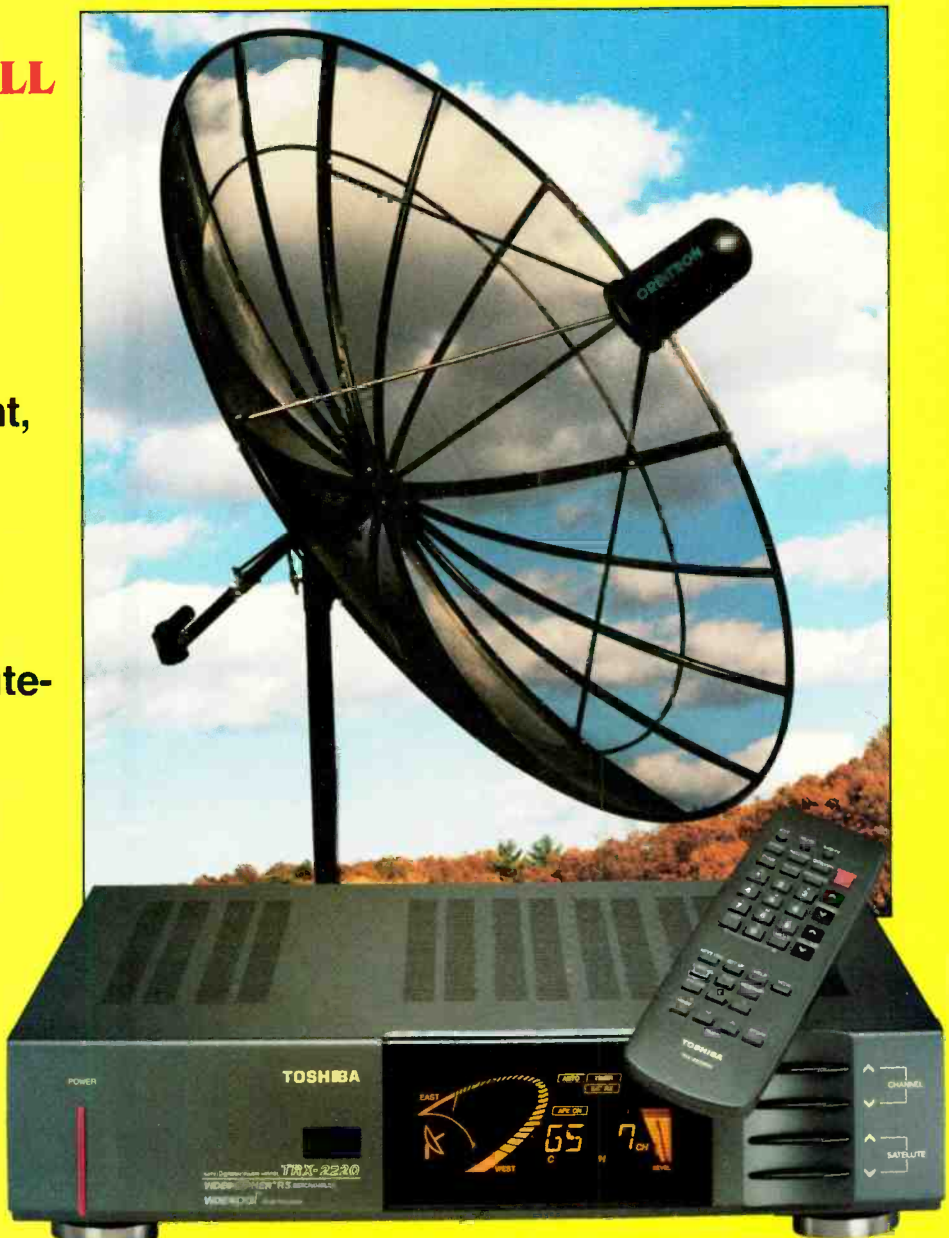
A GUIDE TO TODAY'S SATELLITE TV

Popular Electronics

JUNE 1993



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Popular Electronics (ISSN 1042-170X) Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735. Second-Class postage paid at Farmingdale, NY and at additional mailing offices. One-year, twelve issues, subscription rate U.S. and possessions $21.95, Canada $28.84 (includes G.S.T. Canadian Goods and Services Tax Registration No. R125166280), all other countries $29.45. Subscription orders payable in U.S. funds only, International Postal Money Order, or check drawn on a U.S. bank. U.S. single copy price $3.50.

Postmaster: Please send address changes to **Popular Electronics**, Subscription Dept., P.O. Box 338, Mount Morris, IL 61054-9932.

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Larry Steckler
EHF, CET
Editor-In-Chief and Publisher

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Associate Editor
John J. Yacono
Associate Editor
Byron G. Wels, K2AVB
Associate Editor
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Editorial Assistant
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Customer Service/Order Entry
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Advertising Sales offices listed on page 98

Cover photography by Salvatore Sulla
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Composition by
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EDITORIAL

SATELLITE TV TODAY

Back in the late 1970's and early 1980's, home satellite-TV was an explosively growing industry. It also existed in what was then a gray area of the law. Owners of home receiving set ups (called TVRO's) were considered pirates by program providers and cable companies. The reality, however, was that while many TVRO owners were attracted by the prospect of "free" cable TV, for those who lived in rural and remote areas, TVRO's offered the only hope of getting any TV at all.

In any event, the FCC eventually clarified the status of TVRO ownership, making it legal, and program providers came up with an effective and relatively secure method of scrambling. The later development nearly killed satellite TV. The important word here is "nearly." Scrambling drove the freeloaders out, leaving a smaller, now legitimate industry that has grown steadily every year.

Today, satellite TV has matured, and offers attractive benefits that are unavailable via cable or broadcast channels. Those include quality, variety, and cost.

First, satellite TV offers picture quality that is unparalleled by cable or broadcast TV—it is equal to that provided by laser discs. As for variety, virtually any programming imaginable is available to the TVRO owner. And cost? Even though programming has to be paid for, it is still less expensive than programming from most cable-TV companies.

This month, **Popular Electronics** turns its attention to satellite TV. In **Gizmo**, we detail how you can design and install your own satellite-TV system, and review the components that comprised our test set up. That story begins on page 5.

In a second article, 200 Channels to Choose From, we look at the state of satellite TV today. We examine the variety of programming available, the cost, the benefits and drawbacks of TVRO ownership, and more. That article begins on page 31. If you've ever even remotely considered satellite TV, you'll find both stories well worth your time.

Carl Laron
Editor

LETTERS

A MADE-TO-ORDER PROJECT

I wanted to share a story about Jonathan Gordon's "Gas Gauge Meter" (**Popular Electronics**, February 1993). I have a 1980 Corvette, and I spent weeks trying to repair its low-fuel warning-light module, for as little money as possible. I called GM, but no one there would help me—they just wanted to sell me a new one for $55. We all know there's only about $5 worth of parts on the small PC board. Next, I called about 30 semiconductor manufacturers, trying to cross reference the generic numbers on the GM part, to no avail.

Well, I was looking at magazines in the grocery store while my wife was shopping, when **Popular Electronics** fell on the floor at my feet. It was the February issue, with "The Gas Gauge Gets Smart" in big letters on the cover. The magazine was covered in clear plastic, but I couldn't even wait to buy it before tearing off the plastic (hoping no one was looking). I quickly read the article and was so excited, I started yelling for my wife. Everyone thought I was crazy!

Now I'm sitting here with $15 worth of parts in front of me, about to start building my own warning light. My thanks to you all for coming up with projects like this!

K. L. T.r
Dothan, AL

MADE IN THE USA

In a **Popular Electronics** editorial titled "Made in Japan," which appeared over a year ago (May, 1992), one sentence in particular really hit home and has been going 'round and 'round in my mind ever since. It is: "Two-way trade will only become a reality when we have products that are unique, or better than anything available elsewhere."

McIntosh audio/video equipment fits that description. McIntosh Laboratory Inc. is a quiet company located along the banks of the Susquehanna River in Binghamton, NY. We've been manufacturing some of the world's best high-end stereo equipment since 1949. We have had a very healthy export standing with the Asian market, particularly with Japan, for many years. Not only are our current models doing very well in the Japanese market (accounting for 50% of our current exports), but for years Japanese collectors have revered our products and have scouted the American marketplace for our older equipment. It is truly a love of "quality."

McIntosh recently decided to reissue the MC 275 Tube Power Amplifier, which originally was manufactured from 1961 to 1970 and had a suggested retail price of $444. Today it is difficult to find a used MC 275 because most of them have gone overseas. If you did find one, the cost would be between $3000 and $4000, depending on condition. The reissue of the MC 275 is a direct result of our distributor in Japan asking for it. It's sure to whet the appetite of our loyal foreign customers.

It is that high regard for McIntosh equipment that prompted Clarion of Japan to merge with McIntosh in 1990. Nothing has been done since the merger that affects the uniqueness of the products or the company. All products are still proudly hand-built in New York by the same dedicated American workforce. Clarion has provided McIntosh with the capital to hire more engineers and expand its product line to include home-theater products, a new line of speakers, and updated equipment. On the back of each product is stamped "Made in USA." Foreign parts are used only if they are not available here in the States.

McIntosh is unique because we are an American firm that's Japanese owned. We're becoming more and more of an international company every day.

You're absolutely right about the two-way trade issue. Unique products, or those that are better than can be found anywhere else, are necessary.

Jean M. Michelbach
Dealer and Press Liason
McIntosh Laboratory

CALLING ALL D-I-Y'ERS

It doesn't seem that long ago when the supermarket, drugstore, and airport magazine racks had a fair share of hobby, experimenting, electronics, and model-railroad publications. Now, aside from **Popular Electronics** and a very few similar magazines, the racks are filled with shallow, light reading on subjects like sports, sex, scandals, and television—anything that doesn't require heavy thinking.

It is a shame that things are so difficult for today's electronics hobbyists. If, through your and others efforts, we could somehow reactivate the creative interest of electronic do-it-yourselfers I am sure that some of them would "stumble onto" inventions worthwhile for all of us. Some accounts attribute the telephone to the accidental spilling of battery acid. I heard that Kodachrome color photography was due to two college boys experimenting with chemicals in their kitchen. Throughout history, fortunate accidents have spurred progress.

I wish we had the freedom for do-it-yourself engineers to see who could build the best TV descramblers, and disc and tape copiers. I remember the earlier days of radio, when we could really make a sport of seeing who could build the receiver or transmitter with the furthest range. Our biggest worry was keeping a regenerative receiver from going into oscillation, disturbing the neighbors' radio reception. Today, it is the scrambled TV signals entering our TV dishes.

I am retired after 40 years with Western Electric Company, formerly the manufacturing and supply unit of the Bell System of AT&T. I am a member of the Telephone Company Pioneers of America, an organization of retired telephone workers who help disadvantaged people get needed services. For instance, I volunteered to repair "talking books" for the blind. With many of the projects I work on, however, I experience trouble finding all the necessary parts. I think that your Electronics Market Center will be very helpful to me.

P.D.N.
Springfield, MO

HAVES & NEEDS

I recently came into possession of two old, vacuum-tube receivers. Now I am looking to beg, borrow, or steal the circuit diagrams, specifications, and operating instructions for the two units: a National NC 125 and a Yaesu Muse (Japan) FR 1003.

There is no real problem with the National receiver, as I am fairly familiar with that type of equipment, although the information would be very useful.

The FR 1003 is a different story. The dial is calibrated 0–100, and various knobs and switches have no reference to frequencies, etc. One control position is labeled CALIB, presumably for calibration, but I have no idea how to use it.

Any information on these two units would be greatly appreciated. Thank you.

Ray Morford
C8 Site 28 RR2
Gabriola Island, B.C.
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Thanks for **Popular Electronics**. I've been a reader and faithful subscriber for many years. Now I'm in need of a schematic/operator's manual, including power supply, for a Swan 500C ham band transceiver. Thanks again.

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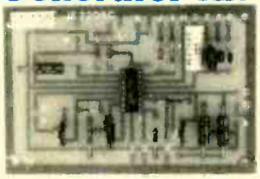

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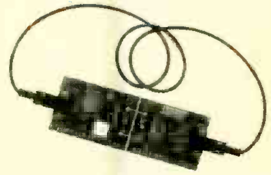

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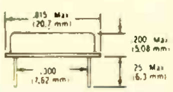

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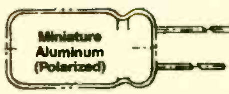

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6P29891	10µF	50V	.13
6P31114	47µF	50V	.15
6P29962	100µF	50V	.19
6P30015	1000µF	16V	.35

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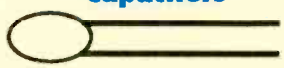

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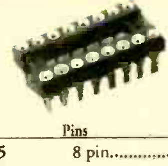

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GIZMO®

VOLUME 6,
NUMBER 6

A CHRONICLE OF CONSUMER ELECTRONICS

How To Become a Bird Watcher

All you need to know before you install your own satellite TV system

In this month's Gizmo, we boldly go where we've never gone before—to explore the world of satellite TV. Although we've been aware of satellite TV for years, through books and articles and conversations with dish owners, until now, we've had no hands-on experience. If your experience with satellite TV is as limited as ours was, we'd suggest you read the article on page 31 for an in-depth look at the field. Here, we'll keep background to a minimum, as we relate the story of our installation while answering the questions that are most likely to arise. In the remainder of this issue of Gizmo, we discuss the practical aspects of choosing equipment, and review some state-of-the-art satellite gear.

WHAT IS REQUIRED FOR A HOME-SATELLITE SYSTEM?

A home satellite-TV system, commonly known as a TVRO (for TV receive only), consists of the satellite dish, which collects the signals relayed by satellite and reflects them to the feedhorn, which holds and adjusts the real antenna. The dish positioner—in modern set-ups a motor-driven actuator—moves the dish into proper alignment so that it can "see" the satellite of choice. The signal received from the satellite is converted to a lower frequency, or downconverted, by the LNB, or low-noise block downconverter. The converted signal is transmitted via cables inside the house to the receiver, which processes the signal so that it can be shown on TV.

WHY GO WITH TVRO?

Whew! If you're unfamiliar with the benefits of TVRO, you might wonder why anyone would bother to spend the time, money, and effort on a satellite setup, particularly if cable TV was available.

There are a few good reasons, which we'll just touch on here, since the article on page 31 covers TVRO advantages in detail. First, satellite offers the widest variety of programs. Second, it provides excellent audio and video quality—better than that of network or cable. And satellite offers an unparalleled choice of program suppliers, allowing you to choose from among dozens of program packagers, instead of being limited to the few options offered by a single cable company.

Finally, it's easier than you might think to enter the world of satellite television. Whether you choose to install a system yourself or hire a local satellite dealer to do it for you, you'll find the process easier once you understand some satellite TV basics.

CAN I DO IT MYSELF?

Installing a satellite TV system—particularly, the dish—requires patience and, most important, careful planning. The Satellite Broadcasters and Communications Association (SBCA) doesn't recommend that the average person attempt it. For the most part, we'd agree.

But if we were to make a couple of assumptions about you, simply because you read **Popular Electronics**, we would guess that you have some basic knowledge of electronics and that you weren't afraid to apply that knowledge to do-it-yourself projects. If that holds true for you, then you should be able to handle a TVRO installation—with the proper information and planning, of course.

WHERE DO I START?

Before you ever think of installing a satellite dish, you have to do a *site survey* to determine that you can place a dish somewhere on your property so that it has a clear view of orbiting satellites. The importance of a site survey cannot be overstated. If you don't have a clear line of sight to the satellite's location, you won't

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Gizmo is published by Gernsback Publications, Inc., 500-B Bi-County Blvd., Farmingdale, NY 11735. Senior Writers: Chris F. O'Brian and Teri Scaduto.

receive any signals. Buildings, hills, and trees will block the microwave downlink signals that are sent from the satellites.

Most satellite systems are installed so that the dish antenna can be moved, allowing it to track and receive signals from all of the orbiting satellites. If you are interested in the signals from just one satellite, you could install a fixed dish. But even then, you must ensure that you have a clear line of sight.

All of the geosynchronous satellites used for TV program distribution are in orbit 22,300 miles over the equator in what is know as the Clarke Belt. What that means, generally speaking, is that your dish should have a clear view of the southern sky. The farther north you are located, the lower the satellites will be in the sky. If you are located in the east, most of the satellites will be west of you, and *vice versa*.

Our installation site was on Long Island, NY, at a latitude of 40° 70 + prime North, longitude 73° 38 + prime West. That meant that most of the satellites would be in the southwest sky, and we'd need a dish with a diameter of at least 8 feet.

WHAT DOES DISH SIZE HAVE TO DO WITH LOCATION?

The signals relayed to earth (downlinked) by satellites are, for the most part, "aimed" at the center of the country. Because signal strength is greatest at the center of the "footprint"—the area that can receive signals from a satellite—and weakest at the fringes, folks in Kansas usually can get by with a 6-foot diameter dish, while folks in Washington or Maine might require one that's 12-feet in diameter. We opted for a 10-foot dish.

HOW DO WE DO THE SITE SURVEY?

The first step in the site survey is to find true south. A compass alone won't do the job because it will point to *magnetic* south. A good way to find true south is to call a local airport and ask for the magnetic variation in your area. On Long Island, true south is about 13 degrees west of magnetic south.

The second step is to determine the bearings to the satellites furthest east, furthest west, and the highest satellite in the belt as viewed from your location. In the U.S., the satellite furthest east is Spacenet 2, which is at a longitude of 69° W. The satellite furthest west is Satcom F1, at a longitude of 137° W. The bird that appears highest in the arc is the one that is closest to being due south of your location. In our case, that's Galaxy 2, which is at a longitude of 74°.

To determine whether you have a clear view of the Clarke Belt, you must first calculate the azimuth and elevation angles to those satellites, correct for magnetic variation, look in the direction of the satellites, and connect the three points in a smooth arc to look for obstructions.

DO I NEED A MATH DEGREE?

No, but some math skills are required. Calculating the azimuth and elevation angles to the satellites is an exercise in trigonometry. Although it's possible to calculate the angles with the formulas shown here (See "Calculating Az/El Angles"), there are computer programs available to automate the process. Some satellite-equipment suppliers will sell you data corresponding to your latitude and longitude and give you the bearings to all satellites in the belt. Our first set of data came from a table in the book titled *Home Satellite TV Installation and Troubleshooting Manual* by Frank Baylin *et al.* The book is an excellent review of satellite TV technology and practice. It is just one of the satellite-related titles from Baylin Publications (1905 Mariposa, Boulder, CO 80302.).

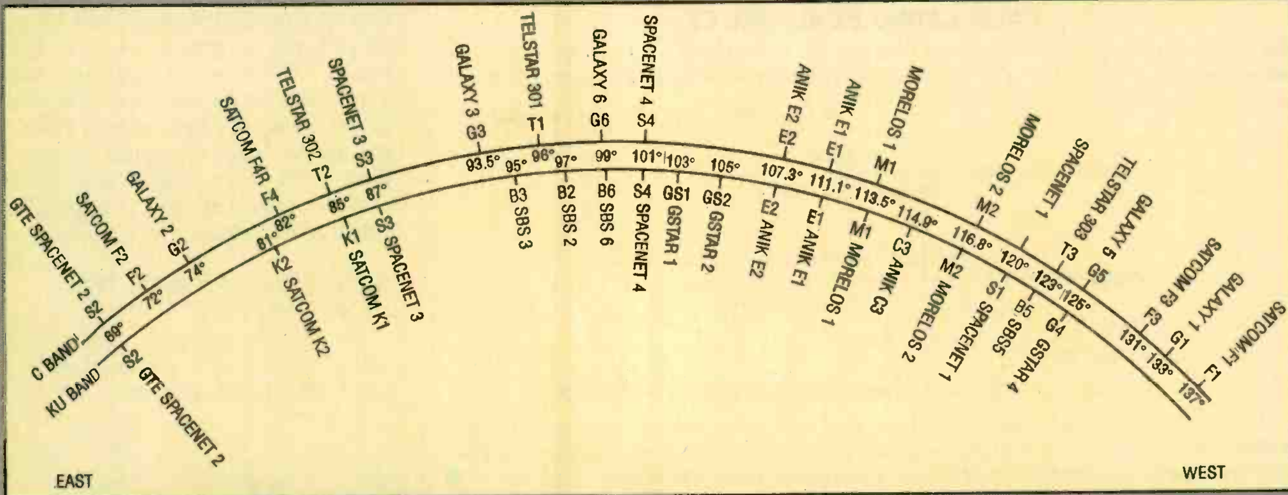
WHAT SURVEYING TOOLS ARE REQUIRED?

You'll need a compass, an "inclinometer" (a fancy name for a protractor), and a straight-edge or tube. Stand so that you're facing the direction of the satellite furthest east, and use the protractor and straight-edge to determine the proper elevation angle. Do the same for the highest satellite and the one furthest west, and then scan between the three points in a smooth arc. Any visible obstructions will block satellite signals.

WHAT IF THERE ARE OBSTRUCTIONS?

Unless you live in a flat, treeless, rural area, you're likely to encounter something that will block your dish's line of site. If that's the case, raising the dish above the ground and mounting it on a rooftop could be the solution. Keep in mind, however, that the higher the dish, the more that wind can be a problem.

How big a dish? The answer depends on where you live! the map shown here will give you a rough idea of what you'll need.



C- and Ku-Band satellites over North America and their orbital positions.

Our site was not an ideal one for installing a satellite dish. Our small lot in a heavily treed portion of suburban New York didn't provide too many options; no ground location offered a view of the satellites. Because we had decided not to mount a dish on the roof of the house, the only feasible location was the roof of a detached garage in the rear of the lot.

Unfortunately, even from that vantage, our site survey showed that we did not have a clear view to all satellites—a neighbor's tree would block some of the signals. We decided to go ahead with the installation anyway; after all, the dish could still see more than a dozen birds. (And maybe if we invited the neighbors over for enough pay-per-view shows, they'd agree to trim a few of their trees!)

The important point is that the site survey let us know what to expect. Imagine finding out only after you installed a dish that the satellite you most wanted to see was blocked!

WHAT ELSE MIGHT A SITE SURVEY REVEAL?

The next part of the site survey is a search for any signals that might hamper reception. Microwave towers that relay telephone and TV signals are the most common cause of terrestrial interference or TI. In fact, one of the reasons that C-Band satellites are low powered is so that they do not interfere with ground-based microwave systems! That's why all of the new, high-powered DBS (direct broadcast satellite) systems proposed are in the satellite-TV-only Ku band.

Professional satellite-system installers often check for TI with a portable receiving system. Not being professionals, we did a TI check by aiming our feedhorn at the satellite arc while observing its output on a spectrum analyzer that we borrowed from Avcom of Virgina. An alternative would be to use a satellite receiver and a feedhorn. Our site was not completely free of TI, but there was no discernible TI in the dish's line of sight.

An important thing to remember about your search for TI is that a potentially troubling source might not be on the air during your test. It's a good idea to check for TI at different times of the day—in particular, at the time when you're most likely to be watching TV—because not all TI is emitted continuously around the clock. Even if you cannot avoid TI, you might have success by installing a TI filter. (Some receivers have TI filters built-in.) You can also use physical shields to reduce or prevent TI. A professional installer will probably be required to overcome severe problems.

One final factor to consider is the distance from your dish to your viewing location. Although cable loss is no longer the problem that it was in the early days of satellite TV, it can still degrade marginal signals. Cable runs of over 300 feet should be avoided.

WHAT IF MY TOWN DOESN'T ALLOW SATELLITE DISHES?

In 1986, the FCC passed the Pre-emption Order to stop cities and towns from restricting the installation of satellite dishes. However, seven years later, many town governments still don't conform to the Preemption Order, and if you get yourself in trouble with your local zoning board, federal help from the FCC might seem very far away. The SBCA recommends that dish owners protect themselves from potential ramifications by checking local ordinances *before* setting up a dish.

To avoid any problems, we applied to our local planning board for a permit to erect a dish. As is common for many locations, our village did not have a set procedure to follow—our request fell into the category "other."

At our application hearing, we were asked some rather interesting questions, among them: "Do you need a license to operate a satellite dish?;" "Will the dish cause interference with your neighbors' TV reception?"; and "Why would you want to watch satellite TV?" We enjoyed the opportunity to educate the planning board members to the many benefits of satellite TV.

In the end, we paid our $50 and received our permit. But even if we had been refused a permit, we probably would have proceeded with the installation—after all, federal law is on our side.

The FCC order doesn't apply, however, to homeowners' associations' restrictions against dishes. That's because each member of the association willingly agrees to the provisions of the covenant when he purchase his home. According to the Community Associations Institute (CAI), an organization that represents homeowners' groups, about 32 million people live in residential complexes or subdivisions that restrict the installation of dishes. The SBCA has recently begun working with the CAI on model covenants that would allow dishes while respecting the homeowners' associations' aesthetic concerns.

WHERE DO I BUY TVRO EQUIPMENT?

Okay, you've decided to go with TVRO, and have determined that your site is suitable. Now you have to select all the gear.

If you spend any time at all in consumer-electronics stores, you've probably noticed that absolutely no satellite equipment is on display. There are a couple of reasons for that. First, a TVRO system, dish and all, would make a rather large and unwieldy display. Second, there are so many pieces needed for a complete system, and so many choices available in each category. Finally—and probably most important—most people do require professional installers, and most consumer-electronics retailers simply don't have staff qualified to do so. Nor do they want to

CALCULATING EZ/AL ANGLES

Although satellite retailers will be happy to sell you aiming data or software to calculate aiming angles, you can calculate azimuth and elevation angles with a couple of formulas and a programmable calculator!

$$\text{Azimuth angle} = \cos^{-1}\left[\frac{-\tan\theta}{\tan\left[\cos^{-1}(\cos\theta\cos x)\right]}\right]$$

$$\text{Elevation angle} = \tan^{-1}\left[\frac{\cos\left[\cos^{-1}(\cos\theta\cos x)\right]-0.15116}{\sin\left[\cos^{-1}(\cos\theta\cos x)\right]}\right]$$

θ = site latitude

x = magnitude of difference between satellite longitude and sitelongitude

The three important satellites to know are the one furthest east (Spacenet 2), the one furthest west (Satcom C5), and the one closest to being due south of your location. Connect the three points in a smooth arc, and you'll know where the Clarke Belt is. ■

be bothered with the post-installation customer service that a professional installer supplies.

Your options are to buy the equipment through a local satellite-TV dealer, or through a mail-order catalog such as that offered for $5.00—but free to **Popular Electronics** readers—from Skyvision, Inc. (1010 N. Frontier Drive, Fergus Falls, MN 56537-9973; telephone: 800-543-3025).

For our installation, we went with a 10-foot Orbitron dish, a Rohn roof mount, a Chaparral Corotor II Plus feedhorn, Chaparral and Norsat LNB's, a Thompson Saginaw actuator, ribbon cable, and the Toshiba 2200 IRD. Each of those items is reviewed individually in this month's Gizmo. Within each review, you'll find information on how to judge the quality of satellite gear, what features to look for, and what the specifications mean.

HOW MUCH WILL IT COST?

Ah, the $64,000 question! You'll be glad to know that the answer is nowhere near $64,000.

As with any consumer item, prices vary according to quality and features. It's possible to spend between $5000 and $6000 for an installed, dual-band, system with Dolby surround sound, PIP, MTS stereo, pay-per-view, and a separate record output for your VCR. It's also possible to install your own value-priced C-Band-only system with IRD for under $2000. And if you're not interested in paying for programming, you can pick up a single-band system without a descrambler for about $500 to $800. (You can always add a separate decoder later.)

Our basic system, had we ordered each component individually from the Skyvision catalog, would have cost just over $3200, including shipping. However, a package deal in that catalog would be much more cost-effective, offering almost the same quality (the primary difference is in the actuator) for about $2650.

That's about average, according to a reader poll conducted by *Satellite Orbit* program guide, whose readers spent an average of $2762 for their systems.

WHAT ABOUT PROGRAMMING?

According to that same *Orbit* survey, 60% of their readers pay for subscription programming, and the average amount they spend each month is about $27. What can you get for that?

A quick scan through the advertisements in *Satellite TV Week*, another popular satellite-program guide, turns up the following: a 20-station package including HBO, Cinemax, The Discovery Channel, CNN, ESPN, Arts & Entertainment, TNN, and Comedy Central would cost less than $23 a month; a similar package offers 22 channels for $26.25; and yet another offers 20 stations for $19.95 a month with the ability to add HBO, Cinemax, or ESPN for just $5.05 a month each. With satellite programming, it's also possible to order "a la carte"—paying for only those stations you truly want, with prices ranging from a dollar a month for the Weather Channel or Discovery, to $7.95 a month for premium movie channels.

Our local cable service, in comparison, charges $9.95 for basic service—basically, just the stations we receive with our rooftop antenna (ABC, NBC, etc.). To that, we can add such premium channels as HBO, Bravo, Cinemax, The Playboy Channel, and The Disney Channel for $12.95 each. A package that includes basic cable plus 25 not-quite-premium stations costs $22.45 a month, to which you can add premium services at $12.95 each. The top-of-the-line package, which includes virtually every imaginable station (except Playboy, an additional $4) costs a whopping $71 a month!

There are three major differences between subscription satellite and cable-TV programming. First, the tremendous competition between satellite programming suppliers keeps prices in line and gives viewers a tremendous amount of choice. Second, you can receive dozens of satellite-TV stations without paying a cent. Third, many of the stations for which you do pay are downlinked on more than one transponder, which means that you can see three HBO channels and two Cinemax channels, broadcasting the same programs but at different times.

HOW DO WE HOOK UP THE HARDWARE?

We'll provide all the installation details within our reviews of each component in our TVRO system. Read on!

Sur-Mount-ing All Obstacles

SAW-HORSE TVRO ROOF MOUNT. Manufactured by Rohn, P.O. Box 2000, Peoria, IL 61656. Price: About $215.

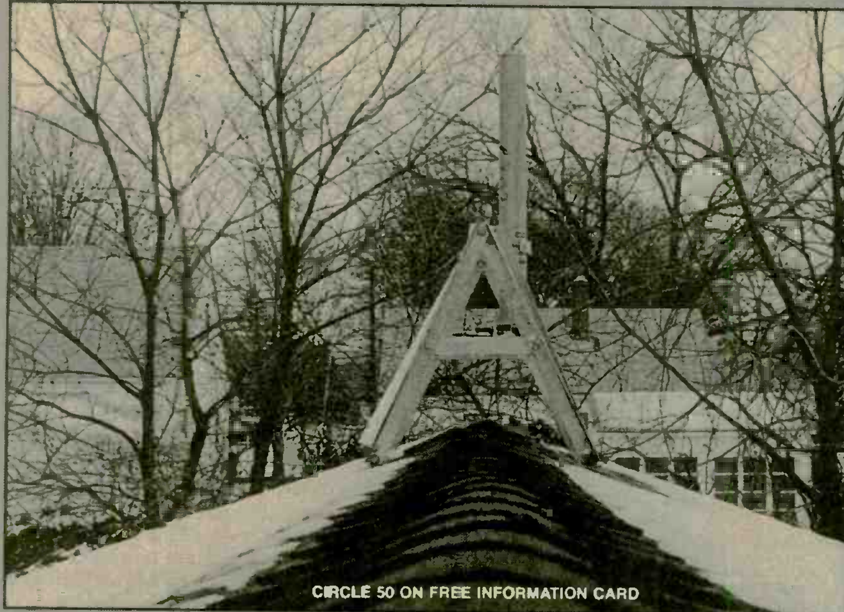
What do you do when your site survey tells you that you can't mount a dish on the ground because your view of the satellites is obstructed? Well, perhaps you call your local cable company and schedule an installation. Or, perhaps you "surmount" those obstructions by mounting the dish on your roof!

Our suburban installation site was surrounded by trees and nearby houses. The only way we could hope to see any satellite was to get the dish up high enough. Our chosen site was a compromise (a neighbor's tree still blocked our view of the western satellites). But we were able to get a boost of about 12 feet by putting the dish up on the roof of our detached garage.

The mount we chose was the *Model SHRM* saw-horse roof mount from *Rohn*, a company well known for its amateur and professional antenna towers. The company also has a complete line of satellite-communications mounts.

Even if you don't have a problem with the view from the ground, a roof mount can be attractive for other reasons. First, there's no need to pour the concrete that's required for virtually all ground installations. And there's also the extra security in knowing that no one can get to your dish without going through a lot of trouble, so accidental (or intentional) damage is less of a problem. A roof mount can also be attractive to people who live on small lots. Why take up what precious little yard space you have with a dish?

Our mount was located atop a detached garage, but mounting a dish on the roof of your house has some added advantages—the cable run can be very short and there's no need to dig a trench to bury it! There is,



of course, a flip side to the coin. Since the saw-horse roof mount is attached to your house, you migh. be required to get a building permit. And, of course, the higher your dish is, the more it will be noticed. For whatever reasons, some people consider satellite dishes to be unsightly. Even though the FCC is on the side of dish owners, many localities try to restrict dish installations.

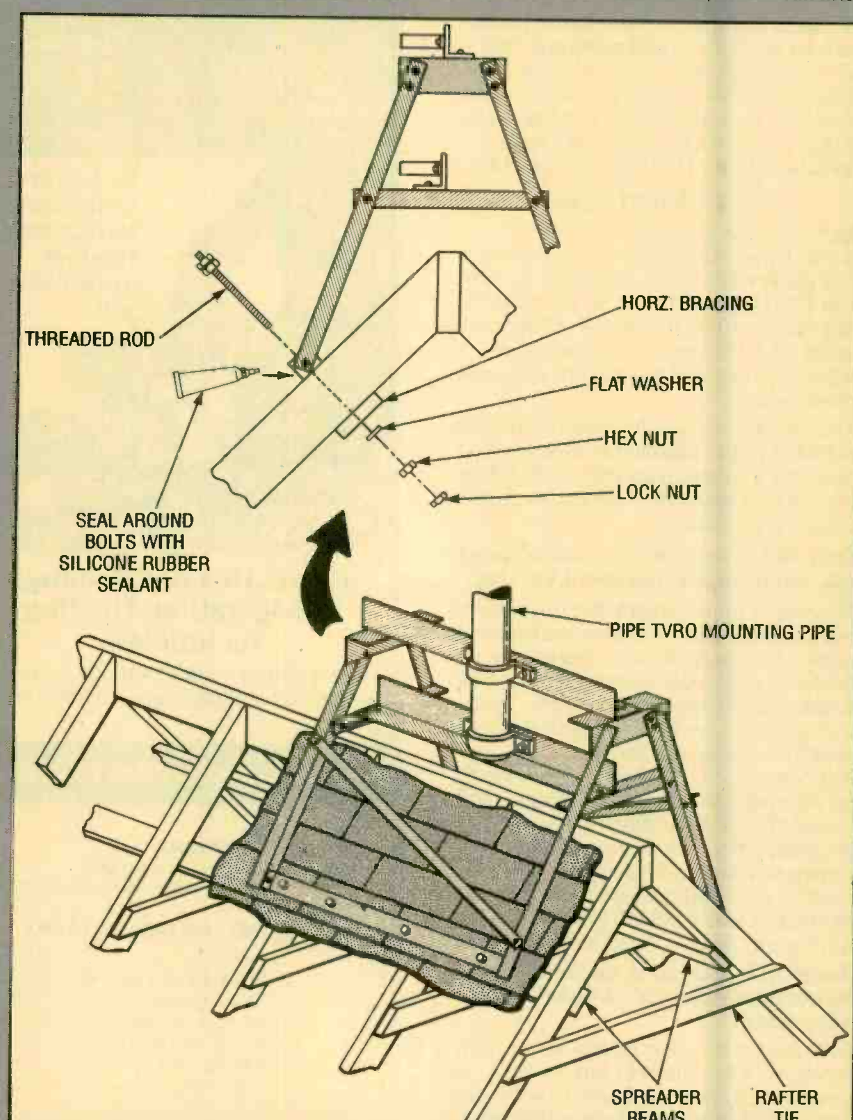
Although a roof mount relieves you of the hassle of pouring concrete to ensure that it stays securely in place, care must be taken to ensure tha. a roof-mounted dish—and the roof to which it is attached—stays securely attached to the building! A satellite dish—even a perforated one—is basically a huge sail. The wind load on a dish, especially one with a ten-foot diameter (and a surface area of 78 square feet) can be tremendous. A roof structure is generally designed to hold itself up in place. By itself, it won't be able to support the forces from a satellite dish.

The roof must be reinforced before the mount is installed. The main purpose is to spread the wind load across the roof as much as possible. In an unfinished garage, getting access to the roof might be easy. In a house, it might not be.

After ensuring that the mount is level and centered over the peak of the roof, the base of the mount is used as a template for drilling holes for the eight threaded rods that hold the mount in place.

The mount is made from heavy angle steel that is "hot dip" galvanized to prevent rust. After the mount is manufactured, it is immersed in a bath of molten zinc, which fuses to the metal and prevents corrosion. While that is desirable in any mount, it's especially important for roof mounts. We certainly wouldn't want brown streaks of rust running down our roof!

The SHRM mount comes with a set of assembly drawings. Because of our inexperience, we would have preferred if a set of step-by-step instructions was included as well. Nonetheless, we didn't have any serious trouble putting it all together. Basic assembly would have taken us just a little more than a half hour, but we ran into



The roof must be reinforced with spreader beams that are lag-bolted to the rafters. The rafters must also be tied together for additional stability.

a couple of slight problems. First, we had to take some extra time to clean up excess galvanizing material on one of the bolts. Second, we found that two of the bolts supplied were the wrong size. (We received two too many 1-1/2-inch bolts, and two too few 1-inch bolts.) Fortunately, the problem was fixed with a few flat washers we had on hand.

The base flanges of the SHRM are the parts that are attached to the roof. Because they are adjustable, they can match a wide variety of roof pitches—from flat to 45°. A total of eight holes are provided in the flanges to bolt the mount to the roof. We used a Rohn hardware mounting kit that consists of eight 14-inch threaded rods, washers, nuts, and roof sealant. We also used a 30-inch TVRO accessory pipe from Rohn.

The results? Well, we haven't had any 70-mph winds—the maximum that the mount is rated to withstand. But we have had gale warnings and gusts of more than 40 mph. And nothing's moved yet! ■

As Easy as One, Two, Three, Four

ORBITRON SST-10 SATELLITE DISH. Manufactured by Orbitron, Industrial Center, Spring Green, WI 53588. Price: $450-$500.

Never having installed a satellite system, we were a little intimidated by the prospect of erecting a 10-foot dish. We had heard, however, that *Orbitron's SST-10* was so easy to set up that it could be done by one person in as little as a half hour. Well, we didn't come close to that speed—nor did we try. But putting the antenna together was one of the easier jobs we had to do!

One reason that the SST-10 is so easy to assemble is that it has only four "petals"—some dishes can have 16 or more. The more petals that have to be pieced together, the longer the assembly takes and the harder it becomes to keep the smooth parabolic curve required for good reception. The only disadvantage to the four-petal arrangement is that the 10-foot dish and mounting hardware cannot be shipped in a box small enough to meet UPS size limits. Actually, it arrived in two boxes. The first, weighing 60 pounds, contained the mount, a "spider ring," and mounting hardware. The second box, also about 60 pounds, contained the four mesh petals, the feed support, and the LNB weather cover.

The mount comes fully assembled except for the plate to which the stationary motor-end of the actuator is attached. The plate can be mounted in one of three positions—the proper one is determined by your longitude. Following the instructions, we installed it pointing straight back, although we weren't sure why. In fact, we didn't really understand the purpose of the adjustments until we had installed the actuator!

After the mount is assembled, the next step is to set it on the mounting pole, a 3-inch (3½-inch outside-diameter) schedule-40 pipe. Orbitron recommends using an 8-foot pole, set in concrete and projecting 4¾ feet above the ground. As you know we chose a roof mount instead. Three bolts hold the mount tightly to the mounting pole. But they shouldn't be tightened yet, so you can move the antenna to a convenient location as you assemble it.

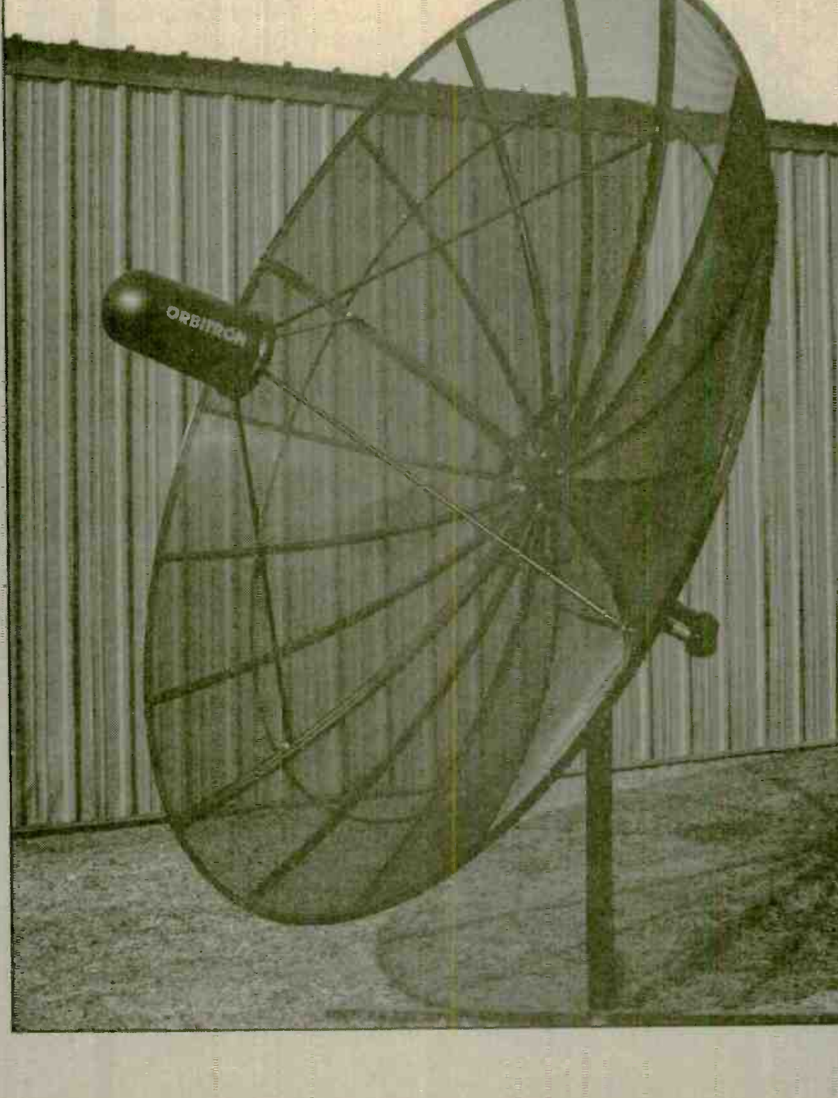
The spider-ring rear hub—the part to which the petals are attached—is then slipped into the mount, but it shouldn't be bolted into place yet either. Being able to rotate the rear hub is what makes the assembly of the SST-10 so easy—you can spin it around to that the section on which you're working is always within reach.

The first petal is hung from the center hub with a single bolt. Then the second petal is placed next to the first, and also held by a single bolt. (Although not suggested in the manual, we tightened the spinning hub while installing the second section because it made the job easier.) Then the two mating ribs of the first two sections are attached together by four bolts. One of the bolts also goes through the channels of the center hub.

Occasionally, it was difficult to get a bolt through the two ribs. As suggested in the manual, gently tapping the bolt using a block of wood and a hammer solved the problem.

Although the instruction manual suggested that for the third section it was not necessary to install all the bolt in the center hub, we found that not doing so made the job a little harder. It was easier and faster to

CIRCLE 51 ON FREE INFORMATION CARD

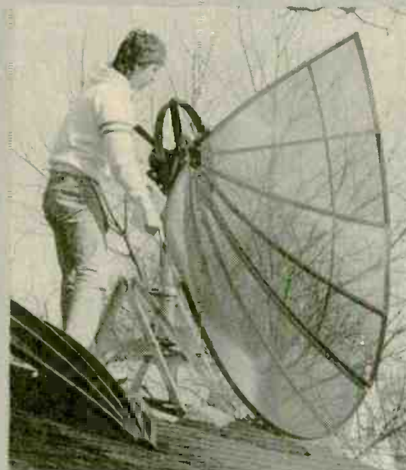


All of the parts, ready for assembly. Now that doesn't look too hard!

The mount, sitting on the support pole. The motor-end of the actuator will be attached to the plate pointing to the right. The moving end attaches to the arm that is pointing left.

The center "spider ring" hub slips into the polar tube, and can spin during assembly.

The first section is attached to the center hub with a single bolt.



The second section is attached to the center hub and to the first section.

hang the third petal as we had the others. The same was true of the fourth petal.

After the four petals are attached to each other and to the rear hub, the front plate is installed. The four bolts that were used to hang the petals from the hub are removed. (The petals are still held to the hub by the bolts that extend through the channels.) Then the center plate is bolted to the center with the four bolts that were previously removed. Four additional clips hold the center of each petal to the ring mount.

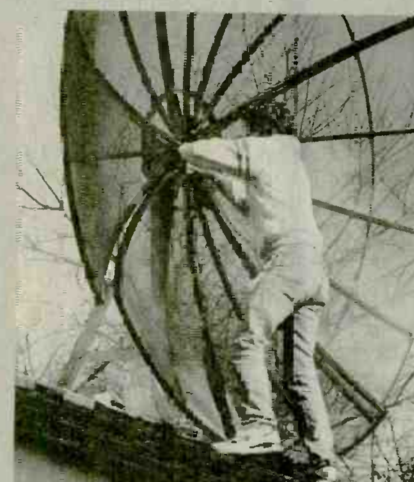
The dish is essentially complete at this stage, but it needs to be checked for parabolic accuracy. A set of crossing strings lets you do that. Being able to rotate the dish makes attaching them a simple job. Since we were on a roof, we were glad we didn't have to get on a ladder to reach the dish's high point! If the dish is out of parabolic shape, the strings won't lay right, and won't touch cleanly at the center. Our dish ended up a virtually perfect parabola on our first try!

The SST-10 is available with either a buttonhook or a quad (four-leg) feed support. Because the height of our roof-mounted antenna subjected it to greater wind stress, we chose the quad support for its better stability. The four legs are bolted to the face of the dish, and then the feed is attached to the free ends. The feed must be installed at the focal point of the dish (with the SST-10, that's 43.2 inches), and it must be parallel to the dish's central surface. We found all our measurements to be virtually right-on on the first try, and we needed to perform only slight adjustments.

With the feedhorn in place, it's time to bolt the dish to the mount so that it can no longer rotate. That's where Orbitron's "Spinclination" mount comes in. You just rotate the dish until a mark on the center hub aligns with the latitude scale on the mount, and then you're ready to tighten the bolts.

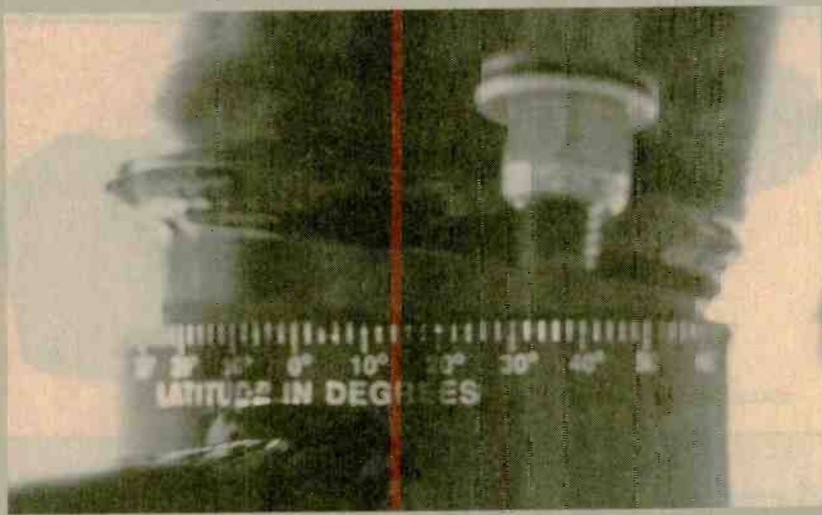
Declination is the degree of difference

This is the SST-10 with three petals attached, ready for the final section.



The fourth section is mounted in place. We found it easier to hang it in place before fastening it to its neighboring petals.

Here, the focal length is being checked for accuracy.



The Spinclination scale makes setting the dish's declination angle a breeze!

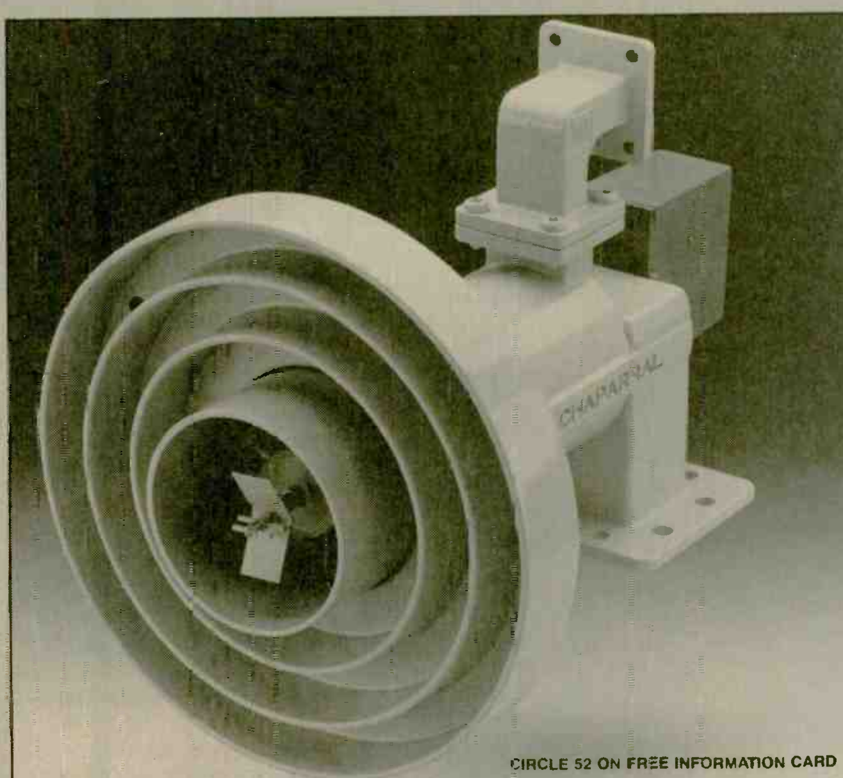
between the Clarke Belt and your location. As the mounting location moves north or south of the equator, the angle between the antenna and the Clarke Belt increases. Spinclination works because the base of the declination tube (the tube sticking out of the spider mount) is cut at a slight angle, and is also not perpendicular to the spider mount. When the declination tube is spun, the angle is changed. But it's not necessary to measure the angle because the tube is calibrated in degrees of latitude.

The actuator is installed next. The stationary (motor) end of the actuator is attached to the actuator mounting plate, which we installed earlier. The other (moving) end of the actuator is attached to an arm on the mount. It took us a little while to figure out how to mount everything correctly. Neither the instructions that came with the dish, nor the instructions that came with the actuator, gave us a very clear picture of what was supposed to happen. A little trial and error got everything working, though.

No, we didn't come close to the 30 minutes that Orbitron suggested. But we didn't expect to. Because we were complete novices, we double- and triple-checked each instruction, and proceeded deliberately. And we were slowed down considerably by the February weather—snow and ice made roof-top work too dangerous (and uncomfortable) for several days running! But we were surprised at how easy the assembly was, and would expect that, if we had to do it again (preferably in June), we could beat the 30-minute mark. ■

The Focal Point

CHAPARRAL COROTOR II PLUS FEEDHORN AND LNB. Manufactured by Chaparral Communications Inc., 2450 North First Street, San Jose, CA 95131. Prices: Feed, about \$150; LNB, about \$120 each.



CIRCLE 52 ON FREE INFORMATION CARD

The job of a satellite dish is to gather the weak signals from geosynchronous satellites and focus them at a single point. It's there, at the "focal point" of the dish, that the feedhorn and LNB's are mounted. The job of the feedhorn is to gather as much of the signals reflected by the dish as possible, while rejecting noise and off-axis signals.

The feedhorn that we chose for our installation was the Chaparral Corotor II Plus, a dual-band (C and Ku) unit. At the output of the feedhorn, we mounted a Chaparral 25 K C-band low-noise block downconverter (LNB) and a Norsat 1-dB Ku-band LNB. Chaparral is the unquestioned leader in the feedhorn industry. In the most recent dealer survey by *Satellite Retailer* magazine, Chaparral took the top three places in the feedhorn category. The company estimates that more than three quarters of the feedhorns in use in the U.S. are made by Chaparral.

The Corotor II Plus is a scalar feedhorn; its concentric scalar rings help to direct the microwave signals in its vicinity into the opening of the waveguide. The scalar feedhorn is efficient at gathering signals from the perimeter of the dish. (Most of the energy reflected by a dish comes from the inner three quarters of its area.)

If the feedhorn "sees" an area larger than the dish, the system is said to be "over-illuminated." The result would be a high level of environmental noise. If the feedhorn sees too little area, very little noise will be introduced, but the signals would be weaker, too—the effect would be the same as using a smaller dish. The ratio of a dish's focal length to its diameter (the f/D ratio) is what determines where a feedhorn must be located.

An adjustable scalar ring allows the Corotor II Plus to be fine tuned to properly illuminate dishes of all sizes. An f/D gauge is cast into the side of the waveguide, so setting the ring is a simple matter. Our 10-foot Orbitron dish has an f/D of 0.36, so we just set the ring to 0.36 and tightened the set screw. Using a spectrum analyzer from Avcom of Virginia, we later verified that the setting was optimum.

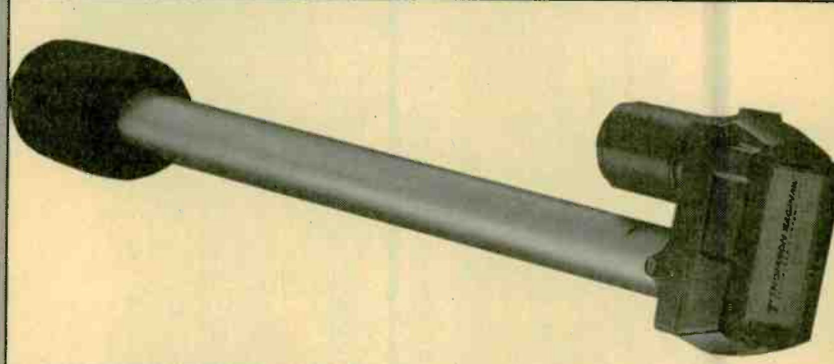
The installation of the feedhorn was aided by a small card that properly aligns the feed with the polar axis of the dish so that the real satellite antennas inside the throat of the feedhorn are properly aligned. The Corotor II Plus features a C-band probe and a Ku-band dipole. According to Chaparral, the dipole is virtually invisible to the C-band probe and does not degrade C-band performance.

The antenna probes in the feedhorn can rotate to receive horizontally and vertically polarized signals. The satellite receiver provides the proper signals to control the servo motor mounted in the feed. Since adjacent satellite channels are not adjacent—they're actually on the same frequency but have opposite polarity—when you flip from channel to channel, the servo motor rotates 90 degrees for proper alignment. We tend to flip a lot. That's why we felt good about Chaparral's long-life servo motor, which they claim will work in temperatures ranging from −40° to 140°F.

The feedhorn feeds the signals that it gathers to the LNB via waveguides. The signals that reach the LNB—even after being collected and focused by a large dish—are at incredibly low power levels. How low? On the order of a hundred thousandth of a billionth of a watt! The LNB, the first active component in the system, has to be able to amplify the signals by a factor of about 100,000. Because of the low signals involved, the amplifiers must add very little noise if it is to avoid drowning out the signals. The feedhorn delivers the amplified signals to standard F-type connectors.

The latest technology to improve LNB's is P-HEMT—pseudomorphic high-electron-mobility transistor. The result is a C-band noise temperature of 25 K, and a Ku-band noise figure of 1 dB (about 75 K). The lower the noise temperature—a measurement that describes how much noise an LNB adds to a satellite signal while it amplifies it—the better. Noise temperature is measured in kelvins (formerly degrees kelvin) for C-band LNB's. Ku-band LNB's are usually described by their noise figure, expressed in decibels.

We were impressed by the ease with which we were able to get the feed installed correctly—the first time. We had anticipated that the electronics hookup could present problems. Thanks to good design and excellent engineering, even we novices got it working—and working well—without a hitch! ■



CIRCLE 53 ON FREE INFORMATION CARD

Arming the Dish

PERFORMANCE PAK BALL-SCREW DISH ACTUATOR. Manufactured by Thomson Saginaw, P.O. Box 9550, Saginaw, MI 48608. Price: about $180.

A dish that can't move is like a fish out of water. An actuator arm is what gives a dish the ability to move and track the satellites in the Clarke Belt.

When we began our installation planning, we didn't give much thought to the actuator. A dish mover, we thought, was a dish mover. But then we began to consider just how much force could be required to move a ten-foot dish in the wind. And we thought about how the actuator is always exposed to the elements. Then we began to take the actuator a little more seriously.

Linear actuators—the kind that we installed on our dish—come in two "flavors:" acme and ball-screw. An acme actuator is basically a threaded rod and a nut. A motor turns the screw, and the nut, which is prevented from spinning, travels linearly in one direction or the other. Attach the nut to a tube, and attach the tube to a dish, and you can move the dish by turning the screw.

Anyone who has ever tightened a nut with considerable force knows first hand that an acme screw is not very efficient—friction causes the nut and bolt get hot when you tighten them. When an acme screw moves a heavy, wind-loaded dish, it has to work harder to overcome its inherent inefficiency.

Thomson Saginaw's Performance Pak actuators, which we chose for our installation, use ball screws instead. A ball-screw actuator solves the friction problem by replacing the nut threads with ball bearings. The screw has a helical grove which forms the inner race for the ball bearing. The nut (the outer race for the ball bearings) has an internal groove. Ball bearings recirculate in the grooves between the screw and nut. The result is very little friction—torque can be converted to thrust with an efficiency of over 90 percent. (That's why ball screws are used in such applications as moving airplane wing flaps, landing gears, and the like.)

One problem for satellite do-it-yourselfers is that installation manuals for most satellite-TV gear is written for dealers, not consumers. Since we had never installed a system before, we needed some things spelled out for us. The instruction sheet supplied with the actuator didn't do that.

We were able to dope out the mechanical installation without too much trouble just by examining how the dish could move in its mount. The electrical hookup proved to be a little more difficult. A dealer who installs a hundred systems each year probably doesn't even look at the instructions.

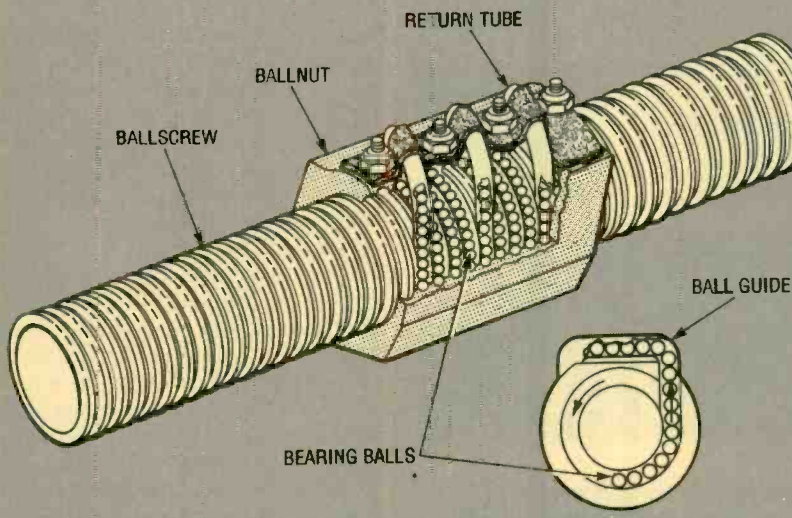
The Performance Pak actuator has a two-wire reed sensor that sends pulses to

FINDING THE HIDDEN SIGNALS

Along with the hundreds of video channels and the hundreds of audio subcarriers that you can pick up with a satellite system, there are hundreds more "hidden signals" that are transmitted by satellite. These SCPC or single-carrier

CIRCLE 54 ON FREE INFORMATION CARD

per channel services are used to distribute audio services across the nation. Everything from National Public Radio news feeds to music programming, from Radio Martie to the Los Angeles Dodgers Radio Network, can be found if you have the right equipment to aid in your search. Next month, we'll show how the SCPC-100 from Universal Electronics (4555 Groves Rd., Suite 13, Columbus, OH 43232) can open a new world of hidden signals to you. ■



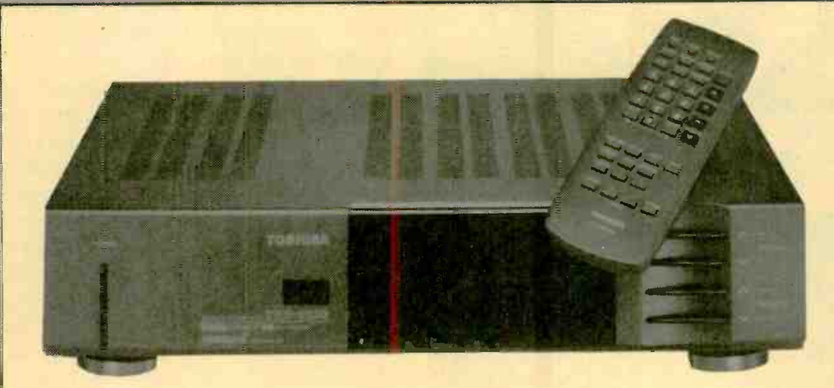
Ball bearings reduce the friction between nut and screw in the Performance Pak actuator.

the receiver which controls the dish movement. The receiver knows where the dish is by counting the pulses that are generated by the reed switch as it moves.

When we wired the actuator, our best guess of how it should be done—which we made after studying both the receiver and the actuator manuals—yielded disappointing results. When we told the receiver to move the dish, it would move slightly. But then the receiver would display an error message on the screen telling us that no return pulses were received from the actuator. *Next* time we'll know that the receiver's GROUND and PULSE terminals should be connected across the reed sensor. The receiver's +5V terminal is not used, nor is the third wire in the actuator cable.

Perhaps a ball screw is a bit of design overkill for the mundane task of moving a satellite dish. But the other features of the actuator are down to earth: The travel limits are adjustable, which can ensure that you don't damage the dish or arm by moving it too far. The reed switch produces 40 counts per inch of movement, which permits accurate dish positioning and thus maximum signal gain. The actuator's weather-protection boot and vented design ensure long life—and if anything goes wrong, the actuator is protected by a two-year warranty.

Maybe overdesign is sensible. After all, as much as we enjoyed our learn-by-doing satellite installation, we don't want to replace our actuator any time soon! ■



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Space-Age Receiver

TRX-2220 SATELLITE RECEIVER. Manufactured by Toshiba America Consumer Products, Inc., 1010 Johnson Drive, Buffalo Grove, IL 60089-6900. Price: $2295.

In the early days of home-satellite systems, a satellite receiver functioned primarily as a tuner, allowing the signals from the downconverter to be displayed on the TV. In the days before major manufacturers recognized a growing market for satellite gear, a receiver was likely to resemble a home-brewed electronic project, warranties were virtually unheard of, and quality was anything but standard. Dishes had to be aimed by hand, and if you wanted to change satellites you had to go outside to re-position the dish, while someone stayed by the TV to let you know when you'd found the right satellite.

Things have certainly changed since then! Today, a receiver is expected to act as command central for the entire satellite system. It contains built-in descrambling circuitry (hence the moniker IRD, for integrated receiver/descrambler), an actuator controller, an array of video and audio ports, an infrared or UHF remote control, an AB switch, and polarity controls. And those are just the basics. Most modern IRD's also offer C- and Ku-Band reception, on-screen graphics, favorite-channel programming, a terrestrial-interference filter, and a parental-lockout feature. Wait, we're still getting warmed up. Mid-range models are likely to offer both satellite and channel memory, a built-in modem for ordering pay-per-view movies and events, and stereo sound. Some top-of-the-line models even offer a VCR-type timer, picture-in-picture, MTS stereo, and Dolby surround-sound processing. And today's IRD's are no slouches in the looks department either!

The Toshiba TRX-2220 is a prime example of a state-of-the-art satellite receiver. A glance at its sleek, futuristic front panel doesn't begin to reveal its capabilities—that is, until you power it up and illuminate its "Image Magic" LCD readout.

The animated display keeps you in touch not just with your other TVRO components, but with the satellites up in the Clarke Belt. The left half of the 6 × 3-inch display contains graphics depicting a satellite dish, with the band of satellites, from east to west, in an arc above it. A solid line extends from the dish to the spot in the Clarke Belt at which it currently is aimed, and a flashing bar points to the location of the satellite you've just selected, providing visual tracking of the dish's movements. The satellite name and channel number are prominently displayed, along with smaller indications of the band (C or Ku) and polarity (horizontal or vertical). At the right side of the display, video- and audio-signal levels are depicted by bar graphs. Other indicators on the LCD let you know if you've activated the favorite-channel, timer, automatic frequency control, VCRS, auto, or mute functions, and whether you've chosen to view regular TV or satellite TV. All of that information appears in bright amber against a black background.

Other than the display, the front panel features only five buttons. Four black, oblong buttons are stacked to the right of the display, recessed into a concave indentation. Those are the up and down controls for selecting satellites and stations. The long, thin, red power button is placed vertically at the left side of the front panel. The combined effect of the animated display and the sparse control buttons give the TRX-2220 a striking, space-age appearance.

The rest of the IRD's functions are accessed via its remote control. The remote is UHF, rather than the standard IR, although the TRX-2220 can receive commands from either type of remote (allowing the use of a universal remote). A UHF remote was chosen for its long range. We were able to use it—albeit with some "iffy-ness"—at our dish (about 100 feet from the receiver) to control our actuator during the dish-aiming process. If you have more than one TV hooked up to your receiver, you can use the remote from other rooms of the house.

And you can hook up almost anything your heart desires to the TRX-2220. The back panel, with its wide array of inputs and outputs, immediately clues you in to the IRD's versatility. There are two satellite-antenna inputs, allowing connection to dual LNB-systems. Other outputs include RF, video, and S-Video. There's even a telephone jack on the rear panel!

All those connection options could potentially get pretty confusing. Luckily, the manual supplied by Toshiba clearly illustrates the various ways in which you can connect the TRX-2220 to the satellite-antenna system and to your TV, VCR, and VHF antenna.

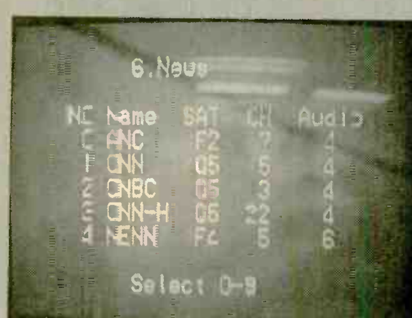
Making the connections is just the beginning of the set-up procedure, however. You have to spend a bit of time teaching the receiver all the tricks that will make your satellite viewing a breeze.

First, you must teach the TRX-2220 where each satellite is. The IRD can memorize up to 60 satellites (30 in each band); 41 have been partially preprogrammed by Toshiba and assigned two-digit alphanumeric codes. The code of each satellite designates its band, polarity, and audio/video frequencies, which have been factory programmed. It's up to you, however, to program the locations for those 41 birds.

Actually, once you have your dish aimed correctly, so that it's pointing in the general direction of the satellite closest to being directly south of your location and is at the proper elevation to view the Clarke

You can keep track of your dish's progress as it tracks the satellites, with the TRX-2220's animated display.

The Category screen lets you choose programming by type, making it easier to find the shows you want to see.



You can choose any of nine news channels by pressing the number corresponding to your choice.

If you're into pop-music videos, you'll want to program VH-1 into your favorite-program list.

Belt, the receiver does most of the work. After putting the IRD into channel-scan and auto-tuning modes, and selecting either the C- or Ku-band, you press and hold the EAST or WEST key on the remote to move the dish until a picture appears on your TV screen. Then you identify the satellite, using a programming guide as a reference, if necessary.

When you have identified the first satellite, you can either enter its 2-digit code or scroll through an on-screen listing of satellites until its name appears. Once you enter the name, the TRX-2220 automatically adjusts the skew and antenna position. The skew adjustment "fine tunes" the polarity setting for each transponder. The results of the automatic tuning are set into memory, so each time you return to that satellite you get the best possible picture. (That the picture truly is the best possible became obvious when we compared our local CBS station to two CBS satellite feeds that were showing the same program—the difference in reception and picture quality was amazing.)

That procedure must be repeated for every satellite that you wish to set into memory. Once you've made the first positive ID, it's easy to identify that satellite's "next-door neighbors" immediately to the east and west.

While ID'ing the satellites, you get your first glimpse of free satellite-TV programming. During our set-up, for instance, we saw the French-language version of *Jeopardy* (and we thought it was tough in English!), several subscription sports channels that we shouldn't have picked up for free, an ESPN sportscaster discussing his makeup as he prepared to uplink his report and asking "Do I look like Tom Selleck now?," a sale of hand-sewn Amish quilts, and an ostrich auction!

Once the process is complete, it's always easy to move from satellite to satellite and channel to channel. You can either press in the 2-digit code (first selecting the proper band) using the alphanumeric keypad on the remote, use the EAST and WEST keys on the remote, or use the front-panel satellite and channel buttons. When moving between satellites, an on-screen message will say "east move" or "west move," and you can watch the dish move on the animated display.

You could stop at that point and be able to watch TV to your heart's content. However, once the novelty of choosing from hundreds of stations has worn off, you'll probably decide it's time to bypass the ostrich auctions and quilt sales in favor of the programming that you really want to see. It isn't easy to keep track of all your viewing options—even before you start subscribing to "the good stuff."

Luckily, the TRX-2220 has a much better memory than we mere mortals. Pro-

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grammed into its memory are various categories of programming—movies, sports, variety, networks, pay-per-view, etc.—and the satellites and transponders on which they appear. A press of the CATEGORY key calls up a menu of program types. When you select a category, a submenu lists the station name and the satellite and channel on which it appears. By choosing any station from the list, the TRX-2220 automatically goes to the right satellite and transponder.

Another way to get around the immense satellite-TV dial more efficiently is to make use of the favorite-channel feature. If you find you like the home-repair and remodeling shows on channel 2 of F3 (Satcom F3), as you watch it you can use the on-screen programming to assign it a favorite-program number. To return to a favorite channel in the future, you press the FAVORITE button on the remote control. An on-screen message requests the favorite-program number; keying it in brings you right there automatically. As many as 20 favorite channels can be programmed. If you have trouble recalling the numbers you've assigned, pressing FAVORITE two times brings up a list of the program services.

Despite the wealth of programming available to TVRO owners at no charge, most dish owners end up subscribing to premium stations. We were no different, signing up for two movie services within a half hour of getting our IRD set up.

When it came to buying programming, our previous experience was limited to rather unpleasant dealings with our local cable company. In our area, if you are considering subscribing to cable TV, you can't simply call up and ask for price quotes over the phone. You can't even request that they mail you literature with price structures. Instead, you must set an appointment with a sales person, who comes into your home to do a hard sell of the benefits of various programming options—pressuring you to buy the $71-a-month super package. Then you have to make arrangements for the cable to be brought into your home. Within a week or two of the initial phone call, you might have the programming you want (and quite a bit that you could do without!). It's no wonder that we don't subscribe to cable.

Imagine our surprise, then, when we called three different toll-free numbers and received quotes over the phone from each program supplier. The operators were pleasant and helpful, but not pushy, even though they work on commission. If we hadn't been fighting a deadline for this issue (and if we weren't receiving those sports channels for free, for some reason that we're not about to question), we would have ordered more channels and spent more time comparison shopping. As it is, we subscribed to HBO and Cinemax for $17 a month—not a bad price. We weren't ready to make any long-term commitments 30-minutes after setting up our system, or we might have gone with the program supplier's winter special and received those two stations for a full year for $90—an incredible $7.50 a month! (Another important difference between cable and satellite is that when you subscribe to a satellite service, you can pick up all its feeds: We counted six for HBO and two for Cinemax, for a total of eight stations for your money.)

The ordering process is simple when your receiver contains a VideoCipher II Plus descrambler, as does the TRX-2220. An "Installation Data" screen provides all the necessary information. The program supplier asks for your unit's ID number, and the name and address to which the account will be billed. She then asks you to tune to a transponder on which the program will appear, and then stays on the phone for the minute or so that it takes for the station to be activated. We were watching a movie before we hung up the phone!

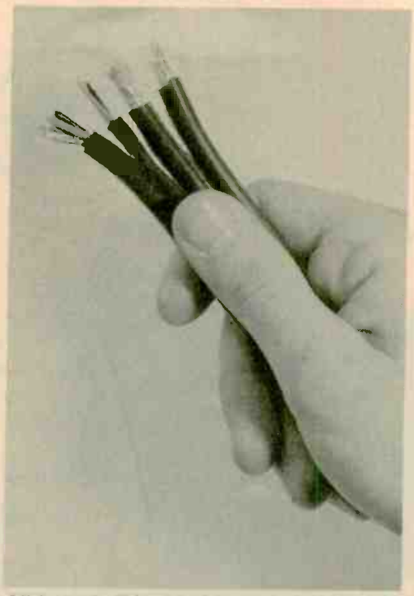
The TRX-2220 contains not only VCII descrambling, but also the yet-to-be-activated VCRS (VideoCipher Renewable Security) module. VCRS represents the next level of programming security—a backup system for that time when VCII is cracked by hackers. What happens when VCRS is cracked? The system will accept smart cards that change the encryption method. If you have a VCRS module, before the encryption changes, you'll be sent an updated TvPass card that you simply plug into your VCRS module.

As if hundreds of free stations and scores of available subscription stations weren't enough to keep you glued to the

OUT OF SIGHT, OUT OF MIND

Once you have your dish—complete with actuator, feedhorn, and LNB's—erected, and your integrated receiver/descrambler set up on a shelf in your entertainment center, you have to supply a means of communications between the two. The signals from both LNB's must be sent to the receiver, and the receiver must send control signals to the servo motor in the feedhorn. Depending on the distance between your dish and your receiver, that can require hundreds of feet of cable. You need two coaxial cables to carry the signals in from the C- and Ku-band feedhorns; three-conductor, 20-gauge stranded cable to link the IRD and the feedhorn motor; 14-gauge stranded cable to power the actuator; and three-conductor, 22-gauge stranded cable, plus a bare wire, for the actuator sensor.

In the old days, you had to run each of those cables separately. Today, however, it's easy to find all-in-one ribbon cable specially made for satellite-TV installations. We used the cable package offered in the Skyvision catalog, which includes the wires mentioned above, and a "cable-fitting" pack of connectors. (The catalog is free to readers of **Popular Electronics**. Contact Skyvision Inc., 1010 North Frontier Drive, Fergus Falls, MN 56537; 800-543-3925.) The cable package is available in lengths ranging from 100 to 350 feet (although a line amplifier might be required with the longer lengths). Our 175-foot package costs $104 plus $27 shipping and handling.



All-in-one ribbon cable contains the two strands of coax needed to bring the C- and Ku-band signals to the receiver, and two wires to bring control signals out to the actuator and feedhorn.

Unless your dish is mounted on the roof of your house and the cable runs directly down through the roof to your living room, all of those cables are going to be subject to the rigors of outdoor use. The ribbon cable we used is intended for direct burial—and once the ground thaws (another problem we encountered doing our installation in February!), we intend to dig a trench from the garage to the house for that purpose. For now, it's inside some PVC piping. Although the ribbon cable appears to be quite durable, we plan to play it safe and bury it in the PVC pipe for added protection against gnawing rodents or mishaps with a shovel.

tube around the clock, you can also order pay-per-view (PPV) movies and events. The TRX-2220 contains a MOM, or modem on-board module, that automates most of the process. Called VIDEOpal, the system uses standard telephone lines and is connected with a standard phone jack. The manual provides a toll-free number of a PPV program provider. The activation procedure is virtually the same as for ordering subscription services, right down to the friendly operator, although it takes a bit longer for the authorization to be processed. Generally, in less than 15 minutes line six on the screen will read "VIDEOpal enabled" and you can begin ordering pay-per-view features. There's a $20 initial authorization fee, a charge for each movie, and a $1.50 service charge every month that you use PPV. Movies cost $2.99 or $3.99 each, while sporting events might cost $25.

After the initial installation, you rarely, if ever, have to talk to another program supplier—all communication is done through the VIDEOpal module, which communicates with the supplier by modem (using a toll-free number) and with you via an series of on-screen menus. For instance, it will ask you to select a purchase password, so that your kids (or their babysitters) don't run up big tabs behind your back. Dubbed the "order recorder," it also lets you know the title, cost, and start time of next available program; takes your order; "delivers" that order to the program supplier; keeps tabs and reports on your credit status; and keeps you informed of the financial end of things. You can even call up an on-screen list of the 16 most recent programs ordered. VIDEOpal won't interfere with answering machines or services like call forwarding and call waiting; however, if you have a party line (we thought those went out with tube radios!), or if you can't make long-distance calls without an operator's assistance or dial out through a PBX, VIDEOpal won't work.

It's possible to videotape PPV movies to watch at a later time, although you do have to be home an hour or so before the movie starts so that you can order it. For recording other satellite-TV programs, you can set the TRX-2220's 8-event/one-year timer to turn the unit on and tune in the right satellite and station at the same time that you've set your VCR to record. And if you have a Super-VHS VCR, the movies you record from satellite will be of noticeably better quality than any you can rent at your local video store.

If your older kids have your permission to order PPV movies, and you've given them your password, you can still place some restrictions on what they are able to see. A separate Ratings Password can be

(Continued on page 24)

CIRCLE 56 ON FREE INFORMATION CARD

Faster than Lightning

TOWERMAX SAT TVRO LIGHTNING AND SURGE PROTECTOR. Manufactured by Panamax, 150 Mitchell Blvd., San Rafael, CA 94903-2057. Price: Towermax Sat and SCL/8, $269; CT module, $89.

Imagine for a minute that you've followed all the information we've supplied here in **Gizmo** to purchase and install your own satellite-TV system. You've done a site survey, mounted the dish in the best possible location, aligned it to clearly "see" the satellites, hooked up the actuator and LNB, run cables to the house, and made all the connections to your IRD. Now you're completely ready to plug it in and start scanning the skies for programming, right?

Wrong. There's one important element that's missing.

Common sense tells you that if you've raised a metal dish (or an aluminum dish on a metal pole) so that it's standing free from or placed above any obstructions, you're tempting fate if you don't protect that dish—and the thousands of dollars of equipment connected to it—against the possibility of lightning strikes. It takes lightning only about 1000 nanoseconds (billionths of a second) to reach damage-causing levels. According to the Institute of Electrical and Electronics Engineers (IEEE) estimates, a lightning surge, measured at an interior wall outlet, could be as great as 500 amps at 6000 volts.

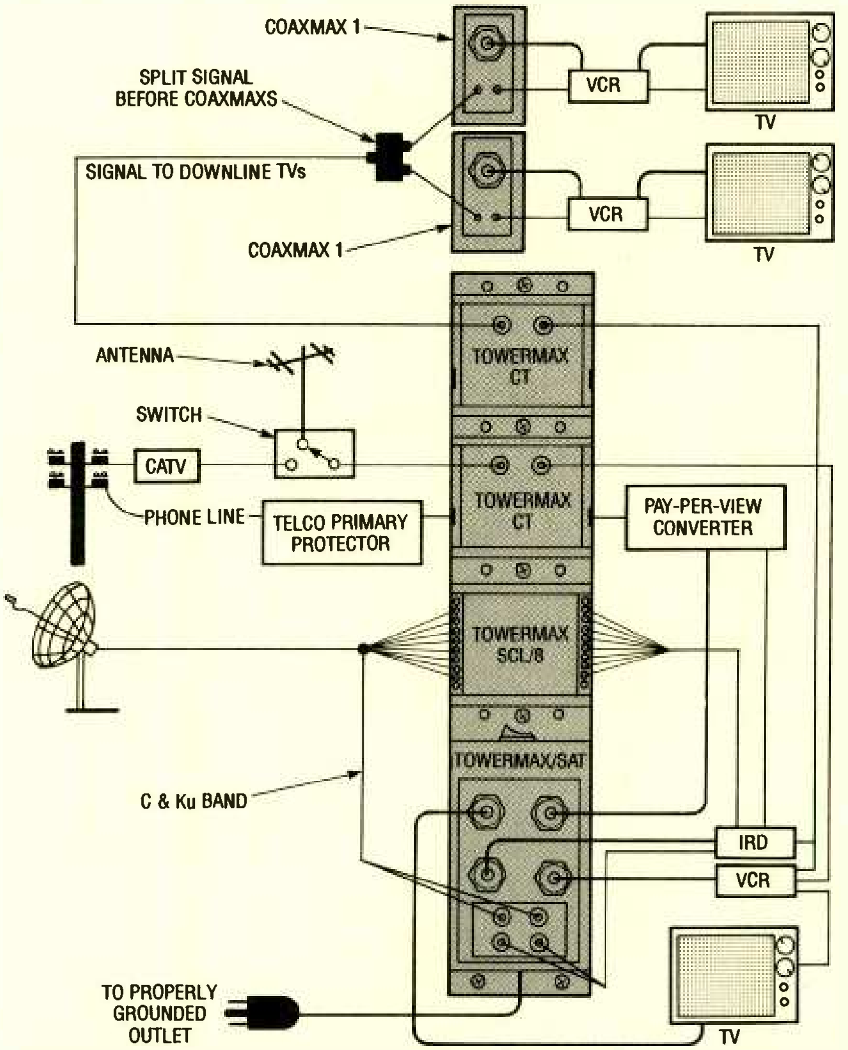
It doesn't take anything near such a catastrophic surge to upset or destroy the delicate electronic components in a satellite-TV system. The spikes and surges that occur frequently on the AC power lines can, at the very least, cause an IRD to lose some of its memory settings, and a near-by lightning strike can burn out components.

While a direct hit might not be too likely in the Northeast, the Plains states are known for severe lightning storms. And a direct hit can do a lot more than just damage your TVRO system—it could destroy your home.

Wherever you live, there are some basic precautions that you can take to reduce the risk of damage from power surges and voltage fluctuations. A lightning rod, or ground rod, can be erected. Your entire TVRO system should be joined together to one common ground. (Proper grounding—an eight-foot rod driven into the earth—also minimizes a form of interference known as "hum bars.") A surge protector, which will instantly transfer large voltage spikes to ground, bypassing your equipment, should also be installed.

Due to the nature of **Gizmo**, it's highly unlikely that the satellite-TV system we describe in this issue will keep the same configuration for very long. We wanted to be sure that, as we find new TVRO components to hook up and review, our surge-protection system could keep up with the changes. That's why we went with *Panamax's Towermax Sat*, a modular system that can grow with our TVRO setup. Your satellite-TV set-up might not change as often as ours will, but there's a good chance that you'll want to connect additional television sets, add pay-per-view capabilities, or hook up an SCPC receiver sometime in the future.

The basic Towermax Sat system consists of two parts. The Towermax AC signal-line base unit protects a satellite system against power disturbances ori-



The Towermax Sat system grows with your TVRO installation. Modules can be added to protect each new piece of equipment.

ginating in the AC power lines as well as in the C- or Ku-Band video lines. The Towermax Sat also includes noise-filtration circuitry said to remove up to 99.7% of EMI/RFI noise. The attached SCL/8 module defends against lightning or other externally created power problems that can occur on the control lines. Together, the two pieces provide effective lightning and other surge protection on all current-carrying pathways.

The system provides true ground-reference equalization—the base unit and all modules are connected to a single ground. That eliminates the chances for power problems to get through on any current-carrying pathway. Each new module added to the system will automatically connect to that ground.

As your TVRO system grows, it's easy to upgrade the Panamax system by adding other modules. The Towermax CT module is the one to choose if you plan to add pay-per-view or FM-stereo capabilities to your system. The module screws right on to the main module to provide protection for a telephone line and any additional video-signal line—for cable TV, FM reception, standard TV, or any other coaxial-based signal. An autoground strap ensures that your system still has complete ground-reference equalization by automatically tying the grounds together when you install it. You can keep adding CT modules as you add additional incoming lines. See Fig. 1 for a look at one possible system configuration.

Panamax offers a generous warranty: If the Towermax Sat or any connected module ever fails—even due to a direct lightning strike—the company will repair or replace the unit. And if any satellite equipment that has been properly connected to the Towermax Sat should sustain surge damage, Panamax will pay to repair or replace that equipment as well.

To avoid accruing such expenses, Panamax built multilayer protection into each module. Metal-oxide varistors (MOV's), choke coils, capacitors, and then more MOV's are used to completely dissipate spikes and surges. The first group of three MOV's covers the hot, neutral, and ground wires. After the MOV's clamp the voltage to a safe level, two large choke coils slow the surge. Three more MOV's serve to clean up anything that makes it through the first two protective stages. Finally, the capacitors and the choke coils work together to remove EMI/RFI noise.

The MOV's used in the Towermax Sat begin working in less than one nanosecond—a thousand times faster than lightning. And each MOV is able to withstand more than a thousand 500-amp/6000-volt surges. In the event of a catastrophic (more than 5000 amp) surge, a high-speed fuse automatically disconnects the power to your satellite system.

We had horrible weather during our installation—two snow storms severely hampered our progress. But if there's one good thing you can say about New York in February, it's that you're not likely to be struck by lightning. Although we didn't get to put the Towermax Sat to the ultimate test, we felt secure knowing that our equipment is protected against possible damage from electrical spikes and surges. ■

SPACE-AGE RECEIVER

(Continued from page 23)

set up so that no one can order a movie rated higher than PG (or whatever rating you chose) without knowing the password.

Two other parental-control features are supplied by the TRX-2220. Antenna lockout can be used to restrict the viewing of all the programming from a satellite, while channel lockout is used to restrict specific, individual stations.

Once you have fully loaded the TRX-2220 with your personal instructions and customized all its optional features, it couldn't be easier to use. Gather up some junk food and get ready for some marathon viewing sessions—there's plenty to keep you occupied for weeks on end, with no further effort on your part. It's a couch potato's dream! About the only thing that we found lacking was audio—we'd like to have seen surround-sound built in. Of course, you can always hook up an A/V amplifier with Dolby Pro Logic.

Our hats are off to those hardy pioneers of home satellite TV. They perceived its potential before the manufacturers and programmers did. They created a demand for products, and that demand spurred the growth of a whole new industry. And that industry has made it easy for even the most dedicated couch potato to enjoy the full benefits of satellite TV—leaving units like the TRX-2220 to efficiently handle all the dirty work! ■

A Hands-on Electronics REPORT

WAVETEK LP50 LOGIC PROBE

CIRCLE 119 ON FREE INFORMATION CARD

If you're in the market for a logic probe, then here's one worth taking a look at.

Technicians around the world will agree, that buying good test equipment is addictive. Anyone who regularly tinkers with electronics will find that they can never have enough test equipment. Even if a particular tool is found to be useful for only one or two tasks, the tool soon becomes irreplaceable for doing just those few tasks.

When a technician has his bench set up just so, and his test leads arranged just so, repetitive test procedures become a breeze. Removing just one of his tools will "gum up the mechanism," and increase the time it takes to thoroughly test something. Since removing test equipment tends to increase troubleshooting time, it makes sense that adding new pieces would shorten troubleshooting time. And that's something everyone can appreciate.

Usually the desire for test equipment starts with a simple general-purpose multimeter, and eventually works its way up to oscilloscopes and logic analyzers. But between purchasing a basic multimeter and an advanced oscilloscope or analyzer, there are typically many other pieces of equipment picked up along the way.

Take, for example, a basic logic probe. Although to some it may be an insignificant tool, a logic probe is actually very handy, even if you already have the function built into your multimeter. That's because it can get very tiresome when you have to keep switching your meter between, say, voltage, resistance, and logic. Also, if you really need to check for logic pulses, then the multimeter's probe function may not be fast enough to properly do the job—many multimeters have a very "slow" logic probe built into them. The logic probes on many multimeters are minimal and often seem included so that the feature can be advertised.

The LP50. When you *need* a logic probe, you need a fast one like the Wavetek LP50 TTL logic probe. It can detect TTL-logic pulses as brief as 10 nanoseconds at repetition rates as high as 50 megahertz. Now that's a logic probe!

The LP50 is a TTL (Transistor-Transistor-Logic) logic probe, meaning that it is only useful for TTL-level signals. The LP50 will assume that anything over 2.3 ±0.2 volts DC is a valid TTL high, and that anything under 0.8 ±0.2 volts DC is a valid TTL low. In the TTL world, those are the only two valid levels, which gives us reliable logic 1's and 0's to run our digital circuits.

Even though the LP50 can measure only TTL levels, it can be powered from any voltage between 4 and 18 volts DC. It draws only 30 milliamps from a 5-volt supply and 80 milliamps from a 15-volt supply. That way the LP50 can be powered directly off the board you're testing without significantly loading down the power supply. The LP50 is power-supply protected at ±20 volts AC or DC for up to 15 seconds. Let's take a closer look at the LP50 and how it's used.

Specifics. The LP50 is easy to hold and use. It measures about 8 inches long and it's about the thickness of a cigar. It's also lightweight, weighing in at only about 1.2 ounces (actually less than a fat cigar).

A sharp metal probe tip makes it easy to test an IC pin without slipping and possibly shorting out something. Two power leads are all that have to be connected to the circuit under test. The ground lead has a mini alligator clip for easy attachment to any grounded portion of the circuit or chassis. The positive lead has a mini-hook on the end so you can get power off an IC pin—even the power pin on the IC that you're testing—in case there's no other easily accessible source. In addition, the LP50's input impedance is 120 kilohms, which won't load down and alter the signal being measured.

Two arrow-shaped LED's (a red one pointing up and a green one pointing down) are used to indicate what logic level the probe is reading. You'd think that only two LED's couldn't provide that much information, but that's not true; two LED's can actually tell you quite a bit about a TTL signal. Naturally, when the red "high" LED is fully lit, the probe is detecting a steady TTL high, and when the green "low" LED is fully lit, the probe is detecting a steady TTL low.

When neither LED lights, there is either an invalid TTL voltage or open circuit present. When the LED's light alternately, the probe is receiving a low-frequency a squarewave. If both LED's appear to be dimly lit, you are measuring a faster squarewave. If the low LED is dimly lit and the high LED is off, the probe is detecting a narrow positive pulse. If the high LED is dimly lit and the low LED is off, the probe is detecting a narrow low-going pulse. (That's a lot of information provided by just two LED's.)

A few words on the instruction manual: we wish there was one. The LP50 comes in a bubble-type package, with a cardboard back. All of the instructions are on the back of the pack summed up in just a few poorly worded sentences, some of which don't make any sense. As an example, a small chart shows a half-filled circle, and the symbol key provided there says that that means the "LED may or may not be on." What it actually means is that the LED is flashing, but at such a fast rate that it will appear to be dim. Frankly though, you don't really need detailed instructions for something as simple and straightforward as a logic probe.

A logic probe is a valuable addition to anyone's tool box. With a list price of $45, and a 1-year warranty, there's no reason not to consider the LP50. It is well-made, easy-to-use, and affordable.

For more information on the LP50, contact Wavetek's Instruments Division (3883 Ruffin Road, San Diego, CA 92123-1898; Tel. 619-495-3200) directly, or circle No. 119 on the Free Information Card, which can be found elsewhere in this magazine. ■

PRODUCT TEST REPORTS

By Len Feldman

Yamaha CDC-735 5-Disc CD Changer

Yamaha (6600 Orangethorpe Ave., Buena Park, CA 90620) offers a pair of 5-disc CD changers that incorporate many electrical and convenience features not found in other multiple-disc CD players. This month, we will look at the model CDC-735, which is the less expensive unit of the pair.

For starters, the unit offers

The Yamaha CDC-735 5-disc CD changer.

"PlayXchange," a proprietary Yamaha feature that isolates the disc being played from the changer drawer to eliminate vibration. That feature also permits up to four of the five discs in the rotary carousel tray to be removed and replaced while the fifth disc is playing.

The player uses a single-bit digital-to-analog conversion system, called S-Bit Plus by Yamaha. The core of that single-bit processing is an independent pulse-density modulation (I-PDM) D/A converter that is said to reproduce pulse waveforms more precisely than previously available converters. According to Yamaha's engineers, this approach is supposed to improve low-level linearity, low-level signal purity, and high-frequency response clarity.

Other performance features include variable and remote-controllable output and headphone levels, and a coaxial digital output (in addition to the usual analog line-level outputs). Yamaha has also incorporated several new convenience features in the CDC-735. A new table of contents (TOC) stores track information for all discs loaded into the 5-disc tray. This provides faster access as programming and play decisions are activated. A tape-edit feature also functions with all five discs so that a favorite-hits tape can be assembled easily.

Other features of the CDC-735 include a 100-disc program file, disc skip, 2-mode random play, 4-mode repeat play, direct track access, 5-disc direct access, music search/skip search, 4-mode time display, 3-mode display illumination, and a front-panel headphone jack. The CDC-735 is supplied with a 32-key remote control and is compatible with other Yamaha RS-system remote components.

CONTROLS

Controls on the front panel include the power switch; open/close button; output-level control; disc-selection buttons; play, pause, and stop buttons; the disc-skip button; the "PlayXchange" button; the required numeric buttons; as well as other buttons used in programming. Random play, search, track-skip, and repeat buttons, as well as the time-mode buttons are also found on the front panel. The display area is located to the left of the numeric buttons and the disc tray occupies much of the upper half of the front panel.

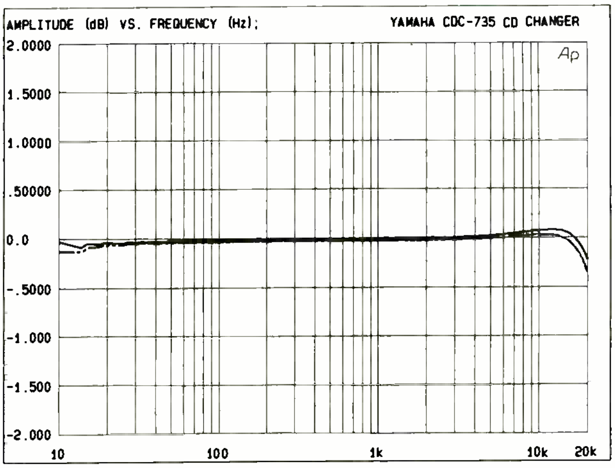
The supplied remote control duplicates all of the front-panel controls except the power on/off switch and adds a dimmer button (for lowering the display intensity) and an "index" button for starting play at a selected index point (for those CD's whose tracks are sub-divided into index points).

However, the index button does not permit you to move from one index point to the next. In other words, you can choose to begin play from index number 2 of track 3 but, having made that selection, you cannot advance to index point 3 of the same track, using the index button. In that respect, the index access feature differs from those we have encountered on other CD players.

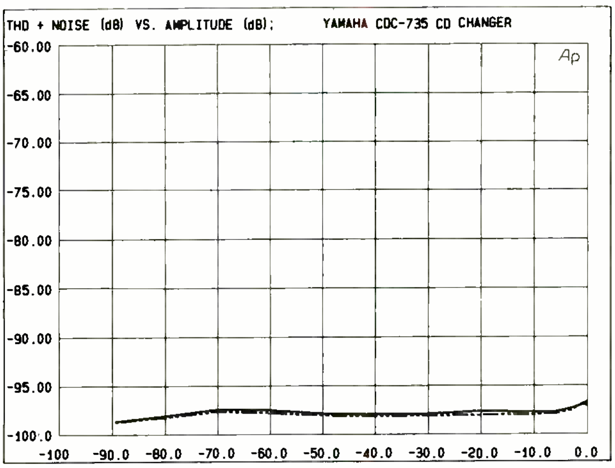
The rear panel of the CDC-735 is equipped with a coaxial digital-output jack and the usual analog line-output jacks.

LAB TESTS

The published frequency-response specification of



As shown in this plot, the published frequency-response specification of ±0.3 dB was easily met. In fact, deviation never exceeded 0.1 dB.



This plot shows how THD-plus-noise varied with signal amplitude. Note that the overall low THD-plus-noise level is maintained even at high (0-dB) signal levels.

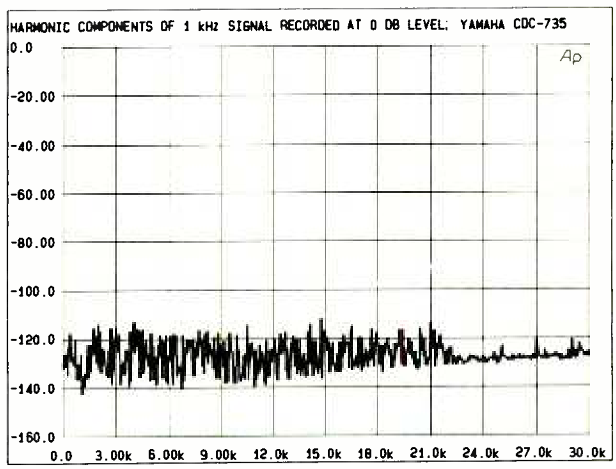
±0.3 dB to 20 kHz was easily met. In fact, deviation from perfectly flat response never exceeded 0.1 dB! Output levels from left and right channels were almost identical in amplitude.

When we plotted harmonic-distortion-plus-noise versus frequency for signals at the maximum recorded level, we found that our sample unit actually exceeded the published specification of 0.0018%, with a reading of a barely measurable 0.0015% at 1 kHz. What's more, we were impressed by the fact that THD-plus-noise did not rise significantly at the higher treble frequencies, as is the case with many CD players we have tested.

We next looked at how THD-plus-noise varied with signal amplitude. We found that both channels exhibited virtually the same THD-plus-noise figures. Readings across almost the entire level-range from maximum to −90 dB hovered around −98.0 dB below maximum recorded level. That corresponds to a percentage of 0.00125%, yielding close correlation with our earlier findings. That level of THD-plus-noise was almost maintained even at the 0-dB recording level, indicating that the output analog stages were not reaching overload levels and are properly designed to handle the amplitudes involved.

Next, we used the FFT spectrum-analysis capability of our Audio Precision test equipment to attempt to separate the actual distortion components from the residual noise. We found that whatever actual harmonic components there may have been, they were "buried" in the noise floor, which never exceeded −115 dB at any frequency! Those results are fully as good as anything we have ever measured, even including single-disc CD players.

signal-to-noise ratio for the CDC-735 measured −114.73 dB for the left channel and −113.73 dB for the right channel. An unweighted spectrum analysis of residual noise while playing the "no signal" track of our CBS CD-1 test disc, using a ⅓-octave band-pass filter showed peaks in noise at 60 Hz, 120 Hz and, to a lesser degree, at 180 Hz; those were generally caused by the line frequency of the power supply. The worst of those, however, was a full −128 dB below the maximum recorded level, and therefore inaudible at any listening level.



Using a spectrum analyzer to separate the actual harmonic-distortion components from the residual noise, we found that if any distortion components existed, they were "buried" in the noise floor.

Channel separation measured between 102 and 104 dB, depending upon which channel was measured. However, separation decreased substantially at higher frequencies, measuring only about 63 dB at 16 kHz. Of course, 63 dB of separation is more than adequate at high frequencies, but from a purely academic point of view, we wondered why such a decrease in separation should have occurred in this CD player.

The overall A-weighted

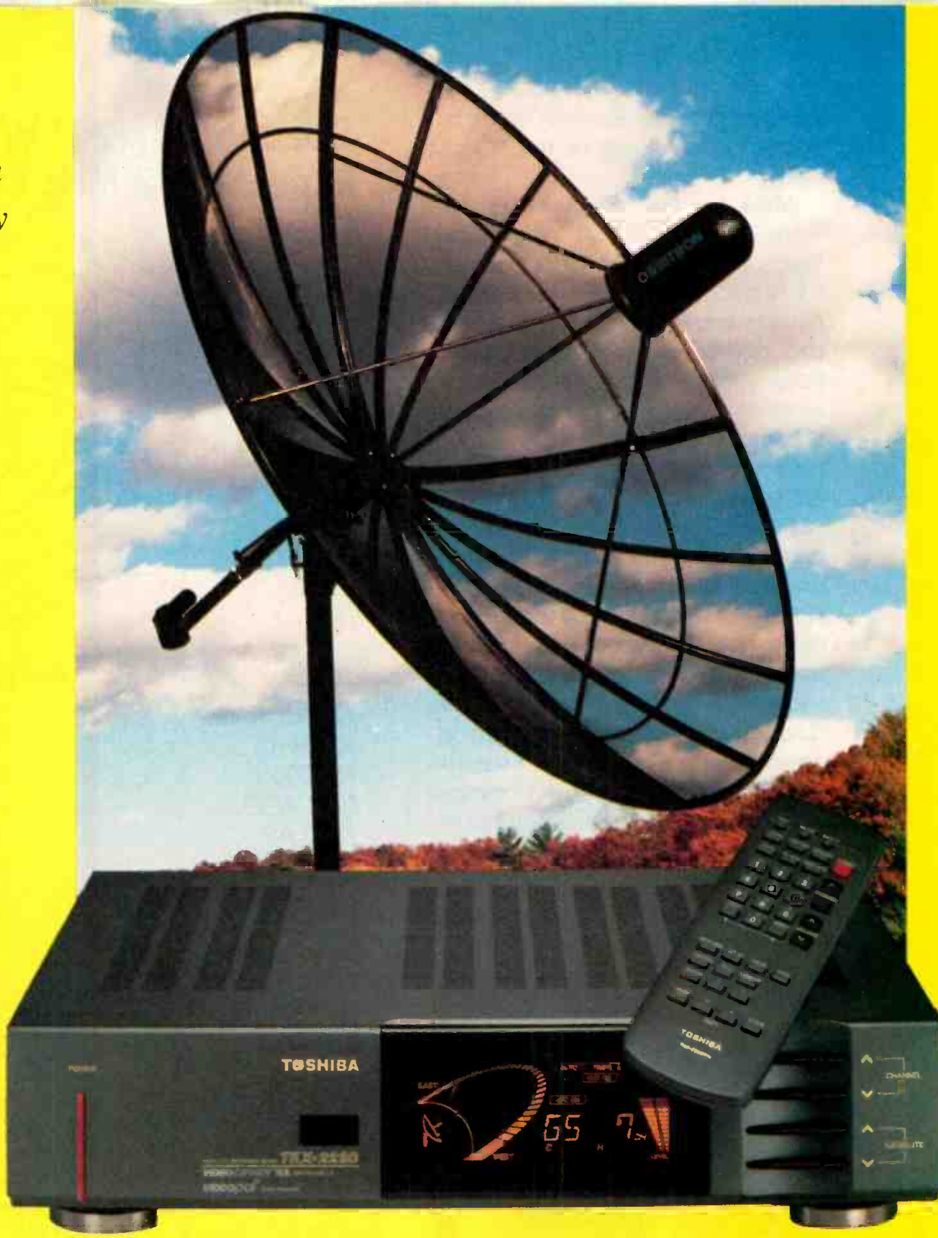
Linearity was about as excellent as we have ever measured for any CD player, whether it be a single-disc unit or a multiple-disc changer such as this one. Deviation from perfect linearity, using undithered signals, was less than +1 dB at −90-dB below the maximum recorded level.

Additional low-level linearity measurements were made using dithered signals. In that instance, we noted even less deviation over the range from −70

(Continued on page 80)

Learn the true story behind satellite TV, and how you can enjoy the unparalleled quality and quantity that it offers

BY TERI SCADUTO and BRIAN C. FENTON



200 CHANNELS TO CHOOSE FROM

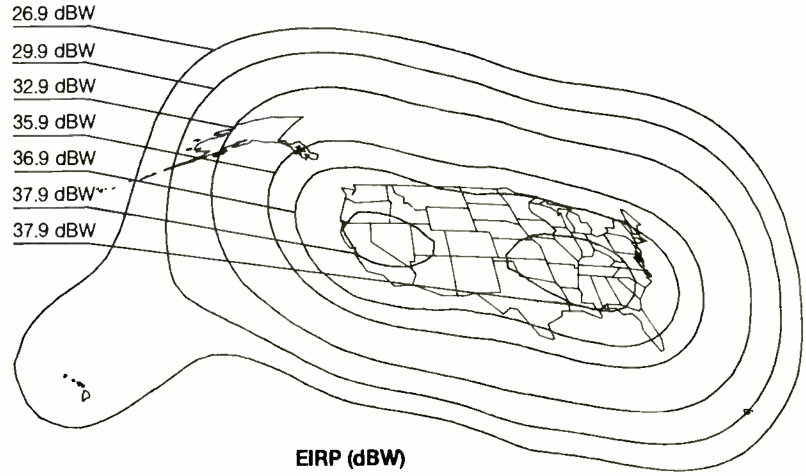
Think "sci-fi" and "outer space," and what comes immediately to mind is expanding human horizons and enriching our lives by exploring distant planets and establishing communications with extraterrestrial beings. Think "reality" and "outer space," and not all that much has been going on in terms of manned exploration in the last 25 years—not even Michael Jackson is "moon-walking" these days.

That's not to say that nothing is going on up there. In fact, a concept first postulated almost 50 years ago by sci-fi writer Arthur C. Clarke and put into effect in the early 1960's has enriched our lives by establishing a communications network not with aliens, but with other humans around the world—in effect, shrinking our horizons. Clarke proposed a communications system based on a series of satellites in geosynchronous orbit with the earth, at approximately 22,300 miles up. Simply put, because the satellites would orbit at precisely the same angular speed as the earth's surface, they would appear to be not moving at all. Transmissions beamed up from earth could be relayed to another place via those geostationary satellites.

Back in the 1940's, the scientific community scoffed at Clarke's idea. No one laughed at the USSR's 1958 launch of Sputnik, however, or at America's successful launch and placement into orbit of the Explorer I the following year. In 1962, AT&T launched and orbited Echo I, the first active communications satellite. In 1963, Syncom 1, the first geostationary satellite, was launched, proving Clarke's theory. By the end of the decade, a series of Intelsat III satellites were orbiting over the Atlantic, Pacific, and Indian Oceans, providing worldwide satellite communications. Today, more than 100 communications satellites are orbiting earth in what has come to be known as the "Clarke Belt."

While the first television satellites were placed in orbit in the early 1960's, it wasn't until the '70's that satellite TV became a burgeoning industry, as domestic satellites were launched. Live and taped programming was transmitted by the networks and for reception by cable companies. The relayed programming was not originally intended to be transmitted directly to individual homes, but in 1976, Bob Cooper Jr. built and installed the first working home satellite-TV system, and wrote articles in *Radio-Electronics* magazine that described precisely how everyone could do the same. The idea caught on, and six years later, thanks in great part to Cooper's efforts, the FCC granted approval to home reception of satellite signals. By the end of this year, more than four-million homeowners are expected to have TVRO (TV receive only) systems.

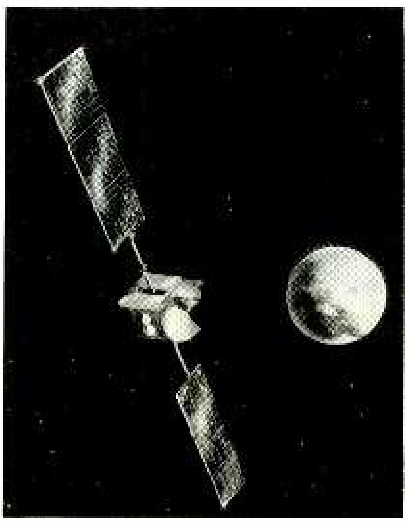
Spacenet I (122° WL)
Expected 72 MHz C-Band EIRP Performance



	EIRP (dBW)
ANCHORAGE	33.8
ATLANTA	38.1
BOSTON	36.9
CHICAGO	37.7
DALLAS	37.9
HONOLULU	27.9
HOUSTON	37.5
LOS ANGELES	37.7
NEW YORK	37.2
ORLANDO	37.3
SAN FRANCISCO	37.9
SEATTLE	37.5

For more information call: 703-790-7700
GTE Spacenet Corporation,
1700 Old Meadow Road,
McLean, VA 22102

This data sheet from a GTE Spacenet satellite launched in 1985 shows the satellite's "footprint." EIRP is the satellite's effective isotropic radiated power, which is measured in dBw, or decibles referenced to 1 watt. The actual power levels seen on the earth's surface ore on the order of a fraction of one billionth of a billionth of a watt per square meter! Designed with a life expectancy of 10 years, Spacenet I is still active. Its location has changed, however, to 120° W.



This RCA Satcom model is just one of the kinds of satellites in the Clarke Belt. Models from other companies (Hughes, GTE Spacenet, and others) have different looks.

In this article, we will take a look at the technology behind satellite TV and what advantages a home satellite-TV system offers the viewer. We will also explain the new technologies—anti-piracy signal encryption and digital video compression—that have brought the satellite industry to a crossroads. If you find yourself intrigued by the idea of satellite TV, and are itching to set up your own TVRO system, turn to this month's *Gizmo* section. There, you'll find step-by-step directions for a dish installation and system hookup, along with reviews of some state-of-the-art satellite gear.

How it Works. Three separate systems are needed to get the picture to your TV. First, the original signal is transmitted to the satellite ("uplinked"); then it is relayed back to earth ("downlinked"); and, finally, it is picked up by your home TVRO system. Actually, even if you don't have a TVRO system, much of your TV programming comes to you via satellite: Cable and broadcast networks use satellites to relay programming around the country. The difference is that with a home satellite system, you can pick up that programming—more than 200 channels of video, and hundreds more of audio—directly, without the picture degradation and noise inherent in the re-transmission of signals from cable companies or networks.

The Earth Station. The programming is produced in the same manner as any television show; it can be live or videotaped, or a combination of the two. The program is sent via land-based facilities to the uplink facility, or earth station. The uplinker is equipped typically with a 30-foot-diameter dish that beams the programming up to a satellite. Most news organizations also use transportable satellite newsgathering earth stations to beam stories from remote areas. Some programmers—CNN and PBS, for instance—maintain their own earth stations, while smaller, independent programmers pay an uplinking fee to

It's hard for many satellite enthusiasts to hide their love of satellite TV. Although small dishes can be used in the central U.S., those of us on the coasts will need 8- or 10-foot dishes.

a common carrier. Signals are beamed up to the satellites in the 5.9–6.4-GHz band.

Birds in Space. Satellites are basically space-based microwave relay stations. Because they orbit in tandem with the earth, no expensive tracking antennas are required at the earth stations. To make up for slight orbital variations due to the earth's gravitational field, the "birds" are equipped with small rocket motors that are controlled by command signals sent from earth to keep the satellite in its precise geostationary position. Each satellite is equipped with a receiving antenna and up to 24 transponders, or transmitting antennas. Signals received from earth stations are amplified and filtered, converted to a specific transponder frequency, reamplified, and then downlinked to earth. U.S. satellites are usually aimed at the central states. Some satellites have "spot beams" that are aimed at the coasts.

The Clarke Belt is a limited resource—there are a finite number of orbital "slots" that can be used because of the threat of interference between adjacent satellites. Satellites are now spaced two degrees apart. Closer spacing would require dish antennas with more precise focusing ability, which comes only with increased size. To further avoid interference, adjacent satellites polarize their signals differently. Satellite B might have all even-numbered transponders horizontally polarized, while the adjacent satellites A and C have vertically polarized even-number transponders.

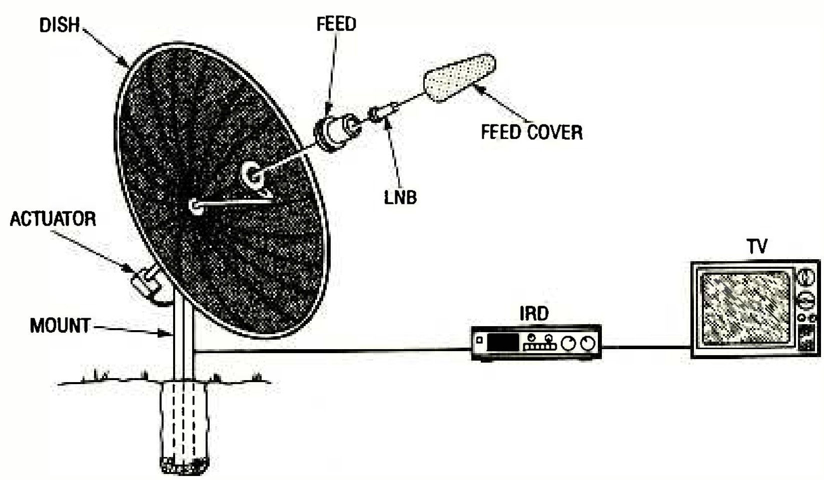
Two bands are used for relaying signals from the satellites to earth. The original band, called the C-band, uses downlink frequencies of 3.7–4.2 GHz. There are 23 C-Band satellites in orbit over North America today.

In 1984, another 500-MHz band was allocated for satellite downlinking. The 11.7–12.2-GHz Ku-band is divided by the FCC into two segments. The first (11.7–12.2 GHz) is known as the Fixed Satellite Service, or FSS; there are 21 FSS satellites orbiting over North America. The 12.2–12.7-GHz frequency range is called BSS, or Broadcast Satellite Service; it will be used for the first time at the end of this year.

The main difference between the C- and Ku-Bands is power output. C-band transponders are required to be relatively low powered so that they don't interfere with ground-based microwave communications, which share the same band of frequencies. Satellites in the C-Band range in power up to 16 watts per transponder, and require receiving antennas 6 to 10 feet in diameter to pick up their signals. FSS Ku-Band satellites are more powerful, ranging up to 50 watts per transponder, so they require smaller dishes (3–5 feet). The upcoming BSS Ku-band birds will range in power from 100 to 200 watts per transponder, which means that dishes as small as 18 inches can be used.

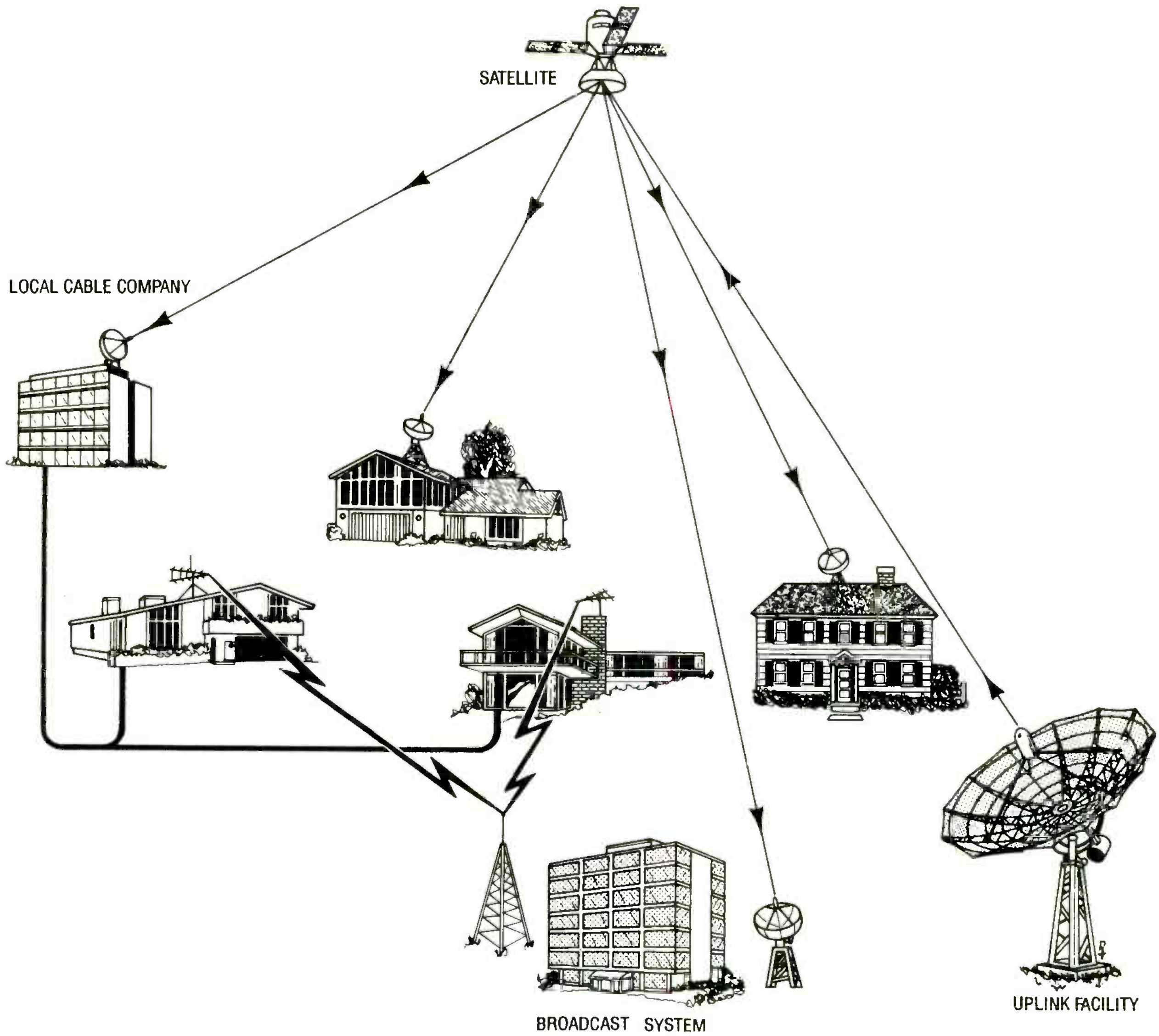
The satellites transmit cone-shaped microwave beams back to earth. The shape of that beam, and the power levels associated with it, is known as the satellite's "footprint." The power level within a footprint varies, with the highest power at the center and the fringes receiving only weak signals. Because most C-Band satellite transmissions are aimed at the middle of the country, the size of the dish also is influenced by your home's geographic location. A homeowner in Kansas (at the center of the footprint) might get good reception from a 6-foot dish, while someone in Florida or Maine might require a 12-foot dish.

On the Homefront. That brings us to the third part of the system—the home satellite-TV system, also called a TVRO (for television receive-only). A TVRO consists of the dish, the dish positioner, the feedhorn, the low-noise block downconverter (LNB), cables, and the receiver. (We'll describe the system components briefly here; for more details see *Gizmo*.)



A basic satellite-receiving system consists of a dish, which reflects the signals to the feed. The feed collects the weak signals and sends them on to the dish-mounted low-noise block downconverter or LNB. Cable gets the signals into the house to the IRD or integrated receiver/descrambler. It also provides control signals to the electronics at the dish, and to the actuator arm, which moves the dish into position.

The dish, a parabolic reflector, gathers the microwave signal transmitted from the satellite. The dish must be installed precisely, aimed at the proper level to be able to "see" the satellites in orbit, with no obstacles such as trees or buildings blocking their view. The dish positioner moves the dish to the proper position to receive signals from a specific satellite. Modern dishes have motor-driven ac-



Much of the programming you currently watch—even if you don't have a dish—comes to you via satellite.

tuators, controlled by the satellite receiver, that have limited the need to position a dish manually. The hard-working actuator stabilizes the dish as it targets a satellite, and moves it from one satellite to another.

The dish reflects the collected signal to the feedhorn, located at the focal point in front of the dish. Inside the feedhorn is the actual antenna, a small probe that can be rotated to receive either horizontally or vertically polarized signals.

From the feedhorn, the signal is sent to the LNB, where it is amplified more than 100,000 times and converted to lower frequencies ("downconverted"). Downconverting the signal makes it possible to use standard, inexpensive coaxial cable to bring the signal into your house to the satellite receiver. Because the LNB downconverts the entire block of signals sent by the satellite, and not just those from one transponder, it's possible to watch a different station (from the same satellite) on a second TV if a second satellite receiver is used.

The receiver—which, if it includes a descrambler, is called an IRD or integrated receiver/descrambler—modulates the signal on a channel (usually channel 3 or 4) that your TV can tune. If your TV also is a monitor, the satellite receiver's direct video and audio outputs can be connected to the monitor inputs, providing exceptional picture and sound quality—particularly if your receiver is equipped with stereo-audio outputs.

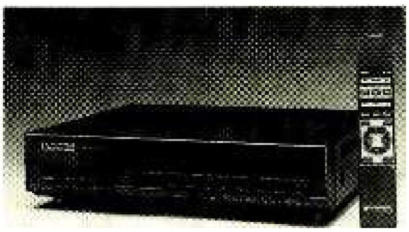
Today's receiver is more than just a satellite tuner. Many receivers incorporate a dish positioner that lets you move the antenna from the comfort of your home; satellite memory—the ability to remember the position of each satellite—which lets you choose a satellite as easily as you can select a channel; and something we've all come to regard as a necessity, not an option: a remote control. In addition, it is likely to include a descrambler that allows you to view the pay stations to which you subscribe.

The Scoop on Scrambling. While there's plenty of free satellite programming, most dish-owners also pay to watch such premium channels as HBO, The Disney Channel, Showtime, The Playboy Channel, and the like. To prevent unauthorized viewing of those channels, the signals are scrambled. To view them, satellite owners must have a descrambler that has been authorized to decode the encrypted signal. But piracy has plagued the industry since programmers first began charging for their product.

The most basic video scrambling is accomplished with signal inversion and sync suppression. Signal inversion converts each image into its negative, while the suppression of horizontal and vertical synchronization signals causes an unstable picture. Those two techniques were combined in various ways in early, unsophisticated scrambling systems. It was pretty easy, however, to unscramble such a picture.

To combat illegal descrambling, a third element was added to create VideoCipher, the first industry-standard scrambling system. The audio signal was digitized, encrypted, and then inserted where the sync pulses should have been. That meant that even if an enterprising hacker managed to stabilize the picture and reverse the inverted signal, there would be no audio accompanying the picture. Along with the encrypted audio, subscriber "addresses" are transmitted. A descrambler that doesn't see its address will not decscramble the signal.

Hackers are a determined and intrepid bunch, however, and VideoCipher was soon "cracked." When General Instrument (GI) upgraded to VideoCipher II, hackers responded with a chip that fooled it into recognizing all scrambled channels as being authorized for viewing. The Three Musketeers chip ("all for one and one for all") was used so extensively that some industry insiders believe that at one time there were more illegal than legitimate descramblers in use. Another chip, called the Wizard, duplicates a legitimate descrambler (called the"mother") that has been authorized to receive every scrambled station, making up to 100 cloned "daughter" receivers. Illegal units could go for as much as $2000, since the buyer was promised that he'd never have to pay for programming. GI countered by developing a method to disable all the daughters



Receivers come in all shapes, sizes, and prices. The Chaparral Monterey 95 is a high-end (about $2000) model that offers such home-theater features as Dolby Surround Sound, picture-in-picture, and more.

whenever it catches a mother receiver, and by introducing the more sophisticated VideoCipher II Plus.

The latest step in the descrambling wars is the introduction of VideoCipher II Plus Renewable Security (VCRS). The VCRS module has a slot into which a TvPass card (a kind of smart card) can be inserted. Easily inserted by the consumer, each card contains an upgrade of the encryption security code, making it easier (and for General Instrument, cheaper) to stay one step ahead of the program pirates.

According to the Satellite Broadcasting and Communications Association of America (SBCA), the transition to VC II Plus went smoothly, with virtually no interruption of service for legal subscribers. Illegal users were left high and dry, although they had the option to buy a module and join the fold, paying for subscriber programming.

TVRO Today. If you still have to pay for the good stuff, and even the bare-bones description of satellite TV given above sounds pretty complex (not to mention expensive), why would anyone want to bother with a home satellite-TV system? Not only is the system not as complicated as it sounds, but there also are a few distinct advantages to TVRO: the incredible diversity of programming, superior picture quality, and freedom from cable companies.

There's no question that the first TVRO systems were anything but user-friendly. In the early days, equipment was unstandardized, rarely guaranteed, and difficult to use. Before the days of electronic dish positioners, the viewer was the dish positioner, venturing out in all sorts of weather to manually move the dish from one satellite to another while another person kept his eye on the screen and shouted directions.

Although those days are long past, TVRO has retained a reputation as being unwieldy and difficult to use (in much the same way that most people still are afraid to program a VCR because of the poor design of the early models). And, to some extent, TVRO owners have retained the image of being rural do-it-yourselfers, willing to put up with any inconvenience to get their eyes on the programs that their more fortunate urban counterparts receive via cable.

In reality, a state-of-the-art, dealer-installed, turnkey TVRO system requires only a little more effort to use than a cable box. And while most TVRO owners do reside in rural areas (after all, metropolitan areas are not likely to offer the clear line of sight required by satellite dishes) and many are also avid D-I-Y'ers, recent reader polls conducted by *Satellite Orbit* and *Satellite TV Week* prove beyond a doubt that TVRO owners are anything but unsophisticated "country mice." Compared to the U.S. population in general, the subscribers to those two popular satellite-programming guides are much more likely to be college educated and to own their own homes, projection TV's, computers, VCR's, and recreational vehicles. So what do those savvy country TVRO owners have that their urban and suburban counterparts are missing out on?

What's in It for You? The two main advantages to home satellite-TV systems are quality and quantity. That is, the picture quality is superior to what you can get from cable or network broadcasts, and the quantity of programming is tremendous.

Home satellite reception is superior because it cuts out the middleman. In a typical cable transmission, for example, the program is uplinked to a satellite, then downlinked to a receiving station. At that point, the picture quality is the same or better than what your TVRO system can deliver. But before that high-quality signal gets to your TV, it is sent over miles of cable, being re-amplified many times to make up for signal losses. By the time you see it, the signal has picked

Channel Choice Services

satellite TV

Radio

SAT/CH	PROGRAM SERVICE	FMT	LEFT	RIGHT
CLASSICAL				
AD/02	Classic Selections*	M-N	6.3	
AD/16	CBC-FM	D-N	5.76	5.94
AD/20	CBC Radio (French)	D-N	5.4	5.58
AD/22	CBU-FM Radio Vancouver B.C.	D-N	5.76	5.94
AD/24	CBC-FM (French)	D-N	5.4	5.58
AD/24	CBC-FM	D-N	5.76	5.94
G5/07	WFMT-FM Chicago	D-N	6.3	6.48
G5/21	Classical Selections	D-N	6.3	6.48
F4/15	WQXR-FM New York	D-N	6.3	6.48
COUNTRY				
S3/09	Modern Country-Transtar	D-N	5.76	5.94
A2/02	CKYC Toronto, Ontario	D-N	6.12	6.3
AD/18	CISN-FM Edmonton, Alberta	D-N	7.52	7.6
AD/18	CJOR-FM La Ronge, Sask.	M-N	7.69	
AD/18	CFWE-FM Lac La Biche, Alberta	M-N	7.9	
AD/18	CKNM-FM Yellowknife, NWT	M-N	7.9	
AD/21	CFWE-FM Alberta	M-W	5.41	
AD/21	Old-Fashion Country Music 4:05-8 p.m.	M-W	5.41	
AD/23	CKRW-AM CHON-FM Yukon	M-W	5.41	
G5/18	WSM Nashville, Tenn.	D-N	7.38	7.56
G5/21	America's Country Favorites	D-N	5.04	7.74
EASY LISTENING				
S3/18	Easy Listening*	M-N	6.3	
S3/18	Safeways in-house music (Various frequencies)	M-N		
G6/14	Religious*	M-N	5.76	
AD/08	CHFI-FM Toronto	D-N	5.41	5.58
AD/09	CHFI-FM Toronto	M-W	6.8	
AD/21	CHFI-FM Toronto	M-W	6.8	
AD/22	Horizon Background*	M-N	7.60	
G5/21	Soft Rock	D-N	5.22	5.4
G5/21	Soft Sounds	D-N	5.58	5.76
F4/08	United Video/background*	M-N	5.89	
INTERNATIONAL				
S2/09	Hispanic Radio Broadcasting Net	D-N	7.75	7.93
S2/22	SUR Radio (Spanish)	M-N	5.8	
F2/01	ANA Arab Net. of America M-F 8 a.m.-6 p.m. Sat. 9 a.m.-1 p.m.	M-W	6.8	
S3/15	Middle East Programs	M-N	6.17	
G6/14	Hispano USA Network	M-N	5.94	
AD/01	CJMS-Montreal (French)	M-N	7.6	
AD/06	CHIN-FM Toronto, Ontario	M-N	6.83	
AD/14	CITE-FM Montreal (French)	M-N	5.76	
AD/14	CKAC-AM Montreal (French)	M-N	6.44	
AD/15	CBC Radio (French)	D-N	5.41	5.76
AD/20	Radio Canada-occasional (French)	M-N	7.38	
A2/17	Radio France Internationale	D-N	5.41	6.12
AS/23	Radio France Internationale	M-W	5.86	
F3/07	BBC World Service	M-N	5.4	
F4/05	Deutsche Welle	M-N	7.02	
F4/05	Deutsche Welle	M-N	7.20	
F4/07	RAI Italian Net	M-N	7.38	
JAZZ				
S3/15	KLON-FM, Long Beach, Calif.	D-N	5.58	5.76
G5/21	New Age of Jazz	D-N	7.38	7.56
NEWS & INFORMATION				
T2/20	WCBS-AM New York City, NY	M-W	7.4	
S3/09	Sheridan Pittsburgh, PA News feeds	D-N	6.30	6.48
G6/17	Radio Genesis International	M-W	7.5	
AD/22	CBC Radio News-British Columbia	M-N	7.36	
F3/07	C-SPAN 1 Capitol Hill & BBC Int'l	M-N	5.22	
F3/07	C-SPAN 1 Schedule Update	M-N	5.6	
F4/10	Business Radio Network	M-N	8.055	
F4/19	C-SPAN 2 Schedule update	M-N	5.6	
G3/09	Sheridan Broadcast Net	D-N	6.3	6.48
RELIGIOUS				
F2/23	Christian Music Network	D-W	6.2	7.6
S3/03	WROL Boston	M-W	6.2	
S3/05	Religious/USA Radio News	M-N	6.12	
S3/15	Ambassador Inspirational Net	M-N	5.94	
S3/15	Salem Satellite Net L.A.	M-N	6.3	
G6/05	WCRP-FM Puerto Rico (Spanish)	M-N	6.53	
G6/14	Lifeline Variety Net	M-N	5.58	
G6/14	Reach the World	M-N	7.56	
G5/11	CBN Radio Network	D-N	6.3	6.48
F4/08	Tidewater Radio Net	D-N	5.58	5.76
F4/08	KILA Las Vegas, Nev.	D-N	7.38	7.56
F1/05	Bonneville Int'l LDS Radio	M-N	5.56	
ROCK				
AD/02	Over Night Rock Radio (After 11 p.m.)	D-N	5.41	5.58
AD/16	CILQ-FM Q107 Toronto, Ontario	D-N	5.76	5.94
AD/18	CIRK-FM Edmonton, Alberta	M-N	7.78	
AD/22	CFMI-FM New Westminster B.C.	M-W	6.8	
M2/08	XEW-FM Mexico City	M-W	7.4	
G5/21	Light & Lively Rock	D-N	5.94	6.12
G5/21	Golden Oldies '50s '60s	D-N	8.1	8.28
F3/23	Cable Radio Net. LA '50s Music	M-N	7.23	
SPECIAL INTEREST				
S2/03	Voice of America-Occasional-Spanish	M-N	7.335	
S2/03	Voice of America-Occasional	M-N	7.425	
S2/03	Voice of America-Occasional	M-N	7.515	
S2/03	Voice of America-Occasional	M-N	7.605	
F6/15	Yesterday USA/Old Time Radio Shows	M-W	6.2	
S3/02	Nebraska Public Radio	D-N	5.76	5.94
S3/02	Radio Talking Book Network	M-N	6.48	
S3/03	Irish Hit Parade Sat. 10:30 a.m.-8 p.m.	M-W	6.2	
S3/06	Yesterday USA/Old Time Radio	M-N	6.48	
S3/22	Sound Solutions/CD Shopping	M-W	6.2	
G3/07	Yesterday USA/Old Time Radio	M-N	5.76	
G5/06	KGAY Denver, Colo.	D-N	6.3	6.48
G5/21	Big Bands Saturday Night 10 p.m.-2 a.m.	D-N	5.58	5.76
AS/22	Radio OZ-Children's programming	D-N	7.925	8.10
F4/10	In Touch-Reading to sight impaired	M-N	7.87	
F4/10	KNOW Minnesota Public Radio	M-N	8.235	
F5/24	Reading to sight impaired	M-N	6.48	
F5/24	KSKA-FM Anchorage-Nat'l Pub Radio	D-N	7.38	7.56
TALK SHOWS				
S3/21	Let's Talk Radio-Daily 9 p.m.-2 a.m.	M-W	5.8	
G6/09	Art Bell-Live Tue.-Sat. 1-6 a.m.	M-W	6.2	
F1/02	For the People	M-W	7.55	
VARIETY				
AD/16	CBC Radio	M-N	5.41	
AD/16	CBC Radio-English	M-N	5.58	
AD/18	CFNR Terrace B.C.	M-N	6.44	
AD/18	CKRW-AM Whitehorse, Yukon	M-N	6.8	
AD/18	CKER-AM Edmonton-Cosmopolitan	M-N	7.42	
AD/20	CBM-AM Montreal, Quebec	M-N	6.12	
AD/22	CBU-AM, Vancouver B.C.	M-N	7.42	
AD/23	VOCM-AM Newfoundland	M-N	6.17	
AD/24	CBC-FM Maritimes	D-N	6.12	6.3
AS/22	WCCO-AM Minneapolis-St. Paul	M-W	6.2	

* News and commercial free station

C-band

EAST	S2 SPACENET 2 69°W	F2 SATCOM 2R 72°W	G2 GALAXY 2 74°W	F6 SATCOM 4R 82°W	T2 TELSTAR 302 85°W	S3 SPACENET 3 87°W	G7 GALAXY 7 91°W	G3 GALAXY 3 93.5°W	T1 TELSTAR 301 96°W	G6 GALAXY 6 99°W	S4 SPACENET 4 101°W	AD ANIK E2 107.3°W	A2 ANIK E1 111.1	M1 MORELOS 1 113.5°W
1		Arab Network of America						Keystone Inspirational Network	recurring & pro sports feeds	SCPC Radio No video		Weather Network (English & French)		
2	Dr. Gene Scott	WRAL-CBS Raleigh, NC	SCPC Radio No video			Nebraska ETV Network (DN 6.12-6.3)			CBS (West) (DW 6.2-6.8) o/c	SCPC Radio No video		TSN sports Network		XHDF Imevision (MW 6.2)
3	USIA					WSBK-Ind Boston			recurring feeds	SCPC Radio No video		Independent & CBC feeds		
4		WABC-ABC New York	pro & college sports feeds			NETV feed*			pro sports feeds	SCPC Radio No video		First Choice		SCPC Radio No video
5	Channel America	NASA feeds			HBO 2 (East)	KTVT-Dallas Ft. Worth			recurring & pro sports feeds	pro sports feeds		CBC sports network feeds		
6									ABC East feed	NCN Shepherd's Chapel	PBS B (DW 5.65-6.2)	MuchMusic (DW 5.41-6.2) (MW 6.67)		
7	Main Street TV	All News Channel	pro sports feeds		CBS East feed			Caribbean Satellite Network	CBS (East) (DW 6.2-6.8) o/c	CBS feed		CBC feeds Newfoundland		
8			pro sports feeds	PreVue Guide				Home Shopping Club		CTNA o/c pro sports feeds	PBS A (DW 5.65-6.2)	CHCH Hamilton	recurring & sports feeds	XHDF Imevision (MW 6.2)
9	Telemundo (Spanish) (DN 5.58-5.76)		CNN feed (MW 6.2)		HBO 3	WPIX-Ind New York	sports feeds	QVC Shopping Network	Keystone feeds o/v	pro sports feeds	Three Angels	WDIV-NBC		Multideporte sports (MW 6.2)
10	Galavision feed			Access America	ABC (West) (DW 6.2-6.8) o/c				ABC (East) (DW 6.2-6.8) o/c	Agrivision sports, recurring feeds	PBS C (DW 5.65-6.2)	WXYZ-ABC	SCPC Radio No video	
11		Home Shopping Spree	pro sports feeds		ABC feed	CNN News feed	I.D. Channel		ABC sports feed		sports feed	CBC North (Pacific)		Multicinema feeds
12		WXIA-NBC Atlanta							ABC East feed (DW 6.2-6.8)	EENET o/v, sports feeds	PBS D (DW 5.65-6.2) pro sports feed	Global TV recurring feeds (DW 5.81-6.2)	CTV feed	
13		NASA Select TV	pro sports feeds			SCPC Radio No video			SNS, recurring feeds	Univision feeds		Super Channel OAK		Guadalajara TV
14			pro sports feeds		HBO 2 (West)					Family Network		CFTM Montreal (French)		XHTV Televisa (MW 6.2)
15			pro sports feeds	Shop at Home	CBS (DW 6.2-6.8)	KTLA Ind Los Angeles (Spanish 6.8)	sports feeds	Video Hits-1	CBS news feed	World Harvest TV		CBC (French)		
16			pro sports feeds		CBS (West) (DW 6.2-6.8)				pro sports feeds	Tavern TV		CBC News Service	CTV Network	
17		SportsChannel America (East)	pro sports feeds		pro sports feeds			MTV (East)	pro sports feeds	American Entertainment Network		Visnews/London CBC feeds	TV5 Quebec (French)	recurring feeds
18		SportsChannel Philadelphia	pro sports feeds	Spice PPV	CBS East news feeds			MTV (West)	Keystone pro sports feeds	NHK feed to Tokyo pro sports	sports feeds	CITV Edmonton	sports feeds	news & sports feeds (MW 6.2)
19	KBL Sports Network-Pittsburgh		pro sports feeds		news feeds	SportSouth-Atlanta		Nickelodeon (East)	Keystone Communications o/v	Keystone, pro sports feeds		CBC North (Atlantic)	Television Northern Canada	news & sports feeds (MW 6.2)
20	AFRTS	NBC sports feed			CBS (East) (DW 6.2-6.8)	pro sports feeds			recurring feeds	recurring & pro sports feeds		CBC Montreal		
21	Cornerstone Television	New England News	pro sports feeds	Nostalgia Television	Cinemax 2	PASS-Detroit			Movie Greats Network	Keystone, pro sports feeds		WTVS-PBS		
22	SUR (Spanish)	SportsChannel New York	pro sports feeds	Silent/ADC	pro sports feeds	Satellite Mkt. USA (DN 6.2-7.4)	sports feeds	Nickelodeon (West)		Caribbean SuperStation		CHAN/BCTV Vancouver	sports feeds	
23	Empire Sports Network	SportsChannel New England	college & pro sports feeds		pro sports feeds	Home Team Sports				L.D.S. Church BYU sports feed		WJBK-CBS		
24		CNN feed	pro sports feeds		pro sports feeds	Radio Television Portugal			recurring & pro sports feeds	pro sports feeds		House of Commons	CTV Network	

Video

ABC East / West Occasionally in the clear		T1•10 T2•10
ABLE TELECOMMUNICATION SERVICE Sun. 8 a.m.-10 a.m. Thur. 1:30 p.m.-3:30 p.m.	ATS	G6/19
ACCESS AMERICA Movies		F6/10
ACTION PPV	ACTN	G1•02
ACTS Baptist family programming	ACVI	F3/06
AGRIVISION feed		G6/10
ALASKA SATELLITE TV	AKTV	F5/24
ALL NEWS CHANNEL	NEWS	F2•07
AMERICAN ENT. NET.	AMEN	G6/17
AMERICAN MOVIE CLASSICS	AMC	F4•01
AMERICA'S DISABILITY CHANNEL Daily 8:30 a.m.-9:30 a.m.		F6/22
ARAB NETWORK OF AMERICA Mon.-Fri. 9 p.m.-1 a.m. Sat. & Sun. 1 p.m.-1 a.m.		F2/01
ARTS & ENTERTAINMENT (st)	A&E	G5•23
ASIA NETWORK Daily 7:50 p.m.-10:55 p.m. (Korean)		SBS-6 /19
BLACK ENTERTAINMENT TV	BET	G5/20
BRAVO (st) Cultural programs, movies, M-F, 8 p.m.-6 a.m. Sun./Sat., 5 p.m.-6 a.m.	BRAV	F4•07
CABLE VIDEO STORE/TVN PPV	CVS	T3•09
THE CALIFORNIA CHANNEL Mon.-Fri. 12 p.m.-7 p.m.		F1/22
CANADIAN BROADCAST CORP. North Atlantic Time Zone French Pacific Time Zone Montreal	 CBCA CBCF CBCP CBMT	 AD/19 AD/15 AD/11 AD/20
THE CARTOON NETWORK		G1•08
CARIBBEAN SATELLITE NETWORK		G3/07
CARIBBEAN SUPER STATION Daily-on air approx. 12:30 am		G6/22
CBS East / West Occasionally in the clear	CBSE	T1•07 T1•02
CFTM Montreal (French)	CFTM	AD/14
CHANNEL AMERICA	CHAM	S2/06
CINEMAX (st) East / West Movies, entertainment	CINE CINW CIN2	G1•19 G5•16 T2•21
CONSUMER NEWS & BUSINESS	CNBC	G5•13
CNN	CNN	G5•05
COMEDY CENTRAL East / West	COME COMW	F3•21 G1•01
CONTINUOUS HITS PPV	HITS	F1•21
CORNERSTONE TV Religious		S2/21
COUNTRY MUSIC TV (st)		G1•13
COURT TV NETWORK	CORT	F3/06
C-SPAN I Live, taped coverage of U.S. House, committees		F3/07
C-SPAN II Live, taped coverage of U.S. Senate, committees Schedule Info. 202-626-2205		F4/19
CTN-Christian TV Network		F1/11
CTNA-Catholic Telecommunications Network of America		G6•08
DEUTSCHE WELLE German		F4/05
THE DISCOVERY CHANNEL 9 a.m.-3 a.m.	DISC	G5•12 F4•21
DISNEY CHANNEL (st) East / West Family entertainment	DISE DIS2 DISW	G5•01 G1•04 G1•24
E! ENTERTAINMENT		F3/23
EENET Emergency Education Net occasional · 301-447-1068		G6/12
EMPIRE SPORTS NETWORK	EMPR	S2•23
ENCORE (st) MOVIES	ENCR	G1•03
ESPN (st) Sports Alternate	ESPN	G5•09 G1•14
ETERNAL WORD TV NET Catholic programming	EWTN	G1/11
THE FAMILY CHANNEL East / West 700 Club is "in the clear"	FAME FAMW	G5•11 F3•01
FAMILY NET Religious	FMLY	G6/14
FLIX-Movies	FLIX	T3•17
FOX Network / East / West	FOXN FOXE FOXW	F1/19 T3/18 T3/23
GALAVISION Spanish *	GALA	G1/20
HEADLINE NEWS		G5•22
HOME BOX OFFICE (st) East / East / West Movies, entertainment, sports HBO2 East HBO3 HBO2 West	HBOE HBOW HBO2E HBO3 HBO2W	G5•15 G1•23 G5•08 T2•05 T2•09 T2•14
HOME SHOPPING CLUB HOME SHOPPING CLUB II		F4/10 F3/10
HOME SHOPPING SPREE		F2/11 F6/24
HOME SPORTS ENT. Alternate	HSE	F1•10 F1•17
HOME TEAM SPORTS Washington; Orioles, Bullets, Capitals	HTS	S3•23
HOT CHOICE PPV	HOTC	F4•18
HOUSE OF COMMONS Audio for French translation is at 7.3 MW.		AD/24
THE INTERNATIONAL CHANNEL	INTL	F1•20
JADE CHANNEL Chinese News Mon.-Fri. 10:15 p.m.-11:15 p.m.		F1/01
KBL Pittsburgh Sports Network	KBL	S2•19
KCNC NBC-Denver	KCNC	F1•14
KEYSTONE INSPIRATIONAL	KEY	G3/01
KMGH CBS-Denver	KMGH	F1•06
KRMA PBS-Denver	KRMA	F1•09
KTLA IND-Los Angeles Angels, Clippers, Movies Spanish occasional M-W 6.8	KTLA	S3•15
KTVT IND-Dallas, Rangers	KTVT	S3•05
KUSA ABC-Denver	KUSA	F1•02
KWGN IND-Denver	KWGN	F1•23
THE LEARNING CHANNEL	TLC	F3/02
LIFETIME Health, crafts, cooking, Medical Network East / West	LIFE LIFW	F4•04 F3•04
MADISON SQUARE GARDEN Sports, pro and amateur Alternate	MSG MSG2	F4•06 G1•07 F6/20
MAIN STREET TV		S2/07
MIDWEST SPORTSCHANNEL Minneapolis	MWSC	AS•22
MIND EXTENSION UNIVERSITY Accredited college classes 1-800-777-6463	MEU	G5/21
MOR MUSIC TV		G5/18
THE MOVIE CHANNEL East / West / West Movies, entertainment	TMCE TMCW	F3•17 G5•14 F4•22
MOVIE GREATS NETWORK M-F 12 a.m., Mon. 8:30 p.m. Sat. 12 a.m.	MGN	T1/21
MUCHMUSIC (st) Music videos	MUCH	AD/08
MUSIC TELEVISION (st) East / West Rock videos, concerts	MTVE MTVW	
NACTV NETWORK North American Chinese TV Net.		
NASA SELECT TV Daily schedule posted at noon		
THE NASHVILLE NETWORK (st) Daily 9 a.m.-3 a.m.	NASH	
NAT'L CHRISTIAN NETWORK	NCN	
NBC East Occasionally in the clear	NBCE	
NBC Ku-band (st) East / Pacific / Central	NBCE NBCP NBCC	
NEBRASKA ETV NETWORK Alternate	NETV	
NEW ENGLAND CABLE NEWS 24 hour news/talk		
NEW ENGLAND SPORTS NETWORK Red Sox, Bruins	NESN	
NEW INSPIRATIONAL NETWORK (st)	INS	
NHK Feed/Japan		
NICKELODEON East / West Children's programs	NIKE NIKW	
THE NOSTALGIA CHANNEL	NOST	
OPEN PUBLIC EVENTS NET. North Carolina Tue. & Thur. 8 p.m.-10 p.m.		
PASS Detroit—Ind Detroit Tigers, Red Wings, Pistons	PASS	
PBS (st) Educational. Audio frequency M-W 5.8 is used for Spanish language and other special services PBS A PBS B PBS C PBS D	 PBSA PBSB PBSC PBSD	
PLAYBOY (st) Daily 8 p.m. to 5 a.m. Available by subscription or pay per view	PLAY	

Just how much programming is out there? This chart, reproduced with permission from Satellite TV Week, gives a glimpse of what you can expect! For a free sample issue, and a Simplified Guide to Satellite Television, call 800-345-8876.

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Ku-band

M2 MORELOS 2 116.8°W	T3 TELSTAR 303 123°W	G5 GALAXY 5 125°W	AS ASC-1 128°W	F3 SATCOM C3 131°W	G1 GALAXY 1 133°W	F4 SATCOM C4 135°W	F1 SATCOM C1 137°W	F5 SATCOM C5 139°W	WEST TRANSPONDERS
	TVN PPV Theater 1	The Disney Channel (East)		The Family Channel (West)	Comedy Central (West)	AMC	Jade Channel feed		1
	TVN PPV Theater 2	Playboy		The Learning Channel	Action PPV	Request TV 2	KUSA-ABC Denver		2
	TVN PPV Theater 3	Trinity Broadcasting Net. (DN 5.58-5.76)		Viewer's Choice	Encore	Nickelodeon (East)	KRMA-PBS Denver	SCPC Radio No Video	3
	TVN PPV Theater 4	Sci-Fi Channel (DN 5.58-5.76)		Lifetime (West)	Disney 2	Lifetime (East)	SportsChannel Pacific	SCPC Radio No Video	4
	TVN PPV Theater 5	CNN		ACTS/VISN	Showtime Event Television	Deutsche Welle TV (MW 6.8)	SportsChannel Chicago		5
	TVN PPV Theater 6	TBS (DN 6.3-6.48)		Court TV Network	Univision (Spanish)	MSG	KMGH-CBS Denver		6
	TVN PPV Theater 7	WGN		C-SPAN 1	Turner Premiere PT24 PPV MSG2	Bravo RAI	Prime Ticket		7
XHGC Televisa (MW 6.2)	TVN PPV Theater 8	HBO (West)	sports feeds	QVC Fashion Channel	The Cartoon Network	Prevue Guide	NBC (East) (DW 5.8-6.2) o/c		8
XHFM Vera Cruz (MW 6.2)	TVN PPV/ Cable Video Store	ESPN		Digital Cable Network	Shop At Home II	QVC Network		SCPC Radio No Video	9
news & sports feeds (MW 6.2)		MOR Music TV (DN 5.58-5.76)		Home Shop Network II	The Movie Channel (East)	Home Shopping Club	Home Sports Entertainment	SCPC Radio No Video	10
Canal Mexicano de Cable (6.2)		The Family Channel (East)		Prime Network	Eternal Word TV Network	Adstar*	Worship		11
TNT Latin America		Discovery Channel	Open Public Events Network N. Carolina		ValueVision	Nustar*	SportsChannel America (West)		12
XEIPN Mexico City (MW 6.2)	pro sports feeds	CNBC		The Weather Channel	Country Music Television	The Travel Channel			13
XEW Televisa (MW 6.2)		The Movie Channel (West)		New England Sports Network	PT24 PPV ESPN Alt. Shop at Home	The Family Channel*	KCNC-NBC Denver		14
TVC (MW 6.2)		HBO (East)		Showtime (East)	WWOR-NY Secaucus, NJ	WWOR	SportsChannel Ohio Florida		15
ZAS-Children's programming (6.2)		Cinemax (West)		MTV (West)	Showtime (West)	Request TV 1		SCPC Radio No Video	16
	FLIX	TNT		The Movie Channel (East)	New Inspirational Network	MTV (East)	HSE & Prime Alternates NHK/Tokyo		17
news feeds	FOX (East) (DW 6.2-6.8) (MW 5.8)	The Nashville Network		Nickelodeon (West)	HBO DigiCipher test	Hot Choice	Prime Network Alternate STEP		18
Graphic News updates (MW 6.2)	Showtime 2	USA (East)		Comedy Central (West)	Cinemax (East)	C-SPAN 2	FOX Net (DN 7.38-7.56)		19
	TVN PPV Spice	BET (DN 5.58-5.76)			Galavision (Spanish)	Showtime (West)	The International Channel		20
Movie Cable (6.2)		Mind Extension University		Comedy Central (East)	USA (West)	Discovery	Continuous Hits	SCPC Radio No Video	21
	FOX news feed	Headline News	Midwest Sports Channel			The Movie Channel (West)	Prime Sports Northwest CAL SPAN		22
	FOX (West) (DW 6.2-6.8) (MW 5.8)	Arts & Entertainment	SCOLA International News	E! Entertainment	HBO (East)	VH-1	KWGN-Ind Denver		23
	TVN Promos	Showtime (East)		Digital Music Express	The Disney Channel (West)		Sunshine Network	Alaska Satellite TV Project	24

	K-2 81°W	K-1 85°W	GSTAR 4 105°W	ANIK E2 107.3°W
1			Education & news feeds	
2				Vision TV
3	NBC (East) (DW 6.2-6.8)			
4		PrimeStar PPV1 VC1		
5				
6				
7	NBC (Pacific) (DW 6.2-6.8)	PrimeStar WWOR		
8	Cycle Sat	PrimeStar KTVU		
9			newsfeeds	o/v
10	NBC sports CONUS news feed			Radio Quebec
11	NBC sports feeds	PrimeStar NHK (Japanese)		
12	college & pro sports	PrimeStar PPV2 VC2	news feeds	TV Quatre Saisons
13	sports feeds			
14	Conus news & pro sports feeds			Canal Famille
15	NBC/NY Skypath news & sports feeds			
16	sports feeds	PrimeStar WSBK		Reseau de Sports
17			sports & news feeds	Alberta Access Vision TV
18			sports & news feeds	TV Ontario/La Chaine (French)
19	NBC (Central) (DW 6.2-6.8)	Private Satellite Net	news feeds	YTV
20		PrimeStar PPV3 Request 1	sports & news feeds	TV Ontario (English)
21			CNN feed & education	Family Channel
22		o/v	pro sports & news feeds	Super ECRAN
23	NBC news feed	PrimeStar WPIX	NASA feed	
24		PrimeStar KTLA		Ontario Legislature
25				
26			CNN feed	YTV
27	NBC news feed	PrimeStar TBS	news feeds	
28	NACTV Net		news & sports feeds	Family Channel
29			news feeds	Knowledge Network
30			sports & news feeds	Musique Plus
31	news feeds	sports feeds & business seminars	Whittle & sports & news feeds	
32		PrimeStar WGN	Whittle & sports & news feeds	Atlantic Satellite Network

F4•17	PRIME NETWORK	PRMN	F3•11
F3•16	PRIME SPORTS Northwest	PRNW	F1•22
K2/28	Rocky Mtn, Utah, Midwest	PRIM	F1•17
	For alternate feeds also check		F1•18
F2/13	PRIMESTAR-Ku		K1
	PRIME TICKET NETWORK	PTN	F1•07
G5•18	PRIMETIME 24 PPV events	PT24	F3•20, G1•07
G6/06	PROSTAR-Sports & events for		F6•11
F1•08	commercial establishments only		
	QVC SHOPPING NETWORK		F4/09
K2/03	RADIOTELEVISION PORTUGAL		S3/24
K2/07	REQUEST 1	REQ1	F4•16
K2/19	REQUEST 2	REQ2	F4•02
S3/02	RAI Italian, variety,	RAI	F4/07
S3/04	M-F 6 p.m.-8 p.m., Sat. 4 p.m.-5 p.m.		
F2/21	Sun. 8 a.m.-2 p.m.		
	Satellite Market U.S.A.		S3/22
F3•14	SCI-FI CHANNEL		G5/04
	SCOLA-International news in	SCOL	AS/23
G1/17	language of origin 712-566-2202		
F1/17	SHOP AT HOME		F6/15
F4•03	SHOP AT HOME II		G1/09
F3•18	SHOWTIME (st) East	SHOE	G5•24
F6/21		SHOE	F3•15
AS/02	West	SHOW	F4•20
		SHO2	T3•19
	THE SILENT NETWORK	SLNT	F6/22
S3•21	Programming for hearing impaired. Daily 9:30-11:30 a.m.		
	SKYVISION TVRO		S3/06
S4/06	Tue., Wed, & Thur, 9 p.m.		
S4/08	SPICE PPV	SPCE	T3•20
S4/10		SPCE	F6•18
S4/12	SPORTSCHANNEL America	SCAM	F2•17
G5•02	Encoded channels Chicago	SCCH	F1•06
F6•22	are in "universal Chicago Plus	SCCP	F6/19
	access" mode, Florida	SCFL	F1•15
	which requires a New York	SCNY	F2•22
	VC II decoder NY Plus	SCP	F2•17
	and authorization New England	SCNE	F2•23
	to any satellite Ohio	SCOH	F1•15
	service. Pacific	SPAC	F1•04
	Philadelphia	SCPA	F2•18
	SPORTS NEWS SATELLITE		T1/13
	SPORTSOUTH	SPTS	S3•19
	STEP Educational programming		F1/18
	STORYVISION Computer data story book for children (204-942-1005)		F3/03
	SUNSHINE NETWORK Sports	SUN	T3•16
	SUPERIOR LIVESTOCK		G6/10
	SUR (Spanish) 800-553-1713		S2•22
	TAVERN TV BMAC		G6•16
	TBS (st) IND-Atlanta Braves, Hawks	TBS	G5•06
	TELEMUNDO Spanish, Daily 9 a.m.-3 a.m.	TELE	S2/09
	TELEVISION NORTHERN CANADA		AD/19
	THREE ANGELS Seventh Day Adventist	3ANG	S4/09
	TNT Movies, sports	TNT	G5•17
	THE TRAVEL CHANNEL	TRAV	F4/13
	Feed		G3/11
	TRINITY BROADCASTING	TRIN	G5/03
	TRUCKER TV Sun.-Thur. 5-11 p.m.		SBS5 Tr.12
	TURNER PREMIERE	TPPV	G1•18
	TV 5 QUEBEC (French) Sun./Sat. 1:12 p.m.-3:20 a.m. M-F 3:12 p.m.-3 a.m.		A2/17
	TVN PPV Theater 1	TVN 1	T3•01
	TVN PPV Theater 2	TVN 2	T3•02
	TVN PPV Theater 3	TVN 3	T3•03
	TVN PPV Theater 4	TVN 4	T3•04
	TVN PPV Theater 5	TVN 5	T3•05
	TVN PPV Theater 6	TVN 6	T3•06
	TVN PPV Theater 7	TVN 7	T3•07
	TVN PPV Theater 8	TVN 8	T3•08
	TVN PPV/Cable Video Store	CVS	T3•09
	TVN PPV/Spice	SPCE	T3•20
	TVN Promos		T3/24
	UNIVISION Spanish	UNIV	G1/06
	USA NETWORK (st) East	USAE	G5•19
	Variety, sports, movies West	USAW	G1•21
	VALUEVISION Shopping Channel		G1/12
	VIDEO HITS-1 (st)	VH1	F4•23
	VIEWER'S CHOICE Pay per view	VIEW	F3•03
	VISN INTERFAITH NETWORK		F3/05
	WABC ABC-NY	WABC	F2•04
	THE WEATHER CHANNEL		F3•13
	THE WEATHER NETWORK Canadian English (M-W 6.8) French (M-N 5.94)		AD/01
	WGN IND-Chicago Chicago Cubs, White Sox, Bulls	WGN	G5•07
	WORLD HARVEST TV		G6/15
	WPIX IND-NY NY Yankees	WPIX	S3•09
	WRAL CBS-Raleigh, N.C.	WRAL	F2•02
	WSBK IND-Boston Boston Red Sox, Bruins	WSBK	S3•03
	WWOR IND-NY N.Y. Mets, Knicks, Rangers	WWOR	F4•15
	WXIA NBC-Atlanta	WXIA	F2•12

This Week

NHK's Tokyo feed has moved from F2/22 to F1/17; The New England News Channel has moved from F6/05 to F2/21; and Fox Net is available exclusively on F1/19.

Key

In the clear — Subscription — Not sold to U.S. satellite market

D : Discrete Stereo **W** : Wide **o/c** : Occasionally Clear
M : Monaural **N** : Narrow **o/v** : Occasional Video

AUDIO : On video channels M-W 6.8 unless indicated

VC II : Subscription channels use this decoder unless noted.

***** : Services scheduled for future broadcast.

TIME NOTED : Times on this page are Eastern

POLARITY Horizontal Vertical

By Interest

EDUCATION

America's Disability Net.	F6/22
Arts & Entertainment	G5•23
Bravo	F4•07
Discovery	F4•21, G5•12
Disney (E)	G5•01
Disney 2	G1•04
Disney (W)	G1•24
KRMA-PBS	F1•03
The Learning Channel	F3/02
Lifetime (E)	F4•04
Lifetime (W)	F3•04
Mind Extension University	G5/21
NETV-PBS	S3/02
PBS A, B, C & D	S4
Silent Network	F6/22

INTERNATIONAL

Arab Net. of America	F2/01
Asia Net. (Korean)	SBS-6
CBC (French)	AD/15
Deutsche Welle TV (German)	F4/05
Galavision (Spanish)	G1/20
International Channel	F1•20
NACTV Net. (Chinese)	K2/28
NHK/Tokyo (Japanese)	F1/17
RAI Feed (Italian)	F3/24
RTP (Portugal)	S3/24
SCOLA (Multilingual)	AS/23
SUR (Spanish)	S2•22
Telemundo (Spanish)	S2/09
TV5 (French)	A2/17
Univision (Spanish)	G1/06

MOVIES

American Movie Classics	F4•01
Bravo	F4•07
Cinemax (E)	G1•19
Cinemax (W)	G5•16
Cinemax 2	T2•21
Cinemax (W)	F3•23
The Disney Channel (E)	G5•01
The Disney Channel (W)	G1•24
Encore	G1•03
Flix	T3•17
FOX Net	G3/02, F1/19
Home Box Office (E)	G1•23, G5•15
Home Box Office 2 (E)	T2•05
Home Box Office 3	T2•09
Home Box Office (W)	G5•08
Home Box Office 2 (W)	T2•14
The Movie Channel (E)	F3•17
The Movie Channel (W)	F4•22, G5•14
The Nostalgia Channel	F6/21
Showtime (E)	F3•15, G5•24
Showtime (W)	F4•20
Showtime 2	T3•19
TNT	G5•17

MOVIES · Pay Per View

Action	G1•02
Cable Video Store/TVN	T3•09
Continuous Hits	F1•21
Hot Choice	F4•18
Playboy	G5•02
PT24 PPV	F3•20, G1•07
Request 1	F4•16
Request 2	F4•02
Spice	F6•18, T3•20
Turner Premiere	G1•07
TVN Theaters	T3•01-9, 20
Viewer's Choice	F3•03

NETWORKS

ABC-KUSA	F1•02
ABC-WABC	F2•04
CBC North (Atlantic)	AD/19
CBC North (Pacific)	AD/11
CBS-KMGH (M)	F1•05
CBS-WRAL (E)	F2•02
FOX Net	F1/19
FOX (E)	T3/18
FOX (W)	T3/23
NBC-KCNC (M)	F1•14
NBC-WXIA (E)	F2•12

NEWS, BUSINESS & INFORMATION

All News Channel	F2•07
CNBC	G5•13
Cable News Network	G5•05
CNN Headline News	G5•22
Canadian House of Commons	AD/24
C-SPAN 1 (House)	F3/07
C-SPAN 2 (Senate)	F4/19
NASA	F2/13
New England News Channel	F2/21
SCOLA	AS/23
The Weather Network	AD/01
The Weather Channel	F3•13

RELIGION

ACTS	F3/05
ATS	G6/19
Cornerstone Television	S2/21
Dr. Gene Scott	S2/02
Eternal Word TV Network	G1/11
Family Net	G6/14
Keystone Inspirational	G3/01
New Inspirational Network	G1/17
NCN & Shepherd's Chapel	G6/06
Three Angels Broadcasting	S4/09
Trinity Broadcasting	G5/03
VISN Interfaith	F3/05
World Harvest Television	G6/15
Worship	F1/11

SHOPPING NETWORKS

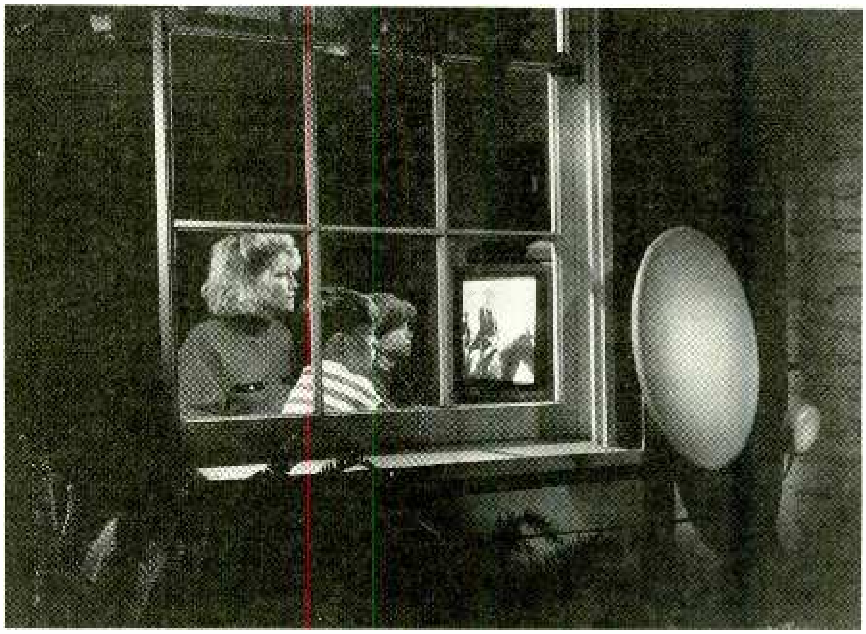
Home Shopping Club	F4/10
Home Shopping Club II	F3/10
Home Shopping Spree	F2/11
MOR Music TV	G5/10
QVC Network	F4/09
QVC Fashion Channel	F3/08
Shop At Home	F6/15
Shop At Home II	G1/09
ValueVision	F6/10

up a significant amount of noise. The direct video signal from your TVRO is about the same quality as that on a super VHS tape, and the audio quality approaches that of a CD.

For most TVRO owners, high-quality audio and video is a bonus. By far the primary reason for investing in a TVRO system is the personal choice offered by the sheer quantity of programming. Viewers can select from approximately 200 channels of programming at any one time. Some of those channels are scrambled by the programmer, and viewers must pay to receive them, as they would with cable TV. The big difference—besides the greater variety of programming, that is—is the greater variety of programming packages available. There's no need to buy a pre-packaged program assortment, with which you often end up paying for some channels that you never wanted in the first place to have the privilege of receiving the stations that you do want. There's a lot of competition between satellite program suppliers, which translates to a lot of choice for viewers who don't have to deal with a cable-company monopoly. And even if you choose not to pay for scrambled programming, there's plenty to watch—more than 150 free, unscrambled channels are available.

Another advantage available only to satellite-TV viewers is the ability to watch direct feeds and "wild feeds." Many live news and sports programs are "fed" to a satellite as they occur. Those direct feeds, or live feeds, are downlinked to television and cable stations to be edited and retransmitted to standard viewers. TVRO owners receive the unedited signals directly, giving them the chance to see and hear plenty of action that was never intended for public consumption. You can catch sportscasters chatting, news correspondents setting up before covering an event, and maybe even see celebrities in some embarrassing situations. (For instance, patient satellite viewers last year got to see Jesse Jackson spend *45 minutes* adjusting his tie before an interview.) More important, with a direct feed you can hear that part of a correspondent's report that the network deemed unimportant or unnecessary.

Watching wild feeds should appeal to scanner buffs and SWL's. Wild feeds are transmissions of syndicated programs to network affiliates and independent stations. Close to 400 of them are broadcast every week, but they change transponders frequently, requiring a lot of hunting on the viewer's part. If you don't like looking for a program, the "Tracker Bob" column in *Satellite TV Week* is devoted to finding new feeds for you.



DirecTv promises to deliver more than a hundred channels of programming to consumers who need only to install an 18-inch dish, buy a set-top decoder and, of course, pay subscription fees.

Another bonus stemming from feeds is that TVRO owners can pick up the same programming at different times. Say, for instance, that you subscribe to HBO. That channel is transmitted via several different transponders, with programming corresponding to different time zones. So, if you're on the east coast, and the movie you want to see starts at 4 PM—two hours before you get home from work—you also have the option of picking up the movie on the HBOW (west) satellite at 7 PM, after you've had a chance to change into something comfy and have a bite to eat.

The variety of video programming available to dish-owners is incredible. Sports fans, in particular, can tune into virtually every televised college and professional game. More than 1600 major-league baseball games are shown on satellite each year, but that's just the tip of the iceberg. There's football, basketball, hockey, and soccer—but there's also fishing, rodeo, auto and truck racing (even tractor pulls), curling from Canada, darts from England, and such international events as the America's Cup and the Olympics seen in their entirety (often without commercials). You can pick up a whole world of news, including unedited coverage from various foreign countries—providing a glimpse of world events previously limited to SWL enthusiasts, but with the added attraction of video. There are several movie channels (offering current hits, foreign fare, classics, and made-for-satellite originals.) And there are channels that specialize in educational, family, comedy, foreign-language, shopping, science fiction, weather, court-room, religious, music-video, TV nostalgia, and children's programming. If you want, you can even pick up Domino Pizza's training videos!

Non-Video Satellite Reception. Satellite reception is not limited to television signals, however. You can also receive radio programming from around the country and around the world. Again, the variety of programming is impressive, ranging from news to religious programs, from jazz to rock. You can pick up National Public Radio feeds, as well as the Canadian Broadcasting Corporation's programming. On the Radio Talking Book Network books and magazines are read on air. "Let's Talk Radio" is a show for ham-radio operators. Data is also available via satellite. A variety of devices are available that hook up to your TV or home computer and allow you to receive wire services from around the world.

Dish Drawbacks. If we've done a good job selling you on TVRO's good points, you might be wondering why more people don't have home satellite-TV systems. First, a large segment of the population lives in metropolitan areas, where tall, closely placed buildings don't allow the use of dish antennas. Many others wrongly believe that their towns don't allow the installation of satellite dishes. In reality, a 1986 FCC ruling bans any state, city, or town laws prohibiting dish installation. Other folks are reluctant to spend thousands of dollars on a system to get what they perceive to be "cable television" programming, when many cable companies offer free hook-up specials. Still others haven't shaken the old image of unsightly dishes and unwieldy, hard-to-use systems.

Other than urbanites who truly are unable to set up satellite dishes on the apartment terraces, most people who wouldn't consider installing a satellite system are influenced by unfortunate misconceptions. In part, the satellite industry is to blame for not properly educating consumers.

But therein lies one source of the problem—satellite systems have never really been considered "consumer" electronics. TVRO systems aren't well suited for showroom display at consumer-electronics stores—which means that if you're checking out widescreen TV's you might be tempted by the laserdisc players prominently on view—but you won't be able to play with the latest satellite receivers. And, just as the average consumer would have difficulty installing a satellite system, so would the average owner of a consumer-electronics shop. The dichotomy between TVRO and consumer electronics also means that when you're in the store, asking advice on what components should go into your home-theater setup, no one is going to suggest setting up a satellite-receiving system.

The home-theater boom could, of course, drive up the sales of TVRO systems just as it's perked sales of A/V receivers and large screen TV's. The superior picture quality demanded by consumers who are shelling out big bucks for their home theaters simply isn't available except from satellite, super VHS, and laserdisc. There is a group of consumer-electronics specialists who already set up custom installations with high levels of customer support that is expected of satellite installers—custom A/V installers, represented by CEDIA (Custom Electronic Design and Installation Association). In fact, Chaparral recently became the first satellite-manufacturer member of CEDIA.

But if anything is likely to bridge the gap between satellite-TV and consumer electronics, it will be the new high-powered "direct broadcast" services.

Direct Broadcast Satellite. Why, you might wonder upon hearing of all its advantages, isn't satellite TV more popular? The main drawback is the large dish required to pick up C-Band transmissions, the complexity of the installation, and the expense of setting up a TVRO system. Direct Broadcast Satellite, or DBS, will address each of those problems.

DBS will use high-powered satellites operating in the upper frequencies of the Ku-Band. Those high-powered satellites will beam down signals so strong that they can be picked up with dishes ranging in size from 12 to 18 inches. The DBS birds will have up to 32 transponders each, but unlike traditional satellites, they won't be limited to one channel per transponder. That's because DBS will put digital video-compression technology to use, squeezing in as many as eight channels-per-transponder, for a total of more than 250 channels-per-satellite. Because one satellite using video compression can provide so much programming, there's no longer a need to track different satellites across the sky. Eliminating the big dish and the dish positioner helps keep the cost down, and one-bird aiming makes the job of antenna installation much easier.

DBS has been making news for some time now. Beginning in 1990, medium-powered systems such as SkyPix and PrimeStar began making headlines with promises of hundreds of stations, easy on-screen menus, and extensive pay-per-view movie libraries. Lately, however, the only news stories we've seen have been concerned with finances and courtrooms. A battle for ownership of SkyPix led to bankruptcy court, and several lawsuits have been filed, leaving the company in limbo. PrimeStar, a service operated by a group of cable company owners, had begun to introduce into test markets a package of several superstations and pay-per-view channels, as well as digital radio and data services. PrimeStar would lease the necessary hardware (including a five-foot-diameter dish until it began using a higher-powered satellite) as part of the programming package, which would be available only through the owners' local cable systems—who probably won't offer it to homes that are served by cable. That arrangement has brought up possible antitrust implications. As we go to press, the situation at PrimeStar is iffy.

But don't count out DBS yet! The primary player at this point is DirecTv, a 150-channel service that Hughes Aerospace plans to launch (literally) in the early months of 1994. The home portion of the system will consist of an RCA-brand set-top decoder box and an 18-inch-diameter antenna. Behind that simple facade, however, are two extraordinarily high-powered Hughes satellites, and digital video-compression technology.

Hughes' high-powered HS-601 satellite, scheduled for launching in December 1993, and the second HS 601 (launch date in 1994), each will carry 16 120-watt DBS transponders. (That compares to typical C-Band power of 16-watts per transponders and Ku-band's 50 watts.) That strong signal, coupled with the wider spacing of DBS satellites, will allow the use of dishes smaller than two feet in diameter.

Eight orbital positions, spaced 9 degrees apart, have been allocated by the FCC for U.S. DBS satellites, and the 12.2–12.7-GHz portion of the Ku-Band has been set aside exclusively for DBS. Because they are spaced so far apart, small-sized dishes will have no trouble discriminating between signals, as they would with closer-spaced birds. The two HS 601 satellites will provide coverage over the 48 contiguous states.

(Continued on page 75)

Build a Beverage Cooler

BY JAMES MELTON

Keep your soft drinks cool, even during a sweltering summer heat wave!

There are several reasons why electronics hobbyist elect to build projects; for example, it can be fun as well as educational. However, there is a practical side to the hobby; hobbyist often must build things that they cannot afford to buy, or those that are simply not commercially available. The *Solid-State Beverage Cooler* described in this article falls into the latter category. The Solid-State Beverage Cooler, as its name implies, is a project that is designed to keep a soft drink or other beverage cold. That is, if a canned drink is placed in the cooling chamber, it will be kept cool indefinitely.

About the Project. The Solid-State Beverage Cooler is built around a cooling module that makes use of the "Peltier effect," which is similar to the effect used in thermocouples; however, the effect is applied in reverse. What that means is that instead of a temperature difference between two junctions causing a current to flow, a current flow is used to cause a flow of heat.

A thermocouple is formed when two different metals are joined together. You can make your own thermocouple for experimental purposes by screwing two pieces of copper wire on either end of an aluminum standoff, as shown in Fig 1. If a voltmeter is attached to the copper wires, and one of the copper/aluminum junctions is placed in proximity to a heat source (such as a candle flame), the meter will register small amount of voltage. The hotter the heat source, the higher the voltage. Similarly, the cooler the cold end gets, the greater the voltage.

With a crude thermocouple like the one shown in Fig. 1, of course, you'll not be able to power any equipment—it does, however, demonstrate the thermoelectric effect. It also simulates the Peltier effect. If a current is passed through the copper/aluminum junctions, one of the two junctions will experience a temperature rise, while the other junction will experience a temperature decrease. But that effect will be so slight on this crude model so as to be virtually undetectable.

Modern solid-state Peltier junctions are formed from various metals, which are doped like semiconductors. Depending on the doping, the metal will either have an excess of electrons (P-type material) or holes (N-type material) in its atomic structure. The metal junctions formed from the two types of doped material act kind of like a thermocouple, but are much more efficient.

Figure 2 illustrates the make up of a commercial Peltier cooler junction. In a commercial junction device (cooling module), more than 50 junctions are series-connected electrically and parallel-connected thermally. That results in a device with an impedance that's high enough so that the cooling modules can be connected directly to a 12-volt power supply.

The Cooler. The cooler itself was built using almost every available means to make it easy, fast, and fun. The cooling module was bought commercially. (I have included the addresses of two places that sell cooling modules in case you have trouble locating one; see the Materials List.) Most of the construction of the cooling module/heat-sink combination was done with epoxy adhesive. That leaves the top of the unit clean in appearance, and helps a little more with the heat transfer efficiency.

The power for the circuit is provided by a commercial (surplus) 12-volt DC, 3-amp power supply that was originally intended for computers. Such a regulated power supply is required because a "brute force" supply will have too much ripple, which will produce excessive heat that must be dissipated somehow. For the convenience of using the cooler in my car, I attached a 12-volt cigarette-lighter power adapter to the unit's cord.

The heat sink has two major requirements: it must be big (far larger than you might think) and it should not

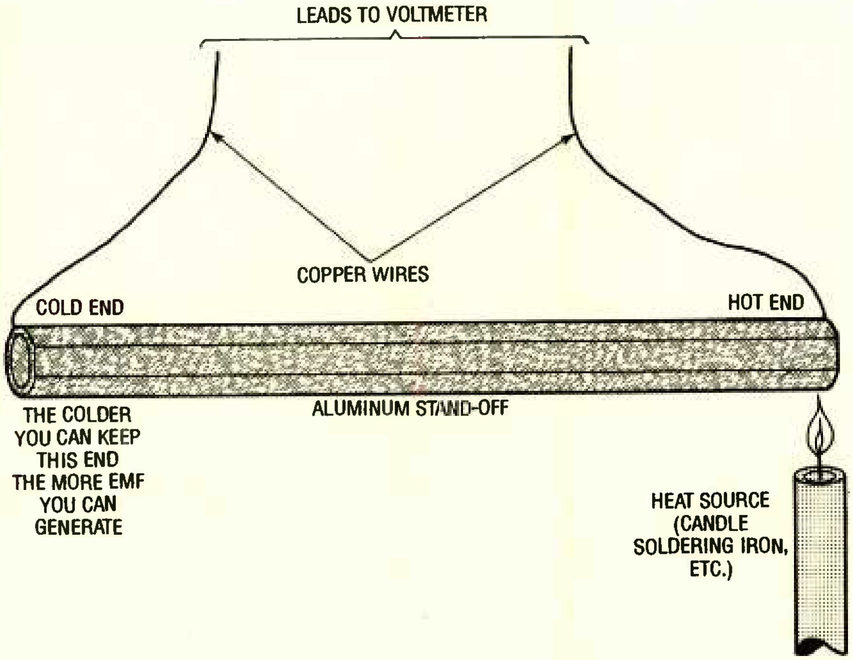


Fig. 1. Modern solid-state Peltier devices are formed by joining two dissimilar metals, which are doped in the same vein as semiconductors to form junctions. Depending on the direction of the applied current, one junction will experience a temperature increase, while the other will experience a temperature decrease.

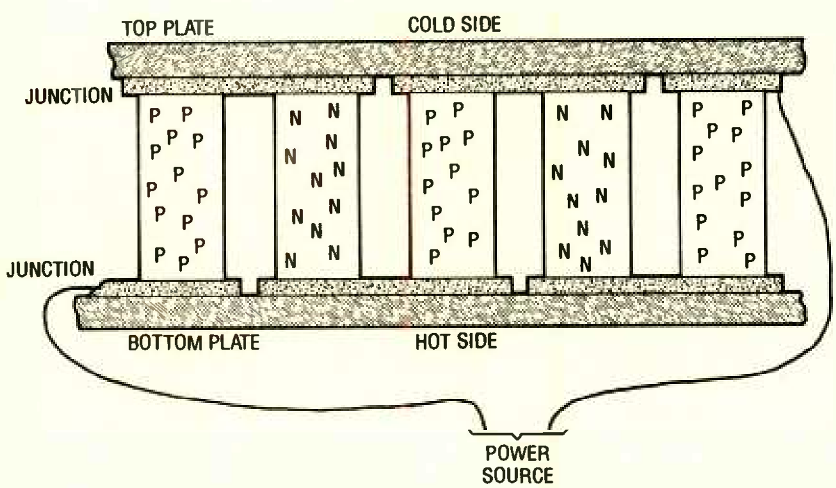


Fig. 2. This illustration shows the make up of the commercial Peltier cooler junction. In a commercial junction device (cooling module), more than 50 junctions are series-connected electrically and parallel-connected thermally.

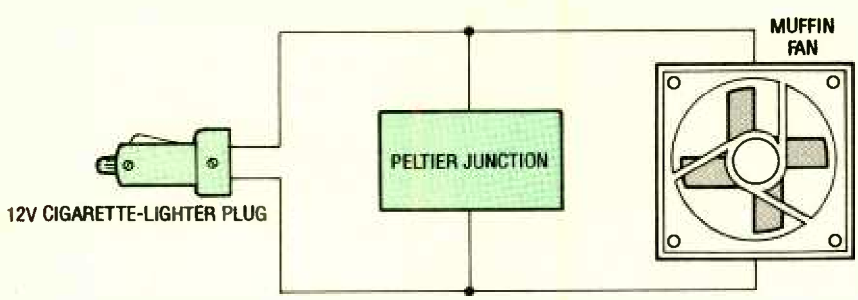


Fig. 3. A small muffin fan is connected in parallel with the cooling module, and in series with the power supply so as to increase the amount of cooling available from the heat sink by several degrees.

MATERIALS LIST FOR THE SOLID-STATE BEVERAGE COOLER

- Thermoelectric cooling module (Melcour CP1.4-71-06L or equivalent)
- 12-volt DC miniature muffin fan
- 12-volt DC power source (see text)
- Large heat sink
- Double-walled soft drink container
- Power supply (see text)
- Enclosure, wire, solder, epoxy, hardware, etc.

Note: Cooling modules can be obtained from Melcour, 1040 Spruce Street, Trenton, NJ 08648 Tel. 609-393-4178; and American Science and Surplus, 601 Linden Place, Evanston, IL 60202. Contact the companies directly for current pricing, shipping, etc.

have any holes at all in the area where the cooling module is to be mounted. That last requirement might be a little hard to meet with general junkbox materials, however, it is essential that you have the best heat transfer to the heat sink obtainable.

As shown in Fig. 3, a small muffin fan is included in the project so as to increase the amount of cooling available from the heat sink by several degrees. The lowest temperature of the cooling module, after the excess heat of the soft drink has been removed, depends on the lowest temperature that can obtained on the heat sink. In the design presented here, the lowest possible obtainable temperature is approximately 30°F below the ambient temperature.

You need a soft-drink container of the type typically sold in gas stations. Such containers are double walled and are ideal for the cooling chamber of this project.

Construction. Begin construction of your cooler with the base (or enclosure), which will hold the cooling module/heat-sink combination and the muffin fan. Obviously, there is nothing critical about the dimensions or layout of the base—it merely has to have sufficient room to accommodate the cooler components.

The cooling module by itself is very ineffective, so you have to help it out every step of the way. To that end, a hole, about 2 inches in diameter, must

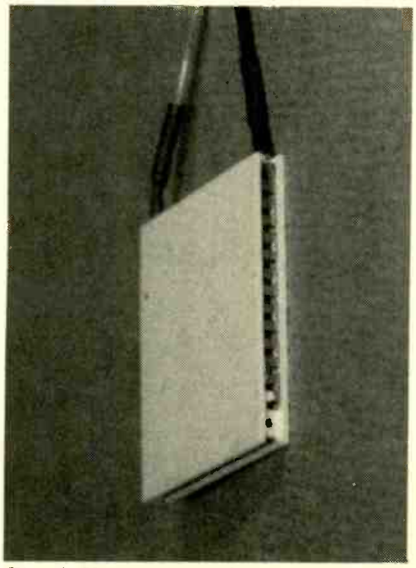


Fig. 4. Here is the cooling module prior to installation in the project. Unmarked units can be tested by attaching a D-cell battery to the cooling module's two leads to determine the hot and cold sides of the device. Under power, one side of the module will be hot while the other will be cool.

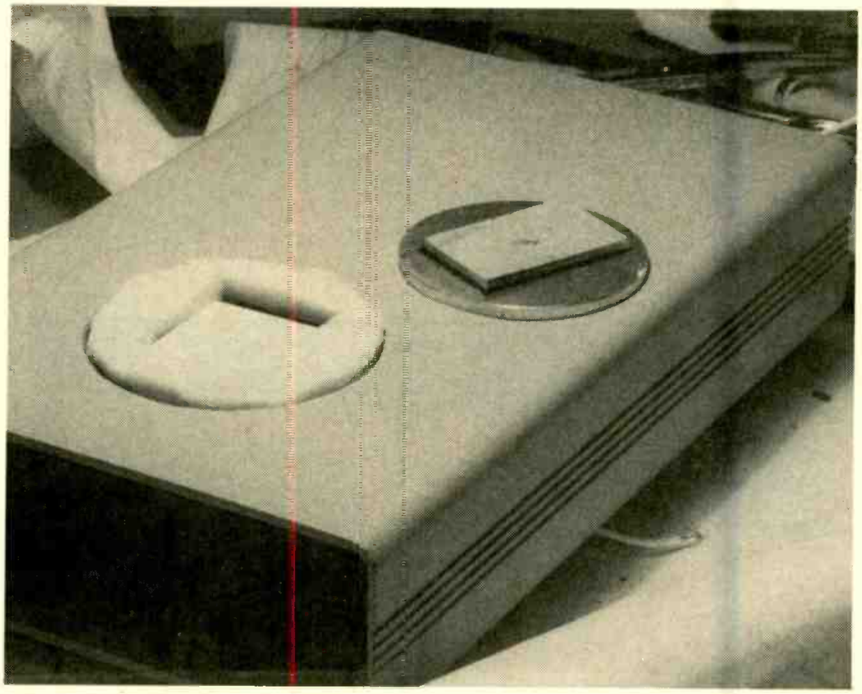


Fig. 5. Using the pieces of aluminum left over from the holes in the base, make a platform (which consists of two pieces) for the soda can. A rectangular aluminum piece, which rests against cooling module, lifts the top circular platform piece into the chamber where it can contact the beverage can.

be made in the top of the base to expose the heat sink. Cut the hole carefully; the cut-away portion of the hole will be used later. Then flip the base over, cut another circular hole in the bottom of the base for the fan. The material from this cut-out will also be used.

After cutting the holes, mount the heat sink inside the enclosure, centered under the 2-inch top hole and flush to the inside surface of the base, using epoxy—the epoxy makes for the best heat transfer possible and also leaves the top of the box smooth.

Figure 4 shows the cooling module. While it's free of its enclosure, attach a D-cell battery to its leads—red to positive and black to negative. Feel both sides of the cooling module to determine the hot and cold side; then mark the hot side with an "H" using a soft pencil. That helps to orient the device in the cooler later.

After the epoxy holding the heat sink has cured, place the cooling module on top of the heat sink, and mark appropriate holes in the heat sink for the leads of the cooling module to go through. Then drill and deburr the holes. Next mount the muffin fan. The muffin fan should be mounted so that it blows out of the bottom (as the author did) or the side of the base. However you mount the

Fig. 6. With the top plate and insulation in place, allow the epoxy to cure, before moving on to the final phase of the cooling chamber construction.

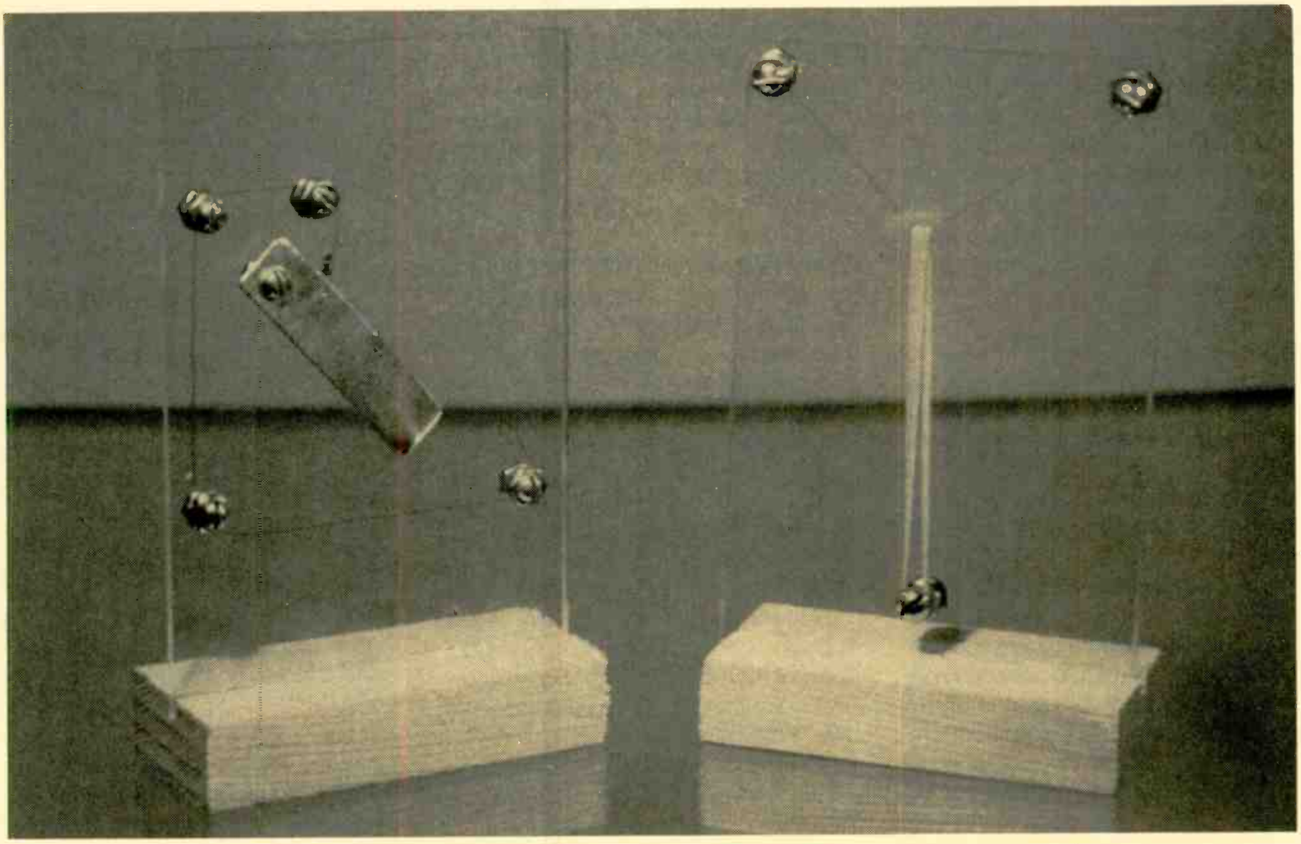
Fig. 7. Here is the business end of the Solid-State Beverage Cooler.

fan, make sure that the flow of air is unobstructed. (I cannot stress enough that the amount of air flow and the size of the heat sink will have a major effect on the final temperature of the cooler.)

Place the cooling module back on top of the heat sink and pre-form the leads so that there is no strain when the cooling module is epoxied in place. After forming the leads, epoxy the cooling module to the smooth top surface of the heat sink. Pass the leads through the heat-sink holes. While the epoxy is curing, clamp or weight the cooling module to ensure that there will be a good strong bond.

Using the pieces of aluminum that you saved when making the holes in the top and bottom of the base, make a piece that will serve as a platform for beverage cans. The platform, which consists of two pieces, is shown in Fig 5. The rectangular piece, which rests against cooling module, lifts the top circular piece into the chamber where it can contact the beverage can. The rectangular piece also leaves room for some foam insulation between the cool top plate and the hot bottom plate. I used the bottom from a foam drink keeper for the insulation.

(Continued on page 81)



Experimenting With Shaped Memory Alloys

Learn about Shaped Memory Alloys and how they work, then perform some hands-on experiments with these fascinating materials

BY JOHN IOVINE

Shaped Memory Alloys (SMA) are alloys of two or more metals that have some interesting properties. One property of the material is that it contracts when heated. This is analogous to the contraction of muscle tissue; note that this effect is the opposite of standard metals, which expand when heated and contract when cooled.

Another property of these alloys is called the Shaped Memory Effect (SME). Simply put, this material will, when heated to a critical temperature, return to a shape that it has been trained to "remember." In short, this material could be twisted, bent, and folded, but when heated it will return to its original shape.

History. In 1932, Arne Olander, a Swedish researcher, discovered the Shaped Memory Effect in a gold-cadmium (AuCd) alloy. In 1951, two researchers, L.C. Chang and T.H. Read, analyzed the crystal structure and changes of the Shaped Memory Effect in the AuCd alloy, and in 1958 those two researchers made a cyclic weight-lifting device to be displayed at the Brussels World Fair.

In 1961, William Beuhler working at U.S. Naval Labs discovered SME in an alloy of titanium-nickel. At the time, Beuhler and his team were looking to develop a heat and corrosion resistant alloy. In any case, the alloy they discovered was, by far, cheaper and safer to work with than any SME alloy to date. The team named the new alloy Nitinol, pronounced night-in-all. The material's name is representative of its elemental components and place of origin. The "Ni" and "Ti" are the chemical abbreviations for nickel and titanium, and "NOL" stands for the "Naval Ordnance Laboratory" where it was discovered.

In later years, other alloys were discovered that exhibited SME. In 1985, Dr. Dai Homma of Japan's Toki Corporation announced an improved version of Nitinol. That improved version of Nitinol is sold in this country under the name trade name BioMetal. A California company, Mondo-Tronics, sells Nitinol wire under the trade name of Flexinol.

There are many interesting applications for this material. NASA had proposed using Nitinol to make space craft antennas that would deploy when heated by the sun, or a secondary heating unit. More down to earth ventures are its use in eyeglass frames, dental-alignment material, pumps, blood filters, solenoids, and an artificial heart.

How it Works. The properties of Nitinol rely upon the crystal structure of the material. That structure is sensitive to both external stress and temperature. Before we discuss the actual mechanics involved, we must define the temperature phases of the material.

Parent Phase refers to a state that exists above the transition temperature, the temperature where the wire contracts or returns to a previously defined shape. In this phase, the crystal structure is cubic. The transition temperature depends upon the exact composition of the material. For the Nitinol wire we will be working with later on in this article, the transition temperature is 100–130°C (190–260°F).

Martensitic Phase refers to state that is below the transition temperature. The crystal structure is needle-like and is collected in small domains. Within each domain, the crystals are aligned. The material is cool and can be bent or formed into other shapes. That external stress transforms the crystal structure of the material. It is sometimes called stress-induced martensite.

The Annealing Phase occurs at a temperature where the material will reorient its crystal structure to remember it's current shape. The annealing phase for the material we are working with occurs at a temperature of 540°C.

With those definitions under our belt, we can discuss how the material works: When a cooled wire is bent or twisted, the crystal structure is transformed. If the wire is then heated above its transition temperature (Parent Phase), the crystal structure changes from needle-like to cubic. Since the cubic crystals don't fit into the same space as the needle-like crystals, they are formed under strain. To relieve this strain they move and change their positions to relieve the strain. This "least strain" position happens to be the original shape (or the annealed shape) of the material.

Where the wire hasn't any stress-induced transformations, the crystal structure still changes, but that change results in no net movement.

Properties. Nitinol metal can generate a shape-resuming force of about 22,000-pounds-per-square-inch. In our experiments later on, we will be using a 6-mil wire. Even so, a 6-mil wire (.006 inch diameter) can generate a contractive force of 11 ounces. If you want more pull, simply multiply the wires till you reach the contractive force you require.

Nitinol wire, as stated previously, is sold under the trade name of Flexinol by Mondo-Tronics. The wire diameter is given in micrometers as a number suffix of the name Flexinol. So Flexinol 150 is a Nitinol wire with a diameter of 150 micrometers. To convert micrometers to inches multiply by .00003937. Doing that, we find the diameter of Flexinol 150 is 6 mils (.006 inch).

The wire can contract up to 10% of it's length. To extend the life of a given sample (greater than 1,000,000 cycles), you should restrict the contraction to only 6% of its length.

Reaction time can be quite short, measured in milliseconds. In addition, full strength is developed at the beginning of the cycle.

The Nitinol material is stronger than many steels. The 6 mil wire has a breaking strength of about 6 pounds.

Activating Nitinol Wire. The easiest way to heat the wire is by passing an electric current through it. The wire's resistance to the current heats the wire and causes it to contract. The volume of the wire doesn't change during contraction, so as the wire decreases in length, it diameter increases by a proportional amount, keeping the volume the same. The activation temperature of the wire is 100 to 130°C (or 190-260°F).

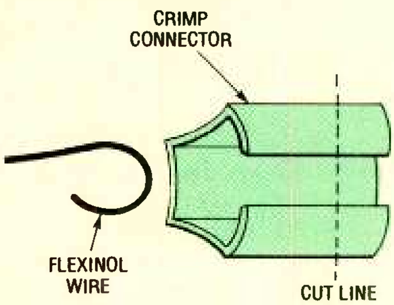


Fig. 1. Soldering directly to the Nitinol wire could adversely affect it. The supplier mentioned in the article supplies crimp terminals that get around that problem.

PARTS LIST FOR THE NITINOL DEMONSTRATION

U1—4011 quad NAND gate, integrated circuit
Q1—IRF511 MOSFET transistor
R1—15,000-ohm, ¼-watt, 10% resistor
C1—1-µF, 35-WVDC, tantalum capacitor
B1—9-volt transistor-radio battery
S1, S2—SPST toggle switch
Nitinol wire, perfboard or plastic, hardware, rubber band, enclosure, etc.
The following are available from Mondo-Tronics, 524 San Anselmo Ave., #107, San Anselmo, CA 94960; Tel. 415-455-9330, 800-374-5764: Shape Memory Wire Guidebook and Sample Kit (part no. 3-074), $29.90; 40 inches of Flexinol 150 (part no. 3-072), $14.95. Please add $4.00 for shipping in the U.S.; international orders add $9.00. California residents must add 8.25% sales tax.

Care should be taken not to overheat the wire or its properties will degrade. The wire has an electrical resistance of a little less than 1-ohm-per-inch. Flexinol wire is supplied with crimp terminals (see Fig. 1). These terminals are used to make connections to the material because the Nitinol wire should not be heated to the temperature that would be required for soldering.

Direct Electric Heating. Nitinol wire can be activated using low voltage, such as a 9-volt transistor-radio battery. A simple circuit can be built using a battery, switch, and a small length of Nitinol (see Fig. 2).

Again, care must be taken not to overheat the wire. In addition, connections to the Nitinol will draw heat away from the ends of the wire. That results in the center of the wire heating faster than the ends. So although direct electric heating works, a better method is pulse-width modulation.

Pulse-Width Modulation Heating. In this technique, a squarewave from a simple circuit is used to turn the electric current on and off. Depend-

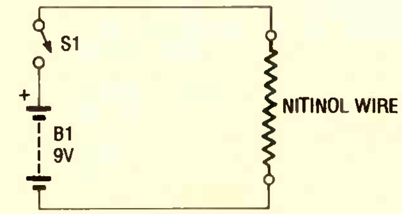


Fig 2. While this is the simplest way to activate Nitinol wire, it has some important limitations.

ing upon the frequency and duty cycle of the squarewave, we can adjust the amount of contraction and maintain the wire in a contracted condition for a longer period of time. Because of the rapid on and off action of the waveform, the wire has time to distribute the heat, which results in a more uniform heating. That is the method that we shall use in our experiments.

The Circuit. The circuit we shall use (see Fig. 3) is designed around a 4011 quad NAND gate. The NAND gate is configured as a squarewave generator. The circuit can be operated manually using a switch (S1), or it can be interfaced to any computer by deleting the switch and connecting the circuit (via pin 1 of U1) to a port line that can be brought high and low under program control. The 4011 can't handle the current requirements of the Nitinol wire, so the wire is interfaced to the rest of the circuit via an IRF511 MOSFET.

Nitinol Demonstrations. To demonstrate the potential of this material, we need to build a small mechanical device. If you're like me, you'll want the simplest unit to start with. To make our electric "muscle," the materials you'll need are 3 machine screws with six nuts, a piece of perfboard or plastic, a small rubber band, and, of course, a length of Nitinol material.

Look at Fig. 4. Three machine screws are arranged in a triangular pattern in the perfboard or plastic as shown. The Nitinol wire is connected to the two top screws. The rubber band is looped around the bottom machine screw, with the Nitinol wire looped through the top of the rubber band. Begin by drilling two holes to accommodate the top two screws. To determine the location of the third (bottom) machine screw, stretch the rubber band from a position that is parallel with the top screws and down. Remember the Nitinol has a pull of about 11 ounces so don't make the rubber band so tight that the Nitinol isn't able to contract and move upwards, although it should be tight enough for it to take up the slack of the Nitinol wire when it is relaxed. Drill the third hole and build the assembly as shown. Finish up by connecting the Nitinol wire to the circuit of Fig. 2.

When the unit is activated, the wire gets hot, contracts, and pulls up the rubber band. When the unit is deactivated the wire cools, elongates, and lowers the rubber band into its resting position.

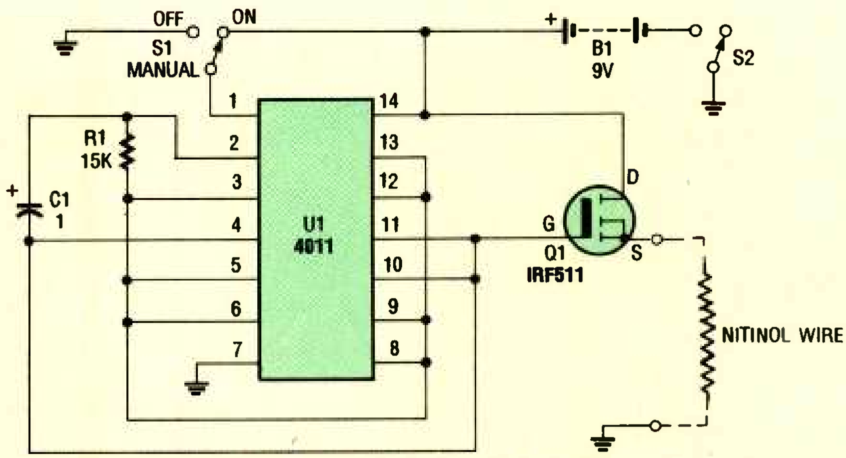


Fig. 3. This circuit produces a squarewave output and provides a much better way to activate the wire. It can be manually controlled as shown, or, with some simple modifications, can be interfaced to a computer.

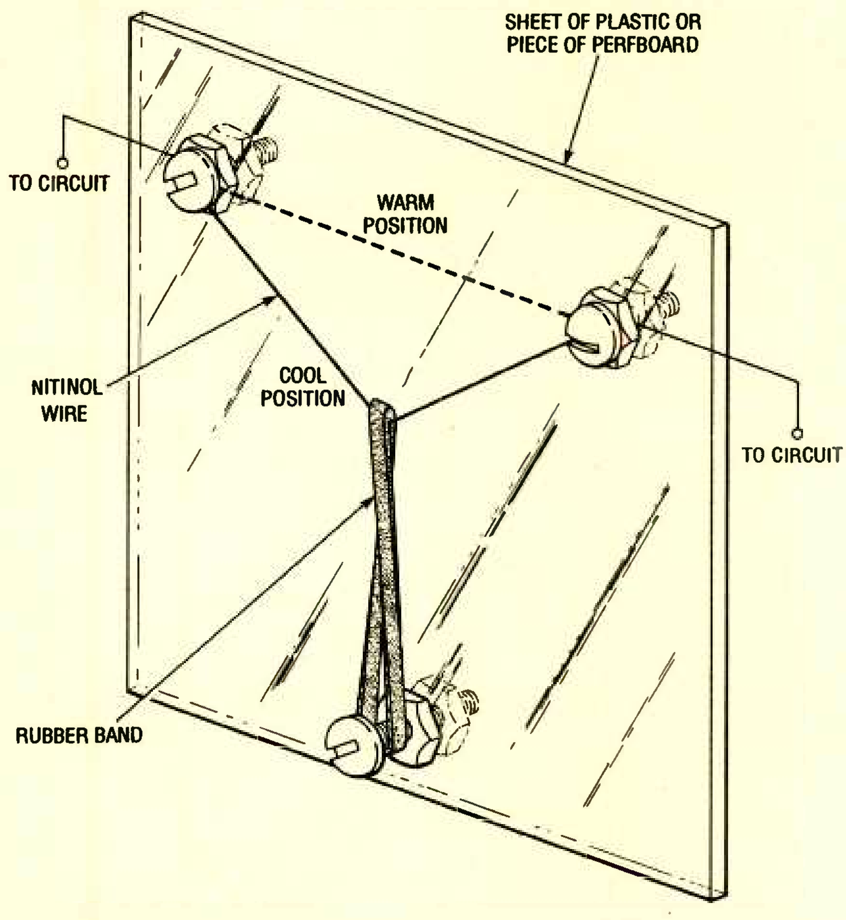


Fig 4. This simple demonstration is easy to build, and shows off the basic properties of the Nitinol wire.

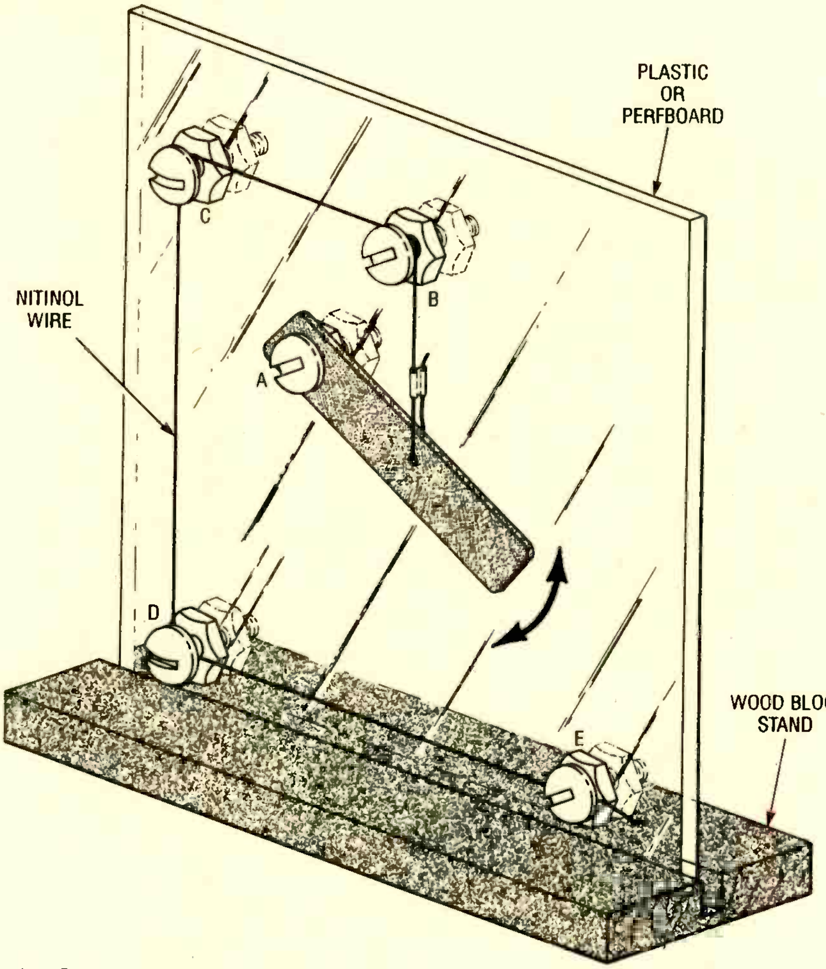


Fig 5. Another simple demonstration, this time showing how the Nitinol wire can be used to move a lever.

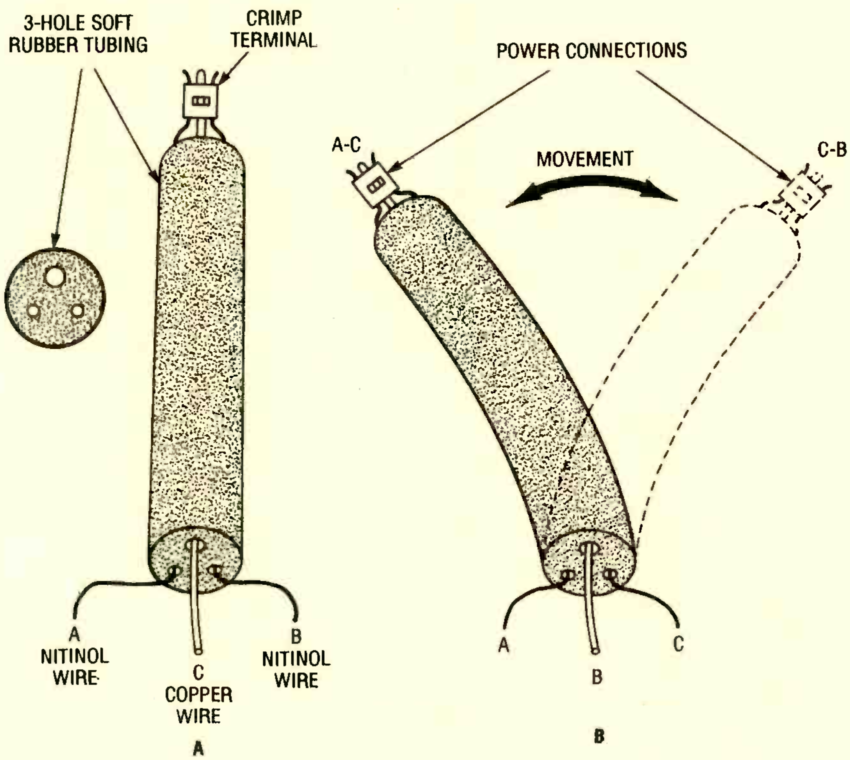


Fig. 6. This simple one-digit flexor can be bent to the left or the right depending on how power is applied to the three leads.

I also built a second Nitinol demonstrator, shown in Fig. 5. That unit shows how you can amplify the mechanical motion of the wire using a lever. The lever pivots on screw A. The Nitinol wire is attached to the lever and screw E. The wire is threaded around screws B, C and D. When activated, the lever rises.

The lever can be made from wood, plastic, or metal. If you use a metal lever, you can make the electrical connections to the wire through screws A and E. If the lever is made from a non-conductive material, use screws B and E for the electrical connections.

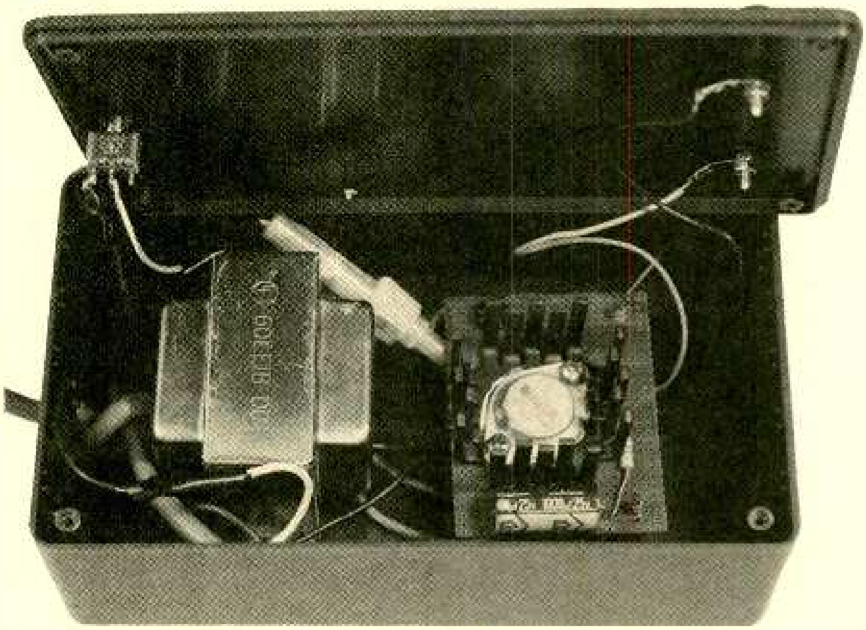
Going Further. We have just scratched the surface of the potential of this material. It is quite possible to build a realistic android hand. As an example, consider the simple single-digit flexor that is illustrated in Fig. 6A. That unit is built using a three-hole soft-rubber or silicone tube. The Nitinol wire is threaded in a loop through the two outer holes. A copper wire is threaded up through the center hole. The loop of Nitinol wire and the end of the copper wire is crimped in a small terminal. By applying current between the copper wire and one end of the Nitinol you can make the tube flex right (A-C) or left (B-C), as shown in Fig. 6B. Or by applying power to the two ends of the Nitinol wire the tube will flex backwards.

Heat engines are another fertile field for experimentation and development. One company sells a toy boat powered by Nitinol wire. The boat has a small cargo bay for ice. The difference in temperature between the ice and the water the boat rests in powers the toy boat.

You may want to attempt to train a piece of Nitinol wire to a particular shape. You can do this by bending the wire to the shape you want, clamping it in position and heating it to about 540°C. You also might want to try direct electric heating of the wire to reach the annealing temperature.

Mondo-Tronics sells a book titled *Working with Shaped Memory Wires*, which shows various actuators and uses of this material. Several Nitinol-wire samples with various diameters are included with the book. It is a worthwhile investment if you plan on doing any experimentation. ■

Build a CONFIGURABLE



POWER SUPPLY

An inexpensive, configurable power supply to suit any device in need of 1.2 to 33 volts at up to 1.5 amps!

BY JOHN YACONO AND MARC SPIWAK

Power supplies are not something that we think about often—we usually take them for granted. But when you think about it, where would electronic projects be without them? And for that matter, where would this magazine be without them? The fact is, we don't usually think about power supplies until we need one.

Usually a power supply is built specifically for a certain project, and incorporated right into the project itself. However, general-purpose power supplies can be even more useful, lending themselves to all sorts of applications. So, what we've got here is a very basic power supply that can be adapted to almost any project. The 12-volt power supply that we came up with was actually built for powering car radios indoors, but it is useful for any 12-volt accessory. With just a few part substitutions, the supply can have an output of from 1.2 to 33 volts—which should be good for nearly anything you can think of. If you'd like to build one of these no-nonsense power supplies, then read on.

Adjustable Voltage Regulators. The adjustable voltage regulators that are readily available today are a great boost to hobbyists building power supplies. Unlike fixed regulators, adjustable units can be programmed to output any voltage within their operating range. (The minimum and maximum output voltage varies from model to model and manufacturer to manufacturer.) Furthermore, the devices come in positive and negative "flavors" to suit any reasonable application.

Our power supply uses an LM317 positive-voltage adjustable regulator. It can produce an output voltage ranging from around 1.25 to 33 volts. We buy these units in place of standard regulators (5-volts, 9-volts, 12-volts, etc.) simply because they can provide any voltage required to suit most needs. As long as one or two of those devices are around, there's nothing to stop us from building any project we desire.

As regulators go, adjustable units provide excellent ripple rejection and have a neat short-circuit shut-off feature: If you short the regulator's output, it shuts down and automatically turns back on when the short is removed. They also shut down if they become too hot.

To add to their value, adjustable regulators are easy to use. In Fig. 1A, a positive adjustable regulator is shown with its two programming resistors in place. A negative adjustable regulator is shown in Fig. 1B. For the sake of discussion, we'll talk about positive regulators, but keep in mind that the exact same rules apply for negative regulators; the only difference is that the input and output voltages for negative regulators are, of course, negative.

Resistor R1 is usually chosen to be around 240 ohms to provide optimal performance, but we often use 220-ohm resistors without the least bit of trouble. While the value of R1 is pretty standard, the value of R2 determines the output voltage of the regulator according to the relation:

$$V_{OUT} = 1.25(1 + R2/R1) + R2^{*}I_{adj}$$

where I_{adj} (the adjustment current, as it's called) is usually between 40 and 50 µA. That amount of current is so small that you can often disregard it and use this abbreviated equation:

$$V_{OUT} = 1.25(1 + R2/R1)$$

Since you usually know the voltage you want, let's rearrange the equation to find R2 based on V_{OUT}:

$$R2 = R1(V_{OUT}/1.25 - 1)$$

There are just three restrictions that you should bear in mind when using an LM317. First, the supply to the regulator should be filtered to supply at least 3-volts rms more than the desired V_{OUT}. That fact will help you to determine the secondary voltage of the

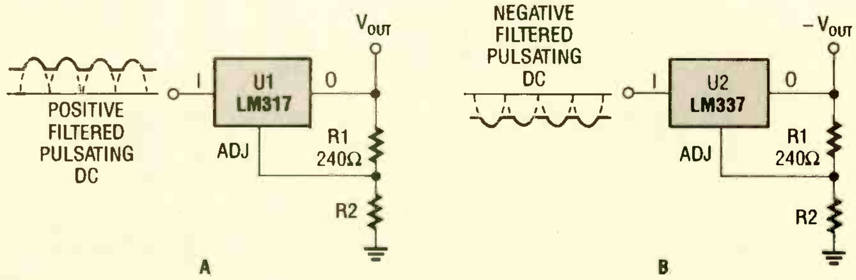


Fig. 1. Adjustable regulators are easy to use. Whether you need a positive (A) or a negative (B) output voltage, you just have to add two resistors and a filtered source of pulsating DC.

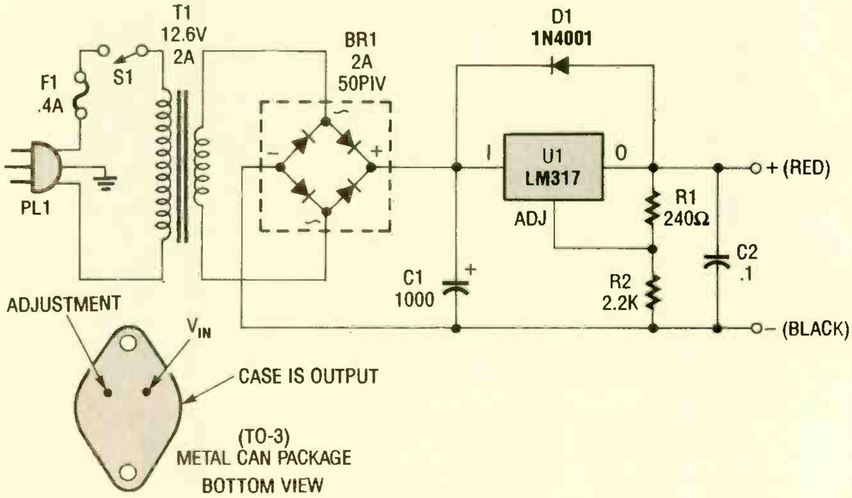
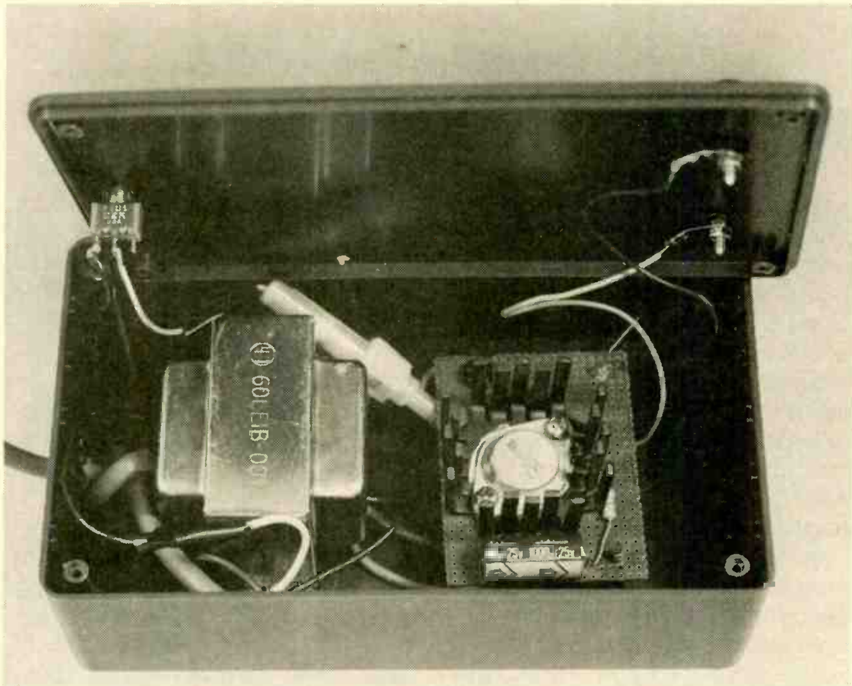


Fig. 2. The adjustable supply can easily be reconfigured by altering the value of R2 and beefing up some other components as necessary.



Because the case size was chosen for the size of the transformer, there's plenty of room inside for the board.

PARTS LIST FOR THE CONFIGURABLE POWER SUPPLY

SEMICONDUCTORS

U1—LM317 adjustable positive-voltage regulator, integrated circuit
BR1—2-amp, 50-PIV, full-wave bridge rectifier (see text)
D1—1N4001 1-amp, 50-PIV rectifier diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—240-ohm
R2—2200-ohm

CAPACITORS

C1—1000-µF, 50-WVDC electrolytic
C2—0.1-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

F1—0.4-amp fast-blow fuse
PL1—3-terminal molded AC power plug with line cord
S1—SPST toggle switch
T1—125-volt primary, 12.6-volt, 2-amp secondary, power transformer (see text)
Perfboard, case, rubber grommets, heat sinks, fuse holder, wire, solder, hardware, etc.

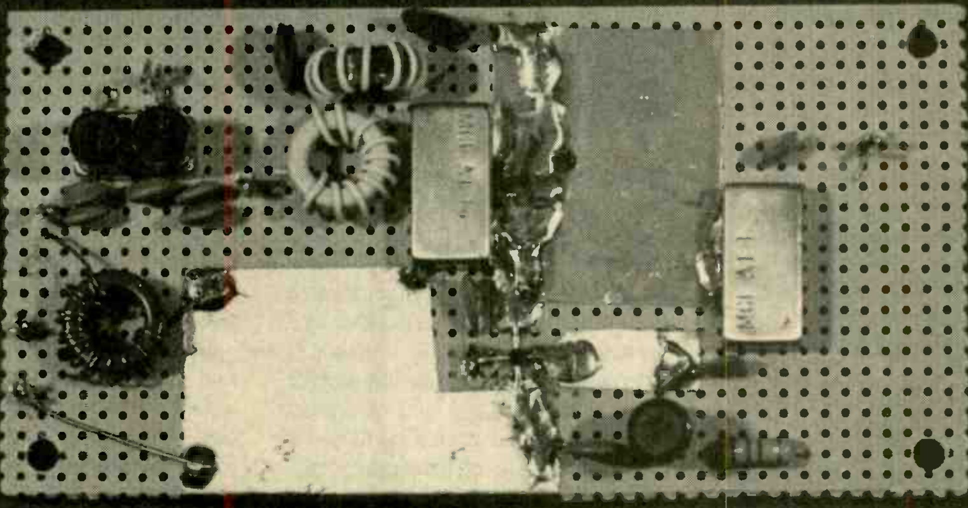
transformer that you should use to supply the LM317 in your design. Second, make sure the the difference between the input voltage to the regulator and the output voltage from the regulator is less than 12 volts rms. That will guarantee at least a 1.5-amp output at the rated voltage, with a possible maximum current of 3.4-amps with good heatsinking. Third, if substantial current (more than ¼-amp) is to be drawn from the regulator, use a heat sink.

One last thing to be aware of is the fact that adjustable regulators have different pinouts than constant-voltage models. In a similar vein, positive and negative adjustable regulators don't have the same pinouts as one another. That's enough theory for now, let's get to the real circuit.

The Circuit. The transformer's primary in the power supply (see Fig. 2) is connected to the AC line via S1 and F1. The value of F1 has been selected to prevent the secondary (yes, the secondary) from experiencing too much current.

(Continued on page 81)

Receiver Preamplifiers That You Can Build



BY JOSEPH J. CARR

Design and build a "front end" for your shortwave or VHF/UHF receiver

Receiver preamplifiers, which are used to boost weak signals before they are applied to a receiver's input terminal, come in two basic forms: tuned and untuned. The tuned version, also called a preselector, passes only one frequency at a time. The untuned version, on the other hand, is designed to pass a wide range of frequencies at the same time.

Until very recently, the task of designing and building very wideband amplifiers was daunting. Stray inductances and capacitances, as well as the limitations of the active devices (usually transistors) in the circuit, conspired to thwart success. While there were a lot of circuits laid out in print, it wasn't until monolithic microwave integrated circuit's (MMIC's) came on the scene that very wideband preamplifiers became easy for electronic hobbyists to build.

Although MMIC's had been around for a while, they were previously limited by price to high-cost equipment. Today, however, hobbyists can easily obtain MMIC's at low cost. The MAR-x series of MMIC's (available from Mini-Circuits, P.O. Box 350166, Brooklyn, NY, 11235-0003) are some of the most useful for projects like the preamplifier circuits that will be discussed in this article.

MMIC. Figure 1 shows the MAR-x package outline. On the surface, it looks like any UHF/microwave transistor. The leads (radiating outward from the body of the unit) are not wires, as with other devices, but flat strips that reduce inductance (a prime limiting factor in VHF and higher frequency amplifiers).

As shown, MAR-x devices have only four leads, two of which are grounds (leads 2 and 4) terminals. The reason for two grounds is to distribute grounding, thereby reducing the inductance of the leads. The other two terminals are the RF input (lead 1) and the RF output (lead 3). Note that lead 1 is marked in two ways: the end of the lead is beveled, and there is a color dot next to it.

MAR-x's come in several varieties (which are designated by a number replacing the "x" in the dummy type number above). The MAR-1 can operate from DC to 1000 MHz (1 GHz), and provide gains of up to 18.5 dB, while providing a noise figure of 5 dB. Other devices (carrying suffixes 2, 3, 4, 6, 7, or 8) operate to 2,000 MHz, with noise figures as low as 2.8 dB. Thus, the MAR-x series can fulfill the requirements of a large number of applications.

Table 1 lists several MAR-x devices along with their capabilities and the unique color dot that indicates the RF-input terminal; the color of the dot indicates the MAR-x version.

An interesting aspect of the MAR-x series is that the input and output impedances of the device are inherently 50 ohms. There is no need to match impedances if the source and load impedances are 50 ohms. That single fact makes MAR-x devices extremely interesting to use, because much of the complex and finicky circuitry associated with RF amplifiers is for impedance transformation.

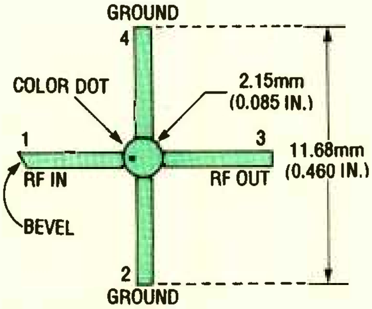


Fig. 1. The package outline of MAR-x series MMIC looks, on the surface, like any UHF/microwave transistor, with its flat leads radiating outward from the body of the unit. The leads (flat strips) help to reduce inductance, a prime limiting factor in VHF and higher frequency amplifiers.

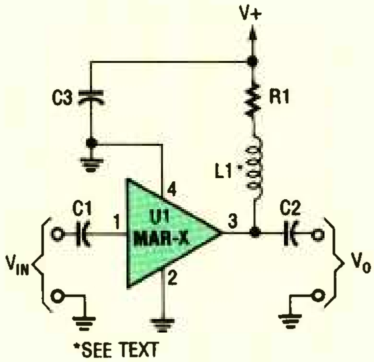


Fig. 2. In the basic MAR-x-based circuit, shown here, both the input and output are comprised of a single DC-blocking capacitor (C1 and C2 for the input and output, respectively). The DC power-supply network (comprised of L1 and R1) is attached to the MAR-x via the RF-output terminal (lead 3).

Basic MAR-x Circuit. Figure 2 shows a bare bones, MAR-x-based circuit that works well in nearly all cases. Note that both the input and output of that circuit consist of a single DC blocking capacitor (C1 for the input and C2 for the output). For frequencies up to 100 MHz or a little higher, C1 and C2 can be ceramic-disc units, but above 100 MHz, they should be chip capacitors. (Digi-Key—P.O. Box 677, Thief River Falls, MN, 56701-0677; Tel. 1-800-344-4539—sells Panasonic-brand, type 0805 and 1206 chip capacitors in 100-unit quantities.) In most cases, C1 and C2 should be 0.001-μF units, although for HF (below 30 MHz) circuits, 0.01-μF units are more suitable. For projects that are strictly for above 100 MHz, 100-pF or smaller capacitors are used.

TABLE 1—MAR-X CAPABILITIES

DEVICE	MAX. FREQ. (MHz)	GAIN (100/50/1000 MHz)	N.F.	COLOR
MAR-1	1,000	18.5/17.5/15.5	5	Brown
MAR-2	2,000	13/12.8/12.5	6.5	Red
MAR-3	2,000	13/12.8/12.5	6	Orange
MAR-4	1,000	8.2/8.2/8	7	Yellow
MAR-6	2,000	20/19/16	2.8	White
MAR-7	2,000	13.5/13.1/12.5	5	Violet
MAR-8	1,000	33/28/23	3.5	Blue

There is also a DC power-supply network, comprised of L1 and R1. The DC power-supply network is attached to the MAR-x via the RF-output terminal (lead 3). The basic component needed in that network is current-limiting resistor R1, with an RF choke (L1) being used in some cases. The resistor is used to limit current to a designed optimum value, which for the MAR-1 is 15 mA. The value of the resistor depends on the value of the V+ and the desired current level, as follows:

$$R1 = (V+) - (V)/I$$

where V+ is the power-supply voltage, V is the voltage at the RF-output terminal of the MAR-x device, and I is the current. Consider this example for the MAR-1 operating from a 12-volt DC supply, and providing +5 volts DC for V.

$$R = (+12) - (5)/0.015$$

$$R = 7/0.015 = 467 \text{ ohms}$$

Because the standard value of 470 ohms is close to 467 ohms, that value is selected instead. (Note: A 5% tolerance 470-ohm resistor may well have an actual resistance of 467 ohms, anyway!) The power dissipation of the resistor is 0.105 watts, so a quarter-watt resistor is sufficient. The resistor selected for R1 should be a non-inductive type such as carbon composition or metal film. No form of wire-wound resistor should be used in the circuit, not even those touted as non-inductive because they are non-inductive only in the audio-frequency range.

The optional RF choke (L1, which is used in many practical circuits) has two purposes: Choke L1 is used to prevent the RF output of the MAR-x from getting into the power-supply circuit or *vice versa*. The choke's other purpose is to act as a peaking coil to improve the circuit's upper-frequency response. The latter purpose is fulfilled because the load impedance seen by the MAR-x is the combination of the inductive reactance of L1 and the resistance of R1. Because L1's reactance increases with frequency, the load impedance is also higher at higher frequencies.

Now that we've got the basic circuit, let's put it together and make a workable project. I selected two projects. The first is a shortwave-band (high-frequency) preamplifier, and the other is a VHF/UHF preamplifier for monitors and scanner receivers.

HF SW Receiver Preamplifier. Figure 3 is an HF preamplifier that is designed to be used in front of shortwave receivers. It can be used to boost weak signals or to form a basic kind of active-antenna circuit (more on that later).

The input to the circuit consists of a broadband toroidal transformer that was made by winding 3 turns of #26 enameled wire on an Amidon Associates (P.O. Box 956, Torrance, CA 90508) T-50-2 (red) core for L1-a, and then winding 10 turns of #26 enameled wire on the same core for L1-b.

From there, the signal is fed to a complex LC network comprised of a 1600-kHz, high-pass filter and a 32-MHz, low-pass filter. Those filters are used to limit out-of-band signals. AM broadcast-band signals (less than 1600 kHz) are usually very strong at most locations, and can easily drive the preamplifier into saturation, causing big problems. The high-pass pi-filter (which is comprised of C1–C3, L2, and L3) is designed to attenuate signals below the 1600-kHz point, reducing their effect on the amplifier.

Inductors L2 and L3 can be made by winding 26 turns of #26 enameled wire over an Amidon Associates T-50-2 (red) toroidal core. However, I used a Toko adjustable core (available from Digi-Key). The Toko 332PN-T1018Z (Digi-Key part no. TK5136) is a good bet (I actually used a retuned 5.6μH version

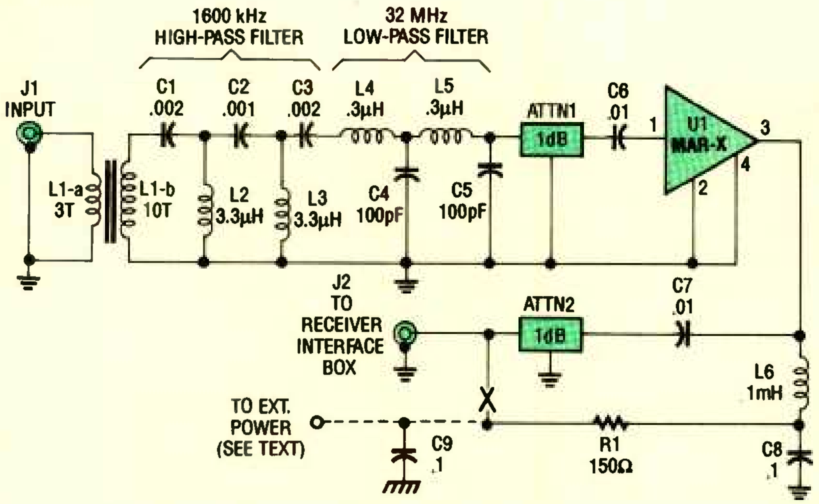


Fig. 3. The HF SW Receiver Preamplifier is comprised of a broadband toroidal transformer (L1-a and L1-b), a complex LC network (comprised of a 1600-kHz, high-pass filter and a 32-MHz, low-pass filter), L2 and L3 (26 turns of #26 enameled wire wound on an Amidon Associates T-50-2, red, toroidal core), a pair of resistive attenuators (ATTN1 and ATTN2), and of course, the MAR-x device.

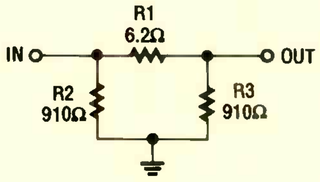


Fig. 4. Shown here is the composition of the basic 1-dB pi-network resistor attenuator used in the circuit of Fig. 3.

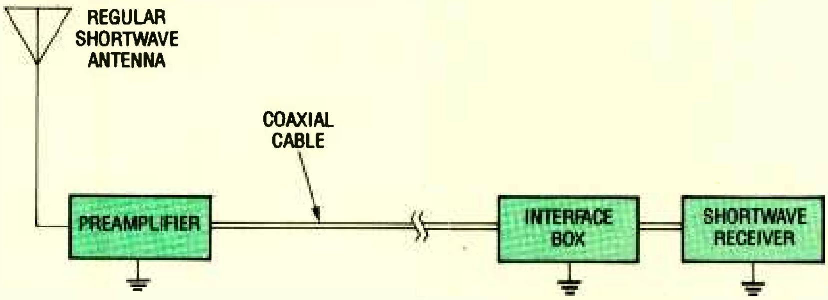


Fig. 6. In this set up, the preamplifier is used with an ordinary SW antenna (such as a random-length wire, vertical, or dipole) in the conventional manner.

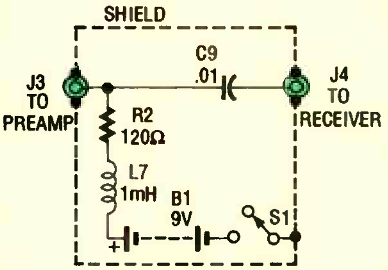


Fig. 5. The purpose of this receiver-interface circuit is to pass RF to the receiver through capacitor C9, while adding DC power to the feedline through R2 and RF choke L7.

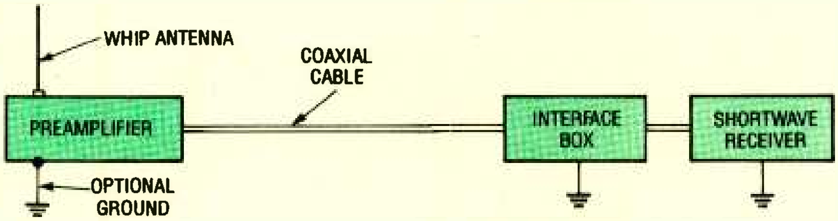


Fig. 7. In the active antenna setup shown here, the SW antenna from the previous setup is replaced by an 18-to 30-inch whip antenna.

of the same coil in the model I built and tested for this article, but that is not an optimum choice). The capacitors are NPO ceramic-disc units.

The two-section 32-MHz low-pass filter is designed to attenuate local VHF/UHF signals, but pass HF-shortwave signals. The capacitors can be NPO ceramic-disc or silvered-mica (the former are preferred) units. Inductors L4 and L5 (0.3-μH units) were made by winding 9 turns of #26 enameled wire on Amidon T-50-6 (yellow) cores.

From the 32-MHz filter, the signal is fed to the first of two 1-dB, 50-ohm resistive attenuators (ATTN1 and ATTN2) used in the signal line at the RF input and output of the MAR-x. Those attenuators are used to swamp out impedance variations in the source and load. Those impedances can vary considerably, and the attenuators help level them out as far as the MAR-x device is concerned. (I used Mini-Circuit's AT-1 1-dB shielded attenuators for the project. But if you don't want to purchase those parts, or cannot for some reason, then you can make them from ordinary ¼-watt, carbon-composition or metal-film resistors.) Figure 4 shows a basic pi-network attenuator pad that will drop the signal 1-dB with 50-ohm input and output impedances.

The output of ATTN1 is fed to U1. That portion of the circuit is essentially the same as the basic circuit of Fig. 2, with a 1-mH RF choke and a 150-ohm resistor supplying the DC power. The power supply end of the resistor is connected to the coaxial connector that carries signal to the receiver. The MAR-x's input and output capacitors (C6 and C7) are 0.01-μF ceramic-disc units.

In order to improve performance at higher frequencies, it is necessary to strip the leads of those capacitors of the ceramic material that flows down onto them during manufacture. A pair of long-nose pliers will crush the ceramic overflow so that it can be removed.

The preamplifier circuit can be placed remote from the receiver; *i.e.*, mounted on the antenna mast or other support structure. That remote capability is possible because the circuit sends DC power up the same coaxial-cable feedline that's used by the RF signals. Sometimes, a decoupling capacitor is used at the junction of L6 and R1 to limit the load impedance to the reactance of L6 (a 1-mH Toko choke, Digi-Key part #TK4312).

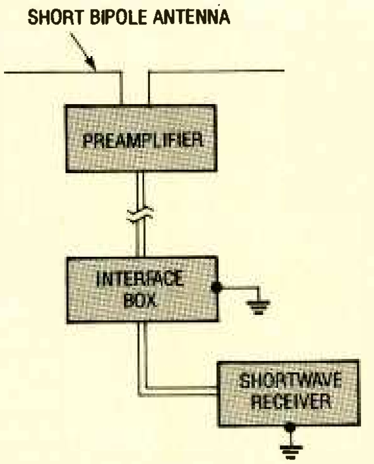


Fig. 8. Here the preamplifier is modified to unground the input coil (L1-a in Fig. 3) so that a bipole *(a small, two-element) antenna can connected.*

route it to the external power source. A 0.01-µF decoupling capacitor is needed in that case.

The preamplifier should be built into a shielded metal box, either die-cast type, or a sheet-metal box with overlapped edges between the top and bottom covers. That type of box prevents RF leakage into or out of the box. Flush-fit boxes are not well shielded and should be shunned for RF projects.

Receiver Interface. A receiver interface for the preamplifier is shown in Fig. 5. The purpose of the interface is to pass the RF signal to the receiver through capacitor C9, and to add the DC power to the feedline through R2 and RF choke L7. The DC power sup-

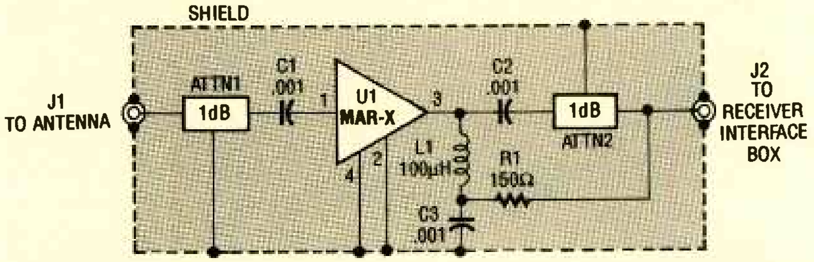


Fig. 9. Here's a VHF/UHF version of the preamplifier. The VHF/UHF preamplifier is similar to the basic configuration shown Fig. 2, while using the DC power-supply, feed system used in Fig. 3.

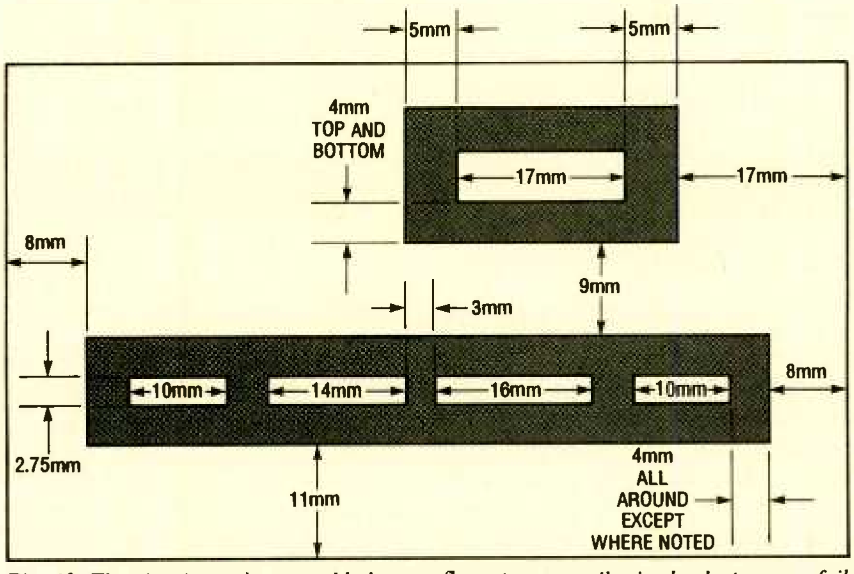


Fig. 10. The circuit can be assembled on perfboard, using adhesive backed copper foil and following the pattern shown here. The back of the board is a solid copper-foil ground plane.

If you wish to use the preamplifier closer to the receiver, with a DC power source that is not fed through the coaxial cable, then break the DC power line at point X in Fig. 3 and

ply is a 9-volt transistor-radio battery. As a precaution, an AC-derived power source is not recommended because the preamplifier is often used outdoors. Switch S1 (an SPST unit) is used to turn the preamplifier on and off.

The project can be built on a section of perfboard. There is some point-to-point wiring on the bottom side of the board, although the MAR-x connections are on the component side. Large ground-plane areas are made from adhesive-backed copper foil. (The foil material is sold in electronic parts stores for those who want to make pseudo-PCB's.)

Figures 6–8 show three different ways that the preamplifier can be used in shortwave-receiver systems. Figure 6 shows the conventional manner, in which the preamplifier is used with an ordinary SW antenna (such as a random-length wire, vertical, or dipole).

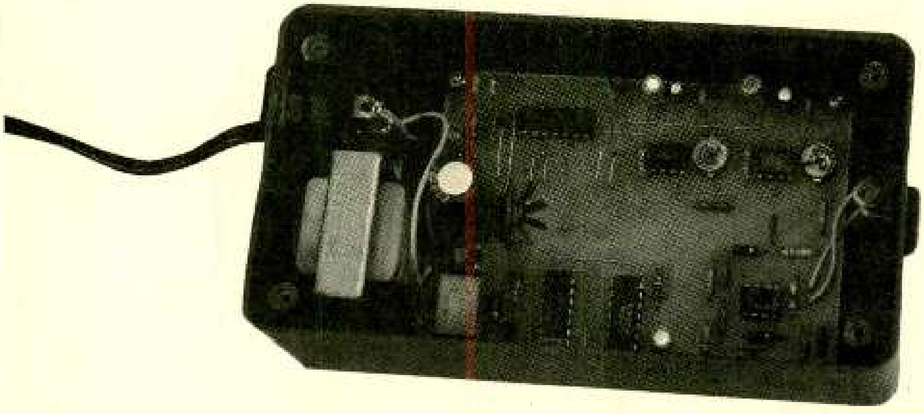
An active antenna setup is shown in Fig. 7. In that setup, the SW antenna from the previous setup is replaced by an 18-to 30-inch whip antenna. In testing that setup, I had good shortwave reception from my dining room table, using a 20-inch telescoping whip antenna that was soldered to the center conductor of a coaxial connector. The original antenna was intended as a portable radio replacement type.

Another active antenna setup is shown in Fig. 8. In that setup, the preamplifier is modified to unground the input coil (L1-a in Fig. 3) so that a *bipole* antenna can connected to it. So what's a *bipole* antenna? I coined that word for a small two element antenna, similar to a dipole. It is not a dipole because the antenna is of similar size to the whip used in Fig. 7. A regular dipole for shortwave bands would be at least 16-feet long for ten meters, and as much as 150-feet long at the lower bands.

VHF/UHF Preamplifier. Figure 9 shows the schematic diagram of a VHF/UHF version of the preamplifier. The VHF/UHF preamplifier is similar to the basic configuration shown Fig. 2, while using the DC power-supply, feed system shown in Fig. 3. The capacitors for the RF input and output must be 100-pF or 0.001-µF chip capacitors. In this circuit, the RF choke (used in Fig. 3) has been replaced by an Amidon Associate FB-43-101 ferrite bead, which is more suitable for VHF/UHF applications.

(Continued on page 98)

Build a



Whistle Switch

You won't just be whistling in the dark with this simple circuit that lets you turn on a lamps, a TV, a radio, or other electronic device with the right whistle tones.

BY DANIEL B. COOPER

There are many ways to turn a lamp on and off—via the switch on the lamp itself, a wall switch or touch-sensitive panel, or by remote control . . . and the list goes on. However, the most effortless way to accomplish that is to use some type of sound-activated control. Sound control offers possibilities. For instance, a voice-command-activated switch based on the VCP200 voice-recognition chip. Such a circuit would have its charm, but might be prone to false triggering during normal conversation.

Another possibility is the old "handclap" switch, which responds a clap of the hand or some other sharp noise. The difficulty with such a device is that it will react to any loud noise, including those not intended to switch the lamp! There is, however, a third alternative—the *Whistle Switch* that's described in this article—which offers the precision of a voice-activated switch with the simplicity of the handclap type, while offering better resistance to false switching than either.

Whistle Switch Design. The Whistle Switch, simply put, is a circuit that reacts to a specific tone or combination of tones. The easiest way for a human to generate a tone is by whistling. However, if the switch were to be designed to respond to a single occurrence of a single tone, it would be prone to false triggering if that tone were to materialize during normal speech or while listening music (perhaps from a television show, stereo, or person in the room).

To prevent that from happening, the Whistle Switch described herein was designed to respond only to two or more occurrences of a specific tone (or a certain sequence of tones) within a specified period. Although either of the aforementioned designs would be relatively simple to implement, the latter offers better control and some interesting options.

The Whistle Switch uses two closely-spaced tones, both of which must be "hit" to trigger the circuit. The simplest design, of course, would be to have successive rising whistles cause the output (and thus the lamp) to switch on and off. However, our design uses a rising whistle (*i.e.*, a low-pitched tone ascending to a high tone) to cause the output to switch on. A descending whistle (*i.e.*, high-pitched tone descending to a low pitch) causes the output to switch off. A short rising whistle that covers the range of both tones is simple to manage, while reducing the possibility of both tones being accidentally produced within the required period.

Although such a circuit has several applications, our circuit was design for switching a 117-volt AC load, such as a lamp. Since the output relay specified has contacts rated at 2 amperes, almost any AC device up to 250 watts can be controlled. For heavier loads, the on-board relay can be used to drive a heavier relay, which would, in turn, control the heavier load.

Inside the Switch. A functional block diagram of the Whistle Switch is shown in Fig. 1. The circuit, which is comprised of an electret microphone, an amplifier, a pair of tone detectors, two timer circuits, and a flip-flop, is a lot simpler than it may appear.

In that circuit, the electret microphone picks up the trigger signal (whistle) and feeds it to the amplifier, which provides a gain of 300. The amplified signal is then fed to a pair of tone detectors (one for the high tones and the other for the low tones). If the two tones arrive within a pre-determined period and are both within the frequency range of the tone detectors (1100–1500 Hz for the low-tone detector and 1400–1800 Hz for the high-tone detector), the output toggles either on or off.

A complete schematic diagram of the Whistle Switch—which is built around seven common IC's—is shown in Figure 2. At the heart of the circuit are the two aforementioned tone detectors, each of which is built around an LM567 tone decoder. Supported by a minimum of additional components, the LM567's respond with a logic-low output whenever they detect tones within a preset range. Both the center frequency and width of the range can be set, using R12 (for the low-tone detector) and R15 (for the high-tone detector). That adjustment range allows the circuit to be "tuned" to respond to a person's characteristic whistle. The detection bandwidth for each is about 200 Hz.

The whistle tones are picked up by MIC1 (the electret microphone) and fed to U2-a (half of an LM358 dual op-amp configured as a high-gain amplifier), whose gain is set by R2 and R3. Capacitor C6 (a 220-pF capacitor

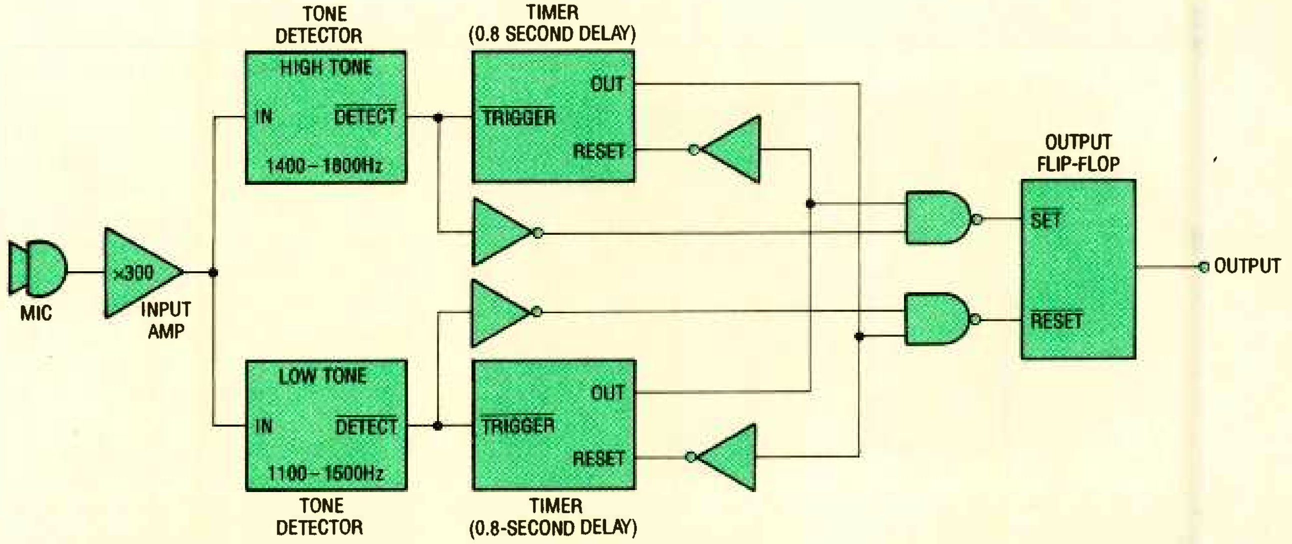


Fig. 1. The Whistle Switch is comprised of an electret microphone, an amplifier, a pair of tone detectors, two timer circuits, and a flip-flop, as shown by this functional block diagram of the circuit.

connected in parallel with feedback resistor R3) provides high-frequency attenuation to reduce amplifier overload. The output of U2-a is fed to U2-b (the second half of the LM358), which is connected as a comparator. Pin 3 of U2-b is connected to the junction of R5 and R6, establishing a reference, and is slightly offset from the artificial ground-threshold of the amplifier (as set by the junction of R4 and R5).

Any signal at the comparator's inverting input (pin 2) that exceeds the reference at its non-inverting input (pin 3) causes its output to switch states, swinging from one supply rail to the other. That provides a sharply-clipped, fixed-amplitude signal. The offset between the amplifier's signal ground and the comparator reference provides the Whistle Switch with a degree of immunity to low-level sounds like normal speech. Sounds that are below a certain volume produce output levels that are too low to cause the comparator to switch. While signals that are strong enough to exceed the comparator reference are converted into a clean, sharply-clipped output.

Resistors R8 and R9 divide the output of U2-b by a 10:1 factor, producing 120-mV rms signal that is coupled via C8 to two tone decoders (U3, the low-tone detector and U4, the high-tone detector), which are built around a pair of LM567 tone detectors. The center point of U3's and U4's detection band is set by an RC pair. Both detector circuits use identical RC networks (consisting of R12/C11 and R15/C15) for tuning. The difference in the two circuits is that R11 (connected to pin 5 of U3) is 82k, while R14 (connected to pin 5 of U4) is 47k. The detection bandwidths of the two decoder circuits is set by a 1-µF capacitor (C10 and C13, respectively).

When no signal of the right frequency is detected, the outputs of the two decoders are held high by pull-up resistors R10 (U3) and R13 (U4). But when either decoder detects a signal that's within its detection band, pin 8 goes low after a short detect-and-lock delay of a few dozen milliseconds (as set by C9 and C12). The output remains low as long as that tone is present.

The outputs of U3 and U4 are fed to the trigger inputs of U5-a and U5-b, respectively, whose outputs, it turn, are fed to one input of U7-a and U7-d respectively. The outputs of U3 and U4 are also inverted by U6-a and U6-d and used to drive the second inputs of U7-a and U7-d. The outputs of U7-a and U7-d are fed to the set (S) and reset (R) inputs of a flip-flop, comprised of U7-b and U7-c.

When a rising whistle is detected, the low tone (which arrives first) causes the output of the low-tone decoder to trigger the low-period timer (U5-a). The period of the timer is a little less than a second. If the high-tone decoder detects a proper tone during the low-period timer's active interval, the output of the flip-flop is latched high. (The same thing happens in reverse with a descending whistle; the high-period timer is triggered, and the detection of a low tone within the timer's period causes flip-flop's output to go low).

To prevent simultaneous triggering of the high- and low- period timers, the output of each is inverted (by either U6-b and U6-c) and coupled to the other's reset input. As long as the output of one timer is high, the other will be prevented from triggering. The second input of both U6-b and U6-c is connected to a common RC pair (C18 and R18) that holds both timers in the reset state for a few seconds at power-up.

The output of the flip-flop (comprised of U7-b and U7-c) is fed to the base of Q1 to control output relay K1 (a 5-volt unit with 117-volt AC, 2-amp contacts), which can be used to control loads of up to 250 watts.

The circuit (which draws about 100 mA) is powered from conventional power supply, comprised of T1 (which can range anywhere from 6 to 12 volts AC at 300 mA), BR1 (a fullwave bridge rectifier), U1 (an LM7805T), and several filter capacitors (C1–C4).

Construction. The author's prototype of the Whistle Switch was assembled on a printed-circuit board, measuring about 4 by 3¼ inches. A template of the author's printed-circuit layout is shown in Fig. 3. Once you've etched and drilled your circuit board, clean the copper traces thor-

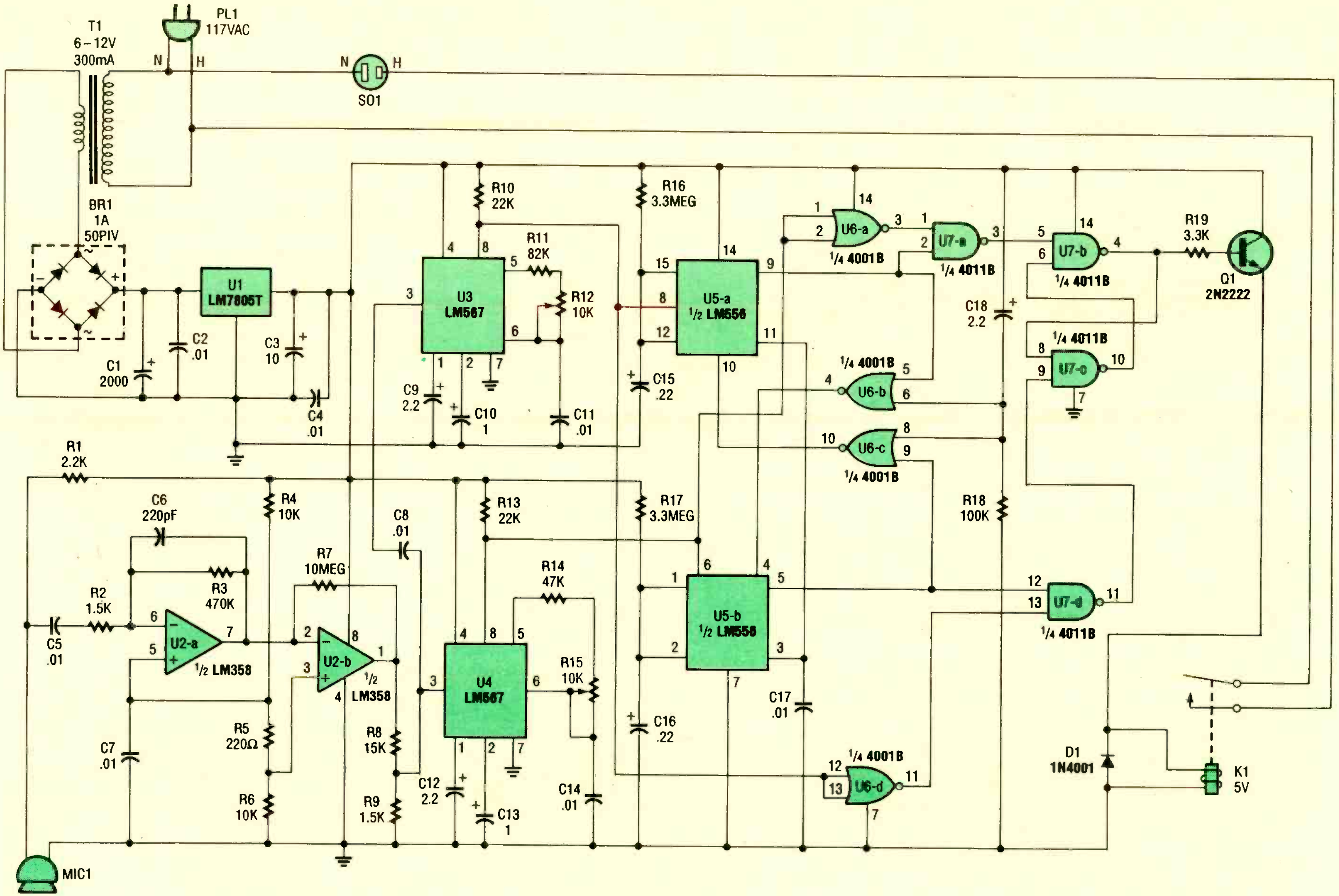


Fig. 2. At the heart of the Whistle Switch are a pair of tone detectors, each of which is built around an LM567 tone decoder, which are supported by a minimum of additional components.

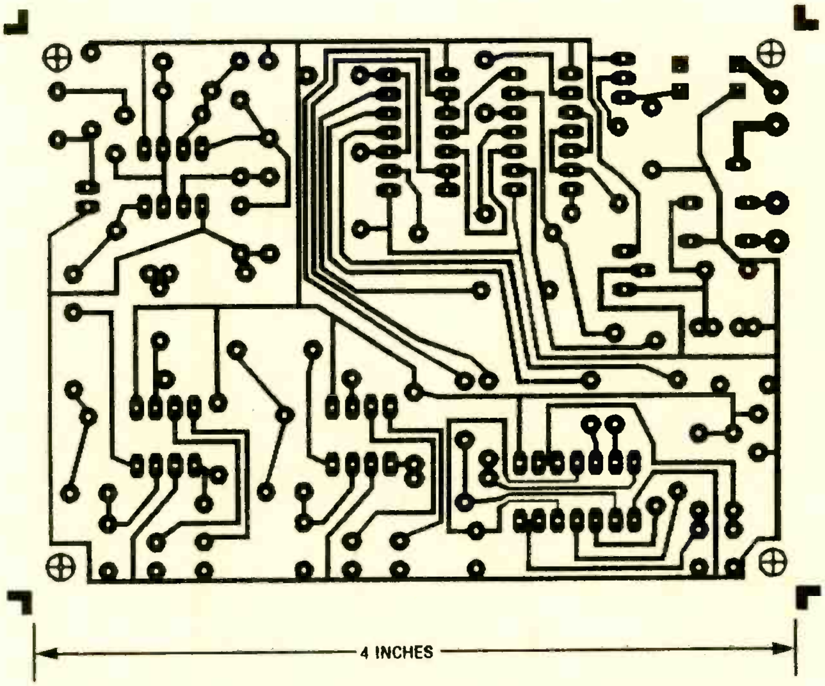


Fig. 3. The author's prototype of the Whistle Switch was assembled on a printed-circuit board, measuring about 4 by 3¼ inches. A template of the author's printed-circuit layout is shown here full size.

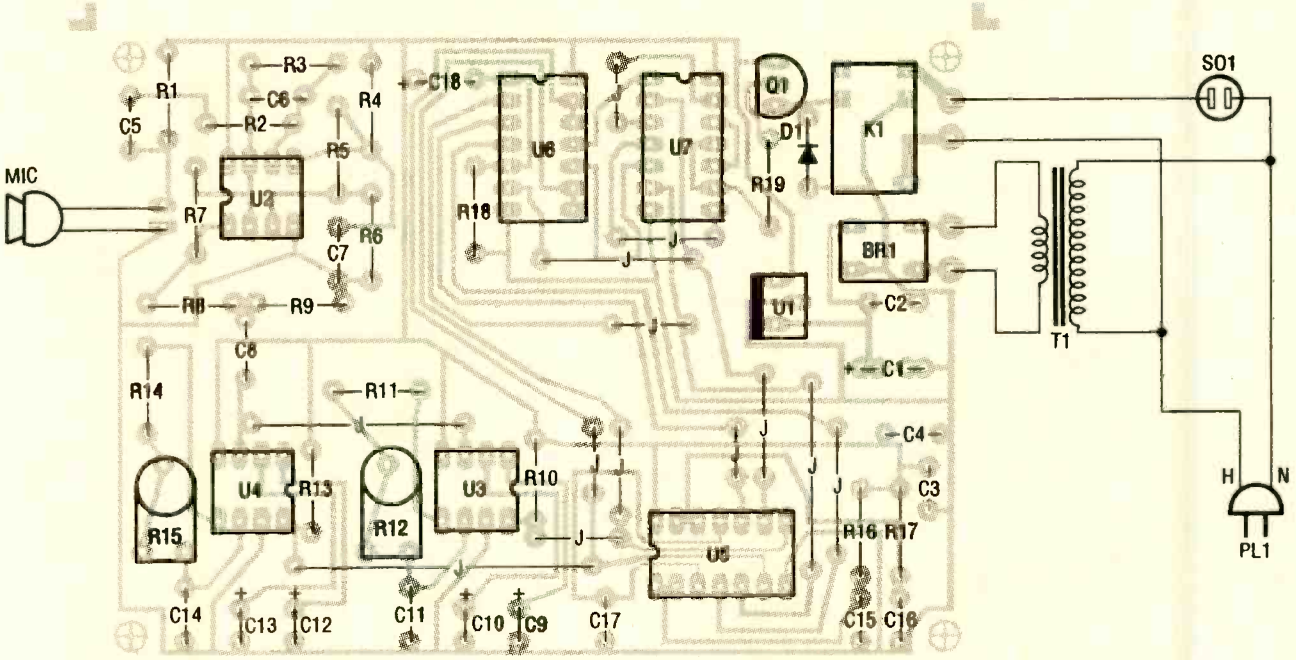


Fig. 4. Guided by this parts-placement diagram, begin construction by first installing 13 jumper connections (keeping them flat and tight against the board's surface) where indicated, followed by the passive components (fixed resistors and trimmer potentiometers, the capacitors, etc.) and then the semiconductor devices.

oughly before you begin stuffing the board. Oxidation and other contaminants can make it very difficult to make good solder joints.

Guided by Fig. 4 (the parts-placement diagram), begin construction by first installing 13 jumper connections where indicated. Keep the jumpers flat and tight against the board's surface. After the jumpers, install the fixed resistors (again making sure that they are flat against the board) and then install the trimmer potentiometers (R12 and R15).

Next, install all of the capacitors, taking care to orient the polarized units as indicated in the parts-placement diagram. After that, install BR1 (a DIP-style full-wave bridge rectifier), followed by Q1. Install all of the DIP IC's, making sure that they are properly oriented before soldering. Finally, install U1 (the voltage regulator) and K1 (the relay). When soldering the relay in place, be extremely careful not to bridge the two contact-pads (the ones nearest the long edge of the board) to the two coil pads (the inner two pads).

Insert the relay into the board and fold its four pins away from each other, onto the surface of their respective pads and solder into place. As a precaution, run a soldering scriber or other sharp, pointed tool between the pads and around the adjacent traces after soldering, to remove any solder splashes.

The Whistle Switch draws about 100 mA—an insufficient amount of current to cause much heating. However, excessive input voltage can cause a severe heat-dissipation problem. If the power transformer that you use produces a raw DC level of 9 volts or less, the bare regulator case should be capable of dissipating the heat. However, if you use a transformer that produces a higher raw DC voltage (as the transformer specified in the parts list will), a small heat sink should be attached to the regulator to help it maintain a cool operating temperature. Any heat sink with about 1–2 square inches of cooling surface should be adequate.

Final Assembly. With the board complete, it's time to decide whether the circuit will be used as a stand-alone unit (mounted in its own enclosure) like the author's prototype, or permanently mounted into the device that it is to control (say a lamp, for instance, assuming that its base has sufficient space to accommodate the both the board and the transformer). In any event, be sure that the board and T1 are securely mounted, and that the trimmers are accessible so that you can tune the circuit's response range.

Once the board and the transformer are satisfactorily mounted, connected them to each other as shown in Fig. 4. Note: If the Whistle Switch is mounted into the a lamp or some other device that it is to control, omit SO1 and replace it with the device to be controlled. In wiring SO1 (or device to be controlled) into the circuit, it will be necessary to separate the hot and neutral conductors of the line cord, and complete the circuit's AC wiring as shown in Fig. 4. Cover the 117-volt AC connections with electrical tape or heat-shrink tubing.

The microphone (MIC1) should be mounted so that it has an unobstructed window to the world outside its enclosure. It is recommended that MIC1 be mounted in a rubber grommet, which will hold it in place, provide a finished appearance, and isolate the pickup from acoustic vibration (sounds transmitted through the body of the lamp, for instance). If the microphone is located more than, say, 4 inches from the circuit board, it should be connected to the board through a small-gauge coaxial cable. That prevents excessive electrical noise pickup. Once the microphone and AC wiring is complete, double-check your work before proceeding.

Testing and Adjustment. Once the project is complete and you've carefully double-checked all of your work, assuming that you've built the stand-alone version, plug a lamp into SO1 and make sure that the lamp's switch is on. Plug the Whistle Switch's line cord into an AC receptacle. The lamp should remain off. Try a rising whistle—it may take several tries before you hit the right range. The lamp should turn on. Now try a descending whistle; the lamp should turn off. After a few attempts, you should be able to get the lamp to consistently switch on or off with a rising or descending whistle, respectively.

If the lamp will not respond, double check that the lamp itself is actually switched on. Then use a voltmeter to check for +5 volts at the output of U1 and the positive-supply pins of U2–U7. Using a logic probe or the voltmeter, check for a logic low at pin 8 of U3 and U4. Whistle up and down the scale while watching the probe or voltmeter carefully; you should get a logic-low pulse or a downward flicker in the voltage when you hit the decoder's detection band.

With a little practice, you should be able to hold the output low for a moment. If neither tone decoder is responding, check for an output signal at pin 1 of U2, using an oscilloscope or AC voltmeter. With an AC voltmeter, look for no signal when there is no sound, and a steady 2-volt rms signal when you are whistling. If there is no output, check pin 7 of U2 for an AC output that varies with the sound level.

If all of the above checks out, monitor the logic level at pin 4 of U7. That output should switch low on a descending whistle and high on a rising whistle. If not, trace back through U7 and U6 to see if each gate is reacting properly.

Once the circuit is working properly, adjust the upper- and lower-tone detection points so that the lamp will respond to your natural whistle. Take your time, and be sure to test each setting thoroughly. You might want to let other family members try their lips at the task, and make your adjustments with them in mind. ■

PARTS LIST FOR THE WHISTLE SWITCH

SEMICONDUCTORS

U1—LM7805T 5-volt, 1-amp, voltage-regulator, integrated circuit
U2—LM358 or LM1458 dual op-amp, integrated circuit
U3, U4—LM567 tone-decoder, integrated circuit
U5—LM556 dual oscillator/timer, integrated circuit
U6—CD4001B quad CMOS NOR gate, integrated circuit
U7—CD4011B quad CMOS NAND gate, integrated circuit
Q1—2N2222 general-purpose NPN silicon transistor
BR1—1-amp, 50-PIV (DIP) fullwave, bridge rectifier
D1—1N4001 1-amp, 50-PIV, silicon rectifier diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—2200-ohm
R2, R9—1500-ohm
R3—470,000-ohm
R4, R6—10,000-ohm
R5—220-ohm
R7—10-megohm
R8—15,000-ohm
R10, R13—22,000-ohm
R11—82,000-ohm
R12, R15—10,000-ohm trimmer potentiometer
R14—47,000-ohm
R16, R17—3.3-megohm
R18—100,000-ohm
R19—3300-ohm

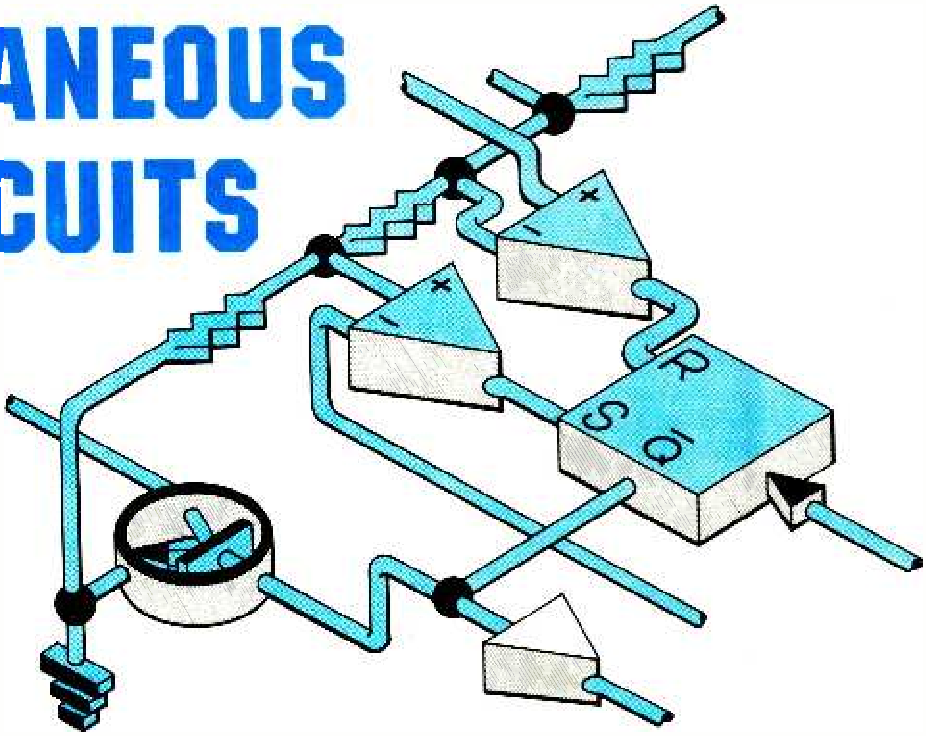
CAPACITORS

C1—2000-µF, 25-WVDC, radial-lead, electrolytic
C2, C4, C5, C7, C8, C11, C14, C17—0.01-µF, ceramic-disc
C3—10-µF, 6-WVDC, tantalum
C6—220-pF, ceramic-disc
C9, C12, C18—2.2-µF, 6-WVDC, radial-lead, electrolytic
C10, C13—1-µF, 6-WVDC, radial-lead, electrolytic
C15, C16—0.22-µF, 6-WVDC, radial-lead, electrolytic

ADDITIONAL PARTS AND MATERIALS

MIC1—Electret microphone
K1—SPDT, 5-volt coil, 2-amp 117-VAC contact relay
T1—6–12-volt, 300-mA power transformer
SO1—Panel-mount 117-volt AC socket
Printed-circuit materials, enclosure, molded AC power plug with line cord, TO-220 heatsink, coaxial cable (see text), grommet, strain relief, spacers, wire, solder, hardware, etc.

MISCELLANEOUS 555 CIRCUITS



We present a mixed collection of practical 555-timer IC applications.

BY RAY MARSTON

The 555 timer is by far one of the most popular IC's around today. That's partly because they are so easy to use. Once you know the basic operation of the 555 timer and understand how it can be used in monostable and astable multivibrator circuits, there's no end to the number of useful circuits you could design with it. In this article we'll demonstrate the versatility of the chip by presenting a number of useful circuits that take full advantage of the 555's unique features.

Schmitt-Trigger Circuits. The 555 is normally used as the basis of either a monostable timer or an astable oscillator, but, it can also be used as a Schmitt-trigger circuit. To do that, the input (or trigger) signal must be applied to pins 2 and 6, which must be connected together. Then once the input voltage rises above $\frac{2}{3}V_{CC}$, the IC output switches low and remains there until the input falls below $\frac{1}{3}V_{CC}$, at which point the output switches high and remains there until the input rises above $\frac{2}{3}V_{CC}$ again, and so on. The difference between these two trigger levels is called the hysteresis value, and equals $\frac{1}{3}V_{CC}$ in this case. That relatively large hysteresis value makes the circuit useful in a variety of signal-conditioning applications.

Figure 1 shows the 555 Schmitt-trigger circuit modified for use as a high-performance sinewave-to-squarewave converter that can be used at input frequencies up to about 150 kHz. The voltage divider made from R1 and R2 biases pins 2 and 6 to a quiescent value of $\frac{1}{2}V_{CC}$ (*i.e.*, mid-way between the upper and lower trigger values), and the sinewave input is superimposed on this pedestal via C1. Resistor R3 isolates the input signal from the effects of the 555's switching action. The squarewave output is available from pin 3.

Figure 2 shows a way of using the 555 in a modified Schmitt-trigger circuit in which some hysteresis is applied by R2. In the circuit, U1 compares the resistance ratio of R3 and R4 with that of the IC's internal voltage divider. If the resistance of R4, a light-dependent resistor (or LDR), is greater than 50% of R3's set value, the 555 output (pin 3) will go low (thus turning the relay on). If the LDR's value is less than 50% of R3's value, the output goes high (thus turning the relay off)

Resistor R4 is a cadmium-sulfide LDR and its resistance is inversely proportional to the amount of light present; thus, this circuit acts as a dark-activated relay switch and can have its sensitivity pre-set via R3; the relay's contacts can be used to control external circuitry, lamps, motors, etc.

The above circuit can be made to act as a precision light-activated (rather than dark-activated) relay switch by transposing R3 and R4, as shown in Fig. 3A. It can also be made to act as a temperature-activated switch by using a negative-temperature-coefficient (NTC) thermistor in place of the LDR, as shown in Figs. 3B and 3C; The one in Fig. 3B is activated by low temperature, while the one in Fig. 3C is activated by high temperature. In the circuits of Figs. 2 and 3B, the LDR or thermistor must present a resistance between 270 to 4700 ohms at the required turn-on level. In the circuits of Figs. 3A and 3C, these components need values from 470 to 18,000 ohms at the required turn-on level.

Astable Gadgets. The 555 astable multivibrator is very versatile and can be used in many applications of interest to the electronics hobbyist. Let's look at some examples of typical 555 astable gadgets.

Figure 4 shows a morse-code practice oscillator, with the tone-frequency variable from 300 Hz to 3 kHz via the tone control, R4. The volume is variable via R5, and the headphones can have any impedance from a few ohms and upwards. Note that this circuit draws no quiescent current when the morse key is open.

Figure 5 shows a simple variation of the above circuit. This acts as electronic door-buzzer that feeds a monotone signal to a small speaker (25 to 80 ohms) when S1, is closed. Capaci-

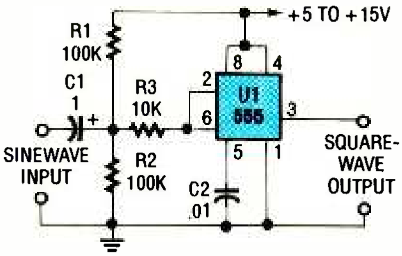


Fig. 1. This 555-based Schmitt trigger circuit converts sinewaves into squarewaves. This is useful for creating clock pulses from analog signals.

tor C1 has a low supply-line impedance and ensures adequate output-drive capacity even when the battery is nearing the end of its useful life.

Figure 6 shows a 555 astable used as an LED-driving flasher that can drive two sets of LED's so that one set turns on as the other turns off, and *vice versa*. Each LED flashes at about one flash-per-second, and has equal on and off times. The basic circuit action is such that all LED's tied high are

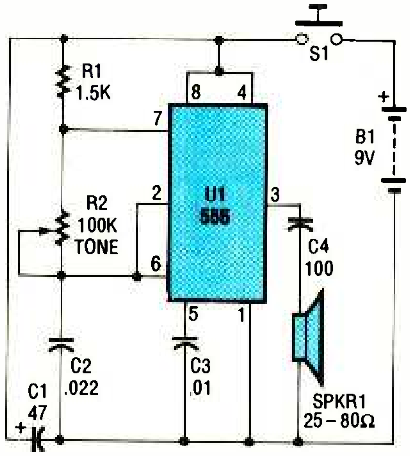


Fig. 5. This simple electronic door-buzzer draws no quiescent current. Once S1 is pressed and released the circuit derives power from C1.

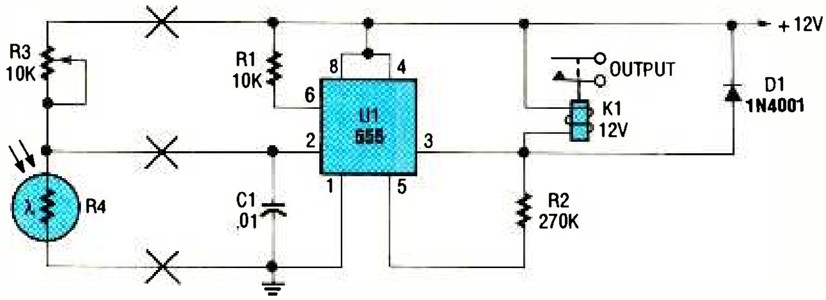


Fig. 2. This precision dark-activated relay switch can be used to turn on walkway or other outdoor lighting at dusk. The hysteresis of the 555 will keep the relay from chattering due to minor changes in illumination.

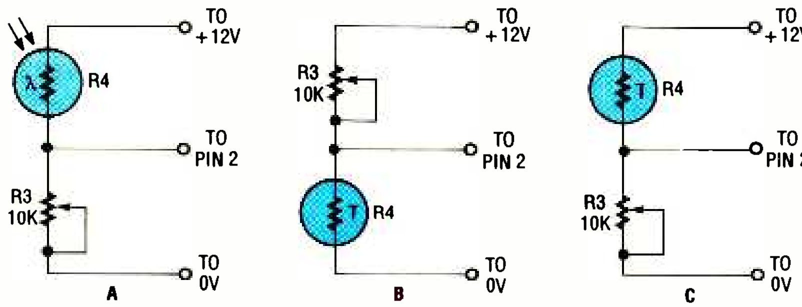


Fig. 3. These are some alternative input circuits for Fig. 2 that activate due to (a) light, (b) low temperature, and (c) high temperature.

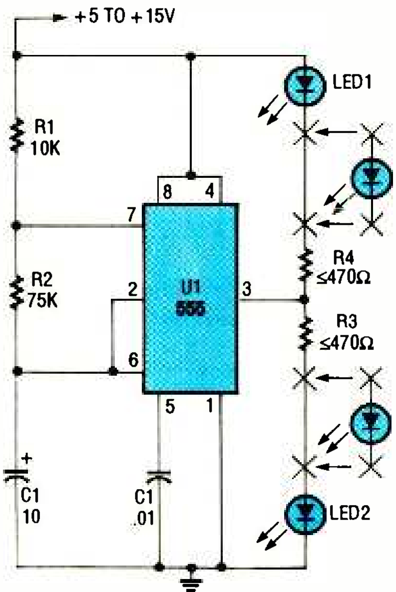


Fig. 6. This LED flasher has a double-ended output connection. The circuit may be augmented with additional LED as indicated.

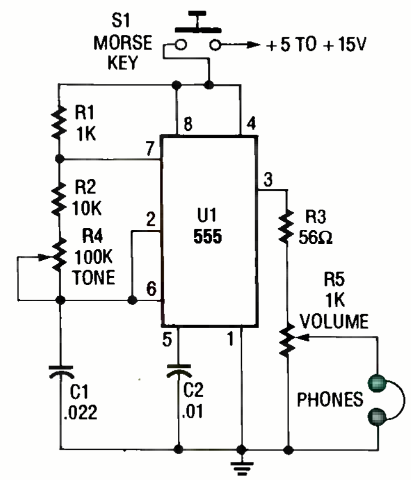


Fig. 4. This code-practice oscillator allows you to vary both the tone and volume of the sound produce when the telegraph key is depressed.

turned on via R4 when the 555 output is low, and the others are driven on via R3 when the 555 output is high. Each set can consist of either a single LED or a chain of series-wired LED's. Resistors R3 and R4 limit the maximum current to their associated set of LED's. The value of those resistors depends on the power-supply voltage and how many LED's are in each strand. The value can be found from:

$$R = (V_{CC} - n1.8)/.015$$

where R is the value you should use for R3 or R4, V_{CC} is the supply voltage, and n is the number of LED's in the strand. In the equation, we assume that the voltage drop across each LED is 1.8 volts and the current through all of them is .015 amps.

Long-Period Timers. The 555 IC makes an excellent manually triggered relay-driving timer when used in the monostable mode. However, its useful timing periods are limited to a maximum of only a few minutes. The best way of getting very long timing periods is to use the 555 IC in the astable mode and feed its output to the relay via a digital counter/divider stage. That way, the relay does not change state until the astable has completed a large, predetermined number of timing cycles. Figure 7 shows, in detailed block-diagram form, a 60-minute timer of this type. Here, a 555 is wired as a 2.28-Hz asta-

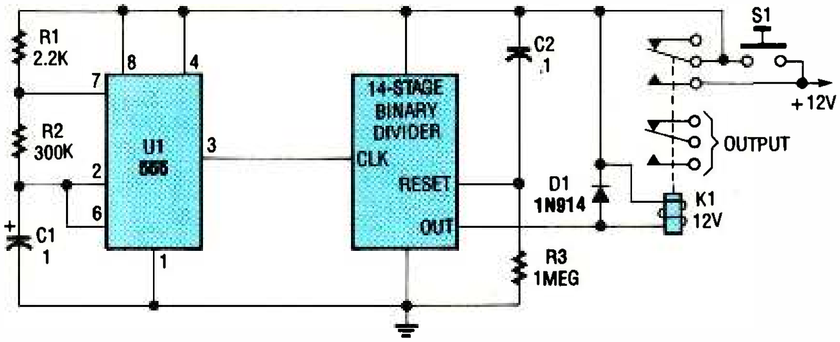


Fig. 7. This method of obtaining a 60-minute timing period from the 555 IC can be expanded upon to produce even longer delays with equal accuracy.

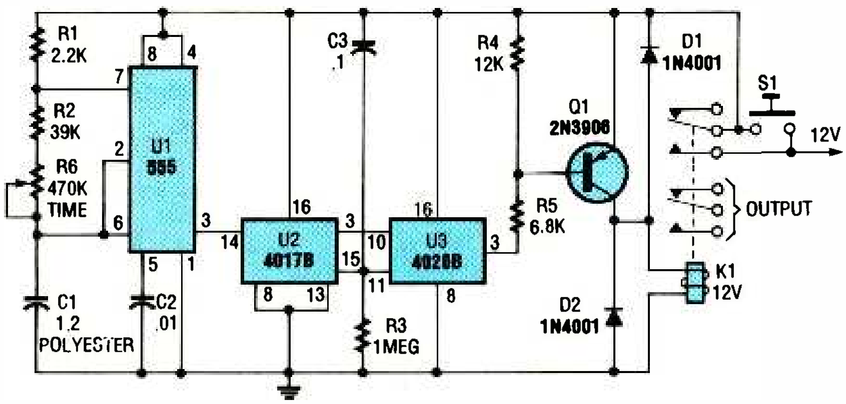


Fig. 8. This realistic variation of the circuit described by Fig. 7 has two operating ranges: 1–10 minutes and 10–100 minutes.

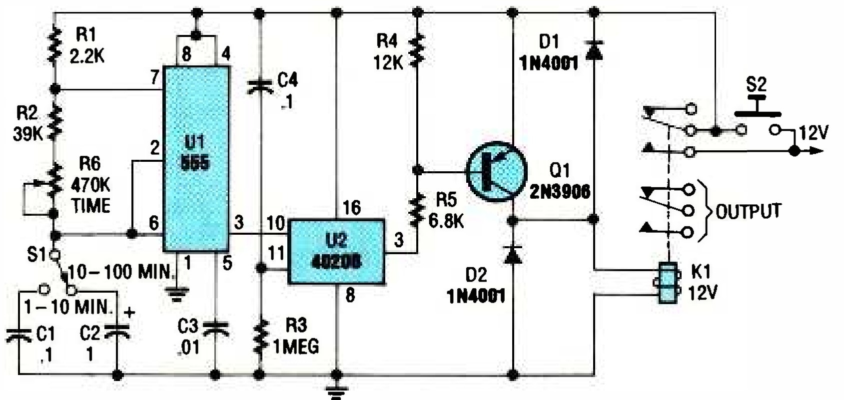


Fig. 9. Extra-long-periods (100 minutes to 20 hours) can be obtained from this circuit because pulses to the 4030B are pre-divided by the 4017B.

TABLE 1 — TIMER COMPARISON

Parameter	ICM 7555	Bipolar 555
Power-supply range	2–18V	4.5–18V
Supply current at V_{CC} = 15V	0.1 mA	10 mA
Output current, maximum	100 mA	200 mA
Power dissipation, maximum	200 mW	600 mW
Peak supply-current transient	10 mA	400 mA
Timing accuracy, drift with V_{CC}	1%/V	0.1%/V
Input current, trigger	0.1 nA	100 nA
Input current, threshold	.01 nA	500 nA
Input current, reset	.02 nA	100 µA
Output rise and fall times	40 nS	100 nS
Minimum trigger-pulse width	90 nS	20 nS

ble oscillator, and its output is fed to the relay driver via a 14-stage binary divider that divides by 16,384. To simplify the diagram, no relay-driver circuit is shown, although one would probably be necessary in a real-world circuit.

The divider action is such that if its output register is set to zero at the start of the input count, its output switches high on the arrival of the 8192nd astable pulse and goes low again on the arrival of the 16384nd pulse, thus completing the count cycle.

The timing sequence is started by closing pushbutton switch S1. That simultaneously connects the circuit to its supply, activates the astable, and (via C2–R3) resets the counter, which drives its output low, turning the relay on. When the relay turns on, a pair of its contacts close to bypass S1, thus maintaining the supply connection once the pushbutton is released. This state is maintained until the 819nd astable pulse arrives, at which point the counter's output switches high and turns the relay off, thus opening the relay contacts and breaking the circuit's supply connection. Note that the astable operates with a period that is only 1/8192 of the relay's timing period, so you can use a polyester (rather than an electrolytic) timing capacitor to achieve reasonable timing accuracy. That will hold true of the rest of the circuits we'll present.

Figure 8 shows the division technique used to make a practical relay-output timer that spans 1 minute to 100 minutes in two overlapping decade ranges. The circuit uses a 12-volt supply, and the relay can be any 12-volt type with two or more sets of contacts (rated to handle the desired load current) and a coil resistance of 120 ohms or greater.

Figure 9 shows how the time delay of the circuit can be further increased by wiring a 4017B decade divider between the output of the 555 and the input of the 4020B to give an overall division ratio of 81,920, thus making delays in the range of 100 minutes to 20 hours available from this single-range timer.

555 IC Variations. To conclude this look at the 555 IC, let's discuss its CMOS cousin—the 7555 timer. The plain 555 is a relatively old IC design

(Continued on page 81)

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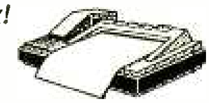

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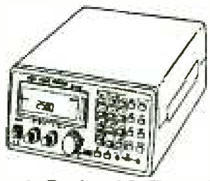

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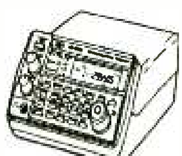

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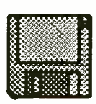

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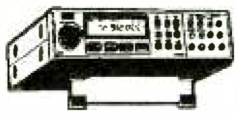

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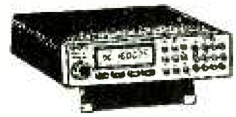

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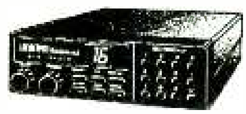

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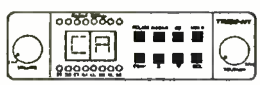

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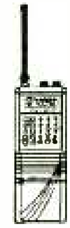

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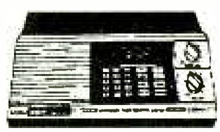

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CIRCLE 26 ON FREE INFORMATION CARD

By Marc Ellis

The Sky Buddy: Buttoned up at last!

I'm happy to say that my several-month battle with the Hallicrafters *Sky Buddy* (more formally known as the *Model S-19-R*) has come to a close. Every restoration project has its problems, but this particular radio has been fighting me every step of the way! Now I think I've won, but not by much.

If you've just joined us and would like to learn more about this popular low-end shortwave receiver of the late 1930's, as well as the restoration work done to date, check the April, 1993 column. It has a bibliography of all the issues devoted to the project up to that time. Extensive work was also done on the set in last month's column.

The Sky Buddy with its cover back on and ready for the display shelf. I decided to leave the original dial pointer (which has a broken tip) in place, rather than craft a replacement.

As of last month, most of the radio's problems had been solved, but it still would not function on the broadcast band. So I decided to try a realignment, thinking that perhaps some long-ago "screwdriver mechanic" had disturbed the receiver's adjustments.

While the realignment certainly improved the performance of the three bands that were already working, it had no effect on the difficulty with the broadcast band. And that's how things stood at the start of this month's session.

A SURPRISING PROBLEM

By now every possible cause of the problem had been investigated—except for the broadcast-band antenna and oscillator coils. Perhaps there was an open winding somewhere.

Actually, I had already checked out the antenna-coil primary because it was a prime suspect. Connected between antenna and ground when its band is selected, this coil can easily be burned out by static charges induced during a thunderstorm if proper precautions are not taken.

Having previously checked out the primary of this coil, I decided to go ahead and test the secondary. Bingo! It was wide open, showing no continuity on my ohmmeter.

I had found the problem, but I couldn't explain it. Sometimes a radio will lose an IF or RF coil because a shorted capacitor has sent a jolt of high voltage through it. However, there was no such opportunity for high voltage to enter the circuitry associated with this coil.

An interelectrode short in the 6K8 oscillator/mixer tube might have caused damaging high voltage to appear across the antenna-coil secondary, and I suppose that's a possibility. However, if that had happened, I'd guess that the secondaries of the antenna coils for some or all of the other bands also would have been burned out.

The reason: It would have been natural for the owner of the defective set to check other bands to see if they were also dead—burning out each coil, in turn, as it was selected. In any case, for what it's worth, the 6K8 tube that came with the radio tests okay on the tube checker and shows no interelement shorts.

As already mentioned, an antenna-coil *primary* is susceptible to being burned out during thunderstorms. It's possible that a damaging voltage could be induced in the secondary if the primary became charged. But if that were the case, one would think that the primary would be burned out as well.

The only other possibility I can think of is mechanical damage. Perhaps an earlier repair person was too rough around the coil assembly and broke a wire. You may recall that, earlier in this project, I found one end of the antenna-coil assembly broken loose from its mounting and had to cement it back in place.

A "BAND-AID" FIX

I'd uncovered a surprising problem, all right, and for a while it seemed as if it might be a problem without a solution. The damaged coil was part of

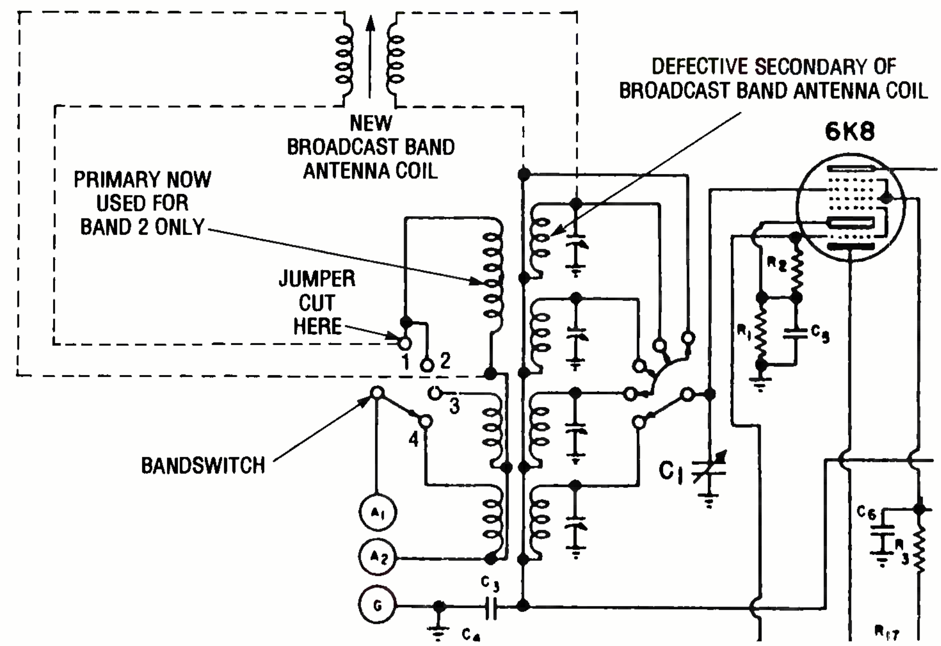
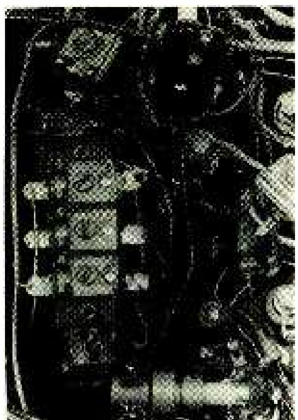


Fig. 1. This schematic of the Sky Buddy's RF stage shows the location of the defective broadcast-band antenna-coil secondary and the method of wiring in the replacement antenna coil.



The original antenna-coil assembly is the vertically-oriented cylinder surmounted by three trimmer capacitors. The new coil is attached to bottom of the original and is at right angles to it. Note the primary and secondary windings.

a specialized assembly containing the antenna coils for three of the Sky Buddy's four bands. They don't carry parts like that at Radio Shack and, alas, Hallicrafters is no longer in a position to help out.

It's just possible that the broken wire in the open secondary is not buried in the coil, but out in the clear where it could be accessed for repair. But here's the rub: In order to see if that's the case, the assembly would have to be removed from the radio—definitely a tedious and risky operation. Tedious because about a dozen wire connections would have to be carefully desoldered so that wires could be labeled and removed. Risky because disturbing those connections might break one or more of the very fine, fragile coil leads—disabling still other bands.

Another cause for concern: The wires that would have to be removed from the coil assembly are all associated with critical RF circuits. If those wires are not reinstalled with their original "dress" or positioning, the result could be unpredictable oscillation, motor-boating, and other forms of unstable operation.

As I weighed my alternatives, I was of two minds. On the one hand, many readers undoubtedly expect me to go to the ends of the earth to complete any restoration undertaken in this column. And that's a reasonable point of view. On the other hand, successful removal of the coil assembly is no guarantee that the defective winding could be repaired.

If it turned out that repair wasn't an option, I doubt that I'd be strongly motivated to reinstall the defective unit. The radio would then essentially become a junker until such time (if ever) that a Sky Buddy in even worse condition—but with a good coil assembly—might fall into my hands.

Finally I decided to try a good temporary fix, a "band aid" approach that would restore broadcast-band operation without performing invasive procedures on the set.

A check of the Sky Buddy's specs had shown that the main tuning capacitor is a 375-pF unit. That is the standard size for broadcast receivers. An ordinary broadcast receiver antenna coil therefore could be installed in place of the damaged one in the Sky Buddy without disturbing the other connections on the antenna-coil assembly.

INSTALLING THE COIL

At first, I thought I could probably cannibalize an antenna coil from a junked broadcast receiver. But the junk sets I had on hand were all equipped with loop antennas. Such sets don't have separate antenna coils because the loop itself *is* the coil.

Then I remembered having seen broadcast-antenna coils advertised in the *Antique Electronic Supply* (6221 S. Maple Ave., Tempe, AZ 85283) catalog. I took a look and, sure enough, there they were. The catalog copy stated that they would "replace broadcast band coils in any tube-type radio." That sounded good to me, and I immediately ordered one. It arrived just a few days before this column was due to be mailed in, so I quickly heated up my soldering iron and made the installation.

The secondary of the new coil was connected across the open secondary of the old band 1 (broadcast-band) antenna coil. The primary of the old coil was still needed because it also serves as the primary for the band 2 antenna coil. Luckily, a connection was provided on the bandswitch for switching in a separate band 1 primary.

In the original installation, this connection was jumpered to the corresponding band 2 connection (see schematic) so that the same primary would serve for both. Cutting this jumper allowed me to hook up the new independent primary for band 1.

The new coil was small and lightweight enough

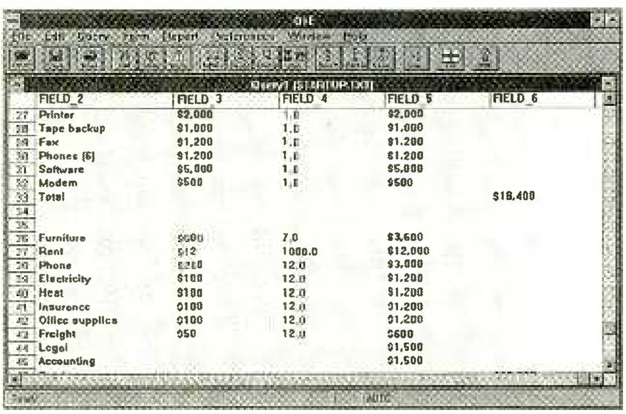
(Continued on page 69)

COMPUTER BITS

By Jeff Holtzman

Versatile Database Editor

One good thing about the PC industry is the wealth of tools that are available for performing different jobs. It's also one of the bad things. The problem is twofold. One aspect is simply learning the quirks and tricks of so many different products. The second lies in dealing with data in so many different formats. Those two factors lead to a market for *bridge-gappers*—easy-to-use tools that allow access to data in a variety of formats. A Windows-based program called Q+E (from Pioneer Software, 5540 Centerview Drive, Suite 324, Raleigh, NC 27606; Tel. 919-859-2220) is one such tool.



Q+E allows you to open, query, edit, and report on data in every major format. Intuitive operation and a scripting language provide power and usability.

Q+E bills itself as "The Database Editor," but that's not really a fair description. As the name suggests, it's main strengths are in multiple-format database editing and interactive (SQL-based) querying. Q+E also has respectable report-writing capabilities. Let's discuss each.

Q+E

With Q+E, you can view, create, and edit database files in nearly every important stand-alone and client-server format: Btrieve, DB2, dBASE, Excel, Ingres, Netware SQL, Oracle, OS/2 Database Manager, Paradox, SQL Server, SQL Base, Tandem NonStop SQL, Text, XDB, and others. Opening a file in any given format is simply a matter of opening the file, or in the case of a client-server or SQL database, logging in and then opening the desired file.

Q+E next presents you with a row-and-column view of the selected database. Initially, the view comes up in a read-only mode; after enabling the editing feature, you can edit data in the file directly. Q+E won't let you enter invalid dates or put alphabetic characters in a numeric field, but that's the extent of the program's data-validation capabilities, and my chief complaint with it.

I'd like to be able to create "picture" strings to ensure valid data entry, and to force table lookups against standard values. The addition of those features would make Q+E database enough for many users.

Q+E's greatest strength lies in its interactive SQL query builder. If you don't know SQL (which stands for Structured Query Language) from beans, don't worry, you don't need to. The program gives you an interactive way of selecting the data you want, and doesn't bother you with the underlying mechanism. In fact, Q+E builds an SQL Select statement that specifies the criteria by which to select records from your database. You can save queries and reuse them later. If you wish, you can even edit the SQL statement directly.

Your query can include one or more fields from one or more database files, and you may join several files on common columns. However, even though it is possible to open several files in different formats, you can only join files in a single format.

Record-selection criteria include numerous operators: =, ,

You can create nice looking reports using any available Windows font, and reports can have subtotal breaks. Headers and footers can have time, date, and page-number variables, as well as bitmap images.

ADVANCED FEATURES

One extremely useful facility is known in Q+E as a dynamic query. When developing the query, rather than specify constant values, you specify variables. Later, when you execute the query, the program pops up a dialog box asking for the desired values. Thus, for example, you might create a dynamic query that would prompt the user for an employee number, start date, and end date before pulling records from the database.

Q+E has a robust scripting language that allows you to perform most Q+E actions under program control, and to hold DDE conversations with other

Windows applications. Another extremely useful feature allows you to attach queries and scripts to icons that appear in the (*de rigeur*) icon bar.

A version of Q + E has been included with Microsoft's Excel spreadsheet program for several years; however, Version 5 is a standalone product with greatly expanded capabilities. The interactive SQL query builder is a nice piece of work, and dynamic queries and icon-bar customization allow you to set up easy-to-use systems for non-experts to use.

In the ideal world, Q + E wouldn't have to exist. In this one, it's a darn good thing that it does. If you're looking for a consistent interface to a variety of databases, or if you want an interactive query and reporting tool, Q + E will fill the bill with style. ■

ANTIQUE RADIO

(Continued from page 67)

that I was able to mount it simply by soldering one of its terminal lugs directly to the appropriate lug on the original coil. The other three connections were made via short wire leads.

With the new coil installed, I broke out my trusty LM-21 frequency meter (see last month's column) and performed the RF alignment procedure for the broadcast band. The other three bands had been aligned in the previous work session but, of course, nothing could be done with the broadcast band at that time. Now everything went smoothly, and it was quite a satisfying moment when I tuned the new coil to resonance and heard the test signal come to a strong peak.

THE RESULTS

With the Sky Buddy connected to a good antenna and ground, strong signals are now received all across the broadcast band and throughout most of the set's shortwave-frequency range. Band 4 (16–46 MHz) is an exception, being relatively insensitive. Actually, the upper end of that band was just wishful thinking on Hallicrafters' part because the circuit design and poor RF wiring practice (long leads everywhere) don't support operation on those frequencies.

The electrical bandspread control operated very smoothly and made it a lot easier to tune through stations that were very closely spaced on the main tuning dial. The BFO (beat-frequency oscillator) also works well, and its pitch control provides a wide range of tones on received CW (Morse code) signals.

Like the bandspread control, the pitch control is smooth-acting. I had no trouble using it to decode the "Donald Duck" single sideband (SSB) chatter of some local hams rag-chewing on the 75-meter band.

For those who don't happen to know, "beating" SSB signals with the BFO is the only way to make them understandable on a communications receiver not designed for sideband reception. But the pitch control requires hair-trigger adjustment to make that strategy work.

I noticed that stations at the lower end of the broadcast band seemed to tune a little broader than stations at the upper end. That may be a normal characteristic of the Sky Buddy, or it may be a result of inaccurate tracking of the replacement antenna coil (which,

(Continued on page 94)

CIRCUIT CIRCUS

By Charles D. Rakes

Switch On/ Switch Off

As the cool winds of spring give way to the warm days of summer and the outdoor activities go into full swing, there's no better to way to relax during the warm summer evenings than to try out a new circuit. And if your too

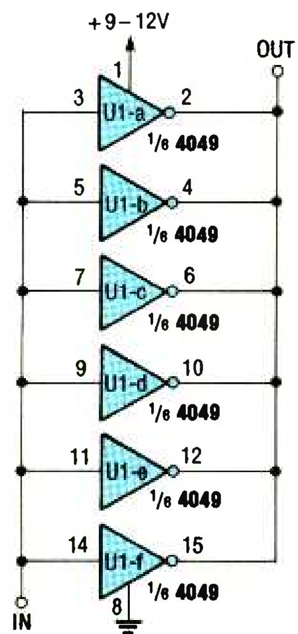


Fig. 1. By parallel connecting all six gates of a 4049 hex inverting buffer, as shown here, you can obtain a much higher output current than would otherwise be available.

tired to build, sit back, prop up your tired old dogs and share some time with us here at the Circus.

LOGIC-GATE CURRENT BOOSTER

Figure 1 shows a circuit in which all six gates of a 4049 hex inverting buffer are connected in parallel to provide a higher output current than would otherwise be available. Due to the IC's internal resistance, losses from a slow rise-time input can cause the IC to overheat and eventually fail altogether; therefore, the input to the circuit must be a fast rising and falling waveform to keep the IC's internal power dissipation within reasonable limits.

We share that information because it is not unusual when designing a circuit around logic gates to end up with one or more unused gates or inverters. Paralleling spare gates can provide added power in areas where the power needs shoring up.

ISOLATED SWITCHING CIRCUIT

The hexFET, a power MOSFET, is without a doubt the best solid-state on/off switch to come down "silicon alley" in some time. (It has an on-resistance in the milliohm rang.) Paralleling several hexFET's results in an even lower effective resistance. There's no need for drive-balancing resistors as is required when using silicon bipolar power transistors, nor is there a junction-voltage loss with hexFET's. The hexFET's current switching and power handling capabilities are primarily limited only by junction heating.

In our first circuit, see Fig. 2, a hexFET (Q1) is used as an isolated DC-controlled switch. In that circuit, an optoisolator/coupler, U1, which has a phototransistor output, separates the hexFET from the controlling circuit, while a 9-volt battery supplies the necessary gate voltage to turn the hexFET on. Applying a positive to pin 2 of U1 turns on its internal LED, lighting the base junction of the phototransistor. The transistor's emitter-collector junction switches on, feeding a bias voltage to the gate of Q1, causing it to turn on.

The gate circuit's current consumption is limited to the current flow through R1 (a 100k resistor) and R2 (a 1-megohm unit). Since the hexFET's gate is strictly capacitive, only an initial charging current is required to raise the gate voltage past the threshold "turn-on" level. After the gate's internal capacitance is charged, there is no current flow into the gate circuit.

If R2 were removed from the circuit, the required turn-on current for Q1 would be, for all practical purposes, zero. The purpose of R2 is to discharge Q1's internal gate capacitance when U1 is in the off state. The hexFET can switch DC power to relays (as shown in Fig. 3A), motors, lamps, and numerous other devices. That arrangement can also be used to switch

PARTS LIST FOR THE LOGIC-GATE CURRENT BOOSTER

U1—4049 hex inverting-buffer, integrated circuit
Perfboard materials, 9–12-volt power source, wire, solder, hardware, etc.

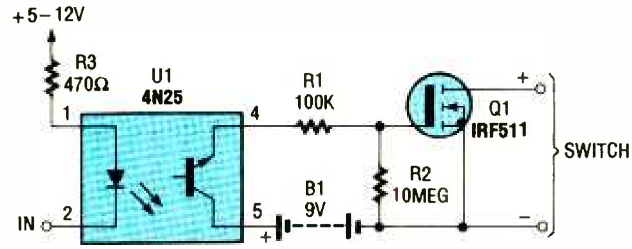


Fig. 2. This DC-controlled switch uses an optoisolator/coupler, U1, to electrically isolated the input signal from the output control device.

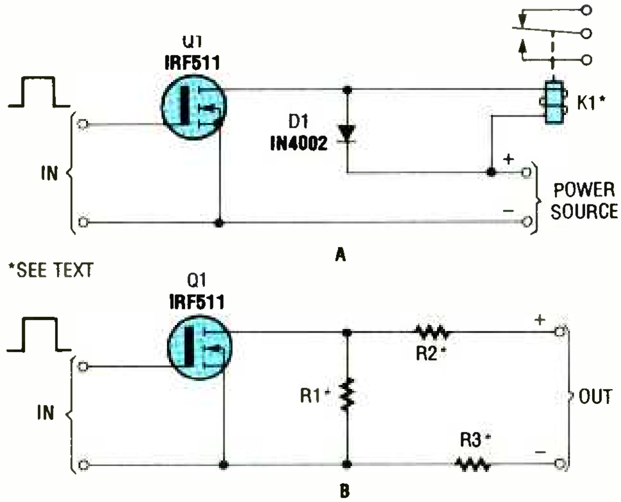


Fig. 3. The hexFET can switch DC power to relays (as shown in A), motors, lamps, and numerous other devices. That arrangement can even be used to switch resistors in and out of a circuit, as shown in B.

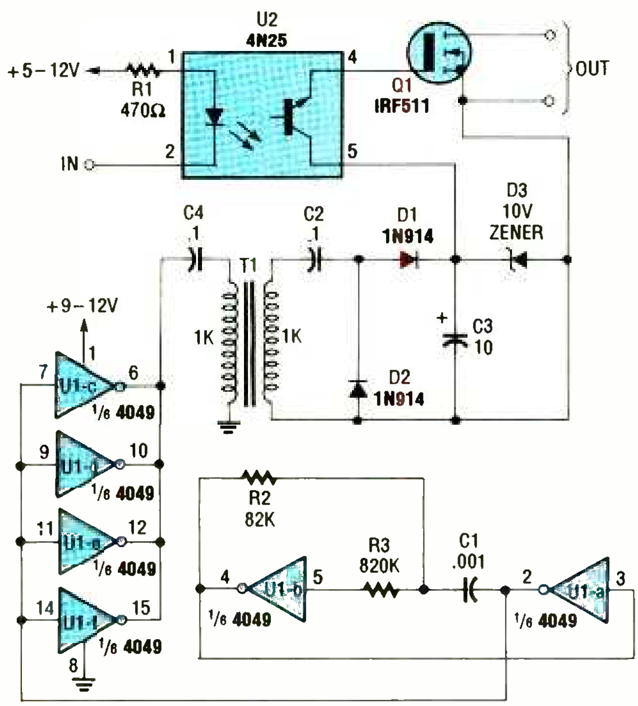


Fig. 4. In this circuit (the oscillator-triggered switch), the hexFET's base bias is provided by a signal generated by an astable oscillator instead of the 9-volt battery used to bias the hexFET in Fig. 2.

PARTS LIST FOR THE ISOLATED-SWITCHING CIRCUIT

SEMICONDUCTORS
U1—1N25, 4N26 (or similar) optoisolator/coupler, integrated circuit
Q1—IRF511 hexFET

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—100,000-ohm
R2—10-megohm
R3—470-ohm

ADDITIONAL PARTS AND MATERIALS
B1—9-volt transistor radio battery
Perfboard materials, IC socket, 5–12-volt power source, wire, solder, etc.

PARTS LIST FOR THE ISOLATED-SWITCH ADD-ON CIRCUITS

Q1—IRF511 hexFET
D1—1N4002 silicon diode
R1, R2, R3—¼-watt, 5% resistor (see text)
K1—See text
Perfboard materials, wire, solder, etc.

PARTS LIST FOR THE OSCILLATOR-TRIGGERED SWITCH

SEMICONDUCTORS
U1—4049 hex inverting buffer, integrated circuit
U2—4N25, 4N26 (or similar) optoisolator/coupler, integrated circuit
Q1—IRF511 (or similar) hexFET
D1, D2—1N914 general-purpose silicon diode
D3—10-volt Zener diode

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—470-ohm (see text)
R2—82,000-ohm
R3—820,000-ohm

CAPACITORS
C1—0.001-µF, 50-WVDC, Mylar or similar
C2, C4—0.1-µF, 50-WVDC, Mylar or similar
C3—10-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
Perfboard materials, Misc. IC sockets, power source, wire, solder, etc.

resistors into and out of a circuit as shown in Fig. 3B.

OSCILLATOR-TRIGGERED SWITCH

In our next switch circuit, see Fig. 4, the 9-volt battery used to bias the gate of the hexFET in Fig. 2 is replaced by a signal generated by an astable oscillator and fed to the gate through a voltage-doubler circuit.

In that Oscillator-Based

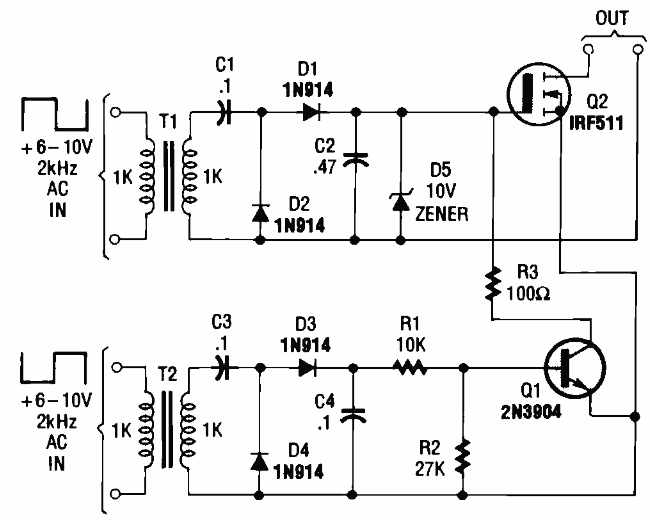


Fig. 5. The Dual-Control Switch uses two 6–10-volt AC sources to trigger the circuit on and off; one source for each function.

PARTS LIST FOR THE DUAL-CONTROL SWITCH

SEMICONDUCTORS

Q1—2N3904 general-purpose NPN silicon transistor
Q2—IRF511 hexFET
D1–D4—1N914 general-purpose silicon diode
D5—10-volt Zener diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—10,000-ohm
R2—27,000-ohm
R3—100-ohm

CAPACITORS

C1, C3, C4—0.1-µF, 50-WVDC, Mylar or similar
C2—0.47-µF, 50-WVDC, Mylar or similar

ADDITIONAL PARTS AND MATERIALS

T1, T2—1000-ohm to 1000-ohm audio transformer
Perfboard materials, solder, etc.

Gate-Trigger Circuit, two gates (U1-a and U1-b) of a CMOS 4049 hex inverting buffer are configured as an astable squarewave oscillator, operating at about 2 kHz. The oscillator's output is direct coupled to the inputs of the remaining four parallel-connected inverters (U1-c–U1-f). The combined output of the parallel-connected inverters is fed to the primary of T1 (a 1k-to-1k audio transformer).

The transformer's output feeds a voltage-doubler circuit (consisting of D1 and D2). The output of the doubler is filtered by C3, and regulated to 10 volts by D3 (a Zener diode). The regulated 10-volt output of the voltage doubler is applied to U2 at pin 5 (the collector of the optoisolator/coupler's output transistor), while pin 4 (the emitter output of the transistor) is tied to the gate of Q1.

The anode end of U1's input LED at pin 1 is tied to a 5–12-volt power source, while the cathode end of the input LED at pin 2 is connected to a signal source. When no signal is applied to pin 2, U1's internal LED remains dark, so the output transistor is off, and no gate bias is applied to Q1. So Q1 does not conduct. When a negative-going signal is applied to pin 2 of U1, its internal LED turns on, activating U1's output transistor. That ties the regulated 10-volt output of the voltage doubler to the gate of Q1, causing it to turn on, applying power to the load device. The circuit can be altered so that it can be triggered by a positive-going input to pin 1 of U1 by tying pin 2 of U1 to ground.

DUAL-CONTROL SWITCH

Our next circuit, see Fig. 5, takes a different approach in controlling the hexFET's gate voltage. In that circuit, two 6–10-volt AC inputs are used to control the hexFET. One AC input is used to turn the hexFET on and the other is used to turn it off. The output of T1 (a 1k-to-1k audio transformer) is fed to a voltage-doubler circuit (consisting of D1 and D2).

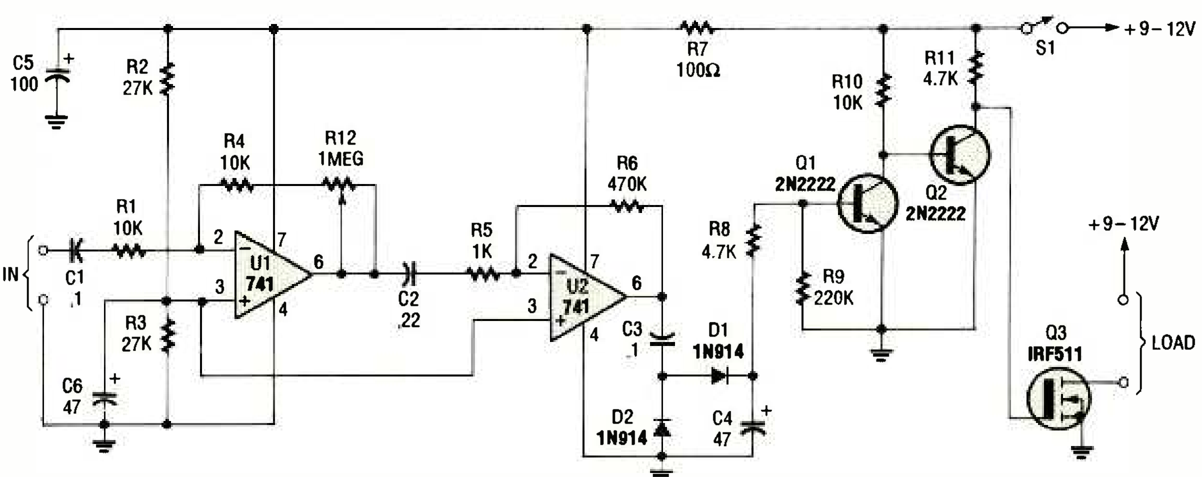


Fig. 6. The Audio-Controlled Switch combines a pair of 741 op-amps, two 2N2222 general-purpose transistors, a hexFET, and a few support components to a circuit that can be to used to turn on a tape recorder, a transmitter, or just about anything using sound.

PARTS LIST FOR THE AUDIO-CONTROLLED SWITCH

SEMICONDUCTORS

U1, U2—741 op-amp, integrated circuit
Q1, Q2—2N2222 general-purpose NPN silicon transistor
Q3—IRF511 hexFET
D1, D2—1N914 general-purpose silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R4, R10—10,000-ohm
R2, R3—27,000-ohm
R5—1000-ohm
R6—470,000-ohm
R7—100-ohm
R8, R11—4700-ohm
R9—220,000-ohm
R12—1-megohm potentiometer

CAPACITORS

C1, C3—0.1-µF, ceramic-disc
C2—0.22-µF, ceramic-disc
C4, C6—47-µF, 16-WVDC, electrolytic
C5—100-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1—SPST switch
Perfboard materials, microphone (see text), IC sockets, 9–12-volt power source, wire, solder, etc.

PARTS LIST FOR THE SPEED-CONTROL SWITCH

SEMICONDUCTORS

Q1—2N2646 unijunction transistor
D1—6A6 6-amp, 600-PIV, silicon rectifier diode
D2, D3—1N4007 1-amp, 1000-PIV, silicon rectifier diode
D4—12-volt, 10-watt Zener diode
SCR1, SCR2—6-amp, 800-PIV SCR (see text)

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—47-ohm, ½-watt, 5%
R2, R3—27-ohm, ½-watt, 5%
R4—22,000-ohm
R5—100-ohm
R6—10,000-ohm, 20-watt
R7—25,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS

C1—0.22-µF, 50-WVDC, Mylar capacitor
T1—240-volt, 1- to 5-amp, step-up transformer
F1—5-amp fuse
S1—SPST switch
MOT1—See text
Perfboard materials, molded AC power plug with line cord, wire, solder, hardware, etc.

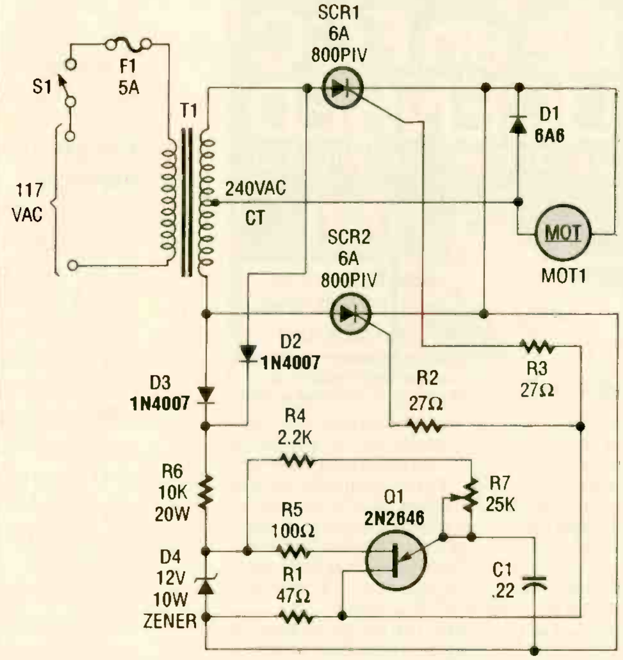


Fig. 7. The Speed-Control Switch offers reasonably good control and stability at both ends of its operating range.

The DC output of that voltage doubler is filtered by C2, and regulated to 10 volts by Zener diode D5, before application to the gate of Q2.

A short burst of a 6- to 10-volt 2-kHz signal at the input of T1 charges C2 to about 10 volts, turning Q2 on. Since there's no resistor tied across the capacitor to discharge it, the positive voltage at the gate of Q2 keeps it on for an extended period of time. The actual time will depend on the quality of D1, D2, D5, C1, C2, and Q1. If all of those components exhibit an extremely low internal leakage, the charge on C2 will remain for a fairly long time. Of course, no electronic component is a perfect insulator; in time, the capacitor will discharge to the point where Q2 turns off.

The same 2-kHz signal at the primary input of T2 produces a DC voltage across C4, turning Q1 on. With Q1 turned on, a discharge path for C2 is provided through R3 and Q1, robbing Q2 of gate bias, causing it to turn off. If both inputs are turned on at the same time, Q2 will remain off.

AUDIO-CONTROLLED SWITCH

Our next entry, see Fig. 6, combines a pair of op-amps, two transistors, a hexFET, and a few other components into a sound-activated switch. The output of the hexFET can be used to turn on a tape recorder, a transmitter, or just about anything via a relay or a Triac-driver optoisolator. In Fig. 6, U1 (a 741 op-amp) is configured as a high-gain audio amplifier that receives its input signal from a sensitive microphone (not shown). The gain and the output level of U1 are set by resistor R12. The output of U1 is fed to U2 (another 741 op-amp), which has a fixed gain of over 400. The audio output of U2 at pin 6 is fed to a voltage-doubler circuit, composed of C3, C4, D1, and D2. The doubler's DC output is fed through R8 to the base of Q1, turning it on, which takes its collector to near ground potential.

That pulls the base of Q2 to ground, turning it off, and causing it's collector voltage to rise to the positive supply rail. Transistor Q2's collector voltage is applied to the gate of Q3 (an IRF511 hexFET), turning it on, which, in turn, switches on the power to the load. The value of C4 sets Q3's on time and may be changed for a specific application. Smaller values of capacitance will give a shorter on time, and larger values give a longer on time.

SPEED-CONTROL SWITCH

Our last entry is a DC-motor speed-control circuit. Not long ago I needed a speed control for a ¼-HP 120-volt DC motor that was being used to drive a shop made coil winder. It had to offer reasonably good speed control and stability at both ends of the operating range. The circuit in Fig. 7 fulfilled that need.

As shown, a 240-volt center-taped step-up transformer, fed from the AC power line, supplies power for motor MOT1. Two 6-amp SCR's are used to control the motor's operating current. A unijunction transistor (UJT), connected in a relaxation oscillator, feeds the gates of the two SCR's (SCR1 and SCR2). Diodes D2 and D3 supply a positive operating voltage for Q1 (a 2N2646 UJT), and D4 (a 12-volt, 10-watt Zener diode) regulates the voltage at B1 of Q1 to 12 volts. Potentiometer R7 (a 25k unit) controls the UJT's firing rate and the motor's speed. The component values used may need to be beefed up for larger motors or reduced in size for smaller motors.

Looks like we've just about run out of time and space for this visit. Good circuitry until we meet here again next issue. ■

"It's got to be a prowler—a rabbit isn't big enough to set off the motion detector."

200 CHANNELS
(Continued from page 39)

The use of digital compression will allow more than 100 channels to be transmitted from only 16 transponders. Thomson's compression system uses some visual sleight-of-hand to streamline and simplify the video data. First, because the human eye perceives color images in less detail than black-and-white images, the system transmits color information at lower resolution. Second, only the portions of a picture that differ significantly from the previous frame are transmitted. If a man is walking down a deserted street, only his image would be transmitted frame-to-frame, while the unchanging buildings would be transmitted only once. For movies, whose images are already divided into 24 "still" pictures per second, Thomson plans to use a digital compression rate of 8:1. Live programming and fast-moving action are harder to compress, and will have a ratio of "just" 4:1.

DirecTv will use error-correction coding and digital encryption methods. Error-correction coding improves picture quality by sending out additional data in a pattern that allows errors to be detected and corrected. DirecTv promises Super-VHS quality video accompanied by CD-quality audio. Digital-encryption technology, supplied by London-based News Datacom, requires the program subscriber to insert a credit-card-like "smart card," which contains the secure decoding information, into the receiver/decoder. If the digital security coding is breached, the cards can easily be replaced.

What will it be like to own a DirecTv system? The small dish will be easy for the consumer to mount inconspicuously on a windowsill, railing, or roof top. The remote-controlled receiver/decoder offers on-screen menus, with programming divided by category to make program selection easier. Both pieces will cost $700 at the introduction. A program subscription is expected to be similar in price to similar cable packages. In addition, DirecTv has sufficient capacity to repeat pay-per-view movies every 30 minutes. So far, The Disney Channel and Paramount Pictures have jumped on the DirecTv bandwagon, and other programming deals are expected to be announced soon.

TVRO Today. DBS has a lot of promise for the future, but it isn't expected to replace C- and Ku-Band satellite TV for some time to come. Contracts signed by major program suppliers, including HBO, to lease C-band transponders ensure that C-Band will remain the primary way that programs are distributed. And existing C- and Ku-band satellite set-ups will be able to receive signals from the new DBS services, although an appropriate decoder will be required.

For a close-up look at how we chose and installed a complete C/Ku-band TVRO system, and reviews of some up-to-the-minute satellite gear, check out this month's *Gizmo*. ■

THINK TANK

By John J. Yacono

Logic and Hi-V

Not to be confused with a high five, this month's letters will deal with hi-V or high-voltage circuits. I'll also continue my presentation of the differences between the CMOS and TTL logic families.

So far, for both families I've presented the key power-supply requirements (voltage, current, and power consumption), meth-

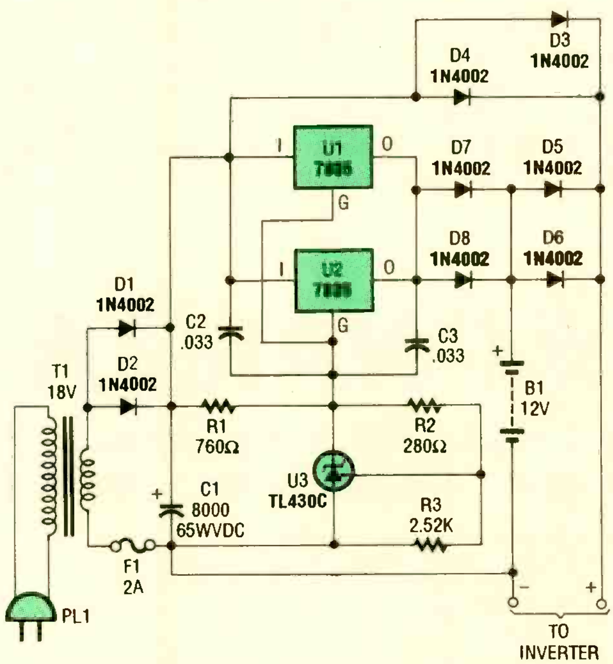


Fig. 1. This lead/acid-battery trickle charger can be used as a stand-alone circuit (for alarm systems and such) or combined with the circuit in Fig. 2 to create an emergency lighting system.

od of operation (using voltage *vs.* current, and logic-level voltages), limitations (due to heat, size, spacing, and/or static sensitivity), and we briefly touched on current-output capability. However, that last topic requires further clarification before we proceed.

Last month, I alluded to the fact that TTL circuits can produce higher levels of output current than CMOS circuits, but that's only a half-truth. In general, a TTL output can pull or sink more current when low than a CMOS output can, but when high, CMOS outputs generate (or source) more output current than a high TTL output can. TTL IC's are generally viewed as having higher output-current capability because they can sink more current than CMOS circuits can either source or sink.

Just as logic outputs have source- and sink-current ratings, logic inputs have minimum- and maximum-current requirements. In order for an input to consider a high signal, it must be supplied with sufficient current; for a signal to be low, it must draw sufficient current from the input. Of course, the input-current requirements for TTL and CMOS circuits are different.

For TTL circuits, an input must be pulled low with around a milliamp or two of current, while a high need only provide from 10 to 50 microamps (the exact values depend on the chip's architecture, which I'll get into at some other time). For CMOS logic, the signal-input current is so small—on the order of microamps—that it's almost negligible. That indicates a drastic contrast between the two families.

The output-current capability and input-current required for a logic family determine how many inputs can be connected to a single output. That characteristic is called "fan-out." Obviously, the fan-out capability of CMOS circuits, which require minimal input current, is far superior to that of TTL circuits, which require a much higher sink-current to represent a low.

The exact number of inputs that can be connected to an output depends, once again, on the chip's architecture, which I'll get to next month. That makes this a good place to stop discussing digital IC's so that I can provide some safety tips for working with high voltage before getting to the hi-v circuits staring in this month's column.

HIGH-VOLTAGE SAFETY

First of all, never work while standing directly on a surface that inherently contains moisture (such as wood or concrete). If your workshop has such flooring, cover the floor where you'll be working with a sheet of some kind of insulating material such as plastic. Do not, under any circumstances use a static-free floor mat for this purpose; they look like insulators, but

WARNING!! This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter, materials and substances. Neither the publisher nor the author make any representations as for the completeness or the accuracy of the information contained herein and disclaim any liability for damages or injuries, whether caused by or arising from the lack of completeness, inaccuracies of the information, misinterpretations of the directions, misapplication of the information or otherwise.

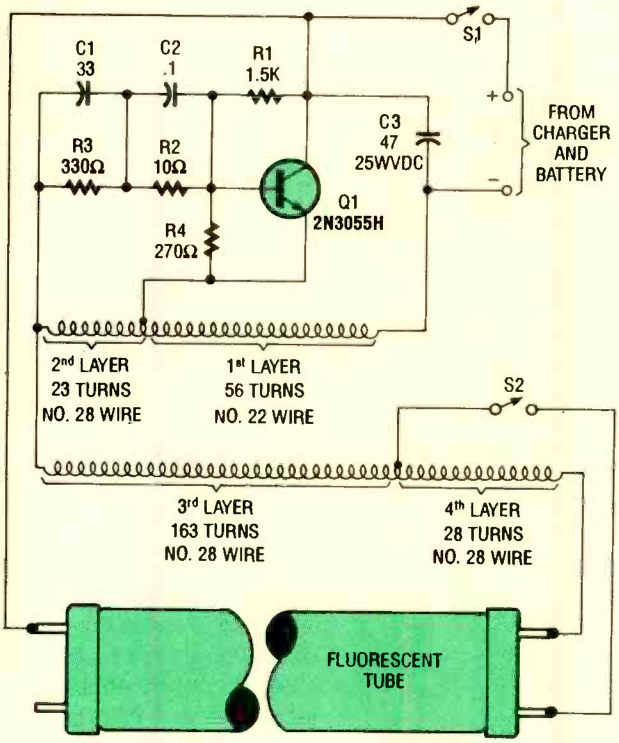


Fig. 2. This high-voltage power supply can operate fluorescent tubes from a 12-volt source, even if the tube has a defective filament. It essentially is an oscillator that excites a home-made autotransformer.

they are really conductive. For similar reasons, be sure to wear non-conductive footwear.

Also, never work on a metal or a static-free table top. The table top can destroy a high-voltage circuit as well as conduct lethal voltages your way.

Never work on high-voltage circuits while they are under power. Furthermore, once a high-voltage circuit has been turned off, discharge its storage capacitors using a high-wattage low-resistance resistor with long, well-insulated alligator leads attached to it. Keep one hand in your pocket as you discharge each one. Remember, even if the charge contained in a storage capacitor is too small to kill by itself, it wouldn't take much charge at all to cause you to impale your hand or body on a near-by object (the number-one cause of fatalities in electricity-related deaths).

If dressing high-voltage leads into a harness, use only high-voltage wire for the leads. Ignoring this step could lead to very confusing operation or a complete melt-down for your project. Along similar lines, use RTV caulk or corona dope on all exposed high-voltage junctions to prevent arcing. If you follow these simple rules and use some common sense you should be okay.

EMERGENCY ILLUMINATION

We have built a low-cost battery-powered emergency light composed of two main sections: a battery charger and a voltage inverter. The charger is designed to maintain the charge on a lead-acid car battery, which in turn supplies the inverter with a voltage that is boosted to light a fluorescent lamp.

The charger (see Fig. 1) is designed to be assembled from cheap, easy-to-find, components. It drives a maximum of approximately 1-amp DC into the lead/acid battery, allowing a totally discharged battery to be fully charged in about 5 days. That very slow charging rate protects the battery's life. The circuit keeps the battery fully charged, needs no attention, and is protected against power failures and short circuits.

It has only a few critical components: filter capacitor C1 (which must be at least a 4700-µF, 30-WVDC unit) and resistors R1–R3 (at least ½-watt each), which fix the floating voltage to the battery at 13.8 volts. It is also important that you use heat sinks for the IC's.

The inverter (see Fig. 2) is basically a high-frequency, high-voltage, medium-current oscillator. It works perfectly well with 20-watt fluorescent tubes and acceptably with 40-watt ones. The components are not critical except for the coil, which must be home made; it is not standard. The coil specifications (wire size, number of windings, etc.) are shown in Fig. 2. Wind the coil on a 1⅞-inch long, 5/16-inch diameter ferrite rod, layer-on-layer as indicated, covering only 1½ inches of its total length. The only other thing to keep in mind is to use a heat sink for the transistor.

The circuit works even on burnt-out tubes, provided at least one filament is still complete. Switch S1 is the master switch; S2 is optional. We found that after warm-up, some tubes increase their light output if S2 is open.

An exhausted car battery, good enough for our purposes, but no longer good enough for a car, gave us satisfactory results.

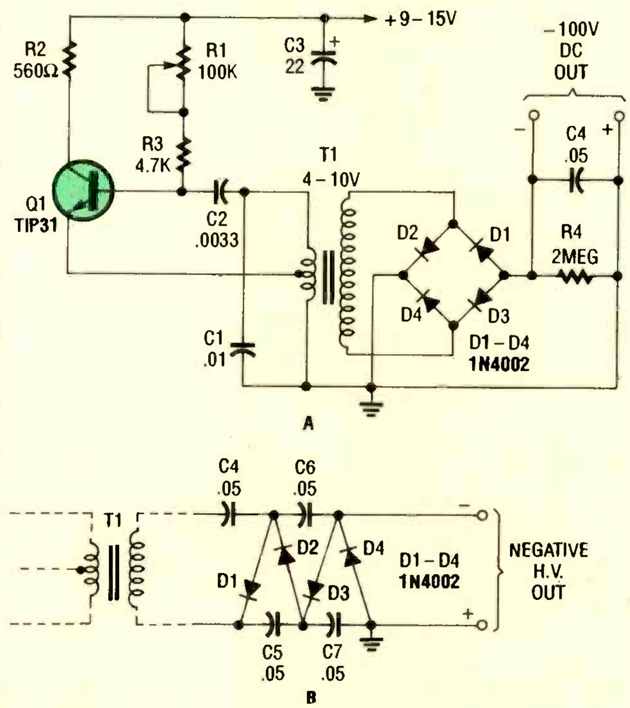


Fig. 3. The combination Hartley oscillator/step-up transformer shown in A can generate significant negative high-voltage, especially if the voltage output of the transformer is multiplied by the circuit in B.

—M. Gomikian, G.A. Locascio, P.E. Berlot, Buenos Aires, Argentina

Finally, a high-voltage project with good coil-winding instructions! Gentlemen, since you've sent in two useful circuits at once, I'll be sending two different books out. Although their are three of you, after seeing how well you have all cooperated to make the circuits, I'm sure you can work something out.

NEGATIVE DC CIRCUIT

Hello John. Here's an interesting circuit I came up with while building my latest project: a ham transmitter. It is a DC–DC converter with an output voltage of −100 volts DC when powered by as little as 9 volts DC. I built it to provide a protective bias at the tube grids in my ham receiver during transmission.

If you look closely (see Fig. 3A), you'll see it's actually a Hartley oscillator. The oscillator's operating frequency is not important, neither is the transistor type. The transformer (T1) was taken from a small plug-in AC adapter and provides an output voltage of somewhere around 5 to 10 volts. Note that the transformer is reversed in this circuit so that the output voltage is taken from it's primary.

You might need to experiment with the values of the two timing capacitors (C1 and C2) to get it to oscillate. (If you build one, switch it off and on a couple of times just make sure that it starts right up each time you apply power.)

The output voltage is adjustable via R1, which sets the transistor bias level. The 2-megohm resistor at the output serves as a bleeder across C4, which, along with the rectifier diodes, needs to have a sufficient voltage rating.

The unit does not supply much current, as you'll see if you try to load it too heavily. Instead of the full-wave bridge rectifier, you could substitute a voltage doubler (as shown in Fig. 3B) to increase the output voltage.

Well, that's all for now. I hope someone finds this circuit useful.

—Jon Danford, Joplin, MO

Unless I'm missing something, the operating frequency of the circuit is somewhat important. Maintaining a high-enough operating frequency ensures that the transformer core doesn't oversaturate (which would waste current on the low-voltage side) and provides maximum average power output. It should also be mentioned that voltage doublers fall prey to the law of diminishing returns; there are only so many stages you can add before there's no appreciable increase in output voltage.

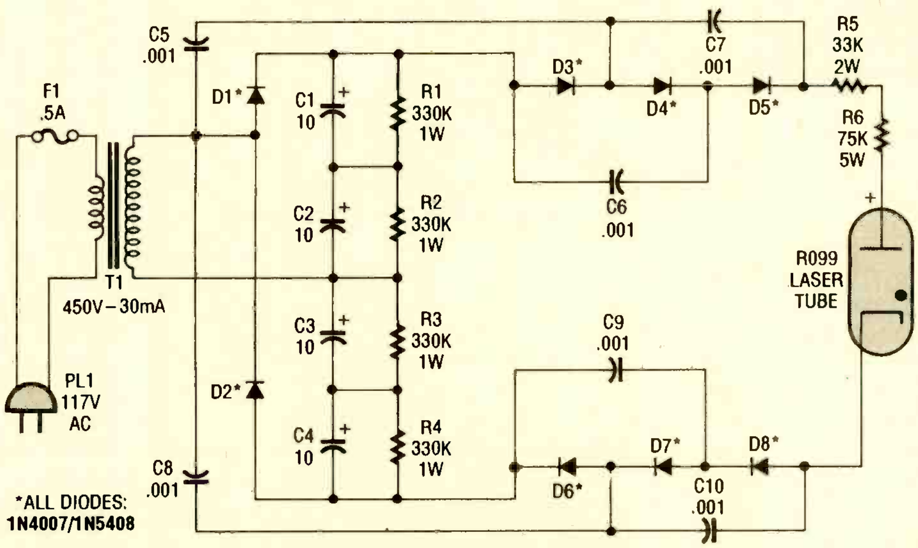


Fig. 4. This laser power supply, with its two-state (ignition and steady-state) operation has all the earmarks of a commercially manufactured unit.

LASING AROUND

Hello again, John: I'm sure you've received a few inquiries concerning laser systems, so here's one for the advanced experimenter knowledgeable in high-voltage circuits. **Warning:** Avoid direct exposure to laser-beam radiation!

Now that helium-neon laser tubes have become reasonable in price, I'm sure a lot of you got the same urge that I did to build your own laser system. If so, you'll soon find out that such items as high-voltage filter capacitors and diodes are not easy to find. However, the power supply presented here (shown in Fig. 4) came from my junkbox, and all the components are readily available.

The laser tube I used was obtained from MWK Industries (call 800-356-7714 for their free catalog) as part number R099 for $25.00 plus shipping and handling, and came with a six month warranty. It generates 1 mW of light when powered from a 1230-volt DC, 3.7-mA source. The tube came with a 75k ballast resistor (R6), which at 3.7 mA drops about 280 volts. Thus, the tube runs on 950 volts. MWK recommends an 8 to 10-kilovolt ignition circuit to initiate lasing, however, I found 6 kilovolts to be sufficient.

The power transformer (T1) used in my circuit had an output rating of 450 volts AC at 30 mA. Unloaded, the actual output is about 550 volts AC, yielding about 750 volts DC when rectified and filtered. Similar transformers should be available at electrical supply stores. All other components can be obtained from Digi-Key (701 Brooks Ave. So., P.O. Box 677, Thief River Falls, MN 56701-0677; Tel. 800-344-4539).

Looking at the circuit, D1, D2, C1–C4, and R1–R4 comprise a voltage doubler that yields about 1500-volts DC un-loaded, and 1375-volts DC loaded. When power is first applied, D3–D8 and C5–C10 provide an additional 4500-volt DC pulse (6 times 750) on top of 1500 volts DC from the doubler to ignite the plasma. When the tube conducts, the voltage drops from 6 kV down to 1375 volts (the steady-state operating voltage), due to the

(Continued on page 92)

DX LISTENING

By Don Jensen

An Arresting Situation

Summer is lightning season and that can spell disaster. Though remote, a direct lightning strike on your home or antenna will likely leave your shortwave receiver in ruins, regardless of preventive steps that you might take. But if that unlikely event occurs, just thank your lucky stars that you weren't similarly "fried."

Radio Canada International, over the years, has offered a number of different verification cards to SWL's who write the station to report reception. Here, from the past, is one of the more attractive QSL's.

However, a likely receiver problem during the summer lightning season is damage to the sensitive "front ends" of solid-state receivers caused by static build-up in your antenna system from nearby storms. Near-miss lightning strikes can send high-energy "spikes" down the AC power line to burn out your receiver.

To prevent the latter, your receiver should be plugged into an AC-line filter—the same sort of transient-voltage protection that you're probably already using to safeguard your computer equipment.

To guard against antenna-system-caused damage to your receiver, you can simply disconnect the antenna when a summer storm threatens. That's a cheap, easy, and relatively effective way to protect your equipment. But, quite frankly, that solution is no solution: It's easy to forget to disconnect the antenna system, and even if you do remember to do it, it's a nuisance. In addition, bad weather might blow in unexpectedly while you're away from home.

A better answer is to install a special protective device between the antenna and the receiver. If you have an older tube-type set, which is much less susceptible to damage from stray voltages, you may get by with an inexpensive, "old fashioned" air-gap lightning arrestor. But for solid-state receiving equipment, that solution probably won't do the trick.

What you need is one of the new breed of arrestors that use a hermetically sealed gas-filled cylinder as a super-fast "switching" device to shunt the energy spikes to ground before they can harm your radio. Gas-discharge technology can respond to short bursts of 250,000 volts at currents of 5,000 amps in one ten-millionth of a second, while allowing normal signal voltages to pass undisturbed. And what does such protection cost? About $20 to $25, depending on the particular model you choose and the type of connectors required by your antenna/receiver combination.

Such gas-discharge, electromagnetic-pulse protectors are sold by various shortwave-equipment suppliers. For instance, the Alpha Delta Transitrap LT is available from Universal Radio, Reynoldsburg, OH (800-431-3939), and Grove Enterprises, Brassville, NC (800-438-8155) markets its own protectors, designated the LA1 series.

STOP ON BY

Over the years, I've traveled a bit, and when I've been lucky enough to go abroad, I've tried not to miss any shortwave stations that cross my path. I've toured some of the biggies, like the *BBC* at its Bush House headquarters in London. I've also visited some tiny, remote and primitively-equipped SW stations in the Peruvian Andes and the Bolivian Altiplano. Invariably, and even when I, unavoidably, arrived without an advance invitation, I was well received. The station personnel were friendly and helpful, and when it was possible, they took the time to show me around their stations. It was a thrill to visit those world-band stations whose international voices I'd previously heard on shortwave back home.

It's also possible to visit SW stations without traveling overseas. For instance, if your vacationing takes you to Montreal, Canada, you may wish to stop in at *Radio Canada International.* Barry Schwartz, writing in the North American Shortwave

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*Credits: Mark Anderson, MI; Peter Grenier, NV; Jerry Klinck, NY; David Morby, NY; Dave Valko, PA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.

Association's *Journal* recently, tells of visiting Canada's international broadcast organization.

Despite severe budget cutbacks and reductions in staff, RCI serves as Canada's voice to the world, with programs in English, French, Spanish, Chinese, Russian, Ukrainian, and Arabic. And it continues to be one of the favorite stations of North American SWL's!

Schwartz says he was warmly received at RCI's offices and studios at 1055 Rene Levesque Blvd. East, and was given a brief, but interesting tour by Maggie Akerblom, RCI's director of audience relations.

If you'd like to visit RCI, an advance phone call to 514-597-7555 would be considerate and advisable.

While you are there, you may also want to visit the facilities of the Northern Quebec Service. That Canadian domestic shortwave service operates from Maison du Radio-Canada (the Canadian Broadcasting Corp. facilities), located a few blocks east at 1400 Rene Levesque Blvd. East. Tours are also available there, Schwartz notes.

While world travel (except via radio) isn't in the cards for most folks, you might have the opportunity to visit one of the North American shortwave outlets—the *Voice of America* in Washington, perhaps, or maybe one of the private U.S. or Canadian SW outlets—on your summer vacation.

If you do visit one or more of the SW stations, drop me a line and tell the rest of us all about your visit; include a snapshot, if you wish. Write to Don Jensen, *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

ALL GREEK TO ME

Fred Poulos, a reader from Brooklyn, NY, sends along some information for other SWL's who are interested in tuning in shortwave broadcasts from Greece.

"Currently," Fred writes, "the *Voice of Greece*'s English transmissions are best heard in North America from 0140–0150 and 0340–0350 UTC, Monday through Saturday, on 9,393, 9,420, and 11,645 kHz." To which I'd add, tune-in 20 minutes or so before each of the two time periods. The programming language then is "all Greek to me," but I love the music!

Fred continues: "Or, look for VOG in English Monday through Saturday at 1540–1550 UTC on 15,630, 15,640, or 17,525 kHz; or 1905–1915 UTC on 7,450 or 9,400 kHz. Daily, you might try 15,635, 15,650, or 17,515 kHz from 1230–1245 UTC.

"A Macedonian regional service, not in English, is broadcast to northern Greece on shortwave, too. *Radiophonikos Stathkmos Makedonias* broadcasts daily on 9,935 and 11,595 kHz at 1000–2215 UTC, and on 7,430 kHz at 1700–2215 UTC."

DOWN THE DIAL

Here are two stations for you to try:

MEXICO—2,390 kHz. Probably one of the lowest frequency shortwave stations you're apt to hear is *Radio Huayacocotla*. Look for this one during the early evening hours, signing off with the Mexican national anthem at around 0120 UTC.

SOUTH AFRICA—4,810 kHz. The commercial domestic South African shortwave station, *Radio Orion*, broadcasting in both the English and Afrikaan languages, has been noted on this frequency with light popular music at around 0200 UTC. ■

YAMAHA CD CHANGER

(Continued from page 29)

dB to −100 dB below the maximum recorded level. Further evidence of the exceptionally good low-level linearity exhibited by this CD changer was shown in our fade-to-noise test, in which a gradually decreasing signal, ranging in amplitude from −60 dB to −120 dB fades into the residual noise. Again, dithered signals were used and once again, virtually no deviation was noted, even at levels of −100 dB. That test also served to define EIA dynamic range which, for this sample, measured more than 110 dB. Using the somewhat different EIAJ method of dynamic-range measurement, we came up with a figure of −99.7 dB for the left channel and −99.5 dB for the right channel.

Another excellent attribute of the CDC-735 was its internal clock accuracy, which showed virtually no deviation from perfect (within the limits of our test equipment). Even more impressive, this is the first time I have ever obtained a frequency deviation reading of 0.0005%, which means that this CD player will reproduce music with virtually "perfect pitch."

HANDS-ON TESTS

The CDC-735 was extremely resistant to external vibration. We pounded on both the top and the sides of its cabinets while playing several musical CD's, and at no time did we detect any evidence of mistracking or muting. On the other hand, using our Pierre Verany "defects" disc, we found that while the player was able to correct for missing data extending to 1.5 millimeters, mistracking occurred when the length of missing data increased to 2.0 millimeters. While that degree of error correction exceeds the minimums required by the CD standard, it is not as good as the error-correction capability that we have measured for some other higher-priced units.

Summing up, the CDC-735's user-convenience features are outstanding, and anyone who likes the idea of owning a multiple-disc CD player with extensive programmability would do well to consider this unit.

For more information on the CDC-735, contact Yamaha directly, or circle No. 119 on the Free Information Card. ■

TEST RESULTS—YAMAHA CDC-735 5-DISC CD CHANGER

Specification	Manufacturer's Claim	PE Measured
Frequency response	20 Hz to 20kHz, ±0.5 dB	+0, −0.25 dB
THD + noise (1 kHz)	0.0025%	0.0015%
S/N ratio	110 dB	114.73/113.34 dB
Dynamic range (EIAJ)	100 dB	99.3/99.5 dB
Dynamic range (EIA)	N/A	>110 dB
Output voltage (Max.)	2.0V	2.017V
Headphone output	200 mV/ 150 ohms	Confirmed
Power requirements	120V, 60 Hz, 20W	Confirmed
Dimensions (W × H × D, inches)	17⅛ × 4¼ × 15¼	Confirmed
Weight	14 lbs. 1 oz.	Confirmed
Suggested retail price	$429.00	

POWER SUPPLY

(Continued from page 48)

If you choose to use a transformer with a different current rating than the 2-amp unit we used, then you will have to compute the value of the fuse to suit your needs. Most transformers are rated by their primary voltage, secondary voltage, and secondary current. You will need to know the maximum current to permit in the primary that will not damage the secondary. Here is a simple relation you can use to determine that maximum:

$$I_P = I_S(V_S/V_P)$$

where I_P is the primary current, I_S is the secondary current, V_P is the primary voltage, and V_S is the secondary voltage.

You may wish to select a slightly lower value for added safety. However, since some of the power produced by the primary is lost in the transformer's iron core, not all of it reaches the secondary. Opinions may vary, but that provides a margin of safety that has proven itself sufficient over the years.

The bridge rectifier BR1 is used to turn the secondary's AC into full-wave rectified, pulsating DC. While we used a 2-amp bridge, you should use one that will handle the maximum current that you expect to draw, plus a 25% safety margin.

Capacitor C1 filters the pulsating DC of the rectifier into a more manageable form for the adjustable regulator. The capacitor at the regulator's output (C2) helps to eliminate destructive transients or other noise that may occur on the power leads.

Of course, R1 and R2 program the regulator for the desired 12-volt output in the fashion mentioned earlier. Note that a diode (D1) has been added to the circuit. It steers any current that might be coming from the device under power around the regulator to prevent the regulator from being damaged. Such reverse currents usually occur when devices are powered down.

Construction. Building the power supply is easy since so few components are required. We mounted the parts on a piece of perfboard and used point-to-point wiring to complete the interconnections. The size of the cabinet was chosen mainly for the size of the transformer, which wouldn't fit in a smaller cabinet. The transformer and circuit board are mounted to the bottom of the case using some drywall screws and scraps of perfboard as "nuts." While standard hardware could also be used, drywall screws cost much less and perfboard scraps are essentially free. To use the drywall screws, all you have to do is countersink the holes on the bottom side of the case and drill a starter hole in the perfboard "nuts." To make the power supply as versatile as possible, we put simple binding posts on the top of the case for the output. We also put the on/off switch there.

The power supply should only take a couple of hours to build. However, we're sure you'll find uses for it for many years to come. ■

BEVERAGE COOLER

(Continued from page 42)

Figure 6 shows the top plate, insulation, and a soda can all in place while the epoxy cures. The last part of the cooling chamber construction is the chamber itself. My chamber is made from a doubled-walled drink container, which are available virtually everywhere. If you buy one specifically for this project (rather than using one you have on hand), try to find one that is insulated. That prevents you from having to stuff insulation into void of the double-walled container (cooling chamber).

Prepare the cooling chamber by cutting off the bottom 2 inches or so of the drink container. If you are fortunate, you'll find insulation between the walls. Obviously, the one I used in the prototype only had air between the walls, so I had to stuff it with the insulation from the soft-drink keeper mentioned earlier. You absolutely need to insulate the chamber for satisfactory results.

Once the drink container has been prepared, epoxy it in place over the cooling module assembly. Just put a decent layer of epoxy all around the bottom, and press it into place. Let the epoxy cure with a weight on top of it.

To finish the chamber, put a single layer of weather stripping around the top of the cooler, on the inside. That seals the chamber from outside air as much as possible. Your soda can should just fit inside the chamber, with about one inch of can sticking out the top. Figure 7 shows the business end of the cooler.

The Hookup. As shown in Fig. 3, the cooling module is wired in parallel with the fan, and both are connected to a 12-volt DC power source. If you are not comfortable soldering the connections, you can use wire nuts. Your car's battery works well as a source of DC to test the unit. (I now use the power supply from my ham-radio equipment to power the cooler.) Remember, the power source must be clean (free of ripple) and capable of delivering a full 3 amps without overheating.

That all there is to it. I hope you have as much fun building and using the cooler as I did. And don't be surprised if you are ask to build several for friends! ■

555 CIRCUITS

(Continued from page 64)

that uses bipolar-transistor technology. In recent years, the 7555 has been developed as an improved (but more expensive) version of the 555. From Table 1 we can see that the 555 must use supplies in the 4.5- to 16-volt range and typically draws 10 mA of quiescent current when operating from 15 volts. A major defect of the IC is that it draws a brief (a fraction of a microsecond), but massive 400-mA current spike as its output goes from one state to the other. That generates an RF noise burst that can play havoc with nearby digital circuits.

The 7555 CMOS device, on the other hand, can use supplies in the 2- to 18-volt range, draws only 100 μA of quiescent current from a 15-volt supply, and draws a peak spike current of only 10 mA when its output goes from one state to another.

However, note that the 7555's performance is inferior to that of the 555 in terms of drift-with-voltage accuracy, pulse-trigger characteristics, its output current, and power-dissipation capabilities. ■

By Joseph J. Carr, K4IPV

A Helping Hand

Are we a nation at risk for the lack of ham/hobbyist constructors? A lot of people lament that ham operators don't build anything anymore. The usual lament is that hams have become "appliance operators," with no interest in technical things. At one time, a large proportion of hams built their own transmitters, and more than a few built their receivers as well. And even those who bought a receiver frequently modified their units.

Jameco Electronics' product line covers just about everything for the electronics hobbyist; electronics components (both discrete devices and integrated circuits), connectors, power supplies and batteries, enclosures, test equipment, kits and accessories, and more.

But, goes the lament, rigs are too complicated these days (sigh), so hams don't build anything anymore. Oh really? That's news to me.

From my mail bag comes ample evidence that hams are building things . . . maybe not single-sideband rigs, but other things. Accessories, QRP rigs, instruments, preamplifiers, antenna tuners, and a host of things digital have emerged from very satisfying letters from my mailbag.

Electronic construction is more than a private passion, for it also affects the future health of the country. Now, now, please don't start laughing . . . hear me out, I mean it. Hams and other hobbyists building stuff and noodling around in basement or garage workshops can affect the future of the United States.

Recently, I read James Gleick's book "Genius," which is a biography of Nobel Laureate physicists Richard Feynman (Gleick also wrote the bestselling book "Chaos," and Feynman is well known as the dissenter on the Presidential Commission on the Space Shuttle Challenger accident who pulled off an impromptu experiment on TV that proved the "O" rings were defective).

Apparently, Feynman believes that we are a nation at risk of declining scientific and engineering competence because the two recruiting grounds for future scientists are now gone: chemistry sets and radio. According to Feynman, the radio has become too complicated and the lawyers stole the chemistry sets.

Well, Feynman is a smart man, but I maintain that there is still great interest in building things electronic. The word radio might be replaced with "electronics," for the field is now much larger than the AM-band receivers that Feynman built, but there is still a large amount of interest.

Each one of us should do our best to mentor a youngster in electronics. And one way to encourage a youngster is to give him or her a gift subscription to **Popular Electronics** or its sister publication *Radio-Electronics/Electronics Now.* Really! This isn't a crass commercial pitch, because I was "stuck" when an electronics-engineer neighbor bought me a subscription to **Popular Electronics** in the late 1950's.

Another way to encourage youngsters is to steer them into electronics projects for school science fairs. Still another is to encourage and help them build electronics gadgets and gizmos.

PARTS-N-STUFF

Obtaining parts can be a problem. Many of the projects seen in this magazine have a parts-source listed. I've built a few of them, and found those sources to be sound. And I've offered parts for my projects from time to time when other sources have high minimum-order requirements ($50 to $500 in some cases), or isn't equipped to handle or interested in small orders.

Other good sources of parts are the advertisers in this magazine. I've ordered literally thousands of dollars worth of stuff from **Popular Electronics** advertisers over the years, and found all of them to be first rate. Indeed, except for a few items of special interest, I make it a policy to buy from advertisers. That isn't mere loyalty to **Popular Electronics**, but rather a form quality control to ensure that you, the reader, can also obtain the parts. After all, it doesn't do a whole lot of good for me to use a special chip that's only available in pallets of 50 or 500, when you need just one. In those cases, unless the column is purely tutorial in nature (rare), I'll usually either offer it myself for a period of time, or arrange for someone else to offer it. Here are some of my favorite part suppliers:

Digi-Key (P.O. Box 677, Thief River Falls, MN, 56701; Tel. 800- 344-4539) offers a free catalog that has a wide range of electronics components. Unlike some catalogs, "electronics" isn't a euphemism for "computer," for they cover the spectrum. For RF builders, such as ham operators, the listing of Toko fixed and variable inductors is a gold mine.

Another catalog dealer in electronic parts that I've found very useful over the years is Mouser Electronics (2401 Highway 287 North, Mansfield, TX 76063-4827; Tel. 800-346-6873). They also cover the waterfront in electronics components, so they can be a major source of supplies.

Jameco Electronics (1355 Shoreway Road, Belmont, CA 94002; Tel. 415-592-8097) sells a lot of components in their Jim-Pak blister packages. Not only are a lot of different components available, some are available in quantity (10 1N4148 diodes, or 10 741 op-amps, etc.).

If you want to use inductors, and none of the Toko inductors are suitable, then you might want to either wind one of your own, or buy some prewound stock from Barker & Williamson (10 Canal Street, Bristol, PA, 19007; Tel. 215-788-5581). They sell coil stock from ¾-inch to 4-inches in diameter under the Air-Dux and Miniductor brands. The idea is that you whack off the right number of turns to make the inductance you need.

Toroidal cores are available from Amidon Associates (2216 East Gladwick Street, Dominguez Hills, CA 90220; Tel. 310-763-5770). In addition to toroidal cores, they also sell a large selection of ferrite rods, beads, bazooka BALUN cores, and other ferrite and powdered-iron inductor products.

Another mail-order electronics parts-supplier, Newark Electronics, has offices all over the map, and they accept credit card orders for electronics parts. Their catalog is one of the most comprehensive available. They have too many locations to list here, but try their central administrative offices at 4801 N. Ravenswood Street, Chicago, IL 60640; Tel. 312-784-5100. Or, do as I did and look in the Yellow Pages. Newark often advertises locally, even when the actual office is elsewhere.

While few on this side of the "great pond" would even consider it, Europe is another source of parts. Electronic construction is a big deal over there, and I've bought substantial material from one of their distributors: Maplin Electronics (P.O. Box 3, Rayleigh, Essex, SS6 2BR, England, UK; or phone from North America: 011-44-0702-554161). The cost of their catalog is 2.95 pounds sterling; with

(Continued on page 92)

SCANNER SCENE

By Marc Saxon

Getting the bugs out

A most interesting piece of receiving equipment recently was introduced. Called the *R20 AM Interceptor*, it's a pocket-sized, non-tunable receiver that detects all close-proximity, amplitude-modulated RF signal sources operating between 500-kHz and 2.5 GHz (and above). Any signal that it picks up is amplified and processed through sophisticated automatic volume-level circuitry, which means that you can listen to it through an earphone and you don't need a volume control.

The R20 AM Interceptor picks up near-field AM signals, including those transmitted by surveillance devices.

Unlike a scanner, which samples many separate frequencies separately one at a time in rapid succession, the R20 continuously monitors its entire, wide frequency range. When it detects a signal, it automatically stabilizes its operation to pick up only that frequency as long as the signal remains present. The signal can be heard, and its relative strength appears on the unit's ten-LED bargraph display. No tuning is required; everything is automatic.

The Interceptor is intended for use in the near-field, which is the region surrounding a transmitter. The actual distance from which the Interceptor can detect a transmission varies depending upon the RF floor and the presence of other strong signals. Distances of up to 100 feet from a 10-mW source can typically be obtained with ease.

The Interceptor can be used to check the operation of two-way radios, make RF signal-strength measurements, locate stuck transmitters, and test microwave ovens for leakage. It can pick up any AM signal, including CB radios. Because it doesn't radiate any signals of its own, the device should be able to be safely used to monitor VHF or UHF aeronautic-band communications from aboard a plane in flight (but only with the pilot's advance knowledge and permission).

The Interceptor gained instant popularity in the surveillance and counter-surveillance fields. It effectively detects hidden room bugs, body microphones, and automobile-tracking transmitters. Even when those devices use FM, the Interceptor will still observe a quieting effect where the background noise level disappears. It also lets a person know if their house is surrounded by people using transceivers. The Interceptor is priced at $119, and comes from Optoelectronics Inc., 5821 N.E. 14th Avenue, Fort Lauderdale, FL 33314. Their phone number is 800-327-5912.

CLUBS AND NEWSLETTERS

We get quite a number of requests for information about scanner clubs and newsletters. First, let's say that there are plenty of them. Second, let's point out that the quality of clubs and newsletters varies with respect to reliability and integrity. In other words, while many are worthwhile, others are not.

Of those we have encountered, we feel very comfortable in recommending the following:

Radio Communications Monitoring Association, Inc., P.O. Box 542, Silverado, CA 92676. Membership is $24 per year ($28 in Canada). They have a fine monthly journal for members.

Radio Monitors Newsletter of Maryland, P.O. Box 394, Hampstead, MD 21074. This excellent monthly publication, centered on the Capitol area and the surrounding mid-Atlantic states, costs $15 per year. A sample copy is available for $2.

Ontario DX Association, P.O. Box 161, Station A, Willowdale, ON, Canada M2N 5S8. Mainly an SWL club for Ontario residents, this organization has a worthwhile scanner column in their quality monthly publication. Memberships are accepted from all areas. Canadian memberships are $30.76; American memberships cost $26 in U.S. dollars.

North-East Scanning News, P.O. Box 62, Gibbstown, NJ 08027. This lively monthly scanner journal is devoted primarily to scanner-monitoring activities in the northeastern states. It costs $26 per year.

FREQUENCY FINDS

Mark Pratt of East Wenatchee, WA, wrote in to report that his local fire dispatcher operates on 154.43 MHz, and he has discovered that this is being repeated on 451.625 MHz. Mark believes that the 451-MHz repeater might be used for fire and EMS personnel in the northeastern part of his state. Mark also advises that police communications on 155.37 MHz (Washington's Law Enforcement Radio Network) are repeated on 465.50 MHz.

From southern California we received a postcard from Ron Sturgis. Ron told us that a firm in his area called Air Combat, Inc., owns several propeller aircraft painted up like U.S. and Russian military fighters. For a fee, they take members of the public up for realistic simulated aerial dogfights. Ron had seen this on TV a few times, and observed that the pilots use radio communications to talk to one another during the dogfights. Ron hoped that we could supply the frequency.

Our sources advise us that Air Combat uses 131.025 MHz, but we don't know if the same frequency is used by other aerial dogfight firms in different areas. Some of these companies are also called Air Combat, Inc.

We hesitate to ask why, but H.W.S. of Missouri wants information on how to monitor his state's Liquor Control Board. He understands that they use several frequencies. He can listen on the state police low-band frequencies. There is also a primary high-band frequency at 154.77 MHz, and the Liquor Control Board can contact many county sheriffs on 155.73 MHz. The agency can operate on the National Law Enforcement Emergency frequency (155.475 MHz). For those whose favorite song is "In the Still of the Night," the frequencies of importance are 458.7875 and 458.8875 MHz, the tactical frequencies of their handhelds. Looks like a job for an Optoelectronics R20 Interceptor!

Barney Klein of Brooklyn, NY, wants to know the identity of the stations he hears using 364.2 MHz, AM mode, with coded call signs. This is a major frequency used by the North American Aerospace Defense Command (NORAD). As such, it is quite active and always interesting.

There goes our space this time around. As always, our address is *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. We hope to hear from you soon! ■

NEW PRODUCTS

Electronic Golf Pro

Here's a Father's Day gift idea sure to appeal to any golfer: *Bel-Tronics' SwingMate*, an electronic device designed to help golfers make consistent, solid contact with the ball by measuring swing speed. The ideal speed varies for each golfer, and swinging too fast or too slow can result in mis-hit shots and reduced distance. Swing-

Mate helps golfers accurately identify their ideal swing speeds and learn to consistently repeat that speed on the practice range and the course. The portable unit requires no club attachments or special mats; it can be used on grass, artificial turf, or even carpet.

The device measures the speed of the club head at impact and displays it in miles per hour on its LCD readout. SwingMate also calculates the distance the ball would travel (under optimal conditions) with the suggested club at the registered swing speed. Results can be stored in memory and compared to subsequent swings. Besides helping golfers identify their best swing speed, the device assists in club selection. The user chooses a club from the menu, and the device calculates the distance the ball would travel using that club at the most recent swing speed registered. Because most golfers vary their swing from round to round, that helps them determine the correct club to use based on the way they are swinging that day.

The SwingMate has a suggested retail price of $249.95. For more information, contact Bel-Tronics Limited, 10250 Industrial Blvd., Covington, GA 30209; Tel: 404-787-6500; Fax: 404-784-9898.

CIRCLE 101 ON FREE INFORMATION CARD

DUAL-DISPLAY LCR BRIDGE

Designed for field-service or general-industrial applications, *B+K-Precision's Model 878* handheld LCR bridge has a wide range of features intended to speed such operations as component testing and sorting. The device has dual digital readouts and measures capacitance, inductance, and resistance at a basic accuracy of 0.7%. When testing capacitors, it displays capacitance and dissipation factor simultaneously. For inductors, inductance and Q can be read at the same time. The display features four and three-digit LCD readouts with function annunciators.

A relative mode stores the value of a reference part, then shows a plus or minus difference between the reference and the measured value. That makes it easy to spot out-of-tolerance components. The Model 878 can be set to beep when a component tests outside of a preselected 1%, 5%, or 10% tolerance around the reference value. A data-hold function freezes any displayed reading, and a min/max/average function keeps track of the running average of readings and records the highest and lowest running values. The microprocessor-based unit even tells users when calibration is needed. Self-calibration is initiated with a pushbutton switch.

The Model 878 handheld LCR bridge has a suggested list price of $275. For further information, contact B+K-Precision, Division of Maxtec International Corp., 6470 West Cortland Street, Chicago, IL 60635; Tel: 312-889-9087; Fax: 312-794-9740.

CIRCLE 102 ON FREE INFORMATION CARD

POWER-LINE MONITOR

An inexpensive electronic power-line monitor from *Power Alarm, Inc.*, bridges the gap between surge suppressors and uninterruptible power supplies. The *Line Alarm* continuously monitors electrical supply voltage and grounds, and sounds an alarm and lights a red LED whenever the 120-volt AC power-line voltage drops below 108 volts or rises above 132 volts (+10%). The device also uses neon lamps to indicate incorrect electrical wiring and missing electrical grounds.

The Line Alarm is intended for use with computers and office electronics, where brownouts and improperly wired wall outlets with missing grounds can cause significant, random problems and equipment failures; at construction sites, where portable offices with temporary on-site wiring are particularly prone to wiring errors, improper grounds, and overloaded circuits; and in recreational vehicles and trailers,

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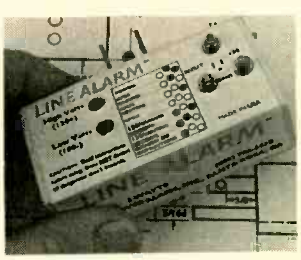
where the device can detect overloaded and faulty power generators that can damage electrical motors and compressors and can warn of



improper power supplied by temporary campground hookups. Technicians can use the Line Alarm to confirm suspected erratic voltages and grounding problems.

The Line Alarm power-line monitor costs $29.95 plus $6 for shipping and handling (California residents must add 7.5% sales tax). For more information, contact Power Alarm, Inc., 462 Rusty Drive, Santa Rosa, CA 95401; Tel: 800-786-6610.

CIRCLE 103 ON FREE INFORMATION CARD

CABLE BOX SOLUTION

It's not unusual when adding cable-TV service to your home video system to have compatibility problems between the cable box and your expensive TV and VCR. Compatibility problems run the gamut from poor reception, to the inability to record one channel while watching another or to preset the VCR-timer function to record different channels at different times. It's not unusual to need the remote control supplied (usually for a monthly fee) if you want to change channels, and such features as on-screen displays and picture-in-picture are often adversely affected by the cable box.

The *Cable Box Solution* from *Milestone Products* allows any

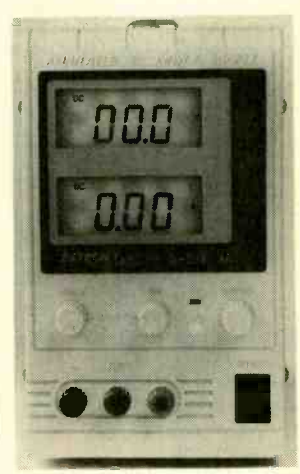
remote to access the cable box when needed for descrambling premium programming. For unscrambled programming, the device completely bypasses the cable box, restoring all TV/VCR features. The deluxe model provides that control independently for both TV and VCR. A proprietary "universal infrared receiver" activates the Cable Box Solution when any remote button is held down for 2–3 seconds. Connecting hardware is built in, making the device easy to install.

The Cable Box Solution basic and deluxe models cost $30 and $40, respectively. For additional information, contact Milestone Products, 3221 West Tompkins Ave., Las Vegas, NV 89103; Tel: 702-795-0124.

CIRCLE 104 ON FREE INFORMATION CARD

DIGITAL DC POWER SUPPLY

Providing dual displays and a linear, adjustable output of 0–30 VDC and 0–3 amps, *Extech's Digital DC Power Supply* also offers automatic constant current and constant voltage with low noise and ripple. The device features 0.02% precise regulation and switchable power



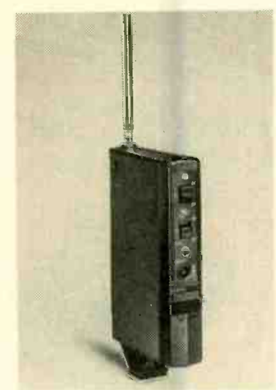
source of 110V/230V. The power supply's circuit design includes overload, thermal, short-circuit, and reverse-polarity protection, as well as protection against overheating even at maximum power output during continuous application.

The Digital DC Power Supply (part number 382210) costs $369. For further information, contact Extech Instrument Corp., 335 Bear Hill Road, Waltham, MA 02154; Tel: 617-890-7440; Fax: 617-890-7864.

CIRCLE 105 ON FREE INFORMATION CARD

WIRELESS CAMCORDER RECEIVER SYSTEM

Using advanced miniaturization and surface-mount technology, *Azden* created a wireless receiver system for video cameras that lets the videographer use two wireless microphones at the same time.



The *Model WR2-PRO* allows the simultaneous recording from two transmitters, each on a separate frequency. The device can be powered by a 9-volt battery, a 12-volt battery pack, or an optional AC adapter. It has a headphone output jack for monitoring the sound being recorded.

Next to each channel selector there is an LED that glows red to indicate that channel's selector switch is turned to "on." When the corresponding microphone/transmitter is switched to that frequency, the LED turns green. When two transmitters are in use, both LED's glow green.

The WR2-PRO wireless receiver system has a suggested retail price of $200. For additional information, contact Azden Corporation, 147 New Hyde Park Road, Franklin Square, NY 11010; Tel: 516-328-7500; Fax: 516-328-7506. ■

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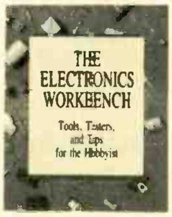

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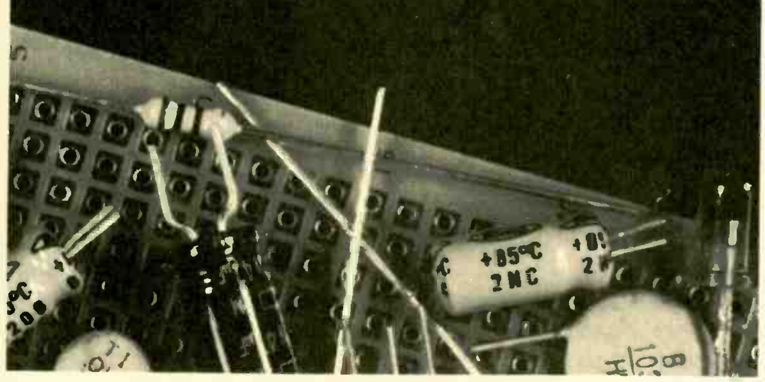

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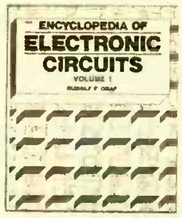

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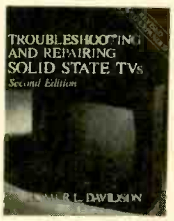

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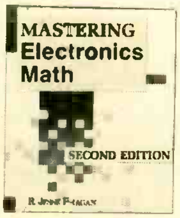

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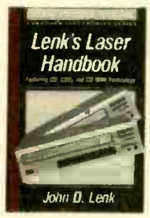

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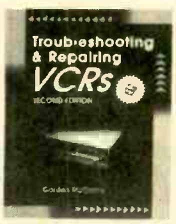

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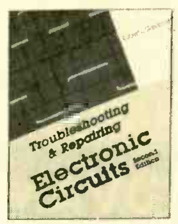

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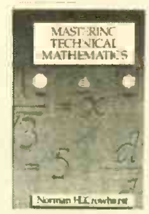

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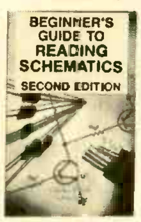

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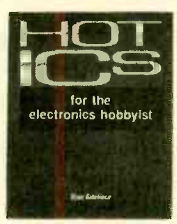

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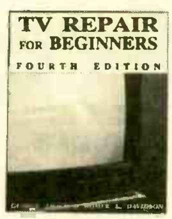

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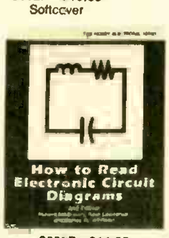

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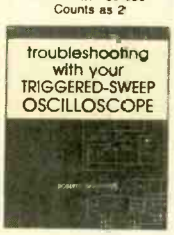

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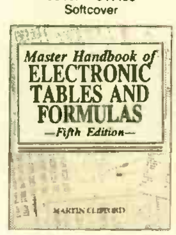

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THINK TANK
(Continued from page 78)

low capacities of C5–C10 in relation to C1–C4. If you need a higher ignition voltage, just add stages onto D5 and D8.

I assembled my power supply on barrier-terminal strips, using test-probe cable for all interconnections. Diodes D1–D8 are 1-amp, 1000-PIV units; C1–C4 are 10-µF devices rated for 450 WVDC; C5–C10 are 0.001 to 0.01-µF, 1000-WVDC ceramic-disc components; and R1–R4 are 330k, 1-watt units. Resistor R5 was selected to drop 1375–1230 volts at 3.7 mA. A 33k, 2-watt device was sufficient for that resistor.

Heed the warnings! Be careful, and have fun!

—Skip Campisi, So. Bound Brook, NJ

Quite an involved voltage multiplier. Readers should be aware that they must use a ballast resistor suitable for their laser tube. Often times, a laser tube comes with the appropriate resistor, but not always. If that is the case for you, use the reasoning outlined by Skip to determine the resistor value your tube needs.

It should also be further emphasized that even low-power lasers are not toys. They are to be respected and ***never*** *aimed at anyone's eyes or manhandled. Further, be sure never to use one in a room containing objects that could reflect significant amounts of laser light and always work with laser safety goggles.*

As always, if you'd like to contribute to this column to try for a book, write to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

HAM RADIO
(Continued from page 83)

the exchange rate at the time of this writing being $1.50/pound, that comes to about $4.43 US.

Although I keep a modest checking account in England for this purpose, you can also order using either Visa, American Express, or Access credit cards. My own experience is that there is no problem ordering from Maplins with a credit card, but one has to understand that the bank will convert the pounds sterling amount charged by the company to dollars for billing. And be warned that the conversion rate might not be as favorable as the best commercial rate.

Finding electronics parts isn't always easy, so it helps to keep in touch. If anyone has sources other than those listed here, then please pass the information along to me (at P.O. Box 1099, Falls Church, VA 22041).

HAM NEWS FLASH

The ARRL Field Day contest is scheduled for the last full weekend in June. Write to ARRL at 225 Main Street, Newington, CT, 06111, or phone 203-666-1541, for details and rules.

Harry Helms and Carol Lewis of HighText Publishers informed me that they have moved from San Diego. If you want my books "The Art of Science" or "Receiver Antenna Handbook," or Harry's book "All About Ham Radio," then write to HighText at 125 North Acacia Avenue, Suite 110, Solana Beach, CA 92075. They also have arranged for Independent Publisher's Group (IPG) to take credit card orders at 800-888-4741. ■

ELECTRONICS LIBRARY

MacArcade: Top Shareware Game Picks

by Don Rittner

For those Macintosh users who are tired of spending their hard-earned money on commercial computer games, this book provides a cost-effective alternative. It allows readers to try out the author's ten favorite games—which are included on a two-disk set—and then inexpensively purchase the ones they like. Don Rittner reviews his top shareware choices in a humorous, fun-to-read style.

The book includes game summaries, compatibility listings, tips on how to get games for practically no money, and game-playing pointers. In addition, two high-density floppies are packed with ten classic games. Purchase of the book/disk set entitles the reader to receive two free issues of *The Ventana Mac Update*, a newsletter filled with information about new games, shareware, and on- and off-line resources.

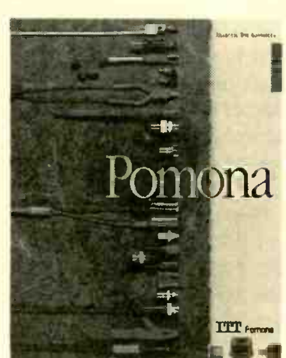
MacArcade: Top Shareware Game Picks costs $27.95 (including two diskettes) and is published by Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515; Tel: 919-942-0220; Fax: 919-942-1140.

CIRCLE 93 ON FREE INFORMATION CARD

1993/1994 ELECTRONIC TEST ACCESSORIES CATALOG

from ITT Pomona

Several new DMM test-accessory products and an expanded line of oscilloscope probe kits—including an active differential probe tip—are highlighted in this 142-page catalog. Also included is a helpful guide that offers accurate SMT test-clip selection pointers for the new low-profile, fine-pitch packages such as SQFP, SSOP, and PQFP styles. An easy-to-use index makes it easy to locate products in twelve major categories, which include jumpers and cables, boxes, plugs and jacks, connectors, adapters, single-point test clips, and static-control devices. New products include test clips, probes, and cable assemblies designed to meet safe operating requirements per IEC 1010 standards.



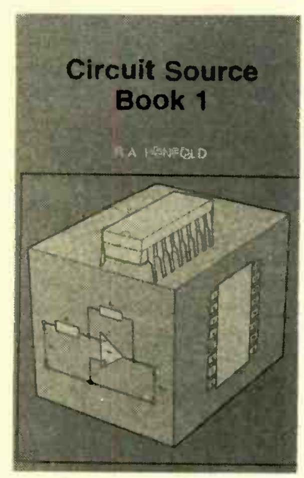
The 1993/1994 Electronic Test Accessories Catalog is free upon request from ITT Pomona Electronics, Customer Service, 1500 East Ninth Street, P.O. Box 2767, Pomona, CA 91769; Tel: 909-469-2900; Fax: 909-629-3317.

CIRCLE 94 ON FREE INFORMATION CARD

CIRCUIT SOURCE BOOK 1

by R. A. Penfold

This book is intended to help hobbyists to create and experiment with their own electronic designs by combining and using the various standard "building block" circuits provided in its pages. Where applicable, advice is provided on how to alter the circuit parameters for other applications. The circuits presented are primarily used for



analog signal processing. They include audio amplifiers (op-amp and bipolar transistors); audio-power amplifiers; DC amplifiers; high-pass, low-pass, band-pass, and notch filters; tone controls; voltage-controlled amplifiers and filters; triggers and voltage comparators; gates and electronic-switching devices; bar graphs; mixers; and phase shifters. More than 150 circuits are provided.

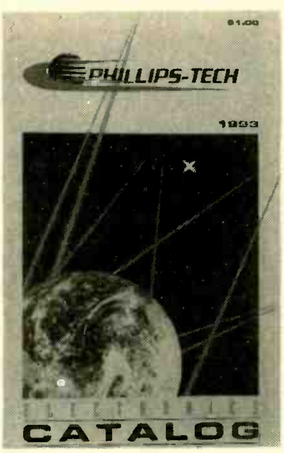
Circuit Source Book 1 (order No. BP321) is available for $6.50 plus $2.50 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

CIRCLE 97 ON FREE INFORMATION CARD

1993 VIDEO ELECTRONICS CATALOG

from Phillips-Tech

Reflecting the changing world of video electronics technology—particularly in the area of microwave audio/video transmission and reception—this catalog specializes in the 1900–2700-MHz frequency-range products.



However, product lines have been expanded to include other electronic, video, and television-reception products and accessories. The 21-page booklet features microwave TV systems that pick up combined audio/video signals in the microwave band, which frequently include "rebroadcasts" from original program sources such as satellites, TV relay, tape delay, television stations, and universities. The systems comprise antennas, downconverters, power-supply tuners, coax cable, and mounting hardware, which are sold separately or as complete microwave-TV systems. The catalog also offers UHF/VHF/FM TV antennas, master-antenna rotors, signal amplifiers, and listings of FCC active licensees, as well as general information about microwave TV and TV-channel assignments.

The 1993 Video Electronics Catalog is available for $1.00 from Phillips-Tech, P.O. Box 8533, Scottsdale, AZ 85252; Tel: 602-947-7700 (7:30 AM–4 PM weekdays); Fax: 602-269-3283.

CIRCLE 95 ON FREE INFORMATION CARD

HEATH NOSTALGIA

by Terry Perdue, K8TP

As readers of **Popular Electronics**, there's a good chance that you have fond memories of building Heathkits projects. As a Heath engineer for 18 years, the author of this book has an insider's view of the company behind those kits.

For many years, Heath Company was the world's largest manufacturer of electronic kits. The company started out with economical test-instrument kits that were widely used by hobbyists, service technicians, and students. Heath soon expanded their product lines to include amateur radio and hi-fi products, and later to a wide variety of other electronic products.

Those kits were the first taste of electronics for many youngsters.

This book contains contributions from several Heath employees. Together with a chapter devoted entirely to photographs, their reminiscences provide an intimate, anecdotal history of the company.

Heath Nostalgia is available for $9.95 (plus sales tax in Washington State) from Heath Nostalgia, 4320 196th S.W., Lynnwood, WA 98036.

CIRCLE 98 ON FREE INFORMATION CARD

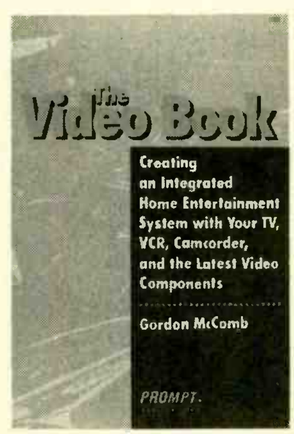
THE VIDEO BOOK

by Gordon McComb

Gone are the days when the family gathered around a console TV in the living room for the latest in video entertainment. These days, the TV is no longer a stand-alone unit—now it's sure to be connected to a VCR, and likely to be hooked up on occasion to camcorders, laser-disc players, and other video components.

This book, subtitled "Creating an Integrated Home Entertainment System with Your TV, VCR, Camcorder, and the Latest Video Components," shows readers how to get the most out of all their video gear. With easy-to-read text and clearly illustrated examples, the book guides readers through the use, installation, connection, and care of video-system components.

The Video Book covers the operating basics of TV's, VCR's, laserdisc players, antennas, satellite systems, video cameras, audio and video processors,



and video selectors. The book removes some of the confusion surrounding connectors, cables, and system interconnections. In addition, it provides maintenance and troubleshooting pointers that anyone who owns or uses video gear is sure to find helpful.

The Video Book costs $16.95 and is published by Prompt Publications, Howard W. Sams & Company, 2647 Waterfront Parkway East Drive, Indianapolis, IN 46214-2012; Tel: 317-298-5710; Fax: 317-298-5604. ■

CIRCLE 96 ON FREE INFORMATION CARD

ANTIQUE RADIO

(Continued from page 69)

per Hallicrafters specifications, was peaked to resonate at the upper end of the dial).

Scattered throughout the bands are numerous odd whistles (luckily, mostly low level)—otherwise known as "birdies," as well as stations that appear in more than one spot on the dial—otherwise known as "images." However, by all accounts, that is the way the set performed when it was new.

Quoting the well-known radio writer William Orr, from the anthology *The Golden Years of Radio* (Ham Radio Publishing Group, 1978), the S-19-R was "... insensitive, unstable, broad tuning, and full of images and birdies. But for the beginning ham who was thrilled to hear signals from across town, the receiver was an outstanding hit! The impressive dial, plus instant bandspread and a beat oscillator, transformed a simple broadcast set into an acceptable ham receiver that sold over 20,000 units before the model was dropped on the eve of World War II." ■

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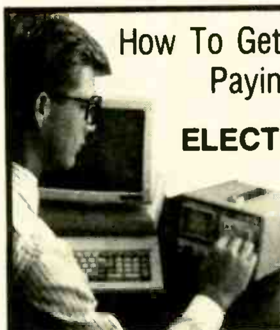

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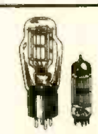

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In recent weeks, the men and women of The Salvation Army were active in three very different communities helping thousands suddenly in crisis due to major disasters or emergencies:

•In **Chicago, Illinois,** Salvation Army emergency disaster teams provided canteen, supply vehicle, and ham radio support in response to major flooding in the city's historical loop.

•In **Guadalajara, Mexico,** Salvation Army mobile emergency canteens from Texas responded to the sewer line gas explosions which killed nearly 200 people. As of the beginning of May, Salvation Army personnel and volunteers have served 125,362 meals and snacks to victims and rescue workers. Canteens are still on hand, providing on-site relief and counseling services to the injured and homeless.

Photo credit: Cheryl Senter

Two firefighters take a welcome break at a red canteen staffed by Salvation Army volunteers.

•In **Los Angeles, California,** the Army helped those affected by the violence and destruction that gripped the city in the aftermath of the Rodney King court decision. Responding to those in need in Los Angeles and surrounding communities, and in support of the National Guard and the military deployed to those areas, the Army assisted over 140,000 individuals. Hot meals, night lodging, clothing, and counseling were among the services provided.

For further information, contact The Salvation Army in your community or write National Headquarters, 615 Slaters Lane, Alexandria, VA 22313.

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RECEIVER PREAMPLIFIERS

(Continued from page 56)

The circuit can be assembled on perfboard, using adhesive-backed copper foil and following the pattern shown in Fig. 10. The back of the board is a solid copper foil ground plane. The preamplifier works better if the perfboard is replaced with the G-10 epoxy fiberglass type of board, and even better yet (to 2000 MHz) with PTFE woven fiberglass board.

Conclusion. Monolithic microwave integrated circuits, like the MAR-x, make it possible to build well behaved receiver-preamplifier circuits that will operate to 1000 MHz in some varieties, and to 2000 MHz in others.

Note: For a limited time after publication of this article, I am prepared to sell an MAR-1 MMIC chip and two 0.001-µF or 100-pF chip capacitors for $6.00, postpaid. You can get them cheaper from Mini-Circuits, but may run into a minimum order problem. If you are interested, contact me, Joe Carr directly (at P.O. Box 1099, Falls Church, VA 22041). ■

Countersurveillance

Never before has so much professional information on the art of detecting and eliminating electronic snooping devices—and how to defend against experienced information thieves—been placed in one VHS video. If you are a Fortune 500 CEO, an executive in any hi-tech industry, or a novice seeking entry into an honorable, rewarding field of work in countersurveillance, you must view this video presentation again and again.

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Wake up! You may be the victim of stolen words—precious ideas that would have made you very wealthy! Yes, professionals, even rank amateurs, may be listening to your most private conversations.

Wake up! If you are not the victim, then you are surrounded by countless victims who need your help if you know how to discover telephone taps, locate bugs, or "sweep" a room clean.

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.

Foiling Information Thieves

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.

Stolen Information

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.

The Dollars You Save

To obtain the information contained in the video VHS cassette, you would attend a professional seminar costing \$350-750 and possibly pay hundreds of dollars more if you had to travel to a distant city to attend. Now, for only \$49.95 (plus \$4.00 P&H) you can view ***Countersurveillance Techniques*** at home and take refresher views often. To obtain your copy, complete the coupon or call.

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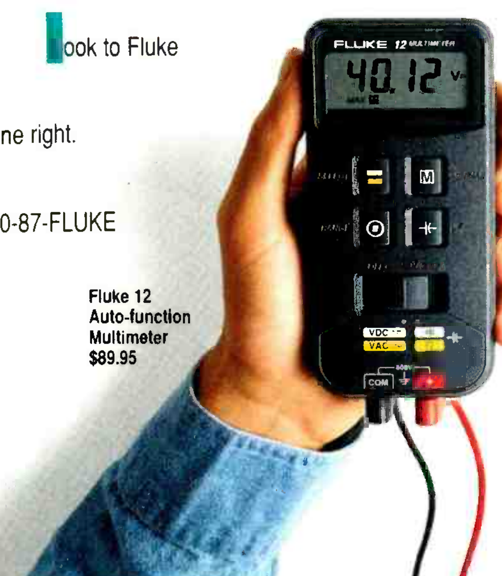

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Two-year warranty	Three-year warranty	Three-year warranty
Continuity Capture™	Yellow holster with Flex Stand™	Yellow holster with Flex Stand™
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