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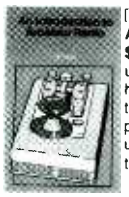

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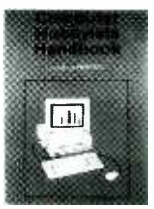

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EDITORIAL

A MIXED BAG

Since deregulation, cable-TV companies have pretty much had their way. In most communities, they enjoy a monopoly. If consumers don't like the pricing structure, programming choices, or have other complaints, they have had little recourse except not to subscribe. And while local governments could threaten a poorly performing cable company with franchise revocation, such actions were essentially impractical. The cable industry could operate as it saw fit, and without fear.

That situation changed somewhat with the passage of the cable-TV bill this past October. Passed over the veto of President Bush the bill helps level the playing field a little. Unfortunately, the key words here are "a little."

Furthermore, the bill is far from perfect. For instance, the new bill provides some limited rate relief. It allows the FCC to regulate only the most basic tier of programming; the FCC has no input on other rates unless it receives complaints from consumers, municipalities, etc.

Also important is a provision calling for cable systems to be technically compatible with all TV's, VCR's, etc. Except where off-premises descrambling is used (and currently few operators use that technology), most scrambling techniques render features such as picture-in-picture essentially useless (unless additional descramblers are rented). Unfortunately, it is unclear how this provision will be interpreted (perhaps it will give life to the EIA's multiport standard?), and it is vague enough to give operators the leeway they need to skirt it with little imagination.

Somewhat troubling is a provision that allows TV broadcasters to charge cable companies for use of their signals. It ignores the fact that broadcasters already receive value for their signals in terms of higher viewership and, hence, higher advertising revenues. Worse, intertwined with modified must-carry regulations, it could tax the channel capacity of older, smaller systems, or deprive viewers of channels they desire. This provision was unnecessary, and could be a source of trouble in the years to come.

In short, all the sound and the fury aside, the bill appears to be a mixed bag. Its benefits will largely depend on how, and how vigorously, the FCC chooses to implement and enforce its provisions. But at least it's a start.

Carl Laron
Editor

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LETTERS

MUDDLED MESSAGE

I'm writing concerning a minor problem with the "Personal Message Recorder" project (**Popular Electronics**, October 1992). As described on page 40, the electret microphone must be tied to analog ground, but according to Fig. 2 (schematic diagram) of the article, there is no such connection. The correct connection is shown in Fig. 1 here. There is

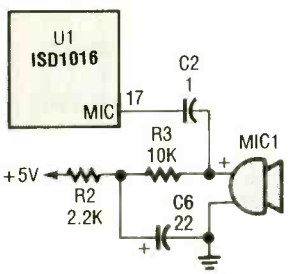

Fig. 1

also a problem with the parts-placement diagram (Fig.4). The designations for the three 0.1-μF capacitors have been interchanged. The part designated C1 is actually C2, C2 is C3, and C3 is C1.

C.B.
Brooklyn, NY

HIGH-ENERGY, HIGH-RISK IGNITION

Charles Ball's article, "Build A High-Energy Ignition System For Your Car" (**Popular Electronics**, September 1992) appears to be a good article in general, but makes a few risky assumptions that must be pointed out to your readers.

First, retrofitting a high-output ignition on an older car requires that the *entire* ignition system be capable of handling all that extra energy that the old point/Kettering ignitions weren't intended or designed to handle. In any ignition that has a 40kV or higher peak output voltage, the distributor cap, rotor, plug wires, and plug-wire boots must be designed with sufficient insulation and high dielectric strength materials, to withstand the high voltages at automotive under-hood temperatures. To prevent problems with ionization and crossfire between adjacent terminals, most late-model high-energy ignitions use distributor caps with wider spaced terminals, many are vented, and most are made of better insulating material. The rotors are correspondingly redesigned and made of high dielectric strength materials. The plug wires have thicker, better insulation and thicker boots (8mm plug wires are used in the late-model ignition systems, compared to 7mm wires with thinner boots that are usually used on point/Kettering systems).

On cars having OEM suppression plug wires, those wires should be replaced after about four years or 35,000 to 40,000 miles, as the carbon core in them doesn't last much longer than that. When the wires go bad, the electricity may find a path to ground through the insulation. You should use high-quality plug wires of suppression core, wire-wound suppression type, or (where legal) copper-core wires made

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by "hot rod" after-market ignition makers such as Accel, Mallory, Jacobs, Moroso, or MSD. The distributor cap and rotor should be similarly upgraded to high-quality after-market parts.

Second, Mr. Ball assumes that higher spark energy automatically reduces emissions, but the degree of emission reductions really depends on many variables such as ignition timing-advance settings, carburetor air/fuel ratio, cam-shaft timing, etc. The air/fuel ratio should be set with the aid of an emission analyzer for best results.

Third, ignition energy may not necessarily improve from the addition of a capacitive-discharge ignition box alone if the original coil is not up to handling the job. Most ignition coils designed for point/Kettering or conventional (non-capacitive discharge) electronic ignitions have higher inductance, especially primary winding inductance, than coils specifically designed to give maximum output with capacitive-discharge (or CD) ignition boxes. To ensure maximum output you should use a CD-compatible ignition coil with a CD ignition unit. Those after-market ignition coils have better insulation to protect against internal coil shorts at very high output voltages for which OEM coils aren't usually designed.

Fourth, while CD ignitions boast extremely fast voltage rise time and high output voltage, you must consider the impedance through which that voltage is measured. Voltage measured on a high secondary side impedance can be very high, but current delivered to the plugs will be low. Spark plugs and wires with lower resistance or impedance will "load" the coil's output and lower the voltage output measurement, but plug current will be higher. Total energy output is voltage × amperage × time, and many CD ignitions produce sparks of shorter duration than conventional point/Kettering or electronically switched ignitions. In fact, some conventional electronically switched ignitions with suitable high-performance coils can produce sparks of sufficient voltage, current, and duration time to rival some capacitive-discharge ignitions.

J.M.N.
Donora, PA

A TESLA COIL ADDICT

I really enjoyed the "Circuit Circus" column entitled "Fun With Tesla Coils" (October 1992). I built the Tesla coil oscillator and was surprised that the coil actually produced a significant (½-inch arc) output with such a small input signal. I am currently modifying the circuit to drive the primary circuit of my standard Tesla coil, with the intent of using the solid-state circuit to help me optimize capacitor/inductor values in my Tesla coil's primary/secondary circuit.

Because I used open construction when I breadboarded the oscillator circuit, using no RF shielding, I managed eventually to fry all my in-stock 567 chips, as well as two or three voltage regulators. I am going to go to a 555 timer chip circuit because that chip is more readily available at my local Radio Shack store. You can be sure that I am also going to shield this thing!

My biggest surprise was just how sensitive these coils are when it comes to setting them to resonant frequency. They are very, very touchy.

I have been building Tesla coils since 1965 (prompted by, coincidentally, a Tesla-coil project in the July 1965 issue of *Popular Electronics*). I have yet to build that one special "big one" that most coil builders dream about, although I really gave it a good try several years ago.

That attempt was a Tesla coil that had a primary nine feet in diameter and a secondary 18 inches in diameter. The 52-inch tall coil was space wound with over 4700 feet of 24-gauge wire, sprayed with 24 cans of acrylic plastic. The primary coil was tapped, of course, but I could also precisely tune it by a mechanical arrangement that varied the spacing between turns—no mean feat on a coil the width of my garage!

The capacitor was an oil-filled glass-plate job, which weighed almost 700 pounds. The transformer was a 4-kva, 300-pound, oil-filled monster that I had rebuilt at a local transformer company. The transformer was originally from a surplus ground-based military radar: 18,000 volts, 220 milliamps. I had to use a 3000-watt clothes dryer as a current limiter because the 100-amp circuit breakers I used as "on/off" switches could not handle the primary current of the transformer!

All that work, time, and money, and I was never able to achieve resonance! I was more disappointed in the failure of that Tesla coil than I was in the failure of my first marriage! A couple of years later, a water leak in a storage building ruined the secondary—a very sad sight, indeed.

I am currently trying to locate as much "practical" information on Tesla coil tuning, construction, etc., as possible.

Anyone who has spent any time building Tesla coils knows that they are addictive, and that they can be the most challenging, frustrating, yet exciting projects that a person can build. I think the article will help in future Tesla-coil projects, and I encourage **Popular Electronics** to publish more Tesla-related articles. In fact, if you were to start a Tesla project construction magazine, I'd become a charter subscriber!

B.P.
Irving, TX

DOWN MEMORY LANE

Reading the article, "Build the Idiot Box" (**Popular Electronics**, September 1992), sent me hunting through the attic for a similar device that I made in 1952. I found it, and it still works.

I made mine with 100 lamps mounted in shallow holes in a square of plexiglass. It was made to be hung like a picture from the wall and was AC powered. It served as a night light and for entertainment for two small children.

In 1952 you could buy bags of surplus components at a very low cost. I believe I purchased 200 capacitors for less than $3, and I got the same number of 10-megohm resistors for even less. The circuit is identical to the one shown in the article, including a potentiometer for adjusting the flicker rate. I probably still have a few of the lamps and other components in my junk box.

Serving as the Electronics Officer on board the USS Saratoga, I made a flashing symbol of an electron to hang over my desk. First I made two loops of #12 wire with the largest dimension being 8 inches. I soldered the body of an NE51 lamp to the loop. I soldered a capacitor in parallel with the lamp and used the resistor to complete the circuit to the other loop. I used #32 wire to support the loops from a battery lying in the cables in the overhead. It looked like it was floating in the air and blinking at the same time. After I had it wired and working, I sprayed the components with gold-colored spray paint, masking the lamps first, so nobody could see what the values of the parts were.

R.A.N., LCDR USN, Ret.
Brunswick, GA

HAVES & NEEDS

I am looking for a schematic of a Model 700 DF-AF crystal marker/TV generator made by the Electronic Measurements Corporation. I am also looking for a VN10K MOSFET transistor. Thanks.

David L. Murphy
4948 Caribee Drive
St. Louis, MO 63628

I own a Sansui SR-838 turntable. Last year it lost speed control and strobe. I have tried several "so-called" Sansui service centers in the local area for repairs. All claim to provide prompt and professional service of Sansui products; however, I have had no success.

Please help me find someone in my area that will service this turntable. I am willing to pay the cost of shipping, if necessary, since I am not ready to trash the turntable.

As a final alternative, I'd appreciate if someone could send me a copy of the schematic and parts list for the SR-838, and I will attempt to repair it myself.

Arthur Alston
1468 Key Parkway, Apt. 302
Frederick, MD 21702 ■

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JANUARY 1993

VOLUME 6, NUMBER 1

Spotlight on Home Theater

We have to admit that we love poring through the glossy pages of *Audio/Video Interiors* and other high-end magazines, ogling custom A/V installations that are as expensive as they are visually, audibly, and aesthetically pleasing. Ten-foot screens gracefully descend from the ceiling, motorized panels slide back to reveal a huge back-projection TV, speakers are recessed into the walls, touch-screen computer monitors control a dozen different A/V "zones." One recent issue featured a custom installation in which the equipment included 97 in-wall speakers plus three other pairs, two amplifiers, a receiver, two tuners, a CD player, a cassette deck, assorted remote equipment to route the audio and video throughout the house, four VCR's, a seven-foot front projection TV, a 50-inch rear-projection set, and 18 (yes, eighteen) 20-inch TV's!

Time for a reality check: If we tried to put all that equipment into our house, there would be no room left for the family, let alone furniture, clothing, and other basic necessities. In fact, it's unlikely that our house is worth as much as was paid for that custom installation!

That's not to say that average people can't incorporate *some* of the ideas and technology represented in that "dream installation" in their own relatively modest homes, keeping within their own relatively modest budgets. In this month's **Gizmo**, we'll take you on a tour of home theater—what it means, what's required, what's optional, and how you can make it work in your home. Then we'll take a look at several products that you might consider integrating into your own home-theater setup.

The goal of any home theater, of course, is to recreate the video and audio sensations experienced in a movie theater (or concert hall, or sports arena, depending on your viewing tastes) as closely as possible in the home. Doing so requires, at the very least, a large-screen stereo television, a stereo VCR, some sort of surround-sound processor, and speakers. Sounds simple enough, right? The problem is that between that basic installation and the custom dream job described above, there lies a whole world of options and a wide range of prices. Deciding what sort of components would work best for you is no easy task.

There are several factors to be considered *before* you venture out shopping and get even more confused by fast-talking sales people. Money, of course, is a major concern. But "bargain" and "value" are totally different concepts. What might be a real deal for someone—grabbing up a sale-priced low-end A/V receiver, or skimping on the speakers, for instance—could ruin the whole home-theater experience for someone with more sophisticated ears. That's not a good value at any price. In a similar vein, you might decide to go all out and splurge on the biggest screen available ("If I'm going to do it, I'll do it right!"), only to get it home and discover that it's much too large for comfortable viewing in your home theater.

WHO, WHAT, WHEN, WHERE?

It's easy to imagine all the things you'd like your home theater to have. But it's important not only to determine what you want from a home-theater system—but also to make sure that your dreams are compatible with your home, your family, and your wallet. Ask yourself the following questions before making any purchase decisions:

Who is going to be using the home-theater system? If you're an electronics enthusiast, and no one else will be touching the controls, then simplicity won't be a high priority. Chances are, however, that everyone in the family will want to use the system. If no one can figure out how to switch functions, there will be a lot of grief—for you as well as everyone else.

When are they going to be watching it? Daylight conditions aversely affect front-projection systems and, to a lesser extent, rear-projection sets; a direct-view set would be a better choice for those who watch TV during the day, or who prefer to keep some lights on in the room.

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Where is the system to be placed? Do you have a room available that can be used solely for home theater? Most of us don't have that luxury. If the system will be set up in the living room, there probably will be restrictions due to decorating concerns. If it's in the family room, keep in mind the other activities carried out there—doing homework or school projects, listening to music, paying bills, reading the paper, playing board games. Again, keep in mind the lighting required for those other activities.

What size is the room? A screen that's too small can get lost in a large room; a screen that's too large can be even worse. We'll discuss component, speaker, and furniture placement later in this article.

What will you be watching? Do you prefer live performances of opera and symphonies, or action films like *Terminator II*? Sporting events, or foreign films? Network sitcoms, or nature shows? All of the above, and then some?

How can your existing components be integrated in the new system? It's often not necessary to buy all new gear. Use your existing TV or hi-fi VCR and put the money you would have spent toward a better A/V receiver; you can always upgrade the other pieces later.

What wiring/installation skills do you possess? Will you have to call in a pro to set up your home theater, or can you handle the connections on your own? If you decide that you need help with all or part of the job, or with selecting the components, you might want to consult an audio/video installer (who should ask you some of the same questions we are).

How much can you comfortably afford to spend on a home-theater system? A well-planned home-theater can provide your family with hours of inexpensive entertainment. But if you have to take a second job to pay for it, you won't have any time to enjoy it!

THE HOME-THEATER ENVIRONMENT

Although home theaters can come in all shapes and sizes, there are some basic rules that should be followed, although they aren't written in stone. Figure 1 illustrates the recommended arrangement of furniture and components. If there are plenty of windows, special curtains or shades might be required to give you better control over the room lighting. Carpeting is recommended to minimize the reflection of sound. The minimum distance from the couch (or recliner) to the screen should be 2–3 times the screen size (measured diagonally). If, for instance, your sofa is 12 feet from the television, the ideal screen size would be 48–72-inches. In general, projectors need to be placed at a distance of about 1½ times the diagonal screen size. (One exception to that rule is the SharpVision reviewed in this issue, which requires somewhat less space between projector and screen; be sure to follow the manual's recommendations.) Chairs and couches should be set up so that the viewing angle doesn't exceed 30°. Speaker placement requires the center speaker to be as close as possible to the screen; magnetic shielding is essential to avoid distortion to direct-view screens. The front speakers should be placed to either side of, and at an equal distance from, the screen; again, shielded speakers will likely be required. The surround speakers go behind the viewers—preferably the same distance behind the viewers as the front speakers are forward, although time-delay circuitry in a surround processor lets you mount the rear speakers closer. A second set of surround speakers might be necessary in very deep rooms; they should be placed at the sides of the room. The subwoofer can be placed anywhere in the room, and many are designed to slide out of view under a couch or chair. For room-shaking bass, you'll probably want a separate amp to drive the subwoofer.

That much equipment can overtake a small room, and push other activities to the background. To avoid conflicts with decor and retain the use of the family room or living room for more than watching movies, you might consider converting a previously unused area of your home for use as a home theater. A basement, attic, or attached garage that you wouldn't consider prime living space due to lack of windows and/or lower than normal ceilings just might be ideal for a home theater. The natural dimness is a plus, and because you'll spend virtually all your home-theater time seated, the only worry with low ceilings is speaker placement. And if you're handy with tools, finishing a previously unfinished space would also give you the chance to create your own custom installation.

Instead of using a separate space, it might be possible to use the same space at different times for different purposes. Front-projection setups are particularly well-suited for home theaters that must disappear when not in use. It's often possible to mount the projector unobtrusively on the ceiling (in custom jobs, you can even have the projector recessed *into* the ceiling on a motorized lift), and some manufacturers offer projectors that have been factory-mounted in coffee tables. Ceiling-mounted screens roll up and out of sight when not in use. Today's in-wall speakers are almost invisible, and a subwoofer can be easily tucked out of sight. Such a set-up allows you to use your living room or family room for everyday activities, until it's time to "raise the curtain" on your home theater.

A friend of ours built an innovative home-theater setup (shown in the opening photo) in a room that measures about 14 × 22, with only one small window on one of the short walls. He replaced that one with an 8-foot-wide picture window. Flanking the window, he built floor-to-ceiling, 18-inch deep shelving units; under the window is an upholstered window seat—a feature that his wife had always wanted. Ceiling mounted in front of the window is a video screen. A Vidikron projector is mounted on the ceiling above the couch. Assorted components—VCR, Pioneer laserdisc player, Fosgate Pro-Log-

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WHAT TO LOOK FOR IN HOME-THEATER COMPONENTS

Televisions and Monitors. First, make sure the stereo TV or monitor you choose is the right size for your room. Keep in mind how big that 27-incher looked when it replaced your old 21-inch set—TV's seem to shrink with time. At the same time, you might want to bring along a tape measure to make sure that that huge rear-projection set will fit through your door, and not take up too much floor space once it's in. Some manufacturers, Mitsubishi, for one, are now making slim-line rear-projection sets that take up surprisingly little space.

The overriding factor in determining the largest screen size you should use is how far away from it you're going to sit. You want to see the picture, but you don't want to be able to see all of the elements that make up the picture. If you sit too close to a screen—no matter what its size—you'll start to see the horizontal line structure of the TV picture. (Some display devices, the Sharp LCD projector that we review in this issue, add their own visible structure as well.)

If you want to get that true movie-theater feeling—where the screen fills a large percentage of your field of view—you might be able to ignore the line structure and sit closer than the recommended 4–8 times the picture height. Usually, though, you'll have to move back. You don't want a *bigger* picture, you want a *better* one.

Let's look at what this means in real numbers. A 50-inch (diagonal) screen has a picture height of 30 inches. (Remember: the aspect ratio of a TV screen is 4 × 3, so the diagonal measurement is the hypotenuse of a 3-4-5 triangle. If you can remember some high-school geometry, you can calculate the picture height once you know the diagonal measurement.) A viewing distance of 10 feet would be required for best viewing of the 50-inch monitor.

Some projection sets suggest that you can sit at 1½ to 2 times the picture height from the screen. They usually have a "soft-focus" setting that exaggerates the width of the horizontal lines. If you can afford the $20,000 price, Faroudja Laboratories has a line-doubling system that lets you get as close as you would to a movie-theater screen.

A laserdisc, which produces the highest-resolution images of any consumer video device, has a horizontal resolution of about 450 lines. Think twice before you consider a monitor or projector that offers less. You'll likely see many projectors and direct-view sets touting much higher resolution.

But the picture on a projector—front or rear—with a horizontal resolution of 500 lines won't look the same as the one on a direct view set with a 500-line horizontal resolution. That's because the contrast and brightness will vary.

For the largest picture, you'll need a front-projection unit. For the brightest, highest-contrast picture, you'll want a direct-view monitor. Rear-projection sets are a compromise between the two. LCD projectors can't match the three-tube projectors—yet. But if you need huge-screen portability, they're the only way to go.

Don't forget to *listen* to your display device, too. Many sets provide good enough sound that you might be willing to forgo a separate audio setup. Some provide traditional surround sound. Others might use two-speaker "surround" systems, such as Carver's Sonic Holography or Hughes Sound Retrieval System.

VCR's. VHS, stereo, and hi-fi are the three most important things to look for in a home-theater VCR. Yes, we know that the S-VHS format will provide better resolution. But if you can't rent tapes—and if you don't have a S-VHS camcorder—who cares?

Do you use a VCR to watch scenes in slow motion or to watch still pictures? You need a four-head deck for those special effects. Otherwise, a two-head deck should do you fine, and merely provide a somewhat worse picture when you're fast-scanning over all those commercials. Do you edit tapes? A flying erase head will help you obtain seamless edits, and audio/video dubbing will let you add something to your edits. Do you use a VCR extensively for time shifting, including when you travel? Easy but sophisticated programming features are what you should be looking for.

Don't forget the little things that can make a VCR special. A 30-second skip feature makes bypassing commercials a breeze. Timer backup lets you laugh at intermittent power outages. And you might consider buying the same brand TV/monitor and VCR, for the matching remotes that many brands offer.

A/V Receivers. An A/V receiver can be the nerve center of your home-theater system and will provide a convenient link to your audio components. Make sure your A/V receiver provides sufficient switching capability. You'll want an easy way to dub audio and video sources, and you'll want everyone in your home to be able to use it as well. Many people find that on-screen displays make the setup easier.

Good sound can draw you into a movie even faster than a terrific picture. For most applications, Dolby Pro-Logic capability is what you want. The added center channel of a Pro-Logic amplifier, and the active sound-steering circuitry, provides a more realistic theater-like sound.

If you must stay on a small budget, consider a standard Dolby Surround (not Pro-Logic) amplifier. It won't compare favorably to a Pro-Logic amplifier in accurately placing and tracking some of the sound, but you might well be happy with it—especially since you should be able to find one at a bargain price these days.

If money is not an issue, you'll want equipment that has Home THX certification. Such equipment must receive an official OK from Lucasfilm, Ltd., the same people who certify THX movie theaters. In short, Home THX certification is a sort of performance guarantee.

Speakers. Speakers are arguably the most difficult components to choose for a home-theater system. The only feature that counts is how they sound. That means that only *you* can choose the speakers that sound best to you. Making your decision more difficult is the fact that speakers sound dramatically different depending on their placement and your home-theater acoustics. Nevertheless, there are some general things to keep in mind as you shop.

If your home theater will use a direct-view screen, your front speakers *must* be magnetically shielded. The purpose of Pro-Logic decoding is to place sounds accurately. Your front speakers should be directive, so they won't muddy the directional information. The surround speakers are meant to provide "fill" sound. They should provide wide dispersion of the sound.

We generally prefer using three matched speakers for the front. If you must scrimp, get a cheaper center-channel speaker. You might also be able to economize on the rear speakers. Many speaker manufacturers have made things easier by selling complete surround-sound speaker packages.

Laserdisc Players. For the highest-quality video and audio playback, you need a laserdisc player. Don't forget that video quality becomes more important with a large-screen home theater. The relatively recent growth of large-screen sales might be why it's taken about fifteen years for laserdiscs to catch on.

Are videodiscs for you? Since videodiscs are still difficult to rent (but generally becoming less difficult), you might be disappointed with a player that sits idle most of the time. But if you like the idea of a video library—and one that will last, presumably, forever—then laserdiscs are tough to beat. Here are a few things to keep in mind as you shop.

If you plan to use your home theater for audio as well as video, a combi player—which also plays CD's—is important. Almost all videodisc players you'll find will offer that capability. Most will play only a single disc. Others provide a 5-disc CD changer.

A feature we think is important is automatic side-changing. Having to get up to flip over a disc reminds us too much of the days of the LP! Digital effects, available on most higher-priced units, can add usable scan and still modes to CLV discs. (CLV discs have longer playing times than do CAV discs, but they require digital effects if pictures are to be scanned.) ■

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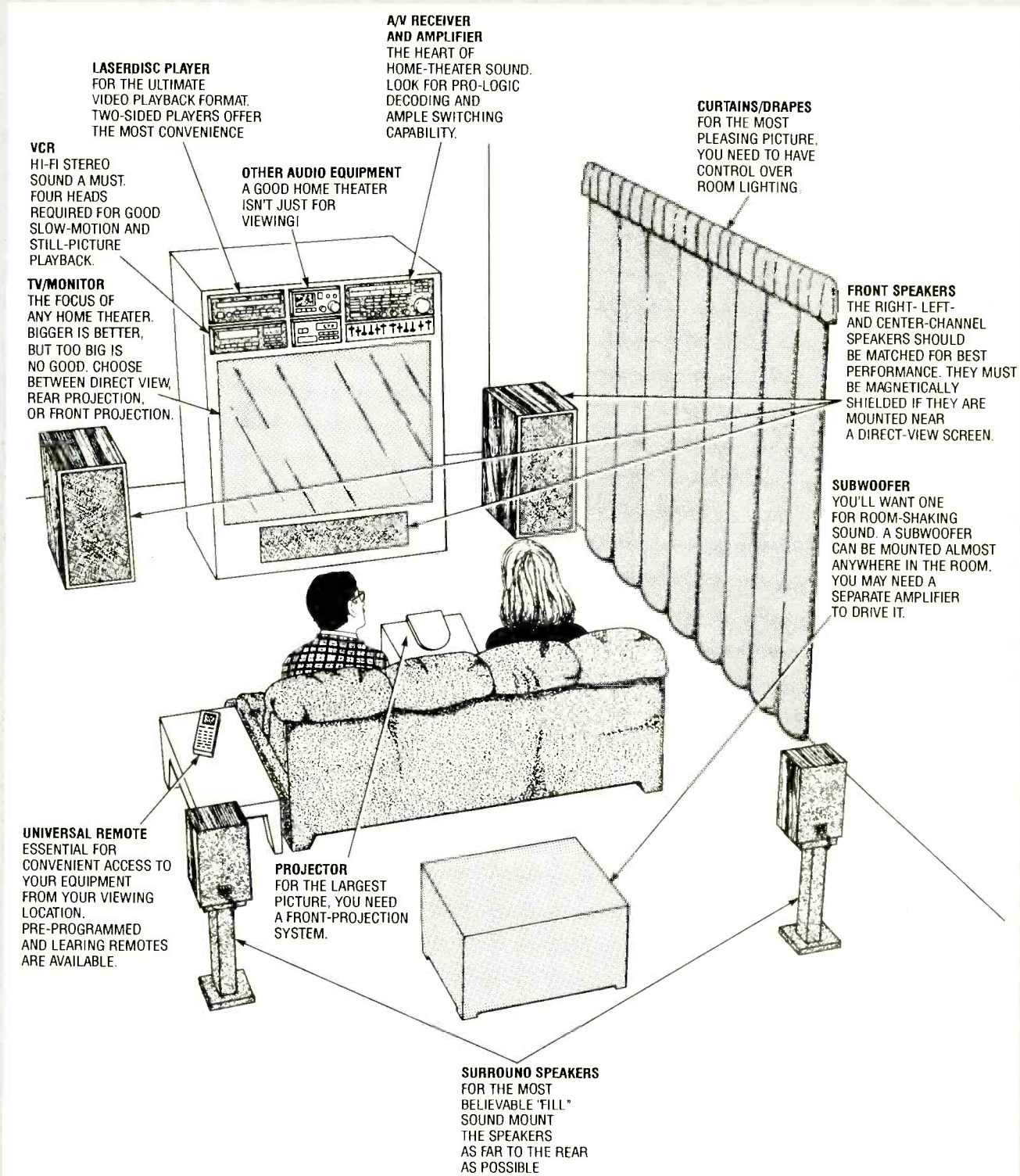

Shopping for a home-theater system can be intimidating if you're confused about the basics. This illustration, which shows the principle elements of any home theater, provides a starting point.

ic surround amplifier —fit neatly on a built-in component rack. Infinity speaker fit n the new shelves; the center channel is mounted inside the window seat, with only the grille showing. The subwoofer is mounted under the floor—a heating grate lets the bass into the room.

The first time we saw the room, we weren't aware that it doubled as a home-theater. But later, watching a football game and a few scenes from *Robin Hood: Prince of Theives*, we realized that it was one of the best setups we've ever seen. The design represents the best of both worlds—excellent audio and video reproduction, and comfortably attractive surroundings. When it's not used as a home theater, the room benefits from added light, extra storage space, improved proportions, and attractive new seating—all thanks to a thoughtful home-theater design.

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CALL IN THE PRO'S

If you're not handy with wiring or with tools, or if you want a system with a ceiling-mounted projector and a motorized screen, it might be wise to call in a specialist. CEDIA, the Custom Electronic Design & Installation Association, can supply a list of professionals in your area (1-800-CEDIA30). They don't work only for millionaires; in fact, according to a responses to a recent CEDIA poll of its members, the "average" job for a custom installation company can range from $400 to $60,000. You can hire a professional to do it all—select the components, design the installation, hire and supervise cabinetmakers and electricians, and calibrate the finished system. Many custom-installed home-theaters are just a small part of whole-house, multi-zone audio-video systems (which is a topic that we'll cover in a future issue of **Gizmo**!). But you can also hire a custom installer to consult on a small project, and some will even come in just to properly set up the components you've purchased.

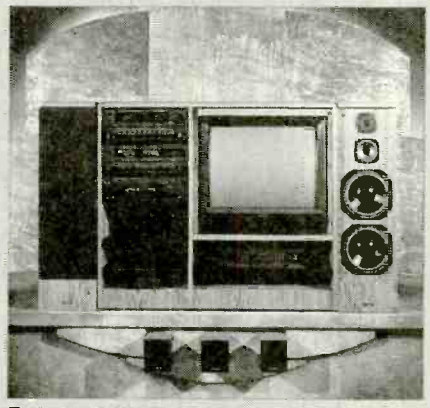
FOOTING THE BILL

So, what can you realistically expect to spend on a home-theater system? The high-quality setup that we review in this issue—Sharp LCD projector, Carver Dolby Pro-Logic A/V receiver, Cerwin-Vega seven-piece Sensurround speaker system, and Toshiba laserdisc player—has a total *suggested retail price* of $6958.95, not counting the screen. (We used our own VCR and an extra amplifier to drive the subwoofers.)

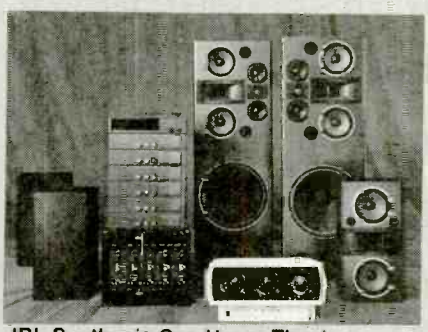
Of course, no one who shops carefully ever pays the full suggested retail price; it pays to shop around. Learn what features on each component are essential, and which are just icing.

Shopping is made that much easier if you decide to go with a pre-packaged system that includes all or most of the required audio and video components. For instance, Fisher's 9235AVX A/V component system includes a 27-inch television, a 120-watts per channel receiver with Dolby Pro Logic, a five-disc CD changer, a double cassette deck, and five speakers. Also included for a suggested price of $2199.95 is a unified remote control that can also operate Fisher VCR's, and a light-oak-finished cabinet. Similar systems are available from several manufacturers; most include TV's that have a relatively small screen size—generally, 26 or 27 inches.

At the opposite end of the pre-packaged spectrum is JBL's Synthesis One, which includes a front projector, a screen, a video controller, signal-processing equipment, multi-component loudspeakers, crossovers, equalizers, a surround-sound processor, dual 18-inch subwoofers, six amplifiers for a bone-rattling total of more than 1400 watts, direct radiators for music playback, and a compression driver horn combination for video playback. JBL's aim is to provide a complete home-theater experience that accurately reproduces movie soundtracks, but not compromise music listening. To that end, the system offers two modes. For home-theater use, Synthesis is THX licensed and approved *and* offers Dolby Pro Logic and ten supplementary surround settings. Switching to the music mode disconnects the center and surround loudspeakers and replaces them with components specifically designed for audio sound systems. The suggested price, which doesn't include a video source (VCR or laserdisc player) or installation (which must be done professionally) is $47,900.



Fisher A/V Component System



JBL Synthesis One Home-Theater System

Whether you decide to go the pre-packaged route, or purchase individual components, good shopping skills are important. Determine precisely what features you expect from each component, and then look for products in your price range that offer those features. Scan the circulars that come in your Sunday paper and read consumer magazines. Then go out to each of the electronics stores in your area to comparison shop.

That's just what we did, and we found some affordable, and some interesting, home-theater alternatives—including a

(Continued on page 17)

Look Sharp!

SHARPVISION XV-H30U HIGH-BRIGHTNESS LCD PROJECTOR. From: Sharp Electronics Corporation, Sharp Plaza, Mahwah, NJ 07430-2135. Price: $3995.

Dedicated **Gizmo** readers might recall our May 1991 review of the *Sharp XV-100* LCD front-projection TV. To recap: The XV-100, weighing just over 31 pounds, had the advantages of portability and easy set up. We put it through its paces, bringing it with us to a ski house in Vermont, and making it the "guest of honor" at an impromptu Super Bowl party. The large-screen experience was vivid enough to make up for a picture that, while quite impressive for a portable projection system, left some room for improvement.

At the last Consumer Electronics Show, demonstrations of Sharp's latest LCD projectors suggested that some major improvements had been made in the past couple of years. We arranged to try out the *XV-H30U* in a home-theater setup.

Physically, the XV-H30U somewhat resembles its predecessor. It's even easier to carry around or store out of sight when not in use, now that close to ten pounds have been knocked off—the XV-H30U weighs only 23 pounds. At the top of the unit is a carrying handle; an on/off button; indicators for power, temperature, and lamp replacement; and a cover that flips open to reveal controls for the adjustment of the projector's picture and audio. That's one major improvement—unlike the XV-100, the new SharpVision is equipped with its own audio amplifier and matched stereo speakers built in. In some installations, those top-panel controls can be difficult to access. But that's not a problem, since the XV-H30U comes with a remote control, another convenience missing from its predecessor. Jacks at the rear of the unit provide audio inputs from two sources, audio output, one S-Video and two video inputs, and a video output. The back of the unit also has a cooling fan; the air intake fan is located on the side of the projector.

The XV-H30U still uses basically the same LCD technology, with some refinements. The projector uses three LCD panels, a series of mirrors, a bright, metal-halide bulb, and a quality lens to project the image. One LCD is provided for each color component of a TV picture: red, green, and blue. The LCD panels themselves provide no color information. They transmit or block the colored light that is fed to them. The light from the metal-halide bulb is separated into the red, green, and blue components by dichroic mirrors, which are special mirrors that re-

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flect light of one color while transmitting all others.

Each LCD panel contains 112,320 pixels (for a total of 336,960 pixels). That translates to a horizontal resolution of 400 lines, compared to the XV-100's 300.

In addition, the SharpVision XV-H30U's high-intensity metal-halide lamp generates up to 800 lux of projected brightness at a 40-inch screen size. That brightness level decreases slightly as the picture size is increased. And you can do quite a bit of increasing—the maximum screen size is 150 inches diagonally, compared to the XV-100's 100-inch maximum. The XV-H30U also offers viewers the option of using it as a rear projector—or using a mirror to reflect the image to the screen—simply by flipping the reverse-image switch.

The differences between new and old models are immediately obvious. With no external audio source required, hookup is even easier. All that's required is connection to a video source (laserdisc player or VCR) via the supplied audio and video cables. While that's perfect for large-screen portability, you wouldn't be happy with the sound in a home-theater installation, where you'd want to connect the projector to an A/V amplifier, surround-sound speakers, a second video source, etc. (The projector's manual, which details various possible setups, is another drastic improvement over the XV-100.) By twisting the zoom lens, the screen size can be adjusted from 25 to 150 inches, depending on the amount of space between the projector and the screen and the size of your room. Actually, room size isn't quite as critical as it was with previous models, because a close-focus lens lets you view a 150-inch picture from just over 18 feet away, or a 100-inch picture from about 12 feet. And once the unit is connected and the screen size selected, the remote control allows you to conveniently adjust the picture without leaving your seat.

Front-projection systems do demand darkened viewing conditions, and Sharp wisely supplies a lighted remote control. The buttons don't remain lighted at all times; pressing any button or the illumination switch located on the side of the remote causes all the buttons to light for about five seconds. The remote can be used to control power and volume, select the video input source, and adjust the video and audio. On-screen displays make it easy to adjust the picture, brightness, color, tint, sharpness, treble, bass, and balance. The remote control also can be used to mute the sound, and to set a sleep timer to turn the projector off after 30, 60, 90, or 120 minutes.

We got a lot of use out of the remote picture-adjustment capability because the displayed image never seemed to be consistent. We found ourselves continually changing the brightness, sharpness, and color to get a watchable picture depending on both the room brightness and the particular movie we were watching.

Audio and video adjustments, as well as input selection, also can be done using the top-panel controls on the projector. The top-panel controls include one that's missing from the remote—a focus-pattern display button. Pressing that button causes a pattern to be displayed on the screen for about 15 seconds, while you make adjustments using the focus ring around the lens. Using the pattern makes accurately focusing the projector much easier.

Our home-theater system—the SharpVision Projector, a Carver A/V receiver with Dolby Pro-Logic, Cerwin-Vega's Sensurround speaker system, and a Toshiba laserdisc player—was installed in a room measuring just 16×14 feet. The room was pretty crowded *before* we unpacked the screen provided by Sharp (sold separately from the projector). On a tripod stand, the screen stood out a couple of feet from the wall, while the projector was set up about a foot from the opposite wall. That left a space of about 13 feet—too short to use the projector to its full 150-inch picture potential. In fact, in such a small room, we were more comfortable with the picture size set to about 70 inches or smaller, although the manual said that 100 inches would be fine at that distance. The screen does make a difference in picture quality, but it simply took up to much space. Because of that, we found ourselves frequently watching videos on a bare white wall instead of bothering with the screen.

Watching movies on the large screen (or on the white wall) was a treat once the picture was adjusted properly. As with any large projection TV, you have to be careful not to make the image too large or you'll see the line structure of the picture. (Large-screen projectors are one reason we "need" HDTV.) With the Sharp projector, you can also see the individual pixels that make up the image. The only real complaint we had with our sample unit, however, was that the picture brightness was not consistent over the entire screen—there were a couple of "hot spots" that we found disturbing.

For everyday "background" television viewing, we found ourselves switching back to our 27-inch set that happened for a couple of reasons: First, viewing the smaller set doesn't require a darkened room, and we like to read the paper or do crossword puzzles while watching. Second, most network-TV shows just don't have enough substance to warrant such a big picture. After all, Rosanne and Dan Connor and family are bigger than life even on the small screen! (And their whining is not enhanced by surround sound, either.)

But when it came to movie-watching, the large picture lent a whole new dimension, surrounding us with video. And, best of all, SharpVision's bigger and better picture is not accompanied by a bigger price tag! We don't think that LCD projection is ready to take over the home-theater market—yet. But as LCD manufacturing technology improves—and the dramatic improvements in the last couple of years are likely to continue—SharpVision projectors are going to be tough to beat. ■

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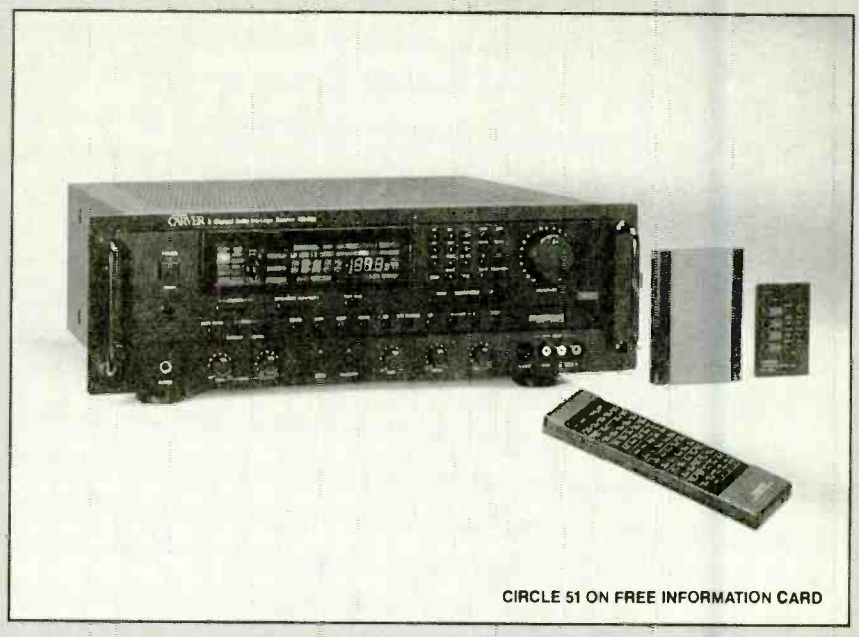
A (Pro-) Logical Choice

CARVER HR-895 AUDIO/VIDEO RECEIVER. From: Carver Corporation, P.O. Box 1237, Lynwood, WA 98046. Price: $1199.95.



CIRCLE 51 ON FREE INFORMATION CARD

We've always maintained that the true heart of a home-theater system is not the video screen. Rather, it's a good audio system that pulls a viewer into the action. We find a small-screen system with big-screen sound far more enjoyable than a big-screen with small-screen sound. The true heart of a home-theater sound system is an A/V receiver, which not only provides the Dolby Pro-Logic sound that's so important, but also serves as a command center for video and audio equipment. This month, in our quest for sensible home theater, we tried *Carver's HR-895 Dolby Pro Logic Audio/Video Receiver.*

The HR-895 is Carver's first Pro-Logic receiver. It features a five-channel surround-sound amplifier, a "learning" type remote, and multi-room capability that allows a user in a second room to use the amplifier to listen to a CD, for example, while the receiver is used in the main room to watch a videodisc.

The front-left and front-right amplifiers provide power outputs of 110 watts per channel. The center-channel amplifier provides 75 watts, and two 35-watt amplifiers provide the surround outputs.

Seven audio inputs, four composite video inputs, and three S-video inputs provide convenient switching capability. Front-panel audio and video inputs are provided for easy accessibility when hooking up a camcorder.

The tuner section of the HR-895 provides a total of thirty FM and AM presets. (If you receive FM-band stations over your cable-TV system, a separate antenna input is available for those stations; that input and the available stations can also be stored in presets.) An auto-preset mode scans through the selected band and automatically stores received stations in the preset memories. While it's possible to let the receiver handle the entire function automatically, we preferred to customize the settings as they were stored. As each received station is tuned, scanning stops for five seconds. During that time, you can set the tuning mode (to mono, for example) and set the IF bandwidth (to narrow, for example). If you do not want to store a particular station, pressing the tuning up control causes it to be skipped.

If you're like us, you might have trouble remembering more than a few preset stations. The tuner, however, includes a function that lets you set the station name so that it is shown in the display each time the station is tuned. Up to five alphanumeric characters can be stored for each memory. Stations can be tuned directly by entering the preset number on either the remote control or the front-panel keypad. It's also possible to scan through the presets, or to change stations by tuning in the conventional manner.

A Carver feature called ACCD (for asymmetrical charge-coupled FM detector) is provided to reduce multipath distortion. ACCD, which is switchable, is said to be able to transform a multipath signal into a clear signal by separating the stereo sum and difference signals and rejecting up to 80% of the distortion-filled stereo signal. Then, "the 15–20% of the signal which is clean is used to accurately recreate the rest of the stereo signal." Because our suburban location is not typically plagued by multipath problems, we can vouch for ACCD's success only by noting that the feature seemed to quiet some noise from marginal signals, without degrading strong signals.

Besides the tuner, the HR-885 offers other purely audio functions; CD player inputs and audio tape inputs and outputs are provided. We're thankful that Carver also included a phono input for connecting a turntable. Primarily intended for use with those functions, Carver's "Sonic Holography" is also provided. The intent of Sonic Holography is to "restore the 3-dimensionallity of a live performance through special signal-cancellation and time-delay circuitry." It attempts to correct the problems of traditional stereo that occur because your ears hear the output of both stereo speakers. It works by injecting some degree of out-of-phase right-channel information into the left channel signal and *vice versa*. Theoretically, with the right time delay, the out-of-phase right-channel information will arrive at the left ear at the same time the signal from the right speaker does, and the signals will cancel. With proper speaker setup—which is very critical for the processing to work—we found that Sonic Holography dramatically widened the soundstage of stereo recordings, and produced excellent imaging. Sonic Holography is not, of course, intended to replace Dolby Pro Logic.

The HR-895 provides rear-panel inputs for a laserdisc player and two VCR's. A front-panel input is provided, primarily for connecting a camcorder. S-video connectors are provided for the laserdisc input and VCR1 inputs and outputs. The second set of VCR connectors provides only composite-video jacks. Why, we wondered, did Carver provide an S-video input for a videodisc player, where it provides little benefit, and not for a second VCR where S-video can be very beneficial? Whatever the reason, we should note that the front-panel inputs do provide for S-video, so tape dubbing between S-video-equipped video recorders is possible, although not necessarily convenient.

Two tape-dubbing options are provided on the amplifier. Pressing the TAPE-VCR1 button lets you dub audio from your audio tape deck to your VCR. (If you haven't discovered that your hi-fi VHS VCR can play the part of a high-quality audio recorder—with the distinct advantage of 6-hour tapes—do yourself a favor and give it a try.) A second, VCR1–VCR2 button lets you dub video tapes. Dubbing can be done even while you're watching a laserdisc. Remember, however, that the VCR2 connections don't support S-video. You'll have to use the front-panel camcorder-input jacks for that; whatever source you

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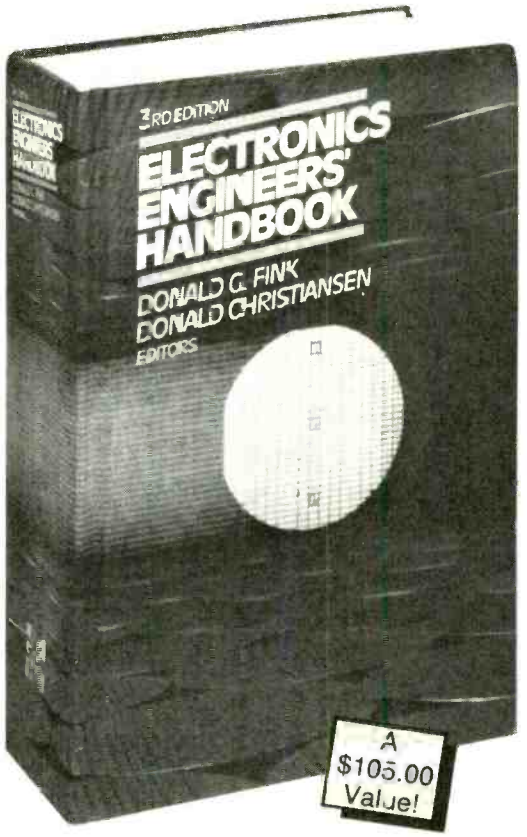

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choose as the main signal source is also output to all video and audio outputs (unless one of the amplifier's dubbing buttons is pressed).

Four surround-sound modes are offered. The Dolby mode is the one to use if your source is Dolby encoded. Most recent movies you're likely to rent will have a Dolby-encoded soundtrack; with proper speaker placement, the results that can be achieved at home will be at least as good as you're likely to hear in most movie theaters. It's likely to be *better*, in fact, because you can adjust the level and location of the speakers to perfectly suit your seating position.

"Hall" and "matrix" surround modes are also provided for non-Dolby sound sources. The hall mode adds what we perceived as time-delay and echo effects to give a feeling of spaciousness. The matrix mode, we assume, passively extracts the difference between the left and right signals and feeds it to the rear speakers. Neither mode can compete with Dolby Pro Logic (to our ears, they simply distort the sound), but we can imagine some instances where they would prove to be useful. A simulated stereo mode is provided to create a stereo effect from monaural sources.

The amplifier also offers four center-channel modes that are switchable. Normally, Dolby Pro Logic requires a center-channel speaker so that on-screen sounds appear to come from the screen. A "normal" mode is provided for that. A "phantom" mode creates a center-channel effect using just the left- and right-channel speakers. A "wide" mode electronically processes the front-channel audio to create a wider soundstage: it's useful if you must place your speakers very close together. The center channel can also be turned off if you wish.

The HR-895 features a clock that can display time in either the 12- or 24-hour format. The clock provides sleep-timer and program-timer capability as well. We think that a program timer is very important in an audio system. (Some of us record more programming from the radio than from television.) While we're happy to see Carver provide a program timer, which many manufacturers ignore, we're not satisfied with the single-event capability.

Our experience with the Carver HR-895 makes us think that it could be a sensible source of terrific home-theater sound. Its multi-room capability will keep the video watchers and audiophiles on speaking terms—or let you keep track of what's happening on the screen when you can't be there to see it. But, the funny thing is, we didn't find ourselves leaving the room very often when the HR-895 was doing its thing. ■

Sound Decisions

SENSURROUND HOME-THEATER SPEAKER SYSTEM. From Cerwin-Vega, 555 East Easy Street, Simi Valley, CA 93065; Price: $1660.

There was a time, not long ago, when we would base our movie-going decisions on sound alone. If we thought a film demanded the depth and drama of Dolby Surround or THX sound systems, we would see them in a good theater. Films whose soundtrack we didn't consider crucial to our enjoyment would be relegated to "let's wait until it comes out on video" status.

Using that selection process, we decided to see *The Commitments*, a film about a group of working-class young Dubliners who form a soul band, at an expensive theater on Manhattan's Upper East Side. We certainly didn't get our $7.50's worth—the theater's outdated sound system didn't do justice to the film's wonderful soundtrack, and since the music made the movie, the whole experience was disappointing.

We finally got to hear the Commitments the way the director intended them to sound. No, we didn't shell out another $7.50 each, or buy the soundtrack on CD. We rented the film on laserdisc, and listened to it through *Cerwin-Vega's Sensurround* seven-piece home-theater speaker system, connected to a Carver Dolby Pro-Logic A/V receiver. We quickly discovered what a difference the right sound system can make!

Sensurround technology was developed by Cerwin-Vega and Universal Studios. It was first used in the movie *Earthquake*, and with such success that its developers were honored with an Academy Award.

That same technology is now available for home use, in a pre-packaged seven-piece system or as separate components. The seven-piece system that we tried out is intended for use with "big-screen" home-theater setups—those using front- or rear-projection TV's. It consists of the *HT-CTR* shielded center-channel speaker, two *HT-100* shielded subwoofers, and four *HT-S6* satellite speakers. For home theaters centered around direct-view televisions, Cerwin-Vega recommends a five-piece Sensurround setup that includes the same four satellite speakers (sold for $380 a pair) and one *HT-210C* "dual subwoofer/center-channel system" ($320). That unit integrates two 10-inch subwoofers and center-channel speakers into a single, fully-shielded cabinet that doubles (or should we say triples?) as a pedestal for the television or monitor. It's also possible to use the HT-210C and a pair of HT-S6 satellites along with a pair of your own speakers, as long as the center speaker matches the left and right ones. (The excellent manual supplied with the speakers explains how to calibrate the system, regardless of the configuration.)

Now that you've heard all the options that are available, we'll get back on track and tell you about the seven-piece setup that we actually tested.

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Our first reaction upon seeing the six large boxes in which the system was packed was that we'd be spending an entire day simply unpacking and wiring the system. In reality, the process wasn't that bad—and our pre-production Sensurround arrived two weeks before the manual did!

The HT-S6 left, right, and surround speakers feature a 6½-inch midrange and 1-inch polycarbonate dome tweeter. (Our pre-production models were not shielded). The direct-radiating speakers are housed in bass-reflex (vented) enclosures that measure 11¾ × 8½ × 11 inches. Their frequency response is rated at 80 Hz–20 kHz, ±2dB.

The HT-CTR center-channel speaker features two 6½-inch midrange drivers and a 1-inch polycarbonate dome tweeter. The speaker system is also housed in a bass-reflex enclosure, but not in a standard rectangular box. Instead, the enclosure is a trapezoid that measures about 16⅝ × 8¼ × 11¾ inches. The tweeter and port are located between, and slightly forward of, the midrange drivers. The midrange drivers are angled out from the center. The idea is to eliminate an on-axis hot spot for smoother, more realistic sound that corresponds better to the on-screen action. The frequency response of the HT-CTR is rated at 80 Hz–20 kHz, ±2dB.

The HT-110 subwoofers are what really make Sensurround work. They consist of a 10-inch driver mounted in a bass-reflex enclosure that measures 17½ × 13 × 24½ inches. The HT-110 can handle inputs up to 250 watts. Although not on our pre-production models, the HT-110 offers a defeatable passive crossover. If you were to use a single amplifier to drive the speakers, you would feed the left, right, and center-channel amplifier outputs to the subwooofer, and then feed the left, right, and center speakers from the subwoofer's wiring panel. The crossover switch would be in, or on, for this setup.

We didn't get to try that wiring scheme, but instead used the line-level subwoofer output of our Carver A/V receiver, along with a separate amplifier, to drive the subwoofers. The results were outstanding. If you enjoy explosions in your home theater, of the sort so plentiful in *Terminator II*, then you won't be able to get enough of the HT-110's. Explosions, we must admit, aren't our thing. Even so, the subwoofers added tremendous enjoyment to the movie watching experience. Trucks sounded like real trucks. Unexpected thumps could make us jump.

Once the setup was complete, we were ready to give *The Commitments* a second chance. We were impressed with the accuracy of the positioning of the sound. Even more impressive, the balance of the sound was so even that we could not pick out the particular speaker from which a given sound was emanating. In other words, we quickly forgot that we were listening to three front speakers—and seven speakers altogether. We were spending too much time enjoying the movie.

For the truly realistic sound reproduction that we experienced, it's crucial that the system is wired, arranged, and calibrated properly. Luckily, the manual that accompanies the speakers goes beyond the call of duty, explaining not just how to set up the system, but providing a thorough tutorial in home-theater concepts that reveals *why* each piece must be placed just so. Detailed drawings depict proper wiring for each configuration. The manual also provides the consumer with advice on improving room acoustics and incorporating existing speakers into the system—all in plain English.

Since we've had the Sensurround system in our living room, we've changed our movie-selection process. Now we prefer to watch even the epics, adventures, and music films on videotape or laserdisc in the comfort of home—where we can realistically expect our sound system to be significantly better than those we found in most local theaters. ■

HOME-THEATER

(Continued from page 12)

46-inch GE rear-projection TV on sale for just $1500, a center-channel speaker from Kenwood for $129, a Fisher A/V receiver with Dolby Pro-Logic for $300, a Panasonic four-head hi-fi stereo VCR for $330, and a Pioneer laserdisc player for $400. That's $2329, and you'd just need to add speakers and perhaps a subwoofer to create a full-fledged home theater. A Sony rack system caught our eye also—sale priced at $1299, it included a tuner, a 5-disc CD changer, a 5-cassette changer, an A/V amplifier with Dolby Pro-Logic, and center-channel, right, left, and two surround speakers. The same system with a dual cassette deck cost $999. Either system would look nice next to an existing large-screen TV, and their racks even had two shelves conveniently available to accommodate a laserdisc player and a VCR.

The scouting around that we did took about the time we might have spent watching a movie. If we were actually about to buy a home-theater system, we'd be willing to spend quite a bit more time than that. We would have auditioned the systems to get a better feel for their capabilities, and we would have pressed the sales personnel with questions—or demanded to see the operating manuals to make sure that each component offered the functions we required. Because in home-theater installations, good planning will definitely pay off. ■

Video Viewing in the 90's

CD/CDV/LD COMBINATION DISC PLAYER MODEL XR-W70A; from Toshiba America Consumer Products, Inc., 82 Totowa Road, Wayne, NJ 07470; Price: $599.

When videodisc players were first introduced back in the 1970's, the format bombed. Video cassette recorders, on the other hand, caught on like wildfire. Considering that most people's home-video setups at the time consisted of a small-screen color TV, it's not surprising that more folks weren't leaping at the chance to buy the more-expensive videodisc players, despite their superior picture and audio quality. After all, the VCR offered consumers the ability to record television shows as well as to watch prerecorded movies—and the selection of films on videocassette was far greater than those available on disc. After a few years of sluggish sales, Philips, the inventor of the LaserVision, pulled their videodisc players off the market, and so did most other videodisc manufacturers.

The LaserVision format, however, was the only videodisc format that was never totally abandoned. Now, in the 90's, it has finally come into its own. In a way, the very success of the VCR, which pushed the videodisc player out of the market in the 70's, helped pave the way toward its increasing acceptance today. There's no question that the VCR changed the way we used our television sets. After all, with all those movies being watched at home, the next logical step was for consumers try to duplicate the movie-theater experience using their home video and audio equipment. Manufacturers were quick to respond to (and inflame) that desire, introducing stereo TV's, increasingly large-screen direct-view sets, rear- and front-projection systems, surround-sound processors, A/V receivers, and speakers intended for use with audio and video equipment.

As consumers became more accustomed to sophisticated home-theater systems, a new niche was created for the laserdisc player. After all, once you've spent hundreds or thousands of dollars on A/V equipment, you're going to want the best possible source material. With good equipment, the flaws in VCR performance become obvious. That's why many serious A/V enthusiasts now consider the laserdisc player to be an essential ingredient in any home-theater installation—more important, even, than a VCR. The difference in quality is dramatic: Laserdisc players

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TEST RESULTS—TOSHIBA XR-W70A LASERDISC PLAYER

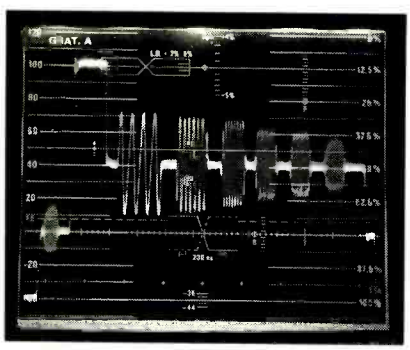
The video frequency response of a laserdisc player is a measurement of how accurately it can reproduce signals of different frequencies. It is measured by playing a special signal from a test disc that contains bursts of several specific frequencies and observing the output on a waveform monitor. The laboratory-measured frequency response of the Toshiba XR-W70A was not what we had expected from our subjective evaluations. At 4.2 MHz, the response was down 3.84 dB. That's a bit worse than we've seen from other, similar players.

The signal-to-noise ratio is a measurement of the amount of unwanted noise on a fixed, flat-field video signal. A red field, used in our lab tests, is usually preferred to measure the chroma signal-to-noise ratio. AM chroma measurements indicate the strength of the color signal, while PM chroma indicate the purity of the color signal. The AM chroma signal-to-noise ratio was measured at 44.8 dB, the PM signal-to-noise ratio was measured at 36.5 dB, both adequate, but not outstanding.

The luminance signal-to-noise measurements indicate the brightness and detail that you can expect to see in recorded videos. Such measurements indicate the amount of snow that you're likely to see in the picture. Depending on the reference luminance level used when making the measurement, the luma signal-to-noise ratio was measured at 45.1 dB, which is what we would expect. Using the S-video output improved the luminance signal-to-noise ratio by about 1.5 dB.

The audio section of the XR-W70A yielded better than average performance, as indicate by the tabulated results.

In summary, the lab results seemed to be a bit of a mixed bag. But the results are the same as with our subjective tests. The XR-W70A is not something that an audio/videophile is going to rush out and buy. But its deficiencies are small enough that a double-blind viewing test between the XR-W70A and some more expensive players would end in a draw.



Testing revealed a larger than expected drop-off at higher frequencies.

TEST RESULTS—VIDEO SECTION

Frequency Response	
(@0.5 MHz)	0 dB
(@2.0 MHz)	−0.78 dB
(@3.58 MHz)	−2.92 dB
(@4.2 MHz)	−3.84 dB
Signal-to-Noise Ratio	
Red Field Chroma	
AM	44.8 dB
PM	36.5 dB
Luminance	
100 IRE	45.1 dB

TEST RESULTS—ANALOG AUDIO SECTION

Output Level	
(1 kHz)	1.53 volts (CX on), 0.52 volts (CX off)
THD	
(@75% modulation)	0.76% (CX on), 0.59% (CX off)
Signal/Noise Ratio	86.4 dB (CX on), 64.1 dB (CX off)

TEST RESULTS—DIGITAL AUDIO SECTION

Output Level	
(1 kHz)	2.17 volts
Signal/Noise	
(De-emphasis in)	110.0 dB
(De-emphasis out)	110.0 dB
Channel Separation	
left	121.0 dB
right	126.9 dB
THD @0 dB	
20 Hz	0.0031
1 kHz	0.0028
10 kHz	0.0045
Linearity Error	
(0 dB to − 50 dB)	−0.01 dB
Frequency Response	
(20 Hz to 20 kHz)	+0, −0.12

ADDITIONAL DATA

Weight	19 pounds
Dimension (H × W × D)	5¼ × 18⅞ × 17¼ inches
Power Requirement	31.5 Watts
Random-Access time	2.0 seconds
Scan Time (Side 1 to Side 2)	5.5 seconds
Notable Features	Flying erase head, Digital noise reduction, Timebase corrector, Bidirectional frame advance, Slow motion play ⅛X and 1/10X), Auto indexing, Real-time counter with memory, 1-month/6-month program timer, Front-panel A/V jacks, Control-L editing interface, Control-S input.

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display twice the horizontal resolution (more than 420 lines) of VHS VCR's, and have the added advantage of providing CD-quality sound.

During those years when the laserdisc was floundering, the audio compact disc (which was introduced a couple of years after the LD), was making a big name for itself. Consumers who have become familiar with the sound quality and convenience features of the CD format now are quite willing to consider a similar format for video. Laserdisc players, like standard CD players, offer quick access to "tracks"—many videodiscs are arranged in sections to make it easy to "fast forward" to a specific scene in a movie or song on a concert video. And now that the price of laserdisc players has dropped and virtually all laserdisc players also play CD's, an LD/CD player represents an economical choice of an A/V component.

In our home-theater setup, we used a combination disc player from *Toshiba*. The *Model XR-W70A CD/CDV/LD Player* can play 3- and 5-inch CD's, 5-inch CDV's (CD with Video discs), CDV singles, 8- and 12-inch CD Video LD's, and 8- and 12-inch laserdiscs. It also adds a couple of convenience features to home-movie viewing.

The most important convenience feature is two-sided play. It's not necessary to manually flip the discs from side 1 to side 2 because the player automatically positions the pick-up carriage assembly from one side of a disc to another. That solves the only complaint we had with videodisc players. (Now, if we could only get disc manufacturers to end side 1 at some place other than the middle of a scene... .)

Intro Scan is another convenience feature that lets you play the first eight seconds of every laserdisc chapter or CD track so you can find what you're looking for. (It will automatically change to the second side of a laserdisc.) You can program the unit to play up to 24 chapters or tracks in any desired order; again, you can switch back and forth between laserdisc sides. (Of course, there aren't too many laserdiscs that *we* would like to watch in random order.) A random mode lets you play all songs on a CD in random order; on a laserdisc with a table of contents (such as a CD video laserdisc), you can play the chapters on one side of the disc in random order.

Another handy feature is automatically called into play if you turn the power switch off during playback of a laserdisc: when you turn the player back on, it will pick up where it left off. For dubbing CD's onto cassette tape, a peak-search function makes it a breeze to set your recording level; it will find the peak level, and output it for about eight seconds so you can properly set your recorder.

When you insert a disc into the XR-W70A, whether it's a CD, a CDV, or a laserdisc, the player will automatically detect what kind of disc it is—just as any other combi player will do. A special function, "Direct CD," tells the player that you are going to be playing a CD. That not only speeds its decision-making process, but it turns off the video circuitry to eliminate the possibility of interference with the audio.

An optical digital output terminal is provided for direct connection to amplifiers and other equipment with digital inputs.

Both the remote control and the front panel offer a rotary three-speed scan control. The clear-scan mode gives slow scanning; the low-scan mode steps scanning up to about 10× normal; and high-scan steps it up to 30× normal. The scanning was serviceable on CLV (constant linear velocity or extended-play) discs, but, of course, couldn't compare to that for CAV (constant angular velocity) discs.

A soft-picture function can filter some background noise from old vintage movies. We also found it useful to soften the image when we were sitting too close to a large screen.

The XR-W70A was a strong performer that doesn't offer any surprises. It didn't wow us with all kinds of high-tech, high-end features, but it certainly did a respectable job doing what it was supposed to. If you're a videophile who's been watching laserdiscs since the late 1970's, then look elsewhere for your next player. But if you're still wondering what all the laserdisc fuss is about, why not find out by giving the XR-W70A a try? ■

MAIL-ORDER LASERDISCS

As laserdisc players have grown in popularity, the selection of movies and music videos available on disc has kept pace. Unfortunately for LD converts who don't live in big cities on the East and West Coasts, stores that sell laserdiscs are still few and far between, and those that offer a decent selection of LD's available as overnight rentals are even more scarce.

Some entrepreneurs have seen opportunity in that situation, and mail-order laserdisc shops are now flourishing. There are big companies, such as Columbia House Laserdisc Club (800-538-2233). Discount clubs include Ken Crane's in Westminster, CA (800-624-3978 or 800-626-1768 in CA); the LaserDisc Fan Club of Long Beach, CA (800-322-2285); Laser Craze in Boston (617-338-9820), Sight and Sound in Waltham, MA (617-894-8633); and Brooklyn-based SEM Video Products (800-247-6644 or 718-645-1663). Used laserdiscs are available from such companies as Video Brokers in Washington DC (202-328-0428) and Triton Video in New York City (212-243-3610).

"Actually, it's made here—the manual just reads like it was made in Japan."

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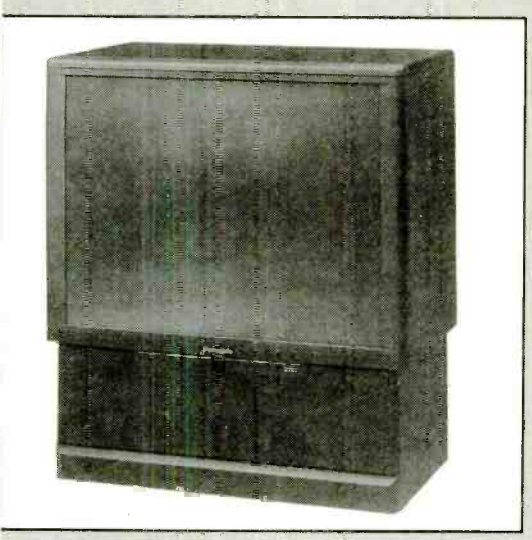
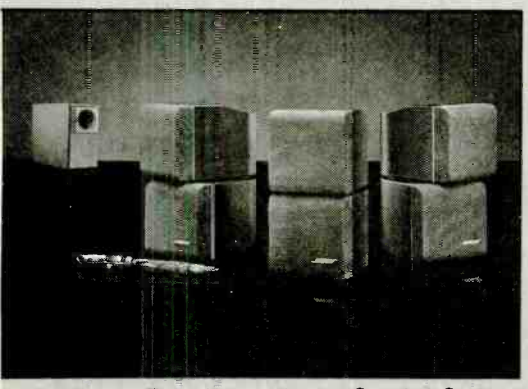
ELECTRONICS WISH LIST

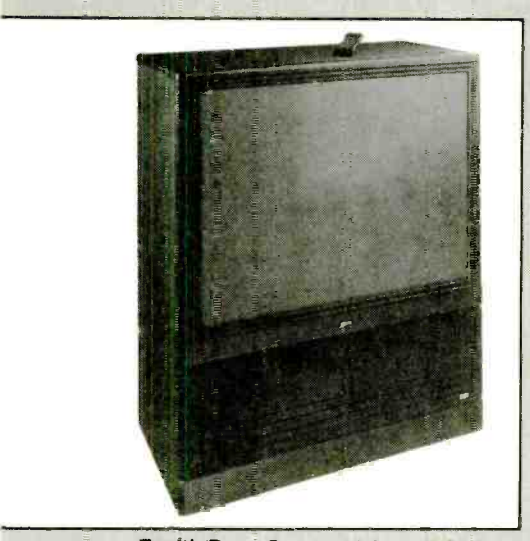
For more information on any product in this section, circle the appropriate number on the Free Information Card.



Panasonic Projection TV



Bose Home-Theater Speaker System



Zenith/Bose Surround-Sound System

SuperFlat Rear-Projection TV

Incorporating much of the technology used in their SuperFlat direct-view TV's, *Panansonic Company's (One Panasonic Way, Secaucus, NJ 07094) PTP-51XF20* also features a new screen and lens system developed for rear-projection sets. The 51-inch set is capable of more than 700 lines of horizontal resolution, and can deliver more than 300 foot-lamberts of brightness for a clear picture even in brightly lit rooms. The TV's audio specs include 20-watts-per-channel output (8 ohms, 60Hz–15kHz, 1% THD), MTS stereo with dbx noise reduction, and Dolby Surround Sound. Other features include picture-in-picture, Artificial Intelligence Control of image quality to maintain the proper contrast level, parental guidance control, built-in clock and sleep timers, dual on/off timers, favorite-channel and favorite-picture memories, and a remote that's capable of controlling most VCR's and cable boxes and all Panasonic laserdisc players. The set is just 27-inches deep, allowing it to fit through standard doorways. Price: $2999.95.

CIRCLE 54 ON FREE INFORMATION CARD

Small Speakers for Big Sound

If you believe that speakers should be heard but not seen, setting up a home theater can be a real challenge. *Bose Corporation* (The Mountain, Framingham, MA 01701-9168) presents an easy solution in the unobtrusive form of their *Acoustimass-7 Home-Theater Speaker System*. The matched, front-channel speaker system includes three dual-cube arrays (center, front, and right channels) and a bass module. The magnetically shielded front-channel speakers, which measure just 6¾ × 3⅛ × 4¾ inches, include hardware that allows several mounting options—wall and ceiling brackets, table stands, and floor stands. Each array includes a pair of 2½-inch wide-range drivers. Using a matched center speaker ensures that sound remains balanced and consistent from channel to channel. The bass module, which is small enough to be hidden anywhere in the room, launches sound waves from a pair of high-performance 5¼-inch low-frequency drivers into the room in the form of moving air masses. All connections are made through the bass module, and built-in protection circuitry guards the system components against excessive input levels. Price: $899.

CIRCLE 55 ON FREE INFORMATION CARD

Instant Home Theater

Intended to provide better sound without complex hookups, the *HTS-100* instant home-theater component from *Mitsubishi Electronics America, Inc.* (5665 Plaza Drive, Cypress, CA 90630) delivers Dolby Pro Logic Surround Sound as a function of normal television operation. Installation requires only one step and does not disrupt the normal connections between the TV and VCR or laserdisc player. Price: $599.

CIRCLE 56 ON FREE INFORMATION CARD

Video by Zenith, Sound by Bose

Bose Acoustimass speaker technology is also available built into several models of *Zenith* (1000 Milwaukee Avenue, Glenview, IL 60025) television sets, creating all-in-one home theaters featuring "Bose VideoStage Surround System." It might not be Dolby Pro-Logic, but for those interested in surround-sound without the fuss, the combination of front-channel speakers built into the TV, and two separate rear speakers works well. The *Model AB5285BG* is a 52-inch rear-projection set that features black level expansion, which expands the number of gray-to-black shades that can be displayed, leading to greater depth and richer colors. White compression reduces glare from bright white areas, for crisper edges of bright images. Lumina noise reduction decreases the "noise" that often occurs when sharpness levels are increased, and edge enhancement circuitry eliminates fuzzy edges in individual scenes. Price: $3295.

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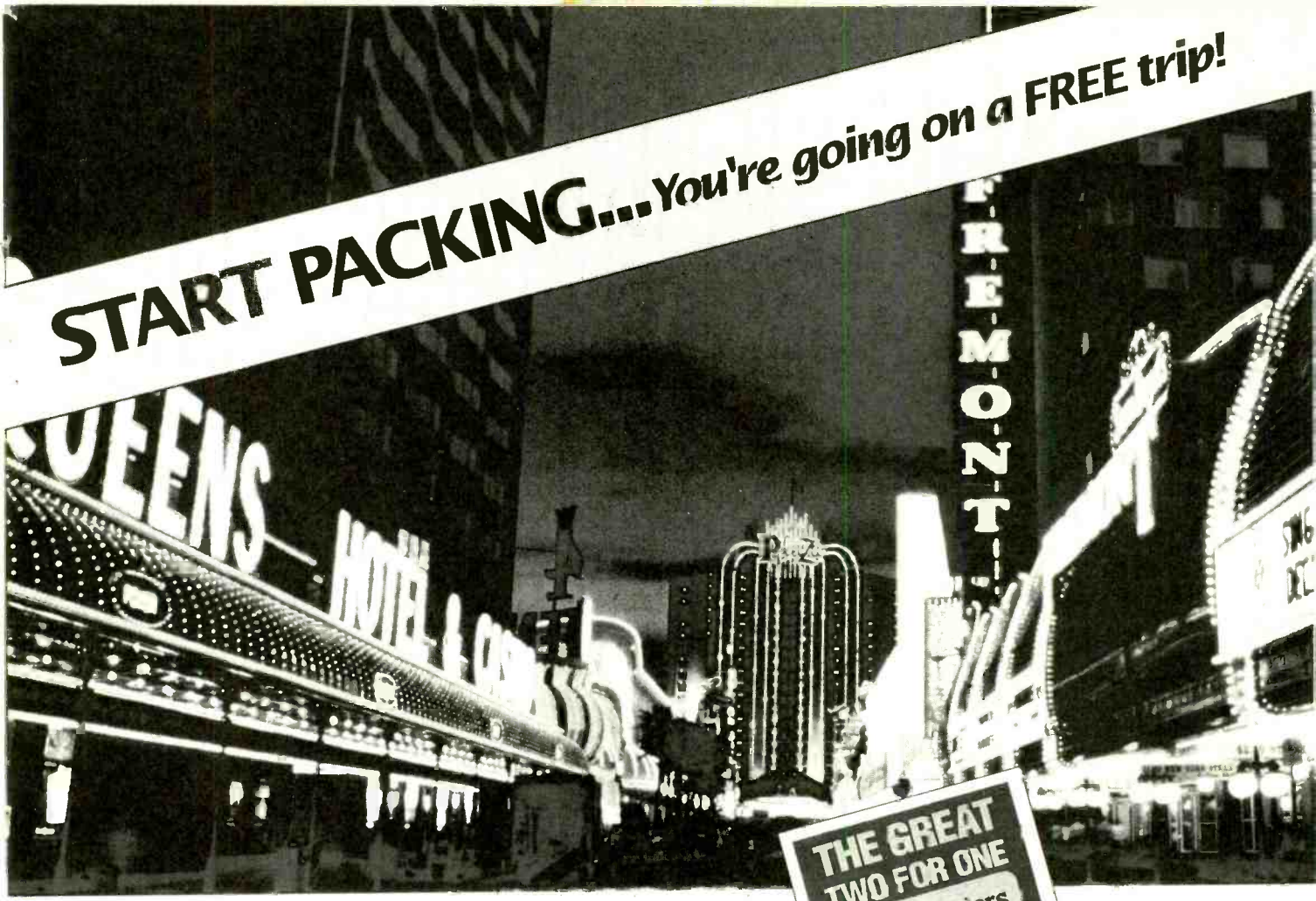

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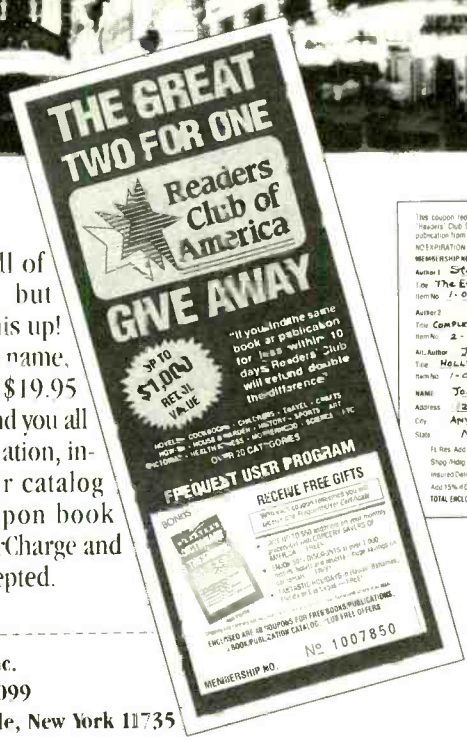

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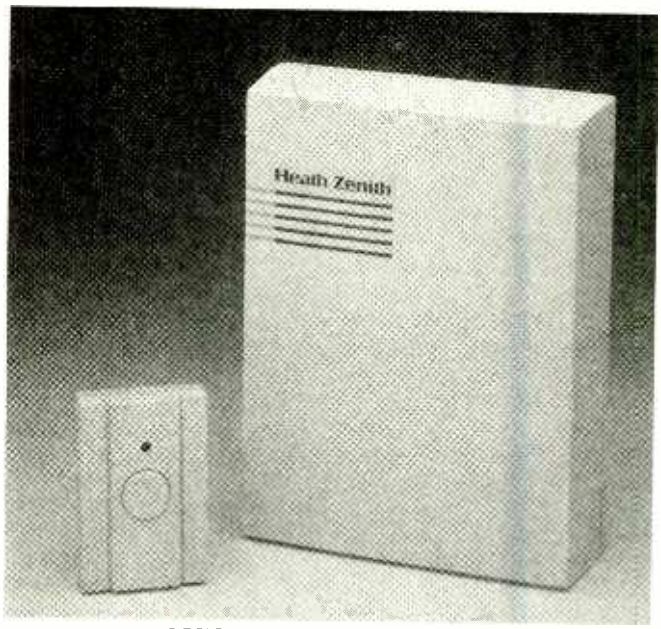
A Hands-on Electronics REPORT

HEATH/REFLEX WIRELESS DOORBELL



CIRCLE 119 ON FREE INFORMATION CARD

A quick and easy way to add or replace a doorbell

Most of you are probably familiar with the Heath Company—or at least "Heath kits." While Heath is no longer in the kit market, they have launched what they call the Reflex line of home electronics. That line of products is designed to allow the home do-it-yourselfer to install automated lighting, wireless light switches, auto-shut-off lighting, or a wireless doorbell. All at very affordable prices. This report will focus on their SL-6153 wireless doorbell.

The Device. The SL-6153 is a pre-built unit that allows you to install a doorbell anywhere without having to hook up any wires at all. Apart from the "doorbell button transmitter" and a "doorbell bell receiver," a few mounting screws or some double-sided tape (both of which are included) are all you need to do the installation. The $29.97 doorbell system has a maximum range of 50 feet and works for a year on one set of batteries. That range should provide plenty of suitable locations to place the receiver.

The transmitter, or button, is roughly the same size as a match box, and it's powered from a small 12-volt battery, which is included with the unit. The receiver, or bell, is powered from three "D" cells, which are not included. The transmitter will look attractive mounted at any doorway, and the receiver looks much like a traditional doorbell chime box—both units are an off-white color.

The receiver unit offers three switch-selectable sound options. There's a traditional "ding dong" setting, a "ding ding" setting, and a single "ding" setting. Besides serving the purpose of user preference, the three sound options allow you to have a different sounding bell at each of up to three doors. That's the main reason why the wireless doorbell is available in three different RF frequencies. It is also useful in case your next-door neighbor has the same unit.

The most obvious need for a wireless doorbell is in cases where no doorbell exists at all. The user is then able to quickly install an "instant" doorbell. You may even want a wireless doorbell for your bedroom door. Many homes will have a doorbell at the front door only, in which case a wireless bell could come in handy for the side or back door.

Installation. When we first tested our wireless doorbell—with one person holding the bell and another holding the button—it did indeed have a range of at least 50 feet. However, when testing out the doorbell at its approximate installation point, we learned the value of something mentioned in the installation manual: "Don't mount the receiver or transmitter directly on a metal surface, as the range will be drastically reduced." If you must locate either the receiver or transmitter on a metal surface, it's suggested that you mount it on a piece of wood at least ¼-inch thick.

Our doorbell has been installed for a couple of weeks now and is still working perfectly. That shouldn't sound impressive to you—after all, two weeks isn't all that much time—but it is at the very least gratifying to this reviewer who had something to compare this new doorbell to; a wireless doorbell from another manufacturer. The receiver of this "other" wireless doorbell used only two "AA" cells for power, which lasted only a couple of days. Also, the chime on the Heath doorbell is much louder and realistic sounding than that other one. Even though that other doorbell cost ten dollars less than the Heath unit, it was certainly no bargain.

If the Heath/Reflex SL-6153 wireless doorbell sounds like something you could use, or if you're interested in any of the other Reflex products, contact Heath (PO Box 1288, Benton Harbor, MI 49023-1288) directly or circle No. 119 on the Free Information Card. ■

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PRODUCT TEST REPORTS

By Len Feldman

Canon UC1 8mm Camcorder

The Canon UC1 compact 8mm camcorder.

More and more camcorder enthusiasts are these days turning to the 8mm format. For reasons that remain something of a mystery, American video enthusiasts initially thought that "bigger is better" and opted for heavy, bulky, full-size VHS camcorders. Lighter and smaller compact VHS units, dubbed VHS-C, made some inroads when introduced. But since recording time was limited to a maximum of 20 minutes, and later extended to 30 minutes, their success was limited. The introduction of the 8mm format solved both the size and weight and the recording-time problems, offering 2 hours of recording time (and, more recently, 2½ hours on somewhat thinner tape).

Canon has been a major proponent of the 8mm format almost since it was standardized. That innovative company now offers three camcorders in their "UC" series. Of those, the UC1, which was tested for this report, is the least expensive, with a suggested list price of $1499.00.

Billed as the world's lightest 8mm camcorder (at 1.28 pounds without tape, wireless controller, and battery), the UC1 features an 8× internal-focus zoom lens and six-layer ceramic circuit assemblies. A detachable, full-function, wireless remote control; an on-screen menu system; and a 2-page title superimposer with "shadow" letters and battery backup (for retaining titles) are a few of its many features. The titles are displayed in frames using an interlace method that prevents the broken diagonal lines that are usually apparent in other camcorders that use a field-memory method.

Other features include a 7-mode high-speed shutter, a "gain-up" switch for low-level (2-lux) light sensitivity, a 24-zone evaluated white-balance system, automatic wind screen, and a variety of power-supply options (including alkaline batteries). As is true of many 8mm-camcorder models, you can set time and date so that they may be displayed at the beginning of a scene or at any time you choose.

More advanced features include "edit erase," a system for erasing up to a minute's worth of unsatisfactory recording and returning to the starting point of a scene that is to be re-recorded; backlighting compensation, which can be used when excessive background lighting occurs behind the subject being taped; fade-in and fade-out; and self-timer recording, a ten-second standby mode that allows you to get into the picture. Finally, if you are using a partially recorded tape, a blank-tape search function allows you to locate the end of the recorded section; that avoids having long blank, unrecorded sections on the tape.

CONTROLS

As viewed from the rear, the left-side surface of the unit houses power-focusing buttons; an automatic-focus on/off button; the fade, backlight compensation, and date buttons; and buttons associated with titling. Toward the rear of that surface, near the electronic viewfinder, are a counter-reset button, a menu/play button, fast- forward/record search and rewind/record search buttons, a select/record review/stop button, and an edit switch. The function of the buttons that have more than one purpose depends on whether you are in the record or play mode.

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The right side panel of the camcorder body (again, viewed from the rear) houses the power on/off switch, a power-zoom rocker switch, the start/stop (record) switch, and a mode select switch that chooses camera or playback modes. A detachable wireless controller can be swung up (or detached) to uncover tape return, rewind, play, fast forward, start/stop, zoom, stop, record, still-frame, and counter reset buttons. With the wireless controller swung out of the way and with the handgrip section swung down, access is gained to the eject switch that is used to open the cassette compartment for loading and unloading of a cassette. As long as a battery or power adaptor is connected to the camcorder, the eject button will work even when power is off.

The audio and video input/output terminals are located up front, below the camcorder's lens and built-in microphone. Those terminals can be used to playback recordings on a TV set equipped with audio/video inputs or to use the camcorder to record from another source, such as a VCR. A battery pack or an AC power adaptor (supplied) attaches easily to the rear of the camcorder.

TEST RESULTS

Advanced Product Evaluation Labs (APEL) measured the performance of this camcorder. Using the "gain up" function, minimum illumination required to produce a full-amplitude video signal was 1.9 lux, which was slightly better than the 2.0-lux level claimed by Canon. White balance, or the amount of chrominance (color) that appears on a neutral object when the white-balance control is set for optimum was 12 IRE, which was a bit poorer than we would have expected. While color contamination (color bursts appearing on a fine black and white pattern) measured 8 IRE when measured from the camera

TEST RESULTS—CANON UC1 8mm CAMCORDER

Specifications	Mfr's Claim	PE Measured
Minimum illumination	2.0 lux	1.9 lux
White balance	N/A	12 IRE
Color contamination	N/A	8 IRE*
Horizontal resolution		
Camera	N/A	330 lines
Record/play cycles	N/A	240 lines
Video signal-to-noise ratio		
Camera		
Chroma AM	N/A	43.9 dB
Luminance	N/A	39.5 dB
Record/play video out		
Chroma AM	N/A	40.1 dB
Luminance	N/A	40.3 dB
Lens	f/1.8, 8× zoom	Confirmed
Minimum focal distance	36 inches	35 inches
Microphone max. output	N/A	0.41 volts
Ext. microphone sensitivity	N/A	3.1 mV
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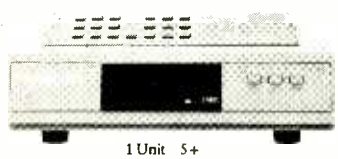

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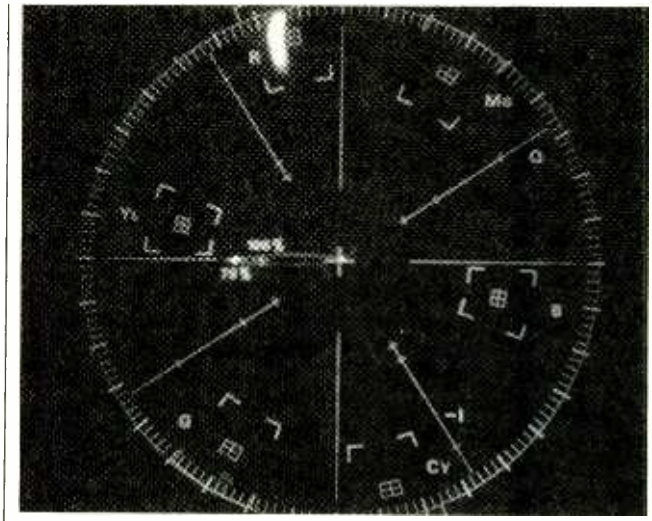

As shown in this vectorscope photo, color-phase accuracy and color saturation were just about perfect.

output itself, that figure decreased to a more than acceptable 2 IRE when the test was made for the complete record/playback cycle.

Color-phase accuracy and color saturation were just about perfect, as illustrated in the vectorscope photo of Fig. 1, which was taken by APEL from a red field. There was virtually no evidence of streaking, lag, or image retention when the camcorder was panned across bright light sources.

Resolution, or the maximum number of horizontal lines as viewed from a resolution test chart, measured 330 lines for the camera output, about equal to the best resolution obtainable from broadcast TV. When measured via the complete record/play cycle, however, resolution decreased to 240 lines, or about what we have come to expect from standard 8mm-format camcorders.

For the camera output, the video color (chroma AM) signal-to-noise ratio measured 43.9 dB, while the signal-to-noise ratio relative to the brightness signal (luminance) measured 39.5 dB. For the complete record/play cycle, those signal-to-noise figures changed to 40.1 dB and 40.3 dB, respectively.

The built-in microphone delivered a maximum audio-output signal of 0.41 volts, while external-microphone input sensitivity measured 3.1 millivolts for full audio output. Audio signal-to-noise ratio measured a satisfactory 58.3 dB.

Additional data supplied by APEL indicated that the minimum focus distance for this camcorder was 35 inches in the normal mode, and ⅛ inch in the "macro" closeup mode. The camcorder consumed 6.5 watts of power when in the record mode. With its battery pack and wireless controller attached, and a 120-minute 8mm-cassette installed, the total weight of the camcorder approached 2 pounds. The overall dimensions of the unit were 5½ (H) by 3⅛ (W) by 6⅜ (D) inches.

HANDS-ON TESTS

Since so many of the controls are of the dual-function type and the unit is so compact, learning how to use the UC1's many features and special effects takes a bit of time and practice. However, it is well

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worth the effort because this very compact unit is able to produce professional-looking video tapes that would have required the use of a much heavier and bulkier camcorder just a couple of years ago.

We should note that those seeking better picture resolution than is provided by the UC1 can choose Canon's UCS1. That unit is a slightly heavier but equally compact model that offers all the features of the UC1, plus Hi-Band 8mm-video recording and several additional features such as a 2-speed 10× power zoom and a built-in character generator with numerous digital title functions. For those who insist upon better sound, Canon offers still another camcorder—the UC20, which features hi-fi stereo and a 7-mode high-speed shutter. The UCS1 carries a suggested list price of $2099.00 while the UC20 has a suggested list price of $1849.00.

However, for the typical camcorder user seeking a lightweight, full featured 8mm camcorder to use for recording vacations, family events, and other memories, we can recommend the Canon UC1 without any reservations. For more information on the UC1 or other Canon camcorders, contact the company directly (Canon USA, Inc., Video Division, One Canon Plaza, Lake Success, NY 11042-1113), or circle No. 120 on the Free Information Card. ■

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Build an Aviation-Band Receiver

Join a growing throng of listening enthusiasts who regularly tune in commercial air-to-ground and ground-to-air aeronautic communications.

BY FRED BLECHMAN

If, like many scanner enthusiasts and ham operators, you are interested in listening in on all the excitement manifest in aeronautic communication, but lack the equipment to pursue your interest, then perhaps the *Aviation Receiver* described in this article is for you. The Aviation Receiver, designed to tune the 118–135-MHz band, features exceptional sensitivity, image rejection, signal-to-noise ratio, and stability. The receiver is ideally suited to listening in on ground and air communications associated with commercial airlines and general aviation.

Powered from a 9-volt transistor-radio battery, it can be taken along with you to local airports so that you won't miss a moment of the action. And even if you're nowhere near an airport, this little receiver will pick-up the air-to-ground and ground-to-air communications of any plane or ground facility within about 100 miles!

Circuit Description. Figure 1 shows a schematic diagram of the Aviation Receiver—a superhetrodyned AM (amplitude modulated) unit built around four IC's: an NE602 double-balanced mixer (U1), an MC1350 linear IF amplifier (U2), an LM324 quad op-amp (U3), and an LM386 audio amplifier (U4).

In operation, an antenna that plugs into J1 picks up the AM signal. That signal is then coupled through C1 to a three-section, tuned-filter network, consisting of L1–L5 and C2–C6. Signals in the 118–135-MHz VHF (very high frequency) range are coupled through C7 to a VHF transistor (Q1), where the signals are amplified. From there, the signals are fed through C8 to the input of U1 (the NE602 double-balanced mixer), which in this application serves as a local oscillator. A variable inductor (L6) and its associated capacitor network set the local-oscillator frequency at 10.7-MHz higher than the incoming 118–135-MHz signals. A tuning network, consisting of varactor diode D1 and potentiometer R1, allows the local-oscillator frequency to be tuned across about 15 MHz.

The 10.7-MHz difference between the received signal and the local-oscillator frequency (*i.e.*, the intermediate frequency or IF) is output at pin 4 of U1 to a 10.7-MHz ceramic filter (FIL1). The filter is used to ensure a narrow pass band and sharp signal selectivity.

The output of FIL1 is amplified by Q2 and then fed through C16 to U2 (an MC1350 IF amplifier), which, as configured, also offers automatic gain control (AGC), as we'll see shortly. The amplified 10.7-MHz IF signal is peaked using variable transformer T1. The AM audio is then demodulated by diode D2. After that, the audio is fed in sequence through the four sections of U3 (an LM324 quad op-amp).

Note that a portion of U3-a's output signal is fed back through resistor R25 to the AGC-control input of U2 at pin 5. That signal is used to automatically decrease the gain of U2 when strong signals are present or to automatically increase U2's gain for weak signals. That keeps the output volume of the circuit within a comfortable listening range regardless of the strength of the incoming signals.

The receiver circuit also contains a squelch circuit that is controlled by potentiometer R3, which is used to kill random noise below a selected threshold level. When properly set, the squelch control virtually eliminates background noise, so that all you hear are incoming signals that can be brought up to a usable level. Potentiometer R2 controls the overall volume fed through C26 to U4, an LM386 low-voltage audio-power amplifier. Due to the overall design and squelch control, the audio output is quite low in background noise, and yet it's capable of driving simple communications speakers or earphones to excellent volume levels.

Construction. The Aviation Receiver was assembled on a printed-circuit board, measuring about 4 × 4¾ inches. Figure 2 shows a full-size template of that printed-circuit board's layout. A kit of parts (which includes an etched and pre-drilled, printed-circuit board, but no case) is offered by the supplier listed in the Parts List.

Although most of the parts for this project are commonly available through conventional electronic-

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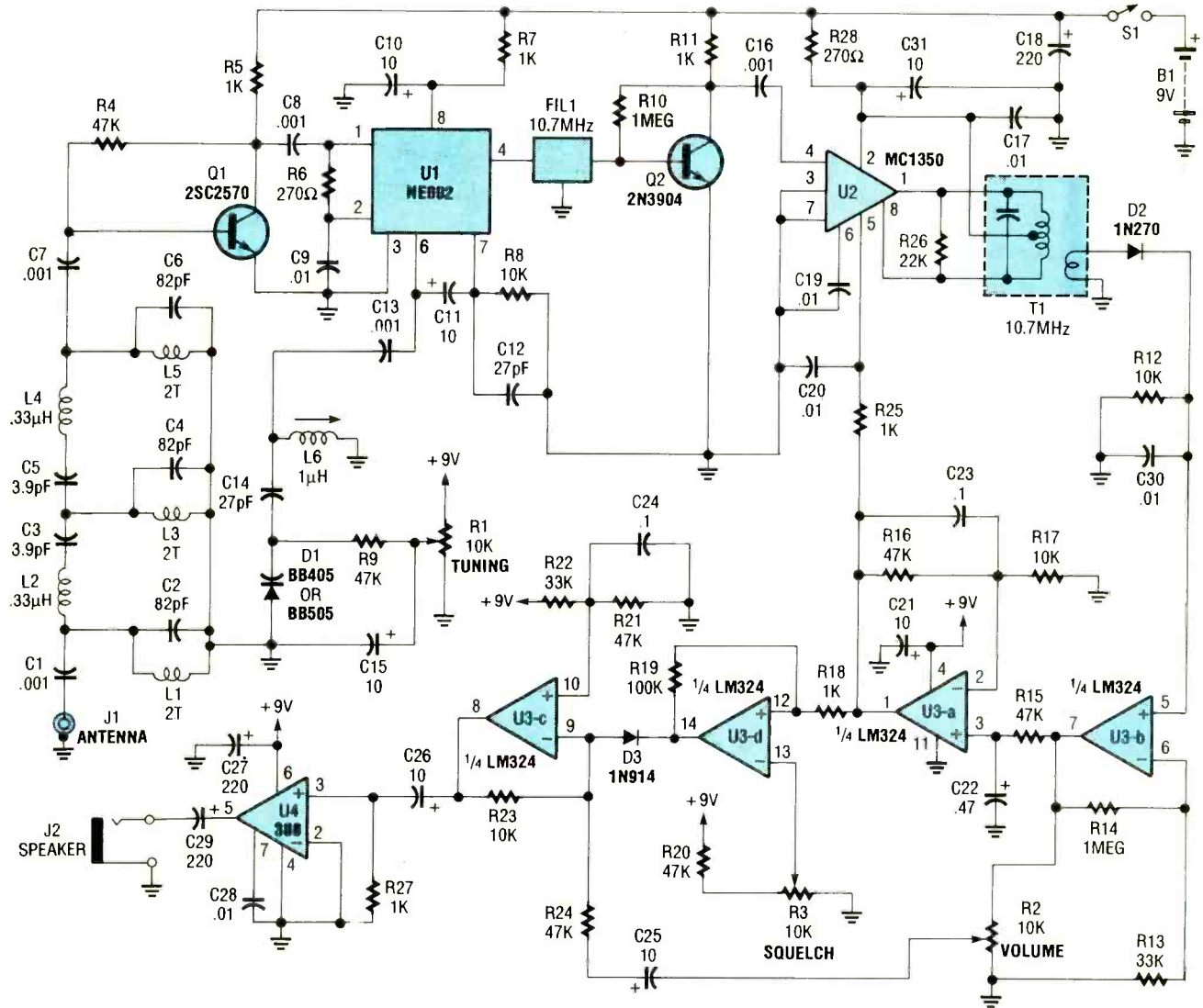
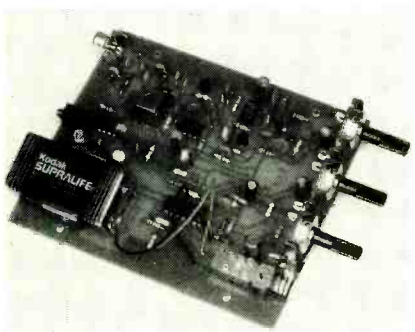


Fig. 1. The Aviation Receiver—a superheterodyne unit, built around four IC's—is designed to receive AM signals in the 118–135-MHz frequency range.



All of the components for the Aviation Receiver (including the 9-volt transistor-radio battery that powers the circuit) mount on a single printed-circuit board.

components suppliers, a source for some of the more difficult to find parts is given in the Parts List for those who prefer to do their own shopping. If you opt to gather your own parts or you plan to use what you have on hand, keep in mind that the circuit-board layout was designed to accommodate components of specific dimensions in some cases; jacks J1 and J2, switch S1, transformer T1, and all three potentiometers, for example. To ease the pain of obtaining those parts, a "Special Parts Kit" is also available from the listed source.

Also note that either of the Siemens parts specified in the Parts List for varactor diode D1 will work, but both may be difficult to find from hobbyist sources. However, the second unit (BB505) is available from Allied Electronics.

However you go about collecting the parts for this project, don't even think about building the receiver circuit without the printed-circuit board. At the frequencies involved, the placement of every wire and part, and every part value is critical for trouble-free performance.

Once you've obtained all of the components and the board for the Aviation Receiver, construction can begin. A parts-placement diagram is shown in Fig. 3. When assembling the project, take special care that polarity-sensitive components (electrolytic capacitors, diodes, and transistors) are installed properly. Just one part installed *backwards* can cause grievous harm!

Begin by installing the passive components (jumper wires, resistors, capacitors, and inductors). Follow that by installing the active components; diodes, transistors, and IC's. Once the active components have been in-

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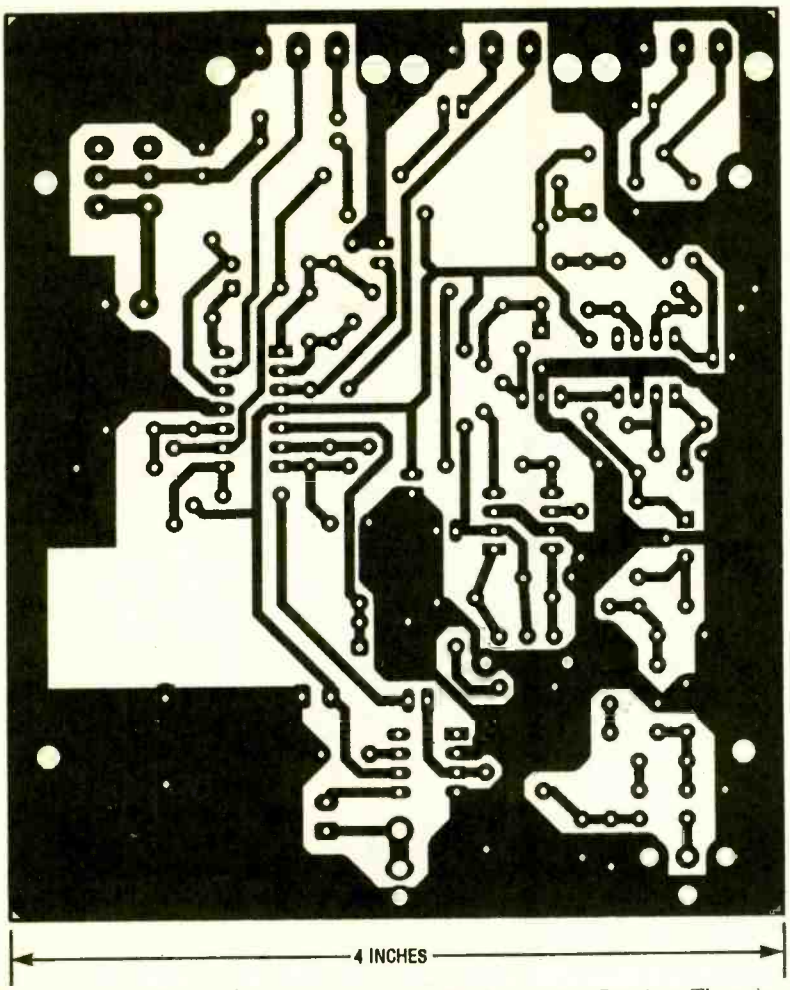
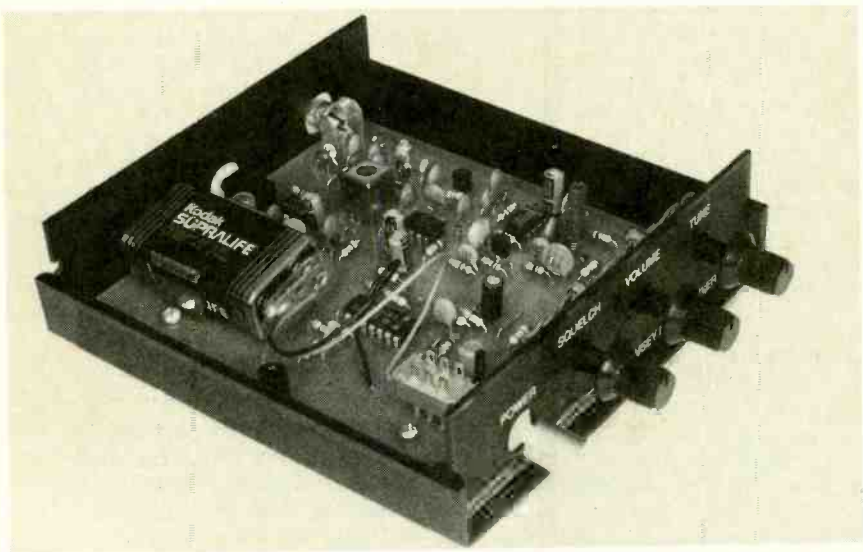


Fig. 2. Here's a full-size printed-circuit pattern for the Aviation Receiver. The printed-circuit board can be purchased as part of a full-blown kit or separately from the supplier listed in the Parts List.



The Aviation Receiver's printed-circuit board fits neatly into this optional 5- × 5.25- × 1.5-inch custom cabinet (which comes with knobs, hardware, silk-screened front and back panels, as well as rubber mounting feet).

stalled, check your work for the usual construction errors: cold solder joints, misplaced or misoriented components, solder bridges, etc. Once you've determined that the circuit has been correctly assembled, it's time to consider the enclosure that will house your receiver.

The receiver's circuit board can be housed in any enclosure that you choose. However, if you prefer, an optional case and knob kit for the receiver is available from the supplier listed in the Parts List. The optional case is supplied with neatly lettered front and rear panels, knobs, rubber feet, and mounting screws.

If you choose a case other than the one available from the listed supplier, it will be necessary to drill holes in the front and rear panels of the enclosure to accommodate the controls (S1, R1, R2, R3) and the jacks (J1 and J2). Once drilled, the front and rear panels of the enclosure can be labeled using dry-transfer lettering.

The antenna for the Aviation Receiver can be as simple as a 21-inch length of wire, or you can get a fancy roof-mounted aviation antenna. If you are near an airport, you'll get plenty of on-the-air action from the wire antenna, but if you're more than a few miles away, a decent roof-mount antenna offers a big improvement.

Alignment and Adjustment. Aligning the Aviation Receiver consists of nothing more than adjusting the slug in the local-oscillator coil (L6) for the center of the desired tuning range, and peaking the IF transformer (T1). The receiver can be calabrated using a VHF RF signal generator, frequency counter, or another VHF receiver by setting R1 to its mid-position; remember that you want to set the local-oscillator frequency 10.7-MHz higher than the desired signal or range to be received. Then, using a non-metallic alignment tool—a metal tool of any kind will drastically detune the coil, making alignment almost impossible—adjust L6 (the LO coil) until you hear aircraft or airport communications.

Once you are receiving aircraft or airport frequencies, adjust T1 for the best reception. Typically, T1 is adjusted 2–3 turns from the top of the shield can. If you don't have any signal-reference equipment for alignment, and are not yet hearing airplanes, your best bet is to pack up the receiver and the necessary alignment tools, and head for the nearest airport! If the airport has no control tower, visit a gen-

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WHAT YOU CAN EXPECT TO HEAR

No matter where you live, you will be able to receive at least the airborne side of many air-traffic communications. If you know where to tune, you can hear any aircraft that you can see, plus planes a hundred miles away and more, since VHF signals travel "line of sight." An airliner at an altitude of 35,000 feet and in the next state is probably still line-of-sight to your antenna.

Similarly, whatever ground stations you may hear are also determined by the line-of-sight character of VHF communication. If there are no major obstacles (tall buildings, hills, etc.) between your antenna and an airport, you'll be able to hear both sides of many kinds of aviation communication. Be prepared for them to be fast and to the point, and for the same airplane to move to several different frequencies in the span of a few minutes!

At most metropolitan airports, pilots communicate with the FAA on a "Clearance Delivery" frequency to obtain approval or clearance of the intended flight plan, which is done before contacting ground control for taxi instructions.

From the control tower, ground movements on ramps and taxiways are handled on the Ground Control Frequency, while runway and in-flight maneuvers near the airport (takeoffs, local-traffic patterns, final approaches, and landings) are on the Tower Frequency. ATIS, or "Automatic Terminal Information System," is a repeated broadcast about basic weather information, runways in use, and any special information such as closed taxiways or runways. Such a broadcast offers an excellent steady signal source for initial adjustment of your receiver, if you are close enough to the airport to receive ATIS.

Approach Control and Departure Control are air-traffic radar controllers that coordinate all flight operations in the vicinity of busy metropolitan-airport areas. When you hear a pilot talking with "Jacksonville Center" or "Indianapolis Center," these are regional ATC (Air Traffic Control) centers. The aircraft is really en route on a flight, rather than just leaving or approaching a destination. A pilot will be in touch with several different Regional Centers" during a cross-country flight.

Airports without control towers rely on the local Unicom frequency for strictly advisory communications between pilots and ground personnel, such as fuel service operators. The people on the ground can advise the pilot what they know about incoming or outgoing aircraft, but the pilot remains responsible for landing and takeoff decisions. Typical Unicom frequencies are 122.8 and 123.0 MHz.

The FAA's network of FSS (Flight Service Stations) keeps track of flight plans, provides weather briefings and other services to pilots. Some advisory radio communication takes place between pilots and a regional FSS. If there is an FSS in your local area, but no airport control towers, the FSS radio frequency will stay interesting. ■

PARTS LIST FOR THE AVIATION RECEIVER

SEMICONDUCTORS

U1—NE602 double-balanced mixer, integrated circuit (Digi-Key)
U2—MC1350 linear IF amplifier, integrated circuit (Allied 858-3011)
U3—LM324 quad op-amp, integrated circuit (Digi-Key)
U4—LM386 low-voltage audio-power amplifier, integrated circuit (Digi-Key)
Q1—2SC2570 or 2N5179 NPN UHF transistor (Allied 858-1041)
Q2—2N3904 general-purpose NPN silicon transistor (Digi-Key)
D1—BB405 or BB505 varactor diode (Siemens, Allied 586-0610)
D2—1N270, 1N34, or similar germanium diode
D3—1N914 silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1–R3—10,000-ohm PC-mount potentiometer
R4, R9, R15, R16, R20, R21, R24—47,000-ohm
R5, R7, R11, R18, R25, R27—1000-ohm
R6, R28—270-ohm
R8, R12, R17, R23—10,000-ohm
R10, R14—1-megohm
R13, R22—33,000-ohm
R19—100,000-ohm
R26—22,000-ohm

CAPACITORS

C1, C7, C8, C13, C16—0.001-μF, ceramic-disc
C2, C4, C6—82-pF, ceramic-disc
C3, C5—3.9-pF, ceramic-disc
C9, C17, C19, C20, C28, C30—0.01-μF, ceramic-disc
C10, C15, C21, C25, C26, C31—4.7- to 10-μF, 16-WVDC, electrolytic
C11—10-pF, ceramic-disc
C12, C14—27-pF, NPO ceramic-disc
C18, C27, C29—100- to 220-μF, 16-WVDC, electrolytic
C22—0.47-μF, 16-WVDC, electrolytic
C23, C24—0.1-μF, ceramic-disc

INDUCTORS

L1, L3, L5—1½-turns #24 to #30 gauge wire
L2, L4—0.33-μH, inductor (Digi-Key M9R33-ND)
L6—0.1-μH, 3½-turn, slug-tuned coil (Digi-Key TK2816)
T1—10.7-MHz, shielded transformer (Mouser 42IF123)

ADDITIONAL PARTS AND MATERIALS

FL1—10.7-MHz ceramic filter (Digi-Key TK-2306)
S1—SPST switch, PC mount
J1—RCA jack, PC mount
J2—Subminiature phone jack, PC mount
B1—9-volt transistor-radio battery
Perfboard materials, enclosure, AC molded power plug with line cord, battery(s), battery holder and connector, wire, solder, hardware, etc.

Note: The following items are available from Ramsey Electronics, Inc., 793 Canning Parkway, Victor, NY 14564; Tel. 716-924-4560: A complete kit of parts (AR-1BP), including printed-circuit board (but not the case or control knobs), $24.95; an etched and drilled printed-circuit board only (AR-1PCBP), $10.00; a Special Parts Kit (AR-1SPKBP) containing all semiconductors, R1–R3, all inductors, S1, J1 and J2, and FIL1, $14.50; Custom case and knob set (C-AR-1BP), $12.95. Please add $3 for orders under $20. All orders are subject to a $3.75 postage/handling charge. New York State residents, please add appropriate sales tax.

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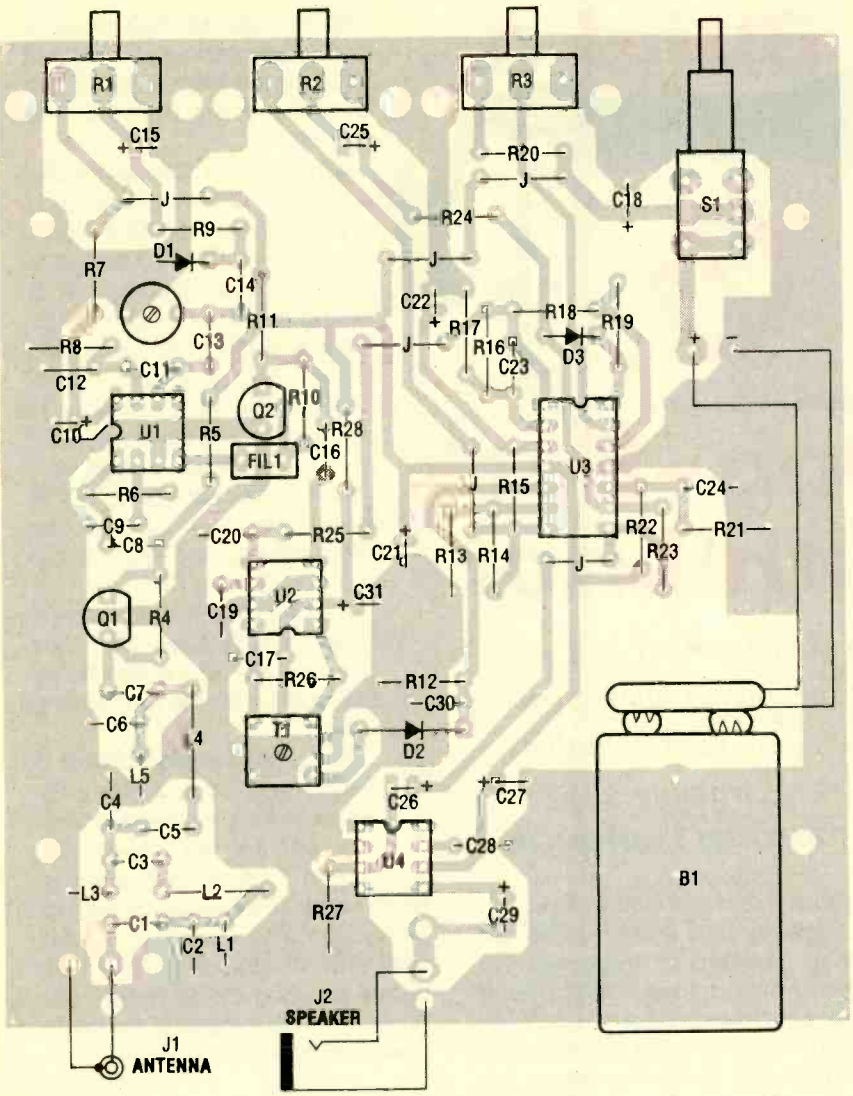

Fig. 3. Use this parts-placement diagram as a guide when assembling the printed-circuit board

eral aviation service center on the airport grounds, and ask which are the most active frequencies. Then adjust L6 and R1 until you hear the action.

A ground-service operator or private pilot may be willing to give you a brief test transmission on the 122.8 Unicom frequency. Remember, also, that if your airport has ATIS transmissions, you can get a steady test signal as soon as you are within line-of-sight of its antenna. (See the sidebar for explanation of Unicom and ATIS.)

Use. Plug an antenna into J1 and a 4- to 8-ohm speaker or earphone into J2. Turn on the Aviation Receiver by closing S1. You may or may not hear background noise. Turn R2 (the SQUELCH control) fully counterclockwise. Then rotate R2 clockwise until you hear a "pop" and some background noise; then back it off slightly (counterclockwise) past the pop. You are now in squelch mode.

With pilots and controllers talking so briefly, you will need to get used to tuning your receiver. As you sweep across the band (via R1), listen for a sound, then rock back and forth slightly to tune it in clearly.

Troubleshooting Suggestions. If the receiver does not work at all, carefully check the obvious things first; battery polarity, soldering of the battery wires and switch, and the connections to the speaker jack. Also, be sure to check that you've correctly installed all of the jumpers. If the circuit's operation is erratic, a solder connection is usually the culprit, or there could be a break in the antenna or speaker wire.

Pay special attention to the orientation of all IC's, transistors, diodes, and electrolytic capacitors. Also, be sure that C11 and C12 in U1's oscillator circuit are of the right values. Local-oscillator operation can be verified with a simple VHF receiver or frequency counter. Remember that the local oscillator should be set to a frequency 10.7 MHz above the desired listening range. If the oscillator works, only a defective or incorrectly installed part can prevent the rest of the receiver circuit from functioning. ■

PILOT AND CONTROLLER TALK

Don't blame the Aviation Receiver if all you hear are short bursts of words that don't make a lot of sense at first. Aviation communication is necessarily quick and brief, but clear and full of meaning. Generally, pilots repeat exactly what they hear from a controller, so that both know the message or instructions were correctly interpreted. If you are listening in, it's hard to track everything said from a cockpit, particularly in big city areas. Just to taxi, takeoff, and fly a few miles, a pilot may talk with 6 or 8 different air-traffic-control operations within a few minutes, all on different frequencies.

Here's the meaning of just a few typical communications:

"Miami Center, Delta 545 heavy out of three-zero for two-five." Delta Flight 545 acknowledges Miami Center's clearance to descend from 30,000 feet to 25,000 feet. The word "heavy" means that the plane is a jumbo jet, perhaps a 747, DC-10, or L-1011.

"Seneca 432 lima cleared to outer marker. Contact tower 118.7." The local Approach Control is saying that the Piper Seneca with the N-number, or "tail number" ending in "432L" is cleared to continue flying an instrument approach to the outer marker (a precision radio beacon located near the airport), and should immediately call the airport radio control tower on 118.7 MHz. That message also implies that the controller does not expect to talk again with that aircraft.

"Cessna 723, squawk 6750, climb and maintain five thousand." A controller is telling the Cessna pilot to set the airplane's radar transponder to code "6750," climb to and level off at the altitude of "5000 feet."

"United 330, traffic at 9 o'clock, 4 miles, altitude unknown." The controller alerts the United Airlines flight of radar contact with some other aircraft off to the pilot's left at a "9 o'clock" position. Since the unknown plane's altitude is also unknown, both controller and pilot realize that it is a smaller private plane not equipped with altitude-reporting equipment. ■

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Build a Dog-Bark Inhibitor

Give yourself and your neighbors some peace and quiet with this training aid

BY ROBERT J. GAFFIGAN JR.

Although it may seem quite distant now, summer is approaching with the anticipation of backyard games, barbecues, and the dog next door barking incessantly. If you happen to be the owner of the irritating, barking dog next door, then neighborhood harmony is at risk. But, worry not... for in this article, we're going to show you how to build a *Dog Bark Inhibitor* that will restore neighborhood harmony by humanely stopping your dog from barking.

Commercially available dog bark inhibitors (electronic devices built into a dog's collar) that are currently on the market are both expensive and can in some circles be considered inhumane. With such devices, every time the dog barks an electrical charge is sent to the dog's neck. While that stops the dog from barking, it can also turn a dog into a cowering animal afraid of its own shadow.

However, the Dog Bark Inhibitor described here is inexpensive and humanely stops the dog from barking by actuating a buzzer every time the barking begins. The buzzing is used to give the dog negative feedback that he'll associate with his barking, causing him to refrain from that annoying tendency.

Circuit Description. Figure 1 shows a schematic diagram of the Dog Bark Inhibitor. At power up, a one-shot multivibrator, consisting of one-third of a 40106 hex Schmitt trigger (U4-c and U4-d), resets U2 and U3, keeping the buzzer (BZ1) cut off. At the same time, resistors R1 and R2 set the trigger level of U1-a, U1-c, and U1-d (¾ of an LP324 quad op-amp) to 2.5 volts. Op-amps U1-a and U1-d are configured as inverting comparators with hysteresis, while U1-c is configured as a voltage follower.

The voltage follower (U1-c) provides a standing DC bias voltage for an electret microphone (MIC1). When MIC1 picks up the dog's barking (see the waveform diagram in Fig. 2A), the bias voltage applied to MIC1 fluctuates, and the output of U1-c follows. Fluctuations in the microphone's bias voltage are applied to U1-d, which amplifies the signal and feeds its output to U1-a. The overall sensitivity of the circuit is determined by the gains provided by U1-a and U1-d. The hysteresis provided by those two op-amps helps to keep background noise out of the signal applied to U1-b, which is setup as a low-pass filter. That low-pass filter is used to remove frequencies from the signal that are not in the range of a dog's bark.

From the filter, the signal (see Fig. 2B) is made compatible with digital circuitry by U4-a (⅙ of a 40106 hex inverting Schmitt trigger), which also inverts the input signal. That signal is again inverted by U4-f and output to the following circuitry as a train of negative-going pulses. Those pulses are produced each time that the sound picked up by the microphone falls within the low-pass range of the filter (see the waveform in Fig. 2C).

The output of U4-f divides along two signal paths: in one path, the signal is fed to the clock input of U2 (a 4040 12-stage ripple carry binary counter); in the other path, the signal is applied to the trigger input of U3-a (½ of a 556 dual oscillator/timer). The negative pulses trigger U3-a, whose output, in turn, enables U2, causing it to count the number of times that the sound falls within the low-pass range of the filter. The purpose of U2 and U3-a is to reject spurious sounds that fall within the filter's range and to allow the dog a period of free barking.

If the counter (U2) counts 256 bark pulses within eight seconds, its output goes high. That high is inverted by U4-b and applied to the trigger input of U3-b at pin 8, forcing its output at pin 9 high. The high output of U3-b is applied to the base of Q1 (an MPSA12 Darlington transistor), causing it to conduct. With Q1 conducting, BZ1 (a 6-volt electronic buzzer) activates for about half a second. At the same time, the ripple counter (U2) is reset via an OR gate, made up of D1, D2, and R11.

If, on the other hand, U2 counts fewer than 256 pulses within that 8-second period, the counter resets, and awaits the next barking session.

The circuit is powered by a 9-volt transistor-radio battery. Because of that, the semiconductors used for this circuit were chosen for their low-current requirements—the circuit draws approximately 0.9 microamps of quiescent current, and 15 mA with the buzzer on—and should not be substituted unless swapped for lower-power components.

Construction. Although the author's prototype was built on a section of perfboard, using point-to-point wiring to interconnect the circuit elements, the final version was assembled on a printed-circuit board, measuring about 3 × 2 inches. A template of the printed-circuit layout is shown in Fig. 3. You can etch your own printed-circuit board from the template shown in Fig. 3, or you can order a printed-circuit board and the parts (separately) to populate it from the supplier listed in the Parts List.

Once you have obtained the board and the parts that go with it, construction can begin. Figure 4 shows the parts-placement diagram for the author's printed-circuit layout. It is recommended that IC sockets be provided for all of the DIP units (U1–U4). The regulator, U5, is housed in a TO-92 style package. Begin construction by installing the DIP sockets and the jumper wires. Once that is done, install

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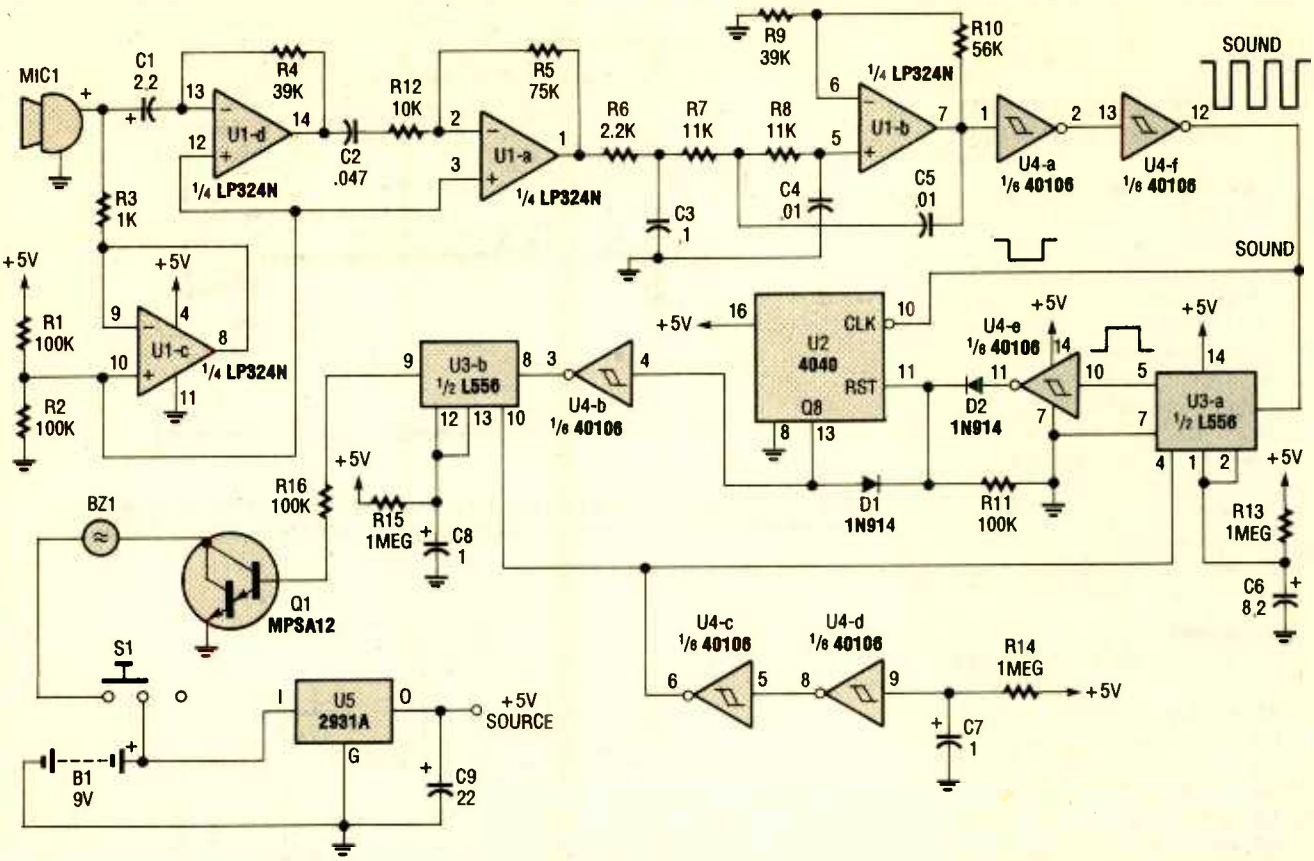

Fig. 1. The Dog Bark Inhibitor is comprised of an LP324 quad op-amp (U1), a 4040 12-stage ripple carry binary counter (U2), an LM556 dual oscillator/timer (U3), a CD40106 hex inverting Schmitt trigger (U4), an LM2931A 5-volt series, low-dropout, voltage regulator (U5), an MPSA12 Darlington transistor (Q1), two 1N914 general-purpose, small-signal silicon diodes (D1 and D2) and a handful of additional components.

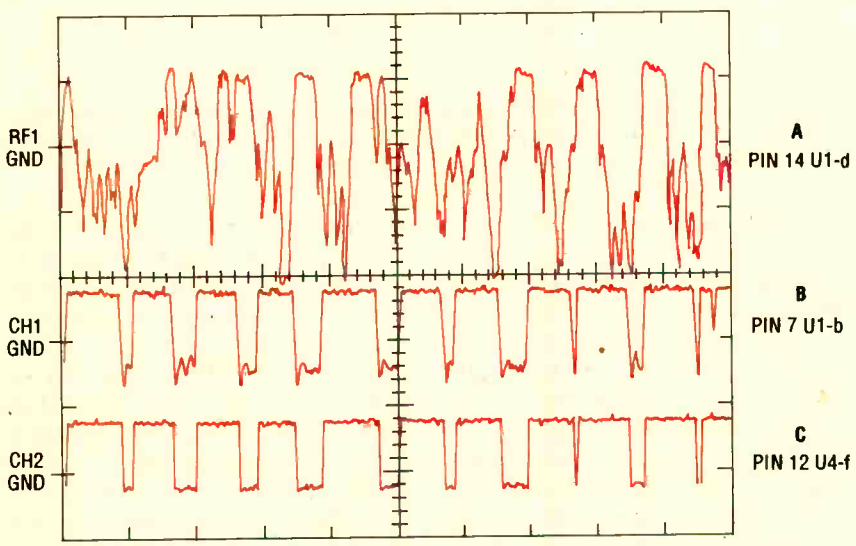

Fig. 2. Shown in A is the waveform produced at the output of U1-d when the dog barks; B shows the same waveform after it has undergone filtering; and C shows how the waveform looks after being processed for application to the digital circuitry that follows.

the passive components (resistors and capacitors).

After the passive components have been installed, mount the active components (excluding the DIP IC's, they will be installed in their respective sockets later), and connect a 9-volt battery connector to the appropriate points on the board. In the author's prototype unit, the microphone (MIC1) was mounted directly to the circuit board, although it might appear otherwise in the parts-placement diagram.

It will be necessary to prepare the enclosure that is to house the circuit board and the off-board components. The author's unit was housed in a plastic project box with a metal lid, measuring about 3¼ × 2⅛ × 1 inches. Begin preparing the enclosure by first placing the circuit board into the enclosure to determine where the microphone will be located when it is permanently mounted. Mark that position on the wall of the enclosure, and drill several tiny holes at that location.

Next, on the same side of the enclosure, drill two holes (one near each end), which will be used to mount a nylon web strap (dog collar) to the project box. Then make two cutouts at opposite ends of the enclosure for the buzzer (BZ1) and the slide switch (S1); the cutouts should be approximately ⅞ × ⅝ inches for the buzzer, and the

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PARTS LIST FOR THE DOG BARK INHIBITOR

SEMICONDUCTORS

U1—LP324 micropower quad op-amp (National), integrated circuit
U2—CD4040 12-stage ripple carry binary counter, integrated circuit
U3—LM556 dual oscillator/timer, integrated circuit
U4—CD40106 hex inverting Schmitt-trigger, integrated circuit
U5—LM2931A 5-volt series, low-dropout, voltage regulator, integrated circuit
Q1—MPSA12 Darlington NPN silicon transistor
D1, D2—1N914 general-purpose, small-signal silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R2, R11, R16—100,000-ohm
R3—1000-ohm
R4, R9—39,000-ohm
R5—75,000-ohm
R6—2200-ohm
R7, R8—11,000-ohm
R10—56,000-ohm
R12—10,000-ohm
R13–R15—1-megohm

CAPACITORS

C1—2.2-µF, 16-WVDC, tantalum
C2—0.047-µF, monolithic
C3—0.1-µF, monolithic
C4, C5—0.01-µF, monolithic
C6—8.2-µF, 16-WVDC, tantalum
C7, C8—1-µF, 16-WVDC, tantalum
C9—22-µF, 16-WVDC, miniature electrolytic

ADDITIONAL PARTS AND MATERIALS

S1—SPST slide switch
MIC1—Electret microphone
BZ1—6-volt electronic buzzer (RS #273-054)
B1—9-volt transistor-radio battery
Printed-circuit materials, enclosure, ¾ × 24-inch web strap, adhesive backed cushion feet, battery holder and connector, wire, solder, hardware, etc.

Note: The following items are available from Futronics, 22524 Millenbach, St. Clair Shores, MI 48081. A complete kit of parts, $29.95; printed-circuit board only, $9.95. Please add $3.00 for shipping and handling. Michigan residents please add appropriate sales tax.

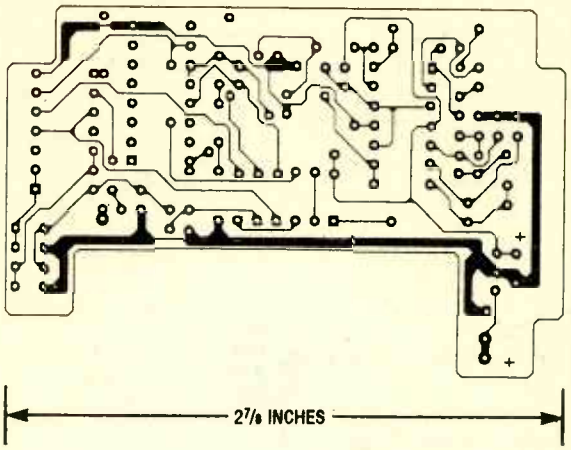

Fig. 3. The final version of the circuit was assembled on a printed-circuit board, measuring about 3 × 2 inches. A template of that layout is shown here full size.

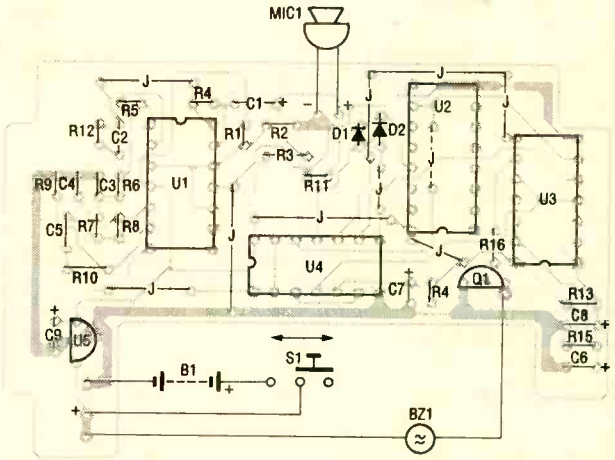

Fig. 4. Once you've obtained the board and the parts that will populate it (either on your own or by ordering them from the supplier listed in the Parts List), use this parts-placement diagram to locate and install the components in their proper positions.

other approximately 5/16 × ¼ inches for the slide switch.

Connect short lengths of hook-up wire to the buzzer and the switch, connect the wires from the off-board components to the appropriate points on the printed-circuit board. Mount the printed-circuit board, switch, and buzzer to the enclosure, and then secure the nylon web strap to the side of the enclosure using a pair of 4/40 screws and nuts. The strapping used to secure the project to the dog's neck is available at most sports and army surplus stores.

Cut off any excess strap length after sizing it to the dog's neck; the free end of the strap should be melted to avoid fraying. Finally, install the IC's in their respective sockets, install a 9-volt battery, and close up the project box.

Operation. Using the circuit is easy. Simply strap the Dog Bark Inhibitor to your dog's neck (be sure to orient the unit so that the microphone is up), turn the unit on using S1. Any long duration or repeated barking by the dog will cause the buzzer to sound for one half second. If greater sensitivity is desired, increase the value of R5.

A longer free-barking period can be achieved by increasing the number of counts U4 allows before turning on the buzzer (that can be done by cutting the trace to pin 13 of U2 and moving the wire to the Q9 output pin 12 or the Q10 output pin 14). The project has been used on the author's dog for more than a year and has stopped the dog's nuisance barking and has restored neighborhood harmony. ■

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On-Board Navigation Systems for your Car

On-board navigation systems, satelite positioning, roadside beacons, and many more developments may dramatically change the relationship between man and his car.

BY BILL SIURU

It's your first trip to this city and you have much business to conduct. You don't have any time to spare, especially driving around lost. Therefore, you spring for a deluxe rental car complete with an on-board navigation system and cellular phone.

Slipping behind the wheel, you immediately notice the small CRT screen in the center of the dashboard. After reading the brief user-friendly instruction pamphlet, you flip on the ignition switch and the screen lights up with a monochromatic map of the city's streets. An icon on the screen displays your current location. Pressing one of the buttons along the side of the CRT, the map changes to a menu. Scrolling through the menu, you enter your first destination. Switching back to the map display, you see another icon at the destination plus the streets you have to travel highlighted. Also shown is the current compass direction and the mileage to your destination. This trip is going to be a piece of cake!

Moving out of the parking garage, you glance to your right and see the map moving with the vehicle as you turn right or left, or even back up. To help keep your orientation, the top of the screen represents "straight ahead." Halfway to your destination, the system starts "beeping" quietly to get your attention. Without taking your eyes off the road, you notice a "congestion" warning and a new route is suggested to avoid the problem. As you near your destination, you press another side button to zoom-in on the display so the local streets are shown in greater detail.

After parking, but before leaving the car for your appointment, you remember you need to make a hotel reservation. Pressing another button brings up a menu that gives you a listing of motels and hotels in a familiar *Yellow Pages* format. You choose one and then use the cellular phone to make the reservation. As you go through this menu, you note for later reference that there are also listings of restaurants, entertainment attractions, towing services, and even local happenings with dates, locations, and times.

Sounds like a bit of science fantasy? Well, in-car navigation systems with at least most of these capabilities are starting to appear on the market in Europe, Japan, and even the U.S. For instance, some 50,000 navigation systems are already in operation in Japan. In Europe and the U.S., navigation equipment is starting to appear in police cars, fire trucks, ambulances, express delivery vans, and other time-critical vehicles. "Civilian" aftermarket units are now on sale in the U.S. as well.

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How They Work. Let's look at the Blaupunkt Travelpilot by the Robert Bosch Corporation, which is already offered in the United States as well as in Europe with a suggested retail price of $2,495. The Travelpilot uses "dead-reckoning" navigation, a technique first used by mariners and aviators, combined with map matching.

Dead reckoning uses speed, time, and compass direction to continuously compute the vehicle's estimated location with respect to a known position. Dead reckoning is sometimes referred to as "deduced reckoning." That is because you are deducing where you must now be given that you have, for example, traveled for 15 miles (determined by an odometer or a speedometer and a clock) due east from a known starting position.

In simple dead reckoning, you would plot your course on a map with a pencil. That roughly corresponds to map matching in a navigation system like the Travelpilot. Here the path being driven (determined from dead reckoning) is compared, or technically called "cross-correlated," with the available paths that are on the map. That is like tracing your path on a piece of paper, putting it over a map and moving it around until it matches up with the roads on the map. Of course, in a computerized navigation system, this correlation is done using hundreds of algorithms (computerized equations) and a digitized-map database. Therefore, if you have driven a path on existing roads, it will correspond to a particular path in the map database. Even if you drive off roads and into parking lots, the algorithms look at the "bigger picture" to find out where you probably are.

Speaking of maps, Etak Inc. in Menlo Park, California is the major producer of digitized maps for use in on-board navigation systems as well as many other applications from taxi and ambulance dispatchers to public utilities and travel agents. Some 75-percent of the U.S. is covered by at least one version of an EtakMap digitized map, as are extensive areas of Germany, France, and the Netherlands.

Travelpilot uses an electronic flux-gate compass and dual wheel sensors to measure direction and distance traveled, respectively (See Fig. 1). The two wheel sensors determine when the car is turning and moving at different speeds. The heart of the Travelpilot system is the "black box" located in the car's trunk or under the seat in commercial vehicles. Inside is a 600-megabyte CD-ROM player and a navigational Computer. The compact disc stores the EtakMap digitized maps of the required geographic region used for map matching. The Travelpilot computer consists of a 16-bit processor with 8k SRAM, 64k EPROM, and 512k DRAM.

The Travelpilot's real-time moving map display (see Fig. 2) shows current location and the alternate routes to get from point A to point B. The distance and compass direction to the selected destination is also shown. The map display scrolls and rotates under the fixed cursor placed over the ever-changing current location. Map movement corresponds to the car's movement on the map and the road. Destinations can be selected by city locale, street address, or the intersection of two streets. Up to 99 user-programmed destinations can be stored in the memory. According to Blaupunkt, a vector-type video display was chosen for the system because it is easier to read than a TV-style raster-scan display. The driver

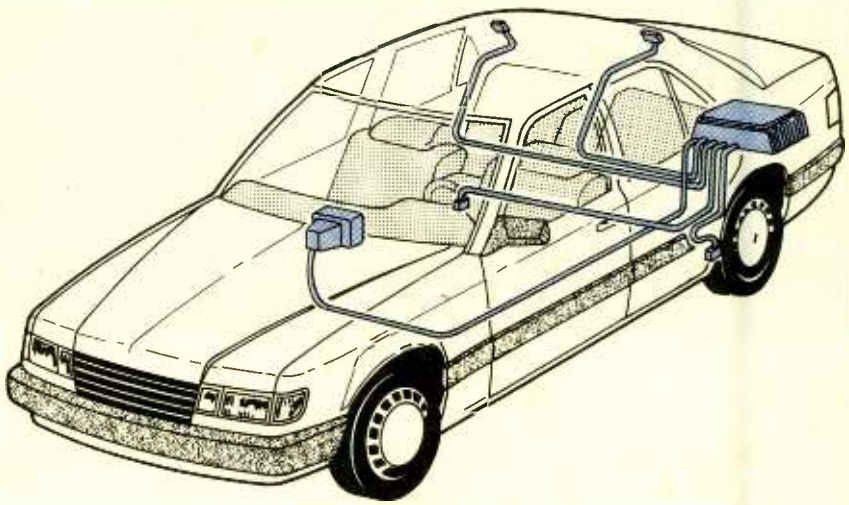
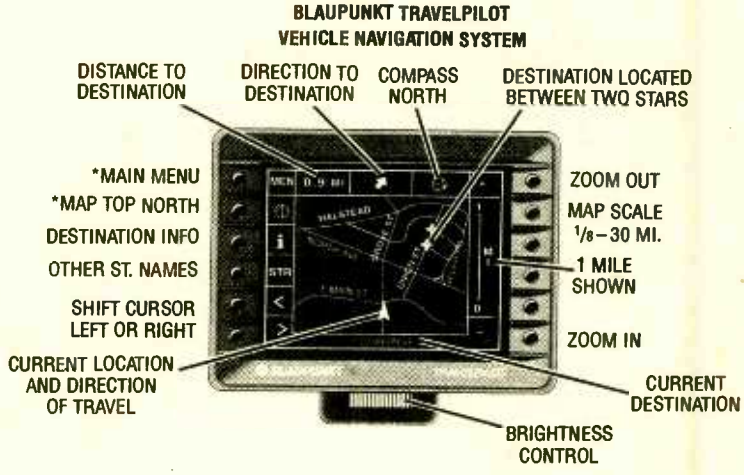


Fig. 1. The computer and CD ROM of the Blaupunkt Travelpilot are located in the trunk. The electronic flux-gate compass is located over the rear window, and speed sensors are located in the rear wheels.



*NO ACCESS WHEN VEHICLE IS MOVING.

Fig. 2. This is the display CRT for the Blaupunkt. Control buttons are located along either side, as shown.

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can zoom the display in or out for more or less detail as is needed.

Obtaining More Accuracy. In the simplest case, you could dead reckon with nothing more than a compass and odometer, plus a map and pencil. However, these "sensors" are pretty crude and location errors can quickly accumulate. Even precision wheel-speed sensors and flux-gate compasses are not prefect. Therefore, while on-board navigation systems like Travelpilot can be completely self-contained and give good results, many on-board navigation systems use external and/or internal methods to further improve their accuracy. External sources involve interfacing with the Global-Positioning System (GPS) satellites in space (for more on this, see the July, 1992 issue of **Popular Electronics**), Loran transmitters, or roadside and overhead beacons. The downside is that these interfaces usually require user fees or, for example in the case of beacons, major investments in infrastructure. Internal methods, on the other hand, require additional inertial-guidance components. However, map matching is still a necessary ingredient to precisely locate the vehicle on the map in just about every system.

The prototype Motorola In-Vehicle Navigation System uses position data from GPS satellites to enhance the accuracy of the vehicle's current location. Besides GPS data, the navigation computer receives measurements from a differential odometer and magnetometer to provide dead reckoning. A digital map stored in the CD ROM is used for map matching, route planning, and route guidance. Drivers are provided instructions via both a simplified dashboard video display and synthesized voice commands.

Germany's Siemens Automotive Ali-Scout navigation system (see Fig. 3) communicates with infrared beacons mounted on existing traffic lights. An infrared transmitter/receiver mounted on the back of the rear-view mirror receives information from the beacons. Infrared communication was chosen because IR diodes emit incoherent beams eliminating interference problems caused by multipath propagation or when several transmitters are operating in mutually overlapping regions. Being an incoherent radiation source, simultaneous infrared flashes can never extinguish each other, only amplify each other. Even the most complicated intersections pose no problems with IR. The IR signal is transmitted at a 125k baud rate at a maximum range of 60 meters (200 feet) so that the vehicle is only within the transmission range when passing near the beacon.

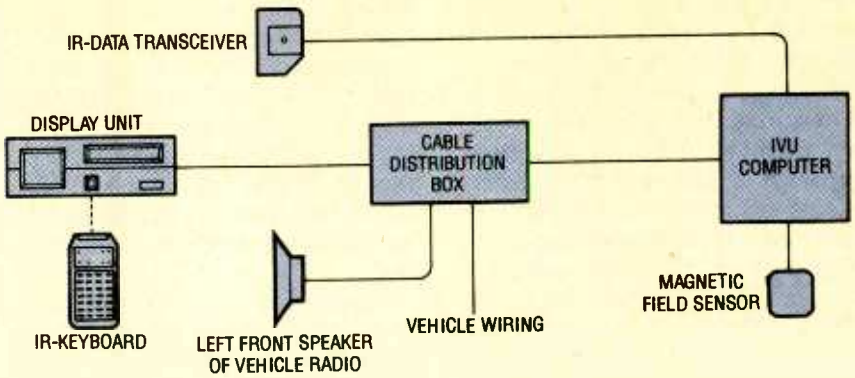

Fig. 3. These are the in-vehicle components for the Ali-Scout navigation system. Note the IR remote keyboard used for entering data and controlling the system.

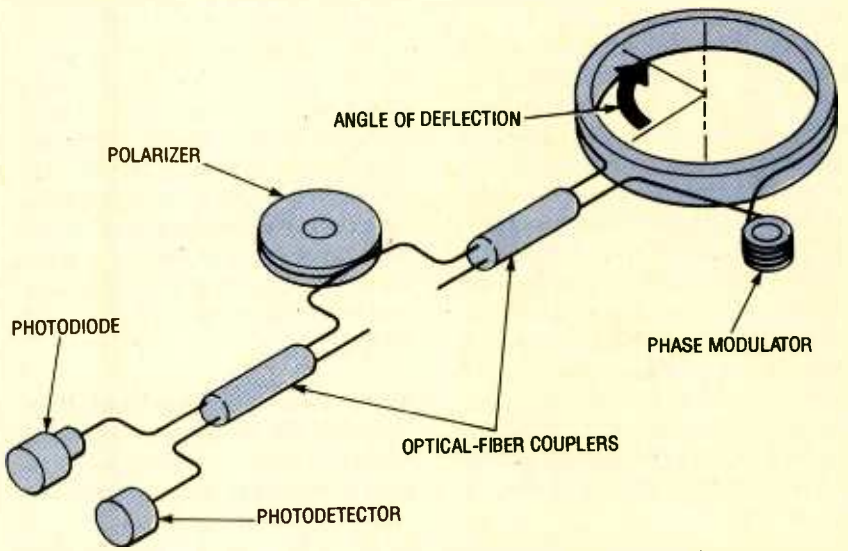

Fig. 4. This is a depiction of the optical-fiber gyroscope used in Nissan's new on-board navigation system available in Japan. Any angular deflection of the large disk results in a variation of angular velocity in the fiber.

The Ali-Scout's dead reckoning navigation computer uses measurements from a magnetic-field sensor that measures the earth's magnetic field. Distance travelled is determined using a speed sensor attached to the odometer or transmission.

One potential problem with on-board navigation systems is that complex map displays can overtax driver attention especially when trying to cope with demanding urban-traffic conditions. Therefore rather than using somewhat more distracting map displays, the Ali-Scout uses a dashboard display with simplified graphic symbols for instructions. For example, arrows show turn directions and a bar graph decreases in size as the corner approaches. The visual display is augmented by audible instructions as well. A 36-key handheld alphanumeric keyboard is used for inputting destinations either in the form of street names or map coordinates. The memory has the capacity for 100 destinations. Some other navigation systems allow both maps and symbolic instructions by changing displays on the screen.

Several navigation systems are already coming into routine use in Japan. For example, Nissan has just introduced its third-generation vehicle-navigation system that is optional on its Cedric, Gloria, and Cima models sold in their home market. The sys-

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tem uses a new optical-fiber gyroscope (shown in Fig. 4) to accurately sense the direction of vehicle motion. The gyroscope uses 100 meters of 0.3-mm optical fiber coiled into a 130-mm diameter loop. The gyroscope measures angular velocities by determining the difference in the time of light traveling clockwise versus counterclockwise in the circular optical-fiber path. The time differences, which are actually frequency shifts, can be correlated with the rate of angular motion. Bumpy roads are no problem because this type of gyro is not affected by shock in the horizontal plane.

Nissan also uses roadside electronic beacons that broadcast their specific location coordinates via digital broadcasts at 2.5 GHz. They are deliberately weak to limit the reception area to approximately 35 meters before and after the beacon in a strip that is only about 15 meters wide. This avoids any possibility of cross-beacon interference. Beacons are already being set up along major roadways in Tokyo, Osaka, and Nagoya, with even more beacons to be installed in the future. Data broadcast by the beacons include intersection names and coordinates, distances from a central point, destinations of roads leading from the intersections, road restrictions, and more. The optical-fiber gyroscope and roadside beacons are used with dead reckoning and a digital-map database to provide greater accuracy than previous Nissan systems, which relied only on position updates from GPS satellites.

Nissan uses a dual-system map-matching logic. In the micromatching mode, the calculated vehicle location is matched every second to roads in the internal map database. Here the searching is done in a small zone by detecting the angular velocity of the vehicle. In the macromatching mode, matching is done about every 50-meters of travel to compare vehicle direction with roadway shapes. Searching in the macromatching mode is done in a wider zone using 5-kilometer segments. The map database is stored on a single CD ROM. According to Nissan, vehicles can be located within five meters.

More Than Finding Your Way. Probably the greatest contribution navigation systems can make to society is helping to reduce urban-traffic congestion and its byproducts: wasted fuel, additional pollution, wasted time, and frayed nerves. There are several major Intelligent Vehicle/Highway System (IVHS) demonstration projects underway in several countries that mate on-board navigation equipment with centralized traffic-management systems.

The $12 million Travtek (which stands for Travel Technology) experimental program in Orlando, Florida probably represents the most ambitious IVHS demonstration project underway in the U.S. today. For this one-year demonstration program, 100 Oldsmobiles have been fitted with an in-dash CRT monitor, TravTek navigation hardware and software, plus radio gear for two-way communication with the Orlando Traffic Management Center. Seventy-five of these specially equipped cars are part of Avis' rental-car fleet in Orlando. The rest will be evaluated by high-mileage drivers. TravTek is a joint program with the American Automobile Association, General Motors, the Federal Highway Administration, Florida Department of Transportation, and the City of Orlando.

For navigation, TravTek uses computerized dead reckoning and map matching with updates from the GPS satellites to pinpoint vehicle location within a 1200 square-mile area that includes 10,000 roadway miles. After the driver enters the desired destination, TravTek computes the best route and then guides the driver to the destination using both visual and synthesized voice commands.

TravTek is much more than an on-board navigation system. It also advises drivers of traffic congestion and delays (see Fig. 5). Besides warnings, the system automatically provides re-routings to avoid the problems using advisories transmitted from the Traffic Management Center. The in-vehicle TravTek processor receives the advisories, then determines if the driver's selected route is affected, calculates a new route and informs the driver that an alternate route is available. These advisories are generated using data from several sources including the city's centralized traffic signal system, the Florida Department of Transportation's freeway-management system, the AAA TravTek Information and Ser-

(Continued on page 92)

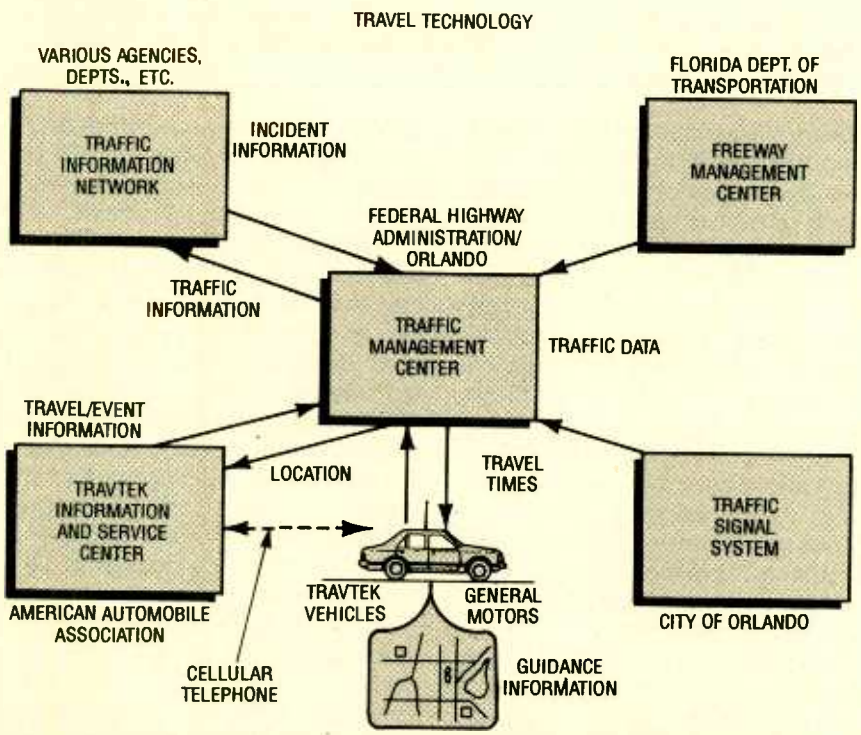

Fig. 5. This block diagram shows the interfaces between on-board equipment, information sources, and the Traffic Management Center that is being used in Orlando's TravTek system.

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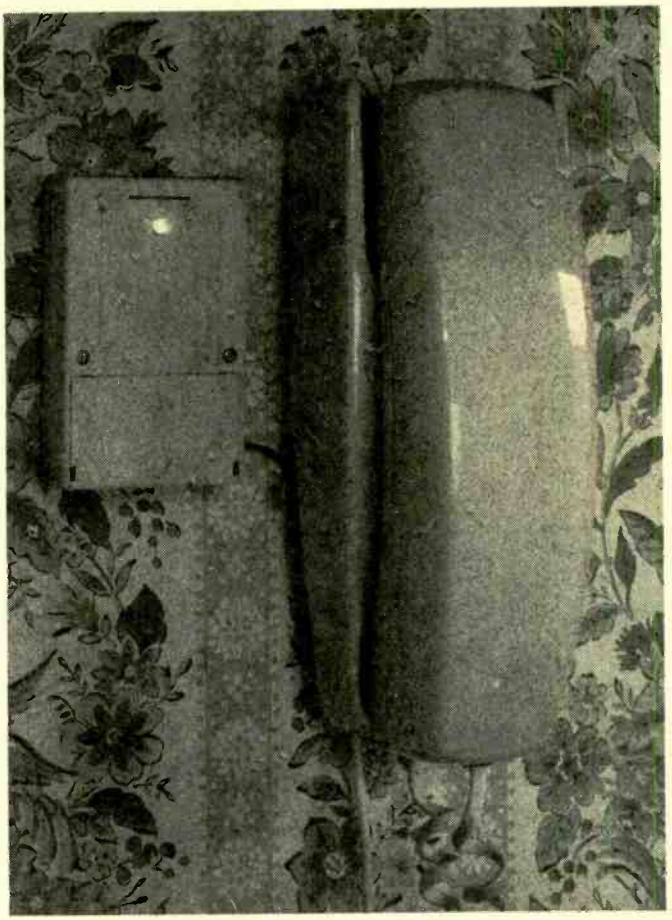
A Telephone-Line In-Use Indicator



Keep others from barging in on your telephone conversations

BY MICHAEL A. COVINGTON

How many times have you lifted the telephone receiver from the hook, in a vain attempt to make an important call, only to find that the phone is in use. Or, what about those times when you're involved in a confidential call and somebody lifts the receiver off hook just in time to hear just enough of the dialogue to misconstrue the meaning of your conversation. Or maybe while you're trying to upload or download a time-dependent, critical computer document, someone takes a remote receiver off hook, allowing noise (which can lead to glitches) to get into the transmission. Such events can lead to inter-family conflicts.

Wouldn't it be nice if your home telephone contained circuitry that would let you know when the line is being used (a feature that is readily available in most office environments). Well, with the *Line-In-Use Indicator* described in this article, you can add such a feature to your present home-telephone network. The circuit—which uses a bright, blinking LED to indicate whether the line is in use—can be installed next to any telephone to warn other family members not to interrupt your modem connections or private conversations.

How It Works. The indicator works by sensing the voltage across the telephone line. The line voltage is normally 48 volts DC when the phone is on hook, and drops to about 2 to 10 volts when a telephone is off hook. When the voltage across the telephone line drops below 15 volts, an LED begins to blink. While many circuits of this ilk pirate power from the phone line for their operation, this one doesn't... it is powered from a 9-volt transistor radio battery. The reason is that there isn't always enough power available to light an LED brightly. The power supply arrangement used for the project ensures that the LED is always bright and prominent.

Figure 1 shows a schematic diagram of the Line-In-Use Indicator. At the heart of the circuit is a CD4001B quad CMOS NOR gate. Two of the gates from that chip—U1-c and U1-d—are configured as a low-frequency oscillator; the other two gates (U1-a and U1-b) are used to buffer the output of the oscillator, which is used to drive LED1.

Resistors R1–R3 sample the phone line voltage and divide it to one third of its original value. When the voltage across R2 exceeds 5 volts, (indicating a phone line voltage of at least 15 volts), the oscillator is gated off and LED1 remains dark.

When the telephone rings, the line voltage goes to 100 volts AC, which puts 33 volts across R2. That is beyond the maximum rating of the CMOS IC, not to mention that the polarity is backward half the time. So why doesn't the IC fry? The answer has to do with the input protection diodes built into every B-series CMOS logic chip (see Fig. 2). Because R1, R2, and R3 are so large, the input current is tiny even when the voltage is very high. The diodes inside the chip shunt the excess voltage to the battery, which absorbs it. Since the current is only a couple of microamps, it has no effect on the battery.

Construction. The author's prototype was assembled on a small section of perfboard. As always, it is recommended that an IC socket be provided for U1. Begin construction by first mounting a 14-pin IC socket to the perfboard. Flip the board over and then mark the pin 1 terminal of the socket, which will serve as a reference point. Now, guided by Fig. 1, wire the circuit together using point-to-point wiring techniques.

When it comes to the LED, there are a couple of ways to handle it. The LED can be wired to the board using hook-up wire, or it can be installed with its leads left long enough so that LED lens protrudes through the enclosure's front panel.

After the circuit has been as-

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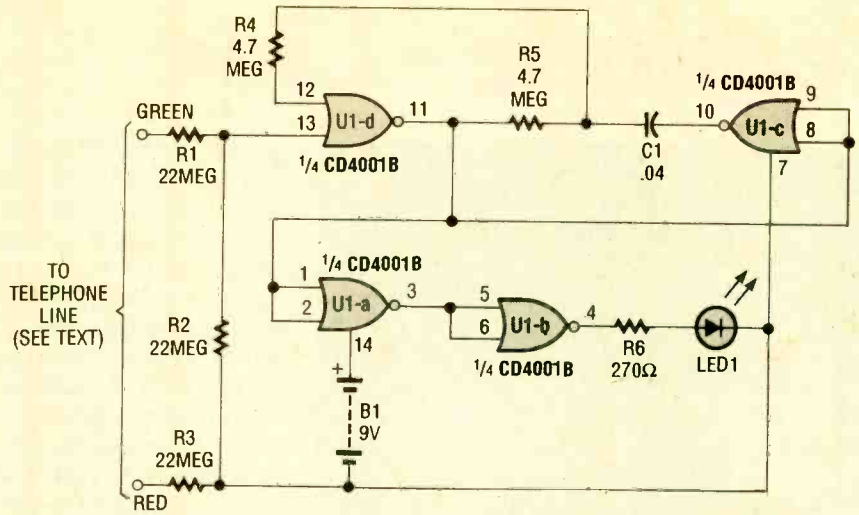
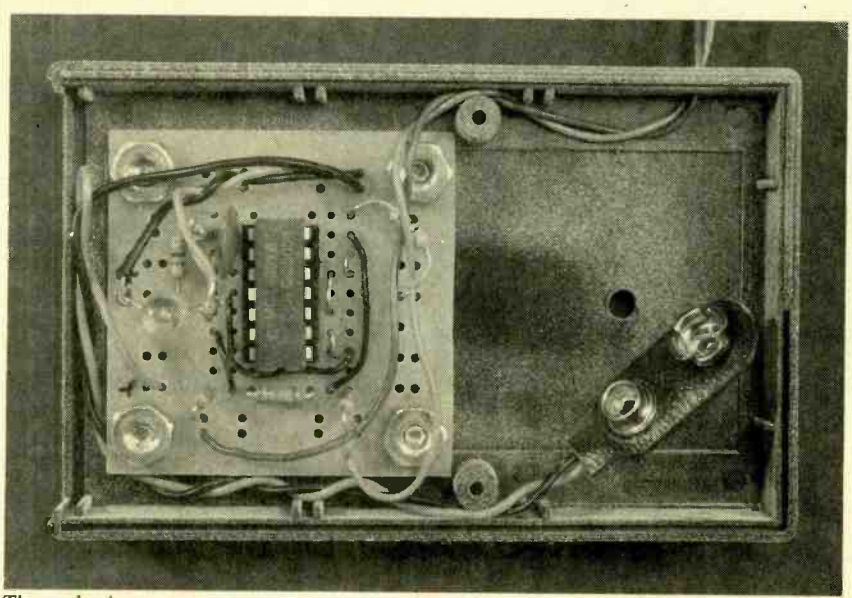


Fig. 1. At the heart of the Line-In-Use Indicator is a CD4001B quad CMOS NOR gate. Two of the gates (U1-c and U1-d) are configured as a low-frequency oscillator; the other two gates (U1-a and U1-b) are used to buffer the output of the oscillator, which is used to drive LED1.



The author's prototype was assembled on a small section of perfboard and housed in a plastic enclosure that comes complete with a built-in battery compartment.

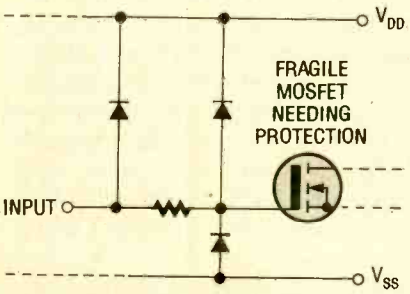


Fig. 2. When the telephone rings, the line voltage rises to 100 volts AC, placing 33 volts across R2. That voltage, which is applied to the input of U1-d, would normally fry the chip, but because the CD4001B has input protection diodes (as shown here) built into it, that doesn't happen in our circuit.

sembled, check your work for construction errors, particularly around the IC socket. If all is well, install the IC in its socket.

The author's prototype was housed in a plastic enclosure with battery compartment (available from Radio Shack as part 270-293). The only enclosure preparation required is to drill two holes in the enclosure; one in the front panel of the enclosure through which LED1 will protrude, and the other in the side of the enclosure for a telephone line cord for connection to the board.

Once the holes are drilled, feed the wire that will connect the circuit to the telephone line through the appropriate hole in the enclosure and connect it to the circuit. The type of wire and the termination used for that will be determined by the terminal block used in your phone installation. The author used two lengths of wire that he twisted together (as in "twisted pair"). However, if your home-telephone network has modular jacks, modular cable is the way to go; in that case, simply connect the red and green wire of a modular telephone cable as shown in Fig. 1. Once the cable is connected, the LED can be press-mounted in the front panel LED hole.

Installation. Installation is a simple procedure; just connect the cable from the project across the telephone line, as indicated in Fig. 1. Resistor R1 should go to the positive (green) wire and R3 to the negative (red) wire. In normal operation, the LED will be off if the line is idle; the LED will blink if a telephone is off hook, a ringing signal is present, or the line is dead (0 volts). If the LED never stops blinking, try swapping the connections.

Don't install the battery until you're ready to connect the indicator to the phone line; if you do, the LED will blink constantly and run the battery down. Conversely, don't leave the indicator attached to the line without a battery installed; it relies on the battery for overvoltage protection. ■

PARTS LIST FOR THE TELEPHONE LINE-IN-USE INDICATOR

SEMICONDUCTORS

U1—CD4001B (or MC14001B) quad CMOS NOR gate, integrated circuit
LED1—Light-emitting diode, any color

RESISTORS

(All resistors are ⅛-watt, 5% units.)
R1, R2, R3—22-megohm
R4, R5—4.7-megohm
R6—270-ohm

ADDITIONAL PARTS AND MATERIALS

C1—0.04-μF or 0.05-μF, ceramic-disc capacitor
B1—9-volt alkaline, transistor-radio battery
Perfboard materials, enclosure, 14-pin IC socket, battery connector, wire, solder, hardware, etc.

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BUILD A WIRE TRACER

Cut those seemingly insurmountable wire-tracing jobs down to size

BY CHARLES D. RAKES

In these difficult economic times, many home owners are opting, wherever possible, to do their own home repairs and remodeling. Do-it-yourself home repairs often entail spending many hours trying to trace the AC wiring through walls and junction boxes. Remodeling, such as adding a new window or door to your home, often requires that you cut a section out of a wall. When hacking through a wall, you had better know the location of the electrical wiring or it's lights out.

A simple solution to those and other similar wire-tracing dilemmas—such as tracing a signal through your automobile's electrical system—can be found in the *McTrak* wire-tracing circuit described in this article. The McTrak can turn a job that might otherwise require hours of cutting, whacking, and pulling into child's play (well almost), cutting your work time from a few hours to only a few minutes.

The McTrak is easy and inexpensive to build, and best of all, there is nothing difficult about using the unit. All you have to do is connect the McTrak to the wire of interest and, using a portable AM receiver, trace a signal (put out by the McTrak) to its final destination.

How It Works. A schematic diagram of the McTrak is shown in Fig. 1. At the heart of the circuit is a 567 tone decoder. The tone decoder (U1) is configured as a simple astable, squarewave oscillator, operating at about 250 Hz. The 250-Hz output of the squarewave oscillator, at pin 5, is fed to the base of Q1 (a 2N3904 general-purpose NPN transistor), which in this application, functions as a buffer stage. The alternating output of U1 causes Q1 to switch on and off in time with the drive signal.

The output of Q1, taken from its collector, is fed through capacitor C2 to Q2 and Q3—a second 2N3904 NPN unit and its companion 2N3906 PNP transistor, respectively—which form a complementary pair. Together, those transistors alternately amplify both halves of the applied signal; *e.g.*, when one transistor is off the other one is on. That pair of transistors provides a low output-impedance signal source that can be used to drive either an open- or closed-loop circuit.

The output of the complementary pair (Q2 and Q3) splits along two paths; in one path, the output of the complementary pair is applied to C5, causing the 250-Hz output of the complementary pair to be induced into the AC wiring and radiated throughout the wiring system. The circuit's 250-Hz squarewave output, which is rich in harmonic signals that reach into the AM broadcast band, allows the signal to be traced through the house or other wiring with an inexpensive AM transistor radio. The radiated signal, when detected by an AM receiver, produces a buzzsaw-like sound in the receiver's speaker.

In the other path, the signal goes through C4 and is delivered to output jack J1 (the open-loop output); the signal also continues on through 47-ohm current-limiting resistor R6 (which is used to protect the tracker's output from overload) to J2 (the closed-loop output). Those output jacks, along with J3 (common), are used when conditions are less than optimum. (We'll give examples of how and when to use those jacks at the appropriate time later in this article.)

Construction. Building the McTrak is simple and the parts layout is not critical, so just about any construction scheme will suffice. However, the author's prototype of the circuit was assembled on a printed-circuit board. A template for that printed-circuit layout is shown in Fig. 2. If you opt to go the printed-circuit route, follow the parts-placement diagram shown in Fig. 3.

As usual, start by installing the passive components (resistors, capacitors, etc.) followed by the semiconductors, double-checking all part locations and their orientations as they are installed on the board. Once the electronic components have been installed, connect a 9-volt battery connector to the board at the points indicated in Fig. 3. Be sure that the proper polarity is observed.

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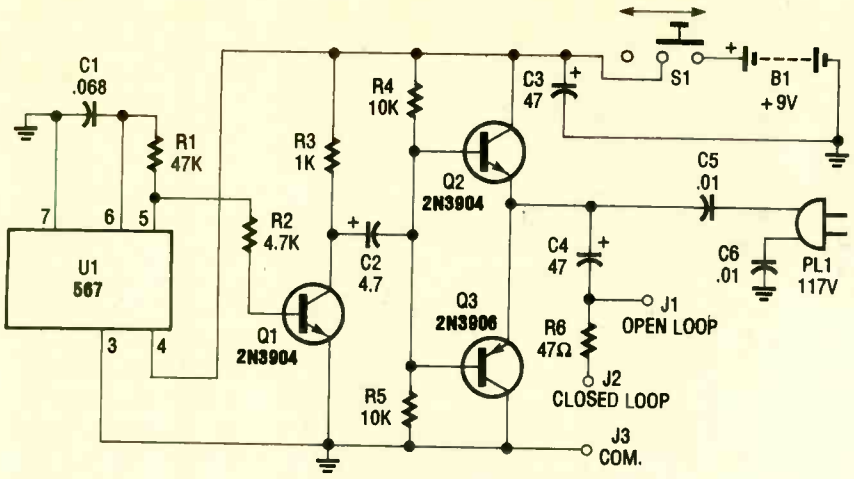

Fig. 1. At the heart of the McTrak is a 567 tone decoder, configured as a simple squarewave oscillator, operating at about 250 Hz.

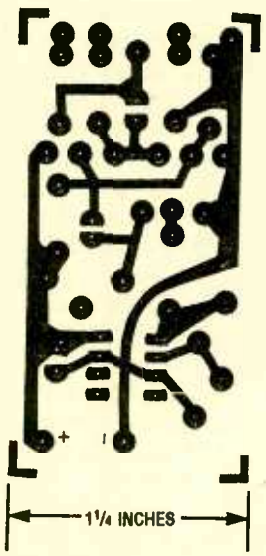

Fig. 2. The author's prototype of the circuit was assembled on a printed-circuit board, the template for that printed-circuit layout is shown here full size.

PARTS LIST FOR THE MCTRAK

SEMICONDUCTORS

U1—LM567 tone-decoder, integrated circuit
Q1, Q2—2N3904 general-purpose NPN silicon transistor
Q3—2N3906 general-purpose PNP silicon transistor

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—47,000-ohm
R2—4700-ohm
R3—1000-ohm
R4, R5—10,000-ohm
R6—47-ohm

CAPACITORS

C1—0.068-μF, 100-volt Mylar
C2—4.7-μF, 16-WVDC, electrolytic
C3, C4—47-μF, 16-WVDC, electrolytic
C5, C6—0.01-μF, 500–1000-WVDC, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery
S1—SPST slide switch
J1–J3—See text
Printed-circuit materials, enclosure (Radio Shack #270-222), molded AC power plug with line cord, 9-volt battery holder and connector, wire, solder, hardware, etc.

Note: The circuit board and all of the parts that mount on it are available for $14.95, plus $1.00 shipping and handling from: Krystal Kits, P.O. Box 445, Bentonville, AR 72712. Arkansas residents please add appropriate sales tax.

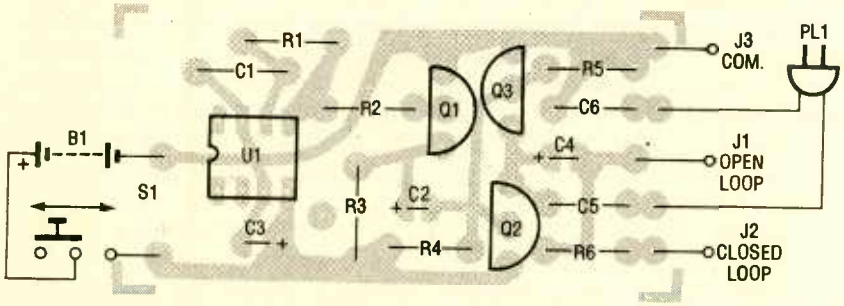

Fig. 3. Follow this parts-placement diagram when assembling McTrak's printed-circuit board. As usual, start with the passive components, followed by the semiconductors, double-checking the part's location and orientation as it is installed.

After all of the on-board components have been installed, check your work for potential problems—solder bridges, cold solder joints, and so on. When you are satisfied that the circuit board contains no errors (of the nature usually associated with hobbyist projects), place the board to the side and prepare the enclosure.

The author's prototype was housed in a 4⅝ × 2⁹⁄₁₆ × 1⁹⁄₁₆-inch plastic project box (available from Radio Shack and other sources) that is slotted to hold small circuit boards in place. The circuit board was sized to fit the case's internal slots.

It will be necessary to drill holes in the enclosure for the off-board components: S1 (along with its mounting hardware), J1–J3, and PL1. Note that although the author used a slide switch for S1, there is no reason that a toggle or even a locking pushbutton (push on/push off) switch could not be substituted. Mount switch S1 to one side of the cabinet, and the three output jacks on the opposite side. Then using hook-up wire, connect the switch and the three jacks to the circuit board at the appropriate points.

Once that is done, mount an AC plug with line cord to one end of the enclosure. That can be accomplished by first passing the plug's line cord the through a ⅛-inch hole in one end of the enclosure, and then clipping off the excess cord length and connecting the line cord to the circuit board as shown in Fig. 3. After that is done, the plug can be secured to the enclosure using hot-melt glue.

Check Out and Use. To check the operation of the McTrak, first install a

(Continued on page 98)

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TRACKING DISTANT SIGNALS

By monitoring the VHF low-band for skip, you could easily make some wonderful long-distance contacts.

BY LAURA QUARANTIELLO

The transmissions were weak, scratchy and, more often than not, lost behind the other voices on the frequency. I'd been listening to 33.7 MHz for two days now and still had failed to hear any information that would help me to identify the station speaking. It had become a minor obsession over the past couple of hours to positively identify the distant fire-department dispatches.

Unfortunately, given the changing nature of the atmosphere, it was likely that when I woke up the next morning and turned on the radio, 33.7 MHz would be silent and the transmissions gone. To understand how a long-distance transmission can appear and disappear like that, we'll have to do a quick study of radio-wave propagation—the near magic of what happens to a radio wave once it heads off into the atmosphere.

One Little Wave. When a radio signal or wave leaves the antenna of a transmitter, it becomes, in theory, two distinct parts: a ground wave that travels along the surface of the Earth and a sky wave that travels out into the sky. The ground wave travels a short distance before it becomes absorbed by the Earth, but the sky wave is much more resilient and that's the wave low-band, distant-transmission listeners tune-in to.

The sky wave travels on its merry way, high up into the wild blue yonder, until it encounters the ionosphere. That layer of the Earth's atmosphere, some 150 to 200 miles high, is constantly bombarded by the Sun, which charges the ionized gases of the ionosphere. When a sky wave hits that layer of charged gas, it is partially reflected. Some of the part of the wave that is not reflected is absorbed by the gas, and the remainder flies into deep space. The portion that is reflected returns to Earth at an angle, which means that it comes down many thousands of miles from its point of origin. That phenomenon is known as "skip."

Skip is almost a mystical thing, affected by sunspots, weather, and even the time of year. It can also be a scanner enthusiast's best friend if you know how to take advantage of it.

Equipment. You don't need a control room full of radios in order to receive VHF skip transmissions. In fact, any scanner that will search the range of 30–50 MHz will do nicely. Having a search feature is important, because you'll definitely want to program-in short ranges of frequencies and let the scanner do the work.

An outdoor antenna is not mandatory, but it will improve your chances of hearing transmissions tenfold. A good all-band ground-plane antenna does nicely, but a beam antenna can have advantages if you are searching for transmissions from a specific direction. Since the prevailing atmospheric conditions have the most to do with reception, whatever you use should pull in some signals, so give it a try.

Frequency guides are a great resource if you're serious about identifying the stations heard. For example, a complete set of *Police Call* magazine's frequency directories is invaluable for tracking down domestic public-safety stations. For military stations, try a federal frequency directory such as Tom Kneitel's *Top Secret Registry of US Government Frequencies*. A good map book of the United States is also handy.

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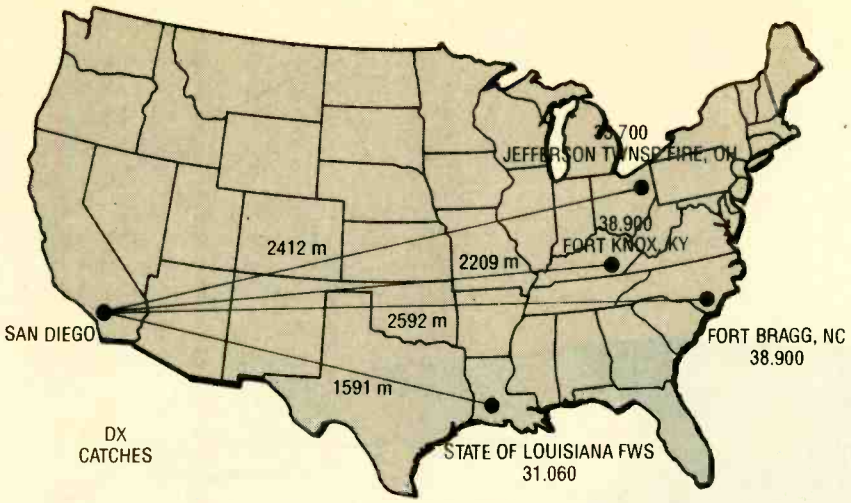

Fig. 1. As you can tell from these catches logged by the author, skip can really help you pull-in transmissions from all over the country.

Finding Skip. Frequencies on the low band—30 to 50 MHz—are most affected by skip because of their long wavelengths. Frequencies on the higher VHF bands tend to skip less. I don't consider 50 MHz the absolute top of the possible skip range. Occasional forays above 50 MHz have netted some interesting catches, but for the best results, "go low."

Searching through the basement of the VHF band, your chances improve drastically. On a good day, it isn't unusual to hear communications from thousands of miles away, sometimes even from Central America, Canada, or overseas. The key to hearing all this is knowing when and where to listen.

Since skip is affected primarily by the actions of the sun, it almost goes without saying that daytime is the best time to listen. Try between 9 A.M. and 7 P.M., or whenever local dusk occurs. If you're shortwave equipped, listen at 18 minutes past each hour for propagation reports from WWV on 2.5, 5, 10, 15, or 20 MHz. The solar flux number they give reflects the amount of ionization of the ionosphere's F2 layer, and so the possibility of picking up long-distance transmissions.

I target specific frequencies, which I check for communications. For instance, 38.9 MHz is a popular military range-control frequency that I have programmed into my regular scan bank. If I hear communications on this channel, I know that skip is present and set-up search ranges to see what other frequencies might be active.

Try programming in the range from 30.0 to 31.0 MHz and set your scanner to scan between these two values. This is about as low as typical scanners will receive and is a good place to start. Here you'll come across business communications, forestry reports, power and water utilities, and some public safety and military communications. If you find active distant stations here, work progressively higher. On some days only a small swath of frequencies will be affected, and on others you won't know where to tune first because of all the activity.

The region between 31 and 33 MHz is a super place to look for military communications, as are the 38–39 MHz and 40–42 MHz areas. Fire departments can be found primarily between 33–35 and 37–38 MHz. Highway patrol, a good target for beginners, can be found operating between 42–43 MHz. These ranges will get you started. Take a look at the back of an issue of *Police Call* for their Consolidated Frequency List, which will further guide you.

Don't be afraid to experiment and seek ranges beyond the norm for skip. I frequently scan from 49.0 to 49.7 MHz, just below the cordless telephone/baby monitor band, which yields up such catches as military-range communications (like Camp Pendleton, California at 49.0 MHz), and tactical operations (such as Army Explosives Ordnance Disposal on 49.7 and 49.8 MHz). You never know what you'll find: I occasionally even hear live horse-race announcements on 41.725 MHz.

During the Gulf War, scanner monitors reported heavy communications activity all across the low band from American and foreign troops in Saudi Arabia. Voices from Central American stations, Panama, Honduras, and the Dominican Republic are regularly heard engaged in US military operations. Furthermore, lots of counter-drug missions take place on the low band, as well as a large amount of fire communications. Fish and Wildlife officers, whose activities often take them far from normal radio range, can often be heard talking on frequencies between 31 and 32 MHz.

Identifying Stations. The first order of business when you come across an active frequency is to take down some of the information you hear coming across the speaker. Call signs, place names, and unit ID's are all helpful. More than once I've tracked down a frequency user by tracing city names through a map book.

Here's an example: say, 42.12 MHz is active with a dispatcher calling herself "San Diego." Looking up San Diego in a map book will reveal a California location. Drag out volume nine of *Police Call*, check all the licenses under 42.12 MHz and you'll find a listing for the California Highway Patrol San Diego Office.

Military stations can be difficult if call signs such as "Alpha Six Echo" are used, but if you listen long enough you might hear the base name or a unit number. When that happens, check a federal frequency book for active stations on the frequency to get you closer to a positive ID.

DX'ing Low Band. Searching for distant signals (DX'ing) can be an engrossing, frustrating, exciting, and highly variable hobby.

As I predicted, the 33.7-MHz signal I mentioned did fade away by the time I listened again the next morning. It was three weeks before I finally heard the signal strong enough to warrant some serious listening. With a little more attention I had my catch in no time: Jefferson Township Fire Department, Ohio.

If local communications are getting too routine and you'd like to explore how other services across the country handle their communications, "go low" and give low-band skip monitoring a try. ■

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Popular Electronics

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The Magazine for the Electronics Activist!

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Abbreviations: (AR)Antique Radio, (C)Construction, (CB)Computer Bits, (CC)Circuit Circus, (D)Department, (DX)DX Listening, (ED)Editorial (FS)Fun Software, (HOR)Hands-On Reports, (HR)Ham Radio, (G)Gizmo (LTR)Letters, (PTR)Product Test Report, (SS)Scanner Scene, (TT)Think Tank

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Onkyo SV70 Pro Audio/Video Receiver (Feldman)(PTR) Jan 73
Panasonic PT-10L Compact Video Projector (O'Brian and Scaduto)(G) Apr 5
Radio Shack Archer Wireless A/V Distribution System (O'Brian and Scaduto)(G) Jan 45
Sansui Model AV-7000 A/V Amplifier (Feldman)(PTR) May 27
Sony MDP-605 CD/CDV/LP Player (Feldman)(PTR) Oct 27
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Videonics
Boing Box Sound-Effects Mixer (O'Brian and Scaduto)(G) Mar 8
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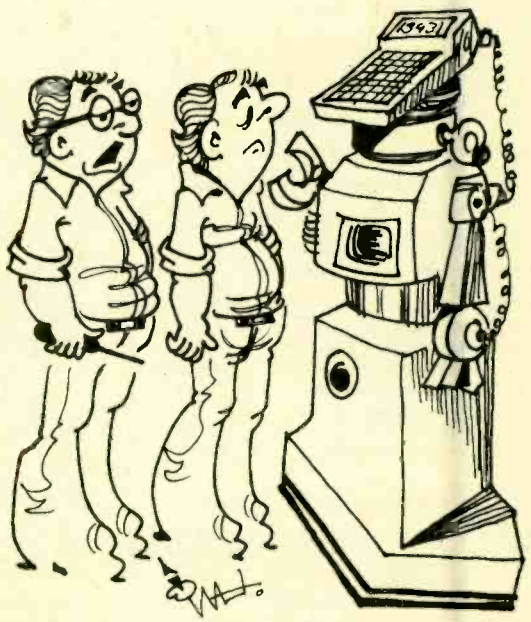
Zenith-Bose Color TV Model ZB2794BG (O'Brian and Scaduto)(G) May 10

"I have a logic probe—I'm looking for an 'illogic probe' for things that don't make sense"



"To be honest, it started out to be a pocket calculator—but it sort of got out of hand"

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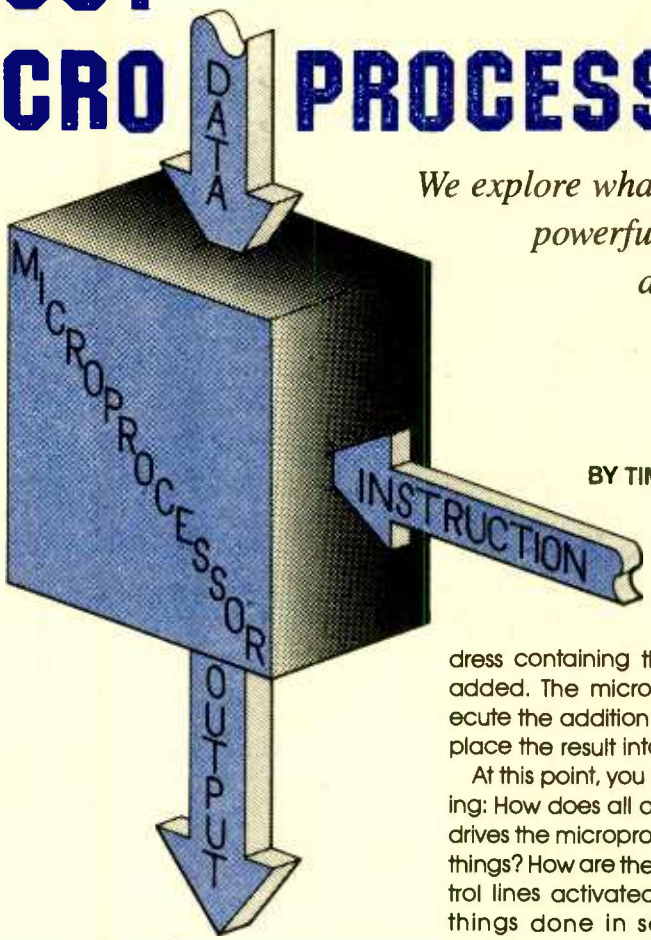
ALL ABOUT MICROPROCESSORS



We explore what makes these powerful chips tick in an informative but intuitive style.

BY TIMOTHY D. GREEN

The most common complaint I hear from old-world hams and technicians about microprocessors is that there is no convenient way to visualize how they work. They make that assumption because most books treat microprocessors as black boxes. They ask the user to memorize what a given microprocessor does rather than try to explain how the microprocessor works. Few introductory books, if any, give the user a way to visualize and understand how a microprocessor works.

The lack of information is due in part to the fact that microprocessors are internally complex devices that require the user to juggle many facts about their hardware and software. However, although they are "messy" to use in practice, they are built out of simple logic devices and can be easily explained in a block-diagram fashion.

In this article, we will break-down the microprocessor into simple logic building blocks such as counters, latches, and read-only-memories. That will make it easier to show you how and why a microprocessor works. However, for the sake of brevity it will be assumed that you more or less know what those building blocks do.

A Microprocessor System. Figure 1 shows a small microprocessor system. The microprocessor can get its program instructions from the Read-Only Memory (ROM). It can get data from or place data in the Random-Access Memory (RAM), and it might get or send data through the ports. The control-lines, "read," "write," "input/output," and "memory" go to the ROM, RAM, and input/output ports as shown.

The microprocessor directs the ROM, RAM, and the ports with its control and address lines according to the microprocessor's internal controls and according to the instructions it receives. The ROM, RAM, and ports are enslaved through the control- and address-line signals that come from the microprocessor. Each of these devices are given unique address codes. As far as the microprocessor is concerned, the sole function of each device is to send data to or accept data from the microprocessor on the data-bus lines when it is selected by the microprocessor.

For example, assume that the microprocessor is about to execute an "add to memory" instruction. This instruction consists of the "ADD" instruction code and two halves of a 16-bit address in RAM. The microprocessor will get the instruction code by setting the address lines to the address of the "ADD" instruction in ROM and activating the "read" and "memory" control-lines. This will select the ROM and allow the instruction code to fill the data bus so that the microprocessor can read the ADD instruction. Then the microprocessor will set-up and read from the next sequential address and read the ROM two more times to get the two halves of the 16-bit RAM address containing the number to be added. The microprocessor will execute the addition just after that and place the result into memory.

At this point, you might be wondering: How does all of this occur? What drives the microprocessor to do those things? How are the address and control lines activated? How are these things done in sequence? What causes the microprocessor to get its own instructions from the ROM? How are these instructions interpreted and translated into action?

To help explain, look at the internal-view of a typical microprocessor shown in Fig. 2. It shows several registers, which the microprocessor uses to keep track of data and address information, the arithmetic-logic-unit (or ALU), which performs math and logic operations, and the internal data bus, which allows the transfer of information within the microprocessor. It also shows an instruction register tied to a "control-unit," which is the source of several control-lines. Although the control-lines shown only point in the direction of the external devices they control, every part of the microprocessor is connected to and manipulated by the control-unit.

The control-unit runs the microprocessor, sequences and commands its internal parts, and interprets and executes the instructions in full. Completely understanding exactly how the control-unit works is the key to

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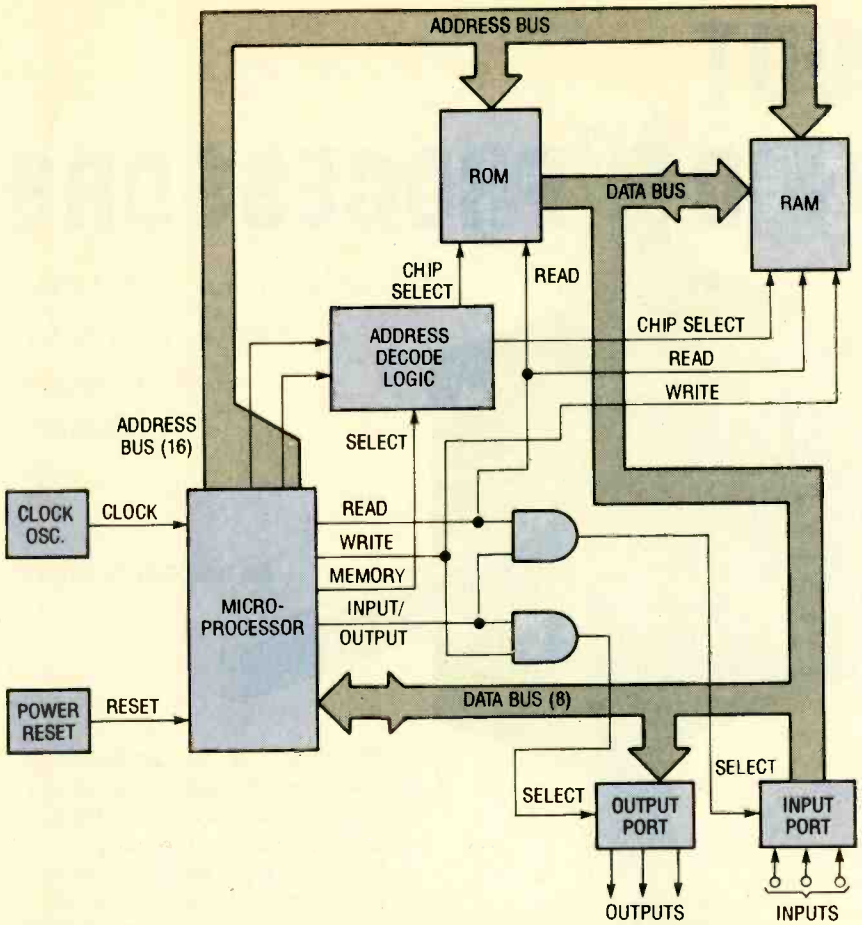

Fig. 1. In a microprocessor system, the microprocessor treats all the other system components as devices to give data to and receive data from.

understanding how and why a microprocessor works.

A Controller. The controller circuit shown in Fig. 3 is not a true control unit, but it has the feel of one and contains most of the essentials of a control unit. Ignoring the dashed portion of the circuit and the instruction latch for now, a binary counter counts clock pulses and sends its count to the address lines of a programmable ROM (PROM). The PROM looks at the address and sends the value of the data located in the address to the input of the octal latch that's connected to the control lines. That latch captures and holds this data at its outputs, thus manipulating the control lines.

Notice that the binary counter clocks on the falling-edges of the clock, while the latch clocks on the rising-edges. That is done for making clean, stable transitions in the latch-output data and for synchronization.

The latch-output lines can be used as a set to represent a number or value. They can also be used individually as controlling signals to other logic devices. For example, when used individually, these lines can drive other gates, flip-flops, counters, latches, PROM's, RAM's, and other devices.

As the counter counts, it provides new addresses to the PROM, which sends out the pre-programmed data from each requested address. One of these lines is fed back to the "clear" input of the counter as shown in Fig. 3. That allows a fixed-length process to run in a continuous loop provided the data and instructions needed for the process are stored in the PROM.

More PROM's can be added to provide more control lines, as indicated by the parts with the dashed outlines. The outputs of the counter would feed the same corresponding address lines of each new PROM.

Some Examples. Figure 4 shows a controller without an instruction latch running a data-acquisition system. The user of this system would program the PROM to select an analog channel to be sent through the analog multiplexer, start and read the analog-to-digital-converter, and latch the output data. This sequence of instructions or steps would then be repeated over and over again as part of an instruction loop. That can be done for a schedule of 100 channels, 200 channels, or any number of channels.

Figure 5 shows another such simple controller running a beacon transmitter and sending Morse code. A fixed-length, repeating message in Morse code would be programmed into the PROM with the sequence to turn on the transmitter and the keyer.

Both of the circuits in Figs. 4 and 5 could have been controlled by the microprocessor system back in Fig. 1. The ROM in the microprocessor system would just have to contain a sequence of instructions to manipulate the output-port lines, which would in turn control the external devices. Both the simple controller and the microprocessor system solve similar control problems and allow the user to program simple, arbitrary-length control sequences with great flexibility. However, the microprocessor can do mathematical and logic operations on its data as well.

The reason that a simple controller lacking an instruction latch cannot serve as the control-unit in a microprocessor is that it would only be capable of running one sequence of instructions located in the PROM. A microprocessor's control-unit must be able to run many different control sequences, therefore it must be able to accept input from the outside world to select the desired control sequence from those in the PROM. That input is received by the control-unit's instruction latch.

The Instruction Latch. To help point out the importance of the instruction latch look back at Fig. 3. Note that the binary-counter outputs only set the lowest six address lines of the PROM. That allows the counter to count out up to 64 sequence steps at a time rather than stepping through the whole PROM.

The instruction latch supplies the PROM with eight, additional, higher-address lines. The input latch and the counter, together, are used to index 256 separate sequences of up to 64 steps each. In a microprocessor, each of the 256 possible latch codes are used as instruction or operation codes. Each instruction code is a sin-

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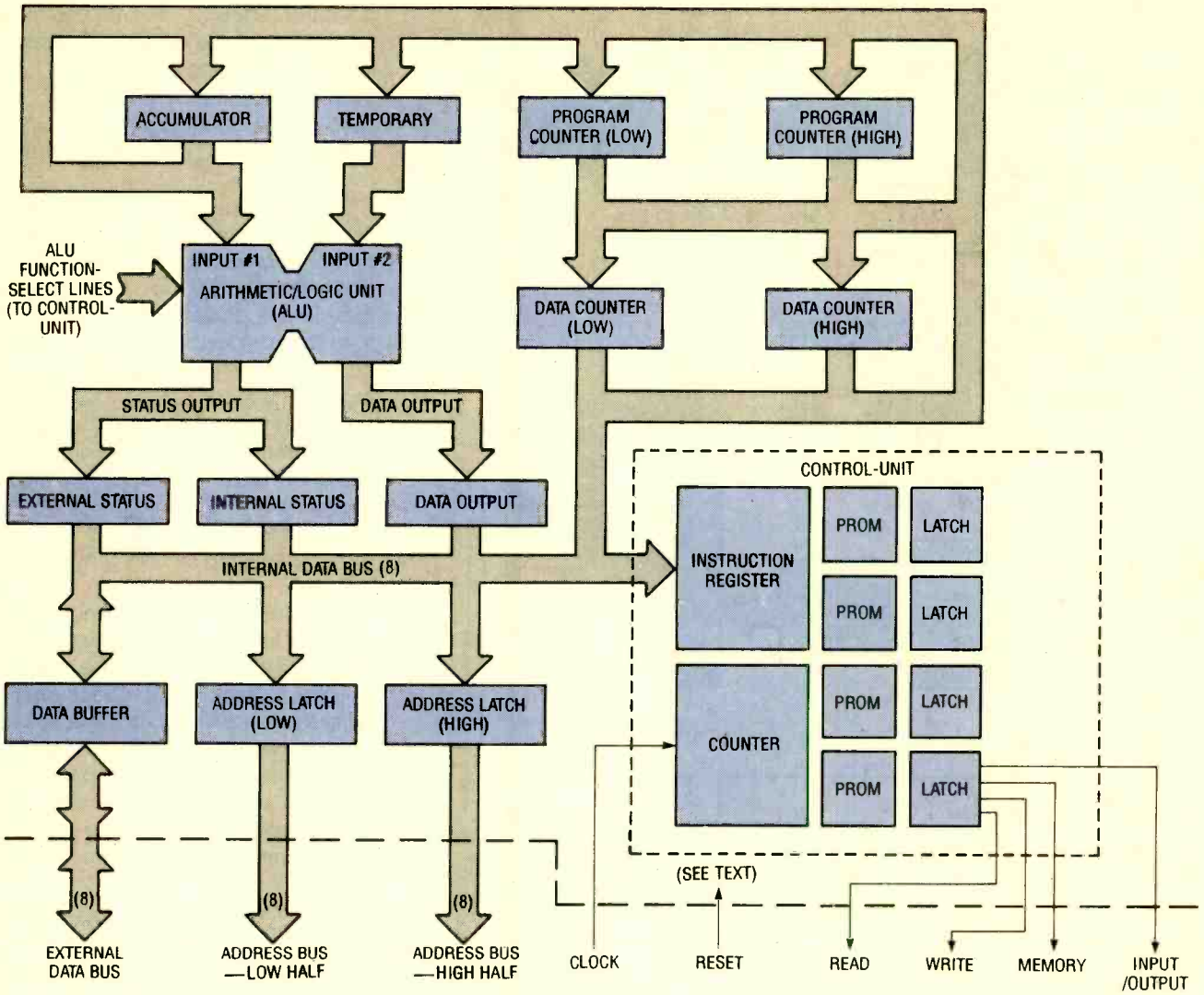

Fig. 2. The inside of a microprocessor is much like the system the microprocessor sits in; there's a data bus for communication between the components.

gle code that indexes a whole sequence of sub-operations within the microprocessor. A sub-operation may be used to manipulate the controls of a latch, a counter, or the ALU. Each sequence of sub-operations will perform one complete microprocessor operation (such as ADD).

As mentioned earlier, more PROM's may be added to the control-unit, so that the new PROM's share the same address bus as the first PROM. It is not uncommon for a microprocessor's control-unit to have more than 80 control lines (or, more than ten PROM's).

Two of the control lines from the output latches of the PROM's go to the "clear-counter" input of the counter and to the "latch" control of the instruction latch. The PROM must be programmed to activate those two lines at the same time to get a new instruction at the end of a sequence, which might be smaller than 64 steps long.

The control-unit shown in Fig. 3 must be modified in two ways to enable it to handle some special instructions and features. These will be discussed later, as they are needed.

Microprocessors vs. Controlers. The operation of a microprocessor is directly parallel to the operation of the simple controller. However, since the microprocessor itself contains a control unit, the microprocessor operates at a "higher level" than a controller. In this higher level, the microprocessor controls the external system in "indirect" instruction steps, at a lower speed than a simple controller. However, a microprocessor can perform many different operations as is, while a controler would require a PROM for each sequence that it must perform.

Back in Fig. 4 for example, we showed how a simple controller would operate a data-acquisition system "directly" from a PROM. There is a one-to-one correspondence between a PROM's latched data and the operation it performs. However, if the data-acquisition system were controlled by the microprocessor system of Fig. 1, the microprocessor system would manipulate the output-port lines to control the same devices using a series of "indirect" instructions from the ROM. There would be no one-to-one correspondence be-

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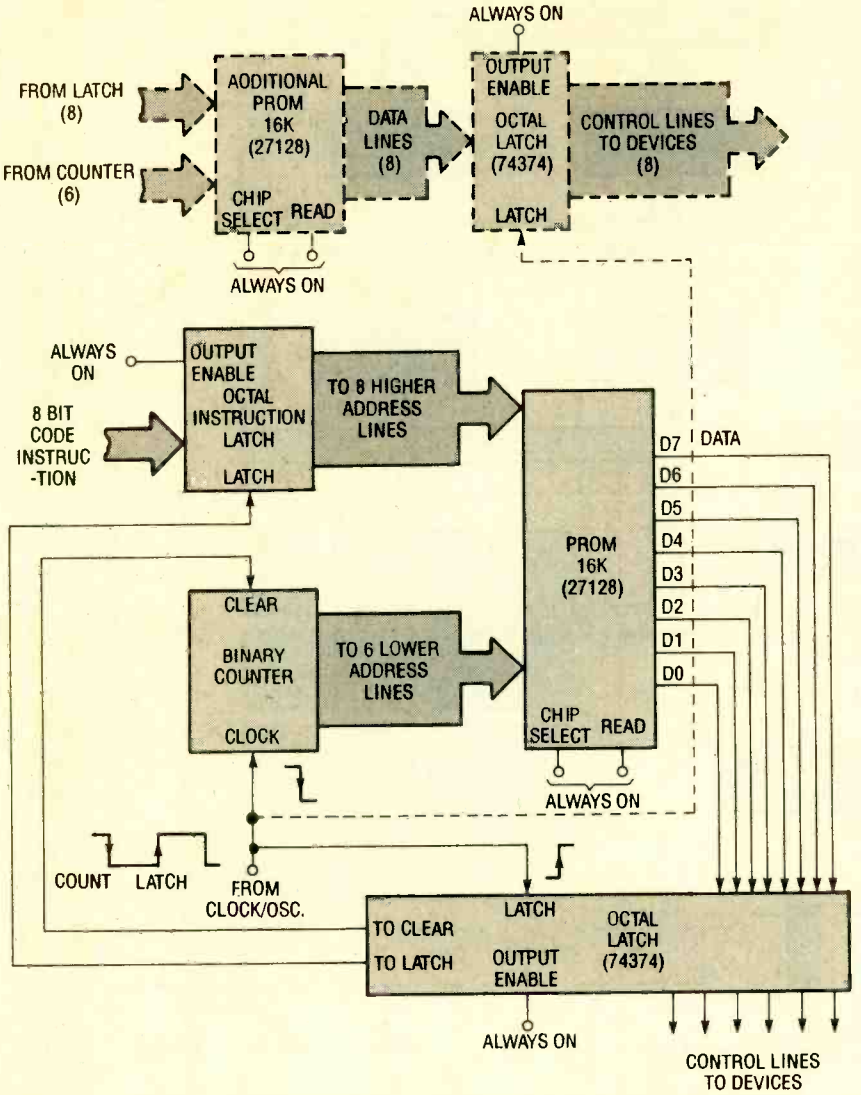

Fig. 3. The control unit is the key to how a microprocessor processes data and performs operations. There are simple descrete controllers available that lack the instruction latch shown here.

tween the instruction codes in the ROM of Fig. 1 and the controlling signals on the output-port lines.

Furthermore, the simple controllers suitable for Figs. 4 and 5 will run their control sequences exactly at the clock speed. The slowest device that these controllers control is the only thing that limits their operating speed. A microprocessor, on the other hand, will run its control-instruction sequence at a lower speed than the clock speed. That is because the microprocessor must run a few sub-operations at the clock speed for each control operation it must perform.

Another key difference is that if the simple controller had a lot of devices to control, it would need several PROM's. However, the microprocessor needs only one PROM for its instructions since the instructions are decoded by the microprocessor's control-unit.

To summarize, although the microprocessor does its controlling "indirectly" and more slowly than the simple controller, it uses a fixed set of instructions which are easily coded into a single PROM. In general, a microprocessor is a compromised controller. Instead of building a separate and complete control-unit to perform each complex task, a microprocessor is used to perform each task with a sequence of instructions selected from a fixed set of instructions. The complete freedom that comes with using a control-unit is traded for the restricted freedom of using a given microprocessor's structure and instruction set.

A Simple Microprocessor. Looking back at Fig. 2 as a guide, let's discuss the intended functions of each of the microprocessor sub-components. A detailed explanation of these sub-components is essential for programming the control-unit.

The microprocessor's internal, eight-line data bus connects the outputs of each register to its own input and to the inputs of the other registers to allow data to be transferred to and from the registers, the ALU, the data buffer, and the address latches. Any register, latch, or device that sends data onto the internal data bus must have three-state (low/high/high-impedance) logic outputs so that it can "disconnect" itself from the bus when it is not needed, as only one device may place data on the bus at any one time.

Each register in Fig. 2, including both the low and high halves of the program-counter and the data-counter, is an octal latch. Each register, or latch, has two control lines to be connected to the control-unit's output latches: one to "latch" or capture the data at the inputs and the other to "three-state" its outputs. The "three-state" control is also called the "output enable."

The arithmetic/logic unit (ALU) performs such operations as addition, subtraction, incrementing, decrementing, and logical operations on the data present at its inputs. The selection of each operation and which input or inputs to operate on is made by giving a binary code to the ALU's control lines. These control lines are, of course, connected to the control-unit.

The ALU can accept data from the temporary register and any other register except the instruction register. The temporary register is used as a temporary holding place for ALU input data.

The accumulator register is used only for the programmer's data. The control-unit must not disturb its contents unless an instruction tells it to do so.

The ALU has outputs for data results and the "status" of the results. The data-output register is a temporary holding place for the results of the ALU's operations. The ALU's status information indicates whether or not there was a bit carried during addition,

(Continued on page 93)

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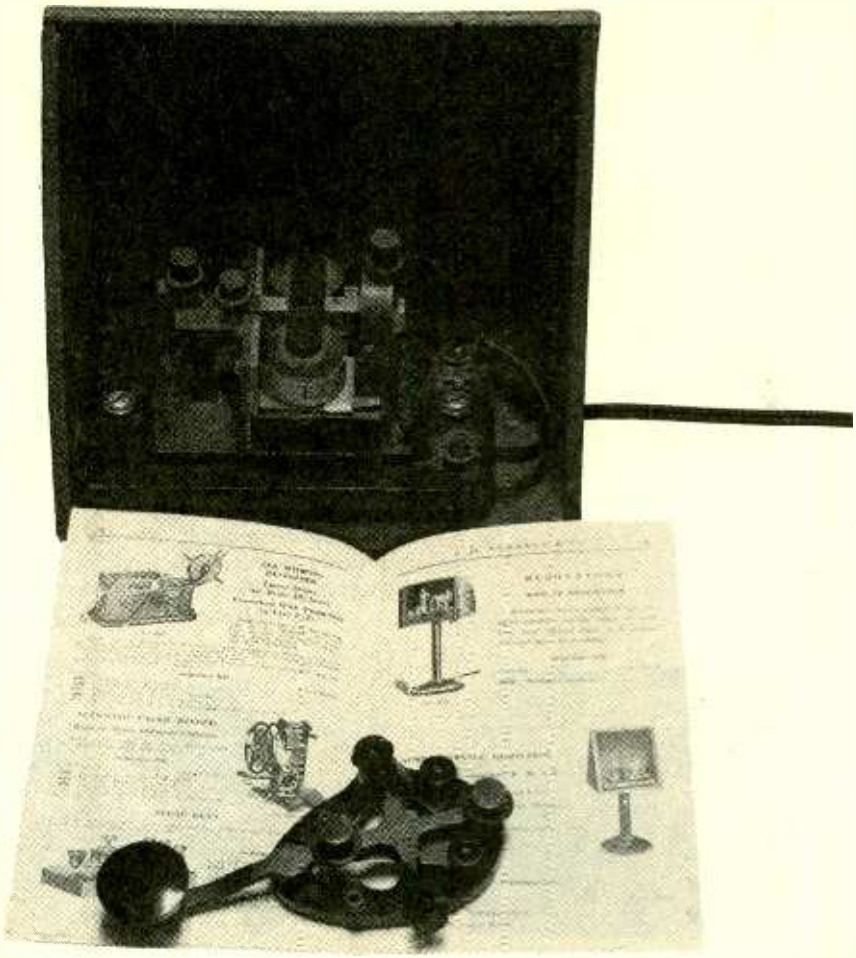

THE CODE MAKERS

Trace the history of code and code-sending gear from its earliest days to today's computerized equipment.

BY LARRY LISLE, K9KZT

Nearly everyone knows that the ability to send messages from one place to another in the form of an electrical code has been around for about 150 years. But relatively few realize that the instruments, and even the code itself, have undergone many changes in that time. In this article I'd like to take a look at some of the devices that opened the age of electrical communication, and then trace the development of the Morse code and code-sending devices to the present time.

The First Telegraph. Samuel Morse didn't use either a key or a letter code for his first telegraph. Instead he used a "portrule," a number code and a "register." The portrule was a wooden stick with a groove designed to hold small lead blocks. (Similar devices were used in printing.) Each of the lead blocks had protrusions arranged to represent the numbers zero through nine. In use, the portrule was pulled past an electrical contact and the protrusions closed the circuit in a sequence corresponding to the number.

At the receiving end, a strip of paper was automatically inscribed by the register with marks corresponding to the protrusions and numbers. An operator would then look up the numbers in a code book and write down the appropriate letter, word, or phrase. There are a few holdovers of that system still in use—the familiar "73" or "best regards" of ham operators and the "30" used to mark the end of newspaper and wire-service stories are two examples of that.

The system worked—but slowly. Unlike others who were experimenting with electrical telegraphs at the time, Morse didn't stop inventing when he had a system that barely functioned. With the help of his assistant and partner, Alfred Vail, Morse improved his telegraph until it was simple, reliable, and convenient to use. The portrule and number code were the first to go.

Enter the Telegraph Key. The first telegraph key was a strip of brass fastened to a block of wood and a wire at one end, and bent upwards at an angle over a contact at the other. Pushing down on a knob at the free end of the strip closed the circuit.

The key used by Morse in his 1844 demonstration between Washington and Baltimore was more elaborate, with a pivoting wooden lever and screw adjustments. Conventional or "straight" keys have changed very little since then.

Morse and Vail also dropped the number and code-book idea. After several false starts, they came up with the system of dots and dashes for letters, numbers, and punctuation that became known as the American Morse Code. In 1851 the code was modified in Europe and called the Continental or International Morse Code. That is the version of the code that was adopted for used when wireless (radio) telegraphy was developed.

As operators became more experienced, it was found they could understand the sound of the register as easily as they could the marks on the moving strip of paper. That led to the invention of the "sounder" by Vail in the early 1850's. The sounder consisted of an electromagnet and a lightweight, movable arm that clicked when the current flowed and the circuit was closed, and clicked again

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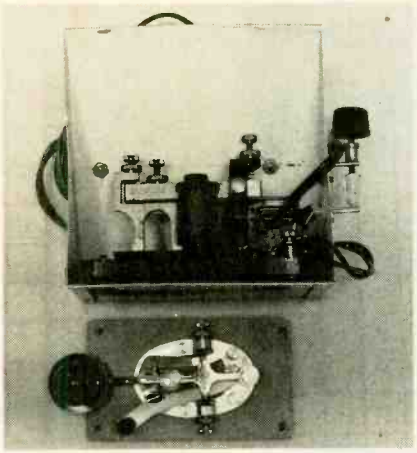
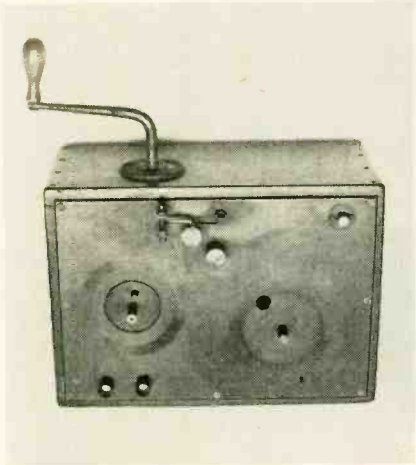


A Signal Electric key and sounder in a homemade metal resonator.

An Instructograph AC-powered code-practice machine. This model had a built-in oscillator. The knobs were used to control volume and speed.



A spring-powered Morse-code sending machine. A perforated paper tape was pulled past the electrical contact and operated a sounder hooked to the binding posts. The speed control is located at the opposite corner.

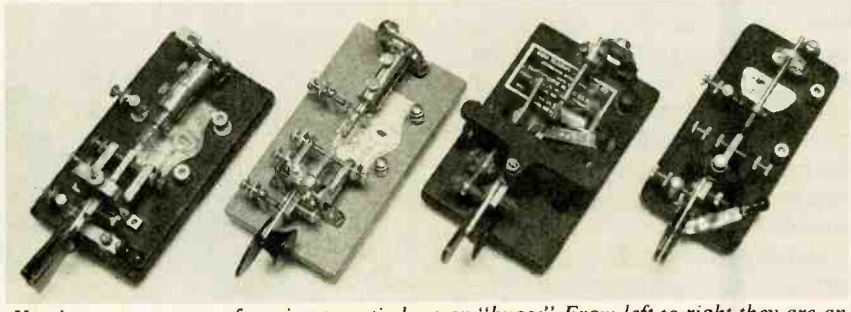
when the current was turned off. A short interval between the clicks was a dot; a long interval was a dash.

Trying to copy a sounder in a noisy office could be difficult, especially if there were several other sounders going at the same time. The usual practice was to mount the sounder in a wooden or sheet-metal box, open on one side, which was called a resonator. That made the clicking seem louder and gave each sounder a distinctive tone.

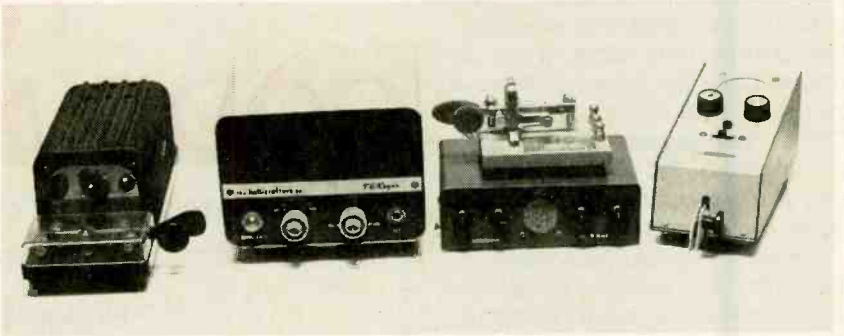
Learning the code in the wire-telegraph days usually meant hanging around the telegraph office and doing odd jobs. During the slack periods, the operator might then be persuaded to teach the code on a practice set. Another way, if you could afford it, was to rent a code-sending machine. These devices used a paper tape punched with holes to represent the dots and dashes of the code. A spring-wound motor pulled the tape past a contact, which operated a sounder. When wireless came in, a buzzer was substituted for the sounder. These machines could be adjusted for whatever speed you wanted—something not always possible when a live operator was doing the sending!

As more and more homes were wired for electricity, code-practice machines were built to run with electric motors, and later ones had built-in code oscillators. Incidentally, should you pick up one of these old devices from a flea market, etc., be very careful. Some were built to poor standards of safety, and even in the better ones the insulation may have deteriorated. If the earphones, key, or cabinet is connected directly to the power line, you might receive a deadly shock.

Improved Sending Devices. Sending high-speed messages for hours at a time with a straight key could be very tiring. Many operators had their careers cut short by a condition called a "glass arm." That was caused by the constant switching of opposing sets of muscles in the forearm from full on to full off and back again.



Here's an assortment of semi-automatic keys or "bugs:" From left to right they are an old and new Vibroplex, a McElroy, and a Johnson Speed-X.



An assortment of electronic keyers: From left to right they are A Mon-Key (the first electronic keyer), the "TO" by Hallicrafters, and models made by Hammarlund and Heath. A "Vibro-keyer" bug sits on top of the Hammarlund unit.

The earliest remedy was the "double-speed key" also known as the "double-action key" or more commonly, the "sideswiper." The sideswiper key moves from side to side instead of up and down. There are contacts on either side and the operator holds the key against one of them longer for dashes than for dots.

(Continued on page 89)

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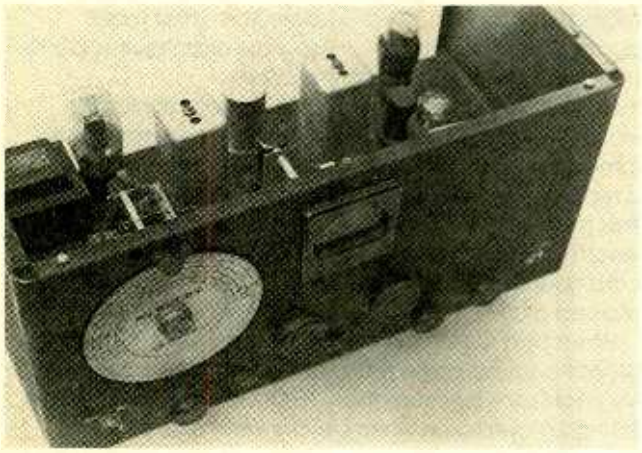
ANTIQUE RADIO

By Marc Ellis

The Sky Buddy: All Together Again!

Last month, we began reassembling our *Sky Buddy model S-19R* receiver, which had been partly dismantled for cleaning and dial-cord restringing. In this column, we'll be completing the job and testing the set for operation. For those who have just joined us, the Sky Buddy was Hallicrafters' "low-end" shortwave receiver during the late 1930's. As such, it was quite a popular starter set for shortwave listeners and newly-licensed hams.



The front view of the Sky Buddy—all together again and ready to try out.

This series of articles began in the May, 1992 issue, with a discussion of the Sky Buddy's history. Restoration work started the following month, and has been continuing at intervals ever since.

THE DIAL CORD HASSLE

Last month's column chronicled the disassembly, cleaning, reassembly, and reinstallation of the subchassis containing the main tuning/bandspread capacitor and associated drive pulleys. In the process, both the main tuning and bandspread control drives were restrung with new cord. And that cord had better last quite a long time! There's no way to restring those controls without disconnecting the subchassis (an arduous job indeed) and removing it from the main chassis.

The removal (not to mention the subsequent reinstallation) was almost as difficult as the disconnection. The subchassis is virtually locked in place by the radio's front panel, which must have been installed after the subchassis was. And the front panel is not now removable because it was fastened to the main chassis by some type of a spot-welding process.

Taking out the subchassis with the front panel in place requires a bit of ingenuity and a bit of forcing, as I described in last month's column. And if anyone out there in reader-land has figured a method for restringing the Sky Buddy's dial cords without going through this exercise, I'd certainly like to hear about it!

THE LOUDSPEAKER HASSLE

With the tuning subassembly back in place, the only major component still to be installed was the loudspeaker. That took a little longer than necessary because of uncertainties about the lead connections. And while I can probably blame the Hallicrafters design engineers for the previously described hassle, I can blame only myself for the difficulty I had with the speaker. The moral: Take the time to make good clear notes when disconnecting wiring.

The speaker in the S-19R has six leads: two to the field coil (which also serves as the power-supply filter choke), two to the primary of the output transformer (which is mounted on the speaker frame), and two from the voice-coil circuit to the closed-circuit headphone jack (which mutes the speaker when phones are plugged in).

In a hurry to get on with the restoration work, I had made only a few rough sketches to indicate where those leads were connected. When reinstallation time rolled around, I found that I hadn't adequately differentiated between a pair of terminal lugs where a couple of the wires were to be connected. (I'd carefully marked one "top" and one "bottom," but now I wasn't sure whether "top" referred to the terminal that would be uppermost with the set in operating position or to the terminal that was uppermost with the chassis upside down for servicing.)

I had also indicated the wrong tube socket as the connection point for a third lead. And just to add to the complication, the color coding on the grimy and time-faded wires no longer seemed as clear to me as it did when I removed them.

"Big deal," you may think. "Ellis has a schematic of the set. What's so hard about finding the connection points for six speaker leads?" In actuality, however, that was more of a problem than it seemed. Set designers of the era

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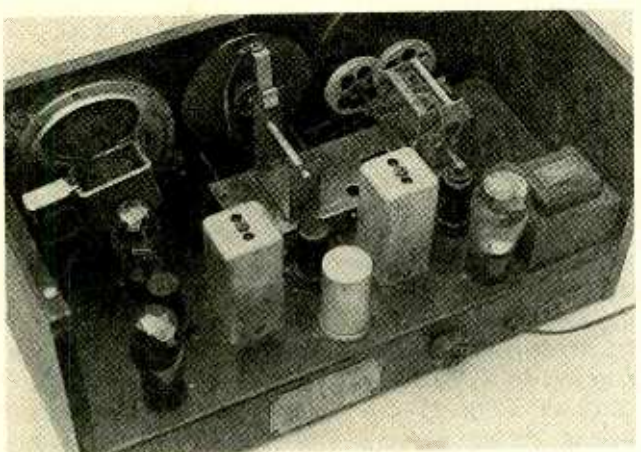
were not as concerned about keeping interconnecting leads short as they were about cabling them neatly together. So I found myself attempting to trace circuit pathways from one side of the chassis to the other via wires obscurely bundled up in harnesses.

The confusion I created for myself extended what should have been a 10-minute job into one that lasted for more than an hour. So don't make the mistake I did! Take the time to sketch accurate diagrams showing the locations of all the connections that you remove. In the long run, that will *save* you time and possibly even prevent you from damaging irreplaceable parts by wiring them incorrectly.



The newly reassembled Sky Buddy as seen from the rear. The tuning control subchassis (behind the IF cans) was a bear to get back in!

ECHOES OF WWII

I have to admit, though, that being forced to rummage around tracing wires did have its up-side! I accidentally discovered that one of the wires from the oscillator coil to the bandswitch had been neatly severed, effectively disabling band 2 (1.7–5.5 MHz). It would have otherwise taken me quite a bit of time to find that problem because the wire was cut so cleanly and so close to the switch terminal that it didn't look disconnected.

I ran into a similar problem with an Echophone set that I restored on these pages a few years ago and I know why, in all likelihood, those wires were cut. During World War II, in a security-related move to restrict shortwave listening, our government apparently encouraged radio service shops to disable certain shortwave bands on sets that were brought in for repair.

I've heard of cases where the zealous service man crushed the shortwave coils, damaging them beyond all hope of repair. Luckily this radio (and the Echophone) were disabled in far gentler fashion, so that all functions could easily be restored after the war. But I doubt that either of the folks who cut those wires would have imagined that half a century would pass before the severed connections were found and soldered back in place!

In one of the Echophone articles, I invited readers who might know something about those wartime government guidelines for disabling shortwave sets to write and enlighten us. No one responded back then, but perhaps someone will now. If you have information about this issue, how about contacting me? I'll be delighted to print your recollections in this column.

FINAL ASSEMBLY AND TEST

After cleaning and reinstalling the knobs, tuning dial, and dial pointer, all I had left to do before the S-19R could be tried out was to add a line cord. The old one, dangerously cracked and deteriorated, had been removed early in the restoration project.

I wish I could tell you that I'd been able to dig up a perfect period replacement for the cord, but I'm not even sure what the original looked like. The clumsy solder joints and shreds of previous wiring at the set's cord connections indicated that the deteriorated cord had itself been a replacement. So I satisfied myself by installing a length of modern black zip-cord having an innocuous molded plug.

When I first turned the set on, not a sound came forth. My heart sank because the set had played a bit when I tried it out prior to disassembly. I figured that I must have messed up the speaker wiring after all, perhaps burning out the unit in the process. Then I realized that the problem could just as well be dirty contacts on the phone jack's speaker-muting switch.

That hunch was correct, since shorting out the switch with a clip lead immediately brought the Sky Buddy back to life. I could hear activity on all bands and, since I was hooked up to a good antenna, I even pulled in several foreign shortwave stations.

Performance was lackluster, however, particularly on the broadcast band—where I definitely was not receiving the full complement of local stations. The tuning in that band also seemed a little broad, and signals were weak. A bad IF stage maybe? Only further testing will tell!

READER COMMENTS

Now that the Sky Buddy restoration has been running for a while, some reader comments have started to come in, and I have room for a couple of the letters here. To start off, I was pleased to receive a note from Alan Douglas, author of the very important three-volume reference set, *Radio Manufacturers of the 1920's* (published by Vestal Press, Vestal, NY, and available from most major sources of antique-radio literature).

In his communication (which was typed on a reproduction of Atwater Kent Manufacturing Works stationary dating from the early 1900's!), Alan pointed out that the yellow deposit I had reported cleaning from the S-19R's IF transformers and other metal parts (October, 1992 issue) could very well have been a compound of cadmium. Cadmium plating of steel parts, he went on to point out, began about 1930 and has been common ever since.

Cadmium plating normally has a bright metallic look, but after long-term exposure to the atmosphere, cadmium oxide (brown) and/or cadmium sulfide (yellow) deposits can form on the surface. When cleaning off such deposits during restoration projects, extreme caution should be used because cadmium is a poisonous substance and inhaling its dust can be quite dangerous.

Many thanks to Alan for

(Continued on page 91)

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COMPUTER BITS

By Jeff Holtzman

The XT Syndrome

In past columns, I have recommended buying as much computing muscle as you can possibly afford. However, in a letter that I recently received, reader T. G. chides me for being too *gung-ho* with those recommendations. Perhaps he is right. It is possible to get by with less. But getting by is not the issue. I don't recommend purchasing powerful computers for the sake of ownership. I'm not advocating some high-tech form of conspicuous consumption. My reason is simple: It takes a lot of power to deal with what I'll call "rich data."

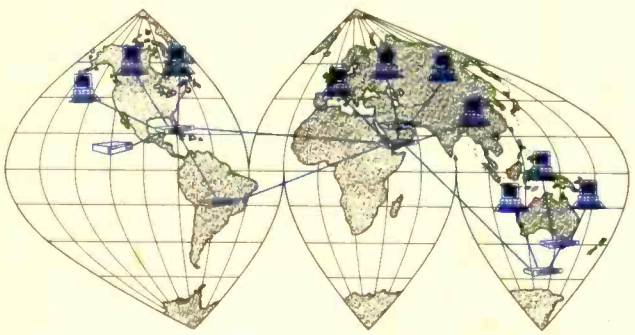

Fig. 1. In just a few years, all-digital global communications networks and high-powered personal computers will totally dwarf the already tremendous changes of the past 30 years in the fields of communications, consumer electronics, computers, and entertainment.

RICH DATA

Computer users who have never used a Macintosh, an Amiga, a NeXT station, a workstation running Motif or Open Look, or a plain old PC running Windows may have trouble imagining computer screens displaying anything but 80 × 25 screens of text. Consequently, that type of user has trouble imagining why anyone would want to. And because said user has undoubtedly paid significant dues in mastering a program or two (DOS WordPerfect or 1-2-3, for example), he or she resists change in direct proportion to the effort expended in paying those dues—not to mention the status earned thereby.

There's a significant problem with that world view. It assumes that computers are here simply to improve the efficiency of common procedures—such as writing letters to the editor. Of course they do that, but they also open up a whole new world of experience that has no analog in past experience. Think about video games. Think about the kind of show that you get at a good planetarium. Think about the effects that you see in movies like Roger Rabbit and Terminator 2. Think about what composers like Todd Rundgren and Philip Glass are doing. Think about fractal graphics. Think about desktop publishing (which didn't exist ten years ago). Think about desktop-video production (coming in a big way in the next few years).

Those phenomena have one thing in common: They're all built around rich data: gobs of formatted text, high-resolution true-color graphics, animation, recorded and synthesized sound, and full-motion video. Like it or not, rich data is here to stay. The "MTV generation" simply demands it.

Those demands are tearing down the wall that's dividing education and entertainment. Some use the term "infotainment" to describe these rich new forms of information.

A DIGITAL WORLD

We're already living in a digital world; it's only going to become more so. Technologies including High Definition Television (HDTV) and ISDN are going to make a big difference during the next decade. You may have heard of ISDN. Officially, the acronym stands for Integrated Services Digital Network, but due to interminable delays, wags have for years supplied alternate expansions: e.g., *I*t *S*till *D*oes *N*othing.

However, that is changing. Some analysts think that ISDN will be available to more than 50% of telephone subscribers by the end of 1993—little more than a year from now. We'll have to buy new phones, and they'll be expensive at first. But we'll be able to throw away our modems, install a cheap digital port (somewhat like an RS-232 card), and get 27 times better performance than a 2400 bps modem. We'll also get videophones, cheap. Talk to Grandma during the holidays, let her see the kids.

We're going to need even greater bandwidth than ISDN can provide to purchase and download videos on demand. Pilot sites on both coasts already provide that type of service. In the business environment, presentations have evolved rapidly over the past few years to include fancier and fancier graphical elements. That trend is likely to continue by adding sound, simple animations (e.g.,

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projected sales growth), and video clips. Clearly, that environment demands powerful computers to accomplish anything beyond mindless data entry.

Factories need to collect data, predict and schedule maintenance activities, and alert management to inventory and manufacturing problems. Workers need on-demand video training. A 30-second video (available instantaneously across the network) detailing a complex assembly procedure is infinitely more effective than five pages of dense prose and static diagrams. Imagine receiving a VHS tape or interactive CD-ROM instead of printed assembly instructions when buying your child's (or grandchild's) next bike.

Schools have unique needs that far exceed the capabilities of the Apple II's and C64's that once promised salvation.

TEACHER'S PEST

Reader T. G. mentions "many middle-aged school teachers. . . who only want to write letters and perhaps look at CompuServe," and then goes on to imply that they don't need big 486's with lots of RAM and hard disk space. That's probably true.

It is also regrettable. It is regrettable both for the teachers themselves and for our society. I have several school-age children, and frankly I don't want them to have those kinds of teachers. I want my kids to be taught by war-scarred veterans who've been tried by fire, who've lived to tell about it, and who are eager for more. I want my kids to experience, first-hand, the new possibilities that these technologies are opening up. I want my kids to experience the frustrations and the joys of using these tools. It's good training, both professionally and personally.

That "middle-aged school teacher" type of complacency is on the way out. Businesses like GM, IBM, Digital, and countless others are trimming the fat. Companies large and small are releasing those who never showed enough initiative to learn new things, to reinvent themselves, to improve their worth to the company. I only wonder how they'll get new jobs when their skills are five, ten, and even twenty years old.

Nonetheless, education will follow, and soon. If the public institutions don't get with the program, expect greater and greater numbers of private institutions to take over. Washington is already talking about education credits that can be applied to both public and private schools.

The U.S. has supported a "secure," complacent way of life for the past 60 or so years. However, that ostrich attitude has come back to haunt us. The old ways were good enough, so we didn't modernize our steel plants, our semiconductor fabrication, or our educational systems. Now we're paying the price. We didn't modernize, so the Pacific Rim countries surged ahead.

The solution is not to try to regain dominance in particular industries. The world is much too complex for that. But that's a topic for another time. For now, don't let anyone fool you. The world is going digital. Everything will be available in digital form. You need lots of computer power to retrieve, create, and manipulate rich data.

It's scary, and it's hard. But even the smallest successes are satisfying. And a big success will let you leave your mark on the world. ■

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CIRCUIT CIRCUS

By Charles D. Rakes

UJT Circuits

This visit, we are featuring several circuits built around the unijunction transistor (or UJT as it is commonly called). The UJT is a two-layer, three-terminal PN device that has two bases (B1 and B2) and a single emitter (known as the gate). If you're relatively new to electronics or just haven't crossed paths with the UJT, then the following circuits just may spark an interest in using this device in some future circuit or project.

RELAXATION OSCILLATOR

Figure 1 shows a UJT configured as a relaxation oscillator. In that circuit, the positive supply voltage is connected to B2, while the negative side of the supply is connected to B1. The emitter terminal is connected to the junction formed by timing capacitor C1 and potentiometer R4; R4 ties the emitter to the positive-supply rail. When the emitter voltage is below the trigger level of the UJT, the impedance between its emitter and B1 is very high. But when the emitter voltage rises to the trigger level, the impedance between the emitter and B1 drops dramatically.

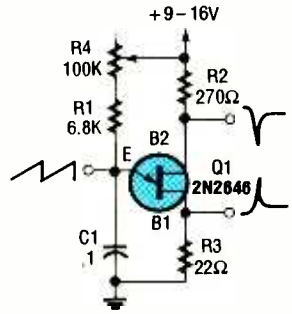

Fig. 1. In the relaxation oscillator, B2 is connected to the positive supply rail through R2, while B1 is connected to the negative side of the supply, and its emitter terminal (commonly known as the gate) is connected to the junction formed by timing capacitor C1 and potentiometer R4 (which ties the emitter to the positive-supply rail).

At the instant that power is applied to the circuit, the voltage across C1 is near ground. As time passes, the voltage across C1 rises. When the charge on C1 reaches the UJT's trigger level, Q1 turns on, discharging C1's stored energy into B1's negative-return resistor, R3, producing a fast-rising pulse at B1. At the same instant, the resistance between B2 and ground is lowered, causing a similar but opposite (negative) pulse at B2. After C1 has discharged, the cycle starts over.

The basic UJT circuit in Fig. 1 can supply output signals for a number of applications. It may be used as a clock generator, a timer circuit, a sawtooth generator, or a positive- or negative-pulse generator.

MODIFIED RELAXATION OSCILLATOR

Our second UJT circuit, shown in Fig. 2, is a slightly modified version of the basic relaxation circuit shown in Fig. 1. A small 8- or 16-ohm speaker replaces B1's ground return resistor (R3), while a three-position switch (S1) and three capacitors (C1–C3) replace C1 in Fig. 1. The switch/capacitor combination is used to set the oscillator to operate in one of the three

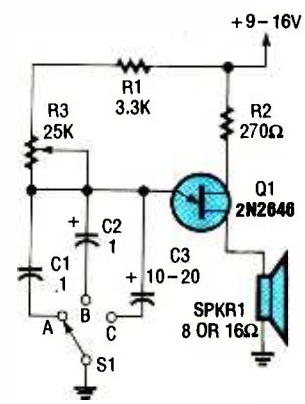

Fig. 2. In the modified relaxation oscillator, an 8- or 16-ohm speaker replaces R3, while a three-position switch (S1) and three capacitors (C1–C3) replace C1.

PARTS LIST FOR THE RELAXATION OSCILLATOR

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—6800-ohm
R2—270-ohm
R3—22-ohm
R4—100,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
C1—0.1-µF, ceramic-disc capacitor
Q1—2N2646 or similar unijunction transistor
Perfboard materials, enclosure, 9–16-volt power source, wire, solder, hardware, etc.

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PARTS LIST FOR THE MODIFIED RELAXATION OSCILLATOR

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—3300-ohm
R2—270-ohm
R3—25,000-ohm potentiometer

CAPACITORS
C1—0.1-µF, ceramic-disc
C2—1-µF, 25-WVDC, electrolytic
C3—10–20-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
Q1—2N2646 or similar unijunction transistor
S1—SP3T switch
SPKR1—8- or 16-ohm speaker
Perfboard materials, enclosure, 9–16-volt power source, wire, solder, hardware, etc.

frequency ranges offered by this circuit. That switch/capacitor combination serves as a coarse frequency adjust. Fine-frequency adjustments for this circuit are made via R3, a 25k potentiometer.

When S1 is in either the A or B position, the circuit functions as a variable, audio-frequency oscillator. When S1 is placed in the C position, the circuit operates as a metronome. The circuit's frequency of operation can be reduced by increasing the values of either C3 or R3.

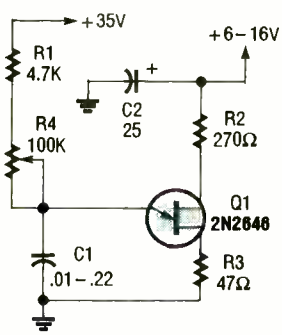

Fig. 3. Linearity in this version of the relaxation oscillator has been improved by adding a separate charging source. By using a higher source voltage to charge the timing capacitor, the entire sawtooth waveform period occurs during a smaller percentage of the total charging voltage.

IMPROVED-LINEARITY RELAXATION OSCILLATOR

Our next UJT entry, see Fig. 3, takes the basic Fig. 1 circuit a bit further—adding a separate charging source to improve output waveform linearity. In any RC charging circuit that's not driven by a constant-current source, linearity is always better at the beginning and deteriorates as charging progresses.

By using a higher source voltage, the timing capacitor charges more rapidly, thereby improving the linearity of the output sawtooth waveform. The higher voltage won't damage the UJT because the voltage at the emitter never exceeds the UJT's trigger voltage, which is always less than the operating voltage applied to B2.

PARTS LIST FOR THE IMPROVED-LINEARITY RELAXATION OSCILLATOR

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—4700-ohm
R2—270-ohm
R3—47-ohm
R4—100,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
Q1—2N2646 or similar unijunction transistor
C1—0.01–0.22-µF, ceramic-disc capacitor
C2—25-µF, 25-WVDC, electrolytic capacitor
Perfboard materials, enclosure, 6–16-volt and 35-volt power sources, wire, solder, hardware, etc.

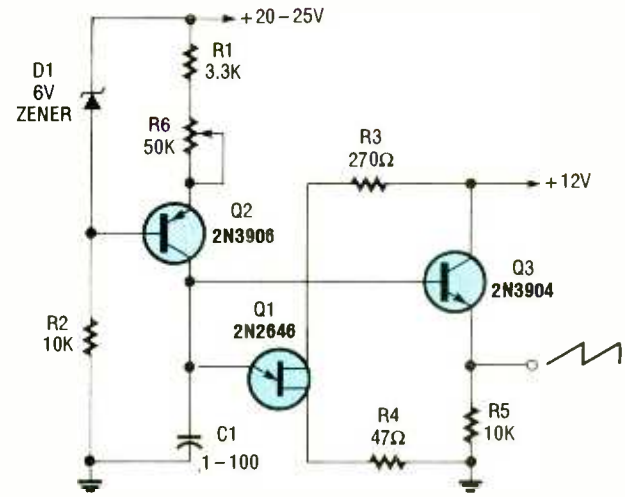

Fig. 4. In addition to the constant-current charging source used in the previous circuit, this one throws a buffer stage into the game, allowing the circuit to drive low-impedance loads.

PARTS LIST FOR THE CONSTANT-CURRENT RELAXATION OSCILLATOR

SEMICONDUCTORS
Q1—2N2646 or similar unijunction transistor
Q2—2N3906 general-purpose PNP silicon transistor
Q3—2N3904 general-purpose NPN silicon transistor
D1—6-volt, ½-watt Zener diode

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—3300-ohm
R2—10,000-ohm
R3—270-ohm
R4—47-ohm
R5—10,000-ohm
R6—50,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
C1—0.01–100-µF, see text
Perfboard materials, enclosure, 12- and 20–25-volt power sources, wire, solder, hardware, etc.

CONSTANT-CURRENT RELAXATION OSCILLATOR

The circuit in Fig. 4 adds a constant-current charging source and a buffer stage to the basic UJT circuit in Fig. 1. In the Fig. 4 circuit, Q2, D1, R1, and R6 form a simple constant-current regulator. The level of regulated current is set by the values of R1 and R6. Transistor Q2's collector supplies the constant charging current to C1, whose value is selected for the desired frequency range. The value of C1 can range from .005 to

(Continued on page 90)

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THINK TANK

By John J. Yacono

RF Bulbs

The topic for this month, about a new light-bulb technology, was inspired by a letter that I'll present shortly. It just goes to show you there will always be a better "mouse trap" waiting to be invented. Perhaps we should re-think the wheel?

After we discuss the functioning and features of the new light, we'll explore a general mix of correspondence, including the "simplest, simplest" headlight reminder, a request from one reader answered by yet another, and advice about circuits that have appeared here before. Now let's discuss this new light under the sun.

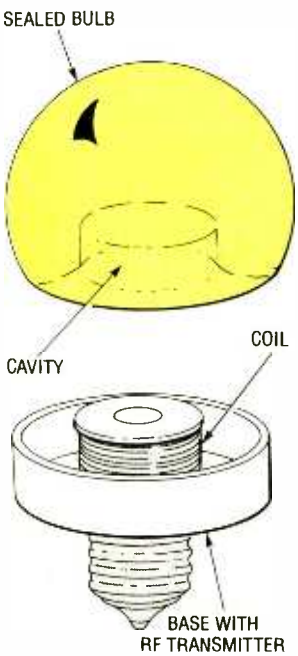

Fig. 1. The small coil transfers RF energy from the transmitter in the base to the gas in the bulb.

A BRIGHT IDEA

Just yesterday, I saw an interesting new product on TV. It was a "radio" light bulb. The globe of the bulb was removed (apparently it wasn't hot) during the show to reveal a thread-spool-like inductor made from heavy-gauge wire (see Fig. 1). I would like to know how this device works and would appreciate any help on this.

—*Loyd J. Crisp, Metairie, LA*

I'd be glad to pass along what I know about the new bulbs. However, it is important to point out that these bulbs are in the prototype stage and may never be commercially available. As to the bulb, it consists of an RF transmitter (located in the unit's base) and a sealed bulb of gas with an internal fluorescent coating. The sealed bulb has a depression on one side (kind of like a finger-hole in a bowling ball) to accommodate an inductor on a cylindrical form that protrudes from the base, as you mentioned. The coil couples the RF energy produced by the transmitter to the gas within the bulb. The RF frequency, the gas mixture, and the coating have been selected so that the RF energy ionizes the gas, causing the coating to radiate light.

The bulb has some great advantages over other fluorescent designs, let alone incandescent units. Since their are no filaments to burn out, the bulb's estimated lifetime is about 30 years. As they don't require the slightly inefficient step-up transformers used in other fluorescent schemes, they conserve energy and are less expensive to operate. By virtue of the coating and gas mixture, the bulbs emit a more complete spectrum of light, reducing (perhaps eliminating) eye strain for those sensitive to other forms of fluorescent lighting. To summarize, they are a nearly 100% efficient, longer-lasting, healthier, cost-effective alternative to anything else we have.

As for me, I have only one concern about these "super bulbs:" it regards the RF radiation they emit. With all the fuss people are making lately about being incidentally radiated (by power-distribution lines, household wiring, and appliances), how safe are these small RF-transmitters? I don't know myself, and I would appreciate hearing from anyone with input on the matter.

By the way, this idea is not totally new. It was originally conceived by Nicola Tesla who thought it might be possible to beam energy directly to bulbs and other devices without wires.

A WINNER

A recent issue told of "one of the simplest" and also the "simplest" headlight reminder. Well, here is an even simpler "simplest" (see Fig. 2). To install it, simply tap into the driver-side, dome-light switch (which is a grounding switch) and into a positive parking-light line and connect a mechanical buzzer to them. To make the connection you will probably need a couple of feet of wire and a couple of connector clamps.

While I have used this circuit for years, my 1990

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Nissan pickup had this warning system from the factory.

—Walt Wheelock, Glendale, CA

I've received dozens of headlight-reminder circuits in response to the column that you've mentioned. Your's has been chosen to appear because it is the simplest one with the highest number of good features. Among its distinguishing characteristics are: one-part design, it turns off when the door closes to further preserve battery life, and it warns you even if just the parking lights are on.

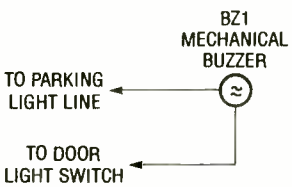


Fig. 2. Can a headlights-on reminder get any simpler than this? If you think so then write in.

The other circuits I've received had one or two of those features, but not all of them at once. Since you were able to distinguish yourself from such a large group of readers I've decided to send you a little something extra with your book. It's the special MC1010 chip mentioned in the first Think Tank *column I wrote. They are hard to find since Motorola no longer supports them, so I though you might like to have the little novelty to add to your junkbox. You've earned it.*

IMPROVING CONDITIONS

First I'd like to thank you for providing me and many other readers with information and projects that have often proved to be just what I needed.

Winter may now be here, but the air-conditioning season will be upon us before you know it. And as those who live in two-level dwellings (as I do) know, when you use air conditioning, the upstairs is often warmer than the downstairs due to hot air rising and cool air sinking. In my own case, that situation is aggravated by the thermostat, which is located downstairs. As the lower level cools more rapidly than the upper level (with lower-level temperature causing the air-conditioner to shut down prematurely), the upper level is always unbearably warm.

In an attempt to preempt that annoying situation, I have concluded that what I need is a way to automatically control a circulating fan so that it cycles on for perhaps ten to fifteen minutes every hour, thereby maintaining a consistent temperature throughout the structure. And if a variable on/off cycle were to be designed into the control circuit, so much the better! Unfortunately, I'm not the designing kind. But, my guess is that such a circuit could be built around a pair of 555's and a relay(?).

If you think this circuit could be of interest to your readers, I'd look forward to your reply in a future installment of *Think Tank.*

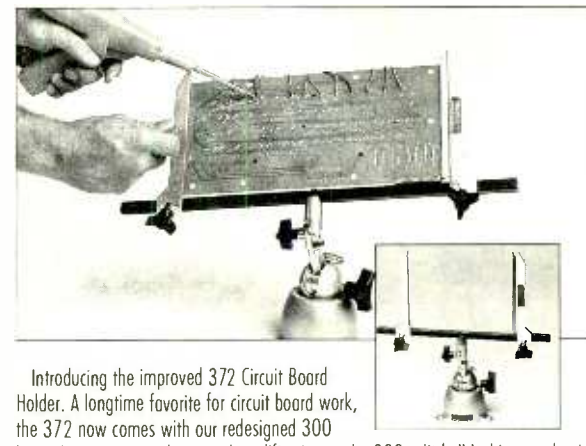
—Jon Hauko, Acworth, GA

One alternative is to use something based on the 558 quad monostable timer (see the November and December installment of Think Tank *for more information on that chip). Another way to go is to use a limited version of the circuit presented by this next reader.*

IN THE DOG HOUSE

This circuit (shown in Fig. 3) can be used in almost any situation to keep the temperature within a cer-

Go ahead, put on some weight



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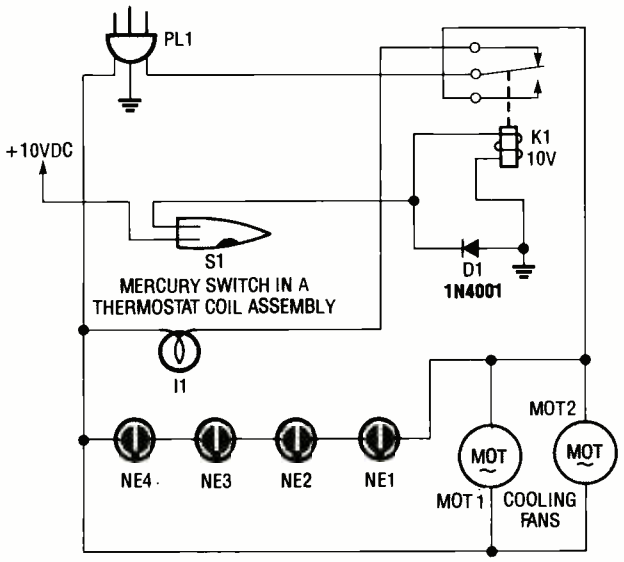

Fig. 3. Here's a complete cycling heating and venting system for any small enclosed space.

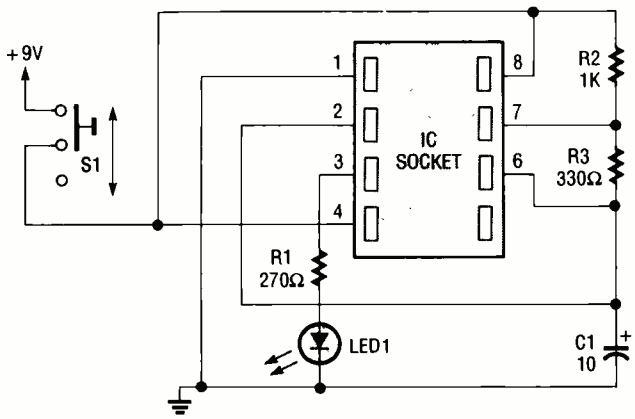

Fig. 4. This circuit can be used to test 555 timer IC's for proper functioning. However, does the circuit need to be modified for its own proper operation?

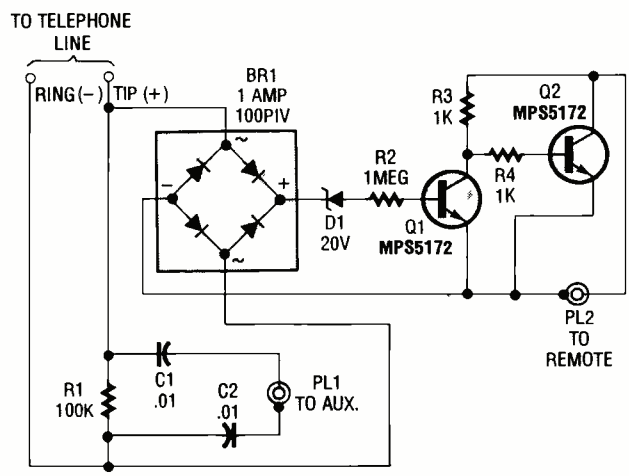

Fig. 5. This recording control relies on the doubled minimum saturation voltage of the Darlington pair to keep from turning off.

tain range. I use it in a doghouse for year-round temperature control. (My wife made me do it.) It can be easily reconfigured to meet many needs.

Switch S1 is a mercury switch located in an old thermostat assembly that mounted in the dog house. You can adjust the temperature range by adjusting the angle of the bulb on the coil.

When building your own control units, make sure the contacts of relay K1 exceed the current draw of the fan(s) and lamp that you use. Mine were old computer-cooling AC fans that were on hand. Neon lamps were used instead of noise-suppressing capacitors for no special reason. It just looks neat when the fans go off and the neon bulbs flash. Just be sure to use enough neon lamps for your fan motor(s) or the counter EMF will burn them up.

The heating lamp, a regular 60-watt light bulb, should be mounted in relation to the thermostat coil to give the desired time you want the area to receive heat. Mounting it far away from the thermostat will allow more heat to escape into the area; mounting it closer will cause the relay to switch on and off more frequently.

—Jim Austin, Arlington, TX

You shouldn't feel awkward about your circuit. Your wife had a good idea that another reader will benefit from. Your book is on the way.

SOME MODIFICATIONS

I built the 555 timer tester (*Think Tank*, October 1991) shown in Fig. 4, but could not make it work until I changed R3 from 330-ohms to 9500 ohms. All other parts in my unit are very close to the indicated values. It now works quite well and is very useful.

I really enjoy *Think Tank*! Keep it up.

—Howard Fogle, Katonah, NY

Thanks for the information. The problems you've experienced could be due to the fact that you used parts other than those originally specified in other places in the circuit.

DOUBLE TROUBLE

I found Andy Barfield's Telephone Recording Control circuit (from August, 1992, and shown in Fig. 5) and your comments about it interesting. The reason that Q2 "doesn't shut itself off by reducing current flow through R3" is that the Q2 collector-emitter junction does not achieve full saturation. The saturation voltage will remain just above the minimum base-emitter forward barrier potential of Q2 (about 0.6V). That's because the saturation voltage is slightly greater than the sum of the 2 base-emitter forward barrier potentials (about 1.2V). The circuit is thus a stabilized self-limiting linear amplifier.

This phenomenon usually presents a common problem when using Darlington-pair transistors. For example, in low-voltage motor-control circuits, such as in a microcassette recorder, which uses only 3 volts, the high saturation voltage of Q2 could result in a slowing of the motor, and distorted sound on playback. It may be possible to give Q2 a little extra "boost" to reduce the collector-emitter saturation voltage by connecting a large-value resistor between the positive output of the bridge, and the collector of Q1.

The value of the resistor should be low enough to provide Q2 with the extra base-emitter current required for collector-emitter saturation of about 0.1 volt with a bridge output of 5 volts. However, it should not

(Continued on page 91)

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DX LISTENING

By Don Jensen

Targeting the World

There's an easy way, and a hard way, to do most things. And there is something to be said for each approach. As a shortwave listener, doubtless you have your goals. It may be to hear as many different stations as you can. Or, perhaps, the challenge is to tune in a certain as-yet unheard broadcaster half a world away.

This station sticker is sent, along with a QSL card, to those SWL's who report hearing WJCR, a new US shortwave station.

For many beginning SW DX listeners, the self-selected target is to tune in, and then collect QSL-card verifications from at least one world-band station on each of the continents. While an interesting goal, it's not too difficult to achieve in this age of super-high-powered shortwave transmitters. With a bit of effort and some time, one can accomplish that even with a fairly unsophisticated receiver.

But logging all continents—Africa, Antarctica, Asia, Australia/Oceania, Europe, and North and South America—can also be a very difficult task if you limit yourself to other stations in those areas, such as low-powered, domestic, or home-service shortwave broadcasters.

When it comes to HAC (Heard All Continents), there's an easy way, and a hard way. So, for beginning SWL and veteran DX'er alike, here are some different ways to accomplish that HAC goal. There are, of course, many other stations that would fit the bill, as well. The following is just a sampling:

AFRICA:

Egypt—*Radio Cairo* shouldn't be difficult as a starter. For years, this North-African SW'er has been a regular on 9,475 kHz during the evening hours. You will find it easily if you tune in shortly before 0300 UTC, when its Arabic-music programming is a dead giveaway. English programming begins on the hour.

Angola—*Emissora Provincial do Lobito*, a difficult catch, is one of the seldom-heard regional stations from this southern African country. It has been logged with Portuguese-language programming in the eastern U.S. on 7,151 kHz at around 2230 until 2304 UTC sign off. It relays the *Radio Nacional* service, but has been heard with a local identification for Radio Emissora Regional Lobito at about 2240 UTC.

ANTARCTICA:

Well, there are only two shortwave stations that have operated from this frozen "bottom-of-the-world" continent, so the choices are limited. The easier of the two is clearly the Argentine Army's *Radio Nacional Arcangel* San Gabriel, LRA36, at *Base Antartida Esperanza* (which translates from Spanish as Antarctic Base "Hope"). When it is on the air, which it is periodically, it can be heard with quite good signals at times on 15,475 kHz, in Spanish from 2100 to 2300 UTC.

The other Antarctic SW station, which has been logged even more sporadically in North America, is the *American Forces Antarctic Network* station at the U.S. research station at McMurdo. Programming is mostly local-deejay pop-music shows. The frequency is 6,012 kHz, and seems best heard from around 100 to 1200 UTC when it is active.

ASIA:

China—*Radio Bejing* is hard not to hear. This is one of the world's major shortwave broadcasters, and it operates many transmitters on many different frequencies. Look for their English programming, which is beamed to eastern North America at 0000–0100 UTC on 9,770 and 11,715 kHz; and to western North America on 0300–0400 UTC, on the same two frequencies, plus 9,690 kHz.

Bhutan—*Bhutan Broadcasting Service*, from Thimpu (the capital city of this tiny Himalayan kingdom), is a prize catch for any DX'er. It has been heard as far east as Ontario, however, at around 1300 to 1345 UTC, or later,

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on 5,025 kHz.

AUSTRALIA/OCEANIA:

Australia—*Radio Australia* is a good choice, since it operates with decent power from about 0000 to 0400 UTC on 21,740 kHz; 0400 to 0830 UTC on 15,240 kHz, and 0830 to 1500 UTC on 9,580 kHz.

Bougainville—Site of a bloody battle during WW2, Bougainville is part of the far-flung island nation of Papua, New Guinea. But the local inhabitants are in a state of rebellion against the distant government. The clandestine SW station, *Radio Free Bougainville* has been heard with some difficulty by North American DX'ers on 3,880 kHz, between about 0800 and 1100 UTC.

EUROPE:

Italy—The choices for an easy European logging are many. I've selected Italy's RAI, *Radiotelevisione Italiana*, whose English programming is beamed to North America at about 0100 UTC on 9,575 or 11,800 kHz.

Scotland—There are no licensed shortwave stations in this northern part of the United Kingdom, but there are a couple of now-and-then illicit "pirates" on the air. One whose low-power signal has been known to jump the Atlantic is *Weekend Music Radio*, which uses different frequencies at different times. One frequency that you might try is 15,044 kHz on the weekends at around 0100 UTC.

NORTH AMERICA:

United States—While there are a number of different shortwave voices that could qualify as easily heard, one of the newest on the air is a relatively small religious broadcaster with a big signal, *WJCR World Wide* in Upton, Kentucky. Try for this one at almost anytime on 7,490 kHz.

Canada—*CKFX* in Vancouver, British Columbia, operates on 6,080 kHz with a mere 10 watts of power. It is a tough log in most of North America. Your best chance for hearing this one would be during the wee hours of the morning between midnight and dawn.

SOUTH AMERICA:

Ecuador—Flat out, the easiest way to log South America is *HCJB* in Quito. There is a good chance that HCJB will be for most beginning SWL's what it was for me nearly 46 years ago, the first shortwave station we ever heard. But if you haven't found it yet, try tuning 9,745 or 15,155 kHz between 0030 and 0500 UTC.

Surinam—*Radio Apintie* on 5,006 kHz has been an extremely tough logging for more than a few years. It has been running a mere 50 watts of power in a noisy area of the 60-meter band. But it was heard not too long ago in the eastern U.S. at around 0400 UTC.

It's up to you whether you want to try the easy or hard path to HAC.

IN THE MAIL

Your letters are always welcome. What are you hearing on the shortwave bands? What are your favorite stations or QSL's? Do you have questions or comments about SWL'ing? Drop me a line in care of *DX Listening*, **Popular Electronics,** 500-B Bi-County Blvd., Farmingdale, NY 11735.

Jack DeAntonio of Coral Gables, FL, has an opinion question for me. "What," he asks, "do you think is the most significant thing that has happened to SWL'ing in the past few years?"

Unquestionably, Jack, it is the drastic and dramatic changes that have occurred in shortwave broadcasting within the former Soviet Union. With the disappearance of the old monolithic USSR, with its huge, centrally directed broadcasting apparatus, shortwave radio has been turned on its ear.

Within the new "commonwealth," there remain hundreds of high-powered SW transmitting facilities and no central controlling organization. What we now are seeing are all sorts of new broadcasting operations, using the existing stations. Some have been leased to western religious broadcasters. Some have come on the air as fledgling commercial stations. There are all sorts of new stations coming on the air.

It's a fun time to be SWL'ing!

DOWN THE DIAL

Here are a couple of eastern European stations to tune for:

BULGARIA—*Radio Sofia* has been reported with English programming from 0300 to 0400 UTC on 9,850, 11,720 and 15,160 kHz.

CROATIA—Zagreb's *Croatian Radio* features English-language news shortly after 0600 and at 0800 UTC. Try 9,830 kHz. They've also been noted on 21,480 kHz at about 1200 UTC.

UKRAINE—The *Radio Ukraine World Service*, formerly "Radio Kiev," can be heard at various times between 0200 and 0730 UTC on 15,195 and 17,690 kHz. ■

*Credits: Dan Ferguson, VA; Bob Padula, Australia; Fred Barkley, Richard Langley, Canada; Art Magnussen, MN; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.

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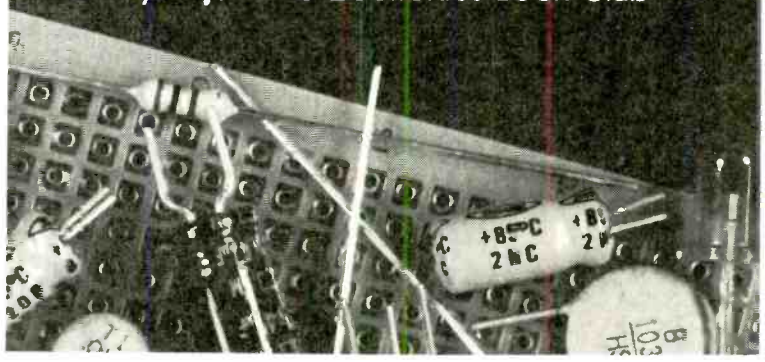

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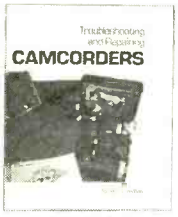

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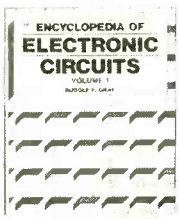

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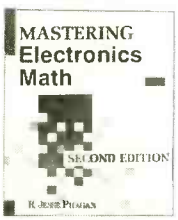

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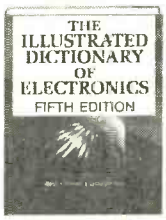

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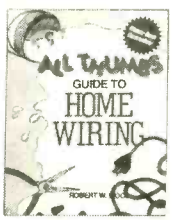

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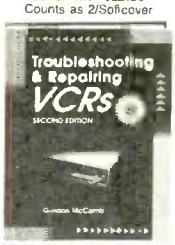

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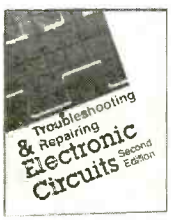

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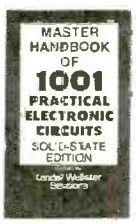

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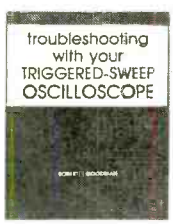

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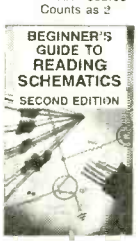

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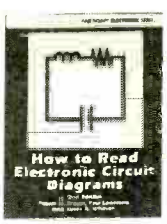

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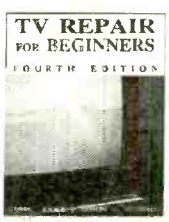

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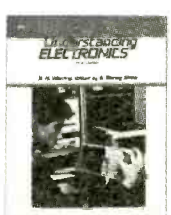

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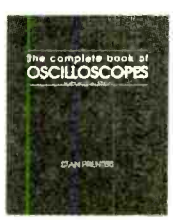

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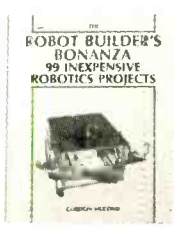

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HAM RADIO

By Joseph J. Carr, K4IPV

Some More Potpourri

From time to time, I like to take a look at my mail bag and answer some questions posed by readers. This "potpourri" usually rambles from one topic to another, as does the actual mail. But first, however, let me say thank you for all of the mail that I've received. With only a couple of exceptions, the mail has been running very positive. I am glad that shortwave listeners, monitor buffs, and general electronics enthusiasts all find this column so useful.

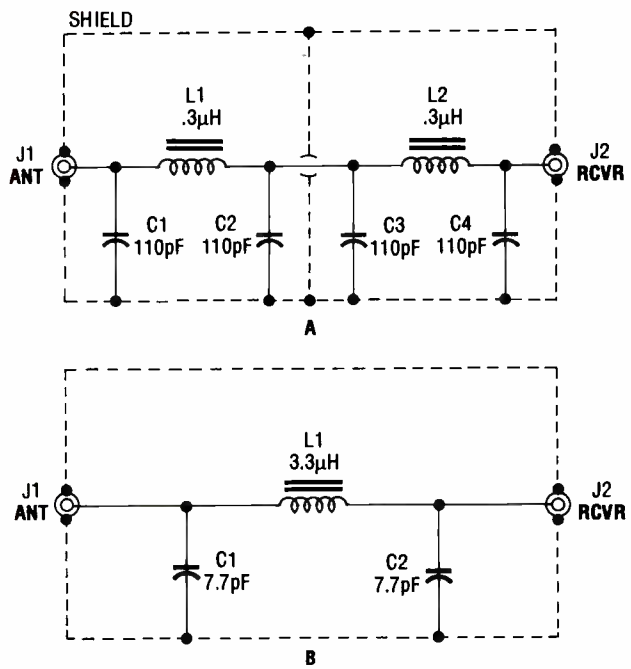

Fig. 1. These two 10-meter-plus LPF circuits, which are designed to remove VHF signals that can cause receiver front-end overload, can be made small enough to fit inside many transceiver cabinets. The LPF in A is a two-section LC filter that has a cut-off frequency in the 32-MHz region. The one in B is simpler, but has a less steep roll-off characteristic above the cut-off frequency.

LOW-BAND VHF SIGNAL'S

One reader complained that the 15- and 10-meter bands were compromised by a local FM broadcasting station (88- to 108-MHz band). It seems that he lived only a few blocks from the FM "blowtorch," and it overloaded the front end of his receiver. Many modern receivers do not have terribly selective front ends. They use a wide bandpass filter rather than peaked, resonant circuits (which was the former way of doing the job). As such, some of those "wonder-boxes" seem eager to overload in the presence of strong local signals.

The solution to the problem is the same as I've harped on for many years: use a lowpass filter (LPF) with a cut-off frequency (F_c) that's above the 10-meter band, but sufficiently below the frequency of the offending signal that it is way down the roll-off curve. All hams should use some sort of lowpass filter in the antenna line in order to prevent TVI from your transmitter (the "good neighbor policy" is best).

However, I've seen some cases where a lowpass TVI filter messes up the bandpass filters that are used in the output circuits of modern solid-state rigs. As long as both the output and input have impedances of 50-ohms, and as long as the entire system is impedance matched, then the filter should cause no harm. But that ideal is seldom reached in practical cases.

There have been some problems when certain brands of LPF's are used with some transmitters. The problems seem aggravated when certain antenna-tuning units are used in the line as well. If you want the receiver to be less sensitive to all forms of VHF signals (including channels 2–5 TV, FM BCB, 6-meter hams, and "low-band" landmobile VHF-FM communications stations), then use a TVI filter in the output of your transceiver.

However, if you are not able to use such a filter because of mismatch problems in your rig, or if you use a separate receiver, then try one of the circuits in Fig. 1. Those circuits are 10-meter-plus LPF's, and will probably do the job. You can make them small enough to fit inside many transceiver cabinets on the receiver side of the T/R relay.

Of course, with a separate receiver that's not a problem. Build them in an outboard shielded box and be happy. The LPF in Fig. 1A is a two-section LC filter that has a cut-off frequency in the 32-MHz region. The capacitors (C1–C4) should be silvered mica or NPO ceramic-disc units. The inductors can be either store-bought (try Digi-Key, P.O. Box 677, Thief River Falls, MN, 56701-0677; Tel. 1-800-344-4539) or made from Amidon Associates (P.O. Box 956, Torrance, CA 90508) toroidal cores. Try Amidon's T-37-6 (yellow) core wound with ten turns of #26 enameled wire.

The other filter is simpler, but has a less steep roll-off characteristic above the cut-off frequency. It will nonetheless work for attenuation of FM signals. The small 7.7-pF capacitors should be either ceramic-disc or tubular-ceramic units. The inductor can be

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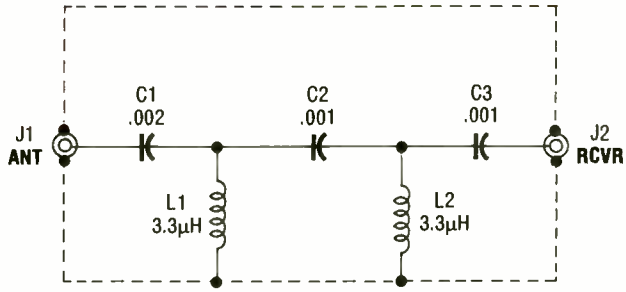

Fig. 2. This HPF filter circuit can be used in cases where AM broadcast-band interference is a problem.

wound on the same core as above (Amidon T-37-6), but requires 33 turns of wire. That's a lot of turns for a T-37-size core, so use #30 wire. Alternatively, use a T-50-6 (yellow) core, wound with 29 turns of #26 wire.

In cases of AM broadcast-band interference, you can use the circuit of Fig. 2 (which I've mentioned before in this column). I've had good results using both the T-50-2 (red) and T-50-6 (yellow) cores. In the case of the T-50-2 core, only 26 turns of #26 wire are needed.

By the way, when I give wire sizes for filters, the wire size is for reference only. The filter will work the same with other wire sizes if you can get the right number of turns on the form. It's the turns count that counts, not the size of wire (except in transmitters, where high power is involved).

Remember, these filters are for receiver applications only. The higher power filters needed for transmitters use heavier duty capacitors and much heavier inductors.

WHAT'S THE "LAW OF RECIPROCITY?"

Well, it's not some flaky New Age concept (George Gurdieff notwithstanding), but rather a property of antennas. The "Law of Reciprocity" concept means that an antenna works on receive exactly as it works on transmit. In other words, if it has 5.5-dBi gain on transmit, it will also have 5.5-dBi gain on receive. The transmit and receiver azimuthal and elevation patterns remain the same in both modes.

There is no known case where the Law of Reciprocity for Antennas is violated. The only case where it looked like such an Earth-shaking breakthrough might have occurred turned out to be a hoax. It appeared in the April issue of a popular ham-radio magazine.

The Law of Reciprocity does not, however, imply that all antennas are "created equal" in regards to the receive and transmit modes. It can be argued that the major antennas (dipoles, yagis, quads, and verticals) are pretty nearly matched with respect to receiving and transmitting. But that is not universally the case: For example, the small loop antenna is great for small-space reception of low frequencies (75-meters down to VLF), but transmits for squat. I've used a 24-inch square loop to cut down the crud on 75-meters by nulling out some of the interference. That scheme works well when the interference is arriving from an angle that's different from the desired station (it doesn't work well at all if your location lies in a line that also passes through both the interfering and the desired station).

Another "dyn-o-mite" receive antenna that doesn't work as well on transmit is the Beverage antenna. This claim may seem contradictory because a Beverage is similar to a long-wire beam antenna. But the Beverage works best on receive over poor ground, and is thus somewhat lossy for transmitting. It's not a total bust, however, and may have more gain than a dipole, but it doesn't work quite as well on transmit as receive.

SECOND RECEIVER

A little earlier, I mentioned that some hams use a second receiver on the HF bands. Why, you ask? Well, there are several reasons. DX'ers like to keep track of other DX opportunities on the band while waiting their turn in a pile-up. The second receiver also makes sense when the pile-up is on one frequency (you eavesdrop on the competition) and the DX quarry is on a slightly different frequency.

To be maximally effective the second receiver must be at least as good as the receiver in the transceiver. One recent model that is a very good radio is the R.L. Drake (P.O. Box 3006, Miamisburg, OH, 45342;513-866-2421) Model R8. That American-made radio receiver walks with the best of them, and is a pleasure to operate. I recently test drove one and was most pleased.

We welcome your letters, comments, suggestions, etc. Send all correspondence to *Ham Radio*, c/o **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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SCANNER SCENE

By Marc Saxon

A Couple of Winners

Radio Shack's *Realistic Patrolman PRO-2026* kicks off the new year with a field goal. It consists of an attractive mobile scanner that reprises a feature we always liked when it was available—service search. Pressing one of the five front-panel buttons marked POLICE, FIRE, AIR, WEATHER, and MARINE, instantly causes the scanner to begin searching (at 19 channels per second) all frequencies assigned to the selected service. You don't have to program search frequency limits for those services on any bands.

The new Radio Shack Realistic PRO-2026 offers service search.

The PRO-2026 has 100 memory slots, arranged in five banks of 20 channels each. The frequency range is 29 to 54 MHz, 108 to 174 MHz, 406 to 512 MHz, and 806 to 956 MHz. The cellular bands are locked out at the factory. The IF frequencies are 10.8 and 450 kHz. Scan speed is 14 channels per second, with an optional two-second delay for each channel. There's also a priority channel that's sampled every two seconds.

This new mobile scanner sells for $199.95, and can be seen at your nearest Radio Shack. We were very impressed with the PRO-2026 and found that the service-search feature was a much used function at our installation. We also liked that the light in the backlit LCD could be turned off, which we appreciated while driving at night. Good set!

ANOTHER INTERESTING PRODUCT

For the many readers who are deeply into monitoring the 800–900-MHz band, we stumbled across something really useful—a powerful, 11-element, rear-mount 800–900-MHz (only) loop yagi beam antenna for base station use. It's fully assembled, so all you need do is attach a coaxial cable with a Type N connector to the beam, and feed the signals into your scanner.

Try this 800-MHz yagi on those distant stations!

If the 800-MHz band stations that you most want to hear are in only one direction, then stick it on your roof aimed in that direction for long-range reception. Or you can mount the yagi on any TV antenna rotor and then aim it in the many directions that suit you. This antenna really pulls them in from far away.

The 800-MHz-band yagi costs $75 (plus $4 shipping), from the Cellular Security Group, 4 Gerring Road, Gloucester, MA 01930. Their toll-free number is 1-800-487-7539.

CALLING DR. SCANNER!

We have always been of the opinion that the least monitored local emergency services relate to medical communications. People load up on police and fire communications channels, but somehow don't take good advantage of this third partner in local emergency service providers.

Frequencies 155.325, 155.355, 155.385, and 155.40 MHz are designated in the U.S. for hospitals communicating with approaching ambulances. Communications on those channels most often consist of the ambulance personnel advising the hospital of their expected arrival time, the nature of the medical problem of the patient being transported, the patient's symptoms and vital signs, plus any special medical conditions that exist.

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Scanner owners tend to overlook the exciting medic frequencies.

Among the frequencies commonly used to dispatch ambulances are 155.28, 155.34, 460.525, and 460.55 MHz, although others might be used in specific communities. Sometimes fire departments have their own medical vehicles, and those might be dispatched on fire-agency frequencies.

Ambulance crews, as well as medic teams using portable equipment, often need to send bio-medical telemetry data. Most often, that consists of an EKG sent to a hospital for quick medical evaluation by a physician who can advise on medication to be immediately administered. Those communications take place on any of eight channels, known as "MED-1" to "MED-8," that run from 463.000 to 463.175 MHz (with 25-kHz spacing), with the mobile and portable units operating on paired frequencies from 468.000 to 468.175 MHz.

Some ambulance crews have low-power handheld transceivers that offer short range. Those units are able to communicate with hospitals only via mobile repeaters installed in the ambulances. The handhelds generally use 150.775 and 150.79 MHz to input to the mobile repeaters.

Hospitals with helipads often have 123.05 or 123.075 MHz available (in Canada, 129.275 MHz is popular) for communicating with arriving medevac helicopters.

All of those frequencies should be entered into your scanner and checked for activity local to your area. There are other medic frequencies as well. You should check for activity on 33.02 to 33.10, 37.90 to 37.98, 45.92 to 46.04, 47.46 to 47.66, 155.175, 155.205, 155.22, 155.235, 155.265, and 155.295 MHz. Some frequencies below 38 MHz are shared with stations in the Highway Maintenance Radio Service.

Although not precisely medical, communications connected with search and rescue activities are related to this area of monitoring. Good frequencies to monitor for those communications include 122.9, 123.1, 148.15, 155.16, 156.30, 157.05, 157.175, 282.8, and 381.8 MHz.

Also remember that 47.42 MHz is the primary American Red Cross frequency.

MOVE OVER, BATMAN!

It's been no secret in recent years that in many metropolitan areas, unlicensed two-way radio users abound on the business and other VHF frequencies. The FCC is too understaffed to adequately crack down on the problem, and, besides, FCC personnel say they don't get paid enough to go into some of the rough neighborhoods where the bootleg stations are located in order to pinpoint their locations and shut them down. Licensed two-way radio users, nevertheless, complain about their communications being disrupted by the bootleg stations.

In Los Angeles, Van Williams (who played The Green Hornet on TV more than 25 years ago) got fed up with the abuses on the frequency of his business radio system so he took matters into his own hands. He got into his van, which was equipped with direction-finding equipment, and tracked down the guy who was chopping up his frequency with unlicensed chatter.

After turning in the bootlegger, Williams said that it was the first time in years that he was able to use the channel without interference. Maybe we need the Green Hornet in every large city.

WRITE TO US

Don't forget, we always look forward to hearing from you. Our address is *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. Send us your scanner questions, frequencies, photographs, comments and news clippings. ■

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ELECTRONICS LIBRARY

1992–93 Educational Systems Catalog

from Heathkit Educational Systems

Edited by: Teri Scaduto

This two-in-one catalog is aimed at electronics enthusiasts as well as vocational and technical teachers and industrial training managers. Half the catalog is devoted to individual learning products, the other half to classroom courses.

The "Individual Learning Products" section of the catalog offers courseware, training hardware, computer software, software applications training, and other high-tech learning products. Subject areas include Electronics, Computer-Aided Instruction; Lasers, Fiber Optics, and Data Communications; IC Electronics and Op-Amps; and Beginning Electronics. Also offered are instructional video tapes; software; test equipment and tools; weather instruments and clocks; and assorted Heathkit projects.

The "Classroom Learning Products" section covers a wide range of subjects, from fundamental electronics for beginners to laser, microprocessor, and telecommunications technologies for advanced students. Each course is designed to lay a foundation of basic theory and hands-on experience on which students can build as they learn new concepts and take on real-life applications.

Highlighted is Heathkit's new Version 2.0 of their computer-aided instruction series of electronics training courses. Using the power of PC's to make learning electronics easier and faster than ever, the courses are available in the topics of DC Electronics, AC Electronics, Semiconductor Devices, and Electronic Circuits; soon-to-be-released computer-aided courses include Digital Techniques and Troubleshooting.

The 1992–93 Educational Systems Catalog is free upon request from Heath Company, Marketing Department, P.O. Box 1288, Benton Harbor, MI 49023; Tel: 1-800-44-HEATH.

CIRCLE 91 ON FREE INFORMATION CARD

LOW-COST TEST EQUIPMENT PROJECTS YOU CAN BUILD

by Delton T. Horn

Budget-minded hobbyists and technicians—in fact, anyone who works with electronic circuitry—will appreciate the money-saving projects presented in this book. Included are easy-to-follow plans and practical instructions for building more than two dozen inexpensive analog and digital test instruments. Projects include equipment for monitoring/measuring voltage, resistance, capacitance, conductance and frequency. Specialized modifications for many of the projects are possible, allowing readers to customize the equipment to directly suit their specific applications. The book shows how to build a voltage range detector, a digital frequency meter, a logic probe, an audio sinewave oscillator, a sweep signal generator, and several other essential pieces of test equipment. All of the projects can be built using readily available components, at a fraction of the cost of buying equipment.

Low-Cost Test Equipment Projects You Can Build costs $13.95 and is published by TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-822-8138.

CIRCLE 98 ON FREE INFORMATION CARD

YOUR QRP OPERATING COMPANION

by Brad Wells, KR7L

The hobby of QRP—ham operating with an output power of 5 watts or less—is both challenging and exciting. Most amateur radio contests have a QRP entry class, and hundreds of hams from around the world participate. In fact, many hams have managed to work more than 100 countries QRP to QRP.

This book is designed to help QRP'ers get the most from their hobby. No special rig or expensive and complicated equipment is needed. Taking a firm stance

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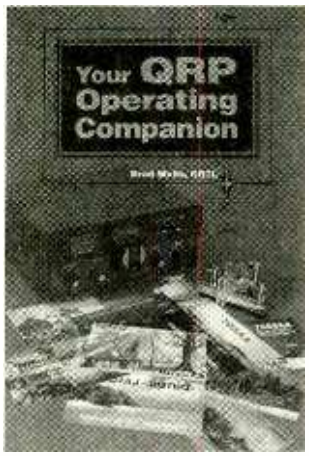


that skill is more important than equipment in QRP, the author shares the wealth of his many years of QRP experience to help readers make more contacts and have more fun. The opening chapter deals with the basics of QRP, including its history and various tests and contests. Subsequent chapters cover operating techniques and explain how to maximize your signal, followed by an in-depth look at propagation. Appendixes list QRP clubs and nets, and contests that include QRP categories.

Your QRP Operating Companion costs $6.00 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111.

CIRCLE 92 ON FREE INFORMATION CARD

PETER NORTON'S ADVANCED DOS 5

by Peter Norton, Ruth Ashley and Judi Fernandez

In this book, Peter Norton, acclaimed authority on DOS and the creator of the award-winning Norton Utilities, provides DOS 5 users with vital information needed to reach peak productivity. This follow-up to *Peter Norton's DOS Guide* reveals insider's tricks to squeezing the most out of DOS 5. The secrets to building effective batch programs with color and graphics are placed at the readers fingertips. In Norton's distinctive style, the best techniques for efficient memory management, data recovery, anti-virus protection, and correcting hardware and software malfunctions are explained. In addition, the book contains thorough explanations of DOSKEY macros, GW-BASIC, and BASICA programming.

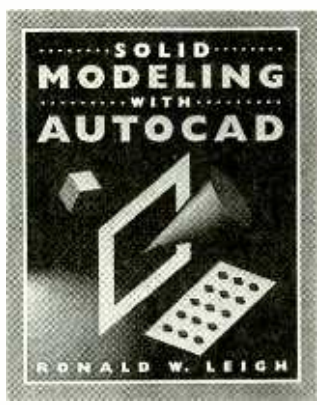
Peter Norton's Advanced DOS 5 costs $29.95 and is published by Brady, Division of Prentice Hall Computer Publishing, 11711 North College Avenue, Suite 140, Carmel, IN 46032; Tel: 1-800-428-5331.

CIRCLE 99 ON FREE INFORMATION CARD

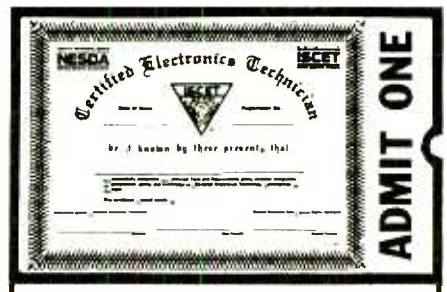
SOLID MODELING WITH AUTOCAD: Second Edition for AME 2.0 &2.1

by Ronald W. Leigh

Just in time for AutoCAD Release 12, the second edition of this book focuses solely on Autodesk's Advanced Modeling Extension (AME) version 2.1—the feature that joins the advantages of wireframe and surface models with descriptive data about the "insides" of the object. Complete with an eye-catching full-color section, the easy-to-read book enables design professionals to exploit the improvements in AME 2.1 to create vivid three-dimensional



models with simple 3D shapes. After explaining the advantages of solid modeling, the book introduces the building blocks of AME: 3D "primitives"—boxes, cylinders, spheres, wedges, cones, and other simple forms that can be joined to create complex solid models. Given a shaded outer shell, such solid models are realistic-looking 3D drawings that can be edited, scaled, taken apart, reassembled, and used to calculate volume, center of gravity, and other mass properties. The book is arranged as a series of



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exercises that illustrate the concepts and procedures of solid modeling in progressive levels of complexity.

Solid Modeling With AutoCAD, Second Edition, costs $29.95. A companion diskette, which includes sample drawings from the book, AutoLISP programs for AME, and batch files that reduce various commands to single-keystroke operations, is available for $49.95. Both are available from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515; Tel: 919-942-0220; Fax: 919-942-1140.

CIRCLE 93 ON FREE INFORMATION CARD

THE CB RADIO HACKER'S GUIDE

by Kevin Ross

This book tells readers exactly which screws to turn, which wires to cut, and which components to add to help substantially improve the performance of their CB's and add updated controls, features, and capabilities. It also reveals methods of unlocking those hidden functions that were never activated at the factory and methods of adding new features that the factory forgot to include.

Charts show how to tweak and peak existing circuits so that they perform at their maximum potential for best power output, full modulation, best AGC and squelch action, and finest all-around operation. The book shows how to add RF and microphone gain controls, a noise blanker, bright/dim control, switchable audio tone, high/low transmitter power, a modulation meter, and more. Also included is practical advice on how to diagnose CB problems, how to test microphones and wire microphone plugs, and other useful information to enhance your CB station and operations.

The CB Radio Hacker's Guide costs $18.95 plus $3.50 shipping (NY residents must add $1.61 sales tax) and is published by CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725.

CIRCLE 90 ON FREE INFORMATION CARD

1992–93 EQUIPMENT, TOOLS & SUPPLIES CATALOG

from Print Products International

This catalog contains 68 pages of discount test and measurement equipment for electronic production, maintenance, and service. Featured are items from such major manufacturers as B+K, Fluke, Avcom, Hitachi, Leader, Pace, Kenwood, Philips, and more. Product categories include oscilloscopes, power supplies, meters, EPROM systems, static-control products, spectrum analyzers, and surface-mount equipment. Also featured are replacement parts and new lines of closed-circuit TV systems.

The 1992–93 Equipment, Tools & Supplies Catalog is free upon request from Print Products International, 8931 Brookville Road, Silver Spring, MD 20910; Tel: 1-800-638-2020 or 301-587-7824; Fax: 1-800-545-0058 or 301-585-5402. ■

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NEW PRODUCTS

Video Information System

Radio Shack has entered the multimedia interactive market with the *Memorex MD-2500 Video Information System*, or *VIS*. The VIS unit, which connects to any TV set and can also be hooked up to a stereo system, plays interactive VIS discs that provide electronic access to reference books, instructional materials, learning and action games, and a variety of educational programs. A wireless controller allows users to interact with the pictures, voice, music, and animation sequences contained in VIS applications. The system provides high-quality pictures with color resolution of up to 16 million colors. Its audio system, which can be connected to a home stereo system using optional cables, is digitally synthesized and provides digital stereo sound from both VIS discs and audio CD's.

The MD-2500 comes with a VIS version of Compton's Multimedia Encyclopedia, which includes all 26 volumes plus a complete Webster's Intermediate Encyclopedia on one disc. A "Save-It" cartridge is included for saving game scores or preserving electronic "bookmarks" in reference books. Options include a second, wired, hand controller, and a modem for connecting to on-line information services.

The Memorex MD-2500 VIS system (Cat. no. 16-376) is available for $699 at Radio Shack stores nationwide. VIS software titles range in price from $29.95 to $79.95. For more information, contact Radio Shack, 700 One Tandy Center, Fort Worth, TX 76102.

CIRCLE 102 ON FREE INFORMATION CARD

PERSONAL AUTOPATCH

j-Com's Model SDP-600 Simplex/Duplex Smart Patch is a microprocessor-controlled interface between a VHF/UHF transceiver and a telephone line that allows the user to make and receive telephone calls from any H/T or mobile rig within range of the base station. Installation consists of connecting the autopatch to the rig's microphone and speaker jacks and plugging in an RJ-11 telephone jack. Control and programming is done by DTMF tones issued from the remote. Separate user-programmable access password codes can be set up for local and long-distance dialing. An external logic output, which can be used to control a repeater or to drive a relay for the control of any ham-shack accessory, is provided. An automatic CW (Morse code) identification transmission occurs at the beginning and end of each call.

The SDP-600 can be used in full duplex mode with a dual-band transceiver. Using full duplex, both parties can hear each other at the same time. Simplex mode may also be used with VOX control based on sampling both the telephone and receiver audio signals or with optional carrier detection. Turn-around beeps indicate the end of each transmission.

With the reverse patch option enabled, incoming calls will cause a short ring-out over the air. The user then can answer the call using his access password code. Ring-out activation can be adjusted from one to nine rings.

The Model SDP-600 autopatch is available at an introductory price of $199.95. For more information, contact j-Com, Box 194, Ben Lomond, CA 95005; Tel: 408-335-9120; Fax: 408-335-9121.

CIRCLE 103 ON FREE INFORMATION CARD

DC POWER OUTLET

If you need a neat and easy way to distribute 12VDC to various transceivers and accessories, the *MFJ-116 Deluxe DC Power Outlet* might be the solution. The multiple DC power-outlet strip features eight terminals for connecting rigs and keyers, TNC's, tuners, and other gear.

Output voltage is continuously monitored on its built-in voltmeter, making it a handy power outlet for electronics hobbyists, too. The MFJ-1116, which can be installed at the rear of a desk to eliminate the tangle of "haywires," features eight outlets with heavy-duty, five-way binding posts with standard spacing for dual banana jacks. The outlets are also RF bypassed. The strip also has a master power switch and a 15-amp fuse.

The MFJ-1116 Deluxe DC Power Outlet costs $44.95. For additional information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762.

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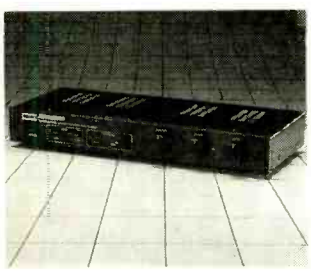
SOUND-ENHANCEMENT COMPONENT

The *Retriever* is a lower-priced version of *Hughes Aircraft Company's* SRS three-dimensional sound-enhancement component for home audio and video systems. The stand-alone unit uses a new VLSI chip that produces a realistic surround-type sound from conventional recorded or broadcast sources. The chip uses Hughes' patented Sound Retrieval System (SRS) technology, which expands the sound signal so that it appears to emanate from outside the physical limits of the usual two loudspeakers. The Retriever retains the same user-control features and stereo enhancement effect of the original model AK-100, but lacks the three-way LED display that is found on the earlier model. At 2⅜ × 16½ × 7 inches, the Retriever also is smaller than the AK-100.



The Retriever sound-enhancement component has a suggested list price of $179. For further information, contact Hughes Audio Products, Division of Hughes Aircraft Company, P.O. Box 7000, Rancho Santa Margerita, CA 92688; Tel: 1-800-2HEAR3D (1-8000-243-2733).

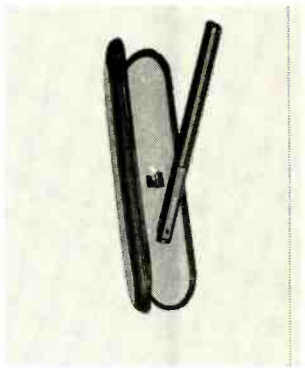
CIRCLE 105 ON FREE INFORMATION CARD

HANDHELD LASER POINTERS

Harnessing the power of micro-laser technology, the *Laser PowerPointers* are the smallest, brightest handheld lasers available to consumers today, according to *Lyte Optronics*. The line includes the *Laser PowerPointer* (pictured) and the *PointWrite Laser Pen*, which combines a laser pointer with a writing instrument—the Space Pen from Fisher. Both PowerPointers use laser light to produce a brilliant orange/red dot that can be seen from 150 to 300 yards away.

The Laser PowerPointer is available in black anodized aluminum, 24-carat gold plate, and titanium; custom finishes and laser engraving also are available. Weighing just one ounce and measuring five inches in length and one-third of an inch in diameter, the pointer fits conveniently in a shirt pocket. Power is provided by two 1.5 volt batteries.

Laser pointers have many applications other than as presentation tools. Engineers and architects use them to point out specific features of a structure without climbing ladders; police officers to survey a crime scene without disturbing evidence; doctors and medical sales consultants to identify anatomical structures and surgical tools in a sterile field; and plumbers, electricians, and contractors to illustrate where a pipe or wire will be installed.



The Laser PowerPointers have retail prices starting at under $200. For more information, contact Lyte Optronics, 3015 Main Street, Suite 450, Santa Monica, CA 90405; Tel: 310-450-8551; Fax: 310-392-1754. ■

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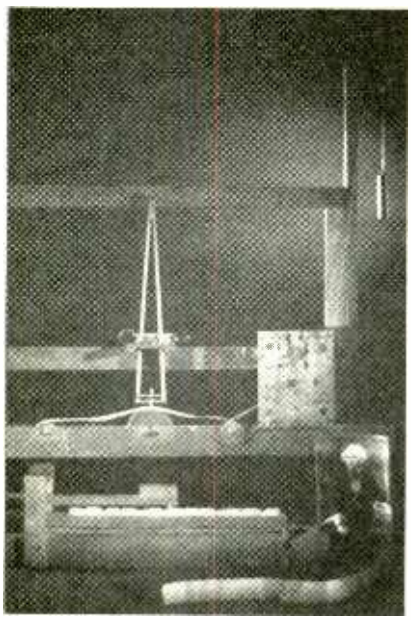
THE CODE MAKERS

(Continued from page 64)



The first Morse telegraph of 1835 didn't use a key! Instead it used a "portrule," which was a wooden stick with a groove designed to hold small lead blocks.

Before long, telegraphers were adding hacksaw blades and additional contacts to make dots automatically when the handle was pulled to the right. Horace Martin refined the idea and patented the famous Vibroplex. That semi-automatic key or "bug" was the standard for high-speed telegraphy from the 1890's until the end of World War II. They're still popular, and in recent years old units have become something of a collector's item. However, if you are not a collector, and don't wish to pay collector's item prices, the Vibroplex Company is still very much in business.

The development of vacuum-tube logic circuits in World War II made electronic keyers practical. These keyers would make automatic dots or dashes depending on which way the lever was pushed and their speed could be adjusted by a knob. The earliest models were crude but soon self-completing dots and dashes, memories, iambic keying, and many other features became commonplace. Today, many operators are using computers and keyboards to send Morse, or a variety of other codes, with speed, code type, and more selectable at the touch of a key. ■

BUILD A WIRE TRACER

(Continued from page 46)

9-volt battery, then connect a clip lead to the closed-loop output, J2, and power up the circuit. Turn on a small AM receiver and position it close to the clip lead. Tune the radio until you hear a buzzsaw-like sound, and then adjust the tuning for maximum signal strength. (The maximum transfer of energy occurs when the radio's internal ferrite loop is positioned perpendicular to the wire).

Once that is done, connect the opposite end of the clip lead to the common output, J3, and note the increase in signal strength. The increase in signal strength is due to circulating current within the closed loop. (Anytime a closed loop can be used, the signal will be greater and, in most cases, easier to track.)

Now plug the McTrak into a 117-volt AC outlet and try to trace the McTrak signal through the AC wiring using the AM receiver. If the wiring happens to go behind a metal panel in the wall or is run through a metal conduit, the metal will attenuate the signal, possibly making it too weak to follow. When that happens (or if the signal is diminished for some other reason), try connecting the open-loop output (J1) to the conduit and see if the signal can be traced along the conduit.

Using McTrak to trace your auto's electrical wiring is just as easy. With all of the electronics in today's cars, it's almost impossible to visually trace a wire from one location to another without going through a maze of cables, and possibly becoming sidetracked. But McTrak can handle that task as well.

To trace your auto's wiring, connect the McTrak's J2 output to the wire you want to follow. Then track the signal by moving the radio along the path that produces the strongest signal. If the receiver's signal is too weak, connect the common lead (J3) to the car's ground system (negative battery terminal or chassis in most vehicles) to increase the signal strength. Since there are some circuits in a car's electrical system that could be effected by the full output of the Tracker, it would be better to always use the closed-loop output when working with automotive electronics. ■

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CIRCUIT CIRCUS

(Continued from page 71)

over 25 µF. Frequencies greater than 50 kHz are possible when using smaller capacitor values for C1.

Transistor Q3, configured as an emitter-follower amplifier (which provides a voltage gain of 1) is used to buffer the output signal, so that the circuit can be used to drive a low-impedance (under 1 megohm) load. Only very high impedance loads may be connected directly to the sawtooth output at the UJT's emitter. Almost any loading at Q2 will cause the output level and frequency to drop, or oscillation to cease altogether.

TIME-DELAY CIRCUIT

Our next entry, shown in Fig. 5, places the UJT in a time-delay circuit. With S1 and S2 in the normally closed position, Q1's emitter and C1 are tied to circuit ground through the two switches and R2, a 100-ohm resistor. Switching either S1 or S2 to an open condition allows C1 to begin charging through R1 and R6. If the switch remains open longer than the RC time period, Q1's emitter will reach the trigger point and fire. When that happens, the positive output pulse at B1 turns on the SCR and the alarm sounder is activated. Even if the switch is returned to its normally closed position, the alarm sounder will remain activated until the circuit's power is interrupted.

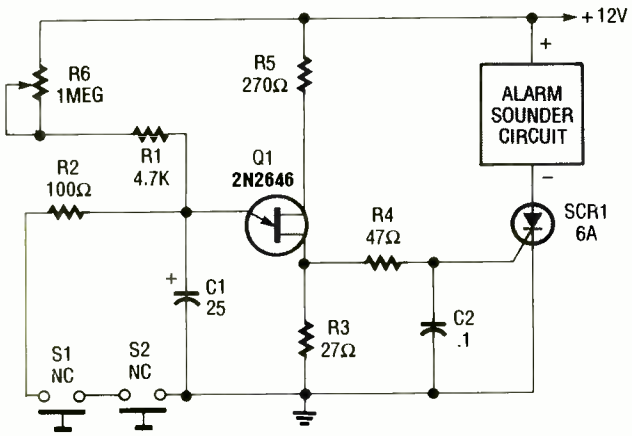

Fig. 5. Here the UJT is used in a time-delay circuit. The time delay afforded by this circuit can be varied from about one second to over 30 seconds by adjusting R6.

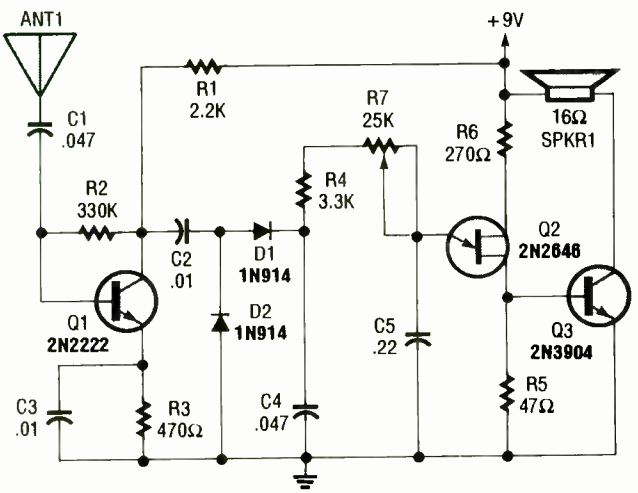

Fig. 6. In this handy little RF snooper, the UJT is configured as a voltage-controlled oscillator. As the RF signal strength increases, the output frequency of the voltage-controlled oscillator increases.

The time delay can be varied from about one second to over 30 seconds by adjusting R6. If a good quality low-leakage 100-µF, electrolytic capacitor is substituted for C1, the time period can be increased to well over one minute. The alarm sounder may be replaced with a relay or optoisolator/coupler to control just about anything.

RF SNOOPER

A handy little RF snooper, using the UJT as a voltage-controlled oscillator (VCO), is shown in Fig. 6. In that

PARTS LIST FOR THE TIME-DELAY CIRCUIT

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—4700-ohm
R2—100-ohm
R3—27-ohm
R4—47-ohm
R5—270-ohm
R6—1-megohm potentiometer

ADDITIONAL PARTS AND MATERIALS

Q1—2N2646 or unijunction transistor
SCR1—6-amp, or less, silicon-controlled rectifier
C1—25-µF, 25-WVDC, electrolytic capacitor
C2—0.1-µF, ceramic-disc
S1, S2—Normally closed sensor switch
Perfboard materials, enclosure, alarm sounder, 12-volt power source, wire, solder, hardware, etc.

PARTS LIST FOR THE RF SNOOPER

SEMICONDUCTORS

Q1—2N2222 general-purpose NPN silicon transistor
Q2—2N2646 or similar unijunction transistor
Q3—2N3904 general-purpose NPN silicon transistor
D1, D2—1N914 small-signal silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—2200-ohm
R2—330,000-ohm
R3—470-ohm
R4—3300-ohm
R5—47-ohm
R6—270-ohm
R7—25,000-ohm potentiometer

CAPACITORS

C1, C4—0.047-µF, ceramic-disc
C2, C3—0.01-µF, ceramic-disc
C5—0.22-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

SPKR1—Miniature 16-ohm speaker
ANT1—19-inch or longer telescoping antenna
Perfboard materials, enclosure, knob, 9-volt power source, wire, solder, hardware, etc.

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circuit, an antenna (ANT1) picks up RF signals. That signal is coupled through C1 to the base of Q1, which is configured as an amplifier. Transistor Q1 amplifies the RF signal, and the resulting output signal (at Q1's collector) is fed to a two-diode (D1 and D2) voltage-doubler circuit, which outputs a positive pulsating DC output at the cathode of D1 that varies with the level of detected RF.

The DC output of the doubler is fed to the UJT-based VCO. As the RF increases in strength, the output frequency of the VCO increases. The VCO output is fed to Q3, which amplifies the signal to a level sufficient to drive SPKR1. Potentiometer R7 allows you to adjust UJT-based VCO's frequency range.

The antenna may be any 19-inch or longer telescoping antenna. The snooper's sensitivity may be increased by increasing the value of R6. That's a good place to experiment to obtain the best overall circuit performance.

Here we are again at the end of our monthly visit. So, until we meet next time, good circuitry. ■

Let's close the book on forest fires.

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ANTIQUE RADIO

(Continued from page 66)

the tip. Those brown films are quite common on early radio equipment, and I've always assumed that they were grease or tar deposits from household cooking or smoking activities. When removing them, Alan points out, one should always use a wet process (rubbing with steel wool dampened in Brasso, as I did, would qualify) so as to trap the dust. Dry sanding or rubbing processes should definitely be avoided.

Reader Duane Buell (Seattle, WA) responded to my musings (September, 1992 issue) about the large circular opening under the Sky Buddy's main tuning dial. That hole had been punched, for no apparent reason, then subsequently filled, during the manufacture of the cabinet. Duane theorizes that the cabinet was manufactured for Hallicrafters by a metal cabinet specialist such as Bud or Par-Metal. The same cabinet was sold, in slightly different configurations, to other radio manufacturers. One of those required the large hole; Hallicrafters didn't.

If *you* have some Sky Buddy lore that you'd like to share, be sure to write!. Contact me c/o *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

"His New Year's resolution this year is to finish the project he resolved to finish last New Year."

THINK TANK

(Continued from page 74)

be low enough to significantly load the telephone line at the on-hook voltage (48 volts). I would start with a 5-megohm potentiometer, adjust for the desired results, then replace it with a fixed resistor. (Note that the saturation voltage of Q2 is also affected by recorder-motor load current.)

What was the purpose for resistor R4? It could be eliminated, (shorted) and that might improve saturation of Q2. A 100K resistor should be connected across the base-emitter junction of Q1. That would shunt the small leakage current of D1 when the bridge output drops to 5 volts, and shunt the reverse leakage current of the Q1 collector-base junction. Cutoff would then be assured for Q1.

I have not had the opportunity to experiment with this circuit. The preceeding analysis was based upon my industry experience.

I was impressed by the simplicity, and usefulness of Andy's circuit. I became interested in electronics myself at about his age. I hope Andy chooses to pursue electronics. It has been a rewarding career for me for the past 24 years.

—Charles Hardin, San Clemente, CA

Thank you for the excellent analysis. While examining the circuit myself, I forgot to double the junction potential to get the minimum saturation voltage for the pair (oops).

That's all the room for now. If you have a circuit, request, or comment you feel might earn you a "Think Tank II" or other book, please write to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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CIRCLE 15 ON FREE INFORMATION CARD

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NAVIGATION SYSTEMS

(Continued from page 42)

vice Center, police agencies, and various agencies doing highway maintenance and construction. Trav-Tek cars themselves provide data by transmitting their speed and location, which can be used to infer when and where the vehicle encounters congestion or a traffic incident.

Travtek also offers an extensive information database of services and attractions and on-line emergency help with the ability to communicate via cellular phone. These include service stations, hotels, motels, restaurants, and tourist attractions. The driver is provided information in several formats. First, there are simplified maps of the Orlando area graphically showing routes plus traffic congestion locations, incidents, and services information. A push of a button brings up another format with information about traffic incidents or available services in text form. Another option provides guidance instructions via simple graphical cues such as directional arrows.

On the other side of the continent, the Pathfinder demonstration program is already underway in Los Angeles. Pathfinder also uses an on-board navigation system that includes a CRT map display that presents traffic advisories and optimal routes sent to it via radio. Alternatively, information can be conveyed by synthesized voice messages over the car radio's loudspeakers.

The on-board system interfaces with the Los Angeles Traffic Management Center that includes the Los Angeles Traffic Management system. Testing is being done on a 13-mile segment along the Santa Monica Freeway, considered to be one of the most heavily used roadways in the country. The "Smart Corridor" used in the demonstration not only includes the freeway, but also freeway feeder roads and five major arterial streets that can be used as alternate routes to the freeway. Besides sensors like existing induction loops embedded in the roadway that measure traffic flow, the Los Angeles TMS uses police accident reports and information on locations where maintenance is underway. Finally, sensors in Pathfinder-equipped vehicles measure position, heading, speed, and number of stops, which is transmitted back by radio to the TMC. The California Department of Transportation (Caltrans), the Federal Highway Administration (FWHA), and GM are jointly sponsoring the Pathfinder Demonstration Project using 25 specially equipped Oldsmobiles.

An even larger IVHS demonstration project is planned for Chicago starting in 1993. Motorola navigation/route guidance system could eventually be installed in as many as 5,000 vehicles in the Advanced Driver and Vehicle Advisory Navigation ConcEpt (ADVANCE) program. These will be tied-in with a Traffic Information Center via RF data-communication links. The Illinois Department of Transportation, Federal Highway Administration, and the Illinois University's Transportation Research Consortium are involved in the project. The field-operation tests will encompass a 200-square-mile area in the Northwest suburbs of Chicago. Incidentally, for about two decades the Illinois Department of Transportation has operated a very extensive and quite successful freeway-surveillance and control system in the Chicago area. Traffic advisories from this system are transmitted to individual drivers via updatable overhead and roadside signs, and reports on cable TV and radio including low-power roadside transmitters.

Over in Germany, the Siemens' Ali-Scout was tested as part of the Guidance and Information System, Berlin, or LISB for short in German. This is one of many "Smart Cars and Smart Highway" projects in the very ambitious Programme for European Traffic with the Highest Efficiency and Unprecedented Safety (PROMETHEUS) project that involves virtually every European automaker, many suppliers, universities, and research institutes. LISB used 700 vehicles, 250 traffic lights, over 2,000 infrared beacons and covered 1500 kilometers (932 miles) of Berlin streets. In the Ali-Scout system, data is transmitted between cars and the Central Computer via the IR link. The degree of traffic congestion is inferred by comparing actual versus nominal travel times between beacons. Information sent from cars is fused with other data such as historical congestion profiles, whether schools are in session, weather conditions like fog or ice, traffic accidents, construction delays, and so forth. In the Ali-Scout setup, the up-date map is contained in the central computer rather than in individual cars. The Central Computer continually calculates a minimum trip-time route and transmits that information to the in-vehicle unit. If an Ali-Scout equipped vehicle is on the path to a traffic snarl, the Central Computer would guide the driver through another route that avoids this slowdown. The Ali-Scout system also adjusts traffic-light timing to smooth overall flow throughout the system. (We will be looking at the Prometheus Project in more depth in a future issue of **Popular Electronics**.)

The Japanese are also prototyping major systems such as the Advanced Mobile Traffic Information and Communication System (AMTICS). Like equivalent projects in the U.S. and Europe, AMTICS uses elements like on-board navigation systems, traffic-management centers, congestion re-routing, and even telephone directories for services and such.

On-board navigation systems could help all drivers, even those without vehicles so equipped. For example, Blaupunkt points out an important fact about advanced driver-information systems: Only a small percentage of the vehicles have to be equipped with the systems to have a noticeable effect. For example, if only 1% of all vehicles in a major metropolitan area were equipped with Ali-Scout, overall traffic flow would be noticeably smoother. A 10% installation would result in a major reduction in congestion. ■

"OK, whose idea was it to hang Apples on the Christmas tree?"

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(Continued from page 62)

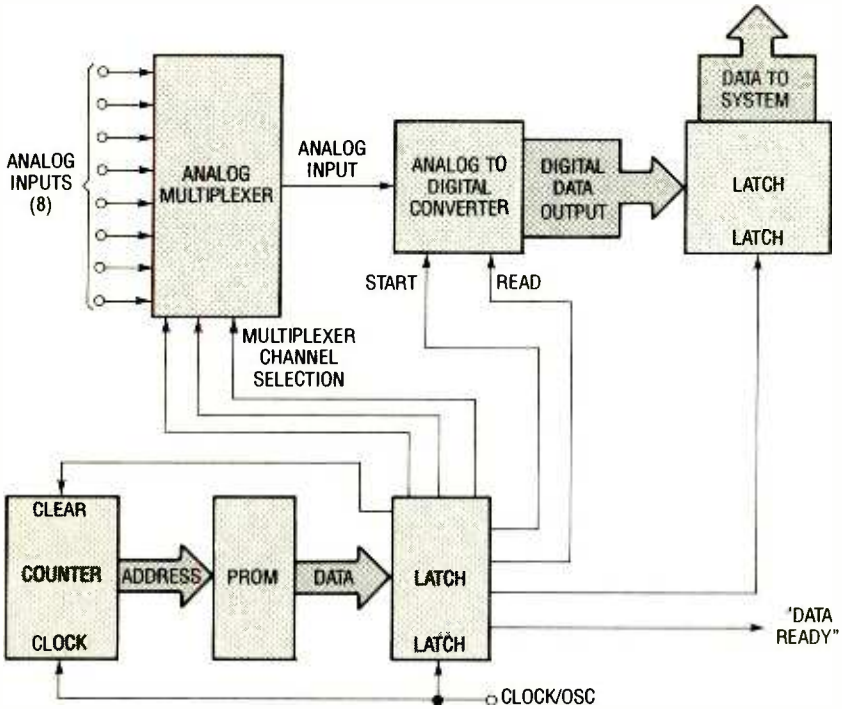

Fig. 4. A simple controller could even run an analog-to-digital data-acqusition system. That is because the task is limited to a series of steps that gets repeated over and over.

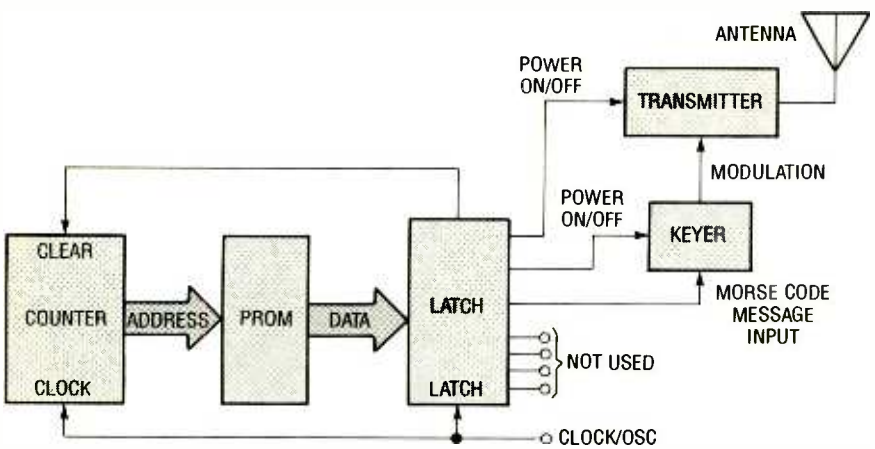

Fig. 5. Since broadcasting a repeating message from a beacon transmitter is a repetative task, a simple controller could operate such a transmitter. The PROM just needs to be programed with the right sequence of steps to perform.

whether the result was a positive or negative value, and/or if the result is zero. The external status register provides these mathmatical results for use by a program, while the internal status register is used for the microprocessor's internal operations.

The outputs of the address latches are connected to the microprocessor's address bus. The address information that is sent here is presented to the ROM, the RAM, and the ports prior to reading or writing data to these devices.

The data buffer is a bidirectional, non-inverting, three-state buffer that connects the microprocessor's internal data bus to the external data bus. That allows the microprocessor to send data to and receive data from the devices on the external data bus. The data buffer has three-state controls and data-direction controls that are connected to the control-unit.

The low and high halves of the program-counter are registers that contain the address of the current instruction being processed. The control-unit increments the program-counter registers and sends its contents to the address latches when the next instruction is to be read or when more information on the current instruction is needed.

The low and high halves of the data-counter are registers that contain the address where data is located in external memory. They may also be used as temporary registers.

The external control lines "Read, , "Write," "Memory," and "Input/Output" come directly from the control-unit's latches.

Next month, we'll look at some instruction examples and some special instructions. That should show how all these separate blocks function together to process instructions. ■

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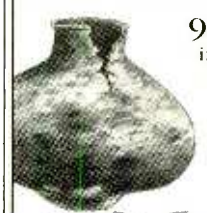

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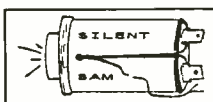

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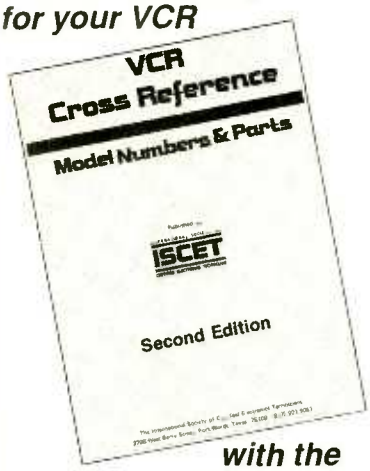

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The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of 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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Convenient autoranging and auto-polarity at a low price. Select the function—meter does the rest. Diode-check mode. Measures to 1000VDC, 750VAC, 200mA DC current, 20 megohms resistance. Fuse protected, UL 1244 listed.
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- **Designed for long life and ease of use**
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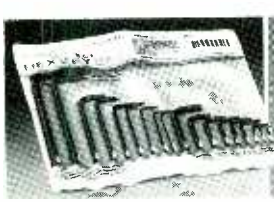
TECHLINE Rechargeable Soldering Gun. Great for autos, boats and campers—solder up to 250 joints on one charge. Trigger lock, light. UL listed AC charger, case.
#64-2194 ..... **39.95**

CD Player AC-to-DC Voltage Adapter. Saves batteries! Connect to your portable CD player's DC jack and plug into wall outlet to play from 120VAC. 3VDC regulated output. UL listed. #273-1659 ..... **16.95**

AC Voltage Sensor. Detects broken connections, blown fuses, defective grounds, open breakers, more. Indicates presence of AC voltages from 70 to 440VAC. Replaceable battery.
#22-103 ..... **11.99**



TECHLINE 18-Piece Hex Key Set. Ideal for engine and machinery work. Heavy-duty steel alloy. Standard sizes.
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IR Transmitter Project Case. For beeper or remote. 9V battery compartment. Molded 7/8 × 2 3/8 × 4 1/4" enclosure.
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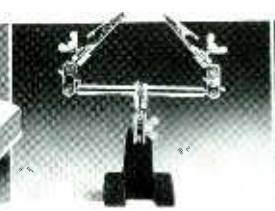
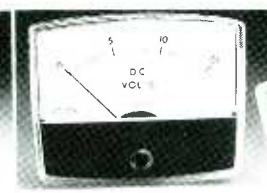


Project Holder. Alligator-type clamps adjust to hold work in any position. Solid cast-iron base prevents tipping.
#64-2093 ..... **8.49**



DC Voltmeter. Measure vehicle or power-supply voltage. Jeweled movement. Mounts in 1 7/8"-diameter round hole.
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Infrared Sensor Card. Detects normally invisible infrared to confirm output from remotes, IR LEDs or lasers.
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