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Everything you need to know page 48

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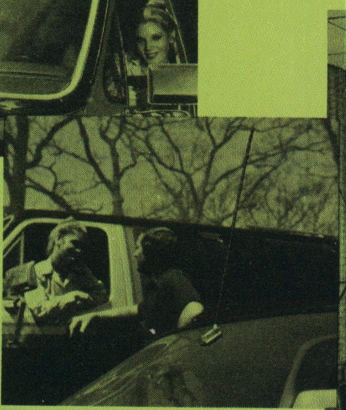

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modern electronics

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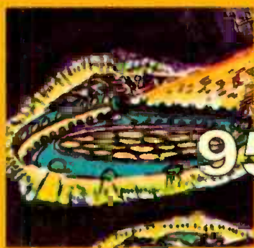
FEATURE STORY

SPECIAL FEATURES



PROJECTS

MONTHLIES

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comment

OUTPUT FROM MODERN ELECTRONICS' EDITOR

by Mort Waters
Editor, Modern Electronics

Following the arrival of your (new) editor there was barely time to dash this off before the issue had to go to the printer, so if it reads as though it had been written at the end of a marathon you will know why.

First and foremost, I want you to understand that I am really working for *you*. When you buy copies of this magazine you pay my salary. If you like it enough to continue, my associates and I will keep on working.

Now that you are acquainted with the way I regard readers, I have a request. I cannot do my job well unless you tell me what you want. Please write. Tell me the sort of articles you want to read. What kind of projects interest you most? What subject areas turn you on? Audio, CB, ham radio, video taping, computer games, computers, or what?

Publishing deadlines being what they are, this is not going to happen immediately or all at once. It will take time, so I ask for your cooperation and patience. I promise you the wait will be worth your while.

As the tv commercials are currently fond of saying, "ME wants to be your electronics magazine. . . ."

On a more personal level I must say how pleased and excited I am to be here—a chance to combine a life-long interest in electronics with a life-long profession. Electronics has been nothing but fun for me. In the coming months and years I hope some of my enjoyment is communicated to you.

modern electronics

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clinic

READERS WRITE FOR HELP WITH TECH PROBLEMS

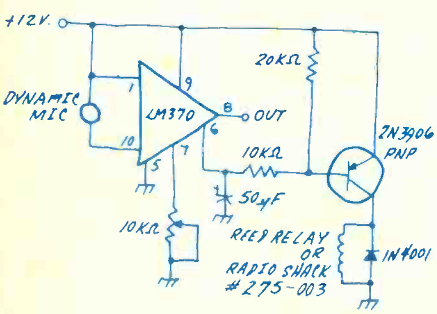
BY JEFF SANDLER

Voice actuated relay

I'm one of the many future subscribers to Modern Electronics, and have been enjoying assembling and applying your circuits around my shop. Can you provide me with a circuit for a voice actuated relay using ICs and a circuit that would provide a verbal output so my computer can talk to me directly?

R.J.R., Kinston, NC

I'm afraid I can't help you with the verbal output circuit—maybe one of our readers has such a circuit. If so, I'd like to see it. Fortunately, I can do a little better on the other circuit. This one, taken from the National Semiconductor Linear Applications Handbook, Volume 1. It's built around an LM370



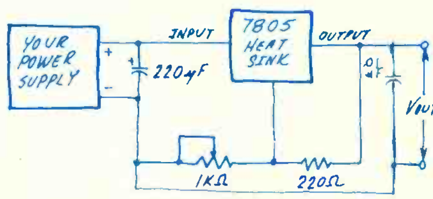
IC. The level at which the circuit trips is set by the 10K pot connected to pin 7 of the IC. When activated, the relay is switched on. How the contacts are wired is left to you. By the way, the LM370 seems to be the IC of choice for voice actuated circuits.

Sloppy supply regulated

I have a fixed 14 volt power supply stripped off a slot car set. It can deliver about a half-amp, but has very poor regulation. I'd like to convert it into a variable, regulated supply, but I don't want to spend more than $5 or so. I buy most of my parts from Radio Shack, so I'd appreciate your using their parts.

T.W.W., Woodland, WA

Here's a simple circuit that will give you the regulated supply you want using Shack parts. The key to the circuit is a 7805 regulator IC. Normally, the 7805 is a fixed voltage regulator producing five volts output. But by adding a 220 ohm fixed resistor and a 1K pot, the IC is tricked into producing a variable output determined by the control setting. One drawback to this circuit is that it can't get down to voltages much below five volts. If you need lower voltages, you can substitute an LM317, an excellent regulator, but not currently available at Radio Shack.



PC pitfall

Whenever I try to build a project from scratch, using a homemade PC board, I run into the same problem. The holes for the pins on the ICs don't line up, and I end up breaking two or three on every IC. How can I get my PC boards to work out right?

S.F., Fair Lawn, NJ

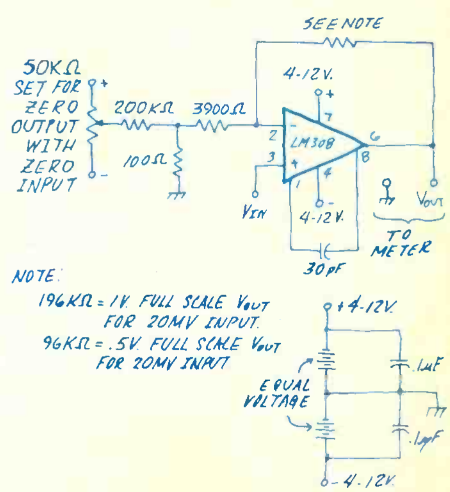
I can really sympathize with your problem. I suffered with it myself when I first started making PC boards. There really isn't enough room in Clinic to describe the best ways to make PC boards, but I hope to have a feature article on the subject in the not too distant future. In the meantime, let me suggest that you use IC pad tapes, which you can get at any art supply store that carries technical or drafting equipment. Make sure the pinhole in the center of each pad is open and etched out. You might also use a center punch to emboss the board before drilling. Otherwise, your drill bit will dance around on the pad. The result will be a misalignment of the holes, and those broken IC pins. You didn't mention what you used to drill out the holes in the PC board. If you plan to do a lot of fabricating, you might consider buying a small drill press stand to hold your drill. It will minimize the danger of misalignment.

Meter amplifier

I'm building an amplifier for my VTVM so I can get accurate readings in the 0 to 20 mV dc range. The circuit I'm using has an input impedance of only 1 megohm. Do you have a way of converting my circuit into a high impedance amplifier? I'm really only interested in using the amp to measure—20 to +20 mV with the VTVM.

S.H., Boulder, CO

The circuit you're using is built around a MC1456G. I think you'll get better results using an LM308. For one thing, it has a .40 megohm input impedance. Another big advantage is that it's inexpensive and readily available. In the circuit shown, it's wired as a non-inverting amplifier with a gain of 25 or 50, depending on whether you want a half-volt or one volt full scale reading with a 20 mV signal. Since you have a half-volt scale, use the 96K feedback resistor. One problem you might run into is that of offset. Most op-



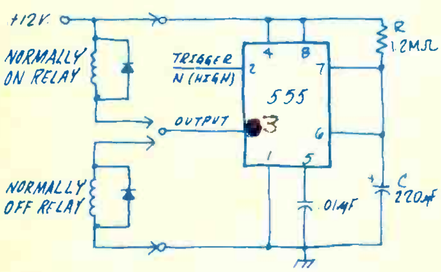
amps have an offset null input, but the LM308 does not. But it does have the high *impedance you wanted. Fortunately, you can use an external offset null circuit, as shown. You can use any battery voltage from four to12 volts, providing that the same voltage is used for both the positive and negative supply. The 0.1 mfd capacitor across each battery helps prevent unwanted oscillations. You can add a pair of protection diodes, as shown, to prevent the needle of your VTVM from slamming against the stop. By the way, you may want to take a look at the twin electronic multimeter elsewhere in this issue. It's battery powered, has high input impedance, and can measure dc levels in the millivolt range without using an external amplifier.*

Five minute relay

I'm currently building a home security system and would like to include an automatic shut-off. What I need is a circuit that will allow a 12-volt relay to close a circuit and then shut if off after five minutes. Can you help?

T.N., Rochester, MN

Every so often a reader sends me a letter complaining that I never use 555s in my



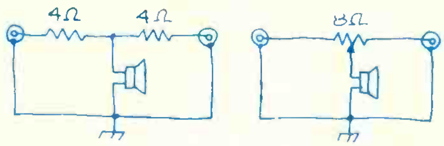
timing circuits. Well this time the old 555 is just right. In fact, all you need in addition to the 555 is a 1.2 meg resistor, a 220 mfd electrolytic and a .01 mfd disk. And your relay with its protection diode, of course. The length of time the relay stays closed is equal to 1.1 x R x C. In this case, the 1.2 meg resistor and 220 mfd capacitor give you about 4.8 minutes. If you need exactly five minutes, you can replace the 1.2 meg resistor with a 1 meg potentiometer in series with a 470K fixed resistor. Then set the control with a stop watch. You didn't say anything about a reset. If you need one, just connect a switch to pin 4 of the 555 that switches it from the positive supply to ground. Although the 555 is rated at 200 mA, I recommend you use a relay that draws 100 mA or less. Don't forget to put a silicon diode across the relay coil as shown.

Two into one

Because of space limitations, I would like to parallel the output of my Teac AC-5 stereo automobile cassette player to power just one speaker. I've been told that this isn't a good idea because one channel will drive the other and cause serious damage to the circuit. Is there a simple circuit which can do the job for me?

G.H.S., Manchester, CT

Parallel a stereo output to feed a mono circuit is a common problem. Your friends gave you



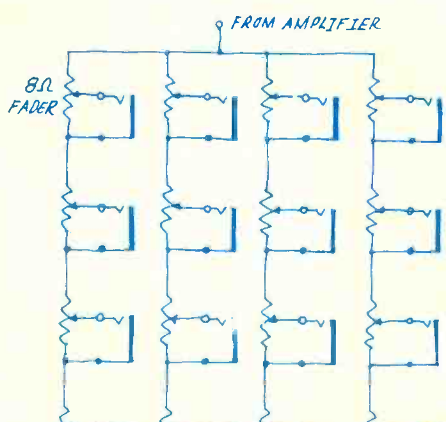
good advice because it is possible for one channel to drive the other. You can get around the problem by connecting the circuit so that each channel still sees a reasonable load. You can use a pair of four ohm resistors, or an eight ohm control between the two outputs, with the speaker connected from the junction or wiper to ground.

Navy phones

I'm stationed aboard a destroyer and have had a brainstorm. In our berthing compartment we have room for 16 men. I have a Fisher stereo receiver with about 45 watts rms per channel. I want to install it in the berthing compartment, but can't use speakers because someone is always sleeping. I'd like to set some kind of headphone system with a jack and separate volume control at each bunk.

ET1 D.S.O., FPO NY

Here's a fairly simple solution to your problem. Just connect the headphone jack to an eight ohm stereo fader control. If you can live with mono, inexpensive surplus fader controls can be used. They're available from several mail order sources for about a half-dollar each or less. The controls are wired into four parallel circuits, each containing four



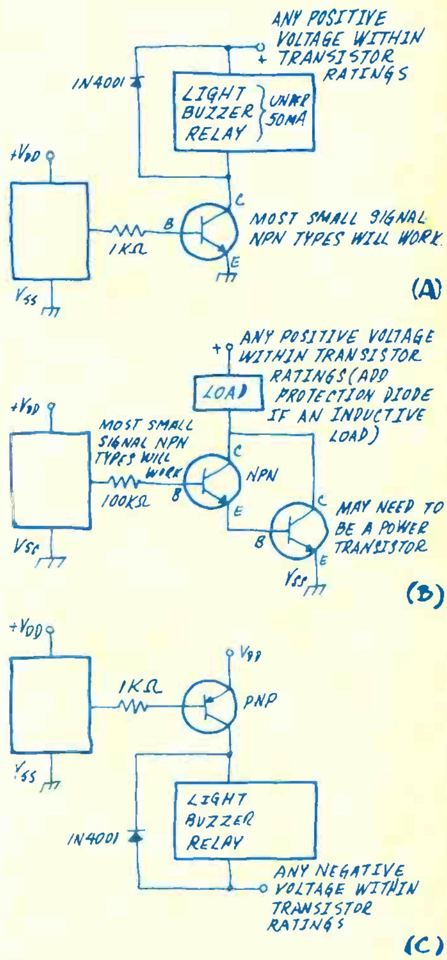
faders in series. The net impedance of the circuit is eight ohms, an ideal load for your Fisher. One nice feature of this simple circuit is that changing the volume setting of any of the outputs has virtually no effect on the volume of the others.

Wake up alarm

I recently built a digital clock using a Radio Shack number 277-1001 clock chip. How can I add an audible alarm to it?

G.G.J., Hollywood, FL

On page 13 of the Shack's new Semiconductor Reference book you'll find a clock circuit



built around the 277-1001. Included is an alarm using a pair of 2N2904 transistors. You can also use the output of the 1001 to trigger a circuit that can be used to power virtually any electrically powered device. You can use almost any NPN transistor connected through a 1K isolation resistor to pin 4, as shown in (a). If your load is relatively high, you can use the circuit shown in (b), replacing the 1K resistor with a 100K unit. If you happen to have PNP transistors on hand, you can use them, connecting the circuit as shown in (c).

If you have a question about electronic circuit design or operation, write to Clinic, Modern Electronics, 14 Vanderventer Ave., Port Washington, NY 11050.

computers

HOW THEY WORK, HOW YOU USE THEM, WHAT THEY CAN DO FOR YOU

BY PETE STARK

Curious about what programmers are and what they do? Here's a look at programming and the people who do it.

This month, more answers to readers' questions:

Dear Computer:
My sister is engaged to a guy who says he is a programmer and makes $18,000 a year. But he doesn't seem too bright. I thought he would have to be real smart to be a programmer. Is he a fake? What's a programmer anyway?
S.W., Cleveland, Ohio

A programmer is a person who writes computer programs. So what's a program? It is the set of instructions that tell a computer how to go about solving some problem.

That sounds simple enough, but actually programmers do many different kinds of jobs. If you pick up the Help Wanted pages of a big city newspaper, you'll see advertisements for systems programmers, application programmers, scientific programmers, business programmers, junior and senior programmers, and even some different titles such as systems analysts and coders.

Though all of these people may do programming, their jobs—as well as their abilities and the money they get paid—may be very different. To get an idea of why, let's look at a specific example.

Consider the case of a small company which wants to computerize its payroll. There is more to the problem than just telling the computer, 'Go print some paychecks.'

In its simplest form, printing payroll checks seems like an easy job. Using a small computer, you could write a computer program which would have the computer work with you, rather than instead of you, to help do the drudgery. Starting with a written list giving the name of each employee, the hourly rate and number of hours he worked during the week, you would sit down at the computer keyboard, type in the employee's name, hourly rate, and number of hours.

The computer would then calculate the weekly pay, subtract federal, state, and local taxes, subtract other fixed charges such as union dues or hospital insurance premiums, and finally print up a complete paycheck. For each employee, the computer could store in its memory the important data. After all the paychecks are printed, it could go back over the memorized data and print out a complete list summarizing everything for the entire company.

This is called the payroll register, and is used to provide long-term records of what happened each week. The trouble is that, useful as all this is, it is still only a small part of what really has to be done as part of the payroll.

First of all, some deductions may vary from week to week. For example, toward the end of the year, some employees may not have Social Security premiums deducted after they have paid in a certain amount. The best way to keep track of whether a deduction is due in any week is to keep track of wages paid since last January 1st—the so-called year-to-date information—and test whether it exceeds the Social Security maximum.

Another task that complicates the job is the fact that every quarter—that is quarter of a year or three months—the company must send to the government a summary of each employee's income for the quarter, his Social Security deductions, and his tax deductions. Thus it is necessary for the computer to maintain not only current data, but also year-to-date and past-quarter information.

While all this could be done manually from the payroll register, it's obviously a good idea to combine everything into one big computer program and have the computer do not only the weekly printing, but also the long-term record keeping. All of this could be done by a small personal computer working alongside a bookkeeper.

Unfortunately, this is really only practical as long as the number of employees is small. As there are more and more, perhaps a few dozen, it soon becomes impossible to use a computer just as a helper to a human; now you have to let the computer do the whole job. This is where the problems start, because you now have to teach the computer—by writing appropriate computer programs—how to handle everything having to do with payroll. Once you take the human being out of the picture and let the computer make all the decisions, you must make sure to give it enough information to make them correctly.

You see, the payroll—printing paychecks and keeping track of money paid out—is just part of a larger problem. To do a payroll, you need a master file of all employees. To get this file, you must set up a procedure for following hirings and firings and all the other possible changes that affect the employee file. In other words, you must tackle the entire personnel situation.

First you must study the way the company works. How are new people hired? How are they fired? How often? What will you do if a woman employee gets married and changes her name? What is company policy on absences? Are people paid by the hour or by the week? How do you check on the time an employee arrived and the time he left each day? Does it make any difference? What about special cases such as jury duty—does he get paid anyway? When someone leaves the company, does he get paid for a few extra weeks after leaving? How many? These are just a few of the questions you must ask before even starting the planning of a payroll program.

Once you know how the company operates and what it wants done, the next question is how to do it in an organized way. When a company is small, a lot of things get done by word of mouth. For instance, when an employee goes on vacation he may simply walk over to the bookkeeper and ask for his vacation pay. They'll have a nice chat, and by vacation time the paycheck will be ready.

But in a large company, things don't work that way. There is a form entitled something like *advance vacation day request* which must be filled out in triplicate, with one copy to a supervisor, another to company headquarters, and the third to payroll. For every exception, there is now a form to cover it.

An enormous amount of paperwork suddenly appears, since all of the old methods of arranging things by having a chat with the right person no longer can

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Audio Output
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Antenna
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be used. There now has to be a procedure—and a form—for telling the computer about the exceptions.

Now we see that there is more to computerizing the payroll than just writing a computer program to print checks. There has to be someone who analyzes the job, decides how to have the computer do it, and prepares all of the supporting paperwork to make the entire system work as a package.

If you visit a large company's computer center, you will find the following people working there:

■ The DP Center Director or Manager. This is the chap who is the overall boss. Often he will be a vice-president of the organization, or report directly to one of the top brass. The DP Manager may earn in the range of $30-50,000 a year, and is concerned with the overall operation of the computer, purchasing equipment, and the kinds of jobs it does.

■ Senior and Junior Systems Analysts work under the DP Manager. They are responsible for the work actually done. They are the people who study the operation of a company, fit the computer operations into the normal way the company does its business, design the forms and paperwork needed, decide which programs get written and how they will fit in with other programs. Systems Analysts get paid from $20-35,000, depending on their jobs and where they work. They plan out the programs, but may not actually do the writing of them.

■ Senior and Junior Programmers do the actual programming. Programmers' salaries range from $15-25,000 a year. Senior Programmers may get just a rough outline of a program needed from a Systems Analyst, and either produce a complete program, or else break up that outline into smaller parts, make up specifications for each part, and hand it over to a Junior Programmer to write the actual program code. Often a Senior Programmer may do some analysis of systems while a Junior Programmer may do nothing but coding—writing the actual program code from a very detailed set of specifications he receives from someone above him. Systems analysis requires a lot of experience and wisdom; coding is rather mechanical and relatively simple.

■ Under the Junior Programmers you will find other jobs such as machine operators, keypunch operators or data entry operators, file clerks, librarians, etc. Machine operators are the ones who actually operate the computer. For each program, they get a list of things to do: Put paycheck forms in the printer, put box number 1284 of cards in the card reader, mount magnetic tape number 93C7 on tape drive 6, and so on. Their job is a very exacting one, but consists mainly of following the instructions prepared by the programmer or analyst who prepared the program. The other people, keypunch or data entry operators, file clerks, and librarians (who manage libraries of magnetic tapes and disks, not books), are support people not having direct contact with the computer.

The above description tells where programmers fit into the business world. There are, of course, scientific programmers as well, but not as many. Scientific programmers tend to be engineers or scientists who have learned to program. The reason is that scientific problems needing a computer solution tend to be much more complex and much harder to understand than the typical business problem. It is often much easier to train an engineer to program than to teach a good programmer to understand the problem he is working on.

Getting back to your sister's boyfriend . . . $18,000 a year is not at all unusual for a business programmer. Perhaps he is a Junior Programmer who does mostly coding. In that case he need not be particularly bright. Is it possible, though, that he's smarter than you think since he's dating your sister?

Dear Computer:
Judging by the want ads in the papers, computer programmers make good money. How do I get to be one?

P.R., Hoboken, N.J.

If you've read the answer to the first letter, you can see that programmers—and especially systems analysts—can make good money indeed. Unfortunately, it is not easy to get such a job.

There are two problems involved: the first is to get the knowledge needed to get the job, and the second is to convince an employer you know enough so he will hire you. Both are tough.

There are many books and schools that claim they will teach you how to get a good paying job as a programmer. Unfortunately, programming is hard to learn from a book, and many of the schools that advertise in the papers do not deliver what they promise. Beware especially of these private schools. Some of them seem to be outright frauds.

Many years ago, I received an advertisement in the mail from one of these, enclosing an aptitude test. The letter claimed that if I took the test and passed it, they would send me information on how to get a high-pay job in programming. Well, I purposely answered 18 of the 20 questions wrong. Being right handed, I filled out everything with my left hand so that it looked as though it was written by a first grader. Then I sent it in and waited.

A month later, my doorbell suddenly rang and a salesman from the computer school stood there telling me how great I did on the test. Need I say more?

That particular school may have been honest, but other sources seem to bear me out. An article in a leading computer magazine some years ago pointed out that many of the teachers in such schools are unemployed programmers who quit as soon as they find their next job. These schools seldom have up to date computers for their students to practice on, and seldom find jobs for their graduates. And they are expensive.

There are some good private computer schools, but not many. One of the few that has a good reputation is Control Data Institute, affiliated with the well-known computer manufacturer. However, it is hard to tell which is good and which is bad.

The best bet for a data processing education is a local community college or business college. Even if their course is no better, at least their tuition will be lower. But their course should be better, since they are more likely to have a stable faculty and adequate computer equipment for student use. Finally, to justify their existence, they must be able to show that adequate jobs exist for their graduates.

In any case, programming of the type that is likely to land a job is not something that can be learned overnight. Buying a home computer will teach you how to talk to a computer, but will not be enough to get that job. If you take a community college course in data processing, you will probably take some business math courses, accounting or business fundamentals, as well as some background material in general business. These, plus some English and social studies courses, will give you that overall polish that today's employers look for.

Actually, once you have taken such a course your work is just starting. You still have to find a job. Programming is a tough job, and even two years of junior college is not enough preparation. There are many inept programmers around who move from job to job, and employers are very wary of hiring someone who doesn't have a proven track record.

The problem here is that it is difficult for a boss to judge whether you are a good programmer until you have been at work for some time. Hence even bad programmers can manage to hide for a few months, long enough to send out their feelers and find another job. That's why lengthy prior experience and a good recommendation is critical to finding a good job.

As a beginner, your chances of being hired as a programmer are slim. With a junior college degree in data processing, you will probably start as a Machine Operator for $8-10,000 or so. It will then be up to you to work your way up, either in the same company or by switching jobs after you have some experience.

Most of the programmers I have met were either college graduates with a four-year degree in math or business, or else were in the accounting or bookkeep-

please turn to page 88

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stereo

AUDIO, VIDEO, RECORDING, PLAYBACK

BY HANS FANTEL

Recordings you make yourself may well become your most treasured possessions, and might also earn you a pocketful of money. Here are some tips that can really improve the quality of those recordings.

The best-tasting fish are the ones you catch yourself. It's the same way with recordings. Chances are the most treasured items in your tape collection will be those you "captured" yourself; for such recordings are, in a very real sense, part of your life.

Whenever my jazz-playing friends get together for some jamming, I usually bring along my cassette deck. Later, when I play the tapes for my friends through my stereo rig at home, I always get plenty of spontaneous reactions—like: "Gee, that was me messing up!" or "Hey, you're dragging the beat!" If there are any singers or musicians in your crowd, chances are they'll welcome you as their recording engineer, especially if you let them make copies of your takes.

If you have good equipment—like a component-type stereo cassette deck and a decent pair of mikes—you may even offer to tape public appearances by singers or groups. There's just one rule about taping a public performance: Never pop up a mike without first obtaining permission.

Even for casual recording, it's a good idea to do it in stereo—two channels with two mikes—because the stereo effect helps sort out individual voices and instruments that might otherwise overlap and hide each other. Proper placement of the microphones is the key to getting natural-sounding, well-balanced recordings. And if you haven't done much live recording to gain practice and experience, the following hints will set you off to a good start.

Place one mike about eight inches from the singer's mouth, at a slight angle rather than aiming directly at the face. Put the other mike lower, on a level with the sound hole in the acoustic guitar, also at a distance of about eight inches. If the guitar sounds too plucky—that is, if the mike picks up too much finger noise from the strings—move it a couple of inches further away. In case of an electric guitar, put the second mike about twelve inches away from the speaker.

Place the two mikes four to six feet apart in front of the group, pointing them slightly away from each other, aiming at the two outermost members of the group. If one of the singers doesn't register clearly on the recording, which you can hear if you monitor your take with earphones, move him or her slightly forward, closer to the mikes. If, on the other hand, one of the group comes through too loud, move him toward the back. The overall blend of a vocal group can usually be improved by not lining them up parallel to the wall of the room, but diagonally across one of the corners. Never place a group in the middle of the room, as this will result in spotty, ragged sound.

Rock or instrumental group

Follow the same setup as with vocal groups. Sometimes you can improve results by hanging the mikes directly over the group if there is a way to suspend the cables from the ceiling.

Leave the piano lid closed and place the first mike squarely in front of the singer at a distance of about ten inches. The other mike should be placed about two feet in front of the piano, in line with the crook in the piano case. If it's an upright piano, put the mikes at both ends of the keyboard about a foot in front of the instrument.

Open piano top and place one mike about six feet away from the piano in line with the strut that holds up the piano lid. Place the other mike closer, almost directly over the piano string board, but turn down the recording level on this channel to keep the sound from getting too clangy. For upright pianos, put the mikes about six feet in front of either end of the piano.

These simple techniques will give your recordings an almost professional quality even without such elaborate and expensive equipment as special input mixers. Finally, here's a couple of *don'ts* to help you avoid some of the most common mistakes:

Don't hand-hold a mike while recording. Even slight motions of the hand will alter the balance. If you haven't got a mike-stand, improvise one by winding the mike-cord around the back of a chair or hang the mike from a lamp.

Don't put the mike directly on the piano. It will pick up the mechanical noise of the keys and pedals through the frame of the instrument.

Don't move in too close to the performer, and don't let a singer hand-hold a mike directly to his mouth, as you often see it done on tv. The mikes used in this way by professional performers are a type especially designed for such close operation. But the all-purpose mikes usually employed for amateur recording will overload and distort when used in this manner. Never put a mike on the same table with the recorder, for the mike will pick up vibrations from the mechanism.

By far the easiest way to record is with a stereo cassette deck—the kind that is part of many component systems. In most situations, you don't need a special portable, battery-powered model. The really good ones are expensive, and after all, if you carry a 25-foot extension cord, you are rarely beyond reach of an electric power outlet.

Open-reel recorders have the advantage of letting you edit the tape by cutting and splicing. But that's a professional routine most amateurs don't want to bother with. For sheer convenience, you can't beat the cassette. While you are recording, listen with a pair of earphones plugged into the monitor terminal of your cassette machine. That way you hear exactly what the mikes are hearing, so you have an instant check on the effectiveness of your mike placement.

As for the mikes themselves, I found that the so-called omnidirectional types—which pick up sound from all directions—are easiest to work with, because the mikes are the core of your recorder, they must be able to cover the full range of musical sound. Most of the cheap mikes furnished with cheap recorders just can't do that. But, you can get very good results with microphones selling from $30 up to $50 apiece manufactured by Sony, Electro-Voice, Shure, and Radio Shack. They are usually of the sturdy dynamic type and most of them come complete with desk stands.

mobile

CAR, BOAT, PLANE, RV: ELECTRONICS IN THE GREAT OUTDOORS

BY RON COGAN

There's no need to miss your favorite tv show just because you're out in the wilderness. With this super compact all-channel portable, you can take television wherever you go.

Portable televisions have become really popular items with the mobile crowd over the years. Advancing technology has seen smaller—and more mobile—units being offered each year, with a variety of features that enhance mobile viewing. The most important feature found in these sets is the ability to run on either the 12-volt dc power in your car or RV, or on an internal, rechargeable battery pack. Most of these televisions can also run on 110-volt ac, so they can be used in the home between excursions too.

One of the most interesting models we've seen to date is the new Sinclair Microvision, a product of Sinclair Radionics, Inc., 115 E. 57th St., New York, NY 10022. The Microvision is about the size of an average paperback book, measuring but 4-inches wide, 6-inches from front to back, and 1½ inches deep. The set's tiny size allows it to be easily carried in a man's suit pocket or a woman's handbag. It weighs in at a mere 26 ounces.

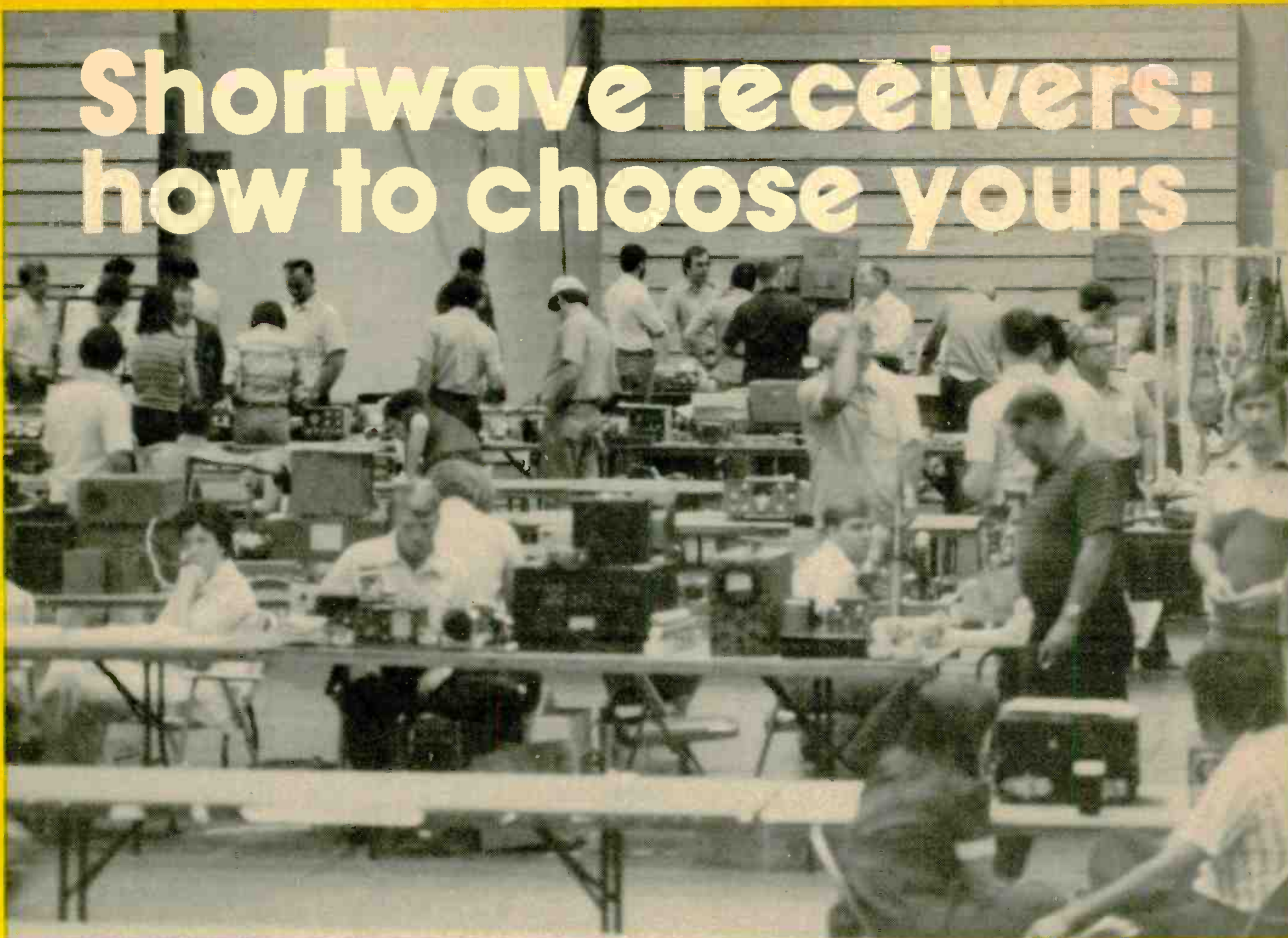
The Microvision's 2 inch diagonal screen produces a sharp black-and-white picture, which, when viewed at a distance of 1 foot, is equivalent to an ordinary compact portable at six feet and to a large 25 inch model at 12 feet. The receiver functions on all VHF and UHF bands, and is capable of receiving transmissions in most countries throughout the world.

Designed to withstand vibration and rough handling, the set is completely self-contained in a heavy duty steel casing with built-in UHF and VHF aerials. The set will operate approximately six hours on four AA NiCads before requiring a charge, or it can be plugged into an automobile's cigarette lighter. It can also be used with an external battery, and on normal ac home current with an adapter. Microvision's accessories include an extra external battery, cigarette lighter car adapter, and two ac adapters—one for the United States and one for other parts of the world.

And just why would you want such a tiny portable? For starters, the set can be carried literally anywhere and its uses are endless. The pint-sized tv comes in handy at sporting events, in the kitchen, on a boat, in your RV, and during lunch time in the office. It's an extremely handy item that will prove its value time and time again—and you'll never be without a television whenever and wherever one is desired. And what more could you ask for?

Although the Microvision has only a two inch screen, when viewed at one foot it provides the equivalent picture of a standard set viewed at normal distances.

Shortwave receivers: how to choose yours



Picking a hearing aid for the short wave bands shouldn't be a trivial matter. The right receiver can make the difference between pleasureable SWLing and the drudgery of trying to pull a weak one out of the soup.

by Karl Thurber

Today, choosing a communications receiver is no easy job, whether you are a brand-new SWL or an experienced amateur radio operator. Prices and features are up, and a mistake in selection can impair an investment of many hundreds of dollars. It really pays to put some deep thought into receiver selection, whether it's your very first receiver or your tenth. Here's what you should look for in searching for the receiver that's best for you, whether brand new or a used or surplus bargain.

Let's first discuss some of the things you should look for in selecting your receiver. Consider, first, that if you have (or expect soon to obtain) a ham license, you may not want to buy a *receiver* at all; a *transceiver* may be the better choice. So let's briefly talk about transceivers.

The transceiver has been available for nearly 20 years. Recently, it has given the separate receiver-transmitter combination some keen competition.

A transceiver is smaller, more portable and less expensive than separates. And, its transmit/receive functions may be more compatible than dissimilar transmitters and receivers simply hooked together. For these reasons, a transceiver may be a very good choice if you intend to work the ham bands, particularly if you want to operate from your car or have limited space in your shack.

On the other hand, the transceiver may involve some serious design compromises to make it all fit in one compact box. For example, it normally can receive and transmit only on the same frequency, and it usually covers only the ham bands. This reduces its overall versatility and restricts its use as an SWL monitor receiver.

Some of the drawbacks of transceivers can be eliminated going the *matched pair* route—using a separate receiver and transmitter that are specifically designed to be used *together* in transceiver fashion, but which can be un-hitched and used independently.

Such combinations as Kenwood's R-

599D/T-599A station, Drake's R4/T4 series, and Yaesu's FR101/FL101 duo are good examples. They give you the advantages of either locked-together or split-frequency operation plus many custom features found in top-of-the-line receivers and transmitters, but often lacking in transceivers.

The choice between transceiver and separates is a tricky one. But if you decide to go the transceiver route, select it as though you were buying the features of a *separate* receiver and transmitter. The better transceivers have most of the best features of both.

Although golden oldies should for the most part be avoided, don't dismiss the older tube-type sets out-of-hand. Some, such as the GPR-90 built by Technical Material Corporation in the mid-50s, are still fine receivers competitive with many of today's units. But if you decide to buy older used gear, stick to the Cadillacs of the period.

The basic receiver

A good communications receiver is the basic requirement for your radio shack. Since receivers last many years and can be the source of a great deal of operating pleasure, it's best to put some effort into its selection.

A number of factors combine to make a *good* receiver. Some are *number specs* that are interpreted easily, such as sensitivity and selectivity. But styling and front panel arrangement can be very important too.

Let's take a look at the most important *top ten* selection factors against which you should gauge your choice:

■ *Frequency coverage:* There are two kinds of receiver in use—*general coverage* and *ham-bands only*. There are several extremely wide range—and expensive—frequency synthesized receivers on the market as well. If you want to listen outside the ham bands, a general coverage receiver is a must. But, if you want to limit your work exclusively to the amateur bands, a ham-bands-only set may be for you. The latter are, dollar for dollar, *usually* better values with improved dial accuracy and more sensitive and selective.

■ *Sensitivity:* The measurement of a radio's ability to pick up weak signals. It's expressed as the number of *microvolts* needed to produce an output of so many dBs, usually 10dB, above the noise. Most solid-state sets now boast *at least* a 1 microvolt sensitivity. Many older tube sets aren't nearly this good, and they drop off noticeably in their performance on the higher bands.

■ *Selectivity:* This refers to the ability of the set to separate one station from others close in frequency. On better receivers, you have the choice of several *bandwidths*. Some offer variable selectivity. Usually, a 500 cycle bandwidth is fine for copying cw while 3 kHz will handle ssb transmissions. Quality am reception requires a 5 kHz bandwidth. Many sets have sharply-tuned crystal or mechanical filters or adjustable audio filters to attain even narrower bandwidths. Some receivers even allow you to *notch out* or reject annoying beats and heterodynes that mar reception.

■ *Stability:* You have to consider two things here—*mechanical* and *electrical* stability. A sturdy, well-built receiver will usually have good mechanical stability—jarring it won't knock it off frequency. Good electrical stability means that the receiver won't change frequency or *drift* much after its initial warmup. This factor is usually specified as a *drift rate* of so many cycles per hour. You want the *lowest* drift rate possible. Cooler running solid-state sets using crystal-controlled local oscillators have largely eliminated problems with both kinds of stability. Older, tube-type sets are frequently plagued with serious stability problems, however.

If you're a licensed ham, choosing between a transceiver such as this Ten-Tec Triton IV and a separate transmitter-receiver set can be a difficult task. If you want a transceiver, choose it as though you were buying a receiver and shoot for the best receiving specs.

■ *Image ratio and spurious responses:* It's possible to receive phantom signals if the receiver's *image rejection* and spurious responses aren't kept under control. You can hear images on your set when tuned to another station because of the way the set's mixer stage works. Without proper filtering, it can allow signals at frequencies above or below the desired frequency to leak through.

■ *Spurious responses,* sometimes called birdies, creep into the best of receivers. The problem can even be *worse* in more complex sets which have innumerable internal frequencies running around inside. In any case, both images and spurious responses should be held to a very low level; they are usually expressed as so many dBs "down" below a given reference. The largest *negative* number is best, and it should be at least -45dB down.

■ *Size and weight:* This is up to you, but bear in mind that a *boat-anchor* bargain isn't very portable. You may have to buy another set if you want to take your gear with you on excursions or business trips. Most modern, non-tube, models are fairly small, and can easily be carried about. Many can operate equally well from ac power, internal batteries, or your car's electrical system.

■ *Audio output:* No big thing, but it should be *at least 1 watt* for good loudspeaker operation—more than this if you want to operate mobile or in high-noise areas. Manufacturers also specify how much *distortion* is present at maximum output. It shouldn't be higher than about 10 percent for good quality sound.

■ *Calibration accuracy and readout:* If you can't locate and read out frequencies with some degree of precision, the radio is next to useless. A good receiver with an *analog* dial readout should let you interpolate to 1 or 2 kHz of the desired frequency. The set should also have a built-in calibration oscillator that you can use to cross-check your frequency readout. Costly, but best, is digital frequency display, which can give you dial accuracy to within a few cycles.

■ *Price:* Considering that a good receiver is likely to last longer than any other piece of electronic equipment in your shack, it's a good idea to invest in the *best* you can possibly afford. Otherwise, you're likely to find yourself trading-up within a year or two, and at a good-sized loss.

■ *Special features:* There are literally dozens of custom extras on receivers that may whet your appetite. These include such handy features and options as automatic noise limiters, noise blankers, S-meters, antenna trimmers, special interference filters, digital readout, built-in preselectors, crystal calibrators, and a host of others. Some of these are a must for good results, others are in the nice to have category. You'll have to make the decision on the extras yourself. It's not economical, however, to load down an inexpensive set with lots of accessories and options. You would be better off in the long run with a more expensive receiver with all the goodies included. Some features I'd consider to be *necessary* standard equipment: anl or noise blanker, S-meter, variable selectivity, and built-in crystal calibrator.

New, used or surplus?

Once you have your specs in mind, the next chore is to search out a suitable radio you can afford. The question is: Should I buy a new set, take a chance on a used receiver, or go the surplus route?

There's little question that the *easiest and safest* way to buy a receiver is to buy a new one. Buying a new model has a lot going for it. You can study the spec sheets, shop around for a good deal—a 10 or 15 percent discount is typical—and have some assurance that your dealer and the manufacturer will stand behind your purchase.

Today's sets are expensive, but even middle-of-the-line, solid-state communications receivers offer features that were unheard of in top-rated tube sets of an earlier era. Sensitivity and stability are up, dial calibration can be read out with surprising accuracy, and selectivity has been markedly improved.

Even the shortwave portable market has taken a quality turn for the better. The serious SWL or amateur wouldn't consider a fancy shortwave portable until recently. But, manufacturers such as Sony and Panasonic now produce portables that offer a good deal of competition to quality communications receivers.

The new Panasonic RF-4800, an LED-readout, highly-selective and sensitive 8-band portable designed for high-performance reception is a good example of the new breed. If you intend to do a good deal of monitoring away from your radio shack, consider these new portables. They are a generation ahead of their predecessors!

You'll find excellent receiving equipment made by such manufacturers as Drake, Kenwood, McKay-Dymek, Yaesu, and Radio Shack to mention but a few. Other companies, such as Hammarlund, Hallicrafters, and National that were familiar to SWLs and hams in the fifties and sixties, have left the field. Much of their equipment, however, lives on in the used-gear market.

Not everyone can afford a brand-new set, and many feel that you can get a better value by shopping for *used* gear. This may be true, if you recognize that you get what you pay for, and that there's an added risk in buying second-hand gear. But the big plus is *lower cost*.

Many of the older sets are still attrac-

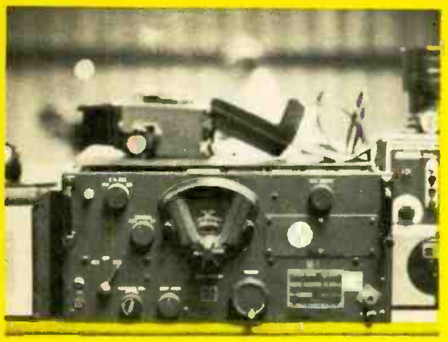
A ham bands only receiver such as this R.L. Drake R4-C gives you the kind of bandspread and sensitivity that makes receiving a pleasure. Front panel controls let you adjust the bandpass to custom tailor selectivity. A built-in notch that can drop out an interfering signal. The R4-C can be used as a transceiver with the addition of the T4-C transmitter.

The top ten factors

Each person will select a communications receiver based on the factors and specs that are most important to him. Listed below are some helpful guideposts for you to use in making a selection. The factors are not necessarily in order of priority.

Selection factor	The criterion
Frequency coverage	*Your choice.* General coverage, ham-bands-only, and wide-range synthesized receivers are the three main types.
Sensitivity or gain	*Smallest* microvolt number is best.
Selectivity	*Narrowest* is usually best; typically 500 cycles for cw, 3 kHz for ssb, 5 kHz for am.
Stability	Receiver should be mechanically solid and have a low "drift rate" after warmup.
Image ratio & spurious responses	Highest *negative* number is best, should be expressed as at least –45 dB down.
Size and weight	Important if portability is a concern
Audio output	At least 1 watt, more if used as a mobile set.
Calibration accuracy or dial readability	Should be to within 1 or 2 kHz for maximum ability to pinpoint stations.
Price	Whatever your finances can afford. Your receiver will likely be with you a long time, so invest with this thought in mind.

Special features you should also consider include the power source, modes of operation, antenna trimmer, S-meter, automatic noise limiter and/or noise blanker, preselector, tone control, rf gain control, built-in speaker, built-in antenna, and the ability to operate transcieve with a companion transmitter.



You'll usually find a handful of military surplus receivers for sale at every swap fest. Unless you're into heavy modification and have the technical knowledge required, you'd be wise to avoid these units.

tive today. Some of the best ones ever made were brought out in the fifties and sixties. Check back issues of electronics and amateur magazines at your library. With a little luck, you may find the specs listed for the set you're after.

Most of the sets are tube-type, and were manufactured from the mid-fifties through about 1970. Many are high-quality receivers that were generally considered to be far ahead of the times. Some, like the Hammarlund SP-600 Super Pro, National HRO-500, and Collins 75A4, command premium prices even today.

You should keep in mind a few simple rules that will help you to stay out of trouble in shopping for a used set:

■ Buy only from a reputable, established used-equipment dealer, one that gets his used stock from new-gear trade-ins and has a no-risk inspection or return-for-credit option. These dealers usually will *recondition* the set prior to its sale. Buying from an individual is okay, provided he is known to you. Or, you can use the services of one of the equipment brokers like *Buyers and Sellers*, P. O. Box 73, Boston, MA 02215. Be careful about buying a set at a CB jamboree or ham swapfest, unless you can inspect it thoroughly or try it out on the spot. Sales are final—Caveat Emptor!

Active audio filters can really pick the signal you want to hear out of a jumble of signals in the crowded ham bands. This Autek Research Model QF1 filter lets you peak up a signal, or notch out one that's interfering. The frequency and the width of the peak or notch can be adjusted with its front panel controls.

Golden oldie receivers

You can often save a good deal of money, and possibly purchase a receiver that you might otherwise not be able to afford, by going the *pre-owned* route. If you buy a used set, however, keep these pointers in mind:

- **Buy only from a reputable dealer or an individual known to you.**
- **Stick with the Cadillac class of high-quality oldies in good condition.**
- **Don't buy older than mid-fifties era sets.**
- **Recognize that like anything else, you get what you pay for.**

Here is a selected listing of some of the more popular and expensive receivers of fifties and sixties vintage you may want to consider for purchase. Most of these can be acquired for about 25 to 50 percent of their original prices, depending on age and condition.

General-coverage ham and SWL receivers

Manufacturer and model	Original price class
Drake SW-4 series	$ 300
Galaxy R-530	700
Hallicrafters SX-62	350
Hallicrafters SX-88	600
Hallicrafters SX-73	975
Hallicrafters SX-115	600
Hammarlund HQ-170A	375
Hammarlund HQ-180A	450
Hammarlund HQ-225	575
Hammarlund PRO-310	600
Hammarlund SP-600 series	1000 up
National HRO-60	600 up
National HRO-500	1300 up
Squires-Sanders SS-1BS and SS1R	1225 up
TMC GPR-90 and GPR-91	1000 up

Primarily ham-bands-only receivers

Manufacturer and model	Original price class
National NC-300 and NC-303	400 up
National NC-400	900
Collins 75-A series (75A1 thru 75A4)	500 up
Collins 75S3	850 up
Drake R-4B	430
Hallicrafters SX-101A	400
Hammarlund HQ-215	570

The listing above is by no means complete, but it should give you a fair idea of the variety of used equipment you may want to consider. Many of the receivers listed were produced over a number of years and varied considerably in price over their production run.

■ Stick with the pre-owned Cadillac—look for oldies in good condition. Check carefully for general appearance, missing parts, mechanical condition, dial calibration, and sensitivity, particularly on the higher bands. Be especially careful about purchasing a receiver that has been wired from a kit, unless you can inspect the wiring and know how to recognize a botched job. And steer clear of low-priced cheapies, such as the S-38, S-40, SW54, NC-60, and the other low-performance oldies that glut the market.

■ Don't buy a set older than one of mid-fifties vintage. Earlier receivers are usually worn out. Its capacitors may have deteriorated, tubes and other parts can be impossible to obtain, and schematics difficult to locate. Also, before the mid-fifties, most sets weren't equipped to receive ssb properly and their sensitivity was usually very poor on the higher ranges.

■ Recognize that you get what you pay for, and no more. Don't expect to be able to transform a non-working clunker into a smooth-running machine—unless you're an electronic whiz.

What about buying a *surplus* set? I'd recommend against doing so, unless you have previous experience in converting them for home use. Most such receivers are very old, dating from World War II. They are difficult and expensive to bring up to modern standards, with most lack-

Add on preamplifiers, such as this Ameco Model PT, can really soup up older tube-type receivers, especially on the higher bands where sensitivity normally tails off. This preamp can give you 20 dB gain up to 54 MHz, and can control station power.

ing adequate bandspread, sensitivity and selectivity, among other things.

If you purchase a surplus receiver, be sure to ascertain beforehand if it has already been converted for 110-volt, 60-cycle ac power. And, don't neglect to obtain a schematic and operating manual for it.

Three later-model surplus sets that are very popular are the Collins-made R-388, R-390, and 51-J1. But, they're expensive, usually topping $300, if you can persuade an owner to part with one. The war-surplus BC-348 is known as a hot beginner's set.

There is one other route to receiver ownership that we should mention—*buying a kit*. A kit can save a good deal of money over a brand-new set, and offers you some experience in electronic construction as well. On the other hand, alignment can be tricky, and it's sometimes hard to get the kit to live up to the manufacturer's published claims due to the many variables in home construction. One good bet, however, is Heath's HR-1680. Since it covers only the amateur bands, it's a bit easier for the beginner to align and test than might be expected.

Getting the most

Usually after a few days or weeks of use, you'll find some quirks in your set's operation that you'd like to set straight. While there are certain modifications you can make to almost *any* radio to soup up its performance, you can only go so far before you are all accessories and no set.

Some deficiencies can be compensated for by the addition of add-on accessories, others require tearing into the set's innards. Still others just aren't practical to set straight, short of completely rebuilding the set.

Some of the things you *can* do to perk up the set's sensitivity is to install a low-noise FET preamp between the receiver and the antenna. Doing this can make the higher bands come alive on lower-priced or older sets.

A converter for the higher bands, which translates signals on, say, 15 to 30 MHz to a lower frequency, such as 7 MHz where the set's sensitivity is likely to be better, can have much the same effect as adding a preamplifier, and can improve image rejection as well. A simple *antenna tuner* can markedly improve the set's rejection of undesired signals.

A very popular and easily installed add-on is the *active audio filter*, a device that is inserted between the set's audio output and the speaker or headphones. These filters allow you to sharply *peak* desired signals or *notch* out interfering stations at will. Adding an external speaker can do wonders to improve the tinny sound characteristic of the small speakers built-in most receivers.

I've suggested that it isn't practical to correct some receiver problems. For example, many cheaper sets are unstable, both mechanically and electrically. To fix stability problems requires an almost complete rebuilding of the set. Such *basic* factors as lack of a BFO or ssb and cw operation, or inadequate bandspread, may suggest that the set is better *replaced* than modified. Remember that extensive modifications and improvements to a set don't increase its value at trade-in time, and may even *reduce* its resale value if the equipment can't be restored to its original condition.

To get the most out of your radio, use it with the best *outdoor* antenna you can install. Ground the set, keep it aligned and adjusted properly, make sure you have read and thoroughly understand the instruction manual, and know well how *all* the controls work.

Final wrap-up

Hopefully, I've been able to help you focus clearly on the receiver features and specifications that are most important to you, and to help you decide whether to buy a new model or to purchase a used or surplus receiver. Take the trouble to decide carefully what you want in a receiver, then go about looking for the one that meets your needs. Give it your best, because your communications receiver is probably the most important radio investment you will make. ■

Who sells what

Before committing yourself to the purchase of any receiver, get all the facts by sending for spec sheets on the ones you're considering for purchase, and read the equipment reviews on ones that strike your fancy. The following list of receiver and transceiver manufacturers, reconditioned equipment dealers, and surplus houses should help in searching for a receiver that's best for you:

Receiver and transceiver manufacturers

Atlas Radio, Inc., 417 Via Del Monte, Oceaside, California 92054
Collins Radio Co., Cedar Rapids, Iowa 53406

R. L. Drake Co., 430 Richard St., Miamisburg, Ohio 45342
Heath Co., Benton Harbor, Michigan 49023 (kits)

Henry Radio Co., 11240 W. Olympic Blvd., Los Angeles, California 92801
McKay Dymek Co., P. O. Box 2100, Pomona, California 91766

Ten-Tec, Inc., Highway 411 East, Sevierville, Tennessee 37862
Trio-Kenwood Communications, Inc., 1111 West Walnut St., Compton, California 90220

Swan Electronics Corp., 305 Airport Rd., Oceanside, California 92054
Yaesu Electronics Corp., 15954 Downey Ave., Paramount, California 90723
Radio Shack Corp., (local dealerships)

Reconditioned equipment dealers

Amateur Electronic Supply, 4828 W. Fond du Lac Ave., Milwaukee, Wisconsin 53216
Barry Electronics, 512 Broadway, New York, New York 10012

Hamtronics, 4033 Brownsville Rd., Trevose, Pennsylvania 19047
Harrison Radio Corp., 20 Smith St., Farmingdale, New York 11735

Surplus dealers

Arch Electronics, 816 Arch St., Philadelphia, Pennsylvania 19103
Barry Electronics, 512 Broadway, New York, New York 10012

Delta Electronics Co., P. O. Box 1, Lynn, Massachusetts 01903
Fair Radio Sales, 1016 E. Eureka St., Lima, Ohio 45802

Reliance Merchandising, 2223 Arch St., Philadelphia, Pennsylvania 19103
Spectronics, Inc., 1009 Garfield St., Oak Park, Illinois 60304

My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

I believe he was right. Today is the age of specialization. And I think that's a very good thing.

Consider doctors. You wouldn't expect your family doctor to perform open heart surgery or your dentist to set a broken bone, either. Would you?

For these things, you'd want a specialist. And you'd trust him. Because you'd know if he weren't any good, he'd be out of business.

Why trust your education and career future to anything less than a specialist?

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FACT: CIE is the largest independent home study school in the world that specializes exclusively in electronics.

We have to be good at it because we put all our eggs in one basket: electronics. If we hadn't done a good job, we'd have closed our doors long ago.

Specialists aren't for everyone.

I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

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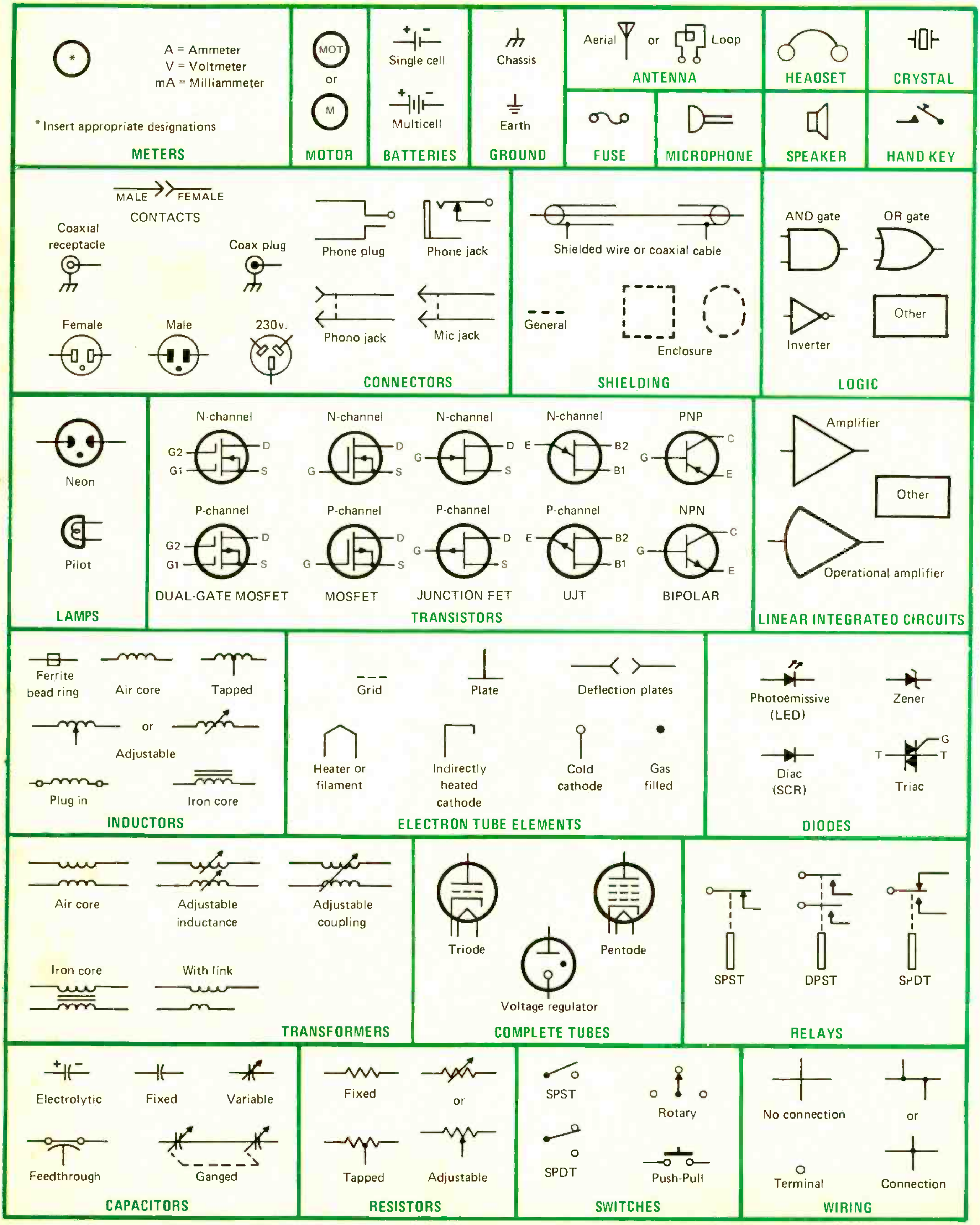


Skip—what's it all about?

Although shooting skip may seem pretty hit or miss to some, you can improve your chances of snagging a rare one if you follow these simple suggestions.

by George McCarthy

One listen on the CB channels or the ham bands in the last few months should be enough to convince anyone that the long-awaited Cycle number 21 has arrived and those sun spots are doing their thing. The effect of the increased sun spot activity has been most evident on the higher frequencies, where long distance skip is an everyday occurence.

For thousands of new hams and CB skip shooters this will be the first of the familiar 11 year cycles. And the fun is only beginning. This current cycle is expected to peak in 1980. Then it will decline for some four years before it begins to bottom out. Yes, we are expecting at least six years of a level of sun spot activity that should support fairly consistent long distance communication.

This new cycle is being greeted with enthusiasm in the ham ranks. But, there are already millions of CBers who are no longer intrigued by the sound of someone calling *CQ-DX* from the other side of the country—right on a channel that had previously been used for local communication.

This article is not primarily about sun spot activity, however. Rather, it is about one of the ways to use this cycle if you do like to chase DX. At this point let me clear up one possible ambiguity. DX is an abbreviation of long standing that means *distance*.

In the amateur radio business it always stands for a contact with another station that is in a different country—outside of the country of the station calling. It is considered bad form to reply to a station calling CQ-DX if you are in the same country. In the CB business, on the other hand, the expression just means that one is calling for a contact with a distant station, preferably in another state and as far away as possible.

Ground and sky waves

In both cases the calling station is making use of the well established fact that his radio signals are putting out a *sky wave* as well as a *ground wave*. Radio signals from the sky wave come off of the antenna at various angles, depending on the antenna and the frequency, and travel on up to the ionosphere, where they *may* be reflected back to Earth some distance away from the transmitting location.

This phenomena was first observed and proved by two physicists, Kennelly of the U.S. and Heaviside of Great Britain. They realized that Marconi's successful transmission of radio signals across the Atlantic could not have taken place on a direct path, but must have been reflected back to Earth. Even today not everything is yet known about how many factors might affect the transmission and reception of radio signals.

The term *skip* came into being when it was first recognized that some radio signals were literally skipping over the space between the point of origin and the point of reception. This phenomena was the result, of course, of the fact that the signal was not following the curvature of the Earth, but was traveling in a relatively straight line up to one of the *layers* above the Earth and then bouncing back down.

A receiving station over the horizon and out of range of the transmitting station's ground wave would not even hear the signal. But another station hundreds of thousands of miles away—where the signal came back down to Earth—would receive it loud and clear. The area in between, in which signals were not heard, became known as the *skip zone* to designate that signals were skipping over it.

There are a couple of things that should be mentioned because they have a direct bearing on the effective use of the right radio path. Looking at *figure 1* you'll see that the lower the angle of radiation, the greater the distance from the point of origin the signal will be when it returns to Earth.

The geometric law that the angle of reflection equals the angle of incidence is not absolutely true. Apparently some bending of the radio wave occurs, rather than a point-to-point reflection. But for most purposes we can assume that the radio wave will be reflected or refracted back to Earth as near the same angle as it arrived.

More Than One

At first it was thought that there was only one layer up there that was doing the bouncing back to Earth. For many years it was known as the *Kennelly-Heaviside layer*, in recognition of its discoverers. After a time it became apparent from various radio soundings that there were several layers up there and they varied in their effective height above the Earth.

Figure 2 shows the layers concerned with long distance propagation. The *E* layer is about 70 miles above the Earth. The *F* layer is actually two layers, the *F-1* layer at about 140 miles and the *F-2* layer at around 200 miles. At night the two F layers recombine into a single layer about 175 miles high. Not shown is a *D* layer, which exists only around the noon hour and affects only frequencies below 5 mHz.

It is important to realize that these layers are not some solid permanent wall up there that bounces signals back like ping-pong balls. Rather they vary in thickness and height and in their ability to reflect radio waves. That is, they are constantly changing in composition.

Perhaps the most important factor for us to consider is the degree of ionization that is present at any one time. It is the ionization that determines if the layer will absorb most of the radio energy, reflect most of it back, or allow it to pass right on through to outer space.

There are many factors that affect long distance radio propagation. Not all of them are yet understood. We have evidence that the Earth's magnetic flux has a decided effect. We are also aware of effects from solar storms, from the aurora borealis, and so forth. However, in this article we are going to concern ourselves only with reflections from the ionospheric layers.

The effects of cosmic rays

What causes these layers to bounce radio signals back to Earth? Apparently it is the ionization level. Ionization takes place when the atoms that comprise the thin atmosphere up there are bombarded by ultra violet rays from the sun. Other particle bombardment from cosmic rays may also be present. The impact of the rays temporarily separates the ions and electrons that are normally in a state of electrical balance.

Where the atmosphere is relatively dense and the atoms close together, the recombination of electrons and ions into a balanced state takes place fairly rapidly. There must be a constant bombardment to keep enough ions split off to maintain a state of ionization in the layer.

Since the source of the bombardment that ionizes a particular layer is the sun, it becomes obvious that if the rays from the sun are not hitting a layer it will no longer have ions splitting off. All will recombine and the ionization will disappear. No ionization—no radio reflection and no skip.

At the higher altitudes, where the atmosphere is less dense, the recombination takes place more slowly. The layer may retain enough ionization to reflect radio signals long after it has ceased to be hit by radiations from the sun. This is true of the nighttime F layer, if it was thoroughly ionized while in sunlight.

The degree of ionization obviously is the controlling factor of how well those layers will provide long distance skip propagation. In turn, that depends on the sun's level of activity in generating solar energy in the form of ultra violet radiations. This appears to be directly related to the so-called sun spot activity.

The spots are actually parts on the sun's surface that are cooler than the surrounding areas. They are the source of tremendous amounts of energy that pour in a stream of hydrogen and calcium gases in a vortex like a cyclone between the two poles of an apparent magnetic loop.

Sun spots

In one 11 year cycle they will be below the sun's equator, while in the next cycle they will be above the equator. In either cycle the effect is stronger as the spots move closer to the sun's equatorial line. We won't go further into this subject except to state that the level of ionization seems to be directly dependent on the number of sun spots.

The cycles actually overlap each other. The current cycle was first noticed several years ago, but will not reach a peak until 1980.

We have, in very general terms, established that layers do exist above the Earth and that they will reflect radio signals, depending on the degree of ionization. We can now direct our attention to the more specific aspects of getting our radio signals from here to there.

We mentioned that both absorption and reflection take place when a radio wave enters an ionized layer. Some of the energy used to excite the ions will be expended in this job, but some will be bounced back.

The phenomena of reflection is very dependent not only on the degree of ionization, but also on the frequency of the radio wave. And that later is a variable because the frequency that will be bounced back is constantly changing in direct relation to ionization. Less ionization is required to reflect the lower frequencies than the higher frequencies.

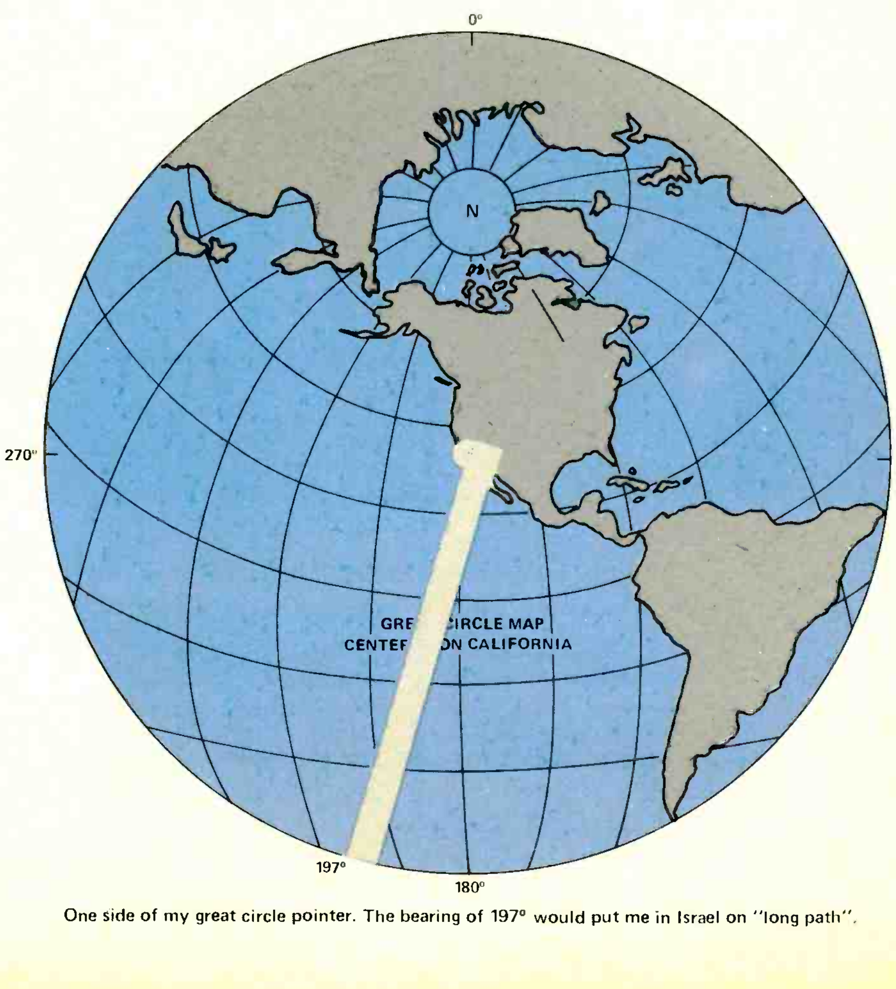
At any one time, for a particular zone of the layer, there will be a *maximum useable frequency or muf*. This represents the highest frequency that will be reflected back to Earth from a specific area of the layer.

The layer is not a homogeneous mass surrounding our Earth with uniform thickness and density. Rather it is constantly expanding and contracting, moving up and down, and variable in the amount of ionization.

For any particular path between two points on our Earth the layer will be in a given state. It will reflect signals up to some maximum frequency. Beyond that the signals will not be reflected, but will penetrate the layer completely.

Changing muf

From the foregoing you can see that the muf is not constant each hour, but must be calculated over a specific radio path, taking into account the degree of ionization that will exist over that path. In general you can get a pretty good idea of possible radio paths if you can visualize the illumination of the Earth as if you



One side of my great circle pointer. The bearing of 197° would put me in Israel on "long path".

were looking at it from outer space. The tv pictures that our astronauts sent back of the terminator line—the edge of darkness and light—from the moon were spectacular proof that half the Earth is in relative darkness half of the time. There is a wide variation depending on time of year and latitude, but while the rays of the sun are hitting, the layers will be ionized to some degree.

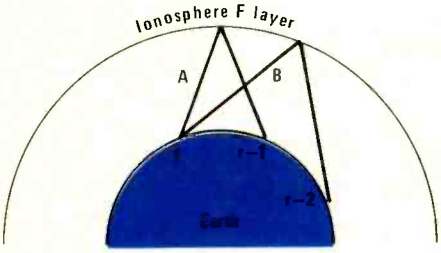


Figure 1 **Showing that high angle signal at A will travel less the distance than the low angle signal at B.**

Your radio signals will travel over the path that offers the best reflecting surface back to Earth. If you are not using a beam antenna, you pretty much have to take what comes. You will notice that the radio path seems to generally move with the sun. As signals fade from the east they pick up strength from the west. This is directly attributable to the decreasing ionization as the F layer thins out and splits into two separate layers.

Generally the first frequencies to lose the reflection necessary for communication are the higher ones, since they require more ionization. First you'll lose contacts on 10 meters. Then, later, 15 will drop out. In winter time, 20 will then drop out and you'll be left with skip propagation only on 40 meters or lower bands.

In summer, during the peak period of the sun spot cycle, 20 meters will be open to some spot on the Earth on a 24-hour basis. 15 meters will frequently be open until almost midnight to the west and even 10 may last well into the evening.

Now, before all of you CBers land on my head with your skip contacts late at night, let me hasten to add that I am talking about radio paths using the F layers. The E layer, which provides one bounce contacts over a 1250 mile maximum path, is also subject to occasional retentions of a high degree of ionization, particularly in the spring and fall months.

This is known as sporadic E skip and it accounts for those very loud signals heard on the higher frequencies over relatively short ranges. Usually the sporadic E skip is fairly local in nature, since the ionization takes place in only particular areas of the layer. You may hear loud signals out of the northwest, but nothing from other areas of the country.

For this discussion we are relating only to the skip from the F layer(s) and preferably obtained with the use of a directive antenna—a rotary beam. In order to make use of the optimum radio path between our location and that of the station we are trying to contact we must know something of both the probable area of best ionization and the correct heading in which to point our beam.

Unlearn old ideas

Heck, you say, point the beam right at the station you want. Right. But, what is *right at?* If you are used to looking at the typical mercator projection map you are going to have to unlearn your idea of directions when it comes to pointing your beam antenna.

From grammar school onwards we are shown maps which seem to indicate that certain areas of the world lie in well-defined directions from our country. You want to talk to Rome from Chicago? Heck, you're almost on the same latitude. You can just about draw a straight line going east and connect the two cities. So you point your beam due east at 90 degrees, Right? Wrong!

Radio signals generally prefer to take the shortest path between two points. Sure, that's a straight line. But it's using the "great circle" path—the same path international airplane flights take if they want to go non-stop the fastest way. You can get a good idea of this path if you pin a string on a globe of the world at your location and then move it around to find the shortest length that will get you to another location.

If you don't have a globe use an orange and visualize where the countries are. Now you will find that your heading for Rome from Chicago should be northeast, not east as you expected.

With a little practice you will quickly start to think in these new dimensions. You will realize that aiming over the polar regions is frequently the shortest path. A great circle chart of the world will aid in finding the right direction. But, you should be aware that it must be centered near your location to be correct, as far as antenna headings are concerned.

Even a shot from Los Angeles to New York City would be east northeast—about 60 degrees—in spite of the fact that we tend to think of "Fun City" as being east—90 degrees. You should learn to visualize the path your signal will take, where it will hit the layer, where it will come down and bounce up again. Yes, I said bounce up again.

Even with a low angle of radiation and a bounce off of the F layer the longest single hop distance is around 2500 miles. The distance from San Francisco to Rome is 6228 miles on the great circle path—the shortest route. Obviously it can't be made on one hop. Most likely it will take three or four hops, depending on the best path and the angle of radiation.

This isn't done for free however. It is estimated that each hop takes about 10 dB off of the signals. That means that only one tenth of the power gets back on up for the next hop.

You can figure what a multi-hop path will cost in the way of lost signal strength. Even with that, I've heard signals from half way around the world pounding in at 30 dB over S-9. Don't lose hope of being heard just because you have to bounce your signal many times.

Practical approach

Let's practice with a few radio paths to demonstrate how we can get from here to there and be heard with a strong signal. Our station is near Los Angeles. On a mercator projection map we can immediately see that it puts us at about 34 degrees latitude and 118 degrees longitude.

I have a quad beam antenna to squirt my signal in a particular direction. The first thing I did was to calibrate the antenna so that my indicator would show, in degrees, exactly what direction it was pointing. To do this accurately I had to know the deviation between *magnetic* north and *true* north, since all bearings are based on true north. For this location the variance is 17 degrees, so I allowed for that correction before bolting the boom-to-mast coupler into position.

Another thing that helps me to work DX is a good 24 hour clock set for GMT, now known as *Coordinated Universal Time* or UTC. Not only do I always keep my log book in UTC to avoid time and date problems when QSLing DX stations, but also I know the local time for most parts of the world.

That's important in calculating how much of the "path" between my station and other parts of the world is or has recently been, in sunshine.

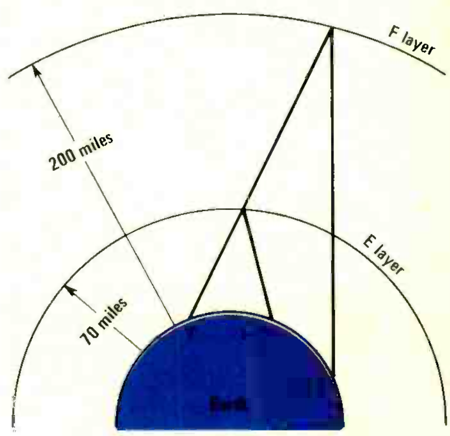


Figure 2 **Showing radio wave reflection off of both E and F layers. Distance at r—2 will be twice that at r—1.**

What about a bearing to swing the quad antenna to? I have a handy little device that is a cardboard great circle map centered on California. It has a plastic pointer that rotates from the middle. I move it to point to the location I want to reach. If, for example, I wanted to communicate with a German station,

please turn to page 88

Computerized interviewing: the latest wrinkle in opinion surveys

The day of man-on-the-street interviews is over—replaced by giant computer-coordinated telephone interview systems. Here's what these new systems do and how they work.

by Bob Grant

Professor Shure and a supervisor man the supervisors area. Here they can monitor the computer displays seen by each of the interviewers, and listen in on the telephone conversation.

Television rating systems, political polls, population census—all these things and many, many more will be handled by computer if the future foreseen by Professor Gerald H. Shure, Director of the Center for Computer-Based Behavioral Studies at UCLA (University of California, Los Angeles) comes to pass. In fact, a massive study of some 30,000 respondents is underway right now in a joint effort with the University of California at Berkeley to survey the status of mental and physical health statewide.

The development of the current CATI (Computer-Assisted Telephone Interviewing system) is being supported by a $178,300 grant from the National Science Foundation—one of several concerned with the general development and improvement of survey research methodology.

Hardware for the system currently in use at UCLA includes a PDP-1145 Digital Equipment Corporation computer, 24 Ann Arbor computer display terminals with keyboards—fundamentally a television tube linked to the computer by an umbilical cord. Other equipment includes a patchboard facility which controls the routing of the video processing system, audio processing, video amplification and switching, audio amplification, video and audio tape recorders, the computer processing system, and a response-time measuring facility.

In addition to the computer and patchboard rooms, the basic facility includes a system of cubicles which can be assembled in any form from two large cubicles to its present 24 individual working cubicles.

Each of the cubicles contains a keyboard computer terminal, a video monitor, a closed circuit television camera and a microphone. This arrangement lets supervisors hear and observe each interviewer any time they wish for research and training purposes. A loudspeaker, a telephone with a headset, and switches and jacks to control various functions such as the response-time measuring unit previously mentioned are also provided.

OK, now we know what the system consists of. But exactly what does it do? And why is it necessary to bring a computer into the simple act of taking a survey? Wouldn't a man going door-to-door with a pad and pencil be able to do the job just as well?

"Not on your life!" states Professor Shure emphatically. "The big problem right now is that politicians, television networks, anyone who gets unfavorable results bitterly complains about the inaccuracies of the present paper and pencil survey system.

Our research here is designed to make the process as accurate, as error-free as possible." The computer basically conducts the entire interview in the sense of presenting to the interviewer the information to be asked of the respondent, according to Professor Shure.

Two-way communication

The on-line computer administration of interviews gives the interviewer *two-way* communication with the computer during the interview process. The question to be asked appears on the video tube, and the answer is entered into the computer with the keyboard terminal.

Closed circuit tv cameras located in each interview station lets the supervisors observe the interviewer. This helps in training and research.

The display system operates at a 7200 baud rate so there is virtually no delay. The information on the display is updated within one second of the time the interviewer enters a response.

The computer is programmed to compare certain answers, and will pick out inconsistent or incorrect responses. For example, take the case of the question: "How old are you?" If an age of 55 is given, and later in the interview the respondent states that he or she is receiving Social Security retirement benefits, there is an obvious discrepancy. The computer will immediately bring this to the attention of the interviewer.

If any problems arise during the interview, a supervisor can be called in through the use of the computer terminal keyboard. "With this information," states Professor Shure, "we can now begin to study the actual interview process."

Telephone interviewing came onto the scene to save money and time over face-to-face field interviews, but there has always been some doubt that the information gathered this way was as valid. And, in fact, there are both advantages and disadvantages to each type of survey.

In favor of the face-to-face interview, there are additional visual checks to confirm the respondent's answers. If, for instance, he claims his income is $100,000 a year, but he lives in a run-down shack, there is reason to question his reply.

On the other hand, there are many people who won't let interviewers into their homes. The only way to reach them is by telephone.

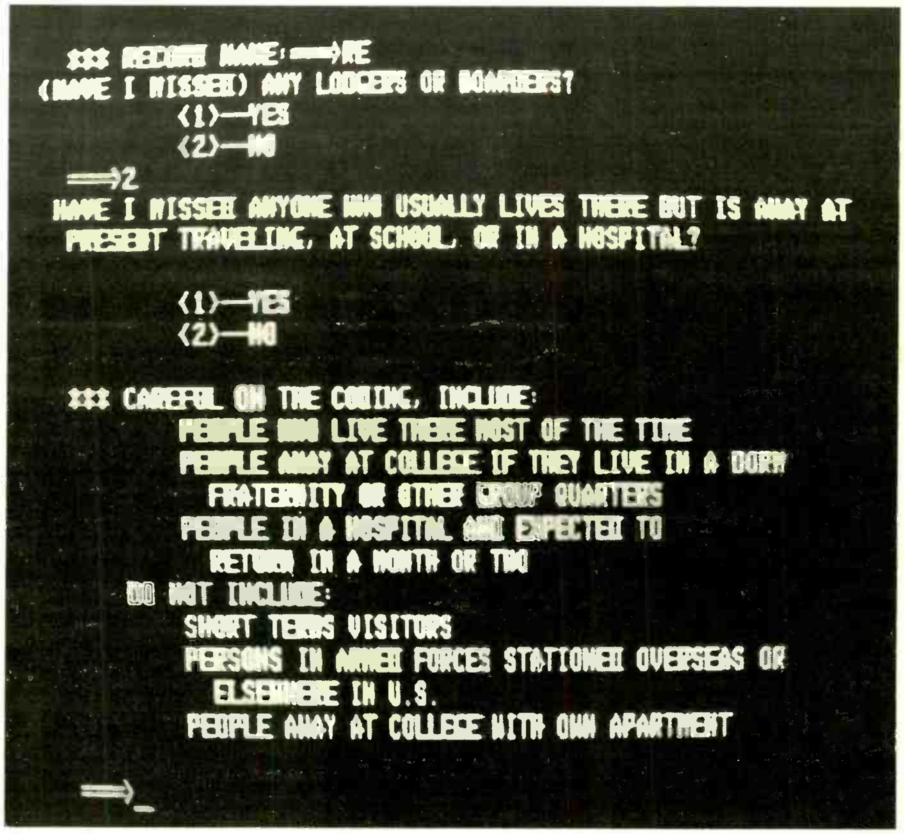
"The findings point more and more," states Professor Shure, "to the fact that telephone interviews are just about as reliable as face-to-face interviews." In order to get a true cross-section sampling, the computer even generates the telephone numbers for the interviewer to call. This is done on the basis of certain random digit dialing specifications designed to get a representative sample of the population of interest.

"Selecting the random respondent is very important," says Professor Shure, "and we have a fairly sophisticated system for obtaining the numbers within any area code and exchange. In addition to supplying the numbers for each of the interviewers to call, the computer also checks on the disposition of the call—whether it is completed, and if not, why not.

Especially important is the computer's ability to store information on a partially-completed interview, including the time and day the respondent should be called back. Completed interviews go into a data base. At the end of each day the data base is reduced giving the researchers a peek at the results the next morning before they go ahead with the next day's interviews.

Custom tailored interviews

Branching is an area in which paper-and-pencil interviewers often get confused, but at which the computer excels. Branching refers to a set of questions to be asked *only* if the respondent answers a specific question a certain way. An example would be: "Are you married?" If the answer is yes, a separate set of questions may be asked. If the answer is no, the interviewer skips the branch questions and goes on with the interview.



The specific questions to be asked during the interview are displayed by the computer on a video terminal.

Each interviewer monitors a computer video terminal which displays the specific questions to be asked. As answers are inputed through the keyboard the computer flashes new questions onto the display.

Branching requires the interviewer to flip back and forth in his paper survey to the proper section. This often gets confusing. But with the help of the computer, it is done automatically. In reply to a certain response, the computer flashes the correct set of branch questions on the monitor.

It's a well established fact that the order in which questions are asked can influence the replies. The computer permits all sorts of manipulations which interest scientists studying the interviewing process. The computer can also control the flow of the process—it can instruct the interviewer to pause if he is proceeding too rapidly, or tell him to speed up if he is going too slowly. It can direct the way the interviewer is to respond if he fails to get the proper kind of an answer.

Reducing error

"Control of this type helps reduce the variance in the interviewer behavior,"

The heart of the system is this Digital Equipment Corporation PDP-1145 computer. The diskpac bulk storage memory lets the computer compare answers with those of other respondents in similar categories to reduce the possiblity of error.

states the Professor. This variance causes some of the variability you get when a survey is repeated with different interviewers. Our aim is to reduce the amount of error that occurs in survey results."

Another important piece of data the computer can collect is timing information—the length of time the respondent takes in answering certain kinds of questions. This provides information about the respondent which has never been collected before because it was just too cumbersome in face-to-face interviewing.

There are many facets to the survey interview, which is a very complex and involved process. Information is collected for the social sciences, for political, and for policy purposes. In fact nearly 88 percent of all the data collected in the social sciences is collected this way.

The marriage of the survey interviewer and the computer promises to be a long and prosperous one. It is now possible to have more accuracy and collect more information than ever before. "And we're just now beginning to understand how powerful a tool the computer can be in this particular area of the social sciences," concludes Professor Shure. "It's going to open up a lot of new doors in helping us understand the attitudes and opinions of the American public!"

Test your pot

If you've been faced with the problem of finding an intermittant open, you'll like this easy-to-build tester.

by Colin J. Shakespeare

Necessity, they say, is the mother of invention, and it was necessity that provided the impetus to design and build this particular piece of test equipment. My problem was to service the potentiometers in the control panel of a theatrical lighting system with the panel removed from the system. The controls are typically 10,000 ohm wire wound linear potentiometers which become noisy with age. This results in some rather startling and disturbing on-stage effects.

The potentiometer tester can, of course, also be used for testing any out-of-circuit potentiometer or any other circuit configuration where an intermittant open circuit is suspected. The circuit detects any momentary open circuit—down to the nanosecond region—and produces a visible flash of approximately one tenth of a second on an LED.

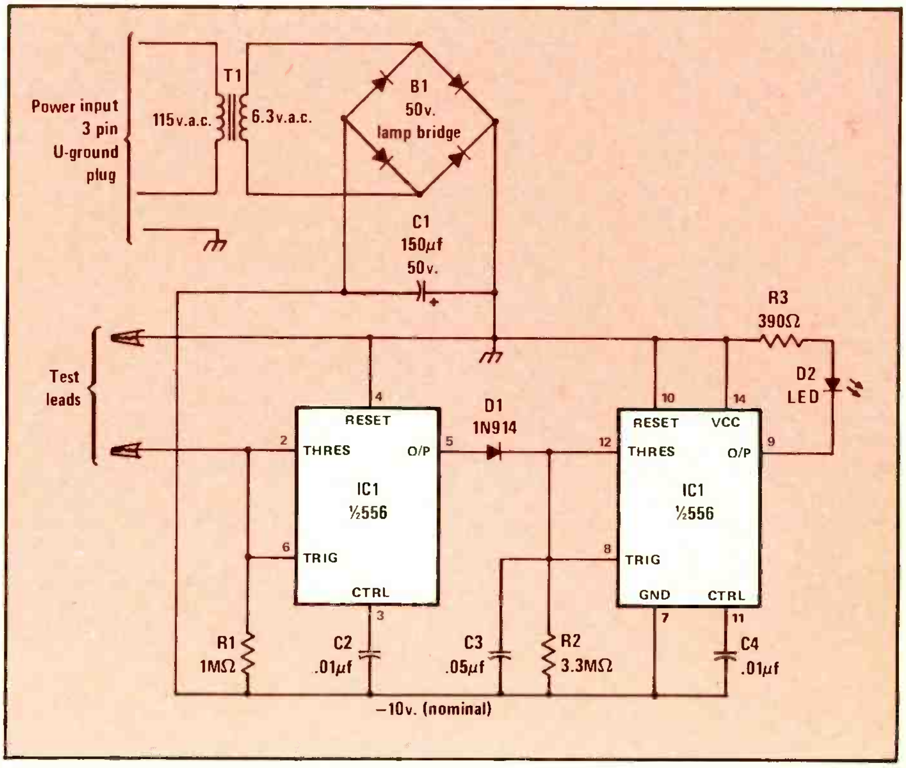
Simple circuit

As with any of these simple circuits, the power supply components cost more than the functional components, but in order to make the unit completely self contained a power supply had to be included. The circuit is tolerant of a wide range of supply voltages and power supply ripple. Component layout is not critical.

An inexpensive 6.3-volt transformer was chosen in the hope that it would give more than 6.3 volts on light load, which tends to be characteristic of the inexpensive ones. Any transformer which gives between 7 and 12 volts ac will work well in the circuit.

The circuitry, as shown, is operated from a negative supply voltage. In the case of my lighting control panel, the potentiometers happen to be connected together in pairs with diodes. Choosing the negative polarity made it possible to test the panel without unsoldering the diodes.

Half of the 556 IC is used as a voltage comparator. Provided the potentiometer



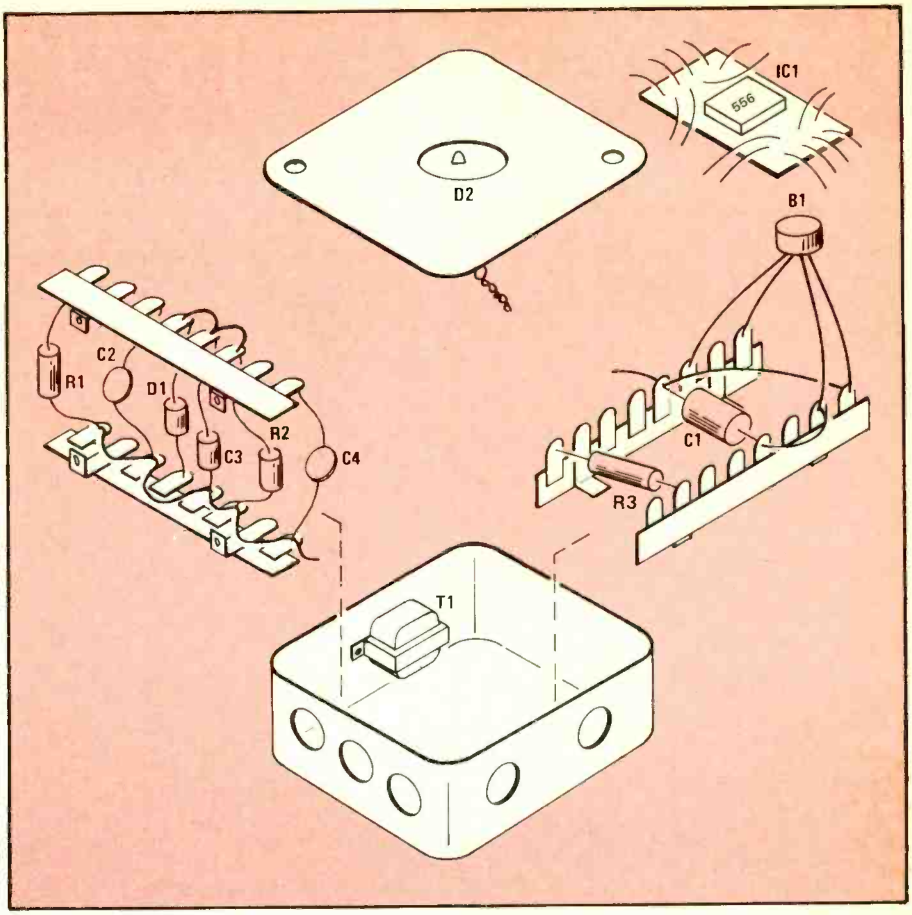
The potentiometer tester is build around a single 556 timer integrated circuit powered by a conventional full-wave bridge rectifier power supply. The circuit shown runs off the negative voltage output of the bridge. However, the circuit can be modified to operate from a positive dc voltage. The potentiometer or circuit under test is connected across the test leads.

under test is less than one half the value of R1, the input to the 556 will stay above the threshold voltage and so the output, pin 5, will be low. When the potentiometer under test goes open circuit, the input to the 556 falls below the trigger voltage and pin 5 goes high, charging the timing capacitor C3. By keeping C3 small, its charging time is comparable with the shortest duration open circuit that can be sensed by the 556. The time, in seconds, that the LED remains lit after pin 5 goes low is approximately equal to the value in ohms of R2 multiplied by the value in farads of C3.

Easy to build

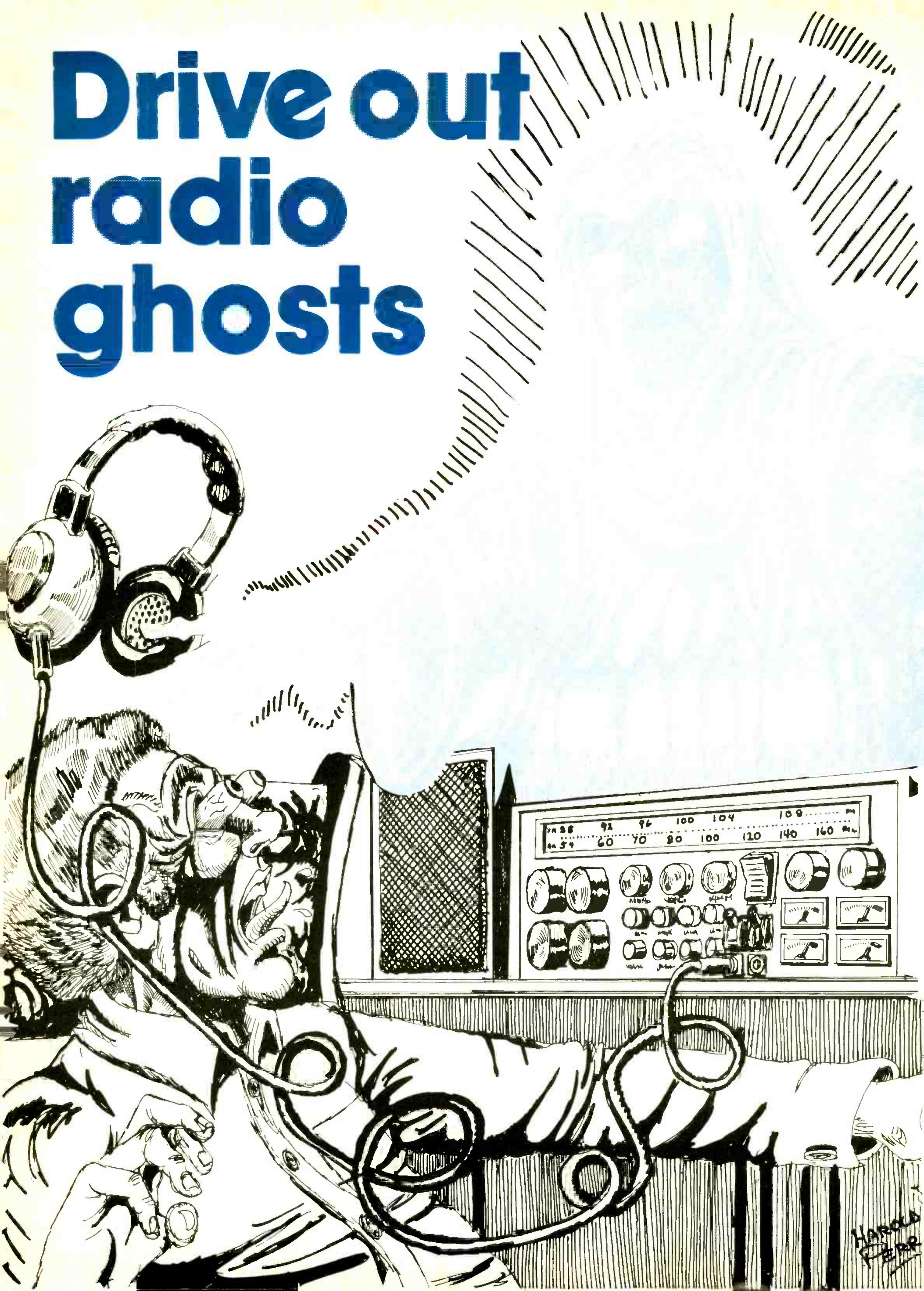
The circuit was built into a standard four-inch electrical box. Being a metal box, it is important that a 3-wire cord be used and that the box be properly grounded. It is also a good idea to tack the knock-outs down with solder, but this is easier said than done. Having made sure the inside of the box is grease free, you'll need a really hot soldering iron and maybe a little extra flux to get the solder to flow properly.

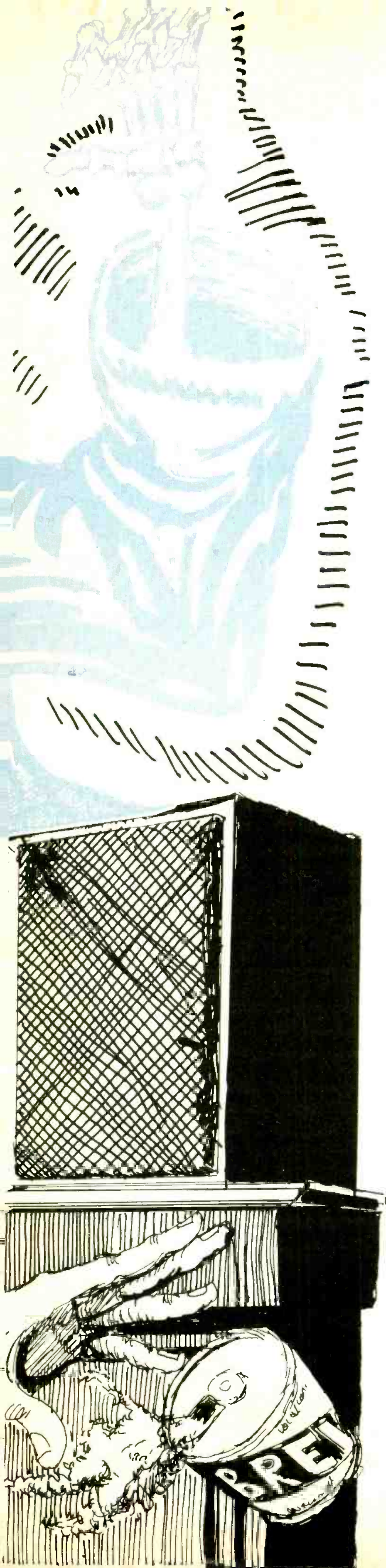
The LED will be more visible if mounted with a black background. In my version the top of the box was sprayed with a matt black paint and the LED inserted through a hold drilled into the middle. Of course, you can build your tester in a black plastic case, or any other suitable cabinet you have handy.



Parts layout isn't critical. Although the prototype was build in an electrical junction box, any cabinet will do.

Drive out radio ghosts





Call them phantoms, ghosts, or just plain interference—those unwanted signals sneaking into your receiver can be downright infuriating. But these simple steps can chase your ghosts back into the grave.

by John E. Shepler

Do you have ghosts in your audio equipment? Perhaps you have heard them—faint little voices in intercom or PA speakers, or maybe strange music coming from your stereo long after the turntable has stopped.

Most likely, these are not contacts from the spirit world but simply a condition known as radio frequency interference or RFI. The voices or music may be originating from a local radio broadcaster or perhaps even a ham or CB operator. RFI is actually an overload condition whereby normally well-behaved audio circuits begin to act like radio receivers.

Very sensitive circuits like microphone or phono preamps are particularly susceptible. The presence of strong rf signals can drive semiconductors out of their linear operating ranges. The transistor or integrated circuit junctions will then act like diode detectors much the same as in a crystal set. Once the radio signals are detected, they will be amplified right along with the normal audio.

What can you do to exorcise these ghosts from your equipment? There are really only two effective methods: shielding and bypassing.

Shielding means putting a metal case around vulnerable circuits so that they are never exposed to outside radio waves. The higher the offending frequency, the tighter the metal shield must be. The reason is that higher frequencies with their shorter wavelengths can sneak into cracks and holes that lower frequencies cannot penetrate.

If the equipment is not entirely self-contained, any cables entering the cabinet will also have to be shielded or bypassed. In stereo phonographs, shielded audio cable is a must between the tonearm and preamp. You should also make sure that the phono connectors are making good contact at both ends and that there is no corrosion where the metal parts touch.

If shielding is not possible or doesn't seem to do the job, the most effective approach is to bypass the offending signal before it can do any damage. Bypassing is really not very difficult, but must be done with caution. One potential problem is that tinkering with the circuitry may void any new equipment warranty. Also, if done improperly, some higher audio frequencies may get bypassed along with the rf.

If you are still not afraid of ghosts, the next step is to isolate the affected stage. In a stereo receiver, the tuner and tape input circuits might be perfectly ok, but a local radio station may be heard faintly in the phono position. In a public address amplifier, the problem may only exist when the microphone level is increased.

Once you have narrowed the rf problem down to a particular stage, check the schematic diagram to see what components might be acting as detectors. Transistors, diodes, and integrated circuits are all likely suspects.

Bypass capacitors

In the case of transistor amplifiers, solder a small value ceramic bypass capacitor directly acorss the base and emitter connections. 50 to 100 pf units are usually very effective and will not affect audio frequencies. Keep the leads of the capacitor as short as possible and solder directly to the printed circuit foil.

For integrated circuits, you will need to locate the inverting and non-inverting inputs on each IC. Note that some integrated circuits have more than one amplifier in a package. Solder 50 pf capacitors to the pins that go to these inputs.

Diodes can be particularly troublesome if they are located in an automatic gain control stage as they are in many popular cassette recorders and two-way radio gear. Bypass each signal diode with a 50 pf capacitor connected from anode to cathode.

If the rf problem is very severe, you may have to bypass more than one stage. You may also have to put bypass capacitors across the inputs and outputs. Grounding the chassis and bypassing the power cord with 0.01 uf/600V capacitors from each side of the line to the chassis may also be needed. These techniques, though, should be needed only in only the most stubborn cases.

One final thought about amplifiers with very long wires to remote loudspeakers—if nothing else works, try using an audio isolation transformer with a 1:1 turns ratio. This may stop your speaker wires from acting like a super-efficient antenna.

Once you have gotten the feel of RFI shielding and bypassing, you may want to offer your services in the neighborhood. Chances are, others are having the same problems and would really appreciate having someone eliminate the radio ghosts that are haunting their hi-fi's.

Play 'random chance'

Fun to build, more fun to use—that's the Modern Electronics solid-state lottery game. Construction is simple, costs are less than $10, and you can set the odds from 1 to 2 to 1 in 1024.

by Jeff Sandler
Contributing Editor

Barnum said one was born every minute. Here's an interesting electronic lottery that'll help you find out which of your friends old P.T. was talking about. It's a completely self-contained, totally unpredictable lottery where you can set the odds from 1:2 to 1:1024. Once you've set the odds, all you do is push the scramble button for a second or two, then let the contestant hit a touch plate. If he's a winner, the buzzer will sound; if not, nothing happens.

The circuit consists of a switch operated free-running oscillator driving a counter, a diode matrix and alarm, and an interrogate flip-flop. Closing the scramble switch causes the free-running oscillator to drive the counter at a high rate. When the switch is opened, the counter freezes at whatever count it has attained.

When a contestant hits a touchplate, it triggers a one second flip-flop, which signals its activation by turning on an LED indicator. It also advances the counter by one count.

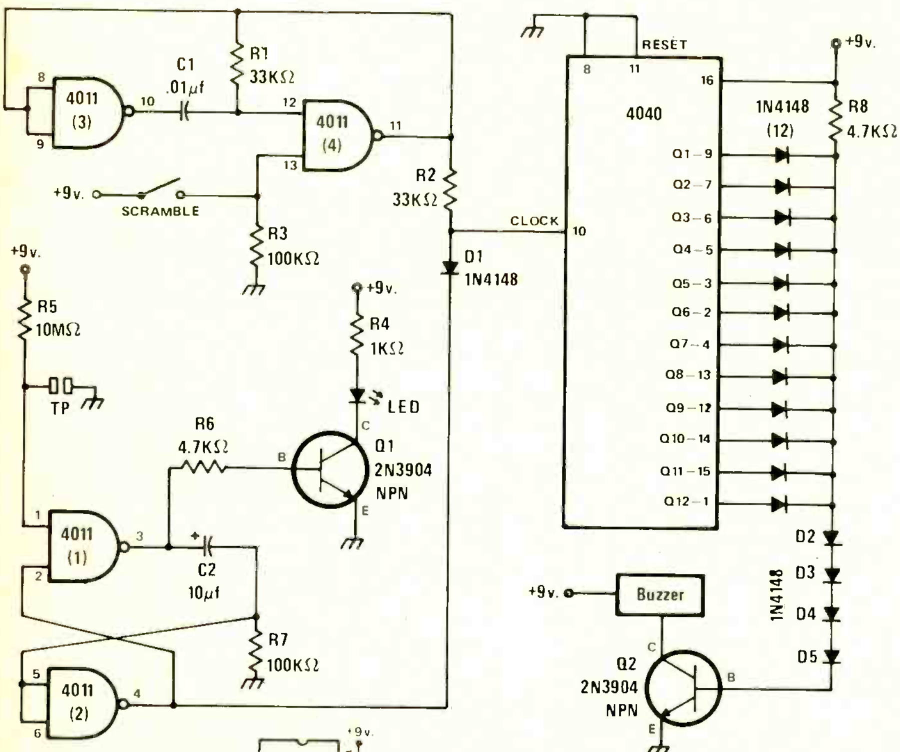
If the counter was frozen at one count less than that needed to go through the diode matrix, hitting the touchplate will advance the count and turn on the alarm buzzer signifying a winner. But, if the counter is frozen at any other count, advancing it by one will not produce the required number, and nothing will happen, signifying a loser.

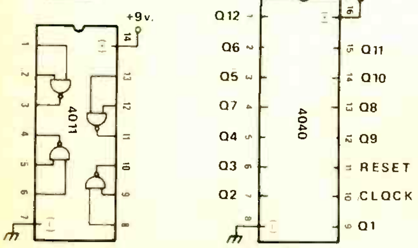
The odds are set by the diode matrix connected to the output of the 4040 counter IC. These diodes form an AND gate. Each and every diode connected in the matrix must be biased *off* for transistor Q2 to turn on and sound the alarm, signifying a winner.

The output of the 4040 counter is a binary number representing the count attained while the scramble switch is closed. Each character in a binary number is either a *zero*—low—or a *one*—high. The diodes in the matrix are biased off when their associated 4040 output is high.

Suppose you only connected the diode at output Q1 of the 4040, which is pin 9. Regardless of the count in the 4040, the odds are 50-50 that Q1 will be high. So, connecting only the Q1 diode, you set the odds at 1:2. By adding a second diode at output Q2, pin 7, you increase the odds to 1:4. Adding the diode at Q3, pin 6, the odds double to 1:8. In fact, you'll double the odds each time you add a diode to the next higher Q output.

You can get away from the 2, 4, 8, 16 progression of odds by skipping some of the diodes. Just remember the odds are set in binary. So, if you wanted to set the odds at 1:10, you'd connect the diodes to

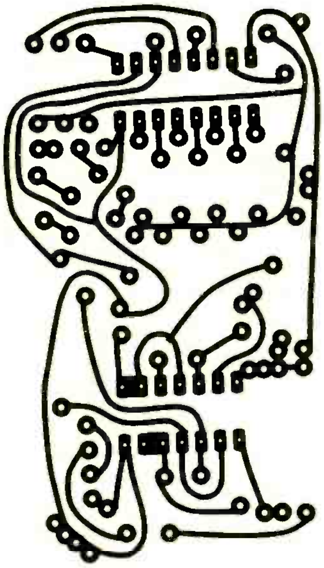




The ME lottery is built around two ICs, a 4011 and a 4020. The odds are set with the diode matrix connected to the output of the 4020. By choosing the right combination of diodes, you can select any odds between 1:2 and 1:1024.

outputs Q2 and Q4, which gives binary 1010, or 10. If you're not up on binary numbers, you'll find a short explanation at the end of this article.

If you set the odds at several times the number of players, you won't have to scramble the counter after each try. That's because there's no way of knowing what the counter contents are, or how many more attempts will be needed to get a winner. However, if the odds are relatively low, it's a good idea to scramble after each attempt.



Printed circuit layout for ME's lottery game showing the foil side of the board.

The circuit is really a lot simpler than its operation might lead you to believe. The scramble circuit and the player's interrogate circuit are built around a single 4011. The scramble switch can be any single pole, single throw unit you have handy. If you plan to buy a new switch, a miniature momentary contact unit such as the Radio Shack 275-1547 is ideal.

The touchplate used for taking a shot at the lottery consists of two metal strips separated by about one-sixteenth of an inch. Bridging the gap with your finger will trip the flip-flop, lighting the LED and advancing the count. The LED can be any unit you have handy. You may have to change the value of R4 to get the proper brilliance from the LED you use, however.

Although 2N3904 transistors are specified on the schematic, you can use most any small signal NPN transistor. The buzzer shown connected to the collector of transistor Q2 can be any unit with current ratings within those of the transistor, or you can connect a relay into the circuit to handle heavier loads. Remember to put a protection diode across the relay coil.

Parts layout isn't critical. If you're careful, you can use perfboard. But, with the diode matrix and two ICs, you're

please turn to page 88

Binary numbers— what are they?

A quick look at ones and zeroes

When does 1 + 1 = 10? When you're using binary numbers, that's when.

Binary numbers are the kind used by computers. And even though computers can process numbers representing billions, even trillions of units in just a fraction of a second, the largest single digit is 1! That's right, the entire universe of computer numbers runs from zero to one.

The reason computers have to use a number system that contains just two digits is that even the most sophisticated computer consists of nothing more than a large number of on-off switches. Since the switches can only be on or off, their position can be described by only two labels. So, when a switch is off, it's said to be in its *zero* state. When its on, its in its *one* state.

In the decimal number system you're used to using, you have ten digits to play with—0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. But even with this much larger group of numbers, you have to use more than one digit to represent large quantities. It's exactly the same with binary numbers.

What makes binary numbers so difficult to understand is that the digit 1 can represent what seem to be a random collection of quantities. In decimal numbers, each place going from right to left is ten times greater than the preceding place. So, its *one* hundred, *one* thousand, *one* hundred thousand, *one* million, and so forth.

In binary numbers, each place from right to left is *two* times the preceding place. So, instead of representing 1, 10, 100, 1000, 10000, binary numbers represent 1, 2, 4, 8, 16, 32, 64, 128 and so on.

A binary number of 10, therefore, doesn't mean a quantity of ten things. Rather, it means a quantity of *two* things *plus* a quantity of *zero* things, or a total of two. That's why 1 + 1 = 10. Using binary numbers, a quantity of one hundred would be written as 1100100. When reading the number, remember that it really means "add 64, add 32, *do not* add 16, *do not* add 8, add 4, *do not* add 2, *do not* add 1." If you do the addition, you'll see that 64 + 32 + 4 = 100.

There's no question about it, binary numbers can be difficult to handle mentally. But, for the computer, which after all only knows on and off, binary numbers are the only way to go.

		binary numbers				decimal
32	16	8	4	2	1	number
0	0	0	0	0	1	1
0	0	0	0	1	0	2
0	0	0	0	1	1	3
0	0	0	1	0	0	4
0	0	0	1	0	1	5
0	0	0	1	1	0	6
0	0	0	1	1	1	7
0	0	1	0	0	0	8
0	0	1	0	0	1	9
0	0	1	0	1	0	10
0	0	1	0	1	1	11
0	0	1	1	0	0	12
0	0	1	1	0	1	13
0	0	1	1	1	0	14
0	0	1	1	1	1	15
0	1	0	0	0	0	16
0	1	1	1	1	1	31
1	0	0	0	0	0	32
1	0	0	0	0	1	33
1	1	1	0	1	0	58
1	1	1	0	1	1	59
1	1	1	1	0	0	60
1	1	1	1	0	1	61
1	1	1	1	1	0	62
1	1	1	1	1	1	63

Binary numbers are written from right to left, just as are decimal numbers. The rightmost digit is the smallest quantity, the leftmost digit the largest. When reading a binary number, bear in mind that the 0 and 1 are not themselves numerals, but no-yes indicators. The binary number 111100 does not mean one-hundred eleven-thousand, one hundred as it does in the decimal system. Rather, it means *yes*, add 32, *yes* add 16, *yes* add 8, *yes* add 4, *no, do not* add 2, *no, do not* add 1. Following these instructions, 32+16+8+4+0+0=60.

Power supply blues

Adding a power supply to your pet project is far from exciting, but it can mean the difference between good operation and no operation at all. Here's the why and how of power supply design.

by Don Taylor

The real enjoyment in an experimental project comes from designing, building, and, believe it or not, *debugging* a circuit. But when it comes time to design and build a dedicated dc supply to power the project, enthusiasm has usually reached an all-time low.

If these symptoms sound more than just a little bit familiar to you, you may be suffering from power supply design deficiency anemia, also known as the "Power Supply Blues". The common home remedy for this ailment is to take a couple of zeners and put the circuit to bed. Before you do, however, read this article carefully and you might avoid common irregularities in your future designs.

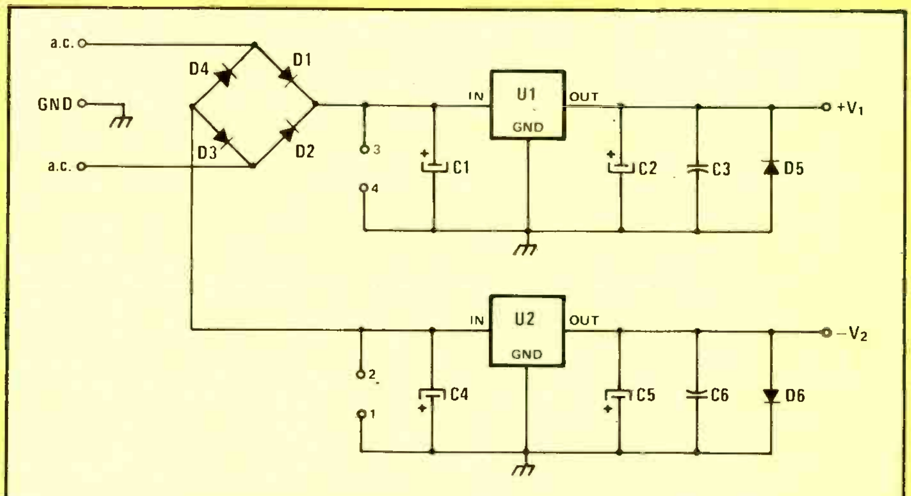
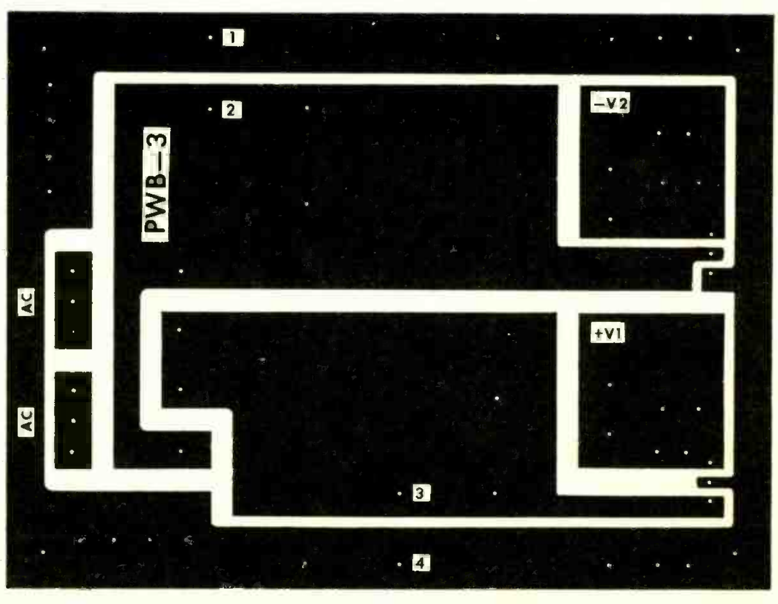


Figure 1 Schematic of dual polarity, standard power supply.



The power supply syndrome

The unfortunate thing about a ho-hum attitude toward power supply design is that it can create more problems than you might at first believe. Have you ever built an audio circuit that worked beautifully on the breadboard, only to have it drive you up the wall whenever a fluorescent light was switched off in the next room? Did your circuit sound a little cleaner in the workshop than it does now, with that inexpensive zener supply you installed? It might be that your circuit's performance is, to some degree, dependent on its power supply!

During debugging, most of us use a bench supply of reputable quality. These supplies usually have excellent line and load regulation and low ripple characteristics. In addition, they usually have other desirable features like adjustable current limiting or overvoltage protection. What happens, though, when that shiny new experimental circuit is connected to a supply with lesser credentials? Will the circuit perform as before, or will it have a new set of problems to debug, caused by such things as higher

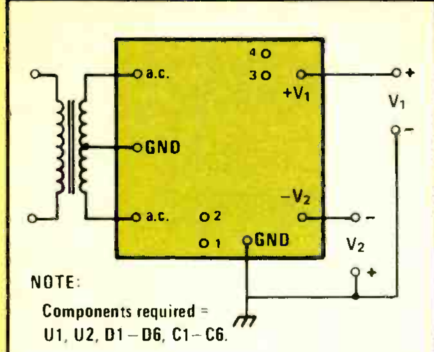


Figure 4 Dual polarity version.

there is an easier way. Use the same supply in your equipment that you use on the bench. If you standardize on a single, inexpensive circuit, circuit problems related to power supply sensitivity virtually disappear. And, power supply design will become a much more fruitful, and bearable, task.

power supply source impedance?

One way to minimize such problems is to connect a variety of power supply circuits to your project, and then select the most inexpensive supply that allows your circuit to perform within its specifications. There is, indeed, an optimum power supply for every project you might want to build. All you need is the time, energy and money necessary to find it.

Some large manufacturing firms that intend to produce a great number of units do find optimum design worth the effort. However, if you view the whole idea of power supply design with the same regard as taking out the garbage

A standard design

Figure 1 is the schematic of a general-purpose power supply that provides both a positive and a negative fixed output voltage. The circuit is based on the 7800/7900 and LM320/LM340 series three-terminal voltage regulators available from many sources. These regulators are supplied in TO-220 packages and come in a variety of fixed voltages.

Output voltage is regulated to within ±5 percent of the nominal voltage. With proper heat sinking, these regulators can source more than an ampere of current—with built-in current limiting and thermal shutdown!

The supply of Figure 1 is both reliable and inexpensive to build. If you etch the board, the total cost of the dual-voltage version, less transformer, should be under $8. It is relatively compact, and can be configured as a dual polarity supply or a single positive or negative supply. When used as a dual supply, non-symmetrical voltages (e.g. +5V, -12V) can be

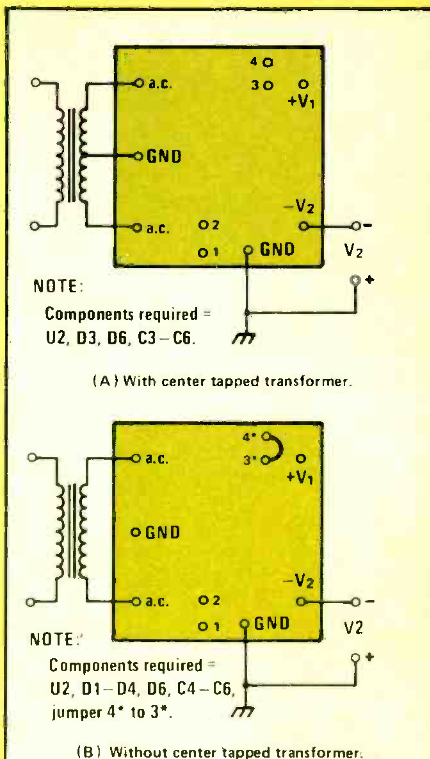
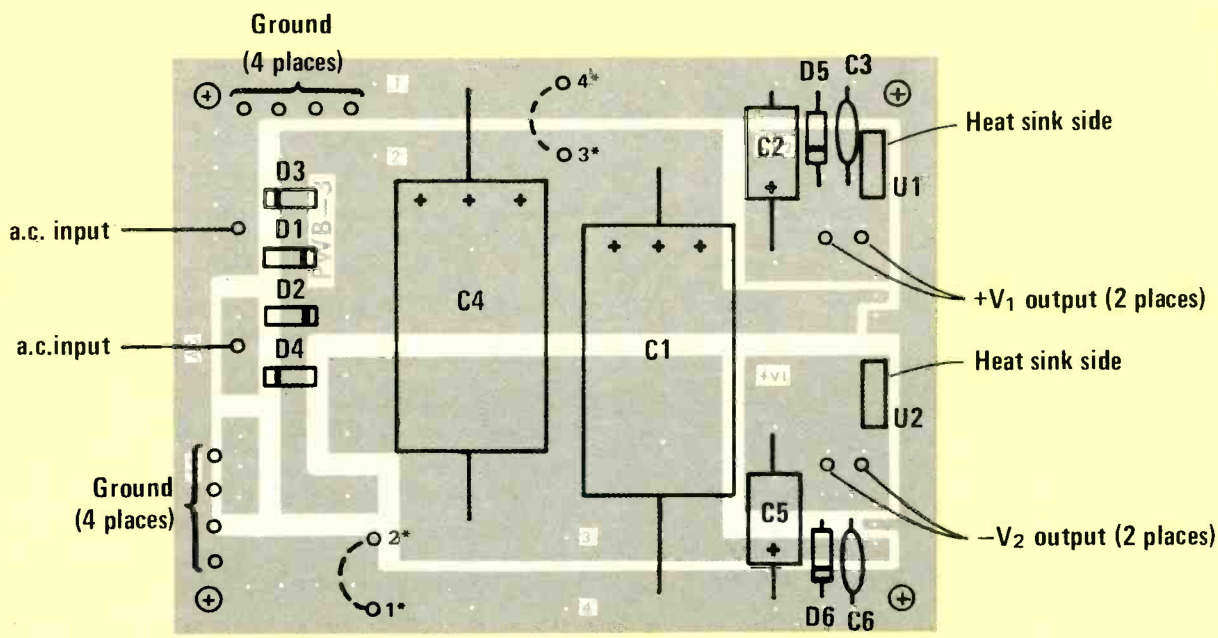


Figure 6 Negative output version.



NOTES:

1. Material: 1/16" G-10 glass epoxy.
2 1 oz., single sided copper clad.
2. Finished size: 4" x 3".
3. Revision A (May 1978)
4. *Jumpers (see text and Figures 5(B), 6(B).

Figure 3 Component placement diagram.

Table I
Parts list for dual-polarity version

Designation	Description
U1	7800/LM340 series positive voltage regulator IC
U2	7900/LM320 series negative voltage regulatur IC
D1-D6	1N4001 (or equivalent)
C1,C4	1000 mfd, 35V electrolytic
C2,C5	2.2–4.7 mfd, 35V electrolytic
C3,C6	.01 mfd, 50V ceramic

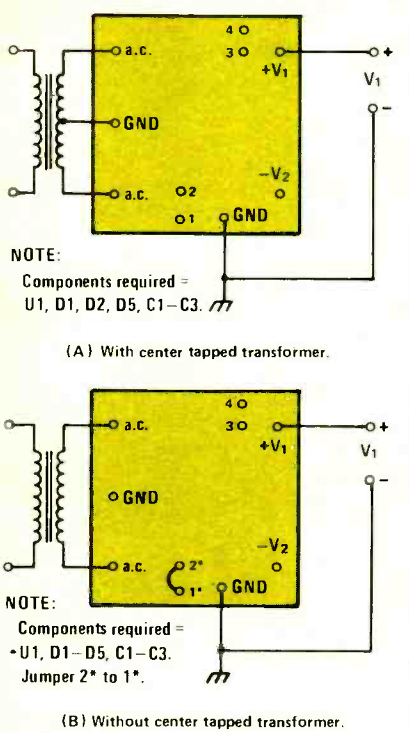


Figure 5 Positive output version.

obtained by selecting the proper regulators.

Figure 2 is the full-size printed wiring board layout, and Figure 3 shows the component locations for a fully-populated board. Holes have been provided in the board for capacitors of different lengths, and for components recommended by different manufacturers for their version of the regulators. A list of parts for a fully-populated board is contained in Table 2.

Wiring connections and the specific parts required for each of the three configurations are shown in Figures 4, 5 and 6. Note the jumpers necessary for single-polarity versions without a center-tapped transformer. Assembly of the board is straightforward,. Observe the polarity of all components, and make certain that working voltages on electrolytic capacitors are high enough to accommodate the regulator output voltage selected.

The regulators may be physically mounted to the board in a number of ways, but you must keep three things in mind: (1) These regulators *must* have adequate heatsinking, (2) the pin arrangements on the positive and negative regulators are different, and (3) the heat-conducting portion of the *negative* regulator *must* be isolated from your chassis ground.

There are two suitable methods of mounting the regulators to the board. For applications where only small amounts of current are needed and the filtered input voltage is somewhat close to the regulator output voltage, the technique shown in Figure 7 should do the job nicely. For larger currents, a larger heatsink should be used. Figure 8 shows how to use the equipment's metal chassis as a heatsink for the regulators. Note that both regulators are electrically insulated from the chassis.

When used as a bench supply, it is possible to install sockets, such as the 4038 series by Molex, on the board so that individually heatsunk regulators can be removed and plugged in to quickly change supply voltages for different projects. Remember to turn off the supply, though, to let the filter capacitors discharge before removing or inserting regulators—if you intend to use them more than once!

This article has presented an alternative for the design of power supplies for experimental projects. Although it's not intended as a panacea for all power supply related problems, it is the treatment indicated for the Power Supply Blues. Prescribe it for *your* next design!

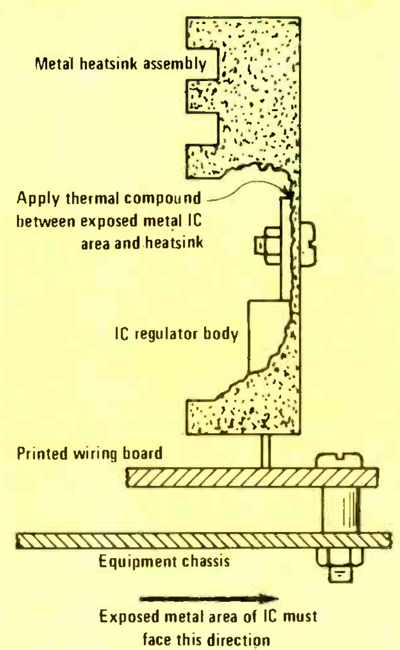


Figure 7 Construction with individual heatsink.

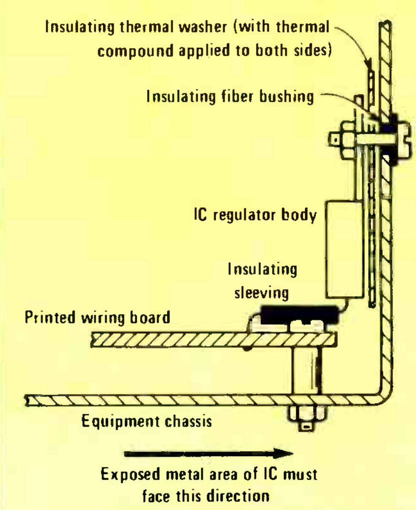


Figure 8 Construction using metal chassis as heatsink.

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Radio Control:
the ABCs of R/C

One of the most interesting electronics-related hobbies is radio-controlled model building and operating. Whether its a model airplane, boat or car, there's nothing quite like being able to control its movements with a mere touch of a control box lever. Here's a rundown of what's what in the exciting world of R/C.

by Timothy J. and George Myers

Although some R/C units are designed exclusively for use with just one kind of model, most can be used for controlling planes, boats and cars. And since the receiver can be moved from model to model, a single transmitter-receiver set can be used to control scores of different models.

Radio-controlled models are expensive; complicated and difficult to operate, right? *Wrong*!! You can operate boats, cars, tanks, trucks, hovercraft and airplanes with two-channel R/C systems that cost less than $100. Since the radio can be moved from one model to another with little difficulty, the first cost is the big one and $150 will get you into operation. The next model can cost less than $25.

Since this is an electronics magazine, let's start with the electronics. All R/C systems have the same functional elements, as shown in Figure 1, so let's take a superficial look at their properties.

■ *Transmitter*—this is a crystal-controlled oscillator, keyed On and Off by a modulator connected to the control levers. Since we are speaking exclusively of two-channel systems in this article, there will be either two control levers, or a single lever that operates left and right in one control function, and up and down in the other. The unit contains batteries for power, an on/off switch, some kind of rf output meter, and a whip antenna about 1 meter long. It weighs about a pound and a half.

The output power depends on the frequency. Units operating in the Citizens Band (27MHz), are restricted to 5 watts maximum power. Ham operators in the 6-meter band can use up to 1000 watts, but few ever use more than 5 watts. Units operating in the 72 to 75 MHz portion of the Personal Radio Service are restricted to ¾ watts. You will need a Class C Citizens Radio Service License to legally operate a transmitter in the 27 MHz and 72 MHz band. You can get yours by simply filling in a Form 505 and mailing it to the Federal Communications Commission, Gettysburg, PA, 17326. If you are over 12 years of age the license will be received in the return mail in 4 to 6 weeks. A Technicians license is required to operate in the 6-meter (50-54 MHz) ham band.

■ *Receiver*—this is your basic battery-powered, crystal-controlled superheterodyne receiver, combined with a demodulator to separate the control signals out to the two servos.

■ *Servo*—the servo is the muscle for the system. Two servos will be provided with a two-channel system. Each servo contains a tiny dc electric motor, gears to increase the motor torque, a position-sensing potentiometer, and an error-signal amplifier. The function of all these parts is to make it possible for the output arm position to follow the position of the control levers on the transmitter.

■ *Batteries*—R/C systems will be provided with either of two types of batteries: alkaline dry cells, or rechargable nickel-cadmium cells. The cheapest systems are cheap because they require dry cells, but none are provided. Addition of nickel-cadmium batteries, with a matching charger, increases system cost by $40 to $60. This looks like a lot of money only until you buy the third or fourth set of dry cells at about $7.50 a set. You decide what your pocket can manage.

Timothy J. Myers with his Cox Aquila sailplane. Its 100-inch wingspan requires the use of a releasable towline for launching, a procedure very much like raising a kite into the air. Sailplanes like the Aquila can be flown in Standard Class competition only if equipped with a two-channel R/C Unit.

Building your own

Most electronikers like to build their own equipment. The catalogs and magazines listed in the following charts will point you toward many manufacturers that offer kits and components for R/C. Complete systems in kit form are offered by ACE R/C Inc., Charlies R/C Goodies, the Heath Company, and Royal Electronics Inc. We've built many of these systems and have always found that they work as well as the guy who built them. If you can read English, follow instructions, and know which end of the soldering iron is cool, you can do it!

Now that you've built your R/C system, what can you do with it? If your model is a tank, car, truck, hovercraft, sailboat or powerboat, you can steer it right and left, and make it go fast and slow, forward, stop and reverse. If you have built an airplane, you can command it to pitch nose up and nose down,

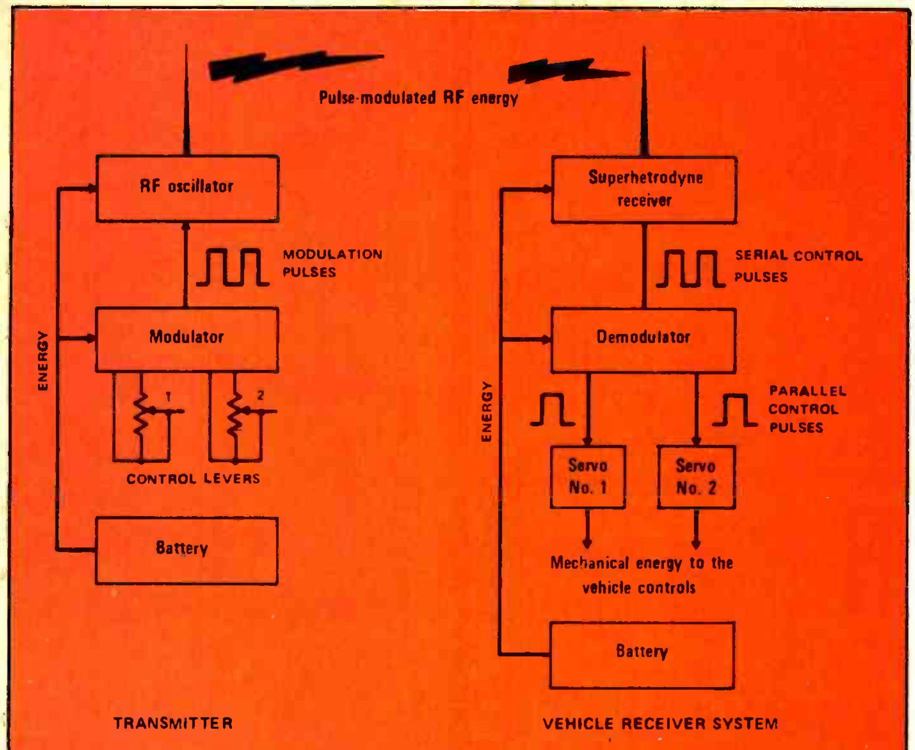


Figure 1— Functional diagram of a typical 2 channel radio-control system.

and roll left and right. With these two control functions, you can make the models do just about anything that the full-scale vehicles do.

Assuming that you want to teach yourself, the simplest model to begin with is an R/C tank. It will introduce you to the fact that when the model turns from "going away" to "coming back" *left and right seem to be exchanged!* This is no small mental obstacle to overcome.

With a tank, any time you get confused you can just shut down the motor and wait for your nerves to settle down. Then you can think through the problem, and learn to overcome it.

A good way to look at the situation is to imagine that you are always steering the far side of the vehicle. Going away, that's quite natural. You move the lever to the right and the vehicle goes right. Coming back, you move the stick to the right and the vehicle goes to its right, which is your left! To get back on track push the control lever the way that you want the far side to go. Now, when you want the vehicle to go to your right, you will automatically push the control lever to the left, which is correct.

The next level of difficulty is the motor-car. Everything works the same way as on the tank, but faster. You'll rapidly learn that you must have a *planned course in mind* before setting the vehicle in motion. There won't be enough time to simply see what the car is doing, then react to correct it.

Model car racing is a highly-organized matter in some parts of the country, with regularly-scheduled competitions. People come from miles around to race against one another, and the clock, on race courses that simulate drag-strips, the Indy 500, Road America and other well-known tracks.

Sail boats too

Perhaps you want more of a challenge, but not that much. You might try R/C sailboating. "Stop" only has relative meaning to a sailboat! Winds, tides and currents keep moving, so you'll have to learn to coordinate your control inputs with Mother Nature's inputs and to *anticipate the result*. From outside, sailboats look graceful and slow, but any skipper will tell you that they provide their share of sweaty palm experiences. Sailboats are raced in competition, just like cars.

The logical progression from sailboats is to power-boats—for some people. Power-boats go faster, which gives them some advantage over Mother Nature, but the speed introduces its own problems. Races are regularly scheduled all over the country, during the warm months.

At this point we should stop and point out that servos come in a wide variety of shapes and sizes. The reason is that control forces are different in the various applications. The sail control winch on a model sailboat doesn't have to move very fast, but it has to hold against some pretty strong wind forces, and it has to take up a lot of rope to change the set of the sails from close-hauled to free-running. Special servos are available from many of the listed manufacturers, but you might want to start with an RS Systems Inc. catalog, if sailing is your interest.

Power-boats need a very powerful servo to control the rudder. The KPS-16H servo from Kraft Systems Inc. is widely regarded as one of the best for this purpose. It also serves well as the steering servo for model racing cars. Some applications require very tiny servos, and the Kraft KPS-18, the Cannon Micro, and the Futaba S-20 are among the smallest available.

You should consider the uses planned for your R/C system when ordering its complement of servos. Some manufacturers use 2-channel systems as low-priced attention-getters, and therefore allow you no options. When you contact the manufacturers tell them that George & Tin Myers referred you to them in the pages of Modern Electronics. They like to know things like that, and it helps *us* to get their cooperation when we are seeking information for articles like this. Don't forget, now!

Wild blue yonder

Ultimately, you'll have trained your eye-hand coordination to deal with left/right reversals, and trained yourself to plan ahead and to anticipate the disturbances of Mother Nature. Then you'll be ready to try model airplanes. Flying requires *continuous attention* and continuous motion. Instead of thinking "stop," you must think "prepare to go *there* next". Planning has to become all-important. You don't want it said of you that "He was so far behind the airplane that he didn't get to the accident until the dust had settled!"

Two controls are sufficient to guide all types of models from a ready-to-fly—radio supplied and installed—trainer to the monster build-it-from-a-kit sailplane. Two-channel R/C systems, by the way, are the only type allowed for a class of racing called ½ *a pylon*. It's extremely popular all over the United States.

The reason for the popularity of this class of racing is that the airplanes are cheap, durable and flyable by novices. The Aquila sailplane is also a member of the two-channel fraternity, and *standard class* sailplane competitions, restricted to two-channel control, are very popular wherever sailplanes are flown. The Aquila usually wins, and is the current World Record holder in its class. Flights of over an hour duration are fairly common with this model.

The engine in the Cox Centurian trainer is not controlled. You start the engine, launch the airplane, and fly it until the engine is out of fuel and has stopped. Then you have a glider! It takes a little planning to be in a good part of the sky from which to make your approach and landing. That's why I said that you have to think "go there next" at all times.

Les Shine launches his Cox Q-Tee airplane with one hand while maintaining radio control with the other. The plane is highly maneuverable, permitting its use in relatively small areas.

At this point, we should have convinced you that you really can get into R/C with less than a $200 investment, and that you won't be buying a useless inferior product when you do it. So now is the time to talk about prices. We have been quoting list prices.

Is paying list price justified, when we all know that discounts are available? Well, this is how we rationalize the situation. If you buy from a dealer who maintains a stock of spare parts, and who is willing to take the time to explain things and advise you when you are ready to make a purchase, then payment of list price is justified. On the other hand, if the dealer is simply handing sealed boxes over the counter, and will send you through the mail to the manufacturer for anything from a single screw to a complete set of batteries, then a discount is justified. If the service falls someplace in between, then so should the prices. We think that this is a reasonable way to assess what is being offered.

What's a fair price

If you are really going to join the hobby, your biggest need will be information. We have listed some of the national organizations for various facets of the hobby, and some of the periodicals. Look up your interest there, and invest in some information. When you are ready to buy, take a look at some of the catalogs listed. They make great wishbooks. Then trot on down to your local hobby dealer and see what he or she can do for you.

One of the biggest services he offers is to put the stock out where you can examine it. Another big advantage is that he stocks fuel. You'll find this very important when you consider the freight charges, if you were to order it through the mail.

Another consideration, when you are ready to make a purchase, is the frequency on which you will operate. Some of the available frequencies are restricted by law to the operation of model airplanes. This is done for safety. When an airplane is high in the sky, its receiver can see transmitters far in the distance.

You wouldn't want to shoot down someone's airplane every time you put a car on the track, or a boat in the water, would you? Of course not. People who fly make a deliberate effort to insure that flying sites are far enough apart to insure that these accidents won't happen. So study the frequency assignments and ponder the uses you plan for your system, before you specify the operating frequency.

Charles Gianetto holds a Cox Cessna Centurian trainer while his brother Michael checks out the controls. The Cox Centurian comes almost ready to fly with its muffled engine installed, control push rods in place and provisions for the R/C receiver molding into the all-styrofoam interior. It's the ideal beginners plane.

Some hobby dealers who offer catalogs

Ace R/C Inc., Box 511H, Higginsville, Missouri, 64037 (all types of engines, kits and electronic parts)

Sig Manufacturing Co. Inc., Route 1, Box 1, Montezuma, Iowa, 50171 (airplane kits, accessories and tools)

Jomac Products, Inc., 12702 NE 124th Street, Kirkland, WA, 98033 (R/C race cars and equipment)

Peerless Corp., 3919 M Street, Philadelphia, Pa. 19124 (R/C boats, cars and planes, and accessories)

Astro Flight, Inc., 13377 Beach Ave., Venice, CA, 90291 (specializing in electric motors, batteries and accessories)

Hobby Lobby International, Route 3, Franklin Pike Circle, Brentwood, TN, 37027 (airplanes, engines, radios, equipment—discounted)

R/C model magazines

Model Aviation, Academy of Model Aeronautics, 815 Fifteenth St., NW Washington, DC, 20005

Model Airplane News, 1 North Broadway, White Plains, NY, 10601

Model Builder, 621 West Nineteenth St, Costa Mesa, CA 92627 (all models)

Flying Models, P.O. Box 700, Newton, New Jersey, 07860 (includes boats)

R/C Modeler, P.O. Box 487, Sierra Madre, CA, 91024 (all models)

R/C Sportsman, P.O. Box 11247, Reno, Nevada, 89510 (a newspaper)

Some R/C modelling organizations

Academy of Model Aeronautics, 815 Fifteenth Street NW, Washington DC, 20005

National Soaring Society, 1042 Embury St. Pacific Palisades, CA, 90272

IMPBA (International Miniature Power Boat Association), 24310 Prairie Lane, Warren, Michigan, 48089

Controlling a power boat model can be as tricky as driving the real thing. The Futaba Industries Model FP-2GA radio, being used here by Bill Dieckmann, is very popular with the boat people.

At this point, we feel it important to note that many parts of the country suffer from radio interference on some of the assigned frequencies. This is due to many causes. The 27 MHz band is crowded with people who operate equipment that spatters into the R/C-only bands accidentally or intentionally. There is also widespread use of illegal high-power linear amplifiers. Because of this, we do not recommend 27 MHz sets for aircraft. They may be perfectly acceptable for boats and cars, however. This is because the receiver antenna in such vehicles is close to the earth, where it is shielded somewhat from interference of all kinds.

Government interference

The PRS (72-75 MHz) frequencies are free from the interference of CB'ers, but not from the government. Lately, the Feds have seen fit to issue large numbers of licenses to voice stations rated at 200 and 300 watts, and operating exactly on the R/C frequencies. We recommend that you talk to your local dealer, and to R/C modelers in the vicinity, before making your purchase. You'll soon learn which frequencies to avoid.

Frequencies assigned as R/C channels

The Academy of Model Aeronautics has designated colored pennants to be fastened to the transmitter antenna for the purpose of identifying the channel in use. These colors are now used in all phases of the hobby. An asterisk is used to show the frequencies reserved for model aircraft exclusively. All of the other frequencies are shared among all types of models.

27 MHz band

use triangular pennants

26.995 - Brown
27.045 - Red
27.095 - Orange
27.145 - Yellow
27.195 - Green
27.255 - Blue

50 to 54 MHz band

use 1"x 16" colored ribbons

53.10 - Black & Brown
53.20 - Black & Red
53.30 - Black & Orange
53.40 - Black & Yellow
53.50 - Black & Green

for super-regenerative receivers

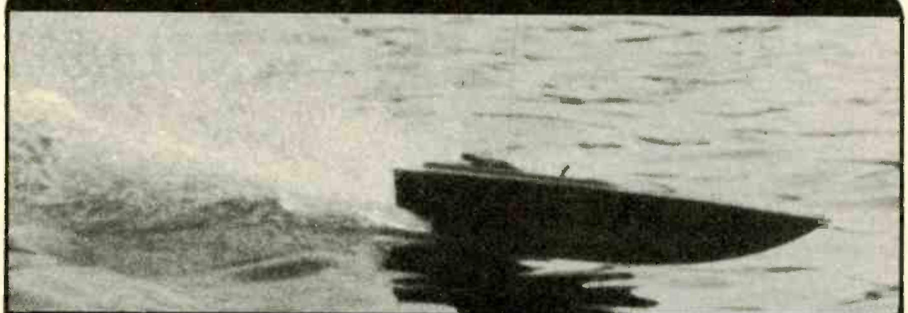
51.20 - Black & Light Blue
52.04 - Black & Violet

72-76 MHz band

use 1"x 16" colored ribbons

***72.08 - White & Brown**
72.16 - White & Blue
***72.24 - White & Red**
72.32 - White & Violet
***72.40 - White & Orange**
72.96 - White & Yellow
***75.64 - White & Green**

This list from the Official Model Aircraft Regulations for 1978/79 is used with the permission of the Academy of Model Aeronautics



While you may think of R/C boating only in terms of slow moving sailboats, there's plenty of fast action in the power boat circuit. These racing boats really move!

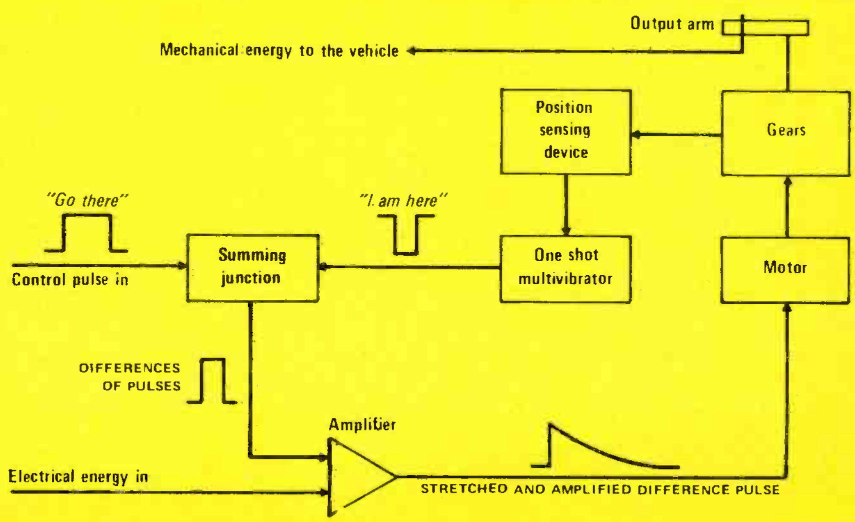


Figure 2— Functional diagram of a typical servo.

If interference appears, complain to the FCC, documenting it as well as possible. They'll politely tell you that there's nothing that they can do, but if enough modelers complain in a given area and time, they might feel or become inspired to find a way. One thing is dead certain: They won't do a thing for people who DON'T complain!

Two and Three Channel Radio Control Equipment

Listed in alphabetical order

ACE R/C Inc.
Box 511H
Higginsville, Missouri 64037
Attention: Mr. Paul Runge
Digital Commander R/C kit—capability of three channels. Two servos included. Transmitter has a dry 9 volt battery. NiCad receiver battery pack with charger. Kit price $119.95 with standard size (ACE/Bantam) servos. $124.95 with Dunham D-5 servos.

Cannon Electronics Corp.
13400-26 Saticoy Street
North Hollywood, California 91605
Attention: Mr. Bill Cannon
Cannon Mini Sport System (Model 810B-22A) is a two channel system with two servos with all dry batteries. NiCads can be added later. Five full channels can be added with simple factory update. $119.95.

Cannon Super Mini System (Model 820-22A) two channel system with two servos (Dunham D-5 Micro size). Two channel weight of 3.2 ounces includes a 100 MAH NiCad receiver battery pack. Transmitter has NiCads as well. $199.95.

Charlies R/C Goodies
P.O. Box 192
Van Nuys, California 91408
Attention: Mrs. Charlie Cannon
Essentially a kit version of the Cannon equipment. Three channel kit with two standard servos (one already assembled). Transmitter uses nine dry alkaline batteries. Receiver pack is NiCad with a charger. $109.95 with standard servos or $124.95 with Dunham D-5 micro servos.

Cox Hobbies Inc.
1505 East Warner Ave.
Santa Ana, California 92702
Attention: Mr. Lee Renaud
All systems mentioned here have two servos and use eight dry alkaline batteries in the transmitter and four more alkaline batteries in the receiver pack. NiCad packs can be purchased at a later time.
Model 8021 has a wheel control and throttle lever expressly set up for R/C cars and boats. (27 MHz frequencies only)
Model 8020 has two stick (separate) transmitter. For the Mode I flyers.
Model 8022 has single stick/two axis transmitter control. Best suited for model airplane control.
Model 8031 has single stick/two axis transmitter with a third channel available for throttle control.
Prices range from $99.95 to $109.95.

EK Products Inc.
3322 Stovall Street
Irving, Texas 75061
Attention: Mr. Bill Haga
Nimbus Sport Two is a two channel system with two servos and a single stick/two axis control using all dry batteries. Servos are the miniature EK-SM model. $129.95.

Futaba Industries U.S.A.
630 Carob Street
Compton, California 90220
Attention: Mr. York Daimon
Model FP-2GA is a two channel system with two servos using two separate transmitter sticks (Mode I) and all dry batteries. $99.95.

Heath Company
Benton Harbor, Michigan 49022
Three-channel system kit with two servos using NiCad batteries and plug-in frequency modules that is expandable by the kit builder to four channels at a later time. $179.95

Hobby Lobby International Inc.
Route 3 Franklin Pike Circle
Brentwood, Tennessee 37027
Radio is manufactured for Hobby Lobby by EK Products and is a three channel system with two servos with 9 volt dry battery in the transmitter and four alkaline dry batteries in the receiver pack. $120.

Hobby Shack Inc.
18480 Bandilier Circle
Fountain Valley, California 92708
Attention: Mr. Paul Bender
Aero Sport Two system (actually manufactured by Futaba Industries) is a two servo system with all dry batteries. NiCad batteries can be added to receiver at a later time. A great buy at $75.

Kraft Systems Inc.
450 W. California Ave.
Vista, California 92083
Attention: Mr. Marty Barry
Model KP-2A Sport Series is a single stick/two axis control system using all dry batteries. Extremely reputable service is available throughout the country. $130.

Model Rectifier Corp.
2500 Woodbridge Ave.
Edison, New Jersey 08817
Attention: Mr. Frank Ritota
Model 772 is a two channel system with a two control stick (Mode I) Transmitter that comes with dry batteries. NiCads can be easily added later. Receiver is also dry powered but NiCads can be purchased as an option later on. $110.

Millcott Corp.
1420 Village Way, Unit E
Santa Ana, California 92705
Attention: Mr. Hugh Milligan
Single Stick Specialist Three is a three channel system using three servos and complete with NiCad batteries and charger. Has a special built-in mixer control for use with "V" tail aircraft. Highly specialized! $275.

Pro Line Electronics Inc.
10632 N. 21st Ave.
Suite 11
Phoenix, Arizona 85029
Attention: Mr. Jerry Bonzo
Three channel Competition Series Model PLN-3-0 has three servos plus full NiCads. $300.

Royal Electronics Inc.
3535 S. Irving
Englewood, Colorado 80110
Attention: Mr. Sid Gates
Kit system components which must be purchased individually. A two channel transmitter kit with NiCads is $75. A two channel receiver kit (less connectors) is $22. Servos and battery packs available to suit your needs.

RS Systems Inc.
5301 Holland Drive
Beltsville, Maryland 20705
Attention: Mr. Frank Goodwin
Model RS-3-S0 is a three channel system with two servos and full NiCads. $235.

Tower Hobbies Inc.
P.O. Box 778
Champaign, Illinois 61820
Three channel system with two servos actually manufactured by Kraft Systems. Transmitter uses a 9 volt dry battery but can be converted to NiCads later on. Receiver comes with NiCad pack and charger. $120.

World Engines Inc.
8960 Rossash Ave.
Cincinnati, Ohio 45236
Attention: Mr. Dave Brown
Expert Series two channel system has single stick control and comes complete with dry battery system for $135 or with full NiCad system for $180.

Static smasher

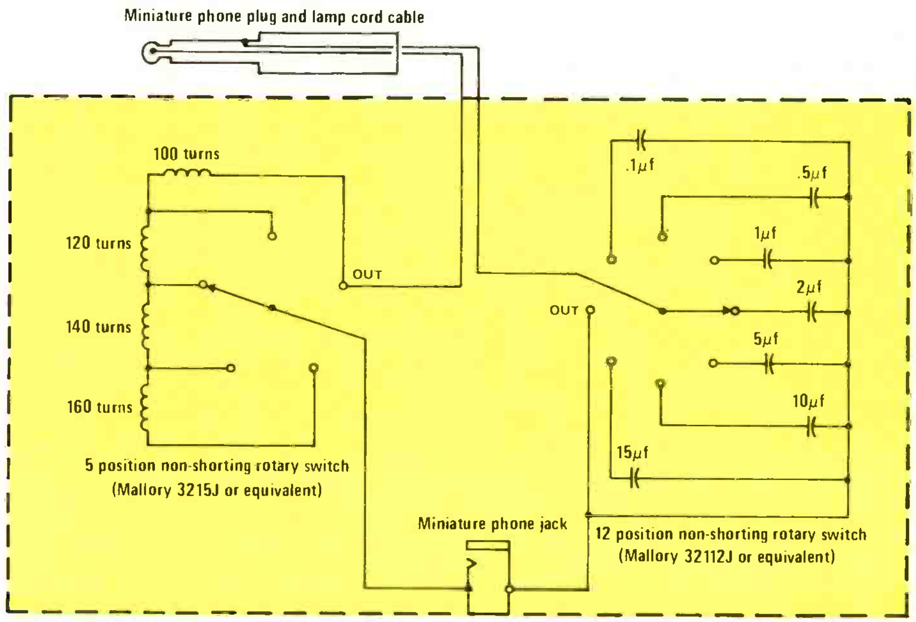
Snap, crackle and pop may be okay in your cereal bowl, but it sure is a pain in your radio. Here's an easy-to-build static filter that can cut the noise level down to size.

Electrical noise—it's the scourge of am radio. Whether it's from an automobile ignition system or a vacuum cleaner, or even mother nature, this background noise can make reception of weak signals a nightmare. That's why most CB radios have automatic noise limiters built-in. But even with a noise limiter, a weak signal can still get buried in the noise.

Generally, the noise you're trying to eliminate is at relatively high audio frequencies—above those of the signal you're trying to copy. Base station operators are sometimes bothered by 60 or 120 Hz hum as well. What's needed is a filter that is smart enough to pass through the signal you're trying to copy while at the same time eliminating both lower and higher frequency signals. And that's just what the Static Smasher does.

The Static Smasher consists of a capacitor and an inductor connected in parallel. The resulting circuit is called a bandpass filter because it passes only a relatively narrow band of frequencies. Unlike many other bandpass filter circuits you may have seen, the Static Smasher gives you a total of 28 different passbands to choose from.

Reducing or eliminating electrical noise is not without its cost, however. By restricting the bandwidth through which the signal passes, you'll reduce the fidelity of the signal you hear. But that's a small price to pay for the ability to copy signals that would otherwise be buried under the noise.



Just plug it in

The Static Smasher filters the signal going to your speaker or headphones, so you won't have dig into your radio. If you plan to use the filter with more than one radio, you can build it so that it plugs into the radio, and the speaker plugs into it.

The circuit is really nothing more than a pair of rotary switches with a tapped coil and a handful of capacitors, all of which can be mounted directly on the switches. So, you can build the Static Smasher in just about any enclosure you have handy.

If you plan to use the filter only with your base station, and have no enclosure on hand, the Radio Shack 270-260 wood-grained project cabinet should be ideal. For strictly mobile use, any aluminum box will do.

The Static Smasher is a snap to build and shouldn't take more than a few hours to complete. The most difficult part of the project is winding the coil. It's made by wrapping number 18 enameled wire, sometimes called 18 guage magnet wire, around a ¾-inch wooden dowel.

As you wrap the wire around the dowel, you'll have to keep track of the times you've gone around it. Each time the wire completes one trip around the dowel, you've added one more *turn* to the coil.

After you've put 100 turns of wire on the dowel, bring the wire away from the dowel to a distance of about four inches. Then, bending the wire back on itself, resume wrapping the wire around the dowel. After you've added another 20 turns, bring the wire away in the same manner. Repeat the procedure again after another 20 turns have been added, then complete the winding by adding a final 20 turns. The result will be a 160-turn coil with taps at 100, 120 and 140 turns.

As you wind your coil, keep the wire confined to a 1-½ inch section of the dowel. You can slip two pieces of cardboard onto the dowel and space them an inch and a half apart to help you hold the dimension. Or you can cut the dowel to exactly 1-½ inches and glue cardboard to each end.

Easy to use

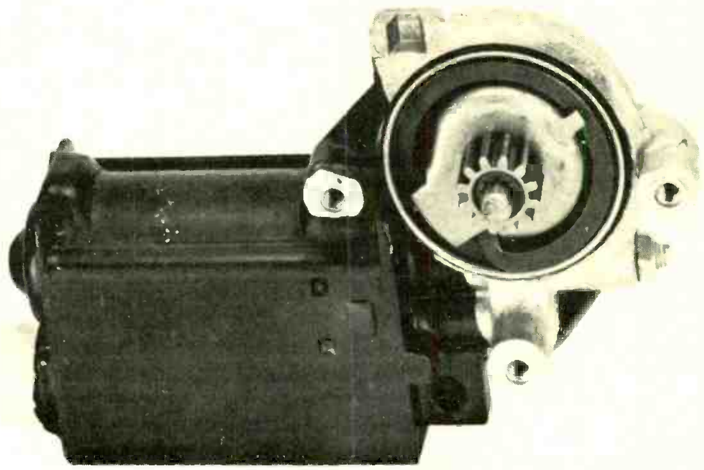
The Static Smasher requires no external power. Just plug it into the speaker line and you're in business. The front panel switch controls let you choose between seven different capacitors and four different inductances. You'll find that the best combination of capacitor and inductance will vary depending on the noise and the signal you're copying.

The Static Smasher is an effective filter for reducing electrical noise interference in am radios. It is not the complete answer to the problem. You can further improve your reception by making every effort to reduce the cause and the amount of noise being generated in your car and electrical appliances.

Powering your robot

Building a robot is easy. Making it move is another matter. The key to success is choosing the right motor for the job. These step-by-step procedures should make choosing your robot's motor a snap.

by David Heiserman



Most robots emerging from experimenters' workshops today are wheeled robots. It's nice to think about building walking robots, but the cost and design problems reach discouraging proportions before anything significant gets done. So for the time being anyway, we ought to stick with the idea of building wheeled robots that operate from ordinary, battery-operated dc motors and standard gear arrangements.

The selection and proper application of dc motors and gearboxes are critical to the success of a robot project. In fact it is a good idea to find the motors, gears and wheels first; then design the robot around them.

Before you start running all over the place looking for some motors for your robot project, however, you ought to make up a list of relevant specifications—things such as required torque or horsepower, geared rpm, operating voltage and supply current. The following discussion is intended to help nail down such specifications for wheeled robots of any weight, size and running speed.

Don't become overwhelmed by the sight of so many equations. You will find each term carefully defined here, and you can see exactly how to use the equations in three specific instances.

Defining terms

All the terms and specifications relevant to selecting robot motors and gear assemblies are given in Table 1. You'll have to determine some of these specs for yourself; namely the finished weight of the robot, its maximum straight-line speed across the floor and the diameter of the drive wheels. The best all-around choice for a supply voltage is 12 V, but your own special requirements might call for a different supply voltage. Most of the remaining terms in Table 1 are calculated from the information you can provide ahead of time and from the equations in Table 2.

Incidentally, Table 1 reflects the fact that the efficiency of dc motors increases with their rated horsepower. Once you calculate the amount of horsepower you need, you must use this motor efficiency chart for finding efficiency figures required for calculating the motor's power rating and current drain.

All of the literal terms used in the equations in Table 2 are fully defined in Table 1. Most of these equations are rather precise. However, those based on the efficiency term (e) yield estimated results. Don't worry about that, though, because you'll still end up in the right ballpark when all is said and done.

Table 3 outlines the exact procedure for coming up with the motor specs you need. The information plugged into the first four steps comes from your own ideas about a robot. Only you can estimate how much the final product will weigh and how fast you want it to run. It isn't hard at all to pick out some wheels and measure their diameter, and, as mentioned earlier, you ought to consider using a 12 V supply. At any rate, pick a supply voltage that is characteristic of readily available batteries.

Simple procedure

Step 5 of the procedure provides valuable information concerning the rpm of the drive wheel. This figure must be known in order to make any intelligent selection of a motor/gear arrangement.

Step 6 yields the torque required for doing the job. This is an important specification for smaller motors, but larger motors are more often expressed in horsepower—a figure calculated in Step 7 of this procedure.

Estimate the system efficiency from

Table 1

Definition of terms

Rg — geared wheel speed in rpm.
s — maximum robot straight-line speed in feet per second.
D — diameter of the driven wheel in inches.
W — maximum robot weight when finished in pounds.
Tf — required wheel torque in foot-pounds.
Ti — required wheel torque in inch-ounces.
hp — motor horsepower.
P — motor power rating in watts.
Ip — motor start and stall current in amperes.
k — required gear ratio between motor shaft and wheel.
Es — motor supply voltage in volts.
Rm — motor shaft speed in rpm.
Ir — motor running current in amperes.
e — motor efficiency (see chart below).
π — pi constant, 3.14.

Estimating motor efficiency (e) from horsepower (hp)

hp	e
up to 0.1	0.7
0.1 to 1	0.8
1 or greater	0.9

the chart in Table 1, then use that information for calculating the motor's electrical power dissipation. Motors are rarely specified according to their power rating, but this figure is necessary for determining its peak current demand in Step 10 and normal running current in Step 11. Both of these figures are necessary for specifying the motor's battery characteristics.

At this point, you know what you need in terms of motor speed and horsepower. Most motors are rated according to these two specifications—plus the supply voltage, of course.

Lucky is the experimenter who can find a dc motor that is already geared down to provide an rpm and horsepower that equals or exceeds the specifications found through this procedure. It's sometimes necessary to acquire the dc motor and gear assembly separately. When this is the case, it's important to work through Steps 12, 13 and 14.

Find a motor that has the horsepower rating calculated in Step 7. Then, determine its shaft speed from the motor's nameplate or manufacturer's specification sheet. This is how you complete Step 12.

In Step 13 you'll calculate the necessary gear ratio that steps down the motor shaft rpm to the rate you need for your own robot—see Step 5. Gearboxes are also specified according to the amount of output torque they can tolerate. You have already figured this specification in Step 6. Make sure the gears you select can handle that amount of torque.

Finally, doublecheck the suitability of the motor by calculating the necessary amount of shaft torque in Step 14. A gear arrangement that steps down the rpm decreases the torque demand on the motor shaft by a proportional amount. The greater the gearing ratio, the smaller the torque requirement of the motor. You might be surprised to find out how little torque you need from a high-speed dc motor. Just make sure the motor you select provides at least the amount of torque found in Step 14.

Motors and gear arrangements suitable for robot applications are available from a number of sources. Unfortunately the usual kinds of electronic supply stores is not one of them. Perhaps the best source of robot motors is an automotive parts outlet. Modern autos, especially luxury models, are loaded with suitably geared, 12 VDC motors that can fill the bill quite nicely.

Looking for motors

Window-lifting motors and the motors used for adjusting seat positions are probably the best overall choice for medium-sized robots. They have the necessary starting torques and most are already geared down to a suitable rpm.

Some robot experimenters have used windshield wiper motors quite successfully; but the limited torque from such motors restricts their application to smaller, lighter weight robots. Electrical

Table 2

Equations

1. $Rg = \dfrac{720s}{\pi D}$

2a. $Tf = \dfrac{WD}{24}$

2b. $Ti = 192Tf$ or $8WD$

3. $hp = 1.8sW \times 10^{-3}$

4. $P = \dfrac{1.36sW}{e}$

5. $Ip = P/Es$

6. $Ir = Ip\,(1-e)$

7. $k = Rm/Rg$

8. $Tm = Tf/k$

Table 3

Procedure

1. Estimate the maximum robot weight (W) in pounds.
2. Estimate the maximum straight-line speed (s) in feet/second.
3. Determine the drive-wheel diameter (D) in inches.
4. Assign the motor supply voltage (Es) in volts.
5. Calculate the required wheel rpm (Rg) from Equation 1.
6. Calculate the torque of the motor/gear assembly:
   (a) in foot-pounds (Tf) from Equation 2a
   or
   (b) in inch-ounces (Ti) from Equation 2b.
7. Calculate the horsepower (hp) from Equation 3.
8. Estimate the motor efficiency (e) from Table 1.
9. Estimate the motor power rating (P) in watts from Equation 4.
10. Calculate motor start-up and stall current (Ip) from Equation 5.
11. Calculate normal running current (Ir) in amperes from Equation 6.

If it is possible to find a motor/gear assembly that comes close to fitting these specifications, there is no need to go any further. However, the following additional steps must be applied when the motor and gear train are obtained separately.

12. Determine the motor shaft speed (Rm) in rpm.
13. Calculate the required gear ratio (k) from Equation 7.
14. Calculate the required motor shaft torque (Tm) from Equation 8.

Example 1

Motor specs for a moderately large robot

1. Maximum expected weight (W) — 30 lb.
2. Maximum straight-line speed (s) — 2 ft/sec.
3. Drive wheel diameter (D) — 6 in.
4. Motor supply voltage (Es) — 12 V.
5. $Rg = \frac{720(2)}{\pi(6)} = 76.39$ or about 76 rpm.
6. $Tf = \frac{(30)(6)}{24} = 7.5$ ft-lb.
7. $hp = 1.8(2)(30) \times 10^{-3} = .108$ or about 1/10 hp.
8. $e = 0.8$
9. $P = \frac{1.36(2)(30)}{0.8} = 102W.$
10. $Ip = 102/12 = 8.5A.$
11. $Ir = 8.5(1\text{-}0.8) = 1.7A.$

This example thus calls for a motor rated at 12VCD at about 5A, followed by a gear train that will turn the wheel at about 76 rpm at 7.5 ft-lb or about 1/10 hp. The supply should be able to deliver surge currents of 8.5A.

If the motor and gear train are obtained separately:

12. Motor shaft speed from nameplate or spec sheet — 13,500 rmp
13. $k = 13{,}500/76 = 177.6$ or about 176:1
14. $Tm = 7.5/176 = 0.042$ ft-lb or about 8.2 in-oz.

Example 2

A micro-robot

1. Maximum expected weight (W) — 3 lb.
2. Maximum straight-line speed (s) — 1 ft/sec.
3. Drive wheel diameter (D) — 1 in.
4. Motor supply voltage (Es) — 6 V.
5. $Rg = \frac{720(1)}{\pi(1)} = 229$ rpm.
6. $Ti = 8(3)(1) = 24$ in-oz.
7. $hp = 1.8(1)(3) \times 10^{-3} = 5.4 \times 10^{-3}$ hp.
8. $e = 0.7$
9. $P = \frac{1.36(1)(3)}{0.7} = 5.8$ W.
10. $Ip = 5.8/6 = .97$ A.
11. $Ir = .97(1\text{-}0.7) = 0.29$ A.

This little system calls for a 6V motor that normally runs at about 290 mA. The output torque of the gear system should be 24 in-oz at 229 rpm.

Example 3

A monster robot

1. Maximum expected weight (W) — 200 lb.
2. Maximum straight-line speed (s) — 10 ft/sec.
3. Drive wheel diameter (D) — 12 in.
4. Motor supply voltage (Es) — 6 V.
5. $Rg = \frac{720(10)}{\pi(12)} = 190.9$ or about 191 rpm.
6. $Tf = \frac{(200)(12)}{24} = 100$ ft-lb.
7. $hp = 1.8(10)(200) \times 10^{-3} = 3.6$ hp.
8. $e = 0.9.$
9. $P = \frac{1.36(10)(200)}{0.9} = 3022W.$
10. $Ip = 3022/6 = 504$ A.
11. $Ir = 504(1\text{-}0.9) = 50.4$ or about 50 A.

If the motor and gearbox are obtained separately:

12. Motor shaft speed from nameplate or spec sheet — 3200 rpm
13. $k = 3200/191 = 16.75$ or about 17:1
14. $Tm = 100/17 = 5.88$ or about 6 ft-lb.

This system calls for a 4 hp, 6VDC motor. It should draw about 500A at start-up or when stalled, but normally run at about 50A. If the motor shaft runs at 3200 rpm, the gear system should have a step-down ratio of 17:1 and be capable of handling a 100 ft-lb torque at its output.

surplus stores and mail-order houses offer nice 12 Vdc motors at rather reasonable prices, usually less than $10.

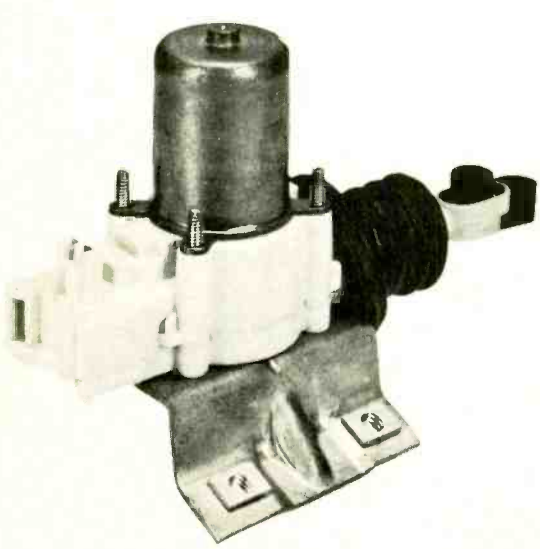
You must exercise some care in such instances, however. Make certain the motors deliver an adequate amount of torque and can be geared down to the right running speed. Sometimes the most attractive motor bargains do not include any gearing at all. In this case, it will be necessary to search out a suitable gear train or even build one from scratch.

Many would-be robot experimenters have a dc motor or two gathering dust somewhere in the workshop. Will that old motor do the job? Assuming you have already gone through the calculations for finding the specs you need, all you have to do is figure out how close the old motor comes to meeting them.

The only bad part about using an old motor is that the specs might be missing. The good part is that it isn't too hard to find out the relevant specs.

The first step is to apply your chosen supply voltage to the motor. If it runs smoothly and without getting too hot, you are on the right track. Then disconnect the motor from the supply voltage and measure the winding resistance with a good ohmmeter. Divide that resistance value into the supply voltage, and you end up with the motor's start-up and stall current, Ip.

Suppose, for example, your motor shows a dc winding resistance of 2 Ohms. If you operate it from a 12 V supply, that means the start-up and stall current will be 6 A. Is that close to the Ip value you calculated earlier? If so, it probably has the right horsepower and torque ratings, too.



The robot in Example 1 is probably typical of most robots people want to build these days. The weight specification is adequate for a nice aluminum mainframe, a good-size battery and plenty of digital logic. It turns out that the drive motor specifications fall into line with some commonly available motors and gear arrangements.

Example 2 considers a micro-robot, probably the smallest robot you can build that does anything interesting. Example 3 goes to the opposite extreme, specifying a monster robot that weighs 200 pounds and is capable of moving at a speed of 10 ft/sec, which is close to 7 mph. Note especially the sobering power requirements in this last example.

ME's new twin electronic multimeter

For less than the cost of most FET VOMs and just a few evenings of your time, you can build a lab quality, dual electronic multimeter with right-reading linear ohms scales.

by Jeff Sandler
Contributing Editor

Without doubt, the most useful, and most common piece of test equipment owned by the electronics hobbyist is the multimeter. Be it a $10 pocket tester or a $200 23-range do-everything multitester, you probably have at least one kicking around your workbench. Well, here's a new breed of multimeter that'll soon retire your present model to the bottom of your junkbox.

The ME twin electronic multimeter, the TEEM, gives you just about everything you could want in a dc multimeter, at a price you'd expect to pay for a typical 20,000 ohm per volt VOM. Probably the nicest feature of the TEEM is its linear resistance measurement. Instead of having to guess the value of resistance measured on a scale that seems all squished at one end of the dial, you read resistance off the same linear dial as voltage and current.

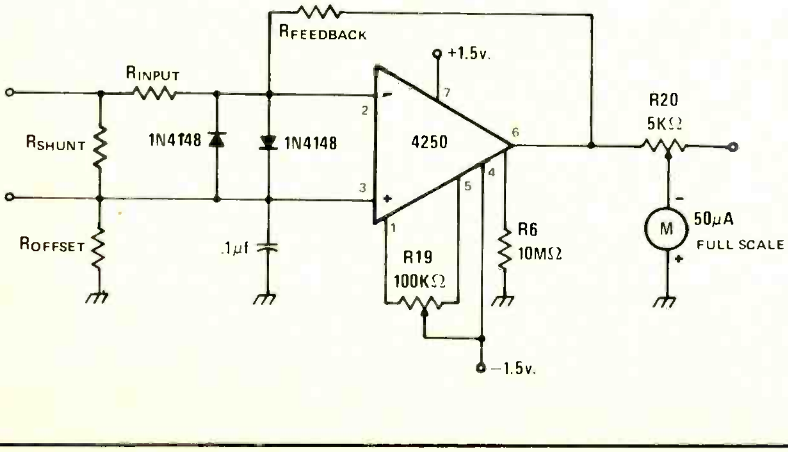
Virtually all electronic VOMs, including the TEEM, are battery powered. Most, however, have relatively high current drains, and require an on-off switch to prolong battery life. Not so with the TEEM. Current drain is so low that the projected life for alkaline batteries is up to five years, which is well beyond ordinary shelf life. Because of this, no on-off switch is needed.

Sensitivity

One of the problems with ordinary analog multimeters is circuit loading. Measuring voltage requires the meter to be connected in parallel with the circuit element across which the voltage is being measured. If the resistance of the voltmeter is less than 10 times greater than the circuit resistance, the net circuit resistance will go down enough to have an effect on operation. The result will be an erroneous voltage reading.

The key specification for any analog VOM is *ohms per volt*. This spec tells you how many ohms of internal resistance will be placed in series with the test leads on any given voltage range. All you do is multiply the ohms per volt rating by the full-scale voltage you've selected. So, if your meter has a 20,000 ohms per volt specification, and you set the range to 10 volts, the resistance will be 200,000 ohms.

Measuring a 10 volt signal across a 2K resistor with a 200K meter is no problem. Measuring the same voltage across the input of a CMOS IC is another matter.



RESISTOR SELECTION GUIDE

Scale	R_{SHUNT}	R_{INPUT}	R_{OFFSET}	$R_{FEEDBACK}$
100v.	Open	10M	0	30K
10v.	Open	10M	0	300K
1v.	Open	10M	1.5M	1.5M
100mv	Open	1M	1,5M	1.5M
10mv	Open	100K	1.5M	1.5M
10a.	.03	30K	0	30K
1a.	.03	30K	0	300K
100ma	.3	30K	0	300K
10ma	,3	3K	0	300K
1ma	.3.0	3K	0	300K
100µa	Open	0	0	3K
50µa	Open	0	0	6K
10µa	Open	0	0	30K
5µa	Open	0	0	60K
1µa	Open	0	0	300K
500na	Open	0	300K	300K
100na	Open	0	1.5M	1.5M

That's why the FET input VOM has been gaining in popularity. It presents a very high input resistance—at least 1 megohm on all ranges. But FET input VOMs are relatively expensive. With only one or two exceptions, they run over $100. For half that price, you build the TEEM, which give you not one, but two high impedance multimeters.

Because the TEEM is built around op-amps instead of FET amplifiers, the input resistance is not constant. On the 1, 10, and 100 volt ranges, the input resistance is 10 megohms. However, it drops to 1 megohm on the 100 millivolt range, and 100K on the 10 millivolt range. But, the ratio is always at least 10 megohms per volt.

The TEEM described here is a twin meter instrument. Each section is independent of the other for voltage and current measurements. Because of this, you can use your TEEM for a variety of measurements not otherwise possible with a single VOM. For example, you can measure the voltage input and output of a circuit simultaneously. Not only will this let you see what's happening as the input voltage changes, it also lets you compute the circuit voltage gain. Just divide the output reading by the input reading.

You can also measure the voltage and current of a circuit or component, and by simply multiplying one reading by the other, compute the power being consumed. And, of course, you can compute current gain by measuring input and output current simultaneously.

At present, the TEEM is strictly a dc instrument. However, the addition of ac ranges will be covered in a forthcoming article to appear in the near future. Even so, most voltage and current measurements made with VOMs are dc, and you should find the TEEM an excellent investment.

Ohms made easy

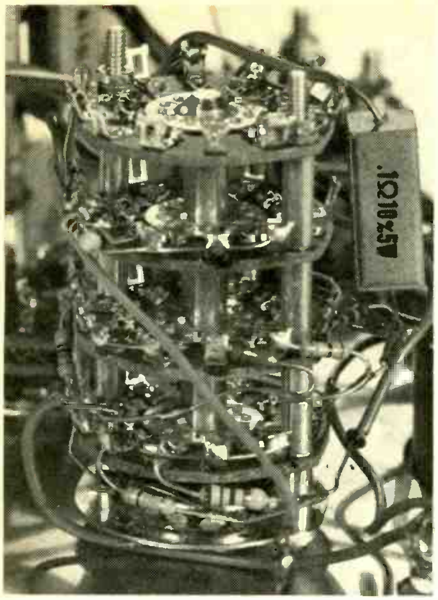
As mentioned previously, one of the nicest features of the TEEM is its linear resistance scales. The TEEM is able to measure resistance on linear scales because as an ohmmeter it functions as a voltmeter. Rather than measure the current flowing through a resistance, as ordinary ohmmeters do, the TEEM pumps a constant, predetermined current through the resistance, and measures the voltage produced.

At first glance, it might seem that measuring voltage and measuring current are pretty much the same thing; both are proportional to resistance. Double the resistance and the voltage doubles, with a constant current, or the current flow halves, with a constant voltage.

The difference is in the full-scale value. In a standard ohmmeter, the needle deflects to full scale when the maximum current flows—a short circuit. Full scale is always the same current value regardless of the ohms range.

Measuring resistance as a function of voltage works just the opposite. Full-scale deflection occurs when the voltage is maximum—which occurs when the resistance is maximum. And you can set the maximum resistance to be anything you want.

This gives you two big benefits. First, the resistance scale reads from left to right—the needle goes *upscale* as the resistance increases. In other words, resistance ranges behave just like current and voltage ranges. Ordinary ohmme-



ters read resistance *downscale,* moving from right to left as resistance increases.

The second benefit, as already mentioned, is a linear scale. Ordinary ohmmeters are built in such a way that maximum resistance must always be an open circuit—infinitely high resistance. Changes of even a megohm are almost insignificant compared in an infinitely high resistance. Yet, at the same time, changes of only a few ohms can mean a double, or even tripling of current flow in an ordinary ohmmeter circuit. The result is a non-linear scale where small changes of resistance at the low end causes large changes in meter deflection, while large resistance changes at the high end are barely noticeable.

The TEEM ohmmeter circuit, measuring voltage as it does, is not bound by the requirement of an infinitely high full-scale resistance. You can, in fact, choose any full-scale resistance you want. By carefully selecting the ohmmeter multipliers, labeled R1 through R5 on the schematic diagram, you can custom tailor your TEEM's ohmmeter scales to suit your particular needs.

Because the ohmmeter function is really measuring the voltage across the unknown resistor, a change of one ohm produces the same voltage change, whether the resistor changes from one ohm to two, or from 1,000,000 to 1,000,001, given a constant current source. The result is a linear scale. And once you start measuring resistance on a linear scale, you'll curse every ordinary ohmmeter scale you'll ever come across.

Is two better than one

The TEEM was designed as a dual multimeter, able to measure input and output signals simultaneously. The applications of a dual-meter are endless. You can use the TEEM to balance circuit bias, to compare outputs of dual-channel circuits, to conditions in two different locations in a circuit, or for any other A-B measurement that you need to take. And there's nothing to prevent you from using just one meter of the TEEM as you would any multimeter.

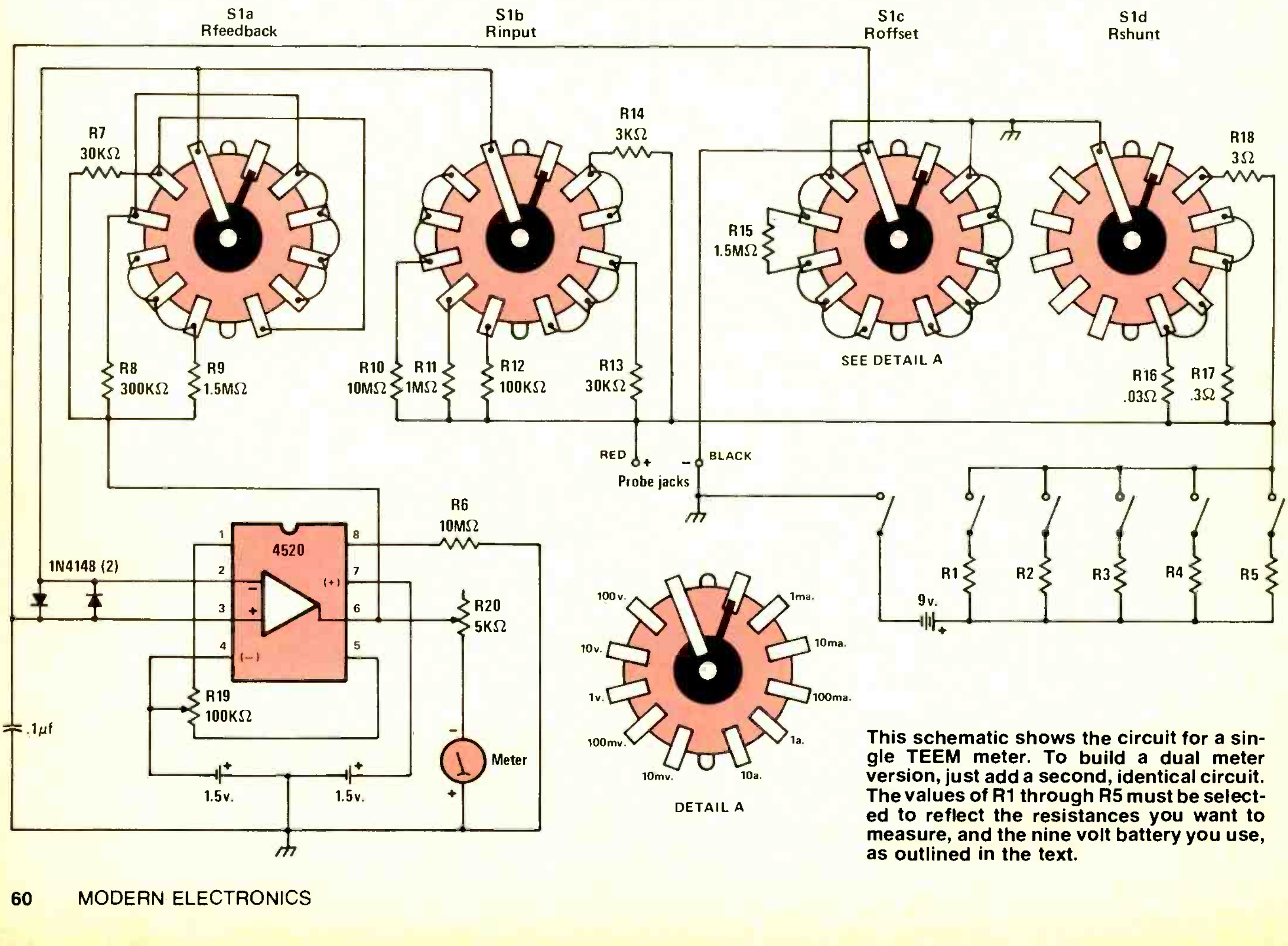
The cost of adding the second metering circuit is about 40% of the total cost. You'll still need a cabinet, hardware and wire. However, if cost is a real problem, a single-meter TEEM is still an excellent multimeter costing far less than an equivalent store-bought unit.

The schematic shows a single-meter TEEM. If you build a dual-meter version, just duplicate the circuit. You can omit the second ohmmeter function if you'd like. Chances are that you won't often have to measure two resistances simultaneously. However, the low cost of a second ohmmeter might pay for itself if you need to precisely match resistances, or balance a resistive circuit.

The ohmmeter as shown consists of an ohmmeter on-off switch and five range switches. The range switches can just as easily be replaced with a single rotary switch.

Ohmmeter operation is, as mentioned, a voltage measurement. That means you read ohms on the voltage scale. To maximize sensitivity, you should use the lowest voltage scale on the meter—10 millivolts. However, because low-end readings would be only a few millivolts, there's a possibility of problems arising in the 4520 due to junction potentials. 100 millivolts is the best compromise between sensitivity and reliability.

Alkaline and carbon-zinc transistor



This schematic shows the circuit for a single TEEM meter. To build a dual meter version, just add a second, identical circuit. The values of R1 through R5 must be selected to reflect the resistances you want to measure, and the nine volt battery you use, as outlined in the text.

batteries produce just about 9.0 volts when new. But after they've been in use for while, their output voltage drops. You'd be better off using the mercury version of the nine-volt transistor battery. Although the output of these batteries is just 8.4 volts, it stays there until the bitter end, which doesn't come near as soon as it does for alkaline and carbon-zinc units.

Is 9 really 8.4

Assuming you use an 8.4-volt mercury battery, such as an Eveready E126 or a Mallory TR126, your ohmmeter multipliers will all have 8.4 as the significant figures. If you stick with nine-volt batteries, which is not recommended, the resistors will all be multiples of 9.

The typical ohmmeter is usually calibrated in ranges labeled Rx1, Rx10, Rx100, and so on. The resistance measured is the reading multiplied by the range. For example, a reading of 32 on the Rx100 range means the resistance measured is 32 x 100, or 3.2K. The same system is used in the TEEM.

The design of the ohmmeter function is really up to you. You can set up the ranges for just about any full-scale value you want. Using decade ranges is, of course, the simplest, and probably the most useful arrangement. But the procedure is the same for any combination.

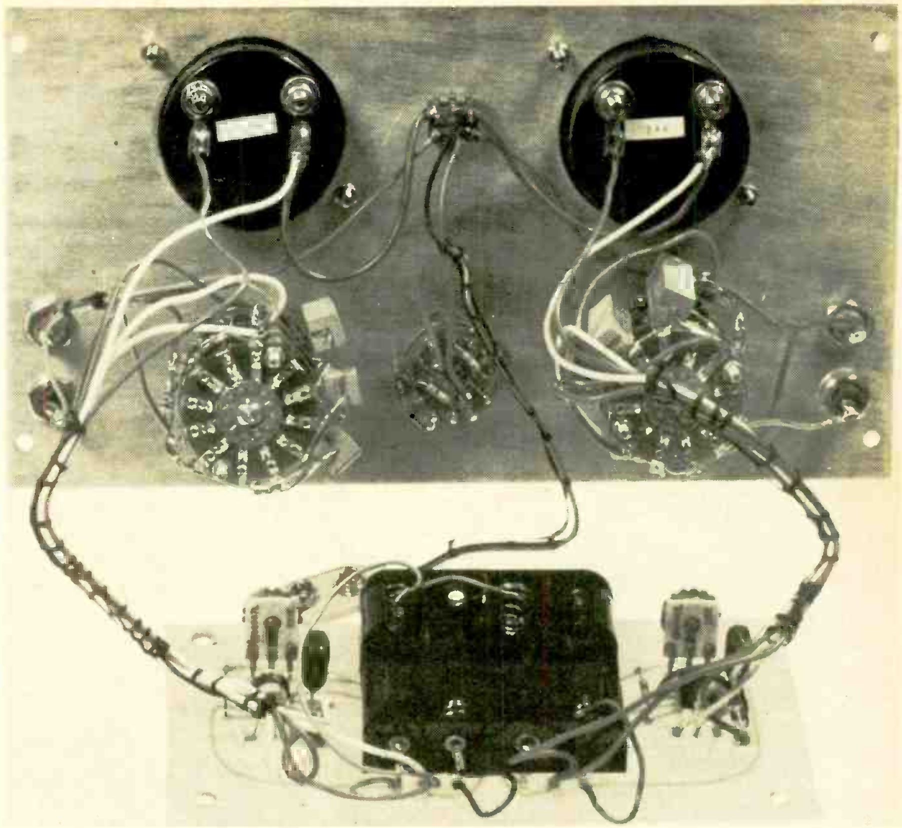
The first step is to select the full-scale resistance and voltage range. The next step is to calculate the current flow necessary to get that voltage with that resistance. For example, assume a 1000 ohm full-scale reading on the 100 millivolt range. 100 millivolts will appear across 1000 ohms when 100 microamps flow through it.

Making it work

Once you know the current that must flow through the full-scale resistance to get a full-scale reading on the voltage range you're using, you need to know the total resistance needed in the circuit to produce that current flow. In the example, you'll need to know how much resistance in series with an 8.4 volt source is needed to limit current to 100 microamperes. Using Ohm's law, the answer works out to to be 84,000 ohms.

If you change the resistance range from 1000 to 10,000, the current would drop from 100 microamps to 10 microamps. Following the procedure outlined, you'll find the total resistance increases to 840,000 ohms. In the same way, a full scale range of 100K would require 8.4 megohms; and a 1 megohm range, 84 megohms.

The question you should be asking now is whether the total resistance calculated includes the resistance being measured. It doesn't matter!! That's right, it doesn't matter one way or the other. The reason is that the maximum



The 4520 op-amp circuitry can be mounted on perfboard, or on a PC board as shown. The small rotary switch in the lower center selects R1 through R5 for the ohmmeter circuit. In this model, the switch located between the meters shifts the ohmmeter function to either meter circuit. If you prefer, you can add the ohmmeter function to each metering circuit by adding another set of ohmmeter resistors and a second nine-volt battery.

resistance being measured is about 1% of the total resistance—10K out of a total of 840K, for example.

Depending on just how accurate you want your ohmmeter to be, you can include the full-scale resistance, exclude the resistance, or split the difference. Following these suggestions, and using this example, you can make R1 830K, 840K, or 830.5K. The choice is yours.

Because the reading is affected by both the value of R1 and the voltage scale selected, it's a good idea to clearly mark your panel to indicate which scale is used with the ohmmeter function. Of course, you can cheat and use another voltage range to add a few scales. By switching the TEEM to its 1-volt range, for example, you can extend the ohmmeter range by a factor of ten. In other words, 100 millivolts will become just one-tenth full scale.

Using the 1-volt range does decrease accuracy, however. The reason is that one volt represents more than 10% of the 8.4 volt battery voltage. That means the full-scale resistance will be more than 10% of the total circuit resistance. Using the previous example, the total circuit resistance could change from 840K to 940K, causing significant changes in current flow, and registered voltage. But, allowing for the error, a quick x10 multiplier can be a handy tool when checking a circuit.

The resistance values given in the schematic will give you the ranges shown. But, you can change them to suit your needs. You'll find the resistance values needed for a variety of scales in the accompanying table.

Most of the wiring can be done directly on the four-deck selector switches. The IC op-amps and trimpots can be mounted on a piece of perf-board if you prefer, or you can use the printed circuit layout shown. Although the prototype was built into a Radio Shack 270-282 low-profile cabinet, you can use most any cabinet you have handy that's large enough to hold the switches and meter.

The prototype used Radio Shack 22-051 50-microampere panel meters, but you can use any you have handy. Using a 100 microampere meter shouldn't present a problem. However, if you use a 500 microamp or even a 1 milliamp meter, you may run into trouble.

For one thing, you may have to change the current calibrator, R20. You may also find your 4520 unable to drive the meter to full scale with only 1.5-volt supplies. If this is the case, you can increase the voltage supplies to three volts each. However, no changes will be required in the values of the ranging resistors.

The TEEM circuit layout isn't critical. Building your TEEM should prove to be fairly straightforward. And when you've completed construction, you'll have an excellent addition to your collection of test equipment.

Universal timer

Need a two-stage timer that can be latched on? That can be set for continuous operation? That can be used for a time-delayed alarm operated by a hidden photocell? If so, try this nifty timer/alarm that can do it all.

by Jeff Sandler
Contributing Editor

About half the letters addressed to Clinic ask about timers and alarms. So here's a universal timer/alarm circuit that can be customized to meet just about any need. The circuit is built around a single 4011 quad NAND gate. A quick look at the circuit will show you that it consists of two almost identical flip-flops, each driving an NPN transistor, which powers a buzzer or alarm relay.

The timer/alarm can be triggered by any device that drops input A on the 4011 to ground from a normally high state. Magnetic door switches, pressure sensitive mats or even a panic switch can be used. If your detector has a positive going output, you can use a single-transistor inverter.

A 2N3904, or other small signal NPN, makes an excellent inverter, as shown in the lower left corner of the schematic diagram. The output of your detector connects to input B of the inverter, the output of which connects to input A of the 4011.

The timer/alarm can also be triggered using a photocell, as shown in the upper left corner of the schematic. The photocell can be connected on either the hot side or the ground side of the input of the 4011. A variable resistor is used to set the light threshold for triggering the timer/alarm.

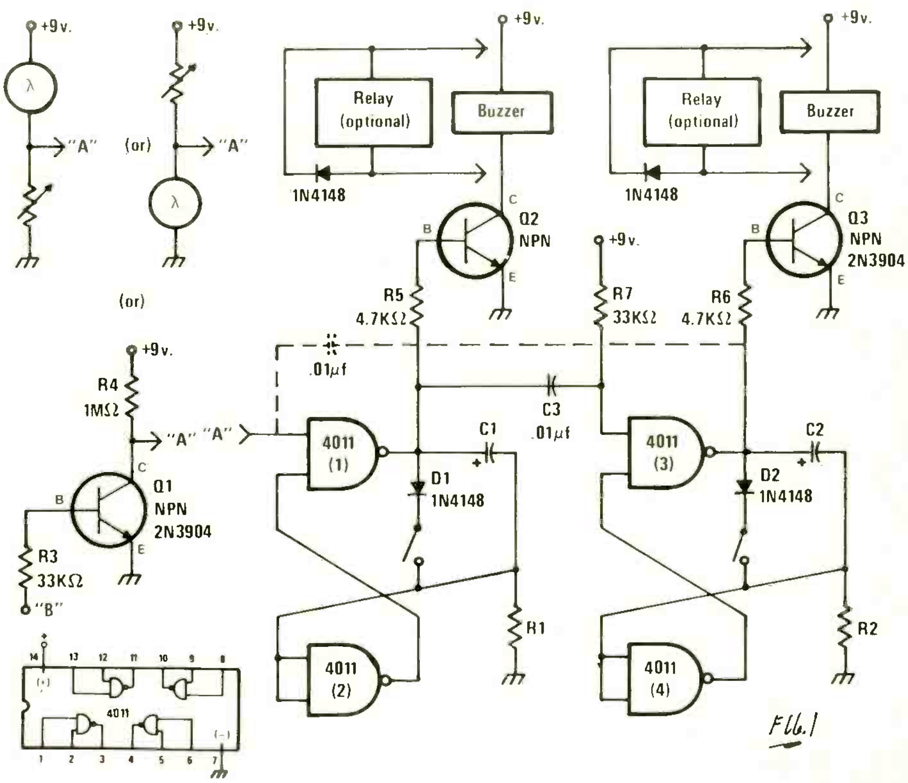
The universal timer/alarm operation is straightforward. In its resting state, the output of the first timer is low, which keeps its output transistor, Q2, off. When you trigger the circuit, the output goes high, turning on Q2, and its associated buzzer or alarm relay. The number of seconds the alarm stays on is approximately equal to 0.7 multiplied by the value of R1 in ohms multiplied by the value of C1 in farads.

After the time period has passed, the first timer will turn off, and in so doing, trigger the second timer. The second timer then turns on its associated transistor, Q3, and its buzzer or alarm relay. The number of seconds this alarm stays on is determined by the value of R2 and C2 in the same way as R1 and C1 did in the first timer.

If you wish, you can feed back the output of the second timer to the input of the first timer, as shown in dashed line, with a .01 mfd capacitor. This arrangement will turn on the first timer when the second goes off. The result will be continuous operation, with one alarm turning on for a period of time, then the other alarm, and so on.

You can build your universal timer/alarm with only the second transistor output circuit, using only Q3 and its associated buzzer or alarm relay. Doing this will give you a delayed alarm, letting you turn it off between the time it's triggered and when the alarm would sound.

The schematic shows each timer with a latching option consisting of a diode—D1 and D2—and a single pole, single throw switch. With the switch left open, the timer works as described. But, with the switch closed the timer once trig-



gered will remain on until the switch is opened.

If the latching option is going to be used, it would most likely be done on the second timer. Latching the first timer on would effectively lock out the second timer. However, there may be situations where you want instantaneous turn-on with a latch on, so provisions for it have been made in the circuit.

In building your timer/alarm, you can wire only those parts of the circuit you need for your specific application. For example, you might build a single-stage timer with an LED substituted for the transistor output. If you use only two of the gates in the 4011, however, make sure to tie the input lines of the unused gates to the positive supply voltage. This will prevent unwanted self-oscillation in the unused gates, with its resulting erratic timer operation.

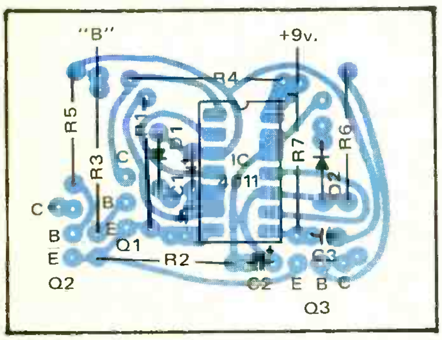
Another approach is to build several fully equipped universal timer/alarms and keep them on hand as junk box items. Then, when you need a timer or alarm, just connect those portions of the pre-wired circuit you need to do the job.

Although you will be tying up a small inventory of parts, your junk box will be considerably enriched with ready-to-use, do-everything boards. And, using parts already in your junk box, and buying in quantity, the total investment per board should be quite low.

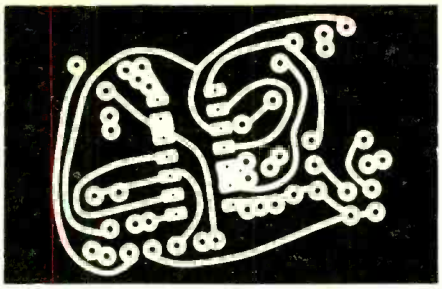
Construction

Building the universal timer/alarm is relatively easy. The parts layout isn't critical. The circuit is simple enough that it can be built on perfboard. However, it is ideally suited to printed circuit board construction, and a typical layout is provided.

There's nothing to prevent you from etching several alarm circuits on one large size board for use as a master control station. If you'd like, you can cascade the timers to form a multi-delay timer. This multi-delay timer can be used for a wide variety of projects ranging from a sequencing controller to a rather elaborate do-nothing box.



The close clearances of the PC layout make parts density higher than you may like. However, power consumption is very low, so there's little chance of overheating.



The universal timer/alarm is ideally suited to printed circuit construction. You can use this template, or create your own multi-stage timer/alarms.

The kind of device used to signal the alarm can be just about anything you have handy. Low current nine-volt buzzers can be driven directly from the output transistor. Other devices will have to be connected to their power sources through relay contacts. Remember to include a protection diode across the relay coil as shown in the schematic.

The prototype alarm used a new self-contained alarm manufactured by Citizen America Corporation, 1710 22nd Street, Santa Monica, CA 90404. The alarm is called a Microbuzzer and comes with 3, 6, 12 and 24 volt electronics. These units can, according to Citizen, produce an alarm with a level of 70 dB at 20 cm, which should be loud enough for your timer/alarm.

The Microbuzzers are now going into general distribution, but you may have a little trouble tracking them down in your area. Citizen American really doesn't like to deal in mail order, but if you can use ten or more of them, you can get them direct by mail. Check with them for price and delivery information.

A look into the future of cassette recordings

A dramatic breakthrough in the quality of cassette tape recordings is just around the corner. New tape, noise reduction systems and head design will give professional results with popular-priced decks. Here's a look at your next cassette deck.

by Bob Margolin
Assistant Editor

This top-of-line Nakamichi Model 1000 II cassette deck offers performance approaching open-reel tape recorders, but at a cost beyond the reach of most consumers. Futurecassette decks will look much like today's, but will offer superior performance at affordable prices.

If you're into tape recording, it's very likely you're using a cassette recorder. Without question, cassette recorders are *the* home tape recorder. Their popularity is no doubt due to their relatively low cost and their simple operation. Just drop a cassette onto the spindles and push a few buttons. That's all there is to it. No empty takeup reel to worry about. No complicated tape threading to perform. In fact, about the only problem with cassette recordings is the relatively poor quality of the sound. But that will soon change.

Within the next year or two, you should see the appearance of a new breed of cassette tape recorder. These new machines, using radically different kinds of recording tape, will give you performance as good or better than most reel-to-reel recorders.

The secret to this quality improvement lies in the recording tape itself. Reel-to-reel recorders usually have a tape speed of 7½ inches per second. Professional recorders run at 15 inches per second. At these speeds, even a mediocre tape will give you decent sound.

With the slower 1¾ inch per second tape speed of the cassette recorder, however, even the best cassette tapes can barely equal the performance of a reel-to-reel recording. The reason has to do with how rapidly the signal can be impressed on the magnetic particles in the tape.

This look into the future of cassette recordings is based on the paper "The Latest Developments in Cassette Recording" released at the 12th annual Consumer Electronics Show by Nakamichi Research, 220 Westbury Ave., Carle Place, N.Y.

First breakthrough

The original cassette recording tapes were based on formulations used for reel-to-reel tapes. Although fine for high-speed recording, they had limited frequency responses, usually no better than 10 kHz, and high distortion, typically 3%, at 1¾ inches per second. But, in 1969, TDK introduced its SD Super Dynamic tape. This new tape could provide an extended frequency response out to 12 kHz on existing recorders. Better, but still no match for reel-to-reel recordings.

A year later, DuPont introduced the revolutionary chromium dioxide tape. Although the new tape required a special biasing signal, it could provide a 15 kHz frequency response. Since then, most high quality cassette decks and recorders have a selector switch that lets you choose between standard tapes and chrome tapes.

1970 also saw the introduction of a Dolby noise reduction system for consumer tape decks. The Dolby system significantly reduced tape hiss, a problem with extended range tapes. Between the new tape technologies and the Dolby system, cassettes were approaching true high fidelity sound.

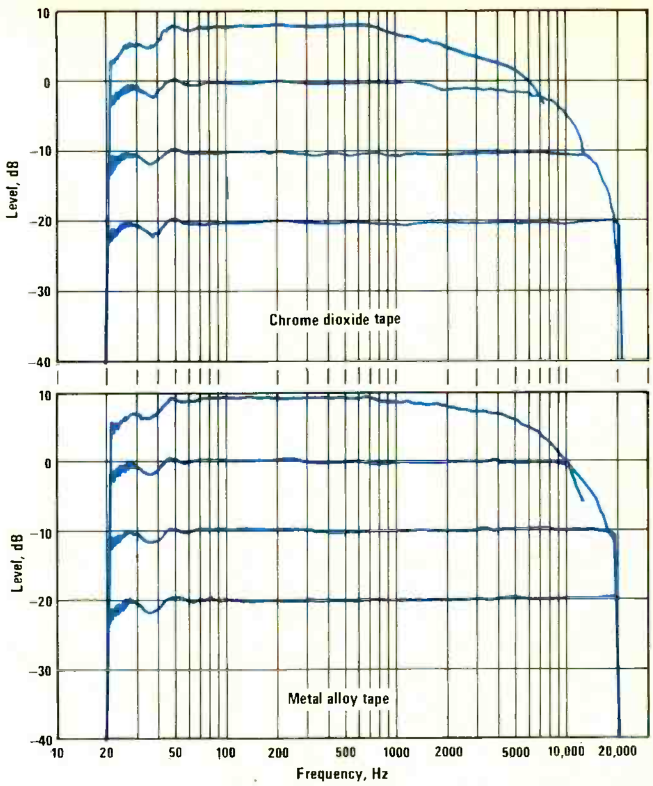
Although there have been several tries at further improving the quality of cassette recording tapes, most have been up to now unsuccessful. The much heralded ferri-chrome tapes were an attempt to combine the best of standard and chrome tapes. But, in actual use they proved to be unstable, with varying level and distortion. Another near miss were the early cobalt-doped tapes. Here standard tape was doped with small amounts of cobalt to improve frequency response and reduce distortion.

It wasn't until 1974 that the bugs were worked out of cobalt-doped tape. Again it was TDK that made the breakthrough, this time with their SA Super Avilyn tape. These new cobalt-doped tapes have proven to be an excellent replacement for chromium dioxide tapes.

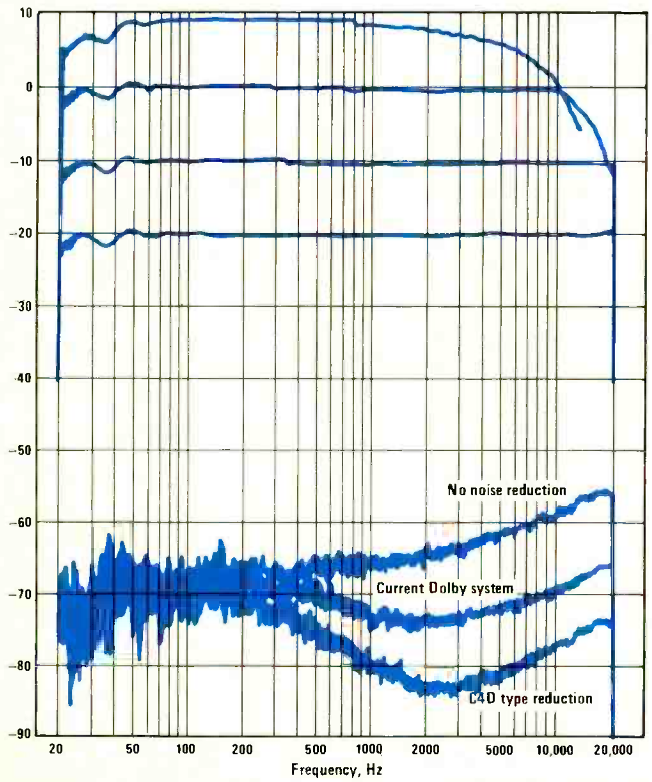
Although the performances now available can equal most consumer-quality reel-to-reel machines, it is available only in professional quality cassette decks with price tags to match. And while the price of top-notch performance may fall some, it will remain well out of reach of most hobbyists.

The latest breakthrough

The next generation of cassette recording tapes will look and feel much like those currently available. But, they will use a new technology. Rather than the current variety of iron-based oxides, the new tapes will use pure metal alloys. Experimental alloy tapes have shown they can provide greater sensitivity, increased dynamic range and an overall lowering of distortion. In other words, they'll give you better sound than anything currently available.



Comparison of frequency response between chromium dioxide and metal alloy tapes. Although both sets of curves look the same at first glance, closer inspection will reveal the superiority of the metal alloy tapes. This superiority is most noticeable at the high frequencies with high recording levels.



Record/playback frequency response and noise levels with the new metal alloy tape and Telefunken C4D-type noise reduction system. The frequency response curves, at the top, show near 20-20,000 Hz flat response at low recording levels. The lower three curves show tape noise amplitude from 20 to 20,000 Hz. The upper trace shows the noise level without noise reduction. The middle trace shows the effect of a current Dolby system while the bottom trace shows a C4D-type noise reduction.

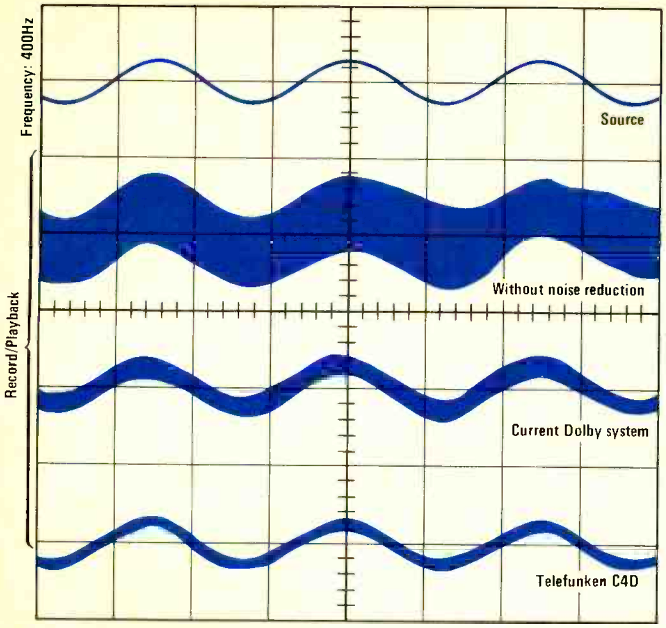
Unfortunately, most of these new alloy tapes are not compatible with current cassette recorders. The major problem is in the design of the recording heads. But work has begun on producing a recording head that can fully take advantage of the new tape. And although still in the experimental stage, some heads have been developed that do provide significant reduction in distortion, and extension of the upper frequency response at high recording levels—a major breakthrough.

Another possibility is the development of a metal alloy tape that is compatible with current cassette recorders, at least those designed to handle chrome tapes. It's very possible that new tapes will be developed that can give you very good sound when used in your present recorder, and professional quality results in decks designed for them.

An experimental metal alloy tape used with an existing, albeit expensive, Nakamichi deck, has produced a ruler flat record/playback response to 20 kHz at low signal levels, and to beyond 15 kHz at much higher recording levels than ever before possible.

Noise reduction

Extending frequency response and reducing distortion is only half the battle. There's still the problem of tape hiss. For several years, the Dolby system has been the standard for noise reduction. That may change, however. Telefunken recently introduced a professional noise reduction system, their Telcom C4D. Although far too expensive for the consumer market, the C4D is exceptionally effective and virtually colorless. In other words, it



Effects of noise reduction systems on recorded signal can be seen on this oscillograph. The clean source, a pure 400 Hz sine wave, is shown at the top. The second trace shows the effects of tape noise on the signal. The third trace shows the noise reduction provided by the typical Dolby system current in use in consumer decks. The bottom trace shows the added noise reduction obtainable with the new Telefunken C4D-type noise reduction system.

takes out the noise, and nothing else.

Telefunken is now working on a consumer version of the C4D that should give you better performance than the current Dolby system, and at a price that you can afford. There's no doubt that Dolby is working on new versions of their system as well.

Compatibility between noise reduction systems is every bit as important as it is between tape technologies. If the Telefunken system, or an improved Dolby, should appear on the next generation of recorders, it could mean that every tape recorded with an older system would have to be re-recorded. Because of this, it's a good bet that new decks will give you a switch-selectable choice between old and new systems—just as you now can choose between standard and chrome tapes.

The cassette recording system of the future—a year or two away—will have to be compatible with current decks and tapes. Except for a few extra switches for newer tapes and noise reduction systems, the next generation will look pretty much like those of today. The tape cassette itself will remain physically unchanged.

Performance, however, will be amazing. A moderately priced cassette deck will no doubt give you 20 to 20,000 Hz sound with distortion under 1%. New duplicating techniques using metal alloy tapes and C4D-type noise reduction will give you pre-recorded tape equal or better in sound quality than the best of today's long-playing records.

Because there are still so many wrinkles to be ironed out, it's virtually impossible to predict just when you'll see C4D-metal alloy cassette recorders from Panasonic, Sony, or any of the other mass marketers. But these decks are just over the horizon. And for the dedicated audiophile, the new technologies are closer yet.

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The editors roundup exciting new products you should know about.

Remote CB perfected

True one-band operation and clear, crisp sound are now yours with this new Royce CB 582. A large seven-segment LED channel display and sequential LED S-meter readout give you instant readout, which means you can keep your eyes on the road. Channel selection is by seperate up and down pushbuttons mounted on the top of the mike case. Other controls include an ANL/PA switch, on-off/volume, and variable squelch—all built into the mike case. Excellent sound reproduction is obtained by using a separate full-range dynamic speaker in addition to the microphone element. Provisions have been made for muting your car radio speaker when the CB is receiving a signal. For information about this nifty CB radio, circle number 113 on our reader service card.

Flameproof resistors

Every now and then, you can find yourself in the position of having to worry about your circuit catching fire. Perhaps its because the circuit is built into a flammable cabinet, or even in an area near flammable materials such as gasoline or cleaning fluids. Whatever the reason, your circuit should be designed with the widest margin of safety, including the use of flameproof resistors, such as these from Sylvania. Available in ¼, ½, 1 and 2 watt sizes with 2%, 5%, 10% and 20% tolerances. According to Sylvania, these resistors can take overloads of up to 100 times without the slighest trace of flame. For more information, circle number 106 on our reader service card.

Mike extension

If you've ever been caught short reaching for your mike, you'll like this 10-foot extension cord from Mura Corporation. The coiled-cord extension has male and female fittings that match Mura's MikeMate connector systems. Labelled the ME-11, the extension cord sells for $11 and is ideally suited for use in RVs, vans and trucks. For more information, circle #112 on our reader service card.

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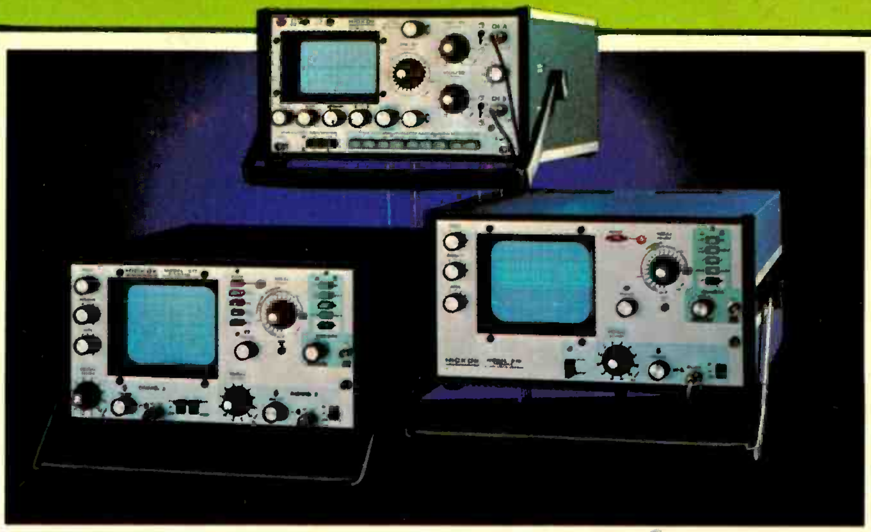
The editors roundup exciting new products you should know about.



Three scopes from Hickok

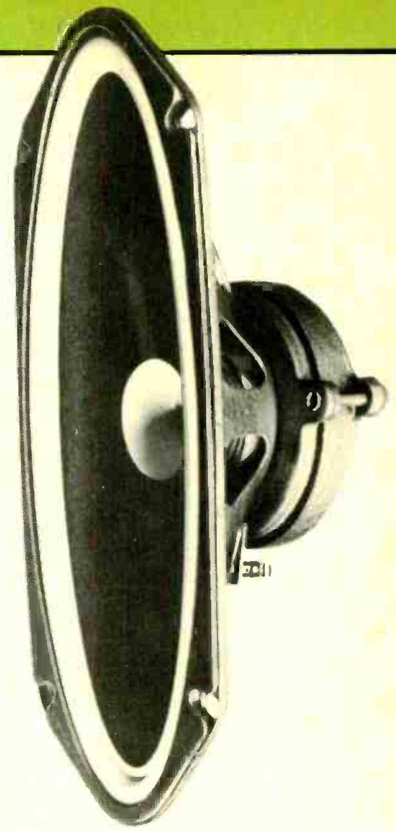
Color-coded front panels and user-oriented control groupings let you set up and operate these scopes quickly and easily. All feature automatic triggering and require a minimum of familiarization. The top of the line Model 532 gives you 30 MHz bandwidth with a risetime of less than 12 nanoseconds and a x4 magnifier, which lets you take a really close look at high-speed digital logic signals. If its $1000 price tag is more than you care to spend for a scope, there's the $500 Model 515 with a 15 MHz bandwidth. It's ideal for tv service work, having built-in sync separators that make looking at complex video a snap. Another interesting feature is x-y input that lets you use the 515 as a vector-scope. You can get the 515 in a dual-trace version as the Model 517 priced at $700. In addition to the usual A and B trace, you can also display the algebraic sum or difference of the two inputs. For more information about these scopes, circle number 102 on our reader service card.

Programmable scanner

J.I.L.'s new SX-100 gives you just about everything you would want in a scanning monitor. A 15-key board lets you program each of the 16 channels to any one of 6000 frequencies in the VHF low, VHF high and UHF bands. You can set the scanning delay to any period from zero to four seconds. An interesting feature is the seek function, which will bypass un-used channels and lock onto the first signal on the band. The large digital display provides a readout of the frequency being received, or functions as a clock giving you the time of day, or the day of the week at the flip of a switch. You can power your SX-100 from your car's 12-volt system, or from 120 volt ac. For more information about the SX-100, circle number 105.

Low distortion function generator

The $175 Model 3010 function generator from B&K-Precision gives you pushbutton selection of square, sine or triangle wave, from 0.1 Hz to 1 MHz. And you can convert the 3010 into a 100:1 sweep generator by applying a 0 to 5.5 volt ramp to the VCO input. Or, by substituting audio for the ramp, you can convert the 3010 into an fm source. A built-in ±5-volt dc offset lets you add biasing voltage to your output function. The square wave output is available with variable amplitude, or at a fixed TTL-compatible level. Symmetry is a near-perfect 99% at 100 kHz. The triangle wave output is linear to within 1%. All this is packed into a cabinet just slightly over 3 x 11 x 7 inches, and weighs in at under 3 pounds. Circle number 101 on our reader service card for more information.



Speaker for GM cars

Adding a high-quality sound system to some of the newer compact and intermediate cars can be a real problem, especially when it comes to mounting the speakers. Quam-Nichols has simplified that chore, at least for the new crop of GM intermediates, with the introduction of their new 410C10FEXGB speaker. It's a 4 x 10 oval air suspension speaker with a heavy-duty 10 ounce magnet that's a good bet to give you the sound you want. For more information about this $8 speaker, and other Quam-Nichols products, circle number 104 on our reader service card.

Two new open reel decks

Although cassette tape technology has closed the gap, reel-to-reel tape recorders still offer the audiophile the best in taped sound. AKAI, one of the leaders in the field, has just introduced two three-head reel-to-reel decks at cassette deck prices. The Model GX-4000B gives you pushbutton selection of 7-½ or 3-¾ inch per second tape speeds, biasing for low noise or wide range tapes, tape or source monitoring, and sound-on-sound recording. Power is provided by a four-pole induction motor that keeps wow and flutter to less than .08%. AKAI's glass and ferrite record and playback heads give you a 30 to 25,000 Hz frequency response, ±3 dB, at 7-½ ips. Other features include dual VU meters, a locking pause control, and four-digit tape counter. The suggested price is $400. But, for an additional $80, you can get the GX-4000D, which is the same deck with a built-in-Dolby noise reduction system. For more information about AKAI reel-to-reel decks, circle number 103 on our reader service card.

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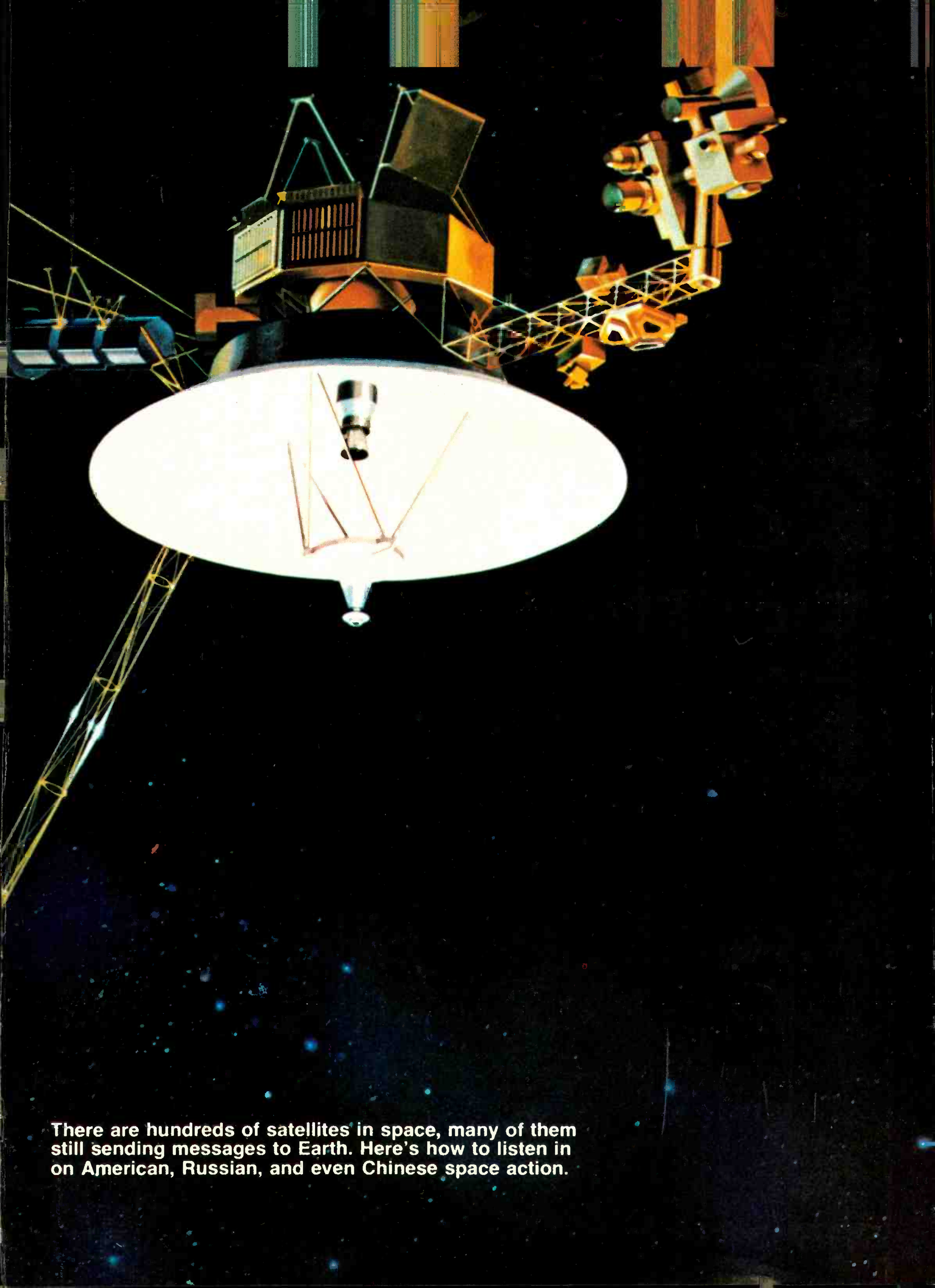

There are hundreds of satellites in space, many of them still sending messages to Earth. Here's how to listen in on American, Russian, and even Chinese space action.

Space DXing: the last frontier

by Harry L. Helms Jr.

A new "shortwave station" came on the air October 4, 1957, and opened up a new era in listening excitement for the active SWL. Throughout the world, listeners tuned their general-coverage receivers to 20,005 kHz and listened in awe. This was no ordinary shortwave station—it was the beacon transmitter of Sputnik I, the first artificial satellite, and it was transmitting the "beep—beep—beep" from high in Earth orbit. For the first time, SWLs were no longer limited to DX targets here on Earth. Listening opportunities had expanded into the universe!

In an era of multi-million dollar space communications systems, most SWLs think that tuning in signals from unmanned *and manned* space missions is impossible. Nothing could be further from the truth. Anyone equipped with a general coverage shortwave receiver, capable of tuning around 20 MHz, can eavesdrop on beacon and telemetry signals from manned and unmanned space missions. And if you have gear which can receive FM signals in the two meter (144-148 MHz) amateur band, you can easily intercept voice communications from orbiting spacemen!

The Russians

Most space transmissions which SWLs can easily hear are from space missions conducted by the Soviet Union. This is because most United States missions are conducted on frequencies which are extremely difficult for the average SWL to tune. Unlike the Soviet Union, the United States has established a worldwide network of permanent, landbased communications and tracking stations. At these stations the United States has erected large parabolic dish antennas and installed exotic receiving equipment. This permits the use of super-high frequencies, such as 1640 MHz, which will be the main voice channel used by the Space Shuttle.

Such extremely high frequencies require more elaborate equipment, but do have the advantage of being more reliable, less noisy, and requiring less transmitter power than conventional shortwave frequencies. Fortunately for the SWL, however, not all American space missions use such super-high frequencies.

Lacking a system of permanent land-based tracking stations, the Soviet Union has instead used tracking ships scattered throughout the world's oceans. Such ships do not have room for the large dish antennas necessary to make effective use of the super-high frequencies favored by American space missions. In addition, Soviet space missions frequently pass over land areas out of the range of their tracking ships. Such factors have forced the USSR to make use of lower frequencies that are easier for the SWL to tune, including several channels in the conventional shortwave spectrum. Not surprisingly, many of these channels are in the vicinity of 20 MHz, near the original Sputnik I frequency.

Another place to tune for both American and Soviet space missions is the 108-136 MHz international aeronautical band. The upper end of the band is heavily used by satellites, as well as the first two MHz above 136 MHz. The 135-138 MHz range is known unofficially as the *satellite band*. Many meteorological satellites use this range for transmitting weather pictures back to Earth, using facsimile.

The Soviet Union also uses frequencies just below the two-meter amateur band (144-148 MHz) for voice communications with its manned space stations of the *Salyut* series. All transmissions here are in FM. This makes it easy to receive the transmissions on two-meter FM gear or public-service band monitoring equipment. One of the frequencies in this range, 143.625 MHz, has been in use by the Soviet manned space program ever since Yuri Gagarin made the first manned space flight back in 1961.

China also has a space program which is based heavily upon the Soviet model. Chinese satellites operate near 20 MHz much like many Soviet space missions. The most recent Chinese satellite, launched in early 1977, transmitted on 20,017 kHz.

How can one tell if a radio signal is really coming from a satellite? The best evidence is the Doppler shift. This is a change in the frequency of a received signal caused by the movement of the satellite past your listening post. The most common example of the Doppler effect is the way the pitch of a train whistle seems to change as the train approaches and then moves away from an observer.

If a suspected satellite signal does not change frequency over a period of several minutes, it is highly unlikely that the signal is actually coming from an orbiting satellite. Beware of jumping to the conclusion that you're hearing a signal from space simply because a received signal varies in frequency. Some less expensive receivers are bothered by drifting. Actual satellite signals will be audible for only a short time, generally less than a half hour, on each orbital pass.

It's difficult to predict in advance exactly which frequencies will be used by a Soviet or Chinese space mission. The table which accompanies this article lists some frequencies which have been commonly used in the past. Particular attention should be paid to the frequencies used by Cosmos 929, a Soviet unmanned space mission which took place in July, 1977.

The Doppler effect

Cosmos 929 was apparently an unmanned test of the next generation of Soviet manned space stations and it is quite likely that the frequencies used on the mission will be used again in the future. One of the stated goals of the Soviet space program is the establishment of permanent manned space stations.

All listening on the frequencies below 30 MHz should be done with your receiver's BFO on. If your receiver has selectable sidebands, use the upper sideband, USB, position.

The beacon and telemetry signals from Cosmos 929 consisted of seemingly "stuttering" pulses in a pattern lasting several seconds and then repeated. Some space listeners have also reported Morse code signals on the frequencies used for Soviet beacons and telemetry. However, such signals are not in standard international Morse code, nor in any known variation of it.

Some SWLs have theorized that certain space-to-ground communications, particularly on the military missions, use this crazy CW to preserve secrecy. It is interesting to note that all manned Soviet space vehicles include a telegraph key at the pilot's control panel!

The first Chinese satellite launched broadcasted that nation's national anthem, "The East is Red," on its 20 MHz frequency. China II, launched in early 1977, had a signal full of beeps and clicks on its 20,017 kHz channel.

Recent Soviet manned activity has made use of the Salyut space station and the Soyuz space capsule. Cosmonauts travel into space aboard Soyuz and rendezvous and dock with the Salyut. While the cosmonauts are still aboard

Soyuz, the main channels for voice communication are 121.625 and 121.750 MHz using wideband—15 kHz deviation—FM. Once the cosmonauts are aboard Salyut voice communications are shifted over to the old reliable voice channel of 143.625 MHz.

One very interesting variation to this pattern took place in August of 1976 during the Salyut 5 mission. Listeners in Europe noted that on numerous cases when the space station entered radio range of Soviet ground stations that voice transmissions would cease on 143.625 MHz. Instead, telemetry-like signals would be heard. Alert listeners also discovered that when voice transmissions ceased on 143.625, signals would immediately pop up on 143.825 MHz. These new signals sounded like highly irregular telemetry. Speculation ran that these new signals were actually some form of "scrambled" communication between the cosmonauts and ground stations—Salyut 5 was a military space mission. Veteran space observers in the West reached this conclusion due to the minimal coverage the flight received in the Soviet Union, the sketchy details released by Tass, and the different orbit from other Salyut missions.

Guide to space frequencies

Frequency (MHz)	Spacecraft name or use
15.008	Cosmos 929
18.008	Cosmos 929
18.060	Cosmos 929
19.946	Salyut telemetry channel
19.954	Cosmos 929
19.995	Soyuz/Salyut beacon channel
20.008	Cosmos 929
20.017	China II beacon channel
121.625	Soyuz voice channel
121.750	Soyuz voice channel
135.600	American ATS weather satellites
137.150	Soviet "Meteor" weather satellites
137.300	Soviet "Meteor" weather satellites
137.500	American NOAA weather satellites
143.625	Most commonly used Soviet voice channel
143.825	Used for coded transmissions during Salyut 5 mission

Tuning in launch support transmissions

SWLs can also eavesdrop on radio communications between rocket launching centers and aircraft aloft for photography and technical measurements in connection with launches. Transmissions from the Kennedy Space Center at Cape Canaveral are in single sideband (SSB) and identify as *Cape Radio* or *Orion Control*. Listen for them whenever a launch is scheduled. Try the following frequencies: 6723, 13,218, 14,896, 19,640, and 22,760 kHz. Listeners in the West can also listen to launch support transmissions at Vandenberg Air Force Base, California, on 22,760 kHz.

Listeners have also reported CW transmissions during Soviet manned space missions on 19,990 and 19,995 kHz. Rough direction finding indicates that these transmissions originate from the Soviet launching site at Baikonour in the Kazakhstan region of the USSR.

. . . But don't forget OSCAR!

***Modern Electronics* has kept readers informed of the very latest happenings in the OSCAR program. But have you tuned in one of the OSCAR satellites yet? OSCAR still provides the easiest way to actually hear a transmission from outer space. Both OSCAR 7 and 8 operate easily-tuned beacons. OSCAR 7's beacons operate on 29.450 and 145.972 MHz while OSCAR 8 uses 29.400 and 435.095 MHz.**

The OSCAR satellites also offer your only chance to get a QSL card for hearing a satellite. AMSAT, The Radio Amateur Satellite Corporation, is the builder of the OSCAR series and they welcome reception reports on the OSCAR beacons. They also engage in fund-raising projects to pay for the OSCAR program and will gladly furnish additional information upon request. Address your reception reports and inquiries, with return postage, to AMSAT, The Radio Amateur Satellite Corporation, P.O. Box 27, Washington, D.C., 20044.

Weather birds

Weather pictures from orbiting satellites have enabled earthbound meteorologists to greatly improve the accuracy of their forecasts. Little known to most SWLs is the fact that it's possible to actually receive and print out weather maps from orbiting satellites!

Weather pictures are transmitted to Earth using the process of *facsimile*. Fax, as it's known to hams, takes an incoming signal and uses it to control a stylus or pen moving across a revolving drum carrying paper. The lightness or darkness of the impression made by the stylus depends on the information contained in the incoming fax signal. With each revolution of the drum the stylus moves further down the paper, eventually reproducing an entire photo.

Facsimile transmission is permitted to hams on frequencies above 50.1 MHz. hams who had fax equipment discovered that it was easy to receive weather pictures from orbiting satellites. They just hooked up their fax printers to receivers that covered the 135-138 MHz satellite band.

Reception of weather pictures is simplified by the fact that most weather satellites are in *geosynchronous orbits*. This means that the satellite's position in the sky does not seem to change, eliminating the need for movable antennas.

Full information on receiving weather satellite pictures can be found in *Specialized Communications Techniques for the Radio Amateur*, published by the American Radio Relay League. Fax receiving equipment is often offered for sale in the pages of *CQ, The Radio Amateur's Journal*.

Even if you don't have the equipment to receive the pictures themselves, you can eavesdrop on the satellites. A fax signal sounds much like a slow-scan tv (SSTV) signal—continuously varying tones. The United States uses 135.600 MHz for its ATS series and 137.500 MHz for the NOAA series. The Soviet Union has its own "Meteor" series operational on both 137.150 and 137.300 MHz. Incidentally, the weather pictures from the Soviet satellites can be received just as easily as from the American ones!

Receiving gear

To tune satellite signals below 30 MHz, almost any general coverage shortwave receiver can be used. Older models which lack sensitivity can benefit from the addition of an outboard preamp. There are a few receivers capable of tuning the 108-136 MHz aeronautical band available on the new equipment market and many more available as military surplus. Another approach is to use a converter with a general coverage receiver. Again, a good place to find such gear advertised is *CQ, The Radio Amater's Journal*.

Amateur two-meter FM gear and public-service band receivers which can tune down to 144 MHz can usually receive the 143.625 MHz Soviet voice channel if a few modifications are made. The biggest change is converting the selectivity from the narrowband (5 kHz deviation) FM commonly used in such devices to the wideband (15 kHz deviation) FM used for Soviet voice transmissions.

Antennas can be relatively simple. Many find that a dipole, ground plane, or vertical gives satisfactory service. For receiving signals below 30 MHz, any antenna that gives satisfactory shortwave reception can be used.

Listening in to outer space, as you can see, is an activity within easy reach of any SWL. The sky doesn't have to be the limit for your DXing activity! ■

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810-F

Parallel resistance made easy

Try these simple one and two step approaches.

by Michael Yurkovich

Not too many years ago, $50 would buy you the latest four-function pocket calculator. Today, that same calculator can be bought for as little as $5. And at that price, just about everybody has one. Yet as popular as the simple pocket calculator is, hardly anything has been written about using them to solve simple electronics problems. That may be due to the availability of moderatley priced scientific calculators with dozens of functions built-in.

Not every new electronic hobbyist has one of those super calculators, however. But the $5 add-subtract-multiply-divide unit can still be used to solve what could otherwise be very tedious calculations. In particular, calculating the net resistance of a parallel network can be a real problem. But not with your five dollar calculator.

Product over the sum

The easiest parallel network to work with is the simple two-resistor combination. The net resistance of two resistors in parallel can be calculated by dividing their product by their sum. For example, if you had two 100 ohm resistors in parallel, the net resistance would be equal to 10,000 (100 x 100) divided by 200 (100 + 100), which is 50 ohms.

Although you could have figured this example in your head, calculating the net resistance of a 27 ohm and 68 ohm resistor isn't quite as easy. Using your pocket calculator, you can get the product (1836) and the sum (95), and then make your division to get the answer of 19.3 ohms. But this involves three separate computations.

You can simplify the process by changing the product-over-the-sum to the sum-over-the-dividend. In this case you simply add the two resistors, then divide by one resistor, then divide again by the second resistor. After you've completed this computation, divide 1 by the result you've just gotten.

Following this procedure, you find that 27 + 68 ÷ 27 ÷ 68 equals .05174. Dividing 1 by .05174 gives you 19.327, or simply 19.3. Following this procedure, you saved one step in computation.

The product-over-the-sum and its derivative only work for two resistors. If more than two are connected in parallel, you'll have to use the old reciprocal-of-the-sum-of-the-reciprocals approach, which is even more difficult to use than to say. Simply put, you must divide 1 by each of the resistances, then add together the results. Then, you have to divide 1 by the sum you've just calculated.

Simple method

You can avoid the grief involved in using the reciprocal approach with this handy method. Let's call the resistors R1, R2, R3, and R4, though you could add as many as you wanted. Just divide R2 by R1, add 1 and divide by R2, then multiply by R3, add 1 and divide by R3, then multiply by R4, add 1 and divide by R4. If there are more resistors, just continue multiplying by the next resistor, adding 1 and the dividing by that resistor. Then divide 1 by the result.

As an example, lets assume the values to be 27, 33, 47 and 56 ohms. You would folow this procedure: 33 ÷ 27 (1.22222) + (2.22222) ÷ 33 (.06734) x 47 (3.16498) + 1 (4.16498) ÷ 47 (.08861) x 56 (4.96216) + 1 (5.96216) ÷ 56 = 0.10646. Then 1 ÷ 0.10646 gives you the net resistance of 9.3931 ohms.

Try it a few times and you'll see how really easy it is. The beauty of it is that the entire procedure up to the last step is a continuous operation—you don't have to write anything down or clear the calculator until the last step.

If your calculator has a constant math function, you can even save that last step. Constant math functions vary from calculator to calculator, so check out the instruction sheet that came with yours. The idea of a constant math function is that you can keep repeating the step by hitting the function button. In other words, 1+1 gives you two, but hitting the + button again gives you 3 and so on.

Using constant math, you can replace the last step, dividing one by the result of the chain computations, with the operation of ÷ = =. In our example, after entering ÷ 56, you would just hit ÷ = = and there would be the answer of 9.3931.

The same procedure outlined for parallel resistors can also be used to calculate the net capacitance of a series capacitor circuit. Just substitute the values of each capacitor for the values of the resistors. Or, if you've calculated the reactances, the values of X_C for the values of R.

As you can see, at least in the area of parallel resistance and series capacitance circuits, the simple four-function calculator can save you a lot of time and aggravation. Considering the bargain prices of these wonders, you can hardly afford not to have one. ▣

Heath's H-8 computer is quite a machine just as it comes. But following these simple procedures, you can make your H-8 even better and more useful.

by Carmine Prestia
Contributing Editor

It seems that no matter what kind of gadget you are using these days, you always find out its limitations rather quickly. The microcomputer is no exception. Standing by itself it really can't do all that much. It needs peripherals to communicate with and do things in the outside world. After doing some programming with my Heath H8 I began to run into some of its limitations.

My system consists of the H8 Computer with 12K bytes of memory, the H9 Video Terminal, the H10 Paper Tape Reader/Punch, and the ECP-3801 Magnetic Tape Drive. There's a full review of this system in the June issue of ME.

The first problem came when I ran out of memory! The H8 had 12K of Memory. That is 12288 *bytes*, or words, each representing a piece of data or character. Since Extended Benton Harbor BASIC takes around 8K of memory, only about 4K *bytes* are free for programming. That didn't mean a lot to me until a couple of my programs generated a *MEMory OVerflow* message. When that happens you either get more memory or shorten your program. I chose more memory!

The next problem to confront me was output, the H9 Video Terminal was my only input/output device. Not many other terminals can beat the speed or convenience of a CRT. However, if you need printed copies of the program results, or a program listing, there is no hard copy output. To make matters worse, when information *scrolls* off of the screen, it is lost. To solve the problem I needed some kind of printer.

Heath had the answer to both of these problems in their catalog. To add to the H8's memory I used the H8-3, 4K chip set.

More Memory

The kit consists of eight IC sockets and eight 4044 memory ICs to add 4096 more *bytes* of RAM . . . Random Access Memory. Installing the kit was almost too easy. It took less than an hour. I had to remove one of the memory boards, solder the sockets to the board, and install the ICs.

Be careful with the chips. They are CMOS and can easily be zapped by static electricity. Heath gives excellent instructions on how to handle the ICs and prevent problems. For more information

Adding a printer to your H-8 computer

on how to handle CMOS ICs, refer to page 63 of the July issue of ME.

With the H8-3 kit installed my H8 now boasts 16K of memory. This is equal to or better than some of the small computers in use on the local college campus. The kit sells for $85.00. Interestingly, Heath has managed to pass a price reduction along to its customers. The H8-3 originally sold for $95.00.

I/O teletype

Adding a printer to the H8 is a bit more complex than memory because there are so many options available. Just about any computer store offers printers that would work with the H8 if you have the right interface board. Heath offers an excellent terminal printer, the LA36 DEC Writer II by Digital Equipment Corporation. The LA36 is fully assembled and sells for $1495, a bit expensive. But, it is a full I/O terminal featuring both upper case and lower case printing, variable width tractor feed for different size forms, and 132 column format. Also available are line printers from other manufacturers at 1/3 to 1/2 the cost of the LA36. They are, however, printers only.

I didn't have to go either of these routes though, since I had available a Model 33 Teletype. This is a full I/O terminal, with hard copy. Teletype Corporation designed the Model 33 specifically for use with computers. It uses the ASCII (American Standard Code for Information Interchange) character set. If you choose to use a Model 33 be prepared to spend close to $1000.

Easy connection

Of course, an interface is needed to allow the H8 to communicate with the Model 33. I had to get another Serial I/O board, the H8-5 ($110). Serial means that the data is relayed to or from the TTY one *bit* at a time. If the printer is a *parallel* device, as many line printers are, the date would be moved 8 bits, or one full *byte*, at a time. Parallel devices are usually faster than serial devices, but that is not a major consideration, unless you are concerned with system time.

Assembly of the H8-5 was not difficult, but I did take my time and I would advise you to do the same. The solder pads and conductors are very tightly packed and it would be very easy to bridge some conductors. At the least the board would not work; at the worst some components could be destroyed. Follow Heath's instructions to the letter, there is no room for error in a device like this. Total wiring and hookup time was 11-1/2 hours.

The H8-5 board has a number of wiring options, based on the terminal you will be using. To support my Model 33 I wired the board for a Baud Rate of 110 (data transmission speed) and a 20 ma active loop. The loop provides the current to drive the TTY. There is a more complete discussion of TTY loops in the June 1978 issue of ME.

The TTY is hooked up to the H-5 through a four conductor cable to terminal strip CL on the Model 33. This strip is located on the lower left rear of the TTY under a lot of wires and a cardboard strip. The accompanying schematic diagram shows the hookup. Four cables are used because the TTY and the computer operate Full Duplex, sending and receiving data at the same time. The keyboard sends a character to the computer and the computer *echos* it back to the printer.

One very important consideration is the *port* address of the serial board. A *port* is an address where a computer performs I/O functions. The Heath manual tells you to wire the board for port 370_8 (Octal Notation), however that would not work with my system because the H9 CRT is using the same address. My serial board is wired for port address 310_8.

I did not do all of this on my own. After planning the options needed, I called the Heath Technical Service and checked with them. When they said my options were correct I went ahead. My time and caution were well rewarded, everything worked the first time around after I corrected an error in the TTY hookup wiring. There were no problems with any of the Heath components.

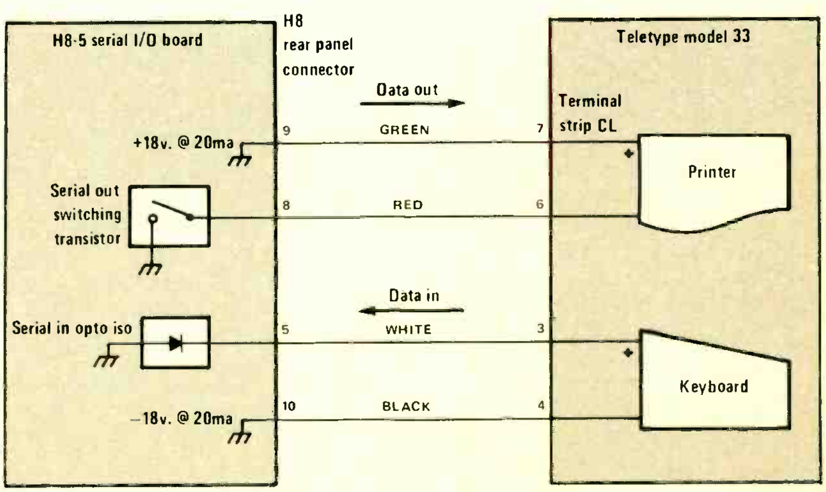
Now I have sufficient memory and a functioning printer. Use of the two is easy. First, BASIC had to be reconfigured from the distribution tape for the higher memory and the TTY. Once that was done I made a copy of the configured language and loaded it whenever the machine is used.

BASIC is made up so that the I/O operations go to port 372_8. To get to the other port a special command has been provided. PORT=. If I type PORT=-200 on the CRT the entire console terminal operation is transferred to the TTY (200_{10} is equal to 310_8). All of my Input/Output operations are carried on at the TTY until I type PORT=-250 returning the console operation to the CRT.

To do things a little differently I can type the command as Port= 200 (the address is positive) in one of my programs. Now any print statement that occurs after that line is executed at the TTY. By doing this, all of the Input can be done on the H9 and only the output appears on the printed copy.

Both of these modifications have made the H8 much more versatile. Programs can now be longer and more complex. I can deal with long tables that take up lots of memory and hard copy outputs can be produced whenever needed. Programming is also easier because I can do all the coding and modification on the CRT, then have a listing type out by the TTY. ▣

The Heath HB-5 Serial I/O Interface Board can be connected to a Model 33 Teletype with just four wires.



program

TRY THIS ON YOUR HOME COMPUTER

BY THOMAS ROHR

I became interested in the 1802 Cosmac Elf microprocessor while reading an edition of an electronics hobbyist magazine. Sometime later I noticed an ad for a "Super Elf" by Quest and decided that a "Super Elf" had to be better than a plain Elf. I sent for the Super Elf and constructed it in two nights. But I faced the problem of programming it to do something other than just read back from its HEX displays the programs I put into it.

The Super Elf is about the least inexpensive microprocessor one can purchase and is well worth the money. It is also a great time saver over the Elf, which doesn't have a hexadecimal keyboard. Unfortunately, Quest does not provide user info with the kit. They give you everything you need, construction instructions, operation instructions, etc., but no programs.

Unfortunately there were no articles on the Super Elf. I still have not seen any. The Cosmac instructions in the Quest construction manual were very basic and did not offer any sample programs. The manual, though very technical and correct, did not solve my problem of running a program that did something.

An electronics magazine had a program that would play music in the Elf. I tried the program but it didn't work in my Super Elf. If at first you don't succeed . . .

I had to modify the program in several places to produce music, but I did manage to make it work. The program now permits the computer to play continuously whatever is programmed, until the "reset button" is depressed, or the power is turned off.

A nice feature built into it lets you watch and hear the program itself step through sequentially. This provides an excellent test to insure your "Super Elf" is functioning properly. No interface is needed. You can, however, replace the speaker supplied with a larger one for better tone.

Here is my program to relieve all those suffering purchasers of the "Super Elf."

Location	Input	Remark
68	EF	(OR e5) SETS X=F
69	F8	LOAD IMMEDIATE
6a	AC	PUT LOW
6b	A5	PUT LOW 5
6c	FO	LOAD VIA X
6d	3A	SHORT BR IF D/O
6e	70	RETURN
6f	70	RETURN
70	A8	PUT LOW R#8 (STORE
71	15	DURATION)
72	64	TURN ON 64 (SPKR)
73	25	DECREMENT #5 (STORE)
74	FO	LOAD VIA X (PITCH)
75	A7	PUT LOW #7
76	F8	LOAD IMM. (STORE)
77	04	LOAD VIA 4 (TEMPO)
78	A9	PUT LOW #9
79	87	GET LOW #7
7a	FC	ADD IMMEDIATE
7b	B4	PUT HI 4
7c	33	SHORT BRANCH
7d	86	GET LO 6
7e	31	SHORT BR IF Q=0
7f	83	GET LO 3
80	7B	RESET Q (TURN OFF)
81	30	SHORT BR.
82	86	GET LO 6
83	7A	SET Q (TURN ON)
84	30	SHORT BR.
85	86	GET LO 6
86	87	GET LO 7 (REPEAT AS
87	FF	SUBT MEM IMM (OFTEN
88	01	LOAD VIA 1 AS PITCH)
89	3A	SHORT BR IF D NOT 0
8a	87	GET LO 7
8b	89	GET LO 9 (REPEAT AS
8c	FF	SUBT MEM IMM (OFTEN
8d	01	LOAD VIA 1 (AS TEMPO)
8e	A9	PUT LO #9
8f	3A	SHORT BR IF D NOT 0

90	99	GET HI 9
91	88	GET LO 8 (REPEAT
92	FF	SUB MEM IMM (AS
93	01	LOAD VIA 1 (DUR.
94	A8	PUT LO 8 (INDICATES)
95	3A	S.BR. IF D NOT 0
96	76	RING SHIFT RIGHT
97	30	S. BR.
98	A1	PUT LO 1
99	C4	NO OP (WAIT
9a	C4	NO OP (WAIT
9b	30	S. BR. (MAKE
9c	9D	GET HI # D (ALTER-
9d	30	S. BR (NATE
9e	9F	GET HI F (PATHS
9f	30	S. BR. (TAKE SAME
a0	79	PUSH X,P TO STACK
a1	7A	SET Q (TIME)
a2	30	S, BR.
a3	6C	INPUT 4 (GET NEXT NOTE)

The program will play "Nocturne," then play the programmed music, the five notes from the movie "Close Encounters," and then run through the preprogrammed monitor ROM. By changing the input in location 77, you can speed up or slow down the music.

You'll also find a table of input for notes and another for duration of notes. With this program any song can be programmed into the locations specified. The program as written must start at location 68.

This program, when correctly loaded into the Super Elf starting at location #68 will play any notes loaded from location #21 to 68 and #A4 to FF. In addition the program lets you hear the computer produce notes for the first 20 bytes of the ROM monitor and the program itself. ▣

Table of musical notes

G —	D — 2d	A# — 19
G# — 43	D# — 2a	B — 17
A — 3f	E — 27	C — 15
A# — 3b	F — 24	C# — 14
B — 37	F# — 22	D — 12
C* — 33	G — 1f	E — 09
C# — 30	G# — 1d	F — 06
	A — 1b	

*middle C

Variables are locations 77-88 and 8d.

Table of note duration

if LOC 77 is 04

1/16— 2d 1/4 — 41 1/2 — 8b

whole — 99

Notes can be repeated by loading it several times. For example, to repeat middle C, load 99 33 33 33 33 33 33 etc.

Location	Input	Remark					
				35	12	64	24
				36	41	65	24
				37	1b	66	24
				38	99	67	24
				39	15	PROGRAM FROM	
				3a	93	#68 TO #a3	
				3b	19		
21	c4	50	2d	3c	41	a4	93
22	41	51	19	3d	1b	a5	if
23	33	52	2d	3e	99	a6	99
23	99	53	1b	3f	1f	a7	1b
25	1b	54	2d	40	93	a8	99
26	41	55	19	41	1b	a9	24
27	1f	56	2d	42	41	aa	93
28	41	57	2d	43	27	ab	33
29	1b	58	2d	44	99	ac	99
2a	99	59	27	45	24	ad	24
2b	1f	5a	2d	46	99	ae	24
2c	93	5b	24	47	2d	af	24
2d	24	5c	2d	48	41	FROM	bo
2e	41	5d	1b	49	33	to	ff
2f	33	5e	2d	4a	41	insert	
30	93	5f	i5	4b	10	24	
31	1b	60	99	4c	41	or repeat	
32	41	61	08	4d	12	data	
33	2d	62	99	4e	2d	from a4	
34	93	63	24	4f	i5	to af	

letters

INPUT FROM MODERN ELECTRONICS' READERS

Unhappy with the articles and projects in Modern Electronics? Want to see an article on your favorite subject.? Pro or con, let us know what you think about us. Here's a sampling of what some of you have to say.

Who has the car

Dear ME:

I read an article in the newspaper about a mini-car powered by batteries that carries two people at up to 30 miles an hour. The article didn't mention who made the car. Do you know? Any information would be appreciated.

Hugh Barrie
San Francisco, CA

Sorry, we can't help you. But maybe one of our readers can pass along the name and address of the car's maker.

Beginners and experts

Dear ME:

Recently I saw a copy of your March issue and I feel that you have a very fine magazine that will soon command its fair share of sales. The article on microcomputers by Mr. Stark was exceptionally well written. Some of the projects and articles were a bit too basic, however.

I don't feel that anyone who needs electricity explained to them (as in the Handbook section) will be prone to buy an electronics magazine. I may be wrong. There may be a market for a magazine that is not over the heads of beginners, yet has articles that can hold the interest of more advanced readers. Personally, I would prefer larger projects.

Richard C. Degler
Hoffman Estates, IL

R.C.D. brings up an interesting point. Should we mix articles aimed at the beginner with projects for the more advanced reader? Let us know how you feel about it.

Hear the trumpets blow

Dear ME:

I inquired of PAIA Electronics about the possibility of keying a synthesizer using a trumpet as the controller. PAIA informed me that it is possible, but they do not make any such kit. They told me that I needed a pitch-to-control-voltage converter. Could you supply me with a schematic to build such a converter? I would also appreciate your thinking about a method or device to achieve control of a synthesizer by a trumpet.

John Dutra
Yorktown Heights, NY

Sounds like a wild idea, J.D. Anyone out there have an answer for him? And if it works, perhaps we can use it in ME.

Ham help

Dear ME:

I liked your article on the FCC strike force that appeared in the March issue. I am a licensed CBer and very interested in microprocessors. I'd also like to see something about how one goes about becoming a ham radio operator, and how one gets a license.

Harvey A. Kurtz, Jr.
Cleveland, OH

Thanks for the suggestion. We'd be interested in knowing how our other readers feel about articles on how to become a ham. Let's hear from you. In the mean time H.K., drop a note to the ARRL, Newington, CT and ask for a list of ham radio clubs in your area that hold licensing classes.

Address correction for SGC

Dear ME:

Thank you for including SGC single sideband radio telephones in your Marine Electronics roundup in the May issue of ME. Please note that the address given in your listing was incorrect.

Larry Kezner
SGC
13737 S.E. 26th St.
P.O. Box 3526
Bellevue, WA 98009

Thanks for the correction. We'd appreciate hearing from any other firm about which we've printed incorrect information.

More robot power

Dear ME:

I would like some information about the function of robots. I have a book that shows how to build a robot car, but it doesn't tell about the function of arms or the head, or give information about the memory bank. Can you give me some information on this?

Willie G. Wilson
Farris, OK

Radar detector

Dear ME:

As a physics student I have been investigating microwaves. The experiments have been rather basic confined to wave length measurements, absorption, and reflection of microwaves. When investigating application of microwaves it was found microwaves were used in radar detection devices. Wanting to find an application of what was learned in class and lab I thought it would be useful and interesting to build a microwave receiver for my car. Rather than design and build a receiver on my own I would like to know if your magazine has ever printed a schematic of such a receiver or if you intend to print one. I would also appreciate any other information you have on the subject of microwaves.

Michael Breen
Sterling Heights, MI

Sorry, but we haven't run any articles on microwave equipment, and have none planned for the near future. But we'd be interested in doing so. If any of our readers have the knowledge and experience to put together an article on microwave gear, we'd like to see it.

Robot power

Dear ME:

I've decided to take a little time to write you about your truly excellent magazine, which I've found to be the most informative piece of electronics literature around. That's the praise for the day. Now for my complaints.

I've been greatly interested in robotics for some time, and became an ME sub-

please turn to page 92

Beat the great boating rip-off

ed by the boat owner isn't
or even great white sharks. It's
wing these simple steps, you
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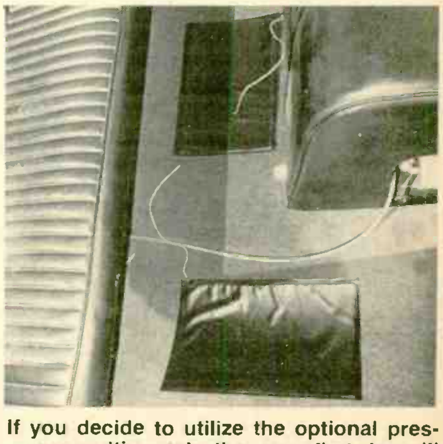
ism.

Unfortunately, the amount of attention devoted to this end usually consists of an occasional glance at the carport, sneaking a quick peek out the window, and a smug self-assurance that "nothin' can happen to me!". As an alternative, California Electronics Industries is now marketing a fully-automatic security system that will serve as your watchdog. You simply install the system according to directions

If someone tries to tamper with the boat or trailer, you and he will be the first to know. A piercing siren will immediately sound, and continue to sound, until two minutes *after* the disturbance has ceased. The alarm then resets itself and guards against any subsequent attacks.

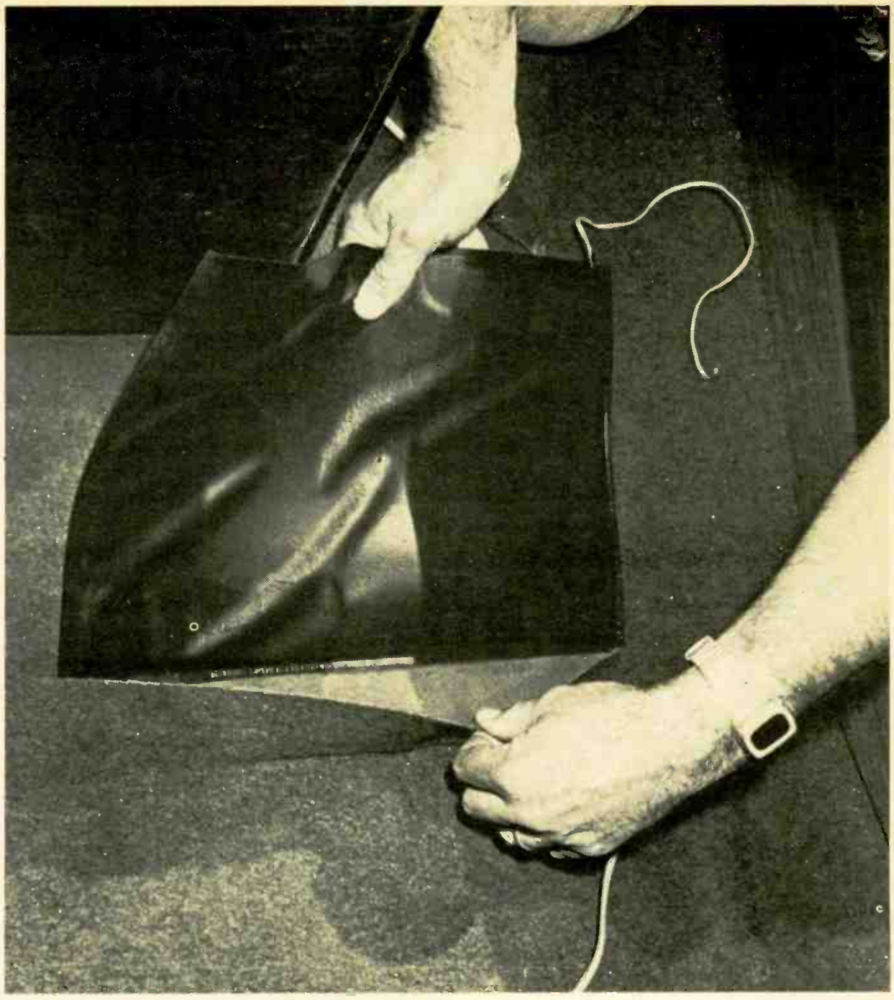
Basically, the security system utilizes a solid-state alarm module that is mounted in a semi-hidden location in the boat, a public address horn, and all wiring and hardware required for the installation. Optional features that may be used in conjunction with the security system include pressure-sensitive—and waterproof—floor mats, a water/gas fume detector, visible strobe light, and a wireless, belt-clip pager that operates



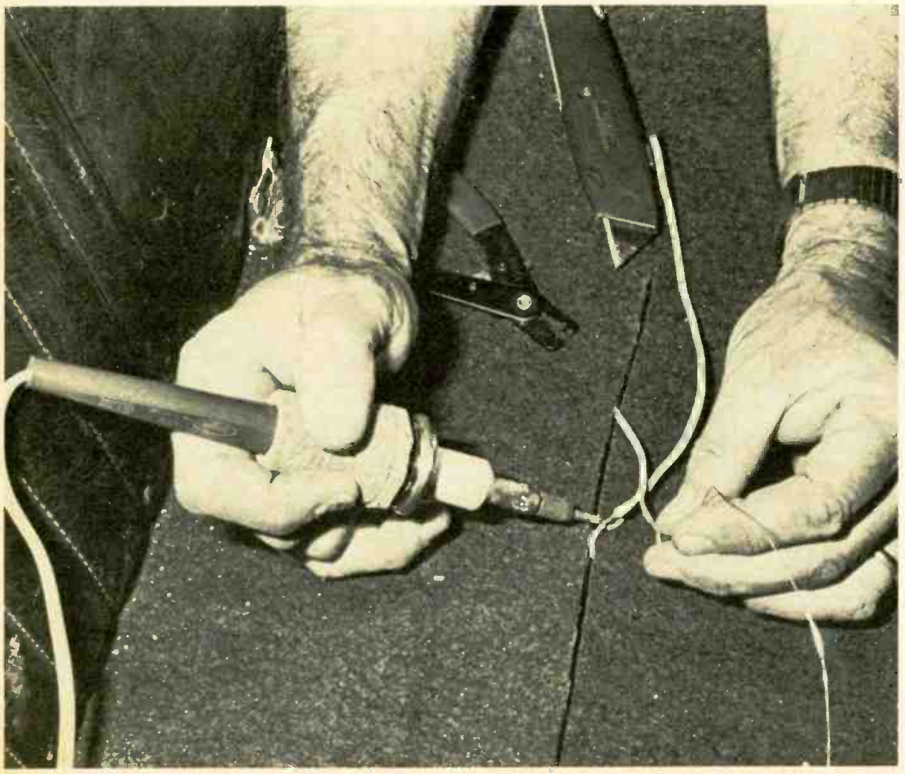
If you decide to utilize the optional pressure-sensitive mats, then your first step will be to locate desirable positions for the mats along all floor areas.

Security system components include a solid-state alarm module, public address horn, and all wiring and hardware required for installation. There are many optional components available to make this a more personalized system for your particular needs.

The system boasts a built-in motion detector that will detect a thief tampering with your boat or trailer. Motion detector sensitivity is set by adjusting a small screw found at the top of the module.

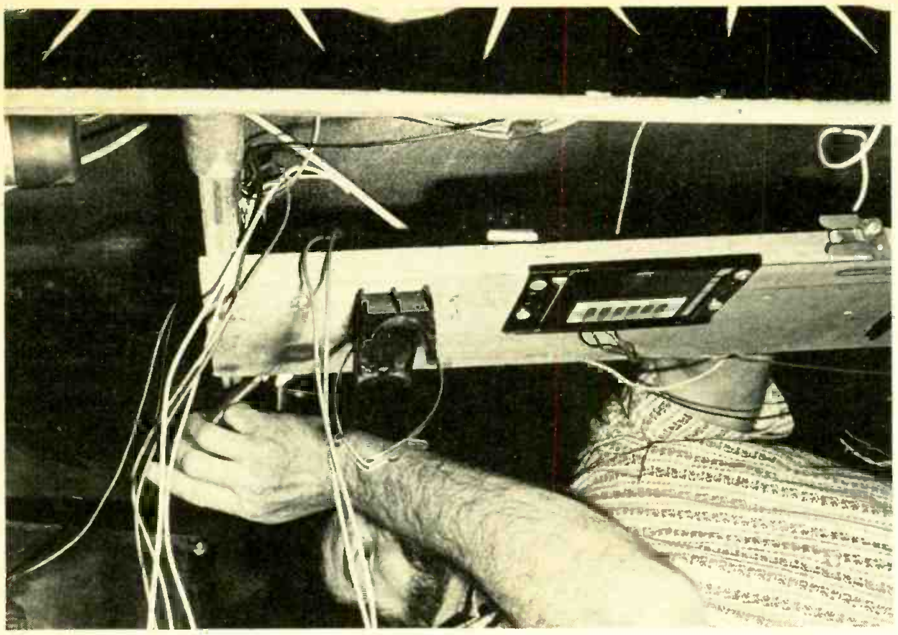


If your boat's carpeting can be pulled up easily, then perform this task and slip the mats underneath. If not, you'll have to slit the carpet with a utility knife for access. Pull back the edge of the carpeting and slide each mat underneath, leaving the wire leads exposed.

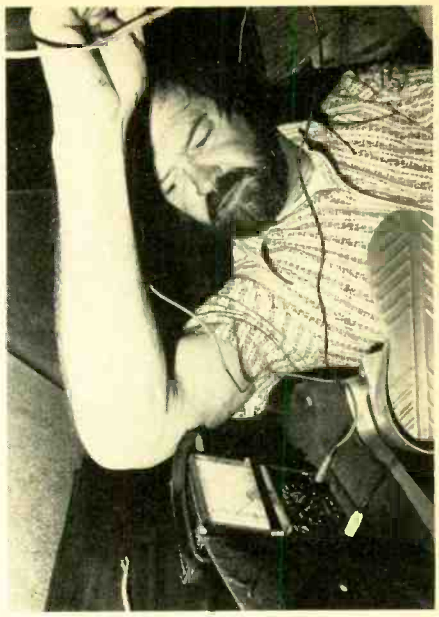


Solder and tape these leads to a main wire that will join all mat leads together. Then, route this main wire underneath the carpet to the spot where the central alarm model will be located.

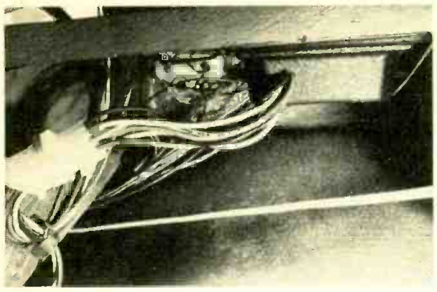
Roll out heavy-duty carpet tape and cut a length that corresponds to the size of the cut made in the carpeting. Slip the carpet tape underneath the carpet so the sticky part of the tape touches carpet on each side of the cut. After the tape is positioned, press down on the carpet along the entire cut edge. You'll hardly know the cut was ever there!



In our sample installation, we decided to install the module above a wood section that ran side-to-side under the dash area. Wires from the alarm's wiring harness are now hooked up to power and ground sources.



Use a meter (or trial-and-error) to locate a wire that is always hot at the ignition switch. A second wire that's hot only when the switch is "on" will have to be located, also.



This close-up view shows the alarm module secured to the wood section with wood screws. Note the quick-disconnect wiring harness provided with the system.

much like those used by doctors for contact in emergency situations.

Unlike cheap vehicle-type alarms that utilize an accessory key switch for arming and disarming the alarm, CEI's *Sea-Curity* system is tied into a boat's stock ignition switch. All a boater has to do to disarm the system is enter his boat and switch the ignition to the on position before a pre-set entry delay time has expired. If you do not wish to leave your keys in the ignition, simply reach to the alarm module's hidden location and flip its switch to the off position. The real benefit of this type of arming and disarming is that there is no tell-tale accessory switch to give a thief advance notice that the boat is electronically protected.

While the boat and trailer are stationary at home or in a parking lot, the system's motion detector and optional pressure-sensitive mats will protect against tampering. You can turn the system off when running the boat by simply flipping a switch on the alarm module. However, if you wish to beach or dock the boat and still keep your craft and equipment protected, just turn the motion detector off and activate the system. The pressure-sensitive floor mats will protect against unauthorized entry, but the movement of the water will not false-trigger the system.

If a thief attempts to steal equipment stored in the boat or jostles it in any way while trailered, the system's built-in motion detector or pressure-sensitive mats will trigger the siren. If, while docked or beached, a thief enters the boat, the siren will again sound and all those within 200 yards will hear the alarm. And if you add the optional transmitter/pocket pager to the security system, you will be personally notified of an attempted theft via a beep-tone at the pager. It's really foolproof.

As you can well appreciate, this security system offers all of the desirable features a sophisticated alarm system should have. It presents the highest degree of protection available on the market today—yet it's easy to install. A typical installation project should take no more than an afternoon for a capable do-it-yourselfer.

Further information on the "Sea-Curity" system may be obtained by contacting California Electronics Industries at 5480 Katella, Unit #207, Los Alamitos, California 90720.

Under the deck, find a suitable mounting spot to attach the horn bracket. Hold the bracket in place, mark through the bracket holes, and drill. Secure the horn to its bracket with hardware provided, then run horn wiring to the alarm module. After all connections are made per directions the system is ready to work for you to protect your investment.

Radio skip

continued from page 33

I'd set the pointer to Germany, and find that the bearing was 30 degrees. That means that my signal would bounce down somewhere in Hudson Bay, in Canada, and take off again over Greenland and come down in the snow, and go up again. The distance is about 5600 miles, great circle, so the third bounce would land me in Germany.

There are two likely times during each 24-hour period, that give me the best chance of hearing signals from Europe on 20 meters. One is early morning when it is late afternoon there. The other is when it is late evening here and morning there. Frequencies as high as 15 or 10 meters are likely to be open between California and Europe at those times.

As you might have suspected the East Coast has an advantage when working skip into Europe compared to the West Coast. They don't have to pay the 10 dB penalty of an extra bounce. Of course those of us on the West Coast have the same type of advantage when working Australia or Japan.

Most of the country has complained of the West Coast's aluminum curtain when they want to reach out into the Pacific. It's often hard to get through all of those high powered California stations.

There are times when the best route between two locations is the so-called *long path*. It's called that because radio signals are bouncing the long way around the Earth. Again, it depends on the state of ionization existing between the stations. Frequently the longer path is actually the stronger path.

When I hear a peculiar echo effect on a DX signal I know that it is likely that I am hearing their signal from both directions at almost the same time. That's when I spin my antenna to a heading opposite the one normally used.

A few months of practicing and you will know most of the bearings automatically, and the approximate local time at the DX location. Knowing that the path depends on those ionized layers allows you to calculate your chances of making contact at a particular hour to some specific place in the world.

Unfortunately, for those hard working types who have a daily job, much of the good DX takes place in the morning hours, so retirees, swing shift people and housewives have a big advantage. I suppose that I ought to include writers, since I keep hearing the statement, "Oh, you're a writer. That sure must beat working!"

Radio propagation is one of the most complex subjects known to man, so you should know that we have barely scratched the surface in this article. However, you ought to have a handle on which way to point your beam antenna if you want to chase DX or shoot skip. Good luck and good DX. ■

Computers

continued from page 10

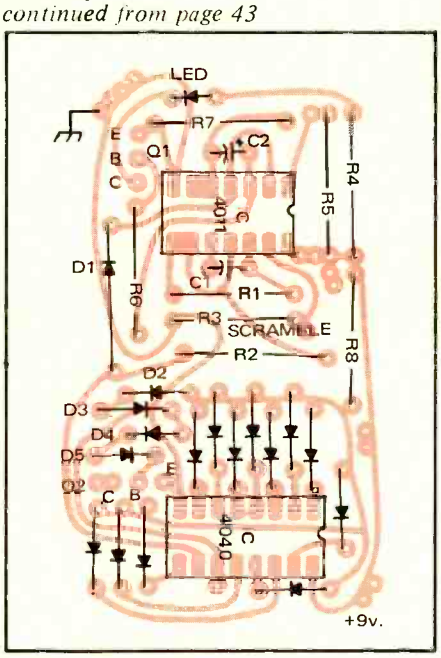
ing department of a company at the time the company went to computers, and were trained that way. In other words, they got into programming through the back door.

If you are interested in college, there are various other programs available to you. One possible one is a Computer Science program, which combines math with computer theory, though not too much programming. Many business colleges also have four-year computer courses which may be easier and more productive in the long run. A very respectable approach is to study accounting or bookkeeping and take a few computer courses on the side. In many cases, the four-year college degree, regardless of what it is in, is almost like a union card. Once you have it, an employer will take a chance even if your computer experience is not really up to date.

I hope this information hasn't scared you away. Computer programming jobs pay well, but are hard to get and keep for beginners. But for a good programmer, the pay is worth it. And there is another benefit too. Even if the employer is cheap and doesn't provide air conditioning for his employees, the computer room is always air conditioned. At least you can be comfortable. ■

Lottery

continued from page 43



Parts loading for ME's lottery game as seen from parts side of the board.

better off using a PC board. Although you can make up your own board, a template is provided, along with a parts loading diagram.

The lottery game can give you hours of fun at your next party. And a lot of fun building it. If you take your time, it should work the first time out. ■

review

NEW BOOKS AND CATALOGS

Computers???

Sooner or later, if you haven't already, you're going to start thinking about buying or building your own computer. If you don't already have a good working knowledge of the vocabulary, most of the information about computers you'll find in hobby magazines and books will only make things even more confusing than they seem now. But that's not the case with Mitchell Waite and Michael Pardee's book, *Your Own Computer*, from Howard Sams.

This 80-page softcover book will give you a good introduction to the computer and its applications without too much technical gobbledygook. What computer jargon is used is clearly defined in the text, and in a 12-page appendix. If you're thinking about getting into computers, but know nothing about them, the two dollars *Your Own Computer* will set you back can be one of the best investments you'll ever make. For more information, circle number 107 on our reader service card.

Although *Your Own Computer* is an ideal introduction to computing, there's not enough in it to satisfy those who want more than just a passing acquaintance with data processing. If you fit into this category, you'll find *An Introduction to Microcomputers*, subtitled *Volume 0, The Beginner's Book*, more to your liking. Its 218 pages of text and four-page appendix cover virtually everything you'd like to know about microcomputers.

As an example of its completeness, consider its treatment of printers. You'll find words and pictures describing matrix printers, thermal printers, ink jet printers, daisy wheel printers and belt printers. There's also a discussion of various paper feed methods and common printer options.

The best thing about the book is the large number of illustrations, averaging better than one per page. If there's any truth to the adage that a picture is worth a thousand words, and all the information in the book were in words, you wouldn't be able to carry it.

An Introduction to Microcomputers will cost you $8, but it's well worth the price. You can get it at most computer stores or directly from the publisher, Adam Osborne and Associates, P.O. Box 2036, Berkeley, CA 94702. For more information, circle number 108 on our reader service card. *—Bob Margolin*

After the H8 review article in June ME was written we received a copy of a booklet called the *Fox Hill Farms Guide To The Heath H8 Computer System*. The guide was done by William N. Campbell to help the ". . . absolute beginner . . ." put together and use a newly purchased and assembled H8.

Mr. Campbell is apparently very pleased with his system. The introduction sells the reader on personal computers, and then sells him on the Heath system. The rest of the booklet is devoted to very basic instructions on how to hook up and use the system. A glossary is even included to introduce you to some of the jargon.

Especially interesting are the sections on cassette player recorder use and programming. The author has written a detailed chapter on just how to set up a recorder/player and use it for loading and dumping programs. The instructions are very complete and include hints like winding past the tape leader before recording, setting the volume and tone controls on the recorder, and suggestions on acceptable brands of tape. There are even instructions on wiring a switch into the recorder control line so that you don't have to keep removing the remote plug for rewinds on the recorder.

The programming sections deal with using TED-8, the Text Editor, to construct and edit files of text. The instructions are step by step, actually keystroke by keystroke in some cases, and an example is used to illustrate how to make up and modify text.

The last part of the booklet is a BASIC program to store a mailing list and output the list onto forms for addressing envelopes or stickers. The program does all the correct spacing and lining. The author explains how to use the program with extensive lists that might exceed the memory available in the computer.

The guide is by no means a replacement for the manuals that come with the H8. Remember, though, that the Heath manuals assume that you already know something about the type of languages supplied. The *Guide* is a very valuable supplement to the manuals and should be very good for someone who is unfamiliar with the languages.

The Heath Users Group (HUG) supplies the "Guide" to members at no charge. By joining HUG you are provided a newsletter, program library, and contact with other Heath users. Details on joining HUG are provided with each computer*—Carmine Prestia.*

Test equipment listing

You know how important test equipment is to your work bench, but do you know exactly what's available? Well B&K Precision does, and they've compiled a 48 page catalog listing their entire line of meters, scopes, counters, function and signal generators, digital probes, semiconductor testers and other gear. Each instrument listing contains a short write-up describing the instrument and typical application, a list of key features, and a complete set of specs. In short, you'll find more than enough information to make an intelligent selection. For your free copy of this easy-to-read test equipment catalog, write B&K Precision, Dynascan Corp., 6460 West Cortland Avenue, Chicago, IL 60635, or circle number 111 on our reader service card. *—Laura Delaney*

Battery catalog

Confused about all the new batteries on the market today? Not sure which battery will work best in your circuit? Well, Panasonic now has a six page short-form catalog that will help you decide which batteries you need. The short format enables you to make preliminary selections and get detailed specs for the batteries that will work best in your design.

Included is a comprehensive listing of various sizes for gelled electrolyte lead acid, nickel cadium, lithium, carbon zinc, silver oxide, alkaline, and mercury batteries. For your free copy write to Panasonic Co., One Panasonic Way, Secaucus, NJ 07094, and ask for the *Short-Form Battery Catalog*, or circle 109 on our reader service card. *—Laura Delaney.*

please turn to page 92

Quickie glossary of audio terminology

What they mean—just in case you are a bit puzzled by one or another of the buzz words often used—but not always correctly—in discussions about audio

Azimuth See head alignment
Base A thin, strong and flexible material, usually a polyester or acetate film, on which is deposited a magnetic formulation to make recording tape.
Bias An electrical signal of relatively high frequency applied to magnetic tape during the recording process, along with the audio signal, to permit the recording of higher (treble) frequencies, ordinarily not possible because of customary magnetic characteristics of all recording tapes. The bias frequency is several times higher than the highest audible frequency the recorder can accept, in the range of 60 kiloHertz.
Capstan A revolving shaft or flangeless pulley which drives the tape by squeezing it against a pinch roller, and which controls the rate at which tape passes over the heads of the tape recorder or deck.
Cassette A compact shell housing a miniature reel-to-reel tape system. It retains the flexibility and freedom of moving back-and-forth provided by a reel system and eliminates the inconvenience of tape threading. The compact elements of the system make for additional convenience.
Chromium Dioxide A special tape formulation that has certain advantages in high-fidelity cassette recording. Because of this oxide's very specialized bias requirements, it requires a special switched bias circuit when recording.
Crosstalk Unwanted sound that comes through from an adjacent tape track or from some other program source, such as the fm receiver. Crosstalk is usually at a low level, but can be very annoying, and should be remedied before any recordings are made. Often, crosstalk between tape channels is caused by poor head alignment.
Cueing The marking or other identification of particular points on sections of tape, to aid in the location of specific, desired selections or portions of the recording. This may be done with grease-pencil or other markings directly on the tape or by making use of the digital index counter, where one exists on the recorder.
Decibel A unit of relative intensity of sound or an electrical signal, used for comparing the loudness of two different signals (e.g. one may be 20 dB greater than another), often expressed with reference to some fixed, arbitrary level (e.g. zero dB). A difference of one or two dB is generally considered the smallest that can be differentiated by the ear.
Degausser See demagnetizer.
Demagnetizer A component or device for removing undesired magnetism that builds up with use in the heads of a tape recorder.
Distortion Falsification of sound in reproduction. Extraneous tones or signals not present in the original sound constitute distortion, but the term may also broadly include noise, hum and peaks or dips (exaggerations or depressions) in the frequency response—in short, any departures from the original.
Dolby Name of a noise-reduction system available as a special circuit on some stereo cassette tape decks. Use of this circuit when the tape is recorded and during playback can reduce hiss level by as much as 10dB.
Domains See particles.
Dropout The momentary bias or reduction in level of a recorded signal caused by an imperfection in the magnetic coating on the tape at the point where that signal is recorded.
Dubbing Copying of already recorded material. In tape recording, playing a tape or disc on one machine while recording it on another. The copy is called a dub.
Echo An instantaneous repetition of the sound heard in playing some tapes or other recordings. This is caused by print-through
Equalization Reshaping the playback characteristics of a recording during playback mode. The simplest way is to adjust the treble and bass controls, but true equalization requires continuous adjustment of the

Excerpt reprinted with permission from "the TDK Guide to Cassettes and Recording". Copies available through TDK dealers.

playback frequency response curve at several points. A graphic equalizer is often used for this.

Flutter A rapid, extraneous variation in the pitch or frequency of a sound, usually caused by mechanical deviation in an element that should maintain constant speed. In tape recording, this may be caused by a faulty mechanism or by momentary sticking of the tape as it feeds through the transport and past the heads.

Frequency The number of cycles or complete alternations per unit of time of an oscillation. In music and sound, this corresponds to pitch (See Hertz.)

Frequency Response The relative sensitivity of a system, particularly any audio equipment, to different frequencies within the range it handles. With ideal or flat frequency response, all signals in the range receive the same degree of emphasis in passing through the system. Where there is deviation from flat response, some frequencies are emphasized or de-emphasized more than others.

Gap See Head

Harmonic Distortion The production of spurious frequencies, not present in the original sound, that are multiples of the original sound frequency. For example, a 100-Hertz tone in the original may produce spurious tones of 200 Hz, 300 Hz, and so on. The result is an audible blurring or loss of clarity in the reproduced sound. Total harmonic distortion of no more than 1 per cent is considered to be inaudible.

Head An electromagnetic device, usually consisting of a ring-shaped metal core wound with coils of wire, in which the continuity of the core is broken at one place, called the gap. Tape touches the head at the gap as it moves past it. A reproducing or playback head senses signals already magnetized (recorded) on tape and transforms them into electrical impulses which are then amplified and fed to a loudspeaker. A recording head accepts electrical signals and transforms them into magnetic impulses that are deposited on tape passing the head gap. An erase head, which the tape usually passes just before it reaches the recording head, demagnetizes the tape to remove previously recorded signals. Most cassette recorders use a single, combination record/playback head.

Head Alignment Adjustment of the recording or reproducing head so that it's at right angles to the longitudinal axis of tape. Also called azimuth alignment.

Hertz The unit of measurement of frequencies or cycles per second.

Hiss See Tape Hiss

Intermodulation Distortion The production of spurious frequencies, not present in the original sound, that result from the interference or interaction of two (or more) sound signals that simultaneously occur in the original. These generally are sum and difference frequencies. For example, a 200-Hz and 75-Hz signal may occur at the same instant. If the equipment is prone to intermodulation distortion, these two may interact to produce a spurious 125-Hz tone. Often abbreviated: IM distortion.

IPS Inches per second, the designation of tape speed

Leader A section of plain, nonmagnetic tape, usually plastic, affixed to the beginning of a length of recording tape. Attached to the end, it is called a trailer.

Monitoring Listening to sounds while they are being recorded, either in the form of the input signals going to the recording equipment or in the form of the already recorded material instantaneously being played back from the tape. Monitoring may also refer to adjustments (of volume, balance and the like) made during such listening.

Noise An undesirable and extraneous sound not found in the original live sound. Sometimes lumped with distortion, but different from conventional forms of distortion, which represent alterations in the nature of the original sound. Noise occurs independently of the original sound and may exist when there is no input signal.

Overloading Application to a system of more signal that it can handle, thus producing unacceptable distortion.

Particles Also known as domains, these small bits of oxide are the recording media on the tape. The smaller and more uniform they are, the better the tape's frequency response, provided they are evenly dispersed.

Peak The maximum level of a sound or electrical signal.

Polyester Base A plastic film material widely used as a backing for magnetic tape.

Print-Through The transfer of magnetization of recorded sound from one layer of tape to immediately adjacent layers of the wound tape. Print-through usually is encouraged by overloading during recording. The audible effect of print-through is echo.

Saturation The point where no more magnetic signal can be accomodated by either a head or by the tape; any additional signal beyond saturation causes distortion. Usually, the zero VU position on the VU meter indicates the point of saturation, although with TDK tapes, the saturation point is actually in the red "danger" area.

Signal-to-Noise Ratio The ratio, usually in dB, between the level of the loudest undistorted tone that can be recorded and the noise that is generated and recorded when no signal is present.

Tape Drive The motor and associated mechanism that pull the tape past the heads of playing or recording.

Tape Hiss Sibilant background noise heard when a tape is played. Although some of this noise is directly attributable to irregularities of the oxide coating, some also is contributed by the recording circuitry.

Trailer See Leader.

VU Usually used with meters, the volume unit is an arbitrary sound-level standard related to the decibel, and is used for calibrating recording levels on the tape equipment.

Wow A slow periodic change in the pitch of frequency of a sound during recording or playing, usually produced by mechanical deviations in the tape transport. Also see Flutter.

Letters

continued from page 82

scriber because of the front page story on your February issue. Well guess what subject hasn't been seen in most of the following issues. I realize the intricacies of robotics make it difficult to cover, but how about at least one small project in each issue? What about the new VORTRAX talk box made to interface with any small computer? Or picking up on Dave Heiserman's Buster article in the March issue?

Robert G. Fullerton
Ringsdorff Corp.
E. McKeesport, PA

Good idea R.G.F. In fact, you'll find a nifty piece on selecting a motor for your robot by Dave in this issue. As for future projects, we'd be delighted to run them. So, if any of our readers have put together their own robots, we'd like to hear from them.

Digital dash for a Vet

Dear ME:

Just finished reading your article on digital automotive dash boards in the May issue. Excellent article—very well done. But I need some help. Do you know of any company building in-dash digital instrumentation for the 78 Corvette or 78 Buick Regal V-6?

M. Bifeld
The Howard Company
Skokie, IL

Can any of our readers help M.B. with company names and addresses? If so, we'd like to hear from you.

Help!

Dear ME:

Could you or your readers help me locate a wiring diagram or owner's manual for a Space Age Electronics Doppler Speed Log manufactured by Detectronics Ltd? I am willing to pay any reasonable cost.

Gerald G. Coombs
Nanaimo, B.C. Canada

Sorry G.G.C., none of us know about the device you mentioned. How about it, readers, can any of you help?

Baby needs shoes

Dear ME:

I enjoyed reading Carmine Prestia's craps program in the June issue of ME. Unless Mr. Prestia plays craps with a 12-sided die, statement 210 of his program is incorrect. It will give equal probability to rolling boxcars and sevens. Statement 210 should be:

```
R=(INT(6*RN
    D(1))+1)+(INT(6*RND(1))+1)
```

This statement will simulate the throw of two six-sided dice with the proper probability distribution. Since it is now impossible to throw a 1, statement 211 can be omitted.

Anyway, keep that good software coming, especially with the flow charts. It's very good for people without Benton Harbor BASIC.

G. Fisher
Guelph, Ont., Canada

Thanks for the correction. Carmine blushed a little when he realized his error, but was very glad to learn that some of our readers were into software enough to catch it. We'd like to know what our other readers think about the Program column

Computer missed

Dear ME:

While I have not studied your computer roundup story in the July issue, you have omitted a low cost Z80 computer. It's called the Bally Home Library Computer and is sold by the JS&A National Sales Group. It has 20K of RAM and 24K of ROM with typewriter and calculator input, and provides a color display when connected to a standard color tv. It costs $650 without the tv.

Paul F. Sells
Chattanooga, TN

Sorry we left the JS&A unit out of our roundup. Although we tried to be as complete as possible, we did omit several models. JS&A tells us the computer is still available with a base price of $220, but the cost of add-ons will raise it. You can get information directly from JS&A at One JS&A Plaza, Northbrook, IL 60062

Qualified success

Dear ME:

If you keep up the good work your new magazine can't help but be a success. You have the best general electronics magazine around. While others are filled with advertisements for electronic junk, I see in your magazine fine products. Better yet, you have more articles than ads. I'm also glad to see you covering more than just the current craze—computers.

C.B.
York, PA

Thanks for the kind words. We're trying to cover as much as we can in an ever expanding field. We'd appreciate our readers letting us know of their interests

A few suggestions

Dear ME:

Your magazine is exactly what was needed to fill the gaps left by the others. However, here are a few suggestions I think will improve it:

1. Get rid of the cartoon strip. There must be something better you can fill those pages with.

2. Yes, we do want the magazine sectioned off. I don't want to have to flip through the pages to find "my" article.

3. You are making too many assumptions. You say "make it up on a PC board." Point-to-point wiring is fine on a non-clad board. And you should have a few articles telling how to lay out a PC board, and how to etch it.

4. Take some of your reader's advice and try their ideas. Don't just write PR textbook paragraphs trying to justify your points.

Here's hoping for a much improved efforts.

John P. Detore
Mount Lake Terrace, WA

Upcoming articles and columns will cover several of the areas you mentioned. But we'd like to hear from the rest of our readers on this subject.

Dear ME:

I am writing in regard to the article on page 50 of the February 1978 issue.

On the electric combination lock part number 4001 is listed for the NOR GATE. Please let me know where this item can be purchased. I have tried local suppliers and they indicate there is no such number.

C.H.,
Hamilton, OH

The 4001 is indeed a quad NOR gate, and is available from most electronics parts distributors. Even Radio Shack carries it, as their number 276-2401 for 49 cents each.

Review

contiued from page 89

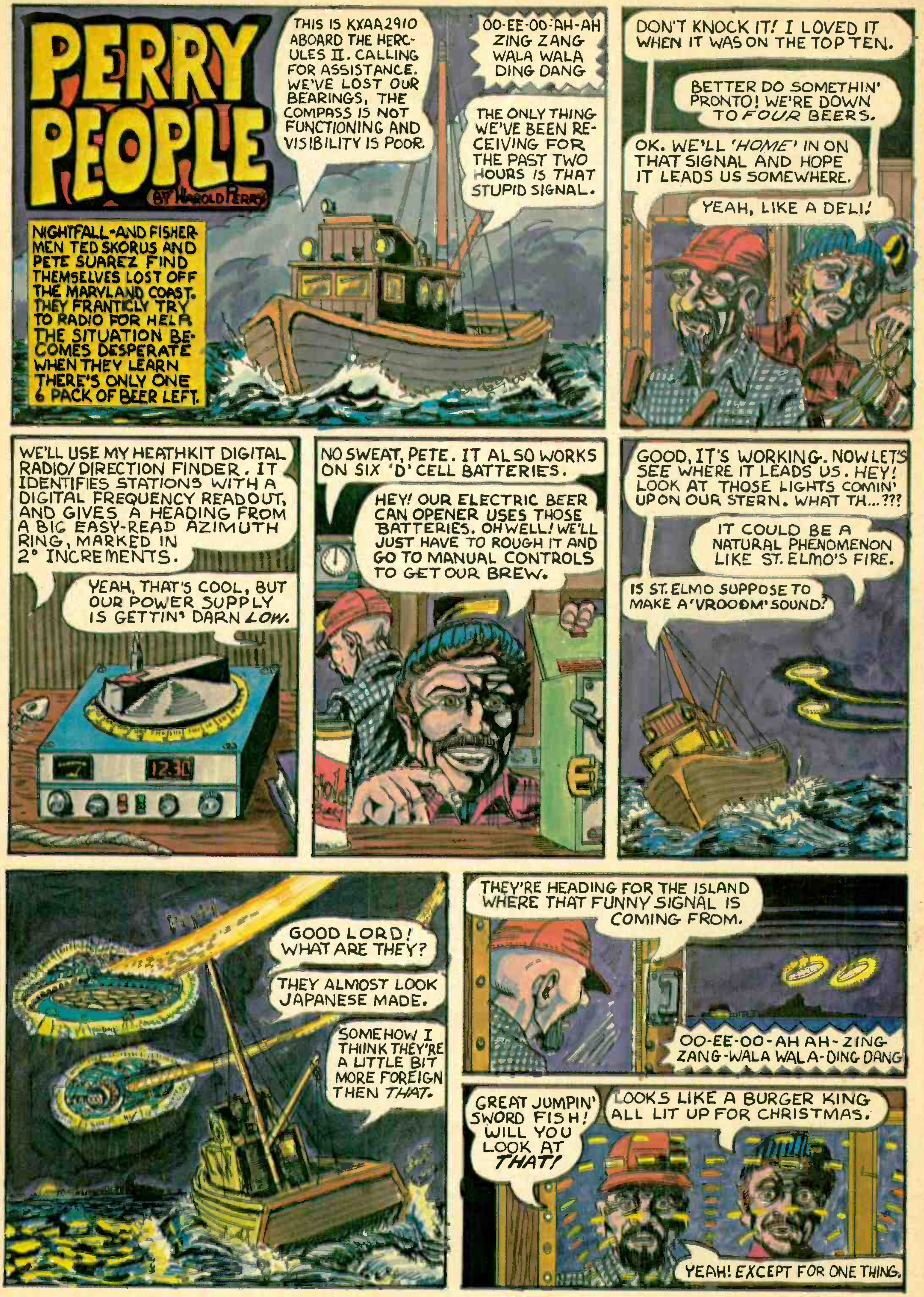
Does Radio Shack carry it?

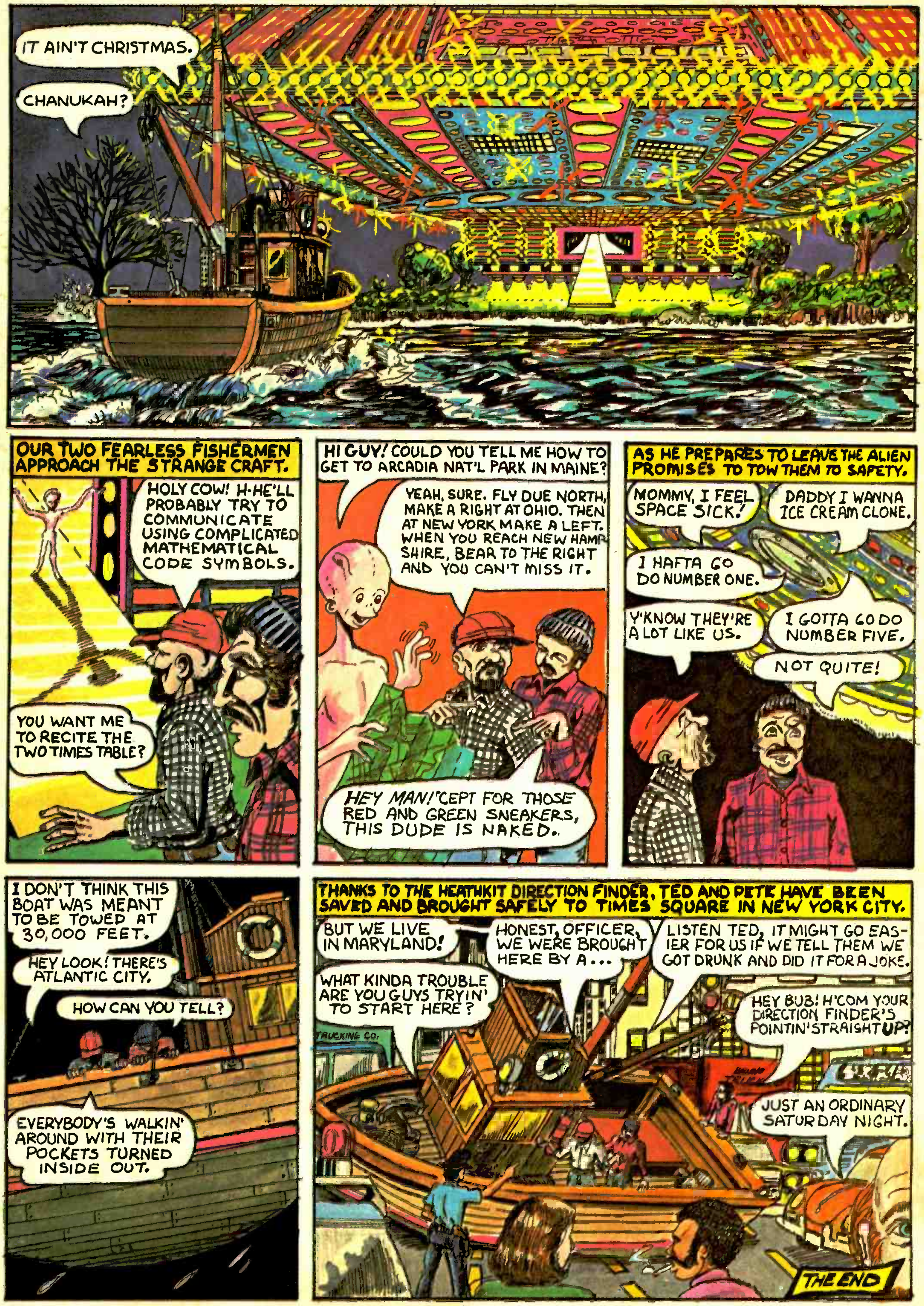
Although there are many electronic distributors in this country, and many lines of semiconductors, there's no escaping the fact that more transistors, diodes, and integrated circuits are sold to hobbyists by Radio Shack than all other outlets combined. This is due, no doubt, to the Shack's more than 5000 stores sprinkled around the country. Their components are no better or less expensive, but they are available. And to compliment their parts inventory, the Shack now has available a new *Semiconductor Reference and Application Handbook*.

This 144-page book, catalog number 276-4002, contains key specs and pinout diagrams for each of the 78 ICs, photocells and LED readouts listed, and a transistor cross reference covering more than 46,000 types. Its $2 cost is well spent if you're going to be using Radio Shack semiconductors in any quantity.

Speaking of quantity, the Shack will send five of these nifty books free of charge to any bonafide club or organization for use as door prizes at conventions, hamfests, coffee breaks, swapfests and the like. Make sure to request the books on official stationary. For more information about the Shack, circle number 110 on our reader service card.

—Bob Margolin


PERRY PEOPLE
BY HAROLD PERRY
NIGHTFALL-AND FISHERMEN TED SKORUS AND PETE SUAREZ FIND THEMSELVES LOST OFF THE MARYLAND COAST. THEY FRANTICLY TRY TO RADIO FOR HELP. THE SITUATION BECOMES DESPERATE WHEN THEY LEARN THERE'S ONLY ONE 6 PACK OF BEER LEFT.
THIS IS KXAA2910 ABOARD THE HERCULES II. CALLING FOR ASSISTANCE. WE'VE LOST OUR BEARINGS, THE COMPASS IS NOT FUNCTIONING AND VISIBILITY IS POOR.
OO-EE-OO-AH-AH ZING ZANG WALA WALA DING DANG
THE ONLY THING WE'VE BEEN RECEIVING FOR THE PAST TWO HOURS IS THAT STUPID SIGNAL.
DON'T KNOCK IT! I LOVED IT WHEN IT WAS ON THE TOP TEN.
BETTER DO SOMETHIN' PRONTO! WE'RE DOWN TO FOUR BEERS.
OK. WE'LL 'HOME' IN ON THAT SIGNAL AND HOPE IT LEADS US SOMEWHERE.
YEAH, LIKE A DELI!
WE'LL USE MY HEATHKIT DIGITAL RADIO/DIRECTION FINDER. IT IDENTIFIES STATIONS WITH A DIGITAL FREQUENCY READOUT, AND GIVES A HEADING FROM A BIG EASY-READ AZIMUTH RING, MARKED IN 2° INCREMENTS.
YEAH, THAT'S COOL, BUT OUR POWER SUPPLY IS GETTIN' DARN LOW.
1230
NO SWEAT, PETE. IT ALSO WORKS ON SIX 'D' CELL BATTERIES.
HEY! OUR ELECTRIC BEER CAN OPENER USES THOSE BATTERIES. OH WELL! WE'LL JUST HAVE TO ROUGH IT AND GO TO MANUAL CONTROLS TO GET OUR BREW.
GOOD, IT'S WORKING. NOW LET'S SEE WHERE IT LEADS US. HEY! LOOK AT THOSE LIGHTS COMIN' UP ON OUR STERN. WHAT TH...???
IT COULD BE A NATURAL PHENOMENON LIKE ST. ELMO'S FIRE.
IS ST. ELMO SUPPOSE TO MAKE A 'VROOOM' SOUND?
GOOD LORD! WHAT ARE THEY?
THEY ALMOST LOOK JAPANESE MADE.
SOMEHOW I THIINK THEY'RE A LITTLE BIT MORE FOREIGN THEN THAT.
THEY'RE HEADING FOR THE ISLAND WHERE THAT FUNNY SIGNAL IS COMING FROM.
OO-EE-OO-AH AH-ZING ZANG-WALA WALA-DING DANG
GREAT JUMPIN' SWORD FISH! WILL YOU LOOK AT THAT!
LOOKS LIKE A BURGER KING ALL LIT UP FOR CHRISTMAS.
YEAH! EXCEPT FOR ONE THING.


IT AIN'T CHRISTMAS.
CHANUKAH?
OUR TWO FEARLESS FISHERMEN APPROACH THE STRANGE CRAFT.
HOLY COW! H-HE'LL PROBABLY TRY TO COMMUNICATE USING COMPLICATED MATHEMATICAL CODE SYMBOLS.
YOU WANT ME TO RECITE THE TWO TIMES TABLE?
HI GUY! COULD YOU TELL ME HOW TO GET TO ARCADIA NAT'L PARK IN MAINE?
YEAH, SURE. FLY DUE NORTH, MAKE A RIGHT AT OHIO. THEN AT NEW YORK MAKE A LEFT. WHEN YOU REACH NEW HAMPSHIRE, BEAR TO THE RIGHT AND YOU CAN'T MISS IT.
HEY MAN! 'CEPT FOR THOSE RED AND GREEN SNEAKERS, THIS DUDE IS NAKED.
AS HE PREPARES TO LEAVE THE ALIEN PROMISES TO TOW THEM TO SAFETY.
MOMMY, I FEEL SPACE SICK!
DADDY I WANNA ICE CREAM CLONE.
I HAFTA GO DO NUMBER ONE.
Y'KNOW THEY'RE A LOT LIKE US.
I GOTTA GO DO NUMBER FIVE.
NOT QUITE!
I DON'T THINK THIS BOAT WAS MEANT TO BE TOWED AT 30,000 FEET.
HEY LOOK! THERE'S ATLANTIC CITY.
HOW CAN YOU TELL?
EVERYBODY'S WALKIN' AROUND WITH THEIR POCKETS TURNED INSIDE OUT.
THANKS TO THE HEATHKIT DIRECTION FINDER, TED AND PETE HAVE BEEN SAVED AND BROUGHT SAFELY TO TIMES SQUARE IN NEW YORK CITY.
BUT WE LIVE IN MARYLAND!
HONEST, OFFICER, WE WERE BROUGHT HERE BY A...
LISTEN TED, IT MIGHT GO EASIER FOR US IF WE TELL THEM WE GOT DRUNK AND DID IT FOR A JOKE.
WHAT KINDA TROUBLE ARE YOU GUYS TRYIN' TO START HERE?
HEY BUB! H'COM YOUR DIRECTION FINDER'S POINTIN' STRAIGHT UP?
JUST AN ORDINARY SATURDAY NIGHT.
THE END

IF YOU'RE WAITING FOR SOLDERLESS BREADBOARDS TO BE FASTER, EASIER, MORE VERSATILE AND LOWER-PRICED...

Incredibly inexpensive. EXPERIMENTOR solderless sockets begin at $5.50* ($4.00* for the 40 tie-point quad bus strip). A spool of solder costs more.

Mix and match. Use large and small chips in the same circuit without problems. There are two sizes of EXPERIMENTOR sockets with 0.3" and 0.6" centers.

Full fan-out. A CSC exclusive. The only solderless breadboard sockets with full fan-out capabilities for **micro-processors** and other larger (0.6") DIP's.

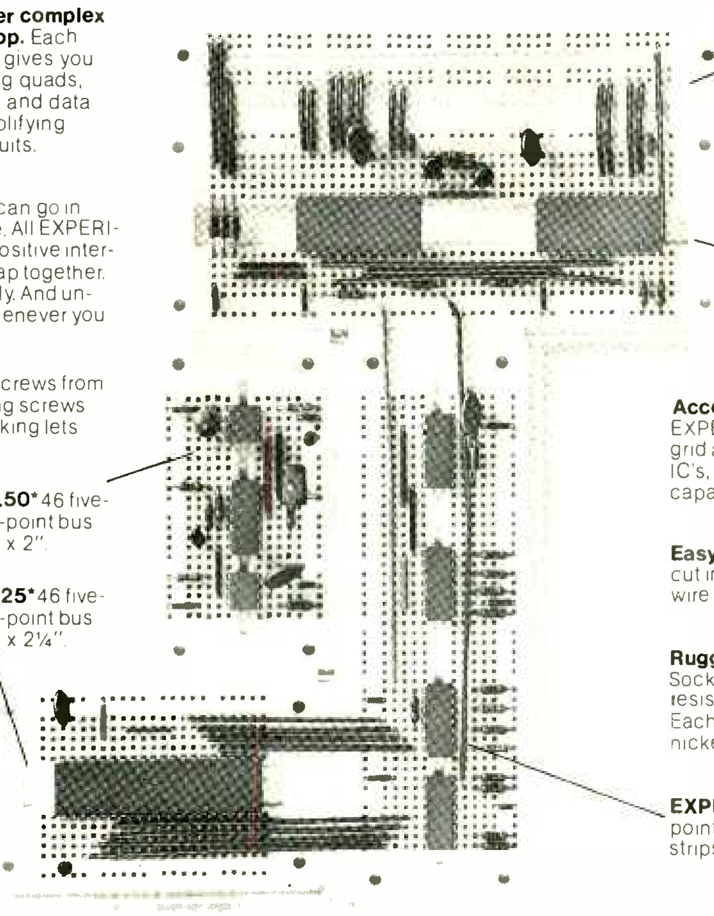
Microprocessors and other complex circuits are easy to develop. Each EXPERIMENTOR quad bus gives you four bus lines. By combining quads, 8-, 12- and 16-line address and data buses can be created, simplifying complex data/address circuits.

Infinitely flexible. Circuits can go in any direction, up to any size. All EXPERIMENTOR sockets feature positive inter-locking connectors that snap together. Horizontally and/or vertically. And un-snap to change a circuit whenever you wish.

Easy Mounting. Use 4-40 screws from the front or 6-32 self-tapping screws from the rear. Insulated backing lets you mount on any surface.

EXPERIMENTOR 350. $5.50* 46 five-point terminals plus two 20-point bus strips. 0.3" centers; 3/8 x 3½ x 2".

EXPERIMENTOR 650. $6.25* 46 five-point terminals plus two 20-point bus strips. 0.6" centers; 3/8 x 3½ x 2¼".



EXPERIMENTOR QUAD BUS STRIP. $4.00* Four 40-point bus strips. 3/8 x 6 x ¾"

Designated tie-points. Simplify translation from bread-board to PC-boards or wiring tables.

EXPERIMENTOR 600. $10.95* 94 five-point terminals plus two 40-point bus strips 0.6" centers; 3/8 x 6 x 2¼"

Accepts all standard components. EXPERIMENTOR sockets conform to an 0.1" grid and are DIP compatible. Also accept IC's, transistors, diodes, LED's, resistors, capacitors, transformers, pots, etc.

Easy hookup. Components push in and pull out instantly. Use #22-30 solid AWG wire for jumpers.

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