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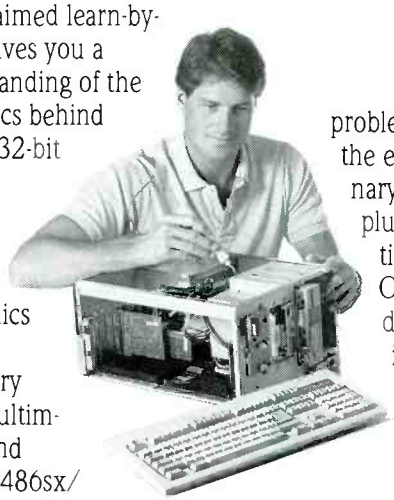

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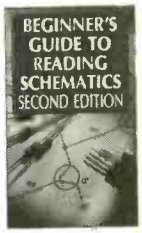

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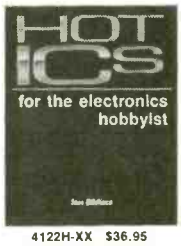

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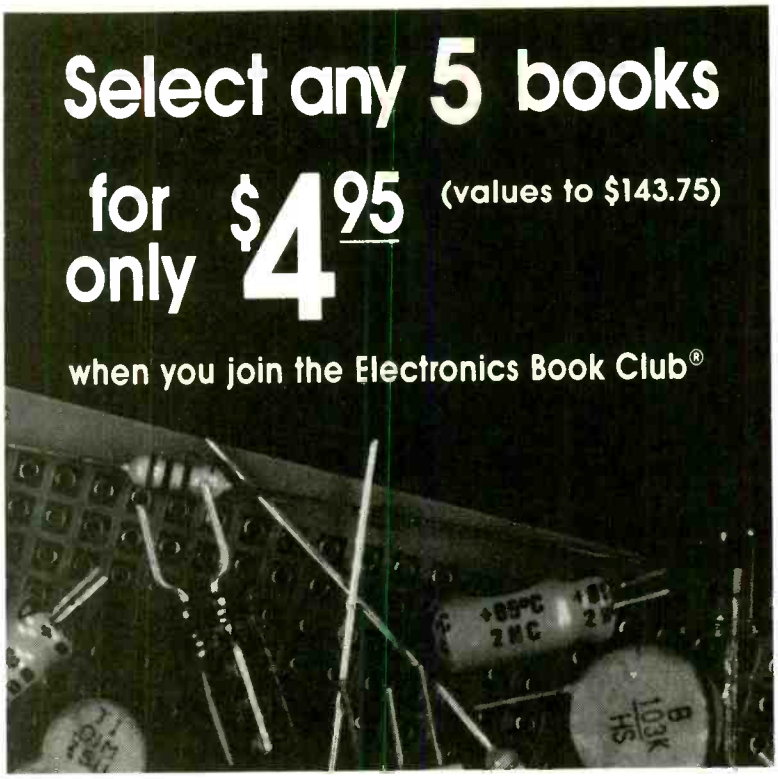

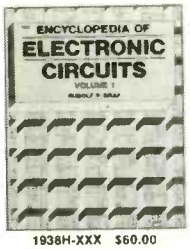

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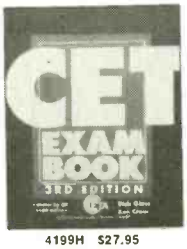

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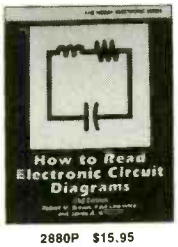

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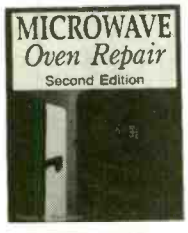

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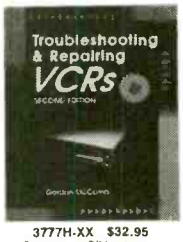

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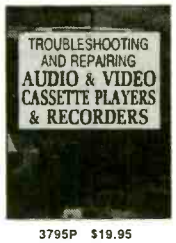

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THE SEASON TO BE MERRY

Since the holiday season is rapidly approaching, it seems appropriate that we join the spirit of the season and offer our readers a "project" that will bring a little cheer to their home or office or workbench, wherever they so desire.

Fortunately, our good friend and contributing author, **Mike Giamportone,** has submitted a manuscript of an interesting project that is made-to-order for the Christmas season and, I'm sure, will bring joy to the hearts of electronic hobbyists and project builders who test their skills on this unique project. **"The 6" Musical Christmas Tree"** that graces the cover of this issue of the **ELECTRONICS HANDBOOK** offers our readers an opportunity to enjoy their hobby and join the spirit of the holiday season.

That's not all. There are lots of other goodies in this issue of the "Handbook," such as the popular "Project Sections," **"Circuit Fragments," "Workbench Projects"** and the **"IC Testbench"** and a multitude of other interesting items, such as **"Building A Crystal Set Amplifier"** by **Lance Borden, "Repairing Cordless Phones"** by **Homer Davidson,** and article on **"Technical Training In Electronics"** by **Ron Johnson, "How To Build A Soldering Iron Heat Controller"** by **Steve Sokolowski** and, to be sure that your stocking is full, don't overlook all the regular items that you will find in every issue of the "Handbook" like the **"New Products Parade," "New Book Reviews," "Letters To The Editor," "The Catalog Corner"** and **"Solid State Up-date,"** all carefully wrapped by contributing authors, to provide many hours of pleasure to the electronics hobbyist and project builder...Have fun and enjoy this issue of the ELECTRONICS HANDBOOK and a MERRY CHRISTMAS AND A HAPPY NEW YEAR TO ALL...

Don Gabree

DON GABREE, PUBLISHER

WANTED: PROJECTS

How would you like to find your own home-brew project in a future issue of the ELECTRONICS HANDBOOK? It could happen. It's up to you! Build your project for yourself...It should have a real purpose. Then, if you think that it is good enough to appear in the ELECTRONICS HANDBOOK, let us know about it...

Write us a brief letter describing your project. Tell us what the project does. Provide us with a legible schematic diagram and a few black-and-white photographs of the project...photos, with good contrast, are important. After we have read your letter describing your project, we'll let you know, one way or the other, whether we would like to purchase your article describing the project.

If you would like some "Editorial Guidelines", send us a S.A.S.E. with your request...All correspondence should be addressed to:

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Looking For Books

Recently, I bought several electronics magazines as a means of getting acquainted with the field. I found that your magazine provided the clearest explanations, making it perfect for the beginner. However, there are still some blanks in my knowledge of general electronics. If you could recommend some beginners' books dealing with such things as schematics, electronic nomenclature, and general principles, I would greatly appreciate it.

— Chris Cardillo, Brooklyn, NY

Glad to hear that you're enjoying ***Electronics Handbook,*** *Chris. As far as books for the newcomer are concerned, your two best sources are Prentice-Hall Computer Publishing (P.O. Box 90, Carmel, IN, 46032) and TAB Books/McGraw-Hill (Blue Ridge Summit, PA, 17294-0850). Catalogs are available on request from both of these companies. In addition, interesting electronics books often end up being remaindered and sold at substantial discounts. I suggest that you obtain the latest bargain-books flyer from* ***Edward R. Hamilton, Bookseller (Falls Village, CT, 06031-5000).*** *The current flyer from this company features books dealing with circuit theory, op amps, solid-state physics, sensors, digital logic, and robotics, as well as a whole host of other interesting titles having nothing whatsoever to do with electronics.*

Now for some specific recommendations. If you are not adept at reading schematics, get a copy of the ***Beginner's Guide To Reading Schematics*** *by Traister and Lisk (TAB Books). A good electronics dictionary will help you identify strange new terms.* ***The Modern Dictionary of Electronics*** *by Rudolf Graf (published by the Sams Division of Prentice-Hall Computer Publishing) is truly excellent but a bit expensive ($40) for a beginner. You might wish to consider the less costly* ***Illustrated Dictionary of Electronics*** *by Turner and Gibilisco (TAB Books).*

A person cannot go far in electronics without some knowledge of circuit theory. ***Introductory Circuit Analysis*** *by Robert Boylestad (Merrill Publishing) is a well-regarded text written for the technical-school or junior-college student. List price is $42.95, but Edward R. Hamilton is offering the 5th edition of this book for $5.95 (plus $3 for shipping). These are new copies which have been superseded by a revised edition. Supplies are probably limited, so check Edward R. Hamilton's latest flyer before ordering. And if the book is out of stock, don't despair, because you can find other equally good books on circuit theory in Edward R. Hamilton's catalog.*

Once you've mastered the elements of circuit theory, you'll be ready to explore the mysteries of transistors, integrated circuits, and other solid-state devices. ***Understanding Solid-State Electronics*** *by Don Cannon (Sams Division of PHCP) seems like a good book for the beginner, though I have not yet had the chance to review it firsthand.*

An electronics enthusiast finds himself working with two kinds of integrated circuits: linear and digital. Most of what you need to know about linear ICs can be found in two books— ***IC Op-Amp Cookbook*** *and* ***IC Timer Cookbook****—both written by Walter Jung and published by Sams/PHCP. These books are models of clarity and thoroughness. As for digital ICs, the two main types are known as CMOS and TTL. Sams/PHCP offers two books by Don Lancaster which pretty much cover the field:* ***CMOS Cookbook*** *and* ***TTL Cookbook.*** *I'd start with CMOS, since it is less power-hungry than TTL and thus well-suited to battery-powered experimentation.*

My final suggestion is that you obtain a good circuit reference book, such as the four-volume ***Encyclopedia of Electronic Circuits*** *by Rudolf Graf (TAB Books). You don't need all four volumes; just one will do. When you're trying to devise a circuit, it's always nice to see how someone else has done the job. That's what makes an encyclopedia of circuits so valuable.*

The books mentioned thus far will give anyone a solid grounding in electronics, but books are not the only source of useful information. Manufacturers of semiconductors and other components publish data books and application notes that are gold mines of technical information. Best of all, application notes are usually free. You can write to Motorola Literature Distribution (P.O. Box 20912, Phoenix, AZ, 85036) and ask for publications BR101/D and BR135/D, which list all of the application notes and data books currently available from Motorola. Similar items are published by other manufacturers. Be sure to peruse the Solid State Update column in ***Electronics Handbook*** *for all the latest information on data books, application notes, and the like.*

Obnoxious Compression

Volume XIII of **Electronics Handbook** featured a letter about audio compression which was most interesting. I, too, have suffered through obnoxious commercials, and your explanation of why compression makes them seem so much louder makes me wonder if there is some simple way to counteract the effects of compression.

Some time ago I read about a "Gabble Snuffer" which was activated by the three factors that make commercials so infuriating. The device was sensitive to an increase in average power level brought about by compression, to an increase in the modulation frequency of the voice caused by rapid speech, and to an increase in the pitch of the voice. Whenever these three factors exceeded normal levels, as they would during a commercial, the sound from the TV or radio was silenced.

It seems to me that a device like the one just described would be especially valuable to the parents of young children. How many of us have put the kids to bed and settled down for a relaxing evening of TV, only to have a commercial come on and blast the kids out of a peaceful slumber? Can you help me locate a commercial silencer or the plans to build one?

— W.N. Deanne, Lynwood, WA

I can sympathize with your plight, W.N., but unfortunately I know of no commercially available product as sophisticated as the one you envision, nor do I know of a source for plans. Obviously, you want a device that will silence a commercial message before it causes pandemonium; otherwise, I'd be tempted to say just use your remote control to snuff out the offending commercial.

For what it's worth, I can remember being packed off to bed while my parents watched late-night TV, and even though the audio was turned way down, I still couldn't get to sleep. The reason? The piercing shriek of the television set's flyback transformer assaulted my ears even through a closed bedroom door. No one would believe that I could hear it. Of course, now that I've grown older, I can't hear a 15-kHz whistle, either.

Say What?

I would certainly appreciate the help of **Electronics Handbook** in locating the circuit diagram of an electronic clock capable of shooting a high-current pulse every one or two seconds to a coil and from there to my spark plugs.

— Charles Foley, Newton, MS

I must admit, Charles, that I had one heck of a time trying to decipher your letter in its original, unedited form. Why do you guys do this to me? Is there some innate satisfaction in stumping the editor? If I could read minds, I wouldn't be sitting here writing this column, I'd be out making a fortune on Wall Street.

Now, as best as I can tell, what you want is a timing circuit capable of supplying a sequence of high-energy electrical pulses to the spark plugs of your car—in short, an electronic ignition system. I'm sending along a couple of schematics that should help you out.

Before I get deluged with any more automotive questions, I want to point out that the last car whose operation I truly understood was a '68 Pontiac GTO. That car had a stick shift, chrome mag wheels, a big V-8 engine, and Ferrari-inspired styling that made it appear to be exceeding the speed limit even when it was parked. Today I drive a Dodge minivan, and couldn't care less about what makes it tick. Such is life.

A Request for Projects

I've been stalling on the renewal of my subscription to **Electronics Handbook,** pending final word on my reassignment to the States. It now appears that I will not transfer until later this year, and therefore, I will go ahead and send my renewal at this time. I would like to suggest a couple of projects while I have your attention. The first is a spike suppressor/voltage stabilizer for use with personal computers and other sensitive electronic equipment. The second project, which I believe many readers would find useful, is a battery tester that would test batteries under load to give a better indication of remaining useful capacity. Needless to say, I enjoy your publication very much and look forward to future issues.

— Robert A. Powers, Vienna, Austria

Your suggestions sound like useful ones, Robert, but I wonder whether they would make good projects. Right now, spike suppressors and voltage stabilizers are a dime a dozen, owing to the intense competition between computer retailers, and it hardly seems possible to build one for significantly less than what the computer discount dealers are charging. As for the second project idea, battery testers that test a battery under load are fairly common and inexpensive, their only drawback being that they cannot test all types of cells. Perhaps one of our authors will come up with a super deluxe battery tester. We'll have to wait and see.

FROM THE EDITOR'S DESK

Ask The Editor, He Knows!

Got a question or a problem with a project—ask The Editor. Please remember that The Editors' column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. Sorry, he isn't offering a circuit design service. Write to:

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Hello, Dahlia

I would like to grow dahlias, but as you can appreciate, they will not survive the harsh winters we routinely experience here in Omaha. Local gardening experts advise that the bulbs be dug about the time of the first frost, put in a drying medium, and replanted the following spring. During the winter they must be maintained at 30-50 degrees F. Anything colder will kill them outright; anything warmer and they'll start to sprout and exhaust themselves by spring. It occurred to me that it should be possible to build a thermostatically controlled device which could be set to maintain a 30-50 degree temperature range. I could put the dahlia bulbs, surrounded by vermiculite to ensure their dryness, into a box along with a light bulb. The bulb's operation would be controlled by thermostat. I sought help from the local Radio Shack store, but got none. This ain't rocket science, folks. All I want is a thermostatic control for a light bulb. Can you help me?

— George Hooper Jr., Papillion, NE

Your question is an interesting one, George. I'm going to give you a series of suggestions based on experience and educated guesswork. The actual details of the project will have to be determined experimentally by you.

To begin with, an ordinary light bulb is not a good choice as a heating element, since much of the energy consumed by the bulb is "wasted" as light. Furthermore, a light bulb does not have a long service life. Your best bet is to use resistance heating. You could construct the necessary heating element from an array of power resistors connected in series and parallel, but it is easier and cheaper to use a commercial heating element. Such an element can be obtained from C&H Sales Co. (P.O. Box 5356, Pasadena, CA, 91117-9988). Heating elements are simply resistors; the power they consume is given by the familiar formula $P = V^2/R$, where P is the power in watts, V is the voltage across the element (either volts DC or rms volts AC), and R is the resistance of the heating element.

The first question confronting us is how much power should the heater be capable of delivering? Assuming the dahlia bulbs are stored in a well-insulated container with an internal temperature of say, 40°F, and an outside temperature much less than that, the minimum amount of electrical power needed to maintain a constant internal temperature is equal to the rate at which thermal energy is radiated or conducted from the box to the surroundings. This, in turn, depends on two factors: how well the box is insulated, and how cold the surroundings are. It makes sense, therefore, to ensure that the box is extremely well insulated. In practice, you should choose a heating element whose electrical power consumption greatly exceeds the rate of heat loss from the box under worst-case conditions. I suggest as a starting point for experimentation that you use 50-100 watts of heater power per cubic foot of space, which is probably much more than absolutely necessary. Better to have too much power than too little. If you're worried about the cost of electricity, bear in mind that the system is going to be thermostatically controlled, so the heater will cycle on and off. Power consumption can be minimized by thoroughly insulating the box. Six inches of fiberglass insulation on all sides should do the trick. A box-within-a-box style of construction would be appropriate.

The heater can be controlled in a number of different ways. Despite your disdain for the rocket-science approach, the best control circuit I could find actually comes from a NASA technical brief, and I'm sending it along to you. If you prefer not to make your own controller from scratch, you can buy one ready-made from Extech Instruments (335 Bear Hill Rd., Waltham, MA, 02154). The great advantages of electronic control circuits are precision and ease of use. However, since precision is hardly an issue here, you could get by with an even simpler temperature-control circuit using a bimetallic thermostat like the Fenwal Thermoswitch, which is available from C&H Sales Co. for about $12. In practice, the Thermoswitch is wired in series with your heater so that power to the heater will be cut off when a set temperature is reached. The Thermoswitch can be calibrated by means of a setscrew. One point worth noting regarding bimetallic thermostats is that they may exhibit hysteresis, i.e., their contacts may open and close at different temperatures. In your application, that's obviously not going to be a problem.

I hope this information is of some help to you, George. And if your dahlia-storage system is a success, let us hear about it.

Vinyl vs. CD

Regarding the letter from L.A. Schwarts that appeared in Volume XII of **Electronics Handbook,** I wish Mr. Schwarts had stated the amount of money he had to invest in his system in order to get the same clarity from vinyl LPs that one gets from a CD. Although he is certainly free to spend as much as he likes on equipment, I'd rather spend my money on music.

In my own experience, the replacement of a turntable with a compact disc player usually produces an astonishing improvement in sound quality, even with a low-cost stereo system. And let's not forget price. You can buy a good CD player for about $100, which is less than the cost of many high-end phonograph cartridges.

In closing, most people don't have $1500-$2000 to spend on the kind of audio system Mr. Schwarts is advocating. Furthermore, CD storage is simpler, finding a CD in a collection is easier, and single-track access is faster. More importantly, I'd rather listen to good music than admire my expensive sound system. —

— Marshall Pearce, Pratt, KS

You've done a pretty thorough job of rebutting Mr. Schwarts's claims, Marshall. About the only thing I can add is that anyone who still clings to vinyl in preference to CDs is going to find his choice of new material limited, since more new releases are coming out on CD than on vinyl. In any case, why should it be an either/or proposition? Many people have both a turntable and a CD player, so that they can enjoy their old, irreplaceable records as well as the new CD releases.

Tiny Batteries

I have several digital watches and a camera that all use little button-type batteries. But when I go to my local jewelry or a big store's watch department they don't have the number (or make) of the old battery. What can a person do about this? Don't the companies making batteries want me to buy their products? — **Melaine Ewing, Point Denison, Texas.**

It's true many stores don't have cross-reference listings for popular batteries. But Radio Shack usually can help you out. They like to sell all kinds of batteries, and they're probably cheaper than many other stores. Also, what about where you bought the watch and the camera?

Our Kind of Guy

Thanks for such a great magazine, and keep up the good work! Unlike other so-called electronics magazines which have become mostly computer magazines, you folks still fill your pages with the kind of real electronics projects that a person can afford to build without taking out a second mortgage on his home.

— Greg Washam, Eddyville, KY

Thanks for the kind words, Greg. We're glad you enjoy the projects and articles we present. Your comment regarding a second mortgage was interesting and perhaps a revelation. Could it be that the expensive electronics projects sometimes featured by our competition are the surreptitious work of second-mortgage lenders seeking to drum up business? Well, not to worry. If one of those bogus manuscripts shows up here, we'll flip it into the wastebasket faster than you can say "foreclosure."

R.G., Are You Out There?

In Volume X of **Electronics Handbook,** I was very impressed by the questions raised by R.G., and by your apt reply. I, too, am interested in the application of infrasonic sound waves, but have been unable to locate suitable project plans or kits. The field of artificial generation of infrasound has been an intriguing one for scientists since the late sixties. One recent event was a project on wildlife by the National Geographic Society of the U.S. in which infrasonic pickups were used. Regardless of what R.G. had in mind, infrasonic sound waves are being explored for use to mankind. As a hobbyist exploring the back alleys of science, I have come across certain references in English, Dutch, and German which R.G. may find of use, and if your magazine's policy is to permit direct contact between readers to share knowledge, R.G. is welcome to write to me. It will be my pleasure to exchange views.

— K.L. Sharma, Jodhpur, India

Thanks, K.L., for offering to share your knowledge with a fellow reader. Unfortunately, we've lost R.G.'s address, but if you're reading this R.G., and want to communicate with K.L., drop us a line. I think R.G. was interested in the use of infrasonic sound waves to disrupt memory, or something like that. I'll have to check. This damn ringing in my ears is driving me nuts.

DX Verification Cards

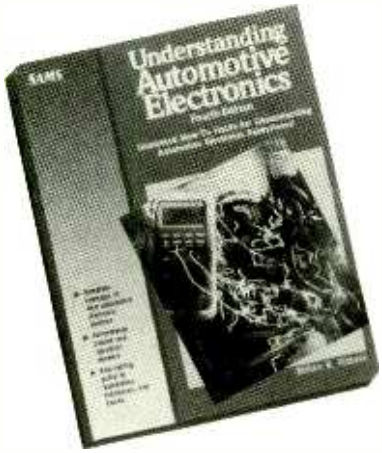
Other readers may be interested in knowing that QSLs (verification of long-distance reception) from Canadian radio broadcasting stations is easy if you get a QSL card to mail. What you have to do is write to Radio Canada International Box C.P. 600, Montreal, Canada H3C 3A8, asking for a blank QSL card. When you get it, just fill in a few details about the program you heard and mail it to the station you picked up.

They will check to see if the details you give prove that you actually picked the station up, and will sign it and mail it back to you. If the details you supply are incorrect (don't use guesswork) they won't reply to you. — **Dan Nelson, Croton-on-Hudson, New York.**

Thanks for this tip for DX fans, Dan.

NEW BOOK REVIEWS

UNDERSTANDING AUTOMOTIVE ELECTRONICS, 4TH ED.
by William B. Ribbens



Like many Saturday-morning auto mechanics, I have come to rely on the auto-repair manuals put out by Chilton, Audel, and others. While these manuals are certainly helpful, the ones that I've seen all suffer from a major shortcoming: inadequate coverage of the car's electrical system. It's as if the electrical system were too complex for the average person to understand. Well, I don't agree, and neither does author William Ribbens. His book **Understanding Automotive Electronics** provides an excellent introduction to the electrical and electronic subsystems of a modern automobile.

Preliminaries such as the fundamentals of automobile design, control systems, electronic fundamentals, and microcomputers are dealt with early in the book. The author then goes on to show exactly how these principles are applied to automotive control systems. We learn about the sensors that measure such variables as intake manifold pressure, crankshaft position, and air-flow rate. Automotive control systems do two important things: they limit exhaust emissions and improve fuel economy. These twin tasks are performed today by an on-board digital computer, the operation of which gets close scrutiny from the author.

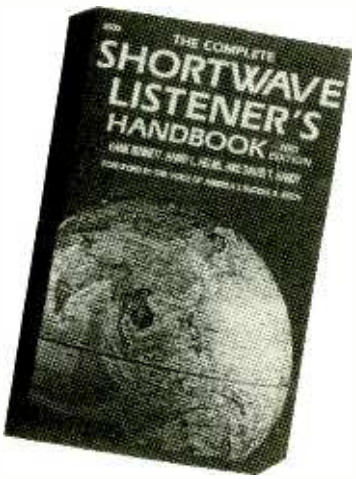
Vehicle motion is also computer-controlled. We get a guided tour of such things as digital cruise control, digital speed control, anti-lock brakes, tire-slip control, electronic suspension, and electronic steering control. The book goes on to explain dashboard instrumentation and the self-diagnostic capabilities of the auto control system.

Curious about the car of the future? Well, according to the author, we can anticipate alternative-fuel engines, continuously variable transmission systems, collision-avoidance radar, and on-board navigation systems in the not-too-distant future. Pretty exciting stuff.

Regardless of whether you do your own repair work or not, it is nice to know how your car's electronic controls really work, if only to avoid being ripped off by unscrupulous mechanics. William Ribbens has written a fine book that covers everything you need to know in an easy-to-understand style.

Understanding Automotive Electronics, 4th Ed., 392 pages, softcover: $24.95. Sams Division, Prentice-Hall Computer Publishing, P.O. Box 90, Carmel, IN, 46032. Phone (800) 428-5331.

THE COMPLETE SHORTWAVE LISTENER'S HANDBOOK, 3RD ED.
by Hank Bennett, Harry Helms, and David Hardy



Any book whose title begins with the words "The Complete" is just begging for some ornery book reviewer to come along and prove that it is not complete. I tried to do just that, but after a careful reading, I've got to admit that **The Complete Shortwave Listener's Handbook** delivers what the title promises.

The range of topics covered is enormous: radio terminology; radio receivers and what to look for when purchasing one; antenna construction; radio frequency assignments; radio-wave propagation through the atmosphere; tips for the successful reception of signals in the short-wave, medium-wave, and long-wave bands; reception reporting and QSL card collecting; UHF, VHF, and ham-band DXing; the transmission, propagation, and reception of TV and FM signals; utility stations and how to "bag" them; proper techniques for filing a reception report with a station; time and standard-frequency stations; how to find and join a radio club; and a glossary of commonly used abbreviations.

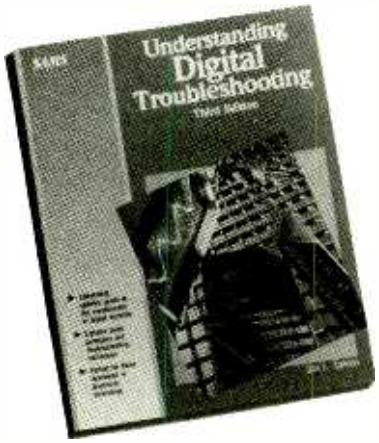
All things considered, it is hard to conceive of a better, more comprehensive introduction to the world of shortwave radio. The authors are true enthusiasts, and their writing will make you enthusiastic, too.

The Complete Shortwave Listener's Handbook, 3rd Ed., 294 pages, softcover: $17.95. TAB/McGraw-Hill Inc., Blue Ridge Summit, PA, 17294-0850. Telephone (800) 822-8138.

UNDERSTANDING DIGITAL TROUBLESHOOTING, 3RD ED.
by Don L. Cannon

The oscilloscope, the multimeter, and the signal generator were all conceived in an age when electronic circuits were almost exclusively analog in nature. Though still useful in an increasingly digital era, these instruments are clearly not enough. We need new instruments and new techniques to troubleshoot

and repair digital circuitry. The logic analyzer, the signature analyzer, and the logic probe are members of this new breed of test instrument. Techniques for using these devices as well as others in digital troubleshooting are the topic of author Don L. Cannon's book.



The book begins with a brief review of the fundamentals of digital circuits, proceeds to discuss the principles of troubleshooting, and then gets down to the nitty-gritty with an attack on the various troubles that afflict digital systems: combinational-logic problems, sequential-logic problems, memory problems, input/output problems, and timing problems. The book concludes with a discussion of the advanced troubleshooting techniques needed in complex digital systems. Numerous examples and an abundance of diagrams make the presentation easy to understand.

Anyone with an interest in electronics today needs to know something about digital troubleshooting, and this is one of the few books on the market that contain the information you need. It is certainly worth adding to your library.

Understanding Digital Troubleshooting, 3rd Ed., 286 pages, softcover: $24.95. Sams Division of Prentice-Hall Computer Publishing, P.O. Box 90, Carmel, IN, 46032. Telephone (800) 428-5331.

ENCYCLOPEDIA OF ELECTRONIC CIRCUITS, VOL. 4 by Rudolf Graf and William Sheets

Volume 4 of the **Encyclopedia of Electronic Circuits** has just been published, and I'm happy to report that it is just as good a reference book as its three illustrious predecessors. The current volume is divided up into 104 sections covering such topics as audio scramblers, battery chargers, oscillators, temperature sensors, and timers. To find a particular circuit, you simply flip to the appropriate section or consult the exhaustive index at the back. These are all brand-new circuits; there are no carryovers from the previous volumes. However, similar **sections** are present in all the volumes. Thus, you can expect to find power-supply circuits, for example, in each volume, but the examples will be different. That's a good concept, because it means that you don't have to buy all four volumes to have a usable reference. (Not that the authors or publisher would mind if you bought all four volumes. In fact, I'm sure they'd be delighted.)

Most of these circuits have been abstracted from magazines, application notes, and manufacturers' databooks. Each schematic is accompanied by a concise description as well as a full bibliographic citation (in case you need more info). Where necessary, formulas and graphs augment the schematics.

A good circuit reference can be very helpful, whether you're a hobbyist or an electronics professional. This particular circuit reference is both excellent and affordable, the kind of book I can recommend without hesitation.

Encyclopedia of Electronic Circuits, Vol. 4, 729 pages, softcover: $29.95. TAB/McGraw-Hill Inc., Blue Ridge Summit, PA, 17294-0850. Telephone (800) 822-8138.

RADIO HANDBOOK, 23RD ED. by William Orr, W6SAI

William Orr's **Radio Handbook** ranks as one of the true classics of radio literature, a reference work used by thousands of engineers and ham radio operators. Comprehensive in its coverage, the book strikes a nice balance between theory and practice. Construction projects abound, making this an ideal book for the radio operator who enjoys building his own equipment. Strictly speaking, this is not a book for beginners, yet neither is it a book for eggheads. If you hold an amateur-radio license, you should be able to understand everything here.

Coverage includes the principles of AC and DC circuits; amplifying

NEW BOOK REVIEWS

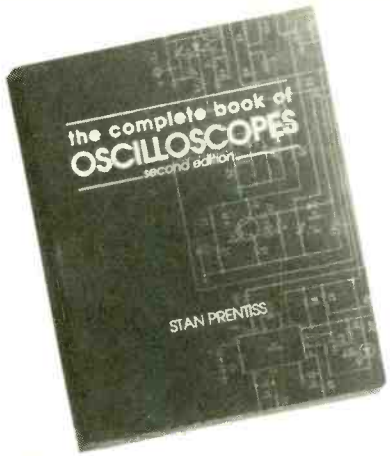
devices like bipolar transistors, FETs, and tubes; principles of single-sideband transmission and reception; techniques of receiver design; frequency synthesis; frequency modulation and repeaters; specialized communication, including satellites; mobile and marine equipment; radio and television interference; the generation and amplification of radio-frequency energy; power-amplifier design; power supplies; the radiation and propagation of electromagnetic waves; antennas; transmission lines; and electronic test equipment. In short, just about everything a radio amateur needs to know.

By the time a book gets into its 23rd edition, you know it must be good, so I won't bore you with superlatives. Instead, just let me say that if you are an amateur radio operator or plan on becoming one, you'll be hard-pressed to find a better single-volume technical reference than this.

Radio Handbook, 23rd Ed., 672 pages, hardbound: $39.95. Sams division, Prentice-Hall Computer Publishing, P.O. Box 90, Carmel, IN, 46032. Telephone (800) 428-5331.

THE COMPLETE BOOK OF OSCILLOSCOPES, 2ND ED. by Stan Prentiss

Just as the lion is regarded as the king of beasts, so too could the oscilloscope be called the king of test instruments. In the right hands, an oscilloscope can do just about anything. In fact, if I had to make do with just one test instrument, it would be an oscilloscope. Getting the most out of an oscilloscope requires a thorough understanding of how it operates. The instruction manual that comes with your scope will provide some guidance, but if you want to become a true scope expert, you need the kind of information found in **The Complete Book of Oscilloscopes.**



Topics covered include the principles of operation of both analog scopes and digital-storage oscilloscopes (DSOs); the analysis of waveforms, including video signals; probes and probe adjustment; use of the oscilloscope timebase; a discussion of the features to be found on modern oscilloscopes; the advantages of digital storage scopes; and an explanation of risetime, frequency response, etc. The remainder of the book deals with certain important cousins of the oscilloscope: spectrum analyzers, logic analyzers, time-domain reflectometers, signature analyzers, and vectorscopes. The treatment is down-to-earth and practical, making things easy to understand.

I have to admit this is a pretty good book, but be forewarned that only one-third of its pages are devoted to oscilloscopes. If you have no interest in spectrum analyzers and the like, this may not be the book for you. But if your interests are such that spectrum analyzers, logic analyzers, vectorscopes, reflectometers, and signature analyzers could be useful to you, by all means get the book, because you'll have a hard time finding information on these instruments anyplace else.

The Complete Book of Oscilloscopes, 2nd Ed., 305 pages, softcover: $16.95. TAB/McGraw-Hill Inc., Blue Ridge Summit, PA, 17294-0850. Telephone (800) 822-8138.

HANDBOOK OF ELECTRONIC TABLES AND FORMULAS by the Sams Engineering Staff

The typical engineering handbook is a thick compendium of useful formulas, data, charts, and graphs. It's great for practicing engineers and technicians, but too broad in scope and expensive for the electronics hobbyist. What the hobbyist needs is a mini-handbook containing basic electronic information but omitting advanced subjects like radar and control-system theory. Such a mini-handbook exists; it's called the **Handbook of Electronics Tables and Formulas.**

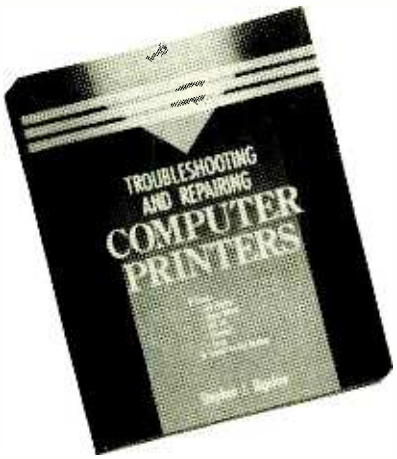
In it, you'll find electronic formulas and laws, reactance charts, decibel tables, an explanation of time constants in RC and RL circuits, transformer theory, a frequency-to-wavelength conversion chart, a table of unit-conversion factors, data on the standard frequency and time signals broadcast by WWV, a worldwide conversion chart, television signal standards, a listing of the standard Q signals, 10-code signals, standard electronic abbreviations, resistor and capacitor color codes, standard electronic schematic symbols, vacuum-tube design formulas, transistor-design formulas, a coil-winding nomograph, filter-design information, mathematical tables and formulas, facts from Boolean algebra, a table

of weights and measures, and an assortment of BASIC-language computer programs useful in circuit analysis.

There's more, but you get the picture by now. This is a compendium of basic electronic information that will be appreciated by anyone who loves electronics but hates to spend more money than he has to. In short, a valuable addition to the hobbyist's technical library.

Handbook of Electronics Tables and Formulas, 6th Ed., 265 pages, softcover: $24.95. Sams Division, Prentice-Hall Computer Publishing, P.O. Box 90, Carmel, IN, 46032. Telephone (800) 428-5331.

TROUBLESHOOTING AND REPAIRING COMPUTER PRINTERS
by Stephen J. Bigelow



Rather than take a broken piece of equipment or appliance to the repair shop, chances are you try to fix it yourself. But could you repair something as complicated as a computer printer? The answer is yes, provided you had the proper guidance. **Troubleshooting and Repairing Computer Printers** provides just the kind of help you need to fix any kind of printer.

Beginning with an introduction to some of the electronic and electromechanical subassemblies that make up a typical printer, the book then proceeds to discuss the principles of operation of the printers you're most likely to encounter: dot-matrix impact, thermal dot-matrix, ink-jet, and electrostatic (including laser and LED types). Assuming that not all readers will be electronics experts, the author next provides a clear, concise introduction to test equipment such as logic probes, oscilloscopes, and multimeters.

The remainder of the book provides specific troubleshooting advice for every important subassembly in the modern printer. This includes: daisy-wheel, impact-dot-matrix, and thermal-dot-matrix printheads; ink-jet printheads; power supplies (both linear and switchmode); the electronic control system, including such things as microprocessors and sensors; mechanical subsystems; lasers and laser-imaging systems; and communication ports (serial, parallel, and GPIB). The book concludes with some diagnostic troubleshooting charts and a list of vendors who can supply repair parts and service info.

Although no manufacturer will ever admit it, printers seem designed to break down just when you need them most. When that happens, you can either wait a week for the repair shop to fix your machine, or roll up your sleeves and do it yourself. With the assistance of Stephen Bigelow's excellent book, there's no printer-repair job you can't tackle.

Troubleshooting and Repairing Computer Printers, 310 pages, softcover: $22.95. TAB/McGraw-Hill Inc., Blue Ridge Summit, PA, 17294-0850. Phone (800) 822-8138.

HOW TO MAKE YOUR OWN PRINTED CIRCUIT BOARDS.

This is a practical book that delivers just what its title promises. It will teach you everything you need to know about pc boards if you've never made one before. And it can also help those who've already made one or two boards but have been discouraged because they didn't get it right; there are little tricks that are explained here but usually left out of the directions you get with most pc board kits.

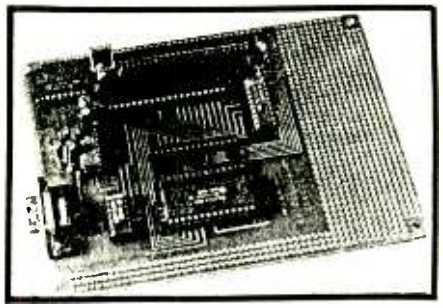
This book tells you how to use pc layouts, like those supplied with the articles in **Electronics Handbook,** to produce finished boards. It also shows you how to produce layouts of your own, using photography. Finally, it tells you exactly how to design your own layouts if you're working with a project of your own or from a magazine article which doesn't include a pc board layout.

One caution is in order here. If you're putting together a fairly simple project, with just one or two ICs and a couple of transistors, it would be wise to use a perforated circuit board (perf board) to support and connect the components instead of going to the trouble of making up a pc board for just one unit. Pc boards are great, but only if you have a complex circuit to build, or if you're going to build several copies of the same project at one time.

R.A. Penfold, 66 pages, Electronics Technology Today, Box 240, Massapequa, NY 11762.

NEW PRODUCTS PARADE

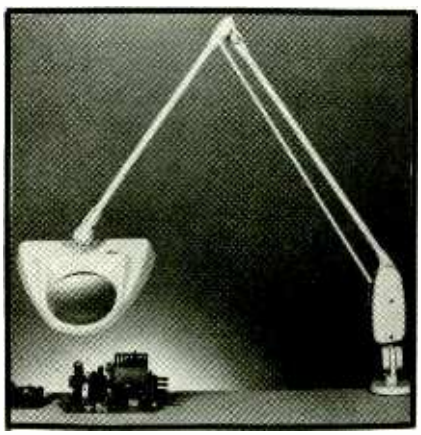
SINGLE BOARD COMPUTER



Suncoast Technologies 70691 BASIC single board computer is designed to allow hobbyists and engineers alike to design highly sophisticated computer programs using the easy to understand BASIC-52. Created by Intel; BASIC-52 is a high level programming language that is stored as part of the internal Read Only Memory of the 8052AH BASIC Microcontroller. By incorporating this "smart chip," programming the 70691BASIC is an easy matter. While in DOS, load PROCOM (a shareware communications program supplied with your purchase), connect 70691 BASIC to your IBM PC/compatible with an interface cable, apply power and press the spacebar. You are now ready to program the 8052 chip through your desktop computer. Test your programs just by typing "RUN" and watch your BASIC-52 creation execute automatically. Watch the operation of the 8052 microcontroller without burning EPROM after EPROM. Modifications can easily be made and tested within a matter of seconds. BASIC-52 programs can be saved in either of two ways. Download program ASCII format from 70691BASIC memory for subsequent saving on hard drive or floppy disk, or you can save the program on EEPROM (using accompanying BASIC-52 EEPROM eraser and software). Interfacing and circuit expansion is also an easy matter for the 70691BASIC. Just like the 70691RAM; 91BASIC also contains a 40 pin header that picks up all major 8052AH terminals (ex. Port1, Port3, Hi-Order Address Line, etc.), thus allowing these points to be brought to your prototype board using inexpensive ribbon cable (available from Digi-Key Corporation). The best feature of the 70691BASIC is to allow fast, easy program development. With this program working just the way you want, BASIC-52 can be transformed into an.ASM program with Binary Technologies BXC51. When converted, this new program can be placed into the EPROM chip of the 70691RAM board. Both 70691RAM and the 70691BASIC are 100% compatible with BASIC-52 and each other.

For further details on the 70691BASIC single board computer, write to **Suncoast Technologies, P.O. Box #5835, Spring Hill, Florida. Voice/Fax (904) 596-7599.**

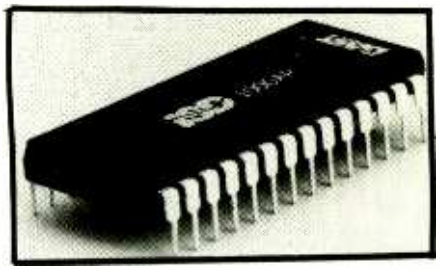
HI-LIGHTING FLUORESCENT MAGNIFIER



The 8MG Series magnifier combines two powerful seeing aids—optically correct magnification and cool, fluorescent lighting. The 5″ diameter, 3-diopter lens provides 3/4x enlargement of the item being viewed. A 13-watt, energy-efficient, compact fluorescent tube, located behind the magnifying lens, casts light at an angle ideal for highlighting object details. This shadow highlighting makes details of uneven surfaces "pop-out" to the viewer. The unique "floating arm" design provides the ultimate in ease and convenience for the operator. It glides with the touch of a finger, and stays where you put it. There are no exposed springs to wear out, squeak, or to distract from its sleek appearance. The magnifier is gray in color and comes with on/off switch, 3-wire cord, and 13-watt compact fluorescent tube. It is available with weighted base (26″ reach) or clamp-on mount (40″ reach).

For further details, contact **HMC, 33 Springdale Avenue, Canton, MA 02021 Phone (617) 821-1870, FAX (617) 821-4133**

VOICE RECORD/PLAYBACK CHIP



Radio Shack now offers technicians and hobbyists an affordable yet powerful voice record/playback integrated circuit for do-it-yourself design of voice storage and playback devices. The ISD1000A can record and playback up to 20 seconds of voice, music, sound effects and tones, store more than one message and operate from a single 5-volt power supply.

The ISD1000A chip employs patented Direct Analog Storage Technology (DAST™), a leading-edge semiconductor design technique developed by Information Storage Devise, Inc. This techniques makes it possible to deliver reliable analog storage on a single chip.

The ISD1000A is designed for use in products such as pager enunciators, cellular telephones, answering/recording devices, and portable answering machines.

Other important applications include voice annunciation in appliances, message integration for user instructions, medical signal recording (such as EKG), industrial/environmental sensor signal storage, voice prompting in computers, speech cache in voice mail and weather/traffic report cache in automotive radios.

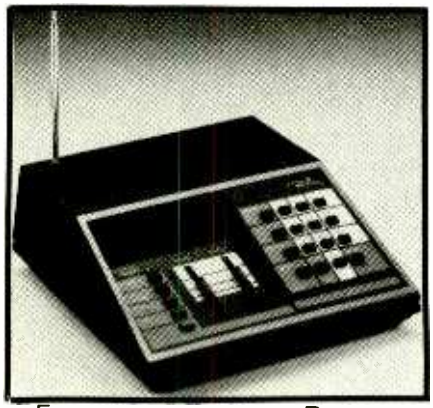
Hobbyists need only a few external components to build a complete voice record and playback system including a microphone, loudspeaker, switches, several resistors and capacitors, and a power supply or battery. All other devices—preamplifiers, filters, AGC, power amplifier, control logic and analog storage—are built into the chip. Audio output is processed and stored in the chip, reconstructed, amplified internally and sent directly to the speaker.

One of the chip's most important features is field recordability which accommodates local accents and dialects in different languages. The chip is especially useful for delivering timely voice messages in playback-only systems such as automated information booths or automated teller machines.

The chip technology includes non-volatile power which saves messages during power outages; high voltage for writing to non-volatile memory cells; digital chip management functions; and, CMOS low power operation. This combination of technologies makes possible such self-contained recording functions as pre and post-amplifications, filtering, analog signal processing, digital control and power management circuits. The low operating power of the ISD1000A is ideal for use in portable, battery-operated environments.

The ISD1000A Voice Record/Playback IC (Cat. no. 276-1325) sells for $17.99 at nearly 6,700 participating Radio Shack stores and dealers nationwide.

DELUXE RADIO SCANNER



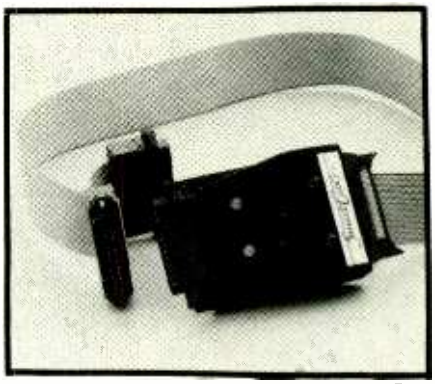
For many years **Regency Electronics** has been making specialized receivers like this one which rapidly scans various broadcast bands. **The Turbo-Scan 800** is their latest and best scanner.

This set scans the Aircraft frequencies (118-136 Megahertz as well as 800 MHz); four sets of Ham frequencies, Federal Government, Land Mobile, and all standard VHF and UHF broadcast bands. Frequencies to be checked are entered using the translucent rubber keypad. Using the kepad and a two-level vaccum-fluorescent display (for night use) to program this scanner, one tells it what broadcast frequencies to check.

Up to 75 channels can be scanned continuously, in order of frequency, or they can be grouped for scanning into six separate scan banks.

The model 800 has an "Accu-Seek" feature which lets it search for a desired channel (punched in on the console) at a rate of 50 channels per second. It also has a Weather key which seeks out and locks onto the nearest Weather station.

The $449 price includes two telescopic antennas, an AC power supply, DC (car) power cord, and a bracket for car/truck mounting. For more information telephone 312-372-7090. **Regency Electronics, 7707 Records Street, Indianapolis, IN.**



UNIVERSAL RS 323 INTERFACE

The problem micro users run into most often is getting their microcomputer to talk to their printer. If you bought them both at the same time, from the same dealer (usually paying a little extra for that privilege) it's not your problem. You probably got the dealer to set the system up and demonstrate it before you took it home, right?

But what if you bought your computer in one place (maybe by mail) and your bargain printer somewhere else? Well, you say printers are either serial or parallel, and so are micros (many handle both). So if you bought a parallel-output micro and have a parallel printer, there should be no problem. Usually that's true. But what if you have a serial-output computer and a serial printer? Are your problems over? Often not.

Enter Smart Cable, which connects to the back of your micro and the input of your serial printer. It's got five little red, green and yellow lights and two slide switches. Just plug it in, turn your system On, and look at the lights.

Smart Cable does the rest. It has logic circuits in it which switch the connections around to match the two units, micro and printer, together. Several models are available, but most situations are a handled by model 817. Smart Cable 817 sell for $49.50.

IQ Technologies, 1811 NE First ST. Bellevue, WA 98005. Toll-free 1-800 227-2817.

NEW PRODUCTS PARADE

SPARKOMATIC CASSETTE/CAR RADIOS

Two moderately-priced electronic-tune radio cassette receivers are the company's model SR 360 and 350 FM/AM Stereo, Auto-Reverse units. They feature programmable memory tunning for five AM and 10 FM stations, automatic Strong Station selection, Memory Scan for preset stations, and automatic Seek-and Scan tunning. Auto-reverse play for cassettes as well as locking fast-forward and rewind are included.

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CORDLESS

TELEPHONE REPAIRS

By Homer Davidson

Among the great inventions found in the home today, are the Television and the Telephone. In recent years, the Microwave Oven and now the Cordless Phone may be the next in line. Nearly everyone now has a cordless telephone at home or in their office. Unfortunately, like all consumer electronic products, they breakdown and require repairs.

Here are some simple repairs that you can perform before calling in the professional telephone technician.

The most common problems found with cordless telephones are weak or dead batteries. More often than not, the phone has been left off the charging unit for several days and needs charging or the base unit will not light up because of a snagged or broken AC cord (Figure 1), a defective or worn wall transformer cord and/or defective transformer. Sometimes liquid has been accidentally spilled into the cordless phone and it will not function. Weak reception may be caused from a broken cordless phone antenna. Before tearing the phone apart, however, check off possible troubleshooting problems. (Figure 2).

Battery Problems

Most telephone nickel-cadmium batteries should be charged at least 10 hours before using the brand new telephone. Nickel-cadmium batteries may

Figure 1. The base unit may be powered with a separate transformer adapter.

Troubleshooting Chart

TROUBLE	CHECK THE FOLLOWING
No dial tone	1. Make sure the base unit is plugged in. 2. Check AC outlet with table lamp. 3. If battery light is on, charge or replace battery. 4. Note if telephone cord is plugged into telephone socket. 5. Defective telephone line...Check with another phone in the house. 6. Check if Standby/Talk switch is in Standby. Switch to talk position. 7. Check dial tone switch or pulse mode button.
No incoming calls	1. Check all of above. 2. Make sure Standby/Talk switch is not in the talk position.
Interference and Static	1. Cordless phone outside range of base. 2. Bring cordless phone closer to base and see if it operates. 3. Low batteries...charge or replace. 4. Base located in high interference area. Relocate base unit. 5. Interference from TV, motors, neon light, power lines...Relocate base unit. 6. Chanel interference...Change digital code on both units.

Figure 2. A typical Troubleshooting Chart for Cordless Telephones.

develop a memory condition. The battery may need recharging when the charging light stays on all the time.

Simply unplug the AC cord from the base unit or remove the power transformer adapter from the wall outlet. Push the cordless phone to "TALK" and let it discharge for 24 to 36 hours. Then switch to "STANDBY" and apply the AC cord to the base unit. Let the battery charge up for 24 hours or longer. To prevent a "memory" battery condition, repeat this process every 2 or 3 months.

Weak cordless phone batteries may leave the unit dead, cause weak reception, or become extremely noisy. Besides noise you may hear a howling or warbling noise from the earpiece with weak batteries. A couple of beeps will be heard every 30 seconds on some cordless telephones with defective batteries. Your phone conversation may be disconnected, while making a call if the battery is too low.

Most batteries will hold a charge for about 2 or 3 days if left out of the cradle, depending on useage. Batteries that will not hold a charge for more than 2 hours should be replaced. Replace the defective batteries if any signs of leakage occurs. Sometimes cordless phones left unplugged for several days will require a week to recharge. Most cordless phones have a low battery light indicating when the batteries need to be charged. Cordless phones batteries should last 3 or 4 years (Figure 3).

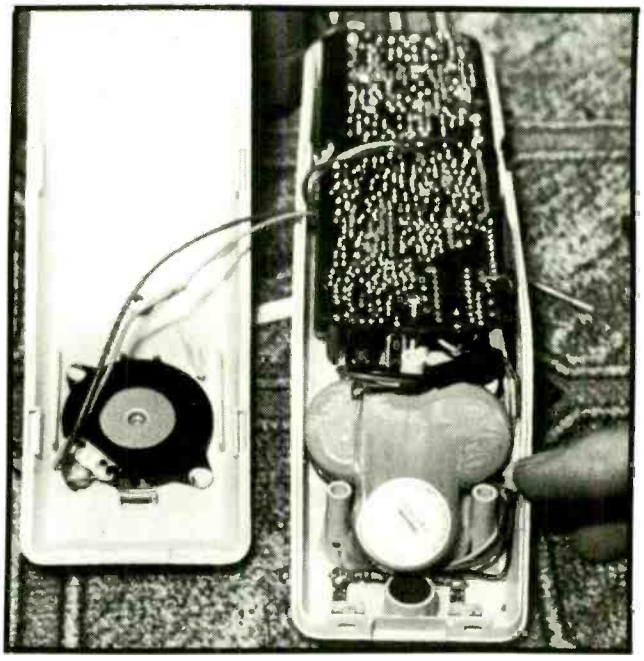

Figure 3. The small nickel-cadmium battery may keep the low battery light on all the time until fully charged.

Typical Battery Removal

You may find a battery compartment with a sliding cover like those found on small portable transistor radios. While in others the whole back cover must be removed before you can get to the batteries. Simply slide the battery cover down and take it off the cordless phone. If the whole back cover must be removed, look under the telephone number window. Remove the clear plastic piece and the paper number where you will see a small bolt or screw. Remove the screw and gently pull the headset apart.

Be very carefull in removing the back cover. Sometimes a coin inserted at the bottom lip will allow you to pry the telephone cover open. Gently pull off back cover and do not dislodge any loose wires.

Inside you will find the battery pack. Unplug the wires to replace the battery. Some batteries are

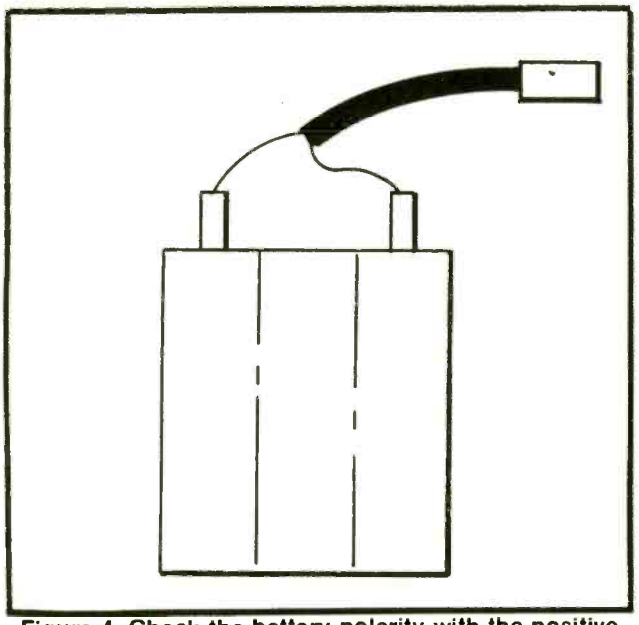

Figure 4. Check the battery polarity with the positive terminal soldered to the red wire and the negative to the black wire.

unsoldered at the terminals, while others may have a connecting cable attached. Before attempting to replace batteries check the battery polarity wires. Make sure when wires are replaced the battery is not reversed (Figure 4).

Dead Or Weak Batteries

Most popular phone batteries operate at 3.6 volts, indicating three nickel-cadmium (Ni-Cad) batteries are wired in series. For cordless devices the battery voltage may range from 1.25 to 4.8 volts. These cordless phone battery packs may have from .250 to .650 ampere-hours. The higher the ampere-hours (Ah), the longer time between charging.

Always replace the same type batteries found in the cordless phone. Otherwise, the battery may not fit in the battery compartment. Usually, the battery cable contains a red and black wire. The red is positive and the black is negative. If in doubt about the battery terminals check with a VOM or DMM for correct voltage and polarity.

Figure 6. Clean off all charging contacts on the cordless phone and the base unit.

Check the battery voltage with weak reception, dead operation or the battery will hold a charge for only a few hours (Figure 5). The fully charged battery should be 3.6 volts or higher. When the battery will not charge over 3 volts, suspect a memory condition or a defective battery. Throughly discharge the battery for 24 hours and charge up again.

Do not throw the battery away, just yet. Make sure the main base is charging. Wipe off charging contacts of the base unit (Figure 6). When the cordless phone is placed in the cradle or holder, these contacts rest against the charging contacts of the cordless phone. Clean off all four contacts with cleaning fluid and cloth.

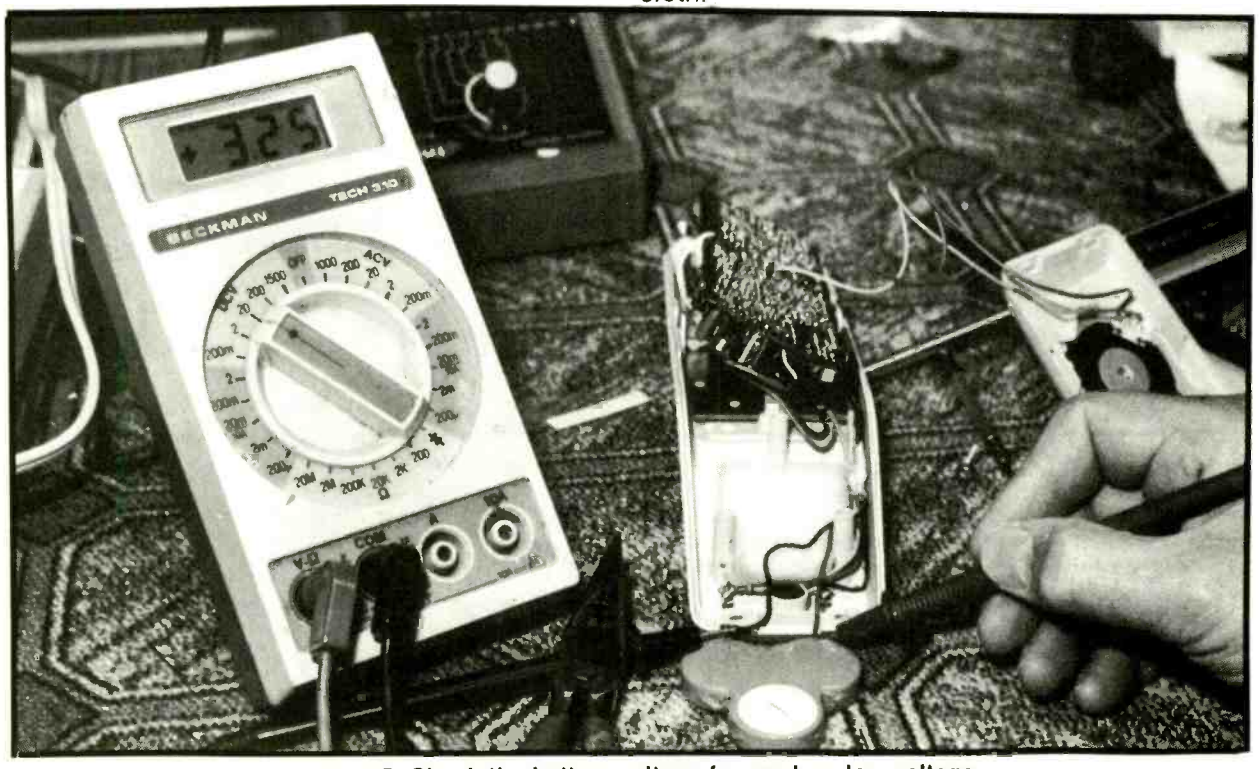

Figure 5. Check the battery voltage for weak or low voltage.

Batteries Will Not Charge Up

You may assume the batteries are defective when they will not charge up in 24 hours or will not hold a charge for more than a few hours. If the cordless phone has been left off the charging cradle for several days, in a cold room, during winter months, it may not charge up for 15 days or more.

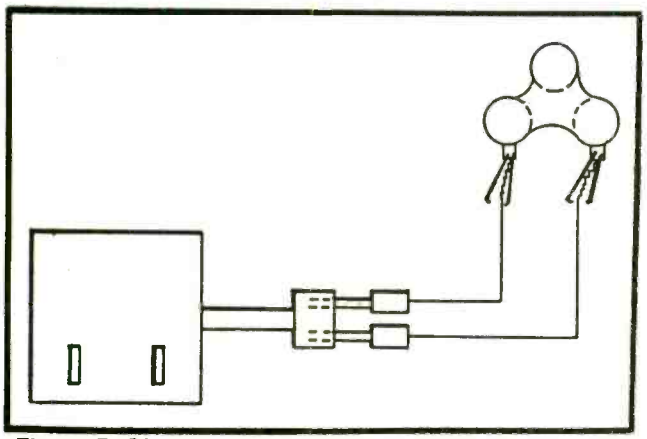

Figure 7. Observe correct polarity of the charger and the batteries with the digital multimeter.

For instance, the homeowner goes south in the winter for a couple of months, disconnects the cordless phone and turns the heat down to 55 degrees. During below zero winter days the cordless phone may become a little colder if located in the bedroom. When the owner returns home the cordless phone base is plugged into the AC outlet and the batteries are charged up for days and never fully charge.

Do you install a new set of batteries each year? Of course not. You check the batteries and lets say they never charge over 2.1 volts. When cordless phone batteries fall below 3 volts, weak, noisy and short distance results. You can charge up those cordless phone batteries with a higher charging voltage.

If you have a cordless power drill or saber saw with a charging adapter, of 4 to 6 volts, use it to charge up the battery before discarding. Remove the battery from the cordless phone. Clip test leads to the charging adapter. Observe correct polarity of battery and charger (Figure 7). Place the battery upon a book or magazine and cover with a towel or rag. Do not exceed 6 volts charging rate on a 3.6 volt battery.

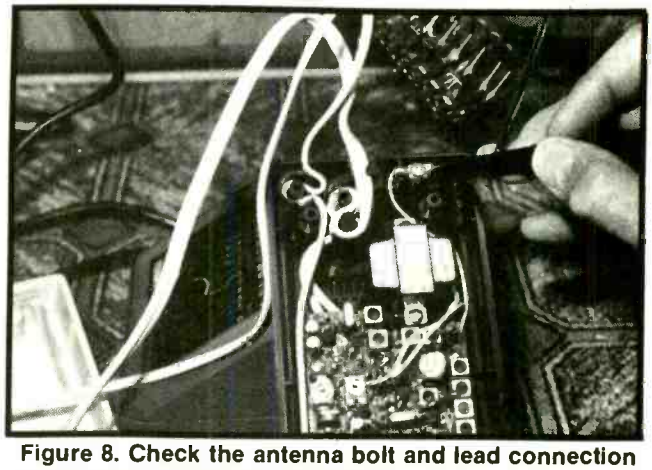

Figure 8. Check the antenna bolt and lead connection for a loose or broken connection.

The battery may run warm during charging. You may find the battery will charge over the 3.6 volt limit, but no damage is done. If the battery will not charge up to its regular voltage within 6 hours, discard the battery. Wrap it in newspapers and throw in the garbage.

Intermittent Operation

Nothing is more downright disturbing than to have a conversation on the telephone when it is

Figure 9. If the microphone is suspected, measure the resistance across the two terminals.

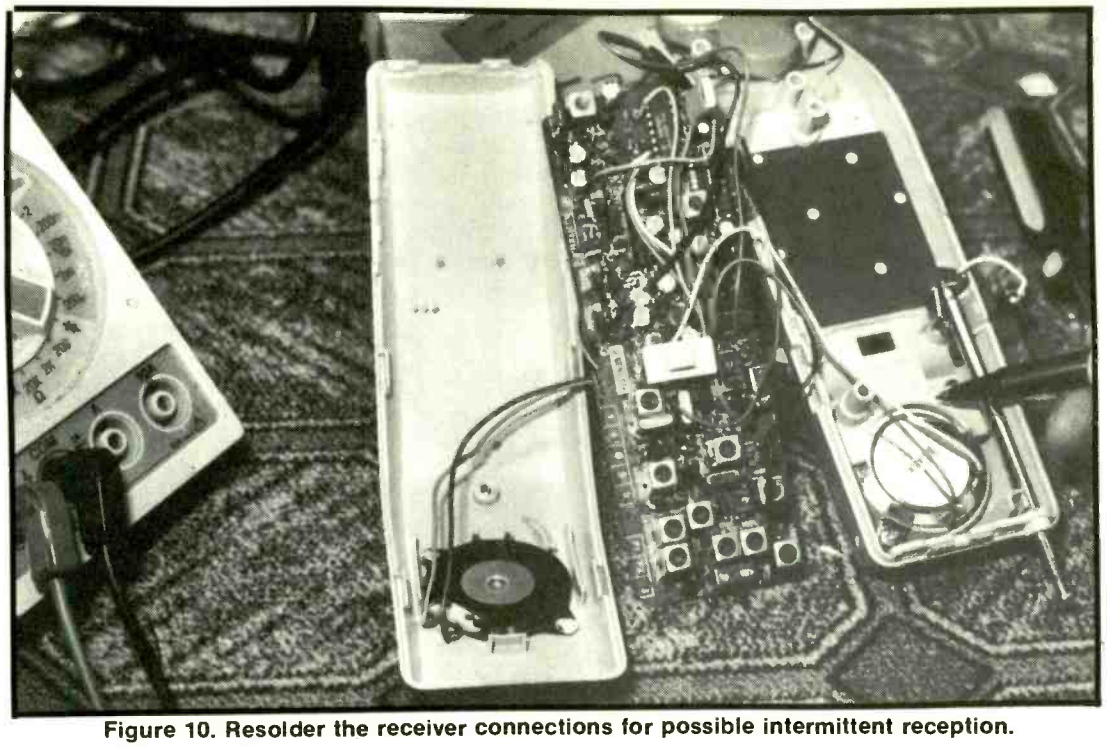

Figure 10. Resolder the receiver connections for possible intermittent reception.

intermittent. You have to guess what the other person is saying. When intermittent and excessive noise is heard, the trouble may be in the telephone system. Hang up the phone and try again. Sometimes another powerful cordless or cellular phone next door or going by in a car may cause intermittent interruptions and/or cut off signals.

If regular telephone communication is normal and the cordless phone conversation is intermittent or noisy, remove the back cover and check the connections. Also inspect the antenna lead-in wire for loose connections (Figure 8). Re-tighten any loose bolts or nuts. Check all long pieces of wires going to other components. Check for loose components on the PC board.

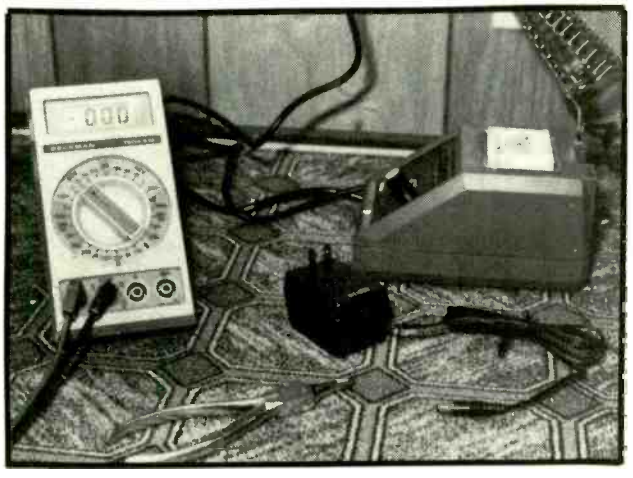

Figure 11. Inspect the cord and plug of the AC adapter for possible breaks or torn areas. Check for AC voltage at the plug end.

If the phone is intermittent while transmitting (Talking) suspect a defective microphone or loose connection. Take a continuity measurement of the mike unit. The resistance should be from 5 to 10 ohms (Figure 9). In an ITT model PC1550, the microphone measures 6.7 ohms. Remove connecting wires and clip a DMM (low ohms) to the two connections. Speak into the microphone and notice if the meter numbers go up and down rapidly in resistance or open up with no measurement.

When the receiver becomes intermittent, check it out in the same manner. The resistance of the small speaker or receiver measures from 3.5 to 10 ohms. Make sure the wire connections are not frayed or broken. Resolder connections if in doubt (Figure 10).

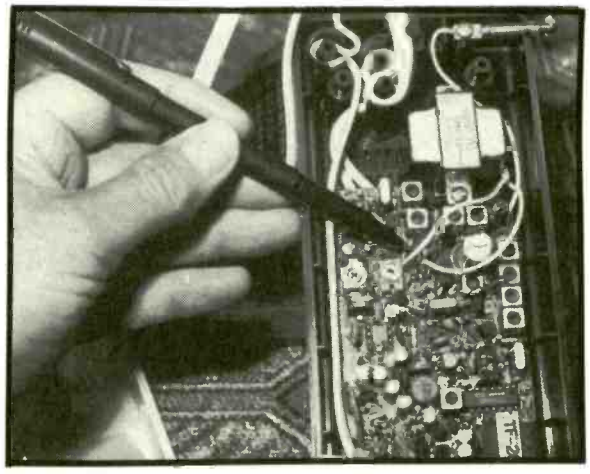

Figure 12. In some base units, the small transformer and diodes are found on the PC board. Check each diode with the diode test of the DMM.

Base Unit Will Not Light Up

Suspect the low voltage power supply or adapter transformer unit when neither light of the base unit will light. Some base units are powered with an AC adapter, cord and plug. Inspect the plug for breakage. Usually, the cord breaks where it enters the plug or right at the transformer adapter. Sometimes the cord

is yanked when cleaning the room or a picture or heavy object falls on it (Figure 11).

Push two small pins or needles through each wire, it will come out of the adapter. Measure the DC voltage. If voltage is found here, proceed to the end plug. Likewise insert the two needles into each wire at the plug end and again measure the voltage. If voltage is present and not at the end of plug, suspect a break close to or inside the plug. Cut off the wires at the plug end and measure again. Replace plug to match the base unit.

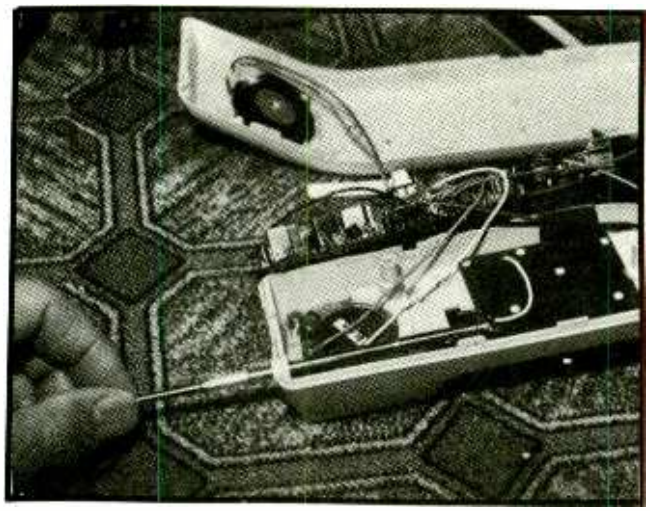

Figure 13. Replace the broken antenna on the cordless phone with an original or a portable radio type found at electronic stores.

If you find no voltage at all, remove the AC adapter and take a low ohm continuity measurement across the AC prongs. **DO NOT** leave unit plugged in for this measurement. No reading indicates an open power transformer. Replace the entire power adapter.

Some base units have the stepdown transformer located right in the base unit. Locate the transformer's secondary leads and find the small silicone diodes. No voltage indicate an open primary winding or defective diodes. Check each diode with the diode test of the DMM (Figure 12). These diodes can be replaced with 1 Amp, 50 volt silicon diodes (1N4001 or 1N4003). Also lightning may destroy the transformer and diodes.

No Charging — Base Unit Normal

Measure the DC voltage at the contact points where the cordless phone lays for charging. Clean off all contacts. Check for broken wires inside each contact point. Trace the wires back and measure the voltage where they connect in the circuit. Again check the diodes.

Broken Antenna

The short telescoping antenna, on the cordless phone, may break off or become bent and will not retract into the telephone. These rods can easily be replaced by getting them from the telephone manufacturer repair center. If this is not possible, replace it with a regular portable radio telescoping antenna found at a local electronic supply store.

Simply unsolder the connecting wire, remove the mounting bolt and install the new antenna (Figure 13). On some units you can loosen the retaining collar with a pair of pliers, unscrew the old antenna and install a new one.

Distracting Radio Transmission

If you have other voices or the telephone is connected with another source, suspect another cordless phone, CB radio or police car causing the disturbance. Most phones have small digital switches in the front area so that you can change frequencies or operate on another band. The digital coding switches are located under a tab on the front of cordless phone and base unit. Both switches must be replaced or changed and matched in both units. Push the switches up or down with a ball point pen. You should find a combination without any interference (Figure 14).

Most telephone repairs are quite simple and can be done by anyone who can use a soldering iron and a meter. It just takes steady hands and correct directions on where to look. Take the cordless phone to professional telephone repair centers for transmitting and processor problems. ■

RADIO CHANNELS

Channel	Handset Transmit & Base Receive Freq.	Handset Receive & Base Transmit Freq.
1	49.670 MHz	46.610 MHz
2	49.845 MHz	46.630 MHz
3	49.860 MHz	46.670 MHz
4	49.770 MHz	46.710 MHz
5	49.875 MHz	46.730 MHz
6	49.830 MHz	46.770 MHz
7	49.890 MHz	46.830 MHz
8	49.930 MHz	46.870 MHz
9	49.990 MHz	46.930 MHz
10	49.970 MHz	46.970 MHz

Figure 14. The Radio Frequencies of the handset and base unit transmit and receive channels.

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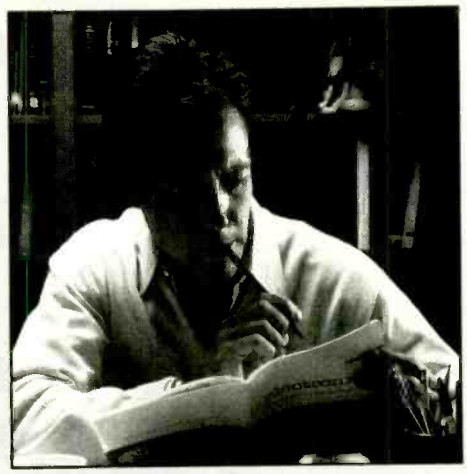

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The 6" Musical Christmas Tree

By Mike Giamportone

Twinkling, while playing your favorite holiday songs. As the tree plays it s classic melodies, all who pass begin to hum or whistle the joyous songs they hear and spread the festive spirit.

With the holidays becoming so commercialized, many of us don't appreciate the true meaning as we once did. Traditional celebrating with unselfish giving doesn't mean going to a department store and buying the most expensive present you can afford. Rather, thoughtful and original gifts are much more cherished. The most considerate gifts require investing a little of your time rather than a lot of money.

The 6" Musical Christmas Tree is one of those presents that year after year, when the ornaments come out, your generosity will be fondly remembered. The trees become a conversation piece. Even if you are not giving them away, adding one to any room in your home will keep the spirit of the season alive. At your place of employment, on your desk or workbench, the aura created quells even the roughest spots in your day.

This six inch tree flickers LEDs while playing a continuous holiday melody to praise the season. On the top of the tree is a super bright LED, twinkling with the rhythm. Several other LEDs alternate brightness, with and opposing the tempo. While more LEDs flash randomly. The tree can play uninterrupted for much of the season on just four AA batteries.

Changing the melody is as simple as plugging in a different 8-pin chip. You may have a different tune playing in each room of your house. Volume is also adjustable for those times when only *you* should hear the music, like when the boss is near. The tree can be built in one evening for around $11 from mail order suppliers or a couple dollars more from Radio Shack. All parts are readily available.

The circuit is constructed around LSI Computer System's LS3404 High Quality Melody Chips. These IC's demand few support components and require just a couple more to play continuous and drive the LEDs. The holiday melodies the circuit can play include: Santa's Coming To Town, Jingle Bells, We Wish You A Merry Christmas, Christmas Angel Medley, Joy To the World, Walking in a Winter Wonderland, and one chip that plays several bars of each!

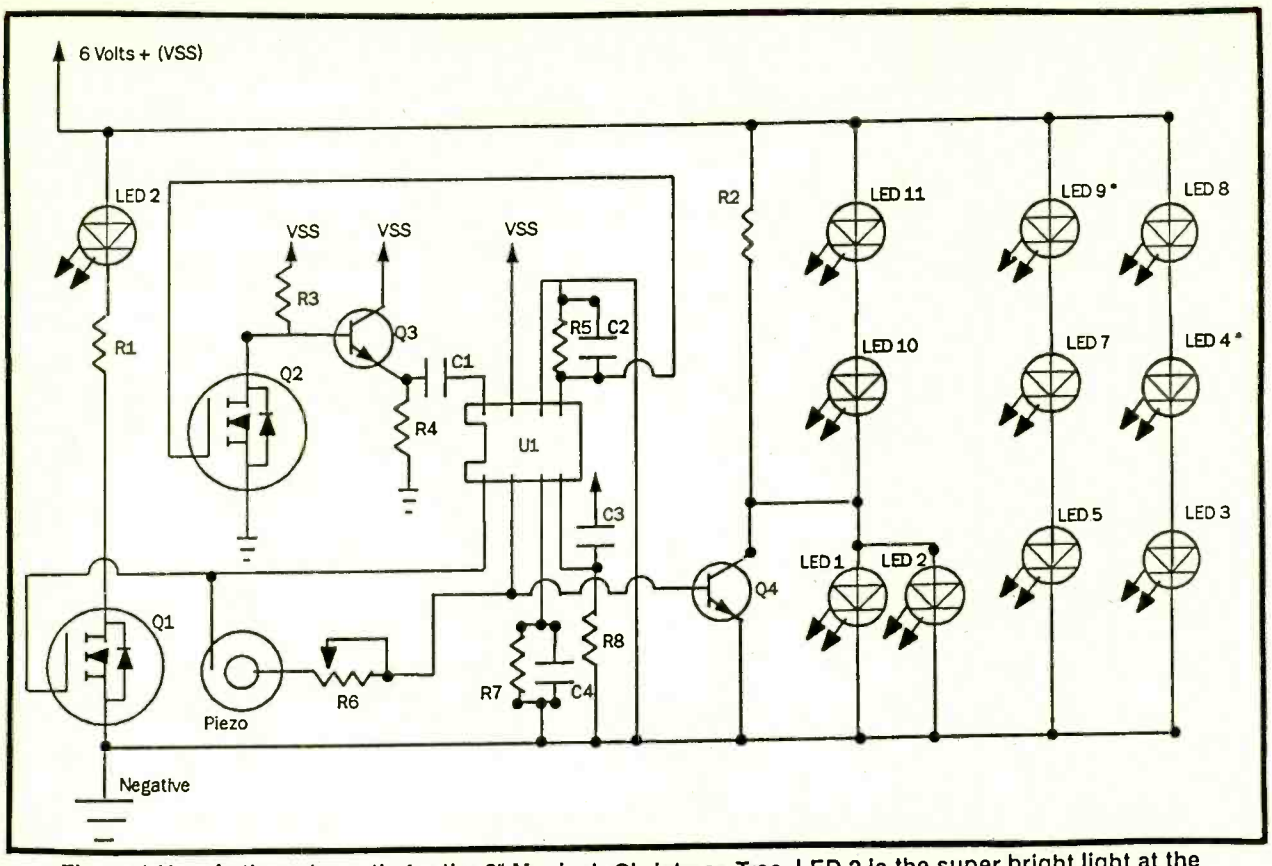


Figure 1. Here is the schematic for the 6" Musical Christmas Tree. LED 2 is the super bright light at the top of the tree that twinkles with the beat. LED's #4 and #9 are the red-flashing LEDs that cause the other LEDs in series with them to flash. When Q4 is biased, it flashes the remainder of the LEDs to light with or opposing the beat for an outstanding display.

About The Circuit

The circuit begins to play as soon as power is applied. See the schematic diagram figure 1. Pin one of U1 not only drives a Piezo speaker, but is connected to the gate of Q1, a metal oxide field effect transistor or MOSFET. Q1, in turn, allows current to flow only with the beat, from the negative source, to R1 and the super bright LED at the top of the tree.

Pin 2 is the second half of U1's 1-2 push-pull team to produce the superb sound with just a Piezo transducer (speaker). It causes Q4 to conduct with the beat. With Q4 biased, current flows from ground to the mid point of LEDs 1, 2, 10 and 11. This creates the opposing brightness levels with the tempo by these LEDs. R2 balances the brightness on this string of LEDs.

LEDs #4 and #9 are red flashing LEDs. They blink automatically when current is applied. Since the remainder of the LEDs are in series with one of these, they must flicker with the flashing LED with which they are in series. This gives a random flashing look with the minimum of cost and parts. These LEDs are in two series strings of 3 lights. They divide the six volts available, thus receiving the approximate 2 volts each one needs.

Once the tune has finished playing, Q2 and Q3 take over and restart the play. Pin 8 of U1 is POR (power on reset). When a high is applied, play is re-initialized or started over. As long as the IC plays, there is about ½ the available voltage present at pin 5. This is used to bias Q2 and hold the gate of Q3, a NPN transistor low. When the music finishes, U1 goes into its low power standby, and removes any voltage from pin 5. This shuts off Q2, and allows Q3 to bias via R3. As the high passes from positive through Q3 and C1, the play restarts. C1 is held low on one side by R4. A capacitor will allow only a brief flow of current if the opposite plate is at another state. This restarts play at the end of each tune.

Q1 and Q2 are Metal Oxide Semiconductor Field Effect Transistors. Power consumption by MOSFETs is just about negligible. This feature is what allows us to tie into such sensitive circuits without an undesirable loading effect. Common silicon transistors would change the sound of the melody. The gates of MOSFETs have no electrical contact with either the source or the drain leads. A glass-like film separates the gate from the remainder of the transistor. With the minute power consumption of MOSFETs, very small currents can bias them.

Since there is such a thin film of insulator between the gate and the other leads, static electricity can easily damage MOSFETs. Clothing, rugs, and plastic items can easily generate voltages high enough to ruin Metal Oxide components. Before handling any MOS device, discharge any static electricity by touching a grounded surface. Better yet, would be to wear a grounding strap to eliminate stray voltages before they build and damage such sensitive semiconductors. This caution goes

for the melody chips and most integrated circuits (IC's).

The BS170 was selected for Q1 and Q2, because it has a built in diode to reduce chances of static damage. Another feature was the TO-92 package. Other MOSFETs will work, but the BS170 small size and static protection fit the bill.

The characteristics of the melodies can be changed to suit your taste. But the only modification required is an occasional alteration in the speed of the tune being played. This is accomplished by changing R8. By increasing the size of this resistor, the tempo slows down and vice-versa. R6, the miniature potentiometer, adjusts the volume of the speaker.

see figure 2 for the author's PC pattern. If putting down your own pattern, the large black filled areas are not required, but will considerably lengthen etchant life.

When cutting the board, be sure to leave 1/8" outside of all traces, then apply the resist, etch, and drill your PCB. Since small children as well as adults enjoy examining your handy work, round off any sharp points of the PCB at this time with a file.

The board will now be used as a pattern to cut two pieces of green felt or indoor/outdoor carpet. I prefer to cover the front of my trees with the plastic-like carpet. This gives them a very authentic pine needle look. Draw or cut with a razor knife around your board, but make it 1/2" longer at the bottom of the trunk. The extra

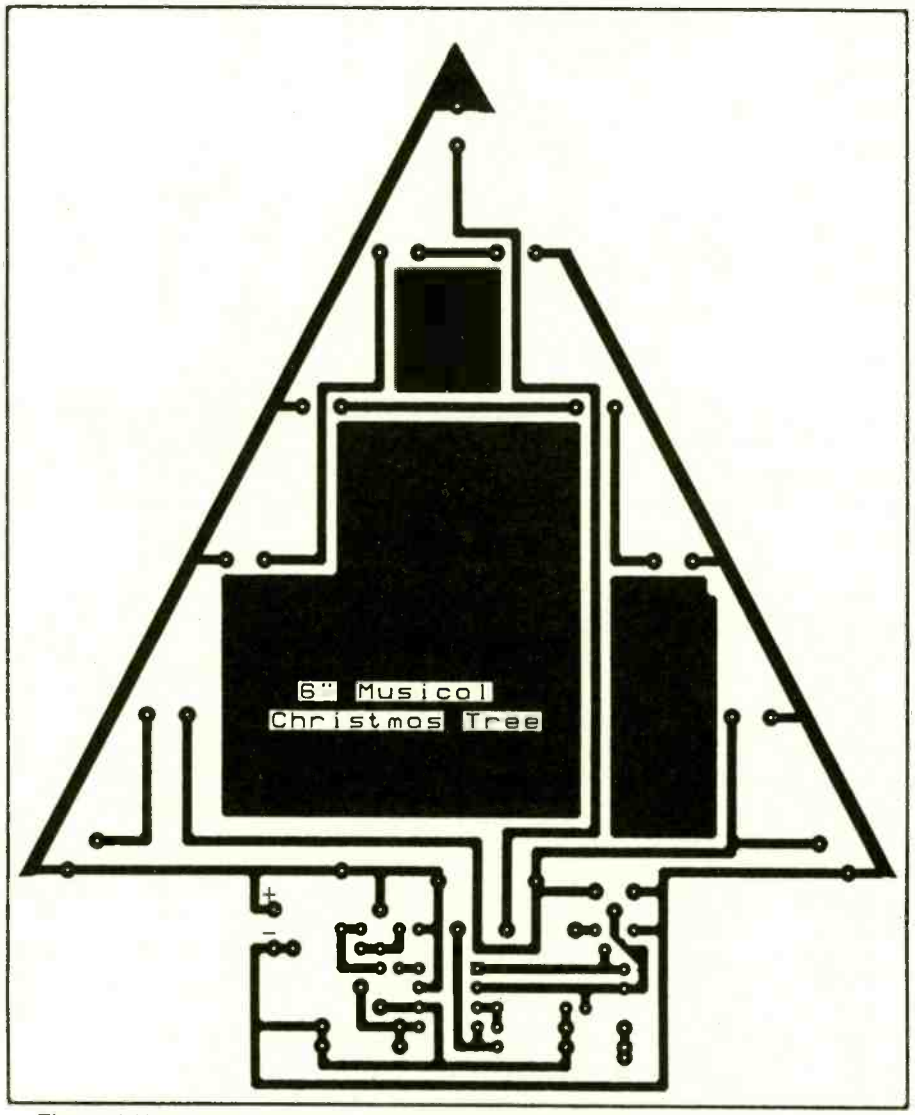


Figure 2.Here is the full-size circuit pattern. The large black areas are not essential but will extend the life of your etchant. Iron-on resist patterns are available to make fabricating your own boards easier.

Construction

After gathering all the needed materials, begin by making your PC board. Wire wrapping and other techniques will work for the circuit, but neatness and size will likely be compromised. Ready-to-drill printed circuit boards or iron-on resist patterns are offered in the parts list, but for those of you who make their own boards, material aids in covering the components on the front of the trunk.

Begin assembly by soldering the components on the face of the trunk. **Do not solder any LEDs or transistors at this time.** Follow parts placement diagram, figure 3. The extra care taken now will prevent troubleshooting later. To conceal the leads coming from

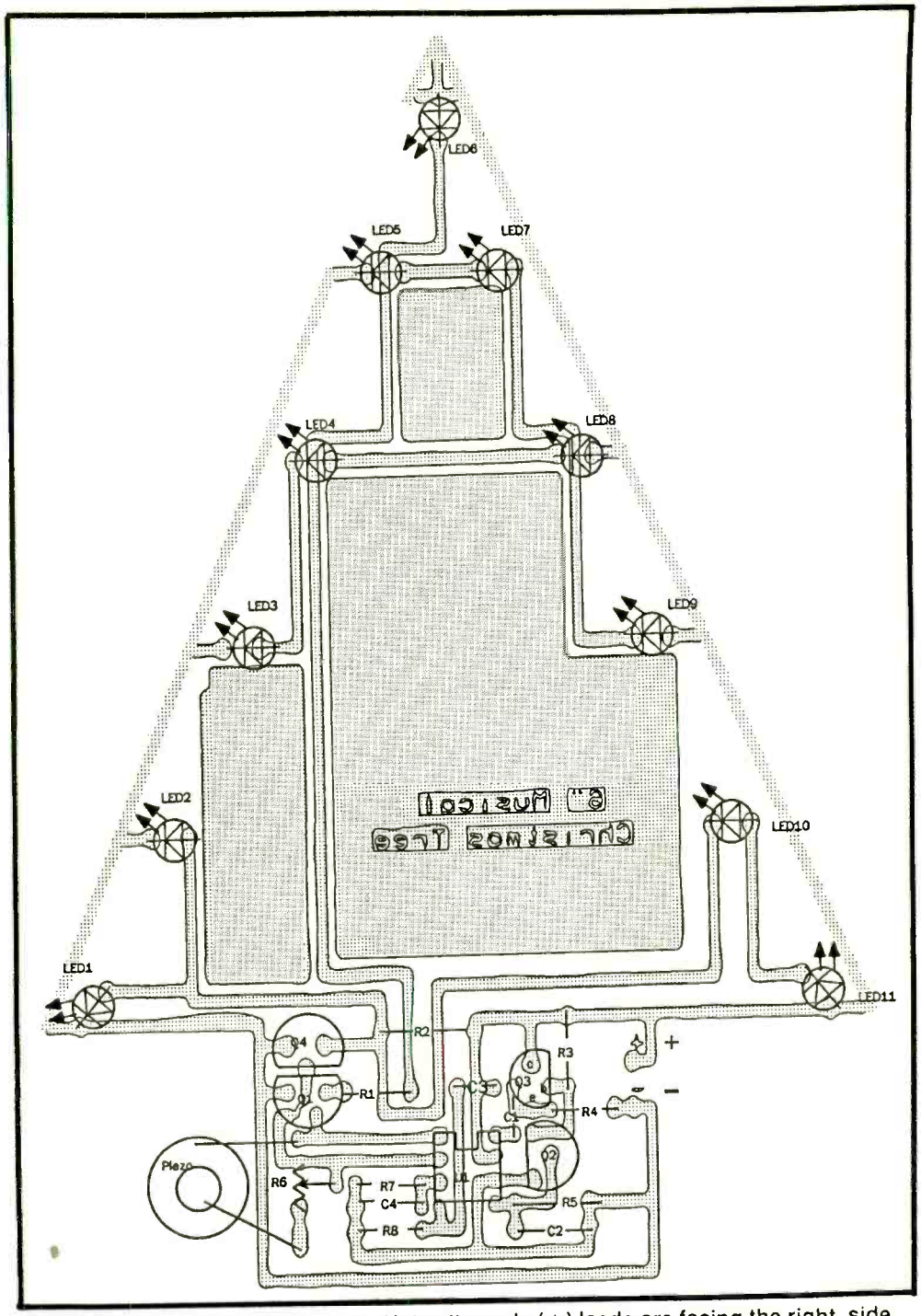


Figure 3. Parts placement diagram. Note all anode (+) leads are facing the right side. This reduces the chance for mistakes. The Piezo speaker is mounted in the rear of the tree on top of the battery pack.

the batteries and speaker, it is recommended they be soldered flat, on the foil side rather than through the holes on the component side of the tree.

With the circuit assembled this far, put in U1 and then apply the necessary 6 volts. Make any changes in the sound of the circuit now. Turn R6 fully clock-wise for maximum volume. If the melody doesn't play immediately, remove a battery, and recheck your work. Don't forget to check the voltage and polarity of the batteries, parts placement, and the direction you plugged in U1. Check for solder bridges, missing traces, or cold solder joints. These are the most common mistakes that cause circuits to fail on the first try.

Once the circuit plays to your satisfaction, remove all batteries and then U1 in that order. Follow the pinout diagram, figure 4, for semiconductors and solder all transistors in place. Be sure not to mix up the MOSFETs with the NPN's. To make concealing the transistors easier, carefully place them as close as possible to the board. Try to solder them in no higher than 1/8" from the board.

Place the carpet on the component (front) side of the

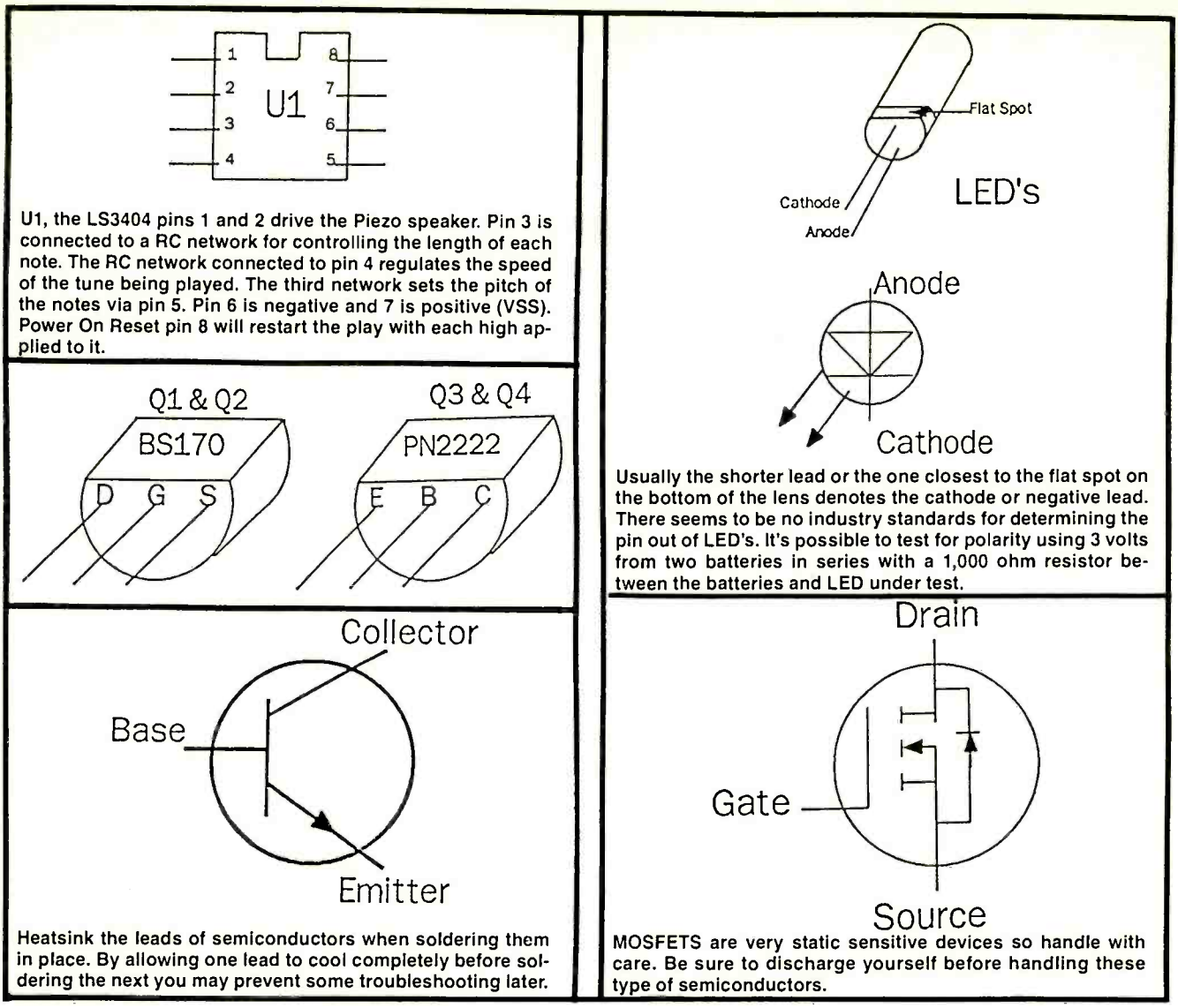


Figure 4.Semiconductor Pinouts.

tree and affix with a quick setting glue like automotive weather-strip adhesive. Fasten it only in the very middle of the board. The LEDs will hold the edges of rug in place. Do not affix the solder-side piece of rug at this time.

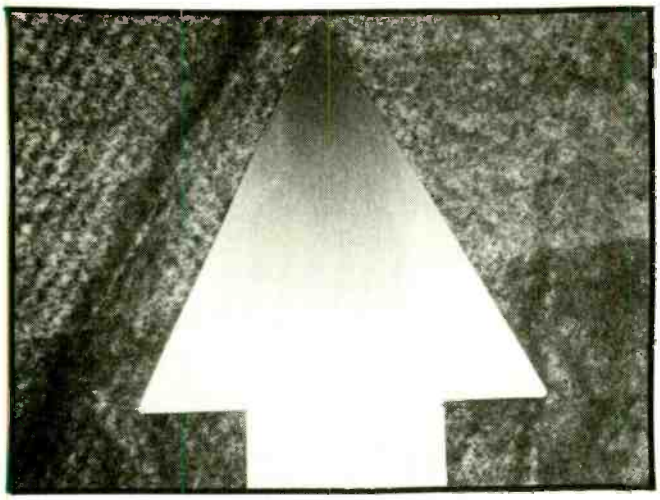
Cut the cathode (−) of each LED one half inch shorter than the anode (+). Refer to figure 4. Depending on the carpet used, you may be able to press the leads of the LEDs right through the rug, but if not, use a drill bit first. By hand, drill each LED hole through the rug. Place the longer anode lead in first. This eases assembly. Except for the LED on the top of the tree, all anode leads are facing the right hand side of the tree, with the cathode leads to the left.

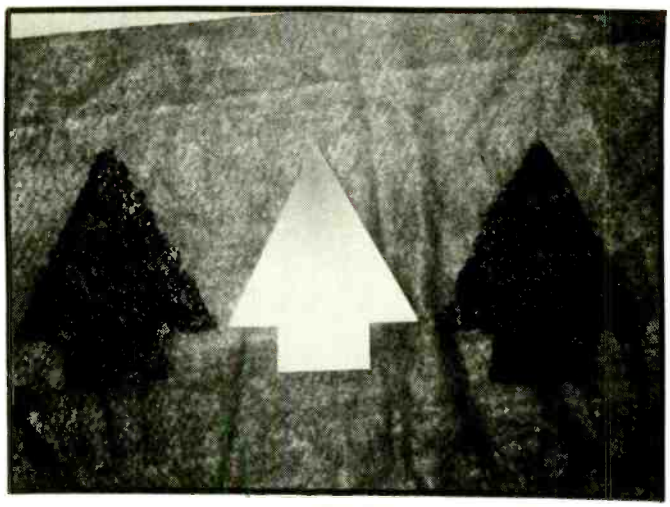
Once again install U1 and power the circuit up. You should have an impressive lit display. If any **three** LEDs did not light, check figures 1 and 3 to see if they are in the same string. One LED soldered in the wrong way will prevent the whole string from lighting. If just **one** LED did not light, check its polarity before condemning it.

Mounting the tree to a plastic battery pack can be the toughest part of the whole project. With a file or sandpaper roughen up the battery pack where the PC board is to fasten to it. Super glue will generally hold temporarily while a better cement is allowed to dry over night. Using excessive amounts of super glue is a common mistake and tends to make things not stick at all. You may have success using hot glue guns, but the strongest bonds are made with epoxies that require overnight to harden.

To reinforce the vertical positioning of the tree, cut two right angle triangles from the scrap PC board left over from the original blank board the tree was cut from. See figure 5. Glue these pieces to the lower back of the tree for added support before epoxying. Be sure not to short across printed circuit traces with the copper on these braces.

Finish the tree once all glue/epoxy has dried by covering the back side of the tree with the last piece of carpet or felt. To prevent an unwanted alteration to the melody, do not glue within two inches of the bottom or





The blank copper-clad printed circuit board is used to trace and cut out the decorative felt or rug masks. For the hobbyist that doesn't intend to etch his own PC board, check the parts list for a ready-to-drill printed circuit board.

anywhere around the music circuitry. Now surround the base of the tree with cotton or Poly-fil to camouflage the batteries and give the appearance of snow covering the base of the tree. Poly-fil is the polyester fiber used to stuff animals and pillows. It is available from most department stores and holds in place better than cotton.

Install the batteries and adjust the volume to your liking by lifting the flap covering the trunk, place your finger over the Pot, and just turn it to the desired volume. It will turn without the need of a screwdriver.

Options

R6 may be replaced with a fixed resistor or solid wire for maximum volume. The extra pad for fixed volume is in the PC pattern.

Other modifications like enlarging R7 expands the duration of each note and decreases the cadence of lighting of LED #6 at the top of the tree. By increasing the value of R5, the pitch of the medley lowers. As stated above, you will likely need no changes in these resistor values, but this knowledge allows for fine tuning the melodies to your taste.

Depending on the type of battery holders you have available, it may make supporting the tree easier. If using two each 2-AA cell battery holders, you could sandwich the PCB between them. When cutting the tree out from the blank board, extend the length of the base of the tree by one half to an inch. Be sure to wire these batteries in series to get the needed 6 volts.

The 3404 music chips can operate on from 4.5 to 15 volts, but you must remember to limit currents through the LEDs. There is a total of 31 medleys available, ranging from Happy Birthday, to the musical score from the Rocky films "Gonna Fly Now". With the addition of

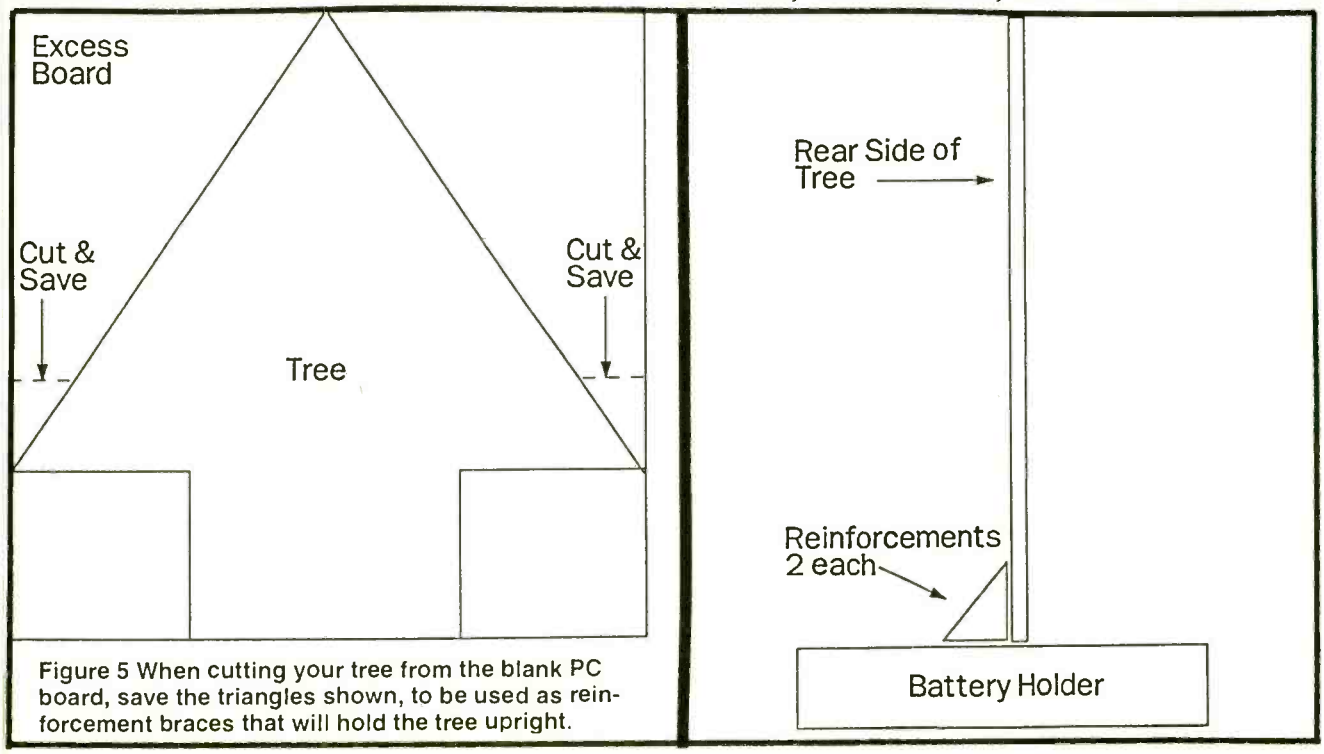
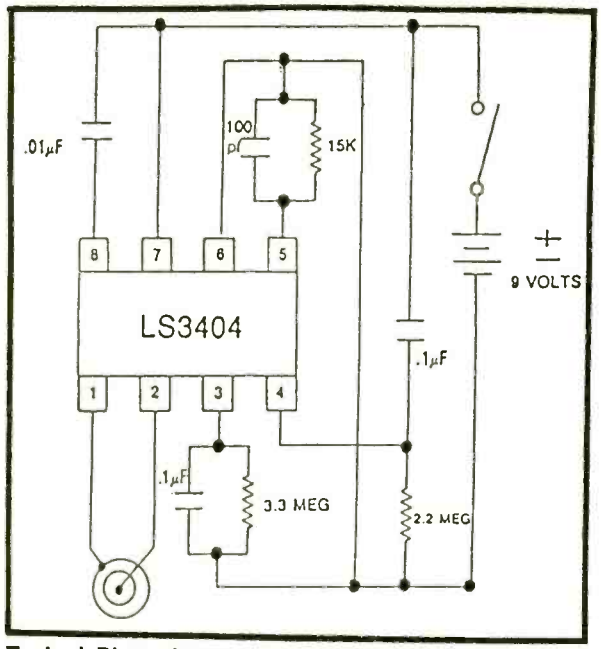
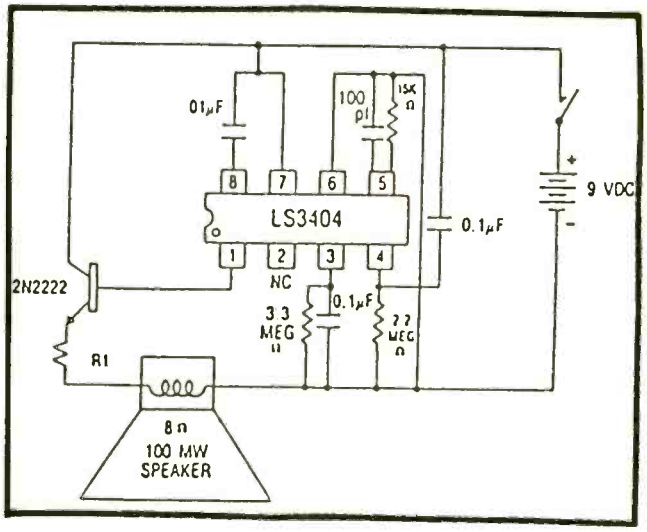


Figure 5 When cutting your tree from the blank PC board, save the triangles shown, to be used as reinforcement braces that will hold the tree upright.



Typical Piezoelectric capacitance type speaker connection diagram.

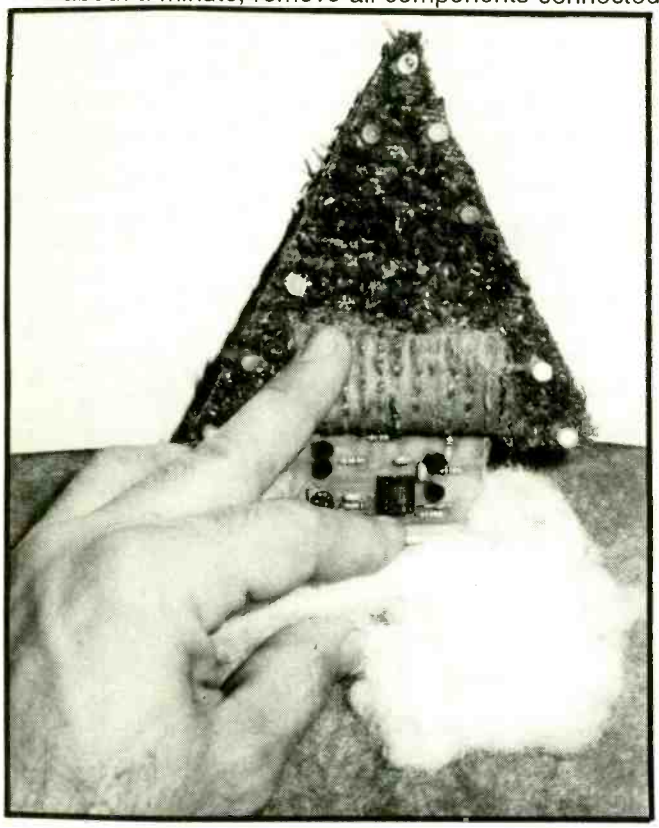


Typical 8-Ohm speaker connection. In this configuration only SP-1 is used to drive the external 8-Ohm speaker in a single ended mode. Resistor (R1) is used as volume control and can be omitted for maximum volume.

another 2N2222 and a resistor, the chip will drive an 8 ohm speaker for extra loudness. Get a copy of the free data sheet for further info (see below). If you want simpler changes in the tune's tempo, R8 could be put in series with a 1-2 meg. potentiometer.

To put the chip in the one shot mode and make it play for about a minute, remove all components connected to pin 8 of U1 and put a .01uF cap to Vss. You could get a one medley play only after say a switch was closed grounding pin 8. Uses then could range from an inexpensive musical doorbell to toys for the tots.

By picking up tiny artificial flowers, or making your own ornaments, the tree could look very authentic. Only your imagination can limit the choices here.



A peek under the indoor/outdoor carpet covering and simulated snow exposes the music IC and the adjustment Potentiometers. By not fastening the covering, melody changes are as simple as plugging in another 8-pin IC chip.

Here is a finished 6" Musical Christmas Tree with an ornamental backdrop. The top light is a super-bright LED that flashes with the beat. Several LED's sparkle randomly while others flash with or opposing the rhythm.

Remember, generosity this holiday season won't be measured in dollars and cents, but by the thoughtfulness and time you put in your presents. The continuous playing of holiday music and lights from the 6" Musical Christmas Tree brings cheer and goodwill to all who come in contact with them. Happy Holidays from the author and all of us here at Electronics Handbook Magazine!!! ■

PARTS LIST FOR THE 6" MUSICAL CHRISTMAS TREE.

The author provided Radio Shack numbers for the parts he felt would greatly ease assembly.

SEMICONDUCTORS
U1 — LS3404-?? See Below
Q1, Q2 — BS170 MOSFET
Q3, Q4 — 2N2222 GP NPN Transistor
All LEDs T-1¾ size
LED1 — Red, .020mA
LED2, LED5, LED8, LED11 — Green, .020mA
LED3, LED7, LED10 — Yellow, .020mA
LED4, LED9 — 3 V Red flashing. Radio Shack #276-036
LED6 — Red, 500 to 2000 mcd, clear lens, .020mA Radio Shack 276-087 or similar

CAPACITORS
C1, C3, C4 — .1uF Ceramic Monolithic 10 volts or more
C2 — 100pF Ceramic Disc

RESISTORS
(all ¼ watt 5% units)
R1 — 180 ohm
R2 — 1,000 ohm
R3 — 10,000 ohm
R4 — 10,000,000 ohm
R5 — 22,000 ohm
R6 — 100,000 ohm PC-mount pot. Radio Shack #271-284
R7, R8 — 2,000,000 ohm

MISCELLANEOUS
Battery Holder for 4 AA's Radio Shack #270-391
Piezo Speaker Radio Shack #273-091
Solder, PC board, carpet or felt, glue, epoxy, etc.

U1 and the BS170 MOSFETs are available from: Thumb Electronics, P.O. Box 344, Marysville, MI 48040. Costs for the melody chips is $2 each plus $1.50 shipping and handling per order. A 5 tune assortment is $11 Post Paid. BS170's are $2 each. Ready-to-drill printed circuit boards are $9 each. Iron-on resist patterns are $2 each with any chip order. Canadian orders add $1 and all other orders outside the U.S. please add $2.50 to the listed shipping.

Holiday Melodies
LS3404-02 "Christmas Medley" (6 short tunes in one)
LS3404-14 "Santa Claus Is Coming To Town"
LS3404-15 "Christmas Angel Medley"
LS3404-16 "We Wish You A Merry Christmas"
LS3404-17 "Walking In A Winter Wonderland"
LS3404-18 "Jingle Bells"
LS3404-19 "Joy To The World"

For a list of all melodies in stock, a free data sheet, or catalog of numerous simple musical construction plans, send a Self Addressed Stamped Envelope to Thumb Electronics mentioned in the parts list (free when requested with any order). Please be specific on your requests. If you are having technical difficulties, send a detailed description of your problem with voltage readings around U1 to the author, in care of Thumb Electronics. They will forward all correspondence to me. Be sure to include a Self Addressed Stamped Envelope if a reply is required.

TECHNICAL TRAINING IN ELECTRONICS

By Ron C. Johnson

Experts on career choice and development say the average person can expect to change career directions several times over the course of his or her lifetime. Some of us may not relish that thought, while others are thrilled by the possibilities. The fact remains that most of us have to accept that a need for training, retraining or, at least, upgrading our skills will eventually lead us into some form of educational experience.

If you have considered electronics or some related area of technology as a possible career choice, you may have also wondered what your options and their associated pro's and con's are. The following is a survey of some of those options and an attempt to illuminate some of the considerations necessary to making good decisions about them.

When I got into this area of electronics, (I'd rather not say how many years ago), the choices were pretty slim. Basically, I had to choose between training as an electrician or an electronics technologist, and that because there weren't many other options, at least that I knew of and where I came from. I chose the electronics course offered at the technical school in my home town and proceeded to find out what it was all about, both during my training and afterward. The course I took was general in nature, providing a background in most of the areas then associated with electronics.

In recent years, because technology continues to expand at a high rate, specialization has become necessary and desirable. Today there are multiple streams you can pursue, each with its own unique features. Trying to choose one from the list can be difficult. Many of the streams available may look similar if you are not familiar with the field and the job market. How do you decide which one, if any, is for you?

Let's consider some training options, first, from the perspective of the types of institutions providing technical education.

At one time a university degree in engineering was considered to be, not only the ideal venue for the technically minded individual, but almost the only venue. However, the need for intermediate levels of theoretical knowledge combined with high levels of practical skills has changed the scenario in the last twenty years or so. Regardless, the option of a university education should be seriously considered.

A degree in electrical engineering with a major in electronics, computers or some other related specialty is a great career option for the person who has the resources to invest. Obviously, the cost of a university education is more than that of other courses if only because of the four years required to complete it. On the other hand, salaries afterward are generally higher and growth potential is usually greater. The level of difficulty in getting a degree is also a factor as well as university entrance requirements. (We'll look at these and other considerations in more detail later on.) Without casting aspersions on this option, it should be noted that generally engineering is more oriented toward design than most of the other options we'll consider here and as such is most often a category of its own.

On the opposite end of the scale of time requirements you could consider a one year technician level course such as Radio-TV technician or Electronic Service technician. These are offered by local technical schools, junior colleges, home study courses, etcetera, and provide the student with a practical, hands-on approach to a particular area of technology. Usually entrance requirements are lower than higher level courses and they concentrate on learning maintenance and troubleshooting skills over design theory. For a student wanting to join (or rejoin) the work force as soon as possible they offer a quick way to move into a new job stream. As might be expected pay expectations of graduates are usually lower than for longer courses, al-

though there are exceptions, depending on the area of technology, demand for personnel, former experience and grades attained.

An intermediate approach, and one of the most popular, is to take a two or three year course in an engineering technology program from a technical school or junior college. Technology courses could be considered to fit in between the level of technicians and the engineers, not only because of the length of the course, but because they attempt to combine the practical skills of the technician with an ability to work as part of an engineering team. Technologists are often cast in the role of implementing the theoretical design within the practicalities of a real life situation. Their knowledge of the design requirements of a situation helps them to improvise when necessary and to provide valuable input to the engineering team which enables modifications to the design. Often technologists find themselves in maintenance roles that require more theoretical background than technicians and more practical skills than engineers. Many technologists fill the role of technical sales representatives (a growing area) in which they provide the applications, knowledge and support necessary to successfully sell technical products to end users.

A fourth way of obtaining technical training to change careers is the apprenticeship route. At one time the type of training offered to the trades had little in common with the technological training offered today. With electronics and other areas of technology profoundly affecting the kind of work tradesmen are performing, apprenticeship training is growing in quantity and depth of the material. Electricians now must be capable of dealing with programmable controllers, motor speed controls, computers and other electronically based equipment. Instrumentation maintenance mechanics must be at least as knowledgeable about electronic measurements and computer applications as about pneumatics. In industry many tradesmen are now cross-training to obtain journeyman tickets in at least two trades. (I met one man, a student, who was working on his seventh ticket...)

The advantage of apprenticeship training is fairly obvious: you work in the field, gaining experience (not to mention a paycheck) and then attend classes for a few weeks every year to get the theoretical knowledge. Usually after four years passing the journeyman examination gives the apprentice his journeyman's ticket, a qualification which usually is accompanied by a significant raise in pay. The efficiency of the system is inescapable as the student can apply his knowledge even as he is obtaining it and make a living at the same time. In addition, this kind of training is relatively inexpensive to the student as many employers cover the costs of text books and other materials.

The choice of the kind of training program, of course, depends largely on what is available for the area of technology you are interested in. Well, what are the options? The list following, while not complete, may give an idea of some options available.

RADIO-TV TECHNICIAN

Usually a one year course concentrating on electronic theory basics, soldering and troubleshooting skills and more advanced training on radio and television servicing techniques.

ELECTRONIC SERVICE TECHNICIAN

Similar to the above but may incorporate additional training to facilitate other kinds of service (office machines, computers, etc.)

ELECTRONICS TECHNOLOGY

A general electronics course ranging from theory basics in electricity, electronics, digital, programming, shop practices, computers, controls, communications, etc.

BIOMEDICAL ELECTRONICS

Often a variation of or continuation of a general electronics technology course. Equips the student to work within the area of biomedical electronics in hospitals, equipment manufacturers, suppliers and maintenance.

COMPUTER TECHNOLOGY

Often a variation of or continuation of a general electronics technology course. Equips the student to work within the area of computer systems in service or design, customer service, maintenance, etc.

TELECOMMUNICATIONS TECHNOLOGY

Sometimes a variation of electronics technology specializing in the area of telecommunications electronics and systems. Prepares student to work with telecommunications utilities, private communications companies, etc.

BROADCAST TECHNOLOGY

Sometimes a variation, sometimes a continuation of electronics technology directed towards television and radio broadcast companies and associated areas.

AVIONICS TECHNOLOGY

Often a variation of or continuation of a general electronics technology course. Equips the student to work within the area of aviation electronics in maintenance, calibration, repair, etc.

INSTRUMENTATION TECHNOLOGY

A two year technology program incorporating electricity, electronics, digital, computer applications and programming, with pneumatics, process equipment, analyzers, control theory, etc. Aimed at the industrial instrumentation field, provides skilled personnel for maintenance and/or engineering related positions.

ELECTRICAL TECHNOLOGY

A two year technology program incorporating electricity, electronics, digital, computer applications, programmable controllers, etc. with electrical power systems, electrical code, etc.

It's important to note, at this point, that many of these courses are available in correspondence form from schools such as NRI (McGraw-Hill), CIE (Cleveland Institute of Education) and others. Some specialize in the area of electronics while others offer a wide variety of

options. The advantages of studying at home, (while holding down a full or part time job), are obvious. Some of these courses have added benefits in that you buy or build test equipment, tools, computers, etc. as part of the course.

While correspondence isn't the easiest way to get a technical education, the quality of many of these courses is well recognized. Most of them provide innovative ways of helping students succeed, such as telephone and computer information service access to instructors.

As previously mentioned this list is not complete and variations exist from one educational institution to the next. For example, some institutions provide industrial electronics technology courses which, while very similar to the general course offered elsewhere, has more emphasis on industrial applications and systems. When choosing a course and an institution these kinds of variations should be considered in light of your needs and interests.

Speaking of needs and interests, what other considerations are important in the choice of a training venue? You have carefully researched what is out there. Now you must count the cost, both monetary and personally, of choosing a particular training option.

AREA OF INTEREST

We have already mentioned this in passing, but it is worth exploring further. As an instructor, I often encounter individuals in my classes who are there for no other reason than the expectation of a good salary when they graduate and start work. That alone would not be a problem except that their innate interest in the area of technology they are studying is often minimal. Some of these students adapt to the area of study and grow to enjoy it but others find it difficult to develop an interest in the material. This usually results in lacklustre performance in class which often carries over into the job they eventually take on.

We may not like every aspect of the careers we choose but common sense would suggest that, when choosing a training option, we should place a high priority on finding something we will probably enjoy doing. How do I know if I will like it before I try it, you say? A good question, especially from a young person just starting out. My answer would be to do some research. Check around with employers in the field you are considering. Most employers would be more than willing to spend some time showing you around their facility and explaining the duties of their employees. Possibly you can get part-time or summer employment with such a firm. This can pay large dividends in terms of employment possibilities on graduation not to mention the chance of a letter of recommendation and good work experience on your resume.

JOB OPPORTUNITIES

Although I said the financial aspect of a career choice should not supersede your area of interest, that should not discount the importance of considering it in its proper perspective. Obviously, if we are training for a first time career or a career change we need to determine if it will be worth the investment of time and money to go that route. During your research of this you might be surprised to find that often there is little correlation between difficulty of a course and the final payoff. For instance, currently, many jobs available to graduates of general electronics programs pay less than jobs in the industrial instrumentation field. This is a function of the health of industry, the money available for maintenance and, often, the supply of skilled and qualified job applicants. In addition, tradesmen often are more highly paid than technologists and even, in some cases, engineers.

All in all, careful study of the job opportunities and pay scales should be done.

Of course there are offsetting factors related to pay ranges. You must consider what kind of a work environment you want to be in. Would you rather work in a clean, quiet laboratory environment with a coffee room down the hall and a five minute drive home? Or are you willing to trudge through piles of spilled industrial product, amidst the noise of a plant, wearing a hard hat and work boots, possibly located in an out of the way community? How far are you willing to move for a job? Do you mind commuting? What about fringe benefits such as pension plans, etcetera? Do you want the security of a large corporation or government job, or are you interested in working for a small company with a good chance for promotion? Do you have aspirations to start your own business? All of these factors can affect your choice of training opportunities.

ACADEMIC AND PRACTICAL REQUIREMENTS

Alas, sometimes we must ask ourselves painful questions: what do we qualify for and can we accomplish the task with the intellectual resources we have? As mentioned previously, a university education, while often desirable, may be beyond our ability to attain. If your high school grades and credits are not sufficient to get entry to a university you may have to take remedial classes before qualifying. Even then you must be sure you can handle the academic level and the workload assigned. Generally speaking, to qualify for entrance into university engineering programs a full set of academic credits including maths and sciences, is necessary.

This is true of more than just a university. Technical schools also require maths and sciences, and even if the student is allowed to enter a program, if he is missing some of the physics, math or chemistry theory, he may find it difficult to keep up at the pace the material is presented.

Over the years technical schools have found it increasingly difficult to pack into two years all of the material deemed necessary to turn out graduates able to satisfy the potential employers need. The workload required in technical school is far beyond that experienced in high school and can be a shock to a student mentally unprepared for the demands it puts on him or her.

Again research of the course you are considering and an honest appraisal of your capabilities is necessary here. Sometimes the difficulty may not be in your abilities but in the amount of time and energy you can bring to bear on the task. For many mature and married

students with families, re-entering the educational environment is a major change in lifestyle. In addition to financial pressures which often accompany such a situation, the time and energy spent evenings and weekends can put a strain on personal commitments and responsibilities.

Finances are a major part of your consideration of education. Tuition fees, text books and school supplies are only a few of the expenses incurred. Accommodation and living expenses, lost income, travel and telephone expenses must be taken into account. For some, a part time job, in addition to attending classes, may be necessary but can also add to those pressures already discussed.

While all of this may paint a somewhat negative picture of attending a technical school or university it is actually just a forewarning of some of the questions which must be dealt with. Of course no improvement in one's situation comes without a cost attached to it and the benefits are usually worth the effort involved.

Well, what are some of the benefits you can expect from taking a couple of years out to train for a new career?

Financial rewards, for one. As mentioned previously, salaries for technical school graduates can be excellent in some fields. Journeymen from various disciplines such as electrical and instrumentation are getting between eighteen and twenty-eight dollars an hour (and more in some circumstances). Technologists earn between twenty-five and forty-five thousand a year depending on their situation. Graduates of radio-television repair courses often open their own shops and become very successful in business.

Couple the financial rewards with the fact that most of these courses are only two years long and the time investment becomes more than acceptable. Most of these courses allow the individual to move into a rapidly changing and interesting field where there is a great deal of room for growth and for which additional training is usually available.

The learning environment itself in technical training is positive and practical. When practical hands-on skills, useable on the job, are taught by instructors with direct industry experience, students find no difficulty in motivating themselves to work diligently toward their goals.

Whether you are a recent high school graduate or an individual now in the workforce, but looking for a new career, the trades and technologies are an excellent choice. Finding the right educational experience for you depends on your interests, needs and resources but the range of choices available ensure a reasonable assurance that you can find a successful and rewarding new career. ■

THE FUN WAY TO LEARN ELECTRONICS

Lab Test ELECTRONICS HANDBOOK For Yourself

Get switched on

In case you're not all that familiar with us, we're not a publication for electrical engineers and other wizards. No way, ELECTRONICS HANDBOOK is expressly for people who like to build their own projects and gadgets—and maybe get a little knee-deep in tape, solder and wire clippings in the process.

In fact, we have a sneaking suspicion that our readers like us because they think we're just as bug-eyed and downright crazy over great new project ideas as they are. And I guess they're right!

ELECTRONICS HANDBOOK thinks of you who dig electronics as the last of a special breed. It's more than just the "do-it-yourself" angle—it's also the spirit of adventure. In this pre-packaged, deodorized world, building your own stereo system, shortwave receiver, darkroom timer or CB outfit is like constructing a fine-tuned little universe all your own. And when it all works perfectly—it really takes you to another world.

ELECTRONICS HANDBOOK knows the kinds of projects you like—and we bring 'em to you by the truckload!

Of course, we can't make you a master electrician overnight. But we can show you the fundamentals of repair plus maintenance tips.

IF YOU'RE NEW TO ELECTRONICS YOU GET A "BASIC COURSE"!

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V14

CIRCUIT FRAGMENTS

One of the best ways to begin your mastery of electronic circuitry construction is to work with discrete components before diving headlong into integrated circuit construction. After all, integrated circuits are nothing more than these individual components and circuits in a more compact package. The only problem is that they don't come in see-through packages to help you identify the individual working areas.

We don't feel that it's of much value to simply "plug in" black boxes without the understanding of what actually goes on inside them. If you can learn what the circuitry of an integrated circuit is supposed to do, then it frees you to come up with your own innovations, and to accurately troubleshoot your creations when you run into the inevitable bugs or "glitches."

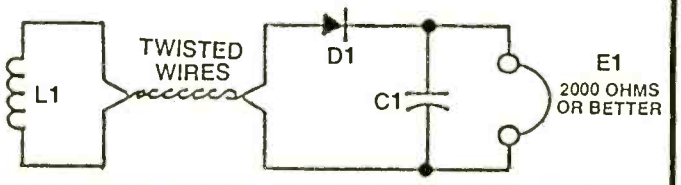
This brings up another point. While some ICs are relatively sensitive to miswiring and are easily destroyed, these discrete components, as a rule, are not. It's a lot better to make your mistakes here than on an integrated circuit project, where ruining an IC due to a reversed diode polarity might set you back two or three dollars. So have fun, but learn!

SIMPLE MODULATION MONITOR

How simple is simple? Take a peek at the schematic diagram of this Simple Modulation Monitor. This simple monitor for AM ham transmitters requires no connection to the transmitter. Just position the loop near the final tank or antenna matching coil until the signal is heard in the headphones. In fact, if you live or work near a broadcast transmitting station, you could use this monitor as an inexpensive "Walkman." To be a bit more selective, you could replace L1 with an antenna coil from a transistor radio and tuning capacitor. One advantage of the circuit is that the batteries never run down. ■

PARTS LIST FOR SIMPLE MODULATION MONITOR

C1 — 100-pF disc capacitor
D1 — 1N914 diode
E1 — Magnetic headphone, 2000 ohms or better
L1 — Coil, 3 turns on 1½-in. diameter form, use any thin gauge wire — add a few turns if necessary



"CHRISTMAS TREE" ANNUNCIATOR

Remember in those submarine movies when they looked at the "christmas tree" to see if all the hatches were closed? If all the lights were green, that meant they could dive as everything that needed to be closed was properly closed.

You can use this circuit as a "christmas tree," as each circuit has a red and a green LED. A closed circuit sensor is used. When the door, window, or whatever is shut, the sensor is closed, feeding current into Q1 and lighting the green LED. When the sensor detects an open condition, Q1 loses base current, turning off. The green LED goes off and base current is applied to Q2. Q2 turns on, lighting the red LED. Each protected entry or opening needs a circuit as shown in the schematic.

All openings are independently monitored, and share only the power supply.

This circuit will work properly from 5 to 12 volts DC, but it requires about 8 volts or more to get the LEDS brightest output. Each circuit should be allowed 20 mA of current. Thus, to monitor 10 openings with each having its own circuit, use 200 mA. Most power supplies will run at least 10 of these circuits, or more.

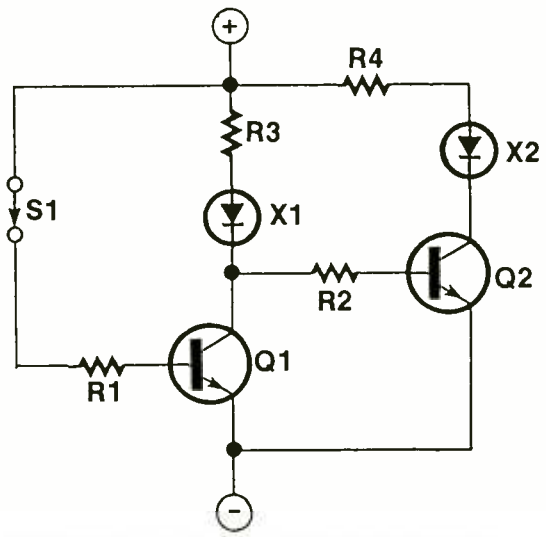
Since voltage regulation is not a problem, all that is needed is a transformer, rectifier, and about 2000 Mfd of filter capacitor per ampere of output current. A fuse in the transformer primary is a good idea. For most units, ¼ Amp is good.

Above 25 VA, use ½ Amp.

VA, or volt-amperes is calculated by multiplying transformer output voltage by output current. Thus, a 12 volt unit with 500 mA current gives 6 VA.

PARTS LIST FOR THE CHRISTMAS TREE ANNUNCIATOR

R1, 2—47K ohms, ¼ watt resistors
R3, 4—390 ohm, ½ watt resistors
Q1, 2—2N2222 Transistors
X1—Green LED
X2—Red LED
S1—Normally closed switch, contacts, magnetic device, etc.



CHRISTMAS TREE ANNUNCIATOR

DUAL VOLTAGE MINI-TESTER

When you see this little circuit, the first question you might ask would probably be what does this do for me at home? Or, why do I need to be able to tell 220 volts from 110 volts at home?

Modern house wiring comes in 208 volts and is 110 volts from hot to neutral. This little tester will test the 208 volts to an electric stove dryer, home heat, welder, or air conditioning. And it will spot loss of one leg of power.

Construction of this tester is important as the voltage will be high.

The best way to protect it is to cover all the connections with heat-shrink tubing and then heat-shrink over the LED and resistors, leaving only the tip of the LED and the test leads protruding. Another way is to buy a clear plastic tube for coins at a dime store and put the whole thing in epoxy inside the tube.

You must seal the circuit so even cracks or minor damage will not expose wiring or connections.

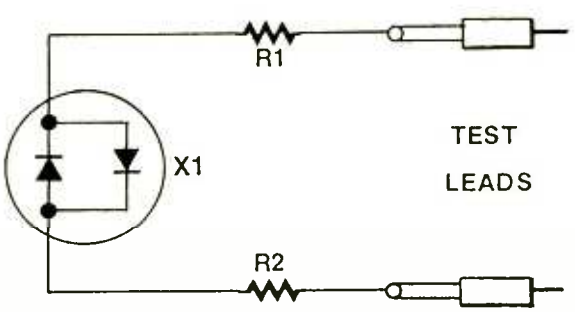
Operation

When connected to AC, the resistors will only pass a small current at 110 volts, so the LED will glow dimly. At 220 volts, the resistors pass much more current, allowing the LED to glow much brighter.

Should you test DC with this, only one part of the LED will glow. ■

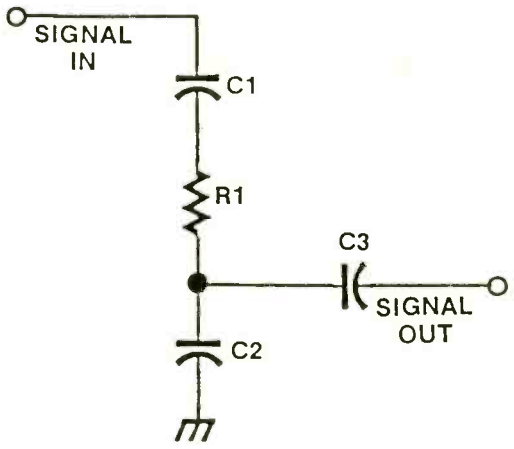
PARTS LIST FOR THE DUAL VOLTAGE MINI-TESTER

R1, 2—10K Ohm, 2 watt, wirewound resistors
X1—Bicolor LED
Misc.—Set of test leads, case



AUDIO "HISS" REMOVAL CIRCUIT

The annoying high frequency hiss emanating from signal amplifier circuits, running at very high gain, can be reduced by eliminating some of the high frequency components. Try using this circuit before the final power Amp driver stage, to help improve the overall sound. Ideally, the noise source should be removed, but if this is not possible a compromise is to reduce it. The signal input is capacitively coupled through C1. A potential divider chain is formed by C1, R1. C2. Output signal is taken from the junction of R1 and C2 and capacitively fed via C3 to the next driver/power Amp stage. Component values are critical; do not change. ■



PARTS LIST FOR THE AUDIO "HISS" REMOVAL CIRCUIT

C1—0.001uF capacitor
C2—0.01uF capacitor
C3—0.1uF capacitor
R1—100K resistor

NIGHT EYES

Not all flashlights are created equal. Some use bulbs filled with Krypton or Xenon gas for brighter light. Sizes of all kinds ranging from tiny to huge. This is a different kind of flashlight: no lamp, just 2 LEDs. It uses LEDs that put out 2 candlepower of light each. You may feel that is not much light, and it isn't. In dark areas it seems bright, and, in darkrooms, it is a handy red light.

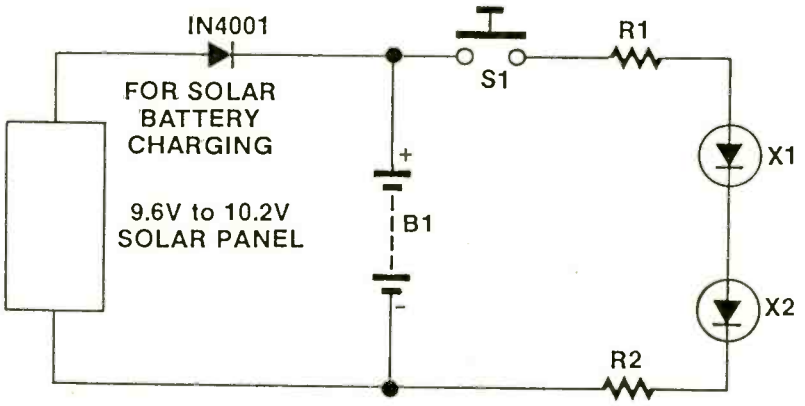
Actually you have a choice as to how bright you can make this light. Radio Shack is selling an LED that would directly replace the present one and yield 5 candlepower per LED.

The drawback of using it is cost: $5.00 each. An alternate hookup is shown in the schematic for powering the flashlight with a solar recharged battery. The light can charge by day and be on at night.

Assuming that you can find a 9 volt solar cell package small enough, you could mount it right on the case. This way, the flashlight's portability is not compromised. ■

PARTS LIST FOR NIGHT EYES

R1, 2—100 Ohm, 1 watt resistors
X1, 2—High brightness LEDs
S1—Normally open pushbutton
B1—9 volt battery. Alkaline batteries recommended



LO-REZ ADAPTOR

Having trouble measuring low value resistances? This little adaptor will assist you in getting more accurate readings from .1 ohm to 2 ohms.

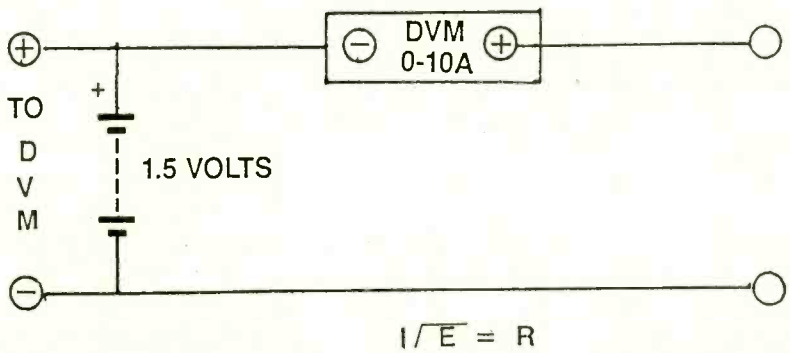
This circuit will read resistance wire and other relatively high current but low resistance devices. All you need is a powerful source of 1.5 Volts. Several size D alkaline batteries might work. A Digital Voltmeter is connected in series with the battery, and is set to 10 Amps DC range. The resistance to be read is placed in series with the battery and meter. For really accurate measurements, use a meter to measure the exact battery voltage with everything connected.

Now, divide the voltage by the current read on the DVM, and you get the resistance.

To illustrate how accurate this can be, let us demonstrate: The current reads 6.23 Amps, and the voltage across the battery under load is 1.26 volts. This yields a resistance of 0.202247 ohms.

Most meters give fairly accurate readings of resistances, but this method puts some power to the resistance being read. And, by using DVMs to take both readings, good accuracy can be obtained. ■

SCHEMATIC OF HOOK-UP: LO-REZ ADAPTER



MILADAPTER FOR DVM

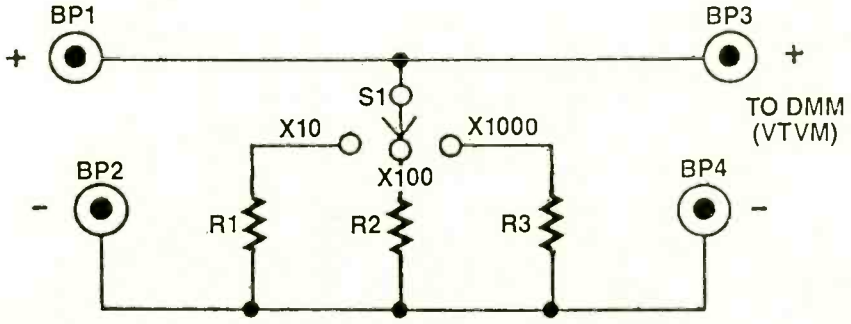
Poke around your junkbox and you may discover most of the parts you need to convert your digital voltmeter (DVM) to an accurate DC milliammeter.

To use the Miladaptor you simply multiply the DVM reading by X10, X100 or X1000 to obtain the DC current. For example, if the DVM indicates 0.1 volt and S1 is set to X100, the current is 0.1 X100 or 10 milliamperes. If the DVM indicates 0.25 volts and S1 is set to X1000, the current is 0.25 X1000 or 250 milliamperes.

The circuit under test connects to binding posts BP1 and BP2; the DVM connects to binding posts BP3 and BP4. Switch S1 must be the make-before-break type. Start with S1 in the X1000 position and downrange until the DVM indicates a convenient reading. The procedure is a must when using a VTVM or multimeter with a meter indicator. ■

PARTS LIST FOR MILADAPTER FOR DVM

BP1, BP3 — Insulated binding post, red
BP2, BP4 — Insulated binding post, black
R1 — 100 ohm, 1-watt, 5% resistor
R2 — 10-ohm, 1-watt, 5% resistor
R3 — 1-ohm, 1-watt, 5% resistor
S1 — 3-pole, single-throw rotary switch, shorting type



SIGNAL ANNUNCIATOR

An action takes place! A switch is tripped, and the buzzer, light, siren, bell—any type of alarm or signal—goes off! You know it is happening and this is important. The signal annunciator circuit does this job very well. In fact, it provides an LED light as a silent signal if you wish. The real versatility of the circuit is the possibility of controlling up to eight (8) separate points where the action can take place and have the alarm signal sound when the relay is activated. This is where the annunciator function of the circuit comes into action. Now, one of eight or less signals can alert an attendant by the action of a relay closing, and providing an LED indication of where the switch is activated. In a burglar alarm system this is desirable. Restaurants can use the annunciator device to call waiters to the kitchen for food that has been prepared. The ideas are limited only by your imagination.

Should you use only the switch circuit, all the parts you require are S1, R1, Q1, D9 and K1. Should you require two or more circuits, diode D1 becomes important, for if it were not used, the closing of S2 would light LED2 and LED1. Diode D1 acts as a reverse current block in this situation. Ditto for D2 when switch S1 is closed. Expanding the circuit for additional signal switches requires use of additional diodes.

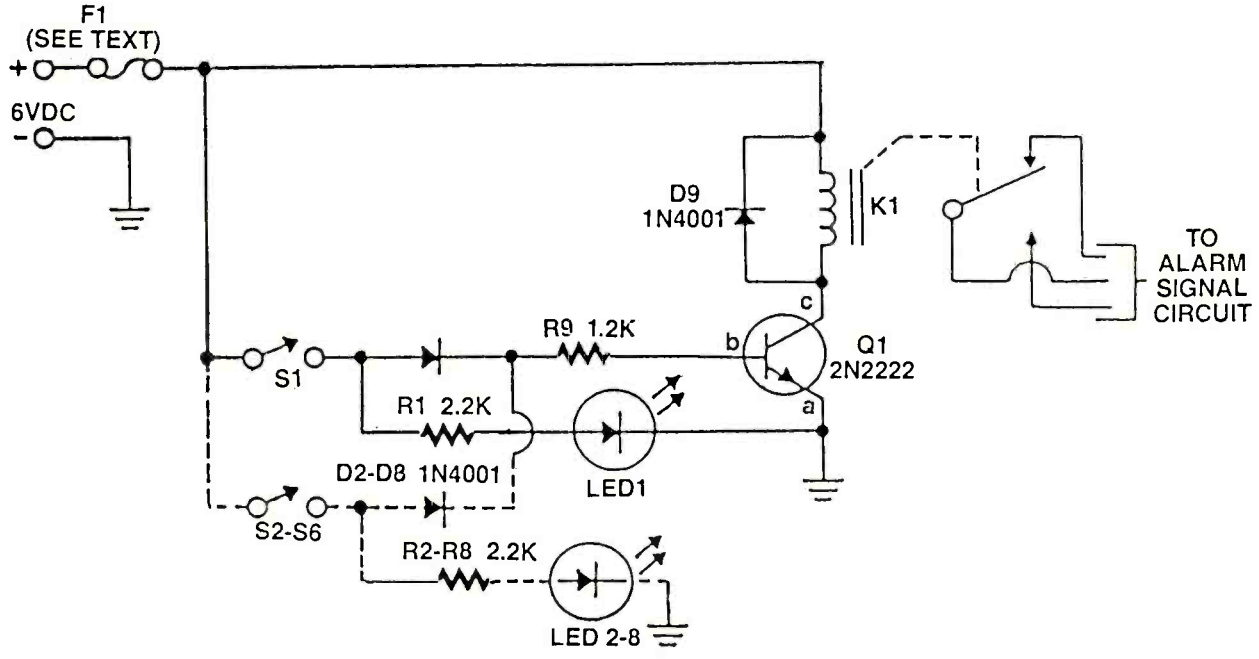
The relay circuit is activated by the +6 VDC. The relay contacts of K1 are completely isolated so that they may be used for any purpose. For example, 5-VDC relays seldom handle large currents, so relay K1 can be used to activate another relay that has a 117-VAC coil and whose contacts can handle 30 amperes. Now we have the possibility of a single transistor circuit being used to control the compressor of a 25,000 BTU air conditioner.

Except for the relay contact circuits, the wires and cables used to interconnect the signal-annunciator circuit need be of the caliber used in bell and telephone circuits. A 1/4 to 1/2-ampere fuse is all that is required to protect the circuit. Actual value varies with the relay, NPN transistor and number of circuit signal legs used.

What if you need a ten-signal circuit, or maybe more? Most probably the transistor Q1 could handle it all, but should Q1 or K1 fail, all circuits would be down. It is a good idea to use another transistor and relay circuit after nine or more switch circuits are installed. ■

PARTS LIST FOR SIGNAL ANNUNCIATOR

D1-D9—1N4001 silicon rectifier diode
F1—1/4 to 1/2-A fuse—select lowest permissable value
K1—5-VDC, SPDT relay (Radio Shack 275-215 or equiv.)
LED1-LED8—Light emitting diode, selected color, any lens type
Q1—2N2222 NPN silicon transistor
R1-R8—2,200-ohm, 1/4-watt, 10% resistor
R9—1.200-ohm, 1/4-watt 10% resistor
S1-S8—Any type of SPST switch, usually with spring return for automatic reset—exact type optional with application



SIMPLE XTAL AM RADIO

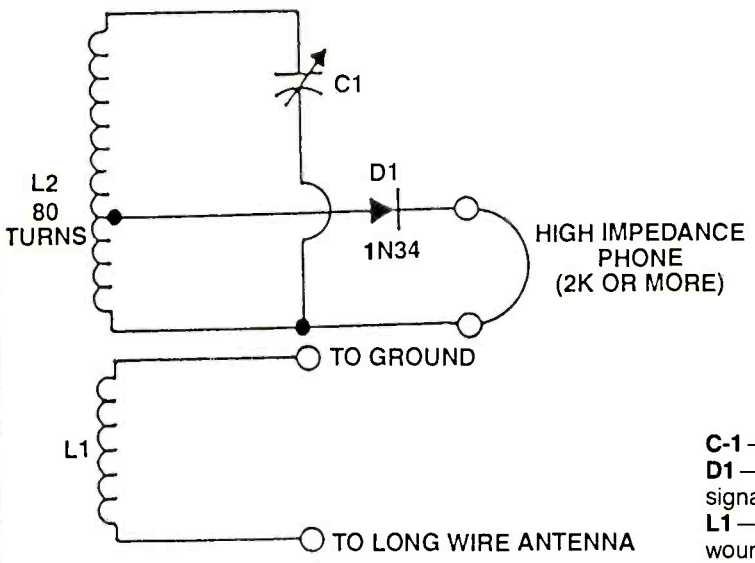
No matter how young or old you are, if you did not ever assemble a self-powered crystal radio, there's something lacking in your electronics hobbyist experience. This simple project can be put together in an hour, and will keep a 5 to 10 year old out of mischief for over a week—maybe launch the child onto a life-long hobby.

To begin, pick up some #22 or #24 enamelled wire from the local parts store. Chances are your junkbox doesn't have any. Then scrounge a 365-pF capacitor from an old tube-type radio and a germanium diode from an old project. Forget about a silicon diode—it's inefficient in this circuit!

Wind the two coils, L1 and L2, on 1 7/8-in. diameter form. A wood dowel is OK, but you may have a pill bottle about that size. You'll need about 2 1/2-in. of length to hold the two coils. Wind the coils carefully, neatly, and with no space between each winding of the same coil. Keep about a one-turn space between the two coils. Wind L1 first, then wind L2 second. After the first 25 turns, tap the diode to L2 and finish the winding. It doesn't matter which terminal of the diode connects to the coil because diode D1 is the only polarized part in the project.

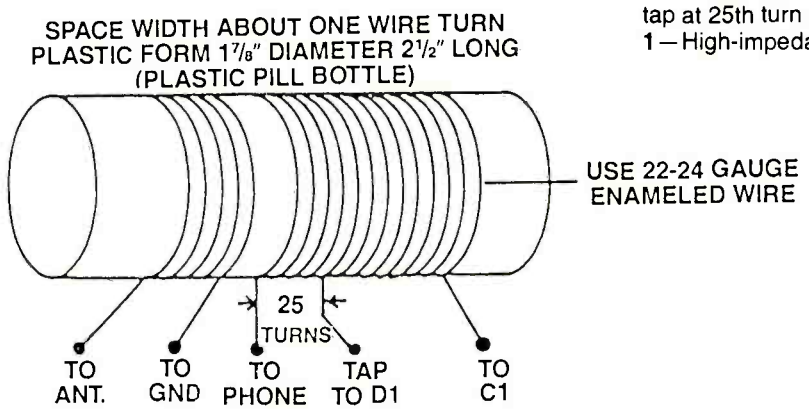
Be sure to use high-impedance headphones. The old 2000-ohm "cans" used by hams are the minimum impedance-type you can use. Crystal headphones are about the best. Do not use transistor radio ear-plug headphones since they are usually under 10 ohms.

Be sure to use a long-wire antenna. Run some wire across your roof or out to a tree. At least 25 to 100 feet are needed, not counting lead-in wire required for the antenna. 50,000-watt stations within 1000 miles may be heard. Local 10,000-watt local stations usually have a 50 to 100-mile effective range. Of course, if electrical noise is high in your area, weak stations will be swamped. ■



PARTS LIST FOR SIMPLE XTAL AM RADIO

C-1—365-pF variable tuning capacitor
D1—1N34 germanium diode, or any other germanium signal diode
L1—25-turns of #22 or #24 enamelled copper wire tight-wound on a 1 7/8-in. form.
L2—80-turns of #22 or #24 enamelled copper wire with tap at 25th turn nearest coil L1 on same form as coil L1
1—High-impedance headphone



SOLDERING IRON HEAT CONTROLLER

By Steve Sokolowski

If you are a newcomer to the fascinating world of electronics, you might not be aware that different soldering jobs require different wattage soldering irons. For example, to solder a wire to a ground terminal requires at least 50 to 100 watts, if you don't want intermittent circuit operation or cold solder joints. Soldering delicate integrated circuits, however, requires an iron with a wattage of about 11 to 25 watts. Anything greater than that and you can just say "good-by" to that expensive microprocessor device. The solution! Go out and buy 4 soldering irons? Yeah...you could do that. But there is a better way. You could build "The Soldering Iron Heat Controller", an electronic device that will accomplish your purpose and doesn't require a large cash outlay. It can be put together in about an hour and, at a touch of your finger, you can easily control the wattage output of just about any soldering iron. The "Soldering Iron Heat Controller" is the more sensible alternative to having a number of irons plugged in at one time.

About the Circuit

Figure 1 shows the complete schematic for the "Soldering Iron Heat Controller." All that's required are a few electrical parts as well as the heart of the circuit, the voltage controller. Or in other words, a readily available "100 Watt Lamp Dimmer." That's right! A Lamp Dimmer. By varying the amount of AC voltage going into a soldering iron (or pencil) the amount of heat generated by the tip is also varied.

By placing the preassembled Lamp Dimmer in series with either the Black or White lead from a 3 conductor Line Cord, by the turn of a knob, you can control the amount of AC voltage delivered to the output receptacle.

The Lamp Dimmer itself consists of an electronic circuit that has graced the pages of electronics

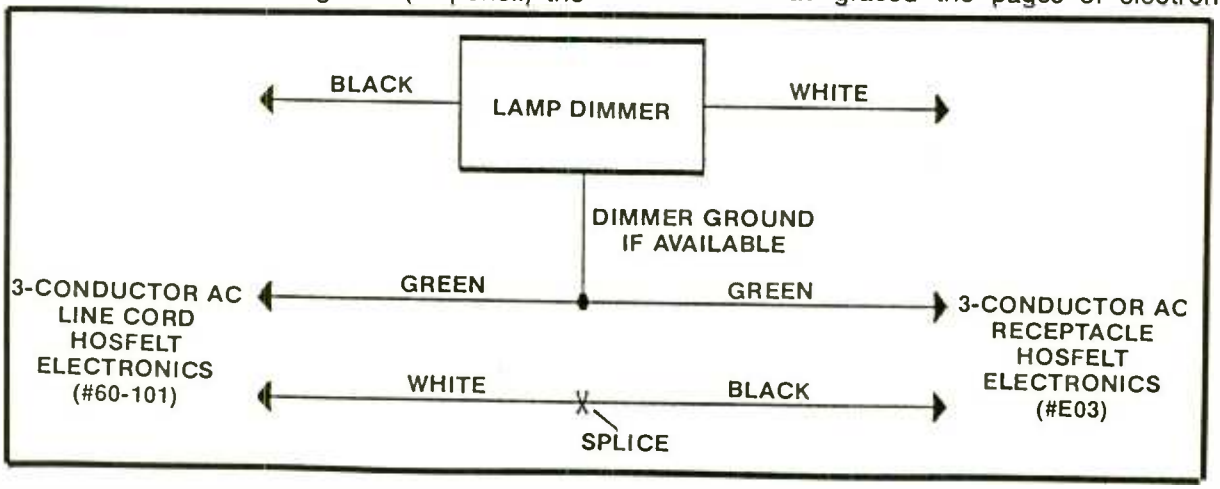


Figure 1

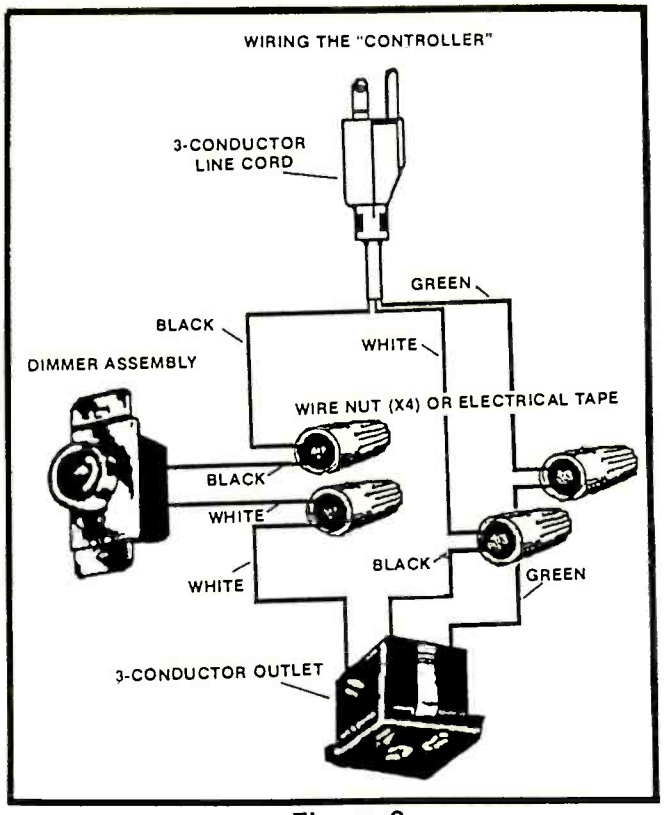


Figure 2

magazines for many years. The dimmer varies the AC voltage by making use of DIACs, TRIACs and a variable resistor that controls the AC voltage. And that's all there is to it, except for the addition of a Radio Frequency Filter. Why spend your bucks and time to reinvent the wheel. Just go to your local hardware store (lighting department) and pick up a dimmer switch for about $3.00 to $8.00 (I've found some dimmers for sale for $2.50. You can probably find a sale in your area).

Figure 2 is a diagram to show you just how easy is to build the "Controller." Just follow the diagram, connect the indicated lead colors together and insulate them by using Electrical Screw-on Caps or vinyl electrical tape.

The entire circuit can be built into one of those Radio Shack plastic boxes. You know, the one you can pick up for about $2.00. The only time consuming task is to drill out the holes for the AC Line Cord, Light Dimmer knob shaft and a rectangular cut out for the 3 prong female receptacle. Because we are working with an un-insulated AC voltage be careful not to short out the line cord voltage. And, it's NOT a good idea to build the "Controller" inside a metal box. Plastic is your best bet. Not only for the same ease of drilling but it will also prevent a nasty electrical shock if the HOT lead should come in contact with the metal.

Calibration

Once the "Controller" is assembled and inspected for miswires, the time has come to fire up this project and calibrate the front panel so you have some means of knowing, approximately, the wattage generated.

Figure 3 shows how the calibration can be accomplished. By placing an AC Voltmeter in parallel with the soldering iron's line cord, we can determine the voltage being delivered to the heating element. Note that the output of the Light Dimmer will be 0 volts if no load is present. So we must plug in the soldering iron, but be careful. This procedure exposes the iron's line cord prongs, so don't drop any metallic objects on them or you will have some early Fourth of July fireworks.

If your iron uses an Ungar 56W Heating Element (Hosfelt Electronics #46-107), the following calculations will hold true. If not, just replace the "W" (Wattage) variable with that of your iron's maximum wattage.

To calibrate The Controller, we must know the current (I) that the Ungar Heating Element is using at the full 110 volts AC. To do this, let's use some elementary electronic formulations:

Wattage	=	**Applied Voltage**	×	**Current**
W	=	**E**	×	**I**

We know that the Heating Element is rated at 56 Watts. But to make the math a little easier let's say that the heater delivers 50 Watts at the full 110VAC, then let's substitute some numbers.

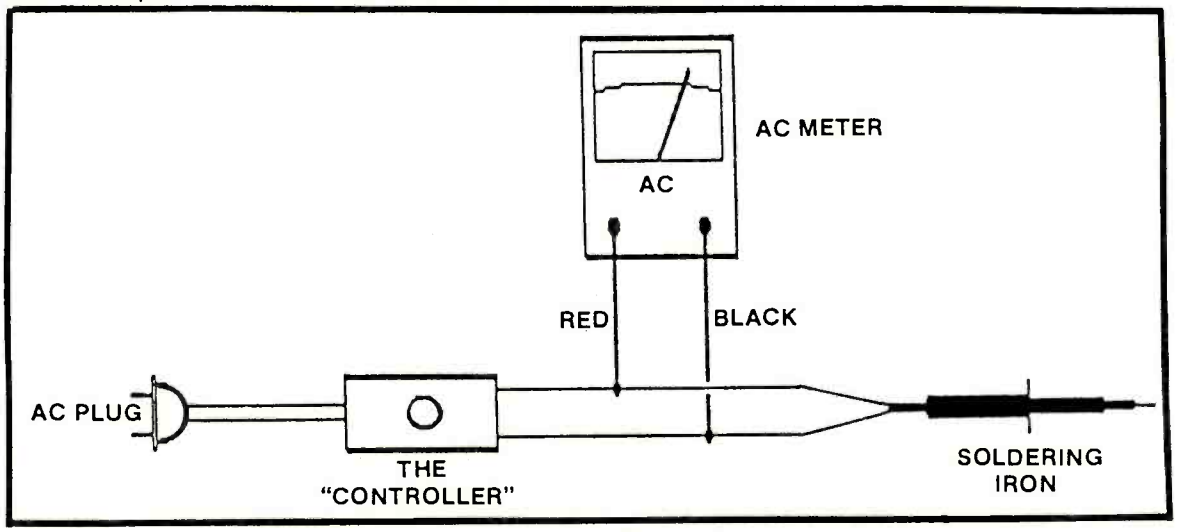


Figure 3

50 = 110 × I
50 = 110 (I)
I = 50/110
I = .445 Amps or 445mA

Now that we know the total current being drawn by the Heating Element, we can easily calculate what input voltage is needed to produce a desired wattage.

To keep the faceplate of The Controller uncluttered, we will calculate the voltage settings for the following wattages.

11 Watts 22 Watts 34 Watts by using this equation derived from the basic W=E×I example.

E = W/I

Let's start off with 11 Watts. To find the voltage, just plug in the following numbers:

E = 11 / .455
E = 24.175 volts

22 Watt calculation

E = 22 / .455
E = 48.35 volts

34 Watt calculation

E = 34 / .455
E = 74.72 volts

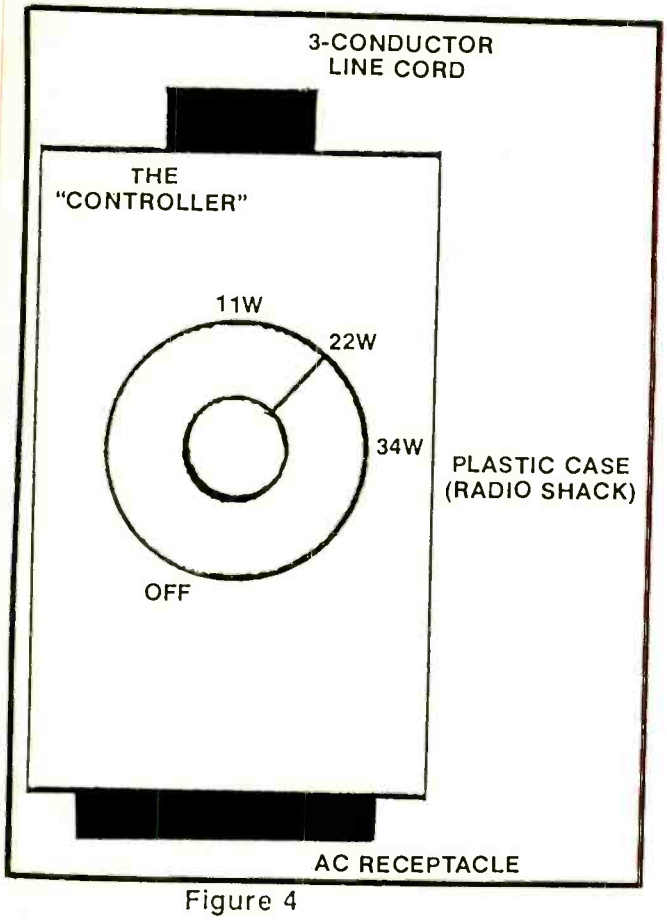


Figure 4

With the three voltages calculated, let's go back to our calibration fixture (Figure 3). Starting with the Light Dimmer knob turned all the way to the left and your AC Voltmeter on its 100V scale, plug in The Controller.

Slowly turn the dimmer knob to the right until the reading is about 24 volts AC. On the front panel of The Controller, mark this location "11 watts" (Figure 4).

Continue turning the dimmer's knob until the meter reads about 48 volts. Mark this location "22 watts." For the "34 watt" mark, turn the knob until the meter reads 75 volts. That's all there is to it.

Summary

All assembled and calibrated? All there is to do now is to find a circuit to build (elsewhere in this issue), get the parts, sit down and dial the appropriate wattage on your new "Soldering Iron Heat Controller."

For a more comprehensive understanding of the intricacies of soldering, it is suggested that you read the author's "Soldering Technique" in Volume #8 of the ELECTRONICS HANDBOOK.

A WORD OF CAUTION

THIS "SOLDERING IRON HEAT CONTROLLER" MAKES USE OF THE 120 VOLT AC HOUSEHOLD CURRENT, WHICH IS POTENTIALLY DANGEROUS IF YOU DON'T KNOW WHAT YOU ARE DOING. IF YOU ARE NOT FAMILIAR WITH WIRING A CIRCUIT USING 120VAC, IT IS SUGGESTED THAT YOU DO NOT ATTEMPT TO CONSTRUCT THIS PROJECT. LEAVE IT UNTIL YOU DEVELOP THE UNDERSTANDING AND FAMILIARITY FOR WORKING WITH HIGH VOLTAGES.

THERE IS NO HURRY. PARTS FOR THE "CONTROLLER" ARE AVAILABLE TODAY AND THEY WILL STILL BE AVAILABLE IN THE DAYS AHEAD. ■

PARTS LIST FOR "SOLDERING IRON HEAT CONTROLLER"

1—3 conductor line cord (Hosfelt #60-101)
1—100 Watt Light Dimmer Assembly (local Hardware Store)
1—3 Prong Female AC Receptacle (Hosfelt #E03)

Misc. Parts:

4—Electrical Screw-on Caps or Electrical Tape
1—Plastic Box (Housing) (Radio Shack)
1—Ungar Soldering Iron or Pencil
1—56W Heating Element Hosfelt #46-107)
1—Micro Soldering Iron Tip (Hosfelt #46-108)

Source for Parts:

Hosfelt Electronics
2700 Sunset Blvd.
Steubenville, OH 43952
1-800-524-6464
Accepts Major Credit Cards

BUILD A SOLID STATE DC MOTOR CONTROLLER

By Don Wilcher

One concern when designing and building robots is the type of circuit that will be used to drive the motor drive mechanism. Generally speaking, DC motors are capable of drawing currents up to several amperes. This high value of load current plays havoc on board space due to the dimensional requirements that the heat sink demands in order to keep the transistors cool. There is a solution to this problem. In the paragraphs to follow, a solid state circuit, capable of powering motors will be described. Although the discussion will be focused around driving one motor, this circuit can be duplicated to control several motors. In addition to expandability, this motor controller allows itself to be interfaced nicely to a PC or laptop computer.

About The Circuit

The solid state DC motor controller is capable of handling load currents up to 1.5A. The heart of this circuit is the L272M power Op-Amp, manufactured by SGS Thomson Microelectronics. This 8 pin IC doesn't require a heat sink, due to its thermal shutdown capability. The Op-Amps are configured as comparators where the switch inputs are compared to a 2.5V reference, established at pins 5 and 8 of the chip. The outputs at pins 3 and 1 will be turned on depending if their inputs (pins 6 and 7) are active. With the input of pin 6 switched on and pin 7 turned off, the output of Op-Amp 1 will be switched on to the supply voltage and Op-Amp 2's output will be at 0V. The motor will then rotate in one direction. By switching pin 7 on and pin 6 turned off, Op-Amp 1's output will be at 0V and the output of Op-Amp 2 will be at the supply voltage. With this established condition, the motor will now rotate in the opposite direction.

Construction

Wiring this circuit is not critical. A printed circuit board can be created or a perfboard using point to point wiring can be used to construct the circuit. I built the circuit using a solderless breadboard and pre-formed jumper wires. Whatever construction technique that is used, be sure to check the wiring for errors prior to powering up the circuit.

Resource

To obtain data sheets and sample parts of the L272M power Op-Amp, contact SGS Thomson Microelectronics at 602-867-6259. ■

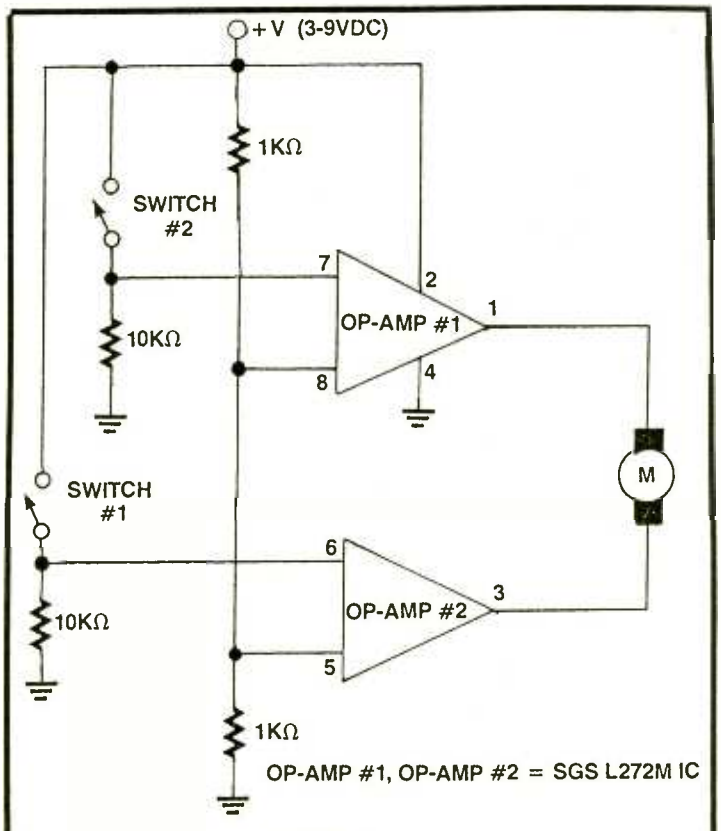


FIGURE 1
A SOLID STATE MOTOR CONTROLLER FOR DC MOTORS

ANTIQUE RADIO CORNER

HOW TO BUILD A CRYSTAL SET AMPLIFIER

By Lance Borden, WB5REX

In the early days of wireless communications, operators used spark transmitters and crystal receivers. Some of the wireless crystal receivers were extremely elaborate; using large, complex tuning circuits consisting of tapped coils, adjustable coupling transformers, variocouplers, variometers, and variable capacitors.

Antenna systems were often very large; consisting of hundreds of feet of wire strung between high towers or poles. On board ships the antennas were rigged between the tips of the masts, which were often several stories tall.

The reason for all of this copper and tuning circuits was that vacuum tubes had not been invented yet and the wireless crystal receivers did not have any means of amplifying the weak signals that were in the "ether." The antenna had to capture as much of the signal as possible and the tuned circuits had to be highly efficient in order to get the most amplitude to the crystal detector and then on to the operator's headset. Even with all of these complex devices, many stations were just too far away and the signals just too weak to copy fully. It was frustrating to operators to be able to barely make out a call sign, but not hear all of a message from a far-off transmitter. Everyone wanted another way to make the signals louder, but nothing practical had been invented for this purpose.

Then, around 1908, Dr. Lee deForest invented the grid-controlled vacuum tube amplifier. The vacuum tube amplifier is generally considered the greatest single contribution to radio and electronics technology after James Clerk Maxwell's prediction of the existence of electromagnetic waves and Heinrich Hertz's experimental proof that led to the subsequent development of wireless communications by Tesla and Marconi.

The "Audion," as deForest called it, was essentially a light bulb with a small wire "grid" installed between the filament and a small metal "plate." A very small change in the charge on the grid caused a very large change in the electron flow between the filament and the plate. Dr. deForest proved that this effect could be used to increase the amplitude of the weak wireless signals and the Audion became the first practical electronic amplifier.

Although the vacuum tube was originally used as an amplifying detector in many sets, alot of early operators used them as amplifiers for crystal receivers. The advent of the electronic amplifier made the crystal receiver much more practical for the reception of radio waves because it made the signal many times louder

and thus increased the effective range of the system. It also made the crystal sets work better because it had a very high input impedance (resistance to a.c.), which caused it to load down the tuned circuits less than headphones. This effect increased the "Q," or efficiency, of the tuned circuits, which caused them to tune more sharply, thus separating stations better and increasing the effective amplitude even more.

Many different circuits were invented in the years that followed the introduction of the vacuum tube. Most modern solid-state electronic equipment in use today was originally designed years ago, using vacuum tubes. This even includes digital computers and video recorders. High powered broadcast transmitters still use vacuum tube amplifiers because practical solid-state devices have not been designed yet that can produce the amount of power that these stations require.

When commercial broadcasting for the public blossomed in the early 1920's, many vacuum tube and crystal receivers were used in homes to pick up the news, sports, and music that were riding the air waves. Vacuum tubes and vacuum tube radios were expensive in those early days and many listeners used crystal sets because they were cheaper and simpler than the commercial tube sets. Some people also used simple one-tube and two-tube radios as a compromise between the crystal sets and the costly multiple-tube radios.

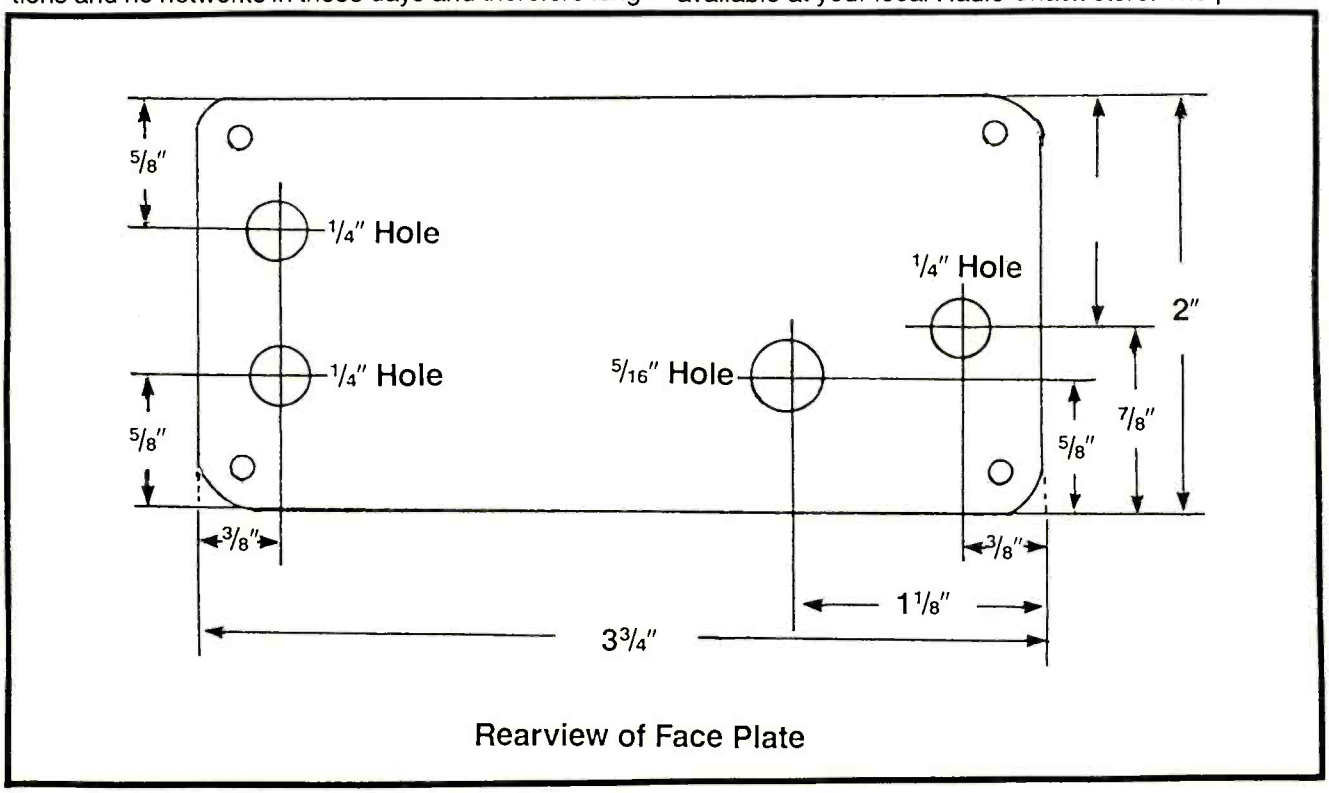
The main drawback of the crystal sets and simple tube sets was that they would only drive headphones and thus limited the number of listeners in a household to one or two. These sets also were not very sensitive and long-distance reception was difficult, with volume being very low. There were not many broadcast stations and no networks in those days and therefore long-distance reception was desirable so listeners could receive programming from localities other than their own.

To help overcome the disadvantages of low volume and weak sensitivity, many owners of crystal sets and simple tube sets bought or built tube-type audio amplifiers. These amplifiers were either built from articles appearing in magazines or they were commercially manufactured units that were available in the local radio stores. Some manufacturers, such as "Uncle Al's Radio Shop" in Oakland, California, even produced commercial crystal sets with built-in tube amplifiers. RCA sold a two-tube "Balanced Amplifier" that was designed to allow their two-tube "Radiola III" receiver to drive a horn speaker.

The following is a description of how to build and use a modern day solid-state version of one of those amplifiers so you can amplify the output of your crystal set or simple tube set. It will produce up to 400 milliwatts of high-quality audio, which is plenty to drive a loudspeaker with more than adequate volume. This little unit also has both a high-impedance and a low-impedance output. This makes it possible to drive modern low-impedance headphones and speakers, as well as old high-impedance horn speakers and headphones.

In addition to amplifying the outputs of simple radios, this amplifier can be used with high impedance crystal or ceramic microphones and phonograph cartridges. Connecting a 1N34 diode, a .001 microfarad capacitor, and a 10,000 ohm resistor to the input turns the amplifier into an effective signal tracer for troubleshooting purposes.

The construction of this amplifier is performed using very simple assembly techniques and readily available parts. Nearly everything needed to build this project is available at your local Radio Shack store. The parts list



Rearview of Face Plate

Figure 1 Face Plate Drilling Detail

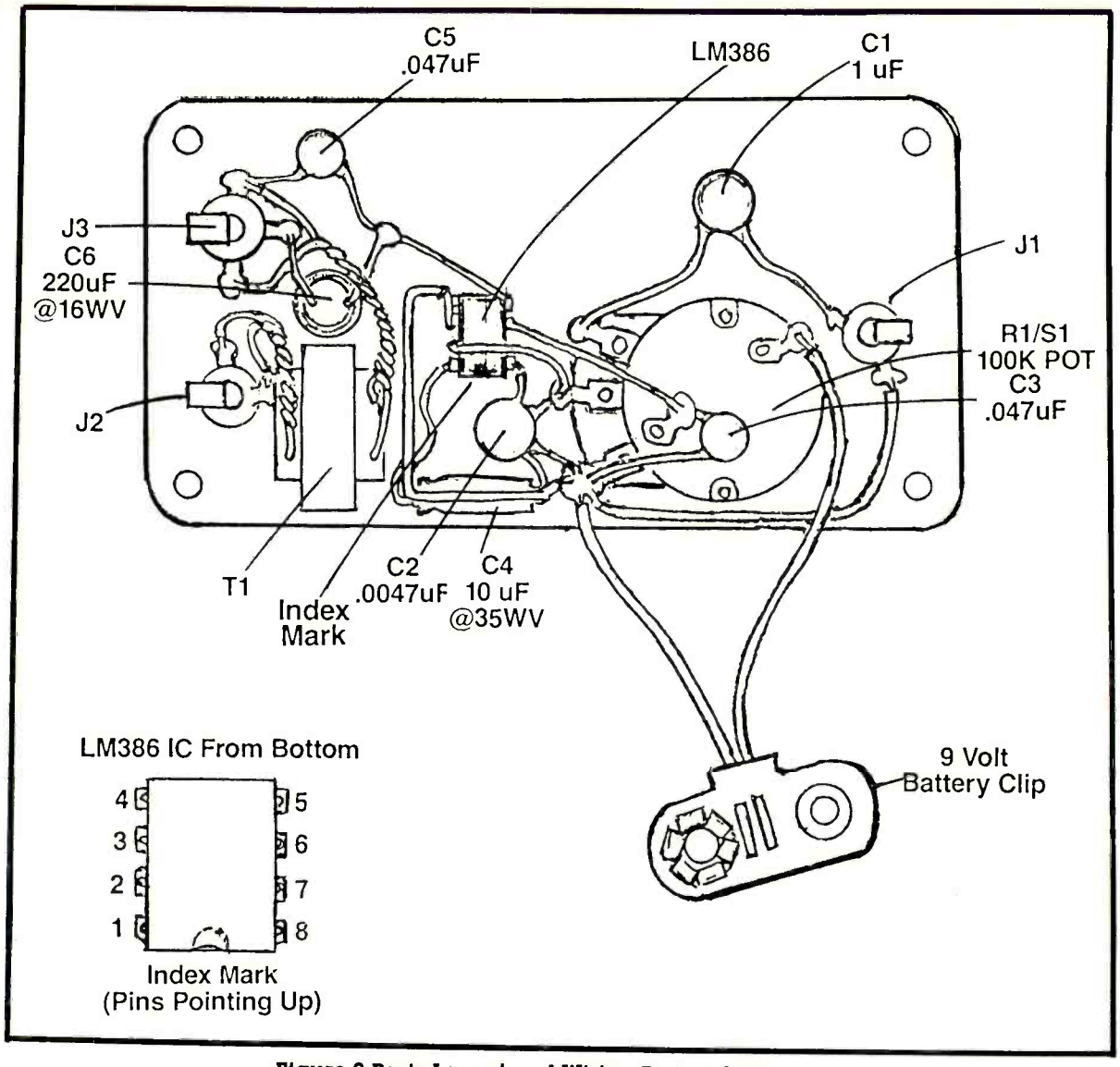


Figure 2 Parts Layout and Wiring Pictorial Diagram

at the end of this article gives the Radio Shack part numbers for the items needed to complete the amplifier.

In the interest of simplicity and practicality, this amplifier has been designed around the highly-efficient LM386 audio amplifier integrated circuit. In our amplifier, the LM386 serves the same purpose as the vacuum tubes in the amplifiers of the old days.

The circuit is extremely simple because most of the components are contained in the LM386 audio amplifier integrated circuit chip. Construction is also simple because a circuit board is not required, as all of the components are mounted directly on the aluminum face plate of the project box.

CONSTRUCTION

Begin construction by acquiring all of the parts and materials you will need before you start. A list of parts, materials, and sources is included at the end of this article.

STEP 1. (Refer to Figure 1 and Photo #2) Drill holes in the face plate as shown in Figure 1. Lightly sand the front of the face plate with 400 grit sandpaper and then clean it with rubbing alcohol. Apply the rub-on lettering as shown in Photo #2. The face plate is finished by spraying it with a light coat of clear acrylic lacquer to seal and protect the lettering.

STEP 2. (Refer to Figure 2 and Photos #2, #3, and #5) Clamp the volume control shaft in a vise and cut it to $^{3}/_{8}$ inch long using a hacksaw. Smooth the rough edges of the shaft with a fine file or emery board.

Remove the back cover of the volume control and install the switch according to the instructions provided on the back of the blister pack that it came in. Mount the volume control and phone jacks to the face plate as shown in Figure 2 and Photo #5.

STEP 3. (Refer to Figure 2 and Photo #5) Use coarse sandpaper to roughen up the mounting surfaces of the LM386 IC, transformer T1, and capacitor C6. Sand the face plate where these parts will be mounted. This will provide clean, textured surfaces for the glue to grip and will ensure a good bond.

Orient the index mark (a notch or dot) on the IC according to Figure 2, then glue the LM386 IC, trans-

Photo #1 Parts Required to Build the Amplifier

former T1, and capacitor C6 to the prepared face plate with gel-type super glue and let it dry completely before proceeding to the next step.

STEP 4. (Refer to Figures 2 and 3 and Photo #6) Use the project box to hold the inverted face plate while performing this step. Consult the Pictorial Diagram, Figure 2, the Schematic, Figure 3, and the Wired Amp, Photo #6 and proceed with the wiring of the amplifier as follows:

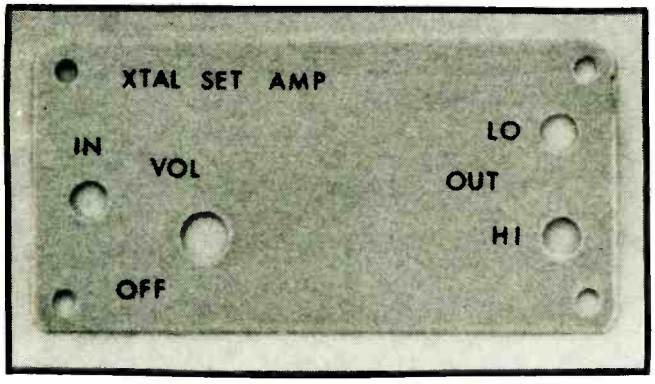


Photo #2 Drilled and Labeled Panel

(A) Begin by cutting the center tap (black wire) off of transformer T1.

(B) Solder the negative (−) lead of capacitor C6 to the phone jack J3 "tip" lug.

(C) Twist the T1 secondary (blue & green) wires together and then solder the green wire to the phone jack J2 "ground" lug. Solder the blue wire to the phone jack J2 "tip" lug.

(D) Twist the T1 primary (red & white) wires together and then connect the white wire to the phone jack J3 "ground" lug. **Do not solder this connection yet.**

Solder the red wire to the phone jack J3 "cut-out" lug.

(E) Connect the phone jack J1 "ground" lug to the volume control "low" lug with insulated hook-up wire. Solder the connection on phone jack J1 "ground" lug. **Do not solder the connection on the volume control "low" lug yet.**

(F) Solder one lead of capacitor C1 to the phone jack J1 "tip" lug and the other lead to the volume control "high" lug.

(G) Solder the red (+) wire of the battery clip to the switch S1 lug that is closest to phone jack J1.

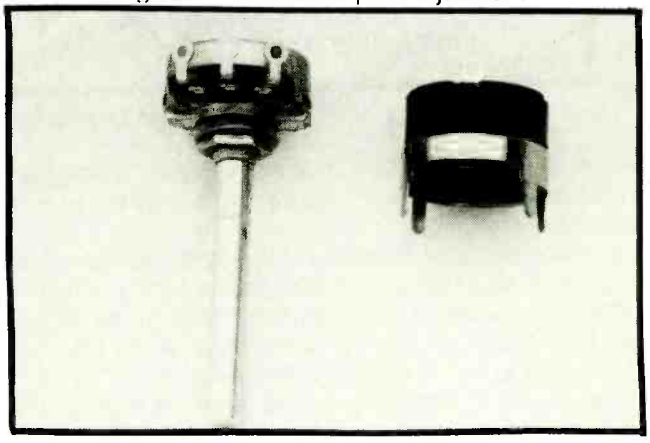


Photo #3 Volume Control and Switch Parts

(H) Connect the black (−) wire of the battery clip to the volume control "low" lug. **Do not solder this connection yet.**

(I) Pass one lead of capacitor C2 through the hole in the volume control wiper (center) lug until C2 is close to the volume control. Do not cut this lead because it will be used later to connect the volume control to the IC.

Connect the other lead of capacitor C2 to the volume control "low" lug. **Do not solder this connection yet.**

(J) Pass one lead of capacitor C3 through the hole in

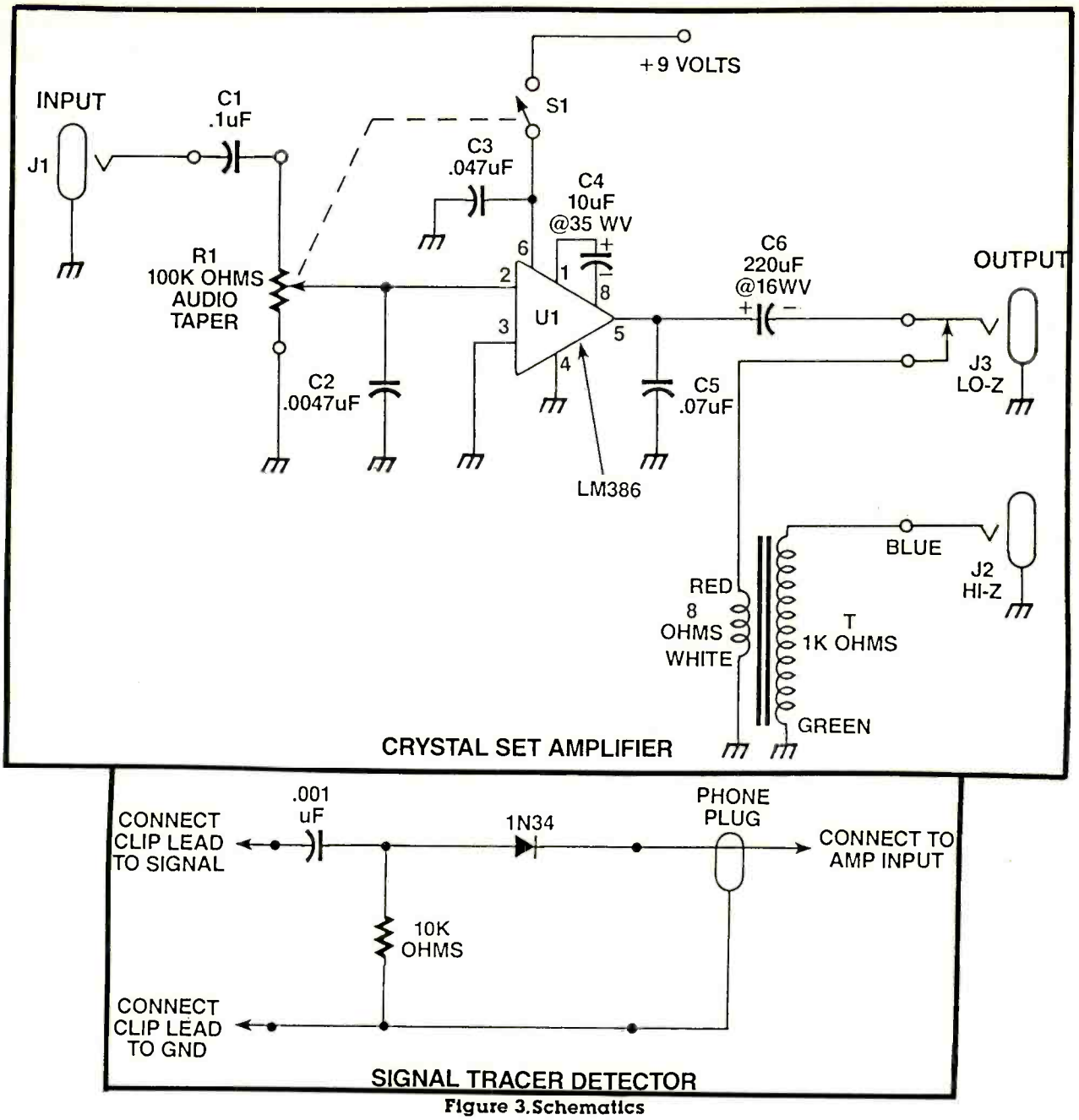


Figure 3.Schematics

the switch lug that is farthest from phone jack J1 until capacitor C3 is close to the lug. Do not cut this lead because it will be used later to connect the switch to the IC.

Solder this lead to the switch lug where it passes through. Connect the other end of capacitor C3 to the volume control "low" lug. **Do not solder this connection yet.**

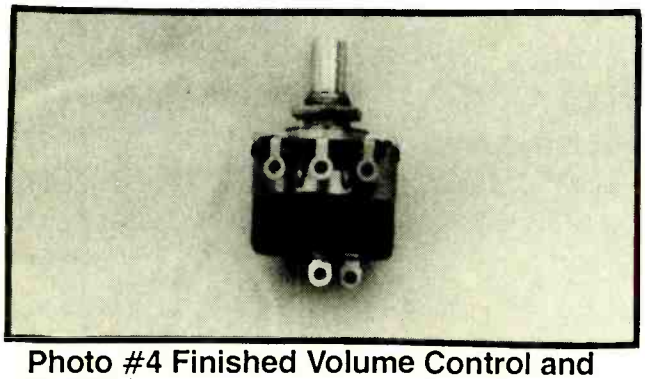


Photo #4 Finished Volume Control and Switch

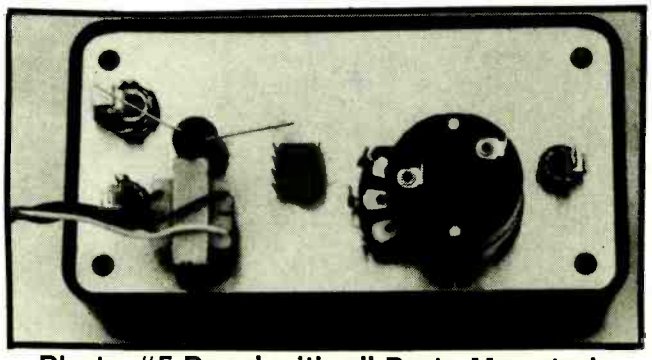


Photo #5 Panel with all Parts Mounted, Before Wiring

(K) Solder one lead of capacitor C5 to the phone jack J3 ground lug as shown in Figure 2. Solder the positive (+) lead of capacitor C6 to the other lead of capacitor C5 as shown. Solder this lead of capacitor C5 to the IC, pin 5.

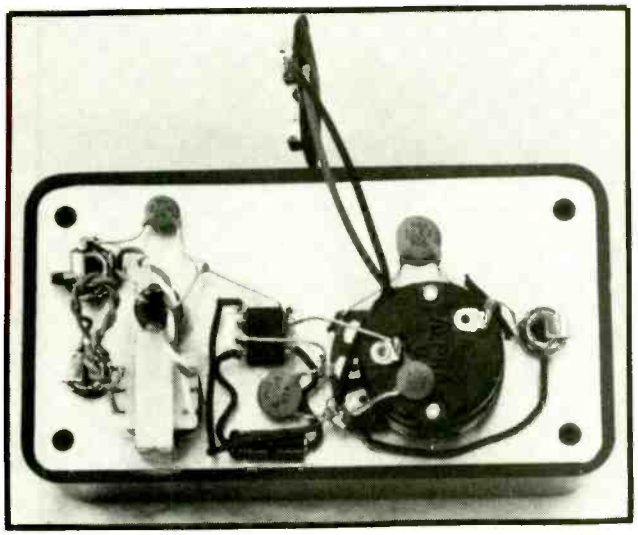


Photo #6 Panel After Wiring

(L) Solder the lead of capacitor C3 that is connected to the switch to the IC, pin 6.

(M) Solder IC pins 3 & 4 to one end of a piece of insulated hook-up wire and connect the other end to the volume control "low" lug.

Now, solder all of the connections that are on the volume control "low" lug!!

(N) Solder the lead of capacitor C2 that is connected to the volume control wiper (center) lug to the IC, pin 2.

(O) Put spagetti or shrink tubing on the leads of capacitor C4 and solder the positive (+) lead to the IC, pin 1 and the negative (−) lead to the IC, pin 8.

(P) Use a piece of string to tie the battery clip leads to the case of the volume control for strain relief. Secure this knot with a drop of super glue.

(Q) Cut the wires of two clip-leads in half and solder these to two phone plugs. Secure the phone plug back shells and then twist the clip-lead wires. These are your input and output connectors.

This completes the wiring of the amplifier

STEP 5. (Refer to Photo #7) Mount the battery holder in the project box with a #4 machine screw and nut as shown in Photo #7. Be careful to position the holder so that the battery will not touch any of the circuitry when the face plate is installed on the box.

Connect a good 9 volt alkaline battery to the battery clip and then snap the battery in place in its holder.

STEP 6. Place the face plate on the project box and secure it in place with the screws that were provided for this purpose.

Installing the knob on the volume control completes the construction of the amplifier.

OPERATION

To use the amplifier, insert one of the phone plugs with clip leads installed into the input jack, J1. If high-impedance headphones or speaker, such as an old horn speaker, are to be used, insert the other phone plug with clip-leads attached into the high-impedance output jack, J2.

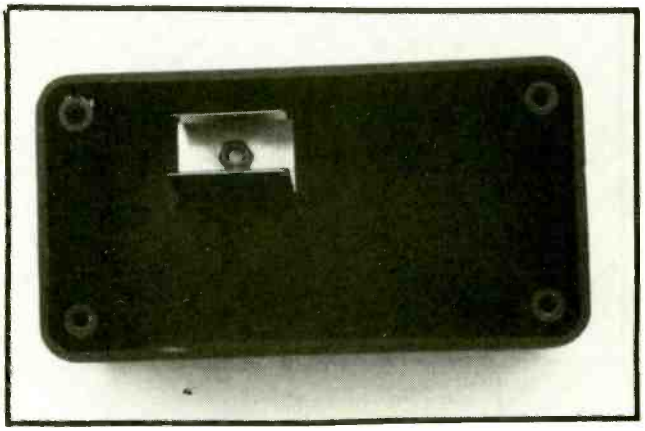


Photo #7 Project Box Showing Battery Holder Location

If low-impedance headphones or speaker are to be used, then insert the phone plug into the low-impedance output jack, J3.

Connect the output of a crystal set, one or two-tube set, crystal or ceramic microphone or phono cartridge to the phone plug in the input jack, J1. If you are using

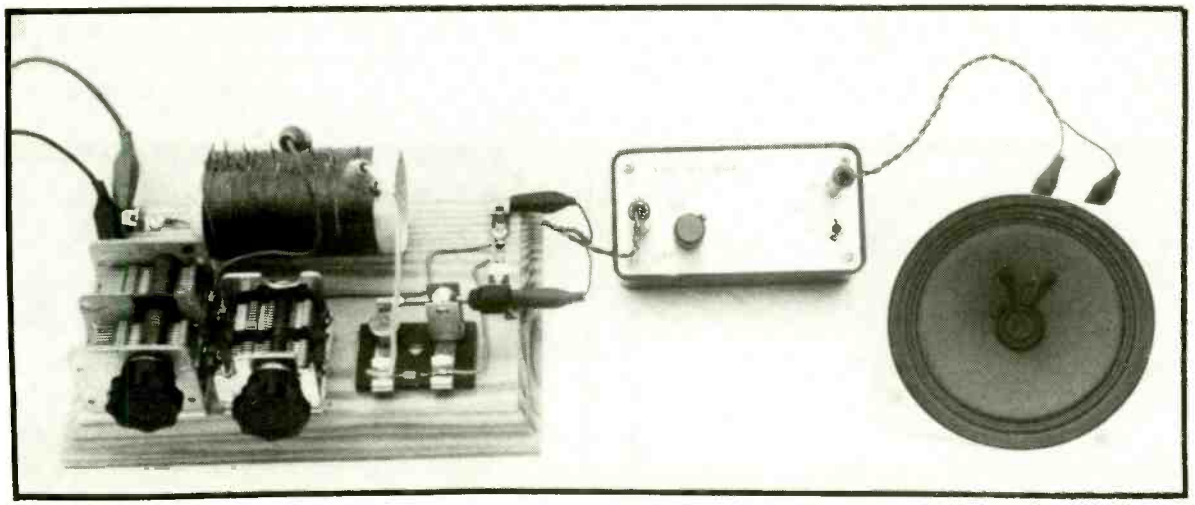


Photo #8 Completed Amp with Crystal Set and Low Impedance Speaker

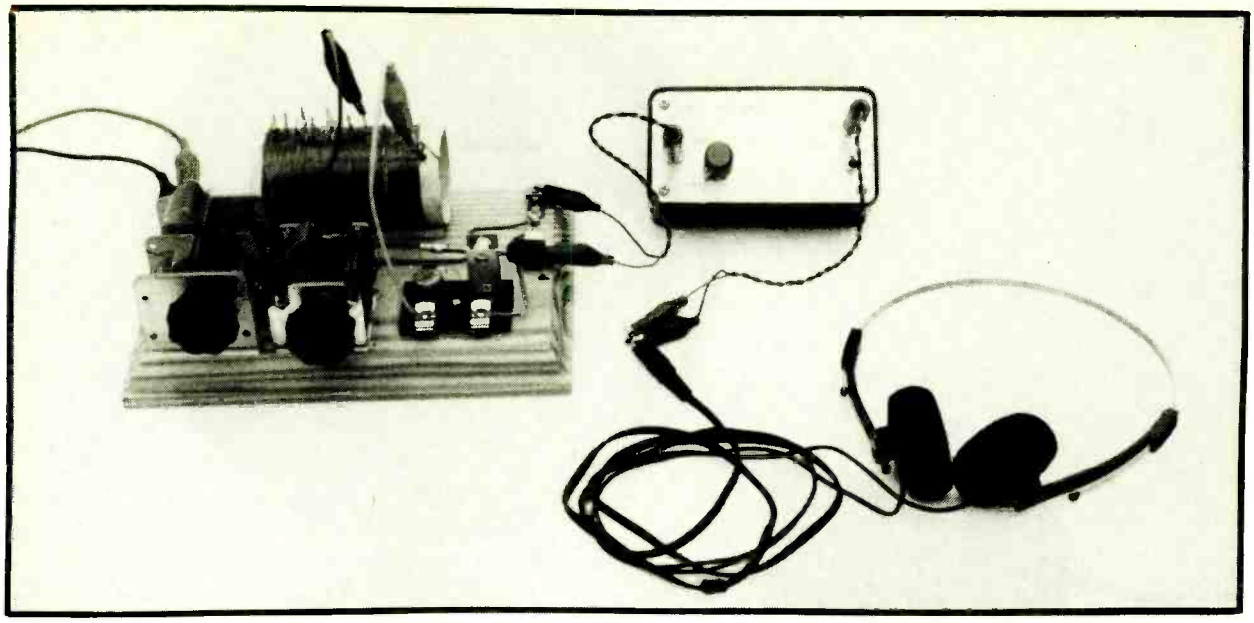


Photo #9 Completed Amp with Crystal Set and Vintage Low Impedance Phones

this amplifier with a one or two-tube set, it will be necessary to connect a 2000 ohm 1/4 watt resistor across the radio's phone jacks to conduct the B+ current in order for the tube to operate.

To use the amplifier as a signal tracer, connect a 1N34 diode, a .001 microfarad capacitor, and a 10,000 ohm resistor to the input jack, J1 as shown in Figure 3. As a signal tracer, the amplifier can be used to detect the audio that is present in the R.F. and I.F. stages of a radio. This can be used to determine which stages are working and which ones have failed.

HOW IT WORKS

Capacitor C1 acts as a D.C. blocking and signal coupling capacitor that couples the input signal to the high side of the volume control potentiometer R1 and prevents inadvertent D.C. from entering the amplifier's input. Volume control R1 performs the job of a controllable voltage divider that allows us to set the amount of signal going into the amplifier at a desired level.

Capacitor C2 bypasses any R.F. or high frequency component of the input signal to ground. This prevents the amplifier from acting like a detector and improves the sound quality of the output. Capacitor C3 works as a bypass capacitor that prevents any signal from causing feedback or oscillation via the power supply input of the amplifier I.C.

Capacitor C4 is used to set the gain of the LM386 amplifier I.C. to 200. Differing values of resistance and capacitance can be used to select any gain value between 20 and 200. A gain of 200 was selected for this

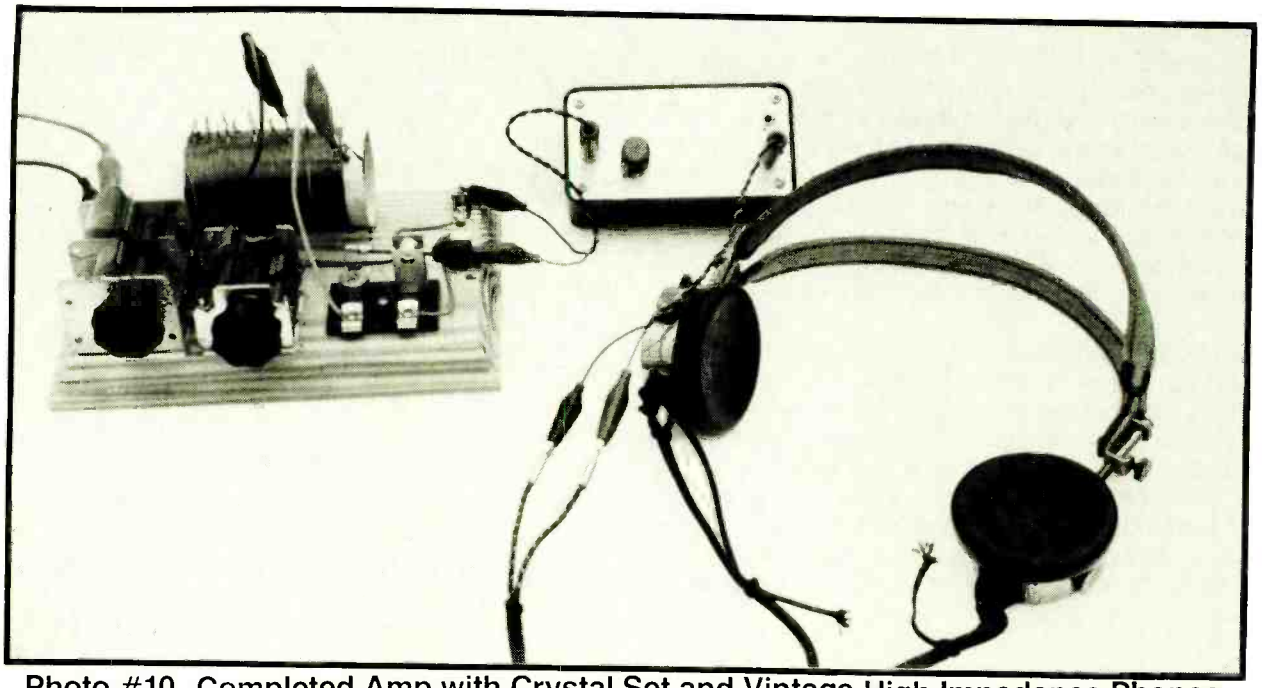


Photo #10 Completed Amp with Crystal Set and Vintage High Impedance Phones

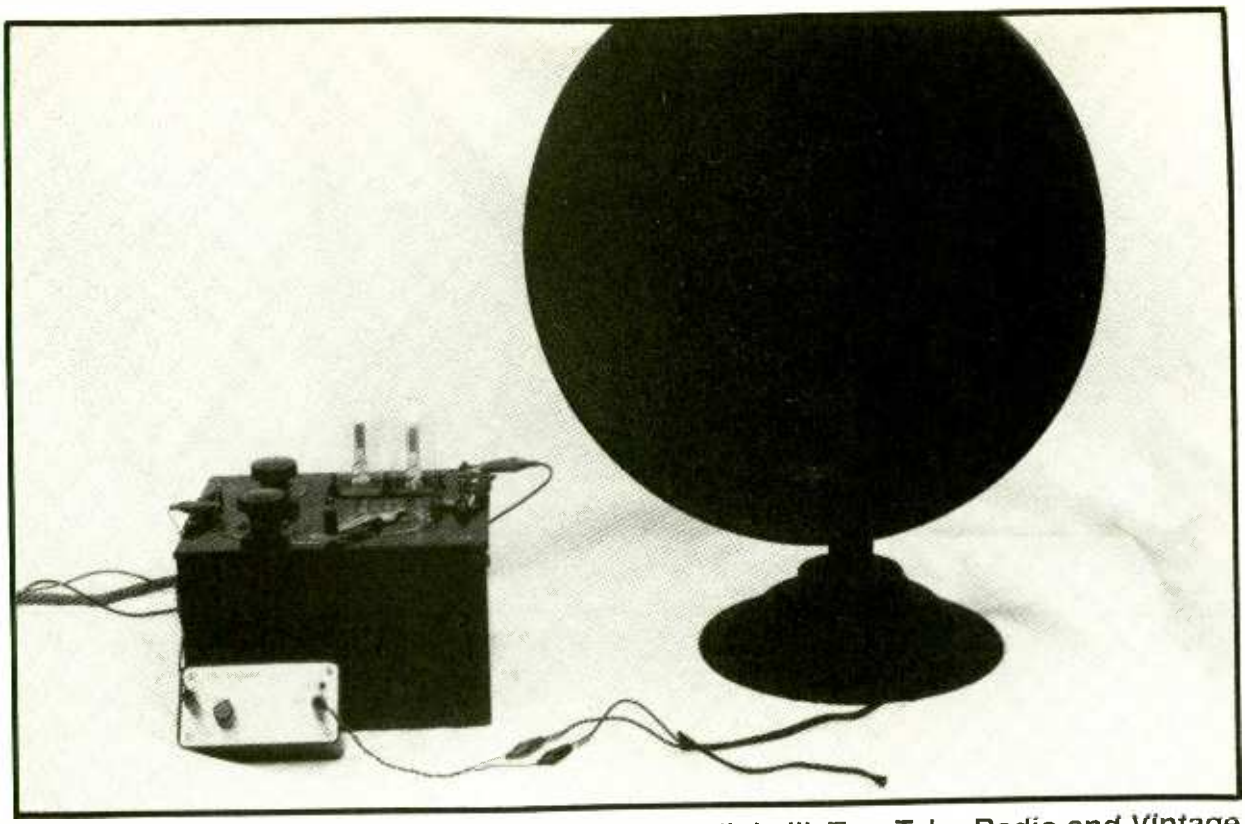


Photo #11 Completed Amp with 1924 R.C.A. Radiola III Two-Tube Radio and Vintage Atwater-Kent High Impedance Speaker

circuit because it offers the most amplification of weak signals.

Capacitor C5 is used as a high frequency filter to improve the output tone of the amplifier and also to help prevent feedback and oscillation. Capacitor C6 is used as a low impedance coupling capacitor that couples the output signal of the amplifier to the load while protecting the I.C. from possible short circuits or D.C. damage.

Impedance matching transformer T1 converts the amplifier's low impedance output to a higher impedance so that high impedance headphones and speakers can be driven efficiently. When the output plug is inserted in the low impedance output jack, J3, the jack's "cut-out" contact disconnects the transformer T1 so that it does not dissipate any of the output power when using low impedance headphones or speakers.

The LM386 integrated circuit is a power amplifier designed for use in battery operated consumer circuits such as portable radios, tape recorders, and portable T.V.'s. It contains a total of ten transistors and their associated circuitry. This I.C. has a high impedance input of 50,000 ohms and a low impedance output of nominally eight ohms. Total harmonic distortion is low and fidelity is very good at moderate volume levels. At high volume levels the distortion increases somewhat but is not very objectionable.

CONCLUSION

In conclusion, very good results can be expected with this amplifier. It has been used with crystal sets, one-tube sets, an antique R.C.A. Radiola III, and with crystal microphones and phono cartridges. The LM386 has plenty of volume and good fidelity when operated at moderate levels.

When connected to a crystal set at this location, many more stations could be heard than with headphones alone. The high impedance input of the amplifier also improved the selectivity of the crystal set greatly.

Be careful when soldering to the LM386 I.C. that you don't overheat it. Too much heat will ruin it, so make these solder joints quickly. Only alkaline batteries should be used with this amplifier because of the relatively high power output and subsequent increased current drain. You will know when the battery needs replacing because the output will become weak and distorted.

Good luck with your crystal set amplifier and happy DX'ing!! ■

References

(1) National Semiconductor. Linear Applications Specific **I.C.'s DATA BOOK,** 1993 Edition

(2) **THE GRID LEAK,** Publication of the **Houston Vintage Radio Association,** Volume 15, Number 1, February, 1993. Pages 5-9. **HOW I INVENTED THE AUDION,** by Dr. Lee deForest, Reprinted from **ELECTRICAL EXPERIMENTER,** March, 1919.

Crystal Set Amplifier Parts and Source List

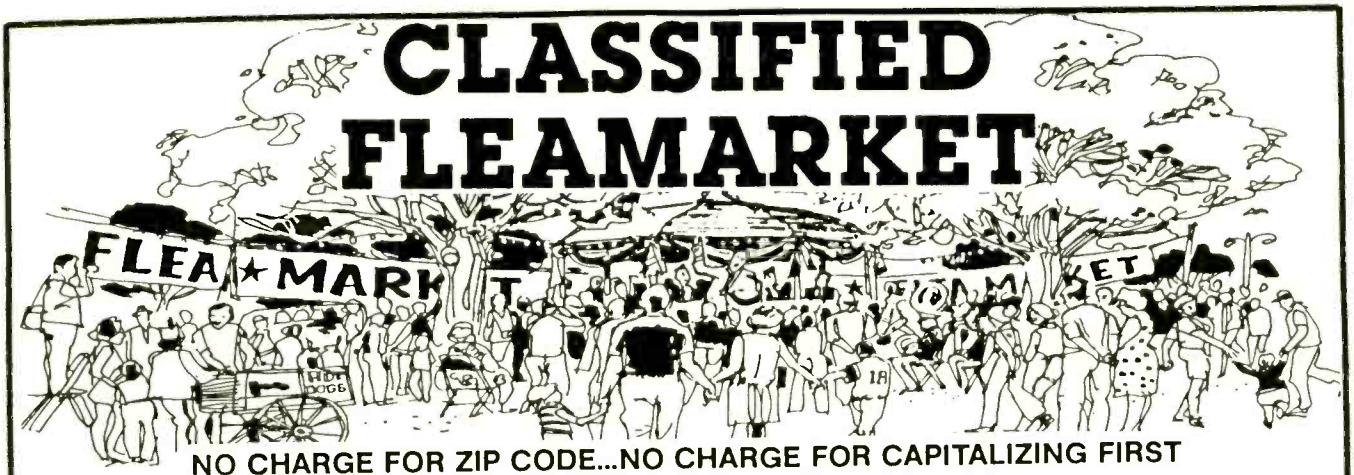
The following parts can be obtained at Radio Shack: The Radio Shack part numbers are from the 1993 catalog.

ITEM	Radio Shack P/N
9 volt battery clip	270-325
9 volt battery holder	270-326A
9 volt super alkaline battery	23-553
Experimenter box, $3^{15}/_{16}$" x $2^{1}/_{16}$" x $1^{5}/_{8}$"	270-231
4" full range replacement speaker	40-1208
Audio output transformer, 1K ohm center tapped to 8 ohms	273-1380
$^{1}/_{2}$ inch blue capped knob	274-403
Audio taper potentiometer, 100K ohm	271-1722
Potentiometer switch	271-1740
$^{1}/_{8}$ inch phone jack, closed circuit type	274-248
$^{1}/_{8}$ inch phone jacks, open circuit type (2 req'd)	274-251A
$^{1}/_{8}$ inch phone plugs, (2 req'd)	274-287A
Clip leads, 14 inches, or more, in length	278-1156
LM386 400 mw audio amplifier I.C.	276-1731
220 mfd @ 16 wv electrolytic capacitor	272-956
10 mfd @ 35wv electrolytic capacitor	272-1013
.0047 mfd ceramic disc capacitor	272-130
.047 mfd ceramic disc capacitors, (2 req'd)	272-134
.1 mfd ceramic disc capacitor	272-135

Miscellaneous Parts and Materials

ITEM	SOURCE
Rub-on lettering	local hardware, electronics, or hobby store
Clear acrylic spry lacquer	local hardware store
Hook-up wire, solder	junk box, Radio Shack, electronics store
Gel type super glue	local hardware store
#4 machine screw and nut	local hardware store or junk box

CLASSIFIED FLEAMARKET



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WORKBENCH PROJECTS

With any electronics assembly and/or project construction, it is important that you understand how the various parts of the circuit work together and the objective of each component before you start gathering the components together and assembling them. With any project that requires Integrated Circuits (ICs) or transistors, be careful to observe precautions about overheating their leads. If possible, use sockets designed for the IC chip required, instead of soldering directly into the chip's wire leads. If you don't have sockets available, be sure to protect the IC and/or transistor lead wires by using long-nose pliers as a "heat-sink" when soldering these leads.

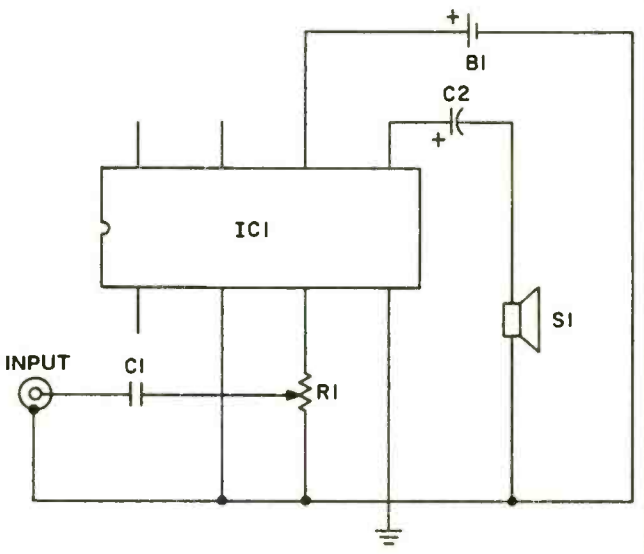
SIMPLE AUDIO AMPLIFIER

There are literally thousands of designs for audio amplifiers available, but you would be hard pressed to come up with a practical design any simpler than this. It only uses 5 everyday parts, and it can drive and 8-Ohm speaker with up to 500 mW of power without the need for an output transformer.

The hero here is IC1, an LM 386 chip designed especially for audio amplification. It can be powered from 4 to 12 volts DC, and a 9-volt battery will work just fine. 2 circuits can be used to make a stereo headphone amp, and there are dozens of uses for the creative experimenter. And if the gadget you're amplifying already had AC coupling and a volume control, you can omit C1 and R1 to make things even easier. ■

PARTS LIST

B1—9-volt battery
C1—.1 uf dic capacitor, 15 volts or better
C2—220 uf electrolytic capacitor, 15 volts or better
IC—1 LM 386 low voltage audio amplifier IC (available at Radio Shack stores and many mail-order suppliers)
R1—100 kOhm audio taper potentiometer
S1—8-Ohm speaker or headphone



SIMPLE AUDIO AMPLIFIER

ELECTRONIC LINE FILTER

Modern electronic equipment is highly suceptible to damage from noise as well as "spikes." Many filters being sold today do not address this problem adequately.

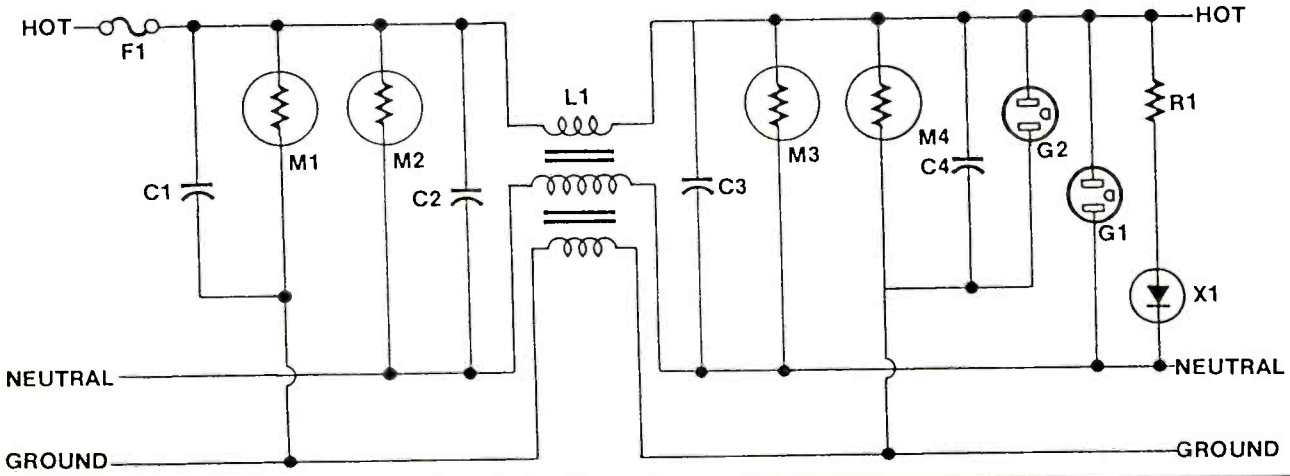
An efficient and successful line filter uses multiple components to insure better protection from line disturbances.

The capacitors and coil (L1) supress the radio frequency noises encountered. These components also weaken the effect of "spikes" and/or "surges." The metal Oxide Varistors and Gas Gaps supress any "spike" or "surge" above their threshold voltage. The combination of these components will give protection against most power problems encountered in the home, office or factory.

LED (X1) indicates that the unit is functional and Fuse (F1) protects the equipment in the event of a "spike" or "surge" that is too large for the filter to supress. A device like this could be cheap insurance for your valuable equipment. ■

PARTS LIST FOR THE ELECTRONIC LINE FILTER

R1—47K Ohms, 1 watt resistor
C1-C4—.01 Mfd, 2000 WVDC capacitors
M1-M4—MOV. 130 volts RMS, 70 joules (Radio Shack #276-568 or equivalent)
G1, G2—CP Claire Gas Gaps, 145 Volts
F1—10 Amp fuse
X1—LED
L1—3 coils, each 10 turns of #16 magnet wire on 2" toroid coil form (keep coils separated)
IT IS ESSENTIAL THAT THIS CIRCUIT BE WIRED CORRECTLY.
Keep the "Hot" wire, "Neutral" wire and "Ground" wires straight.
A substantial enclosure is absolutely necessary.



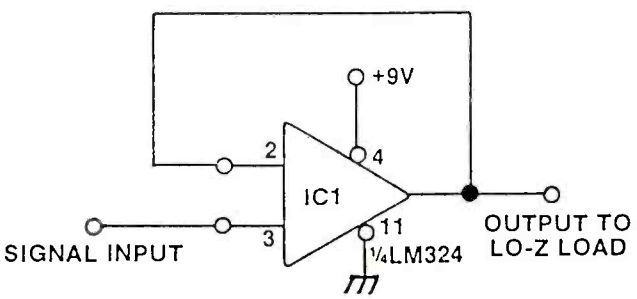
ULTRA SIMPLE OP-AMP ISOLATING BUFFER

This simple buffer circuit can be built around a single Op-Amp, using a minimum of components. The popular LM324 is shown here, since it is designed to operate from a single supply. The main purpose of a buffer is to isolate a low impedance load from shunting a signal source. For example, Op-Amps are ideally suited as small signal pre amps but have no drive capability to be directly connected to a low impedance load, such as 8 ohm headphones or speakers.

Using the buffer shown here, you will be able to operate low impedance devices from the output of 741 type Op-Amps. The signal input is directly coupled to pin #3 (non-inverting input). The inverting input (pin #2) is taken to the output (pin #1). The supply (typically 9 volts) is connected to pin #4 and the ground is connectet to pin #11. ■

PARTS LIST FOR THE ISOLATING BUFFER

IC1—LM324 quad Op-Amp



DISCRETE LOGIC GATES

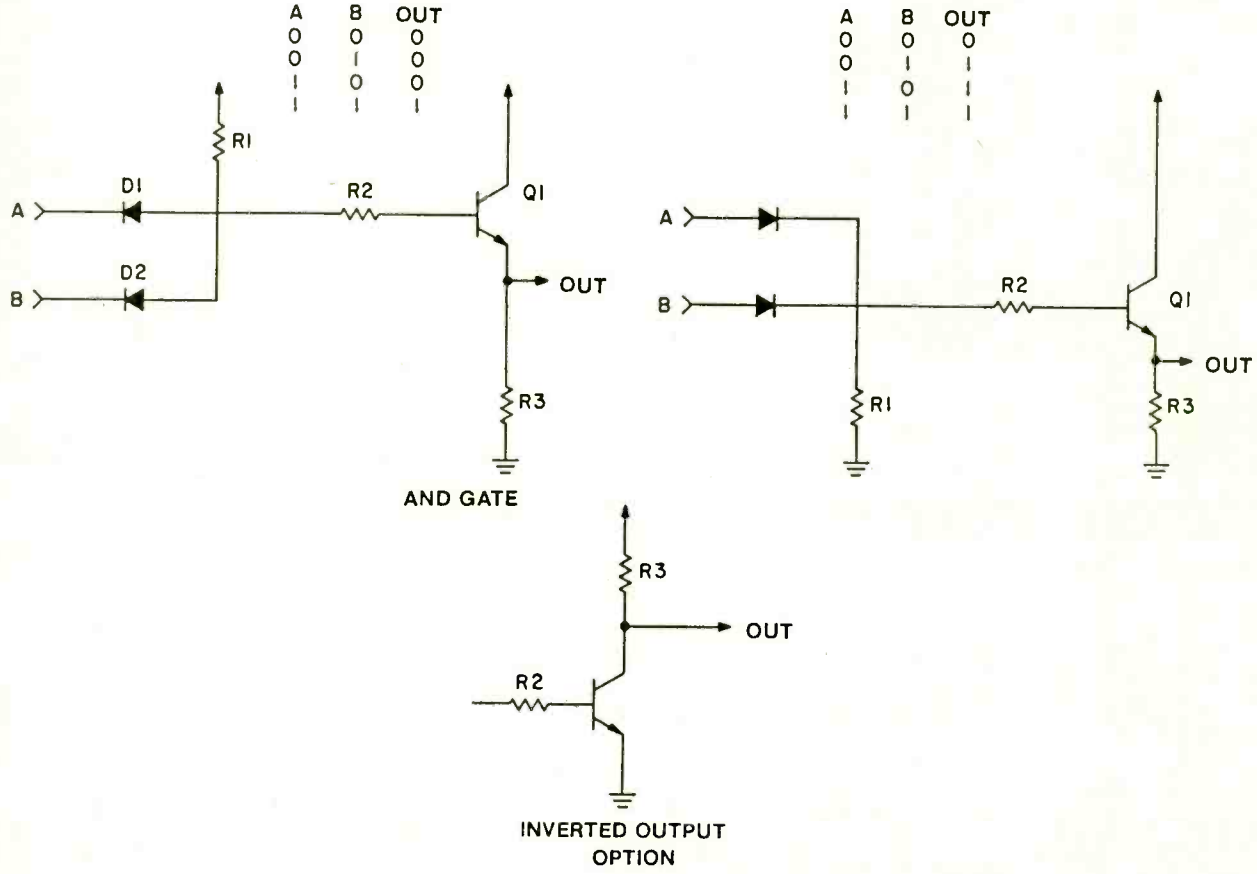
Once in a while, a project may require a modification to meet your present needs, and you can find yourself out of the space needed to mount that extra IC or two. In a digital circuit, sometimes only a single logic gate is required, and it can seem like a waste not being able to use the other gates left over on the chip.

In situations like these discrete transistor and diodes can be used to put together logic functions like AND and OR gates. For example, with the AND gate below, if either input is below 1.5 volts, Q1 will be turned off leaving the output low. Only if both inputs are high (close to V+) will the transistor turn on and give us a positive output. Similarly, if we turn the diodes around and wire RI to ground instead of V+, we have an OR gate, In this configuration, Q1 will be turned on if either or both inputs are high.

Either of these gates can be easily changed to give us an inverted output by grounding Q1's emitter and taking the output from the collector via a pull-up resistor. In all 4 circuits, more diode inputs may be added as desired. They make great logic demonstrators for classroom use, and can be used to replace IC gates in many low speed applications. The author has used these circuits with power supplies of 5 to 18 volts. ■

PARTS LIST

D1, D2— 1N914 or similar diode
Q1—2N2222 or any NPN general-purpose transistor
R1—220 Kohm, ¼ W
R2— 47 K
R3—1K



DISCRETE LOGIC GATES

METRONOME

A good sense of time is one of the skills separating the mediocre from the master musician, and this little circuit can go a long way in improving one's rhythm. It generates a steady series of clicks for the musician to accompany himself or herself. The tempo is adjustable over a wide range by the RATE control, and the output may be fed into almost any audio amplifier.

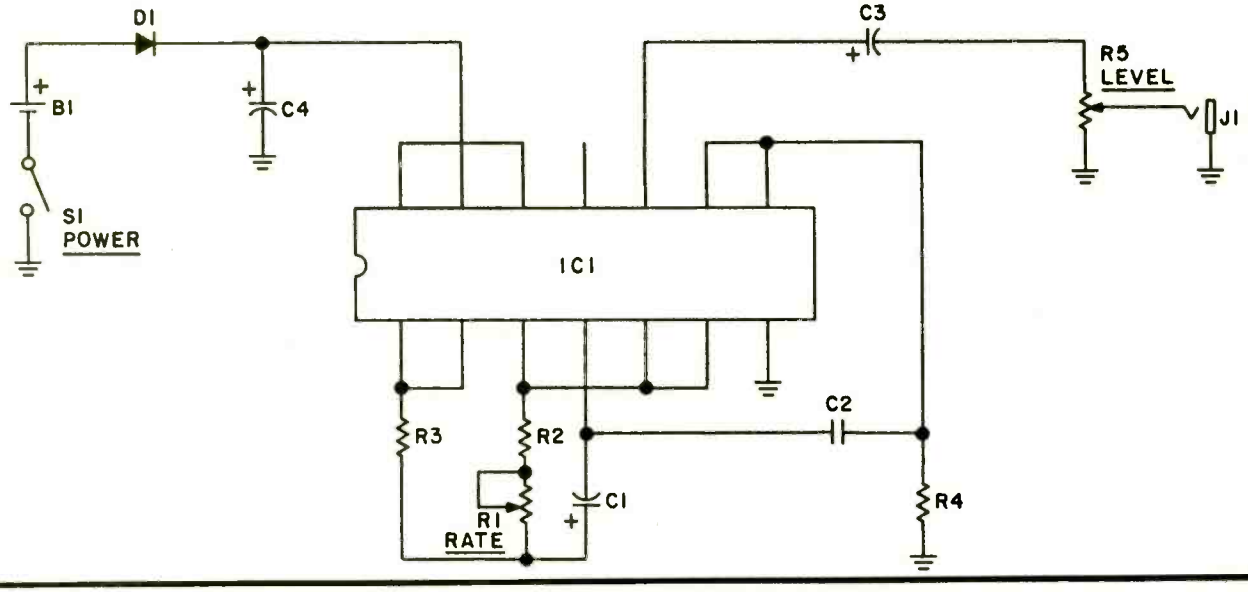
The lower two gates form a simple astable multivibrator. C1, R1, and R2 set the frequency of the multivibrator. The third gate forms a pulse-shortening circuit to give the output it's familiar 'click'. The RC combination here can be modified to change the sound. The circuit is powered by a 9-volt battery, and it is reverse-voltage protected by D1 and decoupled by C4.

Construction is not critical, and you may use any favorite method to put it together. Because the chip is CMOS, the use of a socket or Molex pins is advisable. By the way, you don't have to use a 4001; a 4011 will work as well, as will any CMOS IC with at least 3 inverting gates (although you may have to change the pinout.)

This circuit offers excellent performance at a very low cost, and no matter what style of music you play, this project will help you to 'click' in better! ■

PARTS LIST

B1—9-volt transistor radio battery
C1—3.3 uF electrolytic, 15 VDC
C2—.01 uF DISC
C3, 4—10 uF, 15 volt or better
D1—IN914 or similar diode
IC 1—CD 4001 CMOS quad NOR gate
R1—500k linear taper potentiometer
R2—8.2 Kohm, ¼W
R3—1Meg
R4—200 K
R5—10 K audio taper pot
J1— open circuit phone jack
S1—SPST switch (can be on back of R5)



PHONE STATUS INDICATOR

How many times have you picked up a phone extension and found that the line was dead or busy? Want to avoid that embarrassment?

The Phone Status Indicator is ideal for you. Built in a small enclosure, it sits near a phone. When the line is normal, a green LED is lit. Should the line lose power, no LED is lit.

When a phone is off the hook, the green LED goes dim and the red LED goes on. The red LED will stay on as long as there is a phone off the hook on the phone line being monitored.

The red LED shuts off and the green LED goes on when the phones are all on hook.

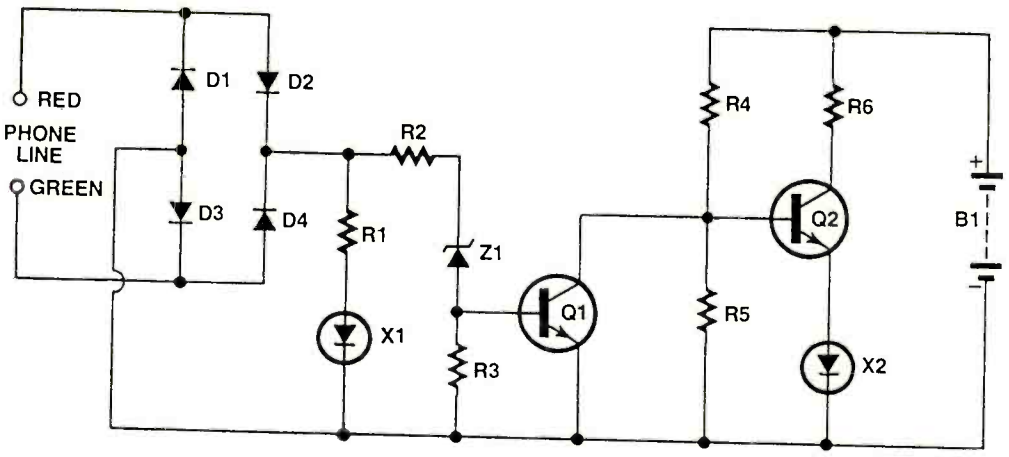
Circuit Operation:

Power from the phone line enters the diode bridge. The bridge passes the DC correctly no matter what the polarity.

The power is then fed to R1-X1, which lights when the phone line is on hook as there is about 50 volts on it at that time. This power passes through R2 and Z1, as Z1 has more than 12 volts across it. The power passing through Z1 turns Q1 on, holding Q2 off and X2 off also.

When a phone is off hook, the voltage drops to about 12 volts. X1 dims, Z1 stops zenering and passing cur-

PHONE STATUS INDICATOR



SCHEMATIC OF THE PHONE STATUS INDICATOR

rent, Q1 shuts off, and Q2 turns on. This turns LED X2 on, indicating busy.

X2 could be a flashing LED, making it more noticable. Adjust R6 accordingly.

It is important to keep R1 to a value over 20K ohms as it must withstand the 220 VAC ring power.

A switch can be installed in series with the phone line and/or the battery to permit shutdown of all or part of the unit.

As the phone lines carry fairly high voltages, all connections should be made inside an enclosure.

PARTS LIST FOR THE PHONE STATUS INDICATOR

D1, 2, 3, 4—IN4007 Diodes
X1, 2—LEDs of appropriate color
Z1—12 volt zener diode
Q1, 2—2N2222 Transistors
B1—9 volt battery
R1—27K ohms, ¼ watt resistor
R2—560K ohms
R3, 4, 5—100K ohms
R6—330 ohms

HEADLIGHT SENTINEL

Sometimes headlights will fail when you least expect it, or the connector may be loose. This simple circuit will tell you if the headlights are OK.

All that is required is 3 parts per headlight. If the filament of the headlight is intact and the connector to the headlight is making a connection, the green LED, X1 is lit.

Diode D1 isolates the headlight filament path from the rest of the electrical circuitry of the car, so the LED is only on if the path through the headlight dim filament is OK. It is best to monitor the dim side as that is top candidate for failure. The dim side also draws less power and thus would not require as big or as expensive an isolation diode.

R1 limits the total current passed through X1, the green LED. This keeps the LED from failing due to overcurrent or overvoltage.

A small panel can attach to the dashboard and hold two LEDs, one for each of the regular headlights.

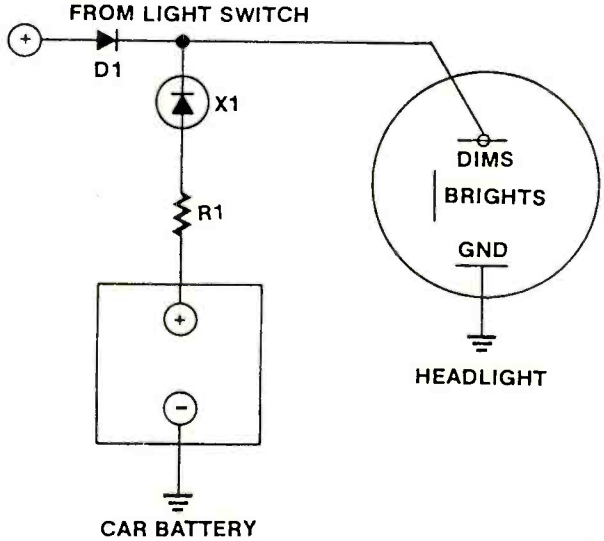
This panel should be rugged enough to avoid failure from damage in an automobile environment.

Actually you could use this circuit to monitor any auto lamp. You could make a panel with an LED for each bulb in your car. You would know about any failed lamps right away.

It is best to mount the diode on a heatsink. Healights draw a good amount of current. ■

PARTS LIST FOR THE HEADLIGHT SENTINEL

R1—390 Ohm, ½ watt, 10% resistor
X1—Green LED
D1—6 amp 200 PIV diode. Digi-Key part G1752
Misc.—Heatsink for D1, panel



HEADLIGHT SENTINEL

BUILD A TONE CONTROL UNIT

If you are contemplating building an amplifier system for your home, you should consider a tone control with a separate bass and treble. Here is how you can do it yourself.

Most tone controls consist of a single control which is labeled TONE. But what does it do? Mostly, these controls just incorporate a couple of passive components to provide the illusion that you are getting a better response.

In the final analysis, all you are getting is a very crude circuit which simply reduces the amount of high frequencies you can hear. And with CDs, this is hardly desirable.

This circuit uses a single IC and provides what is called "active tone control" that is, it provides not only "cut" but "boost" as well, making the higher frequencies sound louder than the bass frequencies, and in many cases this is desired.

IC1 is a high-performance but low-priced LM833 dual OpAmp with IC1a connected as an AC voltage buffer.

Components R2, C3, VR1, R3 and R5 form the bass network while components C1, VR2, C3 and R4 form the treble network. If you look closely, you'll see that both networks are connected in the negative feedback loop of the second OpAmp, IC1b i.e. from the output at pin 7 back to the inverting input at pin 6.

The gain, or the amount of amplification is set by the ratio of the two resistors R6 and R7. By making R7 bigger, you'll make the output louder.

Construction

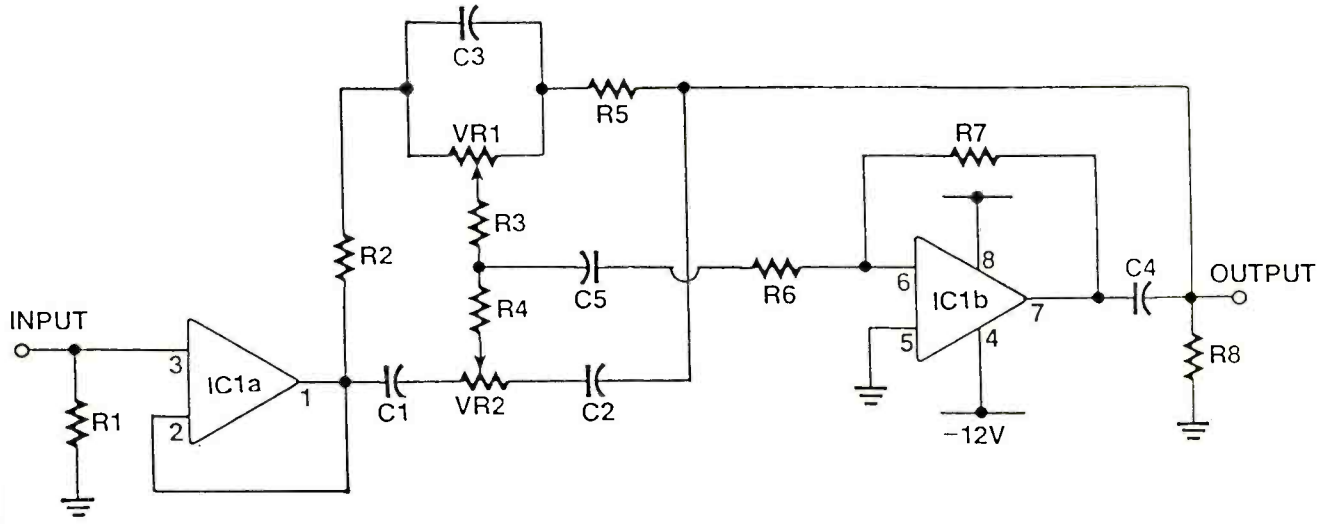
To ensure that your Control Unit sound is as good as possible, there are a few steps you need to follow. Firstly, keep all leads as short as possible. Since these OpAmps are high-performance, they are capable of picking up and amplifying radio waves as well as the music you want to listen to. Keeping your leads short will help prevent this.

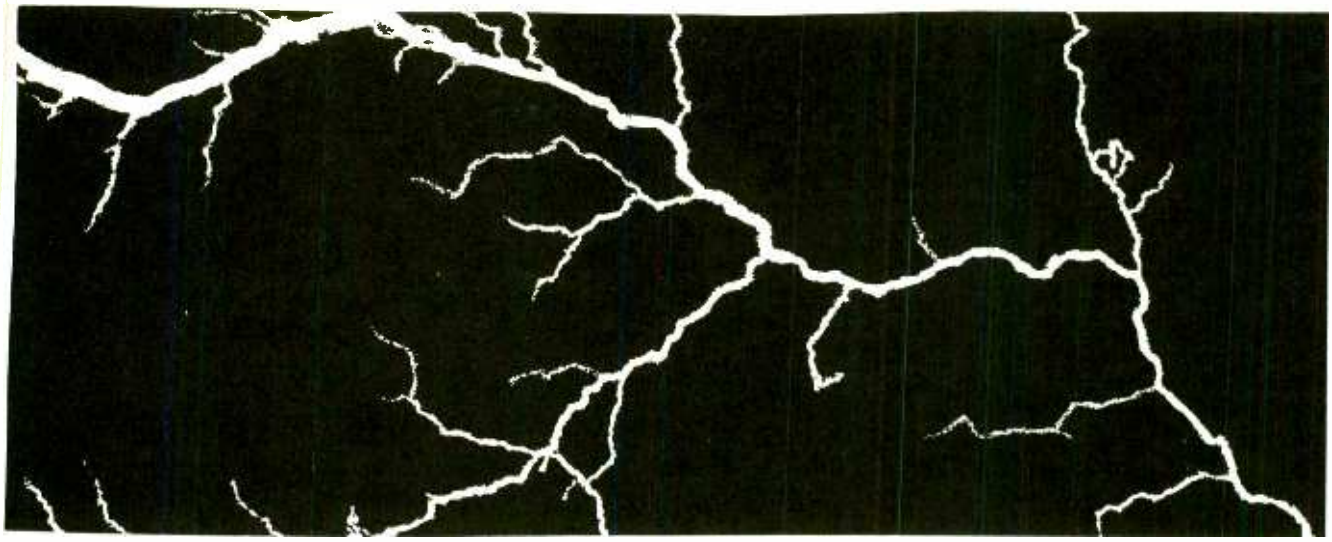
The next thing you have to do is when connecting your wires to link your CD player to the Control Unit, you must use shielded audio cable which you can purchase at your local electronics store. It will most probably have an inner core that has its own plastic cover inside, and then be surrounded by lots of copper wires on the outside, and then finally by the outer plastic covering.

Don't forget if you are building a stereo amplifier, you'll need two of these circuits, with the controls for VR1 and VR2 ganged together just as the volume controls of your amplifier. If you follow these construction rules, this circuit will rival many of those currently on the market. ■

PARTS LIST FOR ONE-CHANNEL VERSION OF TONE CONTROL

C1, C2—0.0022uF mylar capacitor
C3—0.047uF mylar capacitor
C4, C5—4.7uF, 25VW, electrolytic capacitors
IC1—LM833 dual OpAmps IC
R1, R6-R8—100K, 0.25W, 5% resistors
R2, R5—4.7K, 0.25W, 5% resistors
R3—39K, 0.25W, 5% resistor
R4—5.6K, 0.25W, 5% resistor





UNDERSTANDING ELECTRICITY

By Ron C. Johnson C.E.T.

PART VI

In this issue we are going to go for the practical and discuss the basics of oscilloscopes. In the next issue we will dive into magnetics, which is the basis for inductance, motor action and those weird perpetual motion machines you see in the specialty stores.

We could have checked out oscilloscopes before the last issue because the waveforms we were talking about in previous issues are one of the things which oscilloscopes are used to display. No matter, better late than never. After we get into some AC circuits, we will want to know how they work because, if you have access to one, I'm going to suggest some simple experiments you can do.

OK, let's see what scopes are about.

OSCILLOSCOPES

Oscilloscopes are a great piece of test equipment to have on your bench—if you can afford one, at least. They do tend to be one of the most expensive pieces of standard test equipment but, being as versatile as they are, they are well worth a sizeable investment. Actually they have been coming down in price in recent years. You can now pick one up for a few hundred dollars which will do almost anything a hobbyist might want to do. Check out some of the catalogs in the "Catalog Corner" of this issue.

So, you say, what will a 'scope do for me that I should spend the grocery money on it?

Well, oscilloscopes will do a lot. First, an oscilloscope will display repetitive waveforms (like the sine, square and triangle waves we looked at in a previous issue). Because the oscilloscope screen displays amplitude (on the vertical plane) versus time (on the horizontal) it can show waveforms and allow you to measure the amplitude and period (length of one cycle) at the same time. Not only that but it can measure these two variables over a very wide range as we will see later.

While the oscilloscope is displaying repetitive wave-

forms, which are AC voltages, we can also see how much, if any, DC voltage is present.

Another handy aspect of the scope is that most of them have dual trace features which allow you to look at two waveforms at the same time and compare amplitude, frequency and phase differences.

Noise, while not always a repetitive waveform, can be measured using an oscilloscope. This is important, as noise can be a source of real problems in your projects and can't be effectively detected or measured with a meter.

I have mentioned the main parameters which can be measured with the oscilloscope but it's really the application of these that make it effective in testing and troubleshooting. And there are a lot more specialized applications:

By turning off the time base (which we will learn about shortly) and applying signals to both the horizontal and vertical planes, we can use the scope to display "Lissajous patterns." These are a specialized way of comparing two sine waves to determine their exact frequency and phase relationship. If the two signals are exactly the same frequency and in-phase a diagonal trace will appear on the screen. If they are the same frequency but 180 degrees out of phase they will display a perfect circle on the screen.

This same application is used in component testers based on the "tracker" principle. In this case, however, the current versus voltage characteristics of the device under test distorts one of the axis displaying a strange but, with practice, recognizable, pattern on screen.

And there's more...But we are getting ahead of ourselves. We need to look at how this thing works to understand how to effectively apply it.

The Tube

The oscilloscope, except, in a few specialized cases, uses a cathode ray tube for its display. The cathode ray tube, or CRT, is something like a television picture tube, only different. (He's trying to confuse us again.) Not really. The CRT is the same as a television picture tube in that it uses a beam of electrons which are directed at a phosphor coating on the inside of the flat front of the tube. When the beam hits the phosphor it glows, exhibiting a visible spot on the front of the tube. It is different than the television tube in the way that it controls where the beam will strike.

Television uses a technique called electromagnetic deflection in which the beam is deflected by an electromagnetic field created in a 'yoke' or special electromagnet fitted onto the neck of the tube. Oscilloscopes use electrostatic deflection. Electrostatic deflection uses electrically charged plates built into the neck of the CRT to set up an electrostatic field which attracts or repels the electron beam. Figure 1 shows a simple CRT with the vertical and horizontal plates inside. To deflect the beam upward the top plate would be made more positive than the bottom. The negatively charged electrons in the beam would be attracted toward the positive plate, the beam would be bent, and the beam would cause a dot of light on the phosphor screen somewhere above the center of the CRT. The same could be done for the horizontal plane using the horizontal plates.

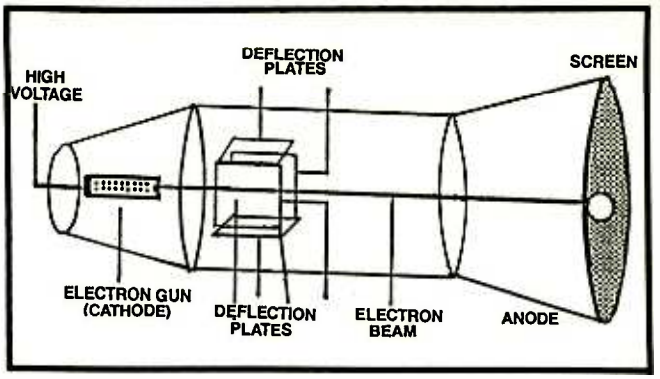


Figure 1. Cathode Ray Tube.

So the position of the spot of light can be controlled by applying voltage to the deflection plates in an appropriate fashion. Let's see how this is done.

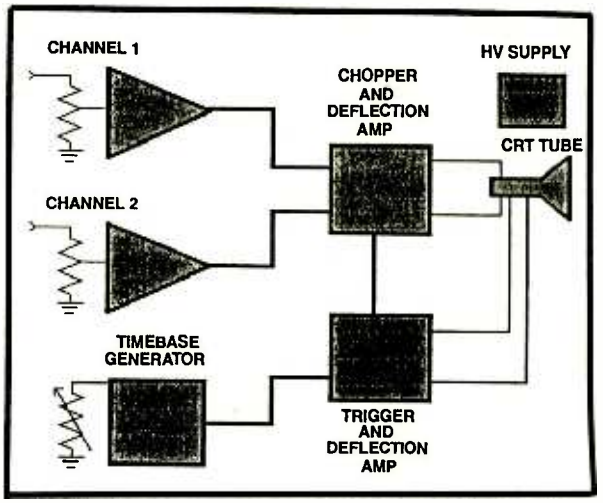


Figure 2. A block diagram of an oscilloscope.

Figure 2 shows a block diagram of a basic oscilloscope. Let's look at the timebase generator first. We said that during normal operation the oscilloscope displays signals with respect to time. This means that the horizontal axis of the scope displays the time axis of the signal. The timebase generator is a circuit which produces a precise and linear signal which will cause the beam to move across the CRT from left to right repetitively so that we can produce multiple traces of the same signal. (We need multiple traces because the signals we want to observe often happen so fast that we could not see them as a single event. We have to repeat them many times in order for our eyes to perceive them.)

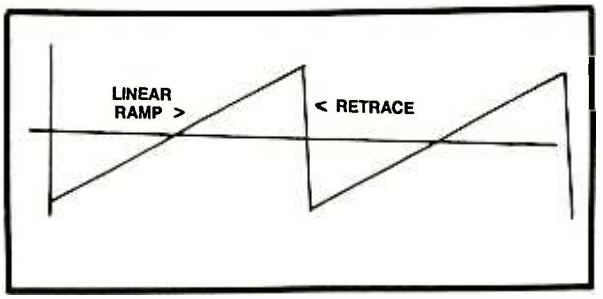


Figure 3. Ramp waveform for timebase.

And what kind of signal should the timebase generator produce to accomplish this? Figure 3 shows a ramp waveform which starts at some negative voltage and rises linearly at some rate of change (slope) to a positive voltage of the same magnitude. At that point the voltage drops very quickly back to the starting voltage. We said before that the beam of the CRT normally strikes the screen in the center and that potentials across the plates create the deflection. To bring the beam to the left side of the screen a negative voltage is required. To bring the beam to the right side a positive voltage is required. The ramp waveform used by the timebase generator, by starting at some negative voltage, positions the beam at the left side to start, then drags it across the screen to the right side. Once there, the voltage dropping back to the negative value drags the beam back across the screen so quickly that it cannot be seen. This is called the retrace.

The length of time required for the signal to change from its negative value to its positive value is the time required for the beam to cross the screen and determines the repetition rate of the time base. The timebase selector is a multiposition switch which is graduated in seconds per division. When a waveform is displayed on the screen, the period of the waveform can be determined by counting the number of divisions required for one repetition of the signal and multiplying that times the seconds per division on the time base selector switch. (See Figure 4 for an example of the screen graticule.)

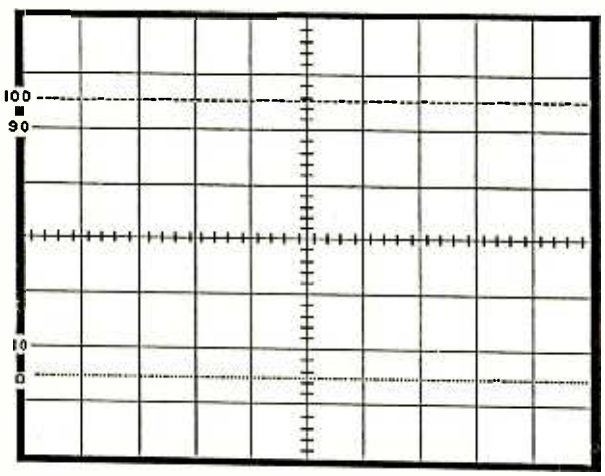


Figure 4. Oscilloscope Graticule.

We are getting a bit ahead of ourselves. What about the deflection amplifier? You will notice that the timebase feeds into the deflection amplifier. The deflection Amp amplifies and converts the signal to a level appropriate for driving the electrostatic plates in the CRT. These control voltages are usually relatively high (100 volts +) in order to create strong enough electrostatic fields to deflect the fast moving electron beam to the sides of the screen.

Before we talk about the trigger circuitry let's go back to the vertical inputs and see what happens to the input signals.

The oscilloscope shown in the block diagram form in Figure 2 is a dual trace scope: there are two signal inputs, Channel 1 and Channel 2. The potentiometers indicate that the level of the signals can be adjusted. More precisely the gain of the amplifier for that channel, called the vertical amplifier, can be selected so that we know what the scope is telling us. The vertical sensitivity, as this control is called, is graduated in volts per division which refers to the major divisions on the CRT graticule. (See Figure 4) When measuring the voltage of any signal, which is shown on the vertical axis, we determine the number of vertical divisions that the signal is from some reference and multiply it by the vertical sensitivity which is in volts per division.

The two input signals, after being scaled and amplified are fed to the chopper and deflection Amp. The chopper is a circuit used to make one beam on the CRT look like two. It alternately samples the two inputs and feeds them on through to the deflection Amp at a rate high enough that we do not notice the switching. On screen we see a small portion of the input to Channel 1 and then the chopper switches to Channel 2 and a small portion of it is displayed. This switching back and forth continues at a high rate as the beam moves across the screen tracing each input signal in a fashion that looks like there are two beams. Older scopes sometimes had dual beams, or two electron guns within the same CRT, in which case the chopper circuit was not needed but there had to be two deflection amplifiers. Most modern scopes use a single gun CRT and the chopper circuit.

Now we have: two signal inputs, scaled by the vertical Amp and sampled by the chopper circuit, and applied to the vertical plates of the CRT by the deflection Amp. As these inputs change with time, the beam is dragged across the CRT by the timebase generator signal which is also applied to the CRT by a deflection amplifier. The result is two traces of the input signal with respect to time.

Next we have to talk about triggering.

So far, we have had the timebase free running at some frequency determined by the seconds per division control, dragging the trace repetitively across the screen. We said that we wanted the beam to trace the waveform over the top of itself many times in order for our eyes to perceive the fast occurring waveshape. In order to have the waveform trace over itself multiple times the beam must start at the same point along the waveform each time. Otherwise we would have numerous traces all shifted with respect to each other.

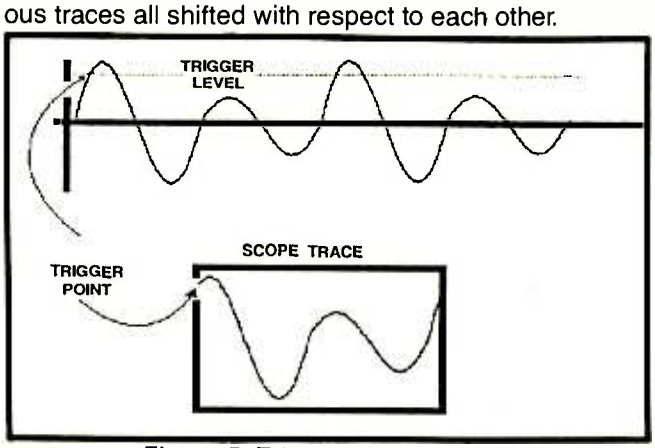


Figure 5. Trigger level and trace.

Figure 5 shows a repetitive waveform which we might want to display on a scope. What we want to do is to start the scope trace at the same point along the waveform every time it repeats itself. Also, we might want to adjust the point at which the trace starts. On a basic scope which has triggering capabilities (they all should to some degree) there is a level control which presets the voltage level at which the scope will start the trace. In Figure 5 the trigger level is shown as a dotted line. It intersects with the waveform level on the positive going side and negative going side of the first peak. The lower peak never intersects the trigger level so we can ignore it. In addition to the trigger level most scopes have a slope switch for positive or negative slopes.

If the scope is set for a positive slope at the level shown, the scope circuitry detects this situation and initiates the trace. This will display the waveform shown. Each time the waveform goes through the level shown on the positive slope the trace will be initiated again retracing the same waveform over the preceding one.

Switching the slope switch to negative slope would cause the scope to initiate the trace at that same level but on the negative going side of the waveform. This would shift the waveform over on the CRT.

Horizontal timebase, vertical amplifiers and trigger circuitry make up the three main sections of an oscilloscope. Certainly the more expensive models can do more: The source of the trigger signal can be changed from Channel 1 to Channel 2, to the AC power line frequency, to an external trigger input signal. Delay can be added to the trigger signal so that the trace will be initiated at some time later than the trigger conditions set.

Another feature of some timebase generators allows the operator to set an alternate sweep rate and highlight a portion of the signal on screen. Once the area of interest is highlighted the scope can be switched to the second sweep rate while still being triggered as before. This expands the area highlighted to allow you to take a closer look at the signal.

Some scopes are providing more than two input channels as well, which is useful in working with some circuits, such as digital ones, where there may be several signals you want to monitor at the same time.

On the topic of inputs it should also be noted that oscilloscope probes are a very important part of the scope. Scope probes come in various shapes, sizes, and configurations but the two most common are X1 and X10 probes. An X1 probe does not provide any attenuation to the input signal so the input sensitivity selector reads directly in the volts per division given on the selector switch. An X10 probe has a built-in attenuator which scales the incoming signal by a factor of $^1/_{10}$ so if the signal is 100 volts peak to peak the scope will show 10 volts peak to peak. In addition to allowing the scope to measure higher voltages the X10 probe also increases its input impedance. The normal input impedance of the scope is usually about 1 megohm (the input impedance using the X1 probe). With an X10 probe the input impedance is about 10 megohms.

If you read this series a couple of issues back, when I talked about meter loading and input impedance you will remember that the higher the input impedance the less the measurement device loads down, or affects, the circuit. So the X10 probe is less likely to affect the circuit you are working on.

One last thing about probes: Because of the high frequencies which are often measured (and high frequency components in harmonic rich waveforms) the X10 has an internal variable capacitor which is adjusted to compensate for the frequency dependant impedance of the scope input. Usually the scope has its own source of a reference square wave which is used to adjust the probe so that the square wave shown on screen is accurately reproduced. The square wave should have no rounding or overshoot on the leading and trailing edges of the waveform.

Well, those are the basics on scopes. There is lots more: As usual, because of microprocessor technology, lots of enhancements are available that were not around on the basic analog scope. We could talk about digital storage scopes which sample the input, digitize it and store the information in memory, and then run it back for later inspection. These are great for one shot or instantaneous events like noise glitches, etc. They are also more expensive.

Another new and very useful enhancement appearing on more scopes is digital information displayed on the screen. Moving cursors on the vertical and horizontal axis can be used to accurately measure time (horizontal) and voltage (vertical) without interpreting the graticule.

Other kinds of test equipment like digital meters and frequency counters are sometimes built into the oscilloscope. As mentioned earlier 'tracker' type component testers are sometimes included as well.

Really we are just scratching the surface. There is lots more but it doesn't mean much if you don't have a scope to actually play with. If you can get ahold of one without mortgaging the kids' future it would be well worth it for its usefulness in project building.

Next issue: Magnetics—in which Captain Coulomb enters into a life and death struggle with the dreaded Dr. Flux and his henchman, Newton Force.

Stay tuned. ■

THE CATALOG CORNER

If you live in a relatively remote area that doesn't have ready sources for electronic parts, you can send away to numerous supply houses, who have good catalogs of electronic parts and assemblies...many of them real bargains.

Following are several catalogs that we have recently received in the mail, with brief descriptions and comments. Most of these suppliers send out new catalogs every four to six months, with many of the items repeated and new ones added, plus some new "specials"...usually on the first couple pages and the last few pages of each issue.

BEST COMPUTER SUPPLIES

That new computer of yours not only makes you a member of a technological elite, it also makes you a consumer of computer supplies, and in case you haven't figured it out already, be advised that over the course of your computer's lifetime, you're likely to spend as much money on supplies as you spent on the computer. A depressing thought, isn't it? Well, you don't have to sit there and take it. Fight back. Get a copy of the **Computer Supplies Digest** from Best **Computer Supplies** and start buying those supplies at discount rates.

Best carries the usual magnetic media like floppies and data cartridges. They've also got optical storage media and drives. Where there's a computer there's usually a printer, too, so Best also stocks computer paper, ink-jet cartridges, laser cartridges, and ribbons. And there's a large selection of doodads and whatzits to keep the computer user—that's you—smiling and happy. Contact **Best Computer Supplies, P.O. Box 1826, Oakdale, CA, 95361. Phone (800) 544-3472.**

J&R MUSIC WORLD

Some electronics catalogs are serious by nature; they feature instruments and tools designed to do work of some kind. Other catalogs promise fun; the items they contain are designed to entertain and amuse the buyer. **J&R Music World's** catalog sort of straddles the line. Yes, there are lots of fun things here: stereo systems, musical instruments, cameras, compact discs, VCRs, televisions, and auto sound equipment. On the other hand, there are many serious items as well—things like computers, printers, modems, fax machines, home appliances, telephones, answering machines, calculators, and so forth. Both the fun stuff and the serious stuff are offered at discount prices, though if you live in New York State, you still have to pay the sales tax. J&R offers an extremely wide selection of items—much more than most local retailers stock—and that may be reason enough to request a copy of this catalog. **Contact J&R Music World, 59-50 Queens-Midtown Expwy., Maspeth, NY, 11378-9896. Phone (800) 221-8180.**

PROJECT PRO

Oftentimes, the hardest component to procure for a project is the box it goes in, especially if you're looking for something distinctive yet reasonably priced. Sure, the big distributors have some pretty nice cabinets in their catalogs, but the prices they ask are in many cases just plain ridiculous. Fifty dollars for a tiny metal box? Who's kidding who? My first car cost $50 (yes, this was many moons ago). In any event, there's no point in getting all steamed up about it. Instead, just check out the latest catalog from **Project Pro.** Here you'll find a wide assortment of beautifully styled cabinets priced below what you'd normally expect to pay. Fancy projects may warrant one of **Project Pro's** metal enclosures, formed of aluminum and steel and painted in a range of colors. Less important projects can go in a plastic box, and they have those, too. For all the info, contact **Project Pro, 1710 Enterprise Pkwy., Twinsburg, OH, 44087. Phone (800) 800-3321.**

HERBACH & RADEMAN

Herbach & Rademan issues a new catalog once every couple of months, and in this catalog they feature an interesting mixture of new equipment and surplus items. Surplus items are marked as such, though in many cases it is hardly necessary, since the low price is a dead giveaway. Being frugal—some would say cheap—I find myself drawn to surplus items like a seagull to a freshly waxed car. As an example of the surplus deals to be found in the H&R catalog, consider the following: a VIZ (RCA) model WM-541A dual-trace adapter, designed to allow the observation of two traces on a single-trace oscilloscope. If memory serves correctly, these babies used to go for close to $100, but H&R is selling them for $19.50. The metal cabinet alone is worth more than that. Naturally, I bought one of these devices, and it works great. There's more to H&R, but I'm out of space, so write to **Herbach & Rademan, 18 Canal St., Bristol, PA, 19007-0122. Phone (800) 848-8001.**

JADE COMPUTER

It seems a safe bet that the vast majority of the people reading this magazine either own a computer or spend a significant portion of their free time hanging out at the home of a friend who does. That being the case, the new catalog from Jade Computer should be of particular interest to all. Jade sells computer hardware and software at reasonable prices. Hardware includes computers, both desktop and laptop, as well as printers, disk drives, monitors, terminals, scanners, plotters, modems, CD-ROM drives, surge arrestors, and various other things. The software selection is more limited and aimed primarily at MS-DOS systems. So, if you're tired of paying through the nose for computer stuff at your local mall, and don't need the so-called "expert advice" that mall stores claim to provide, get the Jade catalog by writing to **Jade Computer, 4901 W. Rosecrans Ave., Hawthorne, CA, 90251-5046. Telephone (800) 421-5500.**

EIL INSTRUMENTS

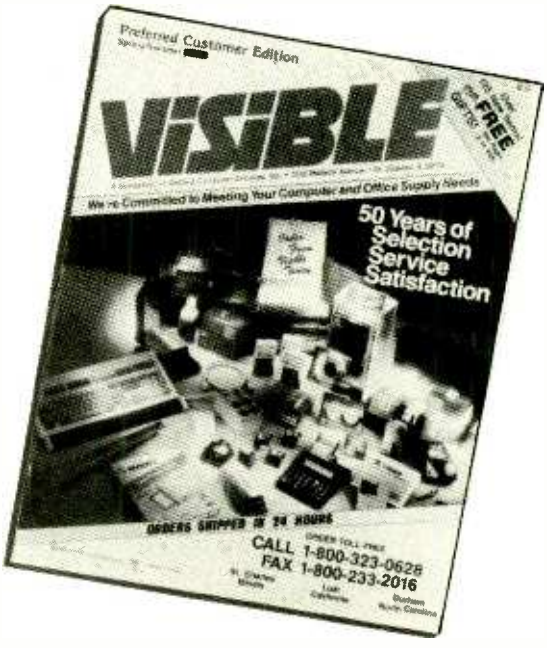
From EIL Instruments comes news of a 506-page Test and Measurement Handbook and Buyer's Guide. Not a hodgepodge collection of test gear, this catalog is neatly and logically organized into nine major sections consisting of the following: electronic test equipment, data and telecommunications test gear, power measurement devices, data-acquisition equipment, calibrators, component and board testers, plant-engineering equipment, force and pressure testers, and special-purpose instruments.

All told, products from more than 120 manufacturers are carried by EIL, including such familiar names as Simpson, Triplett, Wavetek, Weston, Hewlett-Packard, Kenwood, Leader, B&K Precision, Fluke, Extech, and Global Specialties. So whatever your test equipment needs may be, EIL can fulfill them. Send your catalog request to **EIL Instruments Inc., 10946A Golden West Dr., Hunt Valley, MD, 31031. Telephone (410) 584-7400.**

VISIBLE COMPUTER SUPPLY

Computer and office supplies are the stock in trade of the folks at Visible Computer Supply, and their new 274-page full-color catalog is just brimming with all sorts of doodads and gadgets to make your computer system more productive. They've got laser-printer cartridges, dot-matrix printer ribbons, data cables, ink-jet cartridges, paper of all kinds, plotter pens, floppy disks, modems, desks, chairs, and data-storage safes.

Even if you don't own a computer, you may be interested in Visible's selection of the more traditional office supplies, including pens, paper, binders, typewriter ribbons, file cabinets, writing paper, envelopes, labels, rubber stamps, filing cabinets, and calculators. To get your copy of Visible's latest catalog, just write to **Visible Computer Supply, 1750 Wallace Ave., St. Charles, IL, 60174. Phone (800) 323-0628.**



MENDELSON ELECTRONICS

There is no better way of stretching your hobby dollar than by picking up components and gadgets on the surplus market, and in case you're wondering where to find the kind of surplus bargains we're talking about, just check out the new catalog from Mendelson Electronics. In it, you'll find a smattering of just about everything electronic.

Mendelson's got connectors of all sorts, along with a variety of cables (some of them pretty exotic). Would you be interested in a 9-inch CRT for just $10? Or how about an electric motor? They've got induction motors, steppers, and DC permanent-magnet motors—just the thing for the robotics experimenter. You'll also find a good selection of such electronic necessities as switches, relays, potentiometers, capacitors, and resistors. If the thought of all these items at bargain prices has your heart racing, write to **Mendelson Electronics, 340 E. First St., Dayton, OH, 45402. Telephone (800) 344-4465.**

ALFA ELECTRONICS

A showcase of reasonably priced electronic test instruments, that's what the Alfa Electronics catalog is. They've got digital multimeters that span the range from simple to sophisticated. Also an assortment of component testers like capacitance and LCR meters. Maybe you need a clamp-on meter for hassle-free measurements of current. Well, they've got a good selection of those, too. How about a digital thermometer—always a handy thing to have around, and especially nice when it's low-priced, as Alfa's thermometers are. For the amateur chemist or home gardener, Alfa's got a handheld pH meter that will tell you if things are acid or alkaline (more accurately than litmus paper, too). And, of course, what would a test instrument catalog be without an oscilloscope or two. Alfa's scopes range in price from $340 to $750, and look like just the thing for the hobbyist on a budget. Write to **Alfa Electronics, P.O. Box 8089, Princeton, NJ, 08543, or phone (800) 526-2532.**

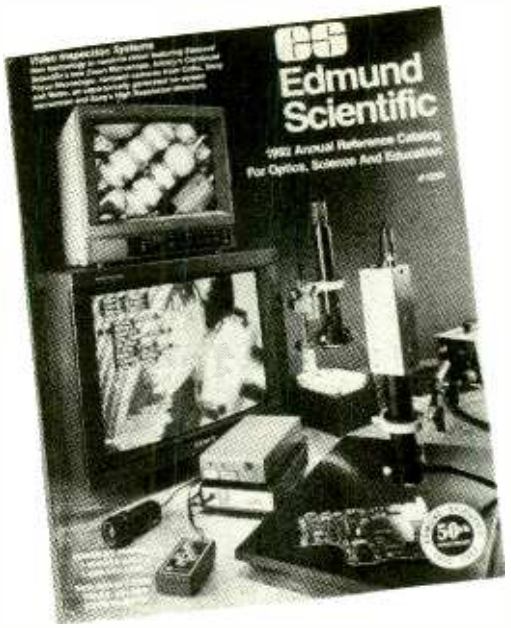
ALL ELECTRONICS

Here's another great source for surplus electronic components: All Electronics. Their latest 62-page catalog is just jammed with electronic bargains of all kinds. In a way, though, it's sad to think that behind every bargain-priced component lies a tale of corporate anguish. Was it a downturn in the market or per-every bargain-priced component lies a tale of corporation anguish. Was it a downturn in the market or perhaps a bankruptcy proceeding that caused this switch or that capacitor to be sacrificed as surplus? Let's pause for a moment to honor the fallen, but then rejoice in the fact that their loss is our gain. And the gain we're talking about here is substantial, as evidenced by All Electronics' wide selection of low-cost switches, microphones, opto devices, relays, transducers, tools, wire, inductors, speakers, fans, pots, transformers, and capacitors. So shed a tear for IBM and the other unfortunates if you must, but then square up those shoulders and write to **All Electronics Corp., P.O. Box 567, Van Nuys, CA, 91408. Phone (800) 826-5432.**

EDMUND SCIENTIFIC

For almost 50 years, the Edmund Scientific Co. has been supplying optical products and scientific apparatus to hobbyists and professionals around the world, and if you don't have a copy of the Edmund catalog on your bookshelf, you're really missing something. Edmund stocks a huge variety of glass lenses, prisms, magnifiers, microscopes, telescopes, diffraction gratings, mirrors, fiber-optic materials, laser light sources, and video cameras.

In addition to the optical stuff, you'll find almost every kind of scientific gadget imaginable, including such things as thermometers, small motors and pumps, magnets of all kinds, weather-prognosticating equipment, laboratory scales, test tubes and other glassware, precision tools, and books. Well, what are you waiting for? Pick up a pen and write to **Edmund Scientific, 101 E. Gloucester Pike, Barrington, NJ, 08007; or phone (609) 547-8880.**



AMERICAN DESIGN COMPONENTS

Egad, what have we here? Another surplus catalog it seems—this one from American Design Components. Do we really need another source of surplus components? Yes, indeed, because competition among the surplus dealers is what keeps the prices down, and because different surplus dealers stock different kinds of items.

So, let's flip through this colorful 48-page catalog and see what American Design Components has to offer. They've got new and used computer systems, monitors, printers, hard drives, computer cables, connectors, tools, robot kits (kinda nice, actually), integrated circuits, capacitors, optoelectronic displays, switches, rechargeable lead-acid batteries, nicad batteries, transformers, power supplies, a great selection of motors, pumps, and compressors. Needless to say, prices are pretty reasonable, too. Write to **American Design Components, 400 County Ave., Secaucus, NJ, 07094. Telephone (800) 776-3700.**

RADIO SHACK

Radio Shack, as you may know, is really not in the same league as most of the companies featured in the Catalog Corner. With more than 7,000 stores and roughly 50 million customers a year, Radio Shack is the colossus of American electronic retailing. As such, Radio Shack needs a free plug here about as much as Ross Perot needs food stamps. Still, the immense size of the Radio Shack empire makes it readily accessible to practically all of our readers, and for that reason alone, it makes sense for us to spread the word about Radio Shack's new catalog. In it, you'll find components of all kinds: resistors, capacitors, ICs, LEDs, switches, tools, etc. You'll also find a wide selection of TVs, stereos, computers, and the like. **Getting the catalog is easy. Just hop in your car and drive off in any direction. In no time at all, you'll find a Radio Shack store, where they'll be happy to give you a free copy.**

IC TESTBENCH

We have said before but it bears repeating. For the beginning project builder, it would be wise to polish your skills on some of the simpler projects in this issue before you tackle the projects in this section.
For those of you who feel ready to try some of the following projects, we offer some suggestions and precautions. Unless you are using a commercially made breadboard, it would be wise to invest in some sockets, whose holes will accommodate the IC pin spacings for the particular ICs which you are planning to use. Through the use of sockets, solder connections can be made without the danger of damage to the IC and voltage and input signal tests can be performed without the IC being exposed to their hazards.
When debugging a circuit, or testing for signals and/or voltages, prior to firing up your project for the first time, it is important that you remember to NEVER apply an input signal to an IC unless the circuit is powered up. Damage will almost certainly occur. Also, in those projects which require a separate input signal, such as a clock source, which is not an integrated part of the circuit you're building, it's a good idea to use a power switch which is capable of controlling the supply to both circuits. This will minimize the possibility of applying a signal to a non-powered chip, both in turning the circuit on and turning it off. If you don't use this method, remember to remove the input signal before turning off the power to the IC circuit...Have fun, and use caution!

SIMPLE BIPOLAR SUPPLY

Many experiments use a battery or a single DC supply to power op amp or other linear circuitry. A single supply is simple and cheap; however, they have serious disadvantages for advanced op amp circuits. First, single supply circuits require additional resistors and capacitors for biasing and AC coupling that are simply not necessary with a bipolar supply! Second, the addition of these components often compromise the noise and distortion levels of amplifiers far worse than needed in demanding applications like audio and lab processors. For those looking to push their op amps performance to the maximun at minimum cost and hassle, we present the Simple Bipolar Supply.

For those into op amps and other linear circuits, the Simple Bipolar Supply has a lot going for it. It has + and - 12 Volt supplies that supply a clean, hum free (conservatively rated) 100 mA, and avoids the use of an expensive center-tapped transformer. The schematic of the Bipolar Supply is shown here.

In our circuit, a 12.6 VAC transformer is used to step the line voltage down to a usable level. The transformer can either mount inside the case with the rest of the supply, or it can even be a plug in AC adpter available at plenty of surplus outlets. A DIP bridge rectifier is used to half-wave rectify the incoming AC instead of the usual full-wave rectification. Since the other half of T 1's secondary is grounded, the rectifier will supply positive and negative going voltages at the + and - outputs of the rectifier.

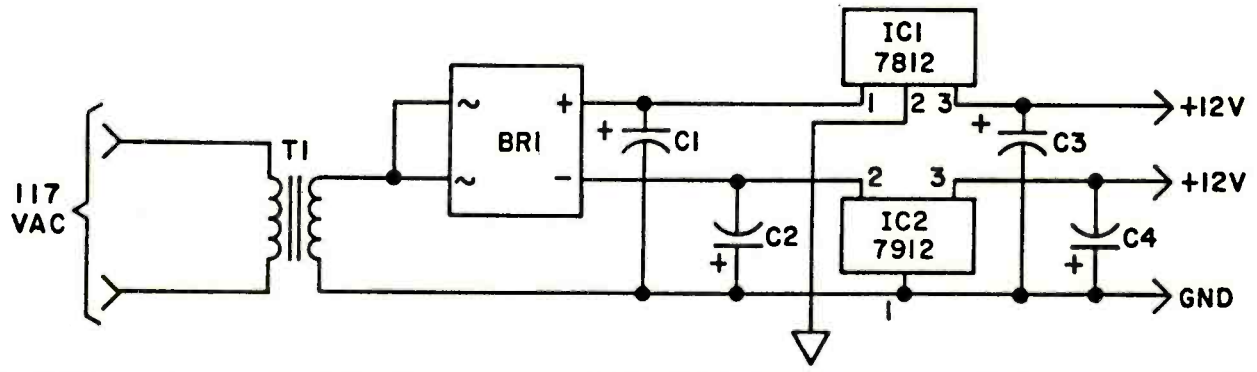
The rectifier outputs are smoothed into regulated DC supplies by C 1 and C 2. The voltages at C1 and 2

should be roughly + and − 18 Volts with no load attached. ICs 1 and 2 turn the DEC voltages at C 1 and 2 into smooth, regulated voltages. With the regulators shown, the outputs will be ± 12 volts; other regulators could be used for smaller supplies such as ± 9 or 5 volts. Finally, C3 and C4 are used to remove the occasional transient from the regulator outputs.

The supply presented here is adequate for a wide variety of op amp and linear IC projects and breadboarding experiments that do not require larger current capacity. As your linear design skills improve, you will probably want several around the bench.

PARTS LIST

BR 1—DIP bridge rectifier, 50V at 1 A (RS # 276-1161)
T 1—12.6 VAC at 300 mA (273-1385)
C 1, 2—2200 uF at 35V (272-1020)
C 3, 4—1 uF at 25 V (272-1434) tantalum preferred
IC 1—7812 voltage regulator
IC 2—7912 voltage regulator
Misc.—Perfboard, hookup wire, solder, AC line cord, grommet, case ■

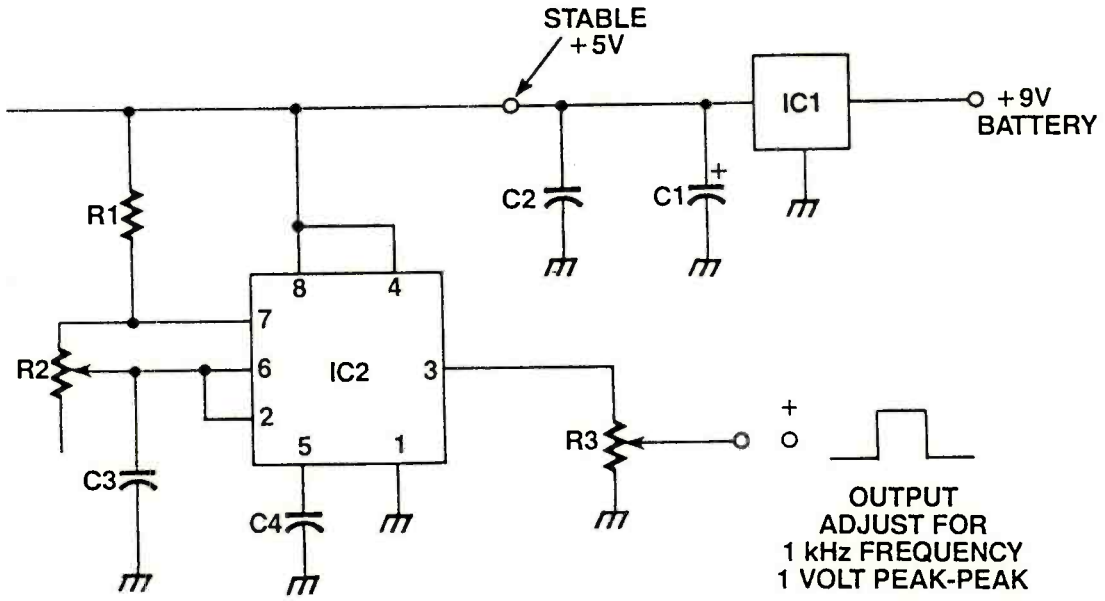


AUDIO AMPLIFIER CALIBRATOR

For calibrating audio amplifiers, a stable signal source with known frequency and amplitude is essential. IC1, C1, C2 provide a stable +5 volt supply, to prevent the signal output changing with aging battery sources. IC1 and its associates components form a normal astable generator. R2 provides adjustment for frequency and R3 sets the voltage amplitude. For best stability use a low leakage mylar capacitor for C1. Adjust the output for a 1KHz/1 volt peak to peak signal against an oscilloscope's internal calibration source or a frequency counter/digital voltmeter combination. ■

PARTS LIST FOR THE AUDIO AMPLIFIER CALIBRATOR

IC1—7805 regular I.C.
C1—100 microfarad capacitor
C2—0.1 microfarad capacitor
IC2—555 timer I.C.
R1—1K resistor
R2—50K potentiometer
R3—10K potentiometer
C3—0.033 microfarad capacitor
C4—0.01 microfarad capacitor



INEXPENSIVE FUNCTION GENERATOR

The function generator is a very useful tool for the hobbyist and technician in many troubleshooting situations. Basically, a function generator can create various waveforms over a range of frequencies. By applying the proper waveform to the input of an ailing piece of equipment, the user can gain important clues to where the problem lies.

Unfortunately, a good function generator can easily cost a few hundred dollars. This ensures that it will be kept off the bench of many hobbyists. However, we have just the thing for members of this group—a circuit that can be used as a function generator in many circumstances at a fraction of the cost. While it can't duplicate the performance of more expensive models, there are many times when it will fit the bill. It has both square and triangle waveforms and can operate over a wide range of frequencies.

There is very little to the circuit, shown in figure 1. Schmit trigger IC A senses the voltage at R3/R4. When this voltage is above 4.5 V or so, pin 7 goes high. THis charges C1 via R1, the FREQUENCY control, and R2. The output of IC B then creeps towards ground until the magic 4.5 Volt threshold is reached, causing IC A to go low and reverse the cycle.

R1, R2 and C1 are responsible for determining the output frequency, and there is a lot of room for experimentation here. We used a 100k pot for R1 as a good compromise, as it gives a fairly wide frequency range with good resolution. A larger pot can be used for a wider range. Ideally, you should use a reverse-audio or 'C'-type taper potentiometer for R1 for smooth sweep. If you use a linear pot, you will find most of the action at the end of the pot's rotation. This makes things a little cramped, but circuit operation is otherwise unaffected. A value of .1 uF for C1 allows the generator to cover most of the audio range. By adding several values and a rotary switch, the frequency range can be greatly extended. Elecytrolytic or tantalum capacitors can be used for very low frequencies, but they *must* be non-polarized.

There are a lot of inexpensive dual op amp ICs that will work for IC 1. These include the LM 1458, the 4458, and the LF 353, but the TL 082 seems to work especially well. It has a high slew rate, which translates into a cleaner waveform at high frequencies, as well as a very low input current. This allows you to use very large values for R1 to maximize the frequency range.

After playing around with this circuit, you're sure to find plenty of other uses. You can try it out on a breadboard first, but be sure to get a piece of perfboard when you buy the other parts—because you'll probably want to keep it around! ■

PARTS LIST

B 1—9 Volt transistor radio battery
C 1, 2—.1 at 15 V or greater (see text)
C 3—10 uF at 15 V or greater
IC 1—1458, 4458, LF 353, or TL 082 dual op amp (see text)
R 1—100k linear or reverse-audio taper potentiometer (see text)
R 2—Ik at ¼W
R 3—470k
R 4—1 Meg
R 5, 6—56k
S 1—SPDT switch

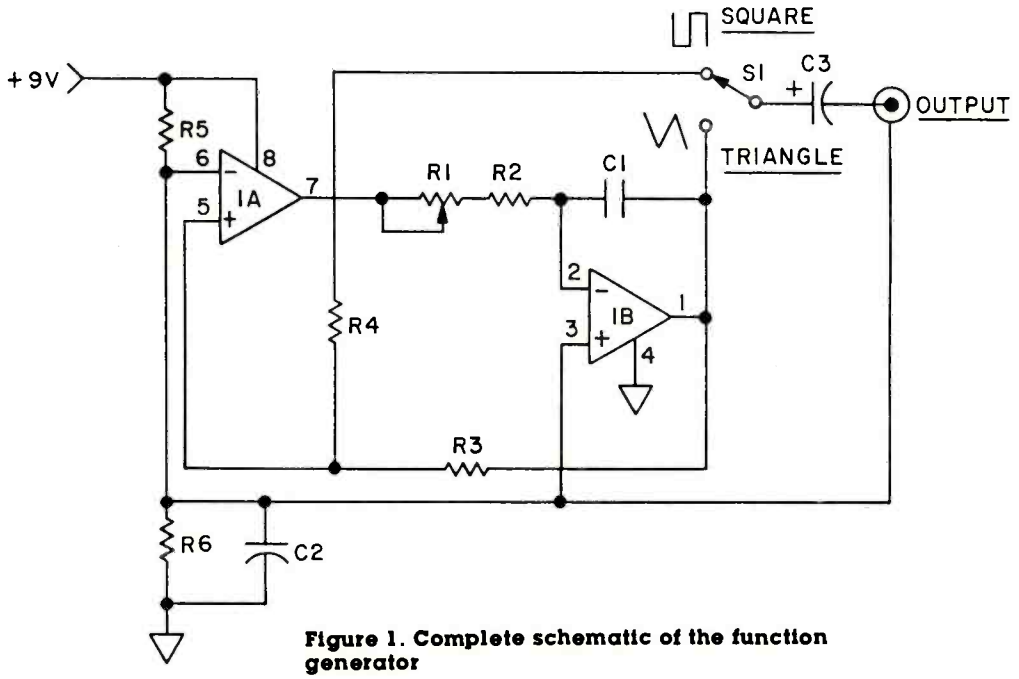


Figure 1. Complete schematic of the function generator

LOW-COST SINEWAVE OSCILLATOR

A Sinewave oscillator is one of the most useful pieces of test equipment that you can have on your workbench. Not only can it be used to test audio amplifiers but it can also be used to test other amateur radio gear as well.

A Sinewave oscillator can be a somewhat illusive waveform because it can sometimes be difficult to generate using a simple circuit. This circuit, however, has a very limited number of parts but it provides a very clean waveform with very little distortion (only 0.02%).

When testing an amplifier for distortion, it is important that the test signal being used be as clean as possible. By 'clean,' we mean that it must contain only one frequency. Any oscillator that contains only one frequency will be a sinewave.

Now, before you get on the phone or get your letter pads out, a square oscillator my oscillate at one frequency but if you hook it up to a device called a spectrum analyzer, it will show you that there are many frequencies present, all at varying amplitudes. The frequency you hear is called the fundamental frequency with the others being called harmonics.

When testing audio amplifiers, it's these harmonics that we definitely don't want. That's why a sinewave oscillator is needed.

This circuit produces a very clean sinewave at a frequency of 1kHz. Looking at the circuit, components R1, R2, C1 and C2 form what is called a Wien bridge. This is a very famous type of circuit which oscillates when connected as part of the positive feedback of an amplifier.

In this circuit, our amplifier is a TL071 OpAmp IC. You can tell it is connected into the positive feedback path because components R2 and C2 form a path from the output at pin 6 back to the non-inverting input at pin 3.

Resistors R3 and R4 set up the DC bias for the amplifier at half the supply voltage. This ensures that the IC is working correctly and that the sinewave produced is as clean as possible.

The circuit must have a gain of at least 3 to oscillate and this is set by components R7 and R5. Resistor R6 and diodes D1 and D2 make sure that the gain oscillations do not get out of hand and clips the output partially to prevent this from happening.

The sinewave generated at the output at pin 6 can then be taken to any audio amplifier for testing.

CONSTRUCTION

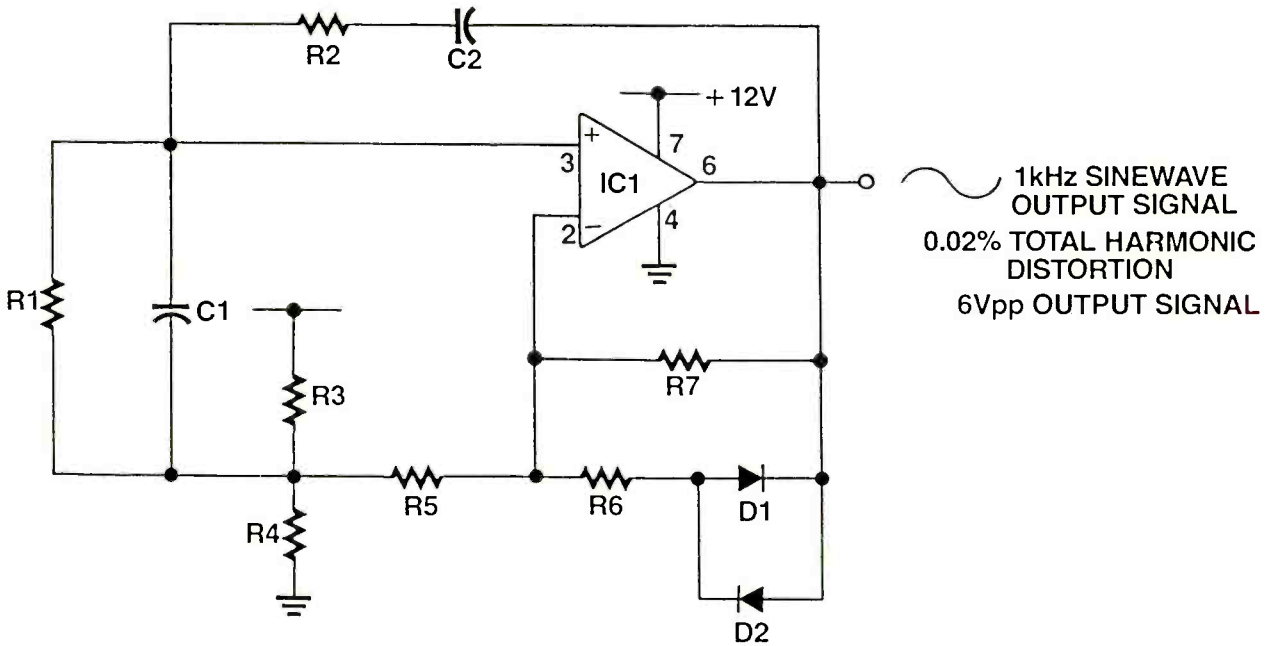
When building the oscillator, it's a good idea to follow the good advice of those who have tried and failed in the past. Learn from their mistakes! Don't use too hot a soldering iron otherwise you'll destroy the IC and the project will never work.

Try the circuit out on a piece of breadboard and then use some perfboard when you're ready to make the final construction. Make sure the leads of the components are not too long and also make sure that each solder joint is a good one.

Be sure that you get the polarity of the electrolytic capacitors correct. It is not uncommon for these components to start spewing their contents in all directions if they are connected the wrong way! ■

PARTS LIST FOR THE SINEWAVE OSCILLATOR

C1, C2 — 0.0022uF mylar capacitor
D1, D2 — 1N914 or 1N4148 small signal diodes
IC1 — T1071 single OpAmp IC
R1, R2 — 68K, 0.25W, 5% resistors
R3, R4 — 10K, 0.25W, 5% resistors
R5 — 47K, 0.25W, 5% resistor
R6 — 1.8M, 0.25W, 5% resistor
R7 — 100K, 0.25W, 5% resistor



LOW-COST AUDIO MIXER

If you are into home videos, then this project will give your sound an added zing. Mix in your favorite music with the sound to set moods and create atmosphere.

These days, home videos can be pretty boring. When you have to stack them up against the latest Steven Segal blockbuster, they tend to fall flat on their face.

This little project allows you to add at least some color to the sound you hear. In fact, you can mix any two audio signals together with this circuit.

Mix your own voice in with your favorite CD or even mix two microphones together. This project will give a lot of scope for variation.

The circuit uses just a single OpAmp, a common LM741. You'll probably have one of these lying around in your junkbox or on your workbench somewhere.

Looking at the circuit, the two in-coming signals are coupled in via two 0.47uF capacitors. This prevents any possible DC loading of either this circuit or the circuit producing the sound.

The amplitude is controlled by two potentiometers VR1 and VR2. These are both 10 Kiloohms in value and should be logarithmic types.

The two signals are then mixed together via two 47K resistors. The signal at the junction of these resistors is both signal sources together.

The 10uF capacitor provides further decoupling from the OpAmp circuit which uses the 741. This is connected as an inverting amplifier with a gain of approximately 4. This is set up by the ratio of the 100K ohm feedback resistor from pin 6 back to pin 2 and the parallel resistance of the two 47K ohm resistors.

The OpAmp is biased from the supply voltage by two 47K ohm resistors. This is again filtered by a 10uF capacitor. The output signal appears at pin 6 and is decoupled from any future circuitry by a 10uF capacitor.

The output from here can be taken to any audio amplifier or tape recorder.

Construction

Because we want the best sound quality we can get, layout with this project is important.

Firstly, the power supply should be smoothed and well-regulated. In the circuit, we suggest that you use a three-terminal regulator such as a 7812 +12VDC type. This will prevent any house wiring hum coming in on the supply.

The next thing concerns the layout. It is important that you use shielded cable for the audio inputs. Because they are by nature, low level high impedance signals, they can easily pick up other unwanted signals such as radio frequencies and this can cause all sorts of problems later on.

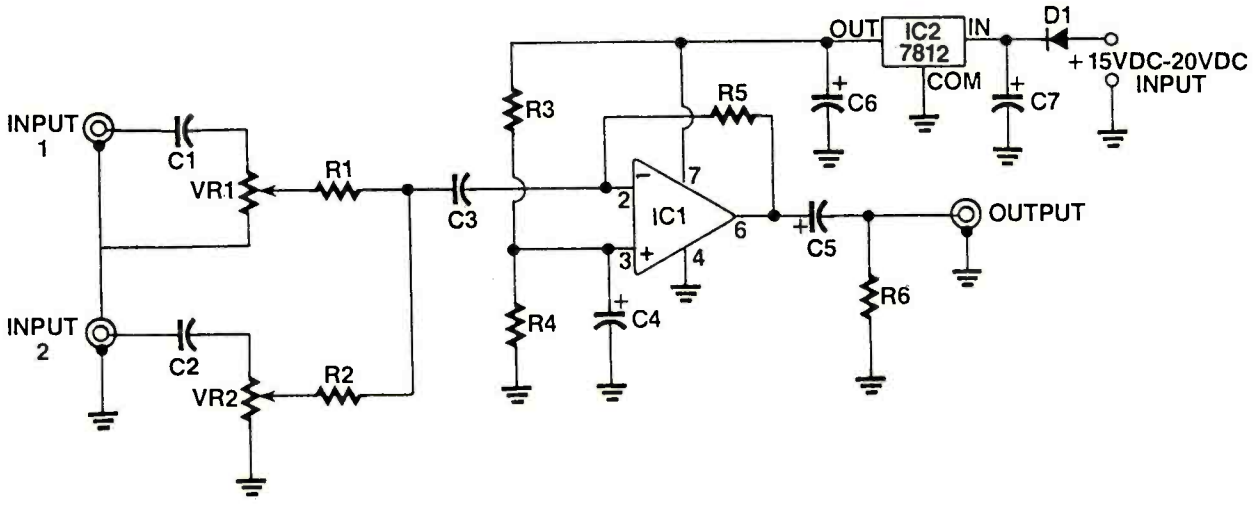
Keep all component leads as short as you can. These can act like the antennae on your TV set if you're not careful.

Another thing, when soldering in the IC do not use too much heat, otherwise you risk damaging the IC.

Despite its simplicity, this circuit works very well and you'll be surprised how much more enjoyable your home video productions will be. ■

PARTS LIST FOR THE LOW-COST AUDIO MIXER

C1, C2—0.47uF Mylar capacitors
C3-C7—10uF, 16VW Electrolytic capacitors
D1—1N4004 Rectifier Diode (or Equiv.)
R1-R4—47K ohms, 0.25W, 5% Resistors
R5, R6—100K ohms, 0.25W, 5% Resistors
IC1—LM741 Op-Amp IC
VR1, VR2—10K ohm Logarithmic Potentiometers
IC2—7812, +12VDC Regulator IC



LOW-POWER FM RADIO TRANSMITTER

Have you ever wanted to build your own radio station? This little circuit will allow you to do just that. It uses just two common transistors and you can get it going in a couple of hours.

This little project allows you to transmit any audio signal through the air to any FM radio or personal stereo. It has a range of about 30 metres with an aerial of about 2 ft.

It has any number of applications. Try these out for size—a baby room monitor to keep tabs on your sleeping baby; front door bell warning transmitter—it keeps an ear on the door while you're out back mowing the lawn. There are many others so let's take a look at how the circuit works.

As you can see the circuit uses only two common transistors. The first, Q1 is the mixer and RF oscillator and Q2 is the RF amplifier. This makes the radio signals a little stronger so that they travel a little further.

The base of Q1 is biased by two 10K ohm resistors and is filtered of radio frequencies by a 0.0015uF capacitor. This prevents the frequency of the transmitter by varying about more than it should.

Because we are using frequency modulation (FM), our audio signal will vary the frequency of the transmitter in step so the transmitter frequency will vary over a small range.

The collector load for Q1 is a parallel LC resonant circuit. This is made up by the coil (L1) which is made up of five turns of enameled copper wire, and the two 100pF capacitors.

This is tuned to approximately 88.5MHz. It will vary slightly for each version you build but it will be close enough for you to be able to find it on your radio.

The two 100pF capacitors in series connected between the collector and the emitter of transistor Q1 provide some negative feedback, which is essential to get the transistor to oscillate at such a high frequency.

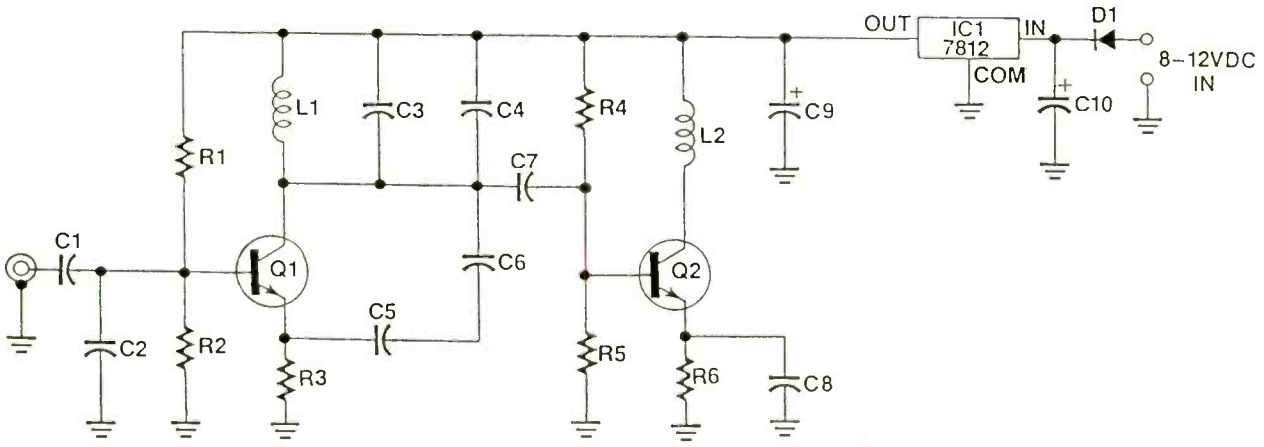
The RF output is taken from the collector of Q1 and fed to the base of transistor Q2 via a 100pF capacitor.

Q2 is biased on via two 10K ohm resistors. The collector load is another coil, this time only four turns of the same wire. This increases the amplitude of the FM signal which can then be taken to an aerial of about a foot in length. The 0.1uF capacitor bypasses the emitter of Q2 so that we get maximum gain.

The power supply for the project can be anywhere from 3 to 20VDC. You can use any form of construction you like so long as you make good electrical connections between the components. Note that the frequency of operation will vary with voltage, the higher the voltage the lower the frequency and visa versa. To keep the frequency more stable you may wish to think about using a three-terminal regulator such as a 7805 5V type. ■

PARTS LIST FOR THE LOW-POWER FM RADIO TRANSMITTER

C1—2.2uF, 25VW Electrolytic capacitor
C2—0.0015uF Ceramic capacitor
C3-C7—100pF Ceramic capacitors
C8—0.1uF Ceramic capacitor
C9, C10—10.uF, 16VW Electrolytic capacitors
D1—1N4004 Rectifier Diode (or Equiv.)
Q1, Q2—2N3565 Low-power silicon NPN transistors
L1—5 turns of 26SWG wire on 5mm diameter air former
L2—7 turns of 26SWG wire on 5mm diameter air former
R1, R2—10K ohm, 0.25W, 5% resistor
R3—180 ohm, 0.25W, 5% resistor
R4, R5—100K ohm, 0.25W, 5% resistor
R6—1K ohm, 0.25W, 5% resistor
IC1—LM7812 +12VDC Regulator IC



HOUSE PLANT MOISTURE MONITOR

By Tony Lee

Do you have trouble knowing when to provide sustenance for your plants? Are you starving them or perhaps killing them with kindness through over-watering?

This moisture monitor takes some of the guess-work and the worry out of caring for them. There is nothing new in electronic house plant moisture indicators and there have been a number of good designs appearing in electronic's hobby magazines but some have had their shortcomings.

The design presented here doesn't just tell you when it's time to water the plants; it also indicates the condition of the soil. An indicator LED in the monitor can indicate three conditions: it winks when the soil is dry; stays on continuously when the soil is just right and turns off when it is saturated.

The aim of course, is to obtain the "just right" condition. This can be achieved by operating a 555 timer IC in a manner probably never intended by the company who first introduced this versatile chip. Those of you who are familiar with this IC will be aware of what pin 4 is used for. It is used as a reset in timing applications or for gating when set up as an astable.

When pin 4 is taken directly to ground, it "freezes" the oscillations and turns off the output at pin 3. When used in this configuration, pin 4 is normally connected to the positive rail via a 22K ohm resistor.

By omitting this resistor and applying a resistance across pin 4 and the negative rail, a condition can be created where the LED stays on continuously. In other words, it disables the oscillator but doesn't turn off the LED if the resistance is sufficiently high. If this resistance was increased still further, at a certain point, the oscillations would commence.

The resistance we are talking about of course, is the soil resistance between the probes when they are inserted in the plant container. Anywhere within the range of 27K to about 320K (on a 9 Volt supply) will result in the "just right" condition. Below 27K or thereabouts, the LED is off, denoting the soil is saturated. Above 320K, the oscillator will be enabled (the LED will flash), indicating a dry condition.

You might think that 27K to 320K is a wide tolerance for an acceptable moisture content but seemingly it is not. Plants in their natural habitat have to cope with wide variations in soil conditions. It is mainly the prolonged saturated or very dry conditions that are detrimental. Soil type and density also play an important part in the moisture readings. Ordinary garden top-soil and the commercially available potting mix will give different results so it is a good idea to use one type only for all your house plants.

It is possible to reduce the resistance range if you have exotic plants in need of special attention. It would be best to consult an expert because your author has very little knowledge of horticulture. However, if you wish to narrow down the "just right" variation, try inserting a 680K resistor across pin 4 and the positive rail and the resistance range will be around 19K to 51K.

Or try a 1Meg resistor and it will give something around 20K to 85K. But for general use, you shouldn't find this resistor necessary.

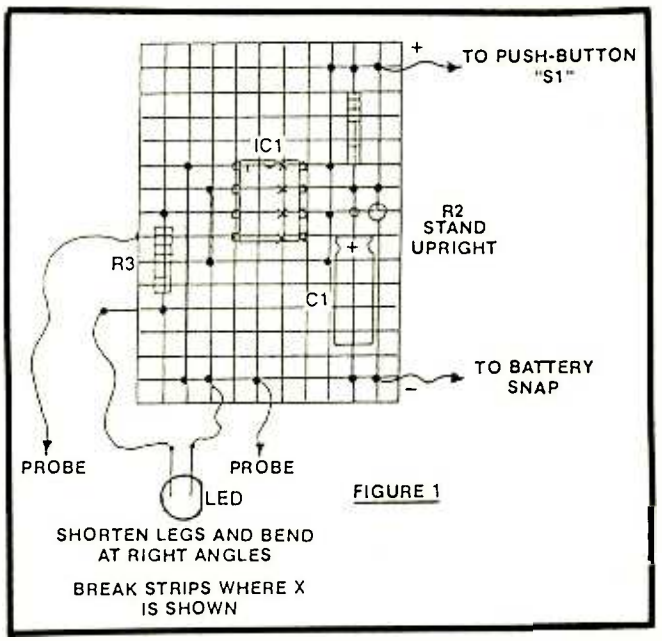


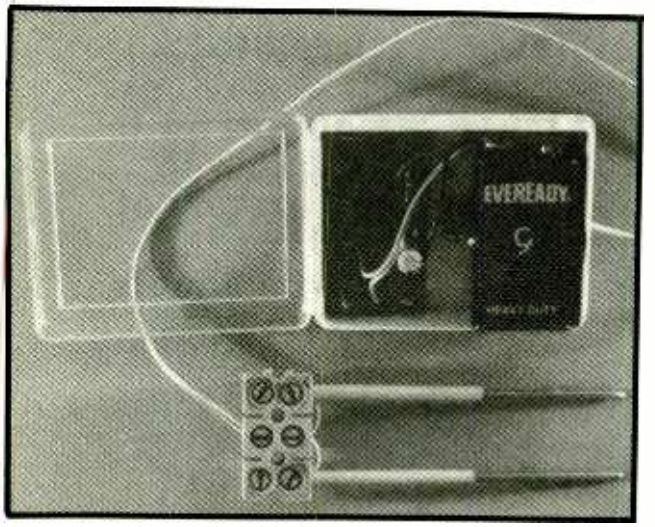
FIGURE 1

Putting it together

A small plastic jewelry box was used to house the

proto-type circuit board, the battery and the push-button switch (see photos). It measures approximately 2¾"×2¼"×¾" usually available from handicraft and jewelry stores. The lid is transparent.

Everything fits very snugly in the case so if you intend using one, the circuit board cannot be any larger than shown in Figure 1. Note that the circuit board seen in the photo was an early proto-type, using plain perforated board. The layout in Figure 1 uses strip board which makes the job easier.



View inside the jewelry box with the lid open. This is an exercise in miniaturization. The proto-type used a single ended capacitor standing vertically. It is better to fit the axial type specified in the parts list.

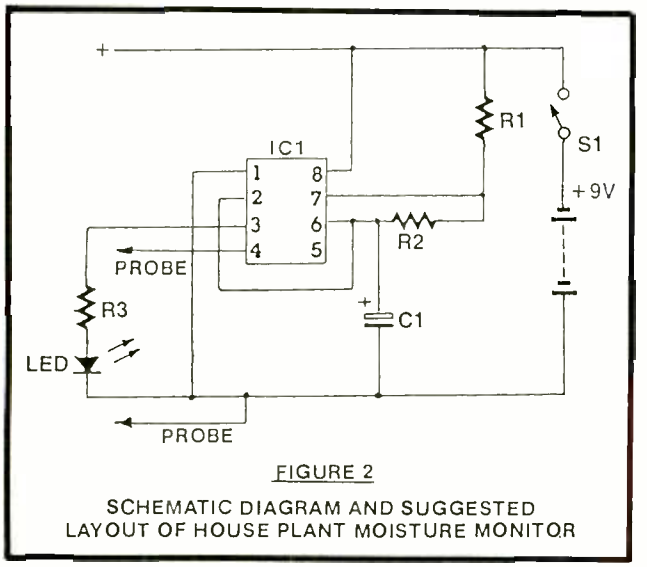
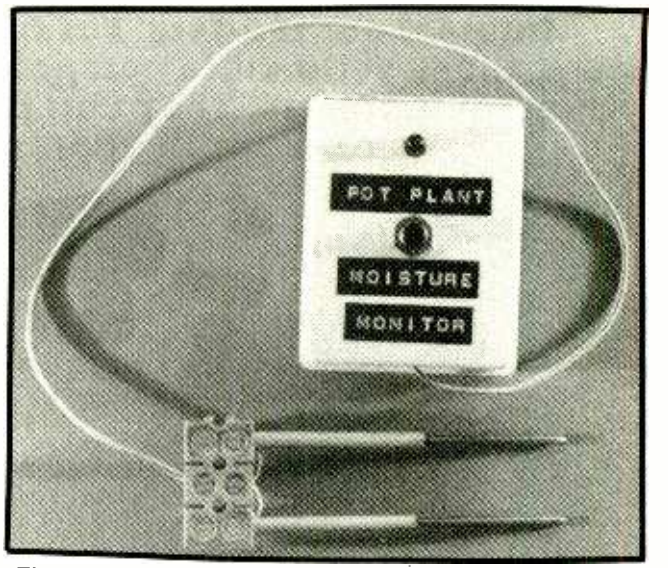


FIGURE 2

SCHEMATIC DIAGRAM AND SUGGESTED LAYOUT OF HOUSE PLANT MOISTURE MONITOR

Construction Guidelines

1. Drill a small hole at one end of the base of the box for the twin wire.
2. Connect about 14 inches of thin wire to the circuit board and pass it through the hole in the base of the box.
3. Fit the switch and LED as shown in the photograph.
4. Stick plastic tape to the back of the circuit board to prevent it contacting the leads of the LED.
5. Cut the battery snap leads to about 2 inches long.
6. Use double-sided tape to hold the board in position.
7. Glue a piece of plastic tape to the base and lid to form a hinge.
8. Make two probes from a wire coat hanger or galvanized wire, approx. one eighth inch diameter; 4 inches long and file the ends to a point.
9. Cut three blocks from a terminal strip and pass the twin wire though the middle one.
10. Split the twin wire and solder to the probes near their end.
11. Insert the probes in the outer terminal blocks and tighten the screws. Gently tighten the screws in the middle terminal block to anchor the twin wire.
12. Cut 1½" of plastic sleeving (2 required) and fit to the probes as seen in the photo.



The completed project. Note the method of threading the twin wire though the middle terminal block of the probes to absorb any strain placed upon it.
The push-button switch is positioned between the battery and the circuit board. The LED is mounted *above* the circuit board. Refer to Figure 1 for details.

Using The Moisture Monitor

The easiest way to test your moisture monitor before inflicting it on your plants is to touch the ends of the probes on your tongue (you may experience a slight tingle) and press the button. The LED should start flashing but as you move them further into your mouth, the LED will remain on without flashing then switch off completely.

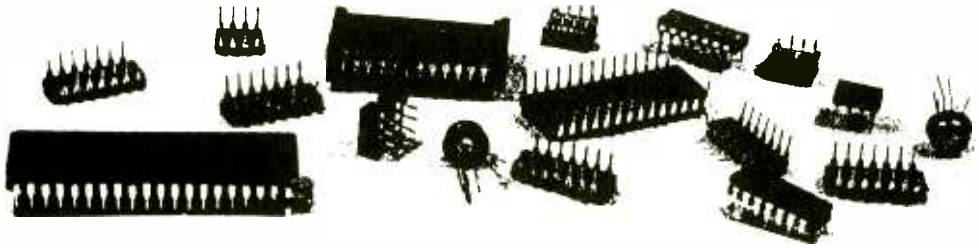
Push the probes into the pot right up to their "hilt" and press the button. Try several locations around the pot and take the average reading. After a little practice, you will develop a consistent testing technique because consistency is what it's all about. ■

PARTS LIST FOR THE MOISTURE MONITOR

R1—1K Ohm ¼W resistor
R2—15K Ohm ¼W resistor
R3—220 Ohm ¼W resistor
C1—10uF 16V. axial type electrolytic capacitor
IC1—555 IC Timer
LED—5mm red light emitting diode
Strip board—(Perfboard) 14 strips × 10 rows

SOLID STATE UPDATE

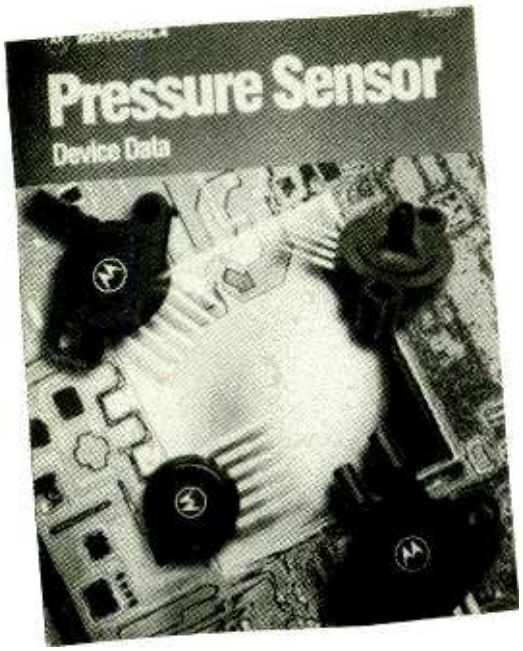
Each month, the manufacturers of solid state components release literally hundreds of new devices. While we cannot report on all of these, we do intend to feature some of the devices that are most likely to interest our readers. For further information on any of these solid-state components, write directly to the manufacturers. They can provide you with data sheets and application notes at no charge.



HEATSINK APPLICATION HANDBOOK

Consider, if you will, the heatsink, a deceptively simple slab of extruded aluminum with fins. If you bolt a hot transistor to it, the heatsink cools the transistor and keeps it from self-destructing. But how big must a heat sink be to successfully cool a given semiconductor? And will the heatsink alone suffice, or will a fan be needed to force air through its fins? These are crucial questions in the proper application of a heatsink, yet many users remain ignorant of the correct answers.

There is no excuse for such ignorance now that Aham Tor Inc. has published its Heatsink Application Handbook. In 68 pages, author Jack Spoor covers such topics as heat flow, cooling requirements of electronic equipment, heat dissipation in semiconductors, thermal resistance and capacitance, conduction, convection, and radiation. For a copy, write to **Aham Tor Inc., 27901 Front St., Temecula, CA, 92390-0739.**

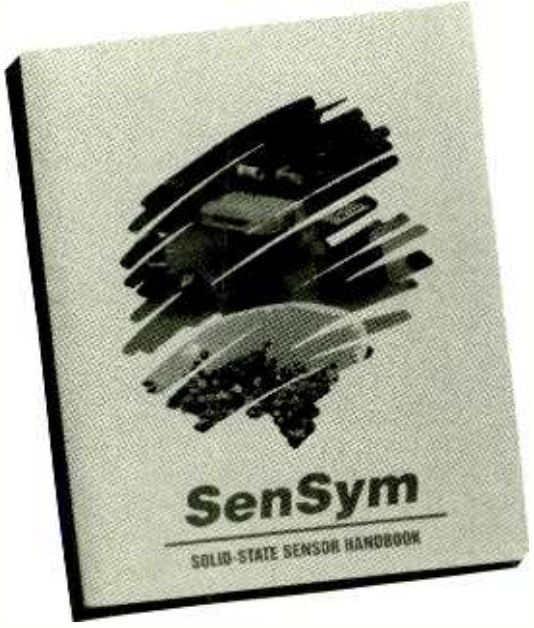


MOTOROLA'S NEW ACCELEROMETER

Motorola has developed a rugged new silicon accelerometer that is highly resistant to shock damage, yet remains remarkably small. The MAS50G accelerometer design features built-in stops to limit travel of the sensing plates when disrupted by g-forces. The unit was intended as a force or acceleration sensor in high-volume, low-cost applications.

"This new sensor was designed from conception for the automotive market," said John Trice, Motorola Operations Manager for Sensors. "It will meet both the ruggedness and cost requirements for automotive designs."

Unique attributes of the MAS50G include a 3-layer differential capacitor, small size, an accurate self-test feature, automotive ruggedness, and a low-cost plastic package. Further details are available from **Motorola Semiconductor Products, P.O. Box 52073, Phoenix, AZ, 85072-2073.**

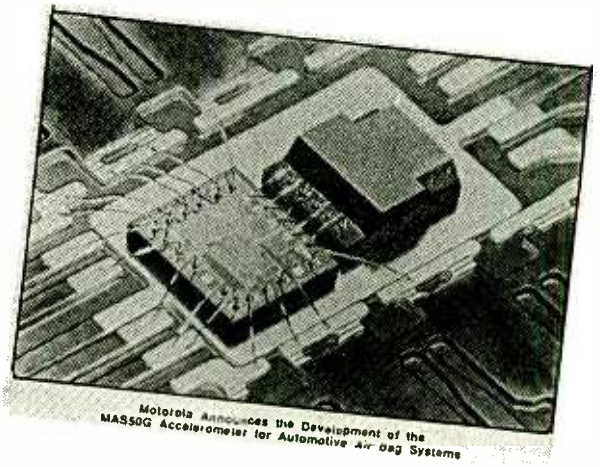


PRESSURE-SENSOR DATA BOOK

We live in a hectic world besieged by pressures of all kinds. There's peer pressure, the phenomenon that compels even sensible people to do silly things, like put a baseball cap on backwards, just because their friends do. Then there's hydraulic pressure. Next time the whine of a garbage truck wakes you up at 5:00 in the morning, blame it on hydraulic pressure.

It's hard to escape the pressure. Even a day at the beach won't give you much respite. Especially not in southern California, where the pressure of molten magma continues to build, anticipating the day when the bedrock cracks, and the whole coastline slides into Davy Jones' locker.

Ah, pressure. Even the smart folks at Motorola don't have a cure for it, but they do know how to measure it. Their Pressure-Sensor Data Book, filled with data and application notes, is available now free of charge. Request DL200/D. **Motorola Literature Distribution, P.O. Box 20924, Phoenix, AZ, 85063.**



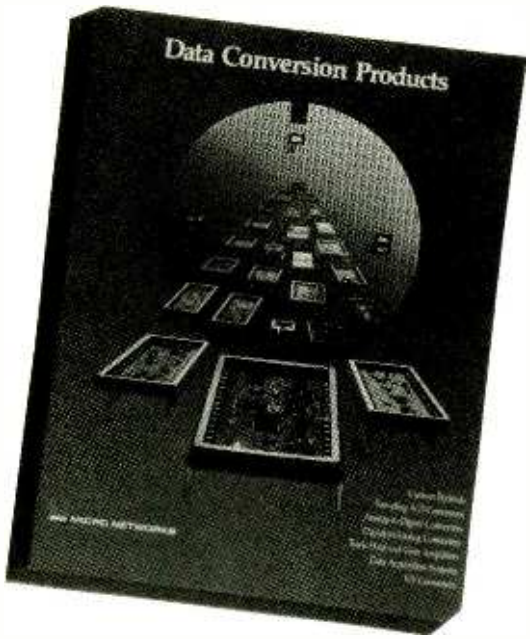
SENSYM HANDBOOK

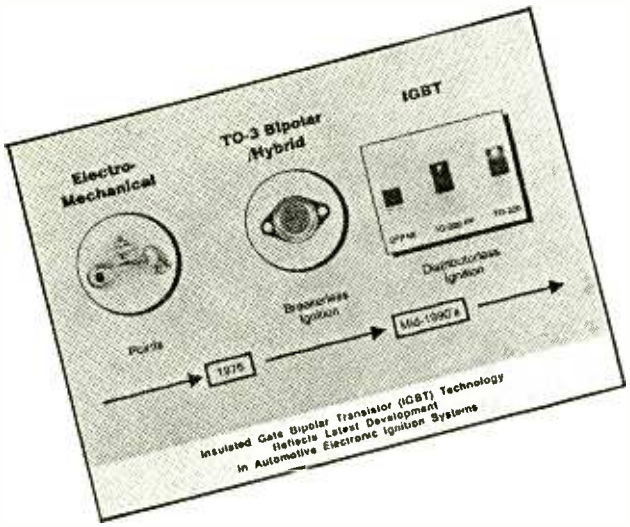
Silicon pressure sensors find use in a variety of electronic products, including altimeters, barometers, scales, depth gauges for deep-sea divers, and blood-pressure monitors. SenSym manufactures a wide variety of pressure-sensing products. Some are uncalibrated, while others come from the factory already calibrated and temperature-compensated. (Sensor output varies somewhat with ambient temperature. Temperature compensation removes such errors.) In addition to basic sensors, the company also manufactures instrumentation for use with these sensors.

The SenSym Solid-State Sensor Handbook provides data on the full line of SenSym products. It also includes a large number of helpful application notes that show the user how to put solid-state pressure sensors to use. Contact **SenSym Inc., 1244 Reamwood Ave., Sunnyvale, CA, 94089.**

DATA CONVERSION PRODUCTS CATALOG

Data-conversion products are integrated circuits that convert data from one form to another; for example, from analog to digital or vice-versa. Remember, the world is primarily an analog place: physical parameters like force, pressure, light intensity, and so forth vary in continuous fashion. But inside a computer, data is allowed to take only discrete values. In other words, digital data cannot change smoothly from one value to another; instead, it jumps in a series of tiny, discrete steps. The problem, then, for a computer that is monitoring or controlling a real-world process is one of converting input signals from analog form to digital, and output signals from digital to analog. Devices that can do this are featured in the Data Conversion Products Catalog from Micro Networks. In it, you'll find analog-to-digital and digital-to-analog converters, as well as voltage-to-frequency converters. **Micro Networks, 324 Clark St., Worcester, MA, 01606.**





IGBT IGNITION COIL DRIVERS

Motorola announces the development of a series of "smart" power devices that automatically clamp spikes in automotive ignition systems and guard against electrostatic discharge. Designed primarily as ignition-coil drivers, the devices feature a logic-level insulated-gate bipolar transistor (IGBT) with an integral active collector clamp and ESD gate protection. "The new devices can withstand high-current pulses without latching, a key factor in ignition systems," said Daniel Artusi, Operations Manager for Motorola's power transistor products.

IGBT devices will be available in two voltage ratings, 350 volt and 400 volt, with a maximum continuous current rating of 20 and 16 amps, respectively. Acting as linchpins of modern distributorless ignition systems, Motorola's new IGBTs reduce component count, save space, and cut overall system cost. Contact **Motorola Semiconductor Corp., P.O. Box 52073, Phoenix, AZ, 85072-2073.**

ANALOG DEVICES OP AMP MANUAL

Analog Devices manufactures an astounding array of high-performance operational amplifiers, the characteristics of which you'll find documented in scrupulous detail in the Analog Devices Amplifier Reference Manual. Handy selection tables in the manual let you choose op amps on the basis of the following characteristics: precision, low power consumption, low voltage noise, low current noise, and high speed. You might expect high-precision op amps to cost plenty, but that's not necessarily so. For example, the low-noise OP-27 and ultra-high-precision OP-177 both go for about $2 today, and their performance far exceeds that of a 741 or any other general-purpose op amp. Also included in this manual is data on comparators, instrumentation amplifiers, and isolation amps. Nominal price of this valuable reference is $12.95, but engineers, technicians, and anyone else who designs or repairs circuits for a living can get a copy for free. Contact **Analog Devices, One Technology Way, Norwood, MA, 02062-9106.**

BUILDING A TELEPHONE BUG DETECTOR

By Jerry Penner

Ever since the deregulation of the telephone company in 1975, the electronics hobbyist has had an entire new world to explore and play with. You as a subscriber to Ma Bell's services may connect anything approved by the FCC to a private phone line, no matter where purchased. Most homes with private lines have more than one phone installed whether it be rented from the phone company or purchased outright. Although a phone in every room makes calling and answering easier, it also makes eavesdropping possible. This project is a simple little device to combat that problem. When more than one phone is off-the-hook at one time, the "bug detector" will give a visual indication of the condition. The "bug detector' is designed to load the line as little as possible, so you can add as many to the phone line as you like without generating an off-hook condition.

No-Legged Bugs

The phone line is a magical thing. The on-hook impedance of a phone is near infinite. The off-hook impedance is between 300 and 1200 Ohms. When a phone goes off-hook, the phone captures the line, lowering the voltage from 48 volts to about 6 or 12 volts. The second phone loads the line a bit more and brings the line down another three volts or so. In Fig. 1, you will see the schematic for the "bug detector." D1-D4 rectify the incoming signals which include voice, a high voltage ringing signal, and a DC voice carrier. The bridge rectifier also makes the device insensitive to line polarity. Resistors R1 and R2 form a divider network that reduces the incoming voltage to a level acceptable to IC1. Resistor R3 is a multiturn trimpot that provides the reference voltage to IC1. IC1 is a 741 opamp acting as a comparator, whose output feeds an LED and current limiting resistor.

As long as the voltage at the negative input is above the positive input, the LED will stay off. As soon as the phone line is loaded with two or more phones, the negative input drops lower than the positive input, and the LED comes on.

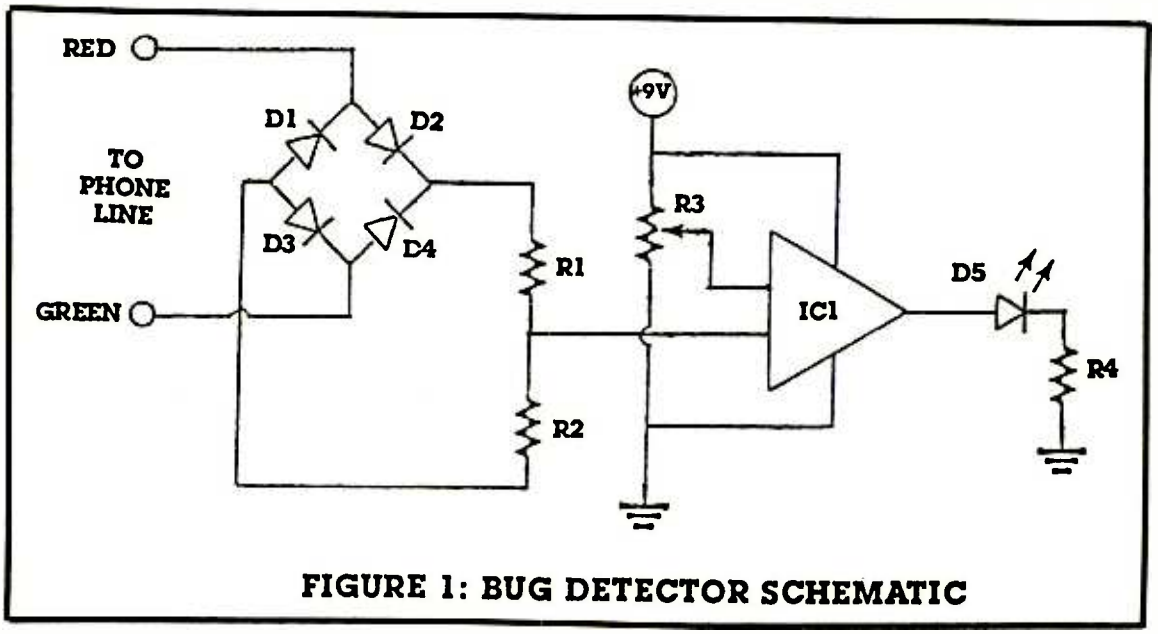


FIGURE 1: BUG DETECTOR SCHEMATIC

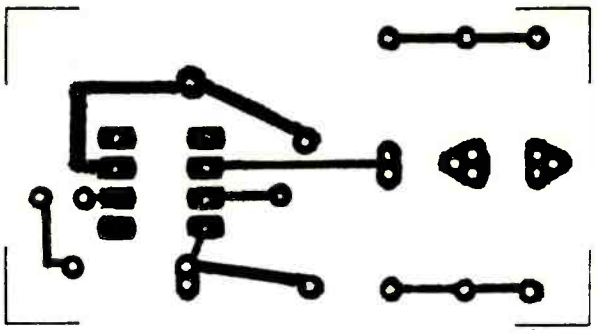


FIGURE 2: FOIL LAYOUT

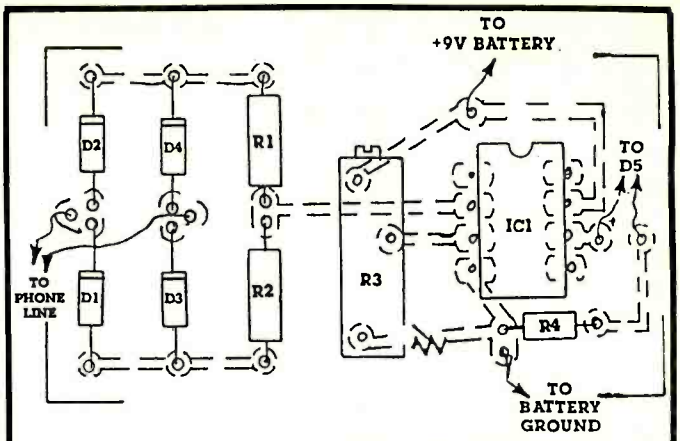


FIGURE 3: COMPONENT SIDE LAYOUT

Construction and Calibration

Construction may be by any method, but printed circuit board is recommended to keep everything compact. Socketing IC1 is also a good idea. Fig. 2 is the PCB foil side layout, and Fig. 3 is the component side layout. The only thing to watch is the orientation of the four rectifier diodes and the LED. As the component layout indicates, all four rectifier diodes are inserted with their bands facing the top of the board. The shorter lead on the LED is the negative side and should be connected to the current limiting resistor.

To calibrate, attach the battery, connect the detector to the phone line, and take one phone off-hook. Adjust R3 until the LED comes on, and then back up until the LED turns off. Now take a second phone off-hook. If the LED is on, calibration is complete. If not, adjust R3 until the LED comes on. If the LED does not come on, check the polarity of all five diodes, and replace the 741 if necessary. Once the unit is calibrated it can be boxed up and put to use. I would suggest that the box you put it in have at least one female phone jack as well. This way you always have someplace to plug in a phone.

Don't Bug Me

The circuit is pretty reliable, but does deserve a couple of precautions. First, as the battery dies resistor R3 will give a lower reference voltage and eventually no longer provide reliable operation. The battery condition should be checked about once a month by taking two phones off-hook and noting the status of the LED. If it isn't on, change the battery. Second, NEVER disconnect the battery from the circuit without disconnecting the phone line first. Opamps really hate having input voltage without supply voltage. They protest by quitting and refusing to ever work again. Always disconnect the battery last and reconnect first.

There you have it. While Necessity may be the mother of Invention, Inventions breed Accessories; and the telephone bug detector is a device too cheap and useful not to have. It really irritates nosy mothers, little sisters...etc. ■

CD AUTO POWER SUPPLY

By Jeff Orthober

Recently, I purchased a portable compact disk (CD) AM/FM player with the intention of connecting it to my car stereo CD LINE input. Unfortunately, this presented problems that I had not anticipated. The portable CD player required a + or - 7.5 volt power supply. The car, of course, has +12 volts for its power supply.

To overcome this dilemma, I built a regulated +/- power supply from a single + power source, which I will describe here for the benefit of readers who might be confronted with a similar situation. I am delighted to say that I can now transport my portable CD player in my car and use it until the gas tank is empty or I arrive at my destination, whichever comes first.

A little research revealed that I needed two integrated circuits (chips) and a few discrete components. The easy part was to regulate the car's +12 volt power supply down to +7.5 volts. From there I figured out how to take the +7.5 and convert it to -7.5 volts.

The chip that I used for the + regulation was the LM317 linear adjustable positive power regulator. This is a fairly common chip, available through most of the mail-order suppliers. With just a few external parts, the LM317 does a very good job of regulating voltage at a set level.

The LM317 is a three-pin package with a heat sink mount. The chip manufacturer recommends that you use a heat sink in all but the lowest power applications. The following formula can be applied to determine the regulated output:

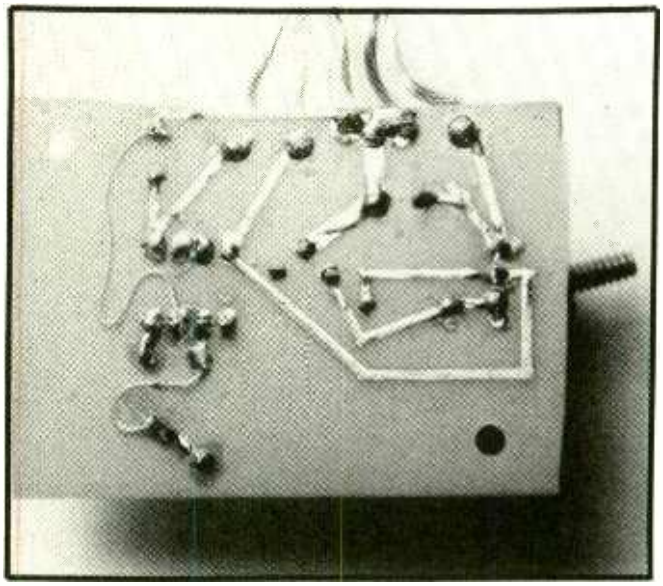


Figure 1. Layout of PC Board viewed from the underside. The LM317 is on the right with the LT1054 on the left and connecting wires on the top.

$$V_{out} = 1.25V_{in} \times \left(1 + \frac{R2}{R1}\right)$$

See figure 1. Normally, R2 is a pot in the 10K to 20K range and R1 is about 1K. The pot can be used to adjust to the desired output voltage. C1 and C2 are used for stabilizing and can be anywhere from.1uF to 100uF.

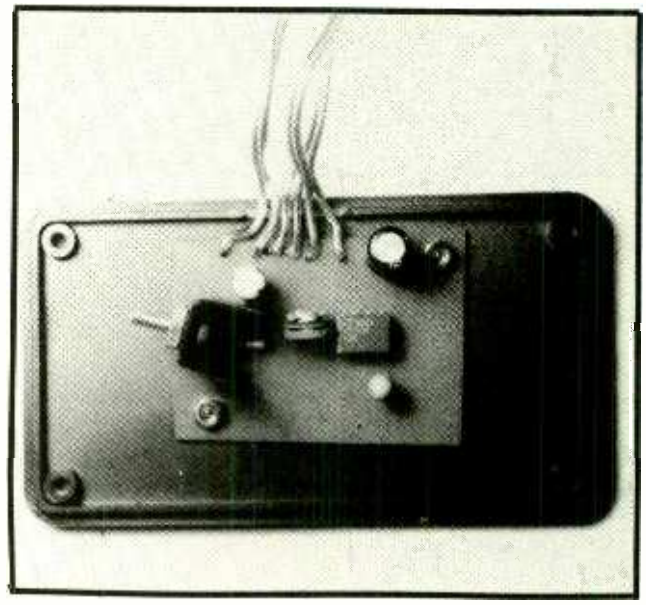


Figure 2. PC Board mounted on the bottom of the enclosure. A small section of the enclosure has been removed so that the wires will fit after the top of the enclosure has been fitted.

Once you have regulated the voltage down to the proper value, you will have to invert it to provide the - voltage supply. This can be accomplished with a single chip, the LT1054, known as the "Switched Capacitor Voltage Converter with Regulator." As you can observe from figure 1, it doesn't require much supporting circuitry to make this chip invert voltages. For those that are interested, there are many other interesting things that can be accomplished by this chip. For more information call or write the Linear Technology Corporation, 1630 McCarthy Blvd., Milipitas, CA 95035-7487, (408) 432-1900 for full data sheet.

It is important to note that the 10uF capacitor must be tantalum to reduce the voltage drop during high current drains. When the CD is just spinning up, the initial current is rather high. During experimentation, the author tried an electrolytic capacitor and the voltage drop was so severe that the CD player motor would not start. Changing to tantalum, corrected this problem. The 100uF capacitor could also be tantalum but it turned out that I did not need it in my application.

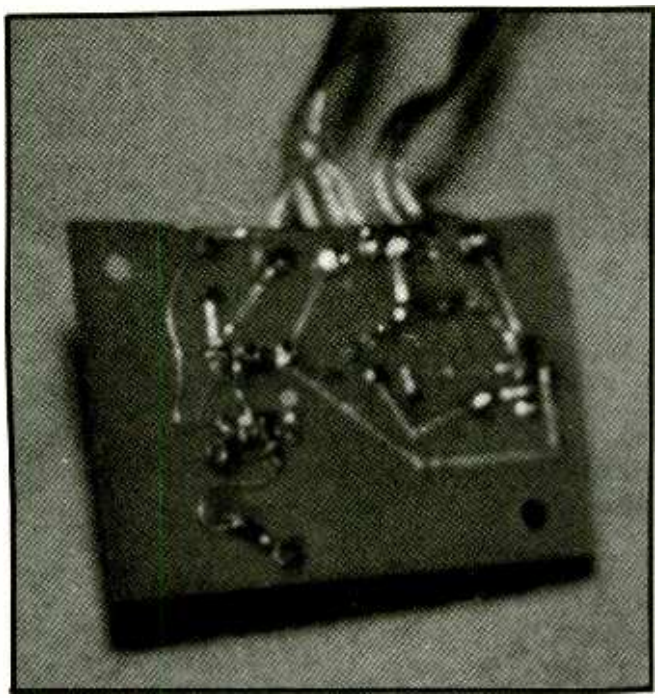


FIGURE 3

Figure 2 shows the top of the project circuit mounted on the top of the enclosure and figure 3 shows the bottom of the project and the traces. I used direct etching to make the board, which took about an hour to complete. For the enclosure of my circuit, I used a project box from Radio Shack. Figure 4 shows the completed project connected to the CD player.

Note that there are separate plugs for the +7.5 and the -7.5 volt power sources, which matched the requirements of my portable CD player. Your particular player may require different connectors or plugs. The inventer chip can handle about 450mA, which for my application was just enough. In the experimental stages, I tried a few other negative voltage converter chips unsuccessfully.

It is estimated that this entire project required about 2 hours of the author's time and cost about $15 for various parts. ■

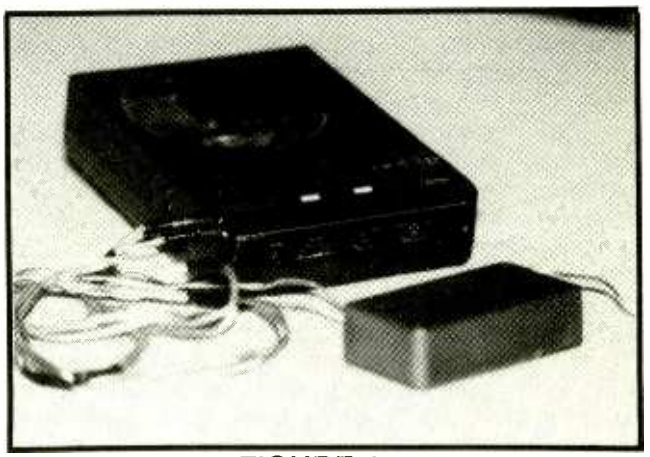


FIGURE 4

PARTS LIST FOR CD AUTO POWER SUPPLY

C1, C2—10uF Electrolytic Capacitors
C3—2uF Dipped-Tantalum Capacitor
C4—100uF Electrolytic Capacitor
R1—1K ¼-watt Resistor
R2—20K Potentiometer
U1—LT1054 (See text)
U2—LM317