ELECTRONICS HOBBY-THEORY PROJECTS

THE FUN WAY TO LEARN ELECTRONICS

VOLUME XII

$3.95

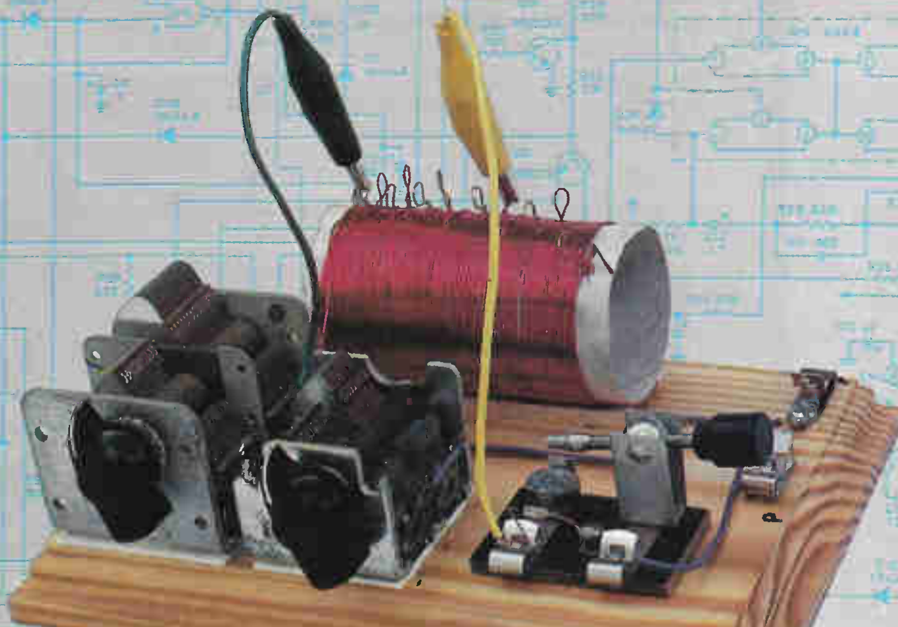
ELECTRONICS HANDBOOK

WPS 36286

IN CANADA $4.50

CIRCUIT FRAGMENTS

BUILD A HIGH PERFORMANCE CRYSTAL RADIO



BUILD AN ELECTRONIC WATCHDOG

THE CRYSTAL RADIO TODAY

WORKBENCH PROJECTS

3&1 POWER SUPPLY

IC TESTBENCH

FUN PROJECTS ANYONE CAN BUILD

0 70989 36286 4 12

Get switched on

Lab Test ELECTRONICS HANDBOOK For Yourself

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.

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

It gives you a complete, ground-floor lowdown on a variety of important electronic subjects. For example—Understanding Transistors...How Radio Receivers Pull In Signals...Cathode Ray Tubes Explained...How Capacitors Work...Using Magnetism In Electronics, and much, much more!

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

TRY A FEW ISSUES AND EVALUATE OUR...

- HOW-TO-DO-IT HELP Tips and pointers that add up to money saved. For example—tuning up your tape player...all about radios ...whys and hows of turntables...care and feeding of speakers.
- EXCITING DISCOVERIES. Whatever your particular interest in electronics, you'll be entering a world of discovery in the pages of the ELECTRONICS HANDBOOK

ELECTRONICS HANDBOOK

CONTENTS

THE CRYSTAL RADIO ISSUE

The idea of reviving the once popular "Antique Radio Corner" has intrigued us for some time and, in this issue, we have taken the proverbial bull by the horns.

The opportunity was thrust upon us when we received a couple of excellent manuscripts on the construction of the "crystal radio." The first is a feature on building a "**High Performance Crystal Radio**," by a new contributor to the ELECTRONICS HANDBOOK, **Lance Borden (WB5REX)**, who is a recognized authority on this subject and a frequent contributor to the "**Grid Leak**" publication, which is a classy "newsletter," published monthly by the **Houston** (Texas) **Vintage Radio Association**, a non-profit organization, dedicated to preserving the history of the development of wireless communication by encouraging the preservation of original records relative to the history and development of wireless and radio broadcasting.

To keep its members advised of its activities, the HVRA publishes the "**Grid Leak**," which has graciously agreed to let us reprint an expanded version of the construction of the "High Performance Crystal Radio" by Lance Borden, which they originally published in their November 1991 issue.

HRVA promotes social contact among its members, so that they can increase their knowledge of vintage communication, meet new members, enlarge their collections, and find needed parts for restoration projects. Through their activities, members contribute significantly to the enrichment and preservation of radio and its history.

We look forward to more manuscripts from Mr. Borden, who will be editing the revived "Antique Radio Corner" in future issues of the the "Handbook."

And, that's not all, in this same issue (Volume #12), we have the first of a two-part feature story on "**The Crystal Radio Today**," by **Lyle Russell Williams**, which should identify Volume #12 as the "Crystal Radio Issue."

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:

DON GABREE, PUBLISHER C&E HOBBY HANDBOOKS P.O. BOX #5148 NORTH BRANCH, N.J. 08876

ELECTRONICS HANDBOOK

PUBLISHER
AND
EDITORIAL DIRECTOR
Don Gabree
SECRETARY/TREASURER
L. M. Gabree
ASSOCIATE EDITOR
Holly Love
CONTRIBUTING AUTHORS
Homer Davidson
Walter Sikonowiz
Tony Lee
Steve Sokolowski
Lance Borden
Lyle Russell Williams
Andrew Singmin, Phd.
George Williamson
Richard Stuart
Darren Yates
John Iovine

ISSN 0897-7631

ADVERTISING SALES
C&E Hobby Handbooks
P.O. Box #5148
North Branch, N.J. 08876
(201) 231-1518

Published by C&E Hobby Handbooks, Inc. Editorial and Business address, P.O. Box #5148, North Branch, N.J. 08876 (908) 231-1518.

ATTACH LABEL HERE

NEW ADDRESS HERE *PLEASE PRINT*

NAME ____________________

ADDRESS ____________________

CITY ____________________ STATE ____________

DATE ____________ ZIP ____________

V12

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:

The Editor
C&E HOBBY HANDBOOKS INC.
P.O. Box #5148
North Branch, N.J. 08876

Energy Conservation

Recent events in the Middle East have given new importance to something that I've been trying to do for a number of years now: make my home more energy-efficient. I've already added extra insulation to the walls and attic of my house, and that has cut our fuel bill in the winter months by a substantial amount. Still, I'd like to cut our energy costs even further. Can you suggest any good measurement for reducing the consumption of energy, electricity in particular, without making drastic sacrifices in comfort or the quality of life? I don't want to resort to lighting the house with homemade beeswax candles.

— Bob Reed, Ann Harbor, MI

Just thought I'd drop you fellows a line to say how much I've enjoyed your magazine. At the same time, I'm wondering if you can offer any advice on conserving electricity. Better still, how about running a feature article on ways to conserve energy in the home. I'm sure a lot of your readers would appreciate that kind of information, especially those who live in my neck of the woods.

— John Larken, Regina, Sask., Canada

These letters from Bob and John are representative of perhaps a dozen similar letters that we've received in the past several months. In the course of researching an appropriate response, I was surprised to learn that the country with the highest per capita consumption of energy is Canada. The United States is a close runner-up. Of course, the total amount of energy consumed in the U.S. is much greater than that consumed in Canada, since the U.S. has a much larger population.

If we consider only the electrical portion of the total energy picture, we find that roughly 25% of all the electricity consumed in the United States is used to provide lighting. It has been estimated that by converting to more efficient lighting systems, we could save as much as 80% of the energy now used to light our businesses and homes. How can this be done? One way is by using the new compact fluorescent lamps instead of regular incandescent light bulbs. For a given light output, compact fluorescent lamps consume 75% less electrical power than incandescent bulbs but last as much as 13 times longer. Further benefits can be obtained by installing newer, more efficient light fixtures. These high-efficiency fixtures have more effective reflectors and therefore deliver more light output per watt of input. If you must use incandescent bulbs, control them with a wall-mounted dimmer switch, and use only as much light as the situation demands. You might also consider installing occupancy sensors, which turn off the lights when a room is empty, though these are perhaps best utilized in offices and public buildings. Finally, use task lighting whenever appropriate. For example, someone writing at a desk would be better served by a 35-watt halogen desk lamp than by a 150-watt bulb in a ceiling fixture.

Motors gobble up even more electrical energy than lights. Currently, more than half of the electricity generated in the United States is consumed by motors. During the past decade, great progress has been made in the development of high-efficiency electrical motors, and manufacturers have been busy incorporating these new motors into their products. Thus, for example, you may find that a new high-efficiency refrigerator or freezer consumes as much as 80% less energy than a similar product manufactured ten years go, thanks to the incorporation of more efficient motors, compressors, and control systems.

Almost everyone is aware of the energy savings that accrue from insulating the walls and attic of a home, but few realize how important it is to have thermally efficient windows. Here's a chilling statistic: it has been estimated that in the course of a year, the energy lost from windows alone in the United States is equivalent to the annual flow of energy through the Alaska pipeline. Window glass is an inherently poor thermal insulator. Thermopane, which consists of two layers of glass separated by a 1/4" air space, was a significant improvement over plain glass, but today we have even better products available. One such product, the low-emissivity (low-E) window, has the same two-layer construction as thermopane, except that the space between the two layers of glass is filled with argon, and the glass panes are coated with transparent, heat-trapping films. As a result, the Low-E window has twice the insulating value of thermopane. An even better product, the so-called superwindow, is similar in construction to the low-E window, except that it has a vacuum between the two layers of glass.

Superwindows have 3 to 5 times the insulating value of thermopane and cost 20-50% more. Industry pundits say that based on energy saved, superwindows will pay for themselves after 2 to 4 years of use (depending, I suppose, on how cold it is where you live).

Here's hoping you can put this information to good use.

TV Descramblers Legal?

On our cable TV system there are two channels which have the picture all scrambled, even though the sound is OK. They show movies most of the time. I've heard that there are TV descrambling ICs you can buy, or even black boxes that use such ICs to unscramble the pictures.

What's the story? Are these devices illegal? Can I go to jail if I use such ICs or black boxes?

—J.R. Dundas, Thompson, AZ.

Yes, there are "Black Boxes" which are illegal to sell or to use. If you make one yourself, for "educational" purposes, which is what those people who talk about them and deal in them claim, there's not much anyone can do about it. Lots of people use them to view scrambled TV programs, both from satellites and from home cable systems.

It's interesting to note that some leading authorities on TV decoders (unscramblers) are presently facing legal action brought by the Cable Home Group of General Instrument, manufacturer of the Videocipher scrambling system. The suit charges Robert Cooper, Jr. of Fort Lauderdale, FL (publisher of Coop's Satellite Digest), Dr. Stephen Bepko of Baltimore (an engineer who lectures on descrabling methods), Karen Howes and Shaun Kenney. These two people appear on the weekly satellite TV program Boresight. The suit charges these four persons sold illegal descrambling devices at a trade conference in the British West Indies recently.

***Boresight** is the weekly program (satellite Spacenet I, transponder number 9 at 9:00 PM EST, Thursdays) which tells viewers about home satellite TV. It has provided addresses outside the US which sell unscrambler ICs.*

*It will probably take a long time for the courts to decide what's what in this matter. Meanwhile, you can't be jailed for watching unscrambled programs using gear you put together. But you could save yourself a lot of headaches (and be watching those movies at home) by renting (for a monthly fee of $10 or so) the **Videocipher** descrambler offered by your cable company. To get the details, telephone 1-305-771-0575 anytime to hear a three-minute roundup of the latest information on the world of satellite-TV-program srambling. No charge, except from the phone company.*

Up with LPs; Down with CDs!

Why are are record markers in such a hurry to push aside the LP record? It's given is the music we want, when we want it (to quote RCA) for nearly 40 years.

Even though many people won't admit it most people can't tell the difference between the same music played on an LP and on a CD particularly when it's played at rock music volume levels. They just want to keep up with "the latest." I'm not going CD for a long time. Instead I shall upgrade my present (good) stereo system. I can't see spending $14-18 on a CD when I can get the same thing on LP for $6-8. *Long live vinyl discs,* is my mott.

I'm tired of hearing people praising the CD to the skies, and claiming LPs are no good. We record collectors must stand together and fight to save the LP record. Join with me in this fight. Time is running out! Don't let the LP recording become the next endagered species. If you would like to make people aware of this by wearing a red and black "Save the Record" silk-screened shirt, join me and many others. To get your shirt; ($12 postpaid.) State your size, S,M,L, or XL.

—L.A. Schwarts, Glendale, CA.

If your agree with Mr. Schwartz, and want to show your support of his viewpoint you can send your $12 to him at Suite 458, 249 N. Brand St. in Glendale 91209.

Better Than Stereo? Again?

Back in the Sixties and Seventies some record companies and hi-fi makers perpetuated what I consider to be a fraud on unsuspecting music listeners who thought they were getting better sound through Four-Channel gimmicks. These were CD-4 (RCA), and SQ (CBS), and QS (Sansui and others) and so on. I, along with lots of other unsuspecting music lovers who wanted to get even better sound than stereo (more realism), bought those 4-channel recordings and decoders and amplifiers, and additional speakers.

So what happened? The companies couldn't agree what was best; after a while the recordings weren't available; and those of us who'd bought the expensive equipment were stuck with obsolete stuff.

Now the companies are trying to do it again. They're trying to fob off "Space-expanding" amplifiers and special speakers which claim to improve the concert-hall illusion —to be a step closer to perfet reproduction of the music we hear when it's performed live. Isn't this just another ripoff to make more sales? Or is it real this time. Will this gear still be useful after this

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:

The Editor
C&E HOBBY HANDBOOKS INC.
P.O. Box #5148
North Branch, N.J. 08876

newest bubble bursts, again?
—J.R. Fairfield, Oak City, IN.

Your question(s) are well put. However, the current offerings by Shure Brothers, Carver, Yamaha, Sound Concepts and others aren't based on different recording methods or coding schemes. These new methods extract information from standard two-channel recordings and process it in ways which appear (audibly) to expand the concert hall stage. Many people like the expanded aural effects, so they buy the equipment, which work with any records.

Such equipment (mostly electronics, with some special speakers which include electronics) can't become obsolete, so long as it provides additional increased sound effects.

Automobile CD Sets

I understand that Compact Discs (CDs) can give higher fidelity sound than LP and 45 RPM records (or cassette tapes). But what good is such super fidelity in a car, where there's so much noise, or in a Walkman, where you have problems with people and other outdoor noises. Is the extra fidelity of CDs in cars and other outdoor listening setups worth it, or can you only get their superior sound in a real home listening setup?—**Nancy White, Norvel, California.**

You've hit the nail right on the head, Nancy. CD records are capable of higher fidelity than LPs and 45s, if you have good loudspeakers and a high fidelity receiver or amplifier in your home listening system. Play music in the noisy environment of an automobile, or outdoors, where you use a Walkman, and there's no way you can take advantage of the superior sound of CDs. It's cheaper and smarter to use cassette tapes in a car or when you're walking (or jogging) outdoors.

LASCR, We Hardly Knew Ye

In past years there were occasional articles in various magazines telling how to make your own photo slave trigger with inexpensive, readily available parts. The only articles I remember, and the ones I have been able to obtain copies of through my local library, show the use of Radio Shack part #276-1095, a light-activated silicon-controlled rectifier. This device is no longer available. I have written to Radio Shack's home office asking for suggestions on a substitute part, but have received no reply. In addition, I've checked the ECG, NTE, and Motorola semiconductor catalogs but could find no substitute. It seems that LASCRs have dropped off the face of the earth. Can you help with a source of LASCRs or the schematic of a photo slave trigger that does not depend on these devices?

— Alex Ethridge, Birmingham, AL

After an exhaustive search of the literature, Alex, I could find no trace of the LASCR in the product lines of the major semiconductor manufacturers. Perhaps some small specialist company still makes LASCRs. In any event, it certainly is possible to build a strobe slave without using an LASCR. A good example of such a circuit appears on page 447 of the ***Encyclopedia of Electronic Circuits, Vol. 3****, by Rudolf Graf. (A copy of this schematic was forwarded to Mr. Ethridge – Ed.) However, I wonder whether it's worth the effort to build your own photo slave trigger when companies like Calumet and Wein sell such devices for as little as $20. It is unlikely that you could assemble one for less. You'll find a good selection of strobe slaves in the latest catalog from Calumet Photographic (890 Supreme Dr., Bensenville, IL, 60106; telephone (800) 225-8638).*

Going Round In Circles

Several months ago I built the electronic compass described in Volume X of Electronics Handbook. On my test bench it worked just fine, but to be perfectly honest, the compass performed poorly in my vehicle. The main drawback of the unit was that it seemed overly sensitive to the various electromagnetic fields present inside a car or truck, and thus, more times than not, the unit provided totally erroneous directional indications. I could only obtain reliable performance when I deliberately held the unit in a few "neutral" zones in my vehicle. The point of this letter, then, is to pass along my solution to this problem. Using a small piece of wafer board, I created a remote mounting board for the compass sensor and interconnected it with the main circuit board using ribbon cable. By doing this, I was able to permanently install the compass sensor behind my truck's rearview mirror, where it provided consistent and accurate directional indications. To further customize my setup, I also remotely mounted the LEDs in a separate enclosure using more ribbon cable so that the LEDs could be easily seen. Finally, I mounted the main circuit board under the dash and routed all the cables under various parts of the interior trim. I hope these suggestions help other builders of the circuit who may be similarly troubled by stray magnetic fields.

— Chuck Robinson, Columbus, GA

Thanks for sharing your solution with us, Chuck. I'm sure that many other builders of the electronic compass will be grateful for this information. As you've noted, the interior of a modern automobile is full of stray electromagnetic fields that can confuse a magnetic sensor, and finding just the right spot in which to mount the sensor will usually be a matter of trial and error.

Low-power Broadcasting

First of all, I'd like to say that I love your magazine. I haven't tinkered much with electronics since high school, but your magazine has rekindled my interest because it's packaged in such a fun and interesting way. Now for some questions. Back in the early 70's, Electronics Illustrated ran an article on a transmitter that would broadcast on an FCC-approved "experimental band." The transmitter was a very low-wattage affair, but I do recall the article saying that a range of 100 miles was not unusual with a good antenna. I believe this was a two-part series, with a later issue containing the receiver project. Do you or your readers know where I could find this information? All I need is the name of the article. Do you have any idea of the frequency band involved? Since it's been about 20 years, is it possible that this band is now being used for some other form of communication? I also need to know what you think of home-study programs. I've spent the past 11 years in radio as an on-air personality, but I would like to educate myself to the point where I can also compete in the job market as a radio-station engineer. Is there a home-study course you can recommend? Would a two-year technical-school course be adequate? I want to be able to get my first-class ticket. Thanks for your help.

— Bob Gardenier, Appleton, WI

Low-power, license-free broadcasting is allowed on the 1750-meter band, Bob. I remember the article you're thinking of, but I don't recall the title or when it ran in Electronics Illustrated. Perhaps some of our readers can help out with this information. The 1750-meter band spans the range from 160 to 190 kHz. You can transmit there without a license using a maximum of one watt of power and an antenna no higher than 50 feet. Average transmission range is 400 miles. Plans and kits for low-frequency transmitters and receivers are available from Panaxis Productions, P.O. Box 130, Paradise, CA, 95967-0130. Telephone (916) 534-0417. As far as home-study courses are concerned, there are a lot to choose from. My advice is to send for information, compare the offerings, and see which course is best for you. Home study is an excellent way to advance yourself while still working full time.

Another Tube Nut

I read with interest the letters page in **Electronics Handbook XI,** especially the letter about tube technology. You're absolutely right about tubes in musical-instrument amplifiers, and their generation of even harmonics during overload. But I think you may be overlooking an even more important aspect of tubes, and that is their response in dynamic music situations. As a guitar player, I own and use several tube amps, including a 100-watt Marshall and an old 80-watt Fender Twin. Believe me, a guitar player can feel the response of a tube amp as he plays. Since he is playing, he is using a tactile sense coupled closely with his ears, which creates a kinaesthetic response. It hardly needs to be pointed out that tubes are physically very different from transistors. Tubes use higher voltage, bigger transformers, and higher-ohmage speakers, and it is the interaction among tube, transformer, and speaker in the presence of a dynamic music signal that creates that great Tube Sound—even on undistorted passages. So, I'm gonna get out my primitive coil-pickup guitar and plug into my EL-34 powered Marshall and enjoy the good clean sound of my jazz chords. You can't beat it!

— William Robinson, Odessa, TX

Thanks for the feedback, Bill. Sounds like our little discussion about tubes really struck a chord with you. Not being a musician myself, I was unaware of this kinaesthetic effect you describe. Is this something that only jazz musicians appreciate, or can rock-and-rollers feel it, too? It seems to me that once you crank up the decibels to the threshold of pain, it hardly matters whether the sonic shock waves emanate from a tube or a transistor amp.

Scotland Yard

How do the British get that hee-haw sound for their police cars?

—W.U., Burlington, IA

In the old days (pre-chip) they used two trompet horns of different tones and mechanically switched back and forth using a simple thermo-element very much like your car's directional blinking device. Of course, today the British must be using a PA system with two tone generators switching back and forth electronically. Got a pair of 555's? See whether you can come up with a simple circuit, or not!

NEW PRODUCTS PARADE

NON-CFC SOLVENTS

With the growing concern for our environment and the "Greenhouse Effect" from the ozone layer, it seems appropriate that we call attention to this new non-CFC solvent that can accomplish your solvent objectives and not do any damage to the environment.

Genesolv® 2000 non-CFC solvents are blends of HCFCs and methanol, specifically developed to replace ozone-depleting CFCs. Each formula removes all rosin and most synthetic flux residues, ionics, greases, oils, and both polar and non-polar contaminants. They are excellent cleaners for difficult applications such as age-hardened fluxes, in addition to being non-corrosive and safe on plastics. These solvents, combined with a unique "trigger grip" applicator, provide you with a way to eliminate the toxic fumes, evaporation loss, accidental bench-top spills, and re-use of contaminated solvents that result from the "dip and brush" method of PC board cleaning. With the Micro Care® system, small amounts of high purity Genesolv® 2000 solvent are dispensed under low pressure by squeezing the trigger of a lightweight applicator. Its natural bristle brush gently scrubs components while fresh, uncontaminated solvent is simultaneously applied, quickly rinsing flux residue away and keeping solvent consumption at a minimum. The heat-resistant hose from the patented "trigger grip" twist-locks into the nozzle of a 16 oz. can of Genesolv® 2000 solvent. A bench mounting kit permits easy access to the system without causing clutter on the workbench, and a wide selection of replaceable brush tips and syringe needles optimizes your cleaning needs.

For further information on this non-CFC solvent call or write to **HMC, 33 Springdale Avenue, Canton, MA 02021, Phone (617) 821-1870, FAX (617) 821-4133.**

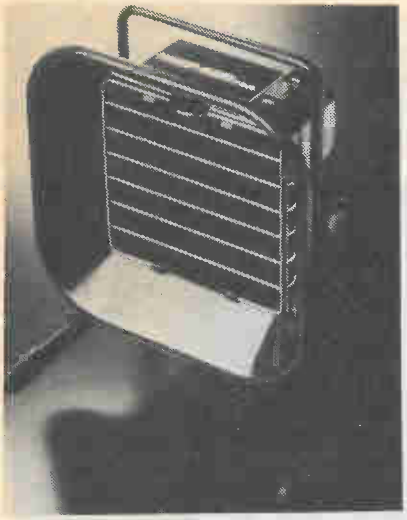
FLUKE 10 SERIES

The **NEW FLUKE 10** Series Multimeters from Techni-Tool. The features include V Check, measures auto or manual capacitance, min/max record with relative time check, continuity capture, and two year warranty. This Multimeter Family combines basic, sleep mode, high performance, low cost and Fluke quality. For more information on the complete line of FLUKE 10 Series, and a **FREE** 240 Page Catalog Call: (215) 941-2400, (24 Hr.) FAX (215) 828-5623, or Write: **Techni-Tool, 5 Apollo Road, P.O. Box 368, Plymouth Meeting, PA 19462 USA.**

FLUORESCENT MAGNIFIER

From the **HUB Material Company,** a stylish magnifier to reduce eyestrain and fatigue by combining the two key factors in aiding vision-optically correct magnification and cool, fluorescent lighting. The standard 5" diameter, 3-diopter lens provides ¾x enlargement of the item being viewed. This 8MG Series magnifier is also available with a 5-diopter (1¼x) or 11-diopter (2¾x) primary lens. 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 contemporary "floating arm" lets you position the light source with the touch of a finger, and keeps it in place so your hands remain free to perform other tasks. All 8MG Series magnifiers are hi-tech gray in color and come with on/off switch, 3-wire cord, and a 13-watt compact fluorescent tube. They are 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.**



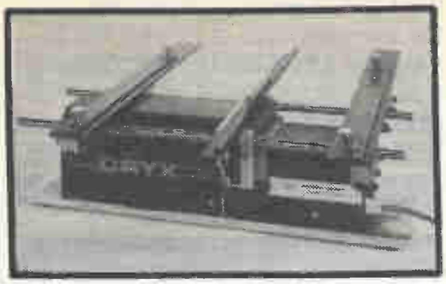
SMOKE ABSORBER

Molded from a non-sloughing static-dissipative plastic, the Model 493ESD is an ideal smoke absorber when soldering static-sensitive components. It's designed to remove noxious substances such as salycylic acid, pinene, and hydrogen chloride found in evaporated smoke that is generated during high temperature, flux-related applications. The unit's carbon-activated urethane filter measures 5" × 5" and absorbs air at a rate of 38ft. 3/min. A snap-shut front grill makes filter replacement simple and easy. Comes complete with three filters, adjustable tilt-stand, on-off switch, and 3-wire cord.

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

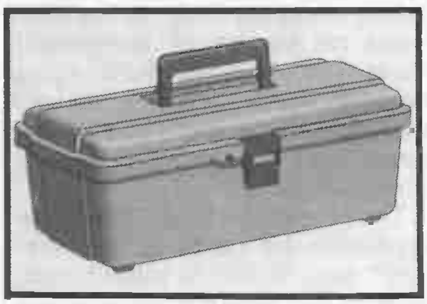
PORTABLE PC BOARD CUTTER

The Model 20-227 is designed to accurately cut both bare PC boards and printed circuit assemblies up to 18" square. Boards are held in place by parallel adjustable support guides; the unit is capable of cutting larger than 18" wide boards when one support guide is used as a straight edge.



The diamond abrasive cutting wheel, enclosed for operator safety, cuts within 5/32" of components and removes just .080" of board material. Its accuracy of cutting makes it particularly suitable for surface mount applications. The chassis allows .4" of clearance under PC boards for components mounted on the underside and unlimited component clearance on the top side. A powerful 115VAC motor generates cutting speeds of 9,000 RPM. The Model 20-227 PC board cutter comes complete with on/off footswitch, adjustable board support guides, dust tray, and a 115 VAC outlet to drive an optional external vacuum (for dust collection). It measures 21½"L × 19"W × 7"H and weights 29 lbs.

For further details, call or write to **HMC (HUB Material Company), 33 Springdale Avenue, Canton, MA 02021, Phone (617) 821-1870, FAX (617) 821-4133.**



TOOL BOX

Techni-Tool offers a tool box that is ideal for the hobbyist and project builder. Every detail has been designed for maximum strength and minimum weight. The inner trays have a comfortable full grip handle and plenty of carrying space for hardware and tools. The tool box features include positive action latches, solid brass pins, padlock tabs and recessed heavy duty handles. All gray molded co-polymer resins provide rustproof, chemical resistant, non-conductive, rugged construction. You can customize these boxes for special repair and service kits. For more information and a variety of other tool boxes, call (215) 941-2400, FAX (215) 828-5623, or write: **Techni-Tool, Inc., 5 Apollo Road, P.O. Box 368, Plymouth Meeting, PA 19462 USA.**

NON-CONTACT AC VOLTAGE SENSOR

The "Volt-Pen" can safely trace electrical circuits, while preventing electrical shocks. It operates by sensing the electromagnetic field through insulation and thus requires no contact with the conductor wire. Current flow is not necessary to locate voltage. Simply apply the plastic probe tip to a connection, or pass it along an insulated wire or cable. If AC voltage is present (between 110 and 550 VAC), an LED in the probe tip will glow cherry red. The glow will cease at a break in the circuit or wire. This test instrument can be used to distinguish between "live" and "neutral" wires; detect "hot" wires in both single and three phase power; locate wires carrying voltage in junction boxes; and identify faulty in-line devices. It

NEW PRODUCTS PARADE

will fit in your shirt pocket for convenience. It's primary use is to prevent accidental contact with an energized electric circuit. The "Volt-Pen" makes an excellent circuit tracer. It will locate breaks in wiring, check fuses, locate defective in-line circuits, outlets and switches. All outer surfaces are non-conductive for safety and comes ready to use with two AAA 1.5 volt alkaline batteries and a lifetime guarantee. For additional information and/or more details contact **HMC (HUB Material Company), 33 Springdale Avenue, Canton, MA 02021, (617) 821-1870. FAX (617) 821-4233.**

FLUKE 93

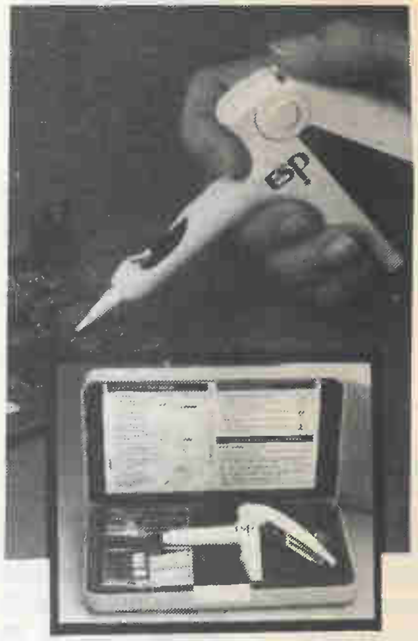
The **NEW FLUKE 93 ScopeMeter** from Techni-Tool is the first truly integrated scope-and-multimeter that lets you see a waveform and digital meter display at the same time from the same input. Special features such as menu and function keys, are fully remote on control front panel. With twelve cursor measurements, that store and recall, add, multiply, invert, filter, or intergrade waveforms, are just a few of the many handheld features included. For more complete information on the New Fluke 93 Scopemeter and the complete line of FLUKE 90 Series, and a **FREE** 240 Page Catalog Call: (215) 941-2400, (24 Hr.) FAX (215) 828-5623, or Write: **Techni-Tool, 5 Apollo Road, P.O. Box 368, Plymouth Meeting, PA 19462 USA.**

SOLDEROLL™ SOLDER APPLICATOR

An ideal, cost effective tool for low volume SMD (Surface Mount Device) production and rework where solder paste application using stencils, screen printers, or syringes are impractical. Solde-Roll™ applies a uniform and controlled layer of solder to fine pitch SMD boards and multileaded components. It can be used for solder leveling or to coat any solder surface from a single device to an entire prototype board. Solder adheres only to metallic areas on boards or component leads. There is no solder bridging between leads, even at 15 mil spacing and the tool's small roller head won't disturb adjacent components.

The Model FPR1000 SMD solder applicator kit contains a Solde-Roll™ tool, ¼ and ½ roller heads, SN60 solder reservoir, RMA (Rosin Mildly Activated) paste flux and dispenser syringe, flux brush, dross remover desoldering braid, solder aids, solder sucker, and storage/carrying case.

For more information and/or details on this product, contact **HMC (Hub Material Company), 33 Springdale Avenue, Canton, MA 02021, Phone (617) 821-1870, FAX (617) 821-4133.**



SMT REPAIR KIT

This handy kit allows you to make easy, accurate and reliable surface mount repairs at your bench or in the field. Also excellent for prototyping, training, and new SMT applications. Dispenser applies exact amount of solder cream or paste flux from pre-filled caplettes. Put solder cream where you need it, even fine pitch geometry. No stirring, no mess, and no mistakes. Easy to use. Just snap-in the color-coded caplette, and gently squeeze the Dot•Maker® dispenser to make accurate dots. Each caplette contains ½ gram of material. A squeeze-bulb vacuum tweezer, with five different-sized tip pads, ensures safe handling and placement of SMD parts without damaging leads or scratching PC board. Kit comes complete with dispenser, vacuum tweezer with five tips, moistening sponge, molded carrying case, and six caplettes (each) of SN43, SN62 and SN63 RMA solder cream, and 411 RMS paste flux. Replacement caplettes are available separately in packages of 10. For more details, contact: **HMC, 33 Springdale Avenue, Canton, MA 02021. Phone (617) 821-1870, FAX (617) 821-4133**

SERVICE VACUUM CLEANER

Techni-Tool introduces a compact, powerful, electro static discharge safe, professionally designed vacuum for high efficiency cleaning of your laser printer and business machines. This unit is completely self contained for maximum convenience. Everything you need is stored inside the lid and held in place by an internal door which easily stores the stretch hose which can be extended from 32 inches to ten feet with hose attachments and a detachable electrical cord for convenient handling during transit... This vacuum gives you the choice of three high capacity filtration systems. A replaceable 1 HP motor gives you maximum cleaning power for speed and efficiency. For more information on this and other vacuum tools, call (215) 941-2400, FAX (215) 828-5623, or write: **Techni-Tool, Inc., 5 Apollo Road, P.O. Box 368, Plymouth Meeting, PA 19462 USA.**

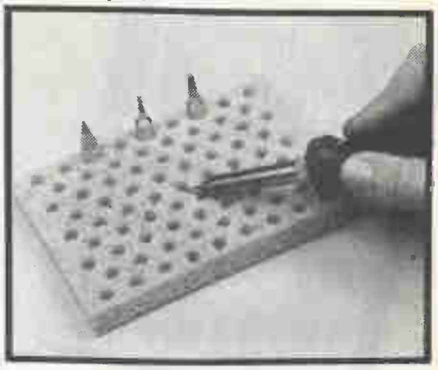
HIGH CAPACITY SOLDERING STATION

Weller's Model HYC3000 soldering station is designed to handle difficult applications requiring high heat output from a small tool. It's ideal for use on thick multilayer boards, heavy ground planes, and large lugs. The station's 42-watt soldering iron uses a sensor imbedded deep into its high-mass tip to provide quick thermal recovery of less than 4 seconds. Temperature is dial-adjustable from 350°F to 850°F in 10°F increments. The ESD-safe iron handle and power unit housing are made of high-impact conductive plastic. A detachable iron holder with sponge tray can be mounted on either the left or right side of the power base, or simply left free-standing. The Model HYC3000 station comes complete with power unit, lighted on/off switch, heating pulse LED indicator, sponge, iron holder, soldering iron with tip (P/N EMA), and 3-wire grounded cord.

For more details, call or write to **HMC (HUB Material Company), 33 Springdale Avenue, Canton, MA 02021, Phone (617) 821-1870, FAX (617) 821-4133.**

SOLDERING TIP SPONGE

This "Swiss Sponge" from the **HUB Material Company** is designed with multiple holes, like Swiss cheese, to catch solder balls and other solder residue. It eliminates time wasted by the assembler looking for the right spot on the sponge to wipe soldering iron tips. The sponge measures 3.5" × 4.8" and comes with patterns for custom trimming to fit any sponge tray.



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

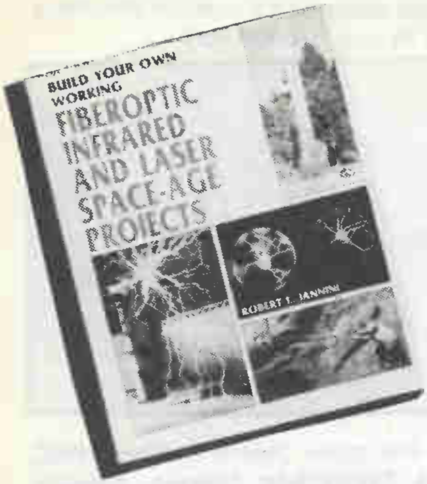
SURGE SUPPRESSOR

They better get better and better. The latest from HMC is the low-budget Terminator™ surge suppressor that provides power protection that pays for itself. Utilizing an advanced filter network, it guards your electronic system against AC spikes, surges and both RFI and EMI line noise. This 3-pathway (between neutral, hot and ground) power "protector" clamps 140 volts and dissipates 140 joules in a billionth of a second. Its six outlets are overload protected by a resettable 15-amp circuit breaker. A protection-status LED lets you know at a glance that it is working. A lighted master switch turns power on to your equipment, all at once and a six-foot cord lets you place it anywhere that is convenient.

For more details and/or answers to your questions, contact **HMC—HUB Material Company, P.O. Box #526, Canton, MA 02021. Phone (617) 821-1870, FAX (617) 821-4133.**

NEW BOOK REVIEWS

BUILD YOUR OWN WORKING FIBEROPTIC, INFRARED, AND LASER SPACE-AGE PROJECTS
by Robert E. Iannini



Tired of books that feature the same old boring projects? Looking for something a bit more exciting? Then check out Robert Iannini's new book of fiberoptic, infrared, and laser projects. There are fourteen different projects, and each one looks like a winner. Of course, you probably won't want to build all fourteen, but even if you build just one, the book should still be a worthwhile investment.

There is quite an assortment of laser projects in this book. For example, you can take your pick of various solid-state continuous-wave lasers, a helium-neon laser, a visible red 2-milliwatt continuous laser gun, a ruby laser gun, and a high-power infrared CO_2 laser. The various laser projects differ in power, cost, complexity, and application. The low-powered ones are suitable for communication and measurement, while the high-powered ones can be used for cutting or vaporizing material. Note that extreme caution is required when working with lasers in order to avoid serious injury to the eyes or skin. For that reason, laser projects are not suitable for younger, inexperienced builders —nor for reckless adults.

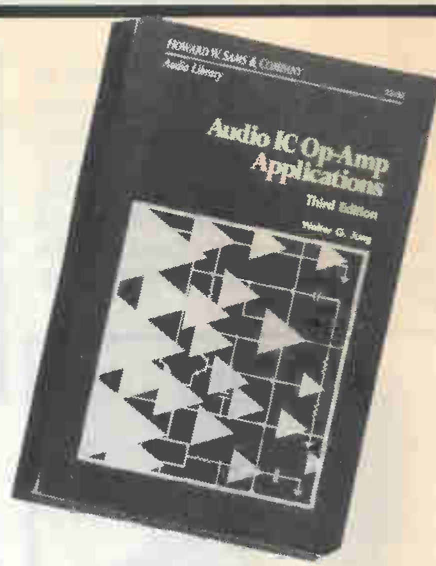
Other projects include a high-speed laser-light pulse detector, an infrared viewer which allows you to see in the dark, a fiberoptic communications system, a voice modulator for a helium-neon laser, an optical light detector and receiver, a plasma tornado display lamp (fascinating to watch, by the way), and a high-voltage DC generator capable of producing up to 250,000 volts. Here again, many of these projects are potentially dangerous and should be kept out of the hands of fools. For the builder who proceeds with caution, however, they should pose no particular threat.

The plans for each of these projects are thorough and easy to understand. Most parts should be readily available, but if you wish you can buy prepackaged kits of parts from the author's company, Information Unlimited. Most devices can be built for less than $100, some for much less, especially if you've got a well-stocked junk box. Instructions are quite lucid, and the author takes great pains to stress safety throughout the book. All things considered, this is an excellent book of high-tech projects for the ambitious hobbyist.

Build Your Own Working Fiberoptic, Infrared, and Laser Space-Age Projects, 262 pages, softbound: $16.95. TAB Book Co., Blue Ridge Summit, PA, 17214-9988. Telephone 1-800-822-8138.

AUDIO IC OP-AMP APPLICATIONS
by Walter G. Jung

One of the reasons for the widespread popularity of the op amp as a circuit building block is its ease of application. With a few hours of careful study, even a rank beginner can begin putting together useful op-amp circuits. But high-performance applications, such as professional audio, usually demand a more sophisticated knowledge of op-amp theory and application if optimum results are to be achieved. With that in mind, author Walter Jung has written a book that shows how to wring the last drop of performance out of op amps in critical low-noise, low-distortion audio applications.



The book begins with a discussion of op-amp circuit theory, which is essential knowledge for the beginner, and a useful review for the expert. Open-loop gain, gain-bandwidth product, frequency compensation, slew rate, and noise are some of the topics covered. Math is kept to a minimum, and the discussion is backed up with plenty of graphs, charts, and scope photos. The basic amplifier configurations—inverting, noninverting, differential, and voltage follower—are also covered from the standpoint of high-quality audio performance.

Once the theory has been dispensed with, the book moves on to practical audio applications. Some of the topics covered include low-noise voltage amplifiers, headphone drivers, line amps, power amps, high-gain preamplifiers, microphone preamps, moving-coil RIAA preamps, shelving equalizers, resonant equalizers, active filters, active crossover networks, notch filters, all-pass circuits, stereo pan pots, VU-meter amplifiers, sinusoidal oscillators, function generators, and compact-disc audio circuits. You can use these circuits as is, or simply study them and use them as inspiration for your own designs. The author explains each circuit in meticulous detail, and for that reason alone he deserves special thanks. Once you've studied one of his descriptions of circuit behavior, you'll have an excellent feel for how that circuit operates.

Author Walter Jung has done a fine job of explaining the intricacies of high-performance audio in an authoritative, easy- to-understand manner, making this a valuable book for hobbyists as well as professional circuit designers.

Audio IC Op-Amp Applications, 336 pages, softbound: $19.95. Howard W. Sams & Co., Division of Macmillan Computer Publishing, 11711 N. College Ave., Carmel, IN, 46032. Telephone 1-800-257-5755.

ADVANCED DIGITAL AUDIO
Ken C. Pohlmann, Editor

During the past decade, digital technology has come to pervade the world of audio, but it has happened so quickly and relatively quietly that many people have been caught napping. Well, here's good news for all the Rip Van Winkles out there: a new book called **Advanced Digital Audio** does an excellent job of explaining the use of digital electronics in audio systems.

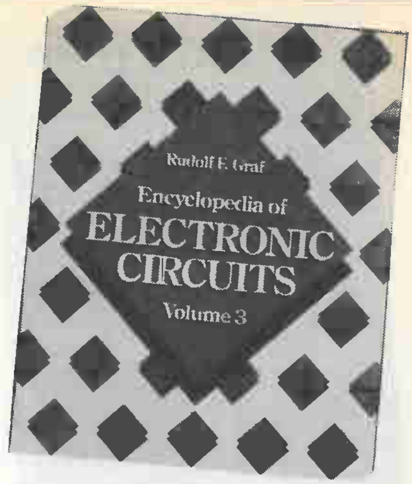
The book begins with an examination of the human auditory system, and then proceeds to discuss pulse-code modulation and sampling. Optical systems figure prominently in the new world of digital audio, and so three chapters are devoted to such topics as lasers, fiber optics, and optical-disc technology. Digital audio has made its mark in video and film, biomedicine, education, and satellite broadcasting, and the book does a creditable job of covering these applications. By far the largest part of **Advanced Digital Audio** is devoted to an exposition of the theory and practice of digital signal processing. The mathematical level is quite advanced; hence, this is not a book for the hobbyist. But advanced users will find plenty of food for thought in this comprehensive, well-written book.

Advanced Digital Audio, 518 pages, hardcover: $39.95. Sams Book Co., Division of Prentice-Hall Computer Publishing, 11711 N. College Ave., Carmel, IN, 46032. Telephone (800) 257-5755.

ENCYCLOPEDIA OF ELECTRONIC CIRCUITS, VOLS. 1-3
by Rudolf F. Graf

How many times have you pored over old technical magazines and books looking for just the right circuit, only to come up empty-handed and disappointed? Well, with a copy of the Encyclopedia of Electronic Circuits sitting on your bookshelf, that's not likely to happen ever again. Author **Rudolf F. Graf** has scoured the technical literature put out by semiconductor manufacturers, government institutions, professional electronic journals, and hobbyist magazines, and amassed the best of what he could find into a truly stupendous 3-volume (soon to be 4-volume) reference work.

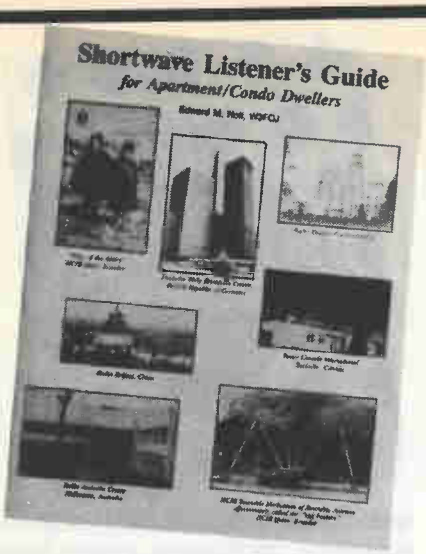
Each volume is divided up into chapters covering a specific type of circuit. For example, there are chap-



ters on alarm circuits, comparators, counters, oscillators, power supplies, phase detectors, photography-related circuits, and timers, to name but a scant few. The nice thing about the way these books are organized is that you'll find similar chapters in each volume. Hence, you don't have to start out by buying the whole 3-volume set. You can start with just one volume and add others later without feeling that you're missing something. Each circuit presented by the author is accompanied by a brief technical description, along with any relevant formulas or waveform diagrams, and a bibliographic citation (so you can look up the original source if needed). Technical descriptions seem to be fuller in the second and third volumes, so it might be a good idea if you're not buying the whole set to start with either Vol. 2 or Vol. 3. Let me point out that even electronics enthusiasts with well-stocked technical libraries can benefit from this series of books, since it is often easier to find a circuit in a well-organized encyclopedia than to search haphazardly through a bookcase full of magazines and databooks.

Encyclopedia of Electronic Circuits, Vols. 1-3, 730+ pages per volume, softcover: $29.95/vol, hardcover: $60.00/vol. TAB Book Co., Blue Ridge Summit, PA, 17214-9988. Telephone (800) 822-8138.

NEW BOOK REVIEWS



SHORTWAVE LISTENER'S GUIDE FOR APARTMENT/ CONDO DWELLERS
by Edward M. Noll, W3FQJ

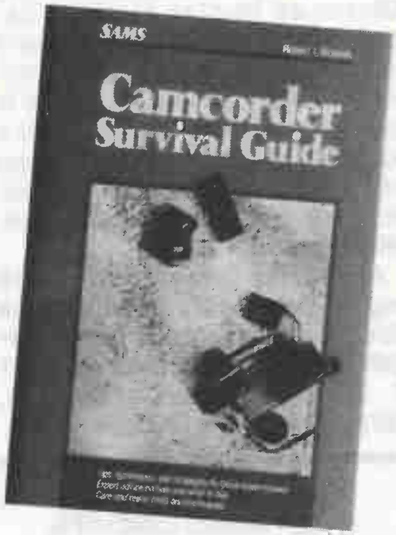
Living in an apartment or condominium can be a constricting experience. In most cases, your landlord will frown on rowdy parties and any pet larger than a goldfish, and he's certainly not going to let you erect a huge shortwave antenna. So what's an apartment-dwelling SWL to do? Get a copy of **Ed Noll's** new book, that's what. The Shortwave Listener's Guide For Apartment/Condo Dwellers not only shows how to fit a first-class listening post into the space of a broom closet, it also serves as an excellent introduction to all aspects of the shortwave listening hobby.

The author surveys the kinds of programs you'll find on the shortwave bands, tells the best times to listen, offers tips on effective QSLing, and most importantly provides a wealth of practical advice on antennas and antenna tuners. All in all, it's hard to imagine a better introduction to apartment-bound shortwave listening than this.

The Shortwave Listener's Guide for Apartment/Condo Dwellers, 60 pages, 8½ x 11", softcover, $9.95. MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS, 39762.

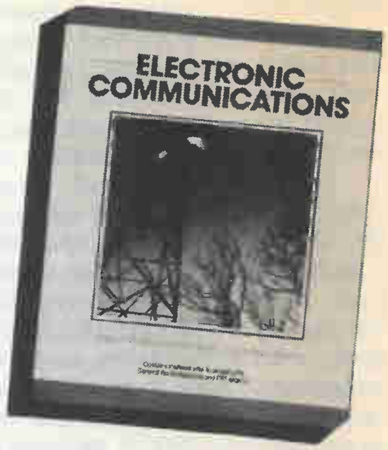
CAMCORDER SURVIVAL GUIDE
by Robert I. Wolenik

Buying your first camcorder can be a daunting experience. Should you get a VHS machine, or one of the other formats like Beta, 8-mm, S-VHS, VHS-C, or Hi-8? Do you really need a super-deluxe machine with a full complement of bells and whistles, or would a simpler and more economical unit suffice? These questions and more are thoughtfully answered in **Robert Wolenik's** book, the **Camcorder Survival Guide.**



After sorting out the various formats available and discussing the relative merits of each, the author goes on to offer advice on shopping for a camcorder and using it once you get home. Technical matters such as lighting the scene and editing the taped results are given good coverage. In addition, there is even a chapter on how to make money with your camcorder (weddings, graduations, and the like). The book ends with some helpful advice on repairs and maintenance. All things considered, this is an excellent, easy-to-read introduction to camcorders that will bring the novice up to speed fast, and even benefit the more experienced camcorder user.

Camcorder Survival Guide, 193 pages, softcover: $9.95. Sams Book Co., Division of Prentice-Hall Computer Publishing, 11711 N. College Ave., Carmel, IN, 46032. Telephone (800) 257-5755.

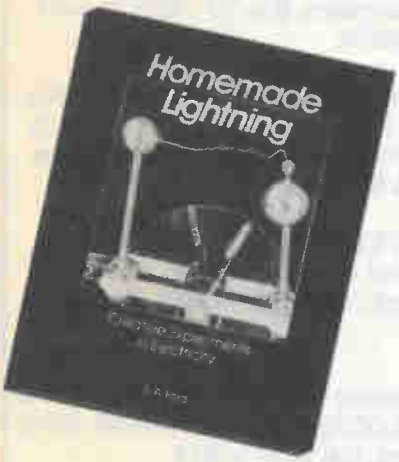


ELECTRONIC COMMUNICATIONS
by John Dulin, Victor Veley, and John Gilbert

The stated purpose of this book is to serve as an introductory text on radio communications and as a reference manual for radio technicians. The material it contains is essential for anyone seeking to pass the FCC General Radiotelephone and CET examinations. In addition, amateur radio operators will find plenty of material here to interest them, too. Part I of the book discusses devices and circuits. The topics covered include filters, solid-state devices, thermionic tubes, amplifiers, oscillators, and digital logic.

Part II of the book concerns itself with the techniques and equipment used in radio communication. Individual chapters treat such topics as AM and FM modulation, transmitters, receivers, antennas, transmission lines, television, and microwave transmission. Throughout the level of mathematics is held to a minimum, so the book should be accessible to a wide audience. But don't get the wrong idea. This isn't a simple-minded text. It is a serious, rigorous introduction to the field of radio communications. The authors mix interesting historical tidbits in with the technical chatter, so readers get a sense of where radio has been as well as where it is going. More importantly, authors Dulin, Veley, and Gilbert have put together a book that is readily understandable, which is more than can be said of similar books in the field.

Electronic Communications, 690 pages, softcover: $24.95, hardcover: $34.95. TAB Book Co., Blue Ridge Summit, PA, 17214-9988. Telephone (800) 822-8138.



HOMEMADE LIGHTNING
by R.A. Ford

With a title like **Homemade Lightning,** how could a book help but be interesting? Author R.A. Ford's intent was to write a book that would enable the average craftsman to build a generator of high-voltage static electricity similar to the Wimhurst or Van De Graff generator you encountered in high-school physics, and I think he has succeeded admirably. Mr. Ford's design is based upon the Wimhurst machine, but contains improvements like an electric-motor drive that eliminates the tedium of cranking. Clear step-by-step instructions along with numerous drawings and photographs make it easy for the reader to duplicate Mr. Ford's work.

The book goes beyond construction to illustrate the use of the static-electricity generator in the study of high-voltage phenomena. There are chapters on electrostatic motors, electrohorticulture, electrotherapeutics, and electroaerodynamics. All in all, a fascinating book. Those of you looking for a spectacular science-fair project might want to peruse the book for ideas. By the way, check out page 146, where you'll find a photo of a highly charged model with long blonde hair sticking straight out in all directions. The wry caption beneath the photo describes this as the author's version of a room-temperature superconductor.

Homemade Lightning, 198 pages, softcover: $14.95. TAB Book Co., Blue Ridge Summit, PA, 17214-9988. Telephone (800) 822-8138.

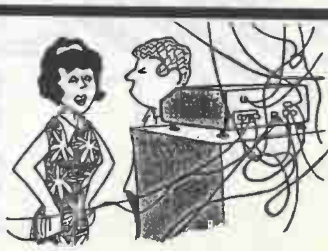
ELECTROMECHANICAL DESIGN HANDBOOK
by Ronald A. Walsh

The **Electromechanical Design Handbook** by **Ronald A. Walsh** is a unique reference work containing mechanical and electrical data that will be of use to the engineer, technician, and advanced experimenter. The book begins with a chapter on mathematics, covering important facts from algebra and geometry for the most part. Chapter 2 is a quick review of the principles of mechanics, both statics and dynamics. Chapter 3 serves up another dose of mathematics, while Chapter 4 deals with the physical characteristics of engineering materials like steel, iron, and a wide variety of plastics. The strength of materials is the subject of Chapter 5.

Basic electrical and electronic design data are the subject matter of Chapter 6. We bounce back to mechanics in Chapter 7, which deals with the principles of spring design. Chapter 8 covers the de-

sign of machine elements such as shafts, gears, belt drives, clutches, bearings, cams, and linkages. Chapter 9 provides a brief treatment of some elements of pneumatics and hydraulics. The subject of Chapter 10 is fasteners—bolts, screws, washers, rivets, pins, adhesives, brazing and welding. Sheet-metal design and fabrication are dealt with in Chapter 11. The remaining pages of the book touch upon aspects of patent law, the making of castings and moldings, and sundry other matters. As you can see, the focus of the book is more upon mechanical rather than electrical matters. There is a lot of information here, making this an excellent reference for the engineer, inventor, or advanced experimenter.

Electromechanical Design Handbook, 642 pages, hardcover: $49.50. TAB Book Co., Blue Ridge Summit, PA, 17214-9988. Telephone (800) 822-8138.



"Is that the best you can do with the wiring?"

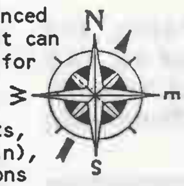
CLASSIFIED FLEAMARKET

Digital Compass Kit

The perfect assembly project for school or for that budding electronic hobbyist.

The Digital Compass is a hand held device that senses all eight compass headings by lighting the appropriate LED.

By making use of the highly advanced Dinsmore Sensor, your compass kit can also provide accurate headings for your car or boat.



Kit comes complete with ALL parts, compass sensor, PC Board (2x3.5in), memory chip and assy. instructions (Less Housing & 9V Battery).

$26.50

Suncoast Technologies
P.O. Box 5835
Spring Hill, FL 34606

VHS-VCR Repair Solution Sets I, II, III, IV, V, VI. Each contains 150 symptoms and cures, Cross Reference Chart, Free Assistance $11.95 each. All six $59.95. **Eagle Electronics, Box "D", 52053 Locks Lane, Granger, IN 46530.**

Design Tesla Coils! Any size, any power, quickly and easily on your IBM computer. Fantastic, fully graphic program! Only $29.95. **W.C.N., 3283 Belvedere, Riverside, CA 92507**

ALL ABOUT CRYSTAL SETS. Theory and construction of crystal set radios. $7.95 ppd USA. **Allabout Books, Dept. "H", Box #14155, Fremont, CA 94539.**

FREE! Fabulous catalog of sensational electronic kits. **LNS TECHNOLOGIES, 20993 Foothill Blvd. Suite 307H, Hayward, CA 94541-1511.**

Lab Test ELECTRONICS HANDBOOK For Yourself!

V12

ELECTRONICS HANDBOOK

P.O. Box #5148, N. Branch, N.J. 08876

☐ Yes. Enter my subscription — 4 issues ONLY $15.00
(Canada $18.00...Foreign Postage add $8.00...U.S. Funds)

☐ Payment enclosed. (Payable to: C&E Hobby Handbooks)

PLEASE PRINT
NAME: ____________
ADDRESS: ____________
CITY: ____________
STATE: ____________ ZIP ________

What's better than speed reading?

Speed Learning.

Speed Learning has replaced speed reading. It's a whole new way to read and learn. It's easy to learn...lasts a lifetime... applies to everything you read. It may be the most productive course you've ever taken.

FOR FASTER SHIPMENT CALL 1-800-729-7323 OR FAX 1-609-273-7766

Do you have too much to read and too little time to read it? Do you mentally pronounce each word as you read? Do you frequently have to go back and reread words, or whole paragraphs, you just finished reading? Do you have trouble concentrating? Do you quickly forget most of what you read?

If you answer "Yes" to any of these questions — then here at last is the practical help you've been waiting for. Whether you read for business or pleasure, school or college, you will build exceptional skills from this major breakthrough in effective reading, created by Dr. Russell Stauffer at the University of Delaware.

Not just "speed reading" — but speed reading — thinking — understanding — remembering — and — learning

The new *Speed Learning Program* shows you, step-by-proven step, how to increase your reading skill and speed, so you understand more, remember more and use more of everything you read. The typical remark from over one million people taking the Speed Learning program is, "Why didn't someone teach me this a long time ago." They were no longer held back by their lack of skills and poor reading habits. They could read almost as fast as they could think.

What makes Speed Learning so successful?

The new *Speed Learning Program* does not offer you a rehash of the usual eye-exercises, timing devices, and costly gadgets you've probably heard about in connection with speed reading courses, or even tried and found ineffective.

In just a few spare minutes a day of easy reading and exciting listening, you discover an entirely new way to read and think — a radical departure from anything you have ever seen or heard about. Speed Learning is the largest selling self-study reading program in the world. Successful with Fortune 500 corporations, colleges, government agencies and accredited by 18 professional societies. Research shows that reading is 95% *thinking* and only 5% eye movement. Yet most of today's speed reading programs spend their time teaching you rapid eye movement (5% of the problem), and ignore the most important part, (95%) *thinking*. In brief, *Speed Learning gives you what speed reading can't.*

Imagine the new freedom you'll have when you learn how to dash through all types of reading material at least twice as fast as you do now, and with greater comprehension. Think of being able to get on top of the avalanche of newspapers, magazines and correspondence you have to read...finishing a stimulating book and retaining facts and details more clearly, and with greater accuracy, than ever before.

Listen — and learn — at your own pace

This is a practical, easy-to-learn program that will work for you — no matter how slow a reader you think you are now. The *Speed Learning Program* is scientifically planned to get you started quickly...to help you in spare minutes a day. It brings you a "teacher-on-cassettes" who guides you, instructs, and encourages, explaining material as you read. Interesting items taken from *Time* Magazine, *Business Week, Wall Street Journal, Money, Reader's Digest, N.Y. Times* and many others, make the program stimulating, easy and fun...and so much more effective.

Executives, students, professional people, men and women in all walks of life from 15 to 70 have benefitted from this program. Speed Learning is a fully accredited course...costing only 1/4 the price of less effective speed reading classroom courses. Now you can examine the same easy, practical and proven methods at home...in your spare time...without risking a penny.

Examine Speed Learning RISK FREE for 15 days

You will be thrilled at how quickly this program will begin to develop new thinking and reading skills. After listening to just one cassette and reading the preface, you will quickly see how you can achieve increases in both the speed at which you read, and in the amount you understand and remember.

You must be delighted with what you see, or you pay nothing. Examine this remarkable program for 15 days. If, at the end of that time you are not convinced that you would like to master Speed Learning, simply return the program for a prompt refund. (See the coupon for low price and convenient credit terms.)

RISK-FREE ORDER FORM

__ **YES!** I want to try Speed Learning for 15 days without risk. Enclosed is the first of 4 monthly payments of $32.25*. If I'm not completely satisfied, I may return it for a prompt refund.

__ **SAVE 8.00!** I prefer to pay the $129.00 now, and save the $8.00 shipping & handling charge. I may still return the program for a full refund.

Method of payment: (Federal Tax Deductible)
__ Check or money order payable to Learn Incorporated

__ Charge to: __ Visa __ MC __ Am Ex __ Discover

Card # ____________________ Exp. __________

Signature ____________________

Phone (______) ____________________

Name ____________________

Address ____________________

City ______________ State ____ Zip ________

*Plus $8.00 shipping and handling. U.S. funds only. For New Jersey residents, sales tax will be added.

learn INCORPORATED Dept. JVE-01 113 Gaither Drive, Mt. Laurel, NJ 08054-9987

3-&-1 POWER SUPPLY

By Homer L. Davidson

Besides three fixed regulated voltages, this power supply has another one that is variable between 1.2 and 29 volts DC. This is a small power supply that should fill all your needs in powering projects and servicing different electronic circuits. The fixed voltages are 12, 8 and 5 volts DC at 1.5 Amps.

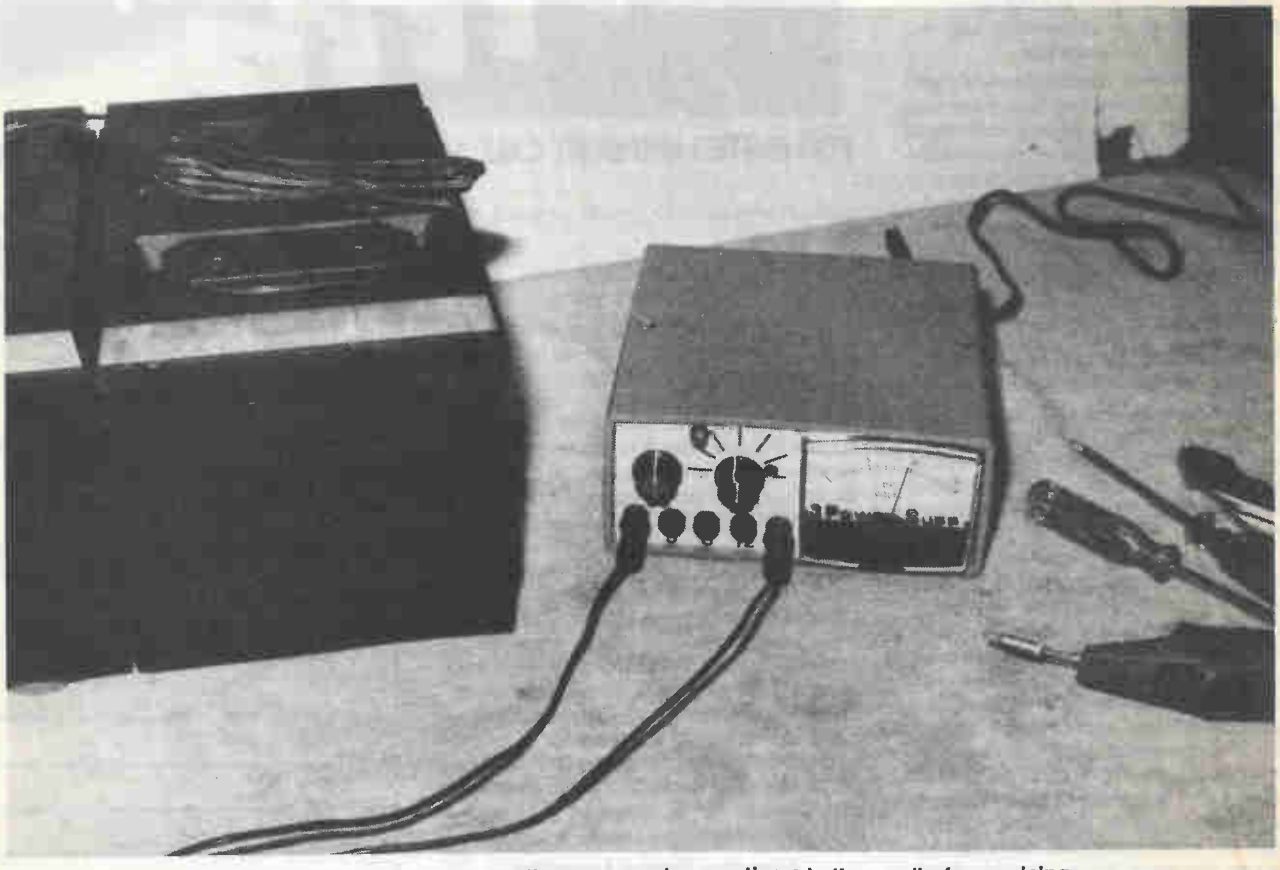


Figure 1. A front view of the small power supply operating a battery radio for servicing.

The variable DC supply source provides 9 ranges of voltage (1.2 to 29 V) for that exact voltage at 1.5 Amps When lower or higher voltages are needed, besides the fixed voltages, just plug in the VAR jack and common ground. Rotate R2 for the required voltage. Although, the meter will measure up to 15 volts DC, added resistance extends the range to 30 volts DC.

Fixed Voltage Circuits

SW1 turns on the small power supply and is located at the rear of R2. N1 indicates power is applied to T1. The step-down power transformer (T1) has a secondary voltage of 18 volts at 2 amps. The bridge rectifier (D1) provides fullwave rectification of the applied 18 volts. C1 filters the DC voltage of around 29 volts (See Figure 2).

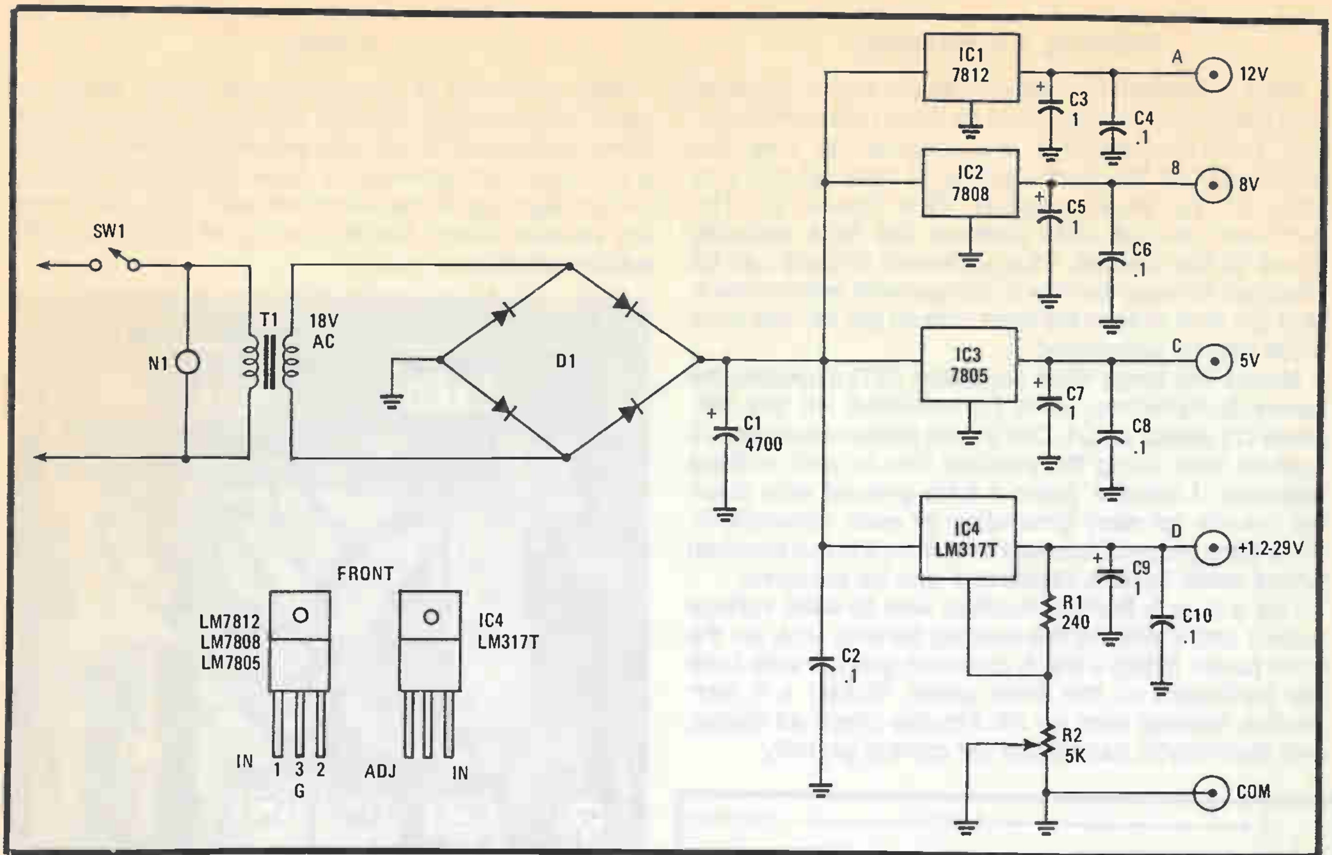


Figure 2. Schematic diagram of all four power sources and regulators. Note how IC4 is connected, compared to the other regulators.

All four IC regulators are tied to the DC output voltage, IC1 is a 12 volt DC regulator at 1.2 amps, IC2 at 8 volts and IC3 at 5 volts source. Make sure the input terminals connect to each corresponding voltage jack. C3 through C10 provide bypass and RF filtering at the output terminals. The center terminal of IC1, IC2 and IC3 is grounded.

Variable Voltage Circuit

Like all other IC regulators, the IC4 input terminal is connected to the 29 volt DC source. The center terminal (ADJ) is not directly grounded, but connected between R1 and R2. Check IC4 terminal connections since they are different from the other regulators. The output of the LM317T regulator is the center terminal. The input terminal is on the right and the adjust terminal to the left. R2 varies the output voltage from 1.2 to 29 volts DC. All four voltage sources can be monitored with the panel meter.

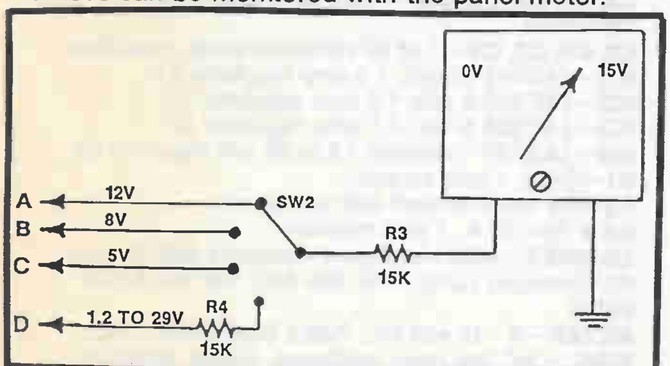


Figure 3. The meter circuit is switched to check or monitor each power output source.

The Meter Circuit

Here a 15 volt DC meter indicates the output voltage of each power supply source. Although, the meter hand only goes up 15 volts DC, with regular DC measurements, two 15K ohm resistors are switched in series with the positive terminal to indicate up to +30 DC volts (See Figure 3). When using the 1.2 to 29 volt power source, just double the reading. If the DC meter reads 10 volts, actually 20 volts is applied to the output terminals.

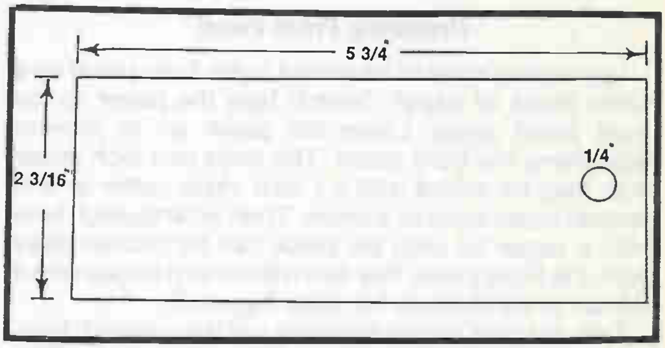


Figure 4. Cut the 5 3/4 × 2 3/16 inch piece from a larger perfboard. Drill a 1/4 inch hole to let the AC cord through.

This Radio Shack (270-1754) 0 to 15 V DC precision panel meter comes with one 15K ohm resistor to read full scale. Just add another 15K ohm resistor to double the voltage range. Read directly on the meter scale for 5, 8 and 12 volt sources. Remember to double the reading when using the 1.2 to 29 volt source. SW2 monitors the different output voltages.

Preparing The Perfboard

Most of the small components are found mounted on a perfboard, except those found on the front panel. The small components are soldered as they are mounted. Cut the perfboard to fit between the side slots of the small cabinet (See Figure 4). The perfboard should slide between the slots securing board to the cabinet. The perfboard chassis can be lifted out for easy service or component replacement. Drill a ¼ inch hole in the right side so the AC line cord wires can be connected.

Mount the large filter capacitor (C1) opposite the power transformer. With C1 mounted on the left, place D1 ahead of C1. Cut a bare piece of number 22 hookup wire along the positive side to each voltage regulator. Likewise, place a bare ground wire down the middle for easy grounding of each component. Tie a bare piece of hookup wire from the out terminal where small bypass capacitors can be soldered.

Cut a 6 inch flexible hookup wire to each voltage output and solder to the correct banana jack on the front panel. Bring a black common ground wire from the perfboard to the front panel. Solder a 6 inch flexible hookup wire for R2. Double check all diodes and electrolytic capacitors for correct polarity.

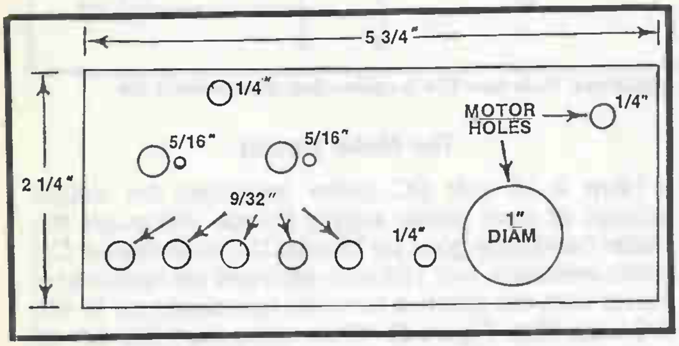


Figure 5. Follow the front panel hole layout to determine where each front panel component is located and what size hole to drill.

Preparing Front Panel

Layout the holes to be drilled in the front panel on a white sheet of paper. Scotch tape the paper to the front panel piece. Leave the paper on to prevent scratching the front panel. The large one inch meter hole may be drilled with a 1 inch circle cutter or drill several small holes in a circle. Then enlarge each hole with a larger bit until the piece can be broken away from the front piece. File down the sharp edges with a rat-tail or semi-circle file (See Figure 5).

Drill all holes before breaking out the one inch hole. Drill two ¼ inch holes to mount the panel meter. This will let you rotate the meter until level with the front panel. Lay the meter cutout piece, found on the rear of the meter package, for correct mounting holes.

Space the 9/32 inch banana-jack holes about ½ inch apart. Place the five holes evenly between the meter and the edge of front panel. Drill two 5/16 inch holes to mount R2, SW1 and the meter switch (SW2). Drill a 1/8 inch hole along side of R2 and SW2 to place the lock stub in place. This prevents the control from rotating or loosening. SW1 is found on the back of R2.

Testing

After all wiring is completed, the power supply is ready to be tested. Double check all wiring before firing up the unit. Make sure the exact voltage source is at the correct banana jack. Now, rotate SW1 and N1 should light up. If the neon indicator does not come on, double check the AC wiring at the line cord, switch and N1.

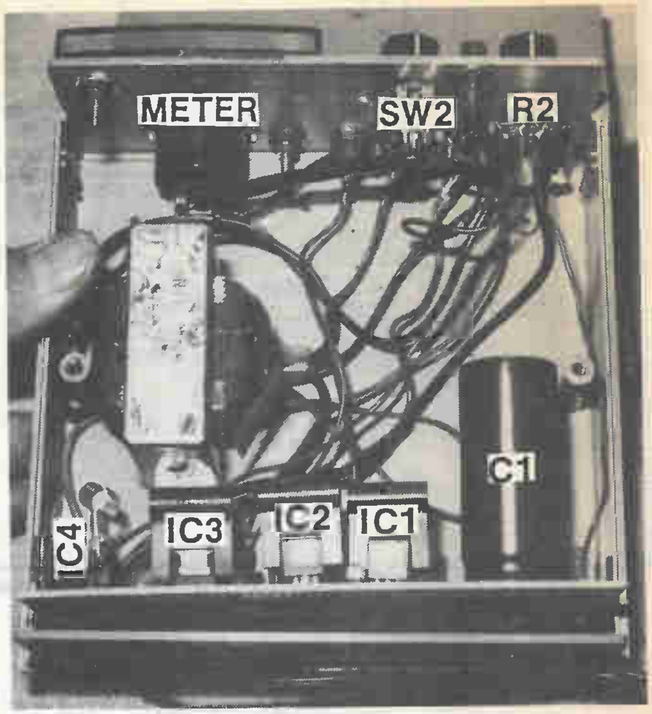


Figure 6. Top view of the completely wired unit. Double check all wiring before testing the power supply sources.

Rotate SW2 to the number 1 to 5 volt position, when the indicator light is ON. The meter should read 5 volts DC. If there is no voltage indicated, pull the

PARTS LIST FOR 3-&-1 POWER SUPPLY

SW1—SPST on rear of R2.
SW2—SPST 4 position rotary switch, 275-1386 or Equiv.
N1—120 V AC neon bulb, 272-712 or Equiv.
T1—18 volt AC secondary power transformer 2 amp type, 273-1515 or equiv.
D1—2 amp bridge rectifier or 4-2 amp silicon diodes.
C1—4700 uf, 35 volt electrolytic capacitor.
C2, C4, C6, C8, C10—.1 uf, 50 volt ceramic capacitors.
C3, C5, C7, C9—1 uf 50 volt electrolytic capacitors.
IC1—LM7812 12 volt, 1.5 amp regulator IC.
IC2—LM7808 8 volt, 1.5 amp regulator IC.
IC3—LM7805 5 volt, 1.5 amp regulator IC.
IC4—LM317T - variable 1.2 to 29 volt regulator IC.
R1—240K, 1 watt resistor.
R2—5K linear control with switch.
R3 & R4—15 K, 1 watt resistors.
CABINET—ABS instrument enclosure MB-3A grey, All Electronic Corp., P.O. Box 567, Van Nuys, CA, 90408.
METER—0 - 15 volt DC, Radio Shack 276-1754.
MISC.—AC line cord, perfboard, rubber grommet, nuts & bolts, solder, hookup wire, etc.

3-&-1 POWER SUPPLY

power cord. Go over the 5 volt regulator wiring. If the wiring is OK, check the DC voltage at C1 and ground (+29 V). With no DC voltage, suspect D1 is wired backwards. If voltage is found at the "on" terminal of IC3 and not at the output terminal, suspect a defective IC3 or improper wiring connection.

Check all voltages at the different voltage sources in the same manner. Double check the regulator IC connections and terminals when one fixed voltage is missing and the others are normal. Make a quick voltage test of input and output voltage on the pins of the regulators, with the DMM or VOM. This should indicate the defective component or connection.

Now, switch SW2 to the 4th position, or the variable voltage. Rotate R2 and the voltage should increase. The output voltage should be from 27 to 29 volts. If not, check IC4 connections, R2 and R1. Make sure the input terminal voltage is correct.

Conclusion

Besides the three different fixed voltages for projects, this little power supply can be used to check out motors in camcorders, CD's and cassette players. The small DC motors, under 5 volts, may be checked on the variable power supply. The battery operated phono or portable cassette motor may be checked with the variable source.

Injected voltage source into the horizontal, vertical, audio and derived scan secondary voltages in the TV chassis may be checked with the variable source. Low voltage powered phonos, cassette players and radio circuits may operate directly from the fixed or variable voltage power source. ■

If You're Serious About a Future in Electronics, Ensure that Future with the Best Educational Training Available.
electronics
FREE!
SEND FOR YOUR CIE HOME STUDY COURSE CATALOG AND RECEIVE A FREE 24 PAGE CIE ELECTRONICS SYMBOL HANDBOOK!
Includes hundreds of the most frequently used electronic symbols. Published by CIE exclusively for our students and alumni. Yours free when you request a CIE Course Catalog.

If you want to learn about electronics, and earn a good income with that knowledge then CIE is your best educational value.

CIE's reputation as the world leader in home study electronics is based solely on the success of our graduates. And we've earned that reputation with an unconditional commitment to provide our students with the very best electronics training.

Just ask any of the 150,000-plus graduates of the Cleveland Institute of Electronics who are working in high-paying positions with aerospace, computer, medical, automotive and communication firms throughout the world.

They'll tell you success didn't come easy...but, it did come....thanks to CIE. And today, a career in electronics offers more opportunities and greater rewards than ever before.

CIE's COMMITTED TO BEING THE BEST....IN ONE AREA....ELECTRONICS.

CIE isn't another be-everything-to-everybody school. We teach only one subject and we believe we're the best at what we do. Also, CIE is accredited by the National Home Study Council. And with more than a 1,000 graduates each year, we're the largest home study school specializing exclusively in electronics. CIE has been training career-minded students like yourself for nearly 60 years and we're the best at our subject ..... ELECTRONICS ... BECAUSE IT'S THE ONLY SUBJECT WE TEACH!

CIE PROVIDES YOU WITH A LEARNING METHOD SO GOOD, IT'S PATENTED.

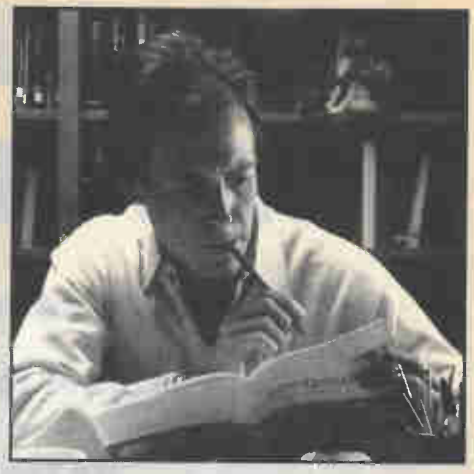
CIE's Auto-programmed lessons are a proven learning method for building valuable electronics career skills. Each lesson is designed to take you step-by-step and principle-by-principle. And while all CIE lessons are designed for independent study, CIE's instructors are personally available to assist you with just a toll-free call. The result is practical training... the kind of experience you can put to work in today's marketplace.

LEARN BY DOING...WITH STATE-OF-THE-ART FACILITIES AND EQUIPMENT.

In 1969, CIE pioneered the first Electronics Laboratory course and in 1984, the first Mircoprocessor Laboratory course. Today, no other home study school can match CIE's state-of-the-art equipment and training. And all your laboratory equipment, books, and lessons are included in your tuition. It's all yours to use while you study at home and for on -the -job after graduation.

PERSONALIZED TRAINING....TO MATCH YOUR BACKGROUND.

While some of our students have a working knowledge of electronics others are just starting out. That's why we've developed twelve career courses and an A.A.S. Degree program to choose from. So, even if your not sure which electronics career is best for you, CIE can get you started with



core lessons applicable to all areas of electronics. And every CIE course you take earns you credit towards completion of your Associate in Applied Science Degree. So you can work toward your degree in stages or as fast as you wish. In fact, CIE is the only school that actually rewards you for fast study, which can save you thousands of dollars.

SEND TODAY FOR YOUR CIE COURSE CATALOG AND WE'LL SEND YOU A FREE 24 PAGE CIE ELECTRONICS SYMBOL HANDBOOK!

FINANCIAL AID AVAILABLE TO QUALIFIED INDIVIDUALS.

WHY CHOOSE CIE FOR YOUR TRAINING?

- 150,000 successful graduates from every country around the world.
- Only CIE rewards you for fast study. CIE offers an Associate Degree program based on actual study time used. The faster you complete your degree the less your overall tuition.
- State-of-the-art laboratory equipment is yours to keep and it comes assembled, ready for hands-on experiments.
- Approved for educational benefits under the G.I. Bill for veterans and other eligible persons.
- Upon graduation, CIE offers free preparation to pass the Certified Electronics Technician Exams.

☐ **YES!** I want to get started. Send me my CIE school catalog including details about the Associate Degree Program. (For your convenience, CIE will have a representative contact you – there is no obligation.)

Name: ______________________

Address: ______________________

City: ______________ State: ________

Zip: ______________ Age: ________

Phone No. (____) ______________

Check box for G.I. Bulletin Benefits
☐ Veteran ☐ Active Duty

CIE
CLEVELAND INSTITUTE OF ELECTRONICS
1776 East 17th Street
Cleveland, Ohio 44114
(216) 781-9400
AEE05

ACCREDITED SCHOOL NATIONAL HOME STUDY COUNCIL NHSC

A school of thousands.
A class of one.
Since 1934.

ELECTRONIC WATCHDOG

A simple educational and fun project for beginners

By Tony Lee

Try getting past this watchdog without him seeing you—from 25 to 30 feet away.

When set up correctly, the incredible sensitivity of the "Watchdog" can detect the slightest movement of the body within approximately 25 feet, depending on light conditions in the home. The project can be arranged as a novelty by fitting it inside a toy dog (live ones would object) or other suitable toy so that the eyes light up when it detects something moving. Even a flapping curtain will annoy it. The actual sensing device can be fitted in the nose of the dog where it will hardly be noticed.

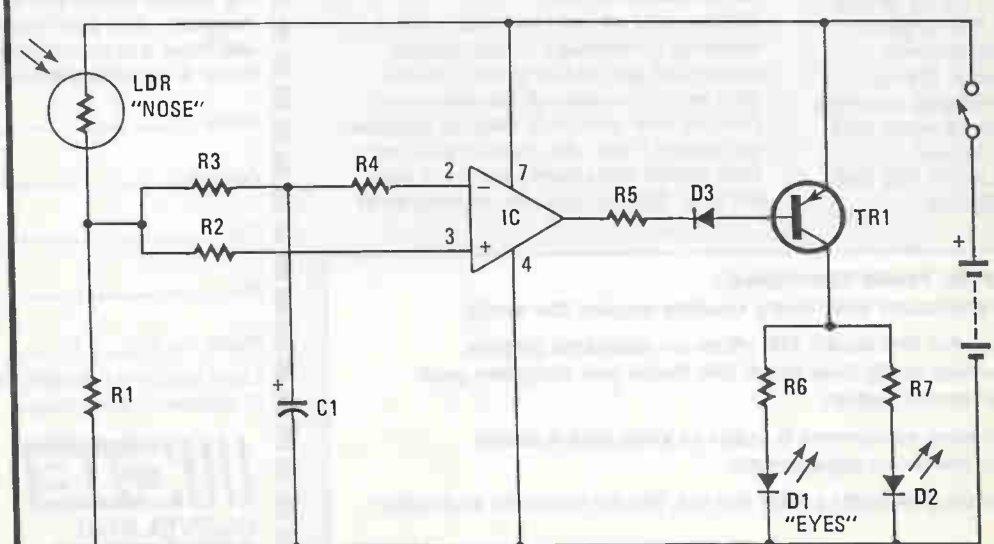
Because of its high degree of sensitivity, it may not be suitable as an intruder alarm but the circuit design allows ample opportunity for experimentation. The project is, therefore, presented as a game in which the object is to move stealthily across a room without being detected. You will find it almost impossible!

It will operate in almost any level of *natural* daylight; unlike many other light dependent sensors which respond to one fixed level.

The circuit works like this: The heart of the unit is an Operational Amplifier, more commonly known as an Op-Amp for convenience, and is used in countless applications. Due to its massive amplification factor, which can be as high as 200,000 or even more, it is normally reduced to practical levels to avoid instability and distortion.

This is achieved by negative feedback; in other words, some of the gain at the output is fed back to the input. If you haven't caught up with this principle, don't be alarmed because in this project, it is not needed. In fact, we take full advantage of the gain to obtain the greatest sensitivity.

The operation of the op-amp can be explained in simple terms. It has two inputs and one output, and is



CIRCUIT DIAGRAM OF THE ELECTRONIC WATCHDOG

ELECTRONIC WATCHDOG

wired into the circuit as a differential amplifier. When the two inputs are fed with an equal voltage, there is no voltage from the output but if there is a differential in voltage between the two inputs, this voltage difference will be detected and amplified, to provide an output.

Note that it doesn't matter what the voltages are on the two inputs; if say, one is 2.2 and the other is 2.3, the difference is .1 volt. Again, if the voltage on one is 5.4 and the other is 5.5, the result is still the same: .1 volt and we get the same output from the amplifier.

The next point to understand is that a very slow change in light intensity such as a passing cloud, will not provide a sufficient differential to obtain an output. However, a fairly rapid change **will** achieve an output. This is what happens: Think of the capacitor (C1) as a tiny battery which is capable of storing a temporary electrical charge. When the light sensor (LDR) detects a small change in light conditions, an equal voltage starts on its way to both inputs but the input connected to the capacitor lags behind momentarily as the capacitor charges up, resulting in a voltage difference and consequently, producing an output.

The capacitor dissipates its charge after two or three seconds and the two inputs again equal each other and so the output shuts off. Note that once the unit has adapted to its new light level, it is ready for the next change in light conditions and will operate again when it comes along. That is the major difference between this *variable* light sensor and conventional *fixed* light sensors commonly used to automatically switch on security lights at dusk.

Finally, the buffer transistor (TR1) interfaces the amplifier output with the two Light Emitting Diodes (LED's), which serve as the eyes. When the transistor switches on, the LED's light up for a few seconds then switch off. The transistor will also drive some other device such as a buzzer if fitted in parallel with the LED's and their limiting resistors.

The unit is best set up in contrasty light conditions and more or less, facing a window some distance away. Switch off all electric lighting for best results, particularly fluorescent tubes. Try the unit in various locations to obtain the most dramatic effect. It was mentioned earlier that you can experiment with other components, for example, try fitting a 20K trimpot between the positive rail and the LDR to alter the sensitivity. Or try a smaller capacitor. ■

PARTS LIST FOR THE ELECTRONIC WATCHDOG

R1, R4—15K resistors ¼W.
R2, R3—220K resistors ¼W.
R5—4.7K resistor ¼W.
R6, R7—270 Ohm resistors ¼W.
C1—1uF Tantalum capacitor
IC—741 Operational Amplifier
TR1—2N3906 PNP transistor or equiv.
D1, D2—5mm Red Light Emitting Diodes
D3—1N914 signal diode
LDR—Light Dependent Resistor

MISSING OHMS MYSTERY

By Michael A. Covington

Coaxial cables and TV lead-ins are rated in ohms, but there's no way to measure these ohms with an ohmmeter. If you try, you'll find that the resistance of each conductor is near zero, and the resistance between the conductors is practically infinite. Nothing on a piece of 75-ohm coax measures 75 ohms. So why is it called 75-ohm cable?

The answer has to do with *transmission line impedance,* one of the most misunderstood concepts in electronics. In this article I'll try to explain it in a simple, intuitive way.

A 300-ohm twinlead cable is just a pair of wires about 0.3 inch apart; 75-ohm coaxial cable is similar except that one wire is hollow and serves as the shield for the other. Either way, a transmission line is just a pair of wires.

Imagine that you have an immensely long cable—thousands or millions of miles long— and you suddenly connect a battery to one end of it (Fig. 1).

As soon as you connect the battery, current will flow into the cable. At this point it doesn't matter what's on the other end of the cable; the signal hasn't had time to reach it. All that matters is that the potential between the conductors used to be 0 volts, and now it has to come up to the battery voltage. The battery is simultaneously putting a positive charge on one of the wires and a negative charge on the other. So a wave of electric charge flows down the cable the way an advancing wall of water flows down a river when a dam breaks.

This process is a lot like charging a capacitor. There's capacitance between the conductors, and the "capacitor"—that is, the cable—has to be charged to the battery voltage. But it can't charge instantly because the cable also has inductance. The inductance puts a limit on the rate of current flow.

In fact, the current, in amperes, ends up being proportional to the battery voltage, *exactly as if the battery were connected to a resistor*. That's where the ohms come from. The ratio of a voltage to a current is always a resistance. As long as the battery is simply dumping current into the cable, and the current hasn't reached the end of the cable yet, the battery thinks it's connected to a resistor. If it's a 75-ohm cable, it's like a 75-ohm resistor.

Eventually the advancing wave of electricity will reach the end of the cable. What happens then?

Any of three things. Suppose that, by good luck, there is a 75-ohm resistive load at the end of the cable. If this is the case, current can continue flowing exactly the way it started. The current going into the cable will exactly match the current drawn by the resistor. The cable will have no effect on the circuit except that it introduces a time delay. This is known as a *perfect impedance match*. It's what we strive for when we match cables to antennas or other loads. It enables signals of all frequencies to get through unchanged.

If the load on the end is *more* than 75 ohms—if, for example, it's an open circuit and there is no load at all—then the load can't accept all the electricity that is coming down the cable. Some of it has to go back where it came from. The battery will receive a voltage pulse called a *reflection* consisting of energy that was placed into the cable, then got to the end and found it had nowhere to go. The reflection will make the battery stop delivering so much current, and—after many reflections in both directions— the system will reach equilibrium.

Reflections sometimes cause ghosts in TV pictures, echoes in long-distance phone calls, and burned-out finals in radio transmitters. On a more mundane level, you may have experienced a reflection when using a stiff-sided garden hose with a nozzle. Suppose the hose is empty, the nozzle is closed, and you turn on the water at the faucet. The hose quickly fills up with water, and then —*thunk*— when the advancing wave of water hits the closed nozzle, a pressure wave reflects back along the entire hose. To use electronic jargon, your garden hose has an impedance mismatch because water can enter it a lot more easily than it can get out.

But back to the 75-ohm cable and battery. What if the load at the end is *less* than 75-ohms? In this case, the load will want *more* current than the cable is delivering, and it will take energy out of the capacitive charge. This will result in a reflection just like the one described above, but of opposite polarity—the battery will see a sudden voltage drop rather than a voltage rise. This will make the battery deliver more current, and eventually, equilibrium will be reached.

Transmission line impedance matters mainly in RF circuits. At low frequencies, equilibrium is reached so quickly, relative to the signal frequency, that reflections don't matter. But at RF, the current switches direction every few microseconds, and if it takes a microsecond to reach equilibrium every time, much of the signal will be eaten up. ■

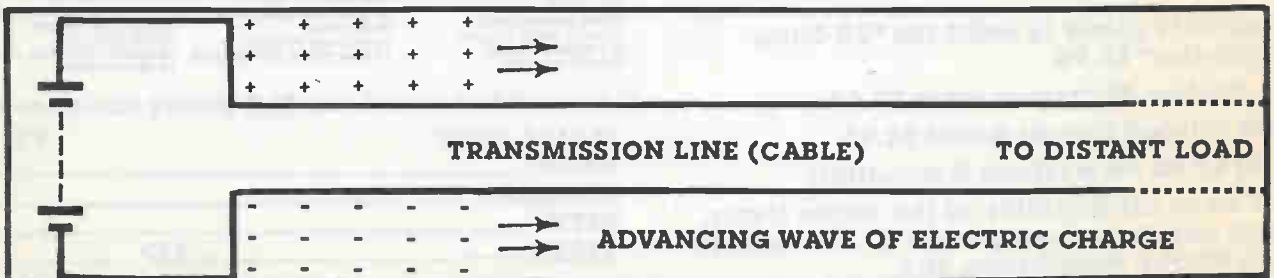


Figure 1. When a battery is suddenly connected to a 75-ohm cable, current flows into the cable as if it were a 75-ohm resistor, until the battery voltage is present along the entire cable.

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!

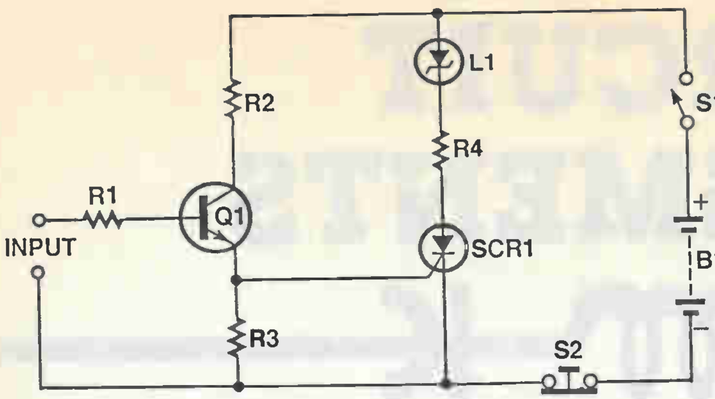
ACTUATION DETECTOR

This little circuit can have many interesting applications, depending on the imagination of the hobbyist. It is a "one-counter" with a manual reset. An input pulse or continuous voltage will turn on transistor Q1, which, in turn, fires SCR1, which stays on. To reset the circuit, just push button, S2.

L1, the LED, is the indicator, lighting for actuation. It is a good device for detecting rapidly occurring events. It may also be used to determine if a powered circuit is self-resetting. An example would be a doorbell. There are times when you suspect that your doorbell is not working every time that someone uses it. Connect this unit to the bell and if power is applied even once, the LED will light and remain lit until manually reset.

Another application may be intermittent circuit trouble in a fire alarm. The "Actuation Detector" will indicate problems as they occur. Again, the LED will remain lit until someone resets it manually and corrects the discrepancy in the alarm. This can save you hours of watching.

ACTUATION DETECTOR



ACTUATION DETECTOR

PARTS LIST FOR THE ACTUATION DETECTOR

R1—47K Ohms, ¼ watt, 10% resistor
R2—1K Ohms
R3—12K Ohms
R4—390 Ohms, ¼ watt
Q1—2N2222 Transistor
SCR1—1 Amp, 50 Volt SCR
L1—LED
S1—SPST Switch
S2—Normally closed pushbutton
B1—9 Volt Battery

INFRA-RED DETECTOR

Here is a nifty little device that can check out the infra-red remote control you may have installed on one of your projects. Or, during your project building, you might want to see if your infra-red emitter is working properly. Try this easy-to-build device that can be constructed in about 10 minutes with a few simple parts.

The author built this device to assist him with his experiments with infra-red emitters. It was important to know if they were operating correctly for his project. It has since come in very handy in many other situations where faulty infra-red emitters were suspected. It has now become a permanent fixture on his workbench.

The key to this device is a Motorola (MRD750), which is really a schmitt trigger logic output infra-red detector. With this device, a resistor and a visible LED, we can see if infra-red is present.

The MRD750 has 3 pins; Power, Ground and Output. When the MRD750 does not detect infra-red, its output pin is in the tri-state and a 220 ohm resistor is used as a pull-up. When the MRD750 sees infra-red, it will pull its output low, allowing the LED to light (See schematic).

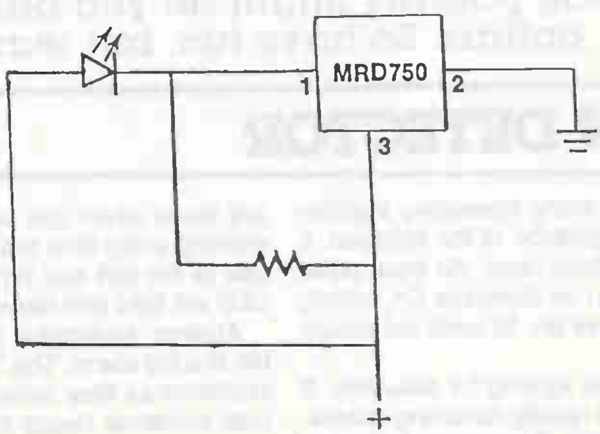
The value of the resistor is not critical. It could range anywhere between 50 to 1K ohms. To use the project, put the infra-red emitting source very near the MRD750 (less than 2 inches) and check if the LED lights.

If you cannot find and MRD750 at your local electronics parts suppliers, they may be purchased from **JL Electronics, 43 White Plains Drive, Nashua, NH 03062** for $3.00 each (2 for $5.00). A complete parts kit, including detailed instructions is availaible from JL Electronics for $10.00. Checks or Money-orders (U.S. Funds only) acceptable.

PARTS LIST FOR INFRA-RED DETECTOR

1—MRD750
1—220 ohm resistor
1—LED
1—9 volt battery harness

INFRA-RED DETECTOR

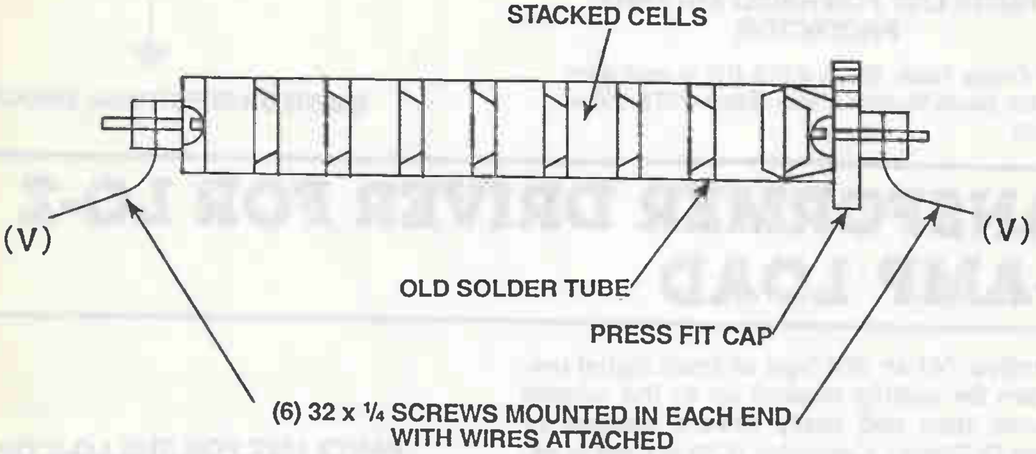


HANDY BATTERY HOLDER

The plastic tubes that hold smaller quantities of solder from Radio Shack, such as part numbers 64-001 or 64-025, can be used as handy holders for button cells or a single AA cell. Any number of button cells may be stacked, and the tubes length can be cut with a knife to the length as needed. Battery contacts can be made by drilling holes in the centers of the main tube and press fit cap. Mount 6-32 x 1/4 inch screws in the holes. Attach wires to the screws using a second nut. If a grounded power supply is desired, the appropriate battery screw may be mounted into a chassis hole directly. This also firmly mounts the holder. If spring contacts are desired, they can be salvaged from an old piece of battery powered equipment and mounted under the screws. In many cases, the press fit cap supplied with the tube will press the screw heads against the battery end caps with sufficient pressure to ensure good contact.

A tapped, or dual polarity battery supply can be made by soldering a small metal contact to a lead wire and placing this contact at the appropriate place in the battery stack as the cells are loaded into the tube. There is usually enough clearance between batteries and the tube wall to permit a #22 to #26 wire to be brought out thru a hole in one of the ends.

The figure shows a typical arrangement of several button cells, such as types #357 stacked in series. Use your imagination and a little inventiveness to fashion your own special battery holder. ■



POWER OUTAGE ALARM

Here's an alarm to alert you to a power failure. This simple circuit will let you know loud and clear.

All you need is a fairly bright neon night light. This unit will work with any night light, or any lamp. It is necessary to cover the photocell with black tape or other light-blocking material. This is to prevent any light but that of the night light illuminating the photocell.

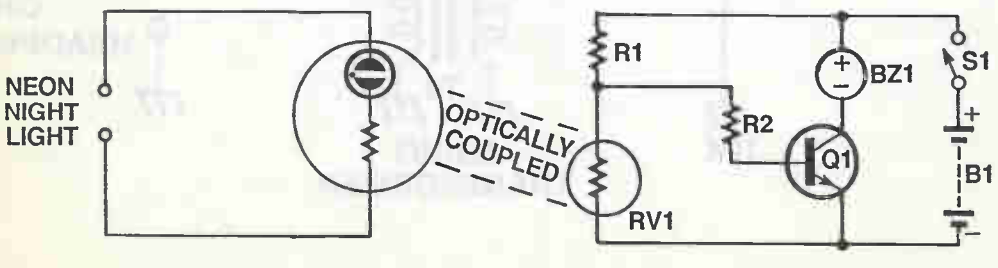
Operation of this unit is simple. When light stops shining on the photocell, the cell goes high resistance, turning on the transistor and setting off the buzzer. Should the light come back on, the photocell goes low resistance, and the transistor cuts off the buzzer.

PARTS LIST FOR POWER OUTAGE ALARM

R1 — 560 K Ohms 1/4 watt resistor
R2 — 12 K Ohms 1/4 watt resistor
RV1 — photocell Radio Shack #276-118 or equivalent
Q1 — 2N2222 transistor
B1 — 9 volt battery
S1 — SPST normally open switch
BZ1 — Buzzer Radio Shack #273-065 or equivalent
Also night light.

This version uses a commercial product for the 110 volt light to make it safer to construct.

POWER OUTAGE ALARM



RADIO ANTENNA PROTECTOR

Most outdoor radio antennas have a lightning arrestor on the line or the antenna, at least they should have this protection. However, a gap-type arrestor is not the optimum level that is needed. What is needed is additional protection, in the form of an MOV (Metal Oxide Varistor).

The circuit shown will supplement the gap-type arrestor. It limits the voltage to under 170 volts instead of thousands of volts which the gap will let through.

L1, the coil will limit the effect of the MOVs capacitance on the signal.

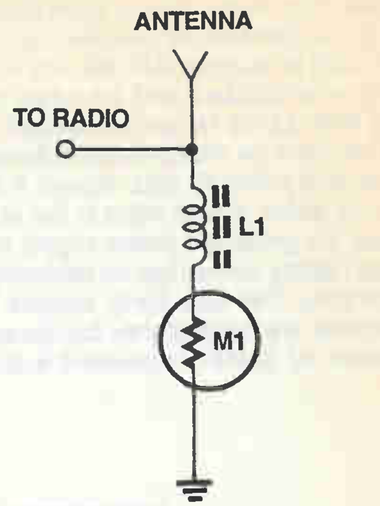
A solid ground wired with #16 gauge or larger wire is a necessity. Also it is recommended that this device be built in a metal box.

No more DXing them lightning bolts!

PARTS LIST FOR RADIO ANTENNA PROTECTOR

L1—RF Choke Radio Shack #273-102 or equivalent.
M1—Metal Oxide Varistor. Radio Shack #276-568 or equivalent.

SCHEMATIC OF RADIO ANTENNA PROTECTOR

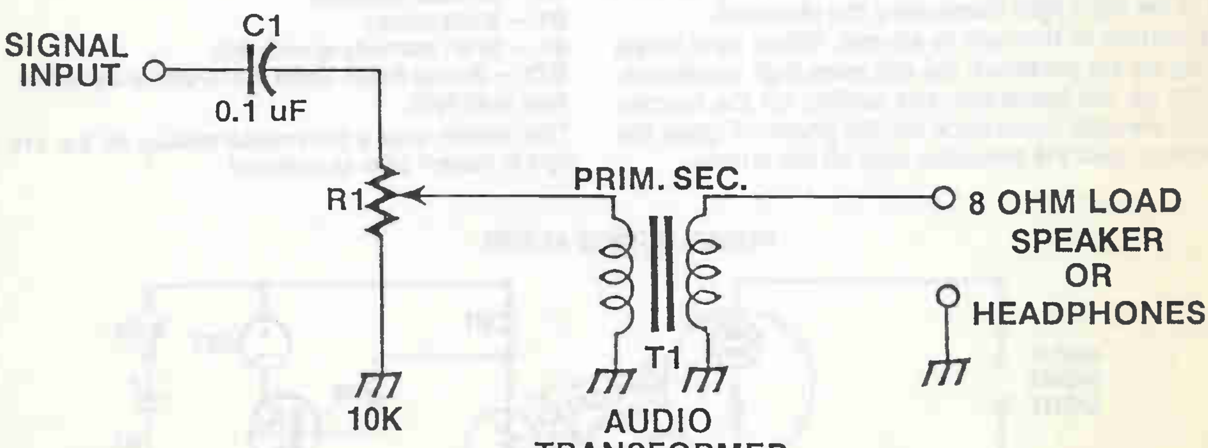


TRANSFORMER DRIVER FOR LO-Z OP-AMP LOAD

The standard 741 or 324 type of small signal preamplifier can be usefuly hooked up to the passive circuit shown here and easily drive a speaker or headphones (8 Ohms). Capacitor (C10 is used to AC couple the Op-Amp output to the 10K load potentiometer/volume control (R1). The signal from the wiper of R2 is coupled to the primary winding of the audio transformer (T1). The secondary winding is connected to the load (speaker or headphones). This circuit has the useful benefit of no active components, therefore no power supply is required. The signal quality is very clear.

PARTS LIST FOR THE LO-Z OP-AMP LOAD TRANSFORMER DRIVER

C1—0.1 uF capacitor
R1—10K linear potentiometer
T1—Radio Shack audio O/P transformer, 1000 Ohm center primary, 8 Ohm secondary



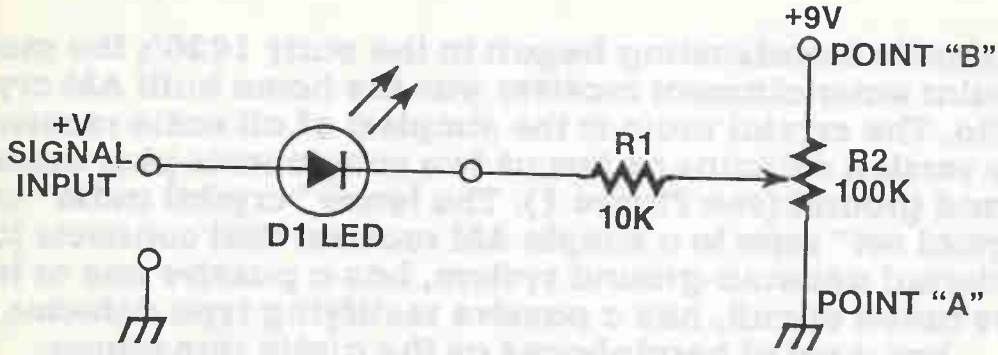
A VARIABLE THRESHOLD LED TRIGGER CONTROL

The standard light emitting diode is a useful, easy to use component for indicating the presence of signals with a few volts amplitude. In the circuit shown here, an extremely useful additional function can be obtained, with the addition of potentiometer (R2).

With the wiper coupled to the ground end of R2 (point A), the LED functions as in any normal application. Connected as shown, a positive signal of a few volts amplitude, will cause the LED to light. Resistor (R1) limits the current through D1 and also the intensity. By adjusting the wiper position from point A to point B, any variable threshold can be set, so that the LED will only trigger after the input exceeds a certain value. This circuit can be used, for example, when you wish to see only peaks of transient signals, superimposed on a steady background noise level.

PARTS LIST FOR A VARIABLE THRESHOLD LED TRIGGER CONTROL

D1—Standard LED (light emitting diode)
R1—10K resistor
R2—100K Linear potentiometer



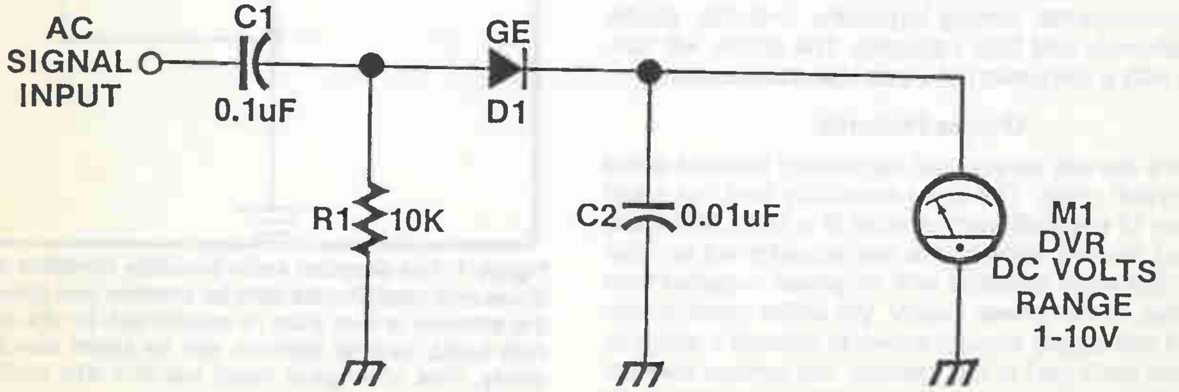
RECTIFIED DC-VOLTMETER DRIVER

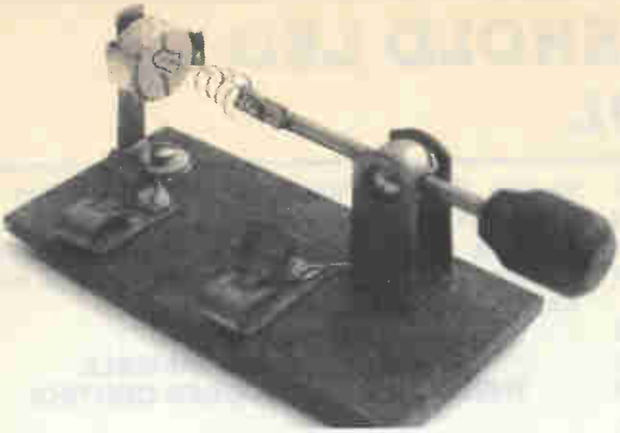
Any AC signal source, e.g. the ouput taken from a standard radio receiver, can be monitored for signal strength, by using the circuit shown here.

Capacitor (C1), AC couples the signal source to resistor (R1), which acts as a stabilizing load. A germanium signal diode (D1), rectifies the incoming AC signal and, connected as shown, provides a positive signal at the cathode end of D1. Capacitor (C2) serves to boost the rectified signal and also helps to give a smoother response. The output signal variations are monitored on a DC analog meter, (M1) or multimeter (Volt Range). The time constant is determined by the capacitor (C2) and the DC resistance of the meter, (M1). To monitor a typical response, set the multimeter to a range in the 1 to 10 volts region and if a receiver is used as the source, turn the volume up with the connection to C1, taken from the earphone socket, until the variations can be seen.

PARTS LIST FOR THE RECTIFIED DC-VOLTMETER DRIVER

C1—0.1uF Capacitor
R1—10K Resistor
D1—1N34A Germanium signal diode
C2—0.01uF Capacitor
M1—Analog multimeter (DC volt range)





THE CRYSTAL RADIO TODAY

By Lyle Russell Williams

PART I

As radio broadcasting began in the early 1920's the most popular entertainment receiver was the home built AM crystal radio. The crystal radio is the simplest of all radio receivers. One version contains as few as two components plus antenna and ground (see Figure 1). The terms "crystal radio" or "crystal set" refer to a simple AM receiver that connects to an external antenna-ground system, has a passive one or two stage tuned circuit, has a passive rectifying type detector, and has a set of headphones as the audio transducer.

Today there are three types of users who have an interest in the crystal radio. Electronic hobbyists and children like the set for its simplicity and ease of construction. The crystal set DX'er enjoys the challenge of logging far away stations with the unamplified crystal radio. The audiophile uses the radio with a good audio system as a high quality AM radio tuner.

In this issue we will discuss some unique features of the crystal radio, changes in the construction and uses of the crystal radio since the 1920's, performance characteristics of the receiver, antenna and tuned circuit considerations, and the ground connection. A bibliography will provide a limited source of information on the early history of the receiver and on constructing traditional type receivers.

In the next issue (Part II) we will discuss the individual components: tuning capacitor, inductor, diode, headphones, and filter capacitor. The article will conclude with a discussion of crystal set modifications.

Unique Features

There are two unique and fascinating features about the crystal radio. The utter simplicity and the small number of required parts results in a radio that looks nothing like any receiver we are accustomed to. Secondly, the radio operates with no power supplied from batteries or AC power supply, yet under some conditions it can supply enough power to operate a speaker.

In the early part of this century, the famous inventor Nicoll Tesla was trying to send electrical power through

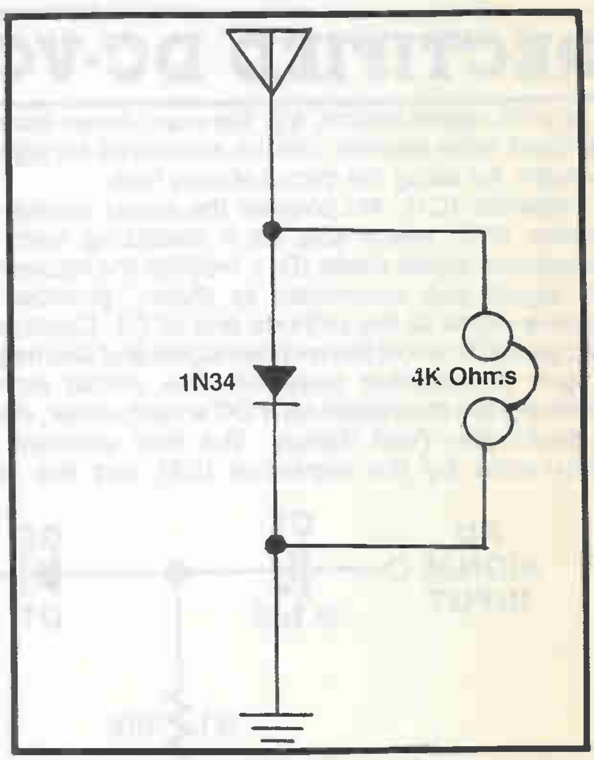


Figure 1. The simplest radio possible contains only a diode and headphones with an antenna and ground. If the antenna is less than ¼ wavelength for the broadcast band, several stations will be heard simultaneously. The strongest local station will probably predominate.

space without using wires. Although his experiments were partially successful, this concept has no commercial application to this day. Our power companies still distribute electrical power by means of wires.

The crystal set is an example of Tesla's wireless power transmission. The energy that drives the headphones comes from the radio broadcast station that is being received. One might wonder whether the energy from the radio station could be used to power some device other than the headphones of a crystal radio, for instance a calculator. The answer is yes.

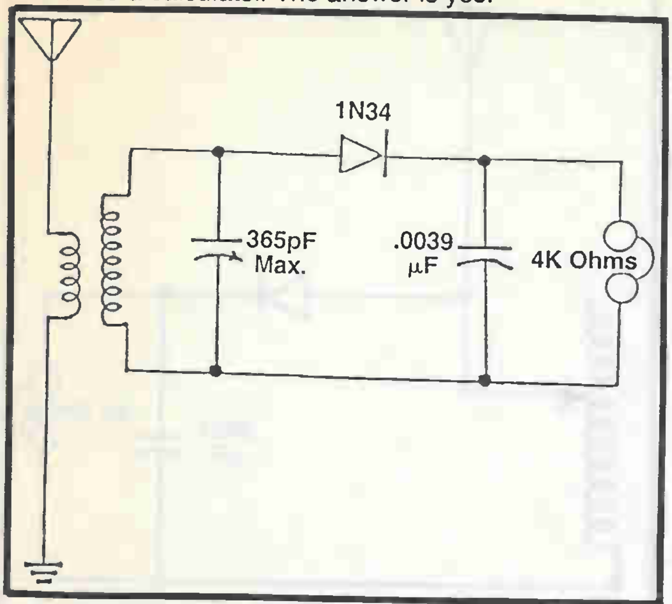


Figure 2. Crystal radio with fixed mutual inductance coupling. The inductor can be a commercial ferrite coil or a home constructed coil.

History

The crystal radio is the culmination of the receiver experiments of Marconi. Marconi's first detector was the Branley coherer. Later experiments utilized detectors based on chemical, electromagnetic, vacuum tube diode (Flemming valve), and mineral crystal properties. By the 1920's, the mineral crystal was the detector most popular in home built receivers. This detector is a precursor of the germanium and silicon diodes in use today and it is from this detector that the crystal radio gets its name.

The crystal radio of the 1920's was constructed at home according to plans in radio magazines of the day. The vacuum tube (then called the DeForest audion) was available but was very expensive and not widely used for home circuits. The crystal set was relatively inexpensive. It required some magnet wire, a coil form, a variable capacitor, a fixed capacitor, headphones, a mineral crystal and holder, a straight wire antenna, and ground connection. The coil was typically wound on a round cereal box such as the present Quaker Oats box.

In the 1950's advances in technology brought several changes to the commercially produced crystal set. The germanium diode became available and was often substituted for the mineral crystal. The ferrite antenna coil which has a larger "Q" than home built coils was substituted for the cereal box inductor. "Q" is the quality factor of a reactance or tuned circuit. The "Q" of an inductor is dependant on the frequency of measurement and is the reactance of the inductor divided by the DC resistance. The "Q" of a tuned circuit (see Figure 3) is the center frequency of the circuit divided by the −3 db bandwidth and is equal to the reactance of either the inductor or capacitor at the center frequency divided by the resistance of the inductor (if there are no external loads on the circuit).

The load on the tuned circuit of traditional headphones (1.0 KΩ to 4.0 KΩ) is a major factor in reducing the "Q" of the circuit. High quality piezo crystal phones with impedances up to 100 kΩ became available in the 1950's. One quality headset with an impedance of 75 kΩ carried a list price in 1958 of $33.00.

The general availability of "high fidelity" sound equipment in the 1950's led some experimenters to attach the input of a "HiFi" amplifier to the headphone terminals of a crystal radio. The sound heard over the HiFi speakers was often better than that available from most AM radios and tuners of the day (assuming the filter capacitor across the phones was not too large). That is because most superhet radios have an IF bandwidth that is too narrow to pass the higher audio fre-

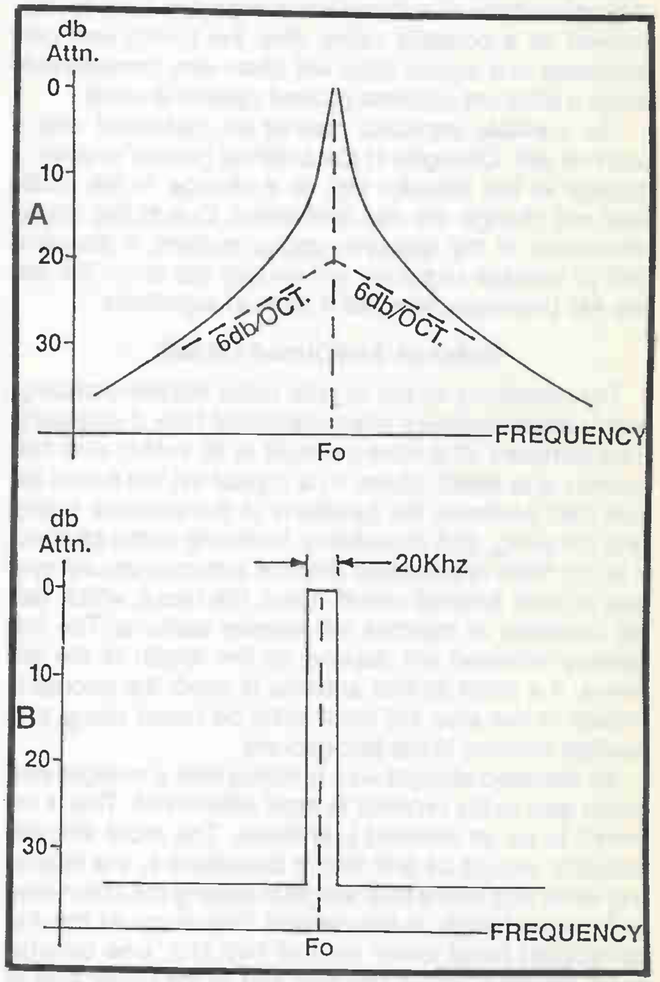


Figure 3. In 3A is the attenuation curve of a resonant circuit. Attenuation is rapid near the center frequency but falls to 6 db per octave slope at frequencies far from center. An ideal tuning curve of 3B would pass all audio frequencies up to 10 Khz with a small and equal attenuation. All frequencies outside the pass band would be strongly attenuated to a level below audibility.

quencies. The wide bandwidth of the crystal radio becomes an advantage allowing the audio high frequencies to reach the amplifier. The J.W. Miller company marketed a crystal radio that was to be used as an AM tuner. The radio remained in the J.W. Miller catalogs as late as the mid 1970's.

Performance

As there is no RF amplification, the crystal radio is the least sensitive of all receivers. With no audio amplification, the signal heard in the headphones is usually weak even with strong local stations. Only one or two tuned circuits with no buffer leads to a radio with wide bandwidth or poor selectivity. It may be difficult to separate a weaker station from a strong local station that is close in frequency.

There is a trade off between selectivity and sensitivity. The more signal that is shunted to the headphones the more the tuned circuit is loaded and the wider the selectivity curve (see Figure 3). The crystal radio can be constructed in a quite small package and one version was the first pocket sized radio. However, the necessity of having an antenna and ground system available where ever it was used detracted from its usefulness as a portable radio. Also the tuning and performance of a crystal radio will often vary considerably when a different antenna-ground system is used.

The variable capacitor cannot be calibrated with a marked dial. Changes in the antenna ground system, a change in the inductor tap, or a change in the audio load will change the dial calibration. Due to the strong interaction of the antenna-ground system, a standard 365 pf variable capacitor will usually not cover the entire AM broadcast band as it does in superhets.

Antenna And Tuned Circuit

The simplicity of the crystal radio notwithstanding, many experimenters misunderstand how it operates. The purpose of a tuned circuit is to select one frequency and reject others. In a crystal set the tuned circuit also performs the functions of the antenna tuning and coupling, and impedance matching to the phones. It is not often appreciated that the antenna-ground system is itself a tuned circuit. Thus, the circuit which has no capacitor or inductor will receive stations. The frequency received will depend on the length of the antenna. If a short 25 foot antenna is used, the strongest station in the area will most likely be heard along with weaker stations in the background.

An elevated straight wire antenna with a straight wire down lead to the receiver is most often used. This is referred to as an inverted L antenna. The most efficient antenna should be one that is broadside to the incoming wave and who's total length including the down lead is 1/4 wave length at the desired frequency. At the AM broadcast band lower limit of 540 khz, one quarter wave length is about 455 feet and at the upper limit of 1600 khz, 1/4 wave length is 154 feet. It is not usually convenient to construct antennas that long.

In a wooden house, a 25 foot antenna running along the top of an attic or indoors along the ceiling is often quite acceptable for reception of local stations. Crystal radio DX'ers use outdoor antennas of 75 feet or more of heavy wire in order to get greater sensitivity.

Any antenna shorter than 1/4 wavelength will have a capacitive reactance at the received frequency and this reactance will have to be matched by an inductive reactance in the tuned circuit. Thus the circuit of Figure 4 will work quite well. The inductor has to be continuously variable so that it can tune out the capacitive reactance of the antenna at the received frequency. As the "Q" of an inductor is higher than the "Q" of an antenna, the circuit of Figure 4 will be sensitive and can be tuned to different frequencies by varying the inductance.

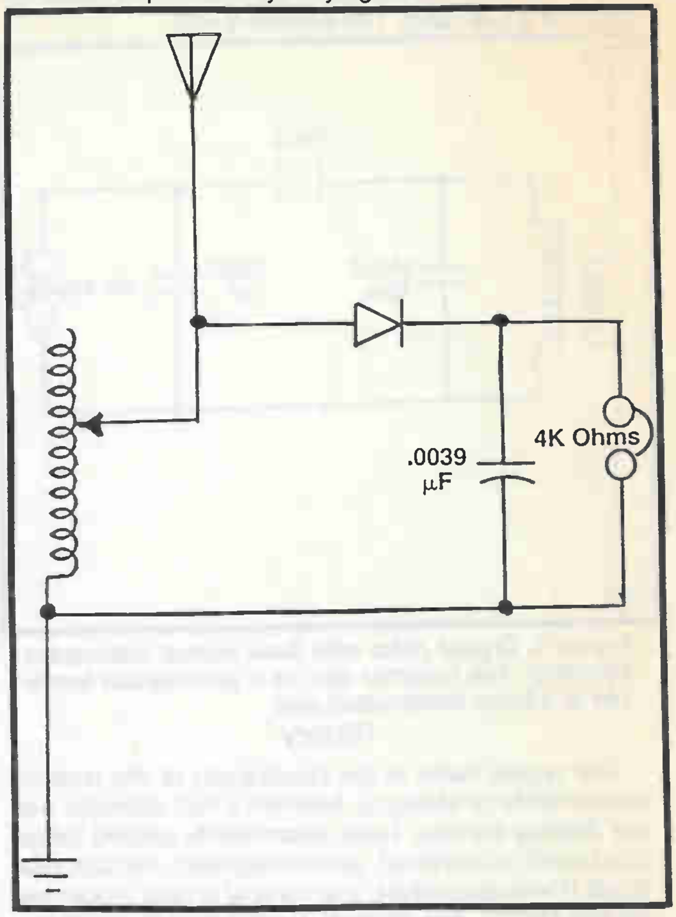


Figure 4. An inductor tuned crystal radio. The reactance of the inductor cancels the reactance of the antenna at the received frequency. The variable inductor can be the home built slider type or the slug tuned ferrite type.

Figure 5 contains the familiar parallel resonant circuit and looks more like a radio receiver. The circuit consists of a variable capacitor (usually 365 pf maximum capacitance) in parallel with a fixed inductor. This combination is usually more sensitive than the circuits of Figure 4. That is because the "Q" factor of the lumped tuned circuit is greater than the "Q" of an antenna alone or the antenna-inductor combination. The "Q" of the parallel tuned circuit is limited by the necessary loading of the antenna and headphones. The parallel tuned circuit in Figure 5 still has to present an inductive reactance to cancel out the capacitive reactance of the antenna at the received frequency.

The tuning curve of a single tuned circuit is shown in Figure 3A. Note that as we move away from center frequency, the response curve drops rapidly at first but flattens out to 6 db per octave at frequencies farther

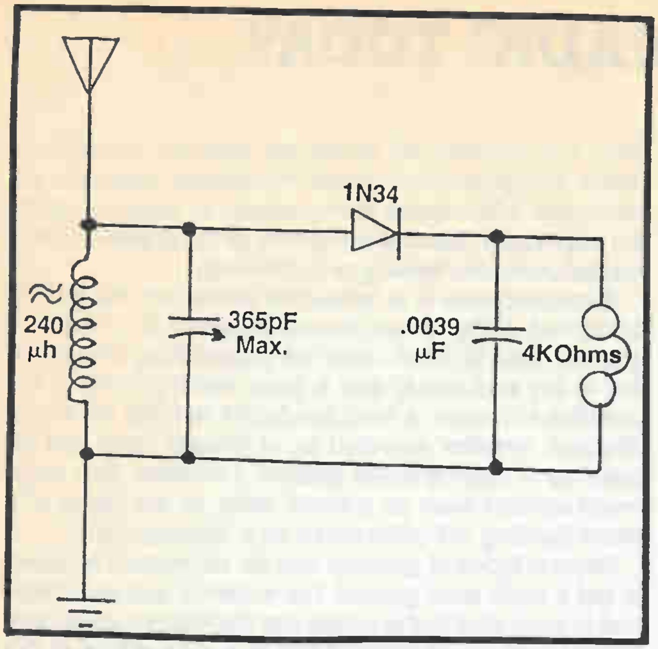


Figure 5. A crystal radio with the parallel resonant circuit. In this circuit the inductor is fixed and the frequency is selected by means of a variable capacitor.

away from center. As a result, strong stations many kilocycles from the received frequency can cause interference in a crystal set. Also note that the upper audio sidebands are attenuated somewhat even in a crystal set. But due to the wide bandwidth, the attenuation of sidebands is usually much less in a crystal set than in most superhets. The ideal tuning curve is shown in Figure 3B. Here there is a flat response in the pass band and very great attenuation outside the pass band. This shape can be approached by a crystal filter. Crystal filters are sometimes used in the IF section of expensive AM superhets. The pass band for good audio should be 20 khz or more.

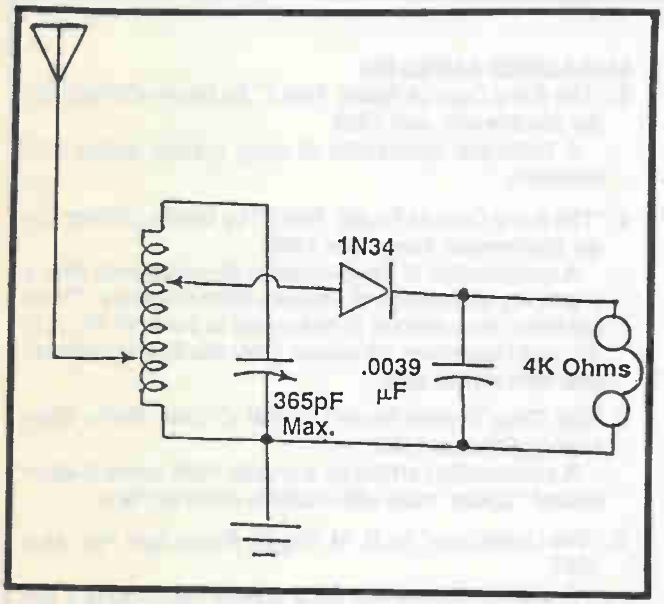


Figure 6. A crystal radio with a double slider coil circuit such as that shown in the photo (Figure #7). Both the coupling to the antenna and the load of the detector-headphones on the resonant circuit can be varied for optimum reception.

In the double slider circuit of Figure 6, the loading of both the antenna and the headphones can be varied in order to limit the loading on the tuned circuit. The circuit of Figure 6 has been used to good advantage with traditional type headphones and relatively short twenty-five foot indoor antennas.

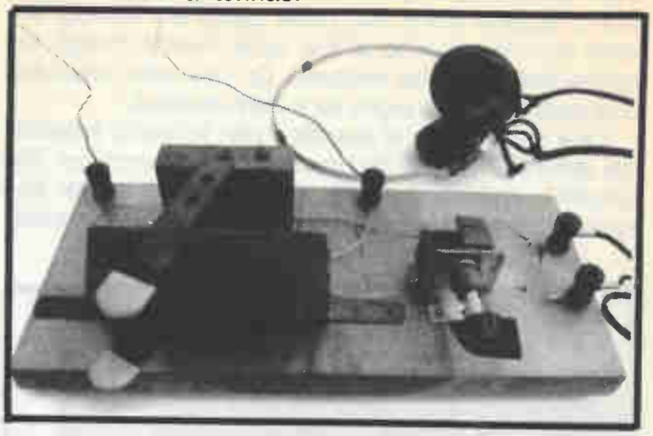


Figure 7. A double slider wooden core inductor radio as described. The headphones are Trimm Featherweight 4K ohms of the 1950's vintage. Wires going toward the rear of the photo are the antenna and ground connections.

Ground Connection

A ground connection means an intimate connection between a conductor buried in the earth and the crystal radio. The wire to the crystal radio should be heavy and

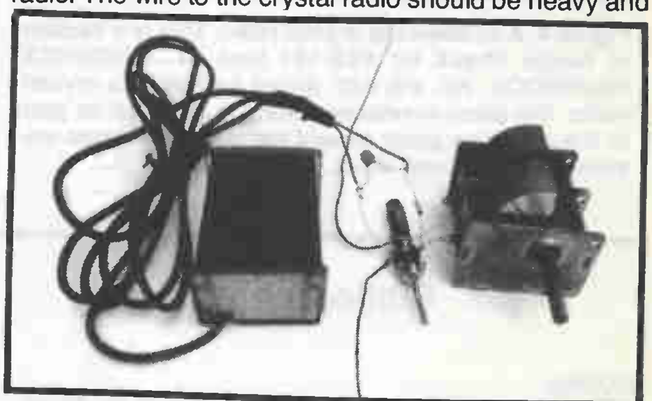


Figure 8. This home-built radio was constructed in about 15 minutes time. It contains an air variable capacitor (only one of the two sections used), and a tapped ferrite inductor similar to the Miller #9011. A ceramic crystal microphone is used as an earphone. The wire going toward the front of the photo is the ground wire. The wire going toward the rear of the photo is the antenna wire and is attached to the center tap on the coil.

as short as possible. A simple example would be a long pipe driven into the ground outside a window with a wire running through the window to the crystal set. At first thought, obtaining a ground connection would seem an easy requirement. But in practice it often occurs that we want to operate our crystal radio in the center of a house built on a slab away from any plumbing, on an upper floor of a multi-story house with plastic pipes, or other place where a ground is not accessible.

Cold water pipes run a considerable distance underground and if they are copper or steel they usually pro-

THE CRYSTAL RADIO TODAY

vide a good ground connection. Cold water pipes are often found on the upper floors of a house and can provide a ground there. Hot water pipes are usually isolated from the ground at the water heater though the connection could be restored. Do not make electrical connections to gas pipes for safety reasons.

If the crystal radio is operated with an audio amplifier the radio will have to be grounded to the amplifier. The amplifier will have an RF ground to the power line through the stray capacitance of the power transformer.

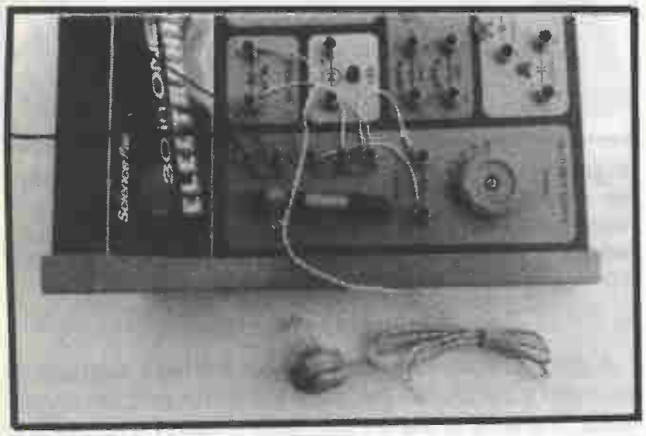
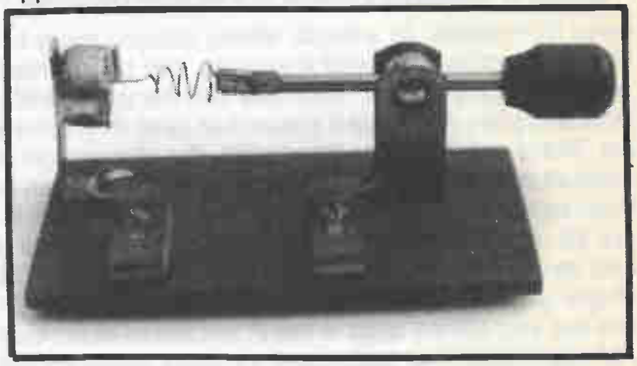


Figure 9. A commercial crystal radio. This is a section of Radio Shack kit #28-161 (see ELECTRONICS HANDBOOK, Vol. #8) with wiring for use as a crystal radio. The piezo crystal earphone is included as part of the kit. Wires going toward the top of the photo are antenna and ground wires.

This may provide an adequate ground. However, a power line ground sometimes introduces noise into the radio and often fades from season to season, giving the impression that the sensitivity of the crystal radio is mysteriously decreasing or increasing.

A counterpoise is a conductor placed on the ground or buried under a horizontal antenna to provide a ground. This is often used for transmitting where the soil is dry and sandy and a good earth ground is impossible to obtain. A long conductor running off in any direction whether elevated or at ground level can be used as a counterpoise ground. Likewise, any large metal surface such as a metal table, or the frame of a metal building will often serve as a useful ground.

Several types of grounds can be connected together to get a more solid ground. For instance a crystal radio that is grounded to the power line through an audio amplifier could also be connected to a pipe driven in the ground outside a window and a counterpoise wire that happens to be available in the area. ■



Bibliography

BOOKS:

1. *Boy's First Book of Radio and Electronics* by Alfred Morgan
(Chapter 8, p126)
This 1956 book is long out of print but is commonly available in public libraries. It is written for children but contains excellent construction details for crystal radios containing wooden core slider type inductors such as the one shown in Figure 7. The single slider and double slider radios (slightly modified, see Figure 6) from this book have been used with excellent results.

2. *Radios That Work for Free* by K. E. Edwards (available from Lindsay Publications: P.O. Box 583; Mantero, IL 60950-0583).
First published in 1977, this book provides a very detailed discussion of all aspects of traditional crystal radio building.

MAGAZINES ARTICLES:

3. "The Early Days of Radio, Part 1" by Martin Clifford *Radio Electronics,* July 1986
A historical discussion of early crystal radios and detectors.

4. "The Early Days of Radio, Part 2" by Martin Clifford *Radio Electronics,* November 1986
A continuation of the discussion of crystal sets plus a beginning discussion of vacuum tube receivers. There are three more articles in this series in the April '87, July '87, and December '87 issues. Only the first two articles deal with crystal sets.

5. "Old Time Crystal Radio" by Pat O'Brien *Radio Electronics,* October 1986
A construction article for a crystal radio using stagger wound "spider" coils with multiple switched taps.

6. "The Lyonadyne" by R. M. Tuggle *Radio Age* Feb.-Mar. 1987
A construction article for a crystal radio using a self supporting stagger wound "basket" type coil.

CONSTRUCTION QUICKIES

SOUND EFFECTS GENERATOR

By Darren Yates

How many times have you wanted to make a sound effect using electronics but haven't been able to find a suitable circuit? Well, the solution is quite simple and can in most cases be generated using a few simple components.

Many of the most requested "noise makers" are either howling wind or rain sounds. You can even simulate the sound of the waves using simple electronic noise makers.

The simple circuit presented here is the basic building block of most sound effects projects and requires only one transistor and one operational amplifier as well as a few other components. The circuit operates from a 12VDC 300mA power pack and produces up to 2V peak to peak of white noise.

The heart of the circuit is the transistor and as you can probably see, it's connected in a very unusual fashion. The reason for that is that we wish to take advantage of the characteristics of the base-emitter junction when it is reversed biased.

Since we have left the collector of Q1 unconnected, it takes no part in the operation of the circuit.

The base-emitter junction of a transistor when reversed-biased acts very much like a zener diode, and because we supply it with more voltage than its zener voltage (which is about 8 volts) the junction begins to break down unpredictably.

The unpredictable nature of this breakdown produces small amounts of noise, around 50mV or so. It's known as white noise because every frequency is present and the amplitude of all frequencies present is equal.

Resistor R1 provides some current protection so that the junction doesn't short circuit to ground and blow up in a haze of smoke. The noise is present at the base of the transistor and we AC couple this to the non-inverting input of IC1, which is simply a 741 opamp.

Resistors R2 and R3 set the DC bias of the opamp to half of the supply voltage to ensure that the opamp is operating in its correct region. Resistors R4 and R5 set the gain of the opamp and determine what level of noise we get at the output.

Amplifier Gain

If we have 50mV input and we want 2V output then the gain must be set to 2V/50mV=40. The gain of a non-inverting amplifier is set by 1+(R5/R4) so if we set R5=39k and R4 to 1k, we get a gain of exactly 40.

Capacitor C5 in series with R4 isolates the DC part of the circuit from ground so that we don't amplify the DC voltage as well. (We need that to stay at half the supply voltage!)

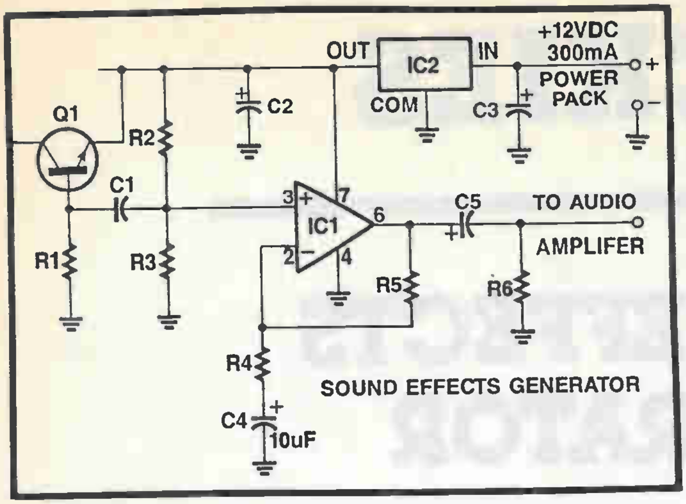
Finally, the power supply for this circuit comes from a 12VDC 300mA power pack and is first filtered by C4 and then regulated by IC2. Some people may think that this cannot work properly because it appears that we are putting 12V into the circuit and expecting a 12VDC regulator to give us 12V output, forgetting about the dropout voltage.

However, the circuit does work because most power packs, if not all, provide about 15-17VDC at the output when only lightly loaded. This provides us with about 3-5V drop across the regulator IC which is more than enough.

Wiring

When you build the project, you need to make careful note of how you place the components on the board. Make sure you know which pins on each component are which so that they go in the right way.

When you've got it going, put your multimeter on amps range in series with your power supply. If you get a reading of less than 30mA then your circuit is working well. Any more than 30mA and you should turn it off immediately and check the circuit to see where you goofed.



SOUND EFFECTS GENERATOR

Otherwise, you're now ready to experiment yourself and see what different types of noises and effects you can come up with. ■

PARTS LIST FOR SOUND EFFECTS GENERATOR

C1—0.1uF mylar polyester
C2—0.1uF mylar polyester
C3—47uF 25VW electrolytic
C4—10uF 25VW electrolytic
C5—2.2uF 25VW electrolytic
IC1—LM741 opamp IC
IC2—LM7812+12VDC regulator
Q1—BC548 or similar NPN small signal transistor
R1—39k ohms 5% 0.25W resistor
R2, R3—100k ohms 5% 0.25W resistor
R4—4.7k ohms 5% 0.25W resistor
R5—100k ohms 5% 0.25W resistor
R6—100k ohms 5% 0.25W resistor

MISCELLANEOUS:
Wire, solder, PC board, box, screws, nuts, washers, etc.

SQUARE/TRIANGLE GENERATOR

By Darren Yates

Transistor oscillators are easy to build and there are literally hundreds of circuits that produce just about every waveform imaginable but they don't have the same versatility as those based around opamps.

Firstly, unless you use a number of transistors, the output impedance remains fairly high. This means that you can't drive low ohm loads like speakers or headphones and you must be conscious of the load you put on them. On the other hand, opamps already have a low impedance output because they already contain up to 30 transistors inside each package.

Circuit Description

This "function generator", as it is called uses the opamp in what is known as a Schmitt trigger configuration. By applying positive feedback between the output and the input, which is what resistor R3 does, we get a Schmitt trigger.

Basically, a Schmitt trigger works on the following principle: it has two threshold voltages, an upper and a lower, both of which are different. If an input voltage is higher than the upper threshold then the output goes high.

If this voltage now falls below the upper threshold, the output remains high until the input voltage falls below the lower threshold.

The reverse is also true, namely, if the voltage at the input now rises above the lower threshold, the output remains low until the input voltage again passes over the upper threshold.

In this circuit, with the opamp, we use the inverting input as the input pin, but notice that we have a capacitor from this pin to ground and a variable resistor from this pin to the output.

When the power is first applied, capacitor C1 has no voltage across it, so the inverting input of IC1 is low. Since the non-inverting input is biased at half the supply voltage by resistors R1 and R2, the output of IC1 is high. This now begins to charge up capacitor C1 via the variable resistor VR1.

Once the voltage on the capacitor has reached about 2/3rds of the supply voltage (i.e. the upper threshold), the output goes low. This is because the inverting input is higher than the non-inverting input.

Now that the output is low, the capacitor begins to discharge through the variable resistor. This means that we have current flowing both ways through VR1. Once the capacitor has discharged in voltage down to about 1/3rd the supply voltage (i.e. the lower threshold), the output of IC1 swings high again, causing the capacitor to begin charging again.

This process continues indefinitely while the power is connected.

By now, you will have realized that through this process, we get a square wave at the output but we haven't discussed the importance of the variable resistor VR1. The speed at which the output changes from one voltage to the other (i.e. the frequency) is dependent upon the speed at which the capacitor charges and discharges. VR1 controls the rate and hence the frequency of the square wave at the output on pin 6.

With VR1 set to maximum resistance, the current flow is very small and so the capacitor takes a long time to charge up. This results in a very low frequency at the output. On the other hand, if we set VR1 to minimum resistance, the capacitor charges up very quickly, giving us a much higher frequency at the output.

How do we determine what resistance gives us what frequency? Well, it turns out that the frequency of the square wave output is $1/(2\times\pi\times R\times C)$ where π is equal to 3.1415926, R is the resistance of VR1 in ohms and C is the capacitance of capacitor C1 in Farads. This should allow you to easily choose your own range of frequencies. The maximum limit with the LM741 opamp is about 300kHz, so, if you want to get higher frequencies, you should use an LF351 or TL071, which should allow you to get up to about 1MHz or so.

Triangle Wave Generator

Remember how we mentioned earlier that the current flows in alternate directions through VR1? This is caused by the charging and discharging of capacitor C1. If you connect a cathode ray oscillascope (CRO) to this spot, you'll see that you get a triangle wave showing the capacitor charging up and down.

In most circumstances, you'll probably find that this waveform is of low enough impedance to be of use to you where you need it, but if you like, you can connect this to another opamp as we have shown in the circuit (IC3). This opamp is connected as a simple buffer which provides the same signal at the output but at a very low impedance.

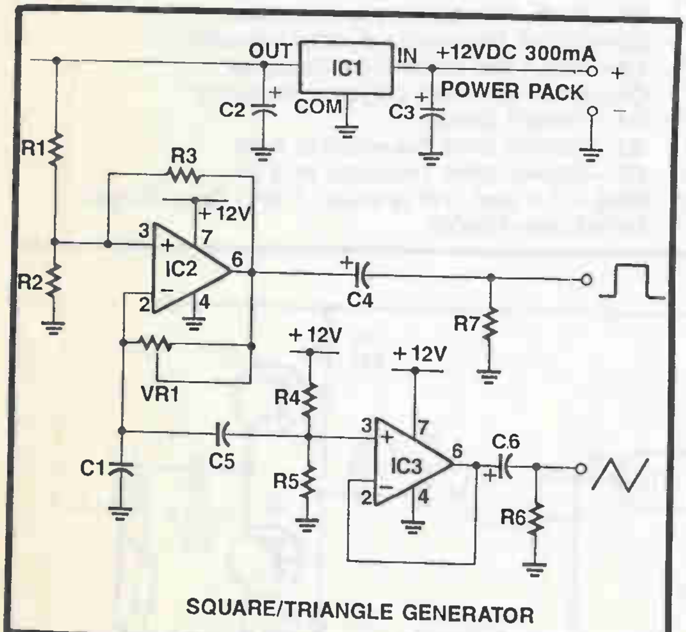
You can now take both of these signals to test your amplifier or frequency meter or any other bit of gear that requires a frequency of some kind to be sent through it.

Wiring

When you build this project, you shouldn't have too many problems laying it out on a bit of perfboard or some of the European VEROboard. The circuit is not very critical, the thing is to make sure you don't wire the ICs the wrong way, particularly the regulator. If you hook this up the wrong way, you will probably get a few puffs of smoke as well...

Testing the circuit is a simple case of hooking up a small speaker to the output of IC2 and IC3. When you turn on the power and provided you've selected a frequency that's in the audio range, you should hear a whine coming from the speaker. If you don't, use your multimeter and check the voltages around the circuit. You should find that the non-inverting and output pins should be at about half the supply voltage and the output of the 12V regulator should be, of course, pretty close to 12V.

OK. That's it! Now you can go and tackle that repair job that you've been putting off all the time... ■



SQUARE/TRIANGLE GENERATOR

PARTS LIST FOR SQUARE/TRIANGLE GENERATOR

C1—choose according to equation (see text) example giving 0.001uF mylar polyester
C2—10uF 25VW electrolytic
C3—10uF 25VW electrolytic
C4-C6—1uF 25VW electrolytic
IC1—LM7812+12VDC regulator
IC2, IC3—LM741 opamp
R1-R5—100k ohms 5% 0.25VW resistor
R6-R7—100k ohms, ¼W, 5% resistor
VR1—100k ohms linear potentiometer

MISCELLANEOUS:
Small box, wire, RCA sockets, power supply (12VDC 300mA), solder, tools, nuts, screws, washers, etc.

FRIDGE DOOR ALARM

By Darren Yates

For those of you who have had the experience, I'm sure that you will agree, a refrigerator door that is inadvertently left a-jar, even a small amount, can result in some serious food losses, which converts to some substantial dollar losses. The odds are that this little project will be of considerable interest to those of you who are anxious to avoid such a catastrophe.

This device simply keeps an "eye" on the fridge interior light, which comes on when the door is open. If the light is on for more than 40 seconds or so, the alarm is activated and begins to scream, telling you that someone has just left the door open.

HOW IT WORKS

Let's take a look at the circuit. As you can see, it consists of only one IC and a handful of other components.

When the door is closed and the light is out, the light dependent resistor (LDR) ORP12 has a resistance of more than 10M ohms. It and resistor R1 form a variable voltage divider connected to the inputs of IC1a. This NAND gate is just connected as an inverter.

Because the resistance of the LDR is so high, the input is considered as a high voltage which means the output at pin 3 is low. This prevents the oscillator formed from gates IC1b and IC1c from oscillating. There is no output signal to the output stage and speaker.

When the door opens and the light comes on, the LDR resistance goes low and the output of IC1a goes high. This starts to charge the RC network made from R2 and C1. After a time equal to RC, the voltage on the capacitor has reached a level that turns the oscillator on, and there is an audible output. If the door is closed before the 40 seconds is up, then the output of IC1a goes low again, and the capacitor begins to discharge through R7 and D1. This makes sure the alarm doesn't come on for false alarms.

Capacitor C4 provides AC coupling to the output stage while R6 provides the gate with an adequate output load. Resistors R5 and R4 set the transistor bias to half the supply voltage, so that minimum current is drawn when the alarm is off.

CONSTRUCTION

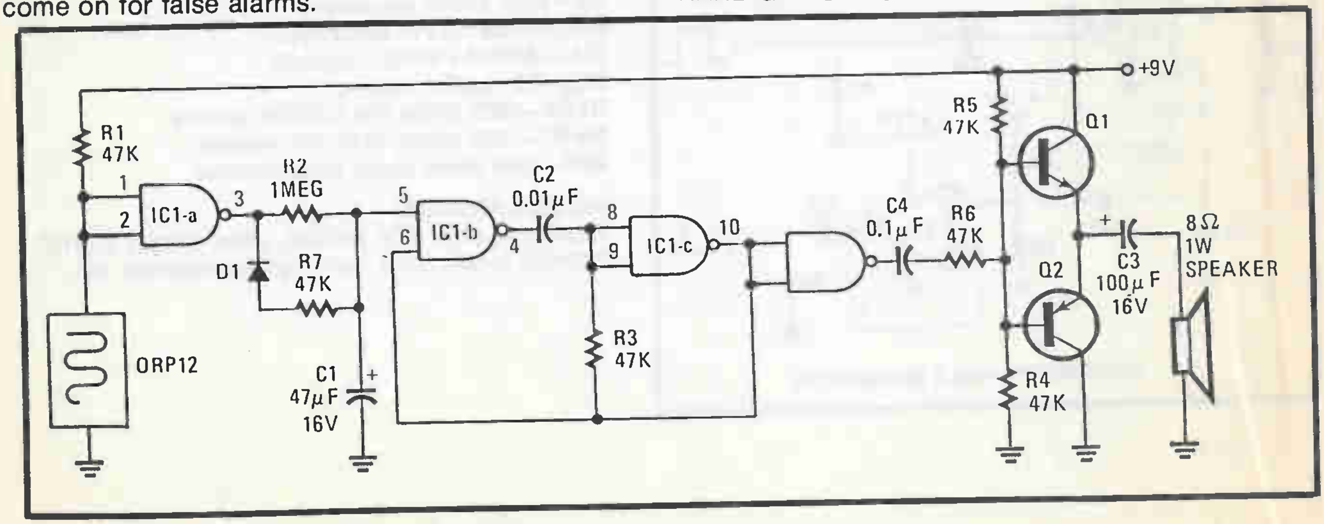
When constructing, follow all the usual rules when dealing with the CMOS IC. You may find it a good idea to just have the sensor on the end of a short lead inside the fridge with the alarm sitting in a box on top of the fridge.

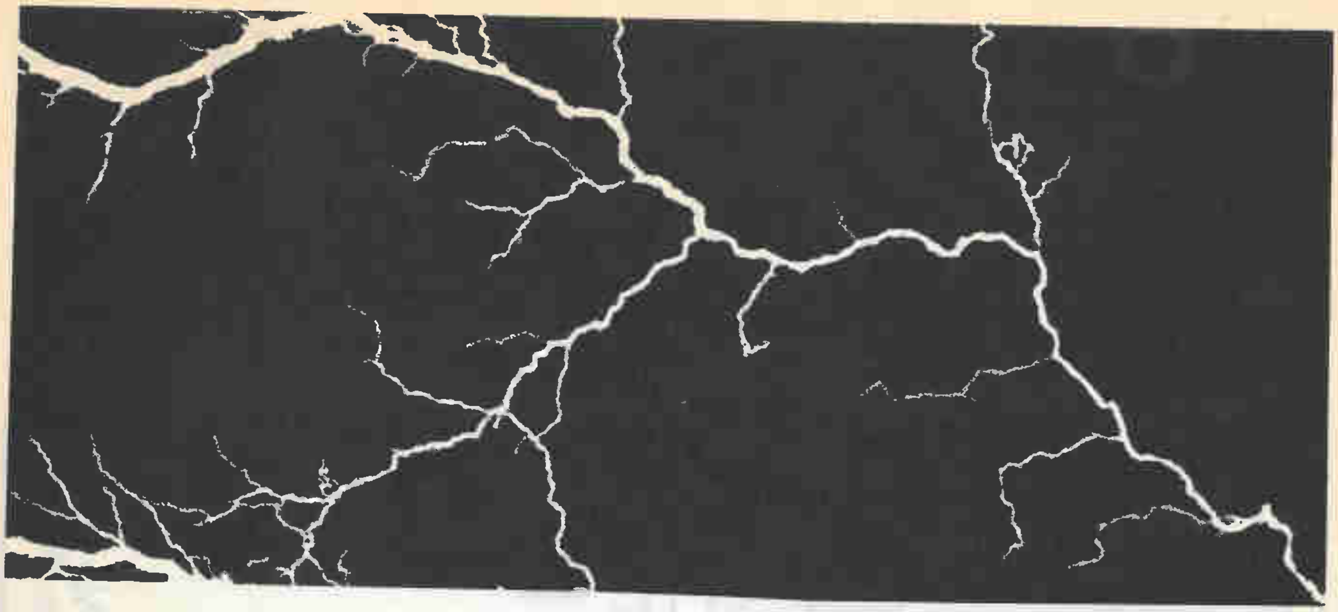
The most expensive part will be the LDR. If you can't get the one specified, don't panic! Almost any one will do the job pretty well. ■

FRIDGE DOOR ALARM

PARTS LIST FOR FRIDGE DOOR ALARM

R1—47K ohm ¼W Resistor
R2—1M Ohm ¼W Resistor
R3-R7—47K Ohm ¼W Resistors
C1—47uF, 16V Electrolytic Capacitor
C2—0.01uF Metalized polyester capacitor
C3—100uF 16V Electrolytic Capacitor
C4—0.1uF Metalized polyester capacitor
D1—1N4001 Diode
Q1—2N4401 NPN Transistor or S1M
Q2—2N4403 NPN Transistor or S1M
Misc.—1 8 ohm, 1W Speaker. 1 4011 Quad 2-input NAND Gate CMOS





UNDERSTANDING ELECTRICITY

By Ron C. Johnson, C.E.T.

PART IV

Well, here we are again for another round of the basics of electricity and electronics. So far in this series we have looked at electricity from the perspective of the physics of charged particles and how current flows. Ohm's Law and its application, power, series and parallel circuits, the resistor color code, scientific and engineering notations, and some basics on meters. This time we'll talk about voltage and current sources, maximum power transfer, and get into alternating voltage and current.

IDEAL AND NON-IDEAL SOURCES

So far the sources we have been using have been voltage sources. We used a D-cell battery in one example and in others we just drew the symbol of a DC voltage source and assumed it was ideal. But what is an ideal voltage source? Is a battery an ideal voltage source? A power supply? And what about the current source I mentioned earlier? How would an ideal current source behave? On the other hand, what would be the characteristics of non-ideal current or voltage sources? Finally, what does all of this matter to the average hobbyist in electronics? Is this important to know in order to do the kinds of things we want to do with electronics? Let's find out.

First, let's talk about where we get an EMF (electromotive force), or voltage from in the first place. Actually there are a number of sources based on several principles. The first one that comes to our mind would be batteries.

Batteries are made up of one or more cells. Cells create an EMF by converting chemical energy into electrical energy. Physically they are constructed with two electrodes with an electrolyte between them.

(See Figure 1) A chemical reaction between one electrode and the electrolyte causes electrons (negative charges) to accumulate at that electrode leaving an abundance of positive charges at the other electrode. The actual chemical reaction and how it works on the molecular level is a bit more complicated than that but for our purposes we are more interested in the results than the process. Suffice to say that the chemical process separates the charges creating a potential energy difference between the terminals of the battery. We'll look at some of the practical limitations of batteries a little later.

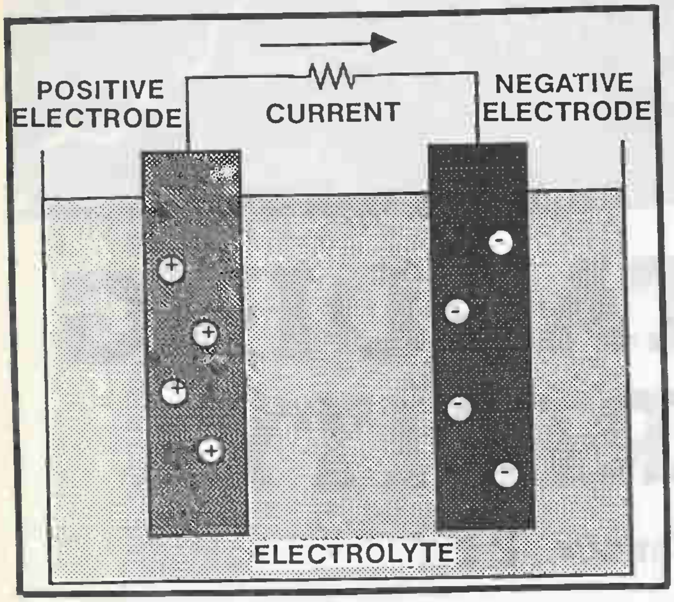


Figure 1. A basic Electrochemical Cell

The other major source of EMF is from electromagnetic induction. Sounds heavy! Well, electromagnetic induction is the process of converting a changing magnetic field into electrical energy. The changing magnetic field is usually obtained by physically moving a magnet or electromagnet in the presence of a coil of wire (or moving the coil in the presence of the magnet). We're talking about a generator or alternator here. The EMF that is produced varies at the same frequency as the magnetic field which produces it. We'll also look at this closer a little later on.

There are several other sources of EMF, most of which don't supply great quantities of power but are still useful. One is the solar cell. It converts photons onto electrons, so to speak. Another is the piezoelectric effect, where physical stress on certain crystals produce an electrical charge across the crystal's surface. Thermocouples are made when two dissimilar metals are connected together. An EMF in the millivoltage range is created across the junction of the metals, which is proportional to the temperature of the junction.

These are the main sources of EMF. Whether they supply power for a circuit to operate on, or create a signal for measurement purposes they are voltage sources and they do have limitations.

Let's do an imaginary experiment with two voltage sources: one ideal and one non-ideal. In this experiment we connect a variable load resistor across each source as in Figure 2A and 2B. Figure 3 shows a graph of the voltage versus current output of the sources. The line labelled "IDEAL" is horizontal because an ideal voltage source would be able to supply its specified voltage regardless of the current it was required to source. The line labelled "NON-IDEAL," on the other hand, slopes downward as more current is drawn from the source. If we think of a non-ideal voltage source as an ideal source with an internal series resistance the "NON-IDEAL" line makes sense: As the load resistance is decreased more current flows, but some of the source voltage is dropped across the internal source resistance so the voltage across the load decreases linearly.

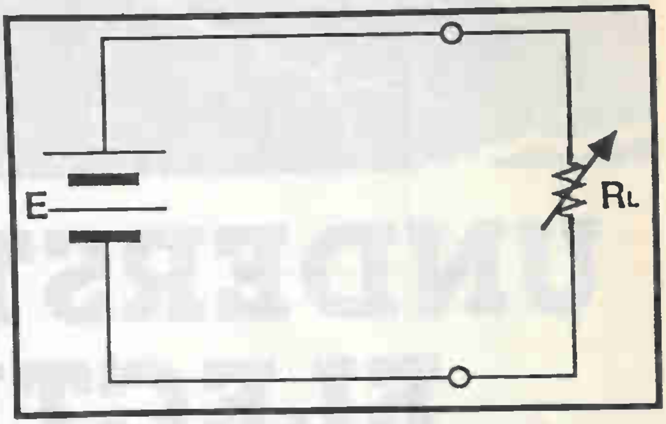


Figure 2a. Ideal voltage source.

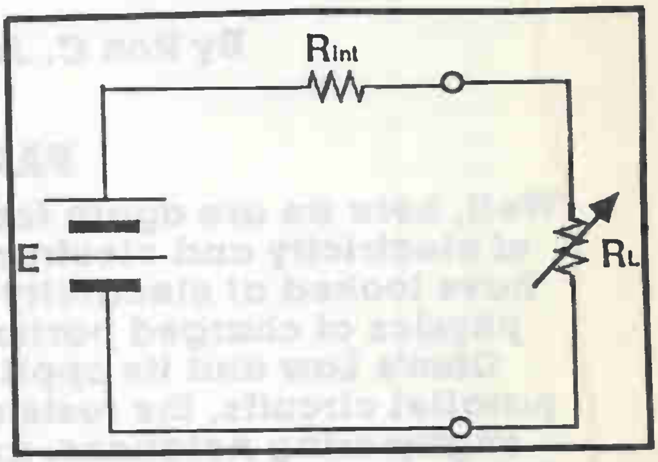


Figure 2b. Non-ideal voltage source.

Although we often talk about voltage sources as if they were ideal (zero internal resistance) actually this is not the case. All sources of EMF are non-ideal but, very often, the internal resistance is a very low value. The DC power supply you may have on your bench is a non-ideal voltage source, however it has been designed and built to simulate an ideal voltage source within a certain range of voltages and up to a specified maximum current output.

The battery on the other hand, is very often not a great voltage source, especially when it is nearly discharged. Depending on the type of battery, sooner or later the electrochemical reaction which produces the charge will deteriorate as the chemicals and electrodes are used up. As that process progresses the internal resistance of the battery increases. When a significant amount of current is required from the battery the voltage drop across the internal resistance becomes an appreciable percentage of the cell voltage. In other words, the battery is almost dead.

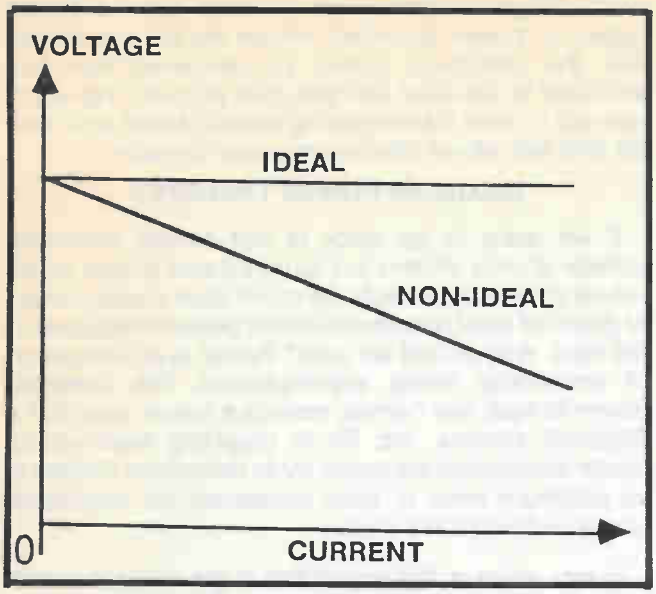


Figure 3. Voltage Vs Current for Ideal and Non-Ideal Voltage Sources.

This brings up an interesting phenomenon about batteries: surface voltage. If you were to take a partially discharged dry cell battery (1.5 volts nominal) and measure the voltage across its terminals with a high input resistance voltmeter you might measure something like 1.4 volts. This doesn't seem too bad. It should work at that voltage, shouldn't it? You then put the battery into your "ghetto blaster" (along with several others in the same condition) and it doesn't work right. No volume, the tape doesn't run up to speed, etc. With the battery still in place, and the power on, you measure the voltage across it again. Now it says.8 volts. What happened? Did the battery lose .6 volts before you put it in the machine? No. The first time you measured the voltage you read the "surface voltage" or the voltage of the internal "ideal" source. Your meter drew so little current out of the battery that virtually no voltage was dropped across the internal resistance. The internal resistance was still there; it just didn't show up in the voltage measurement. When the battery was put under load in the blaster a significant amount of current was drawn and some of the voltage was dropped across the internal resistance. This illustrates why battery checkers should always be designed to load down the battery to draw approximately the same current as will be required in actual use.

An ideal voltage source would source an infinite amount of current without changing its output voltage. Actual voltage sources have internal resistance which drops the source voltage internally. What about the current source we mentioned earlier?

In effect, a current source is the opposite of a voltage source. An ideal current source should supply its rated level of current into the load regardless of the resistance of the load. Figure 4A and 4B show simple circuits for ideal and non-ideal current sources.

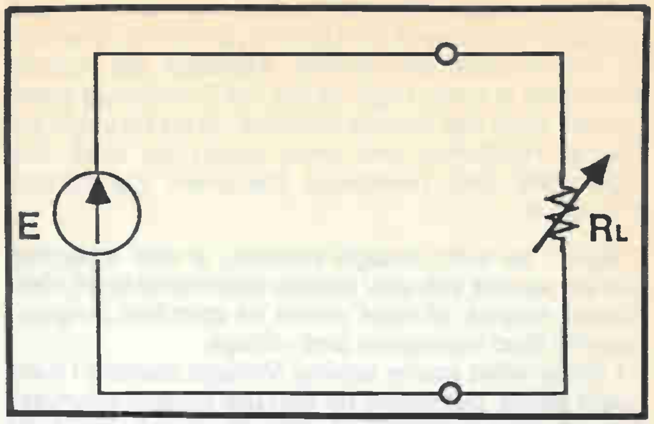


Figure 4a. Ideal current source.

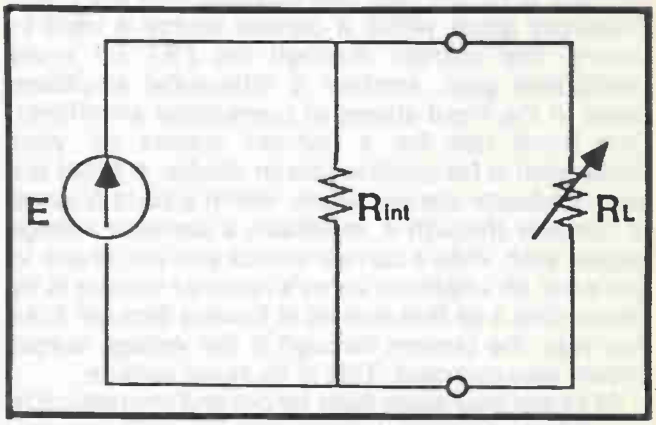


Figure 4b. Non-Ideal current source.

Figure 5 shows the resulting voltage versus current graphs. For the ideal current source, as the load resistance increases the current should remain the same and because of Ohm's Law, the voltage increases. The second circuit shows an internal resistance in parallel with the current source. The

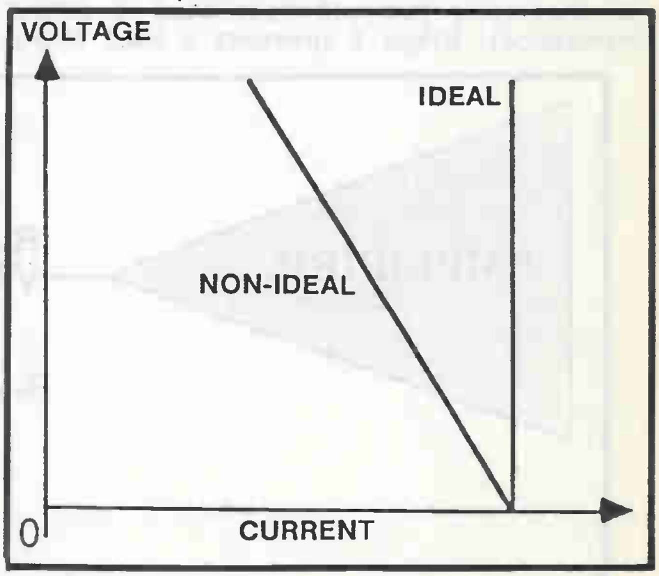


Figure 5. Voltage Vs Current for Ideal and Non-Ideal Current Sources.

corresponding line on the graph shows the current decreasing as the load (and the voltage across the load) increases. The load current decreases as load increases because of the *Current Divider Rule* (which we talked about last month). Although the internal resistance is quite high, as the load increases some current from the source will flow down through the internal resistance and never reach the load. The higher the load resistance the lower the current through it.

Again, as with voltage sources, a well designed current source will very closely approximate an ideal current source, at least within its specified range of current, load resistance and voltage.

I know what you're saying: Voltage sources I have heard about, but where do you use current sources? Actually, there are lots of uses. Quite a few circuits use current sources, (made out of bipolar transistor circuits), to set the bias. One example is in Field Effect Transistor amps where a current source is used to control the current through the FET for more predictable gain. Another is differential amplifiers (used in the input stages of operational amplifiers). One good use for a current source on your workbench is for checking zener diodes. A zener is a semiconductor device which, within a certain range of currents through it, maintains a constant voltage across itself. With a current source you can check to see what an unknown zener's nominal voltage is by connecting it so that current is flowing through it. As you vary the current through it the voltage across should stay constant. This is its zener voltage.

All of this may seem fairly far out and impractical to you. Where does the rubber meet the road, you say. Well, as I have said before: You can't build the house without the foundation. This stuff really does have some useful application in real projects. We can use these same concepts about internal resistance when we talk about stages in an amplifier, for example. In Figure 6, Stage 1 is essentially a voltage source and, because it is not ideal, it has an internal resistance (another term you will hear used is output impedance). Stage 2 presents a load (input impedance) to Stage 1. The values of the internal resistance of Stage 1 and the load resistance of Stage 2 will determine how much of Stage 1's signal will reach Stage 2. This same concept applies to the output of power amplifiers where we are concerned that the maximum power be delivered from the amplifier to the load (for that ever popular "rip-your-ears-off," nerve disintegrating sound of rock and roll). So let's talk about maximum power transfer.

MAXIMUM POWER TRANSFER

If we were to go back to our simple non-ideal voltage source shown in Figure 2B and assign some values to its components we could then create a chart or graph of load resistance versus power dissipated in the load. Why would we care? Power is an indication of something being accomplished. We dissipate power to heat our homes, mow our lawns, play our 4 Gigawatt stereos, etc. So in graphing load versus power dissipation we could try to determine if there is an optimum level of load resistance for maximum power output to the load.

In fact, there is. We would find in graphing this data that when R_L is less than R_{int} that, while the current in the circuit is relatively high, the voltage across the load is fairly low. We know that power is the product of voltage and current so the power would be fairly low. When R_L is greater than R_{int} the voltage across the load is high but now the total resistance in the circuit is much higher so current is low. It turns out that at the point where R_L equals R_{int} maximum power transfer to the load occurs. So according to what we were saying about power amps and speakers before, when the internal resistance of an amplifier is 8 ohms and the speaker load is 8 ohms we will get the maximum possible power out for that amplifier. And so it is. (Of course, as usual, there are a few complicating factors in actual amplifiers but generally the principle holds true.)

It is probably worth mentioning that we may not always want maximum power transfer. At max power

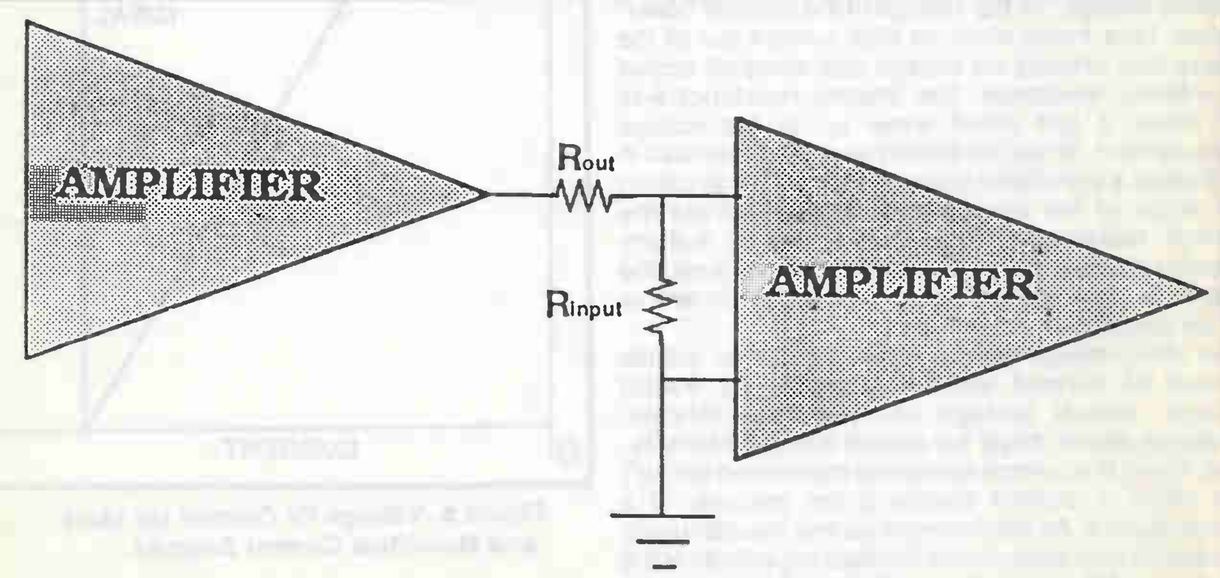


Figure 6. Input and output resistance in amplifier stages.

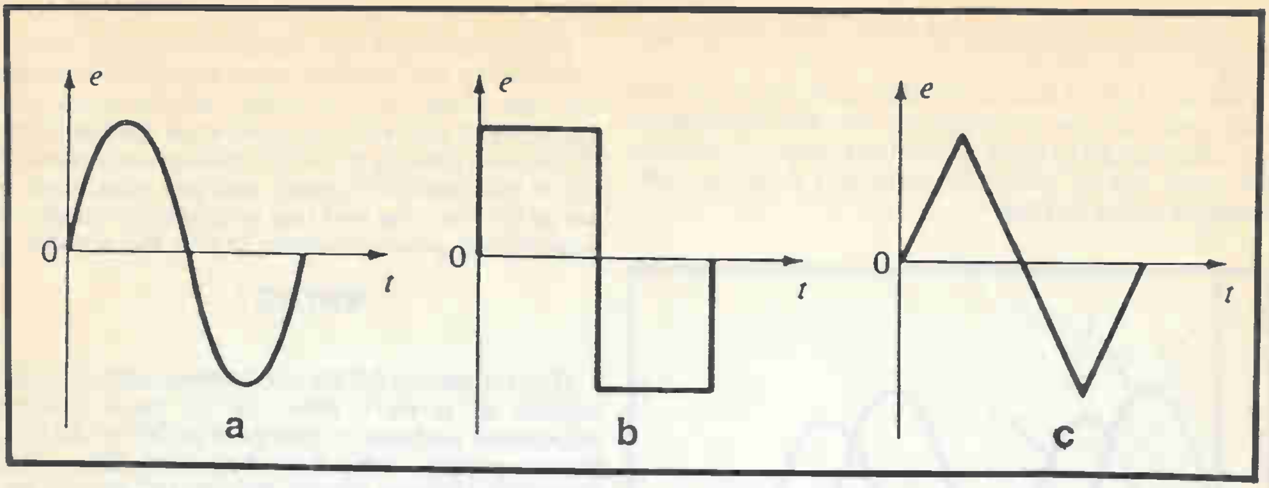


Figure 7. a, b, c. Sinusoidal, Square and Triangle Waveforms

transfer our efficiency is only 50% because half of the source voltage is dropped across the internal resistance. Sometimes we want the maximum voltage gain to the next stage so we would want a very low internal resistance. Whatever the case, you can make an intelligent choice if you know the possibilities.

Okay, let's all sit back, take a breather, and congratulate ourselves on our accomplishment. We have waded waist deep through the swamp of the basics of DC theory. Time now to strap on the oxygen tanks and put on our diving masks. We're about to plunge into the murky depths of alternating voltage and current.

ALTERNATING VOLTAGE AND CURRENT

Up to this point we've been talking about DC voltages and currents; values which are steady state with respect to time. DC is a very important part of electronics because most circuits use DC voltage for their power supplies, references and other applications. On the other hand, lots of practical circuits use some form of alternating signal to accomplish their purposes. First let's look at what we mean by alternating voltage and then we'll discuss some applications.

While it really is a misnomer, we throw around the letters AC pretty indiscriminately. AC stands for *alternating current* but we use it as well when we say AC voltage. Despite its inaccuracy it is easier to use than the more precise "periodic voltage waveform." But that is what AC is: a cyclically varying waveform—voltage (or current) which repetitively varies in a cyclic manner. It could be a sinusoidal waveform (Figure 7A), a square wave (Figure 7B), triangle (Figure 7C) or some other, more complex waveshape.

The waveform can be described in several ways. In addition to the waveshapes we have already mentioned, we can describe the wave in terms of peak value, or amplitude. This is the value from the center to the top of the waveform (on the vertical axis, see Figure 7A). Another important aspect of the waveform is the rate at which it repeats. This is called its frequency, "f," and is given in Hertz, or cycles per second. (For some applications, which we will see later, we also express frequency as angular velocity, "w," in radians per second). When an AC signal is shown plotted as amplitude versus time as in Figure 7 frequency can be determined by finding the time required for one complete repetition of the signal (which is called the period, "T") and finding its reciprocal.

So AC is a voltage or current varying repetitively with time and has amplitude and frequency. Many of you already know some common applications but for those of you starting out we'll check out a few of them.

The most common use of AC is the voltage you connect to every time you plug into an AC wall outlet—the power you use in your home. Commercial AC power is about 120 volts RMS (we'll talk about RMS shortly) at a frequency of 60 Hz. Commercial power is a sinusoidal waveform which is a single frequency. Complex waveforms (square, pulse, triangle, etc) are actually made up of some combination of sinusoidal waveforms at various frequencies, all summed together.

The next most common use of AC would be sound frequencies. The frequencies which make up audible sound range from about 20 Hz to 20 kHz. Your stereo, radio, television, intercom, etc all have amplifiers in them which process AC signals in the audio frequency range. Radios and televisions also have circuits which deal with higher frequencies which are used in transmitting and receiving radio signals. These frequencies run into the MHz range and can travel through the air as electromagnetic waves.

Computers use square waves or pulses at various frequencies to carry information between parts of the computer. Ramp and triangle waves are use in televisions to create the horizontal and vertical video signals. (You get the picture.) These are just a few of the many areas where AC is involved.

Let's get back to the sinusoidal wave. There are a few aspects to it we need to know in order to work with it and use the same language. First, RMS.

RMS stands for Root-Mean-Square. This refers to the mathematical process which is applied to a sine (short for sinusoidal) wave to determine the amount of power which can be obtained from the wave. The process is beyond the scope of this article but suffice to say that a 10 volt RMS sine wave would deliver the same power to a load as 10 volts DC. So, for power, RMS is an equivalent of DC. It is important to remember that any time a level of AC voltage is given in volts only it is assumed that the voltage is in RMS volts.

We said before that AC voltage could be expressed as a peak voltage or amplitude. We also sometimes talk about peak to peak AC voltage (which is 2 times the peak value). How do peak and peak to peak voltages relate to RMS?

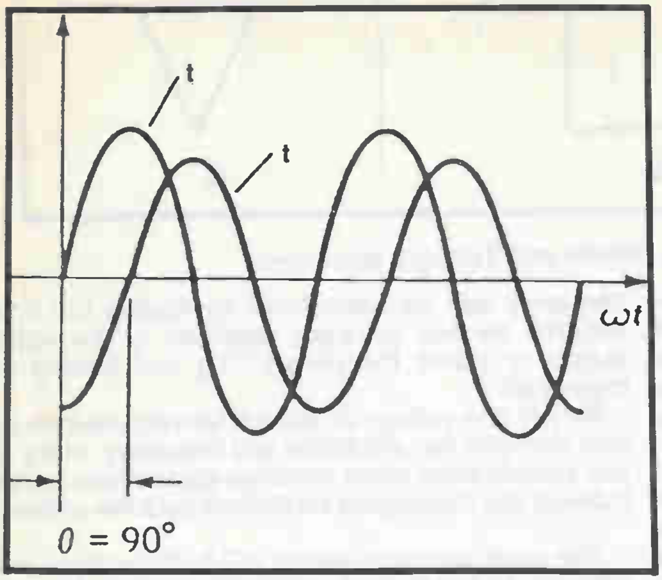


Figure 8. Two sine waves 90 degrees out of phase

One last thing before we tie this one up. AC voltages can be shifted in phase. Figure 8 shows two sine waves. You will notice that one crosses zero going positive at the origin of the graph whereas the other one crosses a few milliseconds later. They are both the same frequency but the second one lags the first. If we consider a sinusoidal waveform to complete each cycle in 360° (as in the arc of a circle) we can express the phase difference between the two waveforms in terms of degrees. In this case the second waveform lags the first by 90°. We could also express it as the first waveform leading the second by 90°.

Having determined that a sinusoidal waveform can have: amplitude, frequency and phase how could we express all of that information together? The answer is to use the following sinusoidal expression:

$$V_{(t)} = A \sin wt \pm \phi$$

where A is the amplitude or peak value
w is the angular velocity in radiants per second
t is the time
and ϕ is the phase angle, in degrees.

Angular velocity w, or radians per second, as we said previously is another way of expressing frequency. Instead of cycles per second it assumes the value of 2π to represent one full cycle. (Don't ask me why. The reasons are rooted in mathematics I don't want to get into.) Nevertheless, this is the standard expression which describes a sine wave.

And what will it do? Besides wrapping up all the information you need to know about the sine wave it will also allow you to find the instantaneous value of the same. If you want to know what the exact voltage of the sine wave is at t = 127 milliseconds (and all the other information is given) you can substitute in the value for the time and use your handy-dandy "sine" function on your calculator to find the answer.

WHY AC?

Why do we use AC for our commercially distributed source of power? After all, in most electronic equipment we have to change it to DC to use it in the power supply. Why not distribute DC voltage? Certainly Thomas Edison though DC should be the standard and he went to great lengths to try to ensure that it was. Fortunately, for us, he failed.

There are several good reasons for using AC for distribution. One, which Edison reportedly tried to cover up, is that higher voltages of DC are more lethal to people than AC. This is because when you come in contact with higher DC voltages your muscles tend to freeze in place which doesn't allow you to release the contact. This can kill you. AC, however, tends to cause the muscles to spasm which, at least sometimes, frees you from contact saving your life.

A second reason relates to electromagnetism (which we will cover more thoroughly in another issue. We need a voltage for domestic use which is high enough to deliver a reasonable amount of power into average loads, but not so high that it is very dangerous and requires expensive insulation procedures. Alternatively, the power utilities want to minimize the cost of distribution. The power lines would have to carry large quantities of current to deliver adequate power at 120 volts and the lines would have to be very heavy to minimize power losses in the lines. Instead, the utilities transform the voltage up to a higher voltage before transmitting it to the customer. When the voltage goes up the current comes down (for the same power) so more can be delivered on the same line. The power is then transformed down before coming into your house. Step up and step down transformers work on electromagnetic principles which are dependent on *changing voltage* so AC must be used.

Okay, I can tell by your reaction to that last one that your oxygen tanks are empty. We'll have to surface and get some air.

Actually, in order to use and understand AC we don't have to do a lot of math, (especially geo-trig). We just need to know the concepts that the math represents. If its a little hazy don't worry. We'll be looking at related stuff again in subsequent issues.

And speaking of subsequent issues... Next time we'll talk about electrostatic fields and capacitors, and see how oscilloscopes work and are used.

Meanwhile, I guess it's time to "sine" off for now.■

KEEPING YOUR HOBBY COSTS DOWN

Dollars can get you anything, but not everything! Smart buys will mean more gadgets and gear for less bucks. We tell you how.

Whether you're buying just a handful of components for a do-it-yourself project, a hi-fi,system, a video tape recorder, a home computer, a table radio, or some electronic gizmo that wasn't even invented until last month, in most instances what you get won't be worth what you pay for it. Not that you will necessarily get inferior goods; rather, you will simply be paying more than the item or service is worth.

Instead of the price of electronic equipment and service representing a true cost/value ratio, it often conceals multiple levels of profits for multiple levels of ownership, company mismanagement and losses for ventures totally unrelated to the normal purpose of the business, governmental quotas to protect certain industries, astronomical charges for repairs because "We're the only place that has the parts," postage and "handling fees" for warranty repairs which actually cost more than the repair itself and...well...the list of unrelated costs that now go onto the price of anything electronic is almost endless. Generally, consumer costs have become "whatever the traffic will bear."

But there are ways in which the *you*, the consumer, can save *big bucks* when buying such things as electronic parts, a video tape recorder, a computer, a TV antenna installation, just about anything. The way to cut costs to rock-bottom is to take advantage of distress and surplus merchandise, seasonal sales, contract service, and, most important, new models.

Let's take a look at some of the things you can do to get the most bang for a buck—how to squeeze almost anything into your budget. But keep in mind that we don't suggest that our recommendations are necessarily the right way for every situation; rather, they are meant only as a guide to help *you* determine how you can get the most for *your* money.

Building it Yourself

First things first, let's look at "homebrew projects:" the gizmos and gadgets you build for yourself. For illustration, let's assume you're into photography and you'd like to have a bare bulb electronic flash unit, the kind of thing that makes your flash pictures look as if they were taken under natural lighting. You dig out the General Electric flashtube manual from under the dust at your local library, and there it is: a complete schematic and parts list for line-powered bare-bulb flash tube.

Only porblem is, when you add up the cost of the parts it comes out to more than a commercial electronic flash would cost You have learned the first lesson of modern home construction: The individual cost of the components ranges from twice to greater than five times the cost of commercially built equipment. Just a small metal enclosure for a hand-sized project will set you back around $5 before you purchase any other components. A toggle switch for power control? Maybe a $1.50 if you use a large one. If you're building a small project and need a miniature switch—it's about $2.50. Transistors? The general replacment at Radio Shack will cost you more than $1; the same item under its own JDEC number will cost between 25 and 50 cents. An LED for an indicator lamp?; maybe 2-for-$1. We could go on and on, but you probably have gone down the road of disappointement before. Worse yet, it's likely often you have gone to great effort and expense to obtain the components for a particular project only to discover that one single component, the one without which the project won't work is unavailable. You have maybe $10, $20 or more invested in components and you can't get the most important part.

If you're really into home cosntruction and want to build things at rock-bottom cost the way to do it is to get out of the "all new" rut. Start thinking "surplus." For almost every item commercially manufactured there are truckloads of components left over that the manufacturer wants to turn into immediate cash by selling them "in bulk" to a surplus distributor. It's all prime stock, but it's no longer needed. It's out there in the marketplace at anything from 50% to 75% below what it sells for as "standard stock." For example,miniaturetoggleswitches similar to the one sold for $2.49 at Honest Harry's Electronic Flea Market and Pet Store can be purchased from a surplus distributor for $1 to $1.25—the exact price depending on the particular dealer. Remember the electronic flashtube we wanted to build? A "standard stock" blister-packaged flashtube will set you back about $7.50. The same tube, surplus, wrapped in tissue paper can be purchased from a surplus distributor for $2.50.

Transistor prices got you down? Why pay extra for a so-called *universal* or *"direct" replacement?* You can purchase "the real stuff" from surplus distributors for about 25% of the "universal price." In fact, you pay about the same price if you purchase the real stuff from a prime source—meaning an authorized distributor for the part.

The truth of the matter is that the marketplace is literally drowning in surplus components. Except for a specific esoteric part, you can find virtually anything you need at bargain prices. But don't get trapped by "postage and handling fees." Often, the store makes more profit on these charges than they do on the components. To keep "postage and handling" charges from escalationg into a major expense, consolidate all your purchases so you order from only one source. If possible, specify only UPS (United Parcel Service) delivery. It's the fastest, least expensive, most dependable way to ship; and every package is automatically insured for up to $100. If anyone has an insurance fee when shipping an under $100 package via UPS better ask yourself if this is the kind of operation you want to do business with. If the store has a flat charge of 10% of the total bill, that works out to $10 per hundred. People have had relatively heavy computer equipment worth many hundreds of dollars shipped via UPS for less. Unless you're buying lead fishing sinkers, or iron weights for a bell bar, 10% of anything should raise some questions in your mind. (It might be reasonable, .but then again, it might not.)

Hi-Fi at the Lowest Cost

If you live outsidethe larger cities there is rarely any discounting of Hi-Fi components, or anything else for that matter. If you have the confidence to purchase mail order you can easily save yourself from 20% to 30% or more on name brand high fidelity components, TV, video recorders, just about anything. Surprisingly, the greatest discounts are from camera dealers, the great ones inNewYork City that go by names such as 47th Street Photo, Competitive Camera, and Focus Camera and Electronics. These are very reliable mail order houses that stand behind everything they sell, and they sell the best-known brands. People come from all over the world to purchase their camera and electronic equipment from these dealers, so you know their prices must be right. Most of them advertise in the Metropolitan and Entertainment sections of the Sunday edition of the New York Times newspaper. If you're ready to spring for relatively expensive equipment it will pay you to search out where you can purchase the Sunday edition. Maybe a friend living in one of the major metropolitan areas will mail you the advertisements. The savings can be very large, so it's worth lots of extra effort to check the advertisements.

If you can't afford the price of a speaker system you would like, then maybe you are better off buying the choice of another hi-fi buyer. By that, we mean that you may be able to buy the speakers you want by watching the used radio equipment classified advertisements in your local newspapers. Many audiophiles are always stepping up and selling at reduced prices perfectly good speaker systems that you can afford. Speakers are good buys because you can listen to them, and should they perform well, they'll perform well at home after you've paid out the cash.

Another money-saver for high fidelity enthusiasts is the twice a year sales when the fidelity industry introduces new models. Overnight, a vast supply of components becomes "last years's model," sold off at a substantial reduction from the usual selling price. If you can wait for the sales, which are generally around September and January-February, you can often get components you never thought you could afford. You might not have the largest possible selection because a line of components you're interested in might not be on sale—there might be no new models in a particular line—but if you're willing to compromise on a feature or two, or perhaps on the brand—maybe substitute Pioneer for Kenwood equipment or viceversa—you can easily save between 20% and 50% of the discounted price what is called "the New York price."

There's also a time to purchase video tape recorders. Selected new models usually those at the low priced end of the line—are introduced around Washington's birthday. That's the time you can get some great prices on both last years's models and the latest versions. Often, the dealer will also throw in a handful of tapes, or maybe a years's worth of free movies.

If you want to cut costs on maintaining a video cassette recorder consider a service contract. Experts rarely recommend taking out a service contract on any home appliance. Unless you get stuck with a "lemon" you won't even break even with a service contract. Video recorders are something else. Almost any repair you can think of is time—consuming. Many authorized repair stations now charge nominally $75/hour for service, plus parts. The video heads for one popular recorder costs $225. A single replacement of heads can cost almost as much as the recorder. While the machines are much better made than they were a few years ago, they still break down, and they are expensive to fix.

If the dealer has a service contract that 100% guarantees parts and labor take it. $50 is not an unreasonable fee considering that major service companies charge more. But keep in mind that a parts-only guaranty is almost worthless; except for the heads, labor is the big expense. Also, make certain the dealer's service contract is renewable after the second year. That's when you're going to have problems if you give the machine heavy service, and if he bails out and doesn't renew the authorized service shop might not sell you a service contract if you didn't have an "authorized service contract" for the first year or two.

If the dealer does not provide his own "carry-in" service warranty buy the best machine you can get. What's the best machine? The one *for which there is an authorized service agency in your town.* All the VCRs are good: many come from the same factory. If your machine does break down, you don't want to have to worry about packaging the machine and shipping it someplace on the other end of the country—paying for shipping costs both ways. The "best" VCR is the one for which there is nearby carry-in service.

Snow All Year

Does everything on your TV look like it's coming from the Winter Olympics in Yugoslavia? You know, the one where everything was seen through a white blur because it snowed all the time. If so, you're probably ready for a new antenna system. Antenna systems do age and run down. Moisture gets into the transmission line, antenna connections corrode, some elements fall off, the mast gets loose. If you haven't priced a TV antenna installation better sit down first. The last time we inquired it ran about $150 to $200 to install the equivalent of what we could purchase at the local Radio Shack for about $25.

There is nothing mysterious about a TV antenna installation. Unless you're out in the deep fringe area where repositioning the antenna a foot in either direction can make the difference between a decent picture or none at all, just about anything will work as long as it uses coaxial transmission line and the installation resembles the antenna installation used by your neighbors. If their antenna is 40 feet above the ground that's where your's belongs. If theirs points NNW, that's where you point your antenna. The secret to good reception is to purchase an antenna that's "milage rated." If you live 25 miles from the TV broadcast antenna you need a receiving antenna rated for at least 25 miles. If you live 40 miles from the TV antenna you need a receiving antenna rated at least 40 miles. The ratings such as "local," "fringe," and "deep fringe" mean nothing unless something also sopecifies the milage sensitivity, which isn't "official" anyway. Radio Shack antennas are milage rated, so that's really a good place to start.

Often, a TV antenna that's been up many years will droop, appear to be ready to fall down, and obviously in need of replacement. However, check the antenna carefully. Often, the drooping is caused by the rusted U-bolts which secure the antenna to the mast and the mast to the wall brackets. The U-bolts are iron and rust thru rather quickly. New U-bolts, which are available from auto supply stores and muffler shops, will make your antenna system stand tall once again.

If the transmission line is more than five years old it's probably got more losses than a gambler in Las Vegas. Transmission line is relatively inexplensive, so repalce it. Between the new transmission line and new mounting brackets you might end up with picture quality the equal of a whole new antenna system, and it will probably save you at least $100 compared to what the local TV shop would charge you.

Cutting Computer Costs

There is almost no such thing as a discount on personal computers. No matter how the advertisements twist and turn the computer itself is generally "full list." It's peripherals such as printers which are discounted, and often a really substantial discount is offered as a "complete package" consisting of a computer and the printer, or the computer, a printer and some other peripheral such as an extra disk drive. In the New York "discount" stores, there are some notably excellent prices on well-known computer/printer packages, such as a Kaypro computer with an Epson or Comrex printer, or an IBM PC with two disk drives and monitor for the usual price of the same system with one disk drive. However, be very wary of packages with unknown or little known printers. They might be quite good, but some of them use special ribbons (that's where they make their profit) that aren't all that available outside the larger cities.

Also be wary of computer packages which include a software bundle worth umpty-up dollars. Is the bundled software really worth anything to you? If you need a personal computer only for applications software and never intend to write any programs, both a BASIC interpreter and a BASIC compiler, which might be worth nearly $500, has no value at all to you. Similarly, a package of expensive word processing software is also worthless if you intend to use some other work processing program, as is keyboard reconfiguring software if you have no expectation of reconfiguring your keyboard. Bundled software packages always appear to be a fantastic value until you ask yourself "Do I really have use for it?"

Summing UP

Almost without exception, there is a way to make substantial savings is "patience." If you don't have to run out and get something "right now;" if you can wait to shop around, wait for the special sale days such a Columbus Day and Washington's Birthday, if you have the confidence to trust in mail order purchases, you can easily average savings of 20% to 50%, particulary if you outside a metropolitan area, for the rule of thumb is "The farther you live from a large city, the higher the price for appliances and equipment of any kind." One final note of caution, however. Never, but never, pay for any mail order purchase by check. It's your money out there in the marketplace and it's your problem if something goes wrong with the sale. Instead, use a credit card. If something goes wrong and you don't get the merchandise you ordered, or you get the wrong merchandise, it's usually the bank's problem. Also, a personal check takes two weeks to clear before the seller will ship to you. With a credit card purchase your order will probably be on its way to you in one to three days. ■

WORKBENCH PROJECTS

Reading about electronics can be fun and instructive, but the only way to become a knowledgeable technician is to get hands-on experience, by actually connecting resistors and capacitors together in circuits that do something. These circuits can be as simple as turning a light on or off, or making some kind of alarm sound. As long as we have a power source and a load connected together by wires, we have a functioning circuit.

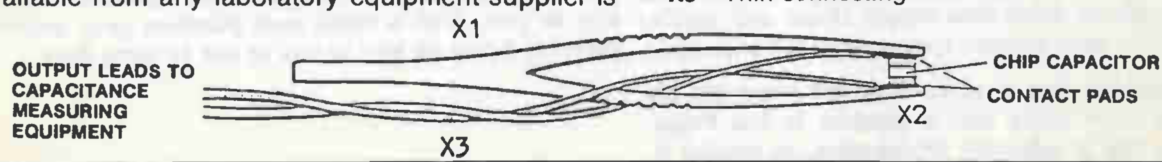
Another way to think about circuits is to consider one part as the input and another part as the output, This is notably true of amplifiers. You will note that the projects in this section usually "do something," that is, they accomplish some useful purpose. With a little experimentation and/or expansion, you may be able to find other uses for these circuits. If you study them and put several combinations together, you will increase your understanding of how all electronic components and circuits work.

CHIP CAPACITANCE VERIFIER

With the greater availability of surface mount components for ultra-miniaturization of circuits, there is the inherent problem of handling and testing these very small components. Surface mount capacitors for example are designed to be epoxied to the mounting surface and are considerably smaller than their traditional counterparts. There are no terminations in the normal sense and testing large numbers of components is a sure test of anyone's patience. To maintain your sanity the circuit idea below has been used for checking hundreds of components. A standard pair of plastic tweezers, available from any laboratory equipment supplier is modified, by bonding a metallic contact pad (e.g. a thin solder tag) to each inner face. Two thin contact leads are brought out through holes drilled into the upper body. These leads are held in place with a quick setting epoxy. The leads when connected to a capacitance verifier will allow for a quick check on the integrity. In one simple action, chip capacitors can now be sorted, counted and tested. ■

PARTS LIST FOR CHIP CAPACITOR VERIFIER

X1—Plastic tweezers
X2—Thin solder tags
X3—Thin connecting wire



SMOKE DETECTOR UPS

A UPS is an Uninterruptible Power System. Expensive and large UPS systems keep big computers powered. When the line power fails, a UPS switches to batteries that it has kept charged. The batteries now power the load.

Our Smoke Detector UPS can power three smoke detectors and has a battery backup. The battery switches in so fast, after power fails, that the transfer is not noticed.

The rechargeable battery can keep the 3 smoke detectors screaming until long after the protected structure is evacuated.

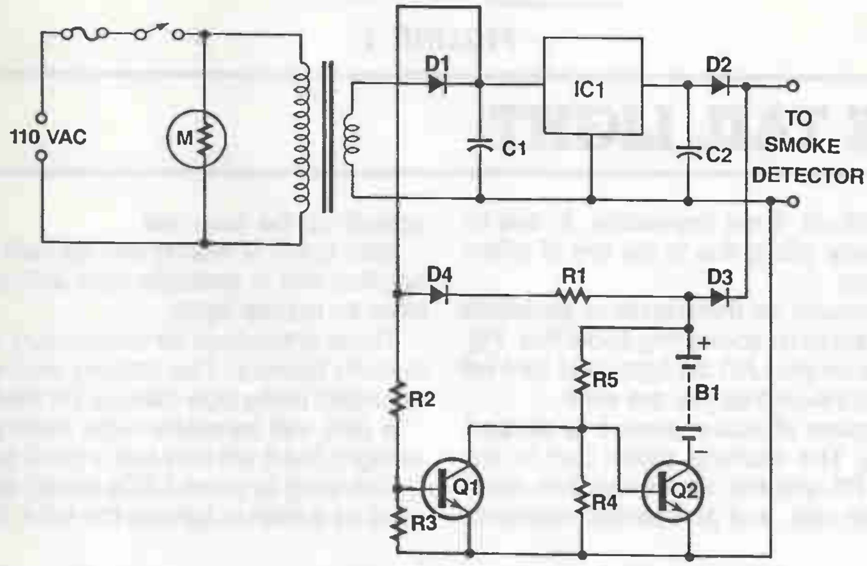
Two batteries or even three may be paralleled to increase power capability if you choose. The only modification to the circuit is in adding 1k ohm resistors in parallel to R1. Each additional battery requires the addition of one more resistor. This resistor supplies charging current.

Smoke detector manufacturers recommend testing the detectors once per week. Add a test of this UPS also. Unplug its power cord and test a smoke detector. The smoke detector should work fine. ■

PARTS LIST FOR SMOKE DETECTOR UPS

R1 — 1K Ohm 1/2 watt resistor
R2,3,4,5 — 47K Ohms, 1/4 watt resistor
D1,2,3,4 — 1N4007 Diode
C1,2 — 1000 mfd 35 WVDC capacitors
Q1,2 — 2N2222 transistors
F1 — 1/8 amp fuse in holder
S1 — SPST switch
M1 — 110 VAC 20 Joule MOV
T1 — 110 to 12 volt transformer, 1.2 Amps
IC1 — 7809 regulator IC
Use 9 V battery clips to connect to smoke detectors (black is +) so you can go back to batteries if necessary.

SMOKE DETECTOR UPS



MOVING POWER

Unusual problems are not new to electronic project builders. How about this: an alarm horn that can run off 110 Volt AC, at a current of 100 milliamperes. A low voltage alarm panel will control it. Also, the horn is to be 100 feet from the nearest 110 Volt source. How do we run it safely and cheaply?

Figure 1 is a schematic showing how the author did it. As you can see, the 110 Volt power is stepped down to 12 volts AC at the source, and fuse protected.

The wires are normal low-voltage wire over to the horn, where an identical transformer connected in reverse steps the voltage back up to 110 Volts at the horn. The power is controlled at the low voltage level, and is safe, since both 110 Volt runs are but a few inches long, and in steel boxes.

This system works as long as the power stays AC, and the transformers are matched. Also, be sure that the transformer will deliver enough current for the device you wish to power. For power ratings, see chart below: ■

TRANSFORMER RATINGS

Secondary rating	110 Volt power available
12.6 Volts 1.2 Amps	120 Milliamps
12.6 Volts 3.0 Amps	300 Milliamps
25.2 Volts 2.0 Amps	400 Milliamperes

MOVING POWER

PARTS LIST FOR FIGURE 1

T1 — 2 12.6 Volt 1.2 Amp Transformers
F1 — 1 Amp fuse in fuseholder

Always build the 110 Volt wiring in a metal box.

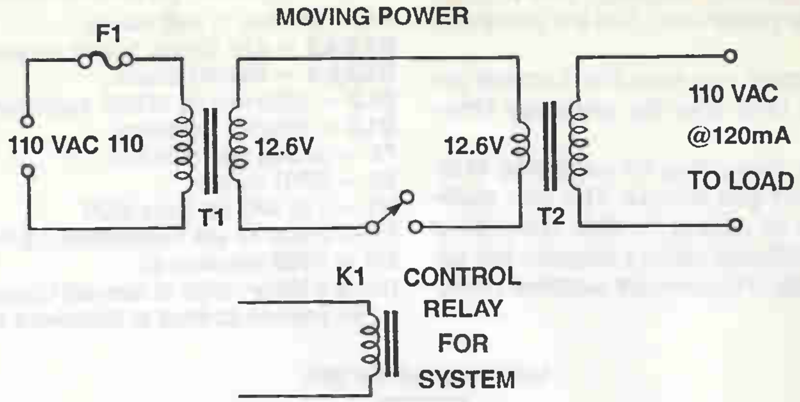


FIGURE 1

BICYCLE TAIL LIGHT

Frequently it is difficult, if not impossible, to see bicycles at night. Usually, this is due to the use of reflectors, only as indicators.

Since bicycles account for thousands of accidents annually, it is important to do something about this. Figure 1 is a circuit for a simple LED tail light. This light will protect your rear and insure that you are seen.

Figure 2 is a bit more effective, since it is strobed, and flashes rapidly. The flashing action can be adjusted by changing R1 and R2. Increasing their resistance slows the flash rate, and decreasing resistance speeds up the flash rate.

Both types of flasher can be built inside a small red housing that is available from auto parts stores and is used for marker lights.

These should run for many hours on a normal 6-Volt lantern battery. The battery and switch should be mounted, using pipe clamps, on the frame of the bike.

A nine volt transistor radio battery could power this tail light, but it will only last a few hours.

Changing to green LEDs would allow this light to be used as a marker light on the front of a bike. ■

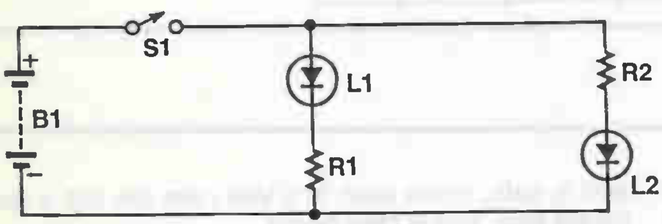


FIGURE 1: BICYCLE TAIL LIGHT

PARTS LIST FOR FIGURE 1

R1,2 — 330 ohm ½ watt resistors
L1,2 — High brightness LEDs
S1 — SPST power switch
B1 — 6 or 9 volt battery
Also case, housing, wire and hardware.

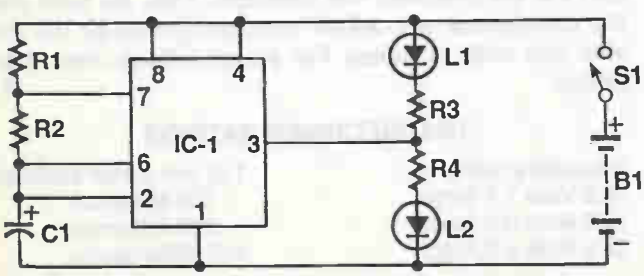


FIGURE 2: STROBING TAIL LIGHT

PARTS LIST FOR FIGURE 2

R1,2 — 560 ohm ¼ watt resistors
R3,4 — 390 ohm ½ watt resistors
C1 — 1.0 microfarad 15 volt capacitor
L1,2 — High brightness LEDs
S1 — SPST power switch
B1 — 6 or 9 volt battery
Also case, housing, wire and hardware.
IC1 — IM555 IC

IC1 — LM555 IC

HIGH SECURITY COMBINATION LOCK

Not all security locks are created equal. Some are better than others.

What is presented here is a simple to use but highly secure lock system.

The only way for this lock to be opened is for the right buttons to be pushed in the correct sequence. Push the wrong button, or the right one at the wrong time, and a buzzer howls and a relay blocks the lock circuit from opening.

Our diagram shows a six button lock with a 3-button combination. This can be expanded simply by adding stages.

Following the operation explanation will help you understand how to expand the lock circuit. The more buttons in the combination the harder it would be to compromise the lock.

Circuit operation is as follows: When the first button in the correct sequence is pushed, S1, power is applied to the gate of SCR Q1. Q1 conducts, latching on. This supplies power to S2A and Q5. Q5 conducts, stopping power conducting through Q6 and allowing S2 to be pushed without triggering the lock block relay.

When S2 is pushed in correct sequence, gate power is applied to Q2, turning it on. Q2 latches on, powering S3A and Q8. Q8 conducts, blocking power to Q7, permitting S3 to function in sequence.

S3, when pushed in sequence, sends gate power to Q3, which latches on.

This pulls in K1, opening the lock.

By using a relay here, this lock circuit can control a wide range of solenoids, catches, even motorized gates.

Should any switch but S1 be pushed out of sequence, gate power will be applied to Q4 and it will latch on. BZ1 will howl and relay K2 will turn on, preventing the opening of the lock even if the buttons are pushed in the correct sequence thereafter. ■

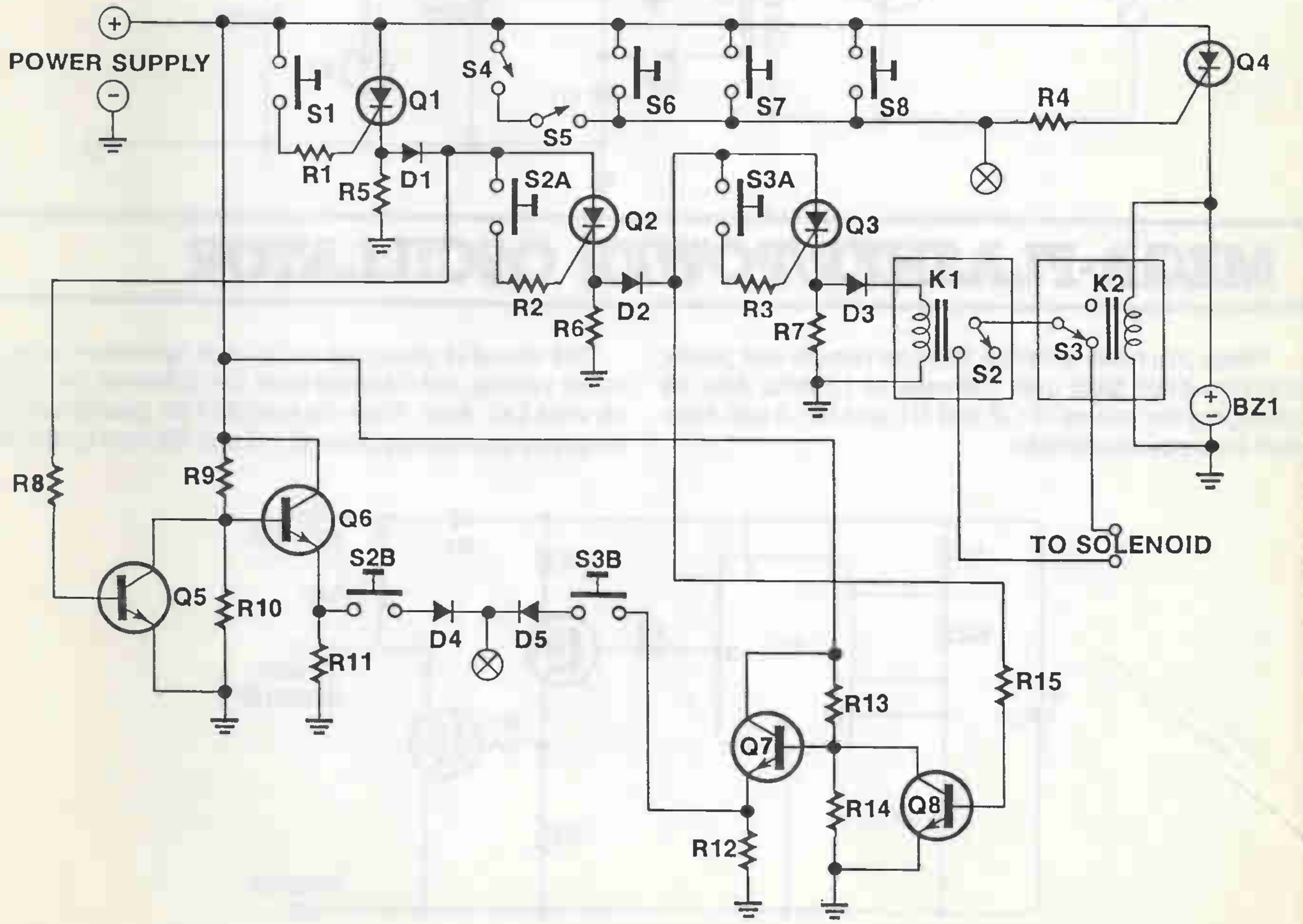
Installing The Lock

It is important to use a steel case and make the enclosure as tamperproof as possible.

PARTS LIST FOR COMBINATION LOCK

R1, 2, 3, 4—1K Ohm resistors
R5, 6, 7, 8, 9-15—10K Ohm resistors
Q1, 2, 3, 4—1 Amp 200 PIV SCR
Q5, 6, 7, 8—2N2222 transistors
D1, 2, 3, 4, 5—1N4004 diodes
S1, 6, 7, 8—SPST, normally open, pushbuttons
S2, 3—DPST N.O. pushbuttons
K1, 2—Relays, 9 volt coil, SPDT contacts at least.
S4, 5—N.C. tamper switches
BZ1—6-12 volt Peizo buzzer

HIGH SECURITY COMBINATION LOCK



HIGH SECURITY COMBINATION LOCK

Conceal all wiring, and consider a battery backup for the power supply.

Extra contacts on relays K1 and K2 can be used for remote indication lights, or any other indication or control function required.

It is important to keep knowledge of the combination as secret as possible. Also, if the pushbuttons are wired with long leads, they can be moved around to change the combination.

The power supply and the lock circuit reset switch should also be concealed.

A steel enclosure is recommended and hard wiring for the AC power.

The pushbuttons can be arranged on a plate and numbered or lettered. The combination should be random, not a known or commonly used number or letter group. It is not wise to use a name, address part, phone or zip code or social security number. A thief will try these first.

Careful construction will give you a lock that is truly hard to "pick."

Power Supply

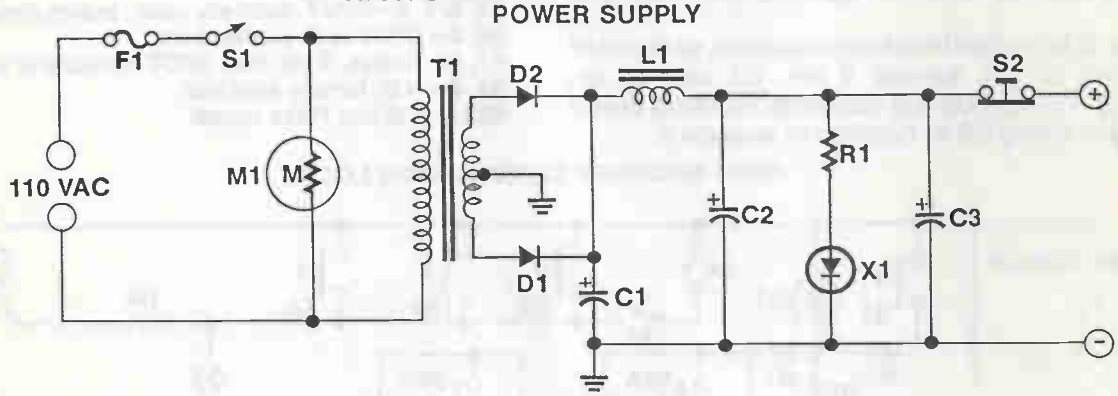
All that is needed is a battery and charger as the lock takes little power on standby mode.

Should you wish to power the lock from AC, then build our power supply. ■

PARTS LIST FOR COMBINATION LOCK POWER SUPPLY

R1—390 Ohm resistor, ½ watt
D1, 2—1N4004 diodes
C1, 2—1000 Mfd, 50 WVDC capacitors
C3—.1 Mfd, 50 WVDC capacitor
X1—LED
F1—¼ Amp fuse
S1—SPST switch
S2—Normally closed switch (could be keyswitch)
M1—Metal Oxide Varistor for 110 VAC
T1—110 to 12.6 V C T transformer at least 450 mA current output
L1—30 turns #20 magnet wire on a 1" diameter ferrite core

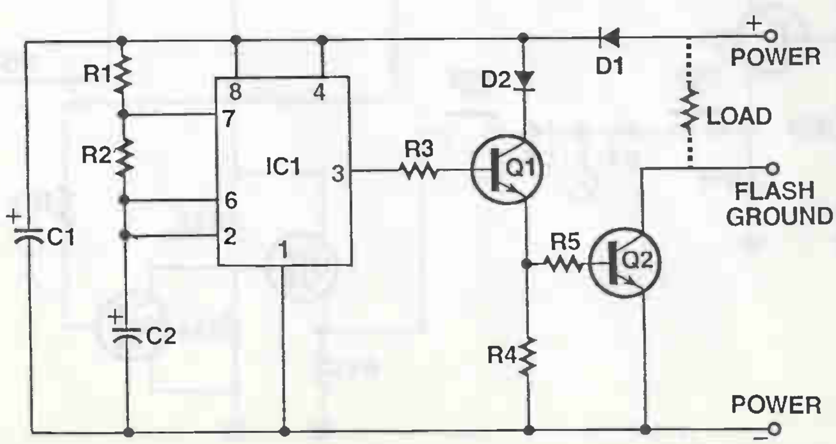
HIGH SECURITY COMBINATION LOCK
POWER SUPPLY



MEGA-FLASHER/POWER OSCILLATOR

When you need a device that can handle real power, this circuit can flash over 100 watts at 12 volts. Also, by changing the values of C2 and R1 and R2, it can function as a power oscillator.

This circuit is designed for 12 volt operation as in a motor vehicle, but it should work fine powered from 9 to 16 volts DC. Also, it can be modified for greater output simply by connecting another R5 and Q2 next to the ex-



MEGA-FLASHER/POWER OSCILLATOR

isting ones. Q1 has more than enough power output.

Q2 will require a heatsink as it will run hot if switching over 25% of rated power or more.

This circuit could be built in a metal box with the box as a heat sink for Q2. The Collector of Q2 should not make an electrical connection to the box.

An adjustable output can be had by making R4 a potentiometer and connecting R5 to the slider of the pot.

PARTS LIST FOR THE MEGA-FLASHER

R1, 2—560K Ohms 1/4 watt 10%
R3—1K Ohms
R4—10K Ohms
R5—100 Ohms 1/2 Watt 10% Resistor
C1—1000 Mfd 35 WVDC electrolytic capacitor
C2—4.7 Mfd 50 WVDC capacitor
D1, 2—1N4007 Diodes
Q1—2N2222 Transistor
Q2—2N3055 Transistor
IC1—LM555V Integrated circuit
Also case, heatsink for Q2.

PROTECTED OSCILLATOR

Shorted outputs and power entering the outputs are not always kind to oscillators. This circuit has some protection from those problems.

This audio frequency oscillator is adjustable. S2 sets the frequency range, and R1 and 2 the ganged potentiometers adjust the oscillator within range. Potentiometer R7 controls the output level.

Protection devices include the fuse, F1, which will blow if power is applied to the output of the oscillator if it exceeds the fuse current rating.

Also protecting the circuit is the small lightbulb since it acts as a high power resistor and limits current flow.

Another protection is the high resistance of R7. Especially at low level settings, this limits current flow toward Q1. Component tolerances being what they are, a calibrated scope would permit exact frequency measurement.

The oscillator will span the audio frequency range and up into VLF.

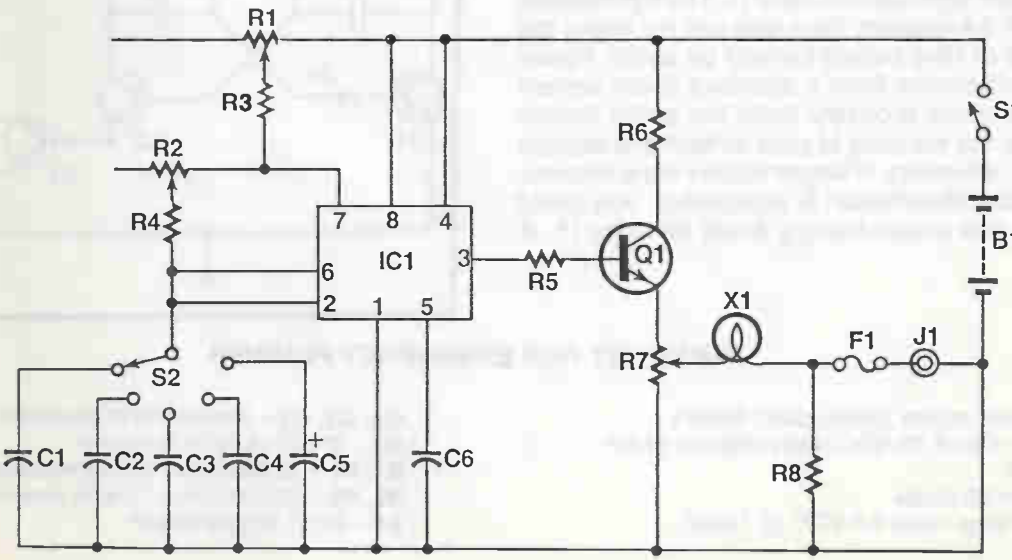
Though not a necessity, a metal case will enhance shielding of the components.

Another recommendation: C1 through C5 are very important, and the closer the tolerance on their capacitance, the more stable the frequency. ■

PARTS LIST FOR PROTECTED OSCILLATOR

R1, 2—dual 50K Potentiometer
R3, 4—1K Ohm, 1/4 watt resistors.
R5, 6—4.7K Ohms, 1/4 watt
R7—100K Linear taper potentiometer
R8—100K Ohms, 1/4 watt resistor
C1—100 PF capacitor
C2—.001 Mfd capacitor
C3—.01 Mfd capacitor
C4—.1 Mfd capacitor
C5—1.0 Mfd capacitor
C6—.1 Mfd capacitor
IC1—1M555V IC
Q1—2N2222 transistor
X1—12 volt lamp, 50 mA
F1—1/8 Amp fuse
J1—Phono jack.
S1—SPST Switch
S2—1-pole, 5-position switch
B1—9 Volt battery

PROTECTED OSCILLATOR



CAR POWER ADAPTER

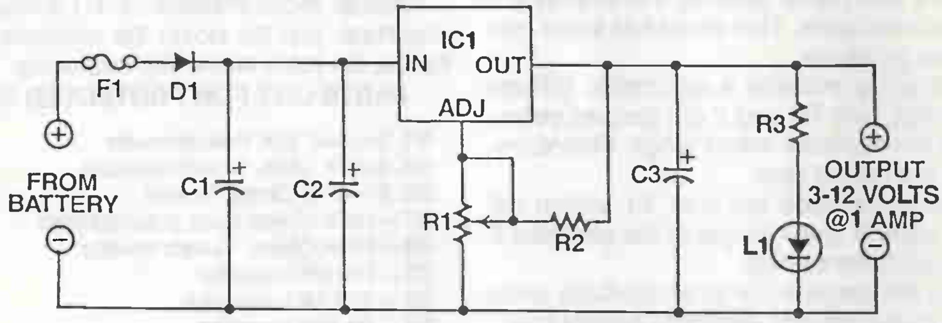
Wouldn't it be nice to have power in your car that would accommodate all of your electronic equipment?

This simple circuit delivers 3 to 12 volts at one amp regulated from a car battery or DC supply, even out of a battery charger. The regulator IC does need a heat sink so it is a good idea to construct this device in a metal box. One of those nice cast aluminum ones would be great, but any metal box would do. You have two options with the voltage control, R1. Have it externally adjustable with a pointer knob on it and marks for various voltages, or hide it and preset it for the voltage you want.

The schematic does not show a power switch, as sometimes an adaptor like this plugs into the cigarette lighter. Should you want to permanently install this adaptor, a power switch should go just before the diode: D1 and after the fuse: F1. ■

PARTS LIST FOR CAR POWER ADAPTER

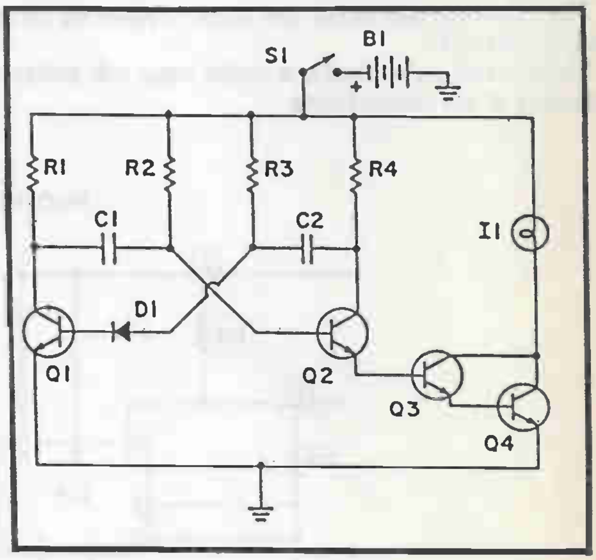
R1—5K linear Taper Potentiometer
R2—270 Ohm ¼ watt resistor
C1—.1 mfd 50 WVDC capacitor
C2, 3—1000 Mfd 35 WVDC capacitors
D1—1N4007 Diode
R3—390 Ohm, ½ watt Resistor
L1—LED
F1—one Amp fuse and holder
IC1—1M317T regulator IC
Also case, connectors



CAR POWER ADAPTER

EMERGENCY FLASHER

For camping or highway emergencies, here is a solid-state light flasher that's compact and reliable. Q1, Q2 and the associated resistors and capacitors comprise a conventional 2-transistor multivibrator. Q2's emitter signal drives the Q3-Q4 Darligton pair, which turns on high-current lamp I1. The light flashes on for about 0.4-second, then darkens for about the same period of time before turning on again. Power for the circuit comes from a standard 6-volt lantern battery. You could probably build the entire flasher circuit inside the housing of your lantern and actuate it only when necessary. If longer battery life is desired, and decreased illumination is acceptable, you could substitute a less power-hungry 6-volt lamp for I1. ■



PARTS LIST FOR EMERGENCY FLASHER

B1—6-volt lantern (heavy-duty) battery
C1, C2—1.0-uF 25-VDC non-polarized mylar capacitor
D1—1N4002 diode
I1—#82 lamp rated 6.5 VDC @ 1-amp
Q1, Q2, Q3—2N3904 NPN transistor
Q4—2N3724A NPN transistor
R1, R4—10,000-ohm, ½-watt resistor, 5%
R2, R3—390,000-ohm, ½-watt resistor, 5%
S1—SPST toggle switch

LED EMERGENCY LIGHTS

By George Williamson

When you think of emergency lighting systems, you usually picture in your mind those large metal boxes with spotlights sticking out like frog eyes.

Perhaps a change is near. LEDs, or Light Emitting Diodes have been drastically improved in the last few years. Some red LEDs are rated at 10 candlepower now, as opposed to a few years ago when the brightest were rated in tenths of a candlepower.

One major advantage of LEDs is power consumption. You can now light 60 high brightness LEDs with one amp of power at 12 volts. Usually, the emergency lights used now drink power like water in the desert. They have to, since there are codes as to how much light emergency lights must produce, in Auditoriums, big stores, and schools, public places where emergency lights are required by law.

PARTS LIST FOR FIGURE 1:

Battery and Charger: Matched to each other. Battery should be 12 volts at 1.0 Ampere-hour or more. See text.
R1—47K Ohms, 1/4 watt resistor
R2, 3, 4, 5—10K Ohms
R6—1K Ohms
C1—10 Mfd, 50 volts capacitor
D1, 2—3 Amp 50 PIV diodes
Q1, 2—2N2222 transistors
SCR1—4 Amp, 200 PIV SCR
S1—Normally closed pushbutton

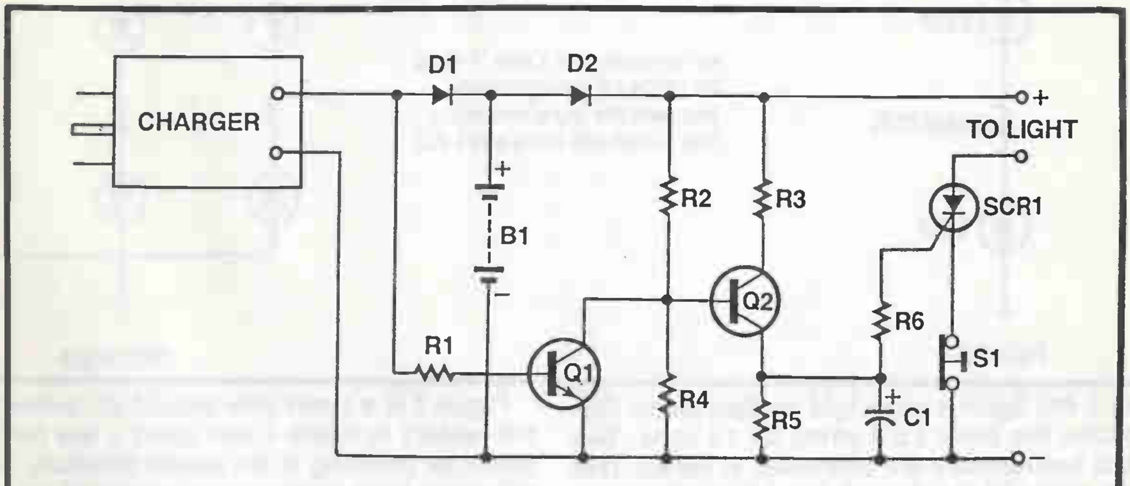


FIGURE 1

None of these laws prevent you from building and using a system in your home, or any place not normally requiring such a system. And, if you use enough LEDs, the light produced might prove surprising.

Let's take a look at the system. There are two parts, the lights and the power supply. First thing to determine is how much light will be needed and where that light needs to be directed. Since the lights will all be red, more light will be required to compensate for the color. Try using red light, you will see what I mean.

PARTS LIST FOR FIGURE 2:

R1—390 Ohm, 1/2 Watt resistor
C1, 2—1000 Mfd, 35 volt capacitors
D1, 2, 3, 4—1N4007 Diodes
L1—LED
IC1—7812 regulator IC
T1—110 Volt to 12.6 Volt at 1.2 Amps transformer
M1—Metal Oxide Varistor, for 110 VAC. 20 Joules
S1—SPST power switch
F1—1/8 Amp fuse in holder

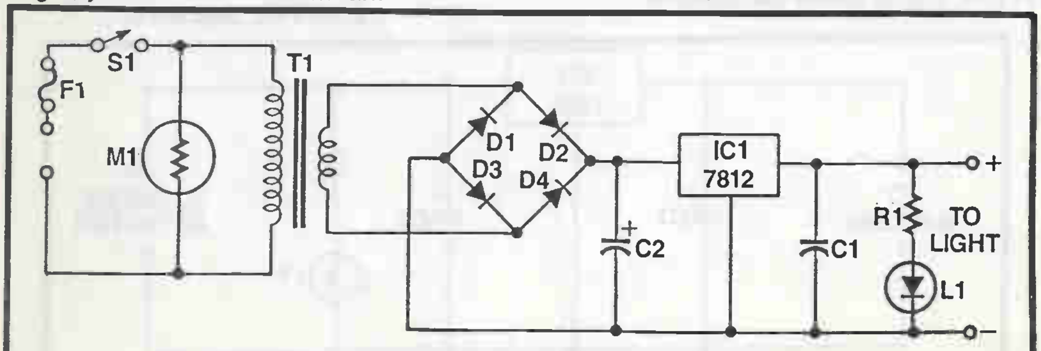


FIGURE 2

When used in an area that is pitch dark, these lights will illuminate it very well. Even where other light may be present, you still can observe a big difference.

Another possible use for these lights is in a darkroom. Since the lights are, individually, not very bright, they may be scattered about the room, to spread the light more evenly than with one red incandescent.

Our first power supply is shown in Figure 1. This is for true emergency systems since it uses a battery and charger. The circuit sits on a standby mode as long as the charger is receiving 110 volt power. The charger keeps trickle charging the batteries.

When an outage occurs, transistor Q1 loses its base bias, so it shuts off. This allows Q2 to turn on, sending power to SCR1, firing the SCR. Twelve volt power is applied to the lights through SCR1.

After power is restored, pushbutton S1 is pushed once to reset the system. If an automatic reset is desired, eliminate S1 and replace SCR1 with a well-heat-sinked 2N3055 transistor. The transistor will only conduct when Q2 supplies base current.

Do not use a car battery in your house if you decide to build this system. Car batteries can produce dangerous fumes and should not be used or stored in a place where people sleep. The best battery for this use is a gel cell. Gel cells with matching chargers are available from places like Newark Electronics, Allied Electronics, and other large parts houses. Radio Shack may be able to order one for you. The second power supply is for non-emergency systems or systems already supplied with emergency power. This supply will drive sixty LEDs.

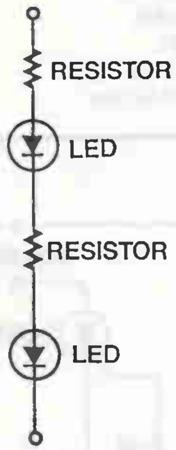


FIGURE 3

PARTS LIST FOR FIGURES 3 AND 4:

All resistors 100 Ohm, 1 Watt
All LEDs High brightness.
You pick the style and color.
The circuit will drive any LED

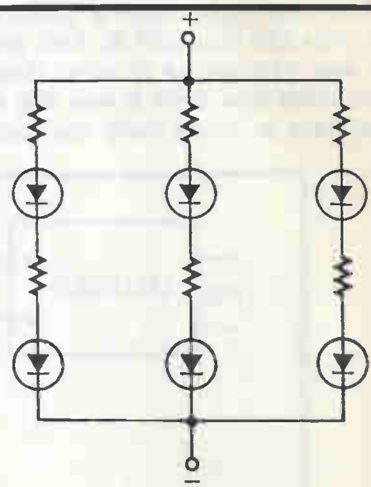


FIGURE 4

Figure 3 and figure 4 show light configurations. Figure 3 shows the basic LED string for 12 volts. Two LEDs and two resistors are connected in series. This feeds the same 33 mA through two LEDs, effectively doubling the light from the same power.

Figure 4 shows a group of 3 strings connected as a larger light. As long as all the strings are made the same, they can be used singly or paralleled in any combination to construct lamps.

Housings are available in auto parts stores, red and clear.

Several suppliers sell low current buzzers that can be added to the system for an audible warning. Make sure that if you use any buzzers, you allow for current to power them in your supply power calculations.

Figure 5 is a clever little circuit that connects across the battery in figure 1 and takes a few milliamps of power for powering 9 volt smoke detectors. Since this will power them continuously, you would not need batteries. Save the rechargeable one in the main power supply. Make sure that the current drain for the smoke detectors is less than half the trickle charge current.

Perhaps you can think of other uses for these circuits that we did not think of. How about powering a string of red, green, yellow and orange LEDs for a party or Christmas decorations? ■

PARTS LIST FOR FIGURE 5:

R1—390 Ohm, 1/2 Watt resistor
C1, 2—1000 Mfd, 35 volt capacitors
L1—LED
IC1—7809 regulator IC

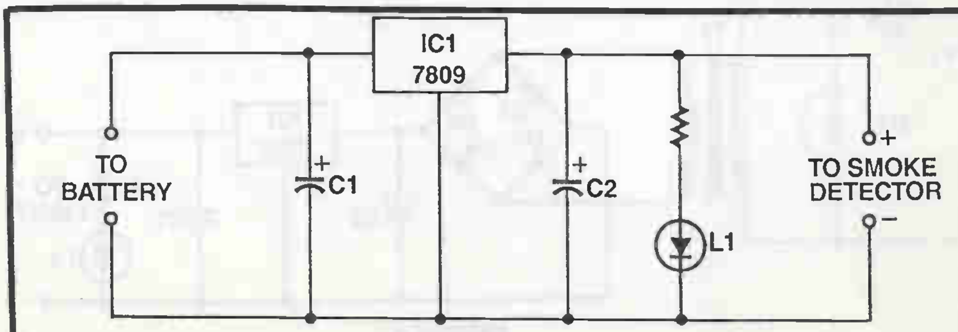
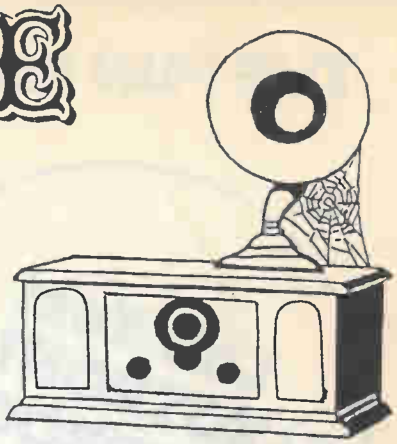


FIGURE 5

ANTIQUE RADIO



HOW TO BUILD AND USE A HIGH PERFORMANCE CRYSTAL SET

By Lance Borden WB5REX

Crystal detectors were introduced around the turn-of-the century for use on wireless receivers. They were a great improvement over the coherers and electrolytic detectors in use at that time. When radio broadcasting became available to the public in the early 1920's, many people built or bought crystal receivers because of their simplicity and low cost.

A favorite pass-time in those early days was to spend an evening trying to "pull-in" distant stations. It was common to hear an excited listener call out to the household, "Hey! Come listen! I've got Pittsburgh," (or Cincinnati, or wherever). Listeners often logged their "catches" and sent reception reports to those far-off stations. In return, the stations would send the "Dx'er," (DX is radio shorthand for distance), a reception confirmation or "QSL" card. The hobbyist would then proudly display those "Trophies" on the wall of his listening room to show off his DX-ing expertise.

Many different crystal set circuits evolved during those early days of wireless and broadcasting as experimenters were trying to devise ways to improve the performance of their sets. Their primary goals were to get more volume from weak signals and to improve selectivity. Various different tuning schemes, antenna tuners, interference traps, and detector minerals were tried in the hope of squeezing just a little more out of their sets.

As radio broadcasting expanded and vacuum tube radios improved and became cheaper, the venerable crystal set still remained popular with many people, because of the "mystique" of receiving radio signals with nothing more than some wire, a chunk of galena or other mineral, and a pair of "phones." These little sets didn't require batteries or A.C. power either, since they were powered by the signal "captured" by the antenna wire alone.

Crystal set experimenting, building, and listening became an established hobby in its own right. Comparing crystal set DX-ing with powered set DX-ing is like comparing sailing to power boating. The former is more challenging than the latter, requiring more skill and finesse to achieve the same goal. The reward is in the feeling of accomplishment attained by doing it.

Crystal sets continued to be designed and built throughout the following decades with numerous books and magazine articles being written on the subject. Many suppliers sold books, plans, kits, crystals, and other related items through stores and mail-order. Many radio hobbyists got their start with one of those sets. Today most of the earlier suppliers are gone, but there are still people selling crystals sets, parts, and information. You might be surprised to know that Radio Shack supplied crystal sets and parts for many years and still carries a crystal set kit and some related parts. (See Volume #8 Electronics Handbook)

One of the most popular serious crystal set circuits to come out of the early days was the double-tuned, tapped-coil unit. One variation was marketed as a kit by Modern Radio Laboratories (1) in California from 1932 until the owner died in 1987. MRL was purchased recently from the original owner's estate and is again selling parts, kits, and plans. Refer to the source list at the end of this article for their address. There is also a version of this set in K.E. Edward's book, RADIOS THAT WORK FOR FREE (2). This set offers good sensitivity, selectivity, and multiple band operation, all in one relatively simple design.

The following is a description of how to build and operate a variation of this circuit using readily-available parts and simple construction techniques. With a good antenna system, some practice, and a little patience, this set can receive distant stations on the A.M. band and real DX can be heard from all over the world on the shortwave bands.

Construction

Begin 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. Spray the coil form with one coat of clear acrylic and let it dry. Spray the board with three coats, letting it dry between coats. (Shellac can be used instead of acrylic, if you prefer.)

Step 2. (Refer to Fig. 1). Punch two small holes in the coil form 1/4 inch apart and 1/2 inch from the end. Pass 6 inches of the 22 AWG coil wire through one hole from the outside and back through the other. Repeat this process once more and pinch the resulting loops with pliers to secure the coil lead.

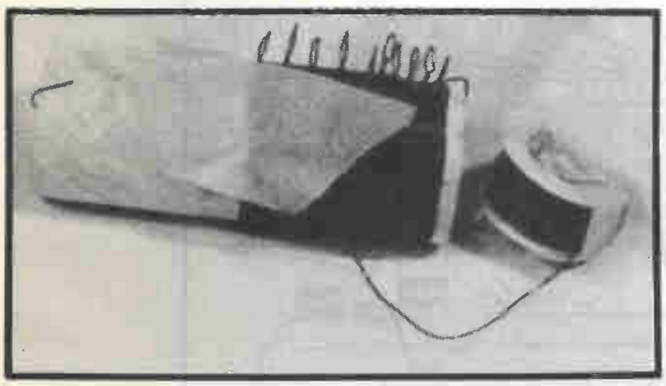


Photo #1. Winding the coil using tape to hold wire while twisting taps.

HIGH PERFORMANCE CRYSTAL SET

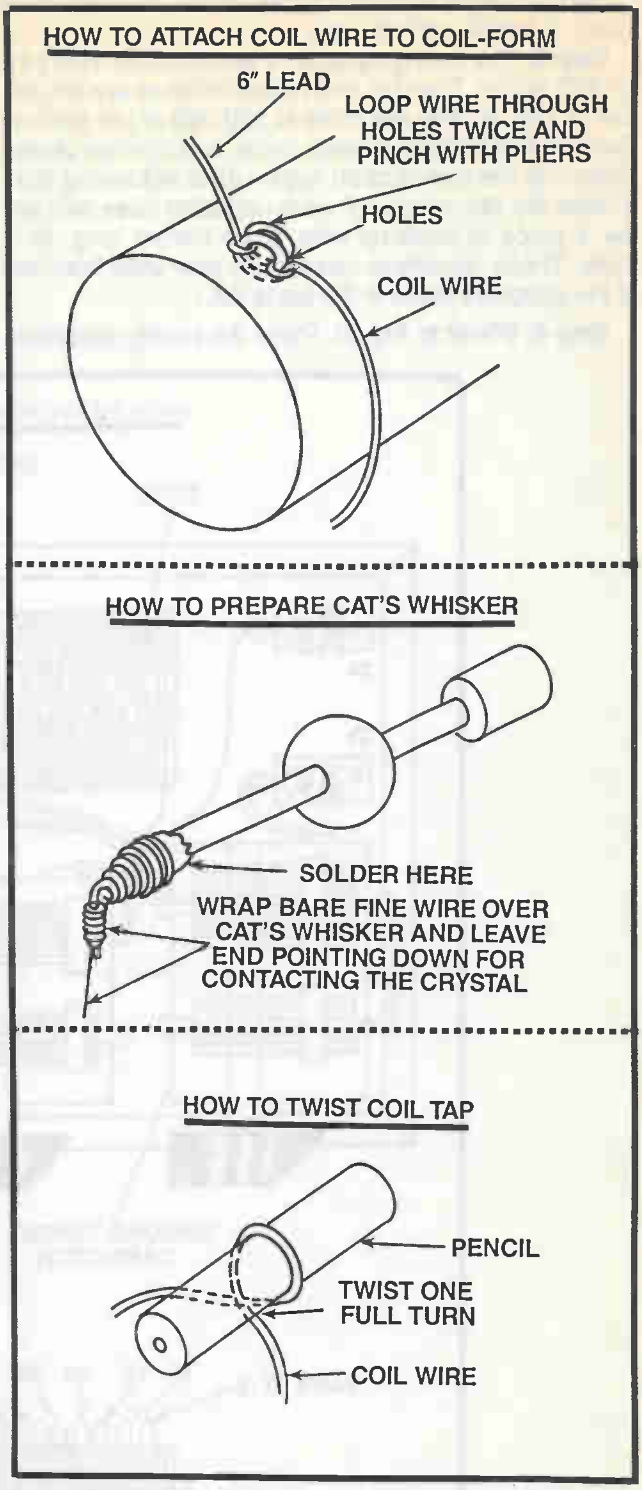


FIGURE #1 DETAILED DRAWINGS

Step 3. (Refer to Fig. 1 and Photo 1). Wind five turns, close but not over lapping, and make a tap by looping the coil wire around a pencil or other round object. Twist the loop once to secure it and wind five more turns and make another tap. Repeat this process and make additional taps on the following turns: 15, 20, 25, 30, 40, 50, 60, 70, 80, and 90. Punch two holes as in step two and secure the end of the coil wire after the 90th turn.

No lead is needed at this end of the coil.

Step 4. (Refer to Photo 1). Spray the coil with three coats of acrylic and let it dry.

Step 5. The tuning capacitors are old units from junk AC/DC radios. The size and values of these are not critical as long as they are close to 320-365 pf per section. Remove the trimmer screws, mica, and trimmer plates. Clean up the connection lugs with a soldering iron. Scrape the rear corner of each capacitor case and solder a piece of hook-up wire, three inches long, to it. (note: These capacitors can also be new units from one of the suppliers listed in the parts list.)

Step 6. (Refer to Fig. 2). Place the tuning capacitors, coil, Fahnestock clips, and detector on the board as shown and outline their locations with a scribe or felt pen.

Step 7. (Refer to Photo 3). Use superglue to attach the two 3″ x 1/4″ wood strips, one inch apart, to the board for the coil mount, (I used balsawood). Glue the coil to the strips with superglue, with the taps pointed up and the lead to the left.

Step 8. (Refer to Photo 4). Cut strips of double-sided foam mounting tape for holding the capacitors and press onto the board. Place the capacitors on the tape and press hard being careful not to bend the capacitor plates. Install the knobs on both capacitors.

Step 9. (Refer to Fig. 1 and 2).

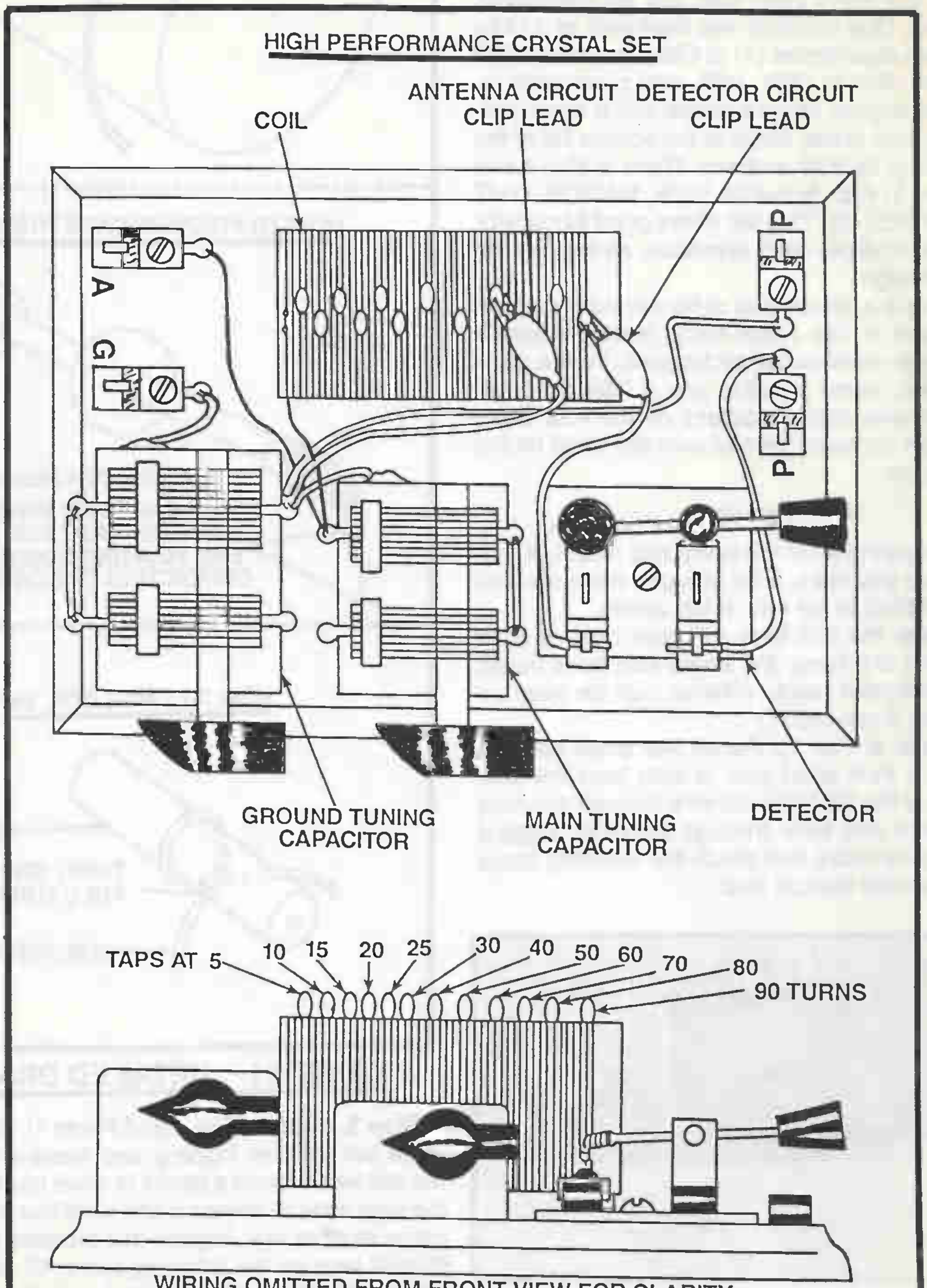


FIGURE #2 PICTORIAL DIAGRAM

Photo #2. Finished coil before spraying with clear acrylic and trimming coil form.

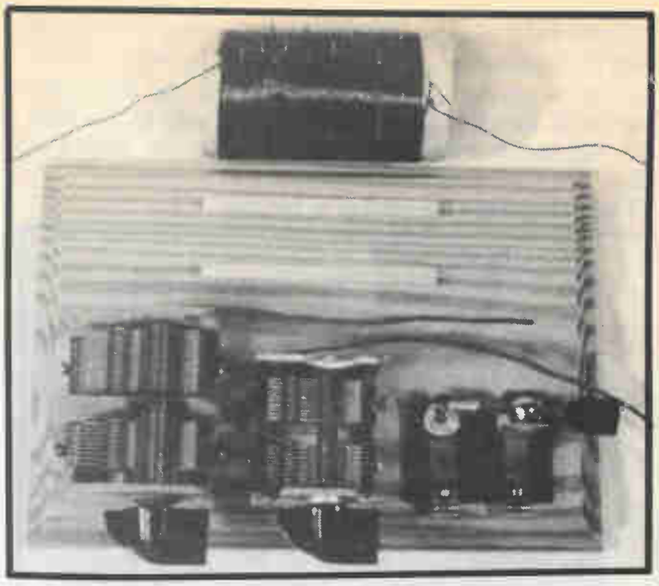


Photo #3. Location of coil mounting strips.

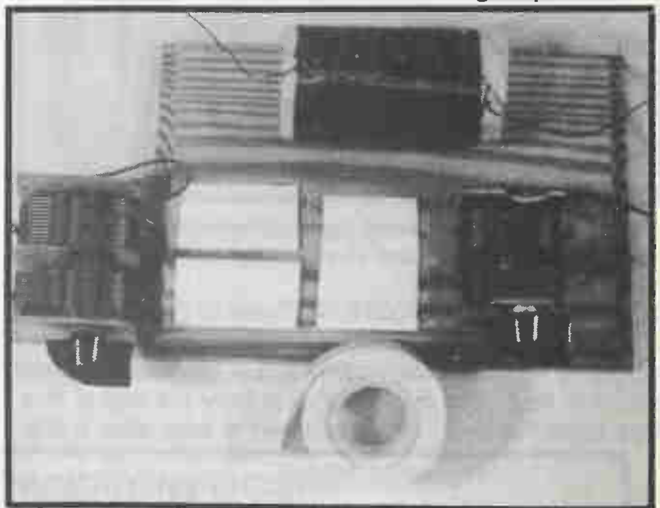


Photo #4. Installing double-sided foam mounting tape prior to securing tuning capacitors.

Detector

You can use the mounted galena detector, as shown, or you can mount two Fahnestock clips and install a 1N34 diode. The galena detector is a little more sensitive and selective, especially on shortwave, but is difficult to adjust. A 1N34 diode can be installed in the mounted detector clips also, as an alternative detector when not using the galena. This is recommended for testing the set because the diode will always work.

If you choose to use the galena detector, drill a small pilot hole to prevent the wood from splitting and mount with a wood screw. The cat's whisker should be soldered to the arm to make a good connection and a short piece of bare, fine wire should be wrapped around the original cat's whisker to contact the crystal. This will help with adjustment of the detector because galena requires a light touch for maximum sensitivity.

Step 10. (Refer to Fig. 2). Drill small pilot holes and mount the Fahnestock clips for the antenna, ground, and phones with wood screws.

Step 11. (Refer to Figs. 2 & 3, Photo 5).

Wiring

Connect the coil antenna lead to the stator of the main tuning capacitor and then to the antenna clip. Be sure to scrape the enamel off this wire where solder connections are made. Connect the stator sections of the main tuning capacitor together with a short piece of hook-up wire, then repeat the same on the ground tuning capacitor.

The alligator clips used by the author were prefabricated test leads bought from Radio Shack with one clip removed. The builder can go with this option or fabricate his own. Make these leads as short as possible while still being able to reach all the coil taps with both leads.

Connect the antenna circuit clip lead, rear phones clip, and rotor, (case), of the main tuning capacitor to the rear stator lug of the ground tuning capacitor.

Connect the rotor, (case), of the ground tuning capacitor to the ground clip. Connect the detector circuit clip lead to the crystal side of the detector. Connect the front phones clip to the other side of the detector.

(NOTE: Polarity of the detector usually doesn't make much difference. You can try either direction to see if you think it may work better one way or the other.)

Bend the coil taps alternately to the rear and to the front to facilitate connection with the clip leads. Then, scrape the enamel off of the taps where the clip leads grip them. Clip the antenna circuit clip lead to the 70th turn tap and the detector circuit lead to the 90th turn tap.

This completes the wiring of the set.

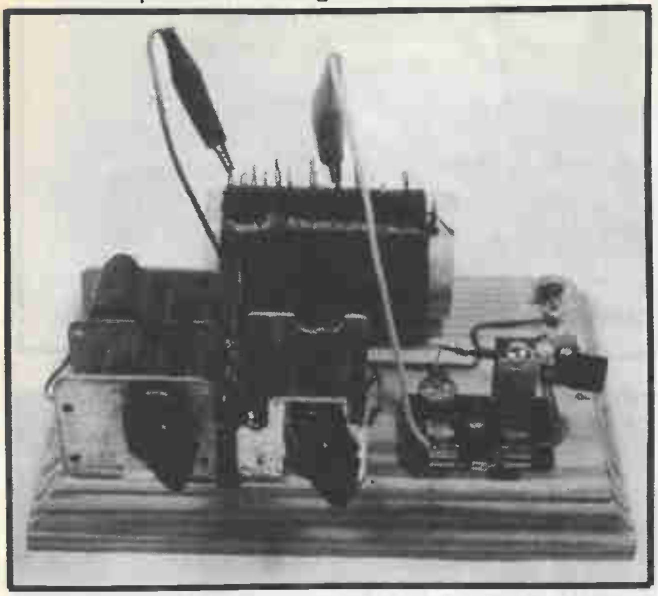


Photo #5. The completed high performance crystal set 1N34A diode installed in detector clips for testing operation.

ANTENNAS and GROUNDS: (Refer to Photo 6)

A good antenna and ground system is of utmost importance for satisfactory operation of a crystal set. Remember that your audio signal is only the signal that has been "caught" by your antenna wire after it has

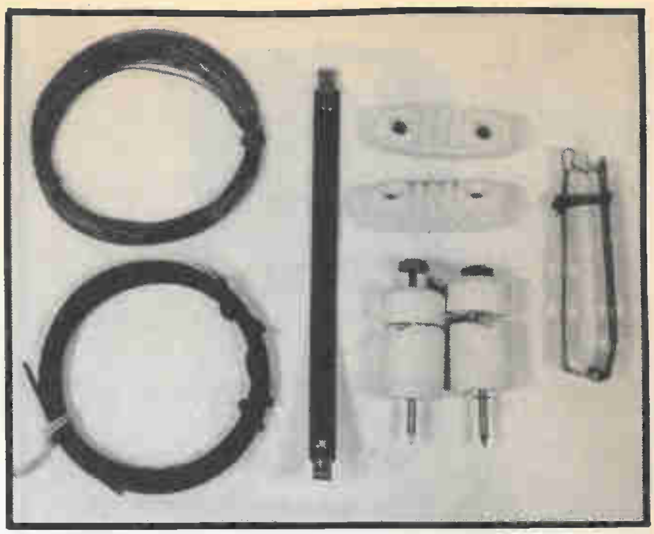


Photo #6. A typical fifty-foot outdoor antenna kit.

been tuned and detected. A short, low antenna will not give satisfactory results.

The traditional rule-of-thumb on antennas is to "make them as long and as high as possible." Most of us have to compromise some on this rule, but follow it as much as you can. Most any kind of wire will wok, or you may want to use one of the antenna kits referenced at the end of this article.

The grounding system is also very important, especially on the lower frequencies. Cold water pipes used to be employed for this purpose, but now most houses are plumbed with PVC pipe and this simply won't work as a ground because it is an insulator. The best ground to use is one of the ground stakes sold by Radio Shack or hardware stores.

HIGH PERFORMANCE CRYSTAL SET

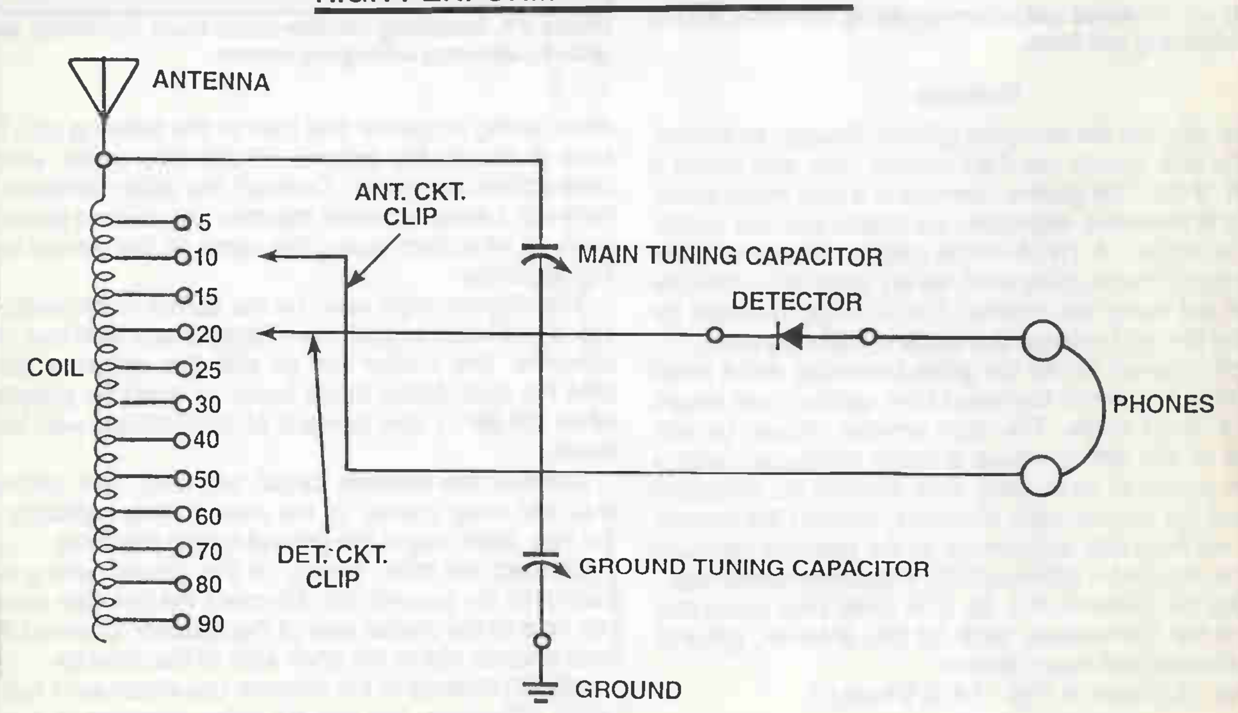


FIGURE #3 SCHEMATIC DIAGRAM

CAUTION!

Always disconnect your antenna when not in use and connect it to the ground. This will keep your antenna from building up a charge and will also provide a path for lightning in case you are unlucky enough to have your antenna "zapped" during a thunderstorm. Common sense tells us not to listen to crystal sets during stormy weather!

Headphones

The best headphones for crystal sets are the old high impedance magnetic phones that were used in the early days of radio and wireless. A minimum DC resistance of 2000 ohms is required and some of the old sets go to 4000 ohms and higher. The higher the DC resistance, the better because they won't load down the crystal set as much as lower resistance units.

The next best choice is the Japanese piezo electric crystal earplugs sold by Antique Electronic Supply. These use Rochelle salt crystals and have a DC resistance near infinity. They are not as loud as the magnetic phones, but make up for this because they plug directly into the ear. Two of these earplugs can be used, connected in parallel.

The last choice is the newly manufactured cheap magnetic head sets. They do have a DC resistance of around 2000 ohms and will work satisfactorily, but are usually not as sensitive as the older units.

Don't try to use stereo earphones, they have a very low DC resistance and won't work at all.

Operation

Connect the antenna, ground, and phones to the appropriate Fahnestock clips. It is recommended to clip a 1N34 diode into the detector for testing purposes until you get the "feel" of adjusting the galena detector. Be sure the cat's whisker is not contacting anything when using the diode.

With the antenna circuit clip lead on the coil tap at 70 turns and the detector circuit clip on the 90 turn tap, slowly adjust both tuning capacitors together through their ranges. You should hear several A.M. stations "booming" in. The two tuning capacitors usually work well when tuned simultaneously to the same positions. You can experiment with different settings to your satisfaction.

The entire A.M. broadcast band can be received by moving the antenna circuit coil clip to various taps down to about the 30 turn tap. The detector circuit clip can be tried on any tap higher or lower than the antenna circuit tap for best volume and selectivity.

Shortwave stations in the 41 and 49 meter band and occasionally lower frequencies can be received at night on the taps at 5, 10, 15 and 20 turns. These signals will often alternately "fade" and "boom in" as the ionospheric charges build and fall. It is normal to hear more than one station at a time, but you can usually tune the weaker ones out.

The shortwave signals must "bounce" off the ionosphere, sometimes in several "hops" to the earth and back, to get to you from other parts of the planet. This ionospheric charging is dependent on the sun's activity, time of day, season of the year, and period within the eleven-year sunspot cycle. Some nights you may not receive anything and other nights you will hear stations all over the globe.

A.M. broadcast DX is also possible with the same general rules as shortwave. The main difficulty here is to pull in the weak ones while being bombarded by strong local stations. K.E. Edward's book, RADIOS THAT WORK FOR FREE, (2) tells how to build an interference trap to help with this problem.

Best results with this little set will be obtained with practice, patience, and familiarity with tuning the capacitors, selecting taps, and adjusting the crystal. From our location we have heard eleven local stations on A.M. and shortwave stations in Europe, Australia, Africa, and the Far East, as well as several across the USA.

HOW IT WORKS (Refer to Fig. 3)

The main tuning capacitor, antenna circuit clip lead, and coil form a tuned circuit that will tune and pass a narrow band of frequencies from the antenna to the detector circuit. The detector circuit sensitivity and selectivity is optimized by selecting the best tap with the detector circuit clip lead. The detector rectifies the radio frequency signal and extracts the audio from it in order to drive the headphones. The ground tuning capacitor matches the antenna and ground circuit input to the tuned circuit made up by the main tuning capacitor and coil.

How To Adjust The Galena Detector

If you don't have much experience with open crystal detectors, use the 1N34 diode at first and tune in to a strong local station. Then disconnect the diode and lightly touch the cat's whisker to the galena crystal. You will find that the crystal has "hot" spots and "dead" spots. Find the loudest "hot" spot on your crystal and carefully adjust the cat's whisker pressure for optimum results.

You are now ready to try weaker stations. Once you have tuned to a weaker station, you will need to re-adjust the cat's whisker for the loudest output. After you practice this technique until you are comfortable with it, the diode can be removed. The galena usually is slightly more sensitive and selective on weaker signals.

HAPPY DX-ing. ■

Reprinted from "Grid Leak" publication, courtesy of the Houston Vintage Radio Association.

REFERENCES

1. Modern Radio Laboratories, Garden Grove, CA, Elmer G. Osterhoudt, #2 crystal set circuit. Now available from Modern Radio Laboratories. P.O. Box #14902 Minneapolis, MN 55414.

2. RADIOS THAT WORK FOR FREE, K.E. Edwards, Hope and Allen Publishing, P.O. Box 926, Grants Pass, OR 97526 $7.95.

HOW TO BUILD AND USE A HIGH PERFORMANCE CRYSTAL SET

SOURCES OF MATERIALS

SOURCE	ITEMS
Radio Shack	Magnet wire, 1N34 Diode, Clip leads, Antenna kits, Ground rods, Knobs
Antique Electronic Supply 6221 S. Maple Avenue Tempe, Arizona 85238 (602) 820-5411 Free Catalog Available	Detectors, 1N34, Diodes, Clip leads, Magnet wire, Variable capacitors, Knobs, Antenna kits, Head sets, Piezo earplugs, Fahnestock clips, Crystal sets
Local Hardware Store	Double-sided mounting tape, Routed boards, Clear acrylic spray, Screws, Wire, Ground rods
Midco 660 North Dixie Highway Hollywood, Florida 33020	Crystal sets, Parts, Plans, Books
Antique Audio 5555 North Lamar Blvd. Suite #H-105 Austin, Texas 78751	Crystal sets, plans and Materials

ANTIQUE RADIOS WHERE YOU CAN GET HELP

The following companies and people will answer your questions and assist you if they can, if you send a large SASE (self-addressed stamped envelope) telling them what parts, schematics or other help you need, related to Antique Radios.

CIRCUIT DIAGRAMS AND/OR LITERATURE

Antique Radio Press, Box #42, Rossville, IN 46065
Byron Ladue, 13 Revere Drive, Rochester, NY 14624
Comtech Electronics, Box #686, Wyandotte, MI 48912
Historical Radio Services, Box #15370, Long Beach, CA
E. G. Roundtree, Box #269, Norris City, IL 62869
Vestal Press, 320 North Jensen Street, Vestal, NY 13850
Vintage Radio Books, Box #2045, Palos Verdes, CA 90274

TUBES AND OTHER PARTS

Antique Radio Parts, Box #42, Rossville, IN 46065
Antique Radio Tube Company, 1725 University Street, Tempe, AZ 85281
Barry Electronics, 512 Broadway, New York, NY 10013
Maurer Television, 29 South Fourth St., Lebanon, PA 17042
Steinmetz Electronics, 7519 Maplewood Avenue, Hammond, IN 46324
John Grey, 3348 Wildridge Road NE, Grand Rapids, MI 49505
George Haymans, Box #468, Gainesville, GA 30501
Historical Radio Services, Box #15370, Long Beach, CA 90815
Unity Electronics, Box #213, Elizabeth, NJ 07026
Puette Electronics, 3008 Abston Drive, Mesquite, Texas 75149

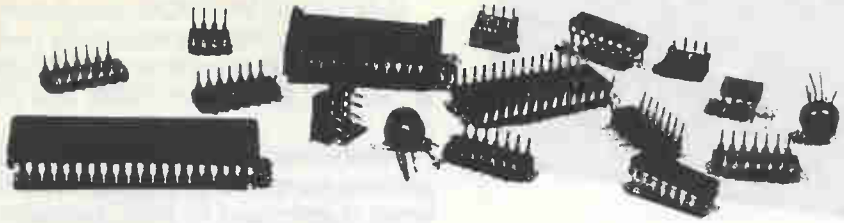
SPEAKERS AND/OR TRANSFORMERS

Amprite Speaker Repairs, 655 Sixth Ave., New York, NY 10011
Antique Radio Restorers, Box #42, Rossville, IN 46065
Lloyd V. Williams, Route #5, Frankfort, IN 46061

MISCELLANEOUS

Midco, 660 North Dixie Highway, Hollywood, FL 33020
Antique Audio, 5555 N. Lamar Blvd., Suite #H-105, Austin, Texas 78751
Grove Enterprises, Inc., P.O. Box #98, Brasstown, NC 28902
Antique Electronic Supply, 6221 S. Maple Avenue, Tempe, AZ 85238 (Free catalog available)

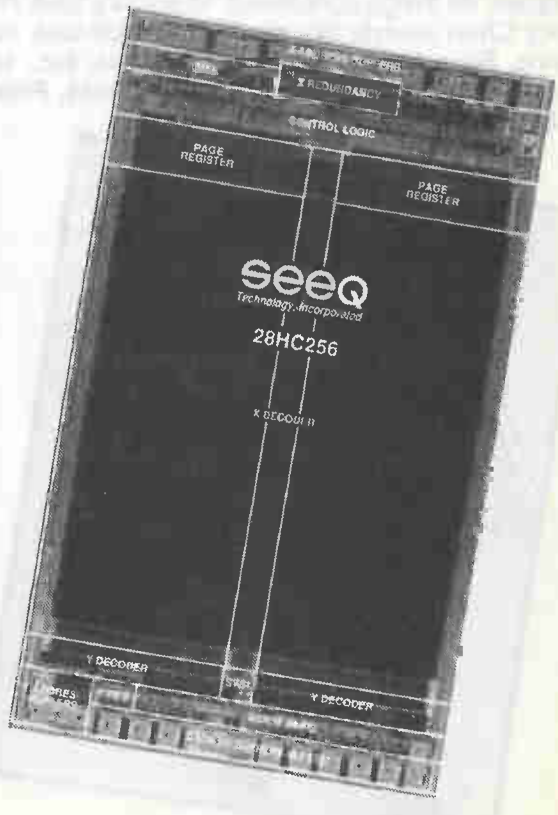
SOLID STATE UPDATE

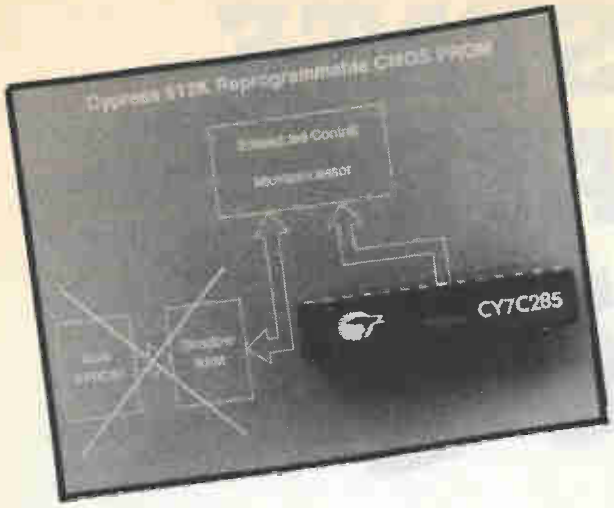


Each month, the manufacturers of solid state components release literally hundreds of new devices. While we cannot report on all of these, we do intend to feature some of the devices that are most likely to interest our readers. For further information on any of these solid-state components, write directly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

HIGH-SPEED EEPROM

An EEPROM, or electrically programmable read-only memory, combines the best characteristics of conventional RAM and ROM memory chips. Like ROM, an EEPROM memory retains data when power is turned off. Like RAM, an EEPROM can be updated, i.e., old data can be replaced by new. There are some drawbacks to the use of EEPROMS, however. One is that EEPROMS are quite expensive; another is that they are considerably slower to access than conventional RAM or ROM. Thus the EEPROM is not a general purpose replacement for ROM and RAM. Rather, it is best employed in digital systems that had heretofore used battery backed-up RAM as a means of retaining data when the power was off. SEEQ Technology's 28HC256 256K-bit, 70-ns EEPROM shines in such applications. The high-speed 28HC256 achieves on-chip error-code correction with 4 parity bits per byte using a modified Hamming code to ensure reliability. Contact **SEEQ Technology Inc., 1849 Fortune Dr., San Jose, CA, 95131.**





MOTOROLA'S USA FREQUENCY CHART

Motorola Semiconductor's RF Products Division and Linear Circuits Division have published a new frequency allocation chart covering the spectrum of RF applications. Motorola's colorful USA Frequency Chart has been extensively revised, as well as changed in shape to make it more suitable for wall mounting.

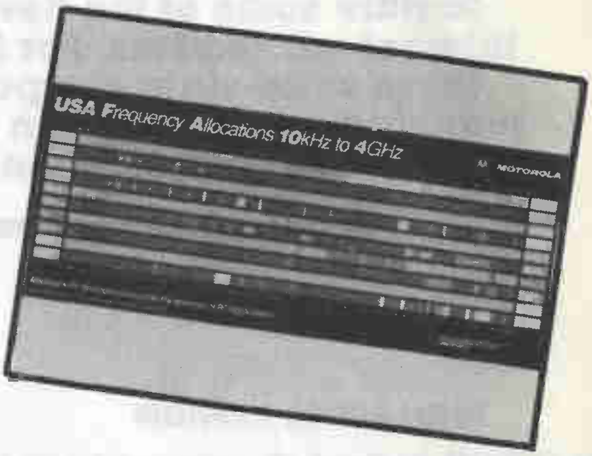
A significant change in the chart has been the addition of the allocation segment called "Part 15," which consists of frequency regions in which operation is permitted without FCC license provided certain radiation conditions are satisfied. Also, frequency coverage has been extended to 4 GHz, and names have been added to popular frequency band such as AM and FM Radio Broadcast. All things considered, Motorola's USA Frequency Chart sounds like the perfect high-tech wall covering. For a free copy, contact **Motorola, Inc., Literature Distribution Center, P.O. Box 20924, Phoenix, AZ, 85063. Telephone (602) 994-6561.**

CMOS PROMS FROM CYPRESS

Cypress Semiconductor's new 512K family of CMOS reprogrammable PROMS features a 20-ns on-page access time that is three times faster than competitive devices. Embedded-systems designers no longer have to provide fast "shadow" RAM for instructions, reducing system costs and saving board space. Even processors running in pipeline mode at clock rates of 40 MHz can fetch instructions direct from PROM.

Cypress's 512K CMOS reprogrammable PROM family also offers UV-light erasability and low power. Maximum operating current for the CY7C285 and CY7C289 is 180 mA; for the CY7C286 and CY7C287 it is 150 mA.

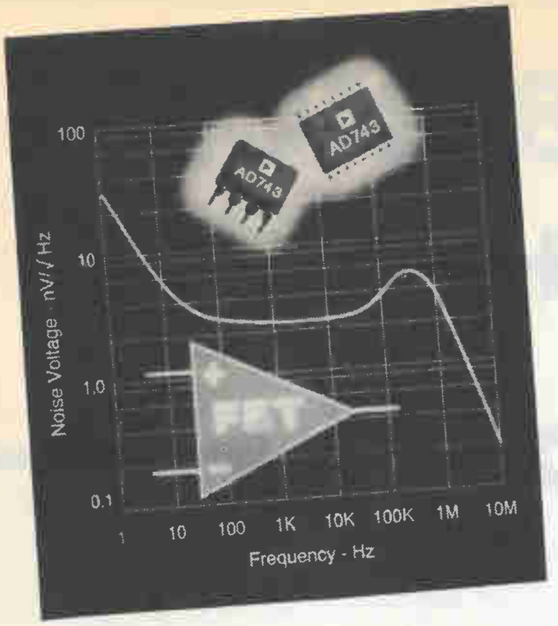
Family members include the CY7C285, which is for general-purpose applications, and the CY7C289, which is optimized for RISC processors that do not assert addresses for a full clock cycle. It allows designers to select registered (the default) or latched inputs. **Cypress Semiconductor, 3901 N. First St., San Jose, CA, 95134-1599.**



BURR-BROWN DC-DC CONVERTER

The Burr-Brown PWR13XX family of DC-to-DC converters is intended for applications requiring extremely high isolation voltages, including medical-grade applications. It offers 4000V of isolation, and is in compliance with IEC601-1 and UL544 standards with an isolation barrier that is 100% tested. The 1.5 watts of unregulated output power that these DC-DC converters provide can be used in applications such as patient monitoring where high isolation is critical. This product is well-suited to high-density PC boards where unregulated power must meet safety standards.

The PWR13XX is a completely self-contained converter and does not require external components to make it perform to specification. Its dual-in-line package uses only 1 square inch of PCB area and features built-in standoffs. There are 18 models in the series to choose from. **Burr-Brown Corp., P.O. Box 11400, Tucson, AZ, 85734.**



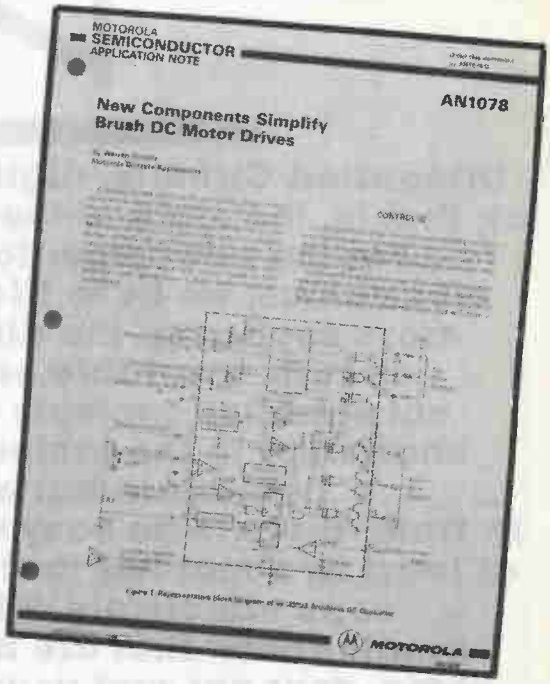
ANALOG DEVICES AD743 OP AMP

Analog Devices' AD743 monolithic FET-input operational amplifier combines the voltage-noise specifications of a premium, bipolar-input amplifier with the very low current noise inherent in a FET-input device. The unrivaled combination of excellent noise specifications, coupled with ultra-low harmonic distortion, makes the AD743 well-suited as a preamp or voltage-to-current converter in systems with high source impedances. Applications include sonar arrays, hydrophones, oximeters, and infrared spectrometers.

In addition to low noise performance, the AD743 features outstanding AC and DC specifications. For more information, contact **Analog Devices, One Technology Way, Norwood, MA, 02060-9106.**

MOTOR DRIVE APPLICATION NOTE

Motorola has published a new application note (AN1078/D) titled "New Components Simplify Brush DC Motor Drives" which discusses a variety of new components that are making brush-motor-drive design easier. One of these components is a brushless motor control IC that is easily set up to drive brush motors. In addition, multiple power MOSFETs. a new MOS turn-off device, and gain-stable optoelectronic level shifters further simplify high-performance DC motor drives. The circuits described illustrate how these components can be combined to make practical drive circuits. Schemes that control speed in both directions and operate from a single power supply are considered. A free copy of AN1078/D, "New Components Simplify Brush DC Motor Drives," can be obtained from **Motorola Literature Distribution, P.O. Box 20912, Phoenix, AZ, 85036.**


MOTOROLA
SEMICONDUCTOR
APPLICATION NOTE

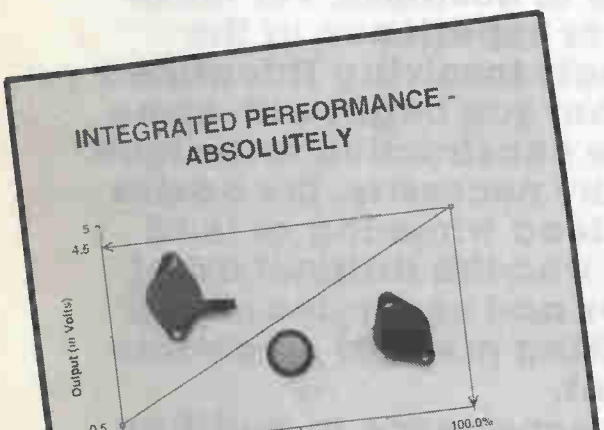
AN1078

New Components Simplify Brush DC Motor Drives

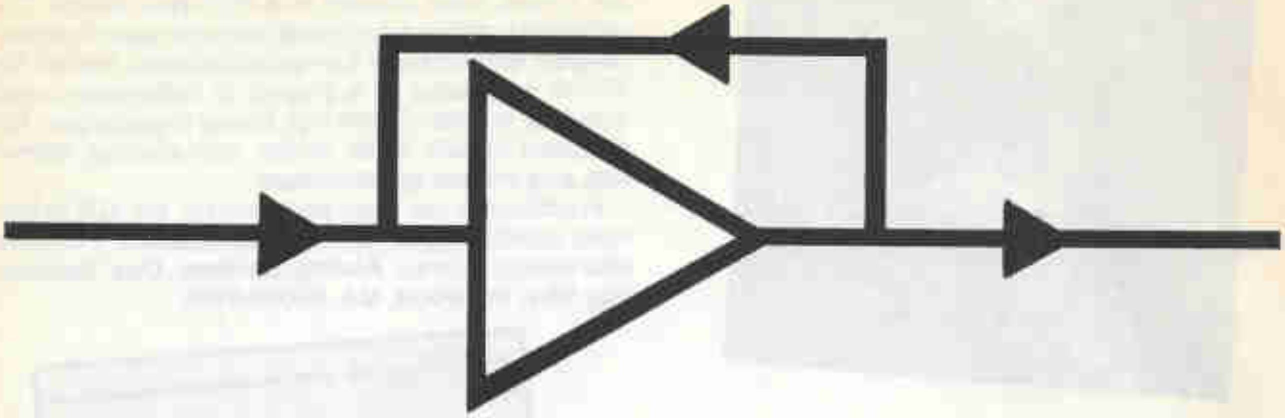
MOTOROLA

MOTOROLA PRESSURE SENSORS

Motorola has introduced the industry's first fully signal-conditioned and microprocessor-compatible absolute pressure sensor. The MPX5100A is a 0-15 psi, fully signal-conditioned-output pressure sensor which combines the sensing element, offset calibration, temperature-compensation circuitry, signal amplification, and an absolute pressure reference, all on a monolithic silicon chip. This new pressure sensor can be directly interfaced to microprocessor-based systems having A-D inputs, since the sensor output is calibrated from 0.5V to 4.5V. The device uses a patented silicon shear-stress strain gauge which is extremely linear over the range of 0 to 15 psi absolute pressure. Typical applications in consumer and industrial markets are barometric-pressure indicators for weather stations, altimeters in hang gliders, and depth gauges for SCUBA divers. **Motorola Semiconductor Products, P.O. Box 52073, Phoenix, AZ 85072-2073.**



IC TESTBENCH



Integrated Circuits, digital and linear, are where it is at; that is, the state-of-the-art in electronics technology. For the newcomer to this fascinating area of electronics, we have tried to select a representative cross-section of the digital and linear integrated circuits available on the market, and design construction projects around them that will be a challenge to the project builder, and will not only entertain but will educate as well.

In truth, there is no easy way to learn electronic theory, at least in a manner that will prepare the individual to cope effectively with the influx of technical applications that are now becoming a part of your home, your car and your place of business. For those readers with little or no prior experience in the construction of electronic projects involving Integrated Circuits, we strongly suggest that you begin with some of the Transistor projects, where construction technique is less critical. You will learn, by necessity, the basics of component arrangement, lead trimming or lead dress as it is properly called, and the difficult art of translating those funny lines and squiggles on a schematic diagram into a working piece of electronic equipment.

For those of you who have had experience in building electronic projects, the word is CAUTION. Integrated Circuits are extremely sensitive devices and require very special handling.

SWL'S SUPER CALIBRATOR

Providing WWV referenced outputs at 1MHz, 100 kHz and 10 kHz, this super calibrator looks quite difficult to assemble, but if you lay it out for a printed circuit board you'll find it's one of the easiest projects to build and get working.

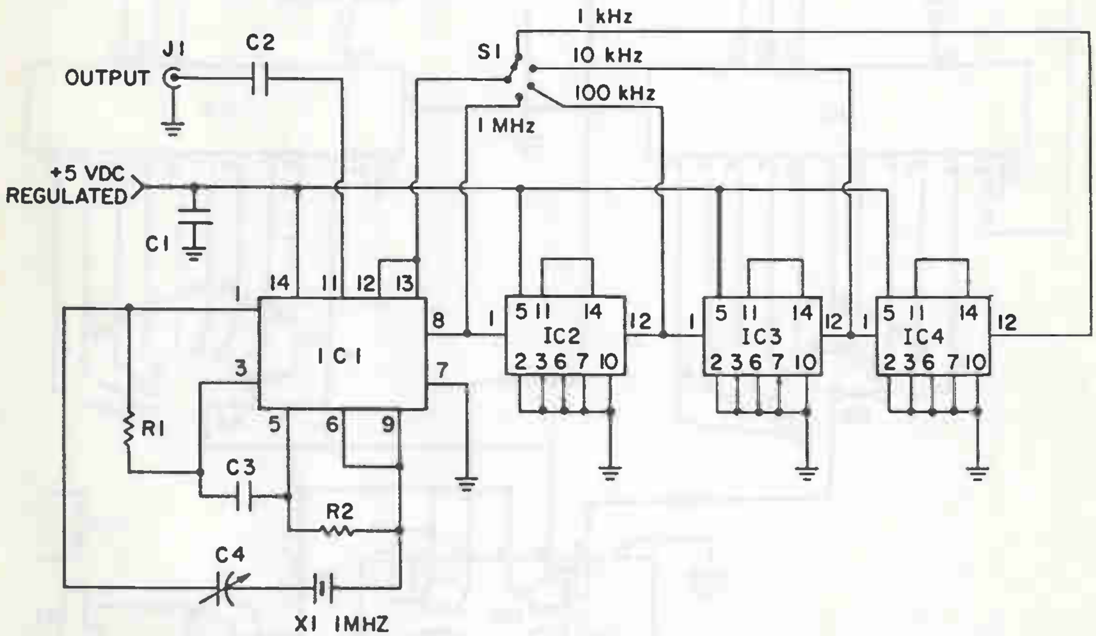
IC1 serves as both the oscillator and buffer amplifier. Another buffer amplifier is used for the output amplifier (terminals 11, 12 and 13), IC1's output at pin 8 is a buffered 1 MHz, ICs, 2, 3 and 4 are *divide by 10 frequency dividers* providing outputs of 100 kHz, 10 kHz and 1 kHz. Since all outputs are square waveform, all output signals are rich in harmonics and so can be used to calibrate receiver dials to well above 60 MHz for the 1 MHz output and to at least 30 MHz for the 100 KHz and 10 kHz outputs. The 1 kHz harmonics can range up to 30 MHz depending on your receiver's sensitivity. The calibrator's output at jack J1 can be connected directly to the receiver's antenna input terminals without affecting the calibrator's output frequency.

The unit is set to zero-beat with WWV with trimmer capacitor C4. It can be assembled in any type of cabinet, but a PC board is specifically recommended for circuit stability.

Power must come from a 5-volt regulated source and we recommend the LM340 5-volt three-terminal regulator for this project. Make certain capacitor C1 is installed as close as possible to IC1 pin 14. ■

PARTS LIST FOR SWL'S SUPER CALIBRATOR

R1, R2—220-ohms, ½-watt, 10%, resistor
C1, C2, C3—0.01-uF, 10-VDC or higher, capacitor
C4—5-50-pF trimmer capacitor
X1—1-MHz crystal, Calectro J4-1900 or equiv.
IC1—Integrated circuit type SN7400
IC2, IC3, IC4—Integrated circuit type SN7490
S1—SP4T switch
J1—Output jack (phono type suggested)

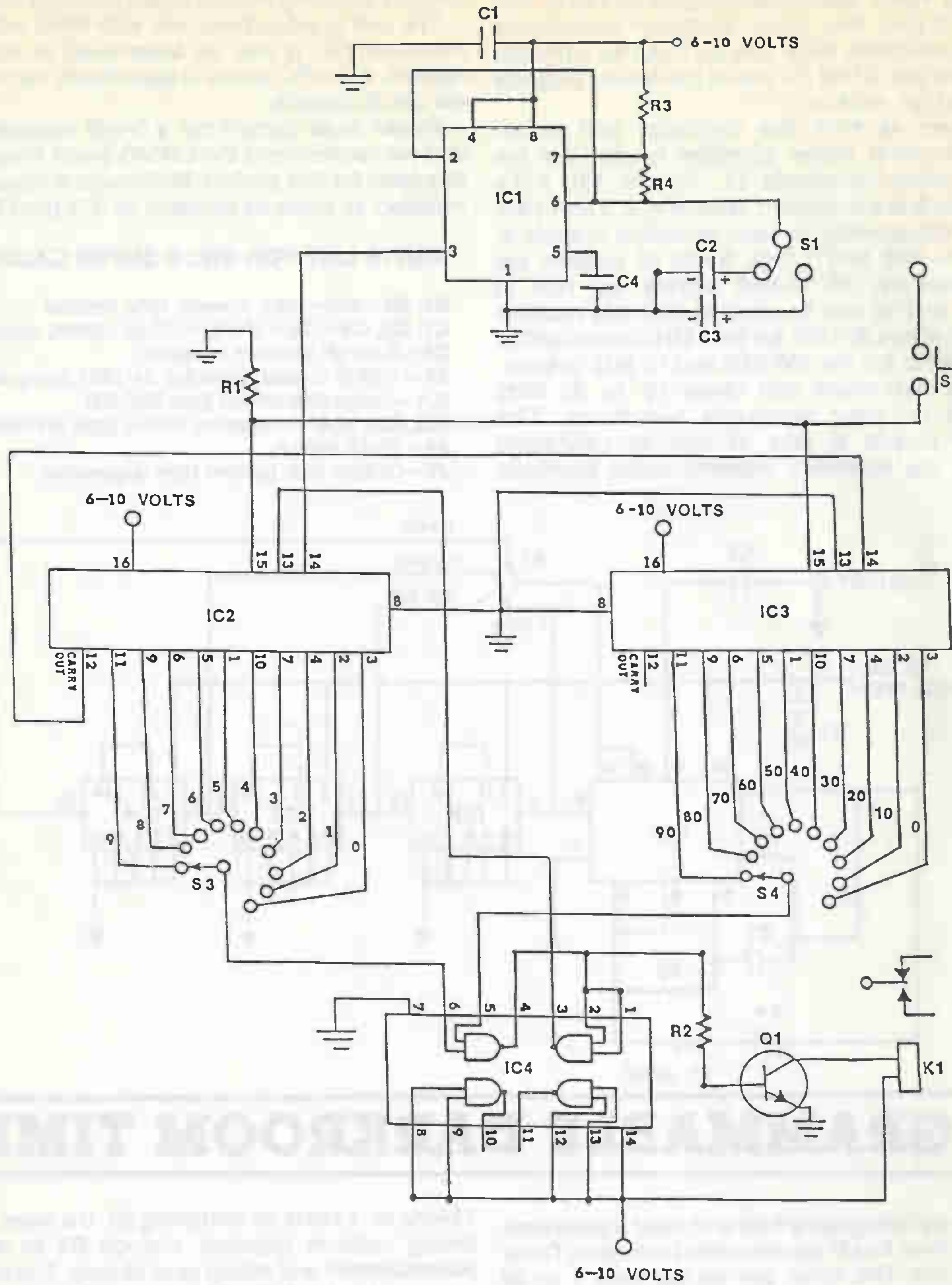


PROGRAMMABLE DARKROOM TIMER

If you are a photography buff and need a good dark room timer, then this Programmable Darkroom Timer will fill the bill. The timer can be set from 1 to 99 seconds in 1 second intervals or from 10 to 990 seconds in 10 second intervals. Just hook the timer to an enlarger and dial in the proper exposure time, and let the Programmable Darkroom Timer do the rest. While the timer was designed primarily as a darkroom timer it can also be used like any other timer. Once you have used it, you will find numerous other applications for it.

Operation of the timer is quite simple. A 555 timer is set up as a pulse generator, which can be set at either 1 Hertz or .1 Hertz by switching S1. If a more accurate timing cycle is required, change R4 to a 100,000 potentiometer and adjust accordingly. The pulses are counted by 4017 CMOS Decade Counter/Dividers, IC2 and IC3. When S3 and S4 are set for the proper time S2 is depressed and the timing cycle is started. If the 555 timer is switched to .1 Hertz, multiply S3 and S4 switch readings by 10. For the relay to be deenergized, a simultaneous high pulse must be received at both inputs of the NAND gate 1, IC4, 4011 Quad NAND Gate. At the same time the relay is deenergized, a signal is sent to NAND gate 2 which is setup as an inverter, disenabling the clock input of IC2. To start the timing cycle again just depress S2.

PROGRAMMABLE DARKROOM TIMER



PARTS LIST FOR PROGRAMMABLE DARKROOM TIMER

C1—.1uf Capacitor
C2—10uf Capacitor 20WVDC
C3—100uf Capacitor 20WVDC
C4—.01uf Capacitor
IC1—LM555 Timer
IC2, IC3—4017 CMOS Decade Counter/Dividers
IC4—4011 CMOS Quad 2-input NAND Gate
K1—Relay 7-9VDC, 500 ohm coil, Radio Shack # 275-005 or Equivalent
Q1—2N3903 NPN Transistor or Equivalent
R1, R2—10,000 ohm ¼ Watt Resistor
R3—15,000 ohm ¼ watt Resistor
R4—68,000 ohm ¼ Watt Resistor
S1—Toggle Switch SPDT
S2—Switch, Mini SPST Momentary, Normally Open, Radio Shack # 275-1547 or Equivalent
S3, S4—Switch, Rotary Type Single Pole With 12 Positions, Radio Shack # 275-1385 or Equivalent.

CGA / COMPOSITE VIDEO CONVERTER

This simple circuit allows you to use a monochrome composite monitor as a video monitor for your CGA card for your IBM PC. It requires only a handful of resistors and two signal transistors to build and it should only take a couple of hours to complete.

The idea of the circuit is to mix the three CGA prime colors, red, green and blue in a grey scale so they can be displayed on a monochrome monitor that has a composite video input.

The RGB inputs are taken from pins 3, 4 and 5 of the DB9 connector and mixed together via the 3.9k, the two 2.2k and 8.2k resistors. The signal is then buffered by transistor Q1 which need only be a common variety NPN signal transistor.

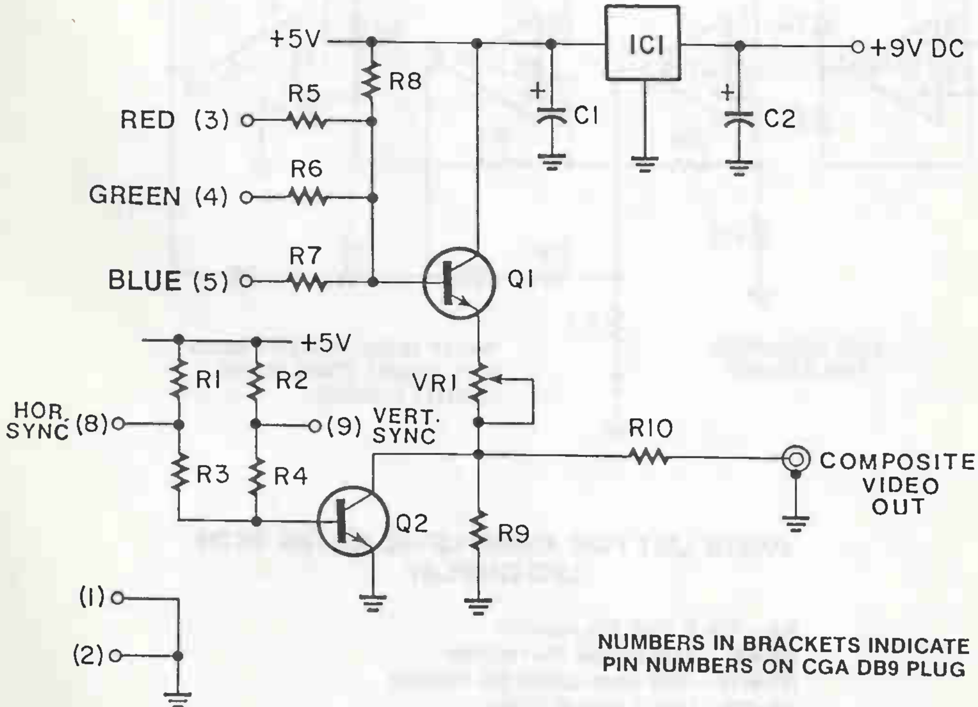
The horizontal and vertical sync pulses are taken from pins 8 and 9 of the DB9 connector and mixed together via the four 2.2k resistors. The resulting signal is fed to transistor Q2, again just a common variety NPN signal transistor. This acts like a switch, providing the sync pulses between 0.3 and 0 volts. The output signal is taken from a 1k resistor and a 1k variable resistor. This variable resistor varies the amplitude of the video signal. The 68 ohm resistor provides the correct terminating impedance for the video output to the monitor.

If you check the output signal the total amplitude should be no more than 1 volt with the video signal being between 0.3V and 1V and the sync pulses between 0 and 0.3V. Pins 1 and 2 of the DB9 connector are connected to the circuit ground.

The circuit is powered by a 9VDC power pack and a common 7805 three terminal regulator to provide the required 5V power. You can use a standard RCA socket for the composite video output to your monitor. ■

PARTS LIST FOR CGA TO COMPOSITE VIDEO CONVERTER

R1-R4—2.2k 0.25W 5% resistor
R5—3.9k 0.25W 5% resistor
R6—2.2k 0.25W 5% resistor
R7—8.2k 0.25W 5% resistor
R8—2.2k 0.25W 5% resistor
R9—1k 0.25W 5% resistor
R10—68 ohm 0.25W 5% resistor
VR1—1k trimmer potentiometer
Q1, Q2—2N3565 or any common NPN small signal transistor
IC1—7805 +5V regulator
C1-C2—10uF 16VW electrolytic capacitors



CGA TO COMPOSITE VIDEO COMPUTER

AUDIO LEVEL METER / LED DISPLAY

If you have ever wanted to copy the LED (light emitting diode) display from your tape deck, then this circuit will do the job.

IC1 is an LM324 quad opamp IC and is the main component of the circuit. IC1a is configured as a half-wave rectifier with a gain of 10. This turns the incoming audio signal into a DC voltage via diodes D1 and D2 and then amplifies that voltage by 10.

The three remaining opamps, IC1b, IC1c and IC1d are connected as a comparator chain, each one checking if the input DC voltage from IC1a is higher than the tapped voltage from the resistor string on its non-inverting inputs via resistors R3-R6.

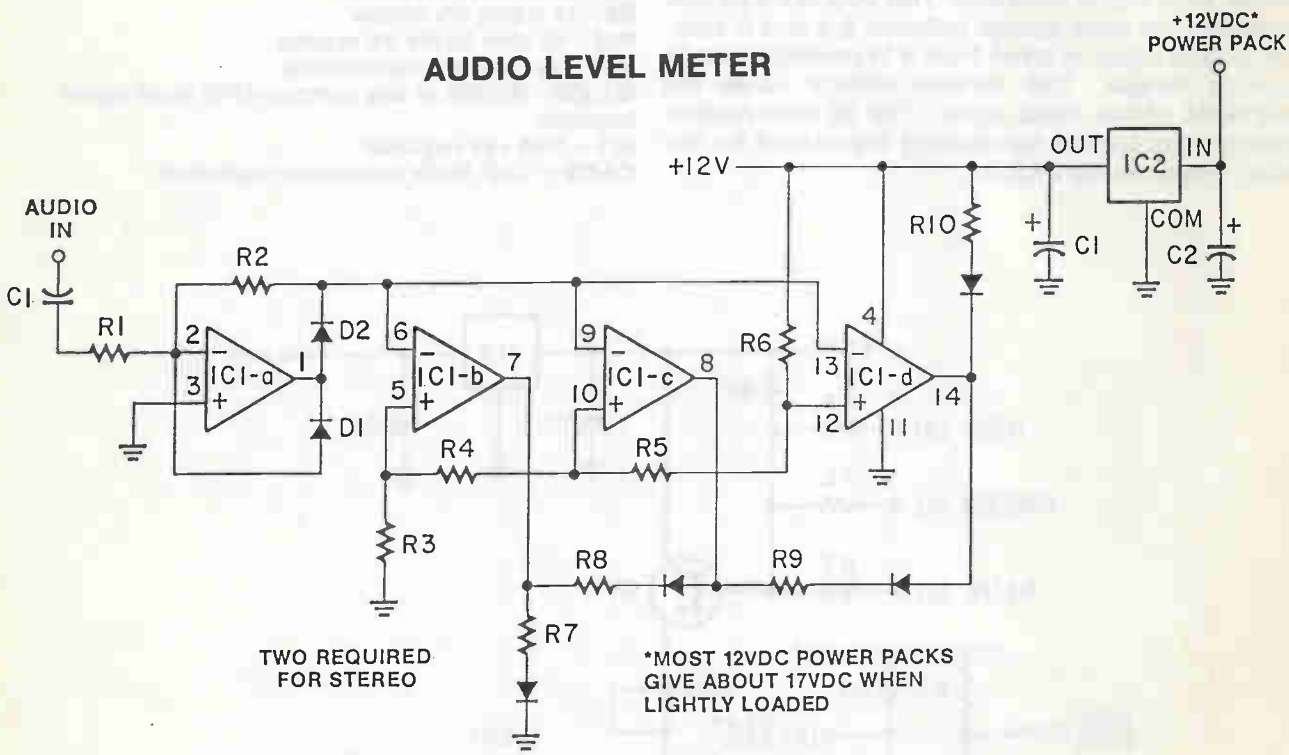
Initially, LED 1 is turned on until the first threshold voltage at pin 5 has been surpassed. This causes LED 1 to now turn off and LED 2 to turn on. If the next threshold voltage at pin 10 is surpassed, LED 2 will turn off and LED 3 will turn on.

Alternatively, if LED 3 is currently on, and the input DC voltage from IC1a falls below the threshold voltage at pin 10, then LED 3 will turn off and LED 2 will come back on again.

The way this works is that the LEDs only come on when the voltage at the anode of the LED is higher by at least 1.6 volts than the voltage at its cathode. Resistors R7-R10 provide current limiting for the LEDs so that they don't burn out.

The circuit is powered by a 12VDC power pack and a 7812 three-terminal regulator. ■

AUDIO LEVEL METER



PARTS LIST FOR AUDIO LEVEL METER WITH LED DISPLAY

R1—10k 0.25W 5% resistor
R2-R6—100k 0.25W 5% resistor
R7-R10—680 ohm 0.25W 5% resistor
D1-D2—1N914 signal diode
IC1—LM324 quad opamp IC
IC2—7812 +12V regulator
LED1-LED4—Any 5mm red LED
C1—0.1uF mylar capacitor
C2-C3—10uF 16VW electrolytic capacitor

SIMPLE LOGIC PROBE

By Darren Yates

For the hobbyists who are into building electronic projects using CMOS IC's, this device can be an enormous help and solve many problems. It allows you to determine the output level of any CMOS chip at any particular time. Very simply, if the red LED is on, the output is high and if the green LED is on, you know that the output of that particular gate is a low voltage.

Looking at the circuit, you will observe that it consists of only a handful of components and it is quite simple to build. IC1a and IC1b are two op-amps wired as comparators. Their job is to compare the incoming voltage from the probe with the reference voltages and to let you know what level they are at.

Resistors R1, R2 and R3 have their junctions connected to the two non-inverting inputs of the two comparators, forming a voltage divider. The voltage at pin 3 sets the upper threshold of 2V/3 volts, while the lower threshold of V/3 volts is at pin 5.

Resistors R7 and R8 bias the input to the halfway mark so that the yellow LED comes on, providing a "power on" indication. If you connect the probe to an input of a logic gate and the yellow LED lights up, it reveals that the voltage at this input is neither high nor low. Voltages in this "No man's land" region often cause circuits to act erratically because the circuit itself doesn't know if the input is high or low. The idea of this logic probe is that it points this out to you, allowing you the opportunity to make corrections to prevent this discrepancy. However, since pin 7 is also high, there is no voltage across the yellow or red LEDs, so neither light up.

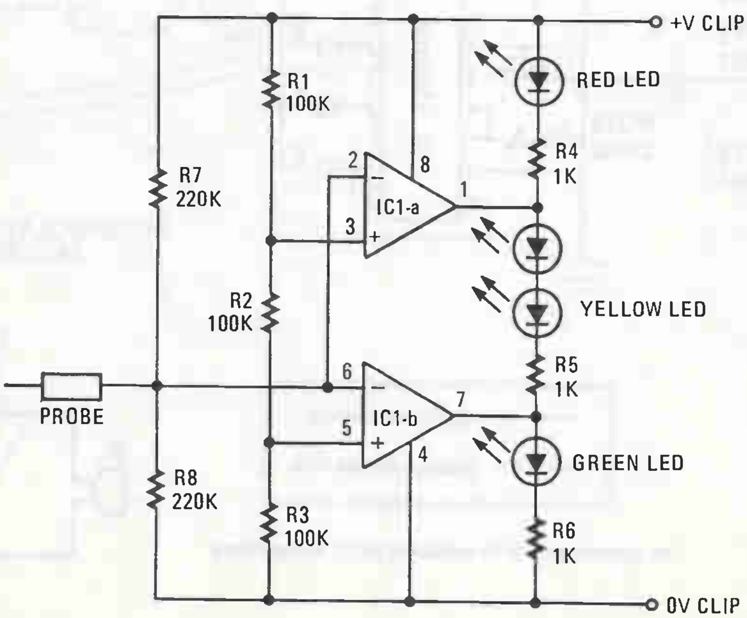
Say you connect the probe to a gate input and the voltage level is neither high nor low. If it is between the upper and lower threshold, then in a CMOS circuit, it is doubtful whether that circuit will work correctly.

If pin 6 is higher than pin 5, as we assume, then the output of pin 7 is low, so the green LED does not light. However, the voltage at pin 2, which is the same as at pin 6, is less than the upper threshold of pin 3, so the output of pin 1 goes high.

Now that we have voltage across the yellow LED, it lights up. The red LED stays off because there are no volts across it (can you figure out why??).

The final possibility is that the probe is connected to a high voltage, which is above the upper threshold voltage. If this is true, then both pins 6 and 2 are higher than their respective partners, pins 5 and 3, so both outputs, pins 7 and 1, are at a low voltage. This means that there is no voltage across both the yellow and green LEDS, so they remain off.

Now that the output of pin 1 is low, we have volts across the red LED, so it lights up.



SIMPLE LOGIC PROBE

When you connect the probe to a varying voltage, such as a waveform, you will see the LEDs flashing. If the red and green LEDs are brighter than the yellow, then the output wave is probably a square wave, If all three have equal brightness, then you most probably have a sawtooth waveform.

It should be quite possible to build this circuit in a small box, since it can be powered from the power supply of the device you are testing. All the components should be easy to locate and the cost should be minimal. ■

PARTS LIST FOR THE SIMPLE LOGIC PROBE

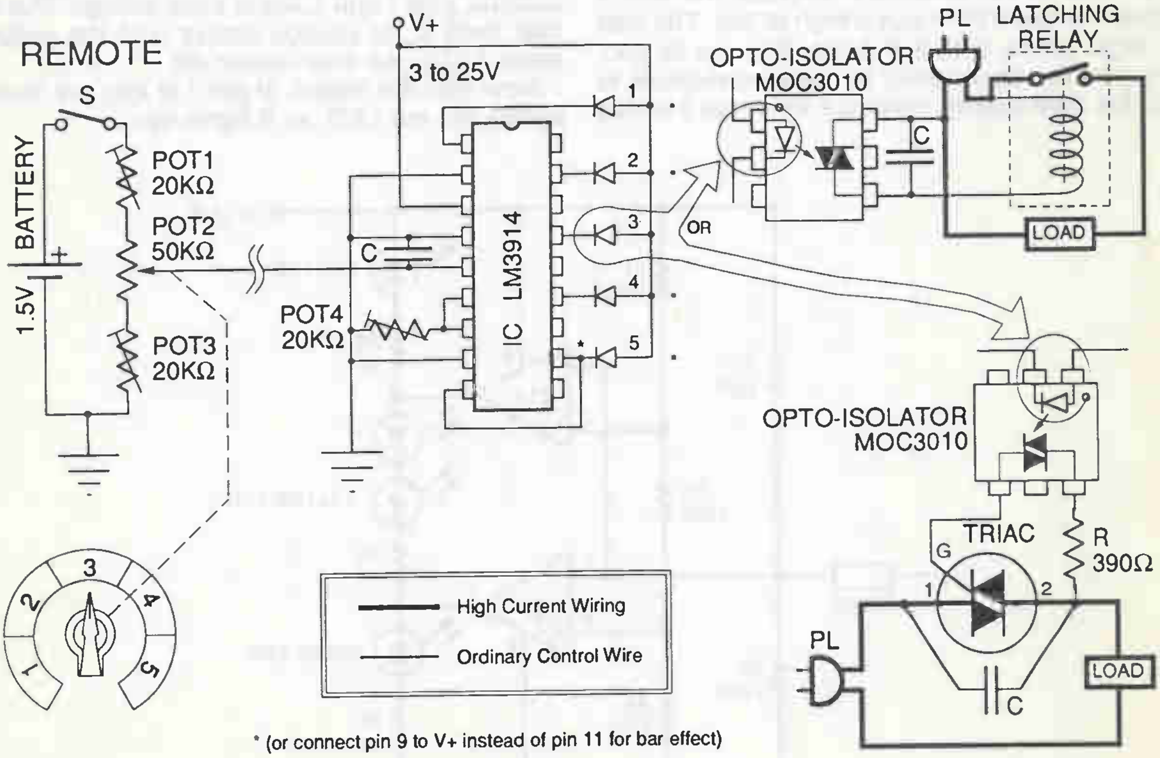
IC1—TL072
R1, R2, R3—100K ohms, ¼W, Resistors
R4, R5, R6—1K ohms, ¼W, Resistors
R7, R8—220K ohms Resistors
Misc.—1 Probe, 2 Battery clips, 1 Red, 1 Yellow and 1 Green LED

AN INNOVATIVE ONE-WIRE REMOTE CONTROL

By Joe O'Connell

This simple and adaptable project allows you to switch several high-power devices on and off from a distance. If a common ground is available, the control signals can be sent over a single low-voltage wire. The safety and economy of low-voltage wiring makes this project especially suitable for controlling theater lights, undewater pool lights or outdoor landscape lights.

The circuit in the illustration makes use of an LM3914 LED bar/dot display driver IC. This chip is designed to turn on one of ten LEDs in response to a voltage applied to pin 5. For this project, the LEDs are replaced by LED-input opto-isolators which are used to control the high-power loads. A variable voltage source in a remote location supplies the voltage that controls the LM3914. In the circuit illustrated, only



AN INNOVATIVE ONE-WIRE REMOTE CONTROL

five of the ten LED outputs of the LM3914 are used. This makes it easier to select the correct voltage with POT2. Ten outputs can be used instead, but you'll have to be more careful when setting POT2.

The outputs of the IC are drawn as LEDs, which is a shorthand way of representing either of the two circuits drawn to the right. The circuit with the triac sends power to a load whenever the appropriate output of the LM3914 is energized. This circuit is ideal if you never want more than one load on at the same time. Using the triac circuit, you would select the appropriate position for POT2 and keep S closed for as long as you wanted that light to remain on.

An interesting modification would be to disconnect pin 9 from pin 11 and connect it to V+ instead. This changes the LM3914 from "dot" to "bar" mode, which means that it energizes not just one LED at a time, but that LED and all those with a lower number than it. This might find some applications in lighting control.

The circuit with the latching relay allows you to turn a particular load on or off by depressing S momentarily. Several loads can be left on simultaneously using this more versatile circuit.

The circuit at the remote location uses a single dry cell battery. Since current drain is so low, almost any size battery will last its shelf life in this circuit. POT1 and POT3 allow adjustment for a weak battery, to accommodate long lengths of wire, and variations in the value of POT2. Since the remote circuitry is completely isolated from the high power load it controls, it can be located near a pool or other area where common sense and electrical codes won't allow load-carrying controls.

The LM3914 IC will accept a wide range of power supply voltages: 3 to 25 VDC. At higher power supply voltages, POT4, may have to be set to limit the current through the opto-isolators to 50mA. At most power supply voltages it will not be needed for this function and can be taken out of the circuit. ■

PARTS LIST FOR AN INNOVATIVE ONE-WIRE REMOTE CONTROL

POT 1,3,4—20K ohm trimmer potentiometer, value not critical. POT4 is necessary only with higher supply voltages.
POT 2—50K ohm panel-mount linear-taper potentiometer
S—SPST toggle switch or momentary-contact pushbutton switch
BATTERY—Any 1.5V dry cell or alkaline battery
C—0.01uF, 200 V or more, bypass capacitors, (value not critical)
R—390 ohm ¼ W resistor
PL—Line cord and plug
OPTO-ISOLATOR—MOC3010 triac-driver opto-isolator or equivalent
TRIAC—200 V triac, rated to exceed the expected load current
LATCHING RELAY—mechanical latching relay (Find them in electronics surplus catalogs.)
MISC—Knob for POT 2, battery holder, suitable enclosures, wire, rub on letters, solder.

HALF-WAVE RECTIFIER HOW IT WORKS

By Darren Yates

If you have a DC voltmeter and you want to measure AC voltages or you just want to use an AC signal to activate some other circuitry, then you'll find this circuit very useful.

This circuit takes an incoming AC signal, which has both positive and negative peaks and just puts out the positive peaks. Now you may be thinking that the diode can do the same thing. However, the diode needs 0.6V across it before it will do anything and since most audio signals are rarely this high, you would only ever get a DC output on the loudest passages of music or whatever.

This circuit gives a DC output for AC signals down to the millivolt range.

IC1a is connected as an inverting amplifier with a gain of 10. This provides the whole circuit with extra gain for really low signals. Capacitor C1 provides AC coupling for the signal to IC1b which is the halfwave rectifier.

IC1b is connected so that it provides a DC output whenever the input signal goes positive. Diodes D1 and D2 are connected in a double feedback loop between the output pin 7 and the inverting input, pin 6. When the incoming signal to pin 6 goes negative,

HALF-WAVE RECTIFIER

the output at pin 7 begins to rise. D1 becomes forward biased and conducts, giving IC1b a gain of 100 for this half of the wave. Diode D2 is reversed biased i.e. the voltage across the diode is the "wrong-way-round" for it to conduct.

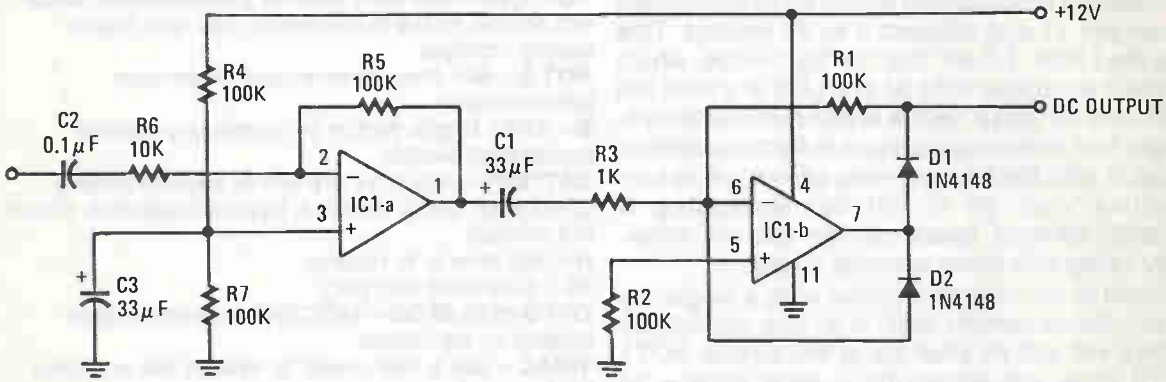
On the positive side of the signal (this is really the negative side for the signal coming into pin 2), the output of pin 7 begins to go lower than the voltage at pin 6, so the diode D2 becomes forward biased and conducts. This gives the op-amp a gain of less than one on this side of the cycle.

The output is then a positive DC voltage for a positive rise in the input signal and nothing for the negative-going side.

When you are putting it together, keep all the component leads short and don't overheat the IC when you are soldering it onto the PC board, as this will more than likely damage it. When using the DC output voltage, make sure that it has a fairly high load resistance, at least 1K ohms, or else you may distort its value. ■

PARTS LIST FOR HALF-WAVE VOLTAGE RECTIFIER

C1—33uF Electrolytic Capacitor (25V)
C2—0.1uF Metalized polyester capacitor
C3—33uF Electrolytic Capacitor (25V)
IC1—½ X LM324
R1—100K ohms, ¼W, Resistor
R2—100K ohms, ¼W, Resistor
R3—1K ohms, ¼W, Resistor
R4, R5—100K ohms, ¼W, Resistors
R6—10K ohms, ¼W, Resistor



THE CATALOG CORNER

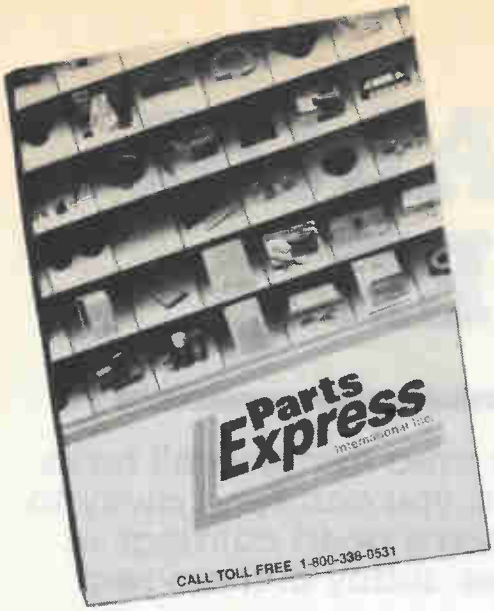
If you live in a relatively remote area that doesn't have ready sources for electronic parts, you can send away to numerous supply houses, who have good catalogs of electronic parts and assemblies...many of them real bargains.

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.

MARLIN P. JONES

Everyone loves a bargain, and nowhere do you find better bargains than in surplus. We're not talking about musty old equipment left over from World War II, but modern surplus in like-new condition. If you'd like to take advantage of the bargains that exist in electronic surplus, we recommend that you get hold of the latest catalog from Marlin P. Jones & Associates. The folks at Marlin P. Jones put out a catalog that is noticeably better organized and illustrated than most. There is an excellent selection of power supplies, transformers, and switches. They also have a variety of mechanical components like pressure gauges, solenoid valves, and electronic motors. Looking for laser components? Well, they've got them, and at reasonable prices, too. You'll also find semiconductors, connectors, magnets, resistors, capacitors, wire, knobs, cabinets, speakers, and a whole bunch of other things in this 62-page catalog. **Marlin P. Jones & Assoc., Box 12685, Lake Park, FL, 33403-0685.**

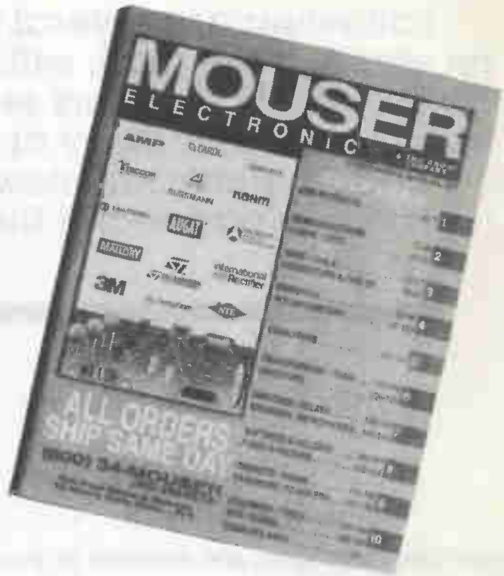
PARTS EXPRESS



Some people have a knack for being direct and to the point. Whoever gave Parts Express its name was probably just such a person. No one has to wonder what the folks at Parts Express do; they sell parts. Electronic parts. And they're quick about it, too; "express' tells us that. This should be all you need to know, but for the sake of inquiring minds, we'll elaborate. Parts Express carries semiconductors of all kinds, both domestic and foreign. In addition, they have a wide assortment of switches, plugs, jacks, resistors, capacitors, wire, transformers, batteries, computer accessories, woofers, tweeters, crossover networks, test gear, tools, chemicals, and books. And the best part is that the folks at Parts Express will send you a free catalog. All you have to do is tell them where you live. **Contact Parts Express, 340 E. First St., Dayton, OH, 45402. Phone (513) 222-0173.**

MOUSER ELECTRONICS

For anyone with more than a passing interest in electronics, the Mouser Electronics name has to be a familiar one. Mouser is a full-line distributor of electronic components and equipment. In Mouser's latest catalog, you'll find a wide selection of integrated circuits, diodes, and transistors, including the sometimes hard-to-find surface-mount types. Besides semiconductors, Mouser stocks almost all of the components you can think of—plugs, jacks, switches, resistors, capacitors, potentiometers, speakers, cabinets, solder, and so forth. Want test equipment? Mouser's got it, from manufacturers like Beckman, Simpson, and Global Specialities. Furthermore, since Mouser has distribution centers throughout the United States, you get your order filled promptly. Mouser's latest 207-page catalog is yours for the asking, so what are you waiting for? **Mouser Electronics, 2401 Highway 287 N., Mansfield, TX, 76063-4827. Telephone (800) 992-9943.**

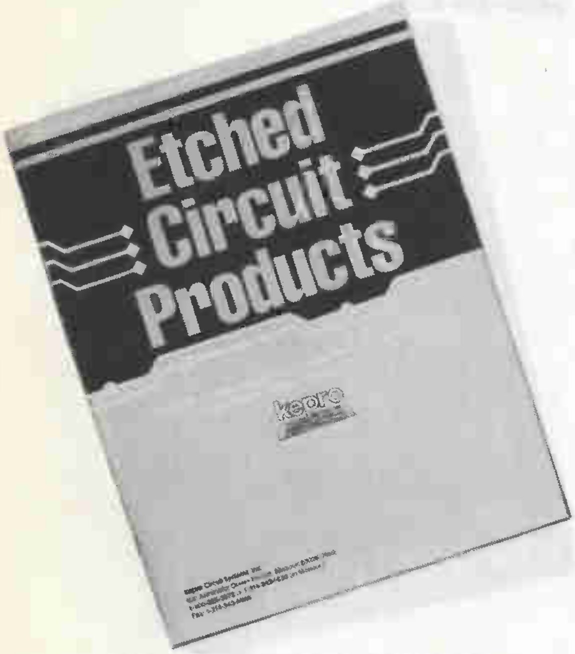


STAR-TRONICS

Of all the catalogs that the postman delivers, the ones most deserving of an immediate and attentive reading are the surplus catalogs. Why? Because the items in a surplus catalog are not only low in price (usually), they're also likely to be in short supply. It's first come, first served, and if you delay, someone else is going to get all the good stuff. Beyond that, surplus catalogs are just plain fun to read. Take, for example, the latest set of flyers from Star-Tronics. Page one has a Russian tank microphone, vintage 1944, for just $7.50—a bargain for those of you who own your own Russian tank, an interesting curio for those of use who don't. But don't get the wrong idea now. Star-Tronics sells more than just electronic white elephants. Most of the items are eminently usable and bargain-priced, which is why you should get on the Star-Tronics mailing list. Just write to **Star-Tronics, P.O. Box 683, McMinnville, OR, 97128. Telephone (503) 472-9716.**

HUB MATERIAL COMPANY (HMC)

Tools and electronic test equipment are what HMC sells, and you'll find an almost bewildering selection of both in the latest full-color catalog from HMC. We hasten to point out that all the tools and test gear are intended for use in electronic design, test, assembly and maintenance; hence, if you're looking for a 24" pipe wrench, don't expect to find it here. But if a multimeter, PCB shear, soldering iron, diagonal cutter, screwdriver, vise, workbench, oscilloscope, antistatic mat, solder pot, or micrometer is what you need, then pick up a pen and address a letter to the fine folks at **HUB Material Company, 33 Springdale Ave., Canton, MA, 02021. Or telephone (800) 482-4440** and ask for a copy of their latest full-line catalog. We think you'll agree that it's a resource well worth having.



KEPRO CIRCUIT SYSTEMS

Copperclad printed circuit stock and a huge selection of equipment for the manufacture of circuit boards can be found in the latest catalog from Kepro Circuit Systems. You'll find all types of copperclad laminate, including paper-based phenolic, glass-epoxy, and epoxy-composite in both single- and double-sided versions. Sheets range in size from 3x6 inches to a whopping 12x24 inches, the latter being intended for use by professional PCB fabricators. A full line of chemicals such as etchants, developers, and strippers is also available, as are PCB kits for the beginner.

To complement its line of copperclad products, the company offers a wide variety of PCB fabricating machinery, including spray etchers and developers, ultraviolet exposure equipment, board shears, and even computer-controlled drilling machines.

To get a free copy of the Kepro catalog, write to **Kepro Circuit Systems, 630 Axminister Drive, Fenton, Missouri, 63026.**

OPTOELECTRONICS, INC.

The latest catalog from Optoelectronics, Inc. features the firm's impressive line of hand-held frequency counters. Though these instruments are small enough to fit in the palm of your hand, they sport all the advanced features and accuracy you'd expect to find in a full-size frequency counter. Optoelectronics makes a wide array of frequency counters, some of which are intended for general-purpose use, the rest of which have more specialized functions, such as the servicing of UHF communications equipment or the detection of bugs (the kind that eavesdrop). The Optoelectronics Frequency Counter Buyer's Guide describes the specifications of the counters that Optoelectronics manufactures, and provides information that will allow you to select the counter that's right for you. To get a copy of this informative guide, write to **Optoelectronics, Inc., 5821 Northeast 14th Ave., Ft. Lauderdale, FL, 33334. Telephone (800) 327-5912.**

SPARTAN ELECTRONICS

Looking for a dealer who can supply just about every conceivable kind of electronic component? Well, you need look no further than Spartan Electronics. Spartan's new 416-page catalog is jammed full of electronic essentials. They've got semiconductors and vacuum tubes, along with passive components like resistors, capacitors, and potentiometers. Cabinets and enclosures are also included, as are printed-circuit supplies and solderless breadboards. For the service technician, they carry a complete assortment of electronic test equipment, tools, and tool kits. In addition, there is special equipment for the testing and maintenance of computer equipment and telecommunication systems. Audio, video, and CATV equipment is also featured, along with a variety of security systems, Address your catalog request to **Spartan Electronics, 6143 Jericho Turnpike, Commack, NY, 11725.**

GLOBAL SPECIALTIES

Many hobbyists will recall that, back in the late seventies, Global Specialties was one of the first companies to produce solderless breadboards. Until that time, it was necessary to build a prototype on perfboard and use wires and solder to establish connections. If the circuit did not work properly, you had a devil of a time trying to modify it. With the advent of the solderless breadboard, however, trouble-shooting of a prototype became laughably simple, because all you had to do was plug or unplug some wires. Hobbyists and engineers loved the concept, and the folks who invented the solderless breadboard made a ton of money. But Global Specialties wasn't content to rest on the laurels of past achievement. No, they began making accurate, reasonably priced test instruments, including logic analyzers, counters, and power supplies. To learn more about these products, write to **Global Specialties, P.O. Box 1405, New Haven, CT, 06505; or call 1-800-345-6251.**

MARK V ELECTRONICS

Changes have taken place in the electronic industry, and we can't say that they've been changes for the better. Some old-time kit makers have gone out of business, and those that remain seem to be offering an ever diminishing selection of ever more expensive kits. What's a poor hobbyist to do? Well, for starters, check out the new catalog of kits from Mark V Electronics. There is something for just about everyone here. Mark V offers a large selection of very reasonable priced kits for the beginner as well as the expert. Audiophiles can choose from among a wide selection of high-fidelity amplifiers ranging in power from 6 Watts to 300 Watts. Test-instrument aficionados will like the wide variety of frequency counters and regulated power supplies. And tinkerers will find a nice selection of low-cost weekend projects such as a wireless microphone or an infrared controller. **Mark V Electronics, 8019 E Slauson Ave., Montebello, CA, 90640.**

MUSIC-ON-HOLD

By Jerry Penner

When the term "simple circuit" was first used, it was probably in reference to this device. Never before have so few components offered so much to so many. In order to build a telephone hold circuit, you need a resistor between 200 and 1200 Ohms and a switch to emulate a telephone going on and off-hook. To build a "music-on-hold" circuit, you don't need much more.

Referring to Fig. 1, you will see R1, one half of T1 and one half of S1 connected to the phone line. The DC resistance the line sees is 610 Ohms. The other half of S1 turns the radio on and off, and also switches an LED. The LED is optional. Disregard it if the radio you use has a visual indication of the "on" condition. The other side of the transformer plugs into the radio's headphone jack.

Construction

Construction can be point-to-point wiring, and could even be put inside the radio if there's room. To cut unneeded expense and make a little room, the radio's speaker could be removed and the transformer connected directly to the leads of the speaker, eliminating the headphone jack.

To wire the power side of the switch, disconnect the wire from the positive side of the batteries and connect the battery positive to the switch. The wire which used to go to the battery positive now goes to the center pole of the switch. If you decide to use the LED indicator, remember that the current limiting resistor impedance must be calculated. A good rule of thumb is to multiply the supply voltage by 100 and find the closest resistance to that number. This will give you a 10 mA current through the LED.

Testing...Hello?

Once the unit is constructed, check the DC resistance of the phone line side with the switch in the "hold" position. The resistance should fall between 450 and 750 Ohms, and the radio should be on. With the switch in the "off" position, the resistance of the phone line side should be infinite.

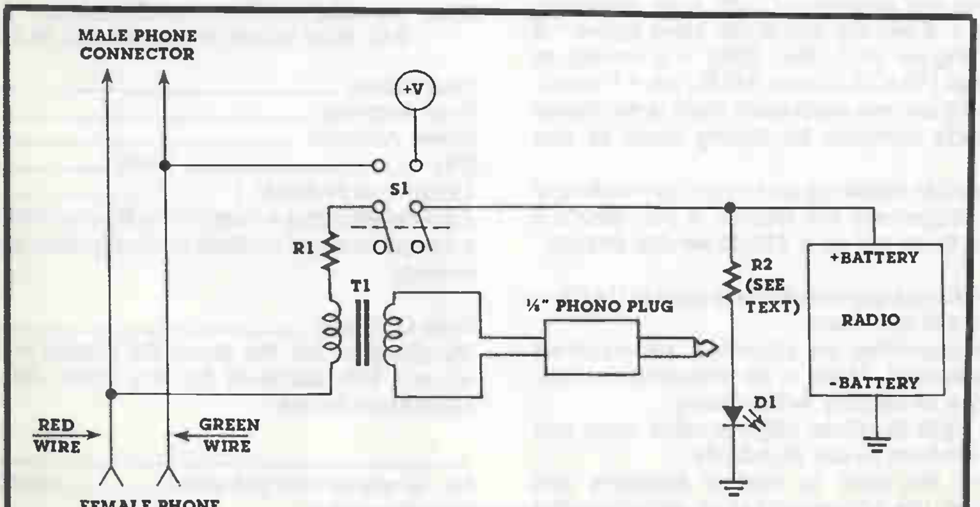
One Moment Please?

The only thing that remains to do is to plug the device into the phone line. Remember though, that since a hold switch acts like a phone's DC impedance, the circuit reduces the number of phones you may have connected to the line. The electrical limit, according to Ma Bell, is five phone loads. If you exceed this limit, Ma will send a large burly serviceman over and remove your equipment from the line to restore order.

This device does have other uses. A friend of mine likes to share music with his friends on the other end of the line. He used to do it by wearing headphones under his chin and turning the music up. Now his headphones sit in a drawer. ■

PARTS LIST FOR MUSIC-ON-HOLD

D1—Red LED
R1—560 Ohm ¼ Watt 20% resistor
R2—See text
S1—DPDT toggle switch
T1—1:1 audio matching transformer (Radio Shack #273-1374)
Misc—transistor radio, telephone extension cord, project box (optional), ⅛" mono headphone plug (optional).



MUSIC-ON-HOLD SCHEMATIC

CLASSIFIED FLEAMARKET

NO CHARGE FOR ZIP CODE...NO CHARGE FOR CAPITALIZING FIRST WORD...ADDITIONAL WORDS IN CAPS—40¢

To run your own classified ad, put one word on each of the lines below and send this form along with your check

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30

CLASSIFIED AD ORDER FORM. PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.

The rate per word for CLASSIFIED ADVERTISEMENTS is $1.00 payable in advance—minimum ad $15.00. Capitalized words 40¢ per word additional.

For Greater Classified Savings...Results...and Profits...

DISPLAY RATES:
1"×2" ($125), 2"×2" ($225), 2"×3" ($300), 2"×4" ($400)

CLASSIFIED AD REQUIREMENTS

Minimum ad 15 words—Please remember to be sure to count your name and address—Count each Abbreviation (B.J. Jones = 3 words), Initial (W. Main Street = 3 words), Single Figure (P.O. Box 3333 = 3 words) or Groups of Figures (10 x 12, 35mm, F.O.B., etc = 1 word). Your Zip and State are one word each, there is no charge for your ZIP. Code numbers for keying count as one word.
There will be regular headings and when no heading is requested, our judgement will decide. If you desire a special heading, there will be a $10.00 service charge.

Ads are set in uniform style with the first word in CAPS—Extra CAPS are 40¢ per word.
Proofs are not submitted on classified ads—correct insertion is guaranteed. There is no deduction for Key Number error due to illegibly written copy.
We reserve the right to refuse objectionable copy and revise copy to conform to our standards.
We also reserve the right to request literature and merchandise from the advertiser before accepting the ad. Advertisers using a P.O. Box must furnish complete name and address for our records.

C&E HOBBY HANDBOOKS

Call (201) 231-1518 or write to:
L. M. Gabree, P.O. Box #5148, North Branch, N.J. 08876

MAIL TO: C&E HOBBY HANDBOOKS—CLASSIFIED,
P.O. BOX #5148, North Branch, N.J. 08876

Your Name ____________________
Firm Address ____________________
Street Address ____________________
City ____________ State ________ Zip ________
Telephone Number (   ) ____________________
Advertisers using a Post Office Box number must furnish a complete street address and telephone number for our records.

Date Of Order ____________________
5% discount for the same Ad placed in 3 successive issues. 10% discount for the same Ad placed in 6 successive issues.

____
No. of words rate per word ________ equals remittance, less discount.
Remittance of $ ____________ is Enclosed.

V12

BLOWN DC FUSE INDICATOR

By Floyd D. Rasmussen

This circuit monitors the status of fuse F1, and gives a relative indication of the nature of any short which would cause F1 to open. If F1 remains good, no voltage drop appears across LED 1 and its bias resistor R1, so the LED remains off. If F1 opens, a voltage is developed across R1 and LED 1, causing it to glow.

Brightness of LED 1 is determined by the amount of current through it. This current is set by the total value of resistance in series with the LED and the supply voltage.

In the case of a continuous dead short beyond power switch, S1, this short will also short R2 out of the LED bias string, leaving only R1. The LED then glows at the level set by R1.

In the case of a one-time only short beyond S1, R2 would remain in the circuit and add to the LED bias resistance. This added resistance reduces current through LED 1, causing it to glow dimmer.

In the case of an intermittent short, such as might occur under heavy vibration in some applications, R2 is intermittently switched in and out of the LED bias string. This causes the LED brightness to flicker in step with the intermittent short.

By observing the relative brightness of the LED, some clue may be obtained as to what type of short happened, and can aid in troubleshooting.

If F1 is mounted in a holder, all components may be soldered directly to the fuse holder. In case of a panel mount, LED 1 may also be mounted alongside.

Values for R1 and R2 may be calculated for any supply voltage by the following steps.

1) Determine the voltage drop across R1 and R2.

This is the supply voltage minus the voltage drop of LED1 (usually 1.9 volts for red, and 2.1 volts for yellow or green). We'll assume a red LED, and, therefore, a drop of 1.9 volts. Assuming a 12 volt supply (you may want to design around some other voltage, such as 6 volts for older automotive equipment, or perhaps 24 to 28 volts for aircraft use).

V(R1 + R2) = 12v -1.9v, equals 10.1V.

2) Determine the total resistance of R1 + R2.

It must allow a nominal current to flow through LED 1. For most LEDs this value is 20 MA. Since we know the voltage, (10.1 V from step 1) and current (20 MA), we can use OHMS law and solve for R.

R = E/I, or 10.1 V/20MA,
or 10.1 V/.020 A equals 505 ohms.

3) Determine the value of R1.

It must limit the maximum current through LED 1 to a safe level in case a permanent short removes R2 from the circuit. For most LEDs this value can be 30 MA. With R2 shorted out of the circuit, the voltage drop across R1 will be the supply voltage minus the voltage drop of the LED. In our case, 12V-1.9V = 10.1V. For a current of 30MA to flow with 10.1 volts, we'll need a resistance determined by R = E/I, or R = 10.1V/30MA, or R = 10.1V/.030A = 337 ohms. We'll use the next standard value of 330 ohms. A 1/4 unit will do.

4) Determine the value of R2.

Since we already have the total resistance value of both R1 + R2 from step 2 (505 ohms), we can simply subtract the value of R1 from it to get the value for R2. 505 ohms - 330 ohms = 175 ohms. We'll use the next standard value of 180 ohms.

Notice that R2 is placed directly across the power supply, in parallel with the equipment, thus, it always draws current from the supply, along with the equipment.

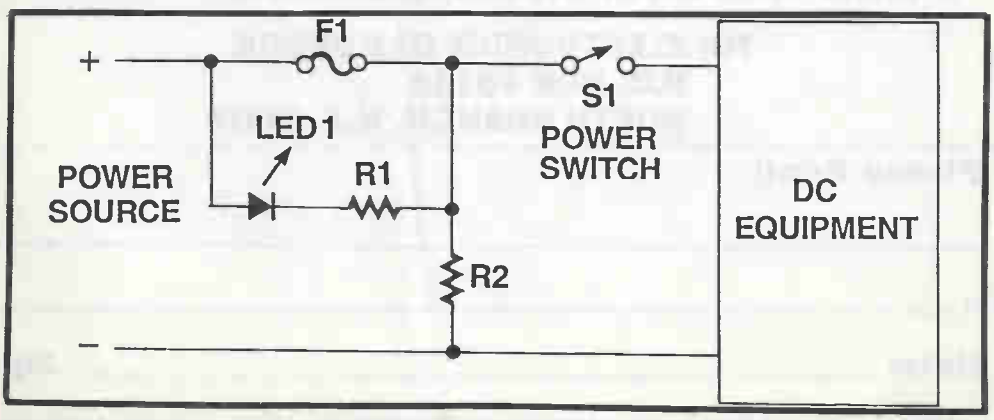
In our case the additional current drain is, by Ohms Law, I = E/R, or I = 12v/180 ohms. This is .067A.

For small battery powered equipment this might be prohibitive, but for most equipment running off 12 volts, this is a relatively small amount compared to 1.5A or more.

R2 must be able to dissipate the heat generated across it. This can be calculated by using the voltage/resistance variation of the power formula...power equals the square of the voltage across a resistance, divided by the resistance, in ohms.

In our case, P = (12V × 12V)/180 ohms, or 144/180, or 0.8W. Use a 1 watt device.

This is a very useful circuit. The author utilized 24 mounted in a panel to monitor all 12 volt and 24 volt circuits powering all electronic equipment aboard a commercial fishing vessel. You may find many other uses. ■



CONSTRUCTION QUICKIE

TAPE RECORDER SIGNAL TRACER

A signal tracer can be easily improvised by using a cassette tape recorder (any tape recorder will do), a capacitor, and an earphone (or loudspeaker), connected as shown in the diagrams. Use the "monitor" switch to hear the output, or connect a loudspeaker or earphones, as shown. Connect the input to the auxiliary jack, if tracing high level signals, and to the microphone jack if tracing low level signals.

Switch the recorder to the *record* mode to trace signals. It may be necessary to defeat the "erase protect" sensing lever in cassette recorders by pressing on it before pushing down on the *record* button. Otherwise, operate the recorder with a cassette in place.

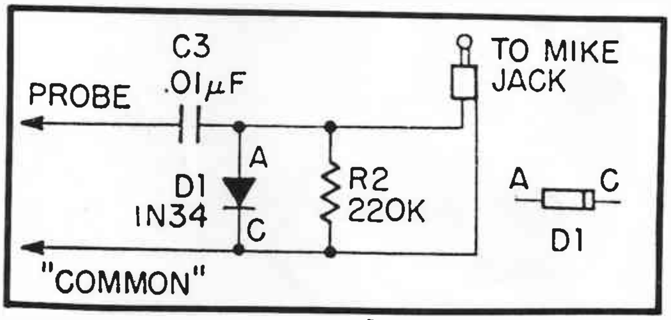


Figure 1.

How It's Done.

Probing with the capacitor lead at the collector and base of each transistor in a circuit, in turn, allows the signal to be traced through the circuit; and faults, such as a dead stage, can be found in a few minutes.

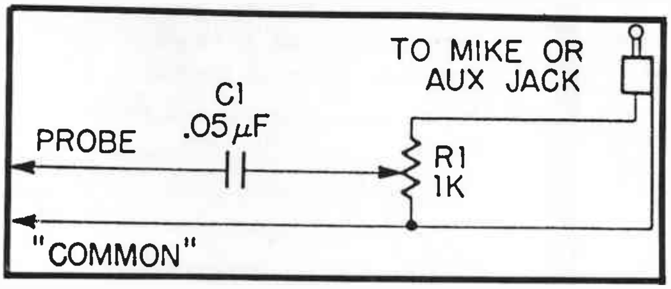


Figure 2.

If the amplitude of the input signal is too high, simply connect an attenuator (Fig. 2) across the input terminals to the tracer, as shown, and adjust the potentiometer for correct volume.

While the circuit is useful for tracing the audio sections of an amplifier or receiver, you may also want to trace the radio frequency (RF) sections. This may done by replacing the capacitor with a simple diode demodulator probe, a sketch of which is shown in Fig. 3.

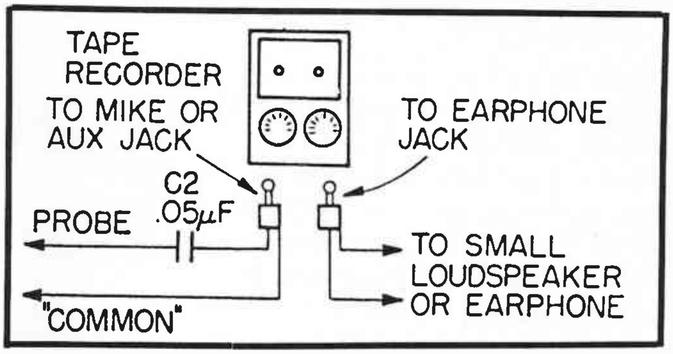


Figure 3.

Safety First.

One good guide by which you should govern yourself when puttering about an apparently defective TV set, is not perform any adjustment poking, prying, snooping, cleaning, etc., that you would not permit a six-year-old child to do. After all, why is a child's life dearer than yours when TV service technicians are available to do the task efficiently and safely ■

PARTS LIST FOR A SIGNAL TRACER

C1, C2—0.05-uF disc capacitor
C3—0.01-uF disc capacitor
D1—1N34, gneral purpose germanium diode
R1—1000-ohm potentiometer, any available type
R2—220,000-ohm, ½-watt resistor