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PUBLISHER
Don Gabree

ASSOCIATE PUBLISHER
H.M. McQueeney

CREATIVE COORDINATOR
Tony DeStefano

SECRETARY/TREASURER
Lillian Beck

CONTROLLER
William Aronson

EDITOR
Hank Scott

ART DIRECTION
Newgraphics, Inc.

ASSOCIATE ART DIRECTOR
Joe DeStefano

MARKETING MANAGER
Jordan Maimed

ADVERTISING SALES
C&E Hobby Handbooks, Inc.
300 W 43rd Street
New York, N.Y. 10036
(212) 397-5200

EAST COAST
Worldwide Publications
(201) 231-1518

WEST COAST
J.E. Publishers Representative
(213) 467-2266

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ADVERTISING OFFICES: New York, 300 West 43rd Street (212) 397-5200 or (201) 231-1518. Los Angeles, J.E. Publishers Rep. 6855 Santa Monica Blvd., Los Angeles, CA 90038 (213) 467-2266.
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86-CIRCUIT FRAGMENTS

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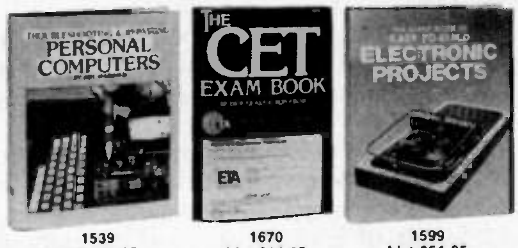

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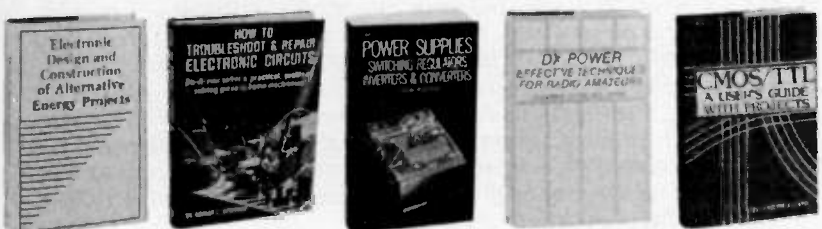

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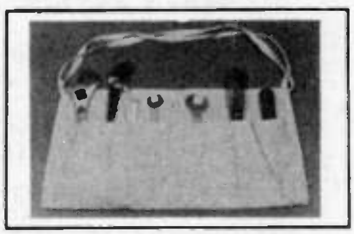

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SO THE PUBLISHER SAYS—

The other day I visited my local new car dealership to get the familimobile patched up for the coming summer, and as I waited, I did what I always do, drifted into showroom and gazed with wide eyes at the new models.

There was another unattended potential buyer walking about and as he came to the sticker on each car that he examined, he mumbled, "Give a guy a break!"

Well, you and I know that if a break is coming your way that break is mainly due to the work you put in to make it possible! Immediately, I thought of the hundreds of letters I received throughout the years telling me of the great savings my readers achieved by assembling projects from one or more circuits in 99 IC Projects. The most popular circuits are the simple ones: audio amplifiers, intercoms, power supplies, and the like. Those readers were giving a break to themselves!

If I were to consider the cost savings made possible by the last decade's issues of 99 IC Projects, I believe that the money saved by the readers who assembled projects to do useful work in place of a purchased components, that amount would make a significant dent in our national debt! A dream? Maybe, yes. Albiet, the amount may be a dream, but the savings are not. In many circumstances, the savings cannot be appreciated, because the project developed and applied to good use may not have a similar component on the marketplace. Think of the service and comfort electronics builders have come to enjoy, more so than other hobbyists.

As I started to leave the showroom, a salesman walked up and said, "Can I help you?"; to which I replied, "Yes, have you ever written an article on an electronics project?"

And to you I say, enjoy this issue of 99 IC Projects!

Don Gabree,
—Publisher

Ask Hank, He Knows!

Got a question or a problem with a project—ask Hank! Please remember that Hank's 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:

Hank Scott, Editor
C & E HOBBY HANDBOOKS INC.
300 West 43rd Street
New York, N.Y. 10036

Power Failure Alarm

How come we never see the schematic diagram for a power-failure alarm in your magazine?
—V.M., Salem, MO.

Never say never! Yes, we did once, or twice, before, but we stopped. The reason was simple. One day in the middle of winter the wind was blowing real hard and I half expected the power to fail. So, I set up the fire place, put a few logs on it and one of those waxed, store-bought logs, and went to sleep. I planned to light the fire when the power failed so that the house would not get cold at all. My wife said that it would be nice to have some kind of alarm. She's right every so often. I was too lazy to wire-up one and went to sleep. In the middle of the night, my GE digital-clock radio woke me up. Believe it or not, it had a built-in, battery-powered, power-failure alarm. We fired up to hearth and had the whole family cuddled in front of it for the remainder of the night. Since that day (actually night) I gave up on building power-failure alarms and purchased radios.

Clock Wanted

I don't see digital clock projects anymore, especially those that operate on 12-volts DC. When I want to build one, there ain't any!
—B.Y., Bronx, NY

Never say ain't! Clock projects are still popular, but everyone has seen his fill. Who would want to read over and over how to buy a clock module and install it in a car. Once is enough! However, if you want to assemble one, call 1-800-344-4539 (in Alaska and Hawaii call 218-681-6674) and ask for a catalog. This outfit is Digi-Key Corporation. They carry the clock modules you see plus thousands of other parts you may need. If you have your Visa card or Master-Charge card handy, you can place an order directly right after you read this.

Op-Amp

Hank, if you were to stock up on op-amps, what types would you get? The reason I ask is that for most circuits that experimenters use the inexpensive varieties are sufficient. Next time I place a mail order with a $25 minimum, I'll toss in some op-amps.
—G.F., Cleveland, OH

Good idea, but you'll get a lot for your money! Try ordering some of the following: 741, MC1458 (dual), LM324 (quad), TL082 (dual), TL084 (quad), LM3900 (quad), LM339 (quad), TLC271, TLC272 (dual), and TLC274 (quad). Dual and quad indicate that the unit has two or four op-amps in one chip. Shop around for the best price. And, always keep a dozen 741's on hand. It seems everyone uses them in projects.

One Opinion

Hank, I don't like solderless breadboards!
—A.R., Belmont, CA

I don't like to unsolder breadboards! So there!

Book Knowledge

I'm getting into logic circuits a lot, especially with a special class in school. I'm having problems finding data on op-amps and logic circuits (TTL and CMOS). Where should I go?
—R.F., Denison, TX

Do go! Write! That is, write to Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268 and ask for their catalog on electrical and electronics books. In particular look at the listing for the following three books:

IC Op-Amp Cookbook by Walter G. Jung

TTL Cookbook by Don Lancaster

CMOS Cookbook by Don Lancaster

Include those titles in your library and you are well on the way in learning logic circuits, and other types, too.

They Never Stop

Will an active antenna improve the ghost rejection on my TV receiver?
—O.P., Silver City, NM

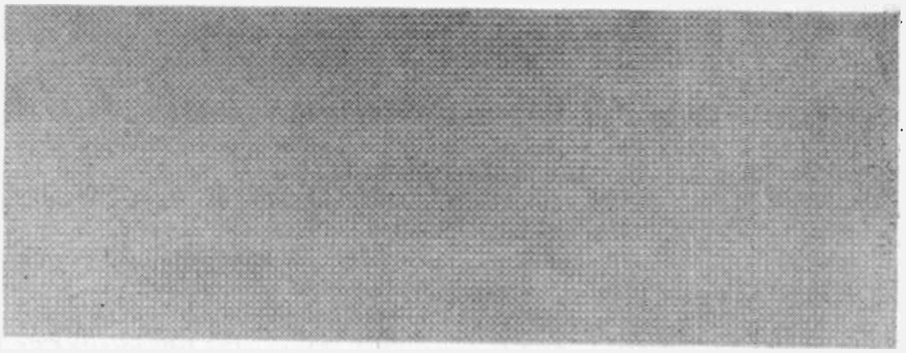
What you receive is what you get (see)! Assuming that your passive antenna is perfect so that it does not introduce ghosts, and ghosts still exist at the receiver, then the signal you are receiving is loaded with a strong multi-path signal that is not in step with the line-of-sight signal. Ghosts are what you will see. I say ghosts, because when there is one, there are usually several more. I have found that a highly directive TV antenna will greatly reduce the ghosts especially when you have a line-of-sight path to the transmitting antenna. Should you end up with too much signal, a simple resistive network can reduce the effect of the antenna's gain.

Twenty-one

I see a lot of people using wall-plug DC supplies as inputs to regulated power supplies for small projects. Is this a good idea?
—F.H., Redmond, WA

Sure is, provided the input voltage is high enough to regulate down and the current drain does not exceed the units design level. In fact, I put a variable supply on a 9-volt wall-plug to reduce it to 4.5-volts DC to power a Black Jack game calculator. I just got tired of buying 3 AA cells every week! No, I don't gamble, I use the calculator section. ■

NEW PRODUCTS PARADE



PLATED-THROUGH-HOLE BREADBOARD HOLDS UP TO 154 16 PIN DIPS

A new plated-through-hole circuit breadboard, with 66 square inches of component space, mounts up to 154 16-pin DIPs or any combination of large or small devices. The Model 8006 padperhole board, from Vector Electronic Company, can be used for breadboarding large circuits or can be cut into smaller sections for piggybacking on other circuit boards.

The board is made of 0.062-inch-thick FR4 green expoxy-glass material, with drilled, 0.043-inch-diameter plated-through hole on 0.1 centers. Copper pads, 0.080-inches in diameter, around each hole are one-half-ounce copper with reflowed solder plating. The board measures 5-inches high by 13.25-inches long (12.7 cm by 33.65 cm).

In single quantities, the Model 8006 is priced at $22.05; Delivery is from stock.

Vector Electronic Company, 12460 Gladstone Avenue, Sylmar, California, 91342; Telephone: (818) 365-9661.

NEW FIX-IT-KIT

If you ever tried to fix an appliance or tightened up inside screws on a late model car you may have discovered pozidrive or torx screws

These odd shaped fasteners need specially designed screwdrivers to fix them properly which is why the 30 piece FIX-IT-KIT has been recently introduced.

This handy kit is designed to help the do-it-yourselfer by providing just about every kind and size of bit needed to remove or install modern fasteners.

The FIX-IT-KIT contains: 5 Allen bits size 5/64, 3/32, 7/64. 1/8 and 9/64; 5 Spade bits size 0–1, 3-4, 5-6, 8-10 and 12-14; 4 Phillips bits sizes P0, P1, P2 and P3; Square Recess bits sizes R0, R1, R2 and R3; 6 Torx bits sizes T-10, T-15. T-20, T-25, T-30 and T-40; 2 Pozidrive bits size PZ1 and PZ2, 1/4 Square drive adaptor, 1 magnetic bit holder (for use with power tools), and 1 storage hand driver and 1 set box organizer.

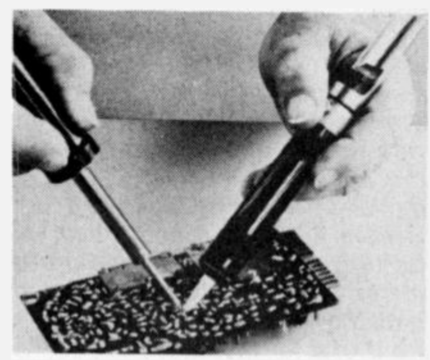
Bits are magnetic and can even be used in power tools that use removable bits.

FIX-IT-KIT is industrial quality and is made in U.S.A. The retail price of each kit is only $24.88 each plus $2.50 for shipping and handling, is fully guaranteed and available from TOOLS, ETC. 510 East Main Street, Louisville, Ky 40202

DP 1 DESOLDER PUMP

DP 1 Desolder Pump offers full industrial performance and features at an "economy" price. The DP 1 features all metal construction with precision components for maximum reliability and ease of operation. Suction is precisely regulated for efficient solder removal without damage to delicate circuitry.

The DP 1 is available in the standard version with long lasting teflon tip, as well as the deluxe static-safe version with special conductive tip and grounding provisions. All DP 1 models incorporate an integral safety shield for operator's safety.

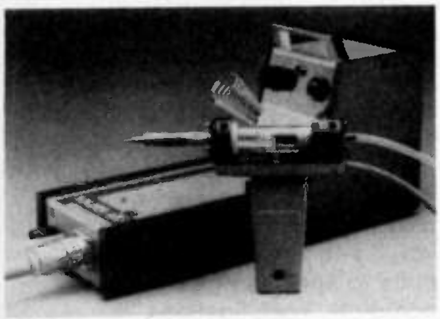


Self-cleaning on each stroke, the DP 1 is quickly dis-assembled without special tools for maintenance or repairs.

Replacement Teflon Tip Part No. 5000-0119. AUTOMATED PRODUCTION EQUIPMENT CORP. 42 Pecomic Avenue, Medford, N.Y. 11763

DESOLDERING SYSTEM

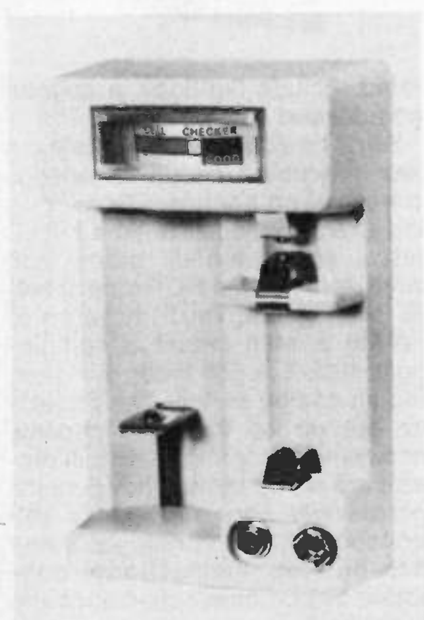
The portable, temperature adjustable, desoldering system Model SA-7 is the latest of a complete series of desoldering equipment from O.K. Industries Inc. The lightweight, pistol-grip shaped desoldering iron allows maximum comfort and board accessibility. The SA-7 requires no shop air, featuring instead a powerful self-contained vacuum pump. Straight flow-through design prevents clogging, and the transparent solder collector is easy to clean and replace, the unit also includes a



built-in tip cleaning rod stored conveniently in the handle. State of the art design with IC controlled ceramic heater allows adjustment of tip temperature for widest variety of desoldering applications. The SA-7 and replacement tips are available from stock at local electronics distributors nationwide or directly from O.K. Industries, 3455 Conner Street, Bronx, New York 10475.

BATTERY TESTER AND BUTTON CELL CHECKER

Checks under load, the standard "D," "C," "AA," "AAA," and 9.0 volt batteries. However, the Model CEC-1 features test slot terminals for the new popular "N" size battery—but more important, will test under load all popular button cell batteries. Normal packaging is blister pack for peg board hang-up



display. Contact: CENTURY ELECTRONICS CORP., 3511 N. Cicero Ave., Chicago, IL 60641, (312) 777-9700

SURGE-SENTRY DATA LINE PROTECTOR

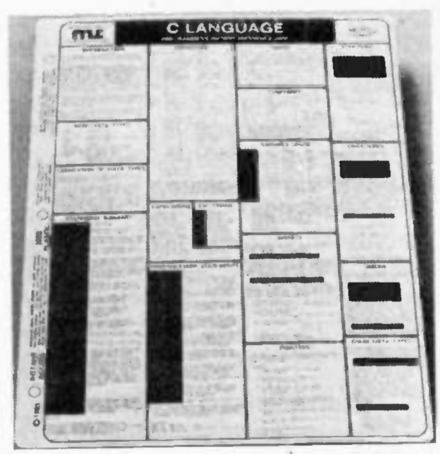
RKS Industries announces a two-stage level of protection for modems, computers and data communications lines. The SurgeSentry data line protector offers a level of protection against power-induced problems such as static, electrical storm and other electrical interference problems.

Transmission problems and board level failures occur with modems and other data communications devices when electrical energy acts upon the lines during a transfer of data. When a modem transmits its data signal via common long-distance telephone lines, that data is passed from sub-station to sub-station and finally transmitted to a receiving modem. As the signal is traveling, the telephone lines can pick up high-voltage spikes and transients caused by storms, nearby power stations and similar high-voltage sources. These disturbances are carried along with the data being transmitted and cannot be avoided. The data line protector constantly monitor the line as a passive device and, once a voltage spike is detected, the data line protector instantly clamps on the surge and absorbs the unwanted power from the data line.

The SurgeSentry data line protector retails for $89.95 and can be purchased directly from RKS Industries at 408/438-5760 in California and 800/892-1342 outside California. Volume purchase discounts are available. The company is located at 4865 Scotts Valley Drive, Scotts Valley, CA 95066.

COMPREHENSIVE REFERENCE CARD

If you program in the "C" language, or are learning it you can now get the info you need much faster from the first comprehensive C reference card. From Micro Logic Corp. of Hackensack, NJ, MICRO CHART #11 entitled, "C LANGUAGE" is a two-sided two-color 8-½ by 11" plastic card filled with 4 point type. It covers not only the full implementation of the language but auxiliary utilities too. The one sheet design gives you very fast lookups and higher programming productivity according to the publisher. Covered are: statement summary, basic data types, conversion of data types, operator definitions with precedences and associativity, escape characters, preprocessor statements, typedef, constants, scope



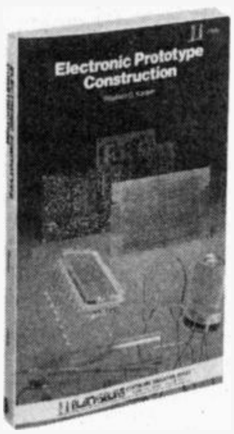
of variables, arrays, pointers, functions, structures, unions, enumerated data types, printf, scanf, the UNIX (tm) cc command, the lint command, and more.

MICRO CHART #11 and other summaries are available with a money-back guarantee for $5.95 each (plus $1 postage) from Micro Logic, POB 174, Dept. P, Hackensack, NJ 07602. (201) 342-6518.

NEW BOOK REVIEWS

BUILDING A BETTER PROJECT

Here is a book, *Electronic Prototype Construction* by Stephen D. Kasten ($17.95—paperback) that every project builder should read. Many books are being written in the wide-open field of electronics concerning the design of microcomputer and computer interfacing circuits. However, very little practical information is available concerning construction techniques for converting schematics and ideas into functional electronic prototype units.



This book was written to fill that gap. Its 399 pages can be divided into the following four major features: Wire-wrapping, printed-circuit boards, graphics techniques, and hardware packaging. If you are an active project builder, look into *Electronic Prototype Construction,* published by Blacksburg Continuing Educational Series, Howard W. Sams and Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268.

TALKING TO THE STARS

Here are some valuable tips on installing your own Earth station. It's all contained in *Satellite Communications* by Stan Prentiss. It provides up-to-date information on communication satellites presently in orbit and those under construction. You find it in a computer program that can make it easy to determine the proper elevation and azimuth of various satellites at any particular TVRO site. And there's much, much more. Written in logi-

cal, easy-to-follow format, it's a book that will bring you up-to-speed in all the various disciplines of satellite communications.

You'll discover the companies involved in satellite communications transmission, and get some fascinating details on new systems now under development. In addition the text covers such transmission means as TDMA, FDMA, and ALOHA!

If you are interested in installing your own personal Earth station, you will find Earth station basing diagrams, data on focal and Cassegrain feeds, low-noise amplifiers, down converters, receivers, and installation instructions. All that in language that can be understood without an advance engineering degree! Included are the facts on satellite and CATV measurements, and the fixed satellite service.

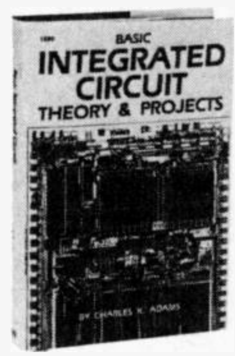
Stan Prentiss, a retired engineer from NASA's Goddard Space Flight Center, has designs flying on three satellites. He is a contributing editor for a satellite magazine and rates color television receivers for Consumers Guide.

The text is published by Tab Books, Inc. Blue Ridge Summit, PA 17214. It sells for $11.50 in paperback—contains 280 pages.

THE IC SOURCEBOOK

Basic Integrated Circuit Theory and Projects by Charles K. Adams ($11.95—paperback) is an ideal workbench guide for anyone who wants to learn how integrated circuits work and to begin using both analog and digital ICs in practical, working applications! No advanced math or science background is needed, because the author has broken down integrated circuit theory into easily digestible segments, complete with applications data and projects that provide you with hands-on use experience.

The text provides background you'll need to apply integrated circuits to specific projects. There are complete specifications for representative integrated circuits including analog devices and both simple and advanced 7400 devices. Applications information further aids your understanding of this versatile electronics technology. You'll get a look at analog applications for the MC14066B analog switch, the 555 timer, the LM340T-5 voltage regulator, the LM324 operational amplifier, and the MC1306P audio amplifier. Digital applications illus-

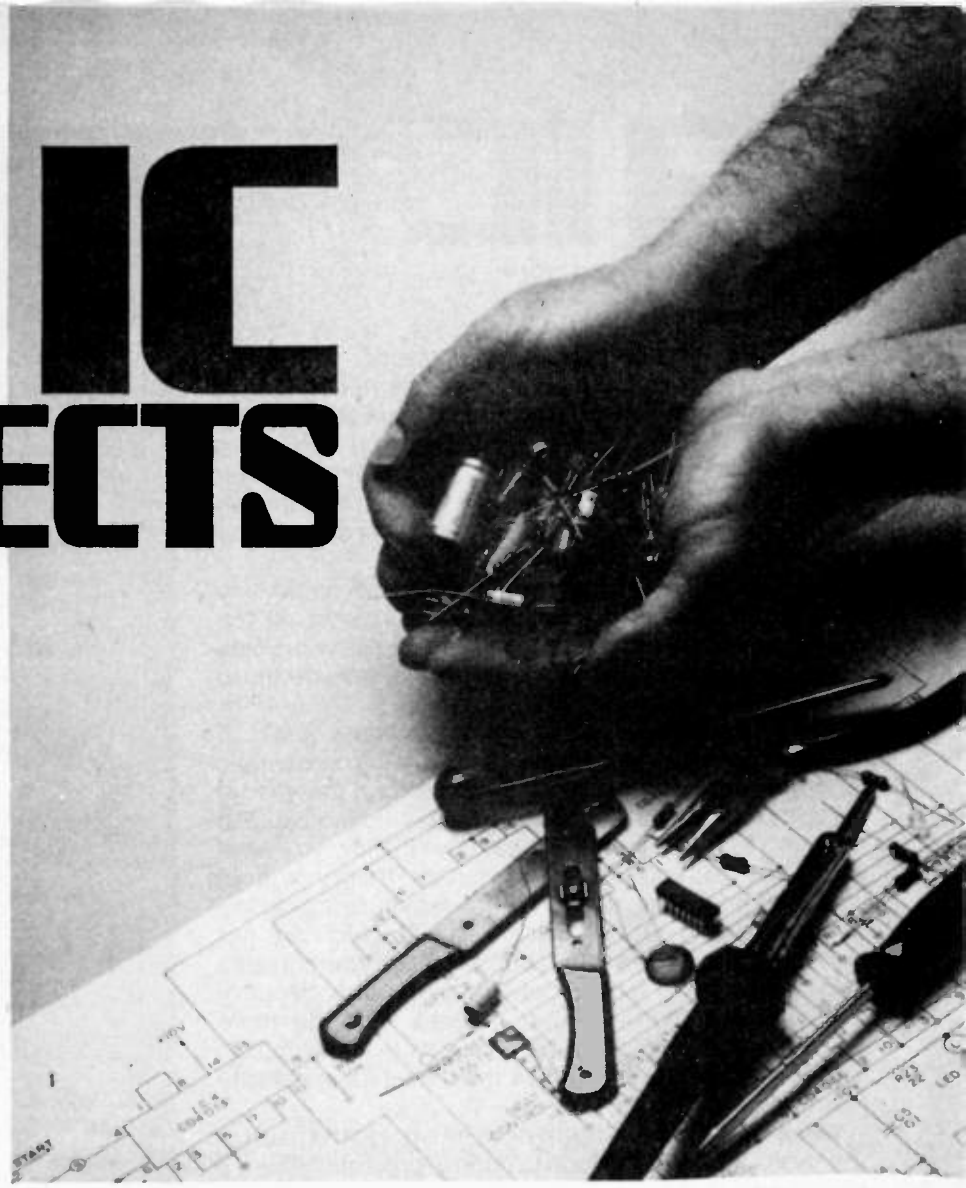


trated include flip-flops, a counter module, and a comparator.

You'll be able to immediately put your integrated circuit knowledge to work using a series of 24 exciting and useful projects. Build a NAND gates, series NAND gates, and wired AND gate, a NOR gate or series NOR gates. You'll move on to making a latch circuit, a complex logic circuit, a 555 timer one shot, and an analog switch. The projects are set up so that they become increasingly sophisticated as projects are set up so that they become increasingly sophisticated as you proceed. With each one you'll find step-by-step instructions, supported by complete schematics and diagrams. ■

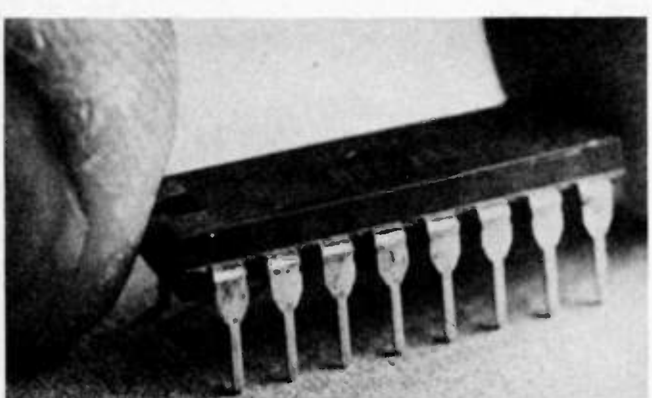
99 IC PROJECTS

1985 EDITION



Here is a cookbook of simple circuits—99 IC Circuits—that can either be the complete project you are seeking or the fractional portion of a larger project.

Look into the desk-top drawer used by any electronics hobbyist and you will find Xerox copies of several circuit that that person saves for a purpose. The nature of that circuit and its ultimate use is varied. The circuits have one thing in common—the experimenter believes that the circuits are valuable and essential to the practice of his hobby. Consider this magazine, 99 IC Projects, as the ultimate collection of circuits from many desk-top drawers, compiled by a hobbyist, your Editor, into one convenient format, corrected, updated, and provided with accurate Parts Lists that are valuable when ordering or buying the circuit elements.



Here's what it's all about, a typical DIP (dual in-line package) integrated circuit. This is a 16-pin package, but many of the ICs you'll be using are 14-pin units. Note the indentation at the left end—when it's facing towards you, the first pin to the right is #1, with pin numbers ascending in counter-clockwise order.

The collection of circuits in this magazine were selected so that their basic circuit action was taking place inside an integrated-circuit (IC) chip. The main advantage of IC's to the experimenter are identical to those of circuit designers and engineers. IC's extend to the circuit designer and project builder a compact, functional circuit element that is pre-designed to operate and perform a selected function saving design time and offering the opportunity to simplify the overall projects complex circuit.

Let us cite a typical example. The project builder need not concern himself with the many elements that make up an operational amplifier (op-amp). He is only concerned that the proper power supply voltage(s) is connected to its terminals, and that the choice of input and output terminals (if any) are correctly connected to the overall circuit. Some op-amps have multi-inputs that provide non-inverted and inverted outputs. The choice of gain-per-stage is available in many instances. We could go on to cover the many other circuit types available in IC's, and discuss the many dual, quad and hex combinations therein; however,

99 IC

lets not stray too far from 99 IC Projects!

In the early days of IC's, the unit costs were high and the availability was scattered and difficult to find. This discouraged project building. Today, you can buy a host of IC's in a local Radio Shack outlet. Mail-order companies abound and have "800" telephone numbers so you can dial FREE and use your credit card to pay for an order.

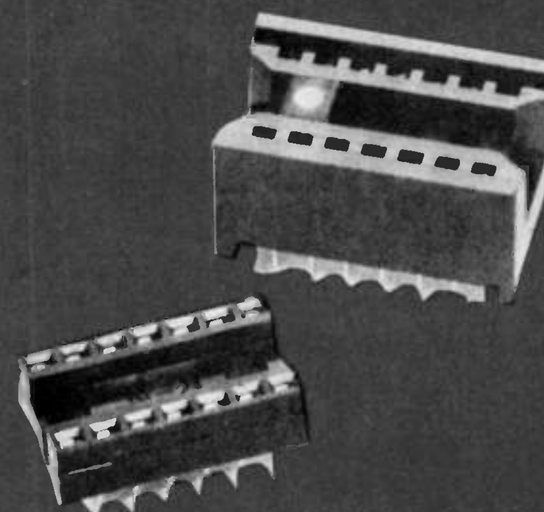
No Excuses! Too expensive, you say? Wrong! Many of the ICs used in the construction projects on the following pages can be had for $1.00 or less with some sharp shopping techniques, and we'll show you those techniques later on.

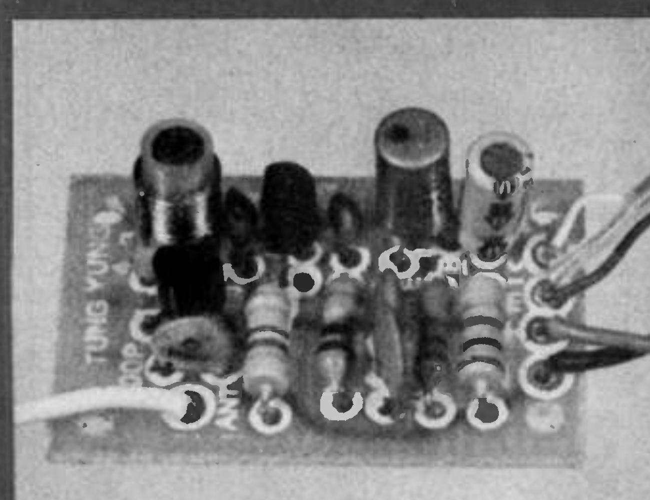
Too complicated, you say? Sorry, wrong again. If you've had any experience in following schematic diagrams to build transistor projects, or, for that matter vacuum tube projects, you'll have very little trouble in adapting to the use of ICs. Again, we'll show you what you need to know, both in circuit theory and in construction theory. And to help build your confidence, we've included 30 Transistor Projects which are not only useful in themselves, but will help you come to grips with solid state construction and circuitry techniques before you get involved with the more complex IC projects. In fact, you can actually "build" your own chip just to see how the digital logic actually functions inside an IC.

Heart of the Matter. Right now, let's get to the heart of the book, the 99 IC construction projects. Even if electronics is your number one hobby, as it is for us, most likely you have other pastimes as well. With this thought in mind, we have tried to bring you a selection of project ideas that will allow you to experience the satisfaction of building a working project that will also be useful to you in other areas. For the musically minded among you, projects such as Mini-Micro Metronome, Organ-Plus Tone Generator, Octave Music Maker, and Multi-Input Music Synthesizer will not doubt grace any practice or recording studio..For the inveterate gambler, Common Cathode Casino, LED Black Jack, and Even Odds will give you the thrill of victory, but not the agony of defeat at the gaming tables. You can use the money saved from gambling to built more projects.

The list goes on and on, and we're sure that you can find many alternative uses for these projects other than the ones which we've suggested. Additionally, you will soon see that many of the projects are compatible with each other. For instance, many of the burglar alarm circuits for both home and car require some sort of alarm device, such as a bell, buzzer, etc. You can combine them with the Two-Tone Siren to create a really formidable protection system.

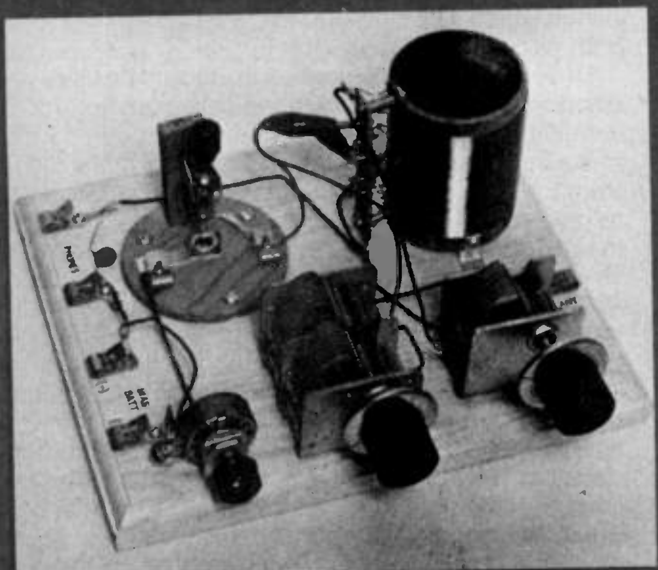
Perhaps the major reason for taking the time to inform you of these possibilities is that the actual text accompanying the projects is very brief—there's just enough there to let you know how to build the project,



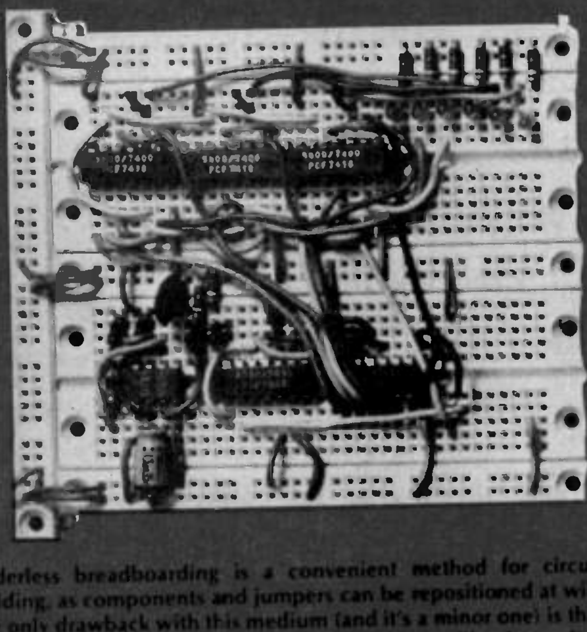


and in some cases how to operate it as well. This was done not because we're lazy, but because we wanted to leave as much as possible to your imagination. The schematics and parts lists have been checked, rechecked, and then checked again to provide you with trouble-free construction. We've also tried our hardest to limit the amounts of different parts you will require to assemble the projects. You will find that both the NPN and PNP transistors used throughout the magazine are of the "general replacement" variety, which means that you can pretty much substitute freely from the junk box. The same goes for the resistors and capacitors. You'll find that we've adhered to the most common values and tolerances—the ones which are easily found either around the shop or at any electronics and/or TV repair supply shop.

At any rate, be sure to see our article on "The Fine Art of Parts Buying" at the rear of the magazine. We've included a list of some of the more popular component outlets, and you can satisfy your parts needs from the pages of their respective catalogs.



The most rudimentary (and least expensive) method which you can use to breadboard a circuit is to use, well, a breadboard. Obviously this is where the name came from. You can use Fahnestock clips (seen at left) to secure all components on the board.



Solderless breadboarding is a convenient method for circuit building, as components and jumpers can be repositioned at will. The only drawback with this medium (and it's a minor one) is that it's not really a permanent setup and care in handling is needed.

Pay Attention! We would undoubtedly be remiss if we didn't pass along some of the do's and don'ts which pertain to the care and handling of integrated circuits during construction. No matter what construcion format you choose—solderless breadboarding, wire-wrap breadboarding (see the articles on these at the rear of the magazine) or even printed circuit construction, if you're so inclined, the following tips apply throughout, and we suggest that you read them carefully before you begin any work.

While integrated circuits are basically composed of groups of transistors and other standard electronics components, some types do require special handling on your part. CMOS types in particular are susceptible to damage in the most innocuous ways. For instance, even though many of these chips are designed with resistor/diode protection circuits on the input leads, it is possible for the slight static electrical charge which is normally built up in your body (your body, by the way, happens to be an excellent natural capacitor) to ruin part or all of a chip's circuitry just by touching the pins when removing it from the packing. A good idea here is to ground yourself by wrapping a few turns of wire (be sure to strip off the insulator if you use insulated wire here—otherwise bare wire will work fine) around your metal wristwatch band, and connect the other end of the wire to a good electrical ground. Alternatively, you can purchase a pair of non-conductive tweezers with which to handle the ICs. There are also IC installers/removers made for the express purpose of handling the ICs when using sockets.

If You Must Solder. If you plan on soldering the IC leads directly into the circuit, something which we do not recommend, there are several precautions which you'll have to take to avoid ruinig your precious ICs. To begin with, put your heavy duty soldering gun on the shelf. Use no more than a 15-watt straight iron. If the iron you have, or the one you contemplate purchasing, does not have a grounded tip, then you'll have to attach a ground lead to the coolest point on the tip, much as you did for personal grounding, as we mentioned earlier. Stray AC in the tip can kill a chip just as surely as stray static charges can. The reason we specify a low power iron, is for the simple reason that the ICs are rather sensitive to heat as well, and you stand a much less chance of doing damage with a smaller iron than you do with a larger one.

Our strong recommendation is that you invest in IC sockets which can be soldered into the circuit directly, and which allow you to insert the IC at such a time as you have checked all the wiring connections and all the voltages to assure safe operating conditions for the IC. The first time you find a potentially damaging wiring error in checking out a socket setup, the price you paid for the socket will have been refunded to you by saving a more expensive chip from destruction.

Again, refer to the articles on solderless breadboarding and wire-wrap breadboarding for easy, convenient methods of wiring up your projects. The added feature of both these methods is that they both allow for easier troubleshooting when de-bugging a circuit that doesn't work quite right the first time out.

Troubleshooting. When de-bugging a circuit, or testing for signal levels or voltages prior to firing up your project for the first time, it is important that you remember to NEVER apply an input signal to a chip unless the entire circuit is powered up. It is almost a certainty that you will cause an overload potential within the chip that cannot be safely dissipated without the power switch being closed, thereby completing the circuit. The damage will usually be irrevocable. For those projects which require a separate input signal, such as a clock source, it's a good idea to power the clock source off the main circuit's power supply if at all possible. This will minimize the possibility of applying the signal to an unpowered chip. Alternatively, if it is impossible to utilize the same power supply for both the signal source and the main project, use a DPST switch which will allow you to control the power feed to both circuits simultaneously.

Of course, the same procedure should be used when disconnecting a circuit as well. If you do not use simultaneous switching or a common power supply, make sure that you remove the external signal source from the chip before shutting down the circuit. Just try to reverse the steps you took in hooking up the circuit in the first place, and follow them in reverse order when shutting down. It's simple, but also easy to forget.

In Conclusion. We've tried to make this issue of 99 Integrated Circuit Projects as self-contained as possible, with as much construction technique and circuit theory as is necessary for you to get the utmost out of the projects we've outlined. Please do take the time to read the articles we've collected on different circuit construction formats, and especially the short course. "Understanding Logic Circuits" by Technical Editor Gordon Sell in which he explains (as painlessly as possible, I promise) the inner workings of the digital integrated circuits with which you will soon become familiar. Then, try your hand with some of the 30 Transistor Projects just as a warmup to perfect your wiring techniques. After that, it's full speed ahead with the IC projects. When you're done, you'll probably wonder why it took you so long to get into IC electronics. Don't worry though, you're not alone. You'll also no doubt be glad you did. You won't be alone in that thought either! ■

1 PHOTOG'S DENSITOMETER

Using the correct grade of paper (from 0 to 5) may seem like a simple choice, but photographer's buy expensive densitometers just for that purpose. Here are the plans for a simple unit that'll take care of your darkroom's needs for many years to come.

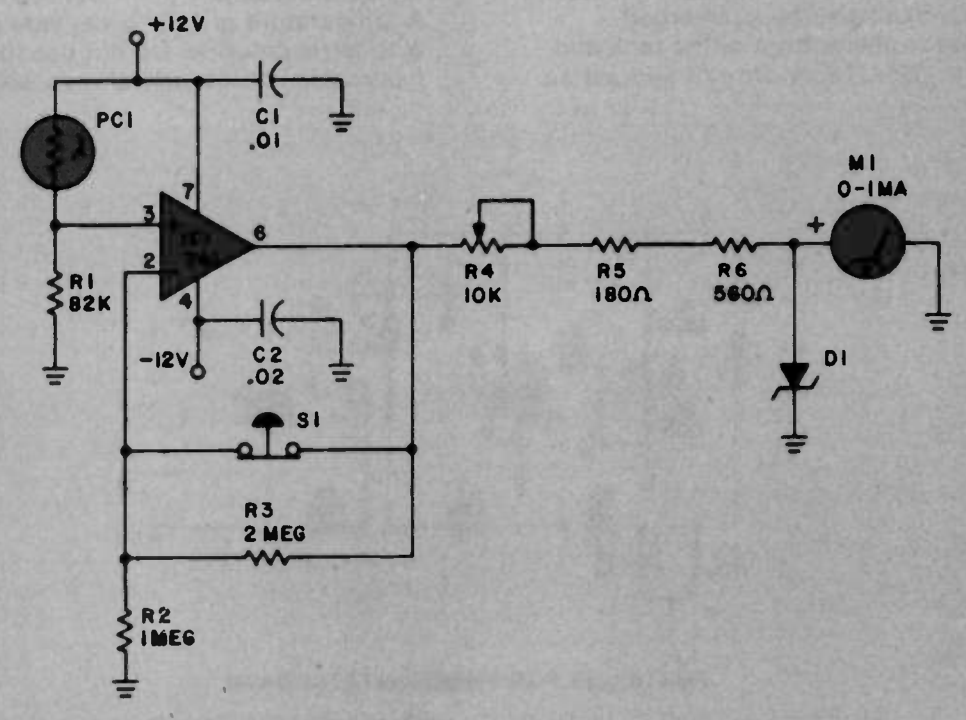
No attempt is made to calibrate the Photog's densitometer other than application and use in the darkroom. Through trial and error, you can so calibrate the meter so that the correct paper will be used. Using a mathematical approach will bring you close to the mark; however, in many instances allowances have to be made and those adjustments bring it all back to trial and error. If that's where you end up, start there!

The ratio of R5 to R6 should be 1/3 exactly. One percent resistors will do the job, however a good match selected by a DMM will be good enough. Use 5% resistors throughout for the other fixed resistances—that's good enough. Potentiometer R5 can be any 10,000- or 15,000-ohm potentiometer. IC1 is a 741 op-amp, but any available unit (equivalent or better) will do.

The dual 12-volt power supply should be regulated. The entire unit should be mounted in a plastic box with the photoresistive cell mounted in an opaque plastic disc connected to the case via a flexible cable. An old headset lamp cord will do. You don't want the light-weight cell assembly moving about because of the unwinding of a stiff cable. The plastic disc may be the cap from a 35-mm film container. Drill a hole 3/16-7/32-in. hole in the cap. (A soldering iron tip of the right diameter will melt the hole in the cap.) The disc is placed on the enlarger print surface and should be reasonably flat—close to the surface. The photoresistive cell is mounted under the hole. RTV cement will hold it in place.

IC1 has two inputs. One leg is from the PC1 circuit and the other is the feedback via S1 or R3 when S1 is depressed. When light hits the plastic disc passing a measured amount of light through to PC1, the internal resistance of PC1 decreases supplying a higher potential to the non-inverting input (pin 3) of IC1. The feedback voltage via S1 or R3 to the inverting input (pin 2) of IC1 tries to reduce the overall effect of the input. The IC produces an output voltage proportional to the combined inputs. That output determines the meter action.

How to use—Set up a typical enlargement scenario.



PARTS LIST FOR PHOTOG'S DENSITOMETER

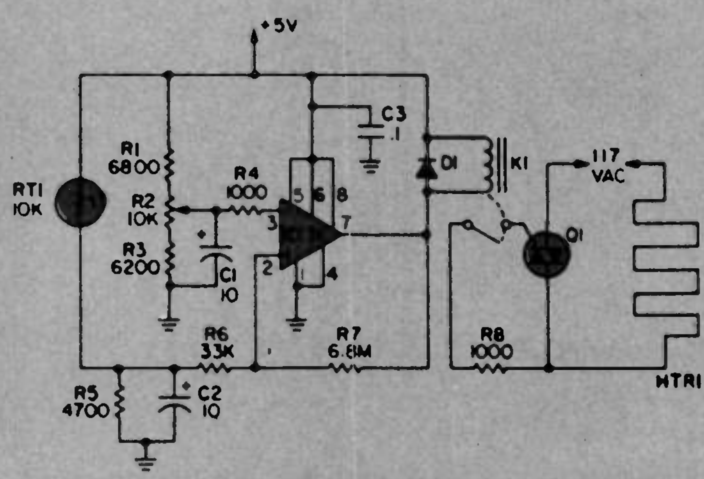
- **C1, C2**—.01-uF disc capacitor
- **D1**—1.5-2.2-volt Zener diode (see text)
- **M1**—1-milliampere DC meter
- **IC1**—741 op-amp
- **PC1**—photoresistive cell, any hobby-type available
- **R1**—8200-ohm, ¼-watt, 5% resistor
- **R2**—1-Megohm, ¼-watt, 5% resistor
- **R3**—2-Megohm, ¼-watt,5% resistor (see text)
- **R4**—10,000-15,000-ohm potentiometer, log-taper, potentiometer
- **R5**—180-ohm, ¼-watt, 5% resistor
- **R6**—560-ohm, ¼-watt, 5% resistor
- **S1**—SPST pushbutton switch, normally closed

Place the disc (PC1) under the brightest area in the negative and set the meter (M1) for full-scale deflection. Now relocate the disc under darkest area that is projected on the enlarger board and record the meter readind. From past experience, guess at the paper grade you should use and make three exposures using the guessed at value, and values one above and one below. One developed exposure will be the best one to your way of thinking. Make a notation of the meter reading and the paper grade that gives the best result. After several plottings with different quality prints, you'll have enough data to mark the meter scale so that it indicates the paper you should use for future readings.

Switch S1 should be depressed whenever there's not enough light to take a reading of the dark scale after the meter has been initially set to full scale at the brightest setting. If R3 is 1 Megohm, the scale reading will be doubled; for R3 equal to 2 Megohms, tripled; for 3 Megohms, quadrupled; etc. Start off using a 2-Megohm resistor for R3 and see if that is best for the match between the meter and photoresistive cell you are using. Diode D1 is a Zener diode rated at 1.5- to 2.2-volts. You could use three rectifying diodes in series. D1 serves to protect meter M1 from hark "kicks" when the room light is turned on. In fact, to avoid such events, the power on switch could be a DPST pushbutton switch. When you walk away from the unit to open the darkroom door, the normally-open switch would disconnect the dual-power circuit.

2 THERMOSTATIC BATH

□ Maintaining a volume of solution at constant temperature is easy if you do it electronically. Photographic processing is the obvious application for a thermostatic bath, but if you etch your own printed circuits, you can also use it to keep your etchant hot. Thermistor RT1 comes packaged as a small glass probe. Waterproof it with several coats of epoxy, and mount it below the surface of the fluid in your tank. The heating element, HTR1, must also be submerged—preferably close to the bottom of the tank and away from RT1. (CAUTION: Do not operate an immersion heater in open air.) Heater wattage depends upon the volume of solution you wish to heat. A 500-watt heater will raise two gallons of water from 70° to 120°F. in half an hour or so. Conventional brass or stainless steel heaters are perfect for a simple water bath, but if you plan to heat an etchant like ferric chloride, get a quartz immersion heater. Pot R2 sets the bath temperature at any point between 70° and 160°F. A temperature of 115° gives safe and fast etching with ferric chloride. Do not use this bath with flammable liquids, and always wear goggles.

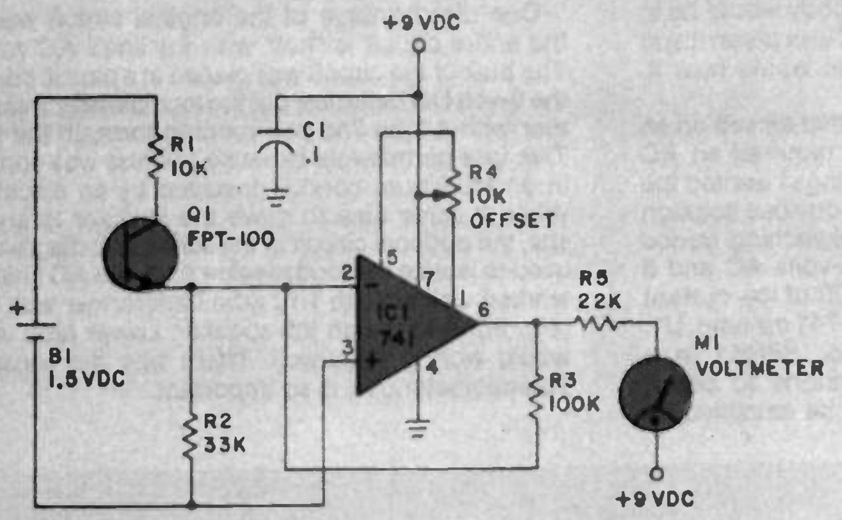


PARTS LIST FOR THERMOSTATIC BATH

C1, C2—10-uF, 10-VCD tantalum capacitor
C3—0.1-uF ceramic disc capacitor
D1—1N914 diode
HTR1—200 to 500-Watt immersion heater (see text)
IC1—LM311 comparator
K1—6-VDC, 500-ohm relay
Q1—200-VDC, 10-A triac
R1—6,800-ohm ½-watt resistor (all resistors 5% unless otherwise noted.)
R2—10,000-ohm linear-taper potentiometer
R3—6,200-ohm, ½-watt resistor
R4—1,000-ohm, ½-watt resistor
R5—4,700-ohm, ½-watt resistor
R6—33,000-ohm, ½-watt resistor
R7—6,800,000-ohm, ½-watt resistor
R8—1,000-ohm, 1-watt resistor
RT1—10,000-ohm, @ 25° Thermistor (Fenwal 6B41P12 or equivalent)

3 BASIC LIGHT METER

The beauty of this Basic Light Meter is that it is almost perfectly-linear over a wide range of light inputs for most frequencies of visible light. It provides you with the basic operation of a camera light meter and can be made to read directly in f-stops and shutter speed. Phototransistor Q1 senses the light level and passes that on to the 741 op-amp where the small voltage is amplified. Meter M1 is any instrument you currently have around the house, or any inexpensive meter you can buy. Potentiometer R4 provides a zero adjustment for the meter.



PARTS LIST FOR BASIC LIGHT METER

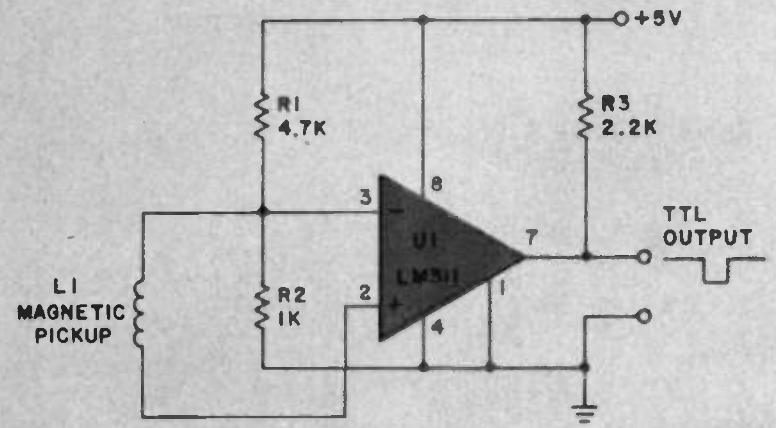
B1—1.5-volt DC dry cell
C1—.1-uF, ceramic capacitor
M1—See text
IC1—741 op-amp
Q1—FPT-100 phototransistor
R1—10,000-ohm, ½-watt, 10% resistor
R2—33,000-ohm, ½-watt, 10% resistor
R3—100,000-ohm, ½-watt, 10% resistor
R4—10,000-ohm, linear-taper potentiometer
R5—2,200-ohm, ½-watt, 10% resistor

4 MAGNETIC TRANSDUCER DETECTOR

What any circuit would like to see is a nice clean squarewave-like pulse that replaces the practically obscene waveform detected by magnetic detectors. That's the function of this circuit.

Imagine a piece of rotation machinery carrying a permanent magnet past the magnetic pickup, L1. The signal, along with a bit of DC biasing from the junction of R1-R2 is delivered to a LM311 (voltage comparator) inverted input, which in turn delivers a clean TTL-type square pulse at its output. The output is held high until a pulse is detected, then it drops to a low (approximately zero volts). This clean output can be used to determine pulses per unit time in an integrating circuit, or it can be applied directly to a counter to determine the total pulses for any interval.

The magnetic pickup may be any commercially-available pickup, or it can be fabricated by winding 100 to 300 turns of #30 plastic-insulated (wire-wrap type) wire on a ¼-inch diameter plastic (non-metallic) form. Depending on the size of the magnet and its proximity to the detector, more, or less, windings will be required. It will take a little practice.



PARTS LIST FOR MAGNETIC TRANSDUCER DETECTOR

R1—4700-ohm, ½-watt, 5% resistor
R2—1000-ohm, ½-watt, 5% resistor
R3—2200-ohm, ½-watt, 5% resistor
L1—Magnetic pickup (See text)
U1—LM311 voltage comparator integrated circuit

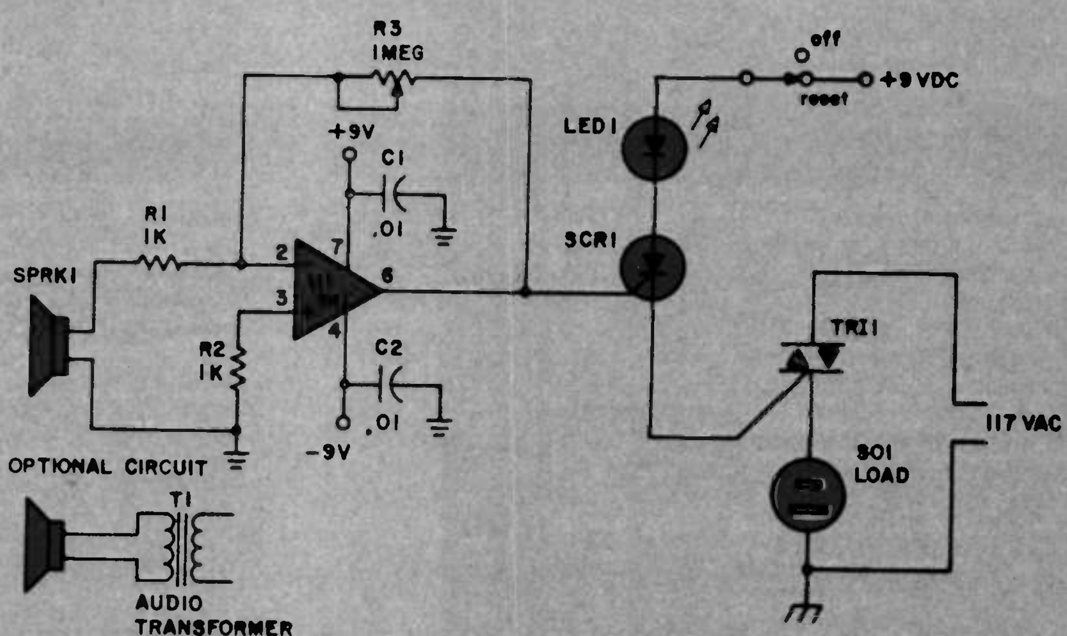
5 SOUND-ACTIVATED SWITCH

I used an intercom system for some time to monitor the action in the rear of my building. There's a lot of materials out there that some people like to borrow—permanently. So I would listen, or whoever was in the office would listen.The end result was that after a few hours, the volume control would be turned down, because the ambient low-level neighborhood noise coming over the intercom drove people out of their minds. (Me, too!). Also, at times nobody would be in the office area so that when a sound was present and amplified over the intercom, no one would hear it. What to do?

The solution was a sound switch that kicked on an indoor and outdoor alarm. Also, I required an AC circuit switcher because in the evenings I wanted the alarm to turn on a spotlight. So, the obvious solution was to design around a GE Triac switching device (TRI1). I used a Triac rated at 200-volts AC and 6 amperes. I fired the Triac with an SCR of low current rating, and that in turn was fired by a 741 op-amp, U1.

I used a 5-inch loudspeaker for SPRK1 in a weatherproof housing as a microphone to detect sounds. The detected signal would be amplified by U1 and supplied to the SCR gate as a triggering pulse. Potentiometer R3 varied the op-amp's gain so that the rushing wind would not trigger the circuit. LED1 offers a visual indication when the SCR is fired, but with a 6-inch bell connected to the circuit, there is no doubt as to its conduction. S1 is used to reset the alarm circuit since once triggered, current will flow until the SCR is shut down.

One disadvantage of the original circuit was that the entire circuit is "hot" with the line's AC voltage. The bulk of the circuit was placed in a plastic box with the 9-volt DC batteries, but the loudspeaker was in the rear with a long line pair running through the plant. This was permissible because the line was enclosed in an aluminum conduit installed by an electrician. When it came time to move the speaker to another site, the optional circuit in the schematic diagram was used to isolate the loudspeaker from the AC line. This worked well with an 1:10 ratio transformer with an 8-ohm input to match the speaker. Lower ratio values would work just as well. That's why the sensitivity potentiometer, R3, is so important.



PARTS LIST FOR SOUND-ACTIVATED SWITCH

C1, C2—.01-uF, 16-WVDC ceramic disc
LED1—Light-emitting diode, any color
R1,R2—1000-ohm, ¼-watt, 5% resistor
R3—1-Megohm, audio-taper, potentiometer
S1—SPST toggle switch
SCR1—Silicon-controlled rectifier, 200-volts DC, 1 amp
SO1—AC socket
SPKR1—3- to 8-inch PM loudspeaker—any available type from 3.2-to 16 ohms
T1—Audio transformer to match speaker input, 1:1 to 1:10 ratio output
TRI1—Trlac, 200-volts DC, 6 amperes
U1—741 op-amp integrated circuit

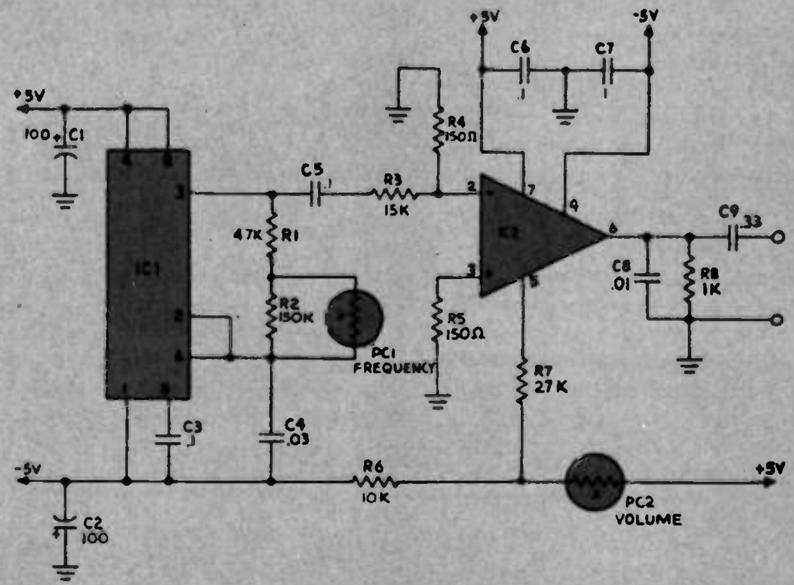
6 THEREMIN JUNIOR

☐ Let's return now to prehistoric times, at least as far as electronic music is concerned. Way back then, nearly forty years ago, an odd-looking and equally odd-sounding instrument known as the Theremin was born. Playing the Theremin entailed waving one's arms spastically between two sets of antennas. The purpose of all this was to modulate the RF fields in the vicinity of these antennas, thereby producing accompanying changes in the frequency and volume of the sound emitted by the instrument.

Controlling the sound was both difficult and inexact. As a result, the Theremin never gained widespread popularity, but was instead relegated to the domain of avant-garde composers and science-fiction-movie soundtracks.

Despite the shortcomings, the Theremin is great fun to play, so we decided to create a simple solid-state circuit. Theremin Junior, for those of you too young to have experienced the real thing. In this instance, photocells replace the Theremin's antennas. To play, you move your hands to cast shadows on two photocells, one of which controlls pitch—the other, volume. PC1, the pitch-control photocell, varies in resistance as the intensity of the light shining on its surface varies. This causes a change in the frequency of square-wave oscillator IC1.

Similarly, modulating PC2's resistance with light changes the voltage at pin 5 of IC2, which controls the gain of the circuit. High light intensity results in high frequency and high volume. Frequencies between 150 and 4800 Hz, approximately, can be produced at a maximum amplitude of about 0.5 volt peak-to-peak.



PARTS LIST FOR THEREMIN JUNIOR

C1, C2—100-uF, 16-WVDC electrolytic capacitor
C3, C5, C6, C7—.1-uF ceramic disc capacitor
C4—.03-uF mylar capacitor
C8—.01-uF mylar capacitor
C9—.33-uF mylar capacitor
IC1—555 timer
IC2—RCA 3080 transconductance op-amp
PC1, PC2—cadmium sulfide photocell (Radio Shack 276-116 or equiv.)
R1—4,700-ohm, ½-watt 10% resistor
R2—150,000-ohm, ½-watt 10% resistor
R3—15,000-ohm, ½-watt 10% resistor
R4, R5—150-ohm, ½-watt 10% resistor
R6—10,000-ohm, ½-watt 10% resistor
R7-27,000-ohm, ½-watt 10% resistor
R8-1,000-ohm, ½-watt 10% resistor

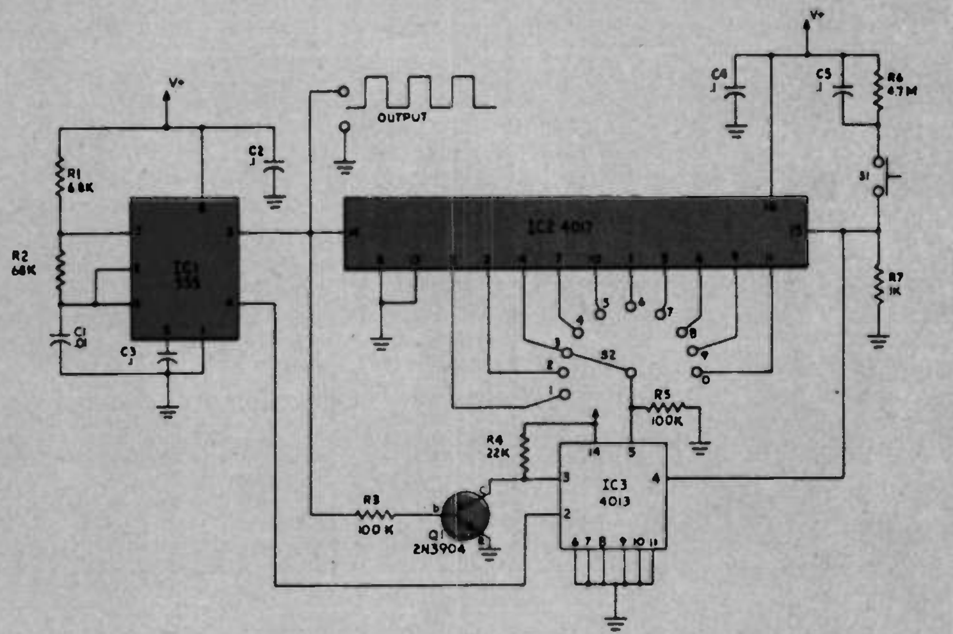
7 MELODIOUS SEQUENCER

☐ Press pushbutton S1, and this circuit will play you a short melody up to nine notes long. The immediate effect of pressing the button is to reset counter IC2 and set pin 3 of the counter HIGH. A voltage, determined by the setting of the pot attached to pin 3 of IC2, gets fed to the input of voltage-controlled oscillator IC3.

IC3's output consists of either a squarewave or a triangular wave, one of which can be selected by S2. The frequency of both these waveforms is identical and is determined by the voltage fed to the VCO. Potentiometer, R21 is the circuit's volume control.

Meanwhile, back at counter IC2, a pulse has just arrived from oscillator IC1. This increments the counter by one, causing pin 2 of the counter to go HIGH, and pin 3 to return to a LOW state. Successive pulses from IC1 cause the HIGH signal to advance along IC2's output (3, 2, 4...9). The ninth pulse send pin 11 high, thereby turning Q1 on and halting the oscillation of IC1. Pressing S1 sends pin 11 LOW and allows normal sequencing to resume.

Potentiometer R3 controls the tempo, which can be varied from 5 notes per second to one note every two sèconds. Trimmers R6 through R14 are used to set the pitch of individual notes over the range from 200 to 2000Hz. If you desire a shorter sequence of notes, omit pots and diodes from end of the sequence starting with pin 9 of IC2 and working backwards.



PARTS LIST FOR MELODIOUS SEQUENCER

R1—6,800-ohm, ½-watt 10% resistor
R2,—47,000-ohm, ½-watt 10% resistor
R3—500,000 trimpot resistor
R4—3,900-ohm, ½-watt 10% resistor
R5—33,000-ohm, ½-watt 10% resistor
R14—20,000 trimpot resistor
R15—4,700,000-ohm, ½-watt 10% resistor
R16—1,000-ohm, ½-watt 10% resistor
R17—68,000-ohm, ½-watt 10% resistor
R18—10,000-ohm, ½-watt 10% resistor
R19—18,000-ohm, ½-watt 10% resistor
C1—100 uF, 25-WVDC electrolytic capacitor
C2, C4, C5—.1 uF, ceramic disc capacitor
C3—3.3 uF, 25-WVDC electrolytic capacitor
C6—.001 uF polystyrene capacitor
C7—.02 uF, mylar capacitor
C8—.47 uF, mylar capacitor
D1-D9—1N914 silicon diode
IC1—555 timer
IC2—4017B CMOS decade counter
IC3—LM566 voltage-controlled oscillator
Q1—2N3904 PNP transistor
R20—4,700-ohm, ½-watt 10% resistor
R21—5,000-ohm, audio-taper potentiometer
S1—SPST normally open pushbutton switch
S2—SPDT switch

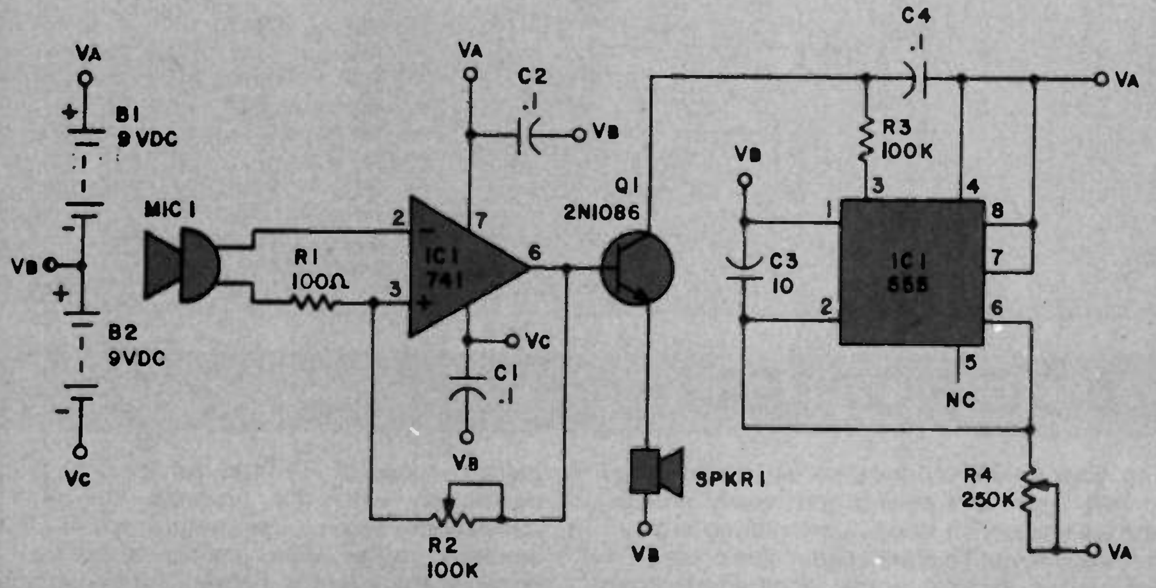
8 VOICE FROM THE BEYOND

At your club's next meeting, why not have Madam Sprocket conduct a seance with a very vocal assistance that's only a voice—an eerie voice. The voice should be that of friend to the group who knows all their personal background, and can humorously taunt them with comments that come from the fourth dimension.

The human voice is operated on what we call the "Voice from the Beyond" amplifier. The 741 op-amp (that old work horse) amplifies the signal from the microphone. The output of the op-amp (IC1) drives audio transistor Q1 (we have to use them once in a while) which in turn drives SPKR1, the loudspeaker. Potentiometer R4 controls the gain of the stage. Don't worry to much about overdriving Q1. The poor sound quality will disguise your voice. Use a high-impedance microphone for MIC1.

IC2 forms a triangular wave that appears at the speaker output when Q1 saturates. The high gain of IC1 can be reduced a bit so that the voice can be understood, but not recognized.

The power supply requires at least two of the three voltages to be disconnected to down-power the circuit; otherwise, no sound will be heard but the batteries will be losing power wastefully. The batteries may be of the transistor-radio type so the entire device, except for the speaker, may be contained in a small chassis box.

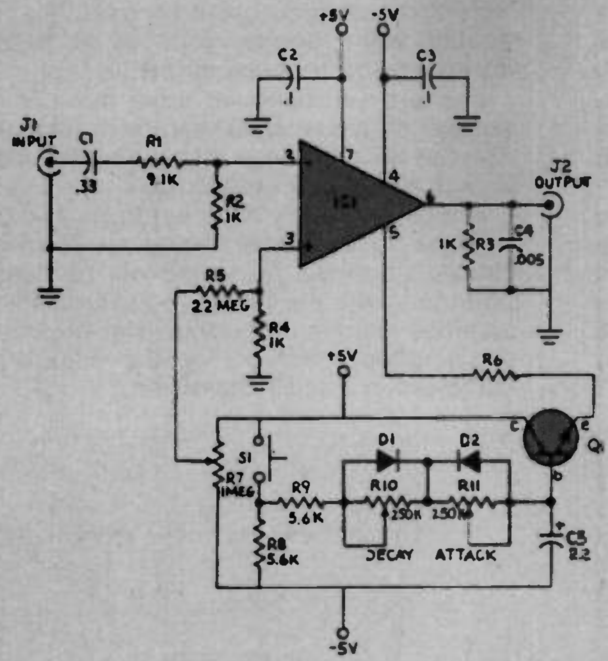


PARTS LIST FOR "VOICE FROM THE BEYOND" AMPLIFIER

- **B1, B2**—9-volt DC transistor-radio type
- **C1, C2, C4**—.1-uF ceramic capacitor
- **C3**—10-uF, 25-WVDC electrolytic capacitor
- **IC1**—741 op-amp
- **IC2**—555 timer integrated circuit
- **MIC1**—high-impedance ceramic microphone
- **Q1**—2N1086 germanium NPN transistor (almost any similar type transistor will function in the circuit)
- **R1**—100-ohm, ¼-watt, 10% resistor
- **R2**—100,000-ohm, linear-taper potentiometer
- **R3**—100,000-ohm ½-watt, 10% resistor
- **R4**—250,000-ohm, linear-taper potentiometer
- **SPKR1**—5-in diameter PM loudspeaker.

9 MUSICAL MODULATOR

□ Feed this circuit a sample audio tone, and it gives you back a musical note with selectable attack, sustain and decay. Input impedance is 10,000-ohms, output impedance is 1000-ohms, and the gain is unity. Best results will be obtained with signal imputs having amplitudes of 1-volt peak-to-peak or less. When S1 is pressed, the output volume rises at a rate determined by attack control R11. As long as S1 is pressed, the sound will be sustained. Releasing S1 causes the note to decay at a rate determined by decay control R10. Try sine, square or triangular wave inputs for musical notes. With a noise input you can imitate such things as gunshots and explosions. Trimmer R7 can be adjusted to cancel out any audible "thumping" (noticeable with very rapid attack or decay).

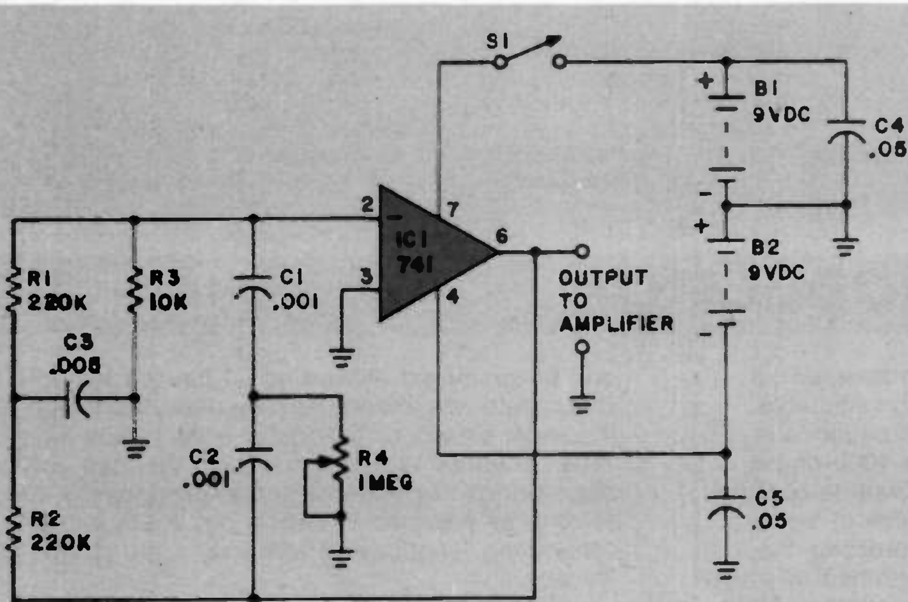


PARTS LIST FOR MUSICAL MODULATOR

C1—0.33-uF capacitor, 35-WVDC
C2, C3—0.1-uF mylar capacitor, 35-WVDC
C4—0.005-uF electrolytic capacitor, 16-WVDC
C5—2.2-uF electrolytic capacitor, 16-WVDC
D1, D2—1N914 diode
IC1—RCA CA3080 transconductance amp
J1, J2—phone jack
Q1—2N3904 NPN transistor
R1—9100-ohm, ½-watt 10% resistor
R2, R3, R4—1000-ohm, ½-watt 10% resistor
R5—2.2 Megohm-ohm, ½-watt 10% resistor
R6—15,000-ohm, ½-watt 10% resistor
R7—1 Megohm trimmer potentiometer
R8 R9—5600-ohm, ½-watt 10% resistor
R10, R11—250,000 linear-taper potentiometer
S1—normally open SPST pushbutton switch

10 DOG HOWLER

The Dog Howler will produce an ear shattering dog-like howl that starts strong and slowly grows weaker and weaker until it stops. Just the thing to play after a werewolf movie! To start it again, just press S1. Useful for alarms, bicycle horns, a different type doorbell, or as a Halloween trick. Changing R1 will change the frequency, or pitch of the howl, but the main purpose of R1 is to set the filter circuit into oscillation with the op-amp. Adjust R4 until oscillations begin. The output should go to an amplifier rather than just to a speaker directly because the effect is better. The added zonk of an amplifier will add a wierd zound dimension.

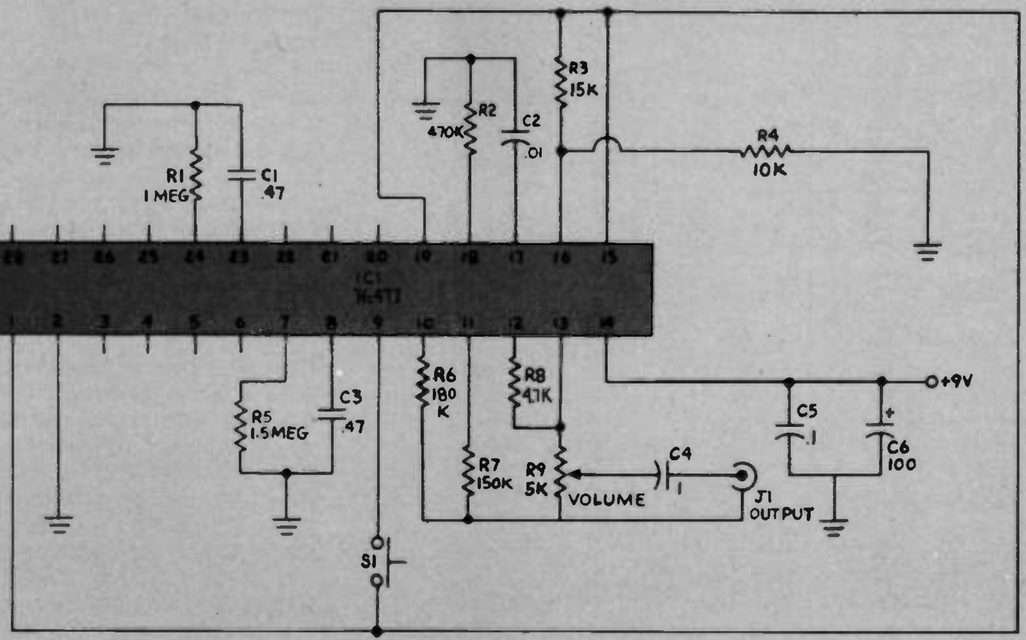


PARTS LIST FOR DOG HOWLER

B1, B2—9-volt DC, transistor-radio -battery
C1, C2—.001-uF, ceramic disc capacitor
C3—.005-uF ceramic disc capacitor
C4, C5—.05-uF, ceramic disc capacitor
IC1—741 op-amp
R1, R2—220,000-ohm, ½-watt, 10% resistor
R3—10,000-ohm, ½-watt, 10% resistor
R4—1-Megohm, linear-taper potentiometer
S1—SPDT, pushbutton switch

11 FEATHERWEIGHT FOGHORN

☐ Despite its small size, the circuit generates an authentic-sounding foghorn blast. Couple the output signal to a good amp and loudspeaker, press switch S1, and you'll unleash a blast that will untie the shoelaces of anyone within hearing distance. The output signal has a 1-volt peak-to-peak maximum amplitude, which is just right for driving the AUX or TUNER inputs of most hi-fi or PA amplifiers. You can change the pitch to suit your own taste by substituting a different value of resistance for R2; larger resistances lower the pitch while smaller ones raise it. Be sure to use a socket with the IC.



PARTS LIST FOR FEATHERWEIGHT FOGHORN

R1—1 Megohm-ohm, ½-watt 10% resistor
R2—470K-ohm, ½-watt 10% resistor
R3—15K-ohm, ½-watt 10% resistor
R4—10K-ohm, ½-watt 10% resistor
R5—1.5-Megohm-ohm, ½-watt 10% resistor
R6—180K-ohm, ½-watt 10% resistor
R7—150K-ohm, ½-watt 10% resistor
R8—47K-ohm, ½-watt 10% resistor
R9—5K audio-taper potentiometer
S1—SPST normally open pushbutton switch
C1, C3—0.47-uF mylar capacitor, 35-WVDC
C2—0.01-uF mylar capacitor, 35-WVDC
C4—1.0-uf mylar capacitor, 35-WVDC
C5—0.1-uf ceramic disc capacitor, 35-WVDC
C6—100-uF electrolytic capacitor, 16-WVDC
IC1—SN76477 sound generator
J1—phono jack

12 NOTE GENERATOR

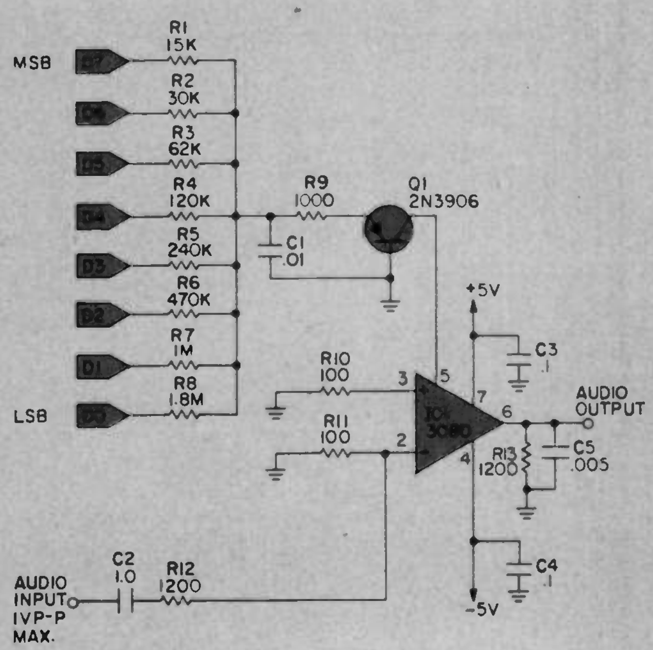
☐ This is a good companion to the computer-controlled note generator. Your computer should have available an 8-bit parallel port with which to control the keyer's gain. Feed the desired audio tone to the keyer's input, and hook an amplifier to its output.

A binary zero on the 8 lines from your computer yields zero output, while a binary 255 (11111111) provides maximum output. (D7 is the most-significant bit, and D0 is the least significant.) During a note's attack interval, count upwards from 0 to 255. Conversely, count down from 255 to 0 to make the note decay. Take tiny steps for best results. Large steps generate thumping sounds in the output.

Let's say we want a fast attack time of 10 milliseconds. Using all available codes, it will take 255 steps to climb from zero to full output. For simplicity's sake, we'll let the note's amplitude rise linearly during attack, which means that the code will be incremented at regular, fixed time intervals. Since we wish to take 255 steps in 10 milliseconds (10,000 microseconds), it will be necessary to increment the code by 1 every 40 microseconds or so.

Linear attacks and decays are easy to figure, but not very realistic—especially for decay. The notes from most musical instruments attack and decay exponentially. This circuit gives you unlimited potential in the specification of a note's envelope, and it lets you change the envelope from note to note.

The audio input should be in the neighborhood of 1 volt peak-to-peak. When using the 12-volt signal from the computer-controlled note generator, raise R12 to 15K ohms to accommodate the increased input amplitude.

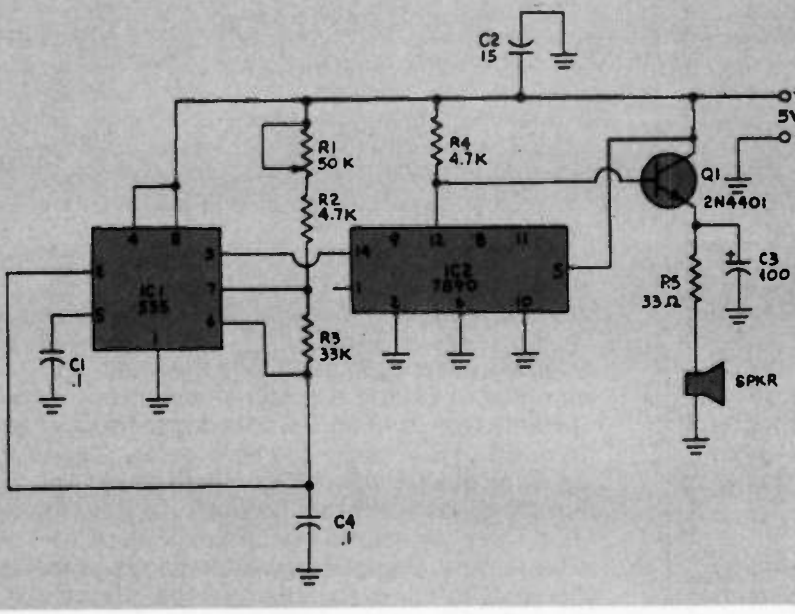


PARTS LIST FOR NOTE GENERATOR

C1—0.1-uF ceramic capacitor
C2—1.0-uF mylar capacitor
C3, C4—0.1-uF ceramic disc capacitor
C5—.005-uF mylar capacitor
IC1—3080 transconductance integrated circuit amplifier (RCA)
Q1—2N3906 PNP transistor
R1—15,000-ohm, ½-watt resistor (all resistors 5%)
R2,—30,000-ohm, ½-watt resistor
R3—62,000-ohm, ½-watt resistor
R4—120,000-ohm, ½-watt resistor
R5—240,000-ohm, ½-watt resistor
R6,—470,000-ohm, ½-watt resistor
R7—1,000,000-ohm, ½-watt resistor
R8—1,800,000-ohm, ½-watt resistor
R9—1,000-ohm, ½-watt resistor
R10, R11—100-ohm, ½-watt resistor
R12, R13—1,200-ohm, ½-watt resistor

13 GUITAR TUNER

☐ By taking advantage of the frequency stability of the 555 timer IC operating in an astable mode, an oscillator can be constructed which can be used as a tuning aid for the guitar. The first string of the guitar, E, produces a note with a frequency of 82.4 Hertz. That frequency of the oscillator is



PARTS LIST FOR GUITAR TUNER

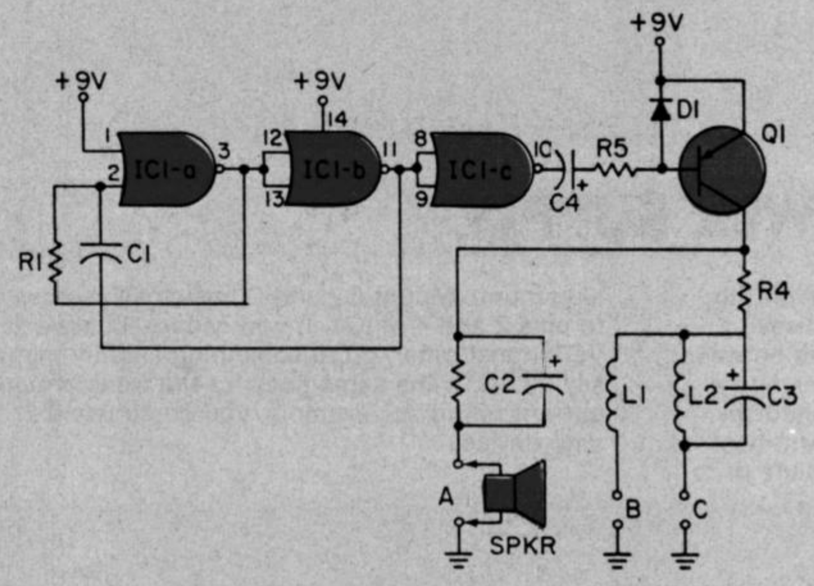
C1, C4—0.1-uF ceramic capacitor, 15-WVDC
C2—15-uF electrolytic capacitor, 15-WVDC
C3—100-uF electrolytic capacitor, 15-WVDC
IC1—555 timer
IC2—7490 decade counter
Q1—2N4401
R1—50,000-ohm linear-taper potentiometer
R2, R4—4,700-ohm, ½-watt 10% resistor
R3—33,000-ohm, ½-watt 10% resistor
R5—33-ohm, ½-watt 10% resistor
SPKR—8-ohm PM type speaker

set to twice this value. 164.8 Hertz, and then followed by a divide-by-two stage to produce the desired frequency. The purpose of the divide-by-two stage is to guarantee that the waveform produced has a duty cycle of exactly 50%. This produces a note with no second harmonic distortion. The frequency of oscillation of the circuit is set by adjustment of R1, R2, and C2 also determine the frequency of oscillation but these components are fixed values and need no adjustment. The output of IC2 is fed to an emitter follower to provide current gain to drive a loudspeaker. C3 acts as a low-pass natural sounding note. The circuit is powered by a 5-volt supply, and this voltage **must** fall within the range of 4.75 to 5.25 volts for IC2 to operate properly.

14 ORGAN TONE GENERATOR

□ Musical organ-like sounds can be generated with this CMOS circuit. The IC generates a nearly square-wave output from pin 11 and the spacings on that output stream of pulses can be varied by changing R1 and R2. If you change them smoothly, you can get a slide-trombone effect.

Outputs A, B, and C are different from the pin 4 output in that the square wave now becomes a sawtooth, a spike and a complex combination of both. Rich overtones result that you can hear with the 8-ohm speaker.



PARTS LIST FOR ORGAN TONE GENERATOR

C1—0.2-uF disc capacitor, 15 VDC
C2—4.7-uF electrolytic capacitor, 15 VDC
C3—6.8-uF electrolytic capacitor, 15 VDC
C4—2-uF electrolytic capacitor, 15 VDC
D1—1N4001 diode
IC1—4011 quad NAND gate
L1—2.5-millihenry RF choke
L2—2.5-millihenry RF choke
Q1—2N4403 transistor
R1—20,000-ohm, ½-watt resistor
R2—100,000-ohm, ½-watt resistor
R3—220-ohm, ½-watt resistor
R4—220-ohm, ½-watt resistor
R5—1,000-ohm, ½-watt resistor
SPKR—8-ohm PM-type

15 LOW-POWER NEGATIVE SUPPLY

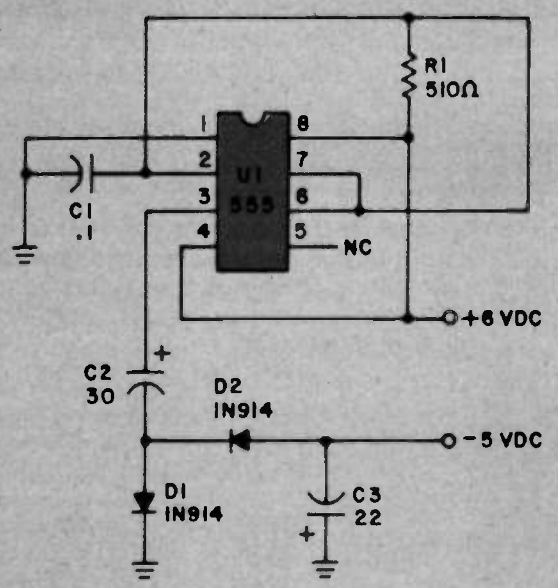
Every so often you require a negative power supply for some small circuit, and it is the cost for the added power supply that prevents you from building the project or adding a new feature to an old one. This low-power negative supply serves the purpose, but don't look for it to power a solenoid or drive a power amplifier.

You are familiar with a voltage doubler where you can get twice the battery voltage at the output—sounds like cheating! In this circuit, we use a 555 timer chip as an oscillator and swing the voltage below ground potential. Resistor R1 and capacitor C1 determine the circuit's frequency.

At pin 3 of the 555 timer chip, U1, the voltage goes high and low. When pin 3 goes high to +5 volts, diode D1 conducts and C2 takes on a charge. Diode D2 does not conduct. When Pin 3 goes low, C2 charges through D2 and C3. A negative voltage is tapped from C3 because the positive terminal of C3 is tied to ground.

This circuit is not an efficient way of obtaining a negative potential, but it sure is inexpensive compared to buying a step-down transformer and rectify circuit elements. The output voltage is numerically lower by a volt or two from the original voltage supplied to the circuit. Thus, a 6-volt input will develop -5 volts out. The circuit can handle voltage inputs up to +18-volts DC. Should regulation be a requirement, a low-power Zener may be helpful—but check the circuit under load conditions.

The Low-Power Negative Power Supply will also work off batteries. Regulation is fair provided the load is constant.

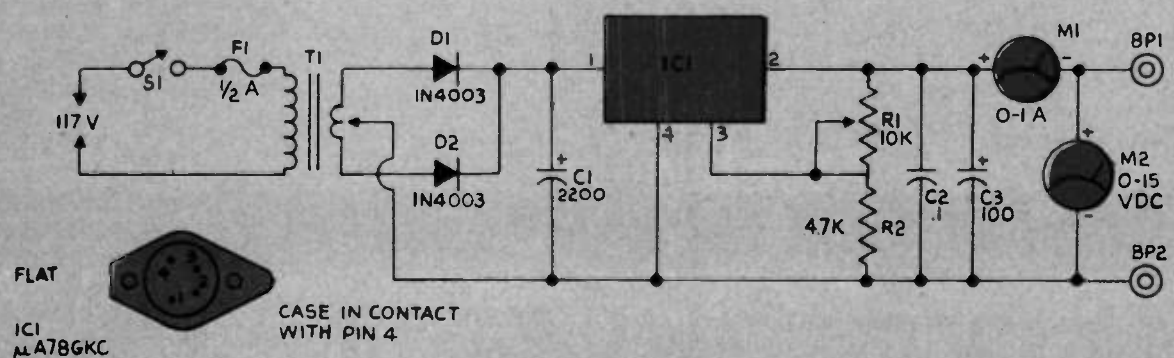


PARTS LIST FOR LOW-POWER NEGATIVE POWER SUPPLY

C1—.1-uF disc capacitor
C2—30-uF, 10-WVDC electrolytic capacitor
C3—22-uF, 25-WVDC electrolytic capacitor
D1, D2—Switching diode such as 1N914
R1—510-ohm, ¼-watt, 5% resistor
U1—555 timer chip

16 VARI-REG POWER SUPPLY

□ There are lots of good power supplies on the market, but why not build your own and save a bundle? This circuit can provide voltages between 5 and 15-volts DC at currents up to one ampere. Be sure to heat-sink the uA78GKC regulator by bolting it to either a commercial aluminum heat sink or to your supply's cabinet (if it's made of aluminum). Mount C2 and C3 as close as possible tc pins 2 and 4 of IC1. If you cannot locate a 28 VCT transformer, go to something slightly higher, say 32 VCT. The same goes for the transformer's current rating; for example, you could use a 2-amp device.



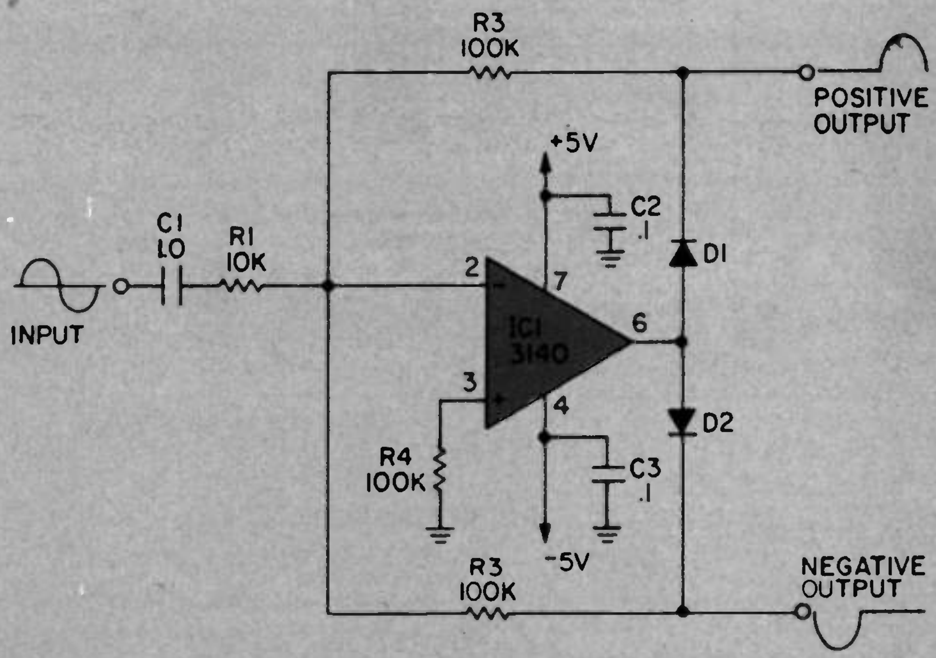
PARTS LIST FOR VARI-REG POWER SUPPLY

BP1, BP2—binding post
C1—2200-uF electrolytic capacitor, 40-WVDC
C2—0.1-uF ceramic disc capacitor, 35-WVDC
C3—100-uF electrolytic capacitor, 25-WVDC
D1, D2—1N4003 (1A,200 PIV) rectifier diode
F1—0.5-Ampere slow-blow fuse
IC1—uA78GKC adjustable voltage regulator
M1—0-to-1 Amp DC meter
M2—0-to-15 Volt DC meter
R1—10,000-ohm linear-taper potentiometer
R2—47,000-ohm, ½-watt 5% resistor
S1—SP-ST toggle switch
T1—28-VCT, 1.2-Amp power transformer (see text)

17 PRECISION RECTIFIER

☐ One of the problems with the conventional silicon rectifier diode is its .6-volt forward drop. Rectification cannot occur until an input signal exceeds this voltage. So it is impossible to rectify a signal with a 250-millivolt peak-to-peak amplitude because it never exceeds the diode's conduction threshold. The precision rectifier circuit diagrammed here gets around the whole problem by tucking the rectifier into an op amp's feedback loop. Signals on the millivolt level can now be rectified with ease.

In addition, the circuit has a gain of —10. The minus sign means that this is an inverting circuit: positive peaks come out negative, and vice versa. Half-wave-rectified positive-going signals are available through D1, while D2 provides the negative rectified output. Remember, positive input cycles are multiplied by 10 and inverted; hence, they show up at the negative output. To keep things from going awry, use both loops (D1-R2 and D2-R3) even if you want output of just one polarity.



PARTS LIST FOR PRECISION RECTIFIER

C1—1.0-mylar capacitor
C2, C3—0.1-ceramic capacitor
D1, D2—1N914 silicon diode
IC1—3140 op amp integrated circuit (RCA)
R1—10,000-ohm, ½-watt resistor
R2, R3, R4—100,000-ohm, ½-watt resistor

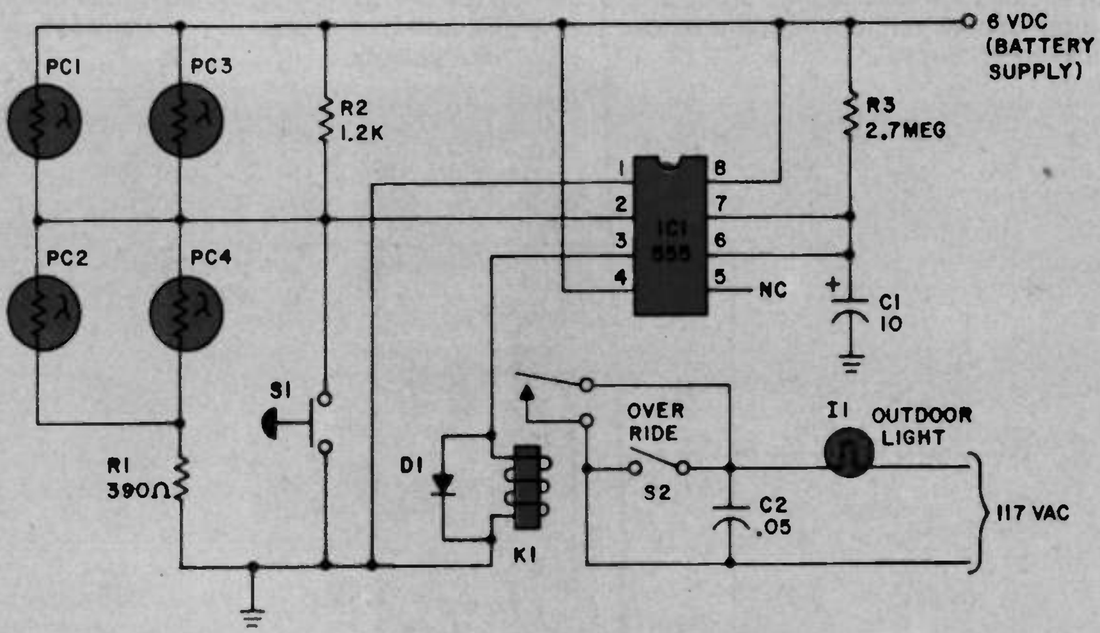
18 CHICKEN LIGHT

I get scared at night when I return home with the family after a late movie. I need a confidence builder like a big, bright 150-watt spotlight lighting up the front of the house and driveway. My pocketbook tells me that I don't leave a light like that burning for hours when it costs about $1-per-kilowatt hour. (It feels like that when the bill comes.) Also, a timer is out of the question, because we sometime stop at the burger-torium for sustenance. We don't know when our return ETA will be.

With that bit of background building, you know that we are coming up with a headlight-activated Chicken Light. As I pull into the driveway, the headlights shine on two photoresistive cells, PC2 and PC4 lowering their internal resistance. Actually, either cell will do the job, but we have them spaced apart because of the wide driveway. The overall effect of the voltage divider on pin 2 of U1 is to drive it low starting the "on" cycle for a predetermined amount of time. The timing cycle is determined by R3 and C1 which is good for about one minute.

Photoresistor cells PC1 and PC3 point to the sky from different corners of the house sensing the daylight sun both in the morning and evening preventing unnecessary outdoor lighting during the day. Fooling with the value of R1 will determine the sensitivity of the circuit to your headlights. Resistor R2 determines when the sky is dark enough so that the headlights can activate the circuit. You may have to fool with their values in your neighborhood to get the right reaction. Longitude and time of year has a lot to do with available sunlight.

The six-volt relay has a relatively low-current pull-in level. If the one you pick up is a double-pole job, tie the contacts together to get better current switching capability, and longer contact life from the relay. Diode D1 prevents and inductive kick from the coil of K1 from destroying the 555 chip. If the timing cycle is too short, increase C1 up to 50 uF for several minutes of lighting. Switch S2 is an indoor over-ride switch that is part of a timer switch that can be left on continuously, or up to 15 minutes. The need for this feature is determined by your particular situation.



PARTS LIST FOR CHICKEN LIGHT

- **C1**—10-uF, 10-WVDC electrolytic capacitor
- **C2**—.05-uF disc capacitor
- **D1**—IN4001 diode
- **I1**—Outdoor light bulb (current not to exceed relay K1 contact rating)
- **IC1**—555 timer integrated-circuit chip
- **K1**—SPST or DPDT relay, 6-volt relay (low current coil)
- **PC1-PC4**—Photoresistive light-sensitive cell
- **R1**—390-ohm, ¼-watt, 5% resistor
- **R2**—1200-ohm, ¼-watt, 5% resistor
- **R3**—2.7-Megohm, ¼-watt, 5% resistor
- **S1**—SPST pushbutton switch, normally open
- **S2**—SPST indoor AC switch

19 COMPRESSION AMP

From time to time you don't need hi-fi for basic audio needs. For example, announcements from a PA system require a small audio-frequency spectrum. Also, tape recording a club meeting has its problem when the weakest voice usually sits further-most from the mike, and the office loud mouth sits closest—how do you set the volume control? That's where the Compression Amp becomes a valuable tool. You want to squeeze the shouts to a normal level and boost the whispers so that all remarks are heard.

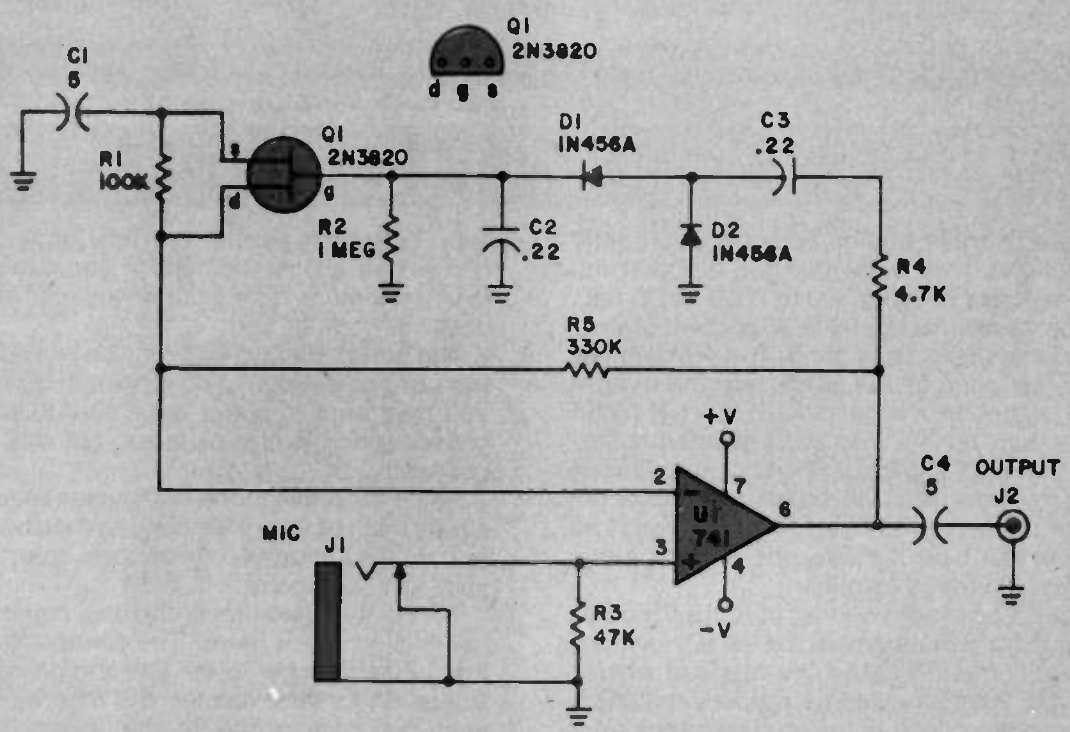
Resistor R3 sets the load resistance for the microphone used. For most high-impedance microphones, 47,000-ohm is suitable. However, follow the specs supplied with the microphone used. If a crystal or ceramic microphone is used, a much higher impedance match is required. If the base sounds are poor, muffled, or just not there, increase the value of R3.

The gain of the stage would be determined by R5 if R1 and the associated circuit of Q1 were not present. However, R1 and the load of Q1, are in parallel with R5. Since the internal resistance of Q1 varies with the signal supplied to it, Q1 has a considerable effect on U1's gain. As the input signal from the microphone via jack J1 increases, a level is reached when diodes D1 and D2 conduct, providing a rectification of some of the output signal which biases Q1 into conduction and reducing its resistance across R1.

The time constant afforded by C2, C3, R2, and R4 provide a gradual attack so that the sound does not have a pulsing quality, or too long of a delay.

The 741 op-amp is not noted for high-fidelity performance in the audio range, but it does function well for human voices. Should you wish to compress music, an op-amp with greater audio-frequency range is preferable.

The circuit requires a dual power supply rated at +20 and—20-volts DC. You may shave some of the voltage a bit, but when you get near to the dual 12-volt DC supplies most of us have, the circuit will not have sufficient gain to activate diodes D1 and D2. Build the power supply for this project using a step-down power transformer that is center-tapped. Use a bridge rectifier to develop approximately 20-volts DC across approximately 500-1000-uF per leg.

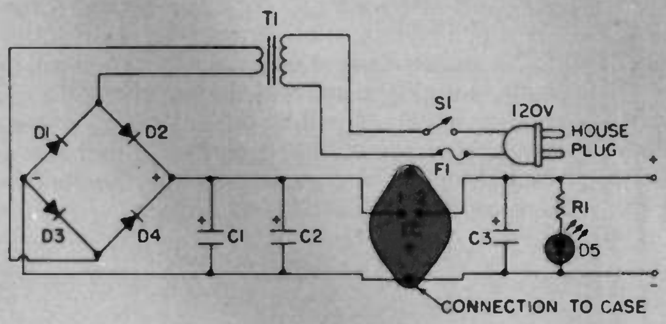


PARTS LIST FOR COMPRESSION AMP

C1, C4—5-uF, 25-WVDC, non-polarized, electrolytic capacitor
C2, C3—.22-uF capacitor
D1, D2—1N456A diode
J1—Closed-circuit phone jack
J2—open-circuit jack (any type)
Q1—2N3820 field-effect transistor (FET)
R1—100,000-ohm, ¼-watt, 5% resistor
R2—1-megohm, ¼-watt, 5% resistor
R3—47,000-ohm, ¼-watt, 5% resistor
R4—4700-ohm, ¼-watt, 5% resistor
R5—330,000-ohm, ¼-watt, 5% resistor
U1—741 op-amp integrated circuit

20 TTL POWER SUPPLY

□ This IC project will provide you with a flat, ripple-free, and locked-on 5 volts for any use around the house or on your work bench. It will prove to be very handy for the TTL projects in this magazine, i.e., those projects using any IC that starts with the two numbers 74. The LM309 is a remarkable IC containing over a dozen transistors and several diodes. IT can handle up to about 1 amp without a heat sink. If you mount it on a heat sink, a 4 by 4 inch piece of aluminum will do, it can supply up to 4 amps without dropping its 5 volt output.



PARTS LIST FOR TTL POWER SUPPLY

C1, C2, C3—1,000-uF electrolytic capacitor, 25 VDC
D1, D2, D3, D4—1N4003 diode
D5—large LED
F1—120 VAC ½ amp fuse, fast acting type
IC1—LM309
R1—500-ohm, 2-watt resistor
S1—SPST toggle switch rated at 120 VAC/15 amps
T1—120 VAC 10 12.6 VAC transformer

21 TELEPHONE LINE INPUT MATCHER

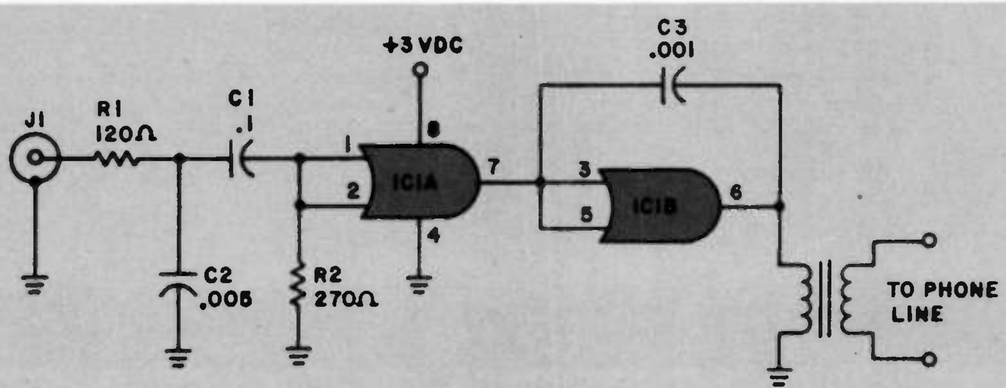
Did you ever wonder why music sounds so poorly on the telephone. It is more that the fact that the frequency response is about 300 to 3000 Hz. In fact, most recordings have about 90 to 95 percent of their information in this frequency band. The problem lies in the audio coupling of the music into the mouthpiece of the telephone. It is not efficient nor is it linear. To get maximum results, and to be pleasantly surprised with the results, use our Phone Couple Circuit to do the job. Now you will be able to place the recording of the school concert "on the phone" so that Grandma can hear it thousands of miles away. We call it the Line Input Amplifier.

We are not going to tell you that broadcast studios use this circuit for remote broadcast feeds. However., it is a good circuit and it takes advantage of what is available in the telephone line by properly matching the phone company's 600-ohm line. The transformer may be difficult to find. The specifications for T1 ideally are 60-ohms to 600 ohms (primary to secondary). Any 1:10 ratio audio miniature transformer rated at 40- to 75-ohm input will do. Also, should the ratio exceed 1:10, you can load the output winding down with resistance so that the final impedance is 600 ohms. Use a potentiometer if you wish and adjust from maximum resistance down until the match is best.

The power supply need only be 3-volt DC supplied from dry cells. Regulation is not critical in this circuit. You may want to add a 10-uF 10-WVDC electrolytic capacitor across the batteries, but this may not be necessary.

Some local telephone companies require that you advise them of your intentions so that they may install a company-approved telephone interface. Check your local company.

To test the operation of the unit, make a telephone connection with a friend. The connect the Telephone Input Line Matcher to the line and play some music. Adjust R1 for best results. You may want to disconnect the microphone in the telephone's handset during this procedure. To hold two-way conversation, connect a microphone to the unit's input Jack J1 and use the receiver in the handset to listen. The circuit is somewhat typical of that used in computer modems.



PARTS LIST FOR TELEPHONE LINE INPUT MATCHER

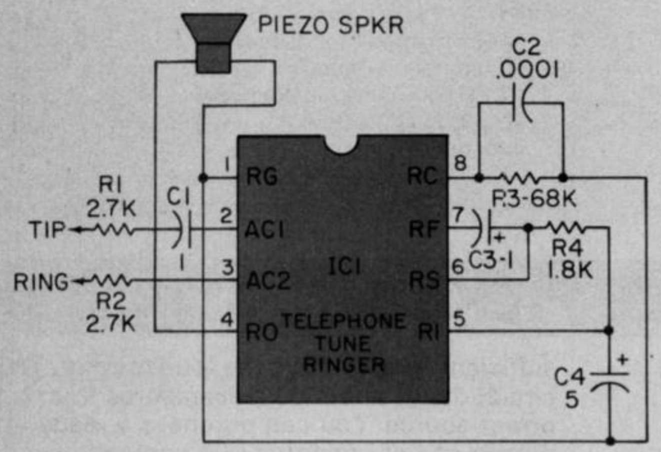
C1—.1-uF ceramic capacitor
C2—.005-uF ceramic capacitor
C3—.001-uF ceramic capacitor
IC1—ECG9914 or equivalent
J1—RCA phono jack
R1—120-ohm, ½-watt, 5% resistor
R2—270-ohm, ½-watt, 5% resistor
T1—Audio miniature transformer, 60- to 600-ohms (see text)

22 TELEPHONE TURKEY CALLER

□ No, this project will not put the white and dark meat on the diningroom table comes Thanksgiving day! We call it the Telephone Turkey Caller because it produces sounds like a turkey to some people. It's pleasent two-tone warbling sound is welcome in place of the harsh bell ringer used in most telephones. Also, since it does not need a phone to operate, it can be placed anywhere in the telephone line in the house, or outside the house, where the telephone normal ringer cannot be heard informing the household that the telephone is ringing.

The chip, a Motorola MC34012, uses the telephone's ringing power to provide the DC to operate the chip. A relaxation oscillator within the chip develops an Fo signal, and from this basic frequency, the chip selects frequencies Fo/4 and Fo/5 (fourth and fifth note in the octive beginning with the frequency Fo), amplifies them and buffers the signal out to a piezo speaker that produces the turkey sound. C2 and R3 determine the Fo frequency. Small changes in the component values will vary the output sound frequencies. Resistor R4 controls the ringing threshold voltage. Its value may be varied between 800 to 2000 ohms. Capacitor C3 can be used to eliminate dial transcients—experiment with values from .5 to 5-uF.

For those who must report the ringer to their telephone company, the ringer equivalent is approximately .7A. Should you own your in-home or office telephone system, you need not report its use to the telephone company.



PARTS LIST FOR TELEPHONE TURKEY CALLER

C1—1-uF, non-polarized capacitor, 200-WVDC
C2—.001 disk capacitor
C3—1-uF, 16-WVDC
IC1—MC43012-1 telephone tone ringer chip
R1, R2—2700-ohm, ½-watt resistor
R3—68,000-ohm, ½-watt resistor
R4—1800-ohm, ½-watt resistor
SPKR—piezoelectric speaker (inexpensive tweeter may be used)

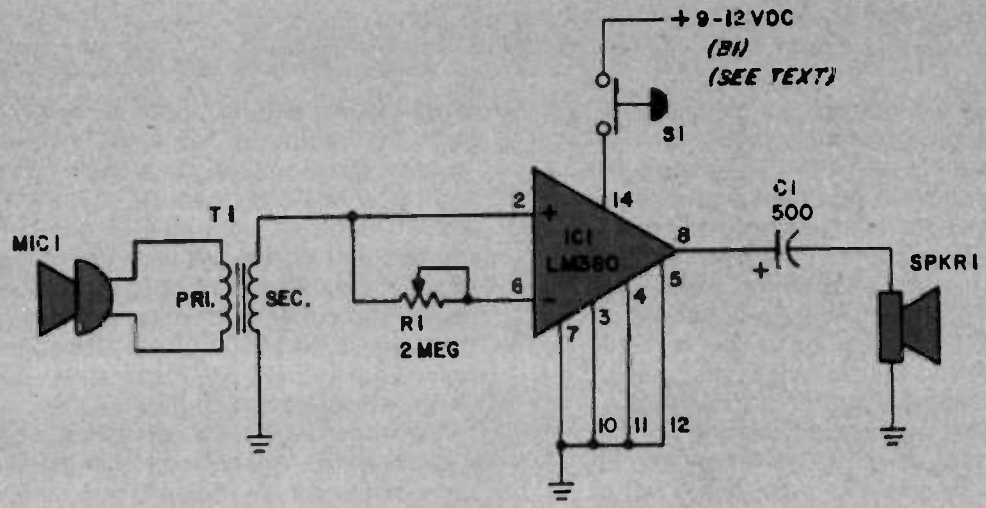
23 ONE-WAY INTERCOM

Every so often a miniature one-way intercom system is required to save strain on the vocal cords. You could consider this project as a low-power PA system. The beauty of it is that the parts may be sitting in your spare parts box right now!

The mini-heart of the one-way intercom is a LM380 op-amp, or one of the many others like it that sell for pennies in the mail order advertisements. The output impedance of this devise is very low so that an 8-ohm loudspeaker will work when connected directly across the output. In fact, you should have success with most PM loudspeaker types in the rated range of 4- to 10-ohms with diameters up to 5-inches. No, you will not get any cone—shattering sounds, but what you will get is sufficient to penetrate across rooms, cellar, garages, workshops, and the like.

The integrated circuit, IC1, is designed for neatsink applications. In this low-power application a heat sink is not needed; however, you can mount it on a 2-inch square, copper-clad printed circuit board that will serve as a heat sink if you wish. The microphone input comes from a crystal or ceramic microphone, MIC1 which is coupled to IC1 via a impedance-matching, audio transformer. Potentiometer R1 serves as the volume control. Since a balanced power supply is not used, an expensive non-polarized (back-to back) electrolytic capacitor is not required.

There is no warm-up time required for this circuit, so a pushbutton power switch, S1, is pressed when the operator speaks into the microphone, and then released disconnecting the power supply. With this set up, the power supply may be a battery as small as a transistor-radio, 9-volt DC battery or a 12-volt DC lantern battery. A wall-plug power supply may be used. Voltage regulation is not a requirement for this circuit.

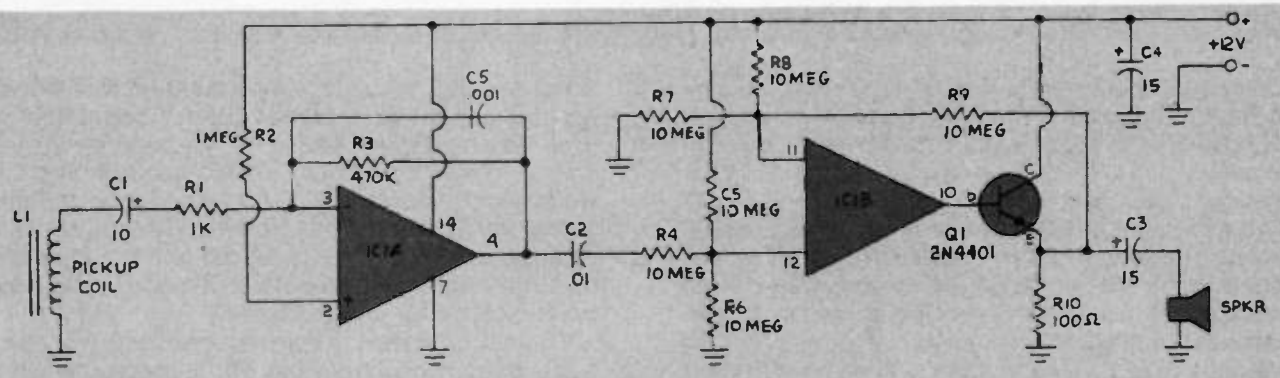


PARTS LIST FOR ONE-WAY INTERCOM

B1—9- to 12-volts DC battery or power supply
C1—500-uF, 16-WVDC electrolytic capacitor
IC1—LM380, ECG740A, or equivalent audio amplifier integrated circuit
MIC1—Crystal high-impedance microphone
R1—2 Megohm, audio-taper potentiometer
S1—SPST pushbutton (normally open) switch
SPKR1—3.2- to 10-ohm, 2- to 5-inch diameter loudspeaker
T1—Audio transformer: Pri. 47,000 to 100 000-ohms impedance; sec. 1000 to 1500-ohm impedance

24 TELEPHONE VOICE PICKUP

□ You can pick up and amplify the voice signals from your telephone by using this simple IC circuit and a small pickup coil. The circuit has sufficient output to drive a loudspeaker. One section of a quad op amp is used as a high-gain voltage amplifier. This increases the relatively low output of the pickup coil (a few millivolts) to a sufficient level to drive the loudspeaker. The circuit draws about 60 milliamperes from a 12 volt power source. You can purchase a ready made pickup coil or construct one yourself using about 200 turns of fine enamel wire wound around an iron core. Place the pickup near the telephone receiver for best results.

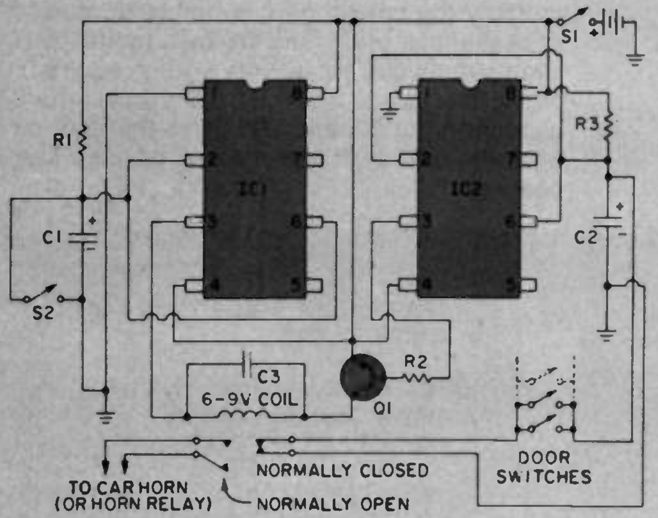


PARTS LIST FOR TELEPHONE VOICE PICKUP

C1—10-uF, 25-WVDC electrolytic capacitor
C2—.01-uF, 15-WVDC ceramic disc capacitor
C3, C4—15-uF, 15-WVDC electrolytic capacitor
C5—.001-uF, 15-WVDC ceramic disc capacitor
IC1—3900 quad amplifier
L1—inductance pickup coil (see text)
Q1—2N4401
R1—1000-ohm, ½-watt 10% resistor
R2, R4—1,000,000-ohm, ½-watt 10% resistor
R3—470,000-ohm, ½-watt 10% resistor
R5, R6, R7, R8, R9—10,000,00-ohm, ½-watt 10% resistor
R10—100-ohm, ½-watt 10% resistor
SPKR—8-ohm PM type speaker

25 AUTO THEFT ALARM

☐ This Auto Theft Alarm aill sound your car horn if anyone opens your car door. The timers allow you to leave and enter the car without the horn sounding. To set, or arm, the alarm circuit, open S2. This will give you five seconds (R1, C1) to get out and shut the door behind you. If anyone opens a door for two seconds (R3, C2), the horn will sound and will stay locked on until S1 is opened. If you open the door to enter, you have two seconds to close S2, which is plenty of time if S2 is conveniently located.

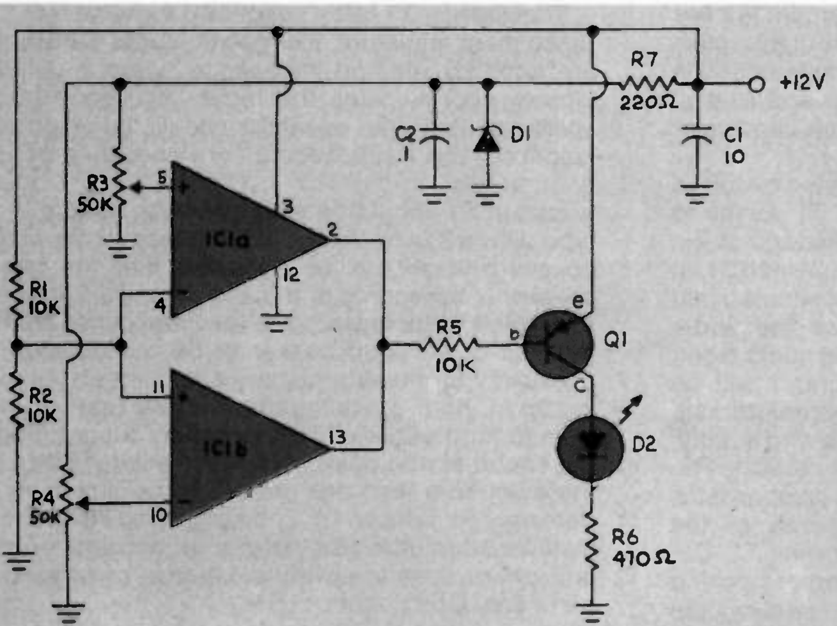


PARTS LIST FOR AUTO THEFT ALARM

C1—10-uF electrolytic capacitor, 15-WVDC
C2—1-uF electrolytic capacitor, 15-WVDC
C3—0.1-uF ceramic disc capacitor, 15-WVDC
IC1, IC2—555 timer
Q1—2N4403
R1—500,000-ohm, ½-watt resistor
R2—270-ohm, ½-watt resistor
R3—2,000,000-ohm, ½-watt resistor
RELAY—6 to 9 VDC coil with switch contacts rated at 15 VDC/30 amps; 1 set SPST normally open, 1 set SPST normally closed

26 ALTERNATOR MONITOR

☐ This circuit will monitor the output of the alternator of any car with a 12 volt electrical system and indicate if the charging system is either undercharging or overcharging. This is accomplished by using 2 sections of a quad voltage comparator IC and connecting the outputs in an "OR" configuration so that the LED will become lit if section A or section B of the comparator detects an improper voltage level. The circuit is connected into any circuit which is active when the car is in operation, such as the ignition or radio circuit. This prevents drain on



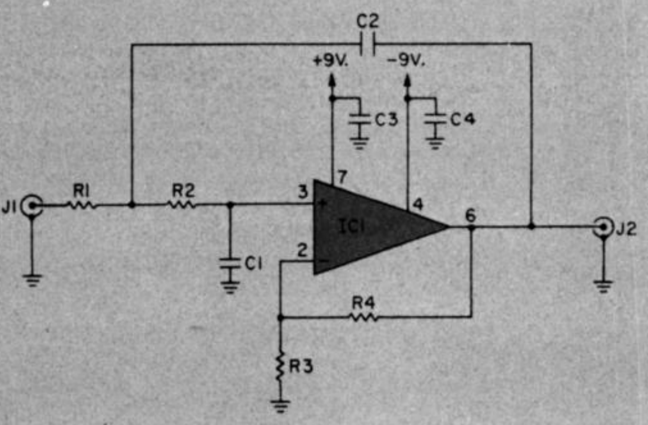
PARTS LIST FOR ALTERNATOR MONITOR

C1—10-uF electrolytic capacitor, 15-WVDC
C2—0.1-uF ceramic capacitor, 15-WVDC
D1—9 VDC Zener diode
D2—large LED
IC1—339 quad comparator
Q1—2N4403
R1, R2, R5—10,000-ohm, ½-watt 10% resistor
R3, R4—50,000-ohm linear-taper potentiometer
R6—470-ohm, ½-watt 10% resistor
R7—220-ohm, ½-watt 10% resistor

the battery when the car is not in use. To calibrate the circuit, connect an adjustable DC power supply to the + and — inputs of the circuit. Set the power supply to 13.4 volts and adjust R3 so that the voltage at pin 5 of IC1A is maximum. Then adjust R4 so that the LED just goes out. Set the power supply to 15.1 volts and adjust R3 so that the LED just goes out. The LED will now become lit if the voltage is outside the permissible range of 13.5 to 15.0 volts when the engine is running.

27 ACTIVE LOW-PASS FILTER

☐ As its name suggests, a low-pass filter passes signals with frequencies lower than some specific value, called the *cut-off frequency,* but blocks passage of frequencies above the cut-off. Illustrated here is an active low-pass filter having a 1000 Hz cut-off frequency. You can shift the cut-off by changing C1 and C2 together. To multiply the cut-off by a factor of N, multiply the capacitances of C1 and C2 by a factor of 1/N. For example, a 2000 Hz cut-off would require 0.005 μF capacitors, while a 500 Hz cut-off calls for 0.02 μF capacitors for C1 and C2. Drive the filter directly from the output of a preceding op-amp stage for best results.



PARTS LIST FOR ACTIVE LOW-PASS FILTER

C1, C2—0.01-uF polystyrene or mylar capacitor, 35 VDC
C3, C4—0.1-uF ceramic disc capacitor, 35 VDC
IC1—741 op amp
J1, J2—phono jack
R1—12,000-ohm ½-watt resistor, 5%
R2—22,000-ohm ½-watt resistor, 5%
R3, R4—68K-ohm ½-watt resistor, 5%

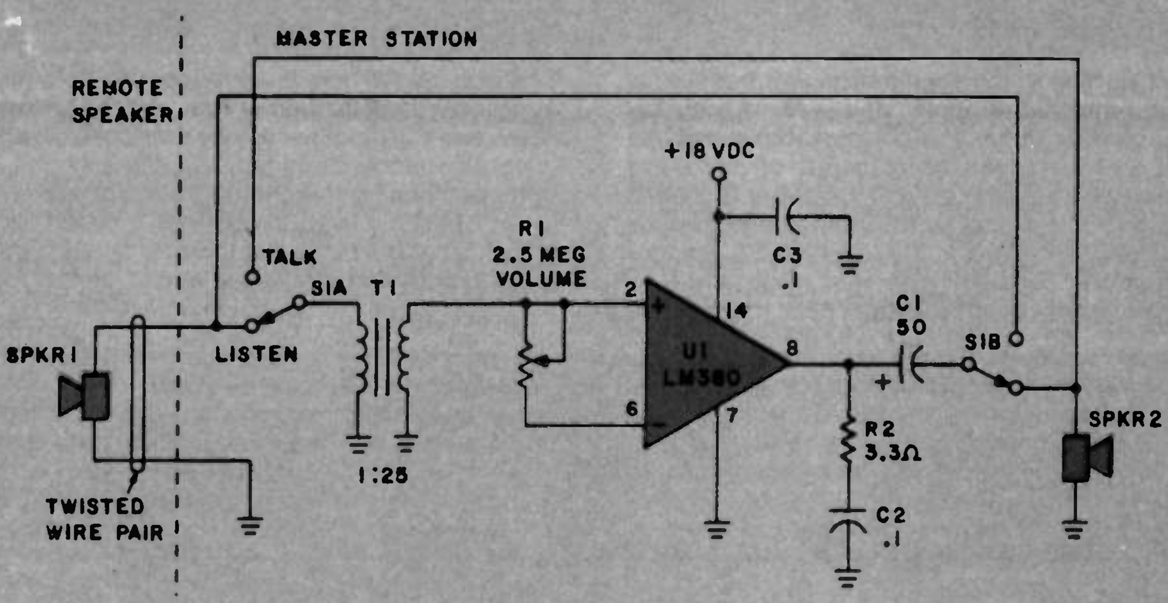
28 TWO-WAY INTERCOM

You may say that the name of this project is longer than necessary. After all, the word intercom implies sending and receiving capabilities. Yes, but this intercom is for only two stations. More complex circuits can be designed to handle one master and several satellite stations, or several stations each capable of being the master control center.

The circuit uses a basic LM380 integrated circuit as an audio amplifier. Input transformer T1 serves to match the impedance of the loudspeaker coil of the speaker being used as the microphone. Switch S1, at the master station, is shown in the talk position so that the remote speaker, SPKR1, provides the audio signal. Potentiometer R1 should have an audio taper, otherwise the bulk of the circuit Control will be crunched at one end of the rotational shaft adjustment. U1 uses an LM380 that requires a single-end supply, in this case +12-volts DC. Tone control network, R2-C2, roll off the high frequencies, which compensates for the characteristic frequency response of the speaker /microphone and input transformer T1. Capacitor C1 serves the time-honor function of blocking the DC at the amplifiers output and passing the amplified audio signal.

Transformer T1 has a suggested turns ratio of 1:25. Since most miniature, low-power, audio transformer are rated by winding impedance, select a unit that closely approximates the input impedance of the speakers used (the speakers should be electrically identical) and has a secondary impedance of 4000 ohm, or more!

Switch S1 should be a double-pole, double-throw type with a spring return. It is located at the master control and should be so wired that the remote speaker is the source of the audio input except when the switch is depressed. The low-impedance characteristics of the loudspeaker voice coil reduces the possibility for interconnecting audio lines from picking up AC hum. Since the circuit is very easy to isolate from ground, especially with a battery supply, ground the circuit at one point only at the master control. If there be more than one ground in the circuit, an AC hum may be induced by a power ground Hoop. Some installer attempt to use the ground circuit of conduit and power lines to save the expense of running an extra line. Don't do it!



PARTS LIST FOR TWO-WAY INTERCOM

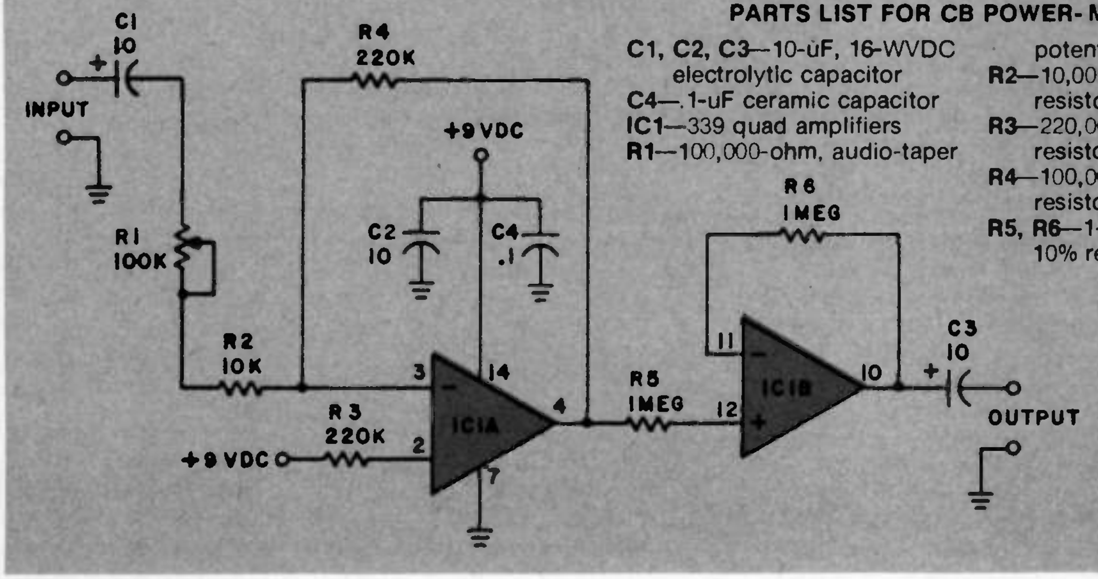
C1—50-uF, 16-WVDC, Electrolytic capacitor
C2, C3—.1-uF ceramic capacitor
R1—2.5-Megohm, audio-taper potentiometer
R2—3.3-ohm, ½-watt, 10% resistor
S1—DPDT, spring-loaded lever or pushbutton switch
SPKR1, SPKR2—8-10-ohm, 3-to 5-inch dia., PM loudspeakers
T1—Audio transformer, 1:25 turns ratio (See text)
U1—LM380 audio amplifier (National Semiconductor)

29 CB POWER-MIKE AMP

A very popular accessory to a CB radio is our CB power-microphone. This circuit provides an adjustable gain of 1 to 10 which will increase the output of a dinamic microphone for higher modulation levels without shouting. The circuit has very low output impedance and will drive the microphone input circuit of any CB radio. Op-amp IC1 provides voltage amplification and is adjustable by potentiometer R1. Op-amp IC1 is a buffer amplifier which provides isolation between the amplifier and output terminal. The circuit draws about 7 milliamperes from a 9-volt supply and can be powered by an ordinary 9-volt transistor-radio battery.

PARTS LIST FOR CB POWER-MIKE AMP

C1, C2, C3—10-uF, 16-WVDC electrolytic capacitor
C4—.1-uF ceramic capacitor
IC1—339 quad amplifiers
R1—100,000-ohm, audio-taper potentiometer
R2—10,000-ohm, ½-watt, 10% resistor
R3—220,000-ohm, ½-watt, 10% resistor
R4—100,000-ohm, ½-watt, 10% resistor
R5, R6—1-Megohm, ½-watt, 10% resistor

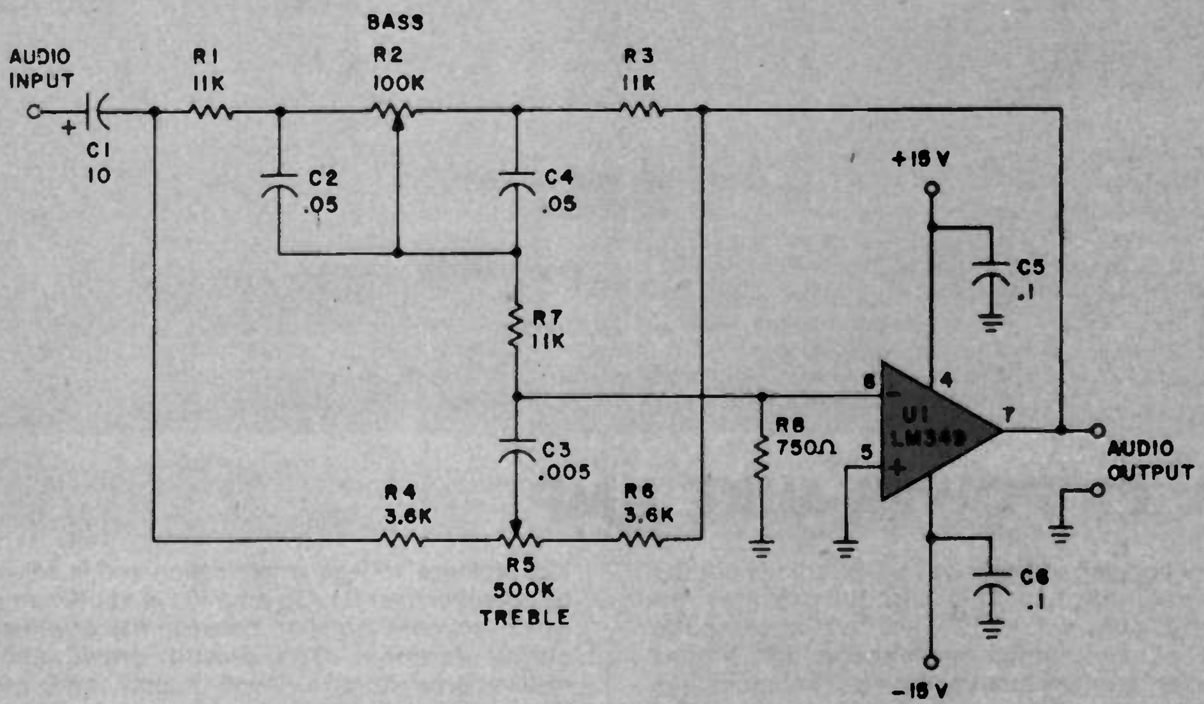


30 BASS-TREBLE ACTIVE TONE CONTROLS

Sooner or later you'll need a bass and treble tone circuit that introduces no signal loss. This is important because it is better to work on audio signal at a low level, and then power-boost them to drive massive loudspeakers. Thus, about 5% of the power is used to generate an audio signal to the input level of the final power amplifier stage, and the remainder is used for listening power.

Any op-amp will do the job, but check the specs so that you get the frequency range, noiseless response, and linear amplification. If you want to add this circuit to an existing amplifier whose tone controls are inefficient, or poorly designed, the entire circuit can be mounted behind the control potentiometers.

An LM349 is used for U1 in this circuit. However, check what is available at low cost should your spare parts box is void of a suitable amplifier.



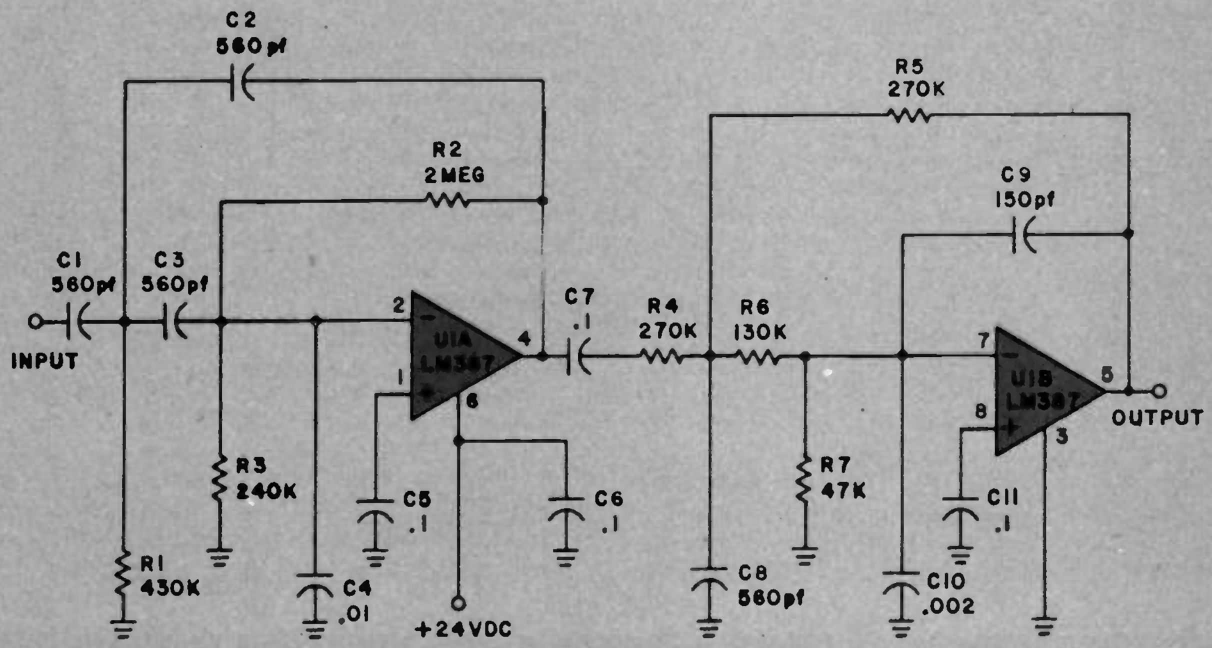
PARTS LIST FOR BASS AND TREBLE TONE CONTROLS

- **C1**—10-uF, 35-WVDC electrolytic capacitor
- **C2, C4**—.05-uF ceramic capacitor
- **C3**—.005-uF ceramic capacitor
- **C5, C6**—.1-uF ceramic capacitor
  (Fixed resistors are ½-watt and 5%, or better)
- **R1, R3, R7**—11,000-ohm
- **R2**—100,000-ohm, audio-taper potentiometer
- **R4, R6**—360-ohm
- **R5**—500,000-ohm, audio-taper potentiometer
- **R8**—750-ohm
- **U1**—LM349 audio amplifier

31 SPEECH FILTER

Here is one circuit that will get much use throughout the years to come. It is a speech filter that zaps the frequencies below 300 Hertz and over 3000 Hertz. Yes, you are right, it is not high fidelity at its best. However, consider the value of speech information contained between 300 and 3000 Hertz. It's all there! Now consider the microphone of a PA system in a noisy area. All that rumble and squeeks will be eliminated providing a "talk power" that the CB'ers advocated for many years.

The first amplifier stage includes circuit elements in its feedback and input stage that limits the high-frequency signal from being amplified. The second stage works on the low frequencies. The voltage gain of the circuit is about one. A 24-volt supply is required.



PARTS LIST FOR THE SPEECH FILTER

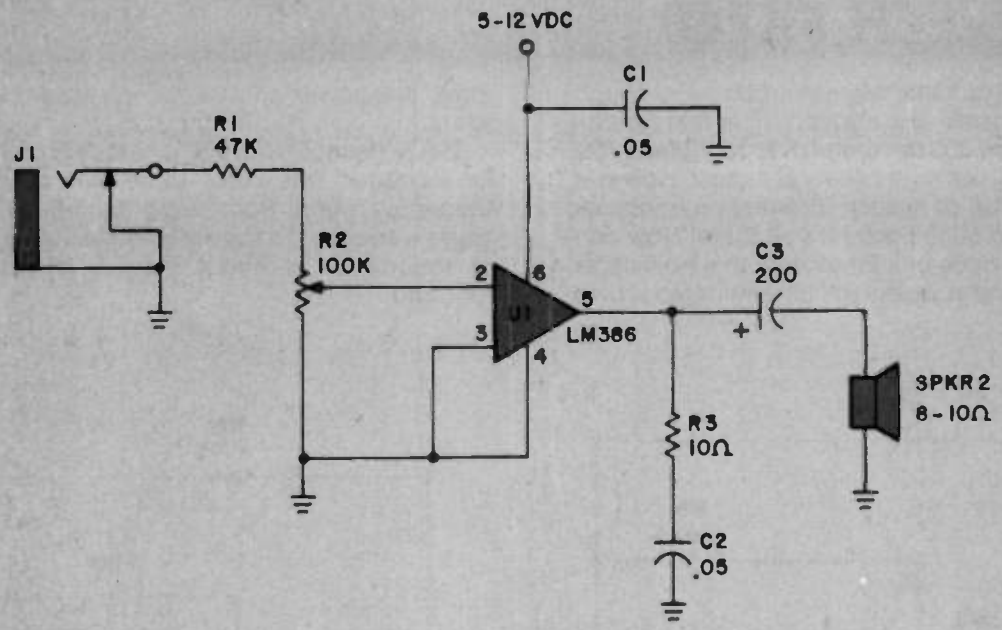
- **C1-C3, C8**—560-pF, ceramic capacitor
- **C4**—.01-uF, ceramic capacitor
- **C5-C7, C11**—.1-uF ceramic capacitor
- **C9**—150-pF, ceramic capac tor
- **C10**—.002-uF, ceramic capacitor
- (Fixed resistors are ½-watt, 5% units)
- **R1**—430,000-ohm
- **R2**—2-Megohm
- **R3**—240,000-ohm
- **R4, R5**—270,000-ohm
- **R6**—130,000-ohm
- **R7**—47,000-ohm
- **U1**—LM387 amplifier (National Semiconductor)

32 20-dB AUDIO AMPLIFIER

This little audio amplifier produces about 400-mW of power into a eight-ohm loudspeaker. It is best considered a quality transistor-radio amplifier that provides bench-top sound reproduction when testing and toying with circuits. The LM386 audio-amplifier integrated circuit can be powered by a 5 to 12-volt DC supply that is reasonably filtered to kill the hum. A regulated supply is not required.

The only unusual aspect of this amplifier is the tone control elements in the circuit's output leg. Here, C2 and R3 are used to roll off the high frequencies so that the sound will be reasonably wholesome to lengthly listening sessions. Capacitor C3 is a DC blocking capacitor to prevent the DC from pin 5 of U1 from reaching the speaker voice coil.

The circuit is so simple that it can be added to circuits with integral power supplies taking up almost no room except for the loudspeaker which may be outboarded. Capacitor C1 is a decoupling capacitor, and if the power supply is adequately filtered C1 is all that is needed.

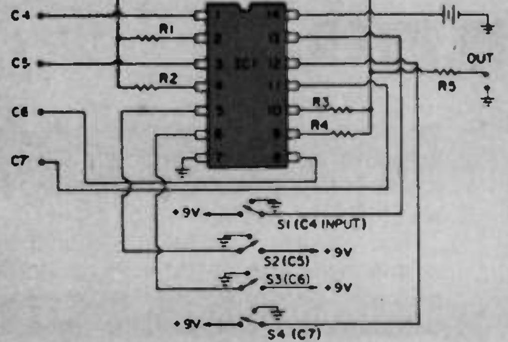


PARTS LIST FOR 20-dB POWER SUPPLY

- **C1, C2**—.05-uF disc ceramic capacitor
- **C3**—200-uF, 16-WVDC electrolytic capacitor
- **J1**—Closed-circuit audio jack, any type
- **R1**—47,000-ohm, ½-watt, 5% resistor
- **R2**—100,000-ohm, audio-taper potentiometer
- **R3**—10-ohm, ½-watt, 5% resistor
- **SPKR1**—8-10-ohm PM loud speaker, 2-3-in. diameter
- **U1**—LM386 audio amplifier integrated circuit

33 MULTI-INPUT MUSIC SYNTHESIZER

□ The inputs to this synthesizer can be from any musical instruments. C4 can be from an electric guitar, C5 from an electronic organ, etc. Or the inputs can be from the outputs of the "Octave Music Maker" project. The voltage should not exceed 9 volts at these inputs. The output will be a combination of the inputs, where you control the combining via the switches. The switch marked "S1" will put the C4 input through to the output when it is switched to the down position.



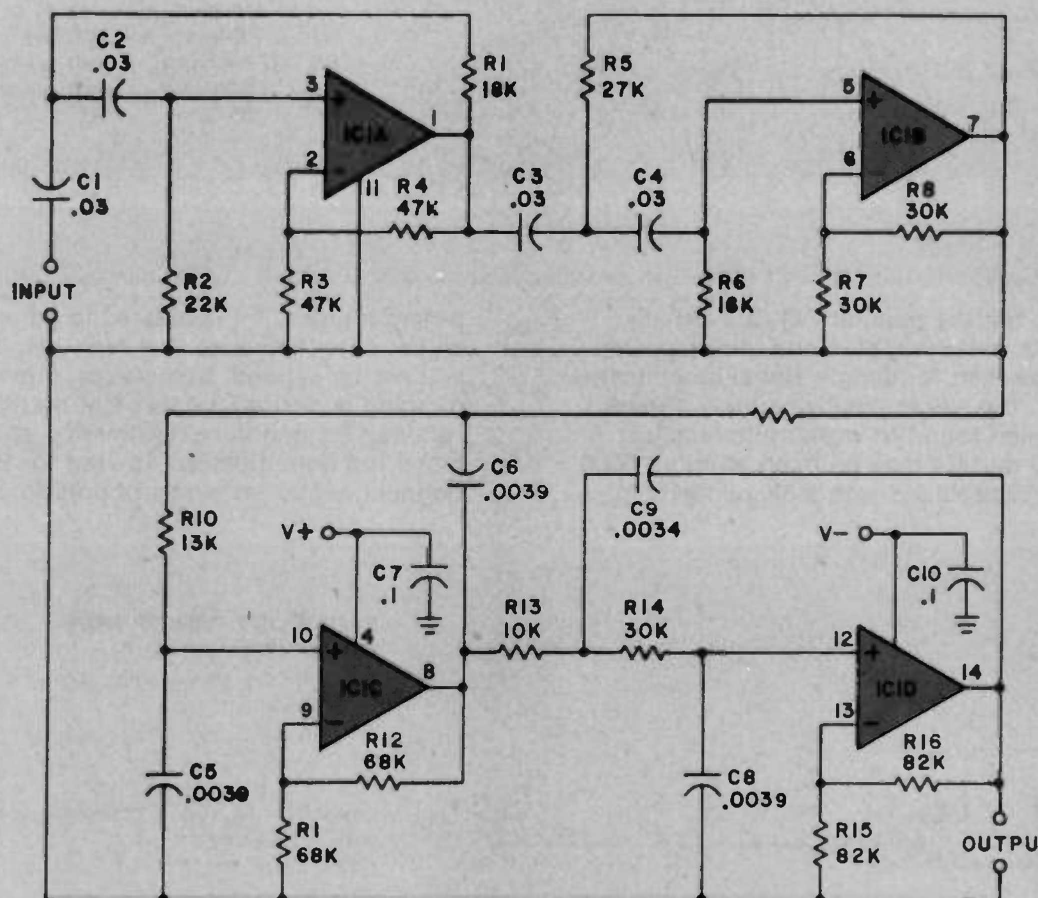
PARTS LIST FOR MULTI-INPUT MUSIC SYNTHESIZER

- **IC1**—4016 quad bilateral switch
- **R1 through R5**—1,000-ohm, ½-watt resistor
- **S1 through S4**—SPDT slide switch

34 AUDIO BANDPASS FILTER

□ There are two different approaches to bandpass-filter design. The first involves use of a high-Q resonant network. You'll find this type of device sold as a CW filter, an application in which it excels. However, the selectivity of a resonant bandpass filter is such as to favor a very few frequencies to the exclusion of all others, and this makes it useless in voice reception. To filter the garbage out of an SSB transmission, you need a filter that freely passes the band of frequencies between about 300 and 2500 Hz but drastically attenuates frequencies outside the passband. An audio filter of this type is constructed by cascading (i.e., hooking in series) very sharp high- and low-pass filters.

That's what we've done here U1a and U1b comprise a sharp, 4-pole Butterworth high-pass filter with a 300-Hz cut-off. The two remaining stages function as a low-pass 4-pole Butterworth filter having a 2500-Hz cut-off frequency. Overall circuit gain is 16. Insert the filter into your receiver's audio chain at a point where the input signal level will be less than 100m V peak-to-peak. If the filter's extra gain causes problems, chop its output down with a resistive divider. A dual supply furnishing anywhere between 2.5V and 15V can be used to power the circuit.

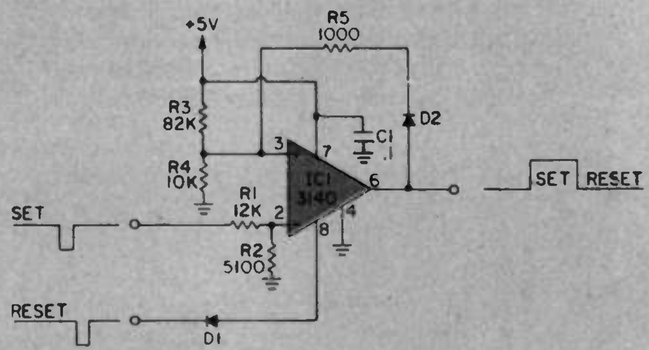


PARTS LIST FOR AUDIO BANDPASS FILTER

C1-C4—0.03-uF polystyrene capacitor
C5, C6, C8, C9—.0039-uF polystyrene capacitor
C7, C10—0.1-uF ceramic disc capacitor
IC1—LM324 quad op amp integrated circuit
R1—18,000-ohm, ½-watt 5% resistor
R2, R9—22,000-ohm, ½-watt 5% resistor
R3, R4—47,000-ohm, ½-watt 5% resistor
R5—27,000-ohm, ½-watt 5% resistor
R6—16,000-ohm, ½-watt 5% resistor
R7, R8, R14—30,000-ohm, ½-watt 5% resistor
R10—13,000-ohm, ½-watt 5% resistor
R11, R12—68,000-ohm, ½-watt 5% resistor
R13—10,000-ohm, ½-watt 5% resistor
R15, R16—82,000-ohm, ½-watt 5% resistor

35 SUPER OP AMP

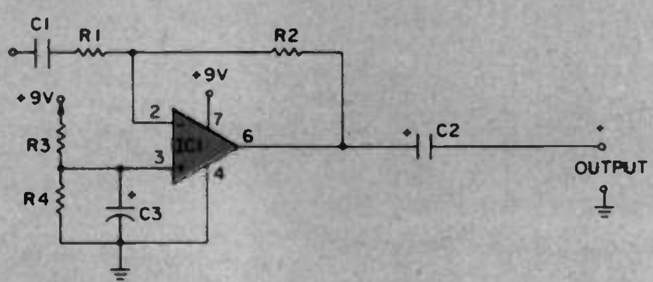
☐ The perfect op amp has yet to be invented, but if you're looking for the next-best thing, try the 3140. It is fast, operates with supplies as low as 4 volts, has internal frequency compensation, and is happy even in very-high impedance circuits (thanks to its FET inputs). Here is an offbeat application using the 3140 as a digital latch that's CMOS- or TTL-compatible. Driving the SET input momentarily low latches the output in a high state, while a low pulse to the RESET input sends the output low once again. When both inputs are high, the circuit rests. Don't send both inputs low at the same time.



PARTS LIST FOR SUPER OP AMP

C1—0.1-uF ceramic disc capacitor
D1, D2—1N914 diode
IC1—3140 op amp (RCA or equivalent)
R1—12,000-ohm, ½-watt resistor (all resistors 5%)
R2—5,100-ohm, ½-watt resistor
R3—82,000-ohm, ½-watt resistor
R4—10,000-ohm, ½-watt resistor
R5—1,000-ohm, ½-watt resistor

☐ Op amps, like the popular 741, are usually operated with matching plus and minus power supplies. However, for simple signal amplification applications, the single positive supply shown below has been found to work quite nicely. Resistors R3 and R4 may be fixed at about 5000 ohms each, or replaced with a 5K or 10K potentiometer, if it is desired to adjust the no-signal output level so that high-amplitude signals will not be clipped. Sometimes, intentional clipping is desired, so this feature may be retained for general experimental applications. Note: If a potentiometer is used for R3, R4, connect center terminals of pots to pin #3 of IC1.



PARTS LIST FOR OP AMP VARIATION

C1—0.01-uF ceramic capacitor, 15 VDC (gain=10)
—0.10-uF ceramic capacitor, 15 VDC (gain=100)
C2—1 to 100-uF electrolytic capacitor, 15 VDC (increase value with frequency)
C3—100-uF electrolytic capacitor, 15 VDC
IC1—741 op amp
R1—10,000-ohm, ½-watt resistor
R2—100,000-ohm, ½-watt resistor (gain=10)
—1,000,000-ohm, ½-watt resistor (gain=100)
R3, R4—5,000-ohm, ½-watt resistor or 5,000-10,000 ohm linear taper potentiometer

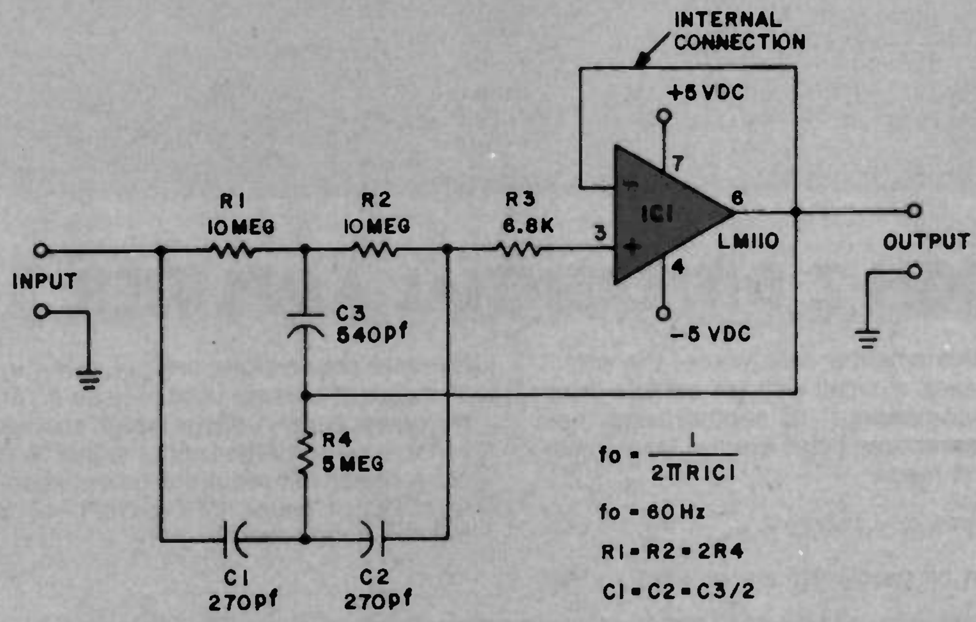
37 60-HERTZ HUM BUCKER

60-Hertz hum is deadly in an audio circuit because it can drive an audiophyle to complete distraction. In a PA circuit, it increases the fatigue of workers raising their tension to an undesirable level. You've got to kill that hum!

The circuit shown was designed for 60 Hertz. A National Semiconductor LM110 (IC1) is used as a voltage follower. In effect, it is a high-class 741 op-amp. A frequency vs. gain curve would show a flat response for almost the entire audio frequency spectrum except for a sudden drop, or notch, in the curve at 60 Hertz. The network in the input circuit is responsible for that. The formulas for cutoff frequency, R1, R2 and R4, and C1, C2, and C3 are given with the diagram. They are easy enough to handle with a calculator.

The diagram shows a feedback path from the output to the inverted (—) input. This connection is made internaly within the IC chip. The dual power supply required may be from 5 to 18-VDC regulated.

Insert the circuit in the audio amplifier at a low level. Some circuits exhibit a hum at 120 Hertz caused by full-wave rectification followed by poor filtering. A second hum bucker can be inserted into the audio amplification chain with R1 reduced to 5 Megohms. Of course, recall that R1 = R2 = 2 X R4.



$$f_o = \frac{1}{2\pi R1 C1}$$

$f_o = 60$ Hz

R1 = R2 = 2R4

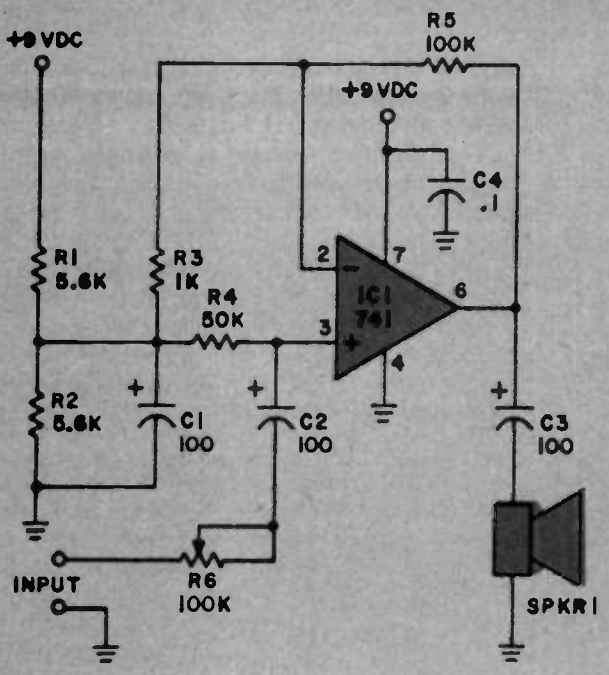
C1 = C2 = C3/2

PARTS LIST FOR 60-HERTZ HUM BUCKER

C1, C2—270-pF, ceramic capacitor, zero drift
C3—540-pF, ceramic capacitor, zero drift
IC1—LM110 op-amp integrated circuit
R1, R2—10-Megohm, ¼-watt, 5% resistor
R3—6800-ohm, ¼-watt, 5% resistor
R4—5-Megohm, ¼-watt, 5% resistor

38 MINI PA

Designed for very private listening, this little amplifier (we call it the Mini PA) sports a tiny loudspeaker of 1½- to 2-inches diameter. The gain may be varied through a feedback resistor from about 1 to 100. Only a single power supply, which may be a 9-volt DC transistor-radio battery, is required.



PARTS LIST FOR MINI PA

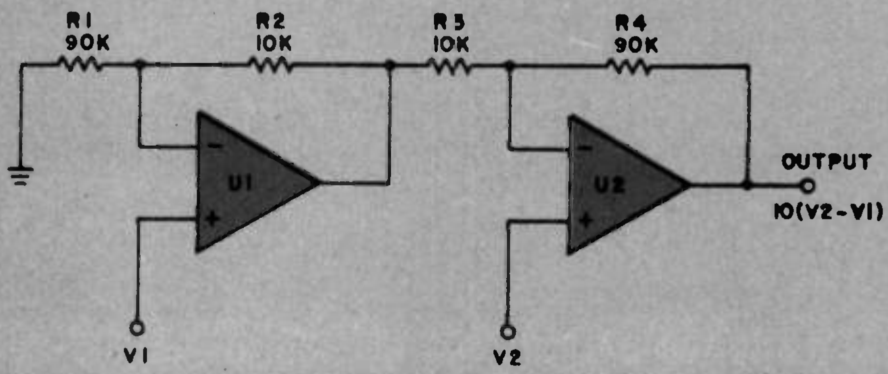
C1—100-uF, 100-WVDC, electrolytic capacitor
C2—100-uF, 6-WVDC, electrolytic capacitor
C3—100-uF, 10-WVDC, electrolytic capacitor
C4—.1-MF, ceramic capacitor
IC1—741 op-amp
R1, R2—5,600-ohm, ½-watt, 10% resistor
R3—1,000-ohm, ½-watt, 10% resistor
R4—50,000-ohm, ½-watt, 10% resistor
R5—100,000-ohm, ½-watt, 10% resistor
R6—100,000-ohm, audio-taper potentiometer
SPKR—8-ohm, 2-in. PM-type loudspeaker

39 HIGH-Z DIFFERENTIAL AMPLIFIER

The name of this amplifier tells you of the circuit capabilities. It takes a small voltage sample from another circuit, compares it to another, and then amplifies the difference ten times exactly. Mathematically, the equation reads:

$$V(out) = 10(V2 - V1)$$

The circuit can be used with any op-amp so that terminal connections are not given in the diagram. The type of op-amp used may be a 741. Be sure that the power supply voltage is nigh enough to handle tne voltage swing of the output signal. A one volt difference signal will require a power supply rated at 12-volts DC or better. Of course, dual power supplies may be necessary.



PARTS LIST FOR HIGH-Z IMPEDANCE AMPLIFIER

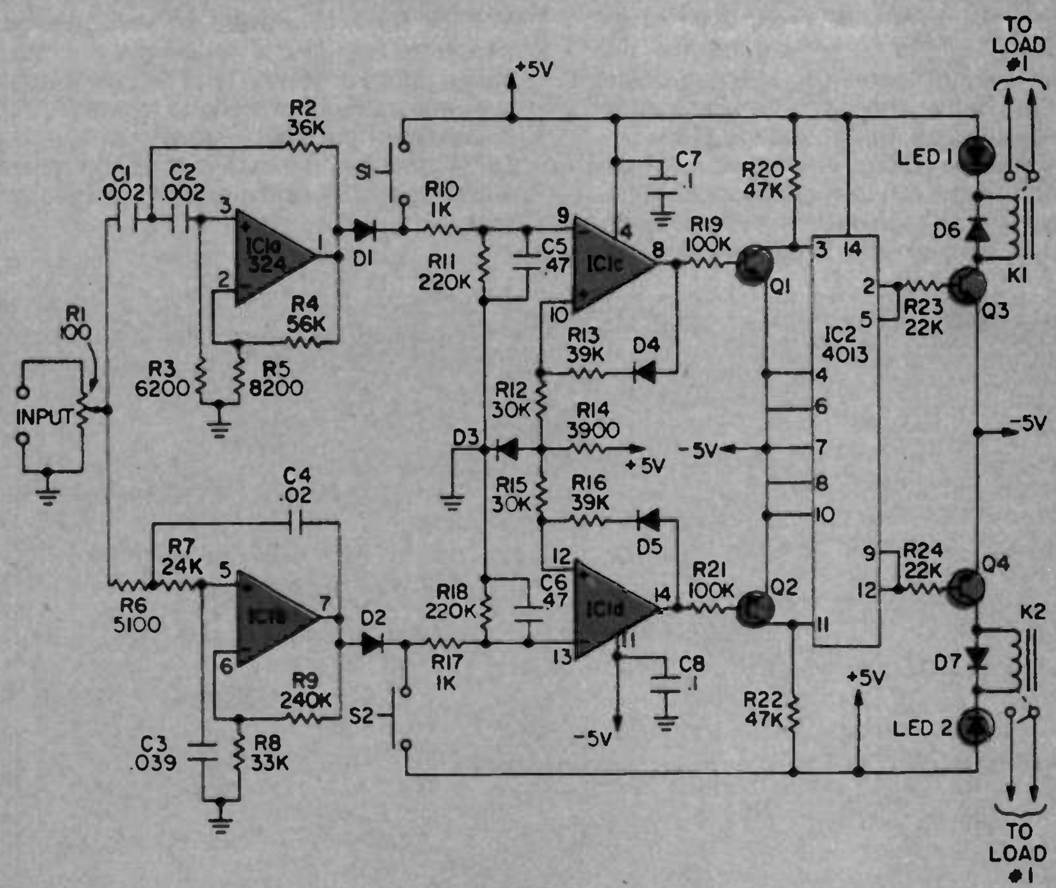
R1, R4—90,000-ohm, ½-watt, 5% (or better) resistor
R2, R3—10,000-ohm, ½-watt, 5% (or better) resistor
U1, U2—Linear op-amp such as 741, or better

40 CASSETTE CONTROL SYSTEM

□ Let's say that you need a programmable control system that can perform a timed sequence of operations. This sounds like a job for a high-priced computer, doesn't it? In many instances, however, just a cheap cassette recorder can do a respectable job—provided, of course, that you build this 2-channel controller.

High-frequency signals (above 5000 Hz) at the controller's input are amplified by high-pass filter IC1-a; then detected and used to clock one half of a dual flip-flop (U2). Each tone burst toggles the flip-flop, causing relay K1 to alternately open and close. These high-frequency audio signals have no effect on low-pass filter U1b, but frequencies below 500 Hz will produce the same effect in the lower channel as high frequencies in the upper channel, with the result that K2 alternately opens and closes a burst of low frequency audio.

Feed the signal from your recorder's speaker output jack to the controller's input. Record a short sequence of tones—about 300 Hz for the low channel, and 7500 Hz for the high channel.



PARTS LIST FOR CASSETTE CONTROL SYSTEM

C1, C2—.002-uF polystyrene capacitor
C3—.039-uF polystyrene capacitor
C4—.02-uF polystyrene capacitor
C5, C6—0.47-uF mylar capacitor
C7, C8—0.1-uF ceramic disc capacitor
D1-D7—1N914 diode
IC1—LM324 quad op amp integrated circuit
IC2—4013 CMOS dual flip-flop integrated circuit
K1, K2—6-VDC, 500-ohm relay
LED1, LED2—light-emitting diode
Q1-Q4—2N3904 NPN transistor
R1—100-ohm trimpot (all resistors 10% unless otherwise noted.)
R2—36,000-ohm, ½-watt resistor 5%
R3—6,900-ohm ½-watt resistor, 5%
R4—56,000-ohm, ½-watt resistor 5%
R5—8,200-ohm ½-watt resistor 5%
R6—5,100-ohm ½-watt resistor 5%
R7—24,000-ohm, ½-watt resistor 5%
R8—33,000-ohm, ½-watt resistor, 5%
R9—240,000-ohm, ½-watt resistor, 5%
R10, R17—1,000-ohm, ½-watt resistor
R11, R18—220,000-ohm, ½-watt resistor
R12, R15—30,000-ohm, ½-watt resistor
R13, R16—39,000-ohm, ½-watt resistor
R14—3,900-ohm, ½-watt resistor
R19, R21—100,000-ohm, ½-watt resistor
R20, R22—47,000-ohm, ½-watt resistor
R23, R24—22,000-oh, ½-watt resistor
S1, S2—pushbutton switch, normally open

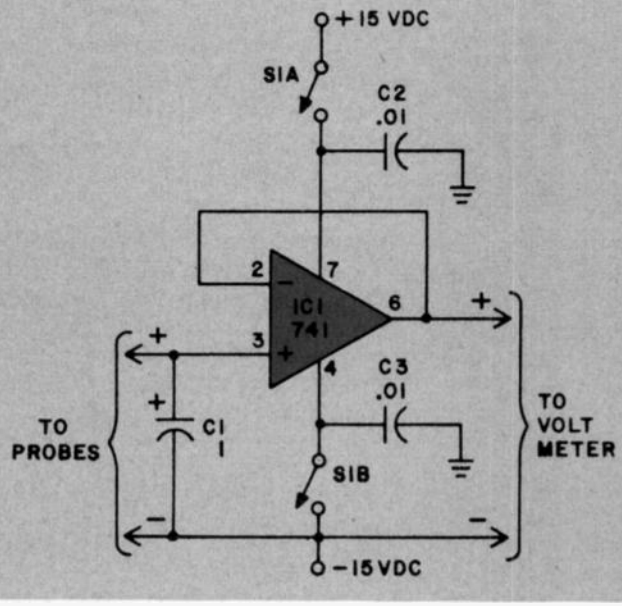
Play back the tape-recorded sequence, and adjust R1 somewhat past the point where toggling of the relays starts. The LED go on and off with the relays and serve as convenient indicators of channel activity. Pushbuttons S1 and S2 can be used to change the status of a channel independently of the audio input. Whistles, tuning forks and electronic oscillators can all be used as tone sources. Whichever you use, strive to keep the level of the recorded signal constant.

41 VOLTAGE BANK

There are times when you want to "save" a voltage for a reason, which is usually so that you can read it off a meter some time after it was recorded. Check this scenario: You are digging deep under the hood of your car checking the continuity of a line and the probes are with you, but the meter is on top of the engine—there's no room or light to read a meter down there. Your probes make contact, then your remove yourself to read the meter. It reads 12.6-volt DC indicating battery voltage is present on the line. Well—the trouble is not there! You keep on poking until you find the trouble. Those problems and others like them can be solved with the Voltage Bank.

This circuit reads the voltage and stores it. When a voltage is applied across C1, the capacitor charges to that value. When the voltage source is removed, the capacitor charge remains and is seen by the non-inverting input of the op-amp, IC1. The 741 op-amp (or any other like it) is wired as a unity gain amplifier which repeats the input voltage to produce an equal output. C1 holds it charge within the limits of its own leakage since the input for the op-amp circuit is a very high impedance.

The circuit's weakness is the charging capacitor. It must have a very low leakage rate to permit the Voltage Bank to provide an accurate reading for a minute of two. Use a Tantalum-type capacitor here with a rating of 16-WVDC. The power supply permits accurate voltage indications to within 2-volts DC of the value of the power supply voltage. Switch S1, a DPST switch, connects and disconnects the power supply negative and positive voltages at the same time.



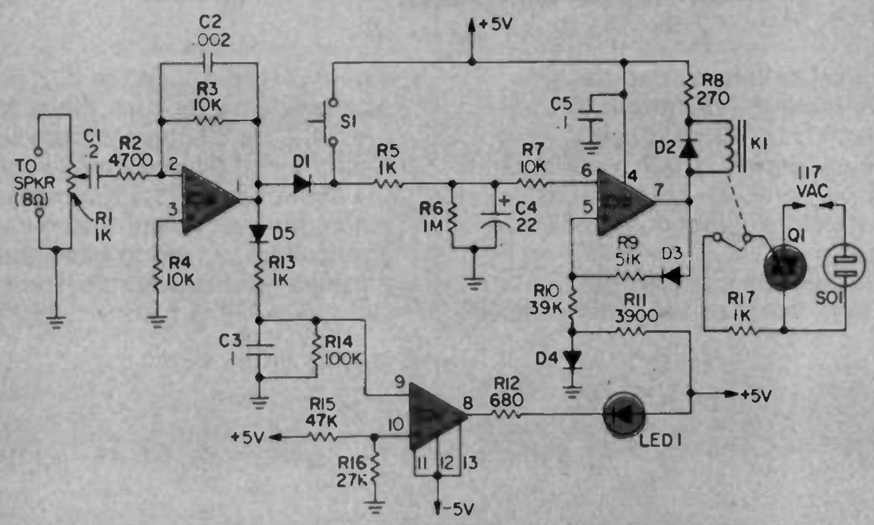
PARTS LIST FOR VOLTAGE BANK

C1—1-uF, 16-WVDC, tantalum, electrolytic capacitor
C2, C3—.01-uF, ceramic capacitor
IC1—741 op-amp (or equivalent)
S1—DPST slide or toggle switch

42 STEREO AUTO SHUT-OFF

□ It's ironic, isn't it? Almost every cheap stereo system shuts itself off after the last record has been played, but just try to find a sophisticated, multi-component system that can do the same. Well, here's a circuit that may solve the problem for you. Plug all of your equipment into SO1. Touch S1 and K1 closes, thereby energizing your system. If no audio is fed from your amp's output (4-16 ohms) to R1, the system shuts down in approximately thirty seconds. However, if music is being fed into the shut-off circuit's input, C4 is constantly re-charged, and the power remains on until 30 seconds after the last record goes silent.

To set the circuit up, select the quietest passage to which you expect to listen. PRess S1 put the tonearm in the groove, and adjust R1 until LED1 begins to flicker on and off with the music. Now relax, knowing that you finally have all the advantages of a cheap stereo.

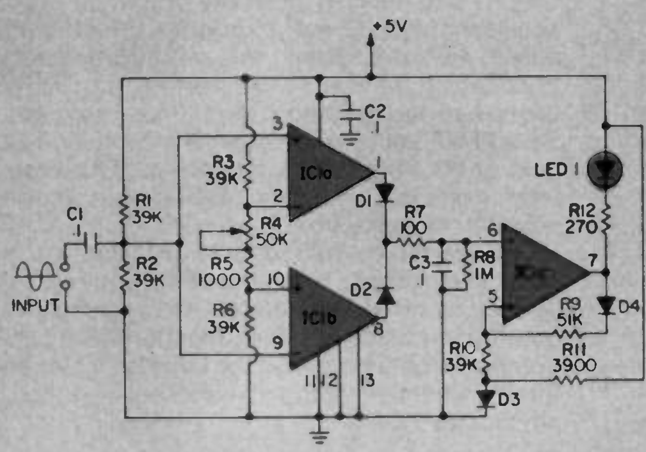


PARTS LIST FOR STEREO AUTO SHUT-OFF

C1—0.2-uF mylar capacitor
C2—.002-uF mylar capacitor
C3—0.1-uF mylar capacitor
C4—22-uF, 10-VDC tantalum capacitor
C5—0.1-uF ceramic disc capacitor
D1-D5—1N914 diode
IC1—LM324 quad op amp integrated circuit
K1—6-VDC, 500-ohm relay
LED1—light emitting diode
Q1—200-VDC, 500-ohm relay
R1—1,000-ohm linear taper potentiometer
R2—4,700-ohm, ½-watt resistor (all resistors 5% unless otherwise noted.)
R3, R4, R7—10,000-ohm, ½-watt resistor
R5, R13—1,000-ohm, ½-watt resistor
R6—1,000,000-ohm, ½-watt resistor
R8—270-ohm, ½-watt resistor
R9—51,000-ohm, ½-watt resistor
R10—39,000-ohm, ½-watt resistor
R11—3,900-ohm, ½-watt resistor
R12—680-ohm, ½-watt resistor
R14—100,000-ohm, ½-watt resistor
R15—47,000-ohm, ½-watt resistor
R16—27,000-ohm, ½-watt resistor
R17—1,000-ohm, 1-watt resistor
S1—pushbutton switch, normally open
SO1—AC power socket

43 PEAK-LEVEL DETECTOR

□ In many situations, particularly in recording, it is more important to know a signal's peak level than its average level. While VU meters are customarily employed for such purposes, you'll find this circuit's LED output easier to interpret and, as a result, more accurate. IC1a gauges the positive peaks, while IC1b does the same for the negative peaks. Both the positive and negative signal thresholds are determined by pot R4's setting. You can choose any threshold from ±20 mV to ±1 V. Whenever the input exceeds either the positive or negative threshold, LED1 flashes on for approximately one-tenth of a second. That's long enough to attract your attention and warn you to cut back on the volume.



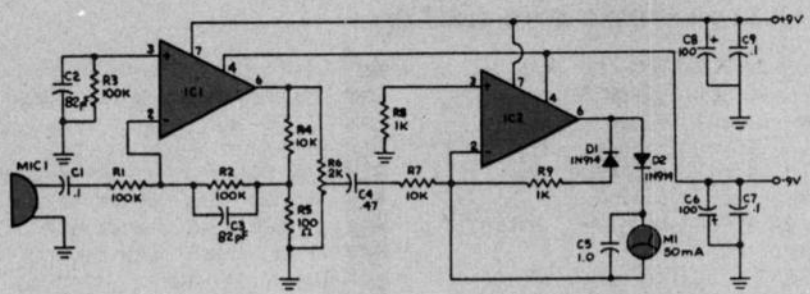
PARTS LIST FOR PEAK-LEVEL DETECTOR

C1, C2, C3—0.1-uF ceramic capacitor
D1-D4—1N914 diode
IC1—LM324 quad op amp integrated circuit
LED1—light emitting diode
R1, R2, R3, R6, R10—39,000-ohm, ½-watt resistor (all resistors 5%)
R4—50,000-ohm, ½-watt trim-potentiometer
R5—1,000-ohm, ½-watt resistor
R7—100-ohm, ½-watt resistor
R8—1,000,000-ohm, ½-watt resistor
R9—51,000-ohm, ½-watt resistor
R11—3,900-ohm, ½-watt resistor
R12—270-ohm, ½-watt resistor

44 SOUND-LEVEL METER

☐ With this sound-level meter you can easily measure the relative loudness of sounds in the range from 20 to 20,000 Hz. Although your readings will not be calibrated in terms of—or even be linearly proportional to—true sound power, this circuit should very adequately fill the bill.

Amplifier IC1 multiples the signals from microphone MIC1 by a factor of 100. This amplied signal is then applied to IC2, which functions here as a precision rectifier. Meter MI is tucked into one of IC2's feedback loops, where it measures a rectified and filtered direct current proportional to the sound level. Potentiometer R6 allows you to adjust the instrument's sensitivity to match the application—anything from audience-applause measurement to sound-system installation.



PARTS LIST FOR SOUND-LEVEL METER

C1, C7, C9—.1-uF ceramic disc capacitor
C2, C3—82 pF polystyrene capacitor
C4—.47 uF mylar capacitor
C5—1.0 uF mylar capacitor
C6, C8—100 uF 25V electrolytic capacitor
D1, D2—1N914 silicon diode
IC1—RCA 3140 FET-input op amp
IC2—741 op amp
M1—0-50 microamp DC meter
MIC1—crystal microphone cartridge
R1, R2, R3—100,000-ohm, ½-watt 10% resistor
R4, R7—10,000-ohm, ½-watt 10% resistor
R5—100-ohm, ½-watt 10% resistor
R6—2,000-ohm linear taper potentiometer
R8, R9—1,000-ohm, ½-watt 10% resistor

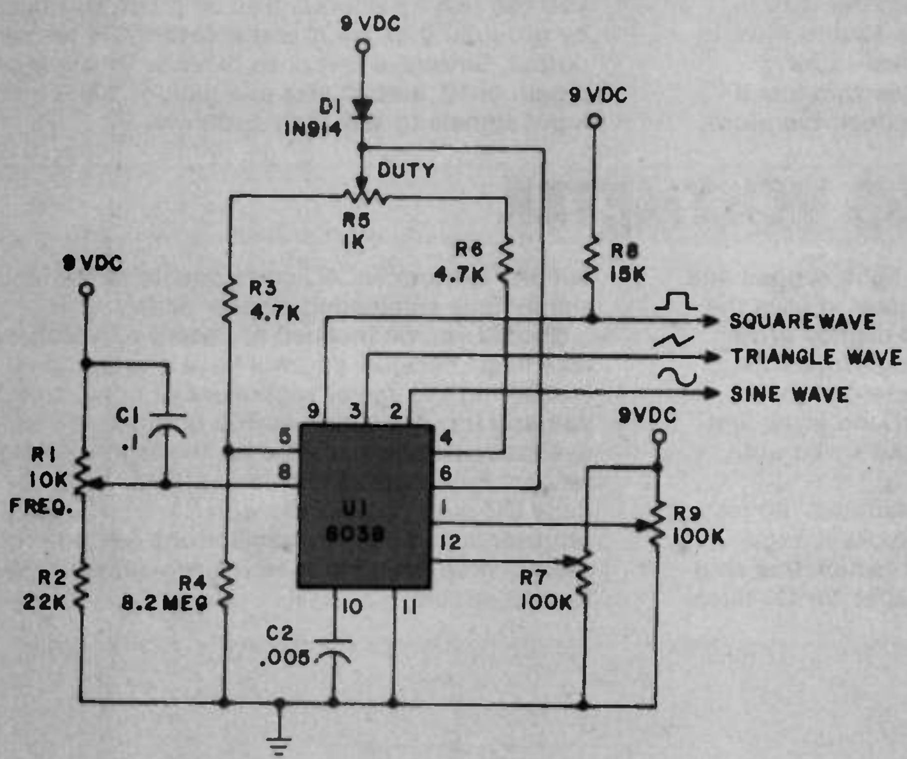
45 TRI-WAVEFORM GENERATOR

There's nothing very clever here, because most of the information is taken from the spec sheet for the 8038 waveform generator integrated circuit. This particular chip puts out three waveforms at the same frequency. The waveforms are: squarewave, sinewave, and triangle wave. We used a 9-volt DC transistor-radio battery to power the chip, however, you can use anything from 9- to 30-volts DC. If you have a dual supply available, consult the spec sheet for application.

The parameters selected from the spec sheet are for an audio frequency range from 20 to 20,000 Hz. Immediately you can see the many possible audio applications available to you as a synthesizer circuit or signal generator. Potentiometer R1 selects the frequency output of the circuit. Potentiometer R5 determines the duty cycle of the output waveforms. By that we mean the wiper will select an output squarewave form at mid-point of its travel so that the waveform will be half the time low, and half the time high. The slopes of the triangle waveform will be equal. The duty cycle range selectable by the potentiometer is extensive covering approximately 95%.

The best way to adjust the distortion potentiometers, R7 and R9, is to place the output sinewave on an oscilloscope and use the scopes sinewave sweep. An elipse will form. Adjust the sync so that a circle is obtained. It will drift a bit making your adjustment procedure longer than it should be. However, adjust R9 and R7 until a perfect circle is formed. Adjust the gain of both the vertical and horizontal sweeps to fill the scope's face with the circle—the bigger, the better adjustment is possible.

The waveform outputs from the chip, U1, are not equal in amplitude. Should that be required, place the sinewave and triangle inputs into an adjustable-gain op-amp circuits and the triangle wave through a unity-gain op-amp (it has the largest amplitude of the three). Adjust the output to equal peaks with the aid of an oscilloscope.



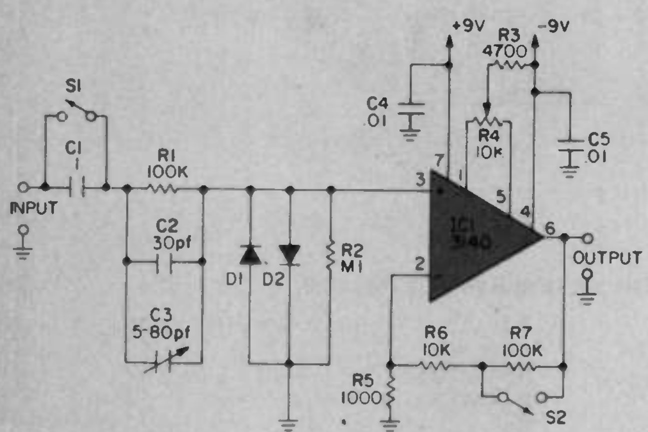
PARTS LIST FOR TRI-WAVEFORM GENERATOR

C1—.1-uF capacitor
C2—005-uF, ceramic-disc capacitor
D1—1N914 silicon diode
R1—10,000-ohm linear-taper potentiometer
R2—22,000-ohm, ¼-watt, 5% resistor
R3, R6—4700-ohm, ¼-watt. 5% resistor
R4—8200-ohm, ¼-watt, 5% resistor
R5—1000-ohm, linear-taper potentiometer
R7, R9—100,000-ohm, linear-taper potentiometer
R8—15,000-ohm, ¼-watt, 5% resistor
U1—8038 Intersil waveform-generator integrated circuit

46 INSTRUMENT SENSITIVITY BOOSTER

☐ This tiny, hign-impedance amplifier will boost the sensitivity of your oscilloscope or voltmeter by a factor of 10 or 100. So, if your oscilloscope's maximum sensitivity at present is 10mV/div, you can boost it to 1mV/div or .1mV/div. Signals you previously could not measure, such as the output of your magnetic phono cartridge, will now be visible. Note also that if all you own is a 20K-ohms-per-volt VOM, the sensitivity booster will not only let you measure smaller voltages, it will give you a 1-megohm input impedance besides.

Switch S2 selects the gain—10 if closed and 100 is open. When you need direct coupling to measure DC voltages, close S1. Otherwise, leave



PARTS LIST FOR INSTRUMENT SENSITIVITY BOOSTER

C1—0.1-uF mylar capacitor
C2—30-pF polystyrene capacitor
C3—5-80-pF trimmer capacitor (Arco 462 or equivalent)
C4, C5—0.01-uF ceramic disc capacitor
IC1—3140 FET-input op amp (RCA or equivalent)
R1, R7—100,000-ohm, ½-watt resistor (all resistors 5% unless noted.)
R2—1,000,000-ohm, ½-watt resistor
R3—4,700-ohm, ½-watt resistor
R4—10,000-ohm, linear-taper potentiometer
R5—1,000-ohm, ½-watt resistor
R6—10,000-ohm, ½-watt resistor
S1, S2—SPST switch

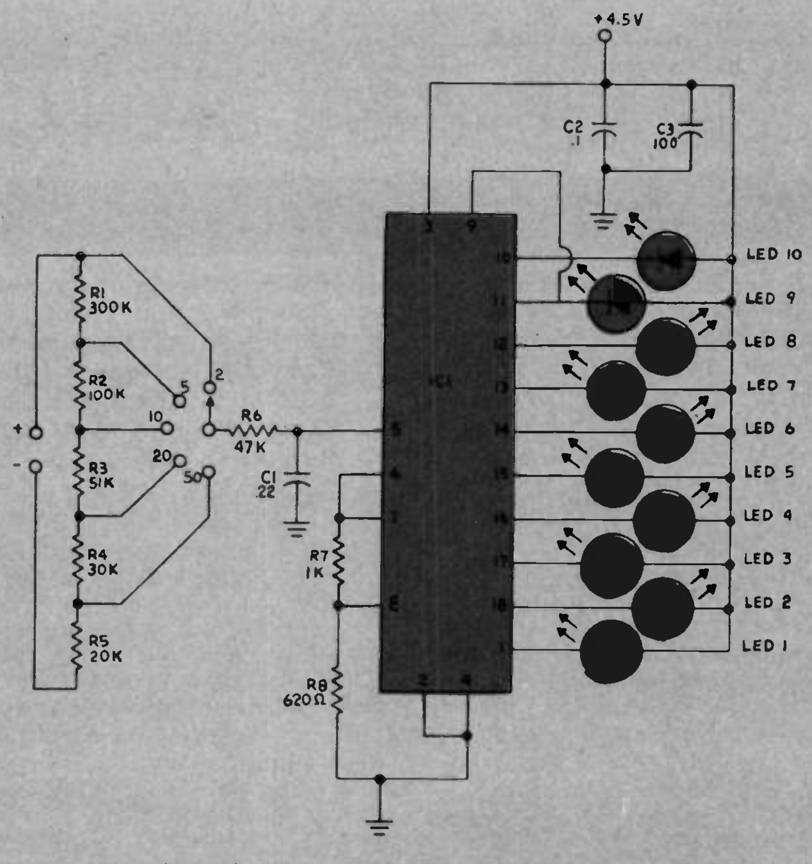
it open for AC coupling. If the booster is to be used with a scope, feed a 20-kHz square wave to its input, and adjust C3 for the best-looking square wave at the output. For use with just a VOM, C2 and C3 will have little effect; therefore, you can leave them out. The amp can be nulled by grounding its input and adjusting R4 for zero output. Sinewave response extends to 400 kHz at a gain of 10, and 40 kHz at a gain of 100. Limit input signals to less than ±100 mV.

47 METERLESS VOLTMETER

□ Here is a DC voltmeter that is light, rugged and, best of all, **cheap.** Instead of a meter, it uses the National Semiconductor LM3914 display driver and ten light-emitting diodes to measure voltage in five ranges. As the voltage present at the instrument's input rises above ground level, first LED1 lights, followed by LED2 and so on until, finally, LED10 comes on.

We have chosen the dot-display mode, so only one LED is on at a time. This is more energy-efficient than a bargraph display (which this chip is also capable of producing). Capacitor C1 filters out any extraneous AC components of the input signal, thus eliminating display jitter.

Should you be inclined to absent-mindedness, take heart because you will have a tough time clobbering this meter regardless of how careless you are. Inputs as high as 100 portionately higher overloads can be tolerated on the higher voltage ranges. Full-scale sensitivities of 2, 5, 10, 20 or 50 bolts DC may be selected with S1. Each LED represents a voltage increment one-tenth of full scale. Three AA cells in series can supply power for this circuit.



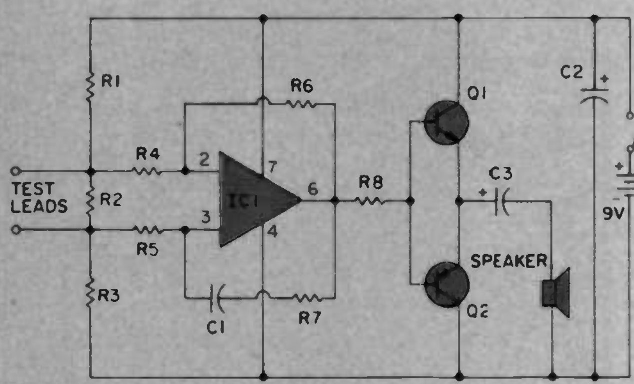
PARTS LIST FOR METERLESS VOLTMETER

C1—.22 uF mylar capacitor
C2—.1 uF ceramic disc capacitor
C3—100 uF, 10V electrolytic capacitor
IC1—LM3914 dot/bar display driver (National Semiconductor)
LED1 thru LED10—light emitting diodes
R1—300,000-ohm, ½-watt 5% resistor
R2—100,000-ohm, ½-watt 5% resistor
R3—51,000-ohm, ½-watt 5% resistor
R4—30,000-ohm, ½-watt 5% resistor
R5—20,000-ohm, ½-watt 5% resistor
R6—47,000-ohm, ½-watt 5% resistor
R7—1,000-ohm, ½-watt 5% resistor
R8—620-ohm, ½-watt 10% resistor
S1—SP5 ps. rotary switch

48 CONTINUITY TESTER

□ After wiring a new electronic project or troubleshooting an old one, it is often good practice to make several continuity checks to be sure that certain connections in the circuit are correct. In the days of vacuum tubes this was accomplished with an ohmmeter, but for today's solid state circuitry you can't use most ohmmeters for several reasons. Some ohmmeters have far too much battery voltage and deliver as much as hundreds of milliamperes into a short circuit. This can easily damage expensive solid state devices. Also, the ohmmeter is an unreliable method to measure circuit continuity, since it will read through an emitter-base or diode junction.

This continuity checker is a handy accessory for troubleshooting circuits, and is safe to use on any solid state device or circuit. The maximum voltage at the input terminals is about 40 millivolts, and negligible current is passed through the circuit when continuity is indicated. The circuit will not indicate continuity for resistance values of about 35 ohms or greater, and will not register through an emitter-base junction or diode. The circuit is powered by a standard 9 volt transistor battery and draws about 1 milliampere when the input leads are open. Shorting the lead causes an audio tone to be generated and draws about 15 milliamperes of battery current.

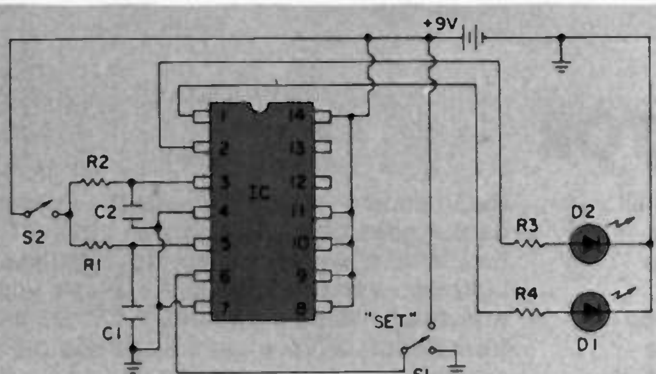


PARTS LIST FOR CONTINUITY TESTER

C1—.001-uF ceramic disc capacitor, 15 VDC
C2—10-uF electrolytic capacitor, 15 VDC
C3—15-uF electrolytic capacitor, 15 VDC
IC1—741 op amp
Q1—2N4401 transistor
Q2—2N4403 transistor
R1, R3, R4, R5, R8—10,000-ohm, ½-watt resistor
R2—100-ohm, ½-watt resistor
R6—4,600,000-ohm, ½-watt resistor
R7—100,000-ohm, ½-watt resistor
R9, R10—10-ohm, ½-watt resistor
SPKR—8-ohm PM type speaker

49 CAPACITOR MATCH-MAKER

□ This useful, but simple circuit will allow you to match two capacitors or to tell if one has greater capacitance than the other. Suppose you have one capacitor of known value, say 1 uF. Put it where C1 is in the circuit. Suppose you have another capacity of some unknown value. Put it where C2 is in the circuit. Now flip S1 from "set" back to ground. Then press S2. If D1 goes off and D2 goes on, it means C2 is less than C1, like 0.5 uF. If D1 stays on and D2 off, it means C2 is equal or greater than C1. You can use this circuit to help you quickly sort through a pile of old capacitors.



PARTS LIST FOR CAPACITOR MATCH-MAKER

C1, C2—see text
D1, D2—small LED
IC1—4013 dual flip-flop
R1, R2—30,000-ohm, ½-watt resistor
R3, R4—1,000-ohm, ½-watt resistor
S1—SPDT slide switch
S2—SPST momentary-contact pushbutton switch

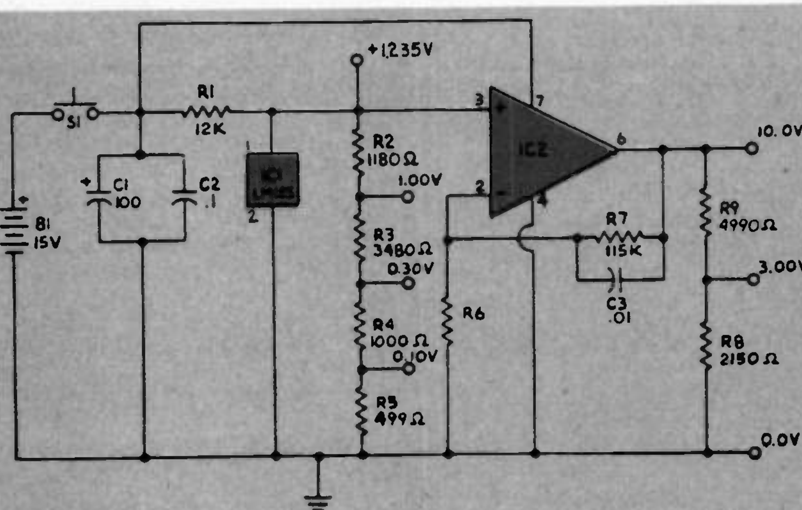
50 PRECISION VOM CALIBRATOR

□ Until now, most of the calibrator circuits appearing in hobby magazines could not be considered as primary reference standards. Instead, they were **transfer standards,** since the builder would be instructed to align his calibrator using a voltage reference of known accuracy. The obvious reaction of most readers was: "If I had access to an accurate voltage reference to begin with, why would I want to build this calibrator?"

Our sentiments exactly. Now National Semiconductor comes to the rescue with a voltage reference IC, the LM185, having an output of 1.235 bolts 1%. What's more, this voltage remains stable in the face of changing ambient temperature and supply current.

The circuit diagrammed here produces six useful reference voltages from .100 V to 10.0 V. As noted above, the 1.235-volt output is accurate to within 1%. All of the other outputs are accurate to within 2% except for the 3-volt output, which has a tolerance of 4%. Reduced accuracy on all derived outputs is the result of errors introduced by the 1% resistor tolerances. Bear in mind, however, that worst-case accuracies are quoted here.

Be certain that the input resistance of the instrument being calibrated greatly exceeds the resistance at the circuit node being read. Most of you who worry about calibration have high-impedance (10-megohm) FET voltmeters, the loading effects of which are negligible here.

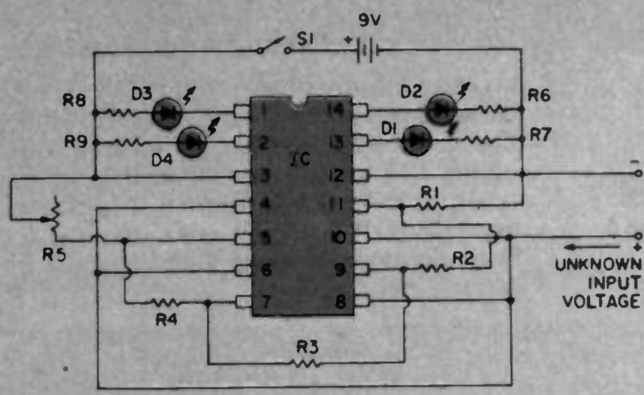


PARTS LIST FOR PRECISION VOM CALIBRATOR

B1—ten AA cells in series to yield 15 volts
C1—100 uF, 25 electrolytic capacitor
C2—.1 uF ceramic disc capacitor
C3—.01 uF polystyrene or mylar capacitor
IC1—LM185 1.235-volt reference IC (National Semiconductor)
IC2—3140A FET-input op amp (RCA) All Resistors ½w, 1% precision unless noted otherwise
R1—12,000-ohm, ½-watt 10% resistor
R2—1,180-ohm, ½-watt resistor
R3—3,480-ohm, ½-watt resistor
R4—1,000-ohm, ½-watt resistor
R5—499-ohm, ½-watt resistor
R6—162,000-ohm, ½-watt resistor
R7—115,000-ohm, ½-watt resistor
R8—2,150-ohm, ½-watt resistor
R9—4,990-ohm, ½-watt resistor
S1—SPST normally open pushbutton switch

51 METER ELIMINATOR

□ This circuit introduces the principle of a digital voltmeter and actually provides a very sensitive, high impedance meter for your workbench. The LM-339 is an IC containing four separate operational amplifiers of a special type. These op amps compare the reference voltage set on one input pin with an unknown voltage on the other. If the unknown voltage exceeds the reference, the output goes high and lights an LED. D1 lights first. With a slightly higher input voltage, D2 will light, etc. Variable resistor R5 allows you to set the voltage steps between D1, D2, D3 and D4 from about .02 volts per step to about 0.5 volts per step.



PARTS LIST FOR METER ELIMINATOR

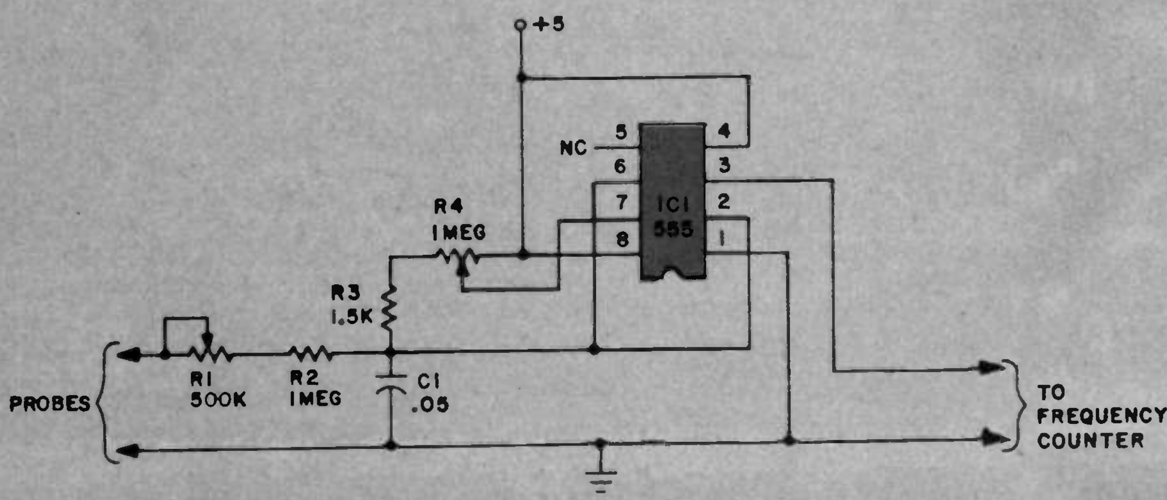
D1, D2, D3, D4—large LED
IC1—LM339 quad comparator
R1, R2, R3, R4—1,200-ohm, ½-watt resistor
R5—1,000,000-ohm linear-taper potentiometer
R6, R7, R8, R9—470-ohm, ½-watt resistor
S1—SPST toggle switch

52 V-TO-F COUNTER/VOLTMETER CIRCUIT

Don't tell a soul—the 555 chip can provide a frequency proportional to a sample voltage provided the input impedance to the circuit under test is one-half Megohm, or better. Thus, you can hookup a voltage-to-frequency circuit between an unknown voltage and a frequency counter providing a readout that is indicative of the test voltage. The circuit will draw a few microamperes, but that will not affect most circuits you test.

Of course, the voltage you can measure is limited by the 5-volt DC power supply to the 555 chip; however, that is why voltage-divider networks were invented. In the circuit you find potentiometer R4 that determines the output frequency of the astable multivibrator. Potentiometer R1 is a scaling device to mate the actual signal to the output frequency such that one-volt input will change the frequency by 10 Hz. That will occur when the sum of R2 and R1 are equal.

Stability is a problem here, so wire the unit keeping the leads extremely short. Use an insulated, shielded probe shell. To get a zero reading, connect the probe tips together and adjust R4 until the last two figures on the frequency counter read 00 Hz. (The other numbers don't count.) Now, place the probes across a 5-volt regulated source that's on the money. Adjust R1 until the last two digits read 50 Hz. These two adjustments will interact somewhat so continue to readjust until the stable 00 and 50 indications are obtained.

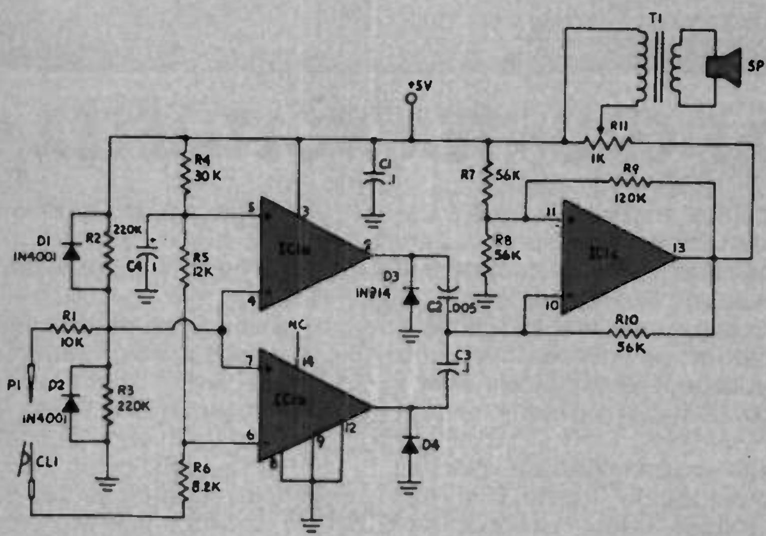


PARTS LIST FOR V-TO-F VOLTMETER

C1—.05-uF disc ceramic capacitor
IC1—555 timer integrated circuit
R1—500,000-ohm, linear-taper potentiometer
R2—1-Megohm, ¼-watt, 5% resistor
R3—1500-ohm, ¼-watt, 5% resistor
R4—1-Megohm linear-taper potentiometer

53 AUDIBLE LOGIC PROBE

□ Here is the old familiar logic probe but with a new twist. Instead of displaying logic status with LEDs, it does the job aurally. The logic-1 state, 2-volts or greater, is signalled by a high tone. On the other hand, a low tone sounds to indicate the logic-O state, 0.8-volt or less. Inputs between 0.8 and 2-volts produce no output. (Note that this probe is designed especially for TTL and cannot be used for any other logic family.) The circuit requires a regulated 5-volt supply, which means that it can be powered by the same supply used by the TTL circuitry under test. Output can be taken from a miniature speaker, as shown in the schematic, or you may use a miniature earphone. Potentiometer R11 sets the output volume level.



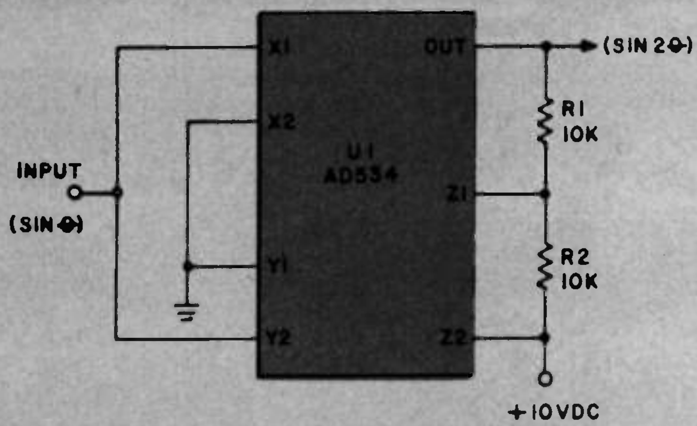
PARTS LIST FOR AUDIBLE LOGIC PROBE

C1—0.1-uF ceramic disc capacitor, 35-WVDC
C2—0.005-uF mylar capacitor, 35-WVDC
C3—0.1-uF mylar capacitor, 35-WVDC
C4—1.0-uF mylar capacitor, 35-WVDC
CL1—Alligator clip
D1, D2—1N4001 diode
D3, D4—1N914 diode
IC1—LM339 quad comparator integrated circuit
P1—Metal probe tip
R1—10,000-ohm, ½-watt 10% resistor
R2, R3—220,000-ohm, ½-watt 10% resistor
R4—30,000-ohm, ½-watt 5% resistor
R5—12,000-ohm, ½-watt 5% resistor
R6—8200-ohm, ½-watt 5% resistor
R7, R8, R10—56,000-ohm, ½-watt 10% resistor
R9—120,000-ohm, ½-watt 10% resistor
R11—1000-ohm audio-taper potentiometer
SPKR—8-ohm miniature speaker
T1—miniature audio output transformer —1,000-ohm primary/8-ohm secondary

54 SINEWAVE FREQUENCY DOUBLER

You have heard a lot about frequency division, which, frankly, is easy. Analog Devices has an integrated circuit, the AD534, that will double the frequency of the sinewave input. The result will be a sinewave output! What can you use this circuit for? It opens many unusual possibilities. For example, it steps up the tone to the next octave. Organ designers should keep that in mind. Also, what effect would it have on a circuit should it be included in the feedback loop on an audio signal amplifier. Strange sounds are possible for the experimenter.

The circuit appears to be so simple, it's worth a try. In fact, imagine the crispness it can add to a fuzz circuit!

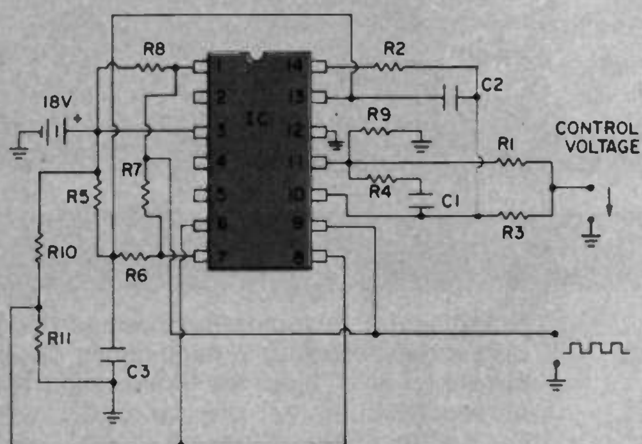


PARTS LIST FOR SINEWAVE FREQUENCY DOUBLER

R1, R2—10,000-ohm, ½-watt, 5% resistor
U1—AD534 frequency double integrate circuit

55 VOLTAGE-CONTROLLED OSCILLATOR

□ By varying the control voltage (a separate battery) between 1 and 25 volts, the output frequency of this oscillator will vary between about 500 Hz and 50,000 Hz. There are a host of experimental applications, such as putting a microphone in series with the control voltage and having the output frequency go into an amplifier and speaker. Voice-like singing sounds can be made. Or run the output of an electric guitar into the control voltage input and listen to the music!

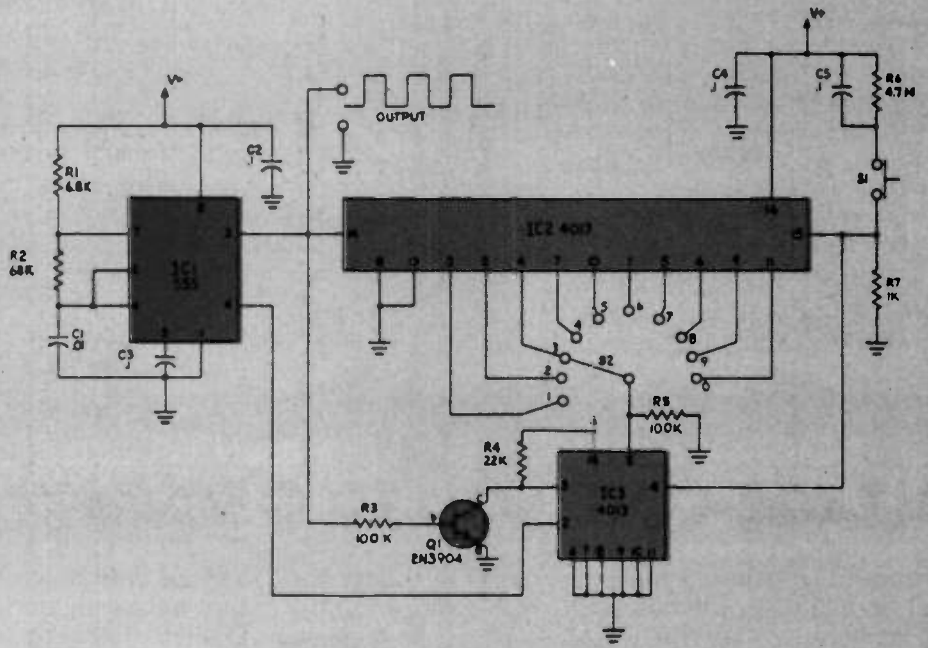


PARTS LIST FOR VOLTAGE-CONTROLLED OSCILLATOR

C1—0.1-pF ceramic disc capacitor, 15 VKC
C2—500 pF mica capacitor, 15 VDC
C3—0.01-uF ceramic capacitor, 15 VDC
IC1—LM339 quad comparator
R1, R7—100,000-ohm, ½-watt resistor
R2,—50,000-ohm, ½-watt resistor
R3—20,000-ohm, ½-watt resistor
R4—10,000-ohm, ½-watt resistor
R5, R8—3,000-ohm, ½-watt resistor
R6—5,100-ohm, ½-watt resistor
R9, R10, R11—30,000-ohm, ½-watt resistor

56 PULSE-BURST GENERATOR

□ This is a fiendishly clever circuit for the digital experimenter. Just press S1, and this pulse-burst generator delivers the exact number of glitch-free pulses you need (as determined by the setting of S2). You can select anywhere from one to ten pulses, which the circuit furnishes at a rate of 1kHz. If necessary, the pulse rate can be slowed down by using a larger value of capacitance for C1. With a 10 mf electrolytic unit as the timing capacitor, pulses arrive at a one-per-second rate, which is slow enough for visual observation (on an LED display, for instance). Any potential (V+) between +5 and +15 volts can be used, depending on the requirements of the circuitry you intend to drive.

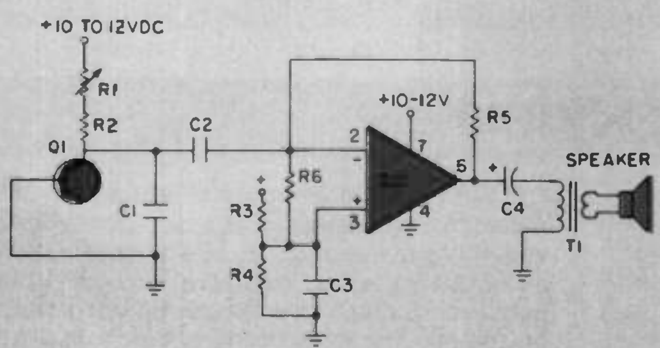


PARTS LIST FOR PULSE-BURST GENERATOR

C1—.01-uF mylar capacitor
C2, C3, C4, C5—0.1-uF ceramic disc capacitor
IC1—555 timer integrated circuit
IC2—4017 CMOS decade counter integrated circuit
IC3—4013 flip-flop integrated circuit
Q1—2N3904 NPN transistor
R1—6,800-ohm, ½-watt 10% resistor
R2—68,000-ohm, ½-watt 10% resistor
R3, R5—100,000-ohm, ½-watt 10% resistor
R4—22,000-ohm, ½-watt 10% resistor
R6—4,700,000-ohm, ½-watt 10% resistor

57 WHITE NOISE

☐ Noise, more or less "pure white" from some source of uncertainty, can be filtered and shaped for various purposes, ranging from radio alignment, to music, or the simulated sounds of rain on the roof. There are various naturally random impulse sources available to the experimenter, including the plasma from gaseous discharges occurring in neon lamps. On the semiconductor level, there are diodes and transistors purposely configured and biased into noisiness. But under certain conditions, many semiconductor junctions develop wide band RF



PARTS LIST FOR WHITE NOISE

C1—.005-uF ceramic capacitor, 15 VDC
C2, C3—10-uF electrolytic capacitor, 15 VDC
C4—75-ukF electrolytic capacitor, 25 VDC
IC1—741 op amp
Q1—2N4401
R1—100,000-ohm linear-taper potentiometer
R2, R6—10,000-ohm, ½-watt resistor
R3, R4—4,700-ohm, ½-watt resistor
R5—1,000,000-ohm, ½-watt resistor
SPKR—8-ohm PM type speaker
T1—audio output transformer with 500-ohm primary/8-ohm secondary

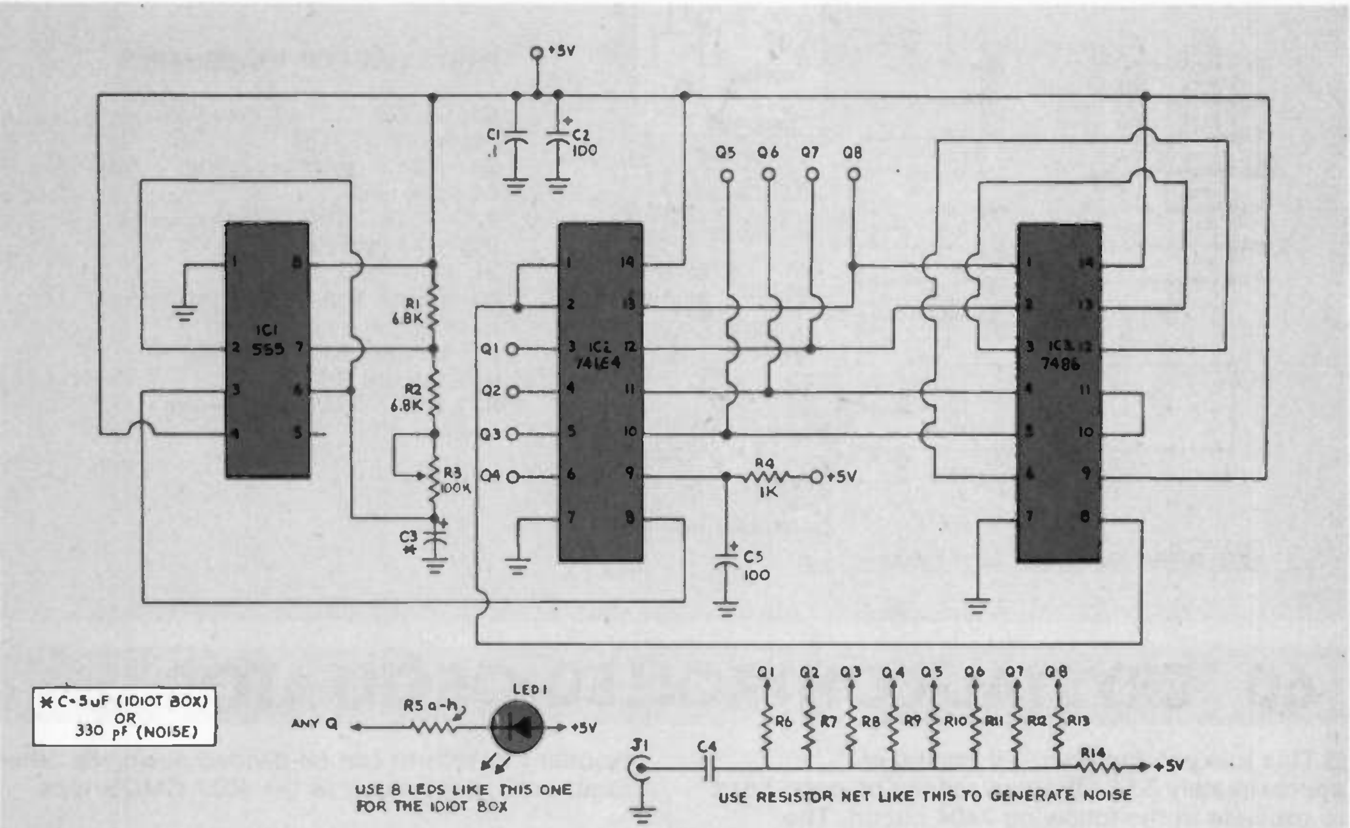
noise. When amplified by a type 741 op amp, which has internal frequency roll-off elements, the result is a continuous hiss in the output speaker, simulating rain. The signal can also be used in the development of "electronic music" and the testing of hi-fi filters and systems.

58 PSEUDO-RANDOM SEQUENCE GENERATOR

☐ A pseudo-random sequence generator is like a scrambled counter. Instead of counting 1,2,3,4,..., the PRSG might yield an output of 2,9,7,1... The PRSG shown here supplies a sequence of 255 scrambled numbers, available in binary form at the eight outputs (Q1 through Q8). Some applications:

First, you might hook up an LED and a 330-ohm resistor to each output as illustrated. Use a 5-uF electrolytic capacitor for C3, and you'll have a dandy idiot box, which will blink impressively on your desk, but do nothing.

Or, you could hook up the resistor network diagrammed, and use a 330 pF polysyrene capacitor for C3. You'll get a 1-volt peak-to-peak noise voltage at J1 which can be used to generate interesting percussive sounds in conjunction with the Musical Modulator presented elsewhere in this issue.

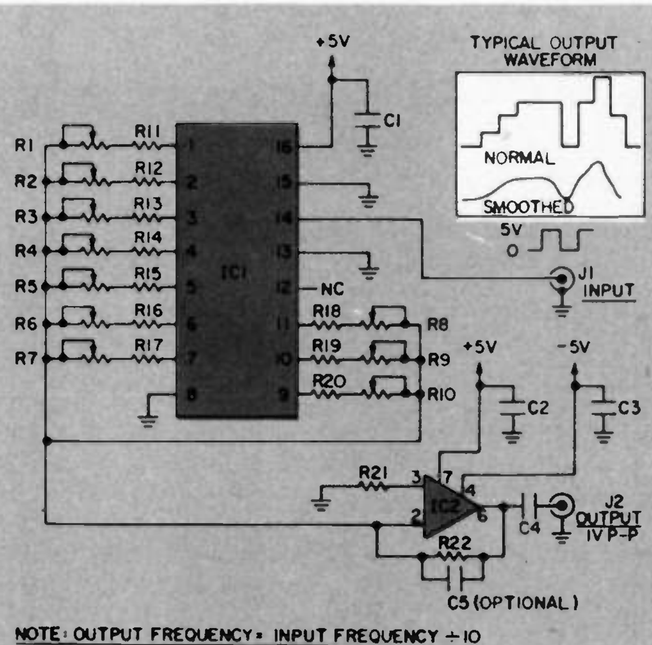


PARTS LIST FOR PSEUDO- RANDOM GENERATOR

C1—0.1-uF ceramic disc capacitor, 35-WVDC
C2, C5—100-uF electrolytic capacitor, 10-WVDC
C3—5-uF 10-WVDC electrolytic or 330-pF polystyrene capacitor (see text)
C4—1.0-uF mylar capacitor (non-polarized), 35-WVDC
IC1—555 timer integrated circuit
IC2—74164 shift register integrated circuit
IC3—7486 quad EX-OR gate integrated circuit
J1—phono jack
LED1 thru LED8—Light-emitting diode
R1, R2—6800-ohms-ohm, ¼-watt 10% resistor
R3—100,000-ohm linear-taper potentiometer
R4-R6—1000-ohm, ¼-watt 10% resistor
R5a thru R5h—330-ohm, ½-watt 10% resistor
R7—2200-ohm, ½-watt 10% resistor
R8—3900-ohm, ½-watt 10% resistor
R9—8200-ohm, ½-watt 10% resistor
R10—15,000-ohm, ½-watt 10% resistor
R11—33,000-ohm, ½-watt 10% resistor
R12—62,000-ohm, ½-watt 10% resistor
R13—120,000-ohm, ½-watt 10% resistor
R14—120-ohm, ½-watt 10% resistor

59 WAVESHAPER

☐ This little circuit illustrates the principle behind multi-kilobuck laboratory-style waveform synthesizers as well as some of the more advanced music synthesizers. Into J1 you should feed a square-wave signal swinging from ground to almost 5-volts. The input signal's frequency should be ten times that of the desired output. Adjusting potentiometers R1 through R10 will enable you to literally design the shape of the output waveform. If you can get hold of an oscilloscope, use it to observe the effect of R1 through R10 on the output. At the same time, feed the output to an audio amp so that you can hear the changes in timbre that occur as the waveshape is altered. Capacitor C5 can be used to smooth out the chunky shape of the output. With a 10 kHz input, start with a value of 0.1 μF for C5 and experiment. Make sure at least one potentiometer is set to maximum resistance and that at least one is set to minimum. This guarantees a full 1-volt peak-to-peak output. You might also try feeding some interesting waveforms into the Musical Modulator (elsewhere in this issue) and listening to the notes formed.

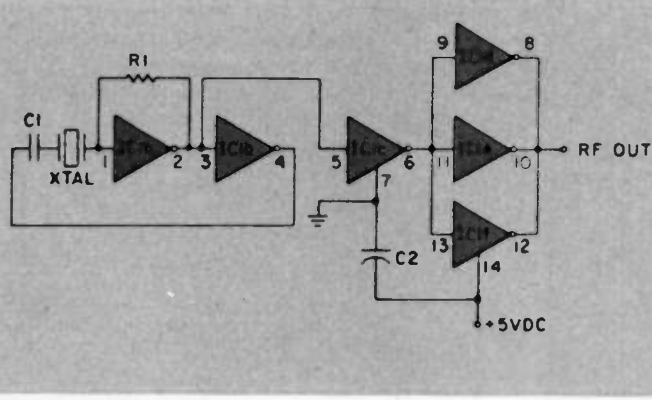


PARTS LIST FOR WAVESHAPER

C1, C2, C3—0.01-uF ceramic disc capacitor, 35 VDC
C4—0.5-uF mylar capacitor, 35 VDC
C5—see text
IC1—4017 CMOS decade counter
IC2—741 op amp
J1, J2—phono jack
R1 through R10—2-megohm linear-taper potentiometer
R11 through R20—68,000-ohm ½-watt resistor, 10%
R21, R22—15,000-ohm ½-watt resistor, 10%

60 CRYSTAL-CONTROLLED OSCILLATOR

☐ This inexpensive color-TV crystal of approximately 3.58 MHz can readily be persuaded to oscillate in the following 7404 circuit. The resultant waveform can be divided down, via other popular IC chips, such as the 4017 CMOS type.

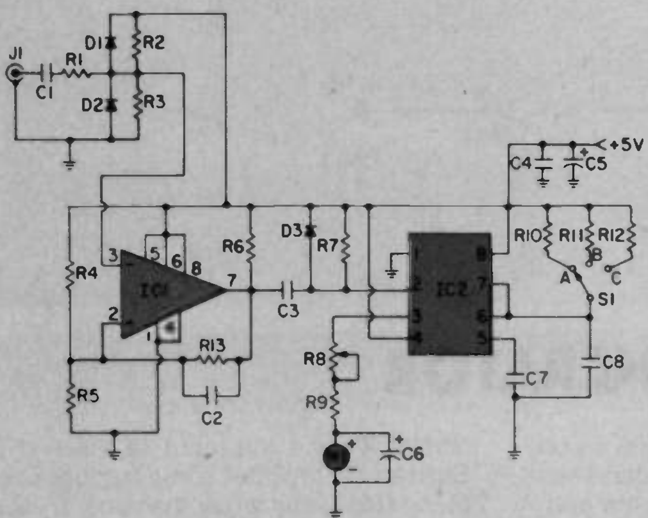


PARTS LIST FOR CRYSTAL-CONTROLLED OSCILLATOR

C1—75-pF mica capacitor, 15 VDC
C2—0.01-uF ceramic capacitor, 15 VDC
IC1—7404 hex inverter
R1—1,000-ohm, ½-watt resistor
XTAL—3.58 MHz crystal (color TV carrier type)

61 FREQUENCY METER

☐ One of the handiest instruments you can own is the digital frequency counter, but unless you do an awful lot of experimenting, the expense is usually hard to justify. However, if you can spare $15, consider building this *analog* frequency meter. Input impedance is 100,000-ohms, and frequencies up to 50 kHz can be measured, which makes the instrument ideal for the audio experimenter. After construction, calibrate the instrument by first selecting the middle range (Range B, 0-5 kHz) with S1. Feed a 5-kHz signal of known accuracy to J1, and adjust potentiometer R8 for a full-scale deflection on meter M1. That's it.



RANGE/FREQUENCY TABLE

Range	Frequency
A	0 to 500 Hz
B	0 to 5 kHz
C	0 to 50 kHz

PARTS LIST FOR FREQUENCY METER

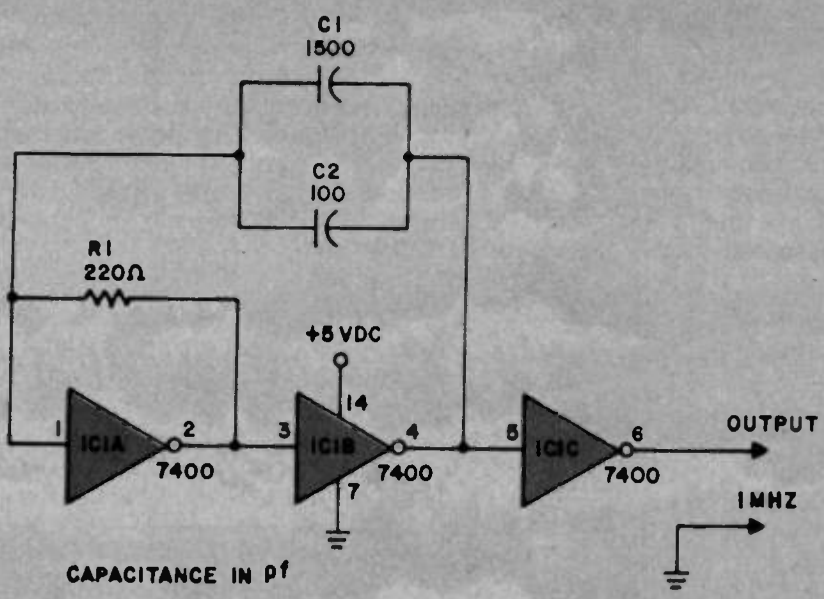
C1, C4, C7—0.1-uF ceramic disc capacitor, 34 VDC
C2—5-pF polystyrene capacitor, 35 VDC
C3—100-pF polystyrene capacitor, 35 VDC
C5, C6—100-uF electrolytic capacitor, 10 VDC
C8—3000-pF polystyrene capacitor, 35 VDC
D1, D2, D3—1N4001 diode
IC1—LM311 comparator
IC2—555 timer
J1—phono jack
M1—0-50 microAmp DC meter
R1—4700-ohm ½-watt resistor, 10%
R2, R3, R4, R5—18,000-ohm ½-watt resistor, 5%
R6—1000-ohm ½-watt resistor, 10%
R7—10,000-ohm ½-watt resistor, 10%
R8—10,000-ohm trimmer potentiometer
R9, R11—30,000-ohm ½-watt resistor, 5%
R10—3000-ohm ½-watt resistor, 5%
R12—3000-ohm ½-watt resistor, 5%
R13—10 Megohm ½-watt resistor, 10%
S1—single pole, 3-position rotary switch

62 RC 1-MHz CLOCK

Here is a very simple clock circuit that kicks out on megaHertz pulses. The timing elements in the circuit are a resistor and capacitor. The accuracy of the count is determined by the value tolerances used. Since one should never put his trust in the accuracy of a RC clock except when the pulse accuracy is not mandatory, precision parts and attending prices do not prevail here.

C1 and C2 are used to obtain 1600 pF (capacitors in parallel sum their capacitances). The value for R1, 220-ohms, is a spare parts box item. Select a 5% value, or better. Resistor R1 provides a measured amount of feedback that makes the circuit ring.

The circuit requires 5-volt DC regulated supply.



PARTS LIST FOR RC 1-MHz CLOCK

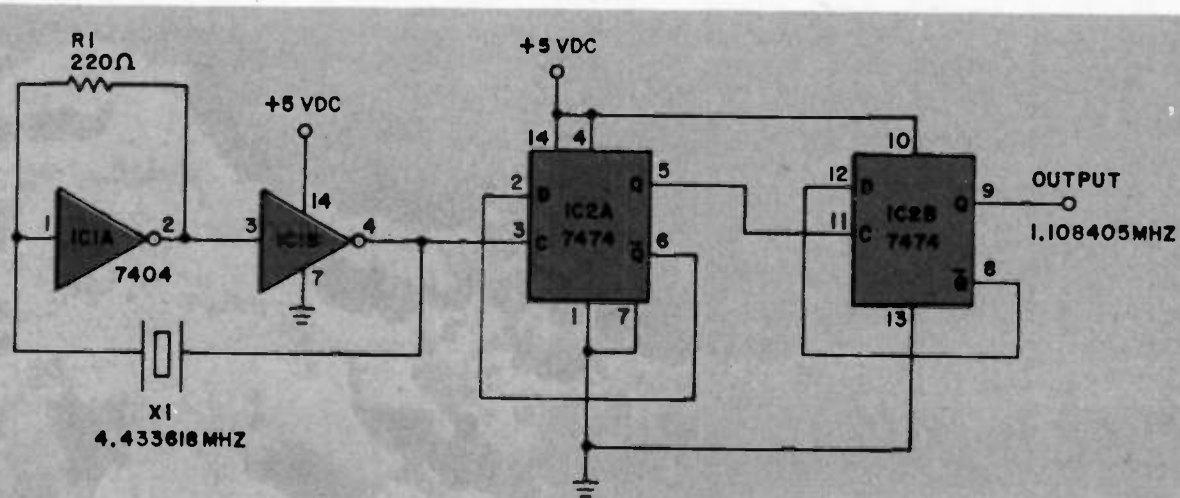
C1—1500-pF disc capacitor, zero drift
C2—100-pF disc capacitor, zero drift
IC1—7404 hex inverter integrated circuit
R1—220-ohm, ¼-watt, 5% resistor

63 TV CLOCK GENERATOR

From time to time you may get involved with color TV work either as a repairman or circuit builder. This is becoming a fact more so each day as more and more color monitors are used in conjuction with personal computers. However, depending upon the frequency of the crystal used, other applications can be found for the TV Clock Generator described here.

The active elements are two sections of a 7404 hex (six) inverter and two sections of a 7474 dual D edge-triggered flip-flop chip. Inverter section IC1a feeds IC1b which in turn provides the feedback to the crystal X1 and the input to the first flip-flop IC2a. Resistor R1 provides some feedback so that the gain of the stage is bit larger than one. Try varying R1 value to see the effect on the output at U1b (an oscilloscope is required here).

The flip-flops divide the output frequency from the oscillator by 2 and then 2 again for a total division of 4. More flip-flops connected in the same fashion will give addition divisions by two for each circuit block. Circuit requires a 5-volt DC regulated supply.

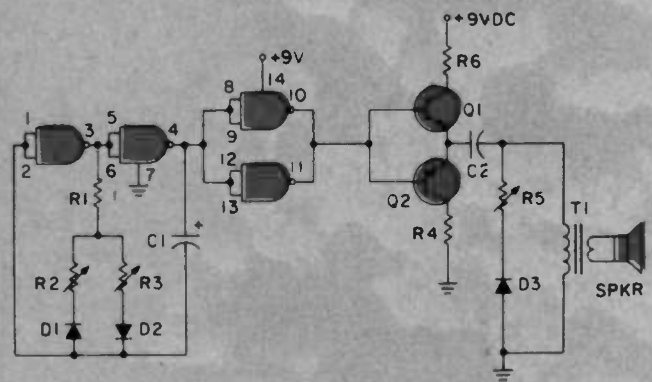


PARTS LIST FOR TV CLOCK GENERATOR

IC1—7404 hex inverter integrated circuit
IC2—7474 dual D edge-triggered flip-flop integrated circuit
R1—220-ohm, ¼-watt, 5% resistor
X1—4.433618-megaHertz TV crystal, PC mount

64 METRONOME

□ Transforming IC pulses into sound, this tiny ticker goes both tick *and* tock, at a rate of about 2 seconds per tic to 6 tocks per second. The timing capacitor, C1, should be a low leakage mylar type of about 2-uF or else a quality tantalum of about 4.7-uF. Although the reversed flow of current through the transformer's primary winding causes a different sound in the speaker from the positive-going inrush, diode D3 and potentiometer R5 can be added to make the "tock" more definitive in its sound quality.

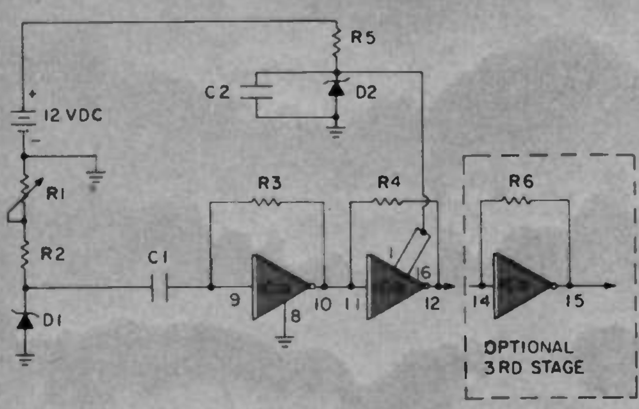


PARTS LIST FOR METRONOME

C1—2 to 5-uF low-leakage mylar or tantalum capacitor, 15 VDC
C2—2.2 to 10-uF electrolytic capacitor, 15 VDC
D1, D2, D3—1N4148 diode
IC1—4011A quad NAND gate
Q1—2N4401 transistor
Q2—2N4403 transistor
R1—47,000-ohm, ½-watt resistor
R2, R3—500,000-ohm linear-taper potentiometer
R4, R6—10-ohm, ½-watt resistor
R5—1,000-ohm linear-taper potentiometer
T1—audio output transformer 500-ohm primary/8-ohm secondary

65 RF NOISE GENERATOR

□ The diode-generated radio-frequency noise has such a wide spectrum of energy that it can be detected by both long and short-wave receivers. Bringing a transistor radio near the circuit shown below will demonstrate the power and limitations of the generator. The noise generator may be used in checking out a defective receiver through RF and IF stages by injecting it at various points. In the circuit, RF amplification was provided by running CMOS inverters in a linear mode. To reduce heating, an operating potential of about five volts was established through the use of a 1N751 zener diode, functioning normally, and not a noise generator in its own right, we hope!

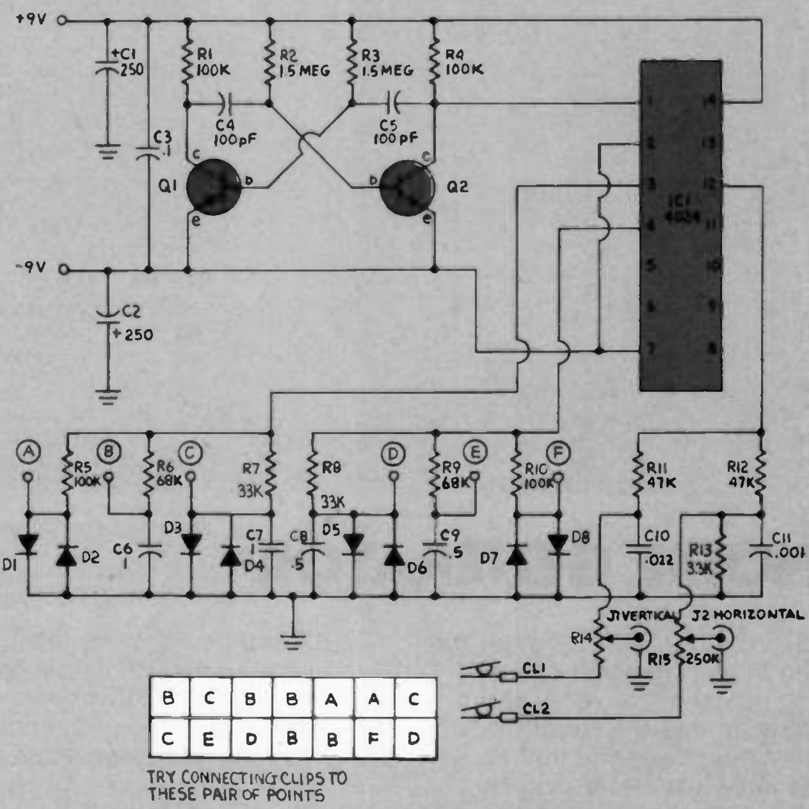


PARTS LIST FOR RF NOISE GENERATOR

C1, C2—0.1-uF ceramic disc capacitor, 15 VDC
D1—1N758 or 1N759 diode
D2—1N751 diode
IC1—4009A hex buffer
R1—500,000-ohm linear-taper potentiometer
R2—10,000-ohm, ½-watt resistor
R3, R4—1,000,000-ohm, ½-watt resistor
R5—300-ohm, 1-watt resistor
R6—1,000,000-ohm, ½-watt resistor

66 VIDEO PATTERN GENERATOR

□ Those of you with oscilloscopes might enjoy bread boarding this pattern generator. Feed the signal at J1 to your scope's vertical input, and connect the horizontal input to J2. Attach the clips to the selected pairs of test points, then adjust potentiometers R14 and R15 to create complex images. Output signals are about 1-volt peak-to-peak.

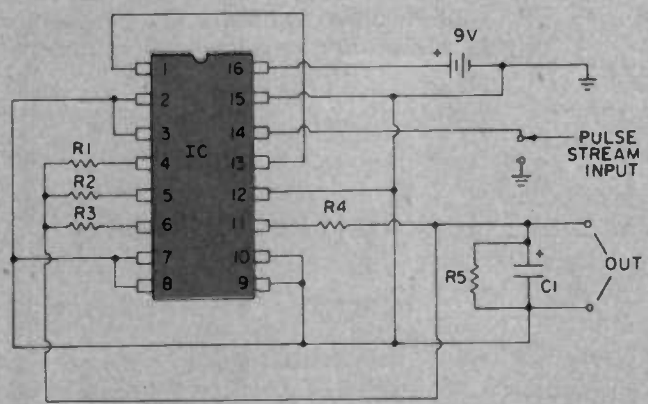


PARTS LIST FOR VIDEO PATTERN GENERATOR

C1, C2—250-uF electrolytic capacitor, 25 VDC
C3—0.1-uF ceramic disc capacitor, 34 VDC
C4, C5—100-pF polystyrene capacitor, 35 VDC
C6, C7—1.0-uF mylar capacitor (non-polarized), 35 VDC
C8, C9—0.5-uF mylar capacitor, 35 VDC
C10—0.022-uF mylar capacitor, 35 VDC
C11—0.001-uF mylar capacitor, 35 VDC
CL1, CL2—alligator clip
D1-D8—1N914 diode
IC1—4024BE CMOS ripple divider
J1, J2—phono jack
Q1, Q2—2N3904 NPN transistor
R1, R4, R5, R10—100K-ohm, ½-watt 10% resistor
R2, R3—1.5-Megohm, ½-watt 10% resistor
R6, R9—68,000-ohm, ½-watt 10% resistor
R7, R8—33,000-ohm, ½-watt 10% resistor
R11, R12—47,000-ohm, ½-watt 10% resistor
R13—3300-ohm, ½-watt 10% resistor
R14, R15—250,000 linear-taper potentiometer

67 SINEWAVE GENERATOR

☐ Think it is possible to have a pulse stream turned into a nice smooth sinewave? This circuit will do it! In fact, you can have the lowest sinewave frequency you can imagine by slowly pressing a button to generate your own manual pulse stream, if you like. The IC is a counter that has been made to divide the input pulse rate by ten. The outputs feed through resistors R1, R2, R3, and R4 to build up a sinewave.

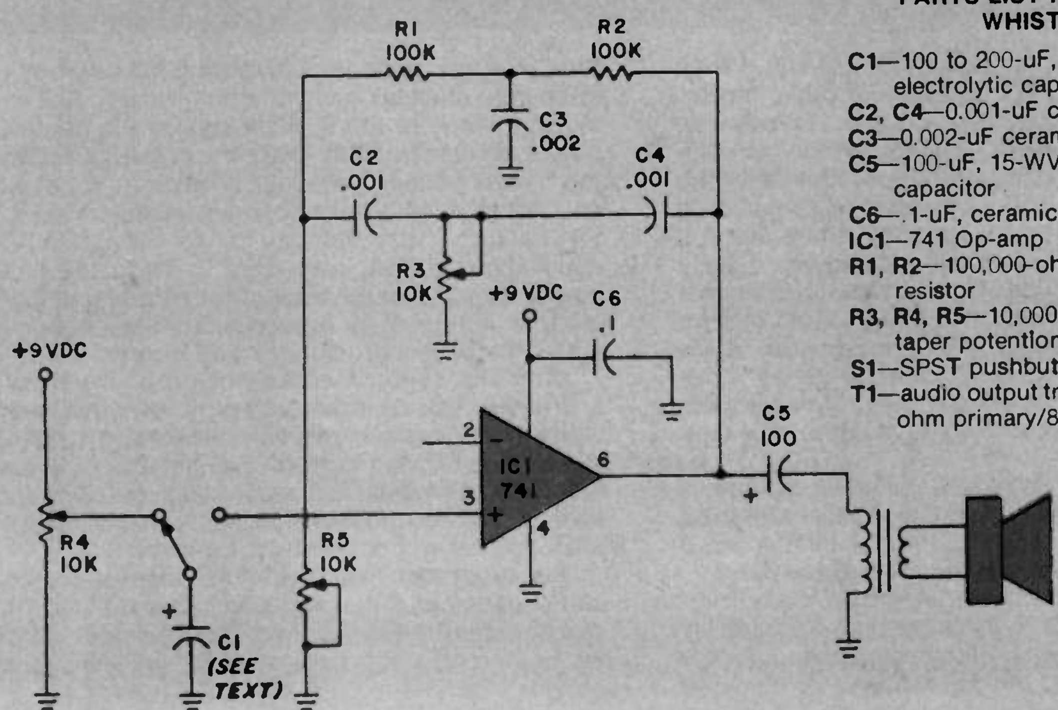


PARTS LIST FOR SINEWAVE GENERATOR

C1—10-uF electrolytic capacitor, 15 VDC
IC1—4018 dividing counter
R1, R2, R3, R4—20,000-ohm, ½-watt resistor
R5—47,000-ohm, ½-watt resistor

68 VARI-WHISTLE

When you hold the pushbutton switch down, the Vari-Whistle lets forth with an attention-getting whistle, which can be tailored to meet a variety of applications. The circuitry is built around a twin-T oscillator, which is triggered into action by a varying positive potential placed on the non-inverting op-amp input. Resistors R1, R2, and R3, together with capacitors C1, C2, and C3, determine the fundamental pitch, with R3 providing a useful variation. When S1 is pushed, the potential stored in



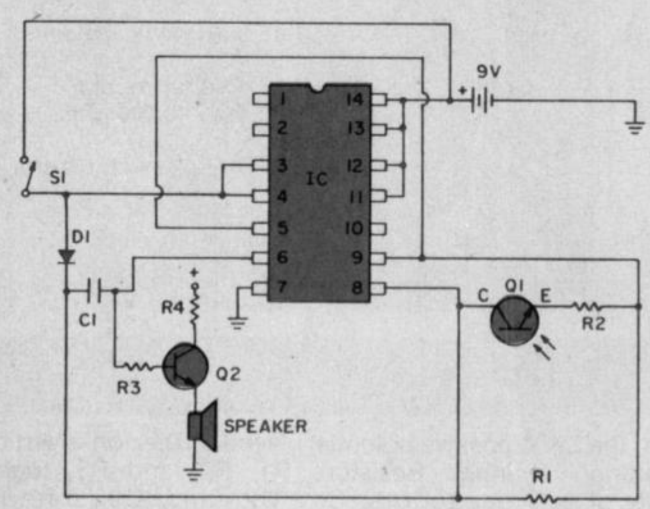
PARTS LIST FOR VARI-WHISTLE

C1—100 to 200-uF, 15-WVDC, electrolytic capacitor
C2, C4—0.001-uF ceramic capacitor
C3—0.002-uF ceramic capacitor
C5—100-uF, 15-WVDC electrolytic capacitor
C6—.1-uF, ceramic capacitor
IC1—741 Op-amp
R1, R2—100,000-ohm, ½-watt, 10% resistor
R3, R4, R5—10,000-ohm linear-taper potentiometer
S1—SPST pushbutton switch
T1—audio output transformer: 500-ohm primary/8-ohm secondary

C4 is placed on the non-inverting input, causing the oscillator to function. The duration is determined by potentiometer R5. The format of the whistle is modified by the setting of potentiometer R4. At full potential, the effect is a sharply rising tone, followed by a more gradual decline. At about half setting, the effect is more bell-like. Play with this circuit, and you come up with a variety of sounds we can't begin to describe.

69 HAUNTED HOUSE

☐ An eerie sound comes from a small box in a dark room. As your friends shine a light toward the sound, it whines with a higher pitch, but falls again as they drop the light and run. The output at A can also be run into your hi-fi system to cause a very loud witch's squeal. The principle is a NOR-gate oscillator with a pitch controllable via the light-sensitive transistor Q1. Changing R1 to a higher value will give a lower-pitched wail.



PARTS LIST FOR HAUNTED HOUSE

C1—0.01-uF ceramic capacitor, 15 VDC
D1—1N4001 diode
IC1—4000 dual NOR gate w/inverter
Q1—FPT-100 phototransistor
Q2—2N4401
R1—30,000-ohm, ½-watt resistor
R2—1,000,000-ohm, ½-watt resistor
R3—2,000-ohm, ½-watt resistor
R4—500-ohm, ½-watt resistor
S1—SPDT toggle switch

70 SCOTLAND YARD SIREN ALERT

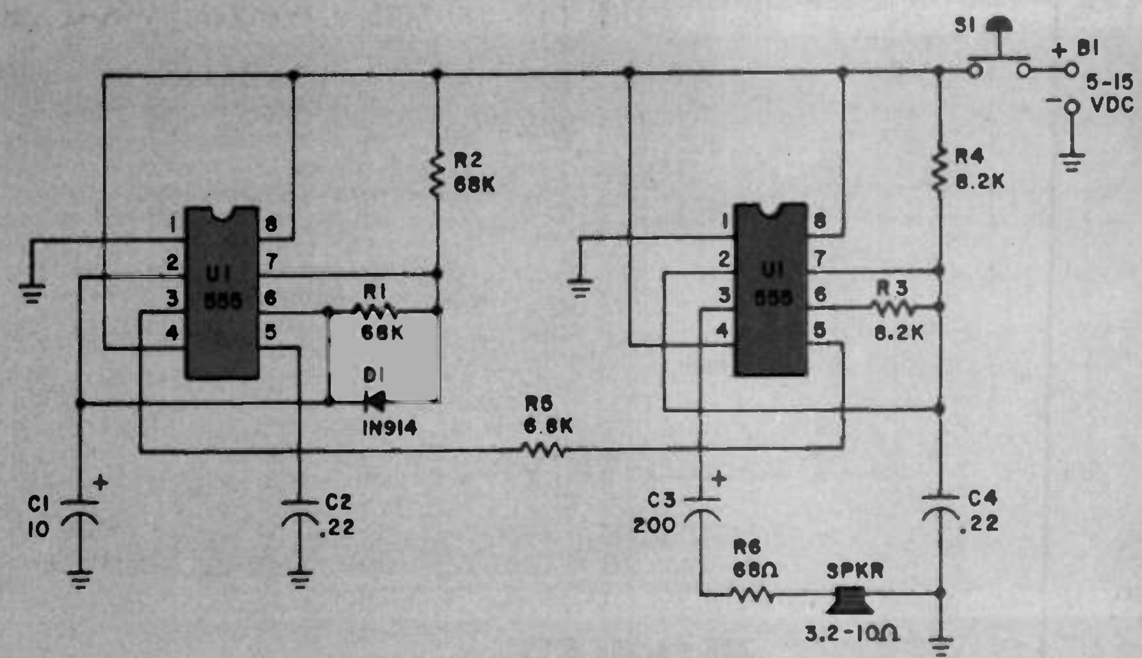
What makes a burglar alarm more effective than originally designed is the addition of other "noise" scources that will confound the burglar. For example, imagine a burglar making a quick entry into your home and the alarm bell goes off. He makes for the bell and yanks free the wires to it in a matter of seconds. All is quiet. Your neighbors believe that you accidently disturbed their sleep and that you quickly reset the system. Too bad for you. Now imagine that the burglar, after he yanks the bell wires free, hears a hee-haw siren screaming from another part of the house. He was not prepared for that so his best move is too pull out quickly. It doesn't take your neighbors long to figure out that something is amiss, and they call the police.

That extra sound from an unknown source is strange and loud. Cat burglars like the scenario to be quiet. In deference to cat burglars and their friends we provide the plans for a Scotland Yard Siren Alert.

Our old friend, the 555 timer integrated-circuit chip makes the scene twice in the schematic diagram. U1 operates as a 1-Hz astable multivibrator while U2 operates at 1000 Hz. U1 (at pin 3) supplies a squarewave output to the control-voltage terminal, pin 5, of U2. This, in effect, provides a switching from high to low (a change of state) every one-half second. The varying of voltage at Pin 5 of U2 causes the frequency output of U2 to go from 1000 Hz to about 800 Hz when the control voltage goes high. The output from pin 3 of U1 is fed directly to a small loudspeaker rated at 3.2 to 10 ohms. The sound may not be enough for your application, so you may want to forgo the loudspeaker direct hookup and opt for an audio amplifier feed to a horn-type loudspeaker. The louder the noise, the better for you. Ask any burglar.

The power supply for initial hookup and test may be a 9-volt transistor-radio battery. The power supply working range requirement is a reasonably stable DC supply rated from 5 to 15 volts. If installed in an automobile, place a 1N4002 diode in series with the supply line so that the negative induction kicks from the starter motor will not destroy the chips.

It is suggested that you bread-board this project and experiment with a variation of output time intervals and sounds. For example, vary C1 from 1 uF to 50 uF, or increase the resistance of R1 at value intervals provided by 10% resistor values to change the time interval. Change R3 and C4 over small ranges to alter the frequency of the output. Once you get the "noise" you want, hard-wire the circuit and incorporate the siren into your alarm system. Use an extra set of contacts in the alarm's output relay, or add a relay to gain the required contacts. You want the output alarm circuits isolated so that a short-circuit on one will not disable the other.



PARTS LIST FOR SCOTLAND YARD SIREN ALERT

B1—5-15-volts DC battery or power supply (see text)
C1—10-uF, 20-WVDC electrolytic capacitor
C2, C4—.22-uF capacitor
C3—200-uF, 20-WVDC electro lytic capacitor
D1—1N914 diode
R1, R2—68,000-ohm, ½-watt, 10% resistor
R3, R4—8200-ohm, ½-watt, 10% resistor
R5—6800-ohm, ½-watt, 10% resistor
R6—68-ohm, ½-watt, 10% resistor
S1—SPST pushbutton switch
SPKR1—Low-power PM speaker, 3.2 to 10 ohms
U1, U2—555 timer integrated circuit

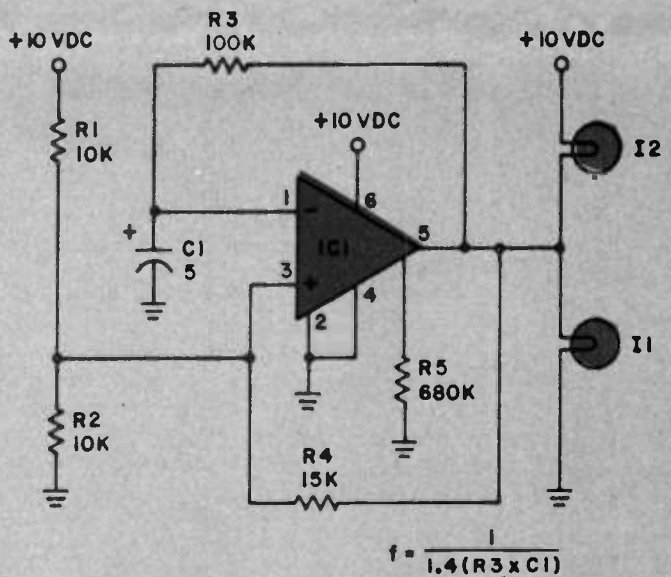
71 ALTERNATING LAMP FLASHER

We were tempted to call this circuit the Low-Frequency Lamp Flasher, but could it be anything else than a low frequency. After all, flashes of 15 per second or more cannot be seen for two reasons. The first is that the eye begins to blend the light flashes into one continuous light at that frequency (approximately) so that the lamp looks like it is always on. Then, the filament itself can not cool quickly enough for the eye to perceive the significant flash rate. So, it has to be low frequency. In the diagram shown, the values of C1 and R3 offer a frequency of 1.4-flashes per second.

Resistance divider circuit consisting of R1 and R2 place 5-volts DC on the positive input of IC1, pin 3. IC1 then drive input 5 to near 10-volts DC at which point it hold at that voltage—the supply voltage. Capacitor C1 slowly takes on a positive charge until the inverted input of IC1, pin 1 cuts off the output to zero volts at pin 5. Now C1 discharges until the circuit conducts again. Capacitor C1 charges and discharges through resistor R3 so that the amplifier is conducting and non-conducting an equal amount of time. The output at pin 5 is alternately high at near 10 volts or near zero volts.

The lamps are tied to either end of the power supply. When IC1, pin 5 is high, the output is 10 volts and the voltage drop across I1 is zero (+10 volts across both end of the filaments. However, I2 has +10 volts across one end and zero volts (ground) across the other. The difference is 10-volts and the lamp will light. When pin 5 drops to zero volts (ground potential), I2 is extinguished and I1 is powered by the same reasoning. Check it out!

Now, I1 and I2 could very well be light-emitting diodes in an opto-coupler used to switch higher current circuits. Or, the lamps could be solenoids of relays switching lamps on and off to attract attention at a construction sight. Thus, this circuit in the germ of an idea to generate many useful applications. The formula in the diagram determines the frequency of the switching cycle.

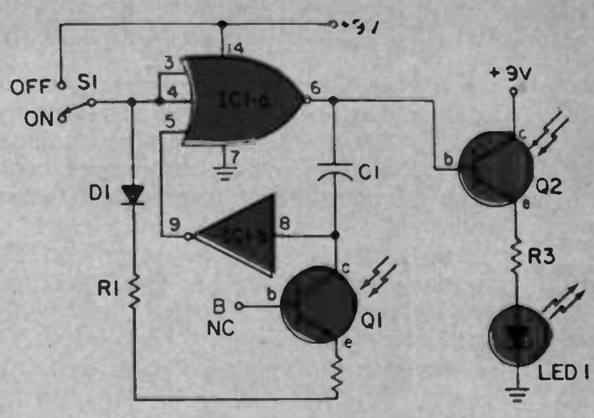


PARTS LIST FOR ALTERNATING LAMP FLASHER

C1—5-uF, 16-WVDC electrolytic capacitor
I1, I2—5-volt lamps
IC1—KM13080 op-amp integrated circuit
R1, R2—10,000-ohm, ½-watt, 5% resistor
R3—100,000-ohm, ½-watt, 5% resistor
R4—15,000-ohm, ½-watt, 5% resistor
R5—680,000-ohm, ½-watt, 5% resistor

72 TINKERER'S BLINKER

☐ We call it "Tinker's Blinker," but what's in a name, if you don't know how the circuit works. Tinkerer's Blinker is a small black box that you place on a table in front of your friends. Connected to the box with a thin wire is a wand with a small red light (LED1) on the end. The light flashes about twice a second, but at your command, it flashes faster and faster. You hand it to your friends, but they cannot do it. The secret? In the box is a small hole with phototransistor Q1 showing through. As LED1 gets closer to Q1, it flashes faster and faster but it will take your friends a long while to catch on. It's especially effective when all the room lights are out. Have fun.



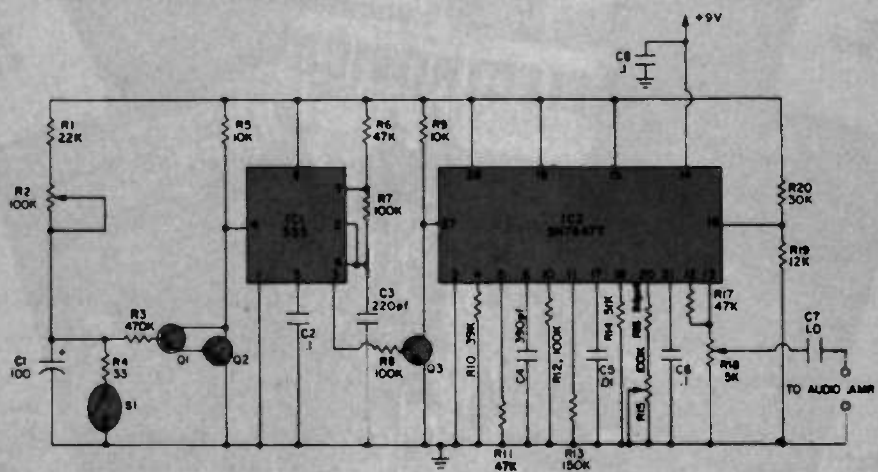
PARTS LIST FOR TINKERER'S BLINKER

C1—0.01-uF ceramic capacitor, 15 VDC
D1—IN4001 diode
IC1—4000 dual NOR gate w/inverter
LED1—Light-emitting diode
Q1—FPT100 phototransistor
Q2—2N4401 trransistor
R1—5,000,000-ohm, 1/2-watt resistor
R2—1,000,000-ohm, 1/2-watt resistor
R3—680-ohm, 1/2-watt resistor

73 TRAIN SOUND EFFECTS

□ Anyone with a model railroad layout will appreciate this circuit. Normal output consists of the characteristic "chuff-chuff" of a steam locomotive. Pot R16 can be used to adjust the chuffing rate to simulate faster or slower train speeds, while R18 sets the volume. Feed the unit's 1-volt peak-to-peak output signal to an amp rated at 10 watts and a 12-inch PA speaker for the utmost realism. (Note: This may not be feasible for apartment dwellers unless, or course, you're looking for a way to break the lease.)

Mount a small, powerful Alnico magnet on your train so that upon reaching a certain track position, the train triggers reed switch S1 with its magnet. This causes the circuit to produce a whistle blast that lasts between .5 and 2.5 seconds, depending on the setting of R2. If you wish to sound the whistle at several points on the track, or if you want to sound it manually, other switches may be wired in parallel with S1 and located at the appropriate positions.

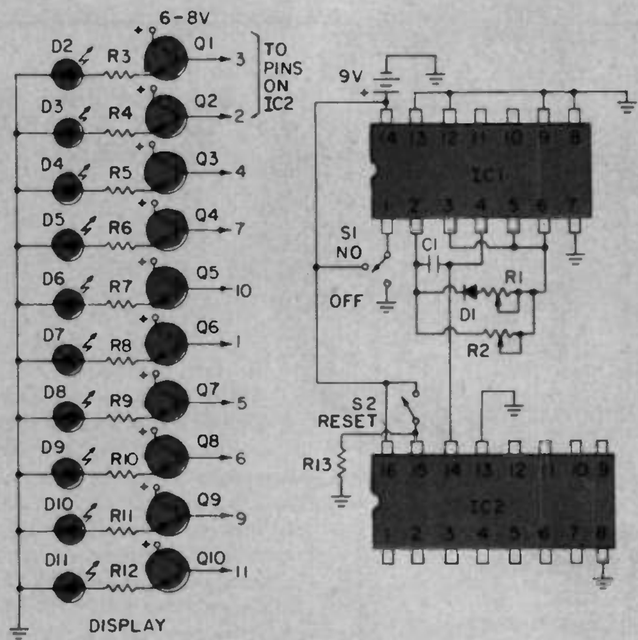


PARTS LIST FOR TRAIN SOUND EFFECTS

C1—100-uF, 16-BDC electrolytic capacitor
C2, C6, C8—0.1-uF ceramic disc capacitor
C3—200-pF polystyrene capacitor
C4—390-pF polystyrene capac tor
C5—.01-uF myular capacitor
C7—1.0-uF mylar capacitor
IC1—555 timer integrated circuit
IC2—SN76477 sound generator integrated circuit
Q1-Q3—2N3904 NPN transistor (all resistors 10% unless otherwise noted.)
R1—22,000-ohm, ½-watt resistor (all resistors 10% unless otherwise noted)
R2—100,000-ohm linear-taper potentiometer
R3—470,000-ohm, ½-watt resistor
R4—33-ohm, ½-watt resistor
R5, R9—10,000-ohm, ½-2att resistor
R6, R11, R17—47,000-ohm, ½-watt resistor
R7, R8, R12, R16—100,000-ohm, ½-watt resistor
R10—39,000-ohm, ½-watt resistcr
R13—150,000-ohm, ½-watt resistor
R14—51,000-ohm, ½-watt resistor
R16—1,000,000-ohm, linear-taper potentiometer
R18—5,000-ohm, linear-taper potentiometer
R19—12,000-ohm, ½-watt resistor
R20—30,000-ohm, ½-watt resistor
S1—magnetic reed switch

74 CHASE LIGHTS

☐ The rippling or chase effect on the ten LEDs is a beautiful and interesting sight, especially if they are mounted atop a nice wooden case and placed in the living room. A nice conversation piece. The speed of the ripple or chase is controllable via R1 and R2, where a smaller R1 and R2 makes the ripple go faster. The "on" of each LED overlaps perfectly with no momentary "off," so the ripple travels very smoothly.

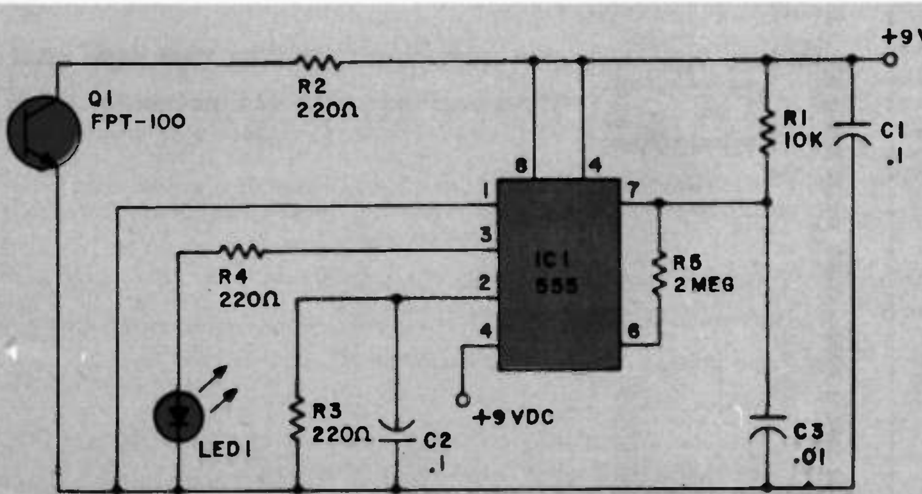


PARTS LIST FOR CHASE LIGHTS

C1—0.01-uF ceramic capacitor, 15 VDC
D1—1N4401 diode
D2 through D11—small LED
IC1—4011 quad NAND gate
IC2—4017 diode counter
Q1-Q10—2N4401
R1—10,000,000-ohm linear-taper potentiometer
R2—500,000-ohm linear-taper potentiometer
R3 through R12—1,000-ohm, ½-watt resistor
S1—SPDT slide switch
S2—SPST momentary-contact pushbutton switch
R13—100,000-ohm, ½-watt resistor

75 NOW YOU SEE IT—NOW YOU DON'T

"As anyone can plainly see, the LED (D1) flashes rather rapidly," you say to an unsuspecting guest. "But in fact, the flashes are an optical illusion. Just hold this white paper in front of the LED and look at the light through the paper. You will see that in fact the LED is not flashing, at least not until you remove the paper." Refer to the paper as an Oppulan-optical filter (no such thing) to add some mystery to what is happening in fornt of his eyes. Your guest will be the victim of optical confusion. The trick lies in the fact that the LED flashes only as long as its light shines on Q1. Put the paper between D1 and Q1 and the LED shines continuously.

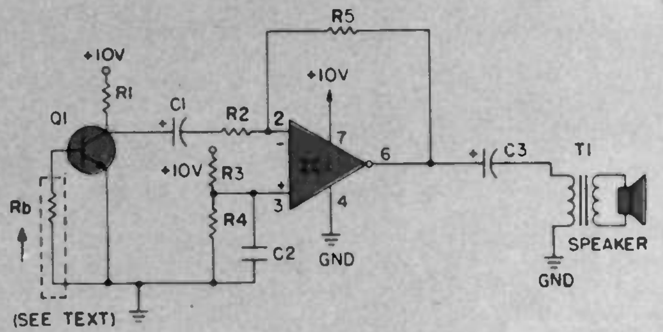


PARTS LIST FOR NOW YOU SEE IT—NOW YOU DON'T

C1, C2—0.1-uF ceramic capacitor
C3—0.01-uF ceramic capacitor
IC1—555 timer integrated circuit
LED1—Large light-emitting diode, red
Q1—FPT100 phototransistor
R1—10,000-ohm, ½-watt, 10% resistor
R2, R4—220-ohm, ½-watt, 10% resistor
R5—2-Megohm, ½-watt, 10% resistor

76 LIGHT INTO SOUND

□ While another project in this book illustrates how sound impulses could be converted into light signals, via an LED indicator, here, a type FPT-100 phototransistor turns light into sound. When connected, the system may be quick-checked with a flashlight, while listening to the speaker and/or observing the op amp output on a scope. Modulating the light source mechanically with a pocket comb produces a buzzing tone, as the teeth of the comb alternately gate the light source. A modulated LED can be used, with proper optical interfacing, as a communication source. The phototransistor is at its greatest sensitivity with the base lead open, though this may introduce unwanted hum. A 100K to 1 Meg resistor (R6) may be run to ground to check the best compromise.

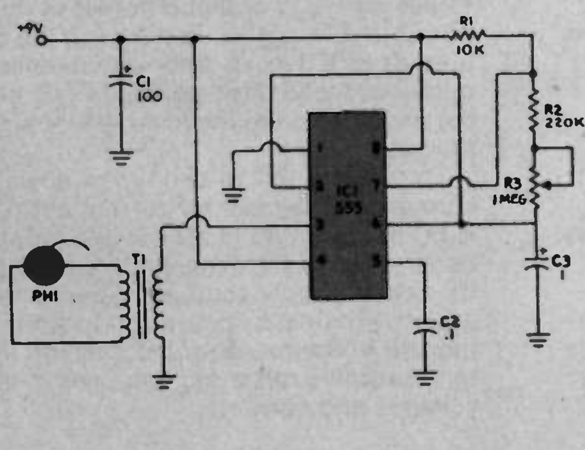


PARTS LIST FOR LIGHT INTO SOUND

C1, C2—10-uF electrolytic capacitor, 15 VDC
C3—50-uF electrolytic capacitor, 25 VDC
IC1—741 op amp
Q1—FPT100 phototransistor
Rb—100,000 to 1,000,000-ohm, ½-watt resistor (see text)
R1—47,000-ohm, ½-watt resistor
R2—1,000 to 10,000-ohm, ½-watt resistor
R3, R4—4,700-ohm, ½-watt resistor
R5—500,000-ohm, ½-watt resistor
SPKR—8-ohm PM type speaker
T1—audio output transformer 500-ohm primary/8-ohm secondary

77 JOGGING PACESETTER

□ One of the problems faced by the beginning jogger, especially on city streets, is that of maintaining a constant pace. Tractor-trailer trucks, careening cars, and ill-mannered dogs can all interrupt your concentration. While there is little that can be done about these nuisances, this little pacesetter may make them less severe. A miniature earphone in your ear driven by a 555 timer produces regularly spaced "ticks" just like a metronome. The pace can be adjusted via R3 from a leisurely one stride per second to a sole-blistering six paces per second. The whole circuit complete with a 9-volt transistor radio battery weighs only a few ounces.



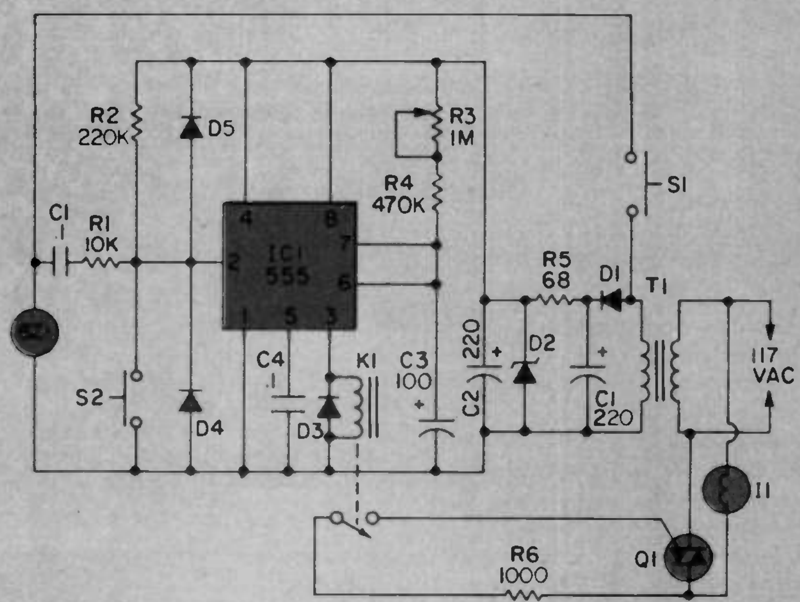
PARTS LIST FOR JOGGING PACESETTER

C1—100-uF electrolytic capacitor, 16 VDC
C2—0.1-uF ceramic disc capacitor, 35 VDC
C3—1.0-uF tantalum electrolytic capacitor, 20 VDC
IC1—555 timer
PH1—8-ohm miniature earphone
R1—10K, ½-watt 5% resistor
R2—220K, ½-watt 5% resistor
R3—1-Megohm trimmer potentiometer
T1—Miniature audio output transformer —1,000-ohm primary/8-ohm secondary

78 SMART PORCH LIGHT

□ For convenience and security, you can't beat this smart porch light. Whenever someone rings your door buzzer with S1, on comes the front porch light. One to three minutes later, depending on the setting of R3, it goes off. If a burglar rings the doorbell while you're away (trying to ascertain whether or not the house is empty), the light will fool him. But even if he's smart enough not to be fooled, he'll think twice about breaking in. After all, there are likely to be more electronic booby traps and alarms waiting for him inside.

You can activate the light timer without ringing the buzzer by pressing S2. Do this as you leave the house at night, and you'll never stumble over a skateboard again.



PARTS LIST FOR SMART PORCH LIGHT

BZ1—6-VAC buzzer
C1, C2—220-uF, 25-VDC electrolytic capacitor
C3—100-uF 25-VDC electrolytic capacitor
C4, C5—0.1-uF ceramic disc capacitor
D1—1N4003 rectifier diode
D2—15-VDC, ½-watt Zener diode
D3-D5—1N914 diode
IC1—555 timer integrated circuit
I1—incandescent porch light
K1—6-VDC, 500-ohm relay
Q1—200-VDC, 6-A triac
R1—10,000-ohm, ½-watt resistor (all resistors 10% unless otherwise noted.)
R2—220,000-ohm, ½-watt resistor
R3—1,000,000-ohm trim potentiometer
R4—470,000-ohm, ½-watt resistor
R5—68-ohm, 1-watt resistor
R6—1,000-ohm, 1-watt resistor
S1, S2—pushbutton switch, normally open
T1—6.3-VAC transformer

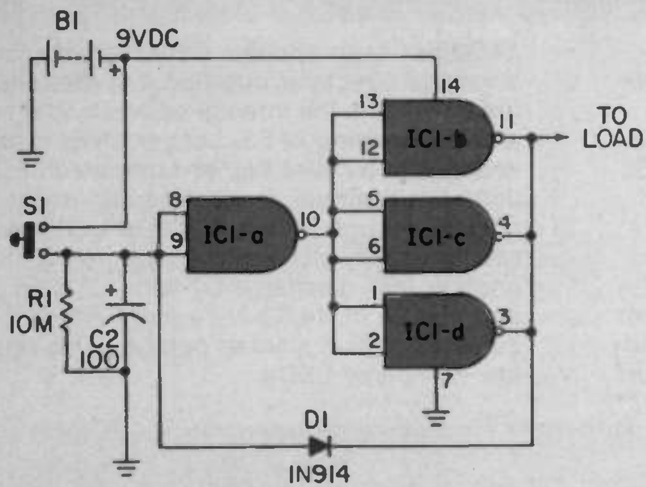
79 10-MINUTE POWER-ON SWITCH

□ There are projects and devices that operate off batteries that are used infrequently. When you switch them on, the battery is dead because the switch was on for the last few days. This happens all too often. So what do you do?

The 10-minute power-on switch delivers up to 10-12 milliamperes from a 9-volt source for ten minutes, then turns off automatically. This is a great feature for most devices, especially test gear, that is used for a few moments, at best—a few minutes, then remains unused for hours, days or longer.

The circuit consists of quad AND gates contained in a single 4011 chip. When S1 is depressed, and released, capacitor C1 charges up to the battery potential of 9 volts. A positive input is supplied to IC1-a for about 10 minutes as C1 slowly discharges through R1—a 10-megohm resistor. A 6.8-megohm resistor provides about 5 minutes of power. Experiment with different values for R1 to obtain different periods. The output of IC1-a goes low driving the combined outputs of IC1-b, -c, and -d to 9-volts DC. The output of these three paralled AND gates provide the power to drive the low-current stages that follow.

The battery, B1, is tied to the quad AND gate chip drawing almost no current when the circuit is at rest resulting in almost shelf life for the battery. Diode D1 completely discharges C1 when the power supply shuts off. Should the circuit you wish to automatically turn off require much more than 10 milliamperes of DC current, let the load be a sensitive relay that can control higher voltages and currents.



PARTS LIST FOR 10-MINUTE POWER-ON SWITCH

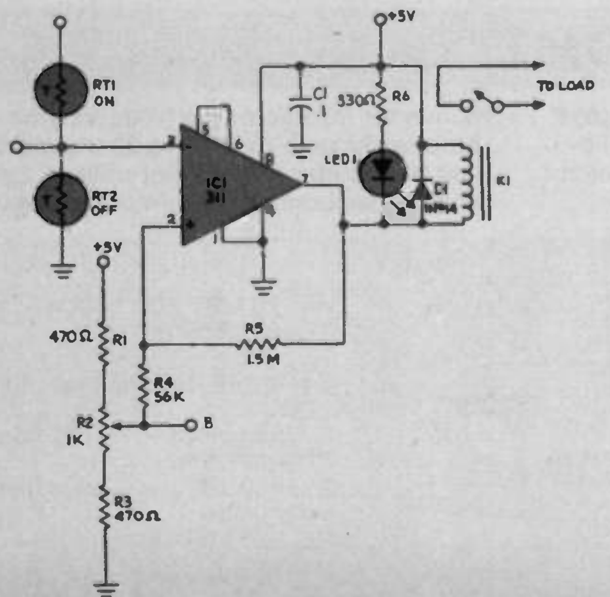
B1—9-volt transistor battery
C1—100-uF, 16-VDC, electrolytic capacitor
D1—1N914 diode
IC1—4011 quad AND gate chip
R1—10,000,000-ohm resistor
S1—Normally-open pushbutton switch

80 THERMAL LATCH

☐ This is a tricky control circuit based on temperature. Touch thermistor RT1, and a moment or two later both LED1 and K1 will be energized. They will stay in that condition after you release RT1. Later, if you decide to turn things off, just touch RT2 until LED1 extinguishes. After you release RT2, the circuit will remain in the off condition.

One preliminary adjustment must be made before you can use the circuit. Connect a voltmeter (20,000 ohms/volt or greater) between points A and B. If the meter deflects backwards, reverse its leads. Adjust R2 for exactly zero voltage on your voltmeter's most sensitive scale. That's it.

For those who care about such things, what we have here is a thermistor voltage divider driving a Schmitt trigger built around an LM311 comparator. As a thermistor heats, its resistance decreases. Hence, the voltage at the junction of RT1 and RT2 is a function of the heat supplied by your finger or hand. This circuit is intended for use at normal room temperatures, that is, 70°-80°F. If the ambient temperature is in the vicinity of human body temperature, clearly you will not have much effect on the circuit by touching it.

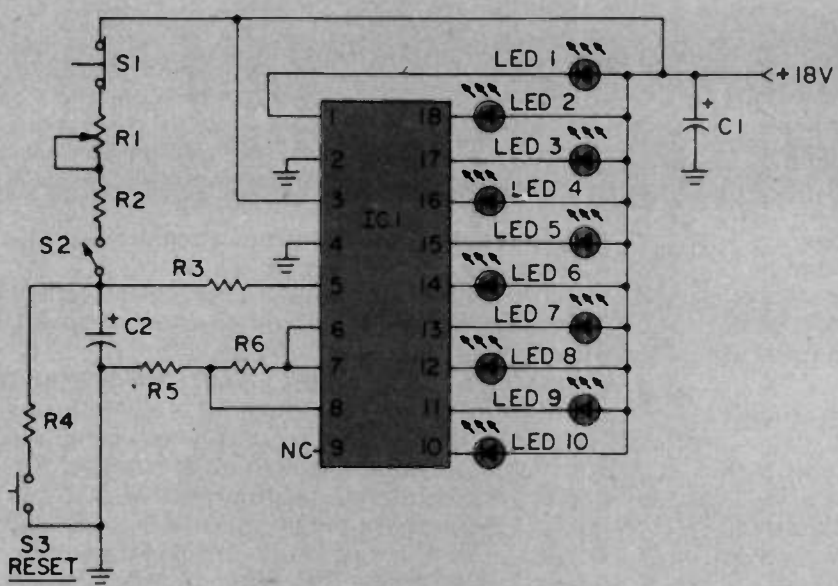


PARTS LIST FOR THERMAL LATCH

C1—.1uF ceramic disc capacitor
D1—1N914 silicon diode
IC1—311 comparator
K1—6-volt, 500-ohm relay or 5-volt TTL-logic relay
LED1—Light-emitting diode, any color
R1, R3—470-ohm, ½-watt 5% resistor
R2—1,000-ohm trimpot
R4—56,000-ohm, ½-watt 10% resistor
R5—1.5 Meg-ohm, ½-watt 10% resistor
R6—330-ohm, ½-watt 10% resistor
RT1, RT2—Negative-temperature-coefficient thermistors, 10K ohms or greater at 25°C. For example, Fenwal #GB41P12 or equiv.

81 ALCOHOL TESTER

☐ It's a curious and unfortunate fact, but many people feel that a drink or two will improve their reflexes. Here's your chance to prove them wrong. Imagine for the moment that S1 is depressed (open circuited), S2 is closed, and C2 has been completely discharged. On command from someone acting as the tester, the person depressing S1 must remove his hand from that switch and use the same hand to open toggle switch S2. When S1 is realease, charging current begins to flow into capacitor C2 through R1 and R2. This current is interrupted, however, as soon as S2 has been opened. C2 will have accumulated a voltage directly proportional to the reaction time, which is the interval between S1's release and the opening of S2. Longer times create high voltages and cause higher-numbered LEDs to light. For example, a sober person might react quickly enough to light LED2 or LED3, while someone truly sloshed will light up LED10. To run another test, discharge C2 with S3, then press S1 and, finally, close S2 once more. R1 should be adjusted so that a sober person lights one of the low-numbered LEDs.

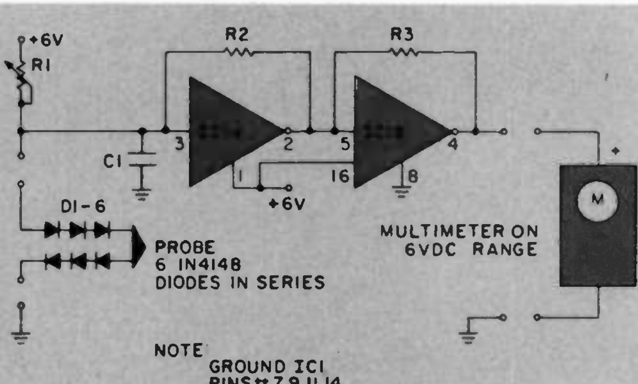


PARTS LIST FOR ALCOHOL TESTER

C1—250-uF electrolytic capacitor, 35 VDC
C2—50-uF electrolytic capacitor, 35 VDC
IC1—LM3914 LED display driver
LED1 through LED10—light-emitting diode
R1—50,000-ohm trimmer potentiometer
R2—5600-ohm ½-watt resistor, 10%
R3—33,000-ohm ½-watt resistor, 10%
R4—47-ohm ½-watt resistor, 10%
R5—1800-ohm ½-watt resistor, 10%
R6—1000-ohm ½-watt resistor, 10%
S1—normally closed SPST pushbutton switch
S2—SPST toggle switch
S3—normally closed SPSt pushbutton switch

82 DIODE THERMOMETER

☐ In another project, it was shown how a package of silicon diodes could be developed into a solid-state thermostat. Here is an analog version, which can be interfaced with a voltage-to-frequency converter for use with a frequency counter, or can be directly read by a 10 to 20 thousand-ohms-per-volt multimeter. The circuit utilizes a pair of 4009 inverter sections, biased into the linear region to



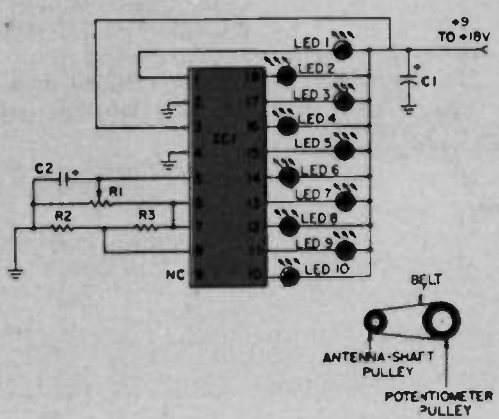
PARTS LIST FOR DIODE THERMOMETER

C1—0.1-uF ceramic capacitor, 15 VDC
D1 through D6—1N4148 diode
IC1—4009A hex buffer
R1—100,000-ohm linear-taper potentiometer
R2, R3—1,000,000-ohm, ½-watt resistor

amplify the temperature effects upon the diode probe. In this application, the adjustment potentiometer, R1, is set to give a mid-scale reading at room temperature on a typical multimeter set on the 6-volt DC scale. If a separate 0-1 DC miliampere meter is available, it could be calibrated directly in degrees F or C, with a suitable resistance in series with the amplifier output.

83 DIRECTION INDICATOR

☐ Using an economy-type rotator with your TV, FM or ham beam-type antenna? Then you probably have a direction indicator that's hard-to-read, inaccurate, or in the case of homebrew rotators, probably non-existent. However, it's easy to add on a direction indicator using LEDs for readout. Referring to the schematic, note direction-sensing potentiometer R1. As its wiper moves away from ground potential, first LED 1 will light, then LED 2 will come on as LED 1 extinguishes; this process continues in numerical succession until finally LED 10 is the only lit LED. Coupling the pot to your rotating antenna's shaft with pulleys and a belt allows the display of LEDs to respond to antenna position. The potentiometer's pulley should have a larger diameter than that of the antenna shaft because most potentiometers cannot rotate through a full 360°.

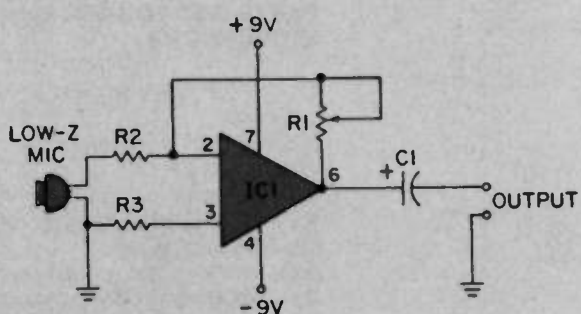


PARTS LIST FOR DIRECTION INDICATOR

C1—100-uF electrolytic capacitor, 35 VDC
C2—5-uF electrolytic capacitor, 10 VDC
IC1—LM3914 LED display driver
LED1 through LED10—light-emitting diode
R1—25,000-ophm linear-taper potentiometer
R2—3900-ohm, ½-watt resistor, 5%
R3—1200-ohm, ½-watt resistor, 5%

84 LOW-Z MIKE BOOSTER

☐ A low-impedance microphone has the property of being able to pass sufficient current to be directly in the feedback path of this 741 amplifier. The gain is controlled by changing the setting of R1. This circuit can feed into your hi-fi unit to give greater power output. You can use two nine-volt DC batteries for the power supplies. The returns for the supplies must be grounded.

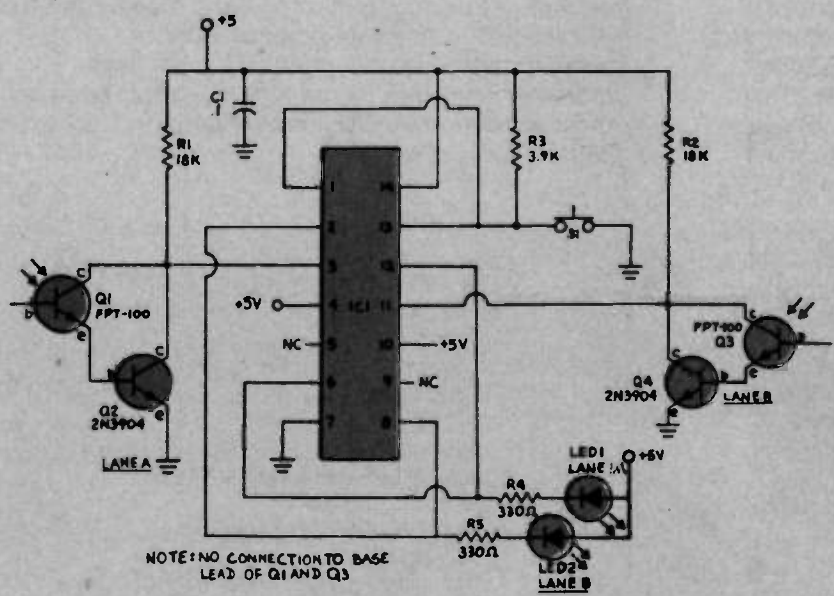


PARTS LIST FOR LOW-Z MIKE BOOSTER

C1—68-uF electrolytic capacitor, 25 VDC
IC1—741 op amp
R1—500,000-ohm linear-taper potentiometer
R2, R3—1,000-ohm, ½-watt resistor

85 SLOT CAR RACE REFEREE

☐ Build this optoelectronic judge and end forever those quarrels over who really won the race. Install phototransistors Q1 and Q3 at the finish line, but in separate lanes of your slot-car track so that the light-sensitive face of each device is facing upwards. The best method would be to cut a small hole into the track for each phototransistor, and mount each unit flush with the track's surface. Arrange for light to fall on both Q1 and Q3; a small desklamp will work well, but ambient room light will usually suffice. Press S1 and both LEDs will go off. The first car to cross the finish line interrupts the light beam and causes the appropriate LED to light up.

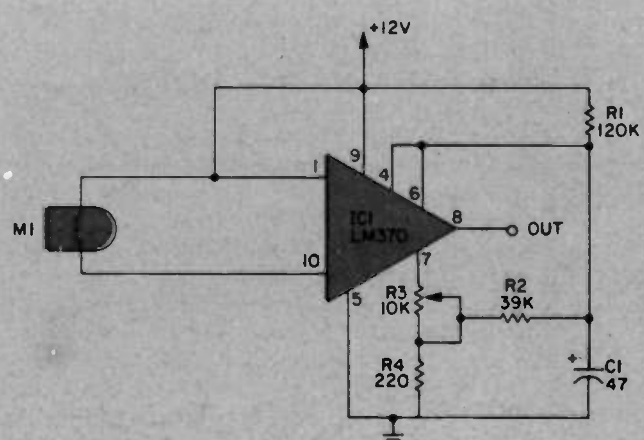


PARTS LIST FOR SLOT CAR RACE REFEREE

C1—0.1-uF ceramic disc capacitor, 35-WVDC
IC1—7474 dual D-type flip-flop
LED1, LED2—light-emitting diode
Q1, Q3—FPT-100 NPN phototransistor
Q2, Q4—2N3904 NPN transistor
R1, R2—18K-ohm, ½-watt 10% resistor
R3—3900-ohm, ½-watt 10% resistor
R4, R5—330-ohm, ½-watt 10% resistor
S1—normally open SPST pushbutton switch

86 SQUELCHED MICROPHONE

☐ Here is a way to eliminate unwanted background noise and conversation when using a microphone for communications or recording purposes. IC1, an LM370, is a preamplifier with squelch capability. This means that amplification does not begin until the input signal exceeds a preset threshold level. Since background noise is, in most instances, not as loud as the voice of the person speaking into the microphone, all output is squelched whenever speech stops. So, instead of noise, you get silence. The squelch threshold can be set by adjustment of R3.



PARTS LIST FOR SQUELCHED MICROPHONE

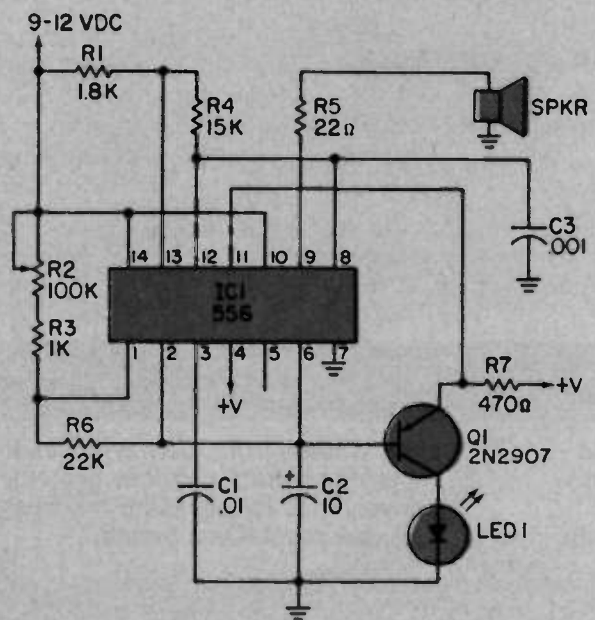
C1—47-uF, 25-VDC electrolytic capacitor
IC1—LM370 AGC amplifier integrated circuit
M1—dynamic microphone cartridge
R1—120,000-ohm, ½-watt resistor (all resistors 10%)
R2—39,000-ohm, ½-watt resistor
R3—10,000-ohm, trim-potentiometer
R4—220-ohm, ½-watt resistor

87 RODENT REPELLER

□ One way to get the unwelcomed squeaks out of your house and the yard area is to squeak back with the Rodent Repeller. This circuit produces freq-squeaks in the ultrasonic range sweeping from 25,000 to 50,000 Hertz. IC1, a 556 dual timer functions as a combined stable multivibrator and a voltage sweeper that varies the oscilator output. The second timer stage effect on capacitor C2 provides the frequency's sweeping effect—enough to drive a rodent nuts. Transistor Q1 isolates the two sections of the timers in IC1. When Q1 conducts, it lowers the control voltage at pin 11 of IC1, which in turn increases the frequency output. The cycle will be about one second or less depending upon the setting of the potentiometer.

You can't hear the output of the Rodent Repeller, so it is suggested that for testing purposes a .01 disc capacitor be connected across C3. You may want to leave it in the circuit if humanoids are your problem.

The speaker is a piezoelectric tweeter out of Radio Shack, that sells for $10, depending on the model you buy. The circuit can be powered by batteries, but fix up an AC-powered supply that will keep costs down. The output from the chip is sufficient to drive the speaker. Do not attempt to put more power into the speaker by adding a stage of amplification unless you know for sure that the speaker is not being overdriven. Heat will destroy it. The 556 provides just enough oomph to do the job.



PARTS LIST FOR RODENT REPELLER

C1—.01-uF, disc capacitor
C2—.10-uF, 16-VDC electrolytic capacitor
C3—.001-uF, disc capacitor
IC1—556 dual timer
LED1—Light-emitting diode, any lens, any color
Q1—2N2907 PNP transistor
(All resistors are 10%, 1/2-ohm)
R1—1800-ohm
R2—100,000-ohm potentiometer (taper not important)
R3—1000-ohm
R4—1500-ohm
R5—22-ohm
R6—22,000-ohm
R7—470-ohm
SPKR—Piezoelectric tweeter speaker from Radio Shack

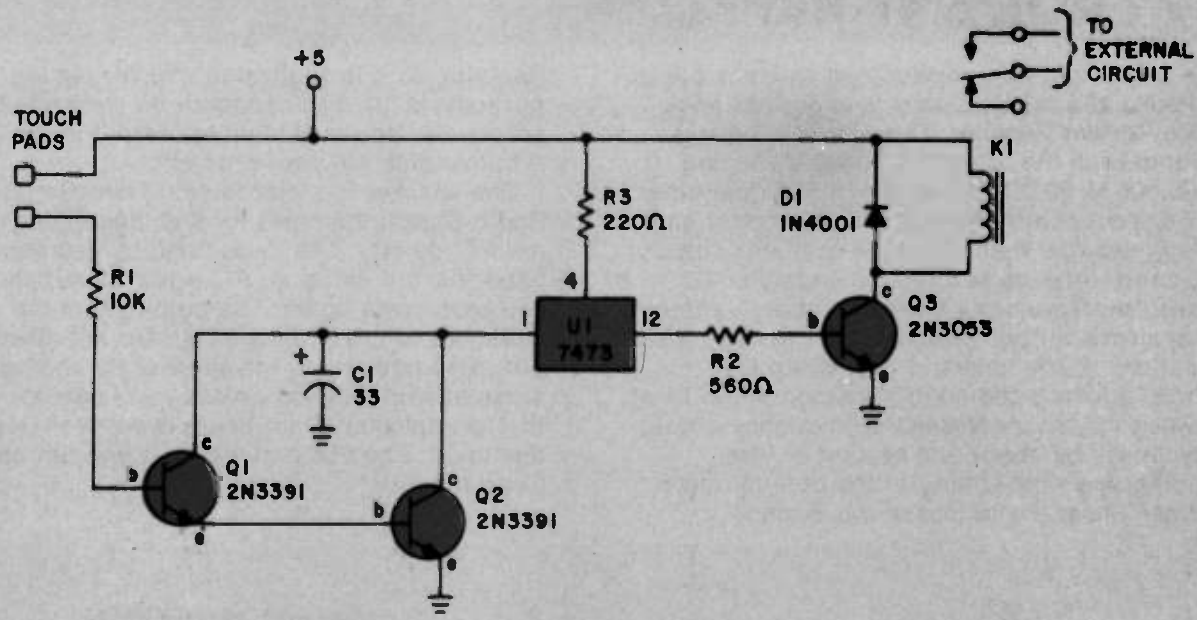
88 TOUCH SWITCH

The problem with most touch-switch circuits is two fold. One is that they sometimes don't work or work when they weren't touched. The other, is that line isolation depends upon extremely high resistances in series between the person and the AC line. Our Touch Switch works when we want it to and it is 100% line isolated. It nice to have your hall light come on, and not you!

The circuit is based on an old friend—the 7473 dual JK flip-flop integrated circuit. When ever the state of pin 1, U1, is pulled to a logic low (0), the output at pin 12 switches state: high to a low, or low to a high.

The very-high beta amplifier consisting of Q1 and Q2 is non-conducting until the plates are touched. A small positive voltage is all that is needed to trigger the transistors into conduction. Then, pin 1 is dragged down to a low state firing the flip-flop either cuts off transistor Q3 or causes transistor Q3 to conduct (depending on its previous conduction state), which in turn energizes or de-energizes the relay, K1. Relay K1's contacts are either open or closed providing the latch operation desired.

The touch pads may be fabricated from a copper-clad, printed-circuit board. Two chrome tack heads may be used, or just about any metalic surface that is easy to clean.

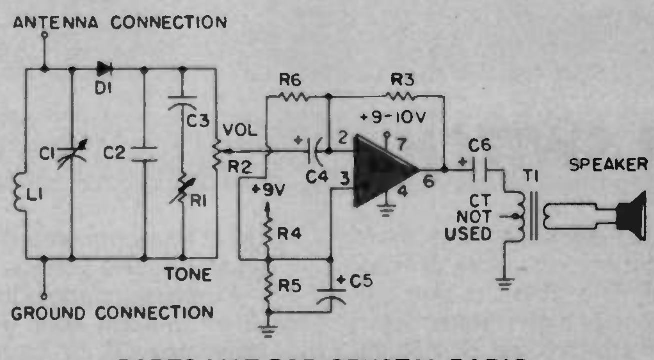


PARTS LIST FOR TOUCH SWITCH

C1—33-uF, 10-WVDC electrolytic capacitor
D1—1N4001 diode
K1—DPDT, 5-volt DC relay
Q1,Q2—2N3391 NPN transistor
Q3—2N3053 NPN transistor
R1—10,000-ohm, ¼-watt, 5% resistor
R2—560-ohm, ½-watt, 5% resistor
R3—220-ohm, ½-watt, 5% resistor
U1—7473 dual D-type flip-flop integrated circuit

89 CRYSTAL RADIO

☐ A 741 mini-power-amplifier can update those 1N34 "cat's whiskers" crystal receivers right into the Space Age. Depending on antenna and ground facilities, good reception is possible with clear volume from the tiny speaker. A 9-volt transistor battery provides protable radio convenience for escaping the frustrations of the IC experimental test bench.

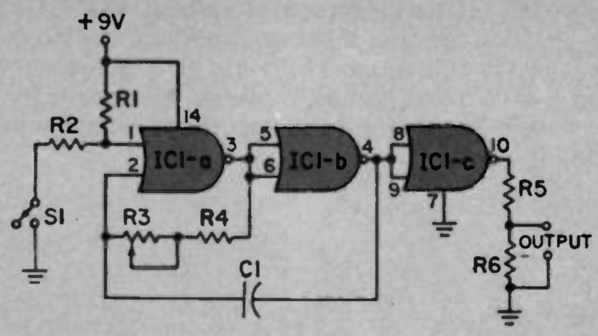


PARTS LIST FOR CRYSTAL RADIO

C1—365-uF variable capacitor
C2—0.01-uF ceramic capacitor, 15 VDC
C3—0.1-uF ceramic capacitor, 15 VDC
C4, C5—100-uF ceramic capacitor, 15 VDC
C6—50-100-uF electrolytic capacitor, 15 VDC
D1—1N34 diode
IC1—741 op amp
L1—loopstick coil
R1—25,000-ohm linear-taper potentiometer
R2—25,000 to 50,000-ohm audio taper potentiometer
R3—1,000,000-ohm, ½-watt resistor
R4, R5—4,700-ohm, ½-watt resistor
R6—10,000-ohm, ½-watt resistor
T1—500/8-ohm audio output transformer
MISC.—8-ohm 2 in. PM type speaker; snap type 9 V battery clip

90 CODE PRACTICE OSCILLATOR

☐ Boning up for your Amateur code exam? Pushbutton S1 makes a very inexpensive Morse code key. The tone out of the circuit at point A; can drive an amplifier or a pair of high-impedance headphones.

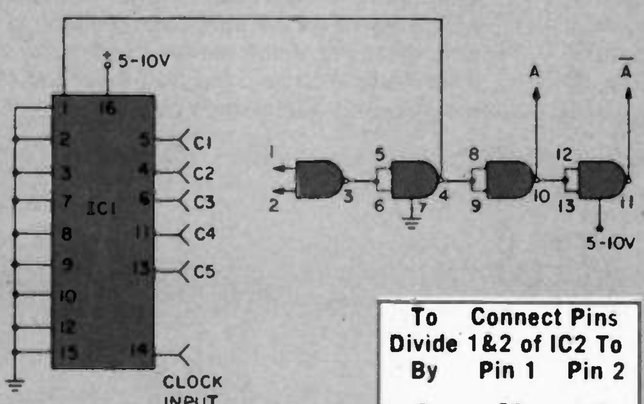


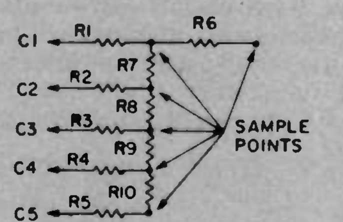
PARTS LIST FOR CODE PRACTICE OSCILLATOR

C1—0.1-uF ceramic capacitor, 15 VDC
IC1—4001 quad 2-input NOR gate
R1—91,000-ohm, ½-watt resistor
R2—220-ohm,linear-taper potentiometer
R4—50,000-ohm, ½-watt resistor
R5—2,200-ohm, ½-watt resistor
S1—SPST momentary-contact pushbutton switch

91 DIVIDER DECIDER

☐ The type 4018 programmable counter is a useful digital tool, especially where a basic clock frequency must be divided down for various timing operations. With proper connections, divisors of from 2 through 10 may be configured. The table shown below gives the connections. The odd divisors do not give symmetrical outputs, but close ratios, such as four-high, three-low for a divide-by-seven setup. Digital-to-Analog Conversion may also be studied by connecting the outputs as shown. Interesting waveforms may be obtained by trying out the various dividing connections, while tying an oscilloscope into the different resistor network junctions. With the circuit set for a divide-by-ten function, a *digital sine wave* may be discovered at certain points along the network. With clock frequencies above 1 KHz, this output may be heard on an audio amplifier. Computer Music, anyone?





DIGITAL TO ANALOG CONVERSION NETWORK

To Divide By	Connect Pins 1&2 of IC2 To Pin 1	Pin 2
2	C1	C1
3	C2	C1
4	C2	C2
5	C2	C3
6	C3	C3
7	C3	C4
8	C4	C4
9	C4	C5
10	C5	C5

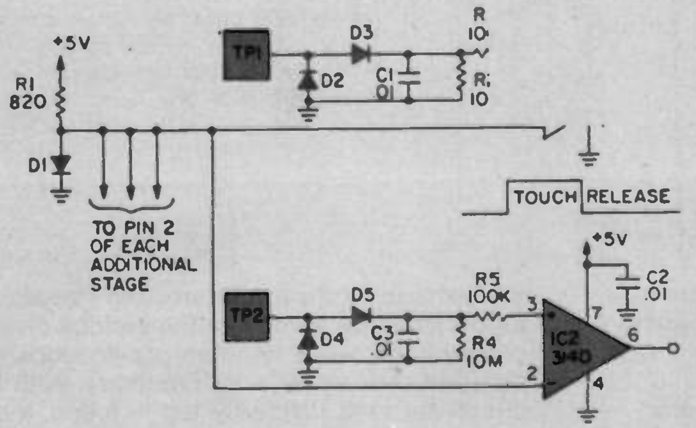
PARTS LIST FOR DEVIDER DECIDER

IC1—4018 dividing counter
IC2—4011A quad NAND gate
R1 through R6—100,000-ohm, ½-watt resistor
R7 through R10—47,000-ohm, ½-watt resistor

92 TOUCH KEYBOARD

□ There's no better way to add an exotic touch to a piece of electronic equipment than by employing touch-sensitive switching. The set-up diagrammed here will enable you to employ one, two or however many touch-sensitive switches you need. Electronic musicians, for example, may wish to use 37 units in a 3-octave keyboard.

Each separate unit consists of a touch plate, a silicon-diode detector system, and a 3140 op amp that functions as a voltage comparator. Finger contact with a touch plate feeds 60-Hz power-line radiation from your body, which acts as an antenna, to the detector system. If the rectified AC exceeds 1.2 volts, the 3140's output swings high and remains there for as long as you touch the plate. All stages use the .6-volt drop across D1 as a reference voltage. NOTE: If you're running a battery-operated device in Dogpatch, this touch-switching arrangement may not work. Most homes, however, have sufficient 60-Hz radiation to trigger these sensitive switches.

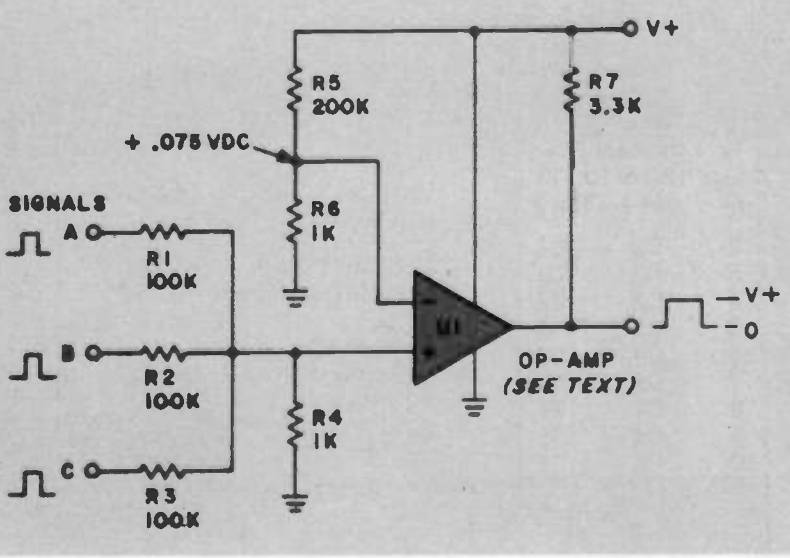


PARTS LIST FOR TOUCH KEYBOARD

C1-C4—.01-uF ceramic disc capacitor
D1-D5—1N914 diode
IC1, IC2—3140 FET-input op amp (RCA or equivalent)
R1—820-ohm, ½-watt resistor (all resistors 10%)
R2, R4—10,000,000-ohm, ½-watt resistor
R3, R5—100,000-ohm, ½-watt resistor
TP1, TP2—touch plates (small, aluminum or copper)

93 MAKE AN "OR" GATE

You need an OR gate, and there's none in your spare-parts box. What to do? Very simple, make do with an op-amp. Before we got fancy with logic circuit chip, we used a summing amplifier driven to saturation to provide the function. In the circuit below, an signal at A, B, or C that is a hi (U1) will produce a hi at the op-amp's (U1) output. Resistors R1-R3 limit the interaction of the three signal circuits. Resistor R4 would serve as the summing resistor in a normal circuit, however, since we are not adding voltages here, it serves only to hold the non-inverting input to U1 at a low (0) until a hi comes by.



PARTS LIST FOR MAKE AN "OR" GATE

R1-R3—100,000-ohm, ¼-watt, 5% resistor
R4, R6—1000-ohm, ¼-watt, 5% resistor
R5—200,000-ohm, ¼-watt, 5% resistor
R7—3300-ohm, ½-watt, 5% resistor
U1—Linear op-amp (741 or better)

Resistors R5 and R6 provide a small amount of DC bias to U1's inverting in out to drive the output of U1 to zero volts DC when there is no signal at the non-inverting input. Resistor R7 pulls the output to the V+ potential when the output is high.

Just about any op-amp can be used. Of course, should your slew-rate requirements be very fast, pick an op-amp that moves fast. The value of V+ can be the usual +5- or +12-volts DC, this depends on the circuit in which the "OR" gate is used.

94 ALARM PEACE MAKER

Did you ever wake at night to the siren or bell of your neighbor's burglar alarm, be a good neighbor by calling the police, and then stay awake all night because your neighbor in away and the alarm cannot be turned off. How many friendships a burglar alarm system can end?

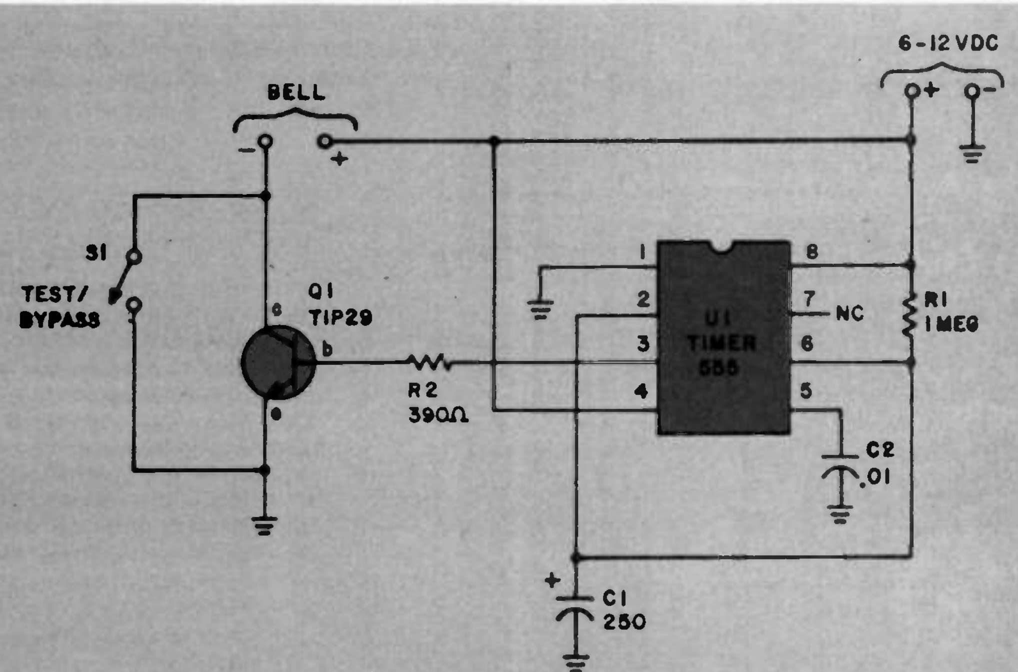
Well, you both can be friends forever provided you make two Alarm Peace Makers—one for him and one for you! This device will let the system run for five or so minutes and then shut off. No burglar is willing to hang around to see what color the patrol car is! So why keep the neighborhood awake.

The alarm's 6-volt DC voltage to the bell is used to power the circuit and sound the bell. The heart of the system is a 555 timer integrated circuit, U1, that needs no initial trigger to start marking time. Depending upon the time delay built into the circuit, the timer takes action as soon as the power is applied to the circuit. The 6-volts is applied to the circuit and the bell as long as the alarm is on. The ground return for the bell circuit passes through transistor Q1 held in a high conducting state by a high at pin 3 of U1. After the selected time interval, U1 shuts down with a low at pin 3. Transistor Q1 goes to cutoff turning off the bell until the Alarm circuit is reset.

A book on the 555 will give a time formula for R1 and C1 so that you could select the time interval for the circuit to keep the bell on. The time (in seconds) is equal to the product of 1.1 times R1 (in ohms) and C1 (in Farads). Thus the circuit shown will provide a delay of about 5 minutes.

Due to the leakage in the capacitor, the largest resistor value you may use is 1 Megohm. The leakage will extend the delay time somewhat. Also consider that capacitor rated values are usually +100%, —20% for electrolytic capacitors.

Switch S1 bypasses Q1 so that the bell circuit can be tested. You never can tell, should the bell not ring for many months, maybe some squirrels will take up residence inside the outdoor bell box. It has been know to happen. Also, there may be times you want to bypass this cutoff feature, thus S1 has a reason to exist in this circuit. The DC voltage range of most alarm circuits is sufficient to activate the circuit.



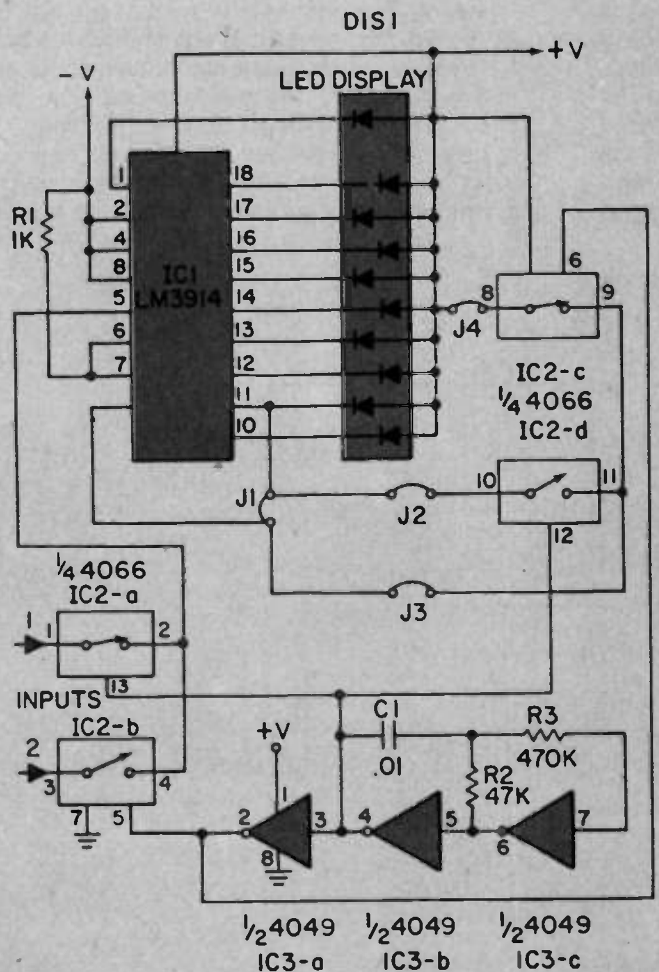
PARTS LIST FOR ALARM PEACE MAKER

C1—250-uF, 16-WVDC electrolytic capacitor
C2—.01-uF disc ceramic capacitor
R1—1-Megohm, ½-watt, 5% resistor
R2—390-ohm, ½-watt, 5% resistor
Q1—TIP29 NPN power transistor
S1—SPST toggle switch
U1—555 timer integrated circuit

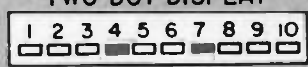
95 DOUBLED-UP BARGRAPH DISPLAY

☐ What could be simpler than comparing two bargraph displays? If you said that one bargraph display is simpler for two signals—you guessed right. This unique circuit switches the inputs of two analog signals and provides a LED bargraph displayed by one driver such as the LM3914 for a linear readout (LM3915 offers a logarithmic display; LM3915, VU display). The circuit may be set to display two dots (see jumper connection data in diagram), so that when they coincide and only one dot is seen, the amplitudes of inputs 1 and 2 are about equal. This unusual setup makes for a very interesting and accurate VU display. The clock section is composed of IC3 (4049 chip) that triggers the switch action of IC2 (analog switch).

Should you want to use a format where the bargraph is used with a dot graph, remove jumper 1 and install jumpers 2, 3, and 4. This setup is ideal for watching the rms value of an audio signal on the bargraph and the peak voltage at that time appears as a dot that will either fall in the bargraph or bounce somewhere above it. This makes for a very unusual display. Remember, with jumper 1 in the circuit, the other jumpers are out; with jumper 1 out of the circuit, the other three are in.

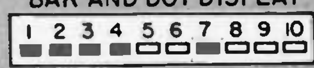


TWO DOT DISPLAY



CONNECT JUMPERS J2, J3 AND J4 ONLY

BAR AND DOT DISPLAY



CONNECT JUMPER J1 ONLY

PARTS LIST FOR DOUBLED-UP BARGRAPH DISPLAY

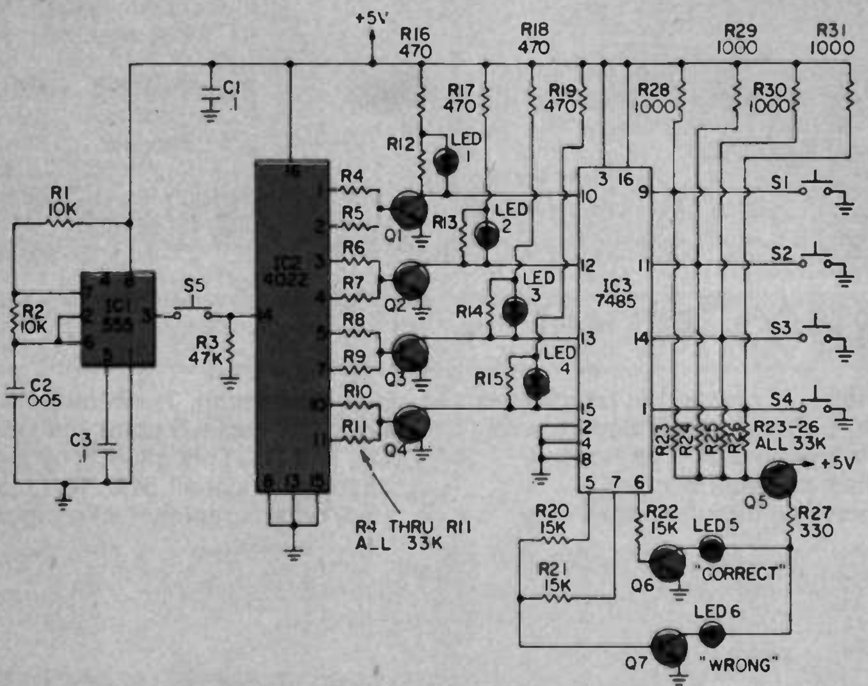
C1—.01-uF disc capacitor
DIS1—Bargraph display with 10 LED elements
IC1—LM3914 bar graph driver
IC2—4066 quad switch
IC3—4049 hex inverting amplifiers
J1-J3—copper wire used as jumpers to avoid expensive switching
R1—1000-ohm, ½-watt resistor
R2—47,000-ohm, ½-watt resistor
R3—470,000-ohm, ½-watt resistor

96 ESP TESTER

□ The closest encounter most of us ever have with psychic phenomena probably comes from in-laws with the uncanny knack for dropping by just as dinner is served. If you'd like to delve somewhat deeper into the world of the unknown, or if you just want an intriguing party game, give this ESP tester a try.

Testing requires three persons—a Tester, a Sender and a Receiver—each one of whom has access only to a part of the circuitry. The Tester has S5, LED5 and LED6. By pressing and releasing S5, he causes the random lighting of one LED out of the set consisting of LEDs 1, 2, 3, and 4. Each LED of this set is identified in some way—usually by a geometric symbol like a star or triangle alongside it. The Sender, who views only these four LEDs, seeks to telepathically transmit the identity of the lit LED by mentally "broadcasting" a picture of the symbol linked with the LED.

The Receiver, whom we hope is monitoring the correct channel, indicates his response by pushing one of the four switches (S1 through S4) at his disposal. S1 corresponds to LED1 and is marked with the same geometric symbol. Likewise, S2 corresponds to LED2, and so forth. If the Receiver makes the correct choice, the Tester sees LED5 light up. On the other hand, if the Receiver's choice is wrong, or if he gets cute and pushes several buttons simultaneously, the Tester is notified of an error by the lighting of LED6.

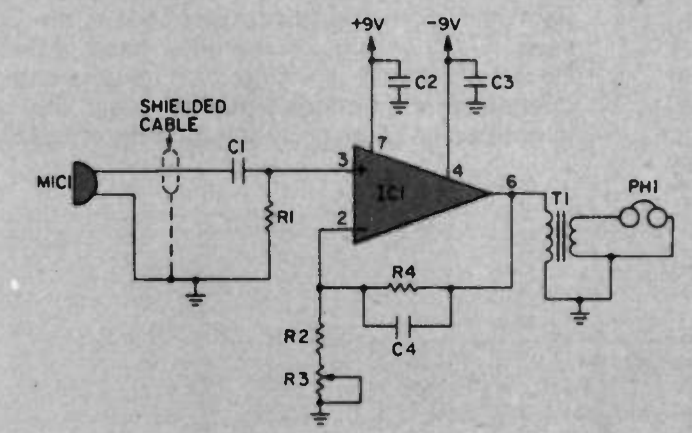


PARTS LIST FOR ESP TESTER

C1, C3—0.1-uF ceramic disc capacitor
C2—.005-uF mylar capacitor
IC1—555 timer integrated circuit
IC2—4022 CMOS octal counter integrated circuit
IC3—7485 4-bit magnitude comparator
LED1-LED6—light emitting diodes
Q1-Q4, Q6, Q7—2N3904 NPN transistor
Q5—2N3906 PNP transistor
R1, R2—10,000-ohm, ½-watt resistor
(all resistors 10%)
R3—47,000-ohm, ½-watt resistor
R4-R11, R23-R26—33,000-ohm, ½-watt resistor
R12-R15—4,700-ohm, ½-watt resistor
R16-R19—470-ohm, ½-watt resistor
R20-R22—15,000-ohm, ½-watt resistor
R27—330-ohm, ½-watt resistor
R28-R31—1,000-ohm, ½-watt resistor

97 SUPER STETHOSCOPE

☐ Ausculation is the medical term for the procedure. In simple language, it means having your ribs ticked with an icy cold stethoscope. Should you ever get the urge to play doctor, we prescribe the simple electronic stethoscope diagrammed here. Best results will be obtained using hi-fi or communications-type low-impedance headphones designed to isolate the listener from ambient sounds. Be sure to connect the microphone cartridge to the rest of the circuit using shielded audio cable to keep noise pickup to a minimum. Potentiometer R3 adjusts the gain. Use a socket when mounting IC1 since it has delicate FET inputs.

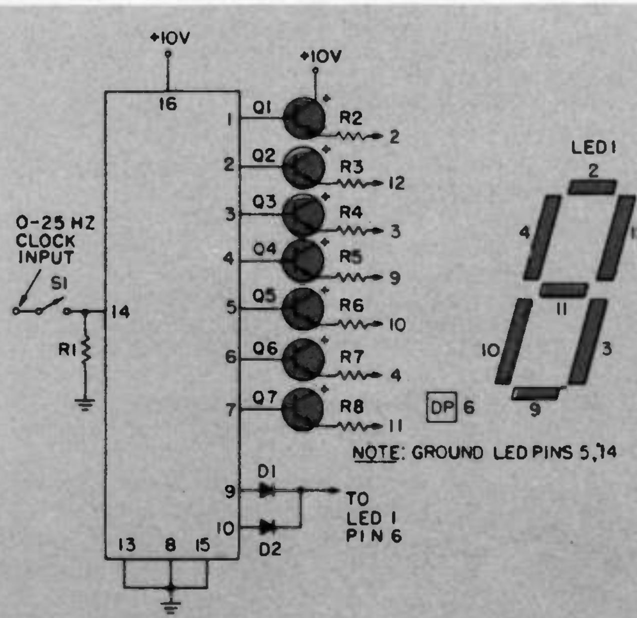


PARTS LIST FOR SUPER STETHOSCOPE

C1—0.01-uF mylar capacitor, 35 VDC
C2, C3—0.1-uF ceramic disc capacitor, 35 VDC
C4—10-pF polystyrene capacitor, 35 VDC
IC1—RCA CA3140 op amp
MIC1—crystal microphone cartridge
PH1—low-impedance headphones, hi-fi or communications type
R1, R4—1-Megohm, ½-watt resistor, 10%
R2—1000-ohm, ½-watt resistor, 10%
R3—10,000-ohm linear-taper potentiometer
T1—miniature audio output transformer—1,00-ohm primary/8-ohm secondary

98 CASINO ROYAL

☐ A simple counter-display circuit can be adapted to a game of chance for up to seven players, with a built-in provision to insure that "The house never loses." Note that all seven display segments, like the previous circuitry, have only one connection. Three outputs (pins 8, 9, 10) now go to the decimal point, via isolating diodes D1, D2, and D3. This gives "The House" a 3 out of 10 chance to take all bets. The clock should be set to provide a rapidly flickering display when the



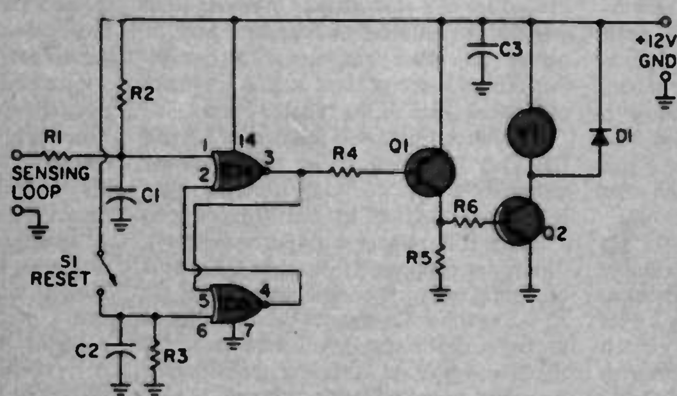
PARTS LIST FOR CASINO ROYAL

D1, D2—IN4148 diode
IC1—4017 CMOS decade counter
LED1—DL-750, 7-segment display
Q1 through Q7—2N4401
R1 through R8—1,000-ohm, ½-watt resistor
S1—SPST momentary-contact switch.

push-button switch is depressed. When the player holds down the switch for a few seconds and releases it, one of the segments, or the decimal point will remain lighted...and the odds are o Point!

99 BURGLAR ALARM

☐ This burglar alarm circuit uses one integrated circuit and operates from a 6 volt battery. It is activated upon the breaking of a circuit, there is virtually no limit to the length of wire you can use. You can protect every window and door in your house. Practical operation by using four D cells for power is accomplished through the use of a four-section CMOS integrated circuit which draws only a few microamperes from the battery. Thus, battery life will be equivalent to its shelf life unless the alarm is activated. The heart of the circuit is a pair of NOR gates connected in a bistable configuration called a flip-flop or latch circuit. When the circuit is in standby, pin 1 of IC1 is held to almost zero volts by the continuous loop of sensing wire. This causes pin 3 to assume a voltage of 6 volts, cutting off Q1 and Q2. When the sensing circuit is broken, C1 charges to battery voltage through R2. This causes the latch circuit to change state and pin 3 goes to zero volts. B1 becomes forward-biased through R4 and turns on Q2 which operates the buzzer. The circuit will remain in an activated state once the alarm is set off, even though the broken circuit is restored. A reset switch has been provided to return the latch circuit to its original state and shut off the alarm.



PARTS LIST FOR BURGLAR ALARM

C1—0.1-uF ceramic capacitor, 15 VDC
C2—0.1-uF ceramic capacitor, 15 VDC
C3—0.47-uF ceramic capacitor, 15 VDC
D1—1N4148 diode
IC1—4001 quad NOR gate
Q1—2N4403
Q2—2N4401
R1, R3—100,000-ohm, ½-watt resistor
R2—4,700,000-ohm, ½-watt resistor
R4, R5—10,000-ohm, ½-watt resistor
R6—100-ohm, ½-watt resistor
S1—SPST momentary-contact pusbutton switch
V1—6 VDC buzzer

the

L. Davidson

SUN-POWERED EMERGENCY RADIO

HERE IS A LITTLE EMERGENCY radio that has a lot of zip and go. The radio is built around a linear integrated circuit (IC) which can be purchased for $2.00. You can tune in your favorite AM broadcast station with excellent audio quality driving a single earphone. This portable radio is easy to assemble, with only a few parts and is solar powered. You do not ever have to replace batteries in this radio for it is powered with three small solar cells.

The emergency radio has a ZN414 IC, which physically looks like any ordinary transistor. Inside is a 10-transistor, tuned radio-frequency (TRF) circuit using a Ferrante C.D.I. technology. The circuit includes a complete RF amplifier, detector and AGC system providing a high quality AM tuner (Fig. 1). Excellent audio quality can be achieved and current consumption is extremely low. In fact, a local broadcast station tuned in with full volume the little IC pulls only .05 milliamperes of current. No set-up or alignment is required and parts mounting is no problem.

How It Works. To obtain good selectivity with any TRF device, the ZN414 chip (IC1) must be fed from an efficient antenna coil (L1) and capacity tuning section (C2). See Fig. 2. The ferrite rod antenna coil should be as long as possible. No additional antenna is needed for this solar radio. On strong local stations the antenna or container may be turned to lower the signal if needed. Sometimes a strong radio station may take up a large share of the tunable band.

The desired station is selected by L1 and C1. This RF signal is fed into the input terminal (2) of IC1 (Fig. 2). Here the tuned RF signal is amplified and detected with excellent audio signal at output terminal (1). The stator (stationary) plates of C1 should be connected to the input terminal of the IC1. Capacitor C4 couples the audio signal to audio driver transistor. Here the audio signal is amplified with a single earphone piece tied to the collector terminal.

Since IC1 and audio transistor (Q1) pull very little current, the ideal power arrangement is provided with solar power. The small radio may be operated out doors in the sunlight or under a reading lamp. You never have to worry about battery replacement. Three small pieces of solar cells wired in series have a working voltage of 1.32 volts.

Locating the Parts. Any combination of L1 and C1 which cover the AM broadcast band may be used. C1 should be of the miniature type and several sources are listed in the Parts List. L1 may be a commercial broadcast ferrite rod antenna or a home wound job as given later. Both the IC and AF transistor may be obtained from Circuit Specialists, Inc. of Scottsdale, Arizona. Practically any NPN low-voltage transistor may be used to drive the earphone. You may find the small fixed capacitors and resistors in the Parts List.

Winding the Coil. Choose the largest diameter ferrite core and length that is handy. Many of these antenna coils are found in radio part stores, in grab bag bargains or may be purchased individually. A ⅜- x 4-inch length core is ideal to wind the wire upon (Fig. 4). It does not matter if the core is flat or round. The length of this core can only be 4-inches long to fit inside the large Old Spice ® deodorant stick container. The longer ferrite core may be cut off with a hacksaw.

Select a 24 or 28 enameled covered wire to

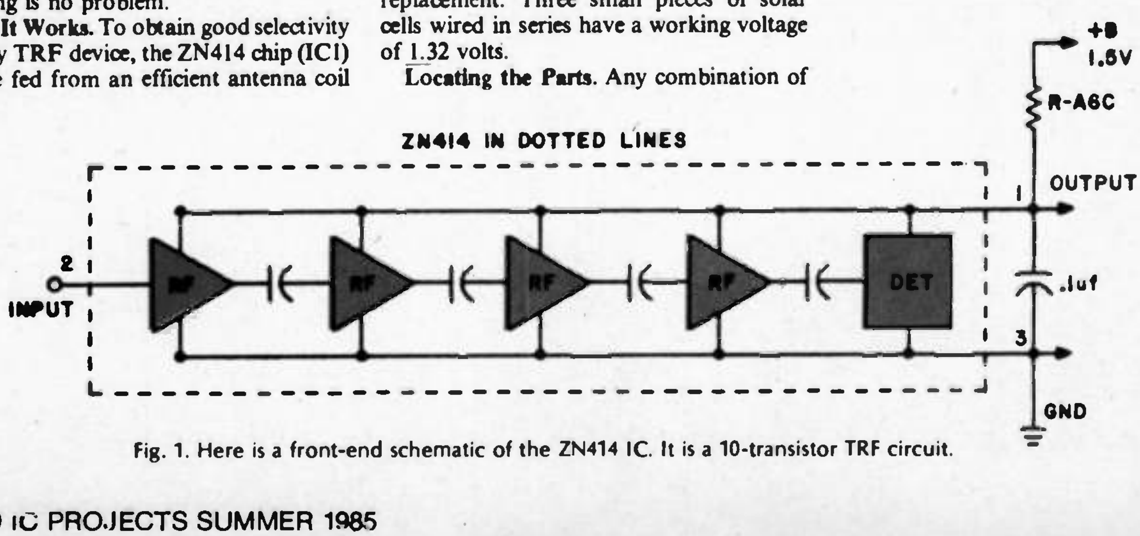


Fig. 1. Here is a front-end schematic of the ZN414 IC. It is a 10-transistor TRF circuit.

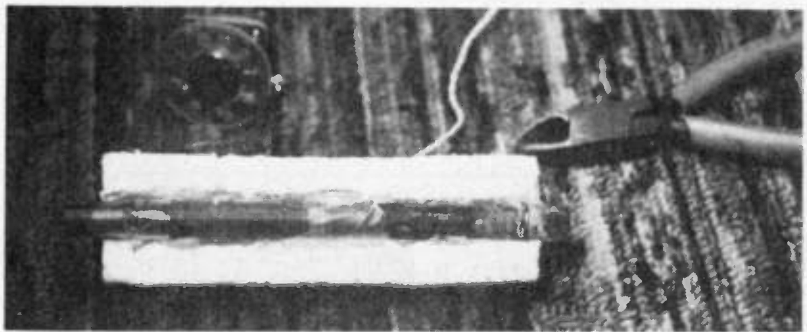
PARTS LIST FOR SUN-POWERED EMERGENCY RADIO

C1—365-uF variable tuning capacitor (ETCO type 185-VA, ETCO Electronics Corp., North Country Shopping Center, Rt. 9 North, Plattsburg, NY 12901, or Circuit Specialists type A1-232—address below)
C2—.01-uF, 100-WVDC ceramic capacitor
C3, C4—.1-uF, 100-WVDC ceramic capacitor
IC1—ZN414m (Available from Circuit Specialists, Inc., P.O. Box 3047, Scottsdale, AZ 85257—$2.00)
L1—Ferrite antenna coil to match 365-uF variable capacitor or wind your own on a ferrite stick 4-inches long and ⅜-inch in diameter. Refer to text. Wire is required.
Q1—ECG123A,SK3044, or any low-power NPN audio transistor
R1, R3—100,000-ohm, ½-watt, 5%
R2—470-ohm, ½-watt, 5%
R4—15,000-ohm, ½-watt, 5%
SC1, SC3—Solar cells (purchase low-priced broken cells or crescent-type cells from: Edmund Scientific, 101 East Gloucester Pike, Barrington, NJ 08007
John Meshna, Jr., Inc., P.O. Box 62, East Lynn, MA 01804
Poly-Paks, Inc., P.O. Box 942, S. Lynnfield, MA 01940
Solar Pump, P.O. Box 27885, Denver, CO 90227

Misc.—Crystal (high-impedance) earphone, hookup wire, winding wire (see text), foam chassis, solder, empty deodorant container, etc.

complete the coil assembly. Place a layer of scotch or masking tape at one end holding the wire tight against the ferrite rod. Close wind (CW) the coil next to each turn until the full 72 turns are completed. Tape down the last few turns to keep the wire from coming loose. The entire antenna coil may be covered with scotch tape, if desired. Better still, lay down a narrow beed of RTV cement. Leave about 8 inches of extra wire at each end to solder to the variable capacitor (C1).

The antenna coil may be wound with #30, AWG Kynor wire-wrapp wire. Not only is this wire ideal to connect the solar cells together,it may be used as hookup and antenna coil wire. Since the wrapping wire is covered with a coat of plastic it may be close wound directly upon the ferrite iron core. The plastic must be removed from each end for soldering. Scrape off with the pocket knife or burn back the insulation with the solder-iron tip.


The antenna coil is mounted down inside the V slot of the foam chassis at the bottom side.

Preparing Chassis. All small parts including the solar cells are mounted upon a piece of styrofoam material. Select and cut a piece of foam ¾-inch thick, 4½-inches long and 1¼-inches wide. This will let the pieces of foam fit snug against the inside of the round plastic container. The foam chassis may be cut from regular ¾-inch foam stock or discarded packing pieces. Pieces of foam packing may come from radio, stereo, TV sets and small appliance boxes. The small solar radio mounts inside a large plastic stick deodorant container.

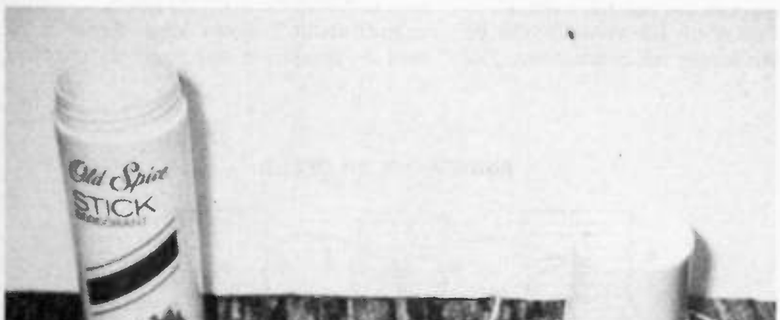
Cut a large "V" grove down the middle area of the bottom side to mount the ferrite antenna coil. Do not mount the antenna coil until all other wiring and mounting of parts are completed. The small radio component will mount to the front top piece and the three solar cells are cemented to the back area of the top side of the foam chassis.

Mounting and Wiring Up Parts. All small parts are mounted as they are wired into the circuit. These parts are kept in a 1- x 1½-inch area. The small resistor and capacitors are wired to IC1 and transistor Q1 terminal before mounted upon the foam chassis. Both the IC and transistor are mounted upside down so the terminal are easily accessible. Use the sharp point of the soldering iron to melt out the foam so the wiring and part will lay flat upon the foam chassis. Small holes may be poked through the foam with an ice pick or the stiff end of a fixed resistor.

Connect capacitor C3 (.1) across the output and ground terminals (1 & 3) of IC1. Solder a four-inch piece of hookup wire to the same ground connection. This ground wire will go through a hole in the foam and serve as a ground connection for emitter terminal of Q1. Connect the .01 capacitor (C2) to the ground terminal. Now connect a 8-inch piece of hookup wire from the top side of C2 which will later connect to C1. Wrap one end of R1 (100K) to this junction and output terminal (1) of IC1. Solder all terminal connections after these connections are wrapped together.

Solder one end of C4 (.1-uF) capacitor to the output terminal (IC1) with R2. Try to keep all parts in a one-inch width area as they are soldered up. Connect the other end of Capacitor C4 to the base terminal of Q1. Place R1 resistor across the base and collector terminals of Q1. Tie R3 to the collector terminal and BM common at R2. Pull the common ground wire up through the foam chassis, cut off and solder to the emitter terminal of Q1.

The crystal earphone connection may be tacked in momentarily to check out the radio. After the small radio is working leave about 4-inches of earphone cord and tie a knot so the plastic end piece will keep the strain off the wired circuit if the earphone



All components are mounted upon a piece of foam 1 x 1½ x ¾-inches thick.

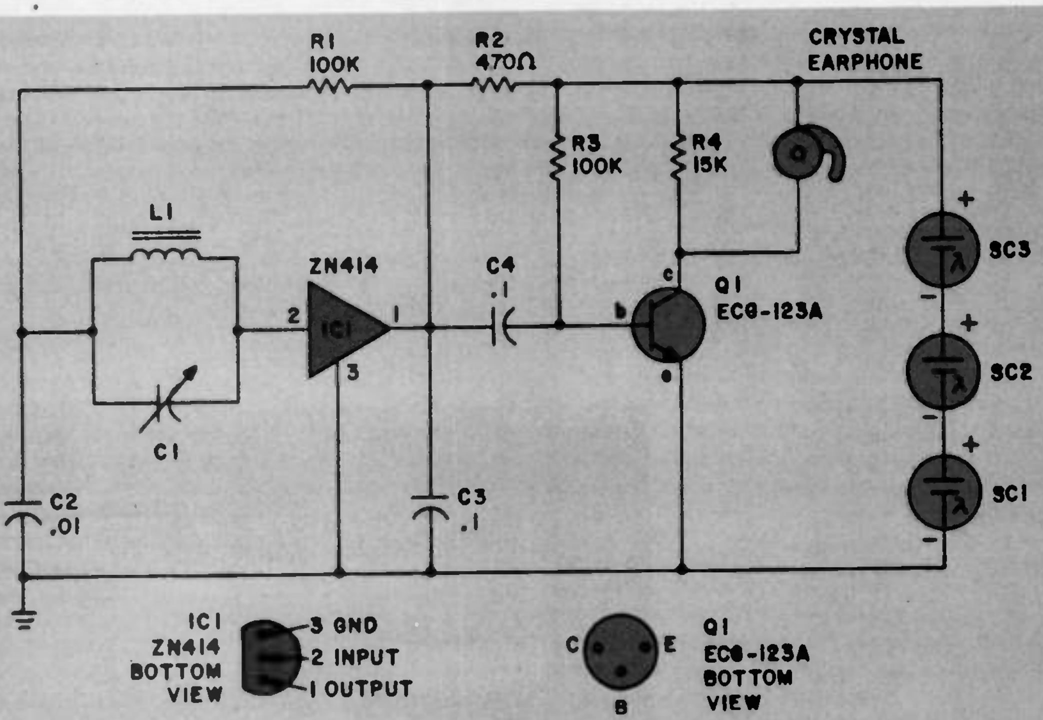


Fig. 2. The actual solar radio circuit with IC1 and Q1. The volume is sufficient to drive a crystal earphone.

cord is jerked or pulled. If the earphone comes with a plug, you may install an earphone jack in the plastic end piece. Here the earphone plug was cut off and soldered directly into the circuit. Burn back the plastic wire coating with the iron tip. Scrape the flexible Litz wire of each earphone cable with a pocket knife. Trim each end before trying to solder into the radio.

The Solar Cells. The small solar cells may be pieces of broken cells wired in a series hookup. These cells may be purchased in a broken cell lot as given in the Parts List. Since the cells must be mounted close together they are wired and connected together before mounted. Use plastic wrapping wire or single strand of hookup wire to connect the cells together or Krynor Wrapping wire. Simply cut a piece of flexible hookup wire six inches long and unwind each strand of copper wire for cell hookup wire.

Remember, the top part of the solar cell is negative with the bottom or silver side as the positive terminal (Fig. 4). Start with solar cell SC1 and solder a lead to the bottom side (M). Cut the lead off just long enough to connect to the top side of cell SC2. Select a T or bar area of a broken solar cell to make the top connection. Now connect another piece of hookup wire to the bottom side of cell SC2 and connect to the top side of cell SC3. Cut two pieces of cell hookup wire three inches long to connect these cells to the radio circuit. Solder the negative terminal to the top side of cell SC1 and the other connecting (positive) wire to the bottom of side of cell SC3. (Refer to figs. 4 and 5.)

Double check the wiring of the solar cells before mounting upon the foam chassis. If a small VOM is handy select a 2-volt range and measure the voltage across the two connecting wires with a 100-watt bulb placed above them. Do not allow the cell to get hot. A total of 1.3 volts should be measured with proper cell connections. The meter may read backwards if test probes are connected wrong. Notice which lead is positive upon the meter. This positive terminal lead is soldered to R3 and the crystal earphone connection (Fig. 5).

After the solar cells are connected together and tested mount them upon the end of the foam chasis. To keep wires and cells down below the foam surface melt out the exact area with the tip of the small soldering iron. Likewise, melt out mounting area for the IC1, Q1 and larger capacitors into the foam area. Cement the solar cells in place with rubber silicone (RTV) cement. Let the cement set up for a couple of hours. A dab of rubber cement may be placed upon larger componets to hold against the foam after the radio is operating.

Preparing Case. A large, plastic, discarded Old Spice ® Deodorant Stick is used to house the small IC radio. Select the largest, about 5-inches long. Remove the used up deodorant end piece and throw it

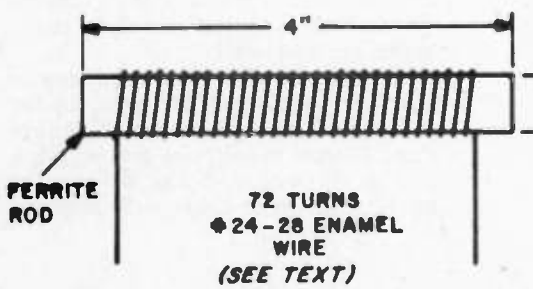


Fig. 3. Wind 72 turns of number 24 or 26 wire upon a G inch ferrite iron core. Cut the rod to 4 inches In length.

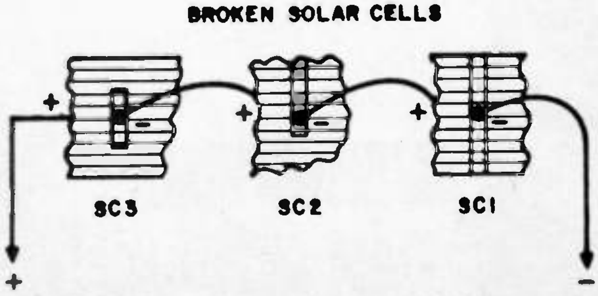


Fig. 4. The three small solar cell pieces are wired together before cemented upon the foam chassis. Burn out a portion of the back chassis so the cells with wires will mount flush with the top of chassis.

away. Drill a ⅛-inch hole in the plastic screw end piece. Cut out a piece of flat plastic to fit in the open end of the container. Drill a 5/16-inch hole in this piece before placing inside of container.

The plastic round end may be cut with a small saw or soldering iron tip. File and cut the piece of plastic to fit inside the end opening. Remove any burr edges so the capacitor will fit flat agains the plastic end piece. Use airplane or similar glue to cement the round plastic to the container. Let the cement set before mounting the small capacitor.

Finishing Up. Now mount the large antenna coil. Turn the foam chassis over and place a layer of rubber silicone cement in the grooved area. Refer to the photos. Push the antenna assembly down into the slotted area. Keep the coil end flat with the front of the foam chassis. Make sure the antenna coil connecting wires are underneath the antenna and pulled out towards C1. Let the cement set up before connecting one end of coil to terminal 2 of IC1 and junction of C2 and R1.

Leave approximately 8 inches of hookup wire from the radio circuit to connect to the variable tuning capacitor. This capacitor will mount directly ahead of the foam chassis into the hole of the plastic end piece. The variable capacitor is fed through the small plastic hole and tighten with the small lock nut. Keep the extra hookup wire to the bottom side of chassis and capacitor so they will not bind up the tuning capacitor. Check to see if the plastic end piece will screw up against the body of the container. Place a layer of rubber cement on top and bottom sides of foam chassis to hold against the plastic container after making sure the radio is working.

Testing. Before firing up the Sun-Powered Emergency Radio, go over each soldered connection and component at least twice. Check off each part upon the schematic diagram. Make sure the soldered connections are tight with a good connection. Be careful, do not leave the hot iron-tip too long upon IC1 or Q1 terminals. Too much heat may damage the small components. Use a pair of long nose pliers as a heat sink.

Now, place a 100-watt bulb close to the radio. Measure the voltage at the two solar-cell output terminals. You should have between 1.1 to 1.3 volts. No voltage indicates a dead short across the cells or the cells are not turned towards the light, also, your inter-solar-cell connections may be open. Disconnect one lead and take another voltage measurement. Double check the wire connections of each cell. Suspect a wire or wrong connection if the voltage returns. Go over the wiring once again.

Place the blade of a pocket knife or screwdriver upon the input terminal (2) of IC1. You should hear a small hum or loud click in the earphone. If a click is heard check the wiring to the antenna and variable tuning capacitor (C1). A wire may break off while mounting the radio chassis.

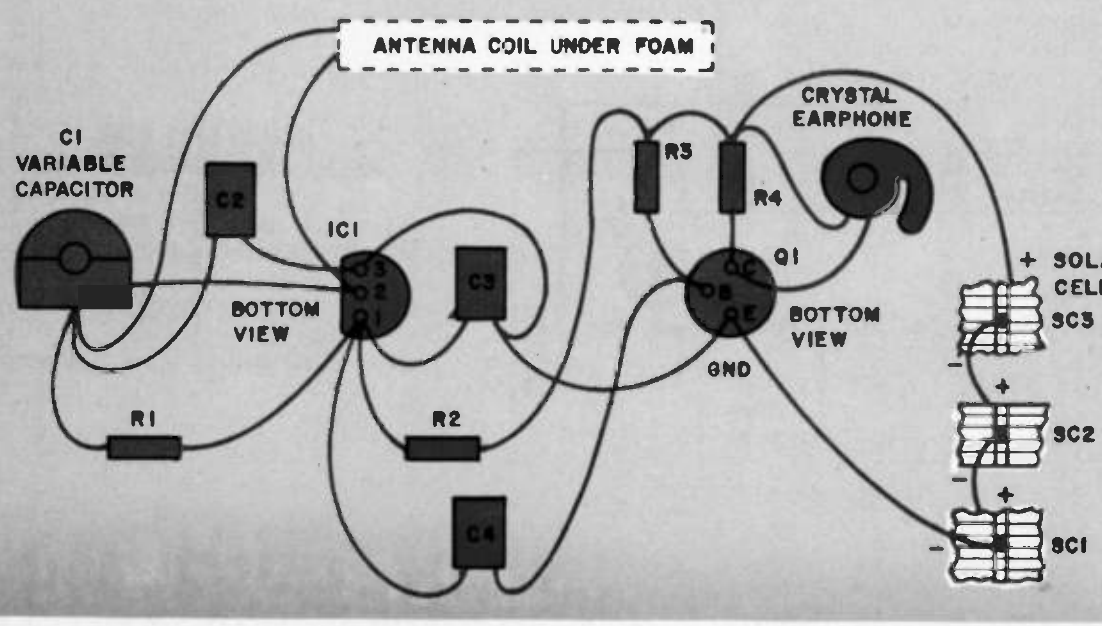
Operation. The Sun-Powered Emergency Radio may be operated under a reading lamp or in the sun. Remove the cap from the end so more light will strike the solar cells. Now slowly rotate the dial until a station is heard. Move the small radio at different angle to increase the volume of the station. Several local stations should be heard over the entire broadcast band. Powerful local stations may be heard with the end cap screwed in place.

Increase the resistance of R2 when a whistling noise is heard on several stations at different portions of the broadcast band. This squealing noise may occur at any point indicating swamp out of the AGC signal. Try a 1000-ohm resistor for R2. Keeping extreme light from the solar cells may help in accurate station tuning. Turning the small radio case towards or away from loud local stations may help in locating a weaker one. To locate and tune in weaker or more distant stations remove the end cap for stronger light upon the solar cells.

This little radio may tune in those long distance stations after the local ones are off the air. Some strong local stations may sign off when the sun goes down, letting the radio pick up the weaker stations. These far away stations may be selected late at night. Slowly rotate the dial to a weaker station, turn the radio until the station is loudest.

Conclusion. Be careful when soldering IC1 and Q1 into the circuit to prevent overheating. Select the correct terminal of IC1 and Q1 before soldering up. Mark the solar cell front area with a dot or line so that area will be turned towards the lights. Check the solar-cell polarity before connecting into the circuit. Double check all wiring before firing up the radio. Mount IC1 and Q1 with a dab or rubber silicone glue to hold in place after the radio is checked out. Remember to keep the solar cells turned toward the sun or light at all times. Strong broadcast stations may be turned down in volume by keeping cells covered with the plastic end piece and rotating the antenna away from the station. Weak stations may be tuned in by turning the radio towards the weak station with a stronger light source. Although the small Sun-Powered Emergency Radio will not blast your ears, easy-private listening can be had without ever changing batteries—just use that internal solar power at no cost. ■

Fig. 5. Here is a pictorial drawing showing how the parts are mounted and wired into the circuit.



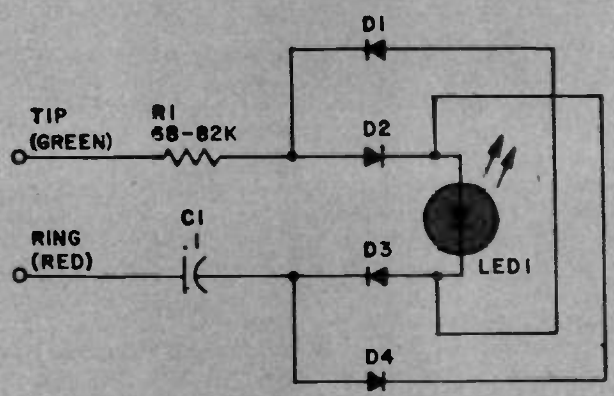
CIRCUIT FRAGMENTS

Here are several circuit fragments that can be added to IC circuits. Their use will not only increase the utility of the original IC circuit, they open new possibilities that are not possible or easy to do with circuits that consist of IC's only. Some of these circuit can be used as diagrammed into other circuits. Others, require some modification mainly due to circuit coupling characteristics.

SIGHT-FOR-SOUND PHONE ALARM

The hard-of-hearing may not hear a telephone ring, or a sleeping child should not be awakened by a ringing telephone. This simple Sight-for-Sound Phone Alarm can do the job for you! What rings your telephone is a 20 Hertz AC signal at anywhere from 60 to 120-volts, depending on your phone company. That same bell-ringing signal can be used ot light an LED with the circuit shown here, without significantly loading the telephone line. Capacitor C1 provides DC isolation to help foolproof this project. The .1 value shown works, but you may want to increase it to .5 microFarads. Use a mylar capacitor (like the Sprague *Orange Drop* series) rated at 250-450 working volts or more.

Why so high? The telephone company keeps its line clear of ice and other trouble by daily sweeping a pulse of high voltage through the system. Too low a working voltage could mean trouble for them, and that is absolutely the last thing you want to use. We might even suggest connecting to the telephone lines only temporarily to verify circuit operation. This will help avoid accidents and trouble. Diodes D1 through D4 act as a full-wave bridge to deliver the AC ringing voltage as DC to LED1. Series resistor R1 limits this current through the circuit. If the LED1 glows too brightly, you can reduce the intensity by slightly increasing the resistance of R1.



PARTS LIST FOR SIGHT-FOR-SOUND PHONE ALARM

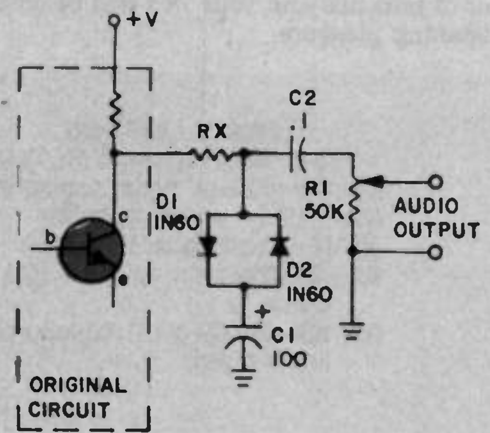
- **C1**—.1-uF 100-WVDC capacitor
- **D1, D2, D3, D4**—Diode, 1N914 or equivalent
- **LED1**—Light emitting diode, any color
- **R1**—82,000-ohm, ½-watt, 10% resistor

CLIPPER POOPER

How many times have you seen your PA system's or intercom system's speaker voice coil literally tear itself loose or burn out a voice coil when overdriven? Almost as bad, the voice coil overheats and warps, adding a scratchy, fuzzy noise to voice messages that cannot be understood. What you need is a Clipper Pooper so that when some clown drops the mike, or screams into it, the speakers will not blow. (Nevertheless, God help the poor microphone.)

An effective speech and noise clipper (Clipper Pooper) for transmitters and PA systems can be made from only two diodes and a capacitor. Connect the diodes to the collector of the microphone preamplifier, the stage with at least a 1V peak-to-peak audio output voltage. The diodes clip at approximately .2V, allowing overall amplifier gain to be increased without speech peaks producting over-modulation or excess peak power output.

Capacitor C1's voltage rating must be a bit higher to the DC supply voltage at the preamp collector. If the preamp uses a negative supply, reverse C1's polarity. The output level to the rest of the amplifier is determined by the R1. Potentiometer R1 can be a PC-mount type and mounted internally along with the remainder of the circuit. Once set, leave it be and use the amplifier's volume control. If the diodes cause distortion in the preamplifier, add resistor Rx, as shown. Use the necessary value between 1000 and 10,000 ohms.



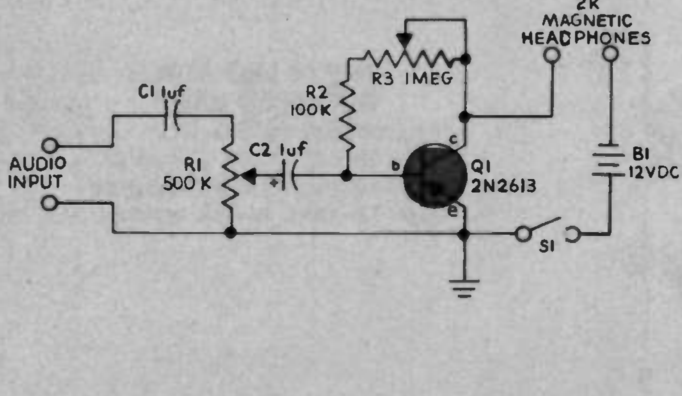
PARTS LIST FOR CLIPPER POOPER

- **C1**—100-uF electrolytic capacitor (see text)
- **C2**—0.1-uF, disc capacitor
- **D1, D2**—1N60 diode
- **R1**—50,000-ohm, audio taper potentiometer
- **Rx**—see text

HI-Z 'PHONE BOOSTER

Quite often the audio output from small, home-brew projects is just barely sufficient to produce a recognizable signal in standard experimenter magnetic earphones. Yet a handful of surplus components will provide enough gain to turn that whisper sound into a roar.

Specifically intended for use with magnetic earphones of from 1000 to 5000 ohms impedance, the HI-Z 'Phone Booster can do double-duty as an audio signal tracer. Transistor Q1 can be any PNP of the



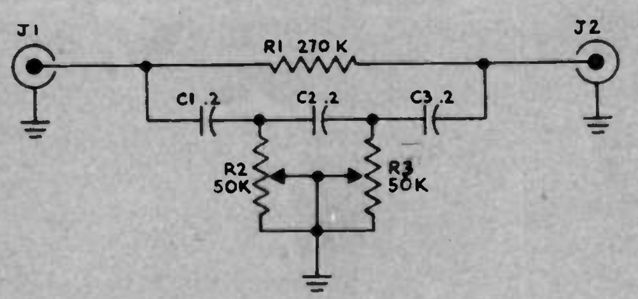
PARTS LIST FOR HI-Z 'PHONE BOOSTER

- **B1**—Battery, 12 volts (two RCA VS068 in series or equivalent)
- **C1**—0.1-uF capacitor, 15-WVDC or better
- **C2**—1-uF electrolytic capacitor, 15-WVDC or better
- **Q1**—PNP transistor, 2N2613 or equivalent
- **R1**—500,000-ohm audio taper potentiometer
- **R2**—100,000-ohm, ½-watt, 10% resistor
- **R3**—1-Megohm potentiometer, any taper will do

2N2613 variety. Even the 10-for-a-buck kind will work. Volume control R1 should have an audio taper. Distortion control R3 can have any taper. Make certain C2's polarity is correct; the positive terminal connects to volume control R1 (wiper terminal). Adjust distortion control R3 for best sound quality. If you use a jack and plug to connect your headphones to this amp, you can eliminate on-off switch S1 because power is removed whenever the headphones are disconnected.

78-RPM SHELLACK FILTER

Your old Bing Crosby records will sound much better on your stereo hi-fi sound system after a little work has been done to equalize their sound. Bing's first records were on the old 78 rpm jobs. The early days saw some new but not too good audio recording instruments and techniques. Yes, they were good for the old black shellack records but not for the modern LP's. Just wire up our 78-RPM Shellack Filter—a device that you can assemble in a few minutes. Mount the project in a shielded can or box to keep AC hum to a minimum. Connect the output of your old 78 player to the Old Smoothie, and its output to a tape recorder. Set potentiometer R2 to a maximum resistance to attenuate the high mid-frequencies comon to most 78-RPM recordings. Then adjust potentiometer R3 for the most pleasing sound you can get from the recording. If you lose too much of the mid-range (Bing's voice) in the playback, then reduce its resistance by rotating the potentiometer. When the results are optimum, record the disk—A and B sides. In effect, the 78-RPM Shellack Filter is an equalizer that bring the old 78-RPM disks back to life. You'll find that a slight adjustment may be needed from artist to artist, label to label, and style to style. A little bit of patience and your 78's will be on tape for your listening pleasure.



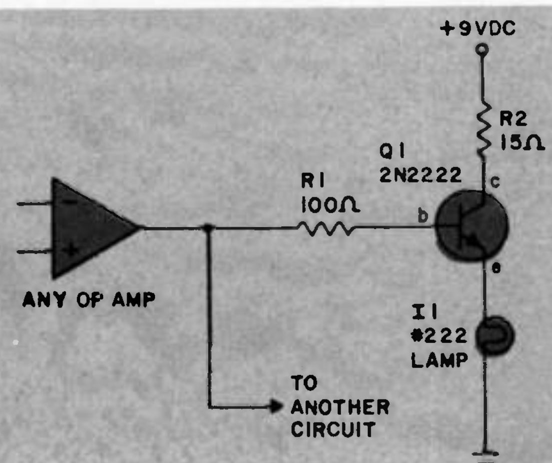
PARTS LIST FOR
78-RPM SHELLACK FILTER

C1, C3—0.25-uF mylar capacitor
C2—0.02-uF mylar capacitor
J1, J2—phono jack, RCA type
R1—270,000-ohm, ½-watt, 10% resistor
R2, R3—50,000-ohm potentiometer linear taper

BUFFERED LAMP

The output of CMOS circuit may require a visual indicator brighter than a light-emitting diode to indicate a circuit high on a test panel or remote site. However, should you connect a filament lamp directly across the op amp output without regard the remaining circuit, you most probably would introduce problems that are not tolerable.

The diagram shows how a buffered lamp can be connected so that it will cause no problem to the circuit to which it is connected. When a circuit high is present (+5-volts DC) the transistor will conduct and the lamp, I1, in Q1's emitter circuit will be powered on. Actually, this circuit is a relatively simple logic probe you may want to construct for other purposes.



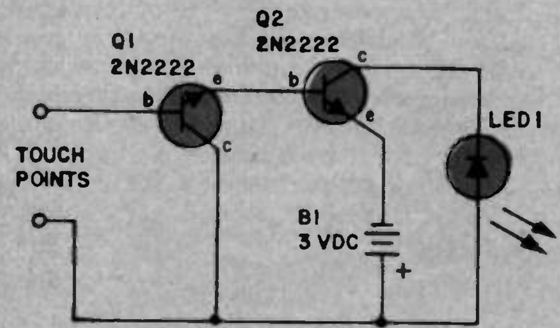
PARTS LIST FOR
BUFFERED LAMP

I1—No. 222 light bulb
Q1—2N2222 NPN transistor
R1—100-ohm, ¼-watt resistor
R2—15-ohm, ½-watt resistor

TOUCH CIRCUIT

The touch circuit may appear to have an application for magic acts only, when actually it can be used with a multiplicity of applications when the output LED1 is coupled to a photoresistive or photoelectric device. In fact, the light-emitting diode could be part of a opto-coupler device.

When your finger is across the touch points, it provides a low-resistive path between the base and emitter circuits of the first transistor, Q1, causing it to conduct. In turn Q1 causes Q2 to conduct passing a current through light-emitting diode, LED1. In the off stage, the current drain on the battery is a few microamperes, or less, so that there is no need for an on/off battery switch.



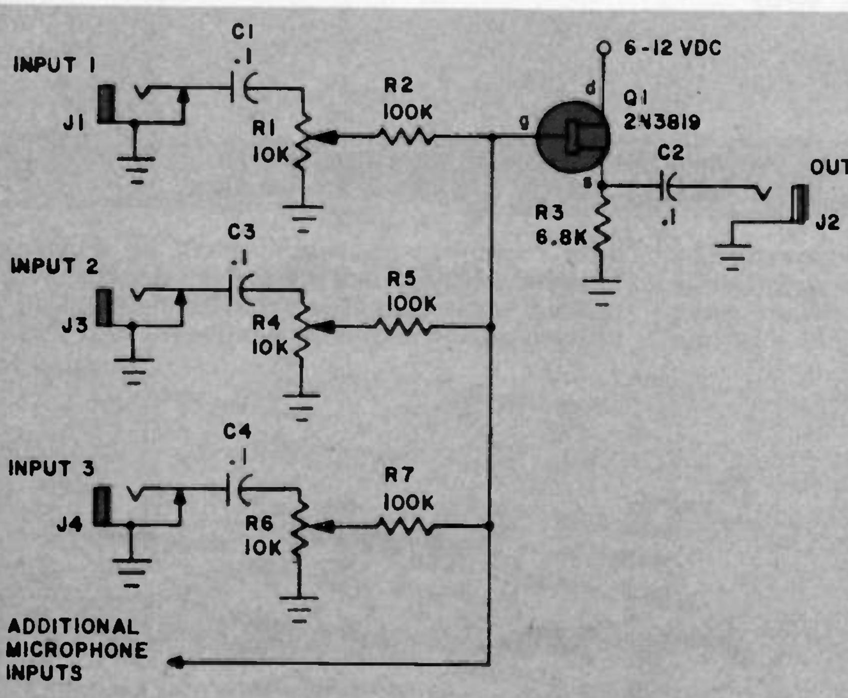
PARTS LIST FOR TOUCH CIRCUIT

B1—3-volts DC battery
LED1—Light-emitting diode, any color, 20 mA
Q1, Q2—2N2222 NPN transistor

MICROPHONE MIXER

Take a look at your cassette deck microphone input jacks and the chances are you will find only one. Should you want to use two or more microphones, you'll want to assemble the Microphone Mixer. The circuit shown makes for an ideal summing circuit for many audio inputs. Only two circuits are shown, but we have seen up to five microphone inputs used without loss of sound quality or undue increase of noise.

Each input circuit consists of a capacitor, potentiometer, and fixed resistor. The signal into input one passes through C1, a .1-uF capacitor that isolates the mike line from the DC circuit of Q1. Should the low-frequency sounds be lost in the playback, increase the capacitance of C1 as required to obtain a balanced sound. This would not be necessary for most high-impedance microphones. Potentiometer R1 selects a portion of the signal from input one so that it would be in balance with the sounds from the other microphones. Since Q1 has



PARTS LIST FOR MICROPHONE MIXER

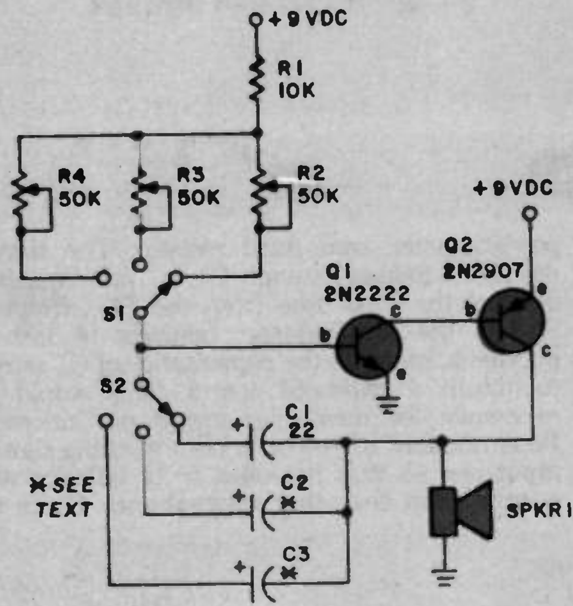
C1, C2, C3, C4, etc.—.1-uF ceramic capacitor
J1, J3, J4, etc.—Phone jack, closed-circuit
J2—Phone jack, open-circuit
Q1—2N3819 junction field-effect transistor (FET)
R1, R4, R6, etc.—10,000-ohm, audio-taper potentiometer
R2, R5, R7, etc.—100,000-ohm, ¼-watt, 5% resistor
R3—6800-ohm, ¼-watt, 5% resistor

usable gain, a portion of the input signal is dropped in resistor R2 and Q1's g-s circuit consisting also of R3. That small portion of the signal is amplified in Q1 so that the signal outputted is approximately equal in amplitude to the signal originally produced by the microphone.

Closed-circuit phone jack, J1, is used to eliminate unnecessary noise input when the phone jack is not used. An open-circuit jack, J2 is all that is needed at the output. Potentiometers at each input circuit serve to balance the respective inputs to each other. Some microphones are "hotter" that others. Also, the sound engineer may want to achieve the audio blend he desires at the recording session. "Yes," Homer, "that's the way they do it in Nashville."

BEGINNER'S METRONOME

The Beginner's Metronome circuit offers the beginner a sure-fire project that can be used as it name implies, or it can be modified to provide pulse, either audio or signal, for experimental purposes. The charge path for C1 is through R1 and R2—R1 providing the minimum charge time when R2 is set at zero. The value of C1 can be selected for different "click" frequency ranges. The options are shown with S1 and S2 drawn in place: however, you could hard-wire the project without the switches using only one potentiometer (R1) and one capacitor (C1). The 9-volt DC source can be supplied by a transistor-radio battery or wall-pack battery charger.

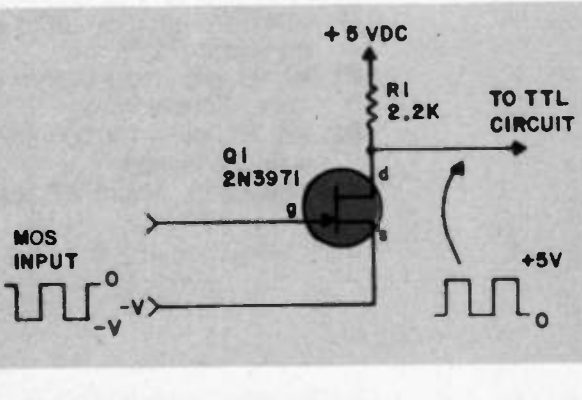


PARTS LIST FOR BEGINNER'S METRONOME

C1—22-uF, 15-WVDC, electrolytic capacitor
C2, C3—Optional capacitors that vary from 10- to 50-uF
R1—10,000-ohm, ¼-watt, 5% resistor
R2, R3, R4—50,000-ohm, linear-taper potentiometer
Q1—2N2222 transistor
Q2—2N2907 transistor
S1, S2—3-pole, single-throw rotary switch (optional)
SPKR1—8-ohm, 2-3 in. dia. loudspeaker

MOST-TO-TTL LOGIC INTERFACE

Here is a problem encountered from time to time by the advanced computer hobbyist: How do you mate the signals from MOS logic (the foundation of many microprocessor and peripheral ICs) to TTL logic (the most convenient and readily available logic form from which to construct add-on circuitry)? The problem stems from thefact that MOS signals swing between ground and some negative voltage (-V in the



PARTS LIST FOR MOS-TO-TTL LOGIC INTERFACE

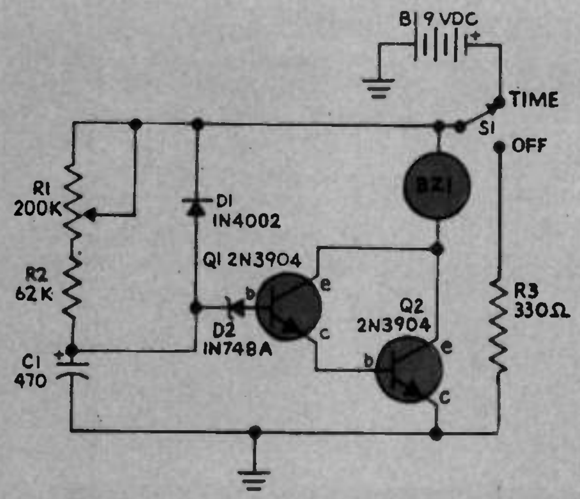
Q1—2N3971 N-channel JFET (junction field effect transistor)
R1—2,200-ohm, ½-watt, 5% resistor

diagram), while signals for TTL should swing from ground to something greater than +2.8-VDC (+3.5-VDC usually). One of the easiest solutions requires just one resistor and one n-channel field effect transistor. Note that Q1's source (S) lead goes to the negative supply potential of the MOS circuitry, and its gate (G) gets driven by the MOS input signal. TTL loads can be driven directly by the output signal available at Q1's drain (D). Finally, not that R1 is tied to the +5-VDC TTL supply and that the level-shifted output signals have been inverted: negative-going input pulses swing positive at the output, and vice versa. The circuit works well at data transmission rates less than 1 or 2 MHz. To interface faster clock signals or very abrupt pulses, use one of the commercially available level-shifter ICs.

DELAY TIMER

Here is a useful delay timer circuit that little Tom Thumb would have approved of—it's small both in size and in cost. With S1 in contact with +9-VDC, capacitor C1 gradually charges through resistor R1 and R2. When the potential across C1 reaches 5.5-volts, base drive flows into the Q1-Q2 Darlington pair through Zener diode D2. This causes the transistors to conduct collector current and activate buzzer BZ1, a miniature, solid state device that emits a pleasant, shrill tone to signal the end of the timed interval. To reset the timer, flip S1 so that it contacts R3, which functions to discharge timing capacitor C1 through diode D1.

Using trimmer R1, you can adjust the timed interval to any value between 30 and 120-seconds. We use this timer to control the development of Polaroid instant films, but you can probably find dozens of other uses, too.

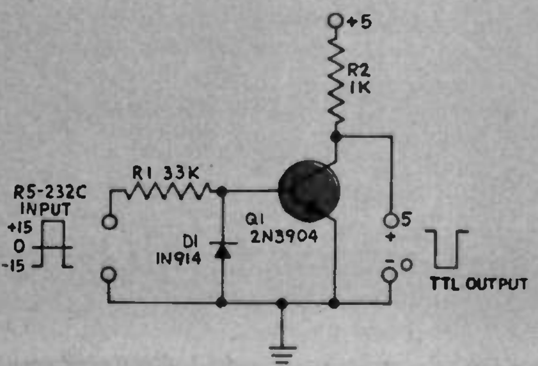


PARTS LIST FOR DELAY TIMER

B1—9-volt transistor delay
BZ1—9-VDC solid-state buzzer (Radio Shack 273-052)
C1—470 uF, 25-W VDC electrolytic capacitor
D1—1N4002 diode
D2—1N748A, 3.9-volt, ½-watt Zener diode
Q1, Q2—2N3904 NPN transistor
R1—200,000-ohm tripmer potentiometer
R2—62,000-ohm, ½-watt, 5% resistor
R3—330-ohm, ½-watt, 5% resistor
S2—SPDT slide switch

RS-232C-TO-TTL CONVERTER

There are two sides to the interfacing problem introduced by the previous project. Not only must TTL signals be converted to RS-232C levels, but RS-232C signals may have to be converted to TTL, too. Fortunately, the latter problem is even simpler to solve than the former. All that's needed is a simple saturating switch, transistor Q1, with its base protected by a diode. This prevents the negative excursion of the RS-232C signal from breaking down the emitter/base junction of Q1. As was the case in



PARTS LIST FOR RS-232C-TO-TTL CONVERTER

D1—1N914 silicon diode
Q1—2N3904 NPN transistor
R1—33,000-ohm, ½-watt, 10% resistor
R2—1000-ohm, ½-watt, 10% resistor

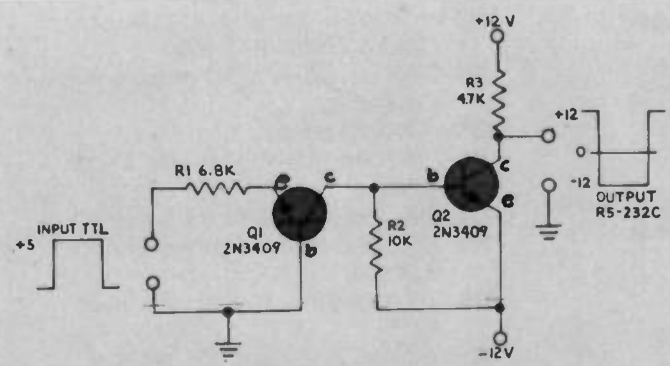
the previous project, you must build one converter for each signal line to be interfaced. To some experimenters, a Zener diode may be all that is necessary. Forget it! Zeners are noisy devices. Also, noise pulses below their firing point would ride through a clipper circuit playing havoc with the RS-232C transmission.

TTL-TO-RS-232C CONVERTER

If you happen to be a computer hobbyist, no doubt you are familiar with the EIA's RS-232C standard, which governs certain aspects of the communication between a computer and its peripherals. By peripherals, of course, we mean things like a CRT terminal, a printer, a modem or whatever else you could dream up. By convention, a high signal is defined by RS-232C as being greater than +3 volts, but no greater than +15 volts. Low signals, on the other hand, must be less than -3 volts, but no less than -15 volts. The region from -3 volts to +3 volts is a limbo area, and signals within this range do not qualify as valid input/output (I/O).

The problem that confronts many an experimenter is one of interfacing a project to his computer. In most instances, digital devices will be based on TTL circuitry, the maximum signal excursion of which is from ground to +5 volts. However, a more typical TTL signal would swing from +.4 volt to +3.5 volts. How do you convert such a signal to levels acceptable to the RS-232C convention?

It's easy, and requires just two transistors. Common-base stage of transistor Q1 acts as a level-shifter that couples the TTL signal to Q2, a saturating switch. Q2's output swings between -12 volts and +12 volts, levels compatible with RS-232C. Note that this is an inverting circuit: High inputs yield in low outputs, and vice versa. Since computer-to-peripheral communication usually requires several I/O Lines, you will need to build one converter for each line in use. Also, see the companion RS-232C-to-TTL converter in this issue.

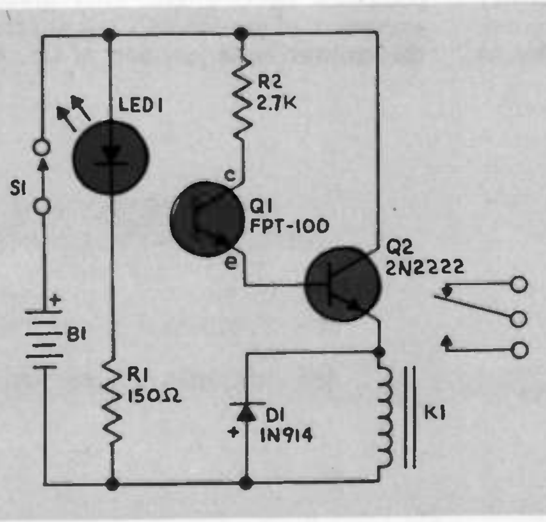


PARTS LIST FOR TTL-TO-RS-232C CONVERTER

Q1, Q2—2N3904 NPN transistors
R1—6800-ohm, ½-watt, 10% resistor
R2—10,000-ohm, ½-watt, 10% resistor
R3—4700-ohm, ½-watt, 10% resistor

PHOTOELECTRIC SNITCHER

How would you like to know whether or not the postal person brought you any post? Or how about a circuit to start something going whenever you put a card in a slot? That's what this little photorelay is all about. Whenever the photostransistor sees the LED, it pulls up the base of relay driver Q2 and pulls in the relay. Stick something between the LED and Q1 and the relay releases. D1 shunts out the relay's inductive



PARTS LIST FOR PHOTOELECTRIC SNITCHER

B1—12-VDC battery
D1—Diode, 1N914 or equivalent
K1—SPDT relay, 12-VDC
LED1—Light emitting diode
Q1—Phototransistor, FPT100 or equivalent
Q2—NPN transistor, 2N2222 or equivalent
R1—150-ohm, ½-watt, 10% resistor
R2—2700-ohm, ½-watt, 10% resistor
S1—SPST switch

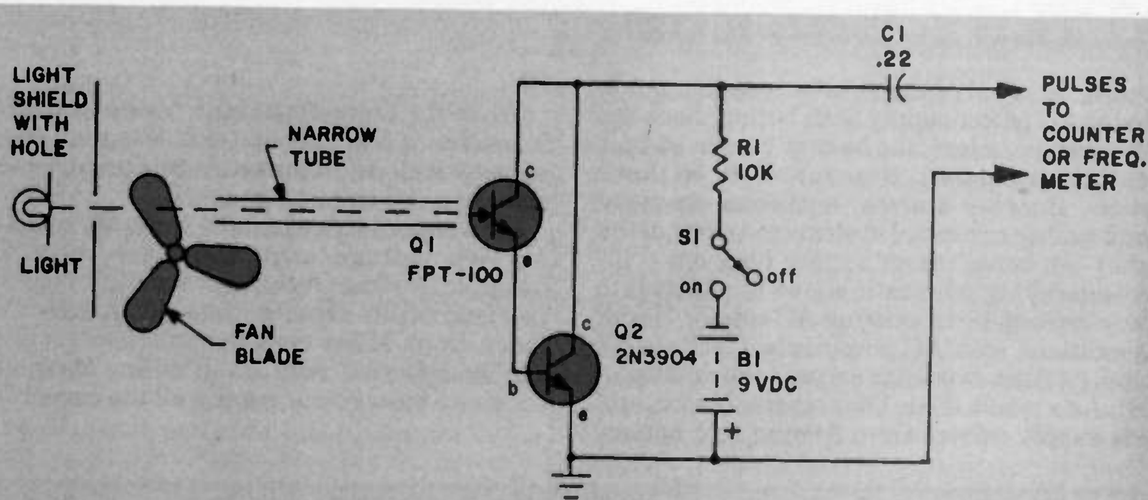
kickback.

If you point the LED and Q1 in the same direction, they will act together as a reflective sensor. Then if anything comes close enough to bounce the light from the LED back into Q1 (assuming both are kept in the dark—any light will trigger Q1), the relay will pull in. The circuit can also be used without R1 and LED1 as a light-or-no-light operated alarm.

LIGHT PULSE TACHOMETER

Here is the basic circuit for a Light-Pulse Tachometer you can build today. To obtain an accurate pulse count you must feed the output to a pulse counter. Since the pulses are not shaped, you could send the output to a Schmidt Trigger circuit and then measure the analog output with a VOM or DVM. However you do it, you can use this circuit to measure the rate of rotation of motors, fans and anything else that revolves and can break a beam of light. The diagram shows that light from the bulb is chopped by rotating fan blades. This chopped light beam then falls on the light-sensitive face of phototransistor Q1. Transistor Q2 amplifies the photo-current from Q1's emitter to yield a rectangular waveform approximately 9-volt in amplitude at the output. Naturally, the frequency of the output pulses is related to three times the fan's speed of rotation (three blades).

Suppose we obtain a frequency reading of 50 Hz with a 3-bladed fan illustrated here. Obviously there are 3 interruptions per revolution. The actual speed is therefore 1000 RPM. For best results, mount Q1 in a small, hollow tube (an old ballpoint-pen barrel for example) with its light-sensitive face recessed with respect to one end. That setup will ensure that only the chopped beam strikes the phototransistor Q1.



PARTS LIST FOR LIGHT-PULSE TACHOMETER

- **B1**—9-volt transistor-radio battery
- **C1**—.22-uF, mylar capacitor
- **Q1**—FPT-100 phototransistor (or equiv.)
- **Q2**—2N3904 NPN transistor
- **R1**—10,000-ohm, ½-watt, 5% resistor
- **S1**—SPST toggle switch

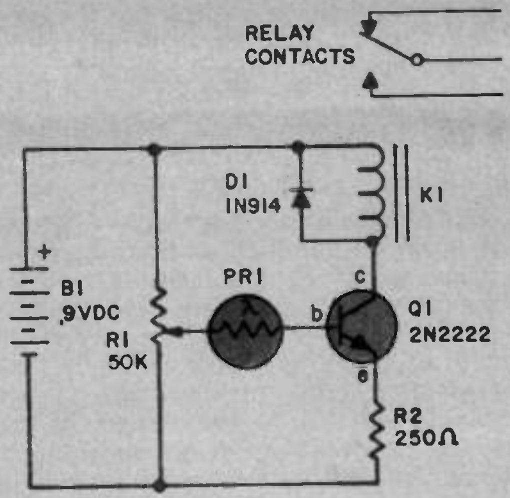
LIGHT-ACTIVATED RELAY

Here is a simple light-activated relay circuit that is sensitive to room light conditions. The light-sensitive device is PR1, a CdS- or CdSe-type photoresistor that is placed in the base circuit of an NPN transistor, Q1. When no, or insufficient, light falls on the photoresistor, PR1, transistor Q1 is biased to cut-off and the solenoid of the relay, K1, is unernergized.

As light strikes the photoresistor the base current in Q1 begins to flow and Q1 conducts enough current to energize the coil of K1, pulling down the relay contacts to the energized position. The contacts are electrically isolated from the circuit, and they can be used to provide control of a circuit using standard line voltages, and even high currents. As the light deminishes, the photocell internal resistance increases, reducing the current to the base of Q1 and shutting down the transistor, and the relay.

The relay should be a low-current type so that the normal non-destructive current through Q1 is sufficient to power on the relay. Suggested relay types are Radio Shack types 275-004. 275-247, 275-212, etc.

Diode D1 eliminates the bucking voltage created by the relay coil when the relay is turned off, thus preventing the destruction of the transistor. Adjust potentiometer R1 so that the circuit actuates at the light level you desire. Also, mask photoresistor PR1 should the light intensity be too high to turn off the circuit at the level you desire.



PARTS LIST FOR
LIGHT-ACTUATED RELAY

B1—9-volt battery
D1—1N914 rectifying diode
K1—Refer to Radio Shack catalog, types 275-004, 275-212, 275-247, etc.
PR1—CdS or CdSe photoresistor (Radio Shack 276-116, or equiv.)
Q1—2N2222 NPN audio-switching transistor
R1—50,000-ohm, linear taper, potentiometer without switch
R2—250-ohm, ¼-watt resistor

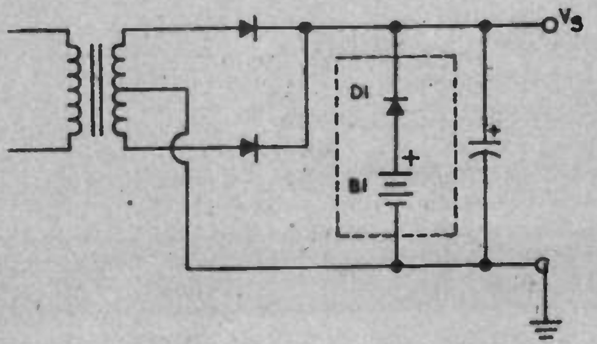
BATTERY BACKUP

Sometimes, it is advantageous to supplement a conventional AC power supply with battery back-up. In case of a power failure, the battery cuts in so that the circuit in question can function without interruption. Burglar alarms, computer memory boards, and timing or control systems are a few of the circuits that can benefit from battery back-up.

The accompanying schematic shows how easy is to add battery back-up to an existing AC supply. Under normal conditions with AC power intact, voltage Vs on the supply's filter capacitor exceeds the voltage of battery B1. As a result, diode D1 is reverse biased, and it prevents supply current from flowing into battery B1.

When the line voltage fails, Vs starts to drop. Once it reaches a level about 1-volt less than the battery voltage, it stops dropping. At this point, battery B1 is powering the circuit through D1.

Let's suppose Vs equals 11 volts. We could choose a battery voltage somewhat less than this—for example, 9 volts. Once the power fails, our circuit will be running on about 8 volts (9V minus 1V for the diode drop). Many circuits can tolerate a diminished supply potential with no ill effect. Make sure your choice of battery can supply all the current demand.

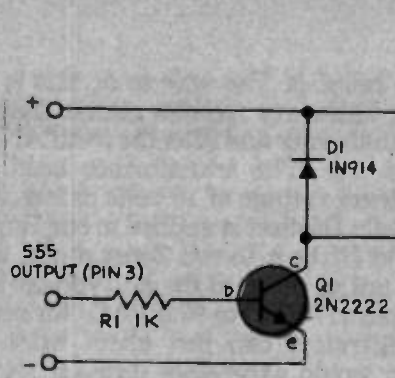


PARTS LIST FOR
BATTERY BACK-UP

B1—Battery of appropriate size (see text)
D1—1N4001 silicon rectifier diode

555 SWITCH HITTER

The 555 integrated circuit is a very versatile timer when you need a time delay or any kind of regular timed event. But if you try to draw more than 100 or 200 milliamps through it, you'll soon be drawing a blank and a new 555 from your parts drawer. With these simple additions, you can draw as many amps as your relay's contacts will carry. Q1 acts as a relay driver, triggered by the output of the 555 (pin 3) through a 1000 Ohm resistor (R1). Relay K1 can be driven from the 555's power supply (choose an appropriate coil voltage for K1) or from a separate positive power supply if the 555's supply handle the extra load. Q2 can handle up to 800 milliamps itself, so any relay coil that draws less than that (100 Ohms or so more than satisfies this) will work fine. Similarly, other loads can be substituted for K1-D1.



PARTS LIST FOR "555" SWITCH HITTER

D1—Diode, 1N914 or equivalent
Q1—NPN transistor, 2N2222 or equivalent
R1—1000-ohm, ½-watt, 10% resistor
K1—Relay, (rated at least equal to system voltage)

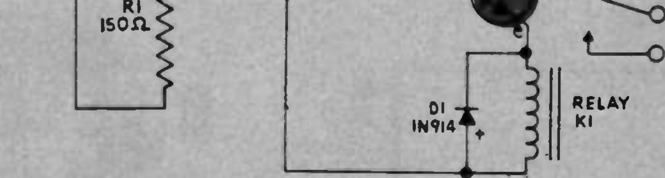
OPTO-ISOLATOR SENSOR

Here's a very simple Opto-Isolator Sensor circuit that you can build this evening. Its unique circuit character is that you can build it, understand it, and modify it to any special requirement you wish. It can ring an alarm whenever the mail is dropped in a slot. It can separate a battery circuit from the AC line providing remote installation without special circuits—bell wire will be good enough. It can be made to do just about anything your imagination will let you think up.

Whenever the phototransistor sees the LED's light, it pulls up the base of relay driver transistor Q2 and pulls in the relay. Stick something between LED1 and Q1 and the relay releases. D1 shunts out the relay's inductive kickback preventing destruction of transistor Q2.

If you point LED1 and Q1 in the same direction, they will act together as a reflective sensor. Then if anything comes close enough to bounce the light from LED1 back into Q1 (assuming both are kept in the dark—any light will trigger Q1), the relay will pull in. The circuit can also be used without R1 and LED1 as a light—or no light-operated alarm—but then we do not have an opto-isolator circuit. The LED1 circuit is powered by B1. The transistors are powered from the AC line via a DC voltage regulated circuit.

It doesn't take a quick mind to realize that should electrical isolation not be necessary, the circuit could be hooked up to only one battery and switch S1 would be a SPST switch.



PARTS LIST FOR OPTO-ISOLATOR SENSOR

B1, B2—12-VDC battery
D1—Diode, 1N914 or equiv.
K1—SPDT relay, 12-VDC
LED1—Light emitting diode
Q1—Phototransistor, FPT100 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
R1—250 ohm, ½-watt, 10% resistor
R2—2700 ohm, ½-watt, 10% resistor
S1—DPST toggle switch

BROWN-OUT ALARM

We call this circuit a Brown-Out Alarm. You can give it any name you wish depending upon how you use it. For example, assume that you want to use this alarm to indicate when the back-up battery voltage in burglar alarm system falls from 12- to 11-volts DC. Wire the circuit as shown and connect +V to the battery positive terminal (+12-volts DC) and the ground circuit to the negative terminal. Select D1 with a Zener voltage of 11-volts. The circuit should not make a sound. Now reconnect the circuit to an 11-volt DC source. Use a voltage divider to do this or a controllable regulator circuit. The alarm should come on. Adjust R1 for the tone desired.

This same circuit can be used as a Brown-Out Alarm as we billed it. The way to do this is build a simple diode, half-wave rectifier circuit that uses a step-down transformer and filter the rectified DC with a .5-uF capacitor. The transformer used should produce a filtered voltage of 18 volts or less. Assume that it is 18-volts DC that is applied to our Brown-Out Alarm. Should D1 be a 15-volt Zener diode, then the alarm would not go off until the line voltage dropped 15/18's, or from 117-VAC to 97.5-VAC. Air conditioners and refrigerators can just about work at this potential, but would experience damage should the voltage drop any lower.

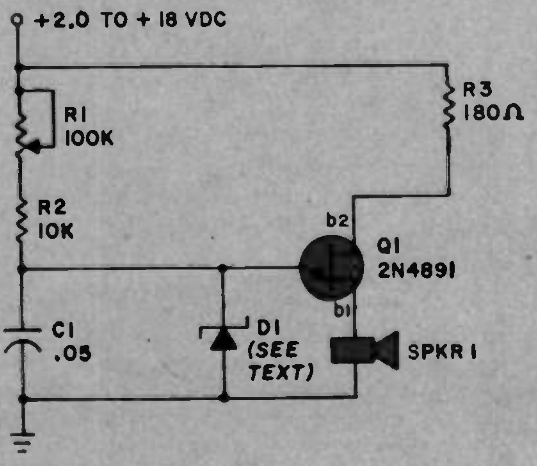
Here is a list of some Zener diodes and their voltage that can be used in this circuit:

ZENER DIODE TYPE	VOLTS
MZ4614*	1.8
MZ4615*	2.0
1N4370, MZ4617*	2.4
1N4371, MZ4618*	2.7
1N4372, MZ4619*	3.0
1N746, MZ4620*	3.3
1N747, MZ4621*	3.6
1N748	3.9
1N749	4.3
1N750	4.7
1N751	5.1
1N752	5.6
1N753	6.2
1N754	6.8
1N755	7.5
1N756	8.2
1N757	9.1
1N758	10.0

ZENER DIODE TYPE	VOLTS
1N962	11.0
1N759	12.0
1N963	12.0
1N4107*	13.0
1N4108*	14.0
1N965, 1N4109*	15.0
1N4110*	16.0
1N1111*	17.0
1N4112*	18.0
1N4113*	19.0
1N4114*	20.0
1N4117*	25.0
1N4120*	30.0

*250 milliwatts, all others are 400 milliwatts

There are many other in-between Zener voltages available. Check the catalog of the parts house you buy from.



PARTS LIST FOR BROWN-OUT ALARM

C1—.05-uF, ceramic capacitor
D1—Zener diode—see text and table
Q1—2N4891 uni-junction transistor
R1—100,000-ohm, linear-taper potentiometer
R2—10,000-ohm, ¼-watt, 5% resistor
R3—180-ohm, 1-watt, 10% resistor
SPKR1—8-10-ohm, 2-3-in. diameter loudspeaker

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