48784

JULY 1989

Popular Electronics

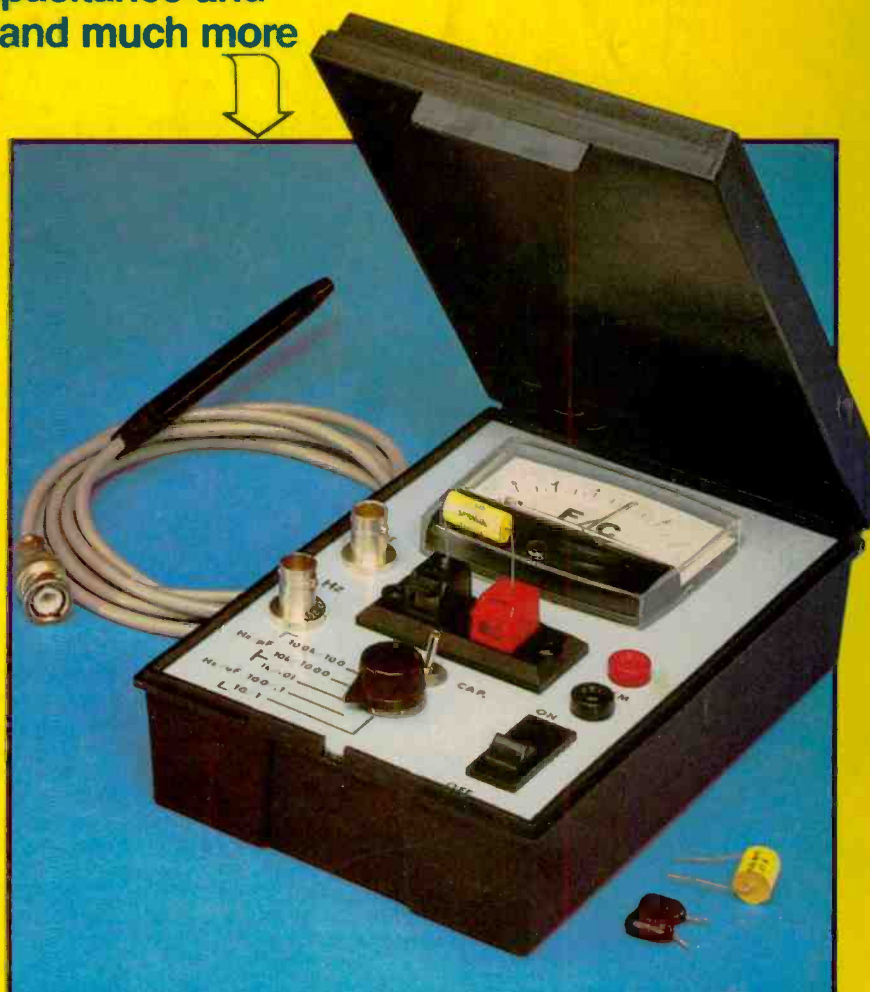
COMBINED WITH Hands-on Electronics

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

THE GADGETEER'S GIZMO BUYER'S GUIDE

The Parts Connection
Pick the right parts for your next construction project, and discover where you can buy them!

The F/C Meter
Use this project to measure capacitance and frequency, as a signal source, and much more



Simple Active Antenna
It really pulls in those hard-to-get AM broadcast-band and SW signals

The EIA Digital Microprocessor Course
A learn-by-doing approach to digital electronics

Big Digit Display
Build a display that really stands out

Wein-Bridge Oscillator
Accurate sinewaves for your next experiment

The Whistler Receiver
Explore the mysteries of Very-Low-Frequency radio

Circuit Circus
A potpourri of build-it-yourself battery chargers

3 NEW FactCards IN THIS ISSUE

$2.50 U.S.
$2.95 CANADA

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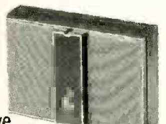
Spring Specials from Heath

Kit projects...

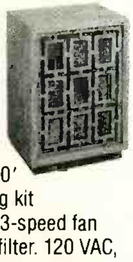
Heathkit Flood Alarm detects unwanted water Avert damage from leaking water pipes or basement wall seepage. Three hours to build. Needs 9V battery. 1¾" H x 3⅝" W x 4⅞" L. Kit GD-1701 (2 lbs.) .. **$12.95**



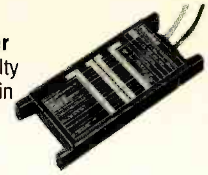
Program your doorbell with a favorite tune Arrange wire leads on one-octave keyboard inside doorbell to program any tune. Includes songbook with 50 + college, seasonal, Christmas and special occasion songs. Back door button activates a part-tune. Volume, tone, speed and delay adjustable. Two-evening kit. Takes standard 16 VAC, 50/60 Hz bell transformer.
Kit TD-1089 (3 lbs.) **$32.95**

Build your own Heathkit draft detector
Easily detect heat loss areas. Turn it on, adjust for silence, then move sensor in areas where heating or cooling losses occur. Temperature changes set off beeping alarm and flashing LED. Used in temperatures from 59-95F. Takes a 9-volt battery (not included).
Kit NE-2112 (2 lbs.) **$14.95**

Heathkit Furnace Air Cleaner.
Works with heating or A/C system to reduce the effects of pollen, dust and cigarette smoke. Power supply mounts onto a cold air duct, and turns on collecting cell when blower is running. 1" collecting cells below directly replace original furnace filter. 120VAC also works with GD-2196 2" filters. Kit GD-3196 (9 lbs.) **$79.95**
Accessory filters 4 sizes available.
each **$74.95**



Heathkit Portable Air Cleaner.
Helps solve tough air-cleaning problems, removes dust, smoke, other pollutants from 6,000 cubic feet (25'x30' x 8' room). One-evening kit includes power supply, 3-speed fan control and assembled filter. 120 VAC, 60 Hz. Dimensions 26½" H x 17¼" W x 13½" D.
Kit GDS-1297 (59 lbs.) **$199.00**
Accessory: Replacement Charcoal Filter Assd. GDA-1297-2 (2 lbs.). **$9.95**



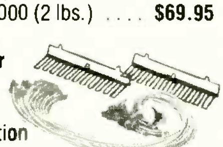
Charging system tester Diagnose faulty components in your car's charging system with accuracy and ease. A two-wire setup and three quick tests show you if the battery has sufficient charge to reliably start the engine, if the battery is being charged by the alternator, if the voltage regulator is faulty (causing the battery to become overcharged), or if the alternator stator windings and rectifier diodes are functioning properly. No external power or battery required. Dimensions are 5½" H x 2¾" W x ¾"D.
Kit CI-2065 (2 lbs.) **$19.95**

Noise generator kit To properly check out any stereo or sound system with a spectrum analyzer, you need a noise source with a nearly constant energy output. This one-evening Pink/White Noise Generator will do just that...and at a fraction of the cost of comparable noise generators.
Kit AD-1309 (2 lbs.) **$24.95**

For the electronic hobbyist...

Pocket-size digital meter for home and shop Compact digital meter includes 3½ digit, LCD display for readings up to 1999, audible continuity checker and diode test. Overload protected on all ranges, new transistor hFE test.
Assd. SM-2310 (1 lb.) Now only **$24.95**

Connector adapter kit Make 108 different coaxial connector adapters with gold-plated pins and Teflon insulation. Kit contains male and female, N, BNC, UHF, SMA TNC and mini UHF connectors. Special in-between fittings allow you to assemble your own adapters in seconds.
Assd. HCA-3000 (2 lbs.) **$69.95**



Coax adapter cables Solve frustrating coax connection problems with this convenient adapter cable assortment. Twenty cables in all help you make almost any connection. Two handy storage racks keep your cables neatly organized. 50 ohm impedance.
Assd. TPI-5000 (5 lbs.) . Now **$49.95**

Unbeatable Scanner Prices...

Uniden 10-Channel/10-Band Handheld Scanner. Save $31. Superportable, programmable, direct channel access, channel lockout, keyboard lock switch prevents accidental reprogramming. 55 dB @ + 25kHz selectivity; audio output 300 milliwatts maximum. Receive 29 to 512 MHz with a 15-channel-per-second scan speed. Requires 5, AA (not included) or rechargeable NiCd batteries.
Assd. BC-55X-LT (1 lb.) **$108.88**

100-Channel/11-Band Uniden Handheld scanner. Reduced $41. 100 programmable channels, 10 scanning banks, 11 bands of coverage. Automatic and manual search, weather search, 10 priority channels, squelch, lockout and delay. Selectivity is − 55 dB @ + 25kHz; audio output is 450mW maximum. Snap-on battery pack gives full-powered portable scanning.
Assd. BC-100X-LT (3 lbs.) .. **$188.88**

Uniden Tabletop Scanner. 11 bands of coverage, 5 or 15 channels-per-second scanning speed. Features automatic memory search, backup, priority, programmable lockout, scan speed control and automatic squelch setting. Selectivity − 45 dB @ + 25 kHz, audio output one watt at 10% THD. Takes 117 VAC, 60 Hz from an external wall outlet. Originally priced at $169.95.
Assd. BC-175X-L (3 lbs.) ... **$148.88**

100 Channel/11-Band Uniden Mobile scanner. Auto search aircraft, police, marine and emergency bands. Fully programmable. Fits neatly under dash, flip-down stand and telescopic antenna included. Audio output is 1.5 watts at 10% THD; require 13.8 VDC (vehicle battery or AC adapter).
Save $61 + .
Assd. BC-580X-LT (5 lbs.) .. **$198.88**

Deluxe Uniden Mobile Scanner. Save $81 + . 100-channel/12-band mobile scanner. Covers 800 MHz band for full 12-channel coverage. Weather search, priority, squelch, lockout, delay, auto and manual band search. Mount under dash, or AC adapter (included), flip-down stand and telescopic antenna. Takes 13.8 VDC.
Assd. BC-760X-LT (5 lbs.) .. **$248.88**

Make life easier...

Full-featured remote control center for your TV, VCR and CATV
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CIRCLE 14 ON FREE INFORMATION CARD

JULY 1989, VOLUME 6, NO. 7

Popular Electronics®

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

CONSTRUCTION ARTICLES

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HANDS-ON REPORTS

COLUMNS

DEPARTMENTS

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Editorial

RADAR, ITS STILL GROWING UP!

I was a radar instructor at the beginning of my electronics career. During those days, I had the opportunity to examine radar equipment used in World War II, the Korean war, and shortly after that. Back then, seeing radar equipment packed with octal radio tubes being replaced by transistor units was the ultimate in progress.

Of course, I eventually strayed to the consumer-electronics field and saw little of radar equipment until I assembled a Heathkit microwave oven in 1970, with its hefty (by today's standards) magnetron. Radar had made its transition to the world of consumer electronics, and its had an important place in it ever since. In our modern convenience-oriented society, a large percentage of households now use their microwave oven more often than their conventional stove. Think about all the radar detectors in private automobiles, and all of the state troopers with radar guns they are trying to outwit. Why, I even had my fast ball clocked at 78 miles per hour. *I'm* not ready for the big leagues, but it sure looks like radar has made it.

Just the other day I was reading some scientific papers on astronomy and discovered that radar is used to determine the precise distance to the planets, and even their surface characteristics and rotational speeds. In 1980, Comet Encke became the first comet to be detected by radar. In 1983, during Comet IRAS-Araki-Alcock's close passage to Earth (only 4.6 million kilometers away), radar was used to obtain crystal-clear radar images of that heavenly object. The diameter of the comet's nucleus was found to be between 5 and 16 kilometers, depending on whether the ice core is solid ice or loose slush. Also, radar determined that the nucleus rotates every 2 to 3 days and that the surface resembles that of a typical asteroid.

What else can radar do? Now that I'm becoming re-aquainted with my first professional association with electronics, I plan to find out. The only problem is that there must be quite a lot out there on the subject, with more being added every day. After all, radar is still growing up!

Julian Martin

Julian S. Martin, KA2GUN
Editor

Letters

SAFETY AND SAVINGS

I'm interested in those new microchip "buttons," which are used to conserve electricity by converting the power fed to light bulbs from AC to DC. They are supposed to be inserted between a light socket and the bulb, but just how safe are they? There's no problem if the microchip opens, but if it shorts and fails to trigger the breaker at the fuse, couldn't that start a fire within the fixture itself? To your knowledge, how safe can those rectifiers be?

E.E.B.
Middlesex, NJ

The "button" you refer to is a device that houses a diode that rectifies the current to the filament in the lamp bulb. Metal contacts on the button at the center of the circular faces contact the center terminals of the bulb and the lamp socket. Thus the diode is in series with the filament when the lamp is screwed in place. Polarity is unimportant, because it doesn't matter which half of the AC cycle is blocked. The bulb doesn't know the difference, so it doesn't matter. It receives only half the power and glows dimly. Power is saved. The lamp bulb will last much longer.

The button is constructed so that it cannot mechanically short out the socket and blow a fuse. Therefore, we have to contend with only two types of failures.

When the diode shorts out internally, it connects the bulb across the line so that it receives full power—the lamp will operate brightly. When the diode opens (open circuit), the bulb can receive no power whatsoever. The light cannot come on.

In either of those two cases, nothing happens to the fused line supply power to the lamp, so there's nothing to worry about.

FOND REMEMBRANCES

Keenan Whitley's article on the foxhole radio (**Popular Electronics**, March 1989) brought back memories of my schooldays in the U.K. in the 1920's, when the BBC was setting up broadcasting stations. I don't know if the same thing was happening in North America back then, but a lot of improvisation was being done by British schoolboys. Crystal receivers were just about within the financial reach of youngsters when galena crystals were obtainable for a sixpence (roughly equivalent to a nickel then), and you could get a silver "catwhisker" for about a dime.

As the article says, components were hard to come by, but I remember when Woolworth's sold component parts for variable "condensers." The plates were semicircular and, I believe, cost about 3 for a dime (fixed or moving versions); endplates, shafts, and knobs sold at similar prices. I think a 500-pF unit could be made up for about a dollar.

Enamelled wire hadn't arrived yet. The usual type was single or double cotton covered (SCC or DCC), and if you were wealthy you could get the superior silk-covered version.

Tin foil was the normal wrapping for cigarettes, not chocolate, and it was possible to make up capacitors by interleaving paper and foil. It was quite easy to make connections to tin, which didn't suffer from an insulating layer of oxide as with aluminum. It was even possible to organize things to give some sort of variable capacitor by arranging the "plates" to be pulled out to reduce the meshing area—but pushing them back in again presented problems!

Incidentally, I remember on one occasion making insulated wire for a coil by a loose coil of bare wire in shellac varnish, letting it dry, and repeating the process two or three times. Eventually, the coil was wound on a toilet-tissue roll, and a contact strip for a slider was made along the lines of the method described in the article.

It was all good fun, and looking back, I think we must have been very successful in our efforts. When living in Ireland, we could occasionally get useful reception from a very low power transmitter in Belfast (which was about 50 miles away) using the then-recommended 30-foot-long and (if possible) 30-foot-high L antenna. We don't know how easy we have it nowadays.

J.N.M.L.
Glovertown, Canada

CASSETTE-RECORDER SLOW-DOWN

I recently purchased a copy of your magazine at the airport and read it cover to cover. I found it informative and helpful for a novice like myself, and now I'm a subscriber.

I'm writing to ask one of those "How do dey do dat?" questions (you must get many), in the hope that you or one of your readers can help.

I have seen ads in various magazines for *modified* cassette recorders that run 600% slower than normal speed. That allows six hours of recording time on one side of a C-*120* cassette. I tried contacting the manufacturer, but the people I spoke to were of little help. I've tried a rheostat in parallel with the motor, and a separate circuit, which was supposed to be a speed controller, spliced into the motor lead. Both had very unsatisfying results.

Various people have told me that I should "change transistors in the circuit board," "use a different motor," or "slow it down using different pulleys and gears." I need to know which method really does work, exactly how to do it, and where to get the proper parts. (I'm not concerned with recording music, just lectures, etc.)

Any assistance you or your readers might be able to offer will be greatly appreciated.

Carl Skowronski
2015 N. Clinton
Saginaw, MI 48602

Anyone who has any info is invited to write to Carl directly.

STEP ON THE BRAKES!

In the March 1989 issue of **Popular Electronics** there was an article entitled "Flashing Brake Light."

A third brake light should activate *only when the brake pedal is pressed*! It should *never* be connected to lamps that are also used as turn signals. If connected to lamps that are used for both brakes and turn signals, diodes D4 and D5 would allow the third brake light to operate whenever either turn signal, the brakes, the 4-way flashers, or any combination of those, were active.

That OR-gate problem wouldn't be corrected by an AND gate. An AND gate would only work properly when the brake pedal was pressed and the turn signals weren't on.

The only solution is to connect this, or any, third brake-light circuit to a lamp that is used only for brakes. Better yet, to avoid conflict with the 4-way flashers, connect it directly to the brake-pedal switch.

F.J.B.
Omaha, NE

BRAKE-LIGHT KUDOS

Thanks for your article, "Flashing Brake Light," in the March issue. I built two units, and they are much enjoyed. The cars are German, with separate circuits for brake lights and turn signals, so D4 and D5 weren't required.

G.W.N.
Ada, OH

HAVES AND NEEDS

At a garage sale, I purchased a Microvox Stringy Floppy Wafer Drive. It is a TRS-80 computer add-on (model 20-202) that uses a small plug-in cassette-like device, which is stamped "EXATON."

No paper work was included with the device, and I'd greatly appreciate any information on it. Can the cassettes be purchased anywhere?

F.C.C. Tom Morrison
U.S.S. Hoel DDG-13
F.P.O. San Francisco 96667-1243

I have a Cossor Model 4100 British-made oscilloscope that needs servicing—so I need a service manual. Can anyone help me obtain a copy, or some leads as to where I can get one? I'm willing to pay any reasonable price.

Ed McLaughlin
1430 Shawsheen St.
Tewksbury, MA 01876

I recently acquired two 8086-based computers built by the now-defunct Lazor Systems Inc., Sunnyvale, CA. One is a desk-sized unit with a 20MB, 14-inch hard disk, and the other is a large box with no hard disk. I have no software or documentation for them. I'd very much like to acquire an operating system called MLX, as well as system documentation and spare boards (especially memory boards). Do any **Popular Electronics** readers have those things, or know where I could find them?

Richard Rinehart
26201 200th Ave. S.E.
Kent, WA 98052

I'd like to ask my fellow readers of your great magazine if they can help me locate a source for a rubber intermediate drive wheel for a Garrard *AT 60* turntable.

Fred T. Strauss
574 Hickory Street
Township of Washington
New Jersey, 07675

A CASE OF MISTAKEN IDENTITY

As a consumer, I always want the latest issue of **Popular Electronics** to be the best, but the March 1989 issue didn't live up to those expectations. That month's "Scanner Scene" describes a *Uniden Bearcat 9500XLT* scanner, but the picture accompanying the article is actually a *Uniden Bearcat 760XLT*, which is the model that I own. And in several places the *9500XLT* is referred to as a *950XLT*. Obviously, someone wasn't paying attention.

J.E.D.
Sapulpa, OK

Actually, it seems that this one caused everyone problems. First of all, the unit is actually a 950XLT. A typographical error in the first paragraph of the report was replicated when the caption was written. And the photograph that accompanies the article does indeed picture a 760XLT. It was what was sent by the manufacturer in response to a request for a photograph of the 950XLT; unfortunately no one noticed the discrepency until it was too late. ■

Electronics Library

To obtain additional information on the books and publications covered in this section from the publisher, please circle the item's code number on the Free Information Card

AUDIO CONTROL HANDBOOK For Radio and Television Broadcasting: Sixth Edition

by Robert S. Oringel

If you're in the broadcasting field, or interested in entering it, you'll want to take advantage of Robert Oringel's years of practical experience, as presented in this reference work. While the sixth edition follows the same format as its predecessors, the text has been completely revised to reflect changes in modern broadcasting.

Written from a professional's prospective, this is a hands-on guidebook, rather than a theoretical discourse, on the technical fundamentals of radio and television broadcasting. In non-technical language, accompanied by plenty of photographs and drawings, the book is a practical introduction to standard audio equipment—including control boards, analog and digital signal processors, microphones, CD players, turntables, and tape recorders—and how that equipment can be used most effectively. The book also explores the non-technical facets of a broadcasting career, discussing trade unions, the FCC, and the other members of the broadcast team.

The Audio Control Handbook for Radio and Television Broadcasting: Sixth Edition is available for $24.95 from Focal Press, 80 Montvale Avenue, Stoneham, MA 02180.

CIRCLE 101 ON FREE INFORMATION CARD

WORDSTAR INSTANT REFERENCE

by David J. Clark

This pocket-sized reference guide provides extensive coverage and the essential details needed by WordStar users. It provides quick answers to reader's problems, clear examples, valuable insights, and handy reminders of key sequences and syntax. The visually organized text features bold, alphabetically arranged headings that make it easy to find each general subject, and subheadings for key sequences, options, and notes so that readers can go right to the answer without wading through pages of text.

The book is divided into two sections. An overview of the WordStar menu is followed by an alphabetical reference of each command, menu, and feature in WordStar 4 and 5. For all WordStar features, the book offers pull-down menus or dot commands, exact keystroke sequences, a list of available options, and discussions of those options. The appendix includes instructions for installing and customizing the program.

WordStar Instant Reference is available for $12.95 from Sybex Inc., 2021 Challenger Drive, Number 100, Alameda, CA 94501.

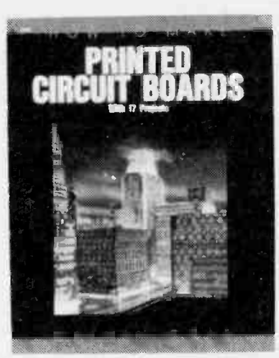
CIRCLE 102 ON FREE INFORMATION CARD

HOW TO MAKE PRINTED CIRCUIT BOARDS: With 17 Projects

by Calvin Graf

Using printed circuit boards gives a more professional look to electronics projects; it also eases component mounting, increases circuit durability, decreases the chance of crowding that can result in overheating and shorts, and makes troubleshooting easier. This book offers clear explanations, in non-technical language, of how to make your own PC boards.

Everything needed to get from schematic drawing to a printed-circuit board is included.



For beginners, or anyone requiring a refresher course, the book explains the general principles of electronics construction, electronic theory, components, diagrams, tools, and soldering. Various types of circuit boards and wiring are discussed, including point-to-point and printed wiring. Design and layout are covered, with details on inking and taping techniques, etching, drilling, mounting, soldering, testing, and troubleshooting the finished board.

The book gives detailed information on commercially available electronic-project kits, including the names and addresses of companies, approximate costs, and how to order the easy-to-build kits. The 17 practical, do-it-yourself projects feature circuit diagrams, parts lists, and detailed explanations of circuit operation. Specific details about parts layout and construction methods are deliberately omitted, allowing the reader to try out his new-learned knowledge and skills. Some of the projects are a headlight reminder, a visual telephone ringer, an ultrasonic transmitter and receiver, and a light-sensor alarm.

How To Make Printed Circuit Boards: With 17 Projects is available for $15.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

SYNTHESIZERS FOR MUSICIANS

by R.A. Penfold

For musicians who don't have degrees in electronic engineering, but want to get the most from their synthesizers and samplers, this book explains today's popular forms of synthesis and takes readers beyond using trial-and-error and the factory pre-sets.

The fundamentals of modern synthesis are covered in non-technical language with concrete examples of how they are actually used—Casio's treatment of phase distortion, Yamaha's frequency modulation, linear arithmetic, and sampling. The book goes on to describe how the instruments are adjusted to create different types of musical sounds, including strings, brass, and percussion. In short, discussion of theory is limited to what the musician needs to know to effectively use a synthesizer or sampler. That includes the make-up of various sounds, all the major methods of sound synthesis, and how to actually use that information to produce the desired sounds. A glossary is included.

Synthesizers for Musicians (Order No. PCP106) is available for $11.95, including shipping, from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

DATA COMMUNICATIONS TESTING AND TROUBLESHOOTING

by Gilbert Held

This book provides practical, working information on testing and troubleshooting data-communications equipment, for communications technicians, engineers, or analysts. The book covers the operation of test instruments that are commonly used in data-communications networks, including cable analyzers, breakout boxes, bit error-rate testers, block error-rate testers, modem test sets, error three-second testers, protocol analyzers, and line monitors.

Also covered are the fundamentals of line measurements and data-channel parameters, RS-232 digital interfaces, and methods of analog and digital testing. The principles of diagnostic testing are explained, and the book describes the use of built-in communications-hardware testing features. Traffic engineering and capacity planning are also discussed.

Data Communications Testing and Troubleshooting is available for $29.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

A CONCISE INTRODUCTION TO OS/2

by N. Kantaris

This book is designed to help multi-tasking PC users learn to use the OS/2 operating system. Written for the non-expert user, information is presented in the order that it is most likely to be needed. It can also serve as a convenient reference source, in which the experienced user can easily locate the answers to specific questions.

The book describes the structure of OS/2, explaining what happens from when the computer is first turned on. It explains how to use OS/2 commands for "house-keeping" operations on disk files; to organize directories and subdirectories to maximize efficiency; and to write CONFIG.SYS, STARTUP.CMD, and AUTOEXEC.BAT files to automate system operations.

A Concise Introduction to OS/2 (Order No. BP260) is available for $7.95 (including shipping) from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

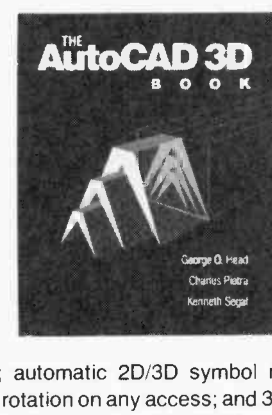
CIRCLE 97 ON FREE INFORMATION CARD

THE AUTOCAD 3D BOOK

by George O. Head, Charles A. Pietra, and Kenneth J.L. Segal

Aimed at engineers, architects, and draftsmen—and students just beginning to discover applications for 3-coordinate work—this book provides complete information on the powerful new 3-dimensional capabilities of AutoCAD's Release 10. It offers practical advice on all 3D commands, from basic to advanced; AutoCAD's User Coordinate System; 3D surfaces and meshes, and AutoSHADE, AutoSOLID, and third-party 3D products. An entire chapter is devoted to exploring the ways in which many traditional AutoCAD commands behave differently in 3D. Dozens of time-saving tips and tricks are presented, to ease the transition to 3D.

Included in the book is a library of AutoLISP programs that readers can enter directly into their computers. The programs—including automatic perspective, snap, and



zoom; automatic 2D/3D symbol replacement; rotation on any access; and 3D curve and helix generation—are all intended to make AutoCAD 3D work faster and more effectively.

The AutoCAD 3D Book is available for 29.95 ($79.95, including diskette) from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27514.

CIRCLE 104 ON FREE INFORMATION CARD

CIRCLE 16 ON FREE INFORMATION CARD

1989 CATALOG

MFJ Enterprises, Inc.

This 16-page amateur-radio catalog features more than 80 accessories, such as antenna tuners, multi-mode data controllers, and an artificial RF ground. Ten new products are presented—including a world-time clock, a lightning-protected antenna switcher, and speaker/mics. MFJ's full line of keyers, filters, packet-radio controllers, computer interfaces, ham software, and other accessories are also represented.

The 1989 Catalog is free upon request from MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; Tel. 800-323-5869.

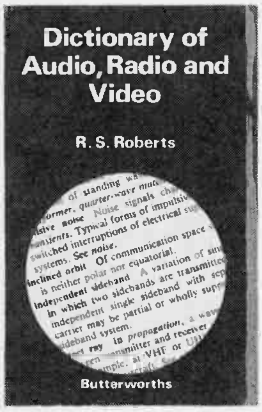
CIRCLE 106 ON FREE INFORMATION CARD

MAKE MONEY FROM HOME RECORDING

by Clive Brooks

This book offers practical ways for recording enthusiasts and musicians to recoup some of the money they spend on recording equipment. There are money-making ideas presented for those with complete MIDI-equipped studios, and for those with more enthusiasm than recording gear.

The book describes how to set up a studio—the equipment needed, soundproofing, wiring, and maintenance—before exploring various ways to use it profitably. Those include cassette copying, location recording, DJ operations, and music-teaching cassettes. Information is included on pricing, marketing, publicity, and money management; a separate chapter covers how to rent a stu-



dio to others. Addresses of manufacturers and magazines, both in the U.S. and the U.K., are included.

Make Money From Home Recording (Order No. PCP106) is available for $11.95, including shipping, from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

MICROPROCESSOR TECHNOLOGY: Theory and Experimentation

by Fredrick W. Hughes

To help the beginner grasp the often-confusing basic concepts and terminology that apply to all microprocessor systems, this book can be used as a self-study course. Its workbook-style format contains clear writing, plentiful illustrations, skill-developing exercises, and self-quizzes to reinforce the learning process. The book also contains BASCOM, a pull-out visual aid designed to help the reader understand data flow in a *BAS*ic *COM*puter as applied to the fundamental machine-language instructions used.

All the information presented is directly related to fundamental microprocessor operations. The book describes microcomputers' major components, and their functions and operating theory; demonstrates how a computer programming step is performed through the orderly sequence of data flow; and teaches readers to perform decimal, binary, and hexadecimal number-system conversions and to calculate signed numbers and 2's-complement arithmetic. It defines various addressing modes used in programming, and shows how to write and debug a simple program. It explains how to identify microcomputer hardware and to determine the correct I/O devices and interfacing techniques to use. The basic concepts of data communication and types of data-transmission systems are explored. Microcomputer troubleshooting tips are also included.

Microprocessor Technology: Theory and Experimentation is available for $30.00 from Prentice Hall, Englewood Cliffs, NJ 07632.

CIRCLE 99 ON FREE INFORMATION CARD

TEST EQUIPMENT CONSTRUCTION

by R.A. Penfold

Simple and inexpensive designs for useful pieces of test equipment are provided in this book. Most are designed to fill the gaps between major pieces of test equipment, and for checking both analog and digital circuits. Although geared for those with some experience, many of the projects are still within the scope of novices. Designs are included for an AF generator; a test-bench amplifier; an audio millivoltmeter; a high-resistance voltmeter; a transistor tester; capacitance and AF-frequency meters; and TTL, CMOS, and analog probes. Circuit diagrams and parts lists are included for all projects.

Test Equipment Construction (Order No. BP248) is available for $7.95 (including shipping) from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

THE NEW ELECTRONIC MEDIA: Innovations in Video Technologies

by Hoyt R. Hilsman

The telecommunications field has grown in leaps and bounds over the past ten years, so quickly that it's difficult to keep up-to-date. This book provides a broad overview of what changes the last decade has seen—but, more important, it puts those events into their historical context. It deciphers past and current developments, and predicts future trends in the industry and the effect that those trends will have on consumers.

The book covers video communications in the home, including VCR's and satellite television; the impact of personal computers on video technology; the rise of cable television; interactive video and CD-I; videotex and teletext, and the home-video industry. It thoroughly examines the development of video, from simple television sets to the complex video systems of the future.

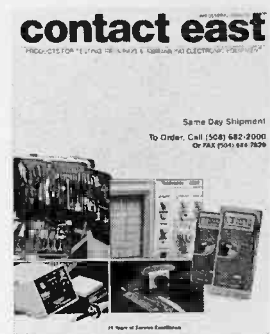
The New Electronic Media: Innovations in Video Technologies is available for $14.95 from Focal Press, 80 Montvale Ave., Stoneham, MA 02180.

CIRCLE 110 ON FREE INFORMATION CARD

HOW TO KEEP YOUR VCR ALIVE: VCR Repair for the Total Klutz

by Steve Thomas, Ph.D. M.I.T

This simple do-it-yourself book is designed to teach anyone how to repair most VCR problems quickly, easily, and inexpensively. Although many VCR repairs involve basic tasks like cleaning or replacing a belt, professional repair jobs are usually expensive—and much of the fee is for labor costs. To enable owners to do their own repairs, this manual, written specifically for the non-



technical amateur, provides complete, step-by-step procedures for VCR repairs. The book covers how to diagnose the problem, where to find the needed parts and supplies, and how to do the actual repair work with only a few simple hand tools and inexpensive parts. Clearly written and abundantly illustrated, it covers all brands of VCR's and comes with a professional head-cleaning stick.

How to Keep Your VCR Alive: VCR Repair for the Total Klutz is available for $24.95 from Worthington Publishing Company, 6907-202C Halifax River Drive, Tampa, FL 33617.

CIRCLE 109 ON FREE INFORMATION CARD

DICTIONARY OF AUDIO, RADIO AND VIDEO

by R.S. Roberts

As with all specialized fields, audio, video, and radio engineering have their own vocabularies; as with all rapidly developing technologies, those vocabularies are constantly growing and changing. This reference is designed to help engineers and technicians keep pace.

The book goes beyond simple definitions

(Continued on page 12)

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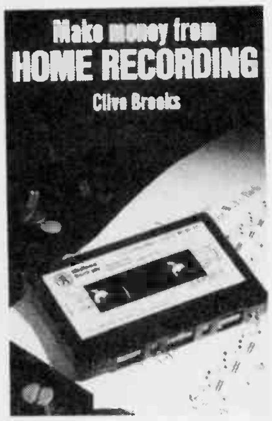
Electronics Library

(Continued from page 8)

of terms. It also provides in-depth explanations of concepts, bolstered by illustrations and extensive cross-references. Appendices cover common acronyms and abbre-



viations (many of which have virtually replaced the original phrases in common usage), radio-frequency allocations, and band descriptions.

Dictionary of Audio, Radio, and Video is available in hardcover for $47.50 from Focal Press, 80 Montvale Ave., Stoneham, MA 02180.

CIRCLE 107 ON FREE INFORMATION CARD

BASIC ELECTRONICS THEORY: Third Edition

by Delton T. Horn

Being both an introductory text for beginners, and a handy reference source for experienced technicians, this comprehensive book could serve as a course in basic electronics theory. It is written in plain English, with plenty of clear illustrations. For self-study, each chapter includes review questions, and 35 sample experiments are provided.

The third edition has been updated and expanded. New chapters have been added on the fundamentals of electronics, Kirchoff's laws (including two techniques for circuit analysis), reading circuit diagrams, project-construction techniques, microprocessors, and amplifiers. There is also increased coverage of motors and superconductivity.

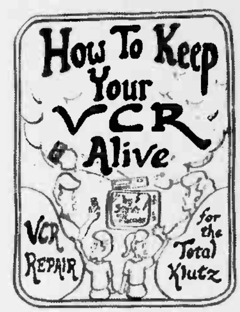
Basic Electronics Theory: Third Edition is available for $21.95 in paperback, and $28.95 in hardcover, from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

1989 GENERAL CATALOG

Contact East

This source book, aimed at engineers, managers, and technicians, features products for testing, repairing, and assembling electronic equipment. Many new products are featured in its 132 pages, including analog/digital oscilloscopes, static-protection products, precision hand tools, soldering stations and supplies, test equipment, and tool



kits. The lines of voice/data-communications test instruments, wire and cable aids, electronic adhesives, and inspection equipment have all been expanded. The product's descriptions include specifications, prices, and color photos.

The 1989 General Catalog (along with one year of technical supplements) is available at no charge, by writing to Contact East, P.O. Box 786, 335 Willow St. So., North Andover, MA 01845.

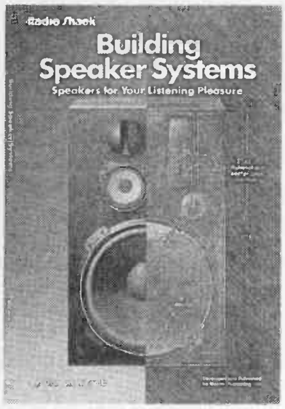
CIRCLE 108 ON FREE INFORMATION CARD

"I'm sorry, Mrs. Young, your son has a computer virus."

BUILDING SPEAKER SYSTEMS: Speakers for your Listening Pleasure

by Gordon McComb

Speakers that look and sound good can be very expensive. And overly complicated specifications and enclosure design make it hard to know just what you're paying for. This book addresses both of those problems, showing readers how to build their own high-quality, inexpensive speaker systems from scratch. It covers everything from selecting the components to wiring and placing the finished products. Complete construction plans for 4 speaker systems are included, with easy-to-understand text and illustrations, specifications, and parts lists.



The book explains the dynamics of speakers, and the various types of enclosures. It defines speaker terms, and discusses the characteristics that effect performance. For audiophiles, the appendixes contain detailed design equations and tables.

Building Speaker Systems: Speakers for Your Listening Pleasure is published by Master Publishing, Inc., 14 Canyon Creek Village, MS 31, Richardson, TX 75080. It is available for $5.95 at local Radio Shack stores.

CIRCLE 105 ON FREE INFORMATION CARD

DESK REFERENCE OF SURFACE MOUNT TECHNOLOGY: Volume One, 1989

IPAC Co.

From the publishers of *SMT Nutshell News* (a free monthly newsletter on surface mounting and related industries), this 128-page, spiral-bound manual provides an easy guide to suppliers of surface-mount and tape-automated bonding equipment, materials, components, products, and services. It is divided into 24 product categories, each containing a listing of companies that supply that product. A sampling of the categories includes adhesives and coatings, reports and studies, software, circuit boards and substrates, components, soldering equipment, and consultants. Each of the over 1600 listings include the company name, address, and phone and fax numbers, along with a product and service description and the name of a technical contact.

Desk Reference of Surface Mount Technology: Volume One, 1989 is available for $45.00 from Lion Publishing, Box 1869, Los Gatos, CA 95031. ■

CIRCLE 103 ON FREE INFORMATION CARD

"As your counselor Tom, I think that a career in microelectronics isn't for you."

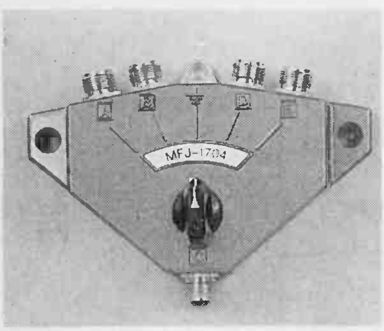
CIRCLE 11 ON FREE INFORMATION CARD

New Products

To obtain additional information on new products covered in this section from the manufacturer, please circle the item's code number on the Free Information Card

ANTENNA SWITCH

MFJ's 4-position coaxial antenna switch (model *MFJ-1704*) offers the convenience of instantly selecting between four antennas, along with built-in lightning protection with a replaceable protector cartridge. The 50-ohm switch handles 2.5-KW PEP, 1-KW CW, with very low SWR. The solidly built device features cavity construction and metal-strip leads that prevent chaffing and



shorting problems common to wire leads. Unused positions are automatically grounded, or you can choose the center-ground position.

The MFJ-1704 antenna switch costs $59.95. For further information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; for orders call 1-800-647-1800.

CIRCLE 74 ON FREE INFORMATION CARD

DESKTOP FAX MACHINE

Northwestern Bell's Faxline is a compact desktop facsmile machine with a built-in feature phone and 100-number speed-dialing capability. While easy to use, it has all the features needed in today's workplace. The unit weights just 11 pounds and measures 11.7 × 11.4 × 3.91 inches.

Faxline is G2- and G3-compatible, transmitting at 2 minutes per page in G2 and at 17 seconds per page in G3. If the machine at the receiving end can't handle the higher speed, the unit's "auto-step-down" feature slows the speed to an acceptable level. Its automatic feed function accepts up to five pages at a time.

The machine has automatic line switching, which allows the user to talk to a sender immediately after receiving a fax message. The call-reservation feature lets the FaxLine owner initiate a conversation with the fax-receiving party.

Faxline's full-feature telephone can store 10 one-touch and 40 two-touch speed-dial numbers in memory. It offers on-hook dialing, hold, last-number redial, an adjustable-tone ringer, and tone/pulse capability. In case of a power outage, the phone has a built-in battery back-up memory.

A large LCD display shows the function, name, number, and facsimile-transmission status (up to 40 characters). That data can

be displayed for the last-sent transmission as well. A comprehensive transaction record, covering the last 40 transmissions sent, can be printed out.

The FaxLine, including a roll of thermal paper, a modular line cord, instruction manual, and a limited one-year warranty, has a suggested retail price of $2099.00. For more informaiton, contact Northwestern Bell Phones, 9394 West Dodge Road, Suite 100, Omaha, NE 68114.

CIRCLE 77 ON FREE INFORMATION CARD

CORDLESS STEREOPHONES

Koss' JCK/300 Kordless Stereophone System combines a high-power transmitter with a high-quality stereophone. The system can be connected to a receiver, tape deck, VCR, TV set, or any other system component.

The transmitter comprises two components—an infrared emitter panel and a modulator base—offers a coverage area of over 500 square feet. (For increased coverage, extra panels can be added.) The emitter panel's 30 LED's send out an infrared signal that is received by the onmidirectional diode located on the stereophone. The panel can be placed directly on the modulator base or connected with the 10-foot extension cord. The variable level control

on the modulator base adjusts the input-signal level to ensure correct modulation. The battery-operated stereophones feature a dual-knob volume control for individual right and left control.

The JCK/300 Kordless Stereophone System, including RCA inputs and stereo-connecting cords, headphone-jack adaptor, and microphone input, has a suggested list price of $275.00. For additional information, contact Koss Corporation, 4129 North Port Washington Avenue, Milwaukee, WI 53212.

CIRCLE 75 ON FREE INFORMATION CARD

CHESS COMPUTER

Saitek's Kasparov Conquistador (endorsed by the current world chess champion, Garry Kasparov) features a sensor board that automatically registers moves, and displays the moves on three colored LED's—green for playing, red for taking back moves, and orange for verifying positions. The time used by each side is displayed on two chess clocks.

The Conquistador offers 17 levels of play, keeping pace as your game improves. Its

12-MHz, 16K microprocessor plays a strong enough game to match most club players, and over 90% of all players, even beginners. There are 8 casual levels, 4 tournament levels, and 5 special levels—including speed chess, blitz chess, and problem solving up to mate in ten. The unit also acts as a coach, offering tactical and strategic advice on the best moves and on how to avoid mistakes.

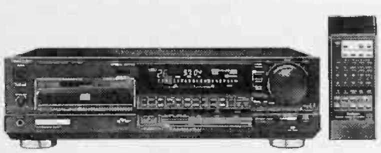
The Kasparov Conquistador, complete with a 190-page instruction/tutorial book and one-year guarantee, retails for $199.00. For more information, contact Saitek Industries Ltd., 2301 West 205th St., Suite 108, Torrance, CA 90501.

CIRCLE 76 ON FREE INFORMATION CARD

CD PLAYER

Technics' SL-P999 compact-disc player incorporates linear 20-bit, 8-times oversampling, 4-DAC signal-processing technology. Two separate digital-to-analog converters are used for each channel—one for the positive and negative sides of each signal—to eliminate zero-cross distortion. The digital filter provides excellent low-level signal reproduction and minimizes computational inaccuracies.

For user convenience, the SL-P999 features Peak Level Search and Edit Guide for easily transferring materials from CD to other formats. The Peak Level Search allows the user to set precise recording levels and to maximize dynamic range. With the Edit Guide, the user selects a standard tape length and the unit automatically calculates which songs on the CD will best fit on each side of the tape. Other features include random play, in which the unit selects the order of play, and program mode, in which track-order selection is up to the user. A 43-key remote can be used to operate most of the player's functions.



The SL-P999 CD player has a suggested retail price of 599.95. For more information, contact Technics, One Panasonic Way, Secaucus, NJ 07094.

CIRCLE 78 ON FREE INFORMATION CARD

ELECTRONIC KEYBOARD

Casio's SK-2 is a "sampling" 32 mini-key, four-note polyphonic keyboard with two built-in speakers. With five PCM-sampled preset instrument sounds and six PCM auto rhythms, the SK-2 allows the user to record a "sample" of any sound. The sound—anything from a rain drop to a popping balloon—can then be stored for future playback. A "parrot" function repeats the sampled sound after it's been recorded. With real-time memory, the unit has a 496-note storage capacity. The musical keyboard comes with a demo tune and batteries. An optional AC adaptor is available separately.

The SK-2 electronic musical keyboard has a suggested retail price of $99.95. For further information, contact Casio, Inc., 570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801.

CIRCLE 79 ON FREE INFORMATION CARD

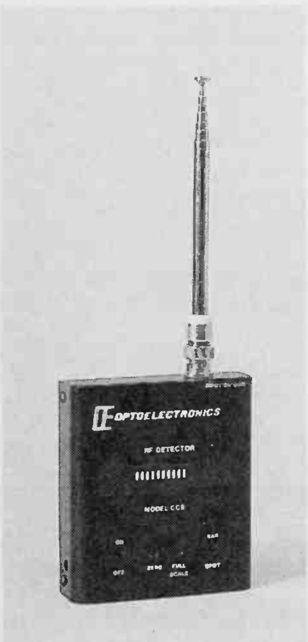
"BUG" DETECTOR

Optoelectronics' Model CCB RF Detector is designed to detect and locate low-power radio transmitters, or "bugs," that have been hidden for the purpose of eavesdropping.

The CCB will indicate the presence of a 1mW transmitter within a 20-foot distance. As the distance to the transmitter decreases, segments on the the unit's bargraph display will successively light up, making it easy to locate unauthorized transmitters.

The CCB can also be used to check the output from small or large transmitters used in radio telemetry; in two-way, ham, CB, marine, aircraft, police, or fire radios; or in appliances such as garage-door openers or cordless and cellular phones.

The handheld RF detector, with 10-stage bar-graph LED readout, has a 2-stage wideband RF amplifier. Its detector



is a forward-biased, hot-carrier diode. The detector's output is filtered and fed to the log-output bar-graph driver circuit; each segment responds to a 3-dB step increase in signal strength. Optional accessories include the Model *TA-100S* telescoping BNC antenna and the *CC-12* vinyl carrying case.

The Model CCB RF detector costs $99.95; the antenna costs $12.00 and the case costs $10.00. For more information, contact Optoelectronics, Inc., 5821 N.E. 14th Avenue, Fort Lauderdale, FL 33334; Tel. 800-327-5981 (305-771-2051 in Florida).

CIRCLE 80 ON FREE INFORMATION CARD

KEYPAD REMOTE CONTROL

Pioneer's CD-M1 is a keypad multi-play CD controller that's designed for use with head units that offer DIN-type AUX-input connection. Using the CD-M1 makes it possible to step up to the convenience of a CD changer without revamping the entire automotive sound system. The keypad is used to operate a trunk-mounted changer, without a separate, dash-mounted control.

The wired keypad controller allows programming of up to 32 tracks on as many as 16 different magazines. When used with Pioneer's CDX-3 component CD player, the unit accesses the changer's "Automatic Magazine Program Selection" memory, for

a total of 512 preset CD selections. The keypad controls audible forward/reverse scan setting, track scan or search, random play or program play, and music repeat functions—all at the driver's fingertips.

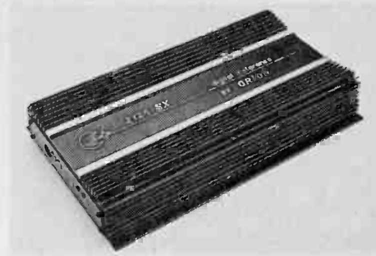
The CD-M1 wired keypad CD controller has a suggested retail price of $120.00. For more information, contact Pioneer Electronics (USA) Inc., 2265 E. 220th St., P.O. Box 1720, Long Beach, CA 90801-1720.

CIRCLE 81 ON FREE INFORMATION CARD

AUTOMOTIVE POWER AMPS

Orion's SX Series of high-power amplifiers for car-audio applications includes the 125-watt-per-channel *2125 SX* (pictured) and the 50-watt-per-channel *250 SX*. The amplifiers offer users a choice of three operating modes—"Normal Stereo;" "Mixed Mono," for driving stereo satellite speakers and a mono subwoofer; and "Summed Mono," for driving subwoofers alone—for optimal performance with the particular system.

The Model 2125 SX is rated at 125 watts per channel into 4 ohms at 0.03% THD,



and can drive 250 watts per channel into 2 ohms with complete stability. In bridged mode, it delivers 500 watts mono into a 4-ohm load. The Model 250 SX is rated at 50 watts per channel into 4 ohms, 100 watts per channel into 2 ohms, and 220 watts total (4 ohms, mono).

Both amps have frequency contouring, which compensates for response aberrations typical in automobiles. Special circuitry protects against overheating, low supply voltage, and excessive current. Separate left- and right-channel peak LED's indicate clipping.

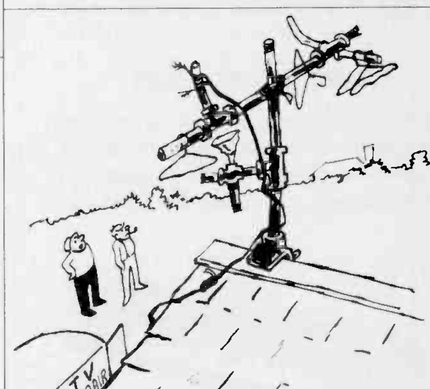
The Models 2125 SX and 250 SX are priced at $649.00 and $409.00, respectively. For further information, contact Orion Industries, 118 W. Julie Drive, Tempe, AZ 85283.

CIRCLE 82 ON FREE INFORMATION CARD

MID-SIZE STEREOPHONE

Audio-Technica's SG600CD combines the lightweight advantages of a mini-stereophone with the wider dynamic range associated with heavier, around-the-ear models. Weighing less than 3 ounces, the SG600CD is recommended for use with portable CD players.

The stereophones' diaphragm assembly responds quickly to high-frequency transients. A comfortable ear seal lets in less outside sound while maintaining a closed cavity for optimum low-frequency sound performance. Its 72-inch long cord ends in a mini-plug, and a standard 1/4-inch phone-



"I don't think the problem is in your set"

plug adaptor is included. The unit has a frequency range of 20 – 20,000 Hz, matching impedance of 4 – 16 ohms, and sensitivity at 1-kHz/1mW of 89 dB.

The SC600CD mid-size stereophone has a suggested retail price of $39.95. For additional information, contact Audio-Technica U.S., Inc., 1221 Commerce Drive, Stow, OH 44224.

CIRCLE 83 ON FREE INFORMATION CARD

AC POWER SOURCE

The *Model WP-29A Iso-V-AC* from *Kappa/Viz* provides isolated-output AC voltage that is adjustable from 0 – 150 volts with maximum current of 2.25 amps. Input-line voltage can be checked on the unit's analog meter, and push-button switching provides output monitoring of AC volts or current.

The input transformer is protected from a thermal overload, and the variac output is protected by a circuit breaker.

The Model WP-29A Iso-V-AC has a suggested retail price of $249.00. For additional information, contact Kappa/Viz Test Equipment, 175 Commerce Drive, Fort Washington, PA 19034.

CIRCLE 84 ON FREE INFORMATION CARD

DIGITAL MULTIMETER

Beckman Industrial's Model 223 3½-digit, professional-grade DMM presents readings through a continuous audio tone that varies in pitch proportional to the position of the reading within the range. By listening to the tone, users don't have to look at the meter, and can keep their eyes and attention on repairing complex circuits. Signal deviations, such as intermittents, are indicated by a "crackling" sound; shorted or open capacitors cause a "looping-type" sound. The Model 223 also features a self-resetting fuse on current ranges, and a built-in logic-pulse detector. Both TTL and CMOS logic pulses, down to 50-ns in duration, can be detected and are indicated by a beep.

Its auto-ranging features, along with a "Skyhook" for hanging and a tilt stand for propping the unit, permit hands-free usage. Weighing less than 12 ounces, and measuring 6.8 × 2.8 × 1.25 inches, the meter is also comfortable to hold.

The Model 223 features DC-voltage ranges of 200mV, 2V, 20V, 200V, and 1000V, with resolution of 100μV and an accuracy of 0.25%. AC-voltage ranges are 200mV, 2V, 20V, 200V, and 750V with resolution of 100μV and accuracy in the 45Hz – 1kHz band of 2.0%. AC and DC cur-

New Products

rent ranges are 20mA, 200mA, and 10A with 10μA resolution.

The Model 223 digital multimeter, including an installed 9-volt battery, test leads, a manual, and a 2-year limited warranty, costs $149.00. For more information, contact Beckman Industrial Corporation, 3883 Ruffin Road, San Diego, CA 92123-1898.

CIRCLE 85 ON FREE INFORMATION CARD

SOLDERING STATION

Elenco's electronic temperature-control soldering station incorporates a sophisticated electronic circuit that lets the user change the tip temperature from 300°F (150°C) to 900°F (480°C), without having to change the tips or the heating element. A unique

temperature sensor located near the tip provides rapid response and little temperature variation. The temperature is maintained within 10°F of its preset temperature.

A linear-array LED readout accurately indicates the temperature of the tip. The unit's tip is isolated from the AC line by a transformer. The heating element is powered by 24 volts. Electronic switching protects voltage and current-sensitive components against transient spikes.

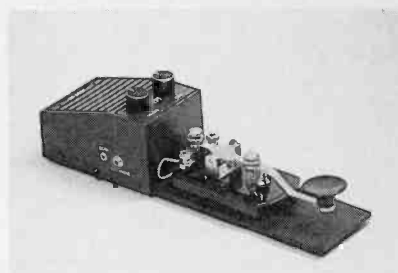
The electronic temperature-control soldering station has a suggested retail price of $169.00. For further information, contact Elenco Electronics, Inc., 150 West Carpenter Ave., Wheeling, IL 60090.

CIRCLE 86 ON FREE INFORMATION CARD

CODE PRACTICE OSCILLATOR

The *MFJ-557 Deluxe Code Practice Oscillator*, manufactured by *MFJ Enterprises*, features a straight Morse key and a code oscillator with a built-in speaker. Both are mounted on a non-skid, heavy steel base. The $8^1/_2 \times 2^1/_4 \times 3^3/_4$ inch unit is designed for travel, allowing the user to practice sending code from practically anywhere.

The code-practice oscillator features volume and tone controls. An earphone jack

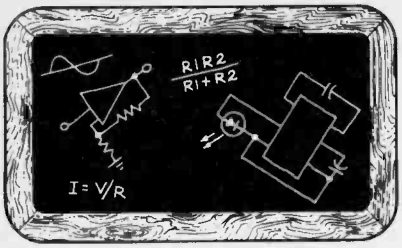


for private listening is included. The unit runs on a 9-volt battery (not included), or 110 VAC with an optional power supply that plugs into a jack on the side. Its straight key, which has screw-adjustable contacts, can be hooked to a transmitter and used for sending code over the air.

The MFJ-557 Deluxe Code Practice Oscillator, with a 1-year unconditional guarantee, costs $24.95. For further information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; for orders only, call 800-647-1800. ■

CIRCLE 87 ON FREE INFORMATION CARD

"A little old lady only used it on Sundays"



Think Tank

By Byron G. Wels

SELF DETERMINATION PAYS OFF

Education is something that all of us undergo each and every day. We constantly seek more information about our trades, our hobbies, and our crafts. The more we learn, the more we realize how little we know, and our thirst for knowledge increases. Sooner or later, it occurs to us that there is really *too much* knowledge for us to absorb, and that the burgeoning field of electronics simply cannot be learned in a haphazard fashion. A more-organized method has to be found.

Finally you look through the pages of this magazine, and find an assortment of courses being offered by home study schools. Just how good are those schools? Can you really learn at home? The answer to both those questions is a definite "maybe." Not that there is anything wrong with the schools or the courses that they offer...many have been in business a long time and some are even accredited by the National Home Study Council, in Washington, DC. No, the problem lies with us.

To successfully complete a course in home study requires a great deal of selfless dedication and determination. Let's face it, after you've devoted the day to your normal work or studies, the last thing that you want to do is come home and study. The appeal of the "boob-tube," while alluring, must be put aside. Your family must be made to realize that study time is your private time, and that time is not to be infringed upon. Trust me, your family will indeed test you. But like anything else, if you stick to it, it will pay off handsomely in increased knowledge, probably a degree or diploma, and a lot of pride of accomplishment.

We learn mostly through our eyes by reading. And if you can't take the time to attend school full time, can't manage or afford a correspondence course, surely the next best way to educate yourself in an easy fashion is by reading magazine columns just like this one.

Destroyer Whooper. If you've ever watched any TV at all and seen those old WWII navy pictures, you've heard that distinctive "whoop-whoop-whoop" as a destroyer sliced through the waves, guns blazing, and everybody yelling "battle stations!"

Well, I don't have a destroyer. What I've got is an old row boat with an outboard put-put on the stern. But when I'm put-putting through the harbor on my way to my favorite fishing spot, I sure attract a lot of attention. You see, I built this "whooper," and it makes heads turn. If you really want to attract attention, feed the output to an amplifier first.

Integrated circuit U1 (see Fig. 1) is connected as a low-frequency asymmetrical oscillator. Its output is inverted by Q1 and fed to the reset terminal of U2 at pin 4. Integrated circuit U2 is configured as an audio oscillator and is enabled when the output of U1 is low. With the voltage at pin 5 of U2 constant, the circuit would just "bleep."

The voltage across capacitor C1 is fed to the base of Q2, turning it on and grounding pin 5 of U2. When the frequency of the reset signal on pin 4 falls, the output frequency of U2 rises. The output then becomes a whoop, starting low in frequency and ending high.

Resistor R1 sets the repetition rate and R2 determines the time duration of the whoop. Resistors R3 and R4 set the center-operating frequency.
—*Murray Stein, Miami, FL*

Migosh, Murray! How did you ever come up with that one? Still, it sounds like a fun application for a couple of 555's. Now don't any of you guys bring one of these into your school library. I'm not responsible for any stay-after-school penalties. Chalk up one Fips book for Murray!

Power Timer. What I had in mind when I built this was the chess games I constantly play with my father. He can take forever to make a move, and I've even caught him falling asleep when it was his turn to play! Then I watched a professional chess match on TV, and saw the device they use. They set a timer and it starts to count down. They have to move before the preset time elapses or they lose the move. After making a move, they slap the switch to reset the timer for the competitor.

The circuit (See Fig. 2) begins when switch S1 (a press-to-make switch) completes the circuit to the battery. Capacitor C1 charges through potentiometer R4 and resistor R1. The base of Q1 moves towards positive until emitter current begins to flow. When the current reaches a high enough level, the drop in EMF across R2 is sufficient to trigger the SCR and the lamp lights. You can replace the lamp with a suitable buzzer.

Switch S1 is a 2-way switch so that C1 discharges and the interval is repeated. The exact time is dependent, to some extent, on the transistor selected for Q1. It can be increased by increasing C1's value, or increasing the com-

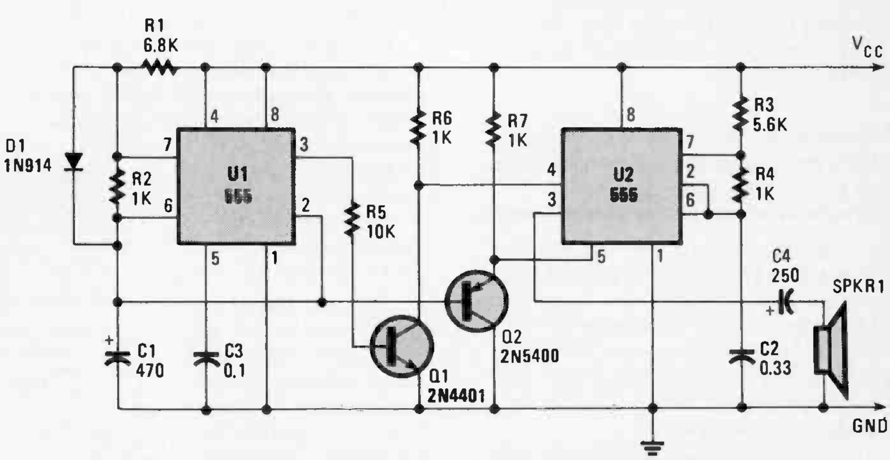


Fig. 1—The Destroyer Whooper consists of two 555 oscillator/timers that are configured so that the output of the first 555 modulates the output of the other.

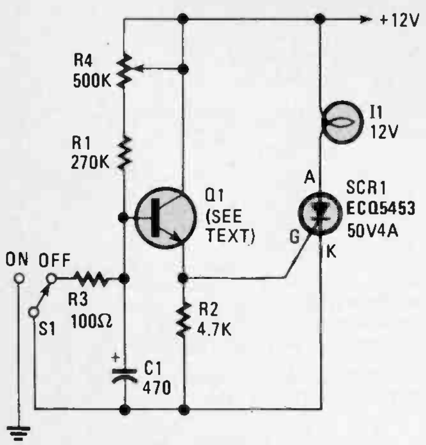


Fig. 2. The Power Timer, consisting of a handful of readily available components, is controlled by Q1, and switch S1.

bined resistance of R4 and R1. If C1 is large and has enough leakage, the circuit will not come on. You can use any high gain NPN transistor for Q1.

You can also modify the circuit by replacing the lamp with a relay, and then using it to control (for example) a walkway light to illuminate the path to your front door. I've done so, and found it extremely convenient. When leaving the house, press the switch and the front or porch light will come on and stay on long enough to get you to the sidewalk before going out. A simple additional switch bypasses the circuit so you can leave the front light on at all times. It's nice when you're expecting company or going to the front door to see if your mail has arrived.

—John Mandel, Abilene, TX

Ha! Keep the front light on, John. The book is on the way!

Simple Mixer. When I was younger, I worked for a firm that made radio tubes. One engineer got a plastic egg beater from his kid's toy kitchen set and cemented it to a 9-pin base. He then put it in a glass envelope, fired the envelope to seal it to the base and sealed it. He said it was "for special mixer applications!" Actually, most cassette recorders need more than the usual MIC, AUX, and LINE inputs.

The simple mixer described here will allow you to make a tape for slide shows complete with sound effects, announcements, and background music. The result is highly professional and can make the shows far more interesting.

See Fig. 3. The circuit is built around a TL072 dual BiFET op-amp with a JFET input stage, and can be powered from single-ended 9- to 18-volt power supply. The microphone input is capacitively coupled to the non-inverting input of U1-a.

Resistors R1 and R3 (which set the voltage gain at about 26 dB) serve as a negative feedback network for U1-a. Capacitors C1 through C3 are DC-blocking capacitors. Most high-impedance microphones have outputs of a few millivolts. Often, a preamp stage just isn't enough. We give the microphone signal a boost of about 20 dB in the mixer.

The non-inverting input of U1-b is biased to half the supply voltage by R6, R7, and C6. Resistors R5 and R8 make up the negative-feedback network and set the voltage gain of U1-b at unity. Capacitor C5 is for DC blocking at this input.

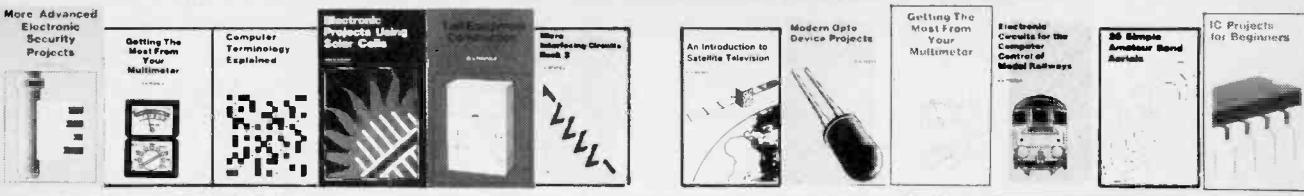
Byron, this circuit will make any cassette recorder far-more flexible and I hope that you (and your readers) will enjoy building it and using it!

—Fred Heising, Reno, NV

(Continued on page 25)

Electronics Paperback Books

GREAT ELECTRONICS PAPERBACKS FROM ETT



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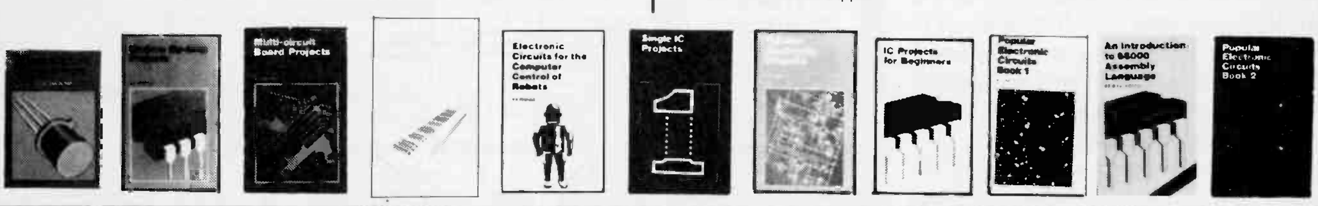

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THINK TANK

(Continued from page 23)

Right Fred, but I should add that minor levels of distortion would be produced at audio frequencies, and the signal-to-noise ratio of the circuit (with an output level of about 500-mV rms) will be better than -60 dB. It will accommodate about 2 volts before any clipping takes place, and you can raise this to as much as 5 volts if you use a total of 18 volts (two 9-volt batteries in series) instead of a 9-volt supply. And before I forget, keep an eye out for your Fips book.

Line-Hum Touch Switch. For years, the touch-plate switch has been a mainstay. The 555 brings it up to date. First, you've got to accept the fact that unless you're in the middle of the Sahara Desert, you're surrounded by line hum. That's a fact that is taken advantage of in this circuit.

See Fig. 4. The monostable period is set for about 1 second, as is the usual case. The induced line hum comes through C2 providing a continuous string of trigger pulses. The output goes low for about 10 ms per second as the monostable times out and then retriggers. Diode D1 and capacitor C3 buffer the relay so it doesn't chatter on those 10-ms pulses. Resistor R2 sets the sensitivity.

The relay energizes when the plate is touched and de-energizes up to one second after the finger is removed. The delay is a function of when the monostable last re-triggered.

Do not connect the circuit directly to the line voltage! Relay coupling *must* be used.

Resistor R1 sets the sensitivity. Typical values are in the range of 47,000 ohms to 10 megohms. In extremely low-noise areas, you can eliminate diodes D3 and D4 and connect R1 to ground. Adjust the value of R1 so the 555 does not trigger permanently.

—*Marvin Collins, Detroit, MI*

(Continued on page 26)

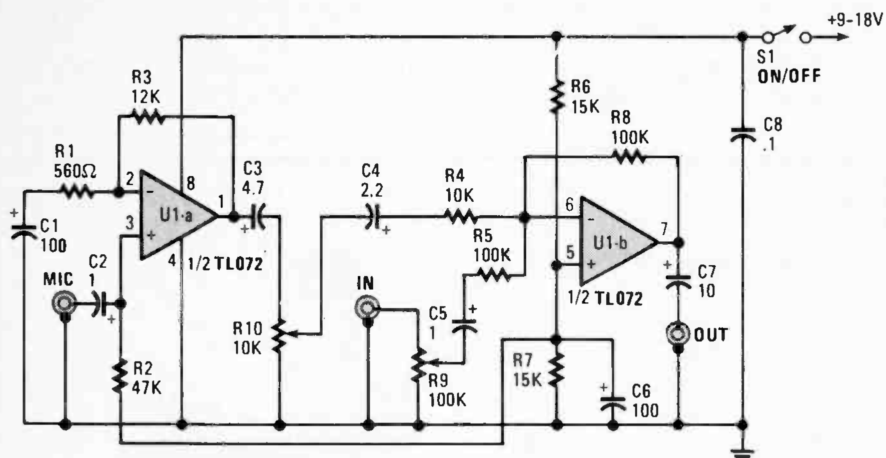


Fig. 3. Powered from a single-ended 9- to 18-volt power supply, the Simple Mixer circuit is built around a TLO72 dual BiFET op-amp (which has a JFET input stage).

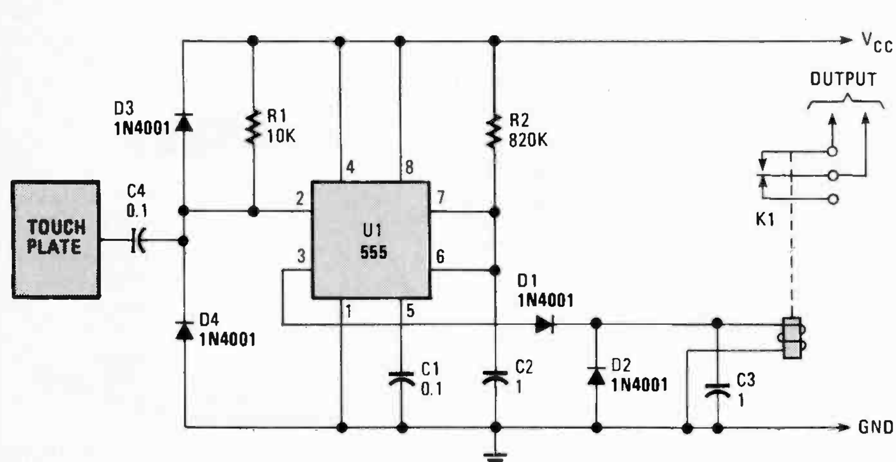


Fig. 4—The Line-Hum Touch Switch energizes when a relay plate is touched and de-energizes up to 1 second after the finger is removed.

Nice job, Marv! And your book is in the mail.

Another Metronome? No. This one is different in that it offers a range of speeds from *largo* to *prestissimo*! The parts values are set so that the repetition rate adjusted by R1 runs from nearly 45 to 184 per minute. The unit is easily built on perfboard. The unit operates off a nine-volt transistor-radio battery and uses a small, 2½-inch, 8-ohm speaker. Note that in this case, a separate switch is used for S1. While you could use a switch on the back of R1, a two-megohm linear potentiometer, you'll soon find that this means the potentiometer has to be set each time that the unit is turned on. The separate switch eliminates that problem.

It's a good idea also, when you're mounting the potentiometer, to mount a white disc to the cabinet under the potentiometer's mounting nut. That will serve as a scale, once a pointer knob is installed, and you can mark the timings with a thin, black, felt-tip pen.

As you can see from the schematic (Figure 5) there isn't an awful lot to the circuit, and it can be put together easily in a single evening. If you choose to mount it in a metronome-shaped wooden cabinet, mount the speaker under grille cloth on the front, and cut a suitable hole for the speaker. You'll need another hole for the switch and one more for the potentiometer—and you'll probably spend more time finishing the wood cabinet than you will on building the circuit!

—*John Mandell, Au Claire, WI*

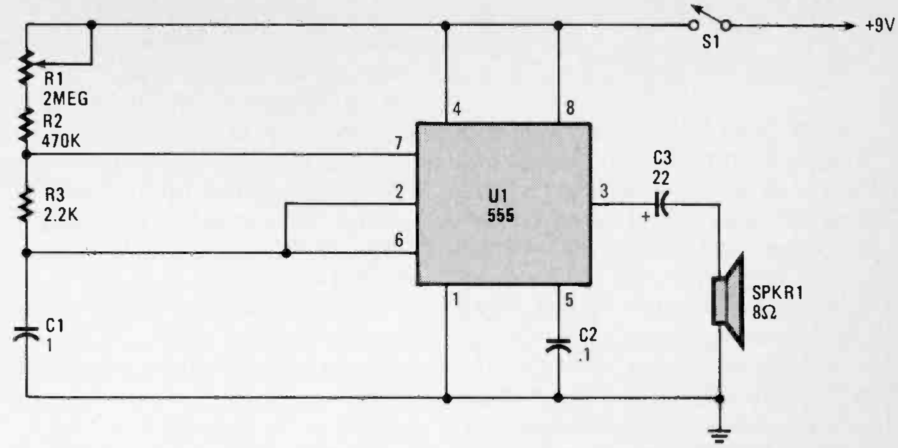


Fig. 5. The Metronome, built around a 555 oscillator timer, offers a range of speeds from largo to prestissimo!

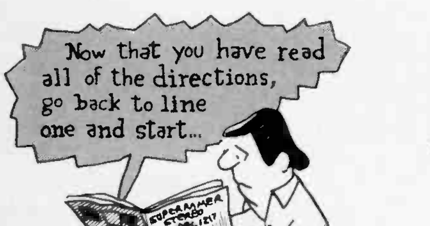
Okay John. I guess the good 'ol 555 will never die. And neither will the Fips book. One is on the way to you now!

Line-Operated Amplifier. It's a pain in the neck to complete a tuner or some other circuit, or even repair a phono or tape, and then have to start hunting for a suitable audio amplifier to run a test on it. I threw this one together from parts that I found in my junkbox, and it not only plugs into an

PROJECT PROFILES

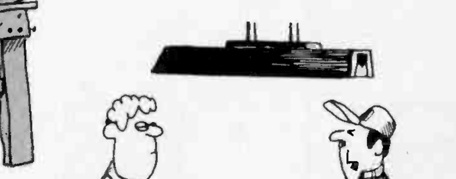
by JACK SCHMIDT

"Byron, when did you start this project?"



"Now, Melvin, don't you think that you should stick to electronics projects and just buy yourself a workbench?"

"If you must know, Albert, I lost the last two pages of the plans!"



"Andy, when they said, 'two-by-four perfboard,' I'm sure that they meant inches!"

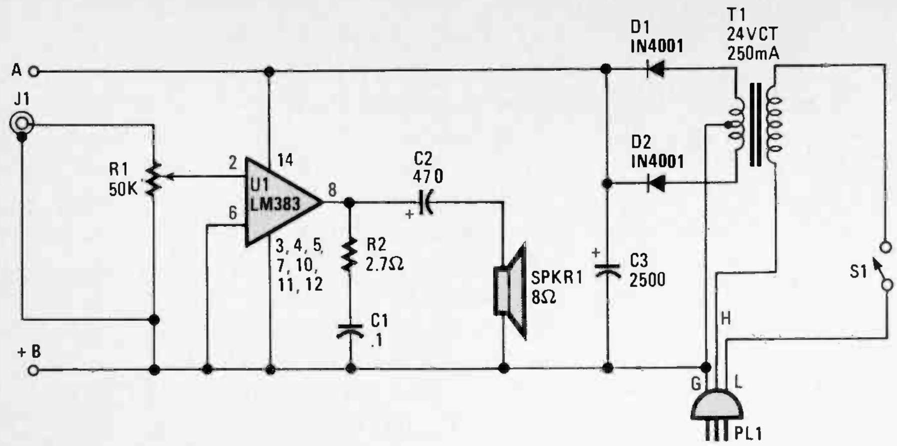


Fig. 6. The time-powered amplifier is isolated from the power source by a 24-volt, center-topped transformer.

AC line, I don't have to look for or test batteries. The power supply built into the unit kicks out a healthy 15- to 18-volts DC, depending on the load. I brought a couple of binding posts out to the front panel, so I not only have a test amplifier, I also have a bench supply of up to 18 volts, right at hand.

See Fig. 6. Transformer T1 isolates the unit from the line, and has a 24-volt, center-tapped secondary. The output of the transformer is rectified by diodes D1 and D2 and filtered by capacitor C3 to provide 15- to 18-volts DC. This particular IC has built-in protection against speaker shorts as well. You can actually draw over two watts from this baby, provided that you heatsink it. If you mount it on a circuit board, you'll probably get sufficient power, but not what you'd find with a sink. The loudspeaker you select (I used a four-inch, 8-ohm unit) and I wouldn't recommend anything less than 4 ohms or over 16 ohms.

Audio signals are applied via a variable resistor (R1) through a piece of shielded cable and a phono plug. If you find that there's not enough gain for your application, add a transistorized preamp.

Okay, there's my contribution. Does it rate me a copy of the Fips book? And when will I be seeing my name in print? *—Sam Hanson, Madison, WI*

Thanks Sam. Actually, from the time that this manuscript goes to the editor, we have to allow about an additional three months. Just keep on reading **Popular Electronics** and keep your fingers crossed. I sent your Fips book out today.

Transistor Tester. The only way to test a transistor (at least for me) was to

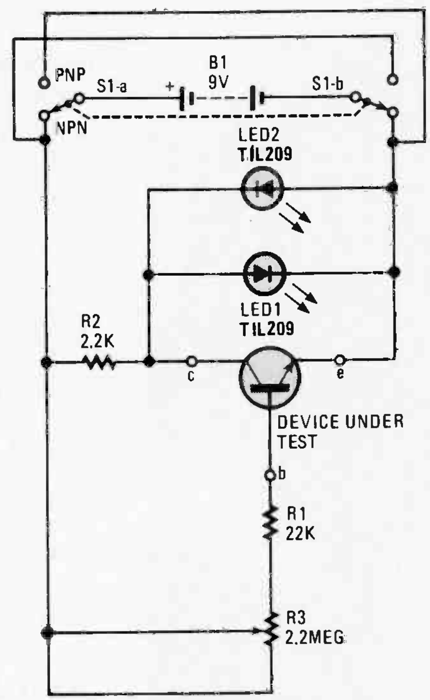


Fig. 7. The Transistor Tester provides an indication of transistor current gain.

replace it with a new one. That created two problems. First of all, I may have been buying new transistors that I didn't need, and I've been filling my junkbox with all sorts of transistors whose worth was dubious at best. This tester provides an indication of transistor current gain, and it didn't cost me much to build, either.

See Fig. 7. Let's consider it first in the NPN mode. If the device under test conducts hard enough to pass a collector current of about 4 mA, there won't be enough voltage across LED1 to bias it into conduction. LED2 won't pass a current either, as it is reverse-biased, so neither one of the LED's will light. If the transistor under test passes

(Continued on page 103)

“Where can I turn for help?”

There is a way to get help when you need it. The American Home Satellite Association. An organization created exclusively to protect and enhance your enjoyment of your satellite TV system.

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Anyone who participates in hobby electronics sooner or later needs electronic test equipment. For most of us who've been into it for a while that means a multimeter and perhaps a low-end oscilloscope. Later many hobbyists spring for a cheap transistor checker, overlooking the need for a capacitance meter or a frequency counter.

After all, if you all ready have an oscilloscope and a multimeter, you can test capacitors (using the multimeter) on a go/no-go basis, or count grids on an oscilloscope to get a pretty close approximation of the frequency in a given circuit. So, at first glance, there appears to be no need for those pieces of test gear.

One reason—the main

THE F/C METER

BY LUTHER M. STROUD

Measure capacitance, frequency, RPM, and more with this easy-to-build and easy-to-use instrument

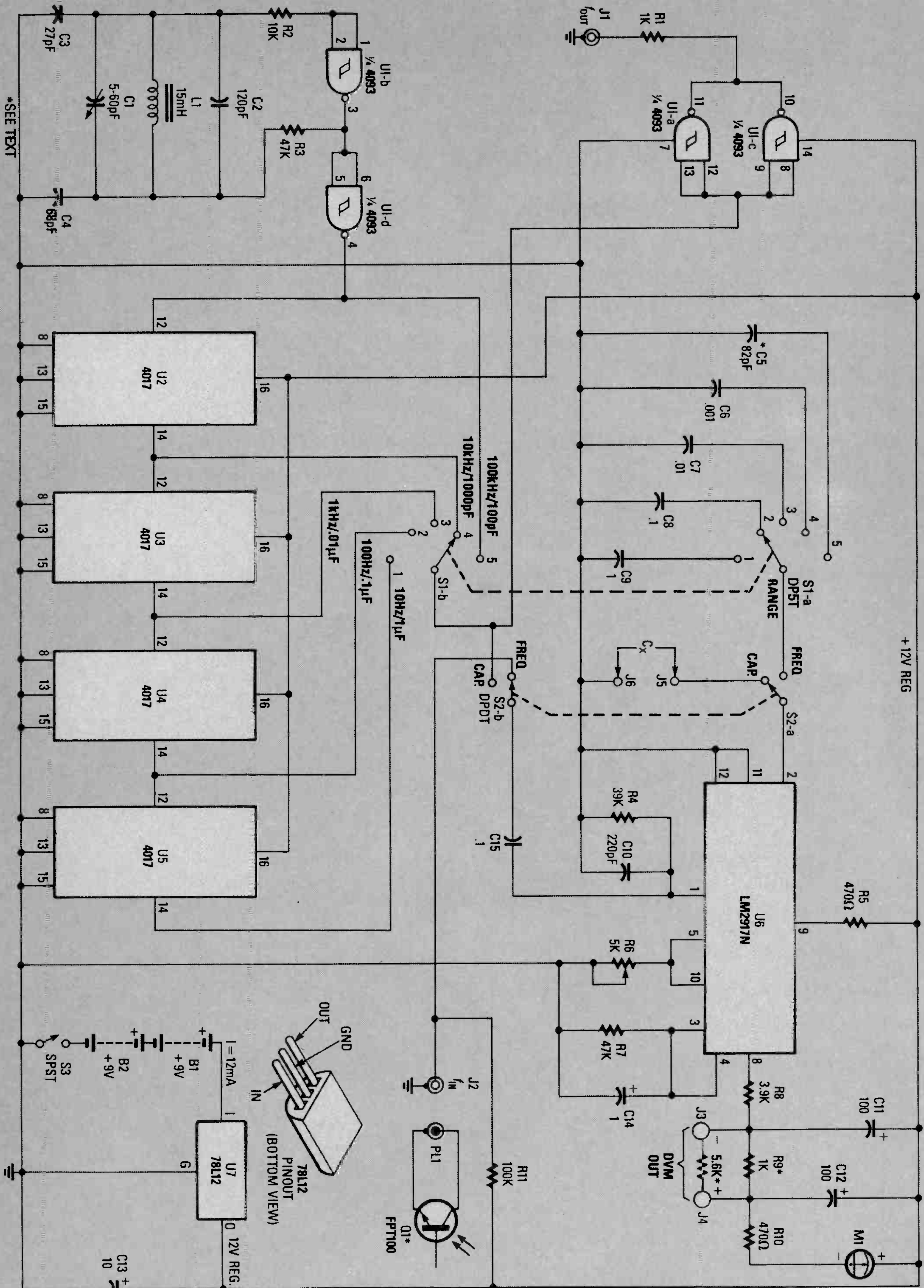
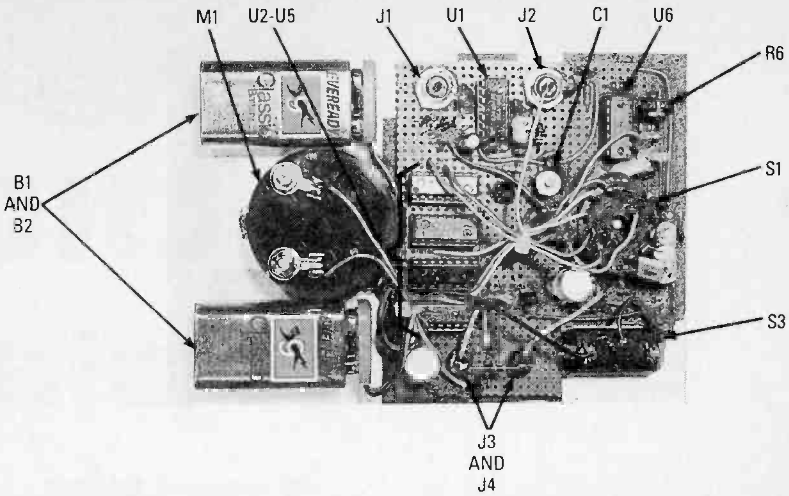


Fig. 1. The F/C Meter can be broken down into two subassemblies: the frequency standard/dividers and the frequency-to-voltage converter circuits.

one—that other instruments are needed is for greater precision. For instance, a frequency counter, whose only purpose in life is to count pulses, will usually read a frequency to within a few hertz, whereas, the same frequency calculated from an oscilloscope screen might be off by as much a 500 Hz or more. That's why specialized "data collectors"—like the *F/C Meter* presented in this article—are needed.

The F/C Meter is a low-cost project that allows you to measure frequencies from 1 Hz to 100 kHz and capacitance from 5 pF to 1 μF over five ranges. It can also provide a frequency standard, or be used as an oscilloscope calibrator, squarewave signal injector, and a marker for audio-sweep generators. If you add the optional optical pick-up probe, you can use the project as a non-contact tachometer. I'm sure you can come up with many more uses.



The circuit board for the F/C Meter and its power source are mounted to an inner front panel of the enclosure. The board is held in place by the mounting hardware that secures J1 and J2 in place, while the dual-battery power source is held in place with strips of double-sided tape.

Circuit Description. Figure 1 is the schematic diagram of the F/C Meter. The circuit can be divided into two parts; the frequency standard/dividers and the frequency-to-voltage converter circuit. The frequency-standard portion of the circuit consists of a 4093 hex NAND Schmitt trigger (U1), four 4017 decade counter/dividers (U2 through U5), and a handful of support components.

When power is applied to the circuit, an L/C oscillator—consisting of U1-a, R2, R3, C1–C4, and L1—begins to oscillate at 100 kHz. The necessary phase shift to start and maintain U1-a's oscillation is provided by R3, C3, and C4. Resistor R2 isolates U1-a's internal input protection, allowing the output frequency to be independent of supply-voltage changes.

The output of the oscillator is fed through U1-b (which is used as a buffer/inverter in this application) to the clock input of U2 at pin 12 and to contact 5 of switch S1-b. Integrated circuit U2 divides the 100 kHz output of the oscillator by 10, outputting a 10 kHz signal at pin 14. The output of U2 is applied to both pin 12 of U3 and to contact 4 of switch S1-b. Integrated circuit U3 divides the 10-kHz input to produce a 1-kHz signal, which is applied to contact 3 of S1-b. That signal is also fed to U4 and U5, each dividing the output signal of the previous stage by 10, to provide 100-Hz and 10-Hz signals that are fed to contacts 2 and 1, respectively.

The signal selected through S1-b is fed to the parallel buffer/inverter combination, U1-c and U1-d, and output at J1 to provide a frequency standard that can be used to calibrate an oscilloscope, provide a clock signal for testing and experimenting, etc.

PARTS LIST FOR THE F/C METER

SEMICONDUCTORS

U1—CD4093B quad 2-input NAND Schmitt trigger
U2–U5—CD4017B decade counter/divider
U6—LM2917N frequency-to-voltage converter
U7—LM78L12 low-power, 12-volt, voltage regulator
Q1—FPT100, TIL63, or similar NPN silicon phototransistor

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R9—1000-ohm
R2—10,000-ohm
R3—47,000-ohm
R4—39,000-ohm
R5, R10—470-ohm
R6—5000-ohm trimmer potentiometer
R7—47,000-ohm
R8—3900-ohm
R11—100,000-ohm

CAPACITORS

C1—5-60-pF, trimmer
C2—120-pF, ceramic disc
C3—27-pF, ceramic disc
C4—68-pF, ceramic disc
C5—82-pF, ceramic disc (see text)
C6—.001-μF, 5%, ceramic disc
C7—0.01-μF, 5%, Mylar
C8—0.1-μF, 5%, Mylar
C9, C14—1-μF, 5%, Mylar
C10—220-pF ceramic disc
C11, C12—100-μF, 16-WVDC, electrolytic
C13—10-μF, 16-WVDC, electrolytic
C15—0.1-μF, ceramic disc

SWITCHES

S1—DP5T rotary switch
S2—DPDT toggle switch
S3—SPST rocker switch

ADDITIONAL PARTS AND MATERIALS

L1—15-mH ferrite choke coil
M1—0-to-1-mA, full-scale, D'Arsonval panel meter
Perfboard materials, enclosure, BNC connectors, IC sockets (optional), knobs, 9-volt transistor-radio batteries and battery holders, snap-on battery connectors, wire, solder, etc.

Note: The following items are available from Pershing Technical Services, PO Box 1951, Fort Worth, TX 76101; A kit of parts containing all intergrated circuits and capacitors, plus L1 for $25.00 (shipping included). TX residents must add sales tax. Please allow 6 to 3 weeks for delivery.

Conversion Circuit. At the heart of the conversion circuit is an LM2917 frequency-to-voltage converter, which was originally designed to convert pulses from an automotive ignition system into a current that's used to drive a meter that's calibrated in RPM.

With S2 in the FREQ. position, a signal can be fed to pin 1 (the tachometer input) of U6. Integrated circuit U6 charges a capacitor (of known value) to a voltage that varies in direct proportion to the incoming signal frequency.

(Continued on page 100)

The BIG-DIGIT Display

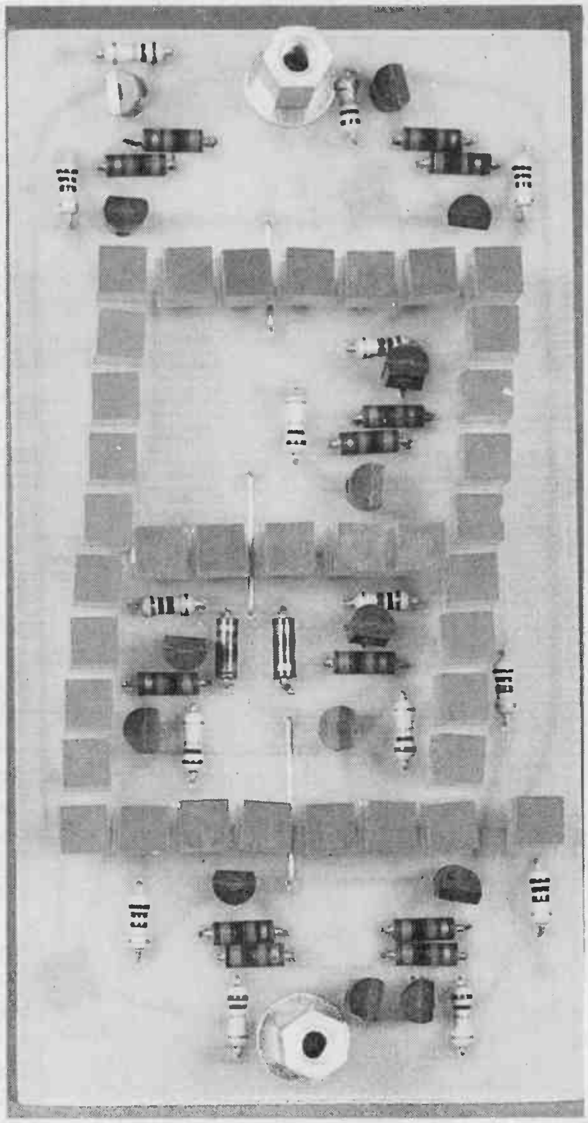
BY WALTER W. SCHOPP

Anyone who has dabbled in electronics has needed a large 7-segment digital readout at one time or other. Looking through the standard catalogs is of little help because (as you've probably already discovered) what they call large is any readout with characters over a half-inch high.

Of course, there are firms that make specialized readouts, but expense, availability, and minimum-order charges usually make you settle for a small readout even though you wanted a big one.

Well, settle no more. For here's a common-cathode readout that provides truly large—2¼-inch high—numerals that can be read from across any room. The circuit—which we'll call the *Big-Digit Display Module*—is built from inexpensive components. Although it was designed (out of necessity) as a readout for a wall-mounted scoreboard, it has many other applications. For instance, it might be used with a timing circuit to produce a truly unusual digital clock.

The readout was built in modular form, allowing individual modules to be mounted side-by-side to make up any size readout required. Even larger display modules can be designed using the same principle. The digit is laid out on a small printed-circuit board, measuring about 2⅜ by 4½ inches, and is designed so that it can be driven individually by a standard driver, or multiplexed in a multi-digit configuration.



This jumbo display module provides an inexpensive alternative to expensive big-digit 7-segment units

The Circuit. Each display segment consists of five LED's, as shown in the schematic of Fig. 1. The five LED's in each segment are connected in series to reduce the circuit's current requirement; parallel-connected LED's would require several times the current drawn by the series arrangement used in our circuit.

Powered from the 12-volt DC source indicated in Fig 1, each string of LED's requires 17 mA to operate, which is more current than can safely be supplied by a CMOS driver. To get around that problem each segment string is fed from its own driver. The drivers require only about 1 mA to activate a segment, thereby making the circuit compatible with CMOS IC's.

The circuit's operation is about as simple as it can get. For the sake of discussion, we'll look only at segment A, but be advised that each of the seven segments that make up the display operate in exactly the same manner as that segment.

The collector of Q1 (a 2N3903 general-purpose NPN silicon transistor) is tied to the base of Q2 (a 2N3905 general-purpose PNP silicon transistor). The emitter of Q2 is tied directly to the +12-volt source, while its base is tied to the +12-volt source through resistor R9. With no signal appled to the input of segment A, no bias is applied to the base of Q1, so it remains off, and the segment is not activated.

However, when a signal is applied to input A, Q1 turns on, clamping the base of Q2 to ground, causing it to turn on. With Q2 turned on, current flows through the LED string to the transistor

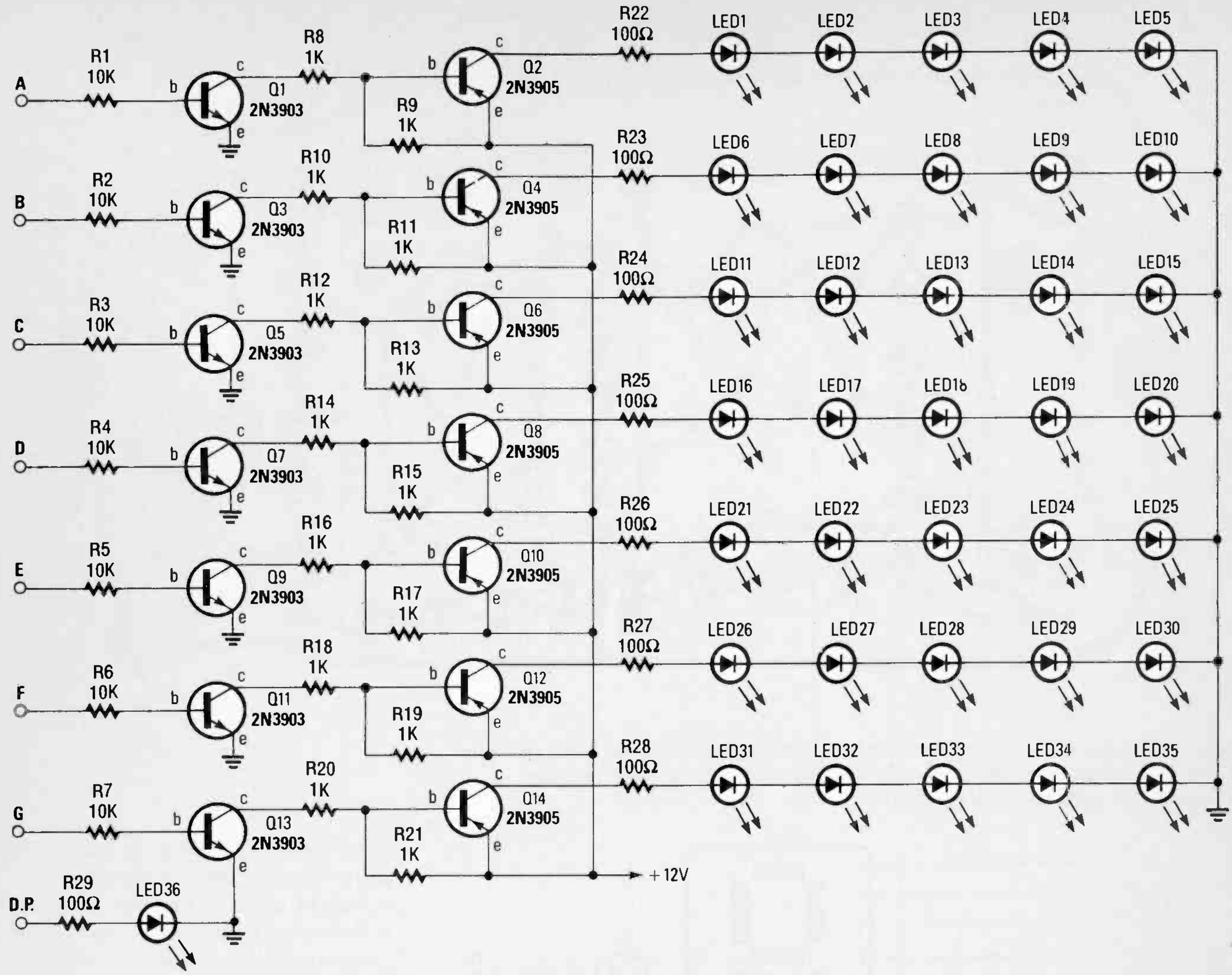


Fig. 1. The schematic diagram of the Big-Digit Display. The circuit contains 36 LED's, 35 of which make up the display segments; the 36th LED serves as the decimal point.

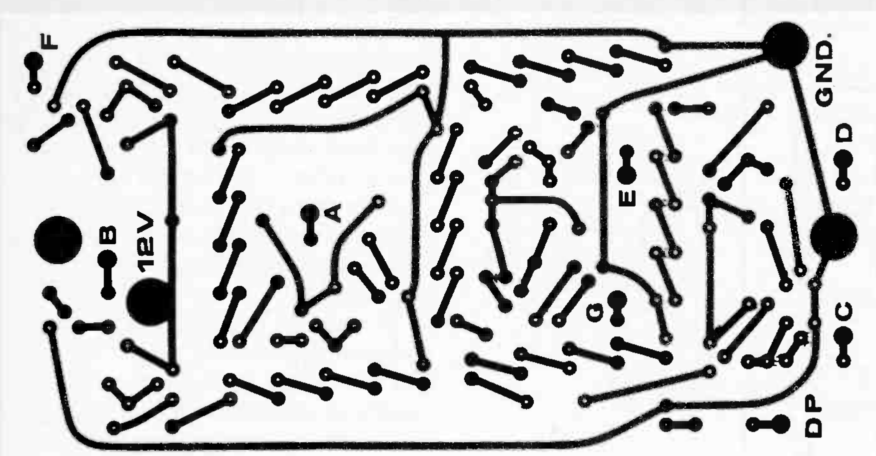


Fig. 2. The author's prototype of the Big-Digit Display Module was built on a printed-circuit board measuring about 2⅜ by 4½ inches.

and to ground, causing the A segment to light.

Construction. The author's prototype of the Big-Digit Display Module was built on a printed-circuit board, measuring about 2⅜ × 4½ inches. The printed-circuit foil pattern used by the author is shown in Fig. 2. After obtaining the necessary parts (see Parts List) and etching a circuit board, assemble the project using Fig. 3 as a guide. Install the jumper connections and resistors first; then the transistors, saving the LED's for last.

PARTS LIST FOR THE BIG-DIGIT DISPLAY MODULE

SEMICONDUCTORS

Q1, Q3, Q5, Q7, Q9, Q11, Q13—2N3903 or equivalent silicon NPN transistor

Q2, Q4, Q6, Q8, Q10, Q12, Q14—2N3905 or equivalent silicon PNP transistor

Q15–Q17—Optional switching transistor, (see text)

LED1–LED36—Large diameter (.203 inch) light-emitting diode (any color)

RESISTORS

(All resistors are ¼-watt, 5% units.)

R1–R7—10,000-ohm

R8–R21—1000-ohm

R22–R29—100-ohm

ADDITIONAL PARTS AND MATERIALS

Printed-circuit materials, enclosure, spacers, wire, solder, hardware, etc.

When installing the transistors, pay close attention to the orientation of

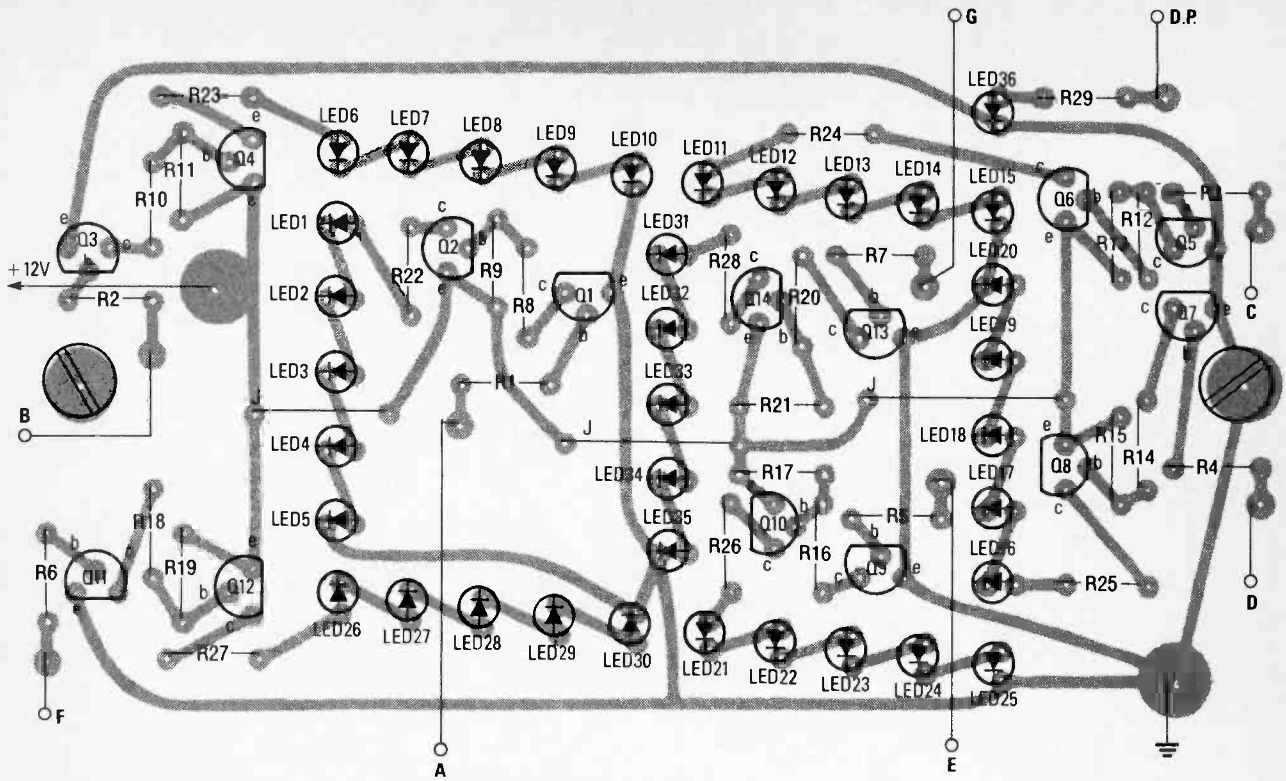


Fig. 3. This diagram shows the placement of the circuit components. To make assembly as easy as possible, install the jumper connections first, followed by the resistors and transistors, saving the LED's for last.

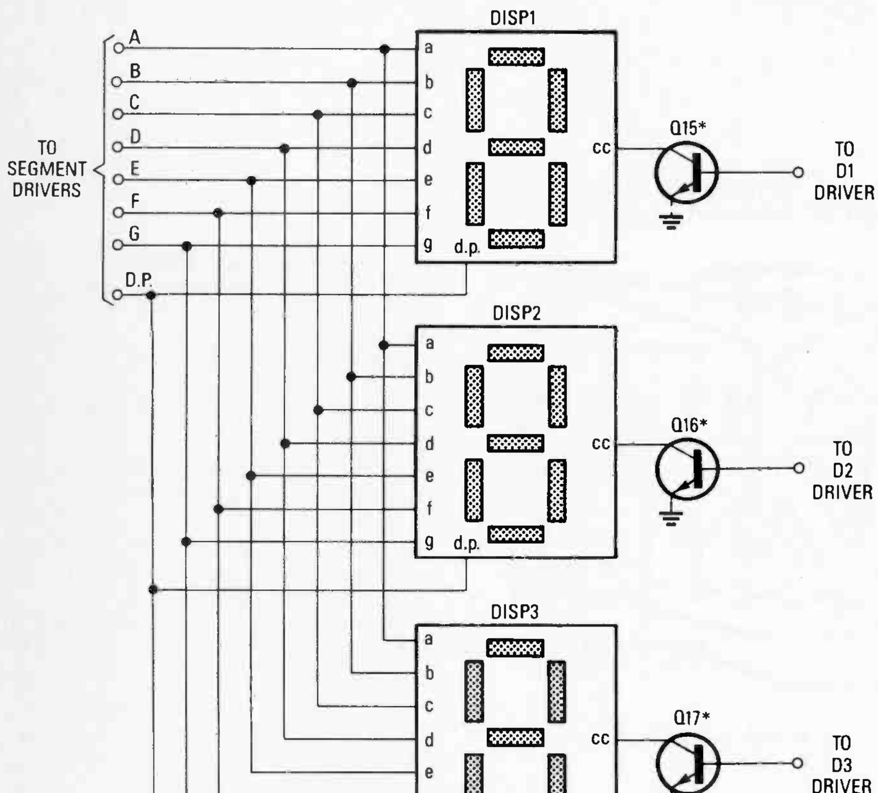


Fig. 4. Here is the basic procedure for multiplexing the Big-Digit Display Module. When multiplexing the individual modules be sure that the switching transistors are capable of handling the total current draw of the module to which it's connected—119 mA total with all segments active.

those units. Also, keep in mind that you're dealing with both PNP and NPN transistors. Installing an NPN unit where a PNP unit is called for will render the circuit inoperative. An easy way to keep track of things is to install the odd-numbered NPN transistors (Q1, Q3, Q5, etc.) first.

With all the jumpers, resistors, and transistors installed, the module is mounted behind a red plastic panel and the LED's are pushed up against the face before they are soldered in place. When installing the LED's, make sure that they are all oriented correctly. A single misoriented unit will render the entire string of LED's for that segment inoperative.

In order to achieve the maximum brightness, the LED's should be positioned as close to the ruby-red plastic panel as possible. In the author's prototype, that's done by using 3/8 or 1/2-inch standoffs between the printed-circuit board and red-plastic panel. Also in the prototype, the driver transistors and resistors were mounted close to the board so that the tops of the transistors are lower than the LED's.

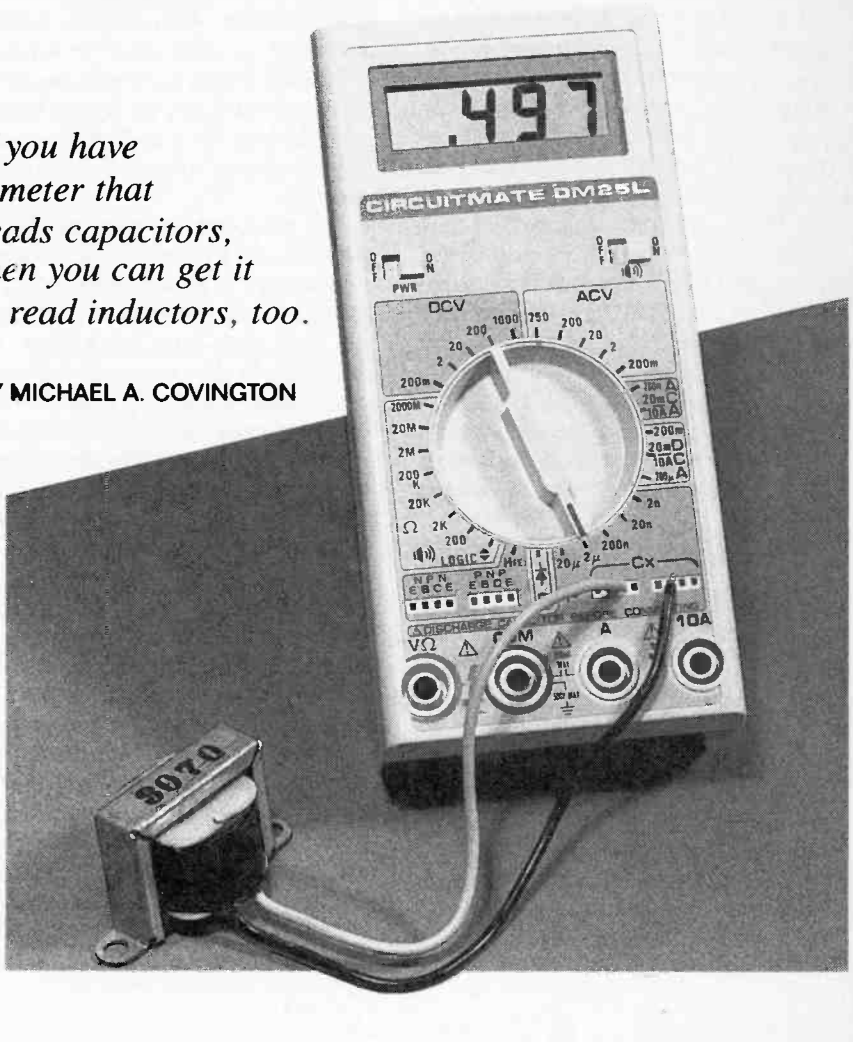
Module Multiplexing. If the intended application of the Big-Digit Display Module requires that two or more mod-

(Continued from page 103)

Measuring Inductance on a Capacitance Meter

If you have a meter that reads capacitors, then you can get it to read inductors, too.

BY MICHAEL A. COVINGTON



There's a simple way to measure inductance on the capacitance scale of your digital multimeter. The useful range for making such measurements is about 20 mH–10 H—good for power-supply chokes, tape recorder bias coils, and other relatively large inductors.

When a digital multimeter measures capacitance, it's really measuring reactance at some particular frequency. The meter can't tell whether the reactance is inductive or capacitive; it assumes it's capacitive and displays the corresponding capacitor value.

Conversion. To read inductance instead of capacitance, all you have to do is make a conversion scale. The one in Fig. 1 works for the Beckman DM25L and other meters whose test frequency is 400 Hz. If your meter works at some other frequency, don't panic—you can make your own scale.

To do so, first measure a 1000-ohm precision resistor as if it were a capacitor. You'll probably get a reading something like 0.4µF. To find the frequency (f) your meter runs at, plug that reading in microfarads into this formula in place of C:

$$f = 160/C$$

Now that you know f, find K using this:

$$K = 25530/f^2$$

And then you can convert capacitance readings into inductance using the formula:

$$L = K/C$$

where L is the inductance in henries, and C is the "capacitance" reading for the inductor in microfarads.

Now use this formula to calculate a few typical values (e.g., 1 µF, 0.1 µF, etc.). Then make a copy of Fig. 1, cut it up the middle, and slide one scale up or down relative to the other until it agrees with the values you've calculated. *Presto*—an instant conversion scale for your meter.

That works as long as the coil's resistance is low—less than about one ohm per four millihenries of inductance. With higher-resistance coils, a further correction is needed:

$$L_{correct} = \sqrt{(K/C)^2 - (R/6.3f)^2}$$

With that formula, readings can be surprisingly accurate. Now that I've found this method, I doubt that I'll ever need an L meter. ■

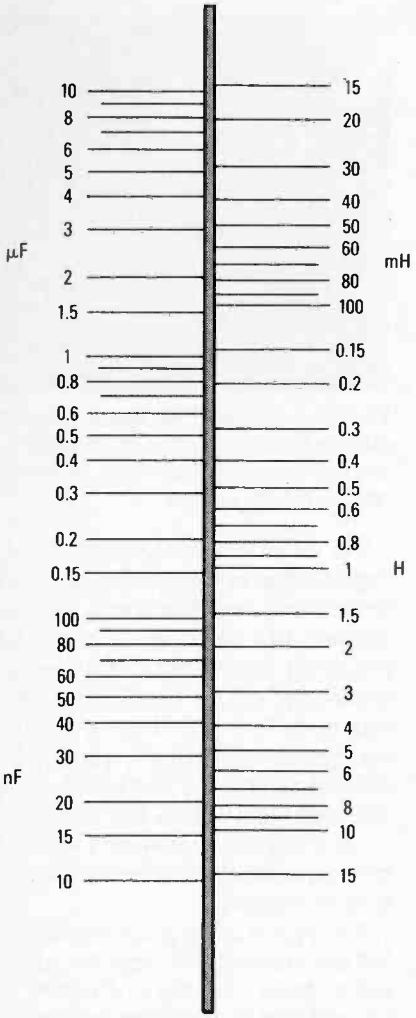
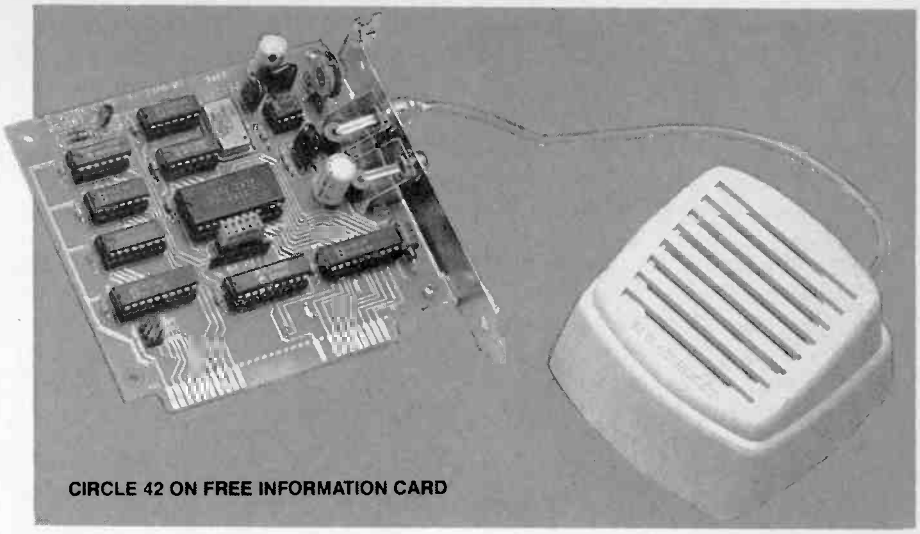


Fig. 1. Here's how to convert capacitance readings to inductance for the Beckman DM25L. See the text on how to adapt this scale to your own meter.



HEATHKIT HV-2000 HEATH VOICE

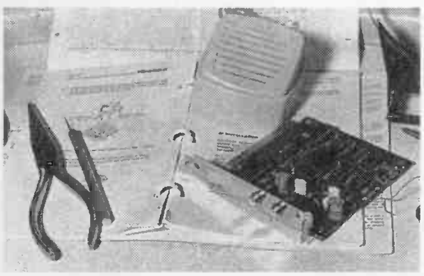
Add a voice to your computer and hear what you have been missing!

Does your computer talk to you? Mine does! When I boot up and the AUTOEXEC.BAT file is run, the last line in that file causes a robot-sounding voice to announce, "OK, stupid, you can play with the computer!" It has a humbling effect on the operator.

I like to shuffle through my papers as the computer checks its systems, initializes itself, and loads memory-resident programs. The spoken message is a humorous way of alerting me to get back to the keyboard when that's all done.

But, there is more you can do than just that with the *Heathkit Model HV-2000 Heath Voice*. It'll add voice, music, and sound-effect capabilities to any IBM PC/AT, PC/XT, and PC-compatible computer.

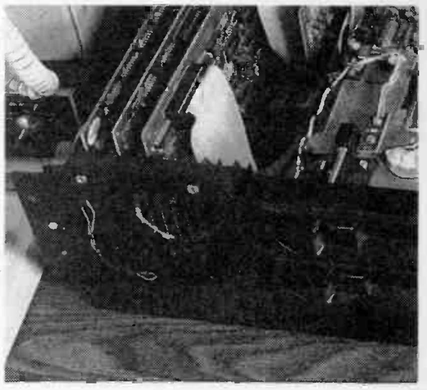
Behind the Speech. The branch of language study that deals with spoken sounds is called *Phonetics. Phonemes* are the basic sounds that are used to pronounce words in a given language. The following attributes are available in Heath Voice to help you generate speech and other sounds. There are 64 phonemes, 4 phoneme durations, 16 speech rates, 4096 discrete inflection levels, 32 transition inflection levels with 8 transition rates, 16 amplitude settings, 8 articulation rates, and more than 250 filter settings. That sounds like a lot of learning and experimentation, but read on.



Here's a bird's eye view of what your work surface will look like when the Heath Voice HV-2000 is completely wired. The standard 62-contact PC card and external speaker/cable assembly can be assembled in one evening—maybe less.

The device-driver software that you receive with the Heath Voice takes full advantage of those features and provides an easy interface to DOS, assembly, and high-level languages. Over 500 rules, which determine the correct phonemes required to speak most English text, have been incorporated into the software. You will also find it easy to select musical notes over a four-octave range, as the device and software does much of the work for you.

Tailoring the Driver. There are several options that you can enable or disable automatically upon loading the driver, or on the fly as text is being spoken. They include the ability to: pronounce the punctuation; use an exception file containing words that are mispronounced by the built-in rules (a special editor is provided to create and maintain that file); speak text with automatic inflection; pause briefly between words for improved clarity; and speak numbers digit-by-digit.



The test setup shows the Heath Voice card installed in a compatible PC/XT. When you first connect Heath Voice, be sure to replace the PC's cover.

The driver will accumulate the text that is written to it, one or more characters at a time, and then speak the accumulated text when either a line-feed (<ENTER>) character is written or a character count of 255 has been reached. Text lines that end with a hyphenated word will accumulate characters until the first space on the following line is written. The hyphen and <CRLF> (carriage return-line feed) are ignored so that the hyphenated word is spoken properly.

The device driver is compatible with text files created with WordStar in Document Mode—control characters that are inserted by WordStar are ignored, as are the extra spaces that WordStar adds to the file to justify lines.

(Continued on page 102)

Build the "Whistler" VLF Receiver

Investigate solved and unsolved mysteries with this super-sensitive VLF receiver

BY TOM FOX

It was a dark, foggy night several years ago when I first turned on the original version of the *Whistler Receiver* described in this article. Seconds after I'd flicked on the power switch, an unearthly, high-pitched sound was heard. Was I in luck? Had I tuned in the famous VLF (*V*ery *L*ow *F*requency) sound known as a "whistler?" Apparently not.

While the tones changed, they did not descend in pitch as a whistler is supposed to do; the sound also repeated itself *exactly* every 10 seconds. Numerous thoughts quickly flashed through my mind—it's probably just oscillation in the amplifier's circuits; it's just feedback from the loop antenna; maybe the darn thing's haunted! None of those speculations added up since the sound repeated itself exactly every 10 seconds (even ghosts aren't that punctual).

Apparently, some rational entity was controlling those signals. Mulling over the logical, earthly possibilities, I recalled reading about a VLF Naval-submarine communication project. The Navy, like much of the U.S. military, usually is quite helpful in solving mysteries, so I didn't hesitate to write them. After about a week, I received an informative letter, along with an inch thick pile of fact sheets, from the Deputy Director of the Naval Communications Division.

The letter suggested that the mysterious signal that I was receiving was probably transmitted by the Navy's OMEGA transmitter located near LaMoure, North Dakota. OMEGA is a VLF radio-navigational system operating between 10 and 14 kHz. (The VLF band extends from 3 kHz to 30 kHz). Figure 1 gives the OMEGA "signal transmission format." One mystery solved (thanks Navy!), several more to go.

While the project described herein will enable you to receive the OMEGA signals, the real fun starts when you pick up a whistler. That strange sound starts as a high-pitched whine, at about 20 kHz, and sweeps down in frequency to a pitch like that of a high-soprano singer; it lasts about a second.

While whistlers—which apparently are produced by lightning—at one time were an unsolved mystery, today they are fairly well understood. The strongest ones (in the U.S.A.) are produced by lightning occurring in the southern hemisphere at a geomagnetic conjugate point (a point in the southern hemisphere that's on the same magnetic line of force as you are).

Roughly, your magnetic conjugate point is at your same geographic longitude. To find the approximate southern latitude, add 10 degrees to your position. Simply put, the theory goes like this: Lightning produces a wide range of radio waves. Some of the VLF waves are bent by the atmosphere and follow the earth's magnetic fields. The ionosphere acts as a prism, in that the higher frequency radio waves travel faster through the ionosphere than do the

STATION \ SEGMENT	A	B	C	D	E	F	G	H
NORWAY (A)	10.2	13.6	11⅓					
LIBERIA (B)		10.2	13.6	11⅓				
HAWAII (C)			10.2	13.6	11⅓			
N.DAKOTA (D)				10.2	13.6	11⅓		
LA REUNION (E)					10.2	13.6	11⅓	
ARGENTINA (F)						10.2	13.6	11⅓
AUSTRALIA (G)	11⅓						10.2	13.6
JAPAN (H)	13.6	11⅓						10.2
TIME(SEC)	0.9	1.0	1.1	1.2	1.1	0.9	1.2	1.0

TIME(SEC) → 0.0 1.1 2.3 3.6 5.0 6.3 7.4 8.8 10.0

Fig. 1. Here is the OMEGA Signal Transmission Format. OMEGA is a VLF radio-navigational system operating between 10 and 14 kHz.

lower frequency ones. That seems to explain why one hears the whistler's high-frequency tones first.

A Low Tech Whistler Receiver. One doesn't need sophisticated equipment to hear a whistler. I've read that one can hear whistlers by simply connecting a high-impedance headphone to a wire fence that has insulated fence posts (such as those supported by wood). Not believing everything I read or hear, I checked it out. Because I didn't have a wire fence, I strung 125 feet of #22 wire along the top horizontal support of the wood fence that encircles my children's play yard.

I connected one lead of a high-impedance headphone to the wire and the other lead to a good ground. Since I tried the experiment during the day, I really didn't expect to hear a whistler (whistlers are generally heard between midnight and dawn). However, I did receive a very weak OMEGA signal. Since a good whistler produces a stronger signal than OMEGA (at least in my area), I had little doubt that one could indeed hear a whistler on such low-tech equipment.

While a wire fence may make a usable whistler receiver, its weak signal and ungainly size can't compare to the solid-state receiver described herein. Of course, you may prefer to listen to whistlers using a wire fence VLF receiver. Such a receiver may light up your life—literally—when a thunderstorm approaches. In other words, *don't attempt to connect earphones to a wire fence during a thunderstorm; lightning doesn't have to hit the fence to turn you into a rather unique statistic!*

A Solid-State Whistler Receiver. The receiver is basically a high-gain audio amplifier designed specifically to have a rather poor low-frequency response to reduce 60-cycle hum. The antenna is a large loop: Actually, three different loop antennas were built and tested. While the circuit is simple, the basic design was achieved by some trial and error.

Originally, several different audio-amplifier designs were tested. The set-up that seemed to work best used a single transistor Class-A power amplifier with the bulk of the amplification accomplished via two op-amps.

Referring to the schematic diagram shown in Fig. 2, the signal picked up by the loop antenna, L1, is fed to the inverting input of op-amp U1-a at pin 2, which provides a gain of about 10 at 5 kHz. The amplified output of U1-a is then fed to the non-inverting input of U1-b (at pin 10), which again boosts the signal to provide a gain of about 120 at 5 kHz. (If you wish to experiment with more gain try increasing R7 to 150k. That will boost the gain to about 150).

The output of U1-b is input to the base of Q1 (a 2N3053 general-purpose transistor configured for Class-A operation), which provides sufficient output power to drive speaker SPKR1. If you wish, the signal can also be fed to an external power amplifier via jack J2.

Since a single battery is used for

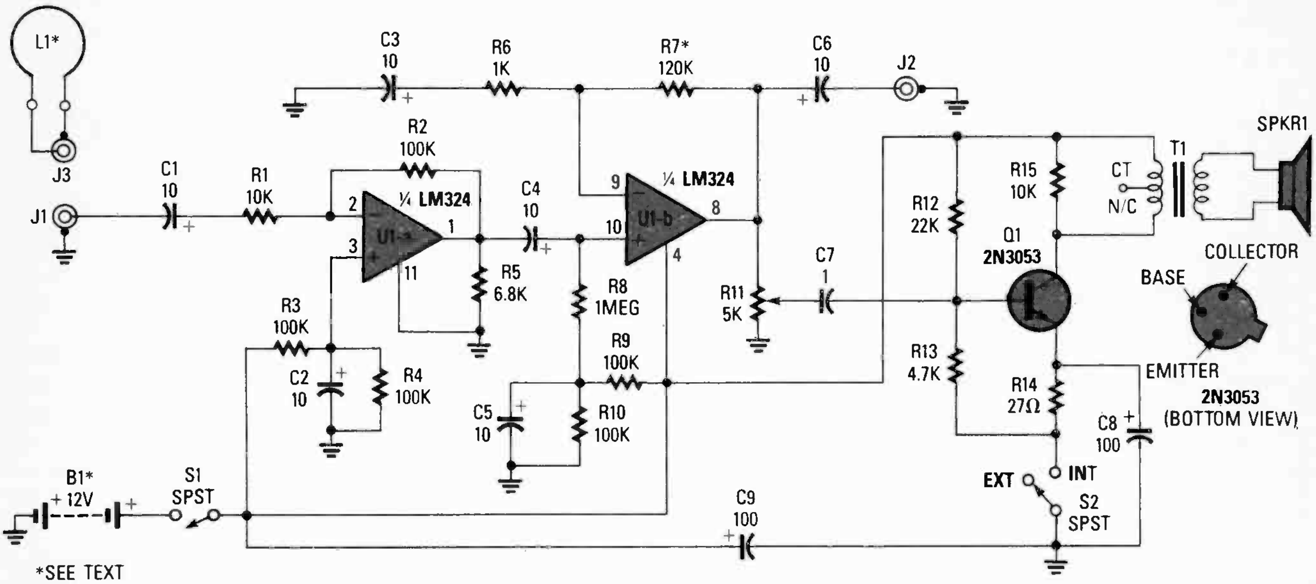


Fig. 2. The signal picked up by antenna L1 is fed to the inverting input of U1-a (which provides a gain of about 10). The output of U1-a is fed to the non-inverting input of U1-b (which again boosts the signal to provide a gain of about 120 at 5 kHz).

economy (+9 to +12 volts), R3, R4, R9, and R10 are required to provide a suitable bias voltage for U1-a and U1-b. If you are using an external amplifier, switch S2, which is connected in the emitter circuit of Q1, should be placed in the EXT position. When that's done, transistor Q1 is effectively removed from the circuit, thereby greatly extending the life of the battery.

Capacitor C9 is included in the circuit to help maintain a stable supply voltage over the life of the battery. The circuit, if operated near power lines, may pick-up the 60-cycle AC hum. If that occurs, the situation can be corrected (somewhat) by reducing C6 and C7 to 0.1 μF.

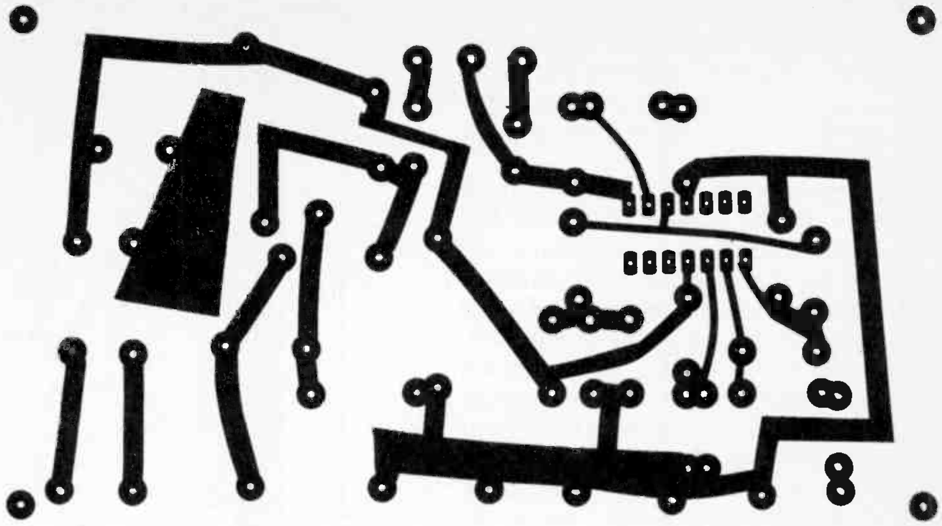


Fig. 3. Here is the full-size foil pattern for the Whistler Receiver's circuit board.

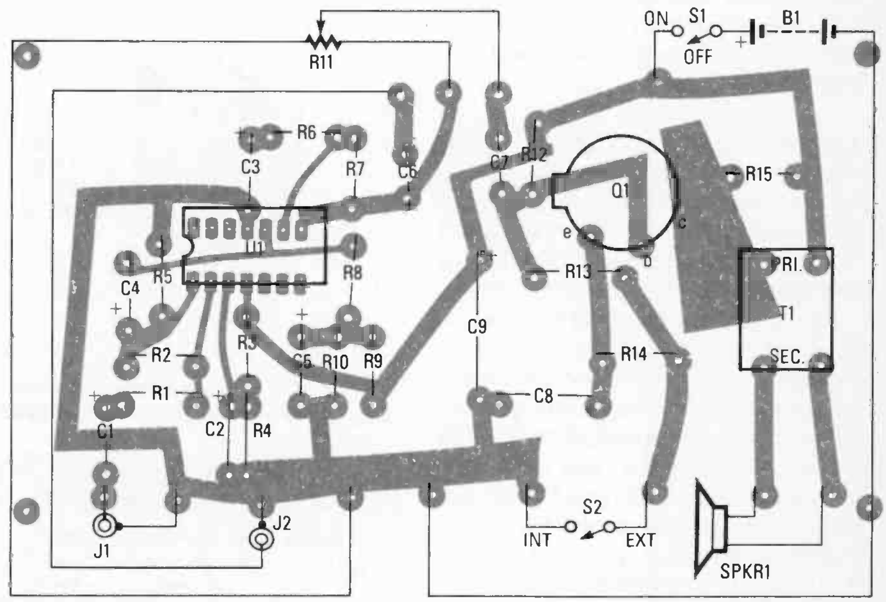


Fig. 4. Once you've etched a board, and collected the necessary components to complete the project, install the parts according to this component-placement diagram.

PARTS LIST FOR THE WHISTLER RECEIVER

SEMICONDUCTORS

U1—LM324 quad low-power op-amp, integrated circuit

Q1—2N3053, or equivalent, general-purpose NPN silicon transistor

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)

R1, R15—10,000-ohm

R2–R4, R9, R10—100,000-ohm

R5—6800-ohm

R6—1000-ohm

R7—120,000-ohm (see text)

R8—1-megohm

R11—5000-ohm-potentiometer

R12—22,000-ohm

R13—4700-ohm

R14—27-ohm, ½-watt

CAPACITORS

C1–C6—10-μF, 25-WVDC, electrolytic

C7—1-μF, 25-WVDC, non-polarized electrolytic

C8, C9—100-μF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery or 8 AA cells in series (see text)

T1—1000-ohm to 8-ohm audio-output transformer (Radio Shack 273-1380 or equivalent)

L1—home-made VLF loop antenna, see text

J1–J3—RCA phono jack

S1, S2—SPST slide or toggle switch

SPKR1—Miniature 8-ohm speaker (see text)

Printed-circuit materials, enclosure, RCA phono plugs, (2) audio cables, IC socket (optional), 9-volt battery holder and snap-on connector or battery pack (see text), wood (1 × 2 or 1 × 3, see text), knob, insulated magnet wire (#28, #22 and #22; see text), wood glue, hook-up wire, solder, hardware, etc.

Putting it Together. Because of the relative simplicity of the project, one might be tempted to go with perfboard construction. However, because of the circuit's high gain (which can cause instability problems) perfboard construction is not recommended. The author built his unit on a printed-circuit board measuring about 5 × 2¾ inches.

Figure 3 shows the suitable foil pattern/drilling guide for the Whistler Receiver's printed-circuit board. Once you've etched a board and collected the necessary components to complete the project (see Parts List), construction can begin. Install the parts according to Fig. 4, the component-placement diagram.

It is recommended that an IC socket be used for U1. Note, from Fig. 4, that all parts except L1, J1–J3, R11, S1, S2, B1, and SPKR1, are mounted on the circuit board. Jacks J1–J3 are RCA phono type.

Once all of the on-board components have been installed, connect lengths of wire to the points on the board slated for off-board components, with the exception of J1 and J2; coaxial audio cables should be used when making connections between those jacks and the circuit board. Also when wiring J1 and J2, be sure that the connections are made exactly like those shown in Fig. 4; if you reverse the connections to the jacks, the circuit will not work.

When making the connections between the volume-control potentiometer (R11) and the circuit board, or between the speaker (SPKR1), and the circuit board, use short, twisted wires. The speaker should be of the miniature type with an impedance in the 8- to 16-ohm range. Refer to Fig. 2 (the schematic diagram) and Fig. 4 (the parts-placement diagram) when connecting R11, S1, S2, B1, and speaker SPKR1 to the circuit.

Power for the circuit can be derived from any 9 to 12-volt DC source. The author's circuit was powered from a 9-volt transistor-radio battery. An alternative battery arrangement would be to use a 9- or 12-volt (multi-battery) battery pack—a plastic battery holder, which when loaded with the appropriate size batteries, connects them in series. Battery packs are available from Radio Shack in both the 9 and 12 volt versions. The 9-volt version holds six 1.5-volt cells, while the 12-volt version holds eight 1.5-volt cells. Be advised that a 12-volt battery results in slightly improved performance as well as extended battery life.

Looping the Loop. I built and tested three sizes of loop antennas (designated A, B, and C). The form for each antenna can be made from 1 × 2 or 1 × 3 lumber. Table 1, and Fig. 5 give details of the antenna's construction.

Since whistlers are about as dependable as a white Christmas at the White House, I compared each antenna's ability to pick up the Navy's OMEGA signal. I was a bit surprised to find that all three antennas were able to receive the OMEGA signal. Perhaps because of its high gain, when antenna A was connected to the circuit it was not possible to turn the volume of the receiver all the way up and still have the circuit operate properly.

On the other hand, there was little detectable difference between antennas B and C, and the A antenna. Although antenna C probably gives the best and most reliable reception, the improvement over the A and B antennas is hardly worth its awkwardness. In general, I recommend antenna B. But feel free to experiment for yourself.

Except for the size of the loop and number of wire turns, the construction of antennas A and B are nearly identical. To build the A or B antennas, cut two pieces of 1 by 2- or 1 by 3-inch lumber to the lengths given in Table 1. Cut notches in the wood as shown in Fig. 5A. Assemble the two pieces of wood with wood glue, as shown in Fig. 5B. The C antenna is constructed similarly, but instead of a single notch at the ends of each piece of wood, five notches are used, as shown in Fig. 5C. Next make a

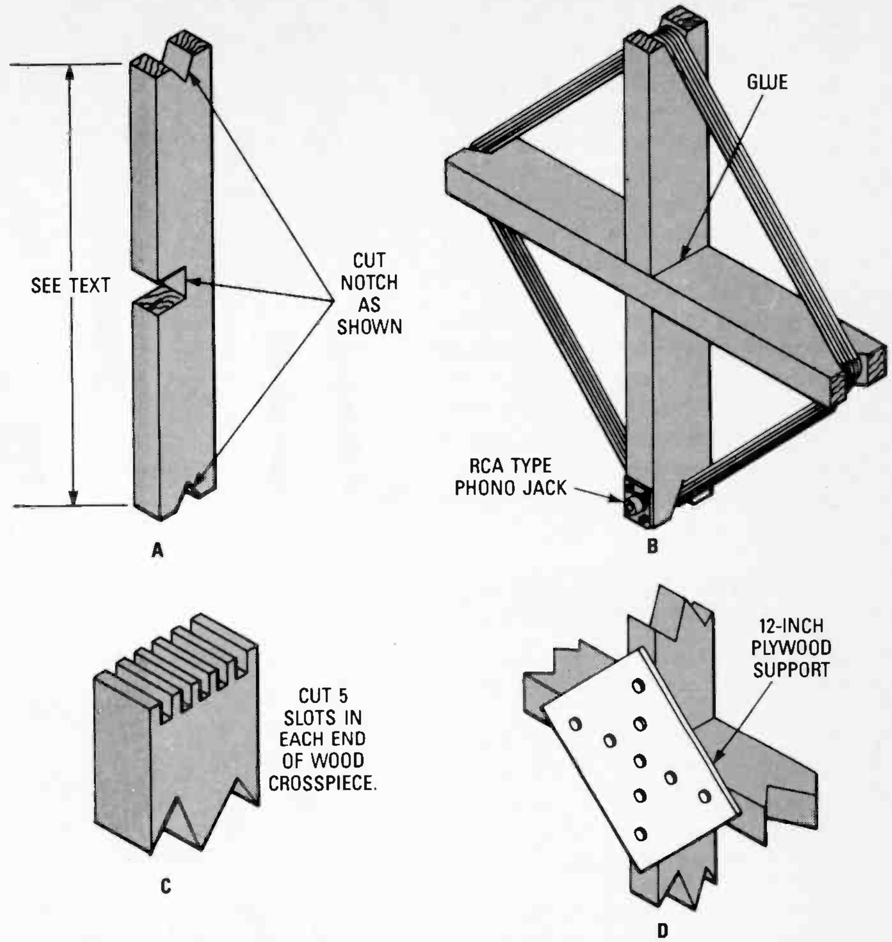


Fig. 5. Here are the construction details for the three antennas tested by the author. This diagram along with Table 1 should make assembling any version of the antennas a snap.

TABLE 1—ANTENNA CONSTRUCTION GUIDE

ANTENNA (L1)	CROSSPIECES (wood length in feet)	WIRE (turns/ gauge)
A	3	80-turns/#28
B	4	28-turns/#22
C	6.5	5-slots (two turns each slot)/#22

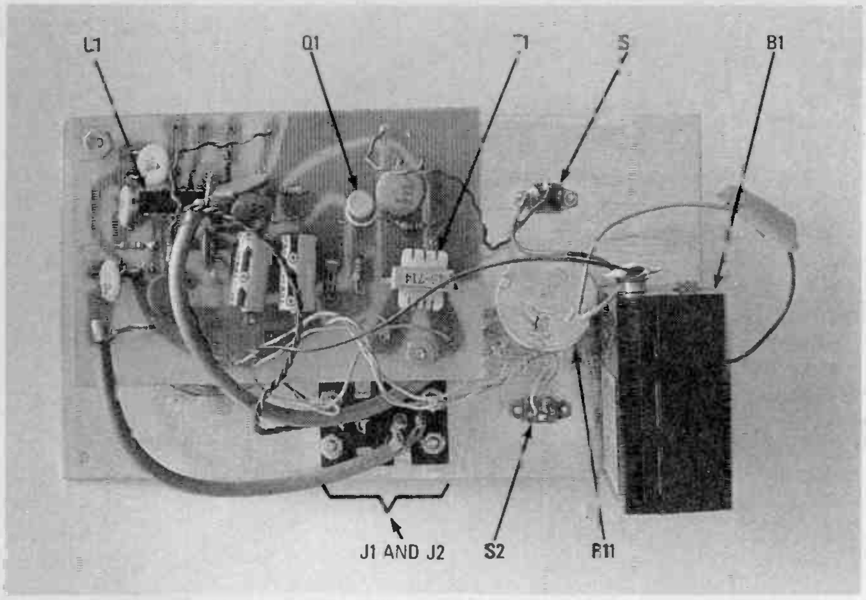
wooden brace, 12-inches square as shown in Fig. 5D, from a piece of plywood.

Now guided by Table 1 for the wire size and number of turns, wind the loop antennas on their respective forms. The wires from each loop should be connected to its own RCA phono jack (J3). Connections between the circuit board and the antennas can be made through a home-made 10- to 15-foot audio patch cord.

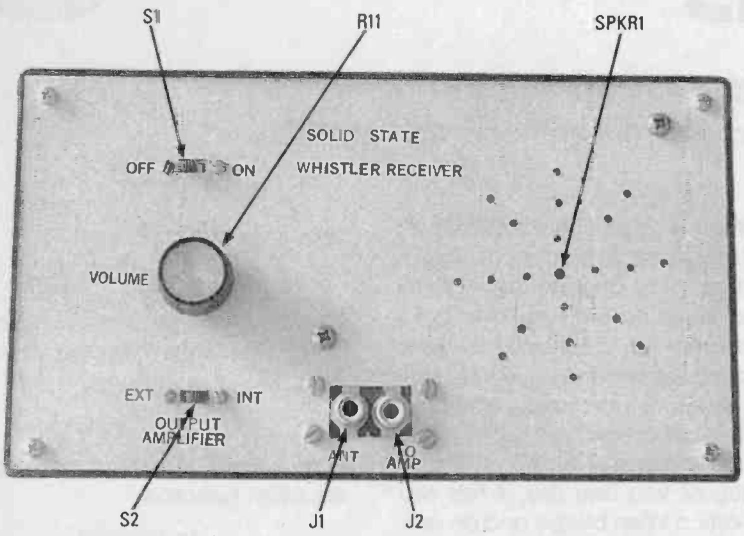
The Thrills Begin. Connect the antenna to the receiver using the audio cable. Place the antenna at least 6 feet from the receiver and position it so that its plane is vertical. Flip S2 to the INT position. For those who desire a room full of whistles, plug one end of an audio cable into J2 and the other end into a 100-watt, hi-fi amplifier. Flip S2 to the EXT position and set the VOLUME control (R11) near its maximum position. A mild hiss should be heard. If a hum or loud buzz is heard, move the antenna to a different location. And be sure to keep it away from the power line!

For test purposes, position the antenna for good reception of the OMEGA signal. Of course, since the OMEGA signal is at such a high pitch, one must have at least normal hearing to hear it reliably. (You must be able to hear sounds as high as 14 kHz). Even with normal hearing, one must listen intently to differentiate the OMEGA signal from background noise.

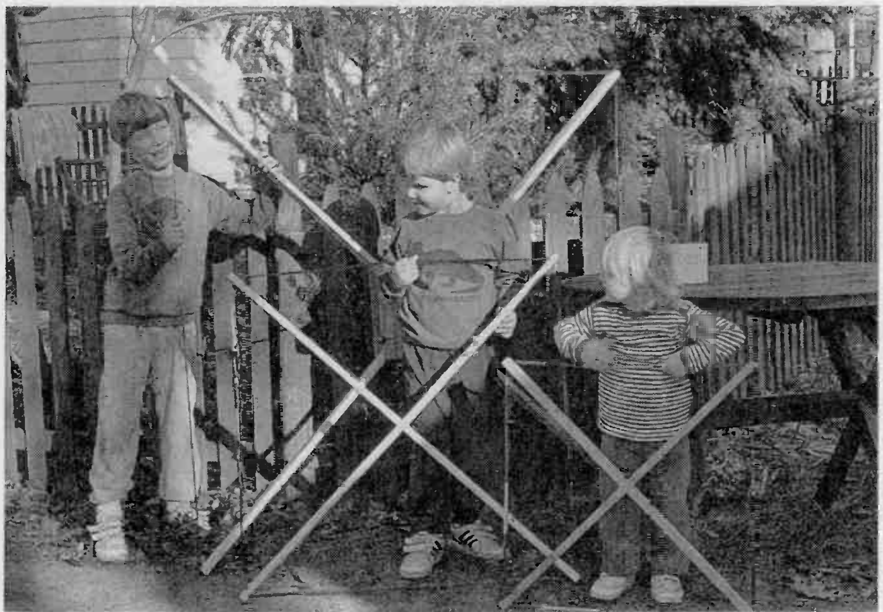
Listening for Whistlers. If you assume that as soon as you flick on the whistler receiver's switch you are going to hear all sorts of weird sounds, you'll probably soon wind up using the loop antenna's frame for kindling. Other than a weak OMEGA signal, you'll most likely only hear noise. However, patience will pay off.



Here is the fully assembled solid-state Whistler Receiver's printed-circuit board.



Close-up of the front panel of author's prototype of his Solid State Whistler Receiver.



The three portable loop antennas, built and tested by the author.

Whistlers are normally heard only when most people are asleep in their beds; they occur most frequently between midnight and dawn. They also are associated with sunspot activity—the more sunspots, the more whistlers. Since we are starting on sunspot Cycle 22, and it appears to be a biggie, the number of whistlers should be increasing in the next few years. During periods of high sunspot activity, one may hear as many as 10 whistlers a minute from 2 to 4 AM.

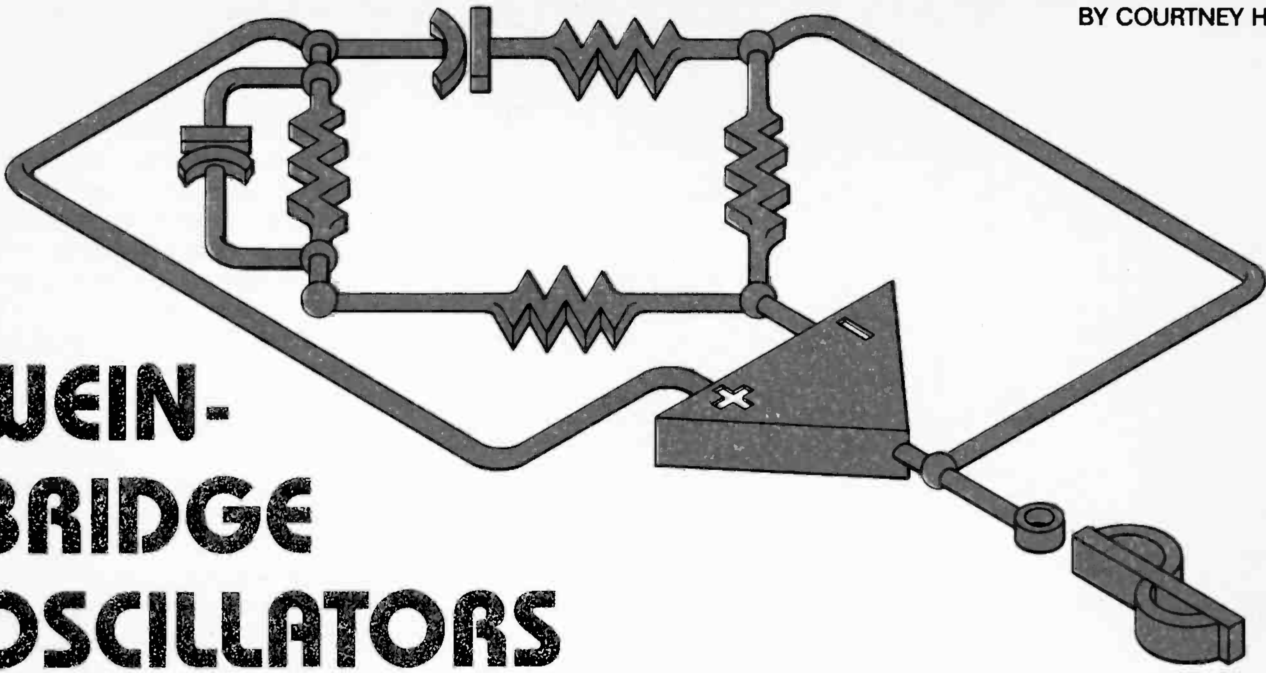
Another fascinating electromagnetic phenomenon that you can pick up on your Whistler Receiver is the "dawn chorus." While this sound is said to be similar to the songs of a flock of birds at the first sign of daylight, a more precise description would be a random series of rising tones in the mid-audio range (1 kHz–4 kHz).

While listening to the dawn chorus early one morning, I also heard for the first time distinct, metallic, clinking noises referred to as tweaks and chinks by VLF researchers. Their origin is an unsolved mystery, although some scientists speculate they may also be related to lightning.

Other Applications. In addition to listening to VLF radio waves, there is an almost unlimited range of phenomenon one can listen to. For instance, take a photovoltaic cell (such as a silicon solar cell) and plug it into the receiver's input. Light a match close to the cell. You will "hear" the match light. Pass your hand in front of the cell and you should hear a click every time a shadow passes across the cell. Point the cell at a fluorescent light and you will "hear" the light turn off and on 120 times per second. (An incandescent lamp will produce a similar sound only it won't be as loud).

By putting the cell near a TV screen, you will hear a similar buzz, only its loudness will vary with the scene. Stick the cell out a window during a thunderstorm and you will "hear" lightning. In fact, you can use the whistler receiver as a thunderstorm detector at night since you will "hear" the lightning well before you can see it. Can you think of another type of sensor to connect to the Whistler Receiver to experiment with? No? How about a small coil of wire such as a telephone pickup coil? Or maybe a UHF TV loop antenna in series with a germanium or Schottky barrier diode? Try them all out for countless hours of experimenting fun. ■

BY COURTNEY HALL



WEIN-BRIDGE OSCILLATORS

Learn about and build a Wien-bridge oscillator to generate high-quality sinewaves for your projects and experiments.

Sinewaves are unique among waveforms. Any other kind of waveform contains multiple sinewaves (harmonics) at various frequencies, and that makes it hard to tell what is going on at any one frequency. With a sinewave, though, you're dealing with only one frequency at a time. Because of that, sinewave oscillators like the *Wein-Bridge Oscillator* have many unique applications in situations where no other instrument will do. For instance, they are required for measuring the frequency response of audio amplifiers and filters.

Also, they are great for producing a sidetone for a ham transmitter or a code-practice oscillator. A clear, mellow tone of an 800- to 1000-Hz sinewave used for sending Morse code is music to the ears of radio operators. They are also of interest to hams because they can be used as audio-sinewave oscillators for modulating RF-signal generators, too.

You'll no doubt find many other applications for a Wien-bridge oscillator because, while it is particularly well suited to produce audio-range frequencies, it can be used up to around 200 kHz. Since they are more versatile than non-sinewave oscillators, and are about as easy to build, it makes sense to build a sinewave oscillator over any other.

Oscillating-Bridge Characteristics. Wien-bridge oscillators have been around for many decades, but they're still one of the easiest circuits to build that generate low distortion sinewaves. The waves they generate are so clean, in fact, that their harmonic distortion is typically less than one percent.

Figure 1 shows a basic circuit for the oscillator. As you can see, it has two main parts: a Wien bridge and an amplifier. Early designs used an amplifier built around two vacuum tubes, but it is common practice in modern circuit design to use an operational amplifier as shown.

Let's deal with the bridge first: the operating frequency (f) is controlled by the left arm of the Wien bridge, which is made up of resistors R1 and R2, and capacitors C1 and C2. The resonant frequency of the network is:

$$f = 1/(2\pi\sqrt{R1R2C1C2})$$

Matters can be simplified considerably if we set the following conditions:

$$R1 = R2 = R$$
$$C1 = C2 = C$$

In that case, the resonant-frequency equation becomes:

$$f = 1/(2\pi RC)$$

where f is in hertz, R is in ohms, and C is in farads.

Drawing the basic circuit in a slightly different way might help us to understand its operation more easily. Redrawing the circuit as shown in Fig. 2, you might notice that there will be some loss of signal through the frequency-determining network between

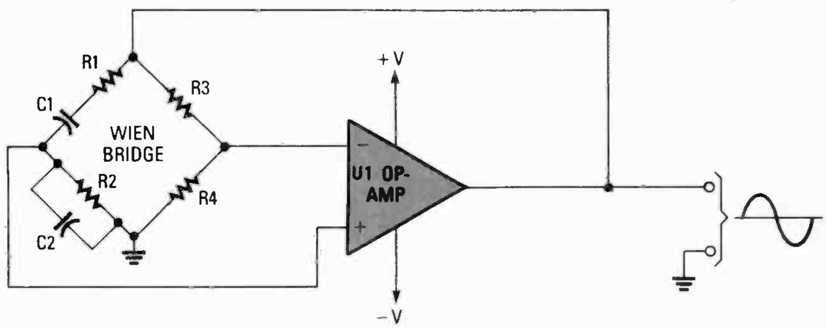


Fig. 1. The modern version of the Wien-bridge oscillator uses an op-amp instead of a two-tube amplifier (which should give you a feel for how old the concept is).

points A and B. The amount of loss can be calculated and graphed for various frequencies to give us insight into what may take place in the circuit.

Figure 3 graphically shows the action of the equations for frequencies from one-tenth of the resonant frequency to ten times the resonant frequency. The amplitude response is shown as a solid curve and the phase angle is shown as a dashed one. (Note that the shape of the amplitude-response curve resembles that of a tuned circuit, which the bridge indeed is.)

Inspection of the figure shows that at the resonant frequency (where the phase shift is zero) the network passes only one-third of the signal from point A. Unfortunately, that is the frequency with the highest possible amplitude; we must therefore make up for that resonant-frequency signal loss in the amplifier stage.

The Amplifier Gain. Circuit theory tells us that we must have positive feedback to the amplifier, and that the voltage gain or amplification around the closed loop must be at least one (unity); if it's less than unity, the circuit won't oscillate. In circuits like ours, where there is no phase shift in the feedback loop, positive feedback is obtained by feeding the output signal back to the non-inverting (+) input of the op-amp. Readers that are familiar with op-amp theory will see right away that the voltage gain of the op-amp from point B to the output can be found from:

$$\text{Gain} = (R3 + R4)/R4 = 1 + R3/R4$$

We have seen previously that the frequency-determining part of the circuit in Fig. 2 reduces the signal to one-third of its value at point A before it reaches the non-inverting input of the op-amp. Therefore, in order to have the required loop gain of one, the op-amp must have a voltage gain of three. That means that R3 must be twice as large as R4. Let's prove that by assigning arbitrary values of 10K and 5K to R3 and R4 respectively, and putting them into the gain equation:

$$\begin{aligned}\text{Gain} &= R3/R4 + 1\\ &= 10{,}000/5000 + 1\\ &= 2 + 1 = 3\end{aligned}$$

Note that in the design we'll present later, some of the resistors connected to the op-amp inputs have such large values that the use of a 741 op-amp would almost certainly result in very large offset voltages at the op-amp output, preventing proper operation. That makes using an op-amp with FET inputs—JFET or MOSFET—mandatory. Because of that, while we'll show a 741 version in an example circuit later, be certain to use a TL082 op-amp as stated in the Parts List when it comes time to build a practical unit.

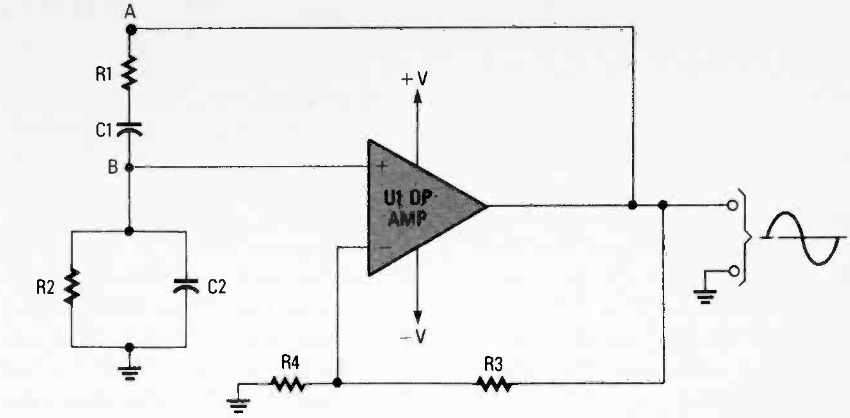


Fig. 2. The signal drops to 1/3 of its value after traveling from A to B. That means the overall gain must be set at 3.

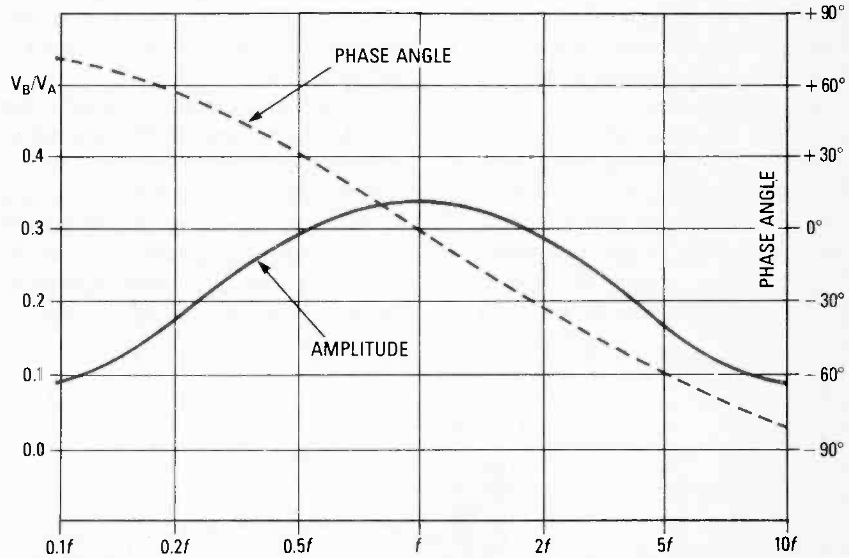


Fig. 3. The resonant wave's amplitude (solid line) is a maximum at the same frequency that phase shift (dashed line) goes to zero. That frequency will be the operating frequency because it will require the least amplification.

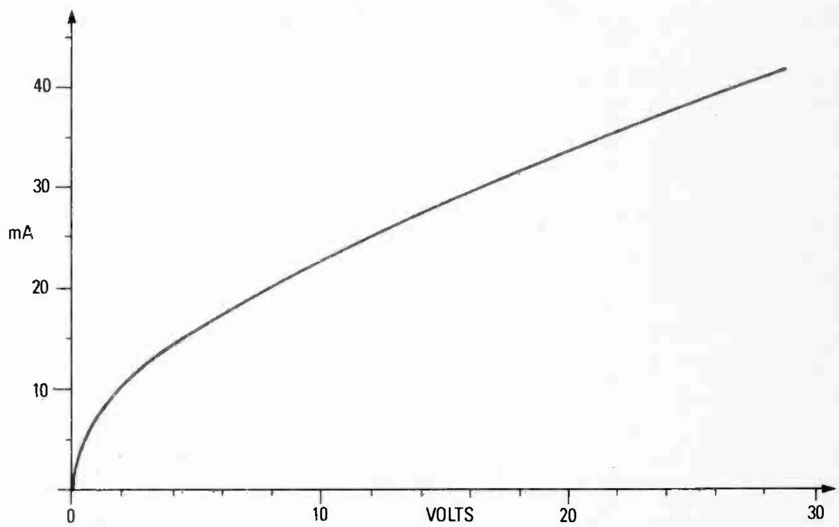


Fig. 4. The strange characteristic curve of an incandescent light bulb will help our oscillator maintain its stability, even if component values or temperature changes.

Another Hurdle. We still have a problem, though: Resistors and capacitors have tolerances so their actual values are only *close* to the value marked on each of them; they almost never have exactly the value marked. If the tolerances of the resistor and capacitor values are such that the loop gain is slightly less than one, the circuit will generate a few waves and grind to a halt. If the tolerances make the loop gain more than one, the output sinewave might be seriously distorted.

You could replace R3 with a variable resistor or trimpot and adjust its value until you had a nice sinewave output. Trouble is, when the room temperature changes a bit or the components age, you have to readjust the trimpot, and that could become tiresome.

Fortunately, there is a simple solution to the problem. Figure 4 shows the voltage-vs.-current characteristic of a type 1819 incandescent pilot lamp. As the voltage across the lamp increases, causing the lamp's tungsten filament to get hotter, the curve becomes more and more horizontal. That's because the tungsten filament's resistance increases as its temperature rises.

When the voltage applied is 2 volts, the current is about 10 mA; that makes the apparent resistance of the bulb 200 ohms. When 28 volts is applied, the current measures about 41 mA, which means the bulb's resistance is 683 ohms; more than three times higher. The sharpest bend in the curve occurs at an applied voltage of 1 to 2 volts, and that is the part of the curve where you get the greatest change in lamp resistance for a given change in applied voltage. (Interestingly, it is just above that sharp bend, at about 3.0 volts, that the lamp filament begins to have a faint red glow.)

By substituting the lamp for R4 in the oscillator circuit (see Fig. 5), it will act as an automatic gain control so that the oscillator will adjust itself to produce a low distortion sinewave. If component aging and/or temperature change cause the oscillator's output voltage to decrease, then the voltage across the lamp also decreases. That causes the lamp's resistance to decrease, and so raises the voltage gain of the op-amp. The higher gain forces the output voltage back up toward its original value. If the oscillator output voltage increases due to aging or temperature, lamp voltage increases, which raises the lamp's resistance. The higher lamp resistance lowers the op-amp gain, and that forces the output voltage back down toward its original value.

PARTS LIST FOR THE WIEN-BRIDGE OSCILLATOR

RESISTORS

(All fixed resistors are 1/4-watt, 1% units.)
R1, R2—22-megohm
R3, R4—2.2-megohm
R5, R6—220,000-ohm
R7—1000-ohm, multi-turn trimmer

CAPACITORS

C1—10–365-pF double-gang variable (Radio Shack 272-1337 or equivalent)
C2, C3—4.7-µF, 35-WVDC electrolytic
C4—3–30-pF trimmer

ADDITIONAL PARTS AND MATERIALS

U1—TL082 dual operational-amplifier integrated circuit
I1—1819 incandescent bulb (Radio Shack 272-1119 or equivalent)
S1—DP3T rotary switch

Perfboard, stand offs, insulated shaft extender or coupler, wire, solder, two 12-volt battery packs, etc.

Filament Operation. The component values given in the schematic diagram will produce an output frequency of about 1000 Hz. Resistor R3 in Fig. 2 has been changed to a trimpot in Fig. 5 to facilitate initial adjustment of the circuit.

If the power-supply voltages are +12 and −12 volts, R3 can be adjusted to result in a clean sinewave output of about 6 volts rms (that is approximately equal to 18 volts peak-to-peak). With 6 volts rms at the oscillator output, and R3 necessarily set for an amplifier gain of three, the voltage across the lamp will be 2 volts rms.

According to the definition of rms (the *R*oot *M*ean *S*quare), 2 volts rms of AC will heat the lamp's filament to the same temperature as 2 volts DC. So as long as we discuss the filament voltage in rms units, we can use the characteristic curve in Fig. 4 to talk about what the bulb's operation will be like. Since the bulb receives 2 volts rms, the operating point will be near the sharp bend in the lamp's characteristic curve. The

(Continued on page 99)

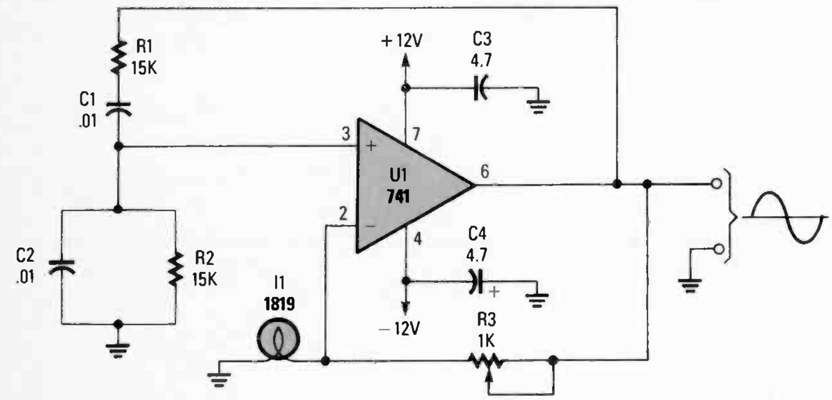


Fig. 5. The incandescent bulb, used as shown, will adjust the circuit's gain.

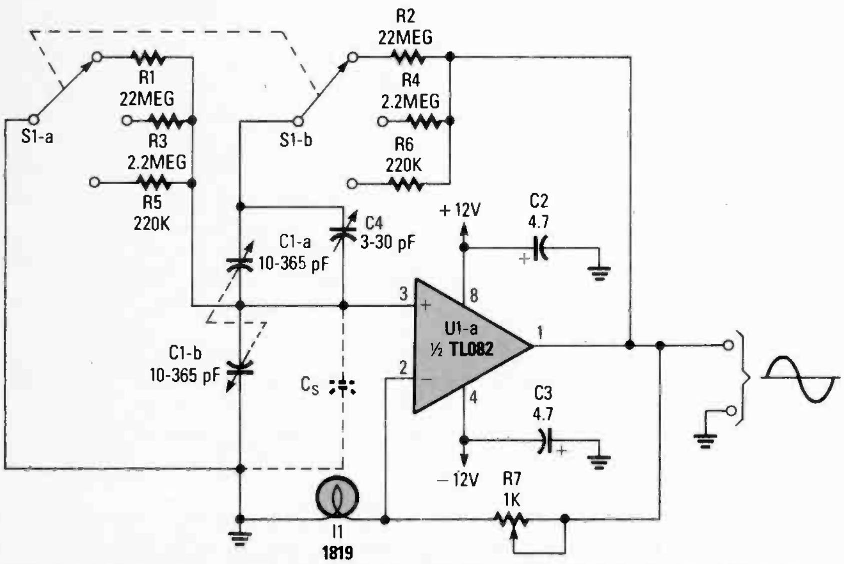


Fig. 6. The full-blown circuit looks like this. Note that a trimmer capacitor is used to balance the ground-coupling capacitance of the bridge.

JULY 1989

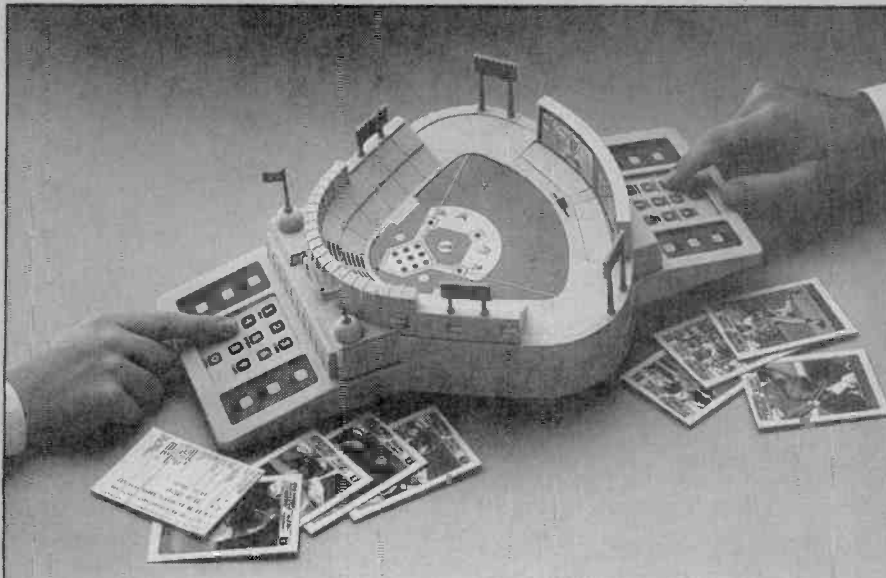
GIZMO®

VOLUME 2,
NUMBER 7

A CHRONICLE OF CONSUMER ELECTRONICS

A Whole New Ball Game

STARTING LINEUP TALKING BASEBALL. Manufactured by: Parker Brothers, 50 Dunham Road, Beverly, MA 01915. Price: $99.95



CIRCLE 50 ON FREE INFORMATION CARD

We've all met the total baseball fan, whose intensity is a reminder that the original term was "fanatic." Name the player—Carleton Fisk, Ricky Henderson, Carl Ripken, Dwight Gooden, Duke Synder, Stan Musial, or Joe DiMaggio—and a true devotee of the diamond will instantly rattle off a statistical profile and an overview of his career.

Starting Lineup Talking Baseball is an electronic game made for just such fans, allowing them to manipulate all-star lineups in fantasy games. It's even intriguing for those of us with slightly less interest in the "national pastime"—but at this time of year, aren't everyone's spirits with the boys of summer?

Starting Lineup is billed as "the most advanced" game of its kind, with a "realistic-sounding" play-by-play announcer, an abundance of possible play combinations, and "statistically driven" electronic action, which makes it the electronic descendent of generations of dice-determined simulated-baseball games. (None of those, however, included a "realistic-sounding announcer"—players had to supply their own chatter—or a miniaturized representation of a baseball stadium.)

Even in the electronic present, where it seems that every sports-simulation game is billed as the "most advanced ever," we were genuinely pleased with Starting Line Up Talking Baseball. Our big gripe regarding other electronic games (**GIZMO**, June 1989) has been that they are ultimately so unchallenging. In this game, which features a quarter-million play combinations with over 15,000 possible contest outcomes, the computer is a hard and wily taskmaster.

You can play the game against the computer, or against another player. The 16-inch-long unit has two 10-button control panels, one at the entrance and one behind the outfield of Starting Lineup's tabletop stadium. An over-sized home plate dominates the diamond. Red lights indicate the path of a pitched ball, and there are red lights at each of the three bases to signify a runner on base.

The game's depth results from its faithful approximation of real baseball. For the true fan, the ability to play Starting Lineup as either player (batter or pitcher) or manager—and the additional option of a "challenge mode," which enables two players to enter into a game in any inning and continue until the finish—comes pretty close to electronic-baseball heaven.

When the player is on the mound, he or she can select fast, curve, or change-up balls. With a .360-batting hitter at the plate, (the lifelike play-by-play that's the recorded voice of a "noted West Coast baseball announcer" provides a rundown on each player's stats), we found that the change-up pitch, in which the ball travels slowest and with the most indirect movement, worked best. We also discovered that pitching the fast ball to a .360 hitter could result in a home run.

After selecting the pitch, a player has the option of selecting a pitch pattern. The keypad's buttons, numbered 1 through 9, correspond to 9 lights in the strike zone of the large home plate. (There is also a zero button, which "throws" an intentional ball.) Acting as the pitcher, the Starting Lineup player can press up to 3 numbers, and they will light up in sequence, indicating the ball's final location over the plate—high, low, inside, outside, or down the middle.

The game offers basic, intermediate, and advanced levels of play. At the basic level, the computer selects the pitch. At the intermediate level, the player selects the fast, curve, or change-up pitch and lets the computer select the strike-zone path. At the advanced level, the player can either press just one numbered key to select the final strike-zone location of the ball, or push a trio of numbers to select its entire path. There's an even higher plateau—the fast-pitch level, in which the lights blink more rapidly than in the normal Starting Lineup game.

The pulsating lights and what they represent are a tricky aspect of the game to master, but they are also what gives the game some of its long-haul amusement potential. When batting, players must watch the blinking lights at home plate before swinging (via a keypad SWING control). On the first blink, the ball leaves

(Continued on page 7)

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This month in GIZMO®

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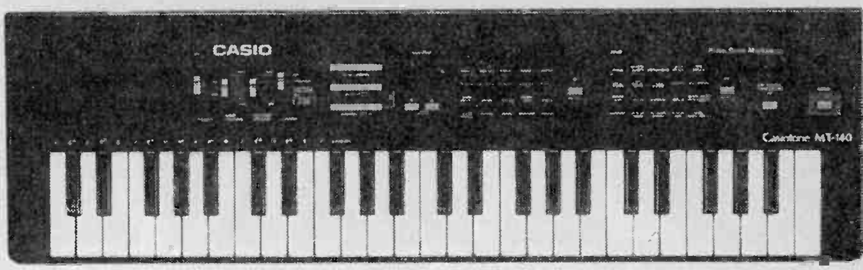


CIRCLE 51 ON FREE INFORMATION CARD

Keyboard Kindergarten

CASIOTONE ELECTRONIC KEYBOARD (MT-240). Manufactured by: Casio, Inc., 570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801. Price: $199.50.

It's only as an adult—when some guy plinking out "Raindrops Keep Falling on My Head" becomes the life of the party—that you realize you should have pursued those piano lessons you scorned as a kid.

Of course, there are other reasons to learn to play music, particularly the simple enjoyment of music. Where does the *Casio MT-240 Electronic Keyboard* fit into all this? With minimal effort, it offers musical klutzes the opportunity to play some semblance of a tune. (Still, remember that all the gimmicry in the world won't take the place of learning the basics.)

The MT-240, part of the Casio line of keyboards, is the lowest priced model that features "MIDI" (Musical Instrument Digital Interface), a technology that has been reshaping the world of music in recent years. Basically, MIDI allows and facilitates the interconnection of musical instruments and computers. That means you can turn your PC into a music-studio component and get a digital translation of everything you do on the keyboard. Using the computer, you can then slow down, overdub, speed up, or change specific bars of a composition.

Frankly, when we purchased the MT-240, MIDI wasn't as much of an inducement as the in-store demonstration. In the store, even a musical klutz with no training or practice could start up that "auto-rhythm" and immediately picture himself as Bill Murray in the throes of his *Saturday Night Live* lounge-act impersonation.

It's when you get home that frustration can rear its vexing head, especially if you possess no musical background. Right there in front of you is an impressive array of musical tones from which to select—there are 200 different sound combinations, integrating the characteristics of 20 preset sounds, ranging from piano, harpsichord, and vibraphone to jazz guitar, accordion, and bells. The sounds achieve amazing fidelity.

There are also 20 "auto-rhythms," ranging from "rock one," "rock two," and "slow rock" to samba, tango, and reggae. With a couple of other buttons, the player can increase or decrease the tempo from between 40 to 256 beats per minute.

So there you are. Now, what? If you're not familiar with the piano keyboard, you can start fooling around—and fooling around is what your "compositions" will sound like when you play them back. The unit has a memory and the capability to record up to 1,250 notes, regardless of how awful they sound.

Fortunately, many stores that sell the MT-240 and comparable units also display a rack of how-to keyboard books. (Such a booklet is a must for beginners, as Casio's instruction manual assumes musical knowledge on the part of the would-be player.) We purchased *Getting Started*, published by Sight & Sound of New Berlin, WI. Using a comic-strip approach, the primer covers such basic musical concepts as chord-accompaniment keys, melody, the musical alphabet, and how to read sheet music. The book also provides "A-B-C-D-E-F-G" stickers for the novice electronic keyboardist to use as "key markers" on the MT-240 keyboard. The booklet also recognizes that we are an impatient lot nowadays. By page 6, it has you playing the melodies to such tunes as "Marianne" and "When the Saints Go Marching In.

Even minimal musical background, of course, increases enjoyment. We know of one outstanding "natural musician" (a chemistry professor who, like many with a mathematical bent, is adept at a variety of traditional instruments), who has fallen in love with this Casio unit.

When you have some basic musical knowledge, you can fully appreciate the many features of the MT-240. By pushing the TONE BANK button, you can access one tone—for example, the organ—as the primary sound, and then add further instrumental voices that integrate with your selected primary sound. That can result in some odd combinations, such as jazz guitar and bells, or it can result in a "rich orchestral texture."

Another feature is "auto-accompaniment." With the CHORD/MIDI selector, the user can access an entire background of bass, chord, *obligatto* line, and rhythm using just one finger. That allows beginning players time to read chord symbols from a piece of sheet music even if they can't quite play actual chords with the left hand.

The PERCUSSION button turns the keyboard into an array of 42 different percussion sounds and effects—bass drum, snare, cymbal shot (great for those at-home, stand-up comedy routines), limbo shot, cowbell, triangle, and even a computer-game sound.

The keyboard is notable for its portability and ease of handling. The molded plastic unit is extremely light, weighing a mere 5.7 pounds. About 26-inches long and 9-inches wide, it can easily be cradled while you recline on the sofa. The unit uses six "AA" batteries; in a gesture toward battery preservation, it will automatically shut off after six minutes of inactivity. An optional adapter is available and recommended. With another adapter, the MT-240 can be powered via a vehicle cigarette lighter for purposes we can only guess at—musically enlivening tedious rush-hour commutes?

Even though we began as musical ignoramuses, we had fun with MT-240. It's also made us aware of how much more we need to know about music basics. But we are learning under the tutelage of this electronic music teacher. Our how-to guide promises that next week we'll master "You Light Up My Life." ■

Easy Listening

HANDS-FREE HEADSET TELEPHONE (SP4). Manufactured by: Plantronics, Inc., 345 Encinal St., Santa Cruz, CA 95060. Price: $89.95.

In many lines of work, headsets are all-important communication tools for those who need both hands free to do the job. From air traffic controllers to commodities traders on the exchange floor, headsets are a necessity—something that allows the user to do his or her job with the upmost efficiency.

Plantronics, Inc. has brought that technology to the home user with its line of hands-free telephone headsets, including the sturdy *SP4*, a telephone in the form of an adjustable lightweight headset. The SP4 telephone consists of a foam-cushion receiver that sits against the user's ear and a black-box base with push-button keypad and ringer. Equipped with a 15-foot modular cord, the SP4 plugs directly into any single-line modular telephone wall jack in the home.

Interestingly, the Plantronics product line is descended from a headset developed by a pilot to free flight crews from heavy and cumbersome headsets of an earlier aviation era. The company has remained an important supplier of headsets and related equipment to both government and industry. We used two Plantronics headsets (the *SP3* in addition to the SP4) that offer some of the same features that are integrated into NASA's flight headsets and the units used by the Chicago Options Exchange.

Both models have a number of features in common, but the SP4 offers more for less money. We purchased the SP3 from AT&T (Plantronics has supplied headset phones to the firm for over two decades), and it lacked a keypad and redial feature. Requiring 4 "AA" batteries, its most irritating aspect was its connection to a standard telephone. We had to take the telephone's receiver off the hook in order to use the headset phone.

The Plantronics SP4 is called a complete headset telephone, with controls and functions including an adjustable headpiece, a microphone, a 12-button dial pad, a flashing-LED on/off indicator, a mute button (which deactivates the unit's microphone so the user can speak to someone present without being heard by the caller), last-number redial, rotary-wheel incoming-volume control, a tone/pulse switch, and a 6-foot cord between the headset and the portable keypad.

Installation—from removing the SP4 from its box, through reading the instructions, to completing our first phone call—took about 10 minutes. The unit's headpiece is easily adjustable and comfortable to wear, although as is the case with other headbands, eyeglasses could create discomfort after a few hours of wearing the SP4.

Feeling like Lily Tomlin's "Ernestine" (the switchboard operator on *Laugh-In*), we punched in the number for time and temperature and got through. In a series of about 50 calls, we had to increase the incoming volume only once, on a call during which the PC printer clattered and a vacuum cleaner roared in the background. The rotary incoming-volume control offers 9 positions, but we seldom use anything beyond 5. For everyday use we keep it on 1, although the company suggests using level 3.

The addition of the SP4 to our home-telephone system doesn't overload the single wall outlet already handling two phones and a message machine. We have five telephones at our number—the "maximum ringer-equivalent number" allowed in many areas (if there are more instruments, they might not all ring)—and this device extends our telephonic flexibility even further. We've also experienced no interference with (or from) radio, television, or other remote-telephone reception in our tests.

More expensive Plantronics instruments are available, including some new models with features like noise-cancellation systems and voice boost. The company's *Liteset* hands-free cordless telephone features an earpiece of remarkable lightness and compactness. A capsule made of saddle-shaped, molded silicone, it perches on the ear while the user moves freely about. The Liteset earpiece can be used in conjunction with a standard wired telephone. Although the SP4's headband unit does the job, the Liteset appears to be the ultimate in hands-free, hassle-free headset telephoning. Whether its extra cost is worth it is something the buyer must decide. All Plantronics products come with a one-year warranty, including the sturdy and reasonably priced SP4. ■

CIRCLE 52 ON FREE INFORMATION CARD

Mighty Micro

PEARLCORDER MICROCASSETTE RECORDER (S-911). Manufactured by: Olympus Corp., Crossways Park, Woodbury, NY 11797. Price: $89.

Few professions depend on tape-recorder performance to the degree that journalism does. Nothing makes an interviewee more uncomfortable than having the reporter frantically scribbling notes or, alternately, fiddling with a malfunctioning tape recorder.

A reliable tape recorder is an essential tool of the trade, which is why it's worth noting how many writers and journalists use *Olympus Pearlcorder Microcassette* units. Available in a number of models, the warhorse of the Pearlcorder line is the *S-911* We've used one in the most demanding situations for two years, and it's still providing flawless service.

The S-911, weighing 7.6 ounces and measuring 5 × 2.4 × 1.1 inches, easily fits into a shirt pocket. The microcassette just as easily fits into the compartment in the front of the palm-sized unit. A counter on the front panel keeps track of tape position. Controls are located on the top and sides of the unit and include a pause switch, a 2-speed option selector, an earphone, remote-control and microphone jacks, volume controls, and fast play—along with the standard STOP, PLAY, FAST-FORWARD, REWIND, and RECORD buttons. A minor but important feature is the RECORDING/BATTERY light, alerting the user to a low battery level. (In any case, it's wise to carry an extra set of "AA" batteries when doing important taping.) An optional Pearlcorder AC adaptor is available from Olympus.

Of course, one key aspect of any recorder is its audio quality. To pirate a Bon Jovi concert at the local stadium, the audiophile should turn elsewhere. Music recorded with the Pearlcorder S-911 sounds tinny and flat. As for conducting surreptitious recordings—keeping the unit hidden under vest or jacket—it might be wiser to consult local law-enforcement agencies to get tips on wires and surveillance. The unit is best used for its intended purpose, to record human speech, ideally sans other sounds or audio distractions.

As such, the S-911 is an extremely efficient recording unit. The "microphone sensitivity control" affords the user a degree of control in setting the level that best suits recording conditions. For recording in a large room, a higher setting is best, while for personal dictation, a lower level is optimum. When set low, it is sensitive to dominant sounds, reducing the amount of background noise recorded. We've conducted dozens of interviews using the S-911, and in the best of circumstances, the voices play back as clearly as a high-powered AM broadcast. When using the machine to take personal notes, the unit records even a whisper clearly. We've used it in the public library without so much as an admonishing "Shhh" from the staff.

The Pearlcorder's plastic casing is a tad on the lightweight side, so care must be taken when traveling with the recorder. The battery compartment can be clumsy to access, and (like many Walkman-type cassette recorders) the battery-compartment cover has a tendency to fall off—a situation that worsens over time as a result of plastic fatigue. Losing the compartment cover has reduced many users to putting Scotch tape on the back to hold the batteries in place.

Another drawback is the placement of the PLAY control. When the unit is not in use, it's very easy to accidentally nudge that button, so the unit runs on and on. That's probably one reason we go through so many "AA" batteries.

Over the years, we've found the S-911's 2-speed tape system to be a genuinely useful feature. Analogous to a VCR's standard and long play, the Pearlcorder system saves tape with seemingly little diminution of audio quality. We usually use 60-minute microcassettes. (They're also available in 90-minute lengths.) On the lower speed, we get one and a half times the recording time per side. At about $2.50 per cassette, we appreciate the savings. Another feature, which conserves time instead of money, is the "fast-forward monitor." Particularly handy for transcription work, it increases ordinary playback speed by 25%. While the effect is chipmunk-like, what's been recorded is still clear and discernible.

Our experience has left us neutral on the question of microcassette vs. standard-size. For on-the-go recording, the micro format's advantages are self-evident. We've found microcassettes to be reliable, although they can be somewhat difficult to find outside of big cities. For recording consistently in the same location, our preference would generally be for the standard audio cassette. In other words, format follows function.

Olympus has developed a number of other Pearlcorder models, newer than the S-911 and more feature packed. Those include the *L200 Microcassette Recorder* and the *Pearlcorder S810*. The state-of-the-art L200, with a suggested list price of $280.50, is claimed to be the world's lightest personal recorder—weighing just 4.4 ounces with batteries. Along with "variable control voice actuated recording," fast-forward and rewinding speeds have been doubled, and the L200 allows the user to insert cue marks at any point in the tape during recording. The automatic cue-marking feature makes finding a particular spot on the cassette simple—the CUE MARK button "tags" the tape, leaving a mark that the machine recognizes during playback or review.

The Pearlcorder S810 is the newest addition to the Olympus line. With a one-touch slide control on the side of the unit, it can be operated with the movement of a single finger. A convenient feature is its "tape-end alarm," which produces a beep at the end of the cassette, letting the user know the tape must be changed. The unit is also capable of music recording, according to the company, which offers two grades ("high fidelity" and "top quality all-purpose") of microcassette, as well as a "cleaning cassette" (*MC-CI*).

The Pearlcorder S-911's longevity, dependability, and adequate audio performance make it a stalwart voice recorder. The S810 and L200 continue its tradition of convenience and reliability while expanding its capabilities.

Since most microcassette recording is conducted in less-than-ideal conditions, a strong, durable, and trusty recorder is a must. Otherwise, an interviewer may find that the clink of restaurant flatware is heard more clearly than the subject's opinions on nuclear disarmament, or a student might miss crucial remarks in a lecture because of paper shuffling and other classroom noises. There's a remedy for those typical microcassette-recording pitfalls, and in our experience it's called a Pearlcorder. ■

Christmas in July

The 86th Annual American International Toy Fair, held February 13–22 in New York, wasn't just about playthings. More important to gizmologists and gadgeteers was a developing conflict in the toy industry between the "back-to-basic" plaything manufacturers, and those who use electronics and video technology in toys and learning tools.

Lionel's Railscope

According to an "advertorial" published by *Nintendo of America, Inc.* in the Toy Fair show daily, "the power of the chip [in toy design] may eventually be exceeded . . . by the potential of CD-ROM and the applications of interactive technology. 1989 will be a milestone year for the [toy] industry as video games move from being labeled as 'hot toys' to representing a new sustained category, built with longevity in mind." The Nintendo statement went on to describe a Japanese product, "the Famicom." Marketed as a home video-game system, Famicom features an external disk drive instead of game cartridges. Users can access "stock information, travel tips, and shopping guides" with the Famicom.

Some American toy manufacturers have started producing software that teaches, because they've perceived video and computer technology as presenting a quick, entertaining, and satisfying way to learn. What's more significant for the child is the gratification of natural curiosity being rewarded and transformed into learning. Many Toy Fair exhibitors presented products that combine electronic play and learning.

Some segments of the toy industry have remained relatively nontechnical. For example, although there were dolls listed under the category of electronics in the Fair directory, the only ones **GIZMO** could find were either familiar talking dolls or retail display models, designed to draw consumers into stores. Interactive technology has yet to develop any strong presence in the doll field.

In other toy categories, however, interactive electronic technology has taken some big strides. *Socrates*, from *Video Technology Industries, Inc.* (400 Anthony Trail, Northbrook, IL 60062) is described as the first comprehensive educational video system to work directly through a TV set without requiring a VCR. Children use a wireless remote-control keyboard to interact with actions on the screen, including math exercises, word and spelling games, music-learning games, and even electronic drawing. Accessory cartridges include "Around the World" (a game similar to "Concentration"), which teaches landmarks and national-flag recognition. The Socrates "base package" retails for about $149. Available options include a voice cartridge ($40), a touch-pad system for pre-schoolers ($50), and a mouse for drawing ($50).

Video Technology's *Little Busy Driver* is an electronic update of a decades-old toy, the auto-dashboard replica that allows the stroller set to "drive." The toy sits in a pre-schooler's lap and features a soft plastic steering wheel, a "car radio" with 8 different songs, a gear shift, and even a car phone. It retails for about $45.

Melody Maker, also from Video Technology, introduces pre-schoolers to the fun of creating music. The board features large, color-coded keys that help the youngster play songs like "Pop Goes the Weasel" in special voices—cow, lamb, dog, or cat—as well as piano. A dozen pre-programmed songs come with it, or the youngster can use the toy to create

Video Technology Industries' Socrates

original songs. The Melody Maker retails for $30.

Last year, *Texas Instruments* (Consumer Products Division, 2305 N University Ave., Lubbock, TX 79415) introduced the *Voyager*, an electronic educational toy that uses interactive voice-recognition technology to present topics in some depth and detail. The Voyager features a unique headset with microphone that asks questions in a synthetic voice and reacts to the user's "yes," "no," "true," and "false" responses with encouragement, rewards, sound effects, and more challenging questions. The Voyager is sold with one software cartridge, "Journey to the Prehistoric World." Three new cartridges were announced at the Toy Fair: "Journey to U.S. Presidents," "Journey to Human Anatomy," and "Journey to the Language Arts." Each costs $19.95 and comes with a 36-page activity guide. Voyager ($70), aimed at kids 5 through 9, has earned awards from *Industrial Design* and recognition from *Time*, *Fortune*, and *Business Week* for its innovative design.

One of America's more traditional playthings, the electric train, has been updated by *Lionel Trains, Inc.* (26750 Twenty-three Mile Rd., Mt. Clemens, MI 48045). The Lionel *Railscope* black-and-white video-camera system lets the user experience the ride from the train engineer's point of view. The new S-gauge *American Flyer Rail Scope Locomotive* has a miniature video camera (1/64 actual size) with a field of vision of 22 degrees (wider than from the engineer's cab in a full-size locomotive) mounted inside twin diesels. The track is seen clearly via a lens which focuses from 2 inches to infinity, so both near and far objects are in focus. A charge-coupled device uses the track as its wire, while the receiver is disguised as a stack of lumber. The American Flyer system uses a 9-volt battery and retails for $375. There's a black-and-white TV available from Lionel for $100, but this seeing-eye electric train can also be used with an ordinary TV or monitor.

Another innovative toy using television was unveiled by the venerable *View-Master Ideal Group, Inc.* (P.O. Box 100, Portland, OR 97207). The firm's *Interactive Vision Television System*, scheduled for introduction this summer, is of the new genre of electronic playthings designed to give kids choices. Youngsters simply pick up the gray-plastic electronic controller and when "Big Bird" or "Mickey Mouse" asks them to help, they press the unit's colored buttons or manipulate the joystick to create a story, song, or game; follow mazes; or answer questions. Characters from the Disney Studio, *Sesame Street*, and Jim Henson's Muppets acknowledge their commands and respond to them. Interactive Vision teaches elementary skills to children ages 3 to 8 and features 12-color graphics and two audio tracks. The system has a suggested retail price of $129.99.

The *Sound Story Books* from *Sight & Sound, Inc.* (3200 S. 166th St., New Berlin, WI 53151) features built-in, life-like audio. When the child pushes the Bugs Bunny "sound picture" and hears "What's up, Doc?" the voice is Mel Blanc's—just like in the cartoons, but it sounds as if Bugs is right there. The Sound Story Books use digitally sampled, synthesized speech from an IC that was developed by the firm that fathered speech synthesis. The books' mylar speakers sounded crisp and clear in the noisy Toy Fair exhibition hall. Power is provided by watch-style batteries. Six titles will be released this year, through licenses with *Looney Tunes*, *Peanuts* and *Disney*. The price per book is $20.

Barbara Thompson, a designer who helped develop a number of educational toys for Texas Instruments and worked on the development of *Magnavox's Videowriter*, has struck out on her own with *Tutor Toys, Inc.* (701 Scarborough Rd., Suite 2032, Oak Ridge, TN 37830). At the Toy Fair, Tutor exhibited the prototype of its *Tutor Clock*, which teaches children ages 5 to 9 how to recognize the relationship between a digital clock and the traditional analog dial, even as it teaches time telling and serves as a timepiece in the child's room. After the youngster plays with it, the Time Tutor even resets itself to the correct time. Power is provided by 4 "C" batteries. Scheduled for an August market introduction, Tutor Clock will retail for $69.

Other teaching toys are being developed by this new firm, including the *Money Machine*, which teaches cash-handling skills for kindergarten through sixth grade youngsters; and *Triple Quest*, an electronic quiz game.

Perhaps the most fun **GIZMO** had at the Toy Fair was with *Dyna Mike*, a new product from *Ohio Art Company* (1 Toy St., Bryan, OH 43506), of *Etch-A-Sketch* fame. A voice-transforming microphone, Dyna Mike gives the user a choice of 16 different voices, from Darth Vader to Michael Jackson. The unit can be used standing alone or can be connected to a "boom box" for greater volume. Aimed at consumers 3 years old and up, it's scheduled for a mid-year market release.

Milton Bradley (443 Shaker Rd., East Longmeadow, MA 01028) showcased its new *Jordan vs. Bird: One-on-One* cartridge for use with the Nintendo game system. It allows the user to maneuver his favorite basketball player in competition against another flesh-and-blood player or

Ohio Art's Dyna Mike

against the system. The user can soar up in the "Air Jordan slam-dunk contest" or run-and-gun in the "Larry Bird three-point shoot-out." For kids 8 and up (or for grown-up kids of all ages), its suggested retail price is $40.

In the category of electronic musical instruments, the distinction between "toys" and "grown-up" products can become rather blurred. *Casio, Inc.* (570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801), among the leading manufacturers of digital-sampling keyboards for amateur and professional musicians, exhibited keyboards for kids including the *EP-10*, for youngsters 5 to 9; the *EP-20*, for 10- through 12-year-olds, and the *EP-30* for older pre-teens. These keyboards have pictures of familiar characters (like Miss Piggy from the Muppets) on them and feature advanced sound technology. Demonstration tunes are stored in the unit's memory. The keyboards are small for tiny hands—but adults may be tempted to express themselves, too. These kiddie keyboards carry a suggested retail tag of $69.95.

Remco Toys (1107 Broadway, New York, NY 10010) has teamed with *Kawasaki*, a Japanese firm active in the electronic-instrument field, to produce a line of *Kawasaki for Kids One Man Jam* digital electronic instruments, including a drum set and a guitar. Aimed at youngsters 7 years old and older, the programmable sounds-equipped guitar is described as "the first guitar that someone with no musical knowledge can play."

We have played the guitar, but that experience didn't get in the way when we gave the Remco instrument a hands-on examination. We pushed buttons on the neck of the guitar to choose the chords and then plucked the strings to advance the chord progression from dominant to fifth to seventh, a musical structure found in most popular songs. It was also possible to play in minor keys. Players are given a choice of tones—rhythm, bass, chord, or lead (for single notes or melodies). The instrument incorporates echo reverberation and a "wah-wah" option, too. Its real strings never go out of tune (tuning can be very frustrating for anyone from a back-porch strummer to an arena-circuit rock star). The guitar has a built-in amplifier, or it can be connected to a home-audio system. The Remco-Kawasaki guitar has a suggested retail price of $85 to $95. Other manufacturers showcasing electronic guitars included *Tyco* (6000 Midlantic Dr., Mt. Laurel, NJ 08054), whose *Hot Lixx* seems to be aimed at aspiring teen-age musicians; and *Fisher-Price* (Division of Quaker Oats Co., East Aurora, NY 14052), whose *Kidtronics*, for kids 4–8 years old, has prerecorded chords in different octaves and "strum bars" instead of conventional strings. It retails for $60.

Also shown by Fisher-Price was a product aimed at parents, a nursery monitor ($60) that was first introduced five years ago. The 1989 edition features a "variable sound level display" that allows mom and dad to both see and hear the level of sound coming from the child's room. Powered either with batteries or via a wall outlet, it can go where the family does.

American retailers sold some $12.75 billion worth of toys last year. In addition, an estimated $1.8 billion was spent by consumers on video games. As such a vast industry, toys play a major role in the development of consumer-electronic products. Many consumers are first introduced to computer chips and microcomputers and other electronic technology by toys. Undoubtedly of more importance, toys can teach youngsters about electronics, preparing them for the brave new digital world. As the Toy Fair's organizer, the Toy Manufacturers of America, observed in its *Toy Industry Fact Book*, "Most toys are miniature replicas of what is popular in adult society." That suggests that for coming generations, the importance of well-designed electronic toys goes well beyond pastime and amusement. ■

STARTING LINEUP

(Continued from page 1)

the pitcher's hand; by the fifth, the hurled ball is over the plate; the sixth blink means it's in the catcher's mitt.

Game action is easier to describe than to master. At the basic level, a player presses SWING before the fifth blink, and the computer determines the swing based solely on the hitter's stats. At the intermediate level, if the player judges the ball to be headed for the strike zone, the swing is activated between the fifth and sixth blinks. Pressing SWING early pulls the ball, and pressing it late hits it to the opposite field, just like in the real game.

The advanced player watches the path of the ball as the lights blink at home plate and, based on a reading of the light pattern, attempts to figure out what sort of pitch it is and where the ball will fall in the strike zone. To hit the ball, instead of using the SWING button, the at-bat player presses one of the buttons numbered 1 through 9, based on his call of where the ball will fall in the strike zone. The button must be pressed between the fifth and sixth blinks; otherwise it's a strike. We were consistently frustrated, ending up mostly with strikes. But as the instruction manual points out, that level is for those who have developed "good timing"—something we've seldom been accused of.

The game offers a variety of other "real-life" play options for both sides. When pitching, an intentional walk can be selected. Pressing PICK OFF tells the computer to try to pick off a runner at base; the outcome is determined by how good a base runner the represented player is. Players can select a relief pitcher, or press INFIELD IN to increase the chances of throwing a runner out at home on a ground ball or bunt. Designated hitters are allowed. The batter can elect to bunt, or go for a "power" hit (increasing the chance of a home run, but decreasing the chances of a safe hit). There's even a "steal" option that's available when there is at least one runner on base.

Especially when trying to steal a base, it's helpful to use the baseball-information cards that come with the game (universally recognizable as baseball trading cards). There's no point in pressing STEAL for a runner who rarely tries base-path larceny in real life.

The player whose team is at bat can opt to play the game as the third-base coach, giving the steal sign and generally providing offensive strategy. The unit also allows play in a "manager" mode, bringing to electronically simulated life fantasies of what strategy should have been pursued during some crucial real-life play. You can order the computer to pull the pitcher off the mound, or make a runner try a steal, to see if the outcome of some classic match-up would have changed.

The unit also allows players to begin a game at any inning, with a preset score. Besides allowing shorter games, that feature gives players another way to set up famous games, making changes to see how the computer would decide the outcome based on the new factors that are introduced.

Programmed into the game are statistics for 40 big-league stars of the current era, on American and National League teams. The unit also features a cartridge with the names and statistics of 20 members of the Baseball Hall of Fame, including such inevitable greats as Babe Ruth, Lou Gehrig, Cy Young, Willie Mays, and Roy Campanella. An additional 8 cartridges (available at a cost of $20.00 each) contain the statistics of some 500 players from 26 major-league teams.

The unit is large enough that two people sitting at a table can comfortably play Starting Lineup, in contrast to some electronic sports games so diminutive as to effectively be one-person contests. Its "patented speech technology" realistically reproduces all the evocative sounds of a crowd. Even the crack of a bat sounds nostalgically authentic, and the laconic, unnamed "West Coast announcer" almost makes the player believe he is hearing the game on the radio.

The game uses 4 "C"-size batteries, which have thus far lasted well into our own Starting Lineup season. On a lazy weekend afternoon, the game will provide hours of intricate enjoyment. What more could anyone ask from a baseball game, electronic or otherwise? ■

CIRCLE 54 ON FREE INFORMATION CARD

Save Your Breath

MEMO ME VOICE BOX (ME-10S). Distributed by: Marco Polo Enterprises, U.S.A., 2622 Quaker Ridge Pl., Ontario, CA 91761. Price: $69.95.

There are a number of electronic-voice memo devices on the market—units that allow tapeless recording and playback of messages—but the one that caught our attention is called the *Memo Me Voice Box*. Besides its use of microchip technology, the product incorporates a passive infrared sensor. When the Memo Me detects movement, it repeats its prerecorded message. Applications, both commercial and domestic, are fairly straightforward. Instead of leaving a handwritten note on the refrigerator door, families could use this talking box for communication. Retailers might use it as a sales tool, for drawing customers' attention to specials or directing them in the store.

The rectangular unit (smaller than a quart of milk but bigger than a box of kitchen matches) is also straightforward in design. The *ME-10S's* front panel incorporates the unit's motion sensor, loudspeaker, microphone, and LCD recording-indicator lamp. Power is supplied either with a 9-volt battery (not included) or through an AC adapter. There are three switches (two on the back and one inside the battery compartment): power, a two-position volume control, and a message-duration setting of either 8 or 16 seconds. The instruction sheet says that the "eight second position is recommended for the clearest playback" for this model. (There's also a Memo Me *ME-20S*.)

On the unit's top is a sensor-on/-off switch and a RECORD/ERASE button. To record a message, the user turns the sensor off and presses down on the RECORD/ERASE control. Holding the Memo Me at a distance of 4 to 6 inches, the message is spoken into the front-panel microphone. At the end of 8 or 16 seconds, the LCD lamp turns off, indicating that time is up. Erasing is as simple as recording. The user turns the sensor off and depresses the RECORD/ERASE button momentarily to erase a message. The Memo Me is so easy to use that carrying one to record instant messages is certainly practical.

However, on either of the duration or volume settings (or any combination of the two), the Memo Me ME-10S produces a rather harsh, strident voice—not very suitable, to our ears, for retail use. The effect on consumers, already assaulted by thousands of audio stimuli daily, might be rather irritating. The Memo Me's tone is more appropriate to a military drill field than the aisles of a department store.

On the other hand, it probably closely approximates the tone of communication, at least on some topics, between parents and their offspring. Instead of claiming, "I've told you a thousand times to clean up your room," the Memo Me-equipped parent could record the appropriate message ("Egbert, clean up your room!") and literally repeat the admonition thousands of times. Can't seem to get a clerk's or food server's attention? Recording a message and placing the activated unit in earshot of the store or restaurant employee is guaranteed to bring a response. Instead of wasting your breath, steadily waving a hand in front of the motion sensor (the effective range is listed as 12 to 16 feet) will endlessly repeat your appeal.

The manufacturer suggests using the unit in a stationary location; it's outfitted with a key slot in the back to facilitate installation on any flat vertical surface.

Maybe it's an occupational hazard, but here at **GIZMO** our first reaction to any number of new products is to imagine them as movie or TV-program props, devices which could fit neatly into the plots of all manner of drama and comedy. A TV police-show villain could use a Memo Me to establish a false alibi—"But I heard Bill in his office at the time of the murder." After the final commercial interruption, the detective would discover the culprit's Memo Me.

Within the limits of a 16-second message, Memo Me's applications (offbeat and mundane) appear near endless. In the rap-music field, the Memo Me could win widespread acceptance as another weapon in the recording artists' arsenal of audio effects (and a budget-priced one at that). We could even imagine an *avant garde* art show in which scores of these chatty objects are placed so their message (or messages) goes off in sequence, or overlaps as the exhibit viewers walk by. What we can't picture, however, is using the Memo Me as a personal-memo unit. Because of its squawky electronic voice, that would be akin to using a bullhorn for communicating in an office setting. ■

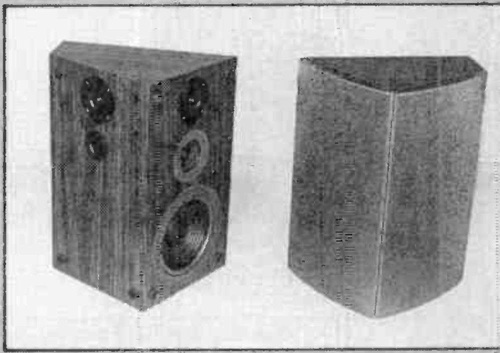
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Bookshelf Imaging Loudspeaker

The much acclaimed "three-dimensional sound field and musically accurate tonal balance" previously offered by larger speakers is now available in the *Bookshelf Soundfield Imaging Loudspeaker (SF 5000)* from *dbx* (Consumer Products, P.O. Box 100C, Newton, MA 02195). Listeners aren't fastened to a spot midway between the speakers in order to experience satisfactory stereo imaging with these dbx units. Available in either a walnut or black finish with color-matched speaker grilles, the unit measures 11¾ inches wide by 15⅛ inches high and 7¾ inches deep. Each speaker weighs 13 pounds, and power is rated at 30–150 watts per channel. Price: (per pair): $450.

CIRCLE 55 ON FREE INFORMATION CARD



dbx Bookshelf Speakers

Electronic Lettering System

From *Casio, Inc.* (570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801), the *Digital Writer (HW-1)* will print on any flat surface. It is perfect, according to Casio, for "printing on index cards, file folders, photo albums, cassette-tape cartridges, transparencies, and numerous other items." The user types letters into the HW-1 (its data storage is rated at 2,066 characters). Then, using the printer wand like a pen, the lettering is transferred to the selected surface by sliding the wand from left to right. The HW-1 beeps when printing is complete. Standard accessories include black-ink cassettes and a battery charger than brings the unit to full charge in about 8 hours. The HW-1 also will function as a 10-digit calculator. Optional accessories include ink cartridges in blue, red, gold, and silver, and a RAM card that will hold up to 53,000 characters. The product offers users a choice of eight different type styles and graphic effects, and features a built-in telephone directory that can store up to 272 names and phone numbers. A memo area allows the user to jot down all kinds of information for later retrieval. Price: $299.95

CIRCLE 56 ON FREE INFORMATION CARD

Casio Digital Writer

Video-Game Carrying Case

More and more kids are getting hooked on video games, and some get upset when they have to go to grandmother's house without their favorite electronic game. The *Voyager Video Game System Carry Case* from *Lebo* (60 West Street, Bloomfield, NJ 07003-4998), however, allows the games to go with the players. Lebo's storage bag holds a complete Nintendo, Sega, or Atari entertainment system, including control deck, accessories, cartridges, and player guides. A dual-zipper flap opens easily and a movable Velcro divider adjusts to fit individual storage needs. There's also a zippered outer pocket, in case the youngster wants to bring along a book to read on the way to grandmother's house. The bag, says Lebo, is perfect for the overnight trip and features strong nylon grips and padded shoulder straps. Price: $19.95.

CIRCLE 57 ON FREE INFORMATION CARD

Lebo Video Game Carrying Case

Personal-Stereo Speakers

One problem with the personal-stereo phenomena is that the popular mini sound systems sometimes isolate individuals behind their headphones. But if you have a special tape or music broadcast you'd like to share with a friend, just unplug the headphones and plug in the *Memorex Mini-Stereo Speakers (MPS750)* from *Memtek Products* (P.O. Box 901021, Fort Worth, TX 76101). These flat speakers have 27% more surface area than conventional cone speakers and reduce vibrations by 50%. The 4-ohm speakers weigh just 16 ounces and feature 86-dB/mW ±2 sensitivity, 1000-mW maximum input, and 180- to 20,000-Hz frequency response. Price: $19.95.

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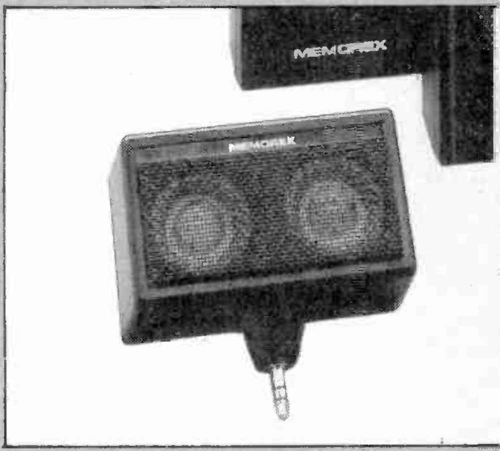


Memorex Personal-Stereo Speakers

ELECTRONICS WISH LIST

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

Soundesign CD Rack System

CD Rack System

Music fans who are looking for a complete audio system at a reasonable price might consider the *CD Rack System (CD63P66)* from *Soundesign* (400 Plaza Two, Jersey City, NJ 07311). The system contains a compact-disc player, a dual-cassette deck, a tuner/amplifier, and a turntable. Its CD player features a 3-beam, one-laser pickup system for stable tracking and a 15-program, random-access memory so that users can listen to music in any sequence. The cassette deck allows continuous play for hours of uninterrupted music. The amp features three-band graphic equalizers for the left and right stereo channels. Price: $419.

CIRCLE 59 ON FREE INFORMATION CARD

Video Technology Talking Rallyracer

Electronic Race Game

The excitement of a video arcade is brought home in a self-contained *Electronic Talking Rallyracer*, a fast-paced favorite of racing fans. The game, from *Video Technology* (400 Anthony Trail, Northbrook, IL 60062), is packed with animated action, special effects, and realistic sound—sound effects include squealing tires, crashes, thunder, and a play-by-play announcer. It allows the player to get behind the wheel and try to beat other cars in a race around sharp corners, over slippery roads, and past fences bordering narrow turns. There's a fuel gauge so the racer will know when to pull over into the pits. Price: $45.

CIRCLE 60 ON FREE INFORMATION CARD

Konica 35mm Camera

Compact Automatic 35mm Camera

Konica U.S.A., Inc. (440 Sylvan Ave., Englewood Cliffs, NJ 07632) is calling the new *A4 Compact Automatic 35mm Camera* "the world's smallest and lightest fully automatic" camera. Pocket-size, the camera features a retractable lens; a precise, 23-step, infrared auto-focus system; 3-second recharge auto flash; automatic film transport; and an LCD information panel. Powered by a 3-volt lithium battery, the A4 comes in either black or silver. Market introduction is scheduled for the spring. Price: $310.

CIRCLE 61 ON FREE INFORMATION CARD

Battery Handbook

With the *Battery Handbook* from *Maxell Corporation of America* consumers can get the most from their portable power sources. The handbook offers use, care, and capability information on various battery types used in everything from toys to camcorders. The handbook answers commonly asked questions like "Can batteries expire if they are not used?" and "How long will a silver-oxide battery last?" It also supplies important safety tips to ensure proper usage and breaks down the complicated array of battery choices so the user gets the most power for his money. It's available by sending a self-addressed, stamped (25 cents), No. 10 envelope to an address specially established for the booklet: Maxell Battery Brochure, P.O. Box CN4780, Trenton, NJ 08650. Price: Free.

CIRCLE 62 ON FREE INFORMATION CARD

Zenith Projection TV

Projection Television

Home-entertainment areas are beginning to resemble movie theaters. After announcing its new *Rear Projection Television System (PV4667)*, Zenith says, "The only thing we left out was the popcorn machine." *Zenith Electronics Corp.* (1000 Milwaukee Ave., Glenview, IL 60025) has long been on the leading edge of the big-TV market. This 46-incher has 520 "footlamberts" for a bright picture, and features a powerful sound system that includes *Dolby Surround Sound, Bose Acoustimass* television sound, and a new Zenith 3-channel system. In addition to the 5-speaker system built into the TV, a separate speaker unit is included that can be snapped apart into two components and placed in opposite corners of the room. Bring on the popcorn. Price: $3,295.

CIRCLE 63 ON FREE INFORMATION CARD

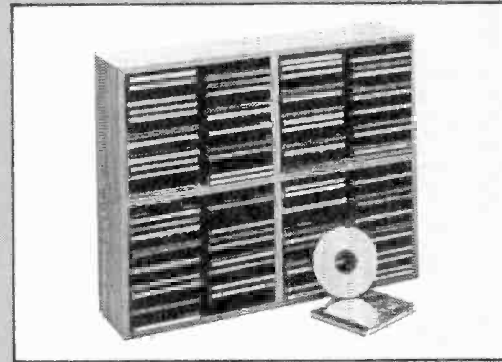
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Compact Disc Cabinet

The compact-disc explosion has created a demand for new storage systems. One approach is the oak-veneer *Compact Disc Cabinet (ODC-120)* from *Case Logic, Inc.* (6930 Winchester Circle, Boulder CO 80301). The unit holds 120 CD's and incorporates heavy-duty plastic inserts to provide precise, proportional spacing for individual compact discs. It stands 17½ inches high, is 22¾ inches wide, and 5½ inches deep. Price: $59.95.

CIRCLE 64 ON FREE INFORMATION CARD



Case Logic CD Cabinet

Sailing Watch

Here's another specialty watch, this one with the sailor in mind. The *Timex Victory* includes a host of features designed to make yacht racing a more precise adventure. Available from *Timex Corporation* (P.O. Box 2126, Waterbury, CT 06722), the watch has a patented pre-set racing-countdown timer that displays the final five minutes before race start in an LCD readout, and audio alarms that sound with increasing frequency as starting time approaches. A tack-ratio computer allows the racer to make an electronic practice run to determine the final approach. A tide ring allows calculation of tidal movements, and a strap extender lets the sailor wear the watch over foul-weather gear. The watch also has a large top-mounted start button, 12- and 24-hour clock, date display, and 2 chronographs with split-time capacity. Price: $75.

CIRCLE 65 ON FREE INFORMATION CARD

Timex Victory Yachting Watch

Electronic Typewriter

Even in the age of the computer, the electronic typewriter remains a useful item. The new *Intelliwriter Plus (PA3140)* from *Sharp Electronics* (Sharp Plaza, Mahwah, NJ 07430), is a fully contemporary keyboard. It has a built-in thesaurus that lists words and meanings, an 80,000-word dictionary, 15,000-character text memory, address-storage capability, and easy full-line correction. The design features a more-prominent placement of "key features and labels" in an easy-to-use system that utilizes color-coded mode and code keys. The company says that for those who use a typewriter this machine "offers an unbeatable combination of features and value." Price: $399.99.

CIRCLE 66 ON FREE INFORMATION CARD

Sharp Portable Typewriter

Heart-Rate Monitor

The fine art of exercising can be dangerous, and the jogger or walker is wise to know where he stands at all times. The *Pro/Trainer Watch (8733)* from *Computer Instruments Corp.* (100 Madison Ave., Hempstead, NY 11550) allows wary exercisers to keep on top of what their bodies are doing at all times. Using a chest-strap transmitter, the heart rate is sent wirelessly to the wristwatch. The watch displays the heart rate and also gives the time of day or stop-watch time. Its high and low alarms can be set based on exercise goals or limits, assuring maximum benefit from the activity without pushing too hard or under-performing. Price: $249.

CIRCLE 67 ON FREE INFORMATION CARD

Cordless Phone

The march of technology continues to produce improved telephone products. One is the *Excursion Phone (3620S)* from *Northwestern Bell* (9394 W. Dodge Road, Omaha, NE 69114). Actually two phones in one, it features two keypads, one on the base and one on the handset, and twin speakers. Each keypad can be used independently; the phone can even be used to carry conversations between parties at the handset and on the speakerphone. The phone base alerts family members that a call is in remote progress with a "line-in-use" display. The unit has high-quality sound transmission and automatically scans 10 channels for the one with the clearest reception. Other features include 20-number memory, 256 possible security codes, hold, mute, and auto redial. Price: $199.99.

CIRCLE 68 ON FREE INFORMATION CARD

Northwestern Bell Cordless Telephone

ELECTRONICS WISH LIST

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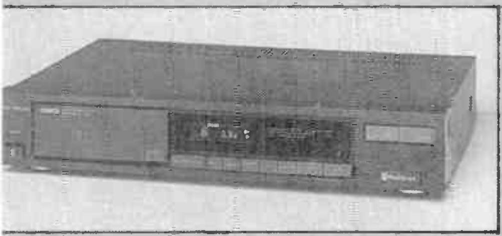

Sherwood CD Player

Compact-Disc Player

As the compact-disc market continues to grow, for those looking to join the crowd at the CD racks in what were once "record" stores, here's a *Compact Disc Player (CD-1160-R)* from *Sherwood* (13845 Artesia Blvd., Cerritos, CA 90701). It contains the company's exclusive "Digilink" feature, which allows a listener to use remote control to send commands to other hard-wired components. The unit features the usual skip/search, repeat, random-play, and program-review functions. It has an LCD display and comes in a brushed-aluminum case. Price: $249.95.

CIRCLE 69 ON FREE INFORMATION CARD

Planum Remote Phone Forwarder

Phone Forwarder

You'll never miss another important call if you equip your home or office telephone with the *Cynex* Phone Forward Remote Access Unit (CD-84) from *Planum Technology Corp.* (1413 Chestnut Ave., Hillside, NJ 07205). The device allows the user to program and access the phone company's call-forwarding service to full advantage. Connected to the telephone and activated by a ring, the Remote Access unit overcomes the problem of inputting new instructions to call forwarding from a remote location. There's also a security system that prevents unauthorized individuals from forwarding your calls. Price: $119.

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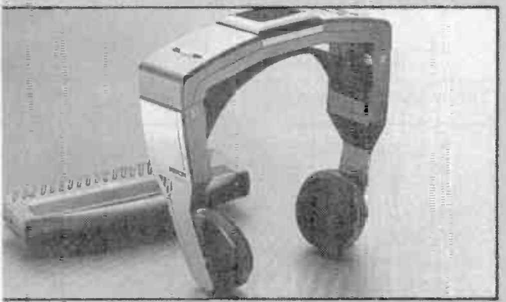

Arkon Solosound II Cordless Headphone

Wireless Headphone

Infrared technology and unique design are combined in the *Solosound II (IR-400)* cordless stereo headphone from *Arkon* (11627 Clark St., Arcadia, CA 91006). The design eliminates the unsightly dome necessary in most headphones. The headphone is plugged into a slim transmitter, which is connected to any stereo receiver or TV and has a range of up to 250 feet. The transmitter features automatic on/off, which allows the user to turn off the source via remote control. The headphone is powered by 2 "AAA" batteries and has left/right volume controls. Price: $149.

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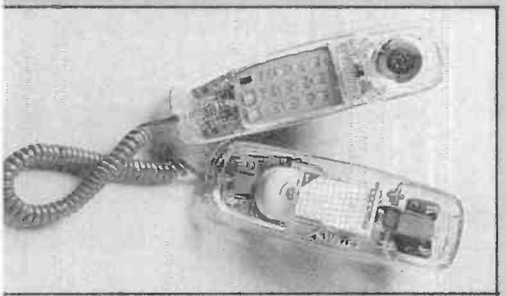


Fun Products Metrolight Telephone

Clear Plastic-Shell Telephone

What do you call a trimline-style telephone featuring a clear "Lexan" plastic shell, multi-colored internal circuitry, and 5 neon lights that flash when the instrument rings? *Fun Products* (2421 Fulton St., Berkeley, CA 94704) calls it the *Metrolight*. The telephone, manufactured by *BellSouth* for the company, is wall-mountable, features tone/pulse selection, and is hearing-aid compatible. The Metrolight also incorporates last-number redial and a ringer-on/off switch. Neon hues are green and white. Quality features include hand-coloring of the instrument's interior components and a plastic shell that "will not break, cloud or turn brown with age." Power for the neon comes directly from the telephone line. Price: $69–$79.

CIRCLE 72 ON FREE INFORMATION CARD

Hitachi Breadmaker

Home Bakery

If you love the smell and taste of homemade bread, but aren't crazy about all the work involved, the *Home Bakery Breadmaker (B101)* is one possible solution. *Hitachi Sales Corp. of America* (401 W. Artesia Blvd., Compton, CA 90220), explains: "Just put in the ingredients, push the start button or set the timer and let the machine do the work." This updated version of the company's previous breadmaker reduces baking time by an hour and can turn out loaves of three different sizes with either dark, medium, or light browning. A special LOCK button prevents accidental tampering during the baking cycle. The baker has a built-in cool-down feature that prevents the bread from getting soggy once it's finished. Price: $329.95.

CIRCLE 73 ON FREE INFORMATION CARD

THE PARTS CONNECTION

BY JACK CUNKELMAN

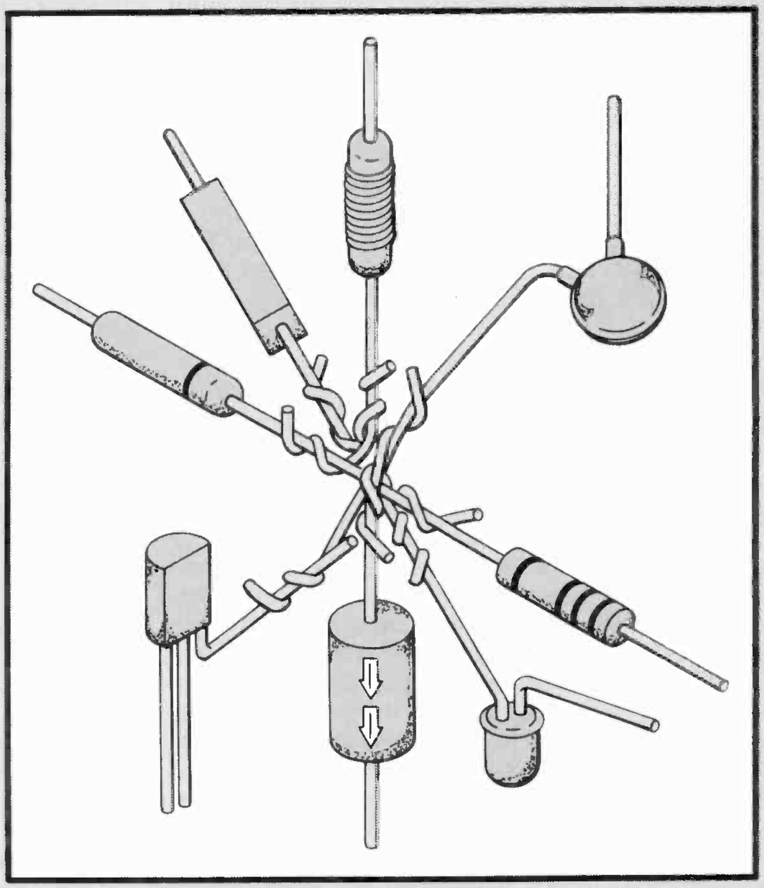
Make your next project your best project with helpful advice on parts selection and mail-order sources.

Most electronic construction projects come to life as the result of a three-part plan: First the schematic and plans are obtained—either created by yourself or taken from a magazine or book; next the parts are gathered; and finally the project is constructed and tested.

Judging from the mail received here at *Popular Electronics*, step two, the gathering of the parts, is a real stumbling block for some. So that is what we are going to deal with here—the how, what, and where of collecting the parts for your projects.

A project always seems to start out better if you have some of the parts on hand. Your stock of parts will never be complete (not as long as they keep creating new devices), but it is very desirable to build up a selection of the generic "building-block" components: resistors, capacitors, inductors, etc. When that's been done, it is only necessary to get any specialized parts needed. A good stock of parts will also allow you to substitute and modify with ease during the testing stage, allowing you to get maximum performance from your circuit.

To start out, let's talk about a few generic items and the different types that are available. The information presented will help you to make intelligent decisions in purchasing the components and in choosing substitutions if a specified component can not be found.



Fixed Resistors. Resistors are found in just about every electronic circuit. They are used to impede current flow and to change voltage levels. When they do either, they dissipate some electrical energy as heat. The heat a resistor is capable of giving off is an important characteristic because overheating a resistor will eventually cause it to change it's resistance value. Heat dissipation is measured in watts. To give you a feeling for what a watt is, low wattage resistors—like a ¼, or ½ watt—should run cool to the touch. However, that is a dangerous test to perform on high wattage resistors, so to find out how much power a resistor must dissipate, you can use this formula:

$$\text{Power (in watts)} = V/R$$

provided you know the resistance, R, in ohms, and you measure the voltage across it, V, in volts:

Resistors made to dissipate large amounts of heat are called power resistors. The most common ones are constructed of wire wrapped on a ceramic form and then coated with a sealer. Because they are made with wire, most power resistors have some inductance and should not be used in circuits involving high frequencies.

For the most part, your projects will use the small ¼- and ½-watt resistors. The three most popular types are carbon composition, carbon film, and metal film.

The carbon-composition type is an old workhorse made by mixing carbon with a binder, fusing them together, and encasing them. That type of construction is susceptible to moisture absorption, which can cause the resistance value to change as much as 20%. Also, carbon-composition resistors can add electrical noise to a circuit. So that type of resistor would not be a good choice when building a low-noise audio preamp. Carbon-composition resistors do, however, have excellent surge- and transient-handling capabilities. They most commonly have either 10% or 20% tolerance.

The newer resistor types are manufactured by depositing a film on a core of glass or aluminum oxide. The film can be carbon (to create a carbon-film resistor) or metal (for a metal-film resistor). That construction technique produces more-stable resistors, and for that reason film resistors are the recommended type to use. Carbon-film resistors are gradually replacing carbon-composition resistors because they are generally less expensive to manufacture.

Carbon-film resistors are generally available with 5% tolerance, however, metal-film resistors are premium-grade resistors with even greater tolerance. Metal-film resistors are *very* stable, work well in high-frequency applications, and are electrically very quiet. The tolerance in a metal-film resistor's value is typically 1%.

Figure 1 illustrates the bands used to identify the resistance values of low-wattage resistors. Both a normal (A) and a high-precision resistor (B) are shown. The numerical values corresponding to the various colors you can find on a resistor are given in Table 1.

The position of a band on a resistor determines what information it will tell you. For instance, the last band (the right-most band in the drawings) on a resistor indicates its tolerance. The first two bands on a normal resistor represent the first two digits in the resistor's value. For a precision resistor, the first *three* bands represent the first *three* digits. The band just to the left of the tolerance band for both types is the multiplier. It indicates the number of zeroes that follow the first digits.

Unlike low-wattage resistors, power resistors have their values printed on their body.

Variable resistors. Variable resistors or potentiometers provide a way of adjusting their resistance value—a moving contact brush that touches the resistive element. Moving the contact varies the resistance value.

The resistive elements are made of various materials—carbon, cermet, and conductive plastic being the most popular. They typically have power-dissipation ratings of one or two watts.

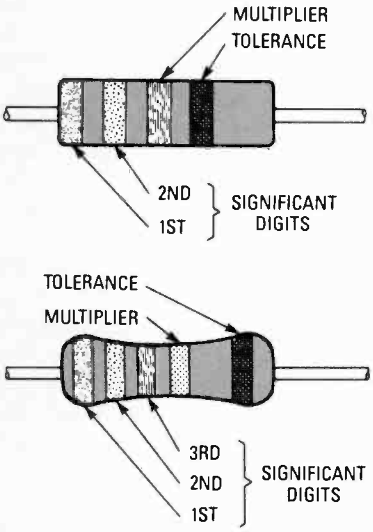


Fig. 1. Here we show the arrangement of bands on both a regular (A) and a high-precision (B) resistor body. Notice the precision resistor has more digits to specify its value more accurately.

TABLE 1—THE RESISTOR COLOR CODE

COLOR	SIGNIFICANT FIGURE VALUES	MULTIPLIER	TOLERANCE
BLACK	0	1	—
BROWN	1	10	1%
RED	2	100	2%
ORANGE	3	1000	3%
YELLOW	4	10000	4%
GREEN	5	100000	—
BLUE	6	1000000	—
VIOLET	7	—	—
GREY	8	—	—
WHITE	9	—	—
SILVER	—	0.01	10%
GOLD	—	0.1	5%

Units capable of controlling large amounts of power are usually called rheostats and use resistive wire as the resistive element.

Small trimmer potentiometers are available to provide adjustable resistance values for fine-tuning circuit operation. They have a rotational life of only a few thousand cycles since they are meant to be adjusted by the builder or servicer of a piece of equipment and not by the everyday user. They are available in single- and multiple-turn styles. Multiple-turn potentiometers obviously have more resolution than single-turn types.

Linear- and Audio-Taper Potentiometers. The taper a potentiometer has depends on the relationship between potentiometer rotation and potentiometer resistance. Most potentiometers have what is called a linear taper. That means its resistance will change in proportion to how much you move its wiper. To determine the taper of a potentiometer, connect an ohmmeter between the wiper arm and one end of the potentiometer. Rotate the potentiometer to the middle of it's rotation range. If the ohmmeter reads close to ½ of the potentiometer's total resistance, you have a linear-taper potentiometer—50% rotation, 50% resistance.

If you are using the potentiometer to control audio levels, a linear taper is not ideal. The ear perceives loudness or gain in a nonlinear fashion, so using a linear potentiometer in such applications will result in a person only using a small portion of the potentiometer's rotation range. What is needed is a semi-log or audio-taper potentiometer. At 50% rotation, the resistance from one end of the potentiometer to the wiper is just 15% of its total resistance.

While an audio-taper potentiometer is best for audio use, if you are stuck with a linear-taper potentiometer there is a simple fix. Connect the signal source to one side of the potentiometer, and a resistor that's 1/10 of the potentiometer's value across the wiper and the remaining terminal. That will approximate an audio taper.

Capacitors. Because there are so many types of capacitors available, the process of selecting a capacitor is a little more complicated than selecting a resistor. There seems to be a natural dividing line between capacitor types at around 1 µF. For example, capacitors above 1 µF are of the tantalum- and aluminum-electrolyte types, and capacitors below that value are made from mylar, ceramic, paper, and several plastic materials. Table 2 lists types of capacitors, their main characteristics, and the best use for each.

The first two types of capacitors in the table, aluminum electrolytic and tantalum, are "polarized." They must be placed in the circuit observing the polarity markings on the body of the capacitor, just as you would for a battery. The higher potential in the circuit must be connected to the positive terminal of the capacitor. To do otherwise will result in the failure of the capacitor. It is also not wise to use a polarized capacitor in a circuit that does not apply a polarizing voltage across the capacitor; they can not withstand any reverse current. And, finally, the voltage rating of the capacitor should be the sum of the DC polarizing voltage plus the peak value of the AC signal being coupled.

There are many capacitor-case styles. Figure 2 shows some of the more common ones for polarized capacitors. The capacitance value is usually written plainly on the case along with the polarity markings for the capacitor.

Figure 3 shows some of the case

TABLE 2—CAPACITOR CHARACTERISTICS

TYPE	TYPICAL VALUE RANGE	TYPICAL TOLERANCE	APPLICATIONS & CHARACTERISTICS
Aluminum Electrolytic	0.68—200,000μF	−10%—+75%	Power-supply filtering, bypass, coupling. Used where large values are needed.
Tantalum Electrolytic	.001—1000μF	5—20%	Bypass, coupling, decoupling. Very stable, long life
Ceramic	1pF—2.2μF	5—30%	Transient decoupling, bypass. Value changes with frequency and temperature.
Mica	1pF—1μF	1—30%	Timing, Oscillator, and AF circuits. Very stable.
Polypropylene	1pF—10μF	2—10%	Blocking, bypass, coupling, and timing circuits. Filter, noise suppression. Good for audio through UHF
Polyester (Mylar)	.001—10μF	5—20%	Blocking, filtering, transient suppression. Good for audio. Small size with medium stability.
Paper	.001—10μF	10—20%	General purpose. Large size, low cost, medium stability, and poor moisture characteristics.
Polystyrene	51pF—0.15μF	1—5%	Timing and tuned circuits. Small capacitance change with temperature. Excellent stability. Good in audio circuits.

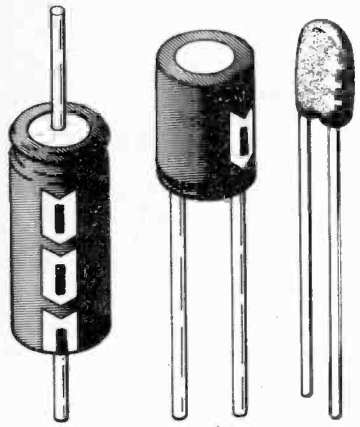


Fig. 2. Polarized capacitors have their polarity clearly marked. Shown are the axial-lead (A), radial-lead, and tantalum (C) types.

styles for non-polarized capacitors (usually below 1 μF). Their value is either written plainly on their body or given using a three-digit code. The first and second digits are significant numbers and the third digit is a multiplier. The value you get by deciphering the number is in picofarads (denoted pF). There are some capacitors whose values are color-coded on their bodies just like resistors. In fact, you can use the same color code as used for resistors to determine their value.

Trimmer and variable capacitors are also available, at values in the pF range. They come in single- and multiple-turn types, just like trimmer potentiometers. The dielectric material used in a trimmer capacitor determines how well it works at high frequencies. Most commonly available trimmers will all work well at frequencies below 30 MHz.

Inductors. When an inductor is used in a circuit, the goal is to make the circuit more or less sensitive to a particular frequency or group of frequencies. A circuit will have either a choke or a coil to achieve the desired effect.

The terms inductor, choke, and coil seem to be used interchangeably at times and to some degree their uses do overlap. Typically though, a coil is used to resonate or peak at a certain frequency, while a choke is used to affect a group of frequencies. Specifications for inductors shown in catalogs lists the

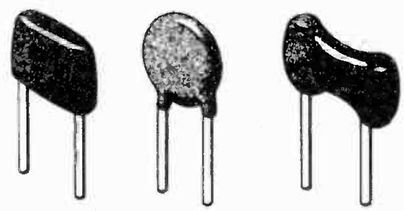


Fig. 3. Non-polarized capacitors come in many different types. Shown are the more popular ones: an epoxy-dipped (A), a disc (B), and a metal-film (C) capacitor.

"Q," "test frequency," and "current" for a particular coil. The Q is called the *factor of merit* of a coil, and is an indication of how sharp the response of the coil is when resonating at the listed test frequency. Since all inductors are wound with wire, the current rating is the amount of current the wire can safely carry.

The type of core in the coil has a great effect on the frequency response of the coil. Iron cores are used at low frequencies (up to 100 kHz). Coils used with frequencies up to 30 MHz are usually space-wound (air core) or wound on cores made of ferrite. Coils used above 30 MHz are usually wound on nonferrous materials such as brass or copper.

An adjustable coil is wound on a ceramic form, which makes it act like an air-wound coil. A threaded slug or core, made from iron, ferrite, or brass (depending on the frequency range of the unit) is screwed into the coil form to adjust its inductance.

A small, hollow section, of ferrite material can be slipped over a single wire to form a very effective radio-frequency choke. That is useful on microphone preamps used near strong radio-frequency fields to keep high-frequency currents from flowing in the wire between the microphone and the preamp input.

Coil characteristics are so precarious, it is probably wise to use the exact coil specified in a particular project. If the coil is to be handmade, follow the article's instructions on how to wind the coil, being careful to use the same core materials and form factor—the ratio of the diameter to length for the coil—specified. The form factor greatly affects a coil's other specifications.

An inductor is a relatively complex device because it has a great many independently variable characteristics, To complicate matters further, value markings on inductors are almost nonexistent. However, some newer construction techniques that coat the inductor with epoxy or plastic do permit the placement of marking bands to indicate the inductor's value. The color bands can be deciphered using the same color-code system as resistors. The value obtained will be in henries.

Semiconductor Substitutions. Before we discuss the major semiconductor components, give heed to these words on semiconductor substitution: Unlike the components discussed

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Active Electronics
P.O. Box 9100
Westborough, MA 01581
Catalog: 240 pages, free to qualified customers
Telephone orders: New England 800/ACTIVE6, elsewhere 800/ACTIVE4
Inquiries/help: New England 800/ACTIVE6, elsewhere 800/ACTIVE4
Hours: 8 am to 6 pm EST Mon.–Fri.
Payment: Personal or company check (orders under $100), certified check (orders over $100), money order, Visa, Master Card, American Express, C.O.D. (orders under $100), open accounts
Minimum order: $25
Shipping method: UPS unless otherwise requested
Shipping charges: Prevailing carrier rate
Notes: Retail stores nationwide, sells components, test equipment, tools, and more
CIRCLE 111 ON FREE INFORMATION CARD

All Electronics Corp.
PO Box 567
Van Nuys, CA 91408
Catalog: 46 pages, free
Telephone orders: 800/826-5432, CA 800/528-6666
Inquiries/help: 818/904-0524
Hours: 7:00 am to 5:00 pm PST, Mon.–Fri.; 9:00 am to 4:00 pm, Sat.
Payment: check, M.O., Master Card, Visa, Discover
Minimum order: $10
Shipping methods: UPS, Parcel Post
Shipping charges: $3 flat fee
Foreign orders: yes
Notes: New and surplus parts; Quantities usually limited; Sells capacitors, connectors, switches, relays, and resistors
CIRCLE 112 ON FREE INFORMATION CARD

Allied Electronics
401 East 8th St.
Fort Worth, TX 76102
Catalog: 740 pages, free
Telephone orders: 800/433-5700
Payment: check, M.O., Master Card, Visa, American Express
Minimum order: none, $5 handling charge for orders under $25
Shipping methods: UPS
Shipping charges: see UPS chart, insurance extra
Notes: 16 branch locations (see catalog); Full-line industrial distributor; Stocks various manufacturer's complete lines
CIRCLE 113 ON FREE INFORMATION CARD

American Design Components
815 Fairview Ave.
PO Box 220
Fairview, NJ 07022
Catalog: 16 pages, free
Telephone orders: 800/524-0809, NJ 201/941-5000
Inquiries/help: 800/524-0809, NJ 201/941-5000
Payment: check, M.O., Master Card, Visa, Amex
Minimum order: $15
Shipping methods: UPS, Parcel Post
Shipping charges: $3 plus 10% of total
Notes: Surplus electronic and electromechanical components; Quantities limited; Sells computers and accessories, motors, power supplies, integrated circuits
CIRCLE 114 ON FREE INFORMATION CARD

BCD Electro
PO Box 830119
Richardson, TX 75083
Catalog: 40 pages, free
Telephone orders: 800/456-2233, TX 214/343-1770
Inquiries/help: 214/343-1770
Payment: check, M.O., Master Card, Visa, American Express, C.O.D.
Minimum order: none, $0.95 handling on orders under $30
Shipping methods: UPS , us mail
Shipping charges: $2.50
Notes: New and surplus parts; Quantities usually limited; They've got a little of everything
CIRCLE 115 ON FREE INFORMATION CARD

Circuit Specialists
PO Box 3047
Scottsdale, AZ 85257
Catalog: 85 pages, free
Telephone orders: 800/528-1417
Inquiries/help: 602/966-0764
Hours: 9:00 am to 5:00 pm MST, Mon.–Fri.
Payment: check, M.O., Master Card, Visa, C.O.D.
Minimum order: $15 for charged orders only
Shipping method : 1st-class mail, Parcel Post, UPS
Shipping charges: $2.00, more for heavy items
Foreign orders: yes
Notes: Stocks most of the popular parts of interest to the hobbyist and serious tinkerer
CIRCLE 116 ON FREE INFORMATION CARD

Cornell Electronics Co.
4217 University Ave.
San Diego, CA 92105
Catalog: 12 pages, free
Telephone orders: 619/281-9792
Inquiries/help: 619/281-9792
Payment: check, M.O., Master Card, Visa, C.O.D.
Minimum order: none
Shipping charges: orders under $100: $2.50 plus 10% of the order; orders over $100: $2.50 plus $7.50
Foreign orders: yes; Canada and Mexico
Notes: Sells TV and radio tubes
CIRCLE 117 ON FREE INFORMATION CARD

Digi-Key
PO Box 677
Thief River Falls, MN 56701
Catalog: 115 pages, free
Telephone orders: 800/344-4539
Inquiries/help: 218/681-6674
Hours: 8:30 am to 5:00 pm CST
Payment: check, M.O., Master Card, Visa, C.O.D.
Minimum order: none, service charge on orders below $25
Shipping methods: UPS, Parcel Post, air freight
Shipping charges: none on prepaid orders
Foreign orders: yes; Mexico and Canada
Notes: A good source of capacitors, resistors, IC's, and transistors
CIRCLE 118 ON FREE INFORMATION CARD

Edlie Electronics
2700 Hempstead Turnpike
Levittown, NY 11756
Catalog: 147 pages, free
Telephone orders: 800/645-4722
Inquiries/help: 516/735-3330
Hours: 9:00 am to 5:30 pm EST, Mon.–Sat.
Payment: check, M.O., Master Card, Visa
Minimum order: charge: $50; other: $25
Shipping methods: UPS, Parcel Post
Shipping charges: from chart: $4.50 (for up to $100) to $15 (for up to $1000)
Foreign orders: some, must inquire
Notes: Sells components, test equipment, video items, and surplus parts
CIRCLE 119 ON FREE INFORMATION CARD

Edmund Scientific Co.
101 East Gloucester Pike
Barrington, NJ 08007
Catalog: 151 pages, free
Telephone orders: 609/573-6250 or 609/547-3488
Inquiries/help: 609/573-6260 (orders); 609/573-6253 (technical)
Hours: 9:00 am to 5:00 pm EST, Mon.–Fri.
Payment: check, M.O., Master Card, Visa, Diners Club, American Express, Carte Blanche
Minimum order: none
Shipping methods: UPS, Parcel Post
Shipping charges: from chart, $3.95 to $18.95
Notes: Has optics, lasers, astronomy, microscopes, lab equipment, general state-of-the-art scientific stuff
CIRCLE 120 ON FREE INFORMATION CARD

Fordham
260 Motor Parkway
Hauppauge, NY 11788
Catalog: 163 pages, free
Telephone orders: 800/645-9518, NY 800/832-1446
Inquiries/help: 800/344-6325
Hours: 8:00 am to 6:00 pm EST, Mon.–Fri.; 9:00 am to 3:00 pm Sat.
Payment: check, M.O., Master Card, Visa, American Express, C.O.D.
Minimum order: $25
Shipping method: UPS, Parcel Post
Shipping charges: flat rate based on total

so far, the number of opportunities to make substitutions are few. We are out of the world of generic parts and into the world of specialized parts. Substitution is risky with such devices and should be done with a great deal of thought and care.

If you really can't find a specified part, the best place to get substitution information is out of the SK- and the ECG-series replacement guides. For more information about the SK-series

order, plus $1 insurance fee
Notes: Sells test equipment, components, and TV and video items.
CIRCLE 121 ON FREE INFORMATION CARD

Halted Specialties
3500 Ryder Street
Santa Clara, CA 95051
Catalog: 40 pages, $1.00 (free withorder or in stors) Telephone orders: 800/442-5833; CA 408/732-1573, BBS 408/732-2814
Inquiries/help: 800/442-5833; CA 408/732-1573, BBS 408/732-2814
Hourse: 8 am to 7 pm PST Mon.–Fri., 9 am to 5 pm PST Sat.
Payment: Check, postal money order, Visa, Master Card, American Express, C.O.D.
Minimum order: $10, orders under $20 subject to $2 fee
Shipping method: UPS unless otherwise requested
Shipping charges: Exact UPS charges; items shipped by other methods are charged the carrier's prevailing rate plus a $5 surcharge.
Notes: Retail stores in Santa Clara, Santa Rosa (6819 Redwood Dr., Cotati, CA 94931), and Sacramento (5549 Hemlock St., Sacramento, CA 95841); SEIls components, surplus gear, computer items, lasers, optoelectronics, test equipment, and more
CIRCLE 122 ON FREE INFORMATION CARD

Hosfelt Electronics Inc.
2700 Sunset Blvd
Stubenville, OH 43952
Catalog: 64 pages, free
Telephone orders: 800/524-6464, OH 614/264-6464
Inquiries/help: 614/264-6464
Hours: 9:00 am to 5:00 pm EST, Mon.–Fri.
Payment: check, M.O., Master Card, Visa, American Express, C.O.D.
Minimum order: none
Shipping methods: UPS
Shipping charges: orders from $1 to $100: $3.50; $101 to $250: $4.50; $250 and up for free
Foreign orders: no
Notes: Sells surplus and new components
CIRCLE 123 ON FREE INFORMATION CARD

Jameco Electronics
1355 Shoreway Road
Belmont, CA 94002
Catalog: 74 pages, free
Telephone orders: 415/592-8097
Inquiries/help: 415/592-8121
Hours: 7:00 am to 5:00 pm PST, Mon.–Fri.
Payment: check, M.O., Master Card, Visa, C.O.D.
Minimum order: $20
Shipping methods: UPS, 1st-class mail
Shipping charges: by UPS: 5% of total order, $2 minimum ($1.50 extra for insurance)
Foreign orders: yes
Notes: Stocks new components, IC's, tools, computer equipment, and some surplus parts
CIRCLE 124 ON FREE INFORMATION CARD

JDR Microdevices
110 Knowles Dr.
Los Gatos, CA 95030
Catalog: 31 pages, free
Telephone orders: 800/538-5000
Inquiries/help: 800/538-5000
Hours: 7:00 am to 5:00 pm PST, Mon.–Fri.; 10:00 am to 3:00 pm Sat.
Payment: check, M.O., Master Card, Visa, C.O.D.
Minimum order: $10
Shipping methods: UPS
Shipping charges: $2.50 for the first lb., and additional over that
Foreign orders: yes
Notes: Stocks new IC's, components, computer boards and computer equipment
CIRCLE 125 ON FREE INFORMATION CARD

MCM Electronics
858 East Congress Park Dr.
Centerville, OH 45459
Catalog: 155 pages, free
Telephone orders: 800/543-4330, OH 800/762-4315
Inquiries/help: 800/543-4330, OH 800/762-4315
Hours: 7:00 am to 8:00 pm EST, Mon.–Fri.; 9:00 am to 5:00 pm Sat.
Payment: M.O., Master Card, Visa, C.O.D.
Minimum order: $1 service charge for orders under $10, $25 minimum for charge, $15 minimum C.O.D.
Shipping methods: UPS
Shipping charges: see UPS rate table
Foreign orders: yes; 800/824-9491
Notes: Japanese transistors, IC's, components, VCR and TV parts, speakers, and computer parts
CIRCLE 126 ON FREE INFORMATION CARD

Mouser Electronics
2401 Hwy. 287 North
Mansfield, TX 76063
Catalog: 183 pages, free; call 800/992-9943
Telephone orders: 800/346-6873
Inquiries/help: 817/483-4422
Hours: 7:00 am to 5:30 pm CST
Payment: check, M.O., Master Card, Visa, American express, Diners Club, Discover, Carte Blanche, C.O.D.
Minimum order: none, $5 service charge for orders under $20
Shipping methods: UPS, Parcel Post
Shipping charges: 10% of order for check or M.O.
Foreign orders: yes
Notes: Stocks most components needed by a hobbyist
CIRCLE 127 ON FREE INFORMATION CARD

Newark Electronics
4801 North Ravenswood Ave.
Chicago, IL 60640
Catalog: free
Telephone orders: 312/784-5100
Payment: Master Card, Visa, C.O.D.
Minimum order: $25
Shipping methods: UPS, US postal express mail, air freight, truck
Shipping charges: actual amount added to charge card
Foreign orders: yes
Notes: Numerous regional offices, order from local office if possible (addresses and phone numbers in catalog); full-line industrial distributor
CIRCLE 128 ON FREE INFORMATION CARD

Parts Express International, Inc.
340 East First St.
Dayton, OH 45402
Catalog: 83 pages, free
Telephone orders: 800/338-0531
Inquiries/help: 800/338-0531
Hours: 8:30 am to 6:00 pm, Mon.–Fri.
Payment: check, M.O., Master Card, Visa, Discover, C.O.D.
Minimum order: none, $1 service charge orders less than $10
Shipping methods: UPS
Shipping charges: $2 flat rate up to 5 lbs on prepaid orders, actual cost on credit card orders
Notes: Japanese parts, semiconductors, TV, VCR parts.
CIRCLE 129 ON FREE INFORMATION CARD

Sintec Company
28 8th St.
PO Box 410
Frenchtown, NJ 08825
Catalog: 67 pages, $2.00
Telephone orders: 800/526-5960, NJ 201/996-4093
Inquiries/help: 201/996-4093
Hours: 8:15 am to 5:00 pm EST, Mon.–Fri.
Payment: check, M.O., Master Card, Visa, C.O.D.
Minimum order: $10
Shipping methods: first-class mail, UPS
Shipping charges: up to $100, costs $3: $100 to $250, costs $4: above $250, costs $5
Foreign orders: yes
Notes: New electronic components
CIRCLE 130 ON FREE INFORMATION CARD

Solid State Sales
P.O. Box 74D
Somerville, MA 02143
Catalog: 17 pages, $0.25
Telephone orders: 800/343-5230
Inquiries/help: 617-547-7053
Hourse: 8:00 am to 4:45 pm EST Mon.–Fri., 10:00 am to 2:30 pm EST Sat.
Payment: check, money order, Master Card, Visa, C.O.D.
Minimum order: C.O.D. or charge $20, check or money order $5
Shipping method: UPS or parcel post
Shipping charges: 10% for orders under $25, 5% for orders between $25 and $50, 3% for orders over $50.
Notes: Sells new components ■
CIRCLE 35 ON FREE INFORMATION CARD

replacement guide write to:
Sales Promotion Services
Thompson Consumer Electronics
Distribution and Special Products
2000 Clements Bridge Road
Depford, NJ 08096-2088
or for information on the Phillips ECG guide write to:
Phillips ECG, Inc.
Distributor & Special Markets Div.
1025 Westminister Dr.
Williamsport, PA 17701

Tel. 800/225-8326.

Parts are not available from the given addresses, must be purchased through their distributors. When purchasing a replacement guide ask for a list of distributors.

A replacement guide listing Radio Shack parts is also available at Radio Shack Stores. Your local Radio Shack store will also order SK-series parts for you and have them shipped to the store.

Another tool that'll help you understand device specifications and packaging is a data book. Start collecting data books from various manufacturers for your reference library. Note that some of the parts suppliers mentioned later have data books available for sale.

Diodes. The two categories of diodes—germanium and silicon—are probably the least difficult to substitute for. However, the two types can not be interchanged because the junctions of each behave differently. Other considerations of substitution are the voltage and current rating of the diode. Use a diode with a rating at or above what the designer of the circuit specifies. If the diode in question is used in a switching power supply or in a high-frequency switching or detection application, it is probably wise to use the exact diode specified, again because of how diode junctions behave. My stock includes a pile of 1- and 3-amp 400-volt diodes and I find that they supply most of my needs for general-purpose diodes.

Transistors and Integrated Circuits. Transistors are the next easiest part to substitute for. A friend of mine has used this simple rule: There are only two kinds of transistors: NPN and PNP; and he has applied it with much success. In reality, however, most projects work the best with the transistors specified.

A generic replacement for almost any transistor made, can be chosen from the replacement guides mentioned earlier. However, the cost of a substitute is usually higher.

Finally, when dealing with integrated circuits, substitutions are best left to the experts. The specified IC is probably the only one that will work either because of physical pin-out specifications or electrical specifications. There are generic substitutions available from the same companies mentioned above, but the selection of substitutes is more limited than for transistors and diodes.

TABLE 3—PACKAGING CODES

PACKAGE	MOTOROLA	NATIONAL	RCA/GE	SIGNETICS	TEXAS INSTRUMENTS
8-pin dip plastic	P	N-8	E	N	P
14 pins or more, plastic	P	N	E	N	N
Dip ceramic	L	D or J	D	F or I	J
TO5-TO101 Metal can	G	H	S or T	H	L
TO220 Tab	T	T	—	U	KC
TO3 Steel	—	K	—	—	—
TO3 Aluminum	K	KC	—	—	K

However, there is some hope because of "second sourcing," as the industry calls it. Second sourcing means a given IC is made by more than one company. That came about because the number of manufacturers of equipment using the more popular IC's created a sufficient market demand to support many chip manufacturers.

Identifying substitutions for parts is a problem because each manufacturer calls a given chip something different, but it is possible to figure out the chip part number. A typical IC part number can be broken down as follows:

XX-YYYY-Z

Where XX is the device family, YYYY is the device number, and Z is the package type.

Take the ever-popular 741 op-amp for instance. The device number, 741, appears in the part number of each supplier, but each puts their own prefix and suffix in the number to describe the part. For example:

National—LM741N
Silicon General—SG741M
Raytheon—RC741NB
Signetics—μA741N
Motorola—MC1741CP1

Table 3 is a cross reference of package suffixes for some of the more popular manufacturers. The plastic *DIP* (*dual in-line package*) enclosure is by far the most popular and least expensive type available to the experimenter. The same device in a ceramic package, for instance, will usually cost more because it has a wider operating-temperature range—the range is usually 0 to 70°C for plastic-packaged devices.

Where Are the Parts? One could not start to discuss the acquisition of parts without mentioning Radio Shack first. They, through their mass-merchandising abilities, have made it easy and convenient to purchase a large number of the parts needed for projects. In fact, many parts lists in magazine projects specify many Radio Shack parts, so use them for convenience. I have never been disappointed by their quality, but remember you are paying a bit extra for the convenience of it all.

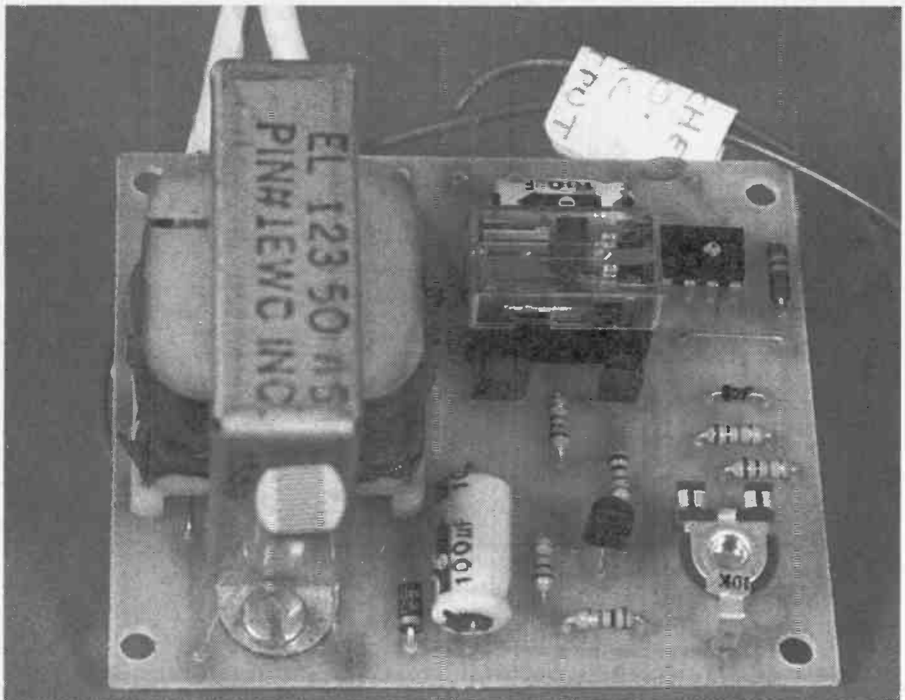
The local telephone book may provide you with the names of other local parts distributors. In my yellow pages they are listed under "Electronic Parts and Supplies." The larger distributors are usually located only in larger metropolitan areas.

By far the most convenient way to do your shopping is by mail. It is, in my estimation, the best way to get the latest technology for the best prices (for that matter, the best prices on the everyday stuff also).

However, there seems to be some natural divisions in the kinds of parts distributors, each having their own advantages and disadvantages. First there are the full-line parts distributors; They may be your only choice if your project requires a newly introduced IC. If they carry a manufacturer's line, chances are they can get you any IC from that manufacturer. Just remember they are accustomed to dealing with industrial accounts, so they may not get excited over your order, but be persistent.

Also, as with most distributors, be aware of any minimum-order amount. It is not negotiable, so you'll have to abide by their rules. Add some other needed items to an order to help you get up to the minimum. I keep a running "want list" on a clipboard for that very reason and use the listed items to "fill-in" any order that does not meet the

(Continued on page 97)

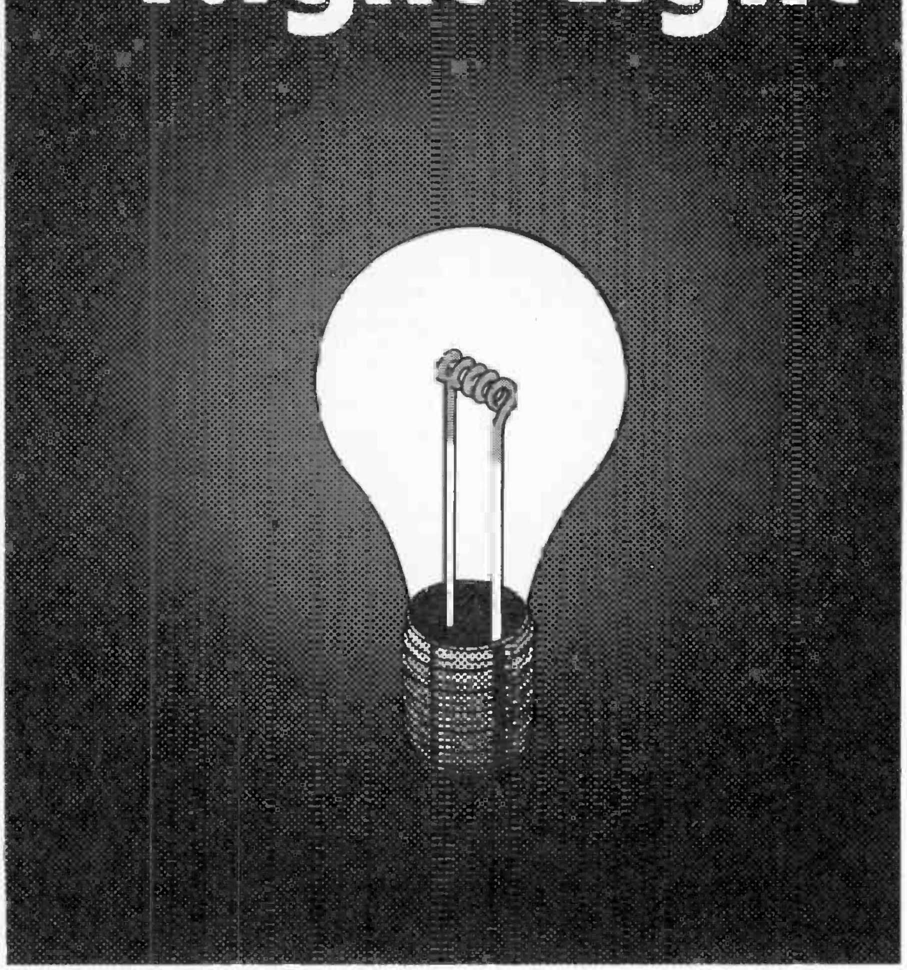


Anyone who has ever built a photocell-based control to automatically turn on a light at dusk and turn it off in the morning has probably been disappointed with it's performance. The frustration starts at dusk when the light-to-dark transition occurs so slowly that the light may cycle on and off for periods of up to a half-hour before finally turning on for the evening.

Sometimes that's caused by a slight increase in the light level seen by the photocell when the controlled light is turned on by the controlling circuit. The turn-on voltage is so critical that the slightest change in light level can and will affect the circuit.

Even if the photocell is completely isolated, the slow change in ambient light levels can still cause some cycling. That on/off cycling is annoying to say the least, and will definitely shorten the life of the relay contacts. If the control is used to turn on a light inside the house, it is a real tip-off to a burglar

Night-Light Control



Not just another night-light switch, but a light sensitive switch that overcomes a problem that plagues many commercial units.

BY WALTER W. SCHOPP

that the light is being activated by some electronic gadget rather than a human hand.

To overcome that problem, a way of locking down the relay when the circuit is first activated is needed. By keeping the relay locked down a sufficient time during the light-to-dark transition period and then turning the control back to the photocell, the cycling problem can be solved. If the time delay is long enough, it masks the cycling time completely.

In the morning, the same circuit can be used to keep the light from cycling during the dark-to-light transition. That's accomplished by setting the circuit to trigger the relay after an ex-

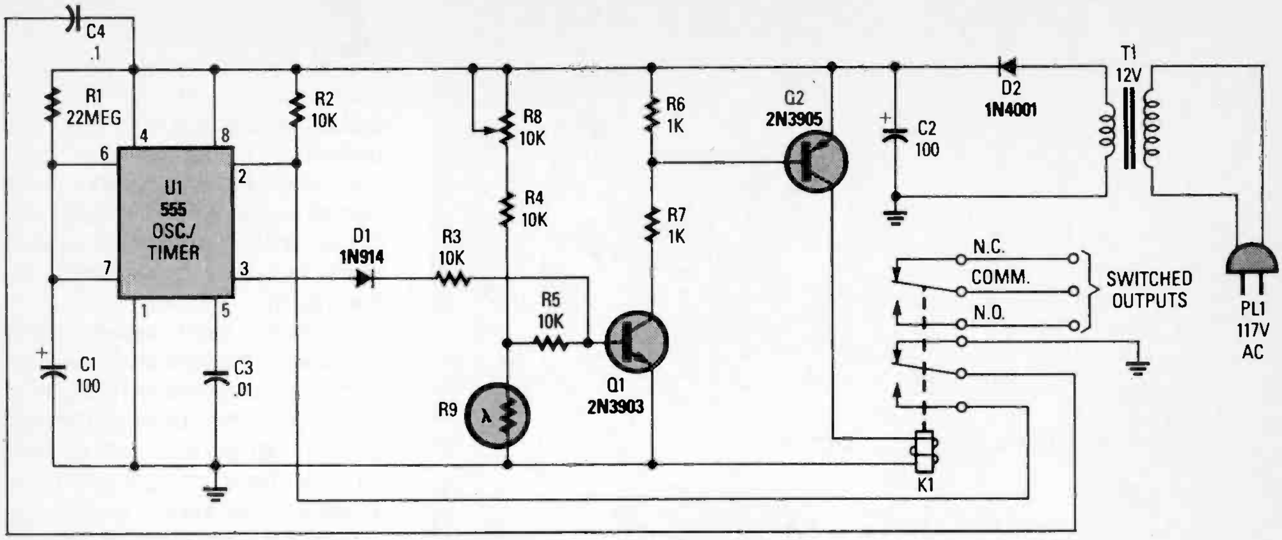


Fig. 1. The schematic diagram of the Night Light Control shows that the circuit is built around a 555 oscillator/timer, a pair of transistors, and a light-dependent resistor that together are used to trigger a relay to activate the light or appliance connected to its contacts.

tended time delay. By the time the relay drops out, the cycling period is over, and the light will stay off for the day.

How It Works. The schematic diagram of the *Night Light Control* circuit is shown in Fig. 1. The circuit is built around a 555 oscillator/timer (U1), a pair of transistors (Q1 and Q2), and a light sensor (in this case, a cadmium sulfide light-dependent resistor, R9).

The LDR-control circuit is comprised of Q1 and Q2. The sensitivity of that subcircuit can be varied via R8—which establishes Q1's base bias—thereby allowing the circuit to be activated at whatever light level is desired. The LDR-control subcircuit is activated by a change in voltage at the base of Q1 caused by the variable resistance of the LDR under changing light conditions.

When the relay pulls in, one set of contacts switches on the light or appliance connected to it, while the other set of contacts triggers U1 into operation. When U1 is turned on, a positive voltage is applied to the base of Q1, the duration of which is determined by an RC network, consisting of R1 and C1. The time period is given:

$$t = 1.1 \times RC$$

where t is time in seconds, R is resistance in ohms, and C is capacitance in farads. By varying the value of either R or C (in our circuit R1 and C1), the duration of U1's output can be tailored to fit the user's needs.

The component values given in Fig. 1 for R1 (22 megohms) and C1 (100 µF) provide a delay of about 40 minutes. The time delay is affected by the tolerances of the resistor and capacitor and will never be exact unless you use precision components. Cutting the resistance value in half, cuts the delay time by the same amount.

At the end of the timed period, the voltage is removed and Q1 is controlled only by the potential set-up by the light level on the LDR. The concept is simple, but very effective.

Putting it Together. There's nothing critical about the construction of the Night Light Control. The author's prototype of the circuit was built on a printed-circuit board measuring about 2½ × 3 inches. Figure 2 shows a template of the foil pattern that was used by the author in the production of that prototype.

Once you've etched your board and obtained the components given in the Parts List, begin assembling the project using Fig. 3 as a guide. Note that T1, the power transformer, mounts directly to the board, so it is recommended that the unit specified in the Parts List be used. If the transformer is to be mounted to the board, be sure to install the jumper, indicated by a dashed line, first. The transformer is then mounted on top of the jumper.

PARTS LIST FOR THE NIGHT LIGHT CONTROL

SEMICONDUCTORS

U1—555 oscillator/timer, integrated circuit
Q1—2N3903 or equivalent general-purpose NPN silicon transistor
Q2—2N3905 or equivalent general-purpose PNP silicon transistor
D1—1N914, general-purpose, silicon signal diode
D2—1N4001, 1-amp, 50-PIV, silicon rectifier diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—22-megohm
R2–R5—10,000-ohm
R6, R7—1000-ohm
R8—10,000-ohm, sub-miniature horizontal PC mount potentiometer (Mouser Part #32RW401 or similar)
R9—Cadmium sulfide light-dependent resistor Radio Shack #276-1657 or similar)

CAPACITORS

C1, C2—100-µF, 16-WVDC, electrolytic
C3—.01-µF, ceramic disc
C4—0.1-µF, 50-WVDC, polyester

ADDITIONAL PARTS AND MATERIALS

T1—12-volt power transformer (Digi-Key #EL12350 or similar)
K1—12-volt relay (Jameco #HB212 or similar)
PL1—117-volt AC power plug with line cord
Printed-circuit or perfboard materials, enclosure, IC socket, battery and battery holder, wire, solder, hardware, etc.

Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; 415/592-8097
Mouser Electronics, 2401 H'way 287 North, Mansfield, TX 76063; 800/346-6873
Digi-Key Corp., PO Box 677, Thief River Falls, MN, 56701; 800/344-4539

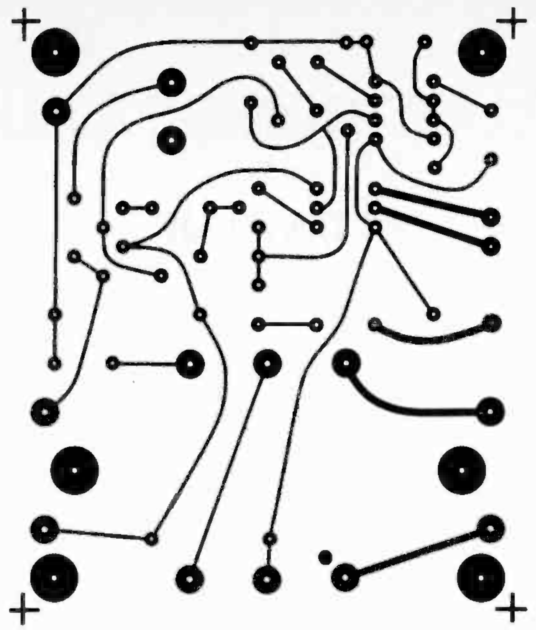


Fig. 2. Here is the foil pattern used by the author in the production of his prototype.

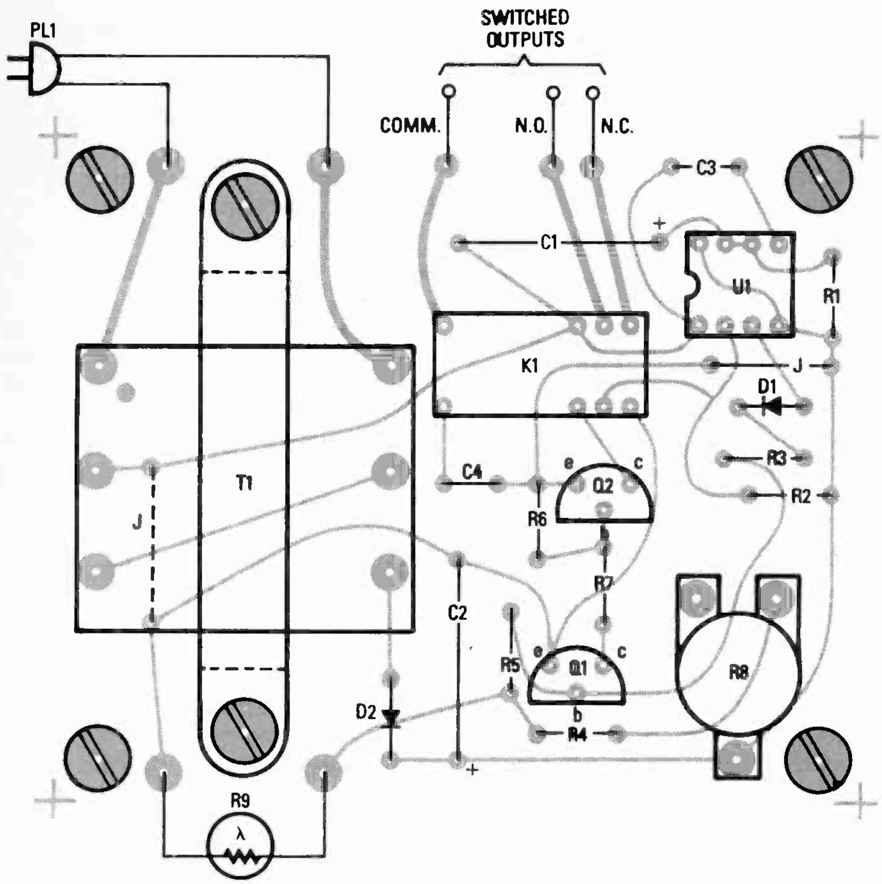


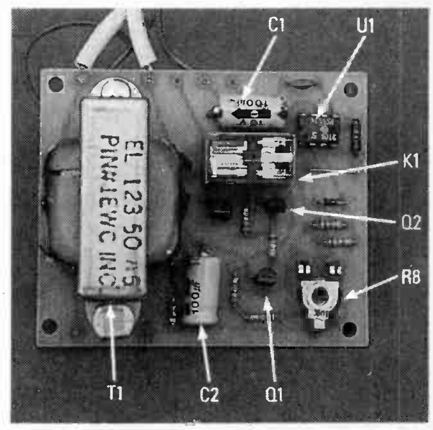
Fig. 3. Follow this parts-placement diagram for the position and orientation of the printed-circuit mounted components.

Also, note that trimmer potentiometer R8 is a horizontal-mounting subminiature unit (a source for which is given in the Parts List). If another configuration is used, some bending and manipulating of its leads may be necessary. The light-dependent resistor, R9, should be mounted at maximum lead length (so that it can easily be positioned), and the leads covered with some sort of insulation to prevent it from shorting to other components.

When the board is mounted in its enclosure, make sure that R9 is shielded from the light that the circuit controls. If R9 isn't shielded properly, each time the light is activated, the circuit will turn itself off and you'll wind up with a slow light "flasher" instead of a control.

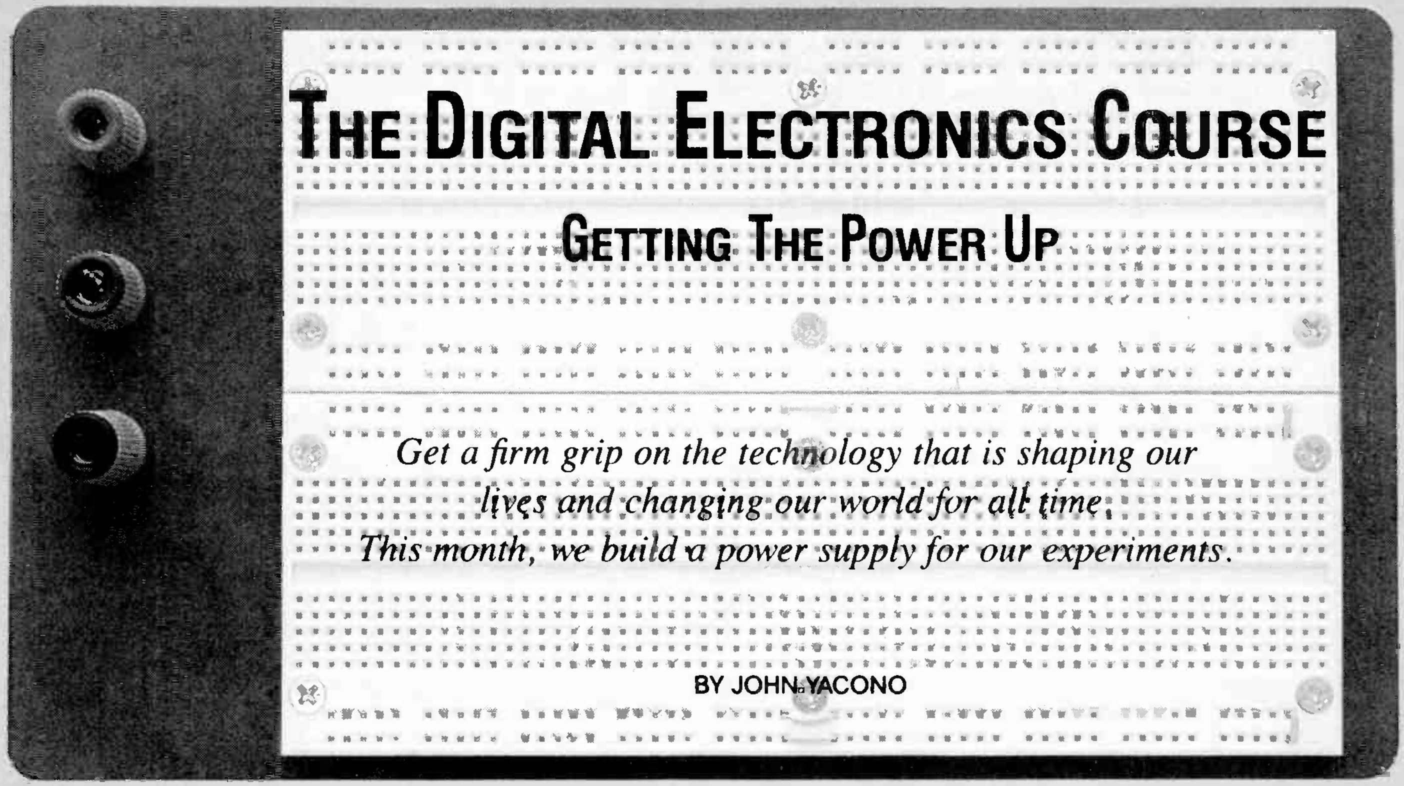
Shielding can usually be accomplished by gluing a short length of PVC tubing over the LDR. That keeps stray light from entering from the side, so that R9 only "sees" the light at the open end of the tube. The length of the tubing that is required will vary depending on the conditions of the light being turned on. If it is feasible, place R9 at some remote location from the light being controlled.

Setting the relay trip point at the proper time can be a problem if you have to wait for the timer to time out each time the relay pulled in. To make it easy to set the trip point, the time delay can be reduced to a few seconds by temporarily soldering a 10,000-ohm resistor in parallel with R1. After the trip point is set, that resistor should be removed to restore the full delay time.



Here is the fully assembled Night Light Control circuit ready to be mounted into an enclosure. When mounting the circuit in an enclosure, make sure that the LDR is in a good position to sense surrounding light conditions.

The circuit has been used for several years on a lighted house-number sign and a fluorescent night light for a front driveway. The two units operate independently and have been trouble-free except for fluorescent tube changes. The parts for the control are inexpensive and the performance of the unit surpasses many commercial units that are afflicted with turn-on oscillations. When you complete the Night Light Control, you, too, should have many years of trouble-free operation. ■



THE DIGITAL ELECTRONICS COURSE

GETTING THE POWER UP

Get a firm grip on the technology that is shaping our lives and changing our world for all time. This month, we build a power supply for our experiments.

BY JOHN YACONO

This is the first in a series of articles we will be presenting based on an introductory course in digital electronics and microprocessors given by the Electronic Industries Association Consumer Electronics Group (denoted the EIA/CEG). As the months progress, the editors of **Popular Electronics** will present select portions of the course in an easy-to-understand style to accommodate those who are new to electronics, but with projects down the road that are sure to interest even the most advanced hobbyist.

The original course was created by a group of EIA/CEG engineering consultants who've also presented the material in workshops and seminars. You can purchase a complete kit of parts with an experiment manual from the EIA/CEG (see the box elsewhere in this article for more information) if you prefer not to collect the components yourself. However, the parts required for the course can easily be obtained from many of the mail-order electronic distributors that advertise in this magazine. In addition, most of the parts are common enough to be found in almost any well-stocked junk box.

Our gratitude is extended to the EIA/CEG for the creation of this course, especially to the consultants who brought it to fruition: Dr. William Mast, Appalachian State University; Mr. Joseph Sloop, Surry Community College; Dr. Elmer Poe, Eastern Kentucky University.

The Breadboard. The experiments we'll present call for the use of a *solderless breadboard*. Such prototyping boards (as they are called) are readily available at electronic-parts and supply stores. Within the plastic case of the breadboard are a number of conductive spring-clips. Note the four large horizontal groups of holes. Each column in those groups has five holes; a wire pushed into any one of the five holes will be electrically connected to the other four holes in that column. That permits the assembler to connect component leads together by merely pushing them into the same column on the board.

Now look at the two pairs of long, horizontal rows running along the top and bottom of the board, and the two pairs in the center of the board. All the holes in each of those rows are connected together, but there is a break in the center of each long horizontal row. In order to make those entire rows electrically continuous, a jumper wire must be pushed into a hole on each side of that break.

Those rows are very helpful since they can be used as ground and power-supply lines for the components (which normally reside where the large grouping of holes is). It is suggested that you place jumpers across the breaks in those rows to make them more useful. Figure 1 shows an arrangement of jumpers that will be most useful in setting up the board. It ties adjacent pairs of rows together and makes them continuous by jumping the break in them.

The arrangment of Fig. 1 also connects the topmost rows with the lower middle pair, and the upper middle pair with the bottommost rows. That allows you to effectively use those rows as supply and ground buses. That setup is recommended for any project that will be powered from a singled-ended power supply. (A single-ended supply is any power supply that has a "hot" side—either positive or negative—and a ground, as opposed to a dual supply, which has both positive and negative outputs, and a ground.)

The large groupings of holes are paired off, with the members of each pair separated by a channel that has the exact width of a standard integrated circuit. If an IC is placed across a channel, its leads will line-up perfectly with the holes in the board. With an IC positioned like that, four wires or leads can be connected to each IC lead by pushing them into a hole in the corresponding column of holes. That makes for a fast, efficient means of wiring prototypes.

Wiring Technique. There will be a sequence of experiments placed on the breadboard. Sometimes you'll be required to keep experiments on the

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board to become part of the next experiment. Because of that, and in general, it is important that good wiring practices are used so that space can be conserved. The most obvious practice would be to keep component leads and/or wires as short as possible.

Long looping wires from one point to another cause confusion during troubleshooting and waste space. Messy wiring is most apt to be accidentally disconnected. All of the wiring placed on the board should be kept neat—flat on the board and as short as possible. Also, do not place wires *over* IC's. If the IC is bad and you must replace it, those wires will have to be removed. That practice wastes repair time and can cause you to make mistakes during the re-wiring process.

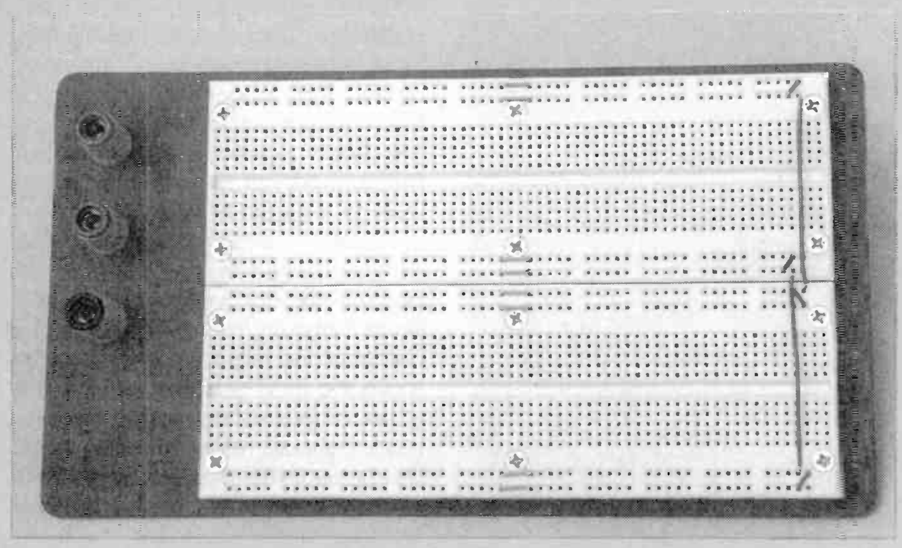
Further, do not use wire that is too large or too small in diameter for the board. Wire that is too large can ruin the breadboard. Wire that is too small may not make good electrical contact. The correct wire type for breadboarding is No. 22 solid-copper wire. Don't attempt to use stranded wire; shorts will result, if not poor connections. The solid wire insulation should be stripped back about a ¼-inch from each end.

As is always the case when working with electronic circuitry, there are certain procedures that should always be followed. For instance, never plug a solid-state component (IC or transistor) into a circuit with the power on; the device could be destroyed. That also goes for making any other changes in a circuit. That is normally a safety precaution followed to protect an experimenter working with high-voltage circuits—here it should be followed for the protection of the equipment and components, and to prepare you for future circuits, in which high voltages may be present.

Speaking of high voltage, filter capacitors should always be discharged before inserting or removing anything from the board. Charged capacitors can damage both components and you during circuit alterations, even with the power removed! Capacitors can be looked upon as energy-storage devices. The charge stored in the unit will quickly discharge through the path of least resistance. Very low voltages, with sufficient current, will cause muscle tremors; while high voltages with sufficient current can cause convulsions, and even death. So be sure that the circuit capacitors (particularly the electrolytics) are discharged before attempting to alter the circuit.

Also keep in mind that CMOS devices must be handled with special care to protect them from destructive static charges. You will learn more about that later. Finally, test leads should have sharp ends. That allows the lead tip to pierce the component's lead oxidation and it keeps the tip from slipping. A dull tip not only makes a poorer connection but it allows the lead tip to slip from the test point, often to short other nearby terminals.

Now that you know about the breadboard, good wiring procedures, and safety precautions, let's study the power supply that will power the experiments.



This is a good way to pre-wire the board, creating useful supply and ground lines.

5-Volt Power Supply. Our discussion of logic circuits commences with their power-supply requirements, and the basic characteristics of the two logic families that are commonly in use today: TTL and CMOS.

Transistor-Transistor Logic (or TTL) integrated circuits are composed of bipolar transistors. The circuits require a +5-volt supply that must be well filtered and regulated. The positive supply terminal is normally denoted $+V_{CC}$ or +V, and the negative side is written GND or $-V_{CC}$.

CMOS (short for Complementary Metal-Oxide Semiconductor) integrated circuits are composed of metal-oxide transistors. Integrated circuits based on CMOS technology operate from power-supply voltages that typically range from 3 to 15 volts. It should be noted, however, that some newer TTL-compatible CMOS circuits must operate from 5-volt supplies. Regardless, the positive supply terminal of a CMOS device is denoted V_{DD}, while the ground is usually denoted V_{SS}.

PARTS LIST FOR THE POWER SUPPLY

U1—7805 voltage regulator, integrated circuit
B1—2-amp, 50-PIV, full-wave bridge rectifier (see text)
C1—2200-µF, 15-WVDC electrolytic capacitor
C2—0.1-µF, ceramic-disc capacitor
C3—2.2-µF, 15-WVDC tantalum, or 100-µF, 15-WVDC, aluminum-electrolytic capacitor
T1—6.3-volt, 1.5-amp secondary, power transformer (see text)
PL1—AC line cord with plug (see text)
Breadboard, ohmmeter, No. 22 wire, etc.

The 5-volt power supply that we'll build in this exercise can provide adequate current for most TTL and CMOS circuits. The operation of the circuit in Fig. 1 is simple. Transformer T1 takes 117-volt AC power applied to its primary from an ordinary household socket and steps down the voltage to 6.3 volts, which appears at its secondary. The 6.3-volt AC, secondary output of transformer T1 is fed to BR1 (a full-wave bridge rectifier) for rectification. After rectification, the DC voltage is not steady, but instead fluctuates between

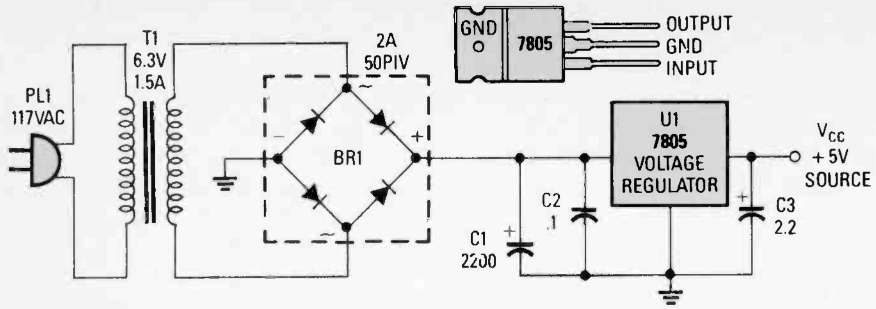


Fig. 1. This easy-to-build power supply will power all the experiments in the series. Note that the plug, transformer, and bridge rectifier may already be assembled in your kit.

ground and its maximum voltage level. That voltage is known as pulsating DC.

The pulsating DC output of the rectifier is applied across C1 for filtering, and is then regulated (held constant) at +5 volts by U1, a 7805 voltage regulator. Capacitor C2 is required if the regulator is located three or more inches from filter capacitor C1. Capacitors C2 and C3 provide noise rejection and improved stability. They should be placed as close to the regulator input and output terminals as possible.

The 7805 voltage regulator is extremely easy to use, and can provide current in excess of one ampere if properly heat sinked. The circuit is well protected against overloads and short circuits. It is also thermally protected.

Procedure. If you choose to buy the kit of materials from EIA, you may find that the voltage rating on the capacitors in the kit differ from those indicated in the Parts List. That's no cause for alarm since the values supplied in the kit and given in the Parts List are larger than necessary anyway. Also, your kit may have a wall transformer with or without a built-in bridge rectifier; or it may have a regular transformer, a line-cord, and a separate bridge rectifier. Modify the following instructions to accommodate your configuration.

Assuming that your kit has a wall-mount power supply, you may need to cut off its output plug if it has one. If you have a kit with a separate transformer and bridge, connect the line cord to the input or primary of transformer T1 by soldering the line cord to the T1's primary and then cover the exposed wiring with tape.

If the bridge rectifier is separate, connect the output or secondary of the transformer to the bridge rectifier, BR1, at the points where AC is indicated. Note: In the schematic diagram (Fig. 2)—and on many integrated rectifier packages—the AC inputs to the bridge rectifier are indicated by a small wavy line near both the terminals.

Connect C1 across the output of BR1 as shown. Capacitor C1 is used to filter (remove the ripple from) the pulsating DC output of BR1. Do that in the upper-left corner of the breadboard. Make the power supply as compact and neat as possible. It will be used with all your experiments. If it and later experiments are not kept as compact as possible, there will not be enough room on the breadboard for all the circuits.

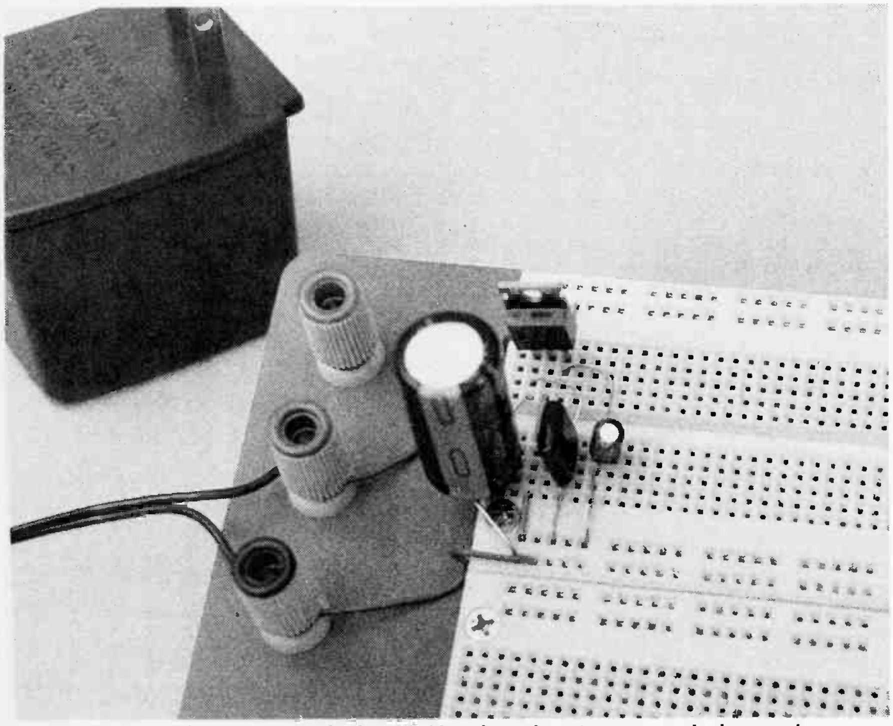
Inspect your work to ensure that the capacitor and bridge are connected with the proper polarity. Next, apply power to the circuit, and make the following voltage measurements on the solderless circuit board while referring to the schematic diagram.

Measure the AC voltage at T1's secondary winding. (This measurement can only be accomplished if you were supplied with a separate transformer and bridge rectifier). The AC voltage at T1's secondary winding should be about 6.3 volts. Your kit may have a different transformer, so check to see if the actual value is stamped on the transformer body.

Measure the DC voltage across filter capacitor, C1. The DC voltage measured should be approximately 1.4 × the transformer's AC voltage rating. For a 6.3-volt transformer, that would be 8.82-volts DC.

Now, remove the external power and discharge capacitor C1. Connect the 7805 voltage regulator. Then, connect capacitor C2 as close to the regulator input terminal as possible. Continue, by connecting capacitor C3 as close to the regulator output terminal as possible. Apply power to the circuit and measure the voltage regulator's output voltage. It should be +5-volts DC.

The 7805 voltage-regulator is internally protected against short circuits and momentary overloads. To demonstrate that point, momentarily short the output of the regulator to ground. Remove the short and measure the regulator output voltage after the overload. It should return to +5-volts DC. Disconnect the power, and put the power-supply circuit, still assembled on the solderless breadboard, away until next time. ■



Your circuit should fit neatly on the board. Note how the wires are snaked around components, avoiding contact and making circuit paths clear for easy troubleshooting.

BY MICHAEL A. COVINGTON, N4TMI

AM/FM/SW ACTIVE ANTENNA

Here's a one-evening project you can build that'll pull in shortwave or AM broadcasts like a magnet!

How much shortwave reception can you get with an 18-inch antenna? Would you believe you could log Radio Australia, all the major European broadcasters, and a few Latin-American locals? The catch is, you must use an *active* 18-inch antenna. Our *Simple Active Antenna* includes a FET amplifier to boost the signal with almost no load felt by the antenna. After all, a short antenna picks up the same RF signals as a long one—the signals are just weaker.

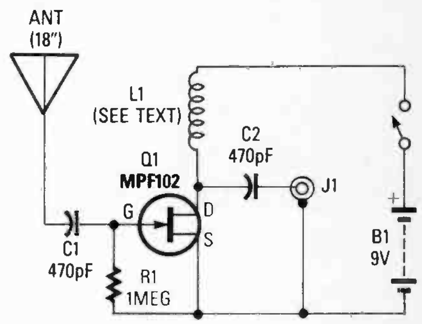


Fig. 1. Transistor Q1 amplifies the signal from the 18-inch whip to emulate the performance of a much larger antenna.

The Unit's Advantages. Most active antennas are much more complicated than ours (shown in Fig. 1). Our's is the simplest circuit that works reliably. I've tried it with a Sony ICF-2010, a Realistic DX-40, and an old Toyota car radio with success.

On the shortwave bands, it's comparable to a 20- to 30-foot wire antenna. On the AM-broadcast band, it's amazing—stations that were weak and scratchy (even when using a 40-foot wire antenna and an antenna tuner) come in loud and clear. It's even usable on the FM-broadcast band, though it's not that much better than an unamplified whip.

The circuit is so simple because it has an untuned high-impedance output. That works well with lower priced receivers that are designed to take an untuned wire antenna, as well as car radios. Performance may be disappointing with ham receivers that have low-impedance inputs.

Before You Start. You must choose coil L1 to work well with your receiver on the frequency bands that most interest you. I used a 470-μH coil because I wanted lots of amplification at lower frequencies. If you're mainly interested in shortwave, and want to avoid overloading from local AM stations, you can make L1 as small as 20μH.

Radio Shack carries a 100-μH RF choke that you can use for L1, but it's bulky. An alternative is to buy a pack-

(Continued on page 106)

E-Z MATH

LOOPS, NODES, AND DETERMINANTS

BY LOUIS E. FRENZEL, JR.

You can solve for any number of variables without manipulating equations with this step-by-step method.

In the last installment of E-Z Math (May 1989), I showed you how to solve simultaneous equations. You saw that there were three basic methods of solving simultaneous equations: by adding or subtracting them, substitution of one into another, or by comparison. You used simple algebra to work some examples.

Next, I introduced the branch-current method of analyzing electronic circuits. Circuits with multiple branches or paths for current, even those with two or more voltage sources, can be analyzed with this method. It helps you write the circuit equations for each branch using Kirchhoff's law. Then all of the currents and voltages can be computed by solving the resulting simultaneous equations.

This time I'll continue with circuit-analysis methods. I'll introduce you to the loop and node methods of analysis. Those methods also produce simultaneous equations. And I'll introduce a new and simpler way to solve them: determinants.

As before, don't let all the high-sounding expressions and unfamiliar terminology scare you off. It's pretty easy stuff, which you can do using simple algebra and some tricks that I will teach you. Just be sure that you have your calculator handy.

While you should be able to get through this article as it stands, it'll make more sense if you have read the last installment. Review your copy or order a back issue from **Popular Electronics**.

Determinants. A determinant is an array or matrix of numbers lined up in rows and columns. We will use matrices composed of the constants from sets of equations. Each row will contain the constants from one equation; the first row will contain the first equation's constants, the second row will contain the second equation's constants, etc. Each column will be dedicated to the coefficients of a particular variable (and sometimes to the constant terms) as you will see. Several determinants can be derived from the same equations depending on how you order the equations and coefficients. By manipulating the numbers in the determinants, the unknown variables can be solved for. Let's take an example. Here is a set of simultaneous equations:

$$x + 2y = 4$$
$$10x + 5y = 15$$

The numbers that go in the matrix are the coefficients on the unknowns x and y, and the constants on the right-hand side of the equations.

One way to form a determinant is to use only the coefficients of the unknowns like this:

$$\begin{vmatrix} 1 & 2 \\ 10 & 5 \end{vmatrix}$$

The coefficients of x are in the left column while the coefficients of y are in the right column. The coefficients for the first equation are in the first row, and the coefficients for the second equation are in the second row. It's almost as though we dropped all the arithmetic symbols, the variables, and the two constants.

That is what is generally known as the characteristic determinant. Note that the coefficient on x in the upper equation is one although it is traditionally not shown in equations.

We can form another determinant by substituting the constants on the right-hand side of the equations for the x coefficients in the left column. The y coefficients remain in the right column. The result is:

$$\begin{vmatrix} 4 & 2 \\ 15 & 5 \end{vmatrix}$$

That is the determinant we would use to start finding x. For our discussion here, we can call it the x determinant.

Another determinant is created by putting the coefficients of x in the left column and the constants from the equations in the right column, replacing the y coefficients. We get:

$$\begin{vmatrix} 1 & 4 \\ 10 & 15 \end{vmatrix}$$

That is the determinant to use to help find y. Call it the y determinant.

Now, to find x you divide the x determinant by the characteristic determinant. Then to find y, you divide the y determinant by the characteristic determinant. But before you can divide, you must evaluate each determinant.

To evaluate a determinant of two unknowns, you cross multiply the numbers and subtract them. The characteristic determinant is evaluated as follows:

$$\begin{vmatrix} 1 & 2 \\ 10 & 5 \end{vmatrix}$$

The first product is formed by multiplying downward diagonally from left to right. The second product is formed by multiplying upward diagonally from left to right. The products are subtracted to form the value of the determinant:

$$\text{value} = \text{1st product} - \text{2nd product}$$
$$= (1)(5) - (10)(2) = 5 - 20 = -15$$

Now, let's evaluate the x determinant:

$$\begin{vmatrix} 4 & 2 \\ 15 & 5 \end{vmatrix}$$

$$\text{x determinant} = (4)(5) - (15)(2)$$
$$= 20 - 30 = -10$$

$$\begin{vmatrix} 1 & 4 \\ 10 & 15 \end{vmatrix}$$

$$\text{y determinant} = (1)(15) - (10)(4)$$
$$= 15 - 40 = -25$$

Finally, we can calculate x:

$$x = \text{x determinant} \div \text{characteristic determinant}$$
$$x = -10/-15 = .667$$

and we can calculate y:

$$y = \text{y determinant} \div \text{characteristic determinant}$$
$$y = -25/-15 = 1.667$$

You can also use determinants to solve equations with three or more unknowns. The formatting and evaluation gets a little complex, but it is a fast and easy way to solve such equations. It is particularly easy if you program the determinant formulas into your PC.

Practice Problems. Now try a couple yourself to be sure you understand the procedure:

1. $2x - 5y = 10$
$6x + 10y = 20$
2. $x - 3y = 0$
$5x - 9y = 6$

Remember when creating your determinants to use the sign of the coefficient as well as its value.

Loop Circuit Analysis. Solving electronic circuit problems is a tedious and a time-consuming process. And it's so easy to make mistakes. That's why engineers look for ways to speed up or simplify the process. Solutions are often found by using some special math techniques. That is true of loop analysis and the node analysis method to be presented later.

The loop method, like the branch method explained in the last column, is used on complex circuits with multiple current paths. You will sometimes hear the loop method referred to as the mesh method because such circuits often resemble a screen mesh.

The basic technique of loop analysis is to assign a current to each closed loop. Then, using Kirchhoff's voltage law, you write the equation for each loop. Finally, you solve the resulting simultaneous equations with determinants or by some other procedure. Once the equations are solved, you will know all the current values and can calculate any voltage drops with Ohm's law. We can boil the process down to a few simple step-by-step rules:

1. Assign a current to each closed loop in the circuit. The direction of the current doesn't matter. A clockwise direction is traditionally used. It doesn't have to be the actual current direction in the circuit.

There should be a sufficient number of assigned loops so that every component is included. However, do not use redundant loops; that is, once every component has at least one current loop make no more loop assignments.

2. Write the equations of each loop using Kirchhoff's voltage law, which states that the sum of the voltage drops around a loop is equal to the source voltage. If the loop current flows out of the positive side of the voltage source, then put a positive sign on the source voltage. If the loop current flows out of the negative side of the source, put a negative sign on the source voltage.

Incidently, it doesn't matter whether you use electron-flow or conventional-current flow assumptions. Just use the rules given and everything will work out.

3. Solve the resulting simultaneous equations to calculate the loop currents.

If you calculate a negative current value, it means that the originally assumed loop direction is opposite to the actual direction.

Let's illustrate the procedure with an example. Refer to the circuit in Fig. 1. First, we examine the circuit to identify how many complete loops or closed current paths exist. There are two, so we assign a loop current to each, in this case I_1 and I_2. Note that I_1 and I_2 both flow through resistor R3, but in opposite directions. The actual current in resistor R3 is the difference between the two currents.

Okay, now let's write the loop equations using Kirchhoff's voltage law. That

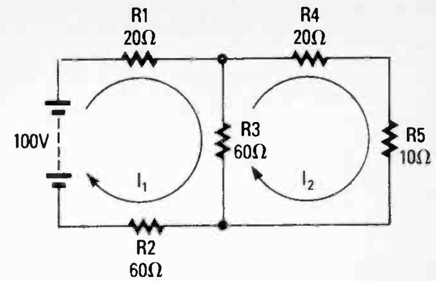


Fig. 1. The two loops of current (I_1 and I_2) both flow through R3.

means that we sum the voltage drops around each loop. We find the voltage drops with Ohm's law by multiplying the assigned current by the resistance. Then we set the voltage drops equal to the source voltage in the loop, assuming there is one. Here is the equation for the first loop:

$$R1I_1 + R3(I_1 - I_2) + R2I_1 = 100$$

You start at the voltage source and work your way around the loop in the direction of the current, summing the voltage drops until you return to the other side of the voltage source. Note that the current in R3 is I_1 minus I_2 since the currents oppose one another. We can now substitute the actual resistance values giving:

$$20I_1 + 60(I_1 - I_2) + 60I_1 = 100$$

The second loop equation is:

$$R4I_2 + R5I_2 + R3(I_2 - I_1) = 0$$

Again, the current in R3 is the difference between the two loop currents. Since there is no voltage source in this loop, we set the sum of the voltage drops equal to zero. Adding the resistor values, we get:

$$20I_2 + 10I_2 + 60(I_2 - I_1) = 0$$

Next, we use basic algebra to expand each equation, collect like terms, and simplify them. For the first equation, we get:

$$20I_1 + 60I_1 - 60I_2 + 60I_1 = 100$$
$$140I_1 - 60I_2 = 100$$

For the second equation, we get:

$$20I_2 + 10I_2 + 60I_2 - 60I_1 = 0$$
$$90I_2 - 60I_1 = 0$$

We can change the order of the equation to put the I_1 term first:

$$-60I_1 + 90I_2 = 0$$

We can now solve the equations using determinants:

$$140I_1 - 60I_2 = 100$$
$$-60I_1 + 90I_2 = 0$$

The characteristic determinant is:

$$\begin{vmatrix} 140 & -60 \\ -60 & 90 \end{vmatrix}$$

Its value is:

$$(140)(90) - (-60)(-60) = 12600 - 3600 = 9000$$

The determinant for I_1 is:

$$\begin{vmatrix} 100 & -60 \\ 0 & 90 \end{vmatrix}$$

Its value is:

$$(100)(90) - (0)(-60) = 9000$$

The determinant for I_2 is:

$$\begin{vmatrix} 140 & 100 \\ -60 & 0 \end{vmatrix}$$

Its value is:

$$(140)(0) - (-60)(100) = 0 + 6000 = 6000$$

I_1 then is:

$$I_1 = 9000/9000 = 1 \text{ ampere}$$
$$I_2 = 6000/9000 = .667 \text{ ampere}$$

The current in R3 is the difference between I_1 and I_2, or:

$$I_1 - I_2 = 1 - .667 = .333 \text{ ampere}$$

Since I_1 is greater than I_2, then the direction of the current in R3 is the same as in I_1. Just remember that the actual current direction may or may not be the same as that assumed for this analysis, but it doesn't matter.

Now that you know all the actual current values, you can compute the voltage drops across the resistors. For example, the voltage across R4 is:

$$V_{R4} = R4I_2$$
$$V_{R4} = 20(.667) = 13.34 \text{ volts}$$

Practice Problems. Test your own ability to use the loop method with this problem:

3. Refer to Fig. 2. Find the loop currents.

Node Circuit Analysis. The node analysis method is an alternative to the loop method. It too is used on complex multi-branch circuits that may have more than one voltage source.

A node is a point in a circuit where two or more components and/or voltage sources are connected. In the node method of circuit analysis, all of the nodes are first identified. Then Kirchhoff's current equations are written

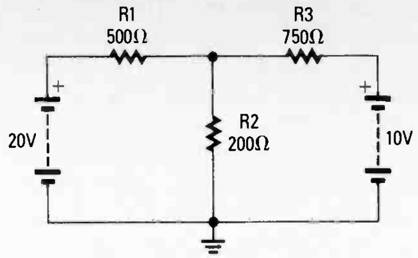


Fig. 2. Use this diagram to help you solve Problem 3. Even if your loop selection is different, the results should be the same.

for each node. Then the expressions for the voltages at each node are written. Next, these voltages are substituted in the current equations. The resulting equations are solved using determinants if simultaneous equations result.

The basic rules for the node method are:

1. Identify all circuit nodes.

2. Use one node as the reference point. Use this node like ground, and reference all other node voltages to this point.

3. Designate a variable to represent the voltage at each node (i.e., V_A, V_B, etc.).

4. Assume a flow of current through each current path at each node. Current direction assignment can be arbitrary but should follow the rules of Kirchhoff's current law:

The sum of the currents into a node is equal to the sum of the currents leaving that node.

5. Write the current equation at each node where the voltage is unknown.

6. Substitute the voltages at each node into the current equations and compute the unknown voltages. You may or may not end up with simultaneous equations.

Here is an example to illustrate the procedure. (Refer to Fig. 3.) First, the nodes are identified. They are labelled A through D. We'll select D as the reference node since it is at ground (although it needn't be).

Next, we label any node whose voltage with respect to the reference is unknown. We know the voltages at nodes A and C as those are the battery or source voltages. We don't know the voltage at B so we give it the designation V_B.

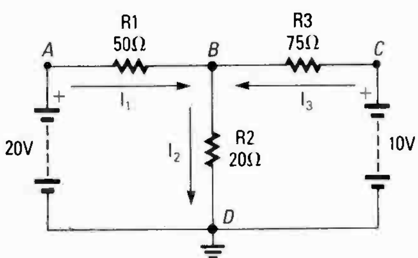


Fig. 3. Here the nodes for the circuit have been labeled and current directions chosen. Note that only one current flows through each component.

Now, we assume some current paths at node B. The ones shown are arbitrary. We can now write the Kirchhoff's equation for node B

$$I_1 + I_3 = I_2$$

Or, we can rearrange it to:

$$I_1 - I_2 + I_3 = 0$$

For each current in the above equation, we will substitute an expression using the node voltages and resistance values.

Ohm's law says that the current through a resistor is equal to the voltage drop across the resistor divided by the resistor value. In Fig. 3 we can see that I_1 flows through R1. The voltage across R1 is the difference between the source voltage and V_B or $20 - V_B$. So I_1 can be written as:

$$I_1 = (20 - V_B)/R1 = (20 - V_B)/50$$

I_2 is the current in R2. The voltage across R2 is V_B. So:

$$I_2 = V_B/R2 = V_B/20$$

I_3 flows in R3. The voltage across R3 is the difference between the voltages at nodes B and C, or $V_B - 10$. So:

$$I_3 = (10 - V_B)/R3 = (10 - V_B)/75$$

We can now plug these values into the basic current equation:

$$I_1 - I_2 + I_3 = 0$$
$$(20 - V_B)/50 - V_B/20 + (10 - V_B)/75 = 0$$

We can solve this equation by finding a common denominator and expanding. The lowest common denominator is 300:

$$= 6(20 - V_B) - 15V_B + 4(10 - V_B)/300$$

We can multiply both sides by 300 to get rid of the denominator. That leaves:

$$120 - 6V_B - 15V_B + 40 - 4V_B = 0$$

Collecting terms in the numerator gives:

$$-25V_B + 160 = 0$$

Rearranging and solving for V_B gives:

$$-25V_B = -160$$
$$V_B = -25/-160 = 6.4 \text{ volts}$$

Note no simultaneous equations resulted from this problem because there was only one node where the voltage

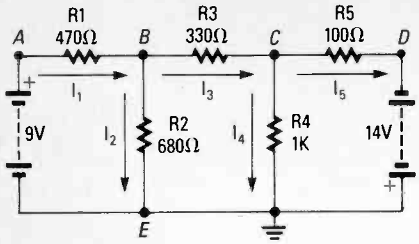


Fig. 4. Since the voltages at nodes A, D, and E are known, solving this circuit is easier than you might think.

was unknown. A circuit with two (or more) unknown node voltages would produce simultaneous equations. Such a circuit is shown in Fig. 4.

All currents and nodes are identified. Node E is the reference. The unknown voltages at nodes B and C are designated V_B and V_C.

Practice Problems. Use the node analysis method on these problems:
4. Find the voltages at nodes B and C in the circuit of Fig. 4.
5. Refer to Fig. 5. Find the voltage at node B with respect to ground.

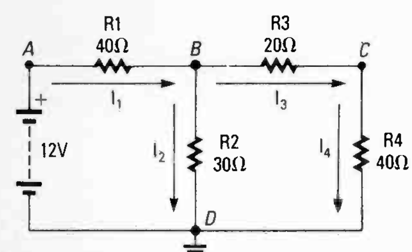


Fig. 5. Use the current directions shown when you're solving problem 5. If you don't, the values will be correct but some of your answers may have negative signs.

Answers.
1. $2x - 5y = 10$
$6x + 10y = 20$
characteristic determinant:

$$\begin{vmatrix} 2 & -5 \\ 6 & 10 \end{vmatrix}$$

$(2)(10) - (6)(-5) = 20 - (-30) = 50$ x determinant:

$$\begin{vmatrix} 10 & -5 \\ 20 & 10 \end{vmatrix}$$

$(10)(10) - (20)(-5) = 100 - (-100) = 200$ y determinant:

$$\begin{vmatrix} 2 & 10 \\ 6 & 20 \end{vmatrix}$$

$(2)(20) - (6)(10) = 40 - 60 = -20$
$x = 200/50 = 4$
$y = -20/50 = -0.4$
2. $x - 3y = 0$
$5x - 9y = 6$ characteristic determinant:

$$\begin{vmatrix} 1 & -3 \\ 5 & -9 \end{vmatrix}$$

$(1)(-9) - (5)(-3) = -9 - (-15) = 6$ x determinant:

$$\begin{vmatrix} 0 & -3 \\ 6 & -9 \end{vmatrix}$$

$(0)(-9) - (6)(-3) = 0 - (-18) = 18$ y determinant:

$$\begin{vmatrix} 1 & 0 \\ 5 & 6 \end{vmatrix}$$

$(1)(6) - (5)(0) = 6 - 0 = 6$ $x = 18/6 = 3$
$y = 6/6 = 1$

3. The two loops are shown in Fig. 6. The loop equations for loop 1 are:

$500I_1 + 200(I_1 - I_2) = 20$
$500I_1 + 200I_1 - 200I_2 = 20$
$700I_1 - 200I_2 = 20$

The loop equations for loop 2 are:

$750I_2 + 200(I_2 - I_1) = -10$
$750I_2 + 200I_2 - 200I_1 = -10$
$950I_2 - 200I_1 = -10$
$-200I_1 + 950I_2 = -10$

The source voltage is made negative because the loop current is out of the negative side of the 10 volt source. The equations are:

$700I_1 - 200I_2 = 20$
$-200I_1 + 950I_2 = -10$

The characteristic determinant is:

$$\begin{vmatrix} 700 & -200 \\ -200 & 950 \end{vmatrix}$$

The value is:

$(700)(950) - (-200)(-200) =$
$665{,}000 - 40{,}000 = 625{,}000$

The I_1 determinant is:

$$\begin{vmatrix} 20 & -200 \\ -10 & 950 \end{vmatrix}$$

Its value is:

$(20)(950) - (-10)(-200) =$
$19{,}000 - (2000) = 17{,}000$

The I_2 determinant is:

$$\begin{vmatrix} 700 & 20 \\ -200 & -10 \end{vmatrix}$$

Its value is:

$(700)(-10) - (-200)(20) =$
$-7{,}000 - (-4000) = -3000$

The value of I_1 is:

$I_1 = 17{,}000/625{,}000 = .0272$ amperes
$I_2 = -3000/625{,}000 = -.0048$ amperes

Note that I_2 is negative, which means that the actual current direction is opposite the assumed loop direction, but the absolute value is correct.

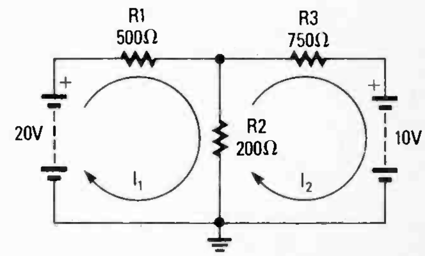


Fig. 6. If you used the same loops as we show here in the same direction, then your solution to problem 3 should be exactly the same as ours.

4. See Fig. 4 for the nodes and currents. The unknown node voltages are V_B and V_C. The current equations at those nodes are:

Node B: $I_1 = I_2 + I_3$, or
$I_1 - I_2 - I_3 = 0$
Node C: $I_3 = I_4 + I_5$, or
$I_3 - I_4 - I_5 = 0$

The currents expressed in terms of voltages are:

$I_1 = (9 - V_B)/470$
$I_2 = V_B/680$
$I_3 = (V_B - V_C)/330$
$I_4 = V_C/1000$
$I_5 = V_C - (-14)/100$

Note that the voltage at node D is -14 because it is negative with respect to ground. Plug these values into the current equations:

$I_1 - I_2 - I_3 = 0$
$(9 - V_B)/470 - V_B/680 - (V_B - V_C)/330 = 0$
$9/470 - V_B/470 - V_B/680 - V_B/330 +$
$V_C/330 = 0$

Factor out V_B and rearrange the equation:

$-V_B(1/470 + 1/680 + 1/330) + V_C/330 =$
$-9/470$

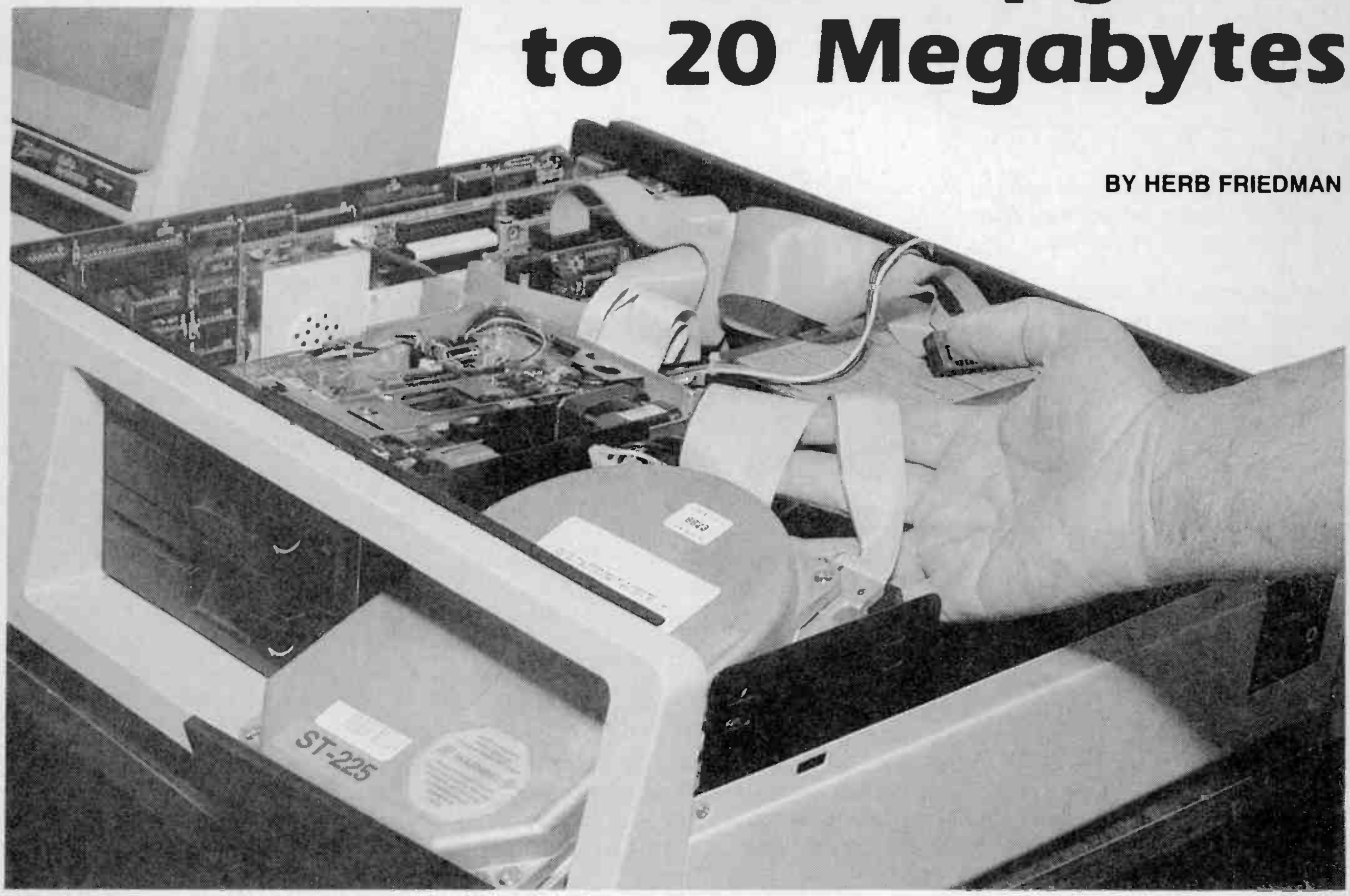
Multiply by -1:

$(1/470 + 1/680 + 1/330)V_B - (1/330)V_C =$
$9/470$

Use your calculator to compute all reciprocals and collect terms:

$.0066V_B - .003V_C = .019$
(Continued on page 98)

Low-Cost Upgrade to 20 Megabytes



BY HERB FRIEDMAN

If you're running out of storage on a 10-meg hard disk, here's the low-cost way to upgrade to 20 megabytes.

While it might surprise many of you who just got into personal computing, the early IBM PC's with hard-disks—as well as their clones—had but 10 megabytes (10MB) of hard-disk storage. It doesn't matter whether only 10MB was supplied in the belief that a 20MB hard-disk drive would be too finicky for personal computer use, or because the 20MB drive was too expensive then; 10MB drives became more or less the *defacto* standard because it was more than enough for personal computing. At least that's what almost everyone believed in the early days of personal computing.

Today, just a few heavyweight programs—particularly graphics software—can use up 10MB of storage before you even get to save some work files.

But even if your budget is tight enough to squeak, you can still easily upgrade your computer to 20 megabytes without having to mortgage the ranch—because you usually don't have to replace the entire existing hard-disk system. As a general rule, you will probably be able to utilize the old hard-disk controller; all you'll have to buy is the disk unit itself, and they are available for about $225—and probably for less in the coming months because the market is flooded with 20MB drives.

The Key. The key to making an easy and inexpensive hard-disk upgrade is the half-height *Seagate* model *ST- 225* 20MB unit shown in Fig. 1. The reason the ST-225 is the drive-of-choice is because recent Western Digital hard-disk controllers were intended to work with either the 10MB ST-412 drive or the 20MB ST-225 drive. In fact, any controller that will handle an ST-412 also works with the *10MB Miniscribe 3012* and the *Microscience HH725*. So, if your computer has one of those 10MB drives, they can also be upgraded with an ST-225. Unfortunately, hackers who have tried to squeeze extra disk capacity with an RLL controller should note that the ST-225's warranty is voided if the drive is used with an RLL controller.

In fact, the controllers are changed from 10MB to 20MB by simply adding two jumpers; but it takes more than the jumpers to get the system running at 20MB—so let's take the upgrade one step at a time.

The Removal. Taking first things first, make certain that your new drive comes with an instruction manual; without one you are wiped out because the manual contains certain software information that you'll need to format the hard disk. Also, make no changes to any jumpers, switches, or whatever on the drive, because the drive is factory-supplied with everything correctly set for a PC having only one hard disk.

Next, check for the small label affixed to the hard drive entitled "error map," which lists defective tracks. (A few defective tracks are normal.) You'll

For a headache-free upgrade to 20MB, use the Seagate ST-225 20MB hard-disk drive.

need that information when formatting the drive, because that's when the defective tracks get locked out, so write it down.

Set the drive aside to begin disconnecting the existing 10MB unit from the computer. Start by disconnecting the power and signal cables (the signal cable should be a flat piece of ribbon cable.) Some computers have polarized connectors on the ribbon cables, others don't, and you may not know if the connectors are polarized until they are disconnected. That being the case, make a note as to how the color stripe—which is located on only one side of each ribbon—is positioned when looking straight down at the top of the drive. That's exactly the way the ribbon cables must be connected on the ST-225.

Normally, the stripe represents pin 1 on the connectors for the disk controller and the hard disk. Unfortunately, the original assemblers of personal computers have been known to reverse the connectors. Everything works out fine if the connectors on *both* ends of the ribbon are reversed, but you're in big trouble if only one connector is reversed.

With the cables disconnected, the drive is ready for removal. If the hard disk is positioned under some other kind of drive, don't try to take it out by itself because you'll most likely damage one of the drives. Take a few extra minutes to remove any drive that's located in the way of the hard disk. Locate and remove all mounting screws, then remove the 10MB hard disk.

Installation. Begin installing the 20MB unit by sliding it in place on the computer. Some computers are so jam-packed with hardware, or the space behind the drive is so tight, that something is bound to break if you try to connect the hard disk's signal and power cables after the drive is in place. If that is the case for your computer, slide the 20MB drive halfway into the cabinet, connect the cables, then slide the drive all the way in. Take extreme care to make sure that the two ribbon cables are installed correctly.

Next, remove the controller card. A half-size controller will resemble the one shown in the photos. A full-size controller will be about twice as long. The overall size makes no difference; what *is* important are the rows of terminals, which are called and labeled as "switches." To prepare the *Western Digital WD1002A-WX1* controller for 20MB operation, you simply install two jumpers in positions 1 and 3. If your controller is not a Western Digital unit, write to the manufacturer for the manual, or call the outfit from whom you purchased the computer or the 20MB hard disk and ask what the jumper connections should be.

Now insert the drive's mounting screws. If after you check out and format the hard disk, you start moving the cabinet around while reinstalling another drive, you could jar the hard disk, so reinstall any drives you may have removed before proceeding.

Hard and Soft. Formatting a hard disk is not the same as formatting a floppy, even though the DOS FORMAT.COM program is used. First, you must do what

If there is a drive installed above the existing hard-disk drive, remove it first. Do not try to slip the hard disk out from under another drive.

is called a *low-level format* on the hard disk, or it can't be formatted further.

There's no need to go into the nitty-gritty of a low-level format because that's not the purpose of this article. Suffice it to say that the low-level format records magnetic signals on the hard disk that tell the computer how many bytes are available, and which, if any, defective tracks to lock out. If you presently have on floppy-disk a low-level format program for your old 10MB hard disk, take note that it can't be used. Oh, it will do the low level formating, but it will record that the drive is only 10MB; and after you're all finished formatting the hard disk, you'll find you have only 10MB available.

The disk controller card has its own BIOS firmware that is accessed through

(Continued on page 96)

Make a note of any information provided on the "error map," because the label might be obstructed once the drive is installed, and it's required when you format the drive.

Circuit Circus

By Charles D. Rakes

BATTERY REJUVENATION CIRCUITS

In response to a reader's request, this month *Circuit Circus* features a couple of battery-charger circuits. We'll also present a monitoring circuit that can be combined with either of the charging circuits, or any other, to let you keep tabs on the status of the battery being charged.

If you're like most electronic hobbyists, you probably have at least a dozen or more electronic devices that are battery powered. It's also a good bet that at least some of those devices are powered from rechargeable batteries, and that some that are not, certainly should be.

Lead-acid, nickel-cadmium, and gel-cells are the three most commonly used rechargeable batteries available on the market today. Lead-acid batteries, such as the ones used to start your car, lawn mower, or motorcycle, can also be a valuable power source for a number of electronic devices. But for most other consumer applications, the most often used rechargeable battery is the NiCd (nickel-cadmium), which can be found powering just about every conceivable electrically operated device.

Lead-Acid Battery Charger. Our first circuit, see Fig. 1, provides a low-to-medium current to charge 12-volt lead-acid type batteries. The circuit can be used to charge motorcycle batteries, or it can serve as a trickle charger for automobile batteries.

The circuit derives its power from the 117-volt AC-power line. The 117-volt AC line voltage is stepped down to 18-volts AC by transformer T1. The output of the transformer is applied across a full-wave bridge rectifier (BR1), which converts the 18-volt AC output of T1 to a DC voltage.

The output of BR1 then travels along two paths. In one path, a portion of the DC output of BR1 is fed to the base of transistor Q1 through R1 to bias that transistor off. (Note that transistor Q1 is a PNP unit, which requires the voltage at its base be more negative than that at its emitter and that the voltage at its emitter be more positive than that at its base.) That voltage is also fed through D1 (which supplies a positive voltage to operate the control circuitry) to C1, causing that unit to begin charging. The charge on C1 is fed to the base of transistor Q1 through R5 and R6 to bias that unit into conduction.

In the other path, SCR1 is used as an electronic switch which, when activated, connects the DC output of BR1 to the battery under charge. Lamps L1 and L2 limit the maximum charging current to protect the transformer, rectifier, and the SCR from overload. In addition, the circuit offers an adjustable maximum-voltage feature that protects the battery from over charging. Resistor R9 sets the maximum charge

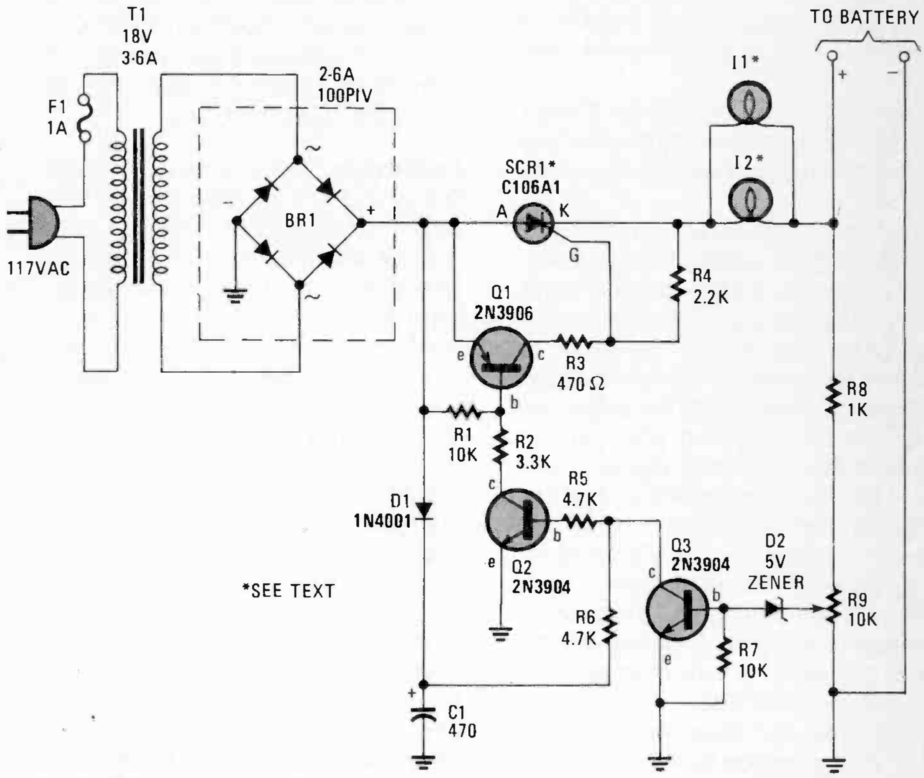


Fig. 1. This charger provides a low-to-medium current to charge 12-volt lead-acid batteries, like those used for motorcycles, or to trickle-charge automobile batteries.

PARTS LIST FOR THE LEAD-ACID BATTERY CHARGER

SEMICONDUCTORS

Q1—2N3906 general-purpose PNP transistor
Q2, Q3—2N3904 general-purpose NPN transistor
SCR1—2 to 6-amp, 100-PIV or greater, silicon-controlled rectifier, see text
D1—1N4001 1-amp, 50-PIV, silicon rectifier diode
D2—5- or 6-volt Zener diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units)
R1, R7—10,000-ohm
R2—3300-ohm
R3—470-ohm
R4—2200-ohm
R5, R6—4700-ohm
R8—1000-ohm
R9—10,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS

C1—470-µF, 50-WVDC, electrolytic capacitor
B1—2- to 6-amp, 100-PIV, full-wave bridge rectifier
T1—18-volt, 3- to 6-amp power transformer, see text
I1, I2—12-volt, 12-watt auto lamp (see text)
F1—1-amp fuse, see text
Perfboard, pins, power cord, lamp sockets, clips, knob, solder, wire, etc.

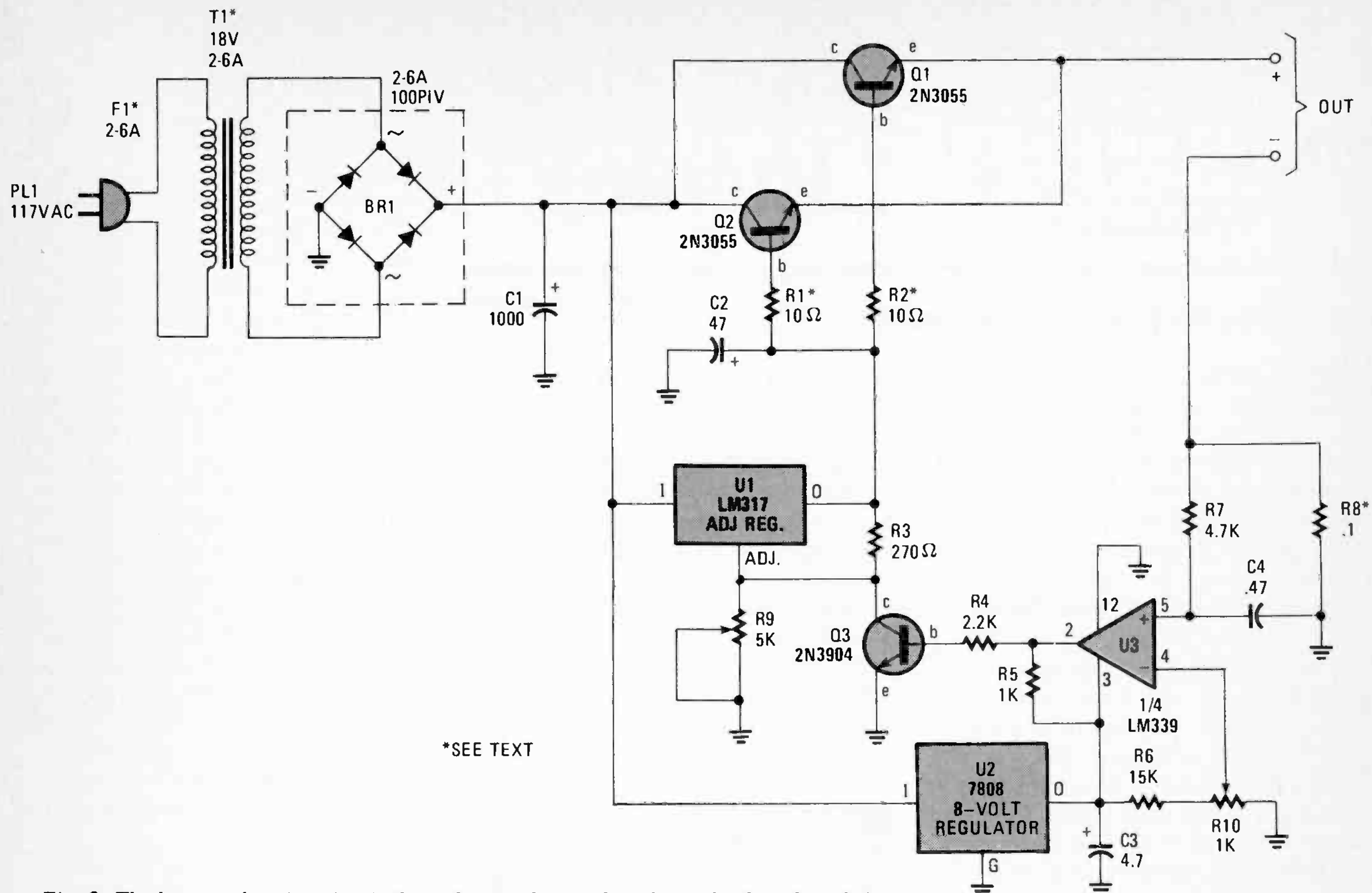


Fig. 2. The battery charging circuit shown here is designed to charge lead-acid, nickel-cadmium, and gel-cell rechargeable batteries. The circuit provides a well-regulated, adjustable output voltage as well as an adjustable output current, making it compatible with most NiCd units.

voltage; as long as the battery's voltage (during charging) is below the maximum setting, no current will flow through D2 and transistor Q3 remains off.

When power is applied to the circuit, the base of Q1 is pulled to ground through Q2, turning it on like a switch. That ties R3 to the positive output of BR1, thereby applying a trigger voltage to the gate of SCR1, turning it on. As long as Q1 is switched on, the charger pours current into the battery.

However, when the battery becomes fully charged, the voltage at the wiper of R9 rises and at some level—as determined by the setting of R9—causes D2 to conduct, turning on transistor Q3. That switches the voltage at the junction of R5 and R6 to ground, turning off Q2, Q1, and SCR1.

When SCR1 is turned off, the charging current ceases to flow, and the battery's voltage is maintained at the pre-set level. The circuit's maximum charging current is limited only by the current rating of the transformer, the bridge, the SCR, and the number of lamps used for current limiting. By changing those few parts, the low-to-medium charger circuit can be converted into a higher current charger suitable for larger lead-acid batteries, or to fast-charge small batteries.

Also, the circuit can be modified to charge batteries with voltages other than 12, by changing T1. To build a 6-volt charger, T1 should have a secondary output voltage of 9 to 12 volts and a current rating great enough to supply the desired charging current.

When working with and around lead-acid batteries be as cautious as possible; the acid in those batteries can cause dangerous and painful burns.

Universal Battery Charger. The charger circuit shown in Fig. 2 is designed to charge all three varieties of the rechargeable batteries. The charger's output voltage is adjustable and regulated, and has an adjustable constant-current charging circuit that makes it easy to use with most NiCd batteries. The charger can charge a single cell or a number of series-connected cells up to a maximum of 18-volts. The charging rate can vary from a low of 25 mA to over 4 amps, depending on the current-carrying components used.

Now lets take a look at the circuit and see how the charger operates. As in the previous circuit, the transformer, bridge rectifier, and filter capacitor C1, supplies the DC-output voltage for the charger's operating circuitry and output charging current.

Power transistors Q1 and Q2 are connected as series regulators to control the battery charger's output voltage and charge-current rate. An LM317 adjustable voltage regulator supplies the drive signal to the bases of the two power transistors, Q1 and Q2. The voltage feeding the battery is only slightly less than the regulator's output. Potentiometer R9 sets the output-voltage level.

A current-sampling resistor, R8 (a 0.1-ohm, 5-watt unit), is connected between the negative output lead and circuit ground. For each amp of charging current that flows through R8, a 100-mV output is developed across it. (All of the charging current going into the battery flows through R8.) The voltage developed across R8 is fed to one input of comparator U3 (¼ of an LM339 quad comparator). The other input of the

(Continued on page 95)

DX Listening

By Don Jensen

SW FROM THE BOTTOM OF THE WORLD

Summertime—and the livin' is easy! Maybe that's true for you and me, in our northern hemisphere hammocks, glasses of iced tea in hand, but not so at the bottom of the world. July is mid-winter in Antarctica and life is anything but easy. At this time of year, the sun never shines on this, the coldest place on Earth. The thermometer often drops to −50°F and colder.

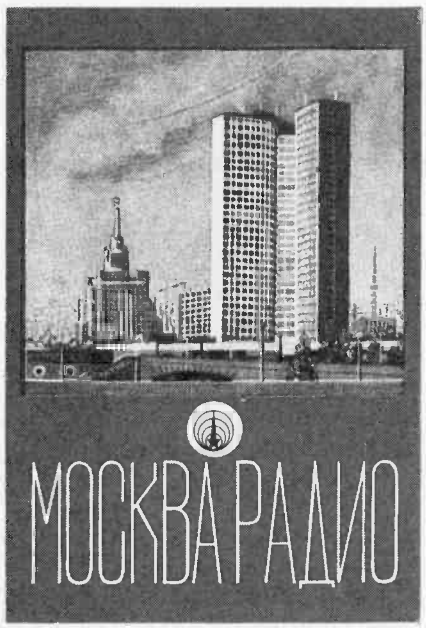
Antarctica is a place of extremes. Its huge mass of ice, 90 percent of the world's supply, contains 70 percent of all the fresh water on Earth. Yet Antarctica gets so little precipitation that it's the world's largest desert. The continent gets more sunlight in its six-month summer than equatorial regions get all year long. But most of the sunlight is reflected back to space, producing little surface warmth.

It is an exotic place in its own strange way. There are no permanent residents, but a goodly number of scientific and military types are temporarily assigned to isolated duty at various frigid outposts. New arrivals are surprised to experience the same lightheadedness as do visitors to the high Andean cities. The polar plateau is a surprising 10,000 feet above sea level, due to the ice, which is almost two miles thick.

Radio broadcasters abound on the other continents. There are hundreds of shortwave outlets, for instance, in South America. There are scores of stations in Africa, Asia, and Europe. In Antarctica, though, there are exactly two! For that reason, and because they are by no means the easiest of catches, those SW stations are much sought-after targets for DX listeners.

One of the pair is AFAN, the *American Forces Antarctic Network* shortwave outlet, which broadcasts on 6,012 kHz. The other is LRA36, *Radio Nacional Arcangel San Gabriel*, a station operated by the Argentine military. The best bet to hear at this time of year is the latter, which broadcasts all in Spanish on 15,476 kHz. LRA36 seems to be a strange operation at first glance. Who, for example, would expect to hear Spanish-language children's programs and Argentine tangos from a polar shortwave station?

It is located at Esperanza, an Argentine army base at Hope Bay on the Antarctic peninsula, some 63° south latitude. It operates, rather clearly, to show the Argentine flag in that remote part of the world. Although it uses a rather modest 1-kilowatt (kW) shortwave transmitter, LRA36 sometimes can be heard with rather decent signals in North America at around 2330 to 0030 UTC, or so.



This is one of many QSL cards issued by the Soviet Union's worldwide shortwave service over the years. The Cyrilic letters spell out the Russian words, Radio Moscow.

Reception reports for Radio Nacional Arcangel San Gabriel may be sent to the station in care of Base Antartida Esperanza, C.P. 9411, Antartida, Argentina, via Buenos Aires, Argentina.

Considerably harder to hear is AFAN, although chances will improve as fall approaches. It is located, as one of its U.S. Navy operators noted, in "downtown McMurdo." McMurdo, at 77° south latitude, but halfway round the continent from the Argentine station, has since 1956 been the key American base in Antarctica. And while other *American Forces Radio and Television Service* transmissions left shortwave last October, AFAN returned to the air with a spruced-up transmitter.

The AFAN SW outlet began operating back in 1974. Over the years, it was a difficult but surely not an impossible catch for stateside DX'ers. Then, in about 1986, it seemingly left shortwave.

It's job, primarily, had been to provide distinctly "local" and American programming for military and civilian personnel at the more remote Antarctic locations, those listeners beyond the coverage area of McMurdo's AFAN FM station on 100.1 MHz. And when the FRT-24 high-frequency, 1-kilowatt shortwave transmitter failed, it was missed.

It was returned to the air last fall, broadcasting from what is called Transmitter Hill, three miles from McMurdo. DX'ers in North America began reporting hearing it occasionally on 6,012 kHz with "canned" pop music, and very few announcements. Apparently AFAN has a shortage of announcing staff, so the technician on duty often simply lets the music roll *sans* announcements.

The best time to hear that SW station is in the early morning hours, say between about 0900 and 1130 UTC. Reception reports may be sent to AFAN McMurdo, U.S. Naval Support Force Antarctica, Fleet Post Office, San Francisco, CA 96601.

Speaking in Tongues. That's what tuning the shortwave bands can sound like to the casual listener. True there are plenty of broadcasts in English, but it doesn't take a newcomer to SWL'ing very long to realize that much of the programming he or she comes across is in some foreign language.

If you automatically dial out any station broadcasting in something other than English, you're unnecessarily limiting your listening adventures. Serious SWL's sooner or later want to tune to those stations broadcasting in other languages. I'm not suggesting that you need to learn one or many other languages to get along on shortwave. It's not necessary to be fluent in a language to be able to pick out key words

*Credits: Mark Coady, Ont; Bill Fergus, CA; Al Gastle, Ont; Fletcher Collins, NY; Ontario DX Association, PO Box 161, Station A, Willowdale, Ont. M2N 5S8, Canada.

that allow you to at least identify the station you're hearing and, perhaps, comprehend at least the gist of at least some of its programs.

There are hundreds of different languages and dialects in the world. But some are much more widely used, and that's a good place to concentrate in the beginning. Most Latin American SW stations use Spanish as their principal language; Brazilian outlets, which broadcast in Portuguese, are the exception. In much of West Africa, French is an important language, a reminder of the colonial era.

Arabic programming is aired by stations in North Africa and the Middle East. Chinese is the language of hundreds of millions of radio listeners in Asia. Scores of languages and dialects are used by the Soviet home-service stations.

A good way to begin is to simply get used to the sound of different languages. Before long, you will be able to at least identify many languages you hear by the way they sound, even though you may not recognize a word in the babble, much less know its meaning.

The *Voice of America's* foreign-language broadcasts offer a good opportunity to simply listen and familiarize yourself with the basic sounds of the different languages. With some time and effort, you will come to recognize the basic sounds of various languages. Some will sound soft and musical, others harsh and guttural. You will note the sounds of the various language groupings by their sound, the Romance languages, the Germanic-Nordic groupings, the Slavic tongues, the singsongy tonal languages of Asia.

Repeated listening will sharpen your ear. You will be able to distinguish Spanish from Portuguese, German from Dutch, even if you don't know a word in any of them. But actually, you will be picking up some useful words as you go along. The words that you should concentrate on, at least initially, are those often heard as part of a station's identifying announcements.

I'll get into some of the specific "identification" words you can look for in the commonly heard foreign languages—Spanish, French, Portuguese, Arabic and Russian—in next month's installment of this column.

Down the Dial. Here are some of the stations shortwave listeners are reporting. Why not pass along some of your own SW loggings for future *DX Listening* columns? Your questions and comments on SWL'ing also are welcomed. Send them to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Canada—5,960 kHz. This one may fool you but Radio Japan's English programming—heard at about 0100 UTC—is actually being relayed by the shortwave transmitters of *Radio Canada International* (RCI) at Sackville, New Brunswick.

Hong Kong—7,180 kHz. Operating on this frequency at around 0930 UTC is the *British Broadcasting Corporation's* (BBC) Hong Kong relay station. You can hear the World Service financial news, followed by an English-Chinese language lesson.

International Waters—6,215 kHz. *World Mission Radio* is a Belgian-based religious organization that leases time on *Radio Caroline International*, an unlicensed station located aboard a ship off the English coast. Try tuning in this one at around 0500 UTC. ■

AmericanRadioHistory.Com

Computer Bits

By Jeff Holtzman

MOTHERBOARD UPDATE

I just found a motherboard that sets a new price/performance standard. The board is based around a 16-MHz 80286, but it can be upgraded to an 80386SX via a special "daughter-board" that plugs into the CPU socket. Its features include as much as 5 megabytes of RAM on the board (16 megabytes total), built-in floppy-disk controller, a parallel port, and two serial ports.

The basic board costs $465 as a kit ($495 assembled). With the 80386SX adapter, the kit price is $695 ($795 assembled). Complete systems are also available.

The board, called the *PT386-PLUS*, is based on the NEAT (New Enhanced AT) chip set from Chips and Technologies, the principal supplier of system-level IC's for IBM compatibles. The PT386-PLUS is sold by Peripheral Technology, 1710 Cumberland Point Drive, Suite 8, Marietta GA 30067, (404) 984-0742.

I had an early prototype of the board in my hands long enough to test it thoroughly. It ran every item of DOS software I could throw at it, including several tough products designed specifically for the 80386 (*Windows/386* and *386MAX*); it ran everything without a hitch.

The board's basic performance equals that of the Compaq 386s (the first commercial 386SX-based PC), a machine that costs about $3800 without a hard disk! Jameco sells a NEAT-based 80286 motherboard for about the same price as the PT386-PLUS, but it has no on-board peripheral controllers.

The bottom line: at $700, the PT386-PLUS offers the do-it-yourselfer the best way to get started in 386-based personal computing. It's also a darned good upgrade option as well.

QEDIT. Ever since I was honest enough to admit to myself that I really didn't need a word processor with everything (one that eats up four or five megabytes of disk space and laughs at anything less than 512K of RAM), I've been searching for a new ideal. If you caught the April issue of **Popular Electronics**, you know that I was captivated by *Q&A Write*. (Actually, I still am.) But Q&A Write still has a few features that could have been implemented better—particularly its ability to deal with ASCII files.

In my work, I evaluate a lot of software and hardware, and I need a quick way of editing the AUTOEXEC.BAT and CONFIG.SYS files, and other short documentation files. The test machines come and go, the peripherals installed in them come and go, and the software I run is constantly changing. And Q&A Write is just too big, too slow, and too inconvenient for fast, convenient ASCII editing.

A friend told me about a shareware program called QEDIT; I've found that it meets my text-editing needs and actually provides an amazingly powerful environment for all sorts of editing. It's also got a huge "underground" following, and at least one company is selling disks of public-domain and shareware QEDIT enhancement utilities.

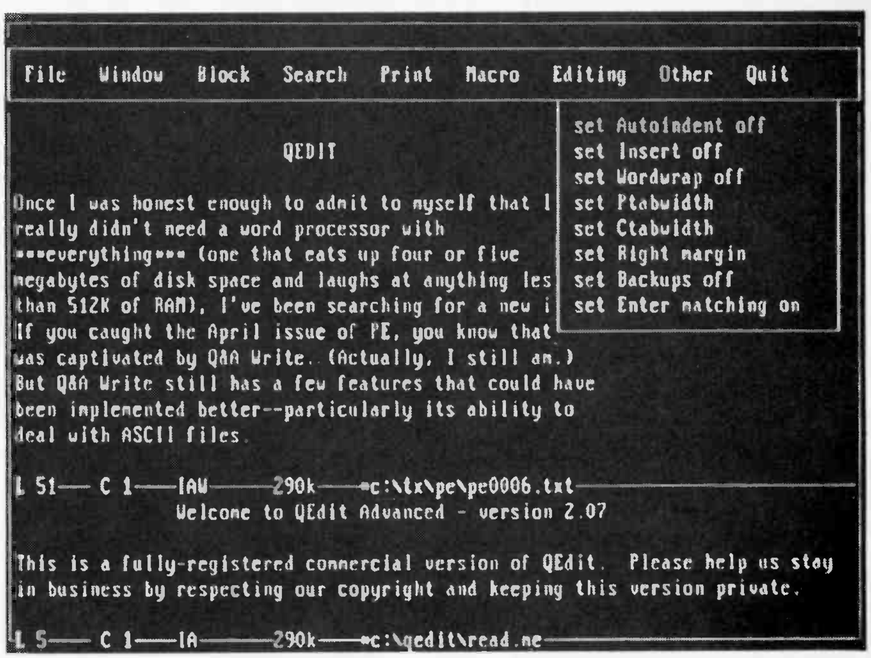
An amazing fact is that the entire program is less than 50K in length. Of course, QEDIT doesn't include a spelling checker, thesaurus, desktop publishing, background communications with Martians, etc. What it does have is an extremely configurable user interface. You can define the meaning of *every* key, including two-key combinations. For example, if you think <CTRL-B> should move the cursor to the "beginning of the line," edit QCONFIG.DAT to read:

```
^b   beg_line
```

then run QCONFIG.EXE, and you've got it. The program comes with WordStar keystrokes programmed as defaults, but you can change those at will. You can also change screen colors, whether the status line appears on the top or bottom line of the screen, whether the screen is "framed," etc.

But that's the gravy; QEDIT also has its share of meat. You can open several files simultaneously; each can occupy a portion of the screen in its own window, or each can occupy the full screen. QEDIT provides a number of commands for manipulating those windows, including: switch to next window, close window, increase/decrease window size, close all but current window, and so on.

You control its operation via either drop-down menus, <CTRL-KEY> combinations (which you can program



QEDIT is a shareware text editor that occupies less than 50K of disk space, runs in 128K of RAM, costs less than $50, and is extremely fast and customizable.

yourself), or a combination thereof. The menus are activated by pressing the escape key; you navigate them in the usual manner using the cursor keys. You can also create macros to automate frequent operations.

QEDIT contains a scrap buffer, an undelete buffer, and 99 scratch buffers. Say you want to copy the same block of text to several locations in a file (or to several files in different windows). First mark the block, then copy it to the scrap buffer by pressing the gray plus (<+>) key. Then move the cursor to the desired location (in the same or a different file), press the gray asterisk (<*>) key, and the block will be pasted in place.

Scratch buffers work in a similar manner, except that you can give them names. Unfortunately, you can't save a set of scratch buffers and reload them later. The undelete buffer allows you to recover the last 30 deletions (the number, like most QEDIT features, is configurable).

The program also includes several features useful for C and Pascal programmers, including the ability to run a compiler from within the editor, pick up the error file, and then be able to point to lines with syntax errors in the program file(s). Not quite as slick as Turbo Pascal and C, but close. QEDIT also offers brace-matching and auto-indentation.

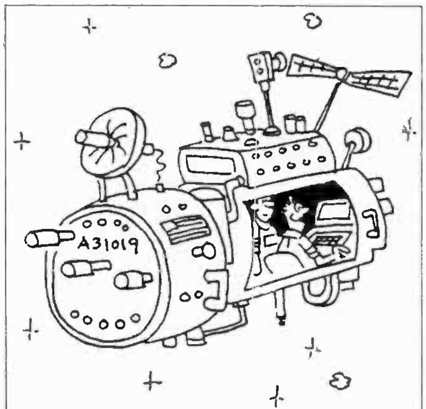
Other miscellaneous features of the program include the ability to edit files as large as available memory, line and box drawing, a word-wrap mode (for word processing), manual paragraph reformatting, column operations, versatile tab handling, support for the 43- and 50-line modes on EGA and VGA systems, ability to insert current time and date into a file, the ability to load multiple files simultaneously (for example, *.txt), and "pick lists." Say, for example, that you want to load a file, but don't remember the exact name. Press <ENTER> at the prompt, and QEDIT presents you with a list of files in the current directory; just use the cursor keys to move to the one you want and press <ENTER>.

The bad news is printer support. There really isn't any. QEDIT will list files to a printer, but it only allows you to set a left margin and a page length. However, you can embed control characters in your files, so you can access your printer's built-in features by looking up the correct codes. And once you figure out the correct combination, you can create printer macros to embed the setup strings in your files automatically. If that's not your cup of tea, however, there are a number of public-domain and shareware programs that provide fairly versatile printing.

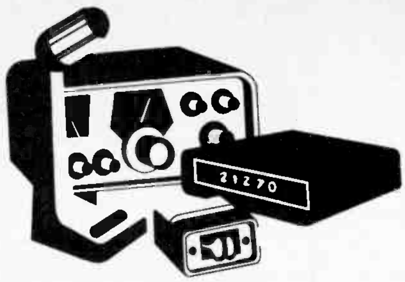
The search-and-replace function is also somewhat weak. QEDIT comes with a single help screen; you bring it up by pressing <ALT-H>; you can customize it to your heart's content. The program's distributor, SemWare, is serious about upgrading QEDIT; for example, from version 2.00 to 2.07, the program's size decreased by 2K, yet a bunch of new features were added.

QEDIT is available on BBS's everywhere (including the *Radio Electronics* BBS; dial 516-293-2283 at 300/1200 bps, 8N1, and download QEDIT207.EXE, a self-unpacking file that contains the program, documentation, etc.); registering the program costs $44.00 for a disk containing the latest version, or $54.95 for the disk and a printed version of the manual. Include $3.00 for postage and handling: SemWare, 730 Elk Cove Court, Kennesaw, GA 30144-4047, (404) 428-6416.

A commercial version of the program, called ZEDIT, is also available; it has all the features of QEDIT, but the menus have been rearranged slightly, and *ZEDIT* includes a few enhancements. The best is the ability to specify top and bottom page margins when printing. In addition, ZEDIT's user manual is much better than QEDIT's; QEDIT's is really just a reference guide, but ZEDIT's includes many practical hints about how to use the program, and it's written in a light and lively manner that is a joyous contrast to the typical computer manual. ZEDIT lists for $59.95 from Telecom Library, Inc., 12 West 21 Street, NY, NY 10010, (800) 999-0345, (212) 691-8215. ■



"We're going to be up here for five years and all you brought was Flight Simulator?"



Ham Radio

By Joseph J. Carr, K4IPV

A POWER SUPPLY FOR THE SHACK

One problem that a lot of ham operators, SWL's, and other electronic hobbyists face today is the proliferation of small devices that require an external DC power supply to operate. In my ham station, I have a Heath audio filter, an MFJ keyer, the MFJ-986 tuner and several other small devices that are all hungry for 6-, 9- or 12-volts DC at some small amount of current.

As a result, my AC-power outlet strip had several power-supply plugs (the kind with the transformer and DC supply built into a black plastic box) taking up more space than I had. So, I built the circuit shown in Fig. 1 to overcome that problem. The circuit uses a 12.6-volt AC, 1-ampere transformer, and a 1-amp, 50-PIV (*P*eak-*I*nverse *V*oltage) full-wave, bridge rectifier to produce a DC voltage, which is then filtered by C1. That voltage is used to feed a series of voltage-regulator circuits (U1–U4 in the schematic diagram), each of which is set to either 6-, 9- or 12-volts DC.

The regulators used for U1–U4 can be either 78xx or LM340-xx series of devices. The H and HM packages can supply up to about 100 mA, while the T-package devices output up to 750 mA. Some people might just want to buy all T-packages for greatest flexibility. In doing so, make sure that the current limit of the transformer is not exceeded. The actual voltage ratings of the regulators selected for your circuit depend on the output voltages that you require.

Figure 2 lists several regulator devices and gives their regulated output voltages. Also shown are the two most common device packages—TO-3 and TO-220—along with their pinouts. Note that no output-current rating is given. That's because the output-current capabilities of the device is denoted by the suffix attached to the device's basic part number.

For instance, for the LM340-xx series, devices with a "T" suffix are capable of 1.5 amps; "L" suffixed devices are capable of 0.1 amp. In the 78xx series, devices with a "CT" or "CK" suffix (7805CT or 7805CK, for example) have maximum output currents of 1 amp. Those are but a few of the suffixes used to indicated the current rating of three-terminal regulators; other suffixes are used to denote various current ratings. Consult the manufacturer's data sheet or device packaging for the current capabilities of the device chosen, and mix and match them in your circuit according to your needs.

The power supply should be built into a well-shielded metal enclosure. The output connectors (J1–J4) are 2.5-mm phone jacks, which seem standard for such power supplies. However, use whatever connectors your applications call for. The RF choke (L1) connected in series with each regulator is used to suppress the RF interference from the transmitter on the regulators. That's also the purpose of the pairs of capacitors (C2/C3, C4/C5, and so on) that are connected on either side of each regulator. Those ceramic-disc units should be mounted as close as possible to the body of each IC regulator.

A New Antenna Tuner. One of the most popular accessories in the amateur-radio world is the antenna tuner. We've discussed a number of different tuners in this column over the years, and will probably do so again in the future. The reason is simple: the antenna tuner is terribly important to amateur operators. There are several reasons for that.

First, most of them tend to suppress harmonics and sub-harmonics, resulting in less TVI and BCI...and better relations with the neighbors. Second, the tuner allows us to flatten the line and look into an optimized VSWR. In the "good ol' days" of vacuum-tube rigs, that feature was not as important as it is today. Solid-state final amplifiers are not as forgiving as tubes when it comes to the VSWR.

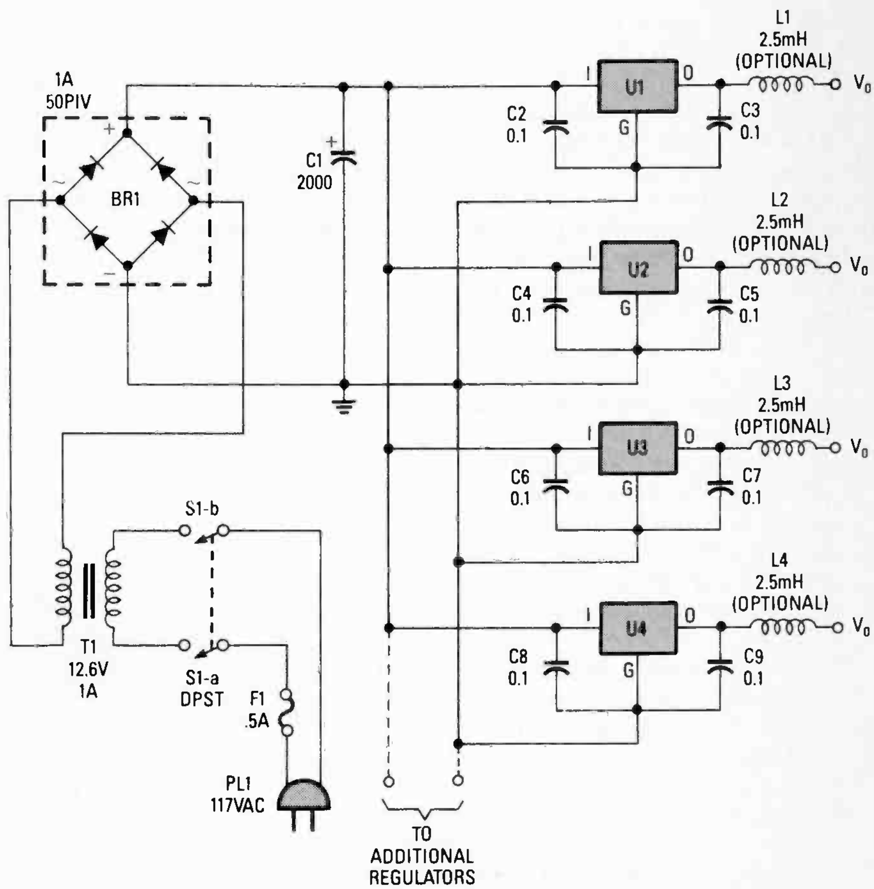
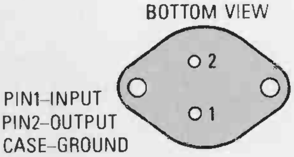


Fig. 1. Here's the schematic diagram of the regulated power-supply circuit.

DEVICE	OUTPUT VOLTAGE (V)
7805	5
7806	6
7808	8
7810	10
7812	12
7815	15
7818	18
7824	24

DEVICE	OUTPUT VOLTAGE (V)
LM340-5.0	5
LM340-6.0	6
LM340-8.0	8
LM340-10	10
LM340-12	12
LM340-15	15
LM340-18	18
LM340-24	24



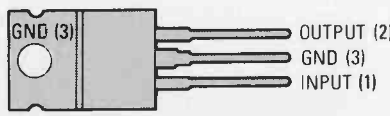


Fig. 2. Shown here are the two most popular regulator package types—TO-3 and TO-220. Lower power units (like the 78Lxx series) are available in TO-92 and TO-39 case styles.

PARTS LIST FOR THE POWER SUPPLY

U1–U4—78xx or LM340-xx series 3-terminal voltage regulator, integrated circuit, see text
BR1—1-amp, 50-PIV, fullwave bridge rectifier
T1—12.6-volt, 1-amp, step-down, power transformer
C1—2000-µF, 25-WVDC, electrolytic capacitor
C2–C9—0.1-µF, ceramic disc capacitor, see text
J1–J4—2.5-mm phone jack, see text
F1—0.5-amp fuse
PL1—117-volt, AC power plug
S1—DPST switch

Printed circuit or perfboard materials, enclosure, heat sink, wire, etc.

The first solid-state rigs available were CB sets, which began to appear in the mid-1960's. I recall large numbers of output transistors being destroyed because of irregularities in the antenna—a high VSWR meant blown transistors. Today, however, the situation is slightly better.

Emitter-ballasted, RF power transistors and VSWR shutdown circuits have all but eliminated the gruesome VSWR problem. The problem now, however, is that the transmitter will shut down if the VSWR gets above 2:1 or so (the exact trip point varies from one manufacturer to another). The tuner flattens the VSWR and allows the transmitter to radiate maximum power.

The MFJ-986 antenna tuner covers the entire region from 1.8 MHz to 30 MHz, including the WARC bands. Because of its roller-inductor design, it can accommodate a wide range of impedance values continuously over its entire operating range.

This month we will take a look at MFJ Enterprises, Inc. (Box 494, Mississippi State, MS, 39762, orders: 1-800/647-1800) model *MFJ-986 Differential-T Antenna Tuner*. That tuner uses a differential capacitor in a T-network circuit to form a 3000-watt antenna tuner. (MFJ credits Boyce Taylor, W5GZM, with the design idea.)

The tuner covers the entire region from 1.8 MHz to 30 MHz, including the WARC bands. Because the MFJ-986 uses a roller inductor (instead of a switched fixed Inductor), it can accommodate a wide range of impedance values continuously over its entire operating range. The MFJ-986 is designed to be connected in the coaxial transmission line between the transmitter and the antenna at a location close to the transmitter.

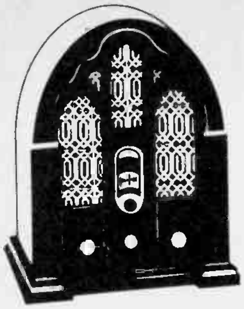
A feature that I like on any antenna tuner is a built-in RF power and VSWR meter. Although I own and use tuners that do not have the meter, having one makes it a lot easier to set-up and use the unit. The meter in the MFJ-986 is interesting in several ways. First of all, it is of the "crossed needles" design. That means that the movement has two pointers, so one can be used for forward power while the other is used for reversed power.

Second, the meter will read your selection of either peak power (which is useful for keyed CW, SSB, or AM operation) or average power (which is useful for FM or key-down CW measurements). Most tuners that use an internal meter only read average power, and so cannot follow keyed-CW, SSB, or AM signals.

The meter has two ranges: high and low. In the high range, it measures forward power to 2000 watts, while in the low range the full scale is 200 watts of forward power. For reflected powers, the high and low are 500 watts and 50 watts, respectively. A feature of the meter that I especially appreciate is the external power jack for an internal lamp. Because antenna tuners are passive devices, most lack a meter lamp...which in the darkened corner of Carr's basement laboratory and ham shack is a pain in the neck. But the MFJ-986 allows me to hook up a DC connection that illuminates the "beastie."

The MFJ-986 has an ANTENNA SELECTOR switch on the front panel. The selections are COAX1, COAX2, COAX1 DIRECT, COAX2 DIRECT, and EXTERNAL DUMMY LOAD. The COAX1 and COAX2 settings feed two different antennas through the tuner, while the respec-

(Continued on page 98)



Antique Radio

EVOLUTION OF A CLASSIC RADIO

By Marc Ellis

Almost exactly two years ago, at one of our local hamfests, I spotted a couple of guys who were having a great time selling a variety of old radios and parts while shooting the breeze with the customers. I stopped to browse, and ended up purchasing an *Echophone EC1* receiver, which soon became a popular restoration project in this column (beginning in the July, 1987 issue).

Once the conversation got around to my interest in antique-radio collecting, one of those fellows, Joe Wieser by name, told me that he owned a very interesting old broadcast/shortwave set. When he identified it as the 1929-vintage *Pilot A.C. Super-Wasp,* I was intrigued. I'd read enough about that model to know that I would enjoy getting my hands on one.

But Joe wouldn't consider selling it just then. Although he wasn't really an antique-radio collector, he wanted to jerry-rig a power supply and try the set out before passing it on to someone else. About all that I could do was leave my phone number and ask him to give me a call if and when he was ready to sell.

One evening a little over a week ago the phone rang, and much to my surprise, it was Joe! He had tried the set on the broadcast band, found that it worked, and was now ready to return to the world of modern electronics. Was I still interested? You bet I was, and thanks to my wife—who didn't mind my stealing a little from the grocery budget—the Super-Wasp is now in my possession and available for us to study.

Here's the A.C. Super-Wasp in the flesh, just as received from my hamfest acquaintance.

A Little Background. The Pilot A.C. Super-Wasp is a 5-band regenerative receiver that covers the frequency range of 14.2 to 500 meters (600 kHz to about 18.5 MHz) using a set of five pairs of plug-in coils. It's a four-tube radio that uses one stage of radio-frequency amplification, a regenerative detector, and two stages of audio amplification. Like all Pilot radios of the period, it was offered only in kit form.

The set is very similar to its predecessor, Pilot's "Super-Wasp," except that newly-developed tubes, which had AC-powered heaters, were substituted for the older battery types. That made it easy and convenient to operate the A.C. Super-Wasp from a compact plug-in power supply, eliminating the clumsy and expensive array of "A" and "B" batteries. The power supply was an external one, which could be home brewed or purchased as an accessory from Pilot or some other manufacturer.

Over the next few months we're going to explore the history, circuitry, and construction of this fascinating radio. Finally, we'll build a modern adaptation of the original power supply, power up the set, and spend some time tuning the broadcast and shortwave bands to see what we can pick up.

Ancestors of the A.C. Super-Wasp. The Pilot A.C. Super-Wasp was at least the third in a series of popular broadcast/shortwave radio kits offered by the Pilot Radio Manufacturing Company. I don't have much data on the original set, which was called simply the "Wasp." (Maybe some reader can help us out here.) I'd assume that it was a conventional early design with a regenerative detector and a stage or two of audio amplification.

The earliest information I have on the "Wasp" series is found in Volume 1 Number 1 (the July, 1929 issue) of *Radio-Craft*, our ancestral Gernsback publication. The back cover of that issue features a full-page ad announcing

The announcement for the original, battery-operated Super-Wasp stressed listening thrills and ease of construction.

the availability of "The Pilot Super-Wasp," offered by the "Pilot Electric M'F'G. Co., 323 Berry St., Brooklyn, NY, Established 1908."

Just a few years before that ad appeared, the plug-in coil regenerative shortwave receiver would have been associated primarily with ham-radio operators and other technically-minded experimenters. But general radio listeners, who had been thrilled by broadcast-band DX'ing, were looking for new worlds to conquer as advances in the radio art made BCB listening a more routine experience.

(Continued on page 92)

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ANTIQUE RADIO

(Continued from page 88)

The shortwave craze was beginning, and Pilot's ad copy was obviously designed to place a Super-Wasp in every living room:

". . .The Super-Wasp shifts from short wave to broadcast band as quickly as you shift from one speed to another on your car!

"When America signs off, international short wave broadcasts open up a whole new world of entertainment. With your Super-Wasp you hop from continent to continent! Distance dissolves and you bring in 10,000 miles as easily as you now bring in locals. . ."

The set's looks also placed it in the living-room category. With its rich-looking, walnut-grain-finished metal front panel, understated gold lettering, and polished-wood knobs, the Pilot would blend in with the finest decor.

But the armchair traveler for whom this set was designed was no technological wimp! He owned a soldering iron and knew how to use it—that was part of the mystique of being a DX'er. So he was only too happy to build his shortwave set from a kit.

The Pilot Super-Wasp concept appealed to a lot of people, and the set was a very popular one. Almost immediately after introducing it, the Pilot company began advertising itself as the "Pilot Radio & Tube Corp."—apparently to emphasize that it was no longer so much a manufacturer of general electrical items as a producer of complete (if disassembled) radios.

What Made it a "Super" Wasp? This radio wasn't just a fun-to-build shortwave set that looked good in the living room. It outperformed the less sophisticated regenerative sets of an earlier era, overcoming most of their traditional disadvantages. For example, regenerative detectors delivered their famed high sensitivity only when operated near the point of oscillation. But that unstable condition made them cranky and hard to keep in adjustment.

Ads for the A.C. Super-Wasp began to appear just a few months after release of the battery version. This one is from a late-1929 Radio-Craft *magazine.*

Hand-capacitance effects could detune the radio when the operator's fingers touched the controls; the received signal might "wobble" if the antenna merely swayed in the wind; and odd resonances in the antenna and lead-in wire might cause the set to go dead at certain spots on the tuning dial. Finally, a regenerative detector in an oscillating mode could become a tiny radio transmitter, radiating a signal from the antenna that would be picked up all over the neighborhood.

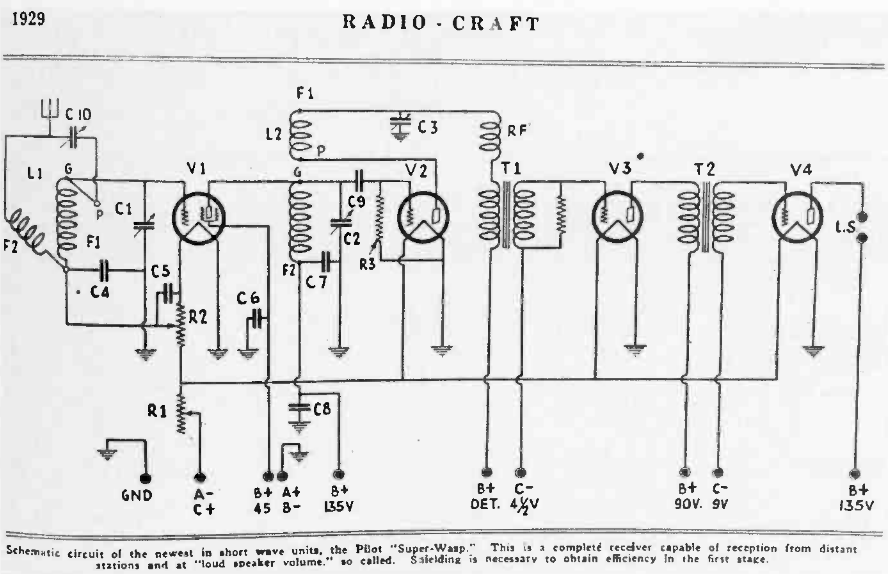
In addition to the Super-Wasp ad, the July 1929 issue of *Radio-Craft* contained an article by John Geloso, Pilot's chief engineer, describing the set. Geloso explained how the Super-Wasp overcame those difficulties.

Following the practice used in early broadcast-band receivers, interactions between the antenna and the regenerative detector could be prevented by inserting a stage of RF amplification ahead of the detector tube. That would also minimize the antenna's radiation of oscillations produced by the detector. However, the triode tubes of the day were not effective RF amplifiers at shortwave frequencies.

The newly-introduced type 22 *tetrode*, or screen-grid, tube *was* capable of working well in that capacity, and some manufacturers of shortwave sets had inserted a type 22 ahead of their regenerative detectors. However, Geloso explained, those manufacturers did not tune the tube's input circuit. Thus, although detector-antenna interactions were blocked, the new tube did little else to improve the set's performance.

Pilot's Super-Wasp, however, *did* incorporate a type 22 with a tuned input, and the stage was properly isolated from the detector circuitry using a well-designed shielding system. So, in addition to solving the antenna-interaction problems, the added tube functioned as an amplifier and contributed significantly to the sensitivity and selectivity of the set.

Since the detector stage was now receiving a much stronger signal, the regeneration adjustment became much less critical. And the set's metal front panel, as well as other strategically-placed shielding, all but eliminated the hand-capacitance problem. In the opinion of the Pilot Company, the Super-Wasp was nothing less than the finest shortwave receiver kit ever produced.



Schematic of battery Super-Wasp shows simplicity of design. Separate B and C binding posts were brought out for each stage so that builders would have the flexibility to accommodate different types of tubes.

Enter the A.C. Super-Wasp. Almost simultaneously with the introduction of the type 22 screen-grid tube came the release of the new AC-heater tubes that would free radio enthusiasts, once and for all, from the inconvenience and expense of storing, recharging, and/or replacing a messy collection of "A" and "B" batteries. The filaments of those new tubes didn't serve directly as the source of the electron stream needed to operate the tube. Instead, they heated a newly-designed element—the *cathode*—which, in turn, emitted the electrons. Using "second-hand" emission isolated the electron stream from power-supply variations, and the new tubes could be lit from ordinary wall-socket AC power (reduced in voltage via a step-down transformer) without introducing excessive hum into the set's audio.

The first such tube to be introduced was the type 27, which might loosely be considered an AC-operated version of the 01A triode used in most battery sets of the era. It was soon followed by the type 24, which was none other than an AC version of the type 22 screen-grid tube.

Almost as soon as the original Super-Wasp was announced, Pilot Radio's engineers had designed a new version incorporating those tubes. Ads for it began appearing toward the end of 1929. The set was operated by a separate plug-in power supply, and used *no* batteries. Armchair adventurers could now "DX" to their hearts' content without worrying about using up their energy sources.

The Pilot A.C. Super-Wasp, as it was called, is the model we're going to explore in this series of columns. We'll look at its circuit in a little more detail next time. However, it's very similar to the schematic of the original Super-Wasp, except that a type 24 substitutes for the original type 22 screen-grid RF amplifier, and three type 27's replace the 01A's that were generally used as audio amplifiers and detectors.

The Universal Super-Wasp. The rush of radio developments during the mid- to late-1920's era brings to mind today's computer field. With state-of-the-art technology rapidly becoming more sophisticated, last year's "miracle" models are quickly forgotten—or dumped at close-out prices—as improved versions with even better bells and whistles capture the spotlight.

In mid-1931, Pilot announced its newest Wasp model, the "Universal Super-Wasp Receiver." The Universal really did incorporate some substantial improvements over the old A.C. Super-Wasp. For one thing, the five pairs of plug-in coils were banished in favor of an internal band-switching arrangement. Any desired segment of the set's 15- to 650-meter tuning range could now be selected by turning a single knob.

A mid-1931 Short Wave Craft *magazine carried this advertisement for the Universal Super-Wasp Receiver. It had many improvements over the A.C. Super-Wasp, but carried a fairly hefty price tag.*

As in the A.C. Super-Wasp, a type 24 screen-grid tube was used as a tuned RF amplifier. Another type 24 replaced the type 27 that formerly served as the regenerative detector. Using a type 24 in the detector stage made it possible to control regeneration by means of a potentiometer placed in the screen-grid bias lead. That prevented the regeneration control from affecting the set's tuning, as did using the Super-Wasp's control method of shunting the tickler coil to ground via a variable capacitor.

A type 27 served as the first audio tube, as in the previous model, but the type 27 second audio was replaced by a pair of push-pull '71A's, which provided better tone and greater driving power for the speaker. And the power-supply was now engineered into the radio chassis, instead of being separate from the set. The internal power supply not only made the radio a more compact unit, it also prevented the set from being operated from incorrect voltages through the use of power supplies not specifically designed for it.

Finally, the radio was supplied with a handsome walnut cabinet—as opposed to previous models, which came "bare."

Of course, all of those improvements didn't come cheap. The Universal Super-Wasp cost $85.00 in partial kit form, or $99.50 assembled. That was quite high compared to the A.C. Super-Wasp kit's tag of $34.50 without power supply, or $64.00 with factory power-supply kit. And Pilot obviously didn't want to burn its bridges right away. A message at the bottom of one of the ads announcing the new radio read:

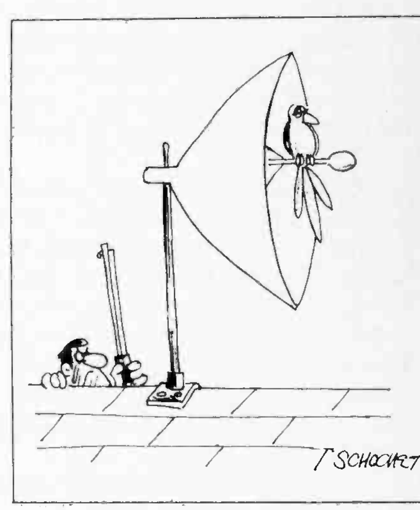
"NOTICE TO 'HAMS': Pilot will continue building the original Super-Wasp in kit form for licensed amateurs and others who want to spread the tuning range on their pet wave bands and add their own audio features. A.C. and battery models."

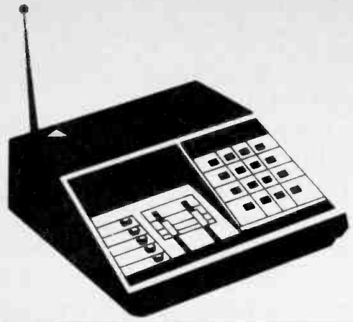
So, as far as Pilot was concerned, if you still had to have a Super-Wasp, you could still buy one. But that former darling of the living room really should be relegated now to the realm of the workshop and radio shack, where its simpler construction would facilitate experimentation and modification. The pricier Universal Super-Wasp, with all of its irresistible new features, ought to inherit the favored spot by the fireplace.

The Lure of the A.C. Super-Wasp. If a Universal Super-Wasp should ever come my way, I'm sure I'd want to report on it in this column. But for now, I'm quite happy that fate has placed an A.C. Super-Wasp in my hands. The charm of the earlier version is that it's still built so much like a battery set. In fact, owners of the battery Super-Wasp could easily convert it to the A.C. model with an inexpensive kit of parts purchased from the factory.

Since the A.C. Super-Wasp is essentially a converted battery set, working with it should really bring back the thrill of a time when the AC and screen-grid tubes were first appearing on the market and experimenters were modifying their home-built sets to use them. And nostalgia is certainly what this column is all about!

See You Next Month. In the meantime, if you have some Wasp memories or information to share, be sure to break out your writing materials! We'll have a roundup of reader comments at the close of this series, so get yours in as soon as possible. Address your correspondence to *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■





Scanner Scene

By Marc Saxon

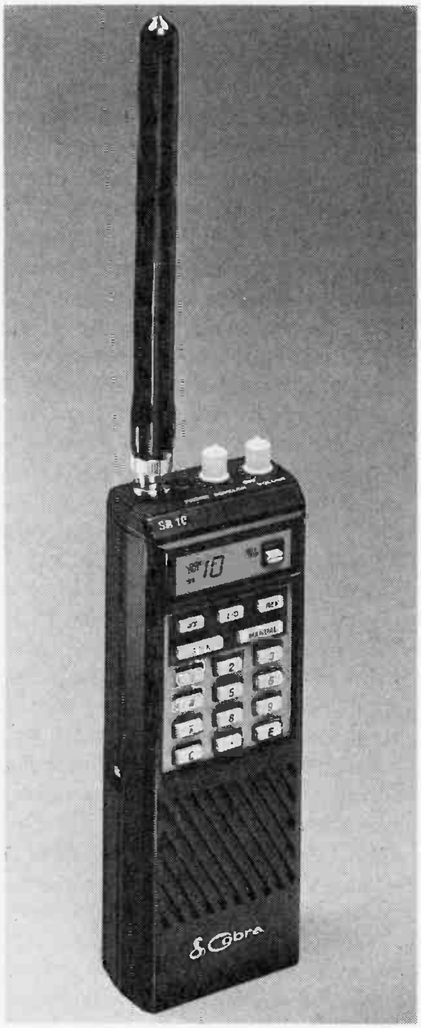
A HOT NEW HANDHELD

Hot as a firecracker—that's the *Cobra SR-10* handheld scanner. This blockbuster has a 10-channel memory and is fully keyboard programmable. Frequency range, you ask? It starts off at 29 MHz and goes to 54 MHz, then picks up at 136 MHz and runs to 174 MHz, finishing up with the 406- to 512-MHz band.

Features? You betcha! It has an LCD channel readout, 15-channel-per-second scanning, 3-second delay, switchable channel lockouts, instant weather-channel access, keyboard lock, manual channel access, a low-battery warning indicator, 30-minute memory retention without batteries, a belt clip, and a rubberized antenna.

From a tech-spec standpoint, the Cobra SR-10 offers IF selectivity of 50 dB at ±25 kHz, with RF sensitivity averaging 0.5 μV for 12-dB SINAD. (It's a tad more sensitive on the low band than it is on UHF, we'd say). It weighs a shade more than 10 ounces and measures about 2½ inches wide, by 1¾ inches deep, by 7 inches tall. The SR-10 uses five "AA" batteries, or an optional rechargeable battery pack, which gets replenished from a charger unit (also optional).

In all, it looks like a nice little handheld—and we've seen them selling in the $125 ballpark. Keyboard-programmable handhelds don't come much more reasonably priced than that, so it's definitely worth your consideration. It's made by the Cobra Consumer Electronics Group, Dynascan Corp., 6500 West Cortland St., Chicago, IL 60635.



Cobra's feature-packed SR-10 offers 10-channel memory, covers 11 bands, and provides instant access to National Weather Service broadcasts.

Wideband Skyhook. A new scanner antenna, called *The Raven*, is a nifty unit that covers all frequencies from the low band through the UHF band. It's 80 inches tall with four short (15-inch) base radials. The whole thing weighs less than 5 pounds, and has low wind resistance. It can also be used for transmitting between 50 and 500 MHz, showing an average SWR of 1:1.7.

The Raven is made by Ohio Radio R&D, 5421 Hickory Ct., Lewisburg, OH 45338. Check with them for further details.

The Mail Bag. The Raven should be just the ticket for reader Jim Lane of Enid, OK, and several others who have asked about omnidirectional scanner antennas that will cover the wide frequency ranges.

We are happy to offer that kind of advice, although a letter from Dave Ashbury, Olathe, KS, asked one that we hadn't been hit with before. Dave wants to know if a hobbyist can assemble some parts and build a scanner, no matter how primitive it may be, from scratch. I've learned never to say "never," but I can say that it would be so difficult and expensive that you'd be better off just buying one built by a manufacturer. I do recall, however, that back in the days of plug-in crystals, there was a scanner kit offered by Heath.

Tony Stalnaker, 2358 Old Al. Rd., Thomaston, GA 30286, is asking for input from any readers who know of any modifications that he can make to increase the frequency coverage of his Regency MX-3000 scanner. Although he doesn't say so, since that scanner covers the three basic scanner bands, I assume he would like it to pick up the 800-MHz band. I haven't heard of any modifications for the MX-3000 that will accomplish that, and I'd bet that there aren't any.

The best route for Tony (and other scanner owners who want to tune the 800-MHz band without buying a new scanner) would be to get an 800-MHz converter. Check out the ones made by RF Limited, P.O. Box 1124, Issaquah, WA 98027, and also those from GRE America, Inc., 425 Harbor Blvd., Belmont, CA 94002. The converters connect (externally) in seconds to any scanner that has standard UHF-band coverage. They will bring in everything between 800 and 900 MHz, and for less than buying a new scanner.

A helpful hint comes from Wes Oblander of Mustang, OK. Wes says that he was having trouble with interference in the VHF high band (152 to 174 MHz). He finally stifled it with a coaxial in-line FM trap (Radio Shack 15-577).

From Calgary, Alberta, Shaw Mulligan passes along information on the frequencies used by his local police. Dispatching takes place on 462.00, 462.275, 462.575, 462.65, and 462.975 MHz. Frequencies 462.15 and 462.375 are for checking records (license plates, drivers' licenses, etc.), and the surveillance channel is 462.875 MHz. We appreciate that type of information, Shaw, and are always pleased to hear from readers with frequency data.

A reader, whose handwriting I had trouble making out, hails from New York City and reports overhearing a cordless-telephone conversation on 44.925

MHz. He recalls reading in this column that cordless telephones operate on 46 MHz, with the handsets on 49 MHz. So what type of cordless phone was he copying on that oddball frequency? Whatever it was, it wasn't a legal cordless phone.

Remember that in many larger metro areas there is no shortage of unauthorized electronic equipment to be had from a variety of sources. Most of it was made for sale and use overseas. How it finds its way over and under the counter is anybody's guess, but it seldom conforms to the design specs required by the FCC for certain communications products made for use in the United States. That affects many areas of electronics, but high-powered cordless telephones with ranges of several miles, and ones that operate on novel, "private" (interference-free), unauthorized frequencies are especially plentiful (and apparently in demand by the public). That is probably what was monitored.

For the many readers who have written asking us to point them in the general direction of a reputable and worthwhile organization for scanner enthusiasts to join, we have a suggestion. Contact the Scanner Association of North America (SCAN), P.O. Box 414, Western Springs, IL 60558.

We always look forward to hearing from our readers with questions, frequencies, helpful hints, news clippings, and general chatter. Our address is: *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

"We used to have light-activated lamps—it was like living in a lightning storm."

CIRCUIT CIRCUS

(Continued from page 81)

comparator is connected to a variable resistor, R10.

The voltage developed across R8 is fed to pin 5 of U3. When the voltage at pin 5 of U3 exceeds the voltage at pin 4, the output of U3 goes high, turning on Q3. As Q3 begins to turn on, its collector starts to pull the ADJ. input of U1 toward ground, dropping the output drive voltage feeding Q1 and Q2.

As the charging voltage across the battery begins to drop, the current through R8 decreases and the voltage feeding pin 5 of U3 goes low and the comparator output follows, turning Q3 back off, which completes the signal's circular path to regulate the battery's charging current.

The charging current can be set by placing an ammeter in series with the charger's output and the battery, and then adjusting R10 for the desired current. The circuit's output voltage is, of course, set by R9.

The majority of the circuit components can be mounted on perfboard. A socket should be used for U3. A good size heat sink, of at least 12-square inches, is a must for the two power transistors. The charger can be mounted in a suitable metal enclosure, with the cabinet serving as the heat sink for the power transistors; or it can be built in a non-metallic enclosure with a separate heatsink. The circuit isn't critical, so build to suit your needs.

PARTS LIST FOR THE UNIVERSAL BATTERY CHARGER

SEMICONDUCTORS

U1—LM317 adjustable voltage regulator, integrated circuit
U2—7808 8-volt, 1-amp, voltage regulator, integrated circuit
U3—LM339 quad comparator, integrated circuit
Q1, Q2—2N3055 NPN power transistor
Q3—2N3904 general-purpose NPN transistor

RESISTORS

(All fixed resistors are ¼-watt, 5% units unless otherwise noted)
R1, R2—10-ohm, ½ watt, 5%
R3—270-ohm
R4—2200-ohm
R5—1000-ohm
R6—15,000-ohm
R7—4700-ohm
R8—0.1-ohm, see text
R9—5000-ohm potentiometer
R10—1000-ohm potentiometer

CAPACITORS

C1—1000-µF, 50-WVDC, electrolytic
C2—47-µF, 25-WVDC, electrolytic
C3—4.7-µF, 16-WVDC, electrolytic
C4—0.47-µF, 100-WVDC, Mylar

ADDITIONAL PARTS AND MATERIALS

T1—18-volt, 3- to 6-amp, power transformer, see text
B1—2- to 6-amp 100-PIV, full-wave bridge rectifier
Perfboard, IC sockets, power cord, heat sink, knobs, clips, etc.

Charger Monitor. The circuit in Fig. 3 is designed to monitor voltage levels, and can be used with most battery chargers to keep tabs on the patient while it's undergoing rejuvenation.

The voltage-monitoring circuit, using the component values given in the Parts List, will keep tabs on batteries with voltages from a low of 1.5 to a maximum of 20. The circuit's operation is simple. Comparator U1 has one of its inputs tied to a voltage divider, consisting of R2–R4, that's connected across the battery. The voltage present at the junction of R2 and R4 is about 1/27 of the battery voltage. Diode D1 supplies about 0.6 volt to VOLTAGE ADJ. potentiometer R6.

As the charge on the battery increases, the bias applied to the non-inverting input of U1 at pin 5 also rises, while the other input, at pin 4, remains at the pre-set voltage level. Resistor R6 sets the battery's fully charged voltage

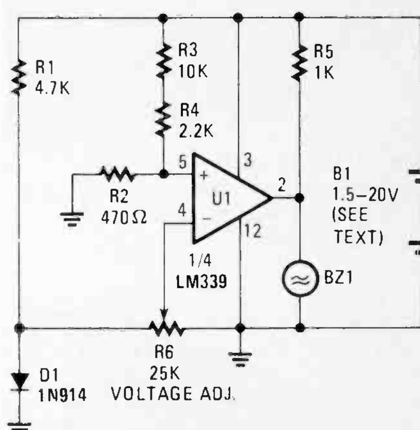


Fig. 3. This circuit, which is designed to monitor voltage levels, can be used with most battery chargers to keep tabs on the battery while it's being charged.

level. When the charge on the battery reaches the pre-set level, the input to pin 5 of U3 goes slightly more positive than the pin 4 input, causing the comparator to switch its output, activating

(Continued on page 102)

LOW-COST UPGRADE

(Continued from page 79)

the DEBUG.COM program that was supplied with your DOS. Place the floppy-disk version of DEBUG in your A: drive and bring it up. When you see the DEBUG prompt, which is a short dash, enter the command:

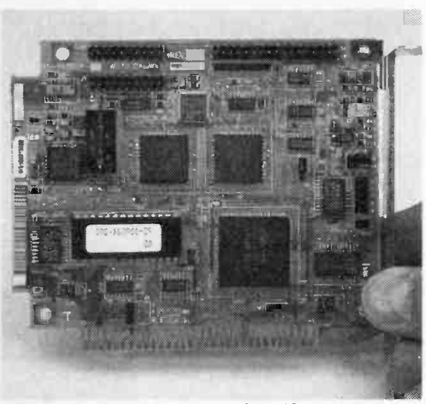
−g=C800:5

The screen will display some kind of message that will depend on your particular disk controller. Simply answer the questions using the information supplied in the drive's manual, and on the error map.

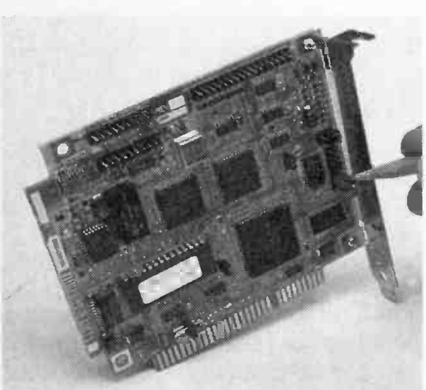
There's no great tragedy if you make a mistake. Either the computer will kick out the error and you'll be asked to re-input the data, or you can simply restart the DEBUG program yourself.

Shown in one of the photos is the screen display when running the DEBUG program. Note that we have deliberately made an error in line 4 (the 615). The program tells us we have an illegal character and restarts.

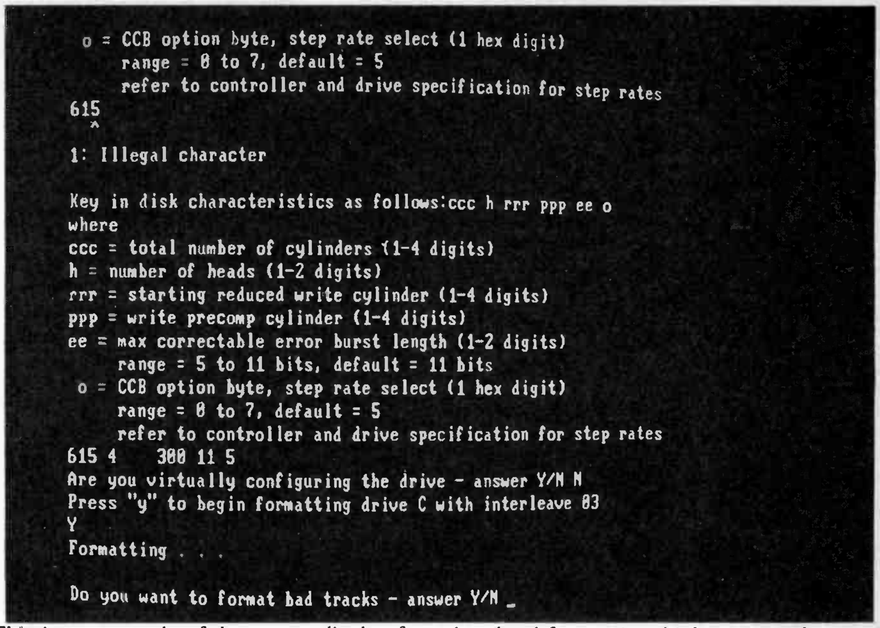
The "starting reduced write cylinder



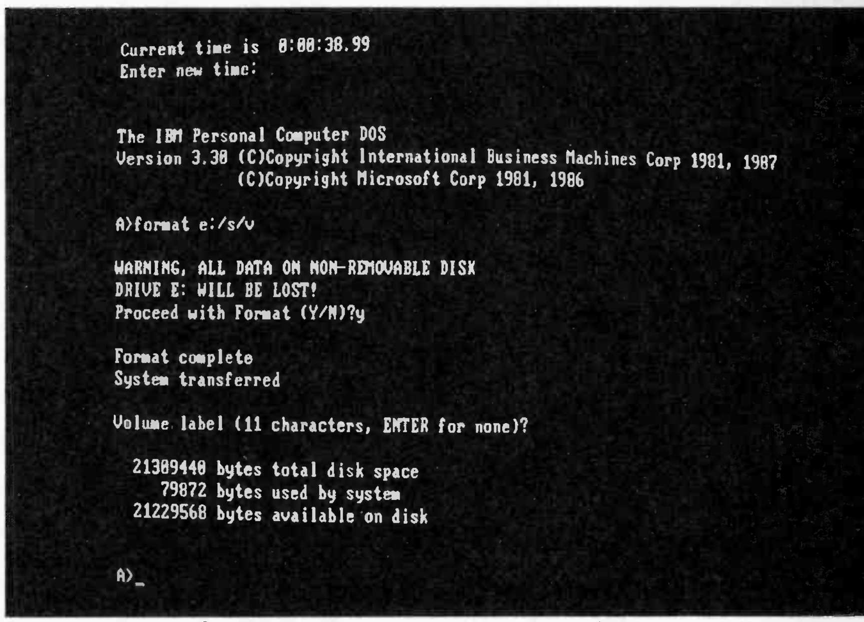
This is a Western Digital half-slot controller. Do not change any jumpers or switches other than those absolutely required for 20MB operation.



To reconfigure the controller for a 20MB drive, you simply install two jumpers—across positions 1 and 3—on S1



This is an example of the screen display for a low-level format in which an error has been entered. The program self-corrects. The actual screen display will depend on your particular controller, but it will be similar to this.



The screen display after the regular DOS formatting shows slightly more than 21MB available. That is correct because 20MB is a "rounded" value.

(1−4 digits)." data (rrr) is not listed in the drive's manual. But the program wants that data or it won't work. (All other requested data is supplied with the drive.) Look down to the line that starts with "615." Note that we have supplied three spaces as the data for rrr, which makes the computer happy. Some data isn't known, such as "error burst length," but the program provides an acceptable default.

When you answer Y (for "yes") to the last question, the computer will automatically low-level format the hard disk. Then you run the DOS programs FDISK and FORMAT. As shown, using the command e:/s/v (or E:/S/V) tells the computer to format the hard disk (in this instance the hard disk is drive E:), record the system and COMMAND.COM, and verify that everything is correct. It's exactly the same as formatting a system floppy disk. If all goes well, the last line will show that you have slightly more than 21MB available.

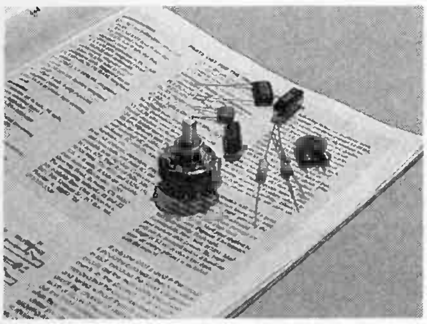
If the final figure is approximately 10MB, you have "cheated" by trying to use some kind of low-level format program that was originally intended for a 10MB hard disk. Go back and do it the right way, using the DEBUG utility program. ■

PARTS CONNECTION

(Continued from page 64)

needed minimum.

The method of payment for big distributors is usually another matter to be dealt with. Most require an open account before you can buy from them. With the widespread acceptance of credit cards, that is no longer much of a problem for most. With most cards, if you pay your credit-card bill the same month you receive it, the convenience costs you only the price of the card's yearly fee (if any).



If you have a well stocked shop, you can move from reading any parts list right into project construction hassle free.

A certain number of first-line distributors specialize in only the more popular parts and some imported parts. If you buy parts from such a place, you'll find the prices are a little lower because the companies specialize in the faster moving parts and do not have to tie up their money stocking slower moving items. They also have minimum orders, but the terms tend to be more liberal. The minimum order is a fact of life in this day and age. Credit cards can be used, but most of these distributors will also accept personal checks as payment. Payment policies do vary, so be sure to inquire first before placing an order.

Another source of parts are the surplus-parts distributors. They deal with manufacturers' overruns, excess inventories, buy-outs, used, and some new parts. You can get the best bargains with this group, but the chances of getting something unexpected is also higher. If you understand that when you make your purchase, you usually won't be too disappointed. Over the years I have had some good experiences and some bad ones, but the good far outnumber the bad.

A list of some of the more popular distributors is given elsewhere in this article. No guarantee is offered and I obviously cannot stand behind what they will or will not do, but I have had dealings with most of them and came away satisfied. Contact them for their catalogs and take it from there. The toll free numbers most now provide are a very convenient way to deal quickly with a lot of the distributors listed.

Using a Database Program. The job of keeping all of your parts-supplier information organized is a natural use for a database program. The various database programs available for most types of computers can be setup for that task.

I have been using a database for some time now that has all of the important information on various suppliers in my field of interest. As I get a new catalog its ordering information immediately goes into the database along with a few key words to help me recall the information. The keywords identify special deals on items or good sources of particular items. The keywords are listed on a piece of paper that i can refer to when I start a search. That's the way I do it, but the beauty of most databases is that you can set them up to suit your own particular needs. The point is to avoid the "I know I saw it somewhere, but I don't remember where" syndrome.

For those of you that would like a good place to start and have IBM/MS-DOS computers, a simple shareware database called "3by5" might suit your needs. The program organizes data as you might do manually with 3 × 5 index cards. It can be downloaded from Gernsback Publication's RE-BBS; board; Tel. 516/293-2283. The file name is 3by5.ARC. The archived file contains a user's manual and several examples. Also included are two files called PARTS.3x5 and PARTS.MAP. They are for use with the database and contain the names and addresses of electronic-parts suppliers that cater to small-quantity buyers.

A disk (5¼-inch, of 360k) containing the supplier listings as an ASCII text file along with the listings in the 3by5 file format is also available. Included free on the disk is a copy of the 3by5.ARC file along with a copy PKXARC to unarchive the program. The cost of the disk is $5 postpaid (OH residents add appropiate sales tax). Send requests to:

Jack Cunkelman
PO Box 397
Milford, OH 45150. ■

HAM RADIO

(Continued from page 87)

tive direct settings feed the same antennas, but bypasses the tuner (but not the RF power meters that are part of the tuner). The DUMMY LOAD setting on the unit allows you to select a 50-ohm dummy load (external to the MFJ-986) in order to test or tune-up a transmitter off the air.

The connections for COAX1, COAX2, DUMMY LOAD, and TRANSMITTER are found on the rear panel of the MFJ-986. Also

All input and output connections for the MFJ-986 are found on the rear panel; included is a pair of ceramic insulators for balanced antenna transmission lines.

found on the rear panel are a pair of ceramic insulators for balanced antenna transmission lines, such as 450-ohm and 600-ohm parallel line (as used on the Zepp, G5RV, and several other popular antennas).

Another feature of the MFJ-986 is the inclusion of a current balun transformer inside the tuner. That transformer tends to force equal currents into the two antenna halves in order to minimize pattern distortion due to unbalanced currents. The latest *ARRL Radio Amateurs Handbook* shows how a balun used on a dipole makes the pattern look more like the ones that are shown in textbooks.

There was little to criticize on the MFJ-986, and believe me I looked because I like to keep product reviews balanced. But the only problem I saw was that the tuning seems a little sharp. But that's a problem that has nothing to do with the quality of the unit, but is a function of almost any design that: covers a wide frequency range; matches a wide impedance range; and has a high enough Q to suppress off-channel signals.

The MFJ 986 antenna tuner sells for 239.95. For more information on the unit write to MFJ Enterprises, PO Box 494, Mississippi State, MS 39762; or call 800/647-1800. ■

E-Z MATH

(Continued from page 77)

Let's follow the same procedure for the Node C equation:

$I_3 - I_4 - I_5 = 0$
$(V_B - V_C)/330 - V_C/1000 - [V_C - (-14)]/100$
$V_B/330 - V_C/330 - V_C/1000 - V_C/100 - 14/100 = 0$
$(1/330)V_B - (1/330 + 1/1000 + 1/100)V_C = 14/100$
$.003V_B - .014V_C = 0.14$

The two simultaneous equations are:

$.0066V_B - .003V_C = .019$
$.003V_B - .014V_C = 0.14$

The characteristic determinant and its value are:

$$\begin{vmatrix} .0066 & -.003 \\ .003 & -.014 \end{vmatrix}$$

$(.0066)(-.014) - (.003)(-.003) =$
$(-.0000924) - (-.000009) = -.0000834$

The V_B determinant and its value are:

$$\begin{vmatrix} .019 & -.003 \\ .14 & -.014 \end{vmatrix}$$

$(.019)(-.014) - (0.14)(-.003) =$
$(-.000266) - (-.00042) = .000154$

The V_C determinant and its value is:

$$\begin{vmatrix} .0066 & .019 \\ .003 & .14 \end{vmatrix}$$

$(.0066)(0.14) - (.003)(.019) =$
$(.000924) - (.000057) = .000867$
$V_B = .000154 / -.0000834 = -1.85$ volts
$V_C = .000867 / -.0000834 = -10.4$ volts

5. The nodes are A, B, C, and D in Fig. 5 where D is the reference. There are unknown voltages at nodes B and C, V_B and V_C. The current equations at nodes B and C are:

Node B: $I_1 = I_2 + I_3$, or
$I_1 - I_2 - I_3 = 0$
Node C: $I_3 = I_4$

The currents expressed in terms of voltages and resistances are:

$I_1 = (12 - V_B)/R1 = (12 - V_B)/40$
$I_2 = V_B/R2 = V_B/30$
$I_3 = (V_B - V_C)/R3 = (V_B - V_C)/20$
$I_4 = V_C/R4 = V_C/40$

Substituting these in the two current equations gives:

$I_1 - I_2 - I_3 = 0$
$(12 - V_B)/40 - V_B/30 - (V_B - V_C)/20 = 0$
$3(12 - V_B) - 4V_B - 6(V_B - V_C)/120 = 0$
$36 - 3V_B - 4V_B - 6V_B + 6V_C/120 = 0$

Multiply both sides by 120, collect terms, and simplify.

$36 - 13V_B + 6V_C = 0$

Multiply by -1 and move the constant to the other side of the equals sign.

$13V_B - 6V_C = 36$

The other current equation is:

$I_3 = I_4$

Substituting the voltages gives:

$(V_B - V_C)/20 = V_C/40$

Multiply both sides by 40 to get rid of the denominator:

$2(V_B - V_C) = V_C$
$2V_B - 2V_C = V_C$

Rearranging gives:

$2V_B - 2V_C - V_C = 0$
$2V_B - 3V_C = 0$

We now have two equations to solve simultaneously:

$13V_B - 6V_C = 36$
$2V_B - 3V_C = 0$

The characteristic determinant and its value is:

$$\begin{vmatrix} 13 & -6 \\ 2 & -3 \end{vmatrix}$$

$(13)(-3) - (2)(-6) =$
$-39 - (-12) = -39 + 12 = -27$

The V_B determinant and its value is:

$$\begin{vmatrix} 36 & -6 \\ 0 & -3 \end{vmatrix}$$

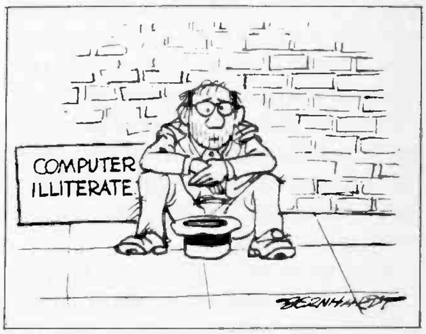
$(36)(-3) - (0)(-6) = -108$

The V_C determinant and its value is:

$$\begin{vmatrix} 13 & 36 \\ 2 & 0 \end{vmatrix}$$

$(13)(0) - (2)(36) = -72$
$V_B = -108 / -27 = 4$ volts
$V_C = -72 / -27 = 2.67$ volts

You may want to go back to the current equations to calculate the actual current values. ■



WEIN-BRIDGE

(Continued from page 44)

sharp bend happens to be the most desirable area to operate the bulb in because it is there that the most control will be exerted over the gain of the amplifier.

It is important to realize that the lamp resistance does not change along with the instantaneous value of the sinewave. That is because the thermal time constant of the lamp's filament is much longer than the period of the lowest audio frequency required, so the filament's temperature can not change fast enough to follow the sinewave. The tungsten filament maintains a fairly constant temperature that depends on the rms value of the sinewave. However, thermal changes in the filament could be a problem at an operating frequency of 1 Hz or less.

Capacitive Tuning. An obvious way to tune a Wien-bridge oscillator is to vary R and/or C in the frequency-determining network. It is necessary, however, to change both resistors and/or both capacitors simultaneously, and by the same amount.

Figure 6 shows how to use a two-gang variable capacitor to obtain variable tuning. The capacitor shown typically will tune over a 10:1 frequency range, such as from 20 to 200 Hz. The resistors can be switched by a band switch to cover two additional frequency ranges covering 200 to 2000 Hz and 2 to 20 kHz.

That tuning method is a very good one because the two sections of the variable capacitor will track each other fairly close, so both sections will have very near the same capacitance throughout their range.

One disadvantage is that the frame of the tuning capacitor must be mounted on an insulated board so that the frame is isolated from circuit ground. Further, the shaft of the capacitor must be isolated with either an insulating shaft coupler or extender.

Stray capacitance from that capacitor to ground is shown in Fig. 6 as C_S. It must be balanced out by adjusting the trimmer capacitor, C4.

Building and Adjusting. When selecting parts, keep in mind that the frequency-determining resistors and capacitors should have as low a tolerance as can be obtained. Do not use capacitors marked "GMV" (Guaranteed Minimum Value) as those capacitors can have any value above that marked on the body.

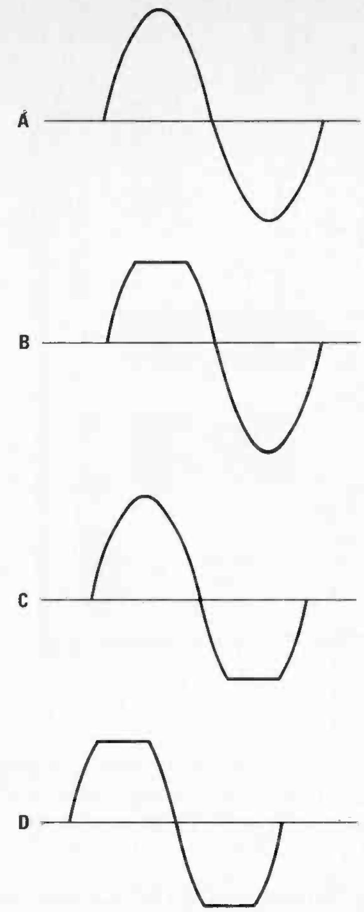


Fig. 7. A sinewave (A) can be distorted in three different ways in our circuit. They all have one thing in common: they occur because the sinewave's amplitude is too large. If the wave's positive-going amplitude is too high it looks like B; and with too much negative-going amplitude it looks like C. An oversized wave is shown in D.

You will need a ±12-volt supply for the circuit that can be easily made by tieing two 12-volt battery packs together in series. You simply connect the red lead of one pack to the black lead of the other, that connection will be ground. The remaining red lead will be the +12-volt lead and the remaining black lead will be the −12-volt lead.

You could use rectifiers, regulators, and capacitors to make your power supply if you choose not to stick with batteries. No matter what supply you will use, capacitors C2 and C3 are required because some op-amp chips do funny things if you don't bypass the power-supply leads at the chip's body. I've gotten some strange-looking waveforms that were corrected by using bypass capacitors.

Also note that the high input impedance of the op-amp we will use requires that the circuit be shielded by a metal enclosure. Last, be sure to obtain the parts necessary to isolate the tunable capacitors as mentioned.

Perfboard-mounting the components is a more than sufficient construction technique for building the project. Once built, adjustment of the oscillator should start by setting the band switch to its mid position—200 to 2000 Hz. If the tuning capacitor already has trimmer capacitors built into it, adjust the trimmer on the grounded section to minimum capacitance before proceeding. Turn the tuning capacitor to its maximum-capacity position—its plates fully meshed. Observe the oscillator-output waveform on an oscilloscope and adjust the 1K trimpot for the highest-amplitude sinewave you can get without distortion (see Fig. 7 to get an idea of what to look for). Note the peak-to-peak amplitude of the sinewave on the oscilloscope. Now turn the tuning capacitor to its minimal-capacity position and adjust C4 to get the same amplitude as before.

Now the unit is ready and you may never have to adjust it again. You are sure to find many uses for the oscillator because of its wide bandwidth, frequency stability, and noise immunity. ■

F/C METER

(Continued from page 31)

That varying voltage is converted to a current, which is then displayed as a frequency on the meter, M1.

The frequency range for the counter function is selected through S1-a. Depending on the setting of S1-a, a capacitor (C5, C6, C7, C8, or C9) is connected to U6 at pin 2.

When S2 is placed in the CAP. position, the circuit can be used to read the value of an unknown capacitor. With S2 set to CAP. and a capacitor connected across J5 and J6, S1 is used to set the range of measurement, by applying the appropriate clock signal to pin 1 of U6. Integrated circuit U6 then feeds a voltage that's proportional to its input signal to meter M1. The current to drive the meter coil leaves U6 pin 8 and is low-pass filtered by the network consisting of R8, R9, R10, C11, and C12.

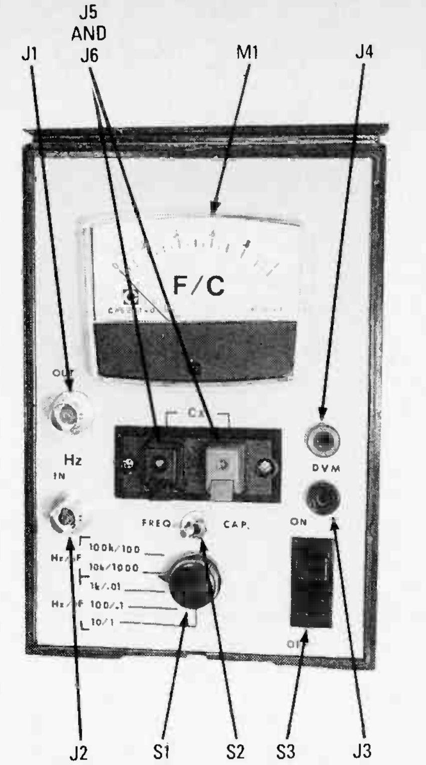
Filtering helps steady the meter reading with input frequencies below 5 Hz. Resistor R9 is placed in the current output loop for easy use of a DVM for improved accuracy in measurements. For a full-scale reading of 1 mA, the voltage drop across the resistor, by Ohms law, is 1 volt. If needed, R9's value can be adjusted by placing another resistor in parallel with it (5600 ohms was used in the prototype).

The LM2917 operates down to 15 mV of signal input and is internally protected from input overload damage up to 28 volts at pin 1. Resistor R4 and C10 reduce the sensitivity to about 50 mV to minimize false readings. Resistors R6 and R7, and capacitor C14, allow calibration for a full-scale meter reading on the 10-Hz range. The calibrations of the higher ranges are determined by the tolerance of capacitors C6–C9.

Two series-connected 9-volt batteries provide power for the circuit, which draws about 12 mA. Integrated circuit U7 (a 78L12, 12-volt, 100-mA voltage regulator) and C13 provide a regulated 12-volt source.

Putting It Together. The prototype of the F/C Meter was built on perfboard, with component connections accomplished through point-to-point wiring techniques. Perfboard construction was used because the component layout is not especially critical.

It is recommended that all of the integrated circuits be socketed. Start by installing the IC sockets on the perfboard; its a good idea to mark (U1, U2, etc.) the sockets for the IC's that will occupy them. That helps to cut down on confusion when the components are being interconnected.



Here is a front view of the inner front-panel layout. Dry-transfer lettering can be used to enhance the project's appearance and make it easier to use.

Once the sockets are installed, begin assembling the project, making all connections as you go. When assembling the circuit, be sure that the wires that go to the 100-kHz oscillator are kept short; the wiring to U7 pin 2, S1 and S2, and capacitors C5 thru C9 should also be short to minimize distributed capacitance, which can affect the readings of capacitors on the low end of the 100-pF range.

Once the circuit board has been assembled, connect short lengths of insulated hook-up wire to the points in the circuit that go to the off-board components. The author used a silicone sealer to cover exposed wires and leads in and around the fully assembled circuit to prevent accidentally short circuiting the project, or destroying some vital component.

Next choose a suitable enclosure in which to house the circuit board. The author used a plastic enclosure, with an attached cover, that measures about 6½ × 4⅜ × 2 inches. The circuit board was mounted to an inner front-panel, which simply snaps securely into position.

Also mounted to the front panel are J1 and J2 (BNC jacks), J3 and J4 (banana jacks), J4 and J5 (two position pushbutton terminals), S1 (2-pole, 5-position switch), S2 (double-pole, double-throw switch), S3 (single-pole, single-throw switch), M1 (0–1 mA meter), and two 9-volt batteries (B1 and B2).

The circuit board is held in place by the mounting hardware that secures J1 and J2 to the front panel. The batteries are secured to the panel on either side of the meter with double-sided tape; the same method might be used to secure battery holders in the same positions to allow easy replacement of the power source.

Checking it Out. Apply power to the circuit and, guided by the schematic diagram, check for 12 volts at the output of the regulator. If an oscilloscope is available, check pin 4 of U1 for a clean squarewave. Use a frequency counter to adjust C1 for an output frequency of exactly 100 kHz at pin 4.

The value of C2 may need to be changed slightly to allow C1 to adjust properly. Check the decade counters (using an oscilloscope) at pin 14 of each stage for a divide-by-10 output. The output at jack J1 should follow the frequencies selected by S1. Now that you have accurate test frequencies available, let's get the frequency-to-voltage converter (U6) going.

Select the 10-Hz/1-μF range and set S2 to the FREQ. position. Jumper a wire from output connector J1 to the switch side of C15. Adjust R6 for a full-scale reading on meter M1. Select the upper ranges. Each upper range should yield a reading within 5% of full-scale. That should be satisfactory calibration for all practical applications.

If you are a purist, R6 can be adjusted slightly lower than full scale, then each range capacitor can be trimmed individually by adding a small-value capacitor in parallel. The 100-kHz/100-pF range is affected by lead dress and layout. Capacitor C5 is about 82 pF; it's actual value should be selected for a correct full-scale reading to compensate for distributed capacitance in the wiring. Remove the jumper. Calibration is now complete.

Using the Project. When the CAP. position of S2 is selected and an unknown capacitor is placed in the test jacks, the correct value will be indicated on the meter. There is a slight offset of about 10 pF when using the 100-pF range, due to distributed circuit capacitance. So when using the 100-pF range, just subtract 10 from the reading.

If you are using a DVM to monitor the readings rather than the meter used in the project, replace M1 with a 100-ohm resistor. The value of R9 may be adjusted slightly for best accuracy, with your DVM set to read 1 volt DC.

An optional phototransistor, attached to an appropriate plug to mate with J2, can be added to allow the circuit to be used as a non-contact phototachometer. The probe is assembled on a scrap of double-sided PC board material and housed inside of a discarded felt-tip pen case. A four foot shielded cable is used to couple the signal into the circuit at J2.

Resistor R11 is added to the frequency-input connector J2 for operating bias voltage for the phototransistor. To measure the speed of a rotating object, place the probe where light reaching it will be interrupted by the moving object. The light source must be DC operated or sunlight. AC-operated lights will interfere with the readings. Remember, however, that the readings obtained are in pulses-per-second (Hz); RPM has to be calculated by the user (RPM = Hz × 60).

Readings of up to 38,000 pulses per second were obtained with the prototype. When the cap is placed over the probe (blocking light), the phototransistor becomes a high impedance. Placing the probe near a sparkplug wire triggers the F/C meter, allowing you to measure the speed of gasoline engines without any electrical connection. I'm sure you will find many uses for this handy instrument and it will be a welcome addition to your workbench. ■

"Now I remember—first you put the safety on, then you plug it in."

HEATH VOICE

(Continued from page 36)

Electrical Specifications. The Heath Voice hardware interfaces with the computer through a standard 62-connector PC card. The audio output's impedance is 10,000 ohms and drives the AUX input with sufficient voltage. The speaker output jack provides approximately 500 milliwatts of power for a standard 8–10-ohm dynamic speaker. The Heath Voice circuit board draws a maximum of 275 mA from a PC's +5-volt DC bus and 10 mA (quiescent) from a PC's 12-volt DC bus.

Putting It Together. The Editors rate the assembly time of this project at *one evening* and *trouble free*! If you start right after dinner, you should be finished and enjoying the 10 o'clock news without hurry or stress.

The circuit-board assembly went smoothly. Just follow the directions in the manual—The Heath Company is good at preparing assembly instructions and diagrams. The 10 IC sockets and the other parts assembled quickly. The only demanding procedure was inserting the IC's into the sockets—again, follow the easy instructions.

The only trouble experienced with the circuit board was after the mounting bracket was attached to it: The bracket's physical alignment in relation to the 62-conductor card edge did not conform to the standard of other such boards. The card's configuration was slightly off and that prevented the placement of the holding screw that locked the bracket to the computer's rear panel. To obtain the desired fit, the mounting holes for the bracket had to be enlarged and the bracket repositioned.

The speaker/cable assembly went together without problems.

Getting Set. Like all other software programs, it is important that you make a working copy of the software disk that came with your Heath Voice. Using the DISKCOPY utility is one good way to do that. Any copy method you use to copy the files from the master diskette to the working diskette is effective. Check the manual of your disk-operating system for details should you have problems. After you have made the copy, use it as your everyday working disk, and store the master diskette that came with the Heath Voice in a safe place.

Now the fun begins: Power down the computer and remove its cover. Install the Heath Voice card into an unused slot like any other board. Connect the phono plug on the end of the speaker cable to the bottom phono jack of the Heath Voice on the rear of your computer. (You can connect the top phono jack through an audio patch cord to the AUX input of your audio/hi-fi system.) Make sure that all connections are firm, then replace the computer's cover.

Power up and allow the computer to boot. Some very low-level computer noise that keeps in step with the booting procedure can be heard. That noise and a very low "digital" background noise is due to the computer's radiation, and Heath says that it is unavoidable. You should now see a message on the screen announcing that the Voice device driver was installed. That may be followed by other messages, depending on which (if any) parameters you set automatically while loading the driver. From the DOS prompt, type SPEAK SPEAKME.TXT. Your computer, speaking through the loudspeaker, will congratulate you if all is well. If not, remove the installed card and recheck the wiring and placement of parts very carefully.

Try doing what I did: from the DOS prompt, type "SPEAK" followed by any line of text you wish and then press the <ENTER> key. The computer will speak the line back to you. I typed:

SPEAK OKAY STUPID YOU CAN USE THE COMPUTER

followed by the <ENTER> key. Notice the input text requires no punctuation nor a closing quote mark.

A voice came back sounding lifelike and with a strange inflection on some words. Without reading the manual, I was able to modify the text input to read:

SPEAK O KAY STUP ID YOU CAN PLAY WITH THE COMPUTER

Back came the voice after I pressed the <ENTER> key enunciating in a clear voice with improved pronunciation.

Inside Sound. There's much to be learned about phonemes, mnemonics, combination sounds, and voice attributes to understand the generation of computer speech. As you delve into it, you become aware that the pitch can be varied to generate musical tones. It could be possible to have a voice sing, but this reviewer is tone deaf, so that was not attempted. Many of the disappointments at the first few tries, later inspired attempts at strange sounds for unusual effects. One way is to raise the pitch of the generated voice to some eerie level. At the present time the reviewer is generating a robot-voice message for his telephone answering machine.

Heath Voice has special terminal-emulator software that enables you to add a voice to modem communications at baud rates from 150 to 38,400. Incorporated into an amateur-radio station, Heath Voice lets you add a voice to received RTTY messages. The Heath Voice can be controled by a BASIC or assembly-language program, if either suits your needs.

The Heath Voice Kit HV-2000 is available from Heath Company, Benton Harbor, MI 49022 for $89.95, plus shipping charges. You can place your order by telephoning 800/253-0570, 24 hours a day. If you wish to obtain a catalog of Heath products and kits circle No. 42 on the Free Information Card in this issue. ■

CIRCUIT CIRCUS

(Continued from page 95)

PARTS LIST FOR THE CHARGER MONITOR

U1—LM339 quad comparator, integrated circuit
D1—1N914 or similar type silicon diode
R1—4700-ohm, ¼-watt, 5% resistor
R2—470-ohm, ¼-watt, 5% resistor
R3—10,000-ohm, ¼-watt, 5% resistor
R4—2200-ohm, ¼-watt, 5% resistor
R5—1000-ohm, ¼-watt, 5% resistor
R6—25,000-ohm potentiometer
BZ1—Piezoelectric buzzer
Perfboard, IC socket, clips, small plastic cabinet, knob, etc.

the piezo sounder (BZ1), calling your attention to the fully charged battery.

To calibrate the monitor, connect it across a variable power supply, and use an accurate voltmeter to set the power supply's output level to that of the desired battery voltage. Start off with R6 set fully clockwise (maximum voltage position), then slowly rotate R6 counter-clockwise until the piezo sounder sings out.

Well, once again, we've run out of space. But be sure to join us here next month, when the Circus will once again guide you through another adventure in circuit land. ■

BIG DIGIT

(Continued from page 34)

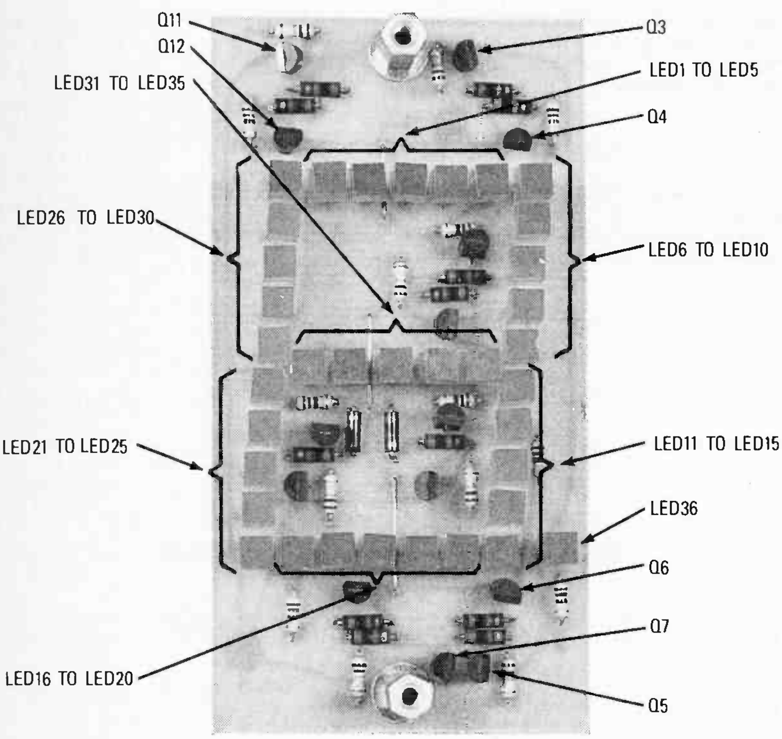
ules be multiplexed make a larger readout, the common-cathode (the cathode end of the LED strings) must be connected to ground through a switching transistor for that application. In addition, it will be necessary to select a transistor that can handle the expected high level of current draw.

When the number eight is displayed, the switching transistor must be able to handle the total current drawn by all seven segments—in this case 17-mA

and its base must be more positive than its emitter. Just the opposite is true of PNP transistors; its collector must be more negative than its base and its base must be more negative than its emitter.

Feeding an active-low signal to the base of an NPN transistor would keep the transistor turned off. The same is true of feeding an active high to the base of a PNP unit. So for drivers having an active-high output, use an NPN unit as the switching transistor; and for active-low drivers, use a PNP unit.

When configuring the modules for



Here is one completely assembled display module. Thirty-five LED's are used to form the seven segments of the display; the thirty-sixth LED is used as a decimal point.

per segment, which works out to about 119-mA total current per module. Care should be taken when choosing the switching transistor; choose a transistor that can handle at least 250 mA or more.

Figure 4 shows the basic procedure for multiplexing several Big-Digit Display Modules. Although the transistors shown in that diagram are NPN units, it may be necessary to substitute PNP units in the circuit, depending upon whether the multiplexing display driver used to control the modules is of the active-low or active-high variety.

So which type of transistor do you need for your application? Recall from basic electronics theory that in order for an NPN transistor to conduct, its collector must be more positive than its base

multiplexed operation, connect all like segments together; ditto for the decimal points. The switching transistors are then connected between the segment cathodes and ground as shown, and the base of each transistor is tied to its assigned digit driver—*i.e.*, the base of the transistor that is connected to DISP1 (in Fig 4, Q15) is connected to digit driver D1; DISP2's is connected to digit driver D2; DISP3's is connected to digit driver D3, and so on. Once that's done, your super-sized readout is finished.

Now that you have the big display for that obscure project you once thought about, go ahead and build it. Even though you may not need a scoreboard, I am sure that many readers will find other uses for the Big-Digit Display Module. ■

THINK TANK

(Continued from page 27)

less than 4 mA, LED1 will pass a current and light.

Resistor R3 is adjusted just low enough to extinguish LED1. It adjusts the base current needed to turn off LED1 and that depends on the current gain of the transistor. With R3 set for maximum, a current gain of about 1000 is needed to switch off LED1 and that reduces to 10 with R3 at minimum resistance. You can easily estimate the gain of the transistor under test by setting R3 when it is adjusted to cut-off.

In the PNP mode, S1 switches the supply polarity so that it is correct, and LED2 becomes the indicator while LED1 is reverse biased and does not function. Otherwise, the circuit operates as indicated previously. You can use several assorted sockets connected in parallel. The sockets should be selected to accommodate any transistor you may have. Another way out, is to use colored test leads with insulated alligator clips to make the connections. What do you think, is this worth a Fips book? *—Dominic DiBiasi, Altoona, PA.*

Good thinking, I especially liked the simplicity of switching polarities. The first thing I thought of was to build *two* units, one for NPN and another for PNP. Your system makes a lot of sense! The Fips Book is on the way out to Altoona right now!

That should do it for this month. Remember that *Think Tank* is totally comprised of contributions (schematic diagrams and brief circuit descriptions) from you, our readers. We reward contributors with a copy of the Mohammed Ulysses Fips book, which is made up of the April Fools columns written by our founder, Hugo Gernsback. It's some of the funniest writing that you've ever read, and a book that I'm sure you'll enjoy. It's also interesting to note how many of Hugo's humorous devices eventually became reality. To earn your copy, send your own original contributions to *Think Tank*, **Popular Electronics** 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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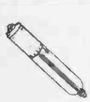

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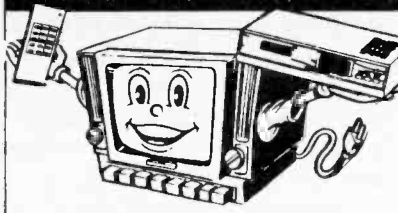

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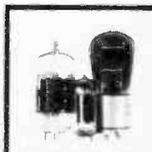

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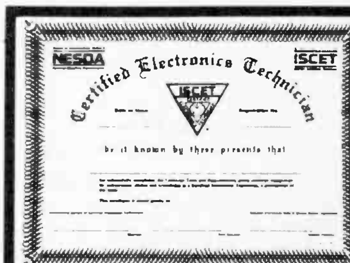

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ACTIVE ANTENNA

(Continued from page 73)

age of surplus inductors (Radio Shack 273-1601) and try several until you find one that works well. Many inductors are color-coded like resistors (they even have the same color-coding scheme), and should be read starting at the top. For example, an inductor marked yellow-purple-brown is 470μH and orange-orange-black is 33μH. Others are marked with three digits. The third digit tells you how many zeros to put after the first two, so that 471 on an inductor means the inductance is 470μH, and an inductor marked 332 would be 3300μH.

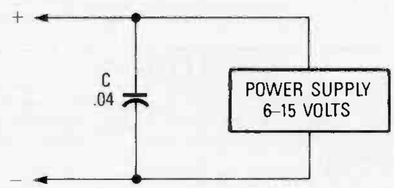


Fig. 2. Power can come from any source of 6 to 15 volts. Bypass the power supply with an 0.04-μF capacitor to prevent noise pickup from a remote power supply if one is used.

Surplus inductors are often color-coded like resistors, starting at the top. Yellow-purple-brown means 470μH.

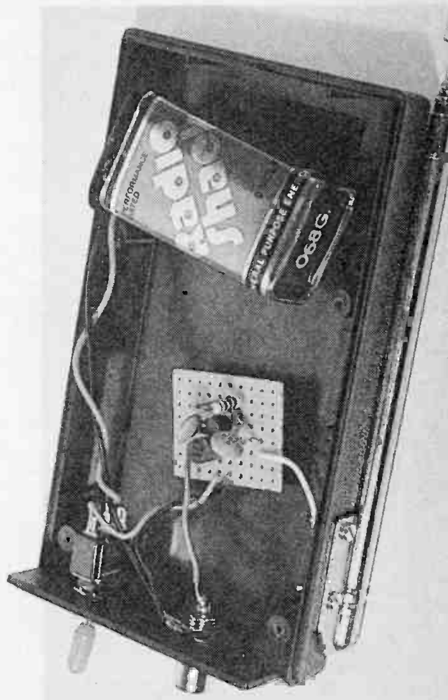
Construction. I built the amplifier on perfboard and housed the device in a store-bought project box. However, if you want to use the circuit as an AM car-radio antenna booster, build it in a grounded metal case to reduce noise pickup. You can build yours on perfboard also, using point-to-point soldering with Fig. 1 as a guide. If you wire-wrap the project, you may not achieve desirable results because of the high frequencies of the signals involved.

Build the circuit compactly; keep all leads short and keep the antenna and output jack and wires well separated. Connect the output to the receiver with a short piece of 50- or 75-ohm coaxial cable—a long cable will cause signal loss. Better yet, use low-capacitance car-radio antenna cable. Don't use unshielded wire.

PARTS LIST FOR THE SIMPLE ACTIVE ANTENNA

Q1—MPF102 field-effect transistor
R1—1-megohm, ¼-watt resistor
C1, C2—470-pF ceramic-disc capacitor
L1—20- to 470-μH inductor (see text)
J1—RCA phono jack
S1—Miniature SPST switch
B1—9-volt battery

18-inch collapsible whip (Radio Shack 270-1409 or equivalent) enclosure, battery connector, perfboard materials, hardware, etc.



The active antenna fits neatly into a small plastic case; the whip folds down for storage. Keep wires short and keep the antenna input away from the output jack.

Troubleshooting. Two problems may arise: If you hear strong squeals and chirps, but few radio stations, the active antenna and the receiver may be oscillating. That happened to me with a 50-year-old Hallicrafters S-38 that has no RF stage. If that happens to you, the cure is to make L1 smaller. If the battery runs down too quickly, replace Q1; the quiescent current of an MPF102 is normally about 5 mA, but it can be as high as 20 mA, which will drain the battery quickly.

You can use an external power supply if you filter it with an .04-μF capacitor placed near Q1 (see Fig. 2). ■