COLLECTING SHORTWAVE FOLK MUSIC

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE MAY 1976/$1

Build the Audio "Detective"

MEASURES PHONO CARTRIDGE AND MIKE OUTPUTS

How to Improve Equipment Grounds

Severe-Weather Alert Project

ACTIVATES EMERGENCY WEATHER BROADCASTS

TV Table Tennis II

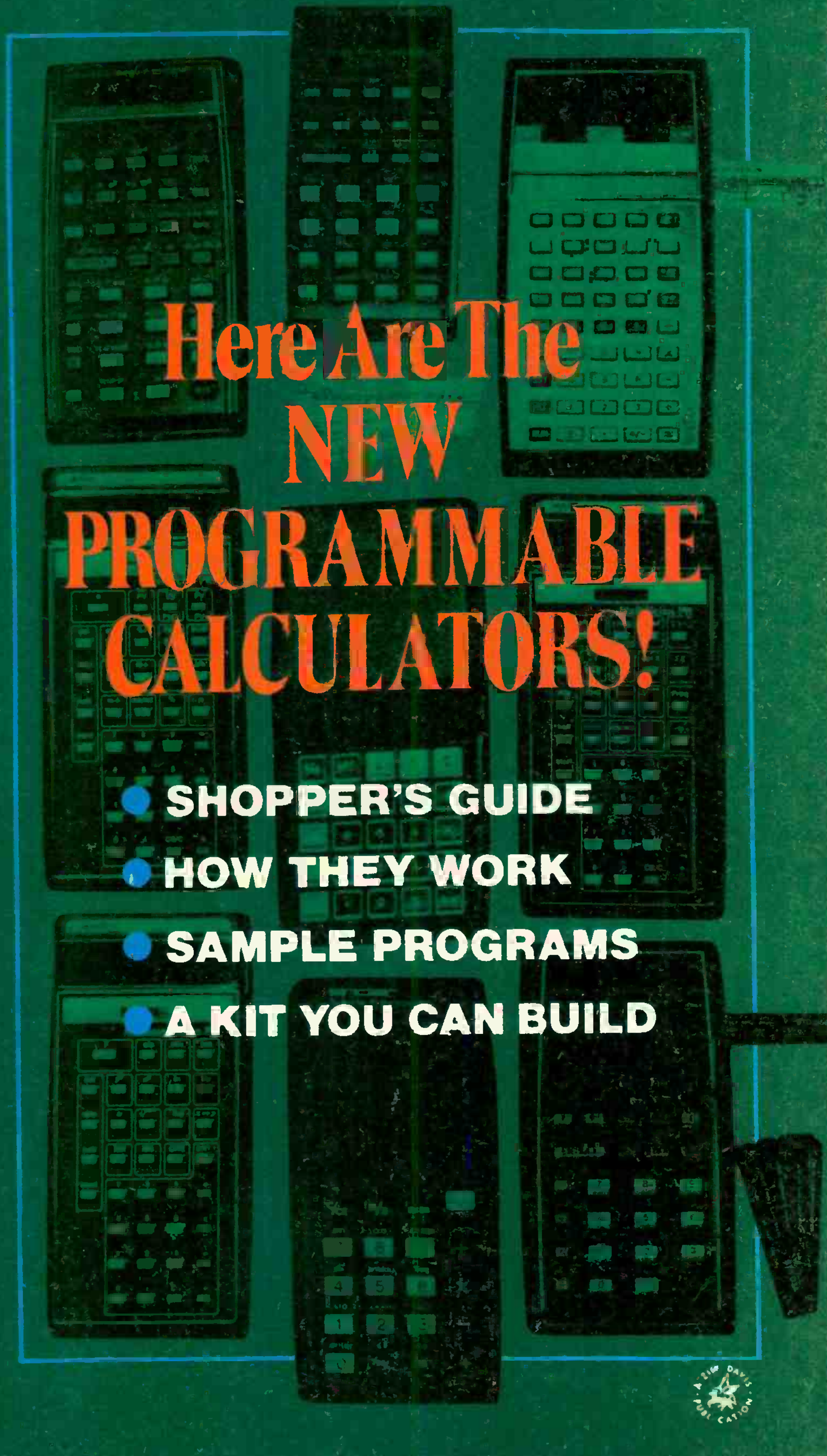
ADDS SCORING & SOUND

Test Reports

STAX SR-5 ELECTROSTATIC HEADPHONES

EPICURE MODEL 4 STEREO PREAMPLIFIER

KRIS VICTOR II MOBILE



Here Are The NEW PROGRAMMABLE CALCULATORS!

- SHOPPER'S GUIDE
- HOW THEY WORK
- SAMPLE PROGRAMS
- A KIT YOU CAN BUILD

A ZIFF-DAVIS PUBLICATION

AN INTRODUCTION TO STEREO.

At Yamaha, we feel uniquely qualified to introduce you to the joys of true stereo high fidelity sound.

Since 1887, Yamaha has been making some of the finest musical instruments in the world. Pianos, organs, guitars, woodwinds, and brass.

With our musical instruments, we've defined the standard in the *production* of fine sound. And today, with our line of state-of-the-art stereo components, we're defining the standard of its *reproduction.*

However, at one time, owning a Yamaha stereo system tended to be a rather expensive proposition. Our "ultimate" system, for example, hailed by the critics for such innovations as Vertical-FET circuitry and beryllium dome speakers, carries a suggested retail price of over $7,000.

But now, Yamaha introduces a selection of new stereo components that let your Yamaha audio dealer create a high quality system for a suggested retail price of around $700.

What you're getting is the same performance and design concept of our most expensive system, but without the frills. Also, each component has been specially selected and matched to enhance the performance of the other components.

The Receiver: There's a lot more than power to our new CR-450 stereo receiver.

You'll enjoy brilliant tonality resulting from super low distortion—0.1% intermodulation and total harmonic distortion. (These figures are amazing, considering most other competitive receivers are typically .5% to 1.0%!)

In addition, Yamaha offers a full complement of functional features on the CR-450. Twin meters for precise tuning. High and Low Filters to eliminate noise interference. And two headphone jacks, so you don't have to listen alone. Plus our own exclusive Variable Loudness Control, which gives you full tonal balance—even at low volume levels.

The Turntable: Yamaha's new high-performance YP-450 shares many of the features of our "ultimate" system turntable, the YP-800.

A low mass tonearm, with adjustable height and anti-skating, allows the stylus to track flawlessly at the lightest pressure. And the cue control is viscous-damped in both directions to prevent record damage.

A handsome walnut-grained base and a dust cover are standard.

The Speakers: By the careful refinement of proven acoustic and electronic engineering principles, Yamaha's NS-2 rivals the sound quality of many larger, more expensive speakers.

The NS-2's soft dome tweeter and high compliance, foam surrounded woofer (the same design principles featured in our superlative NS-690 speaker) offer excellent high frequency dispersion as well as clean, accurate bass reproduction.

Underneath the NS-2's removable grille cloth, quality construction is evident in the fully finished front cabinetry.

The Headphones: Yamaha's patented new Orthodynamic design HP-2 combines the smooth highs of the best electrostatic headphones with the full, rich bass of the best dynamic types.

The HP-2's comfortable, featherlight styling (by Italian designer Mario Bellini) is now on display in the New York Museum of Modern Art.

An Introduction to Stereo. Chances are, when it comes to understanding terms like watts, dB's and signal-to-noise ratios, you're probably a little confused. So we've prepared a booklet that explains the basics of the world of sound.

Appropriately enough, it's titled "An Introduction to Stereo."

To get your free copy, just send us the coupon.

Then, once you know the basics, visit your local Yamaha audio dealer. His knowledgeable salesmen and extensive demonstration facilities can save you a great deal of time and money in helping you select a system. And his first-class service will keep you happy.

So talk to your Yamaha audio dealer. His experience and your ears make the perfect introduction to stereo.

Yamaha International Corporation,
Audio Division, P.O. Box 6600-L,
Buena Park, Calif. 90620

Please send my free copy of
"An Introduction to Stereo."

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YAMAHA

CIRCLE NO. 71 ON FREE INFORMATION CARD

Laser Beam Digital Watch

Never press another button, day or night, with America's first digital watch that glows in the dark.

Announcing Sensor's new Laser 220—the first really new innovation in digital watch technology.

It's ingenious, it's simple and it makes every other digital watch obsolete. Scientists have perfected a digital watch with a self-contained automatic light source—a major scientific breakthrough.

SELF-CONTAINED LIGHT SOURCE

The Laser 220 uses laser beams and advanced display technology in its manufacture. A glass ampoule charged with tritium and phosphor is hermetically sealed by a laser beam. The ampoule is then placed behind the new Sensor CDR (crystal diffusion reflection) display.

The high-contrast CDR display shows the time constantly—in sunlight or normal room light. But, when the room lights dim, the self-contained tritium light source automatically compensates for the absence of light, glows brightly, and illuminates the display.

No matter when you wear your watch—day or night—just a glance will give you the correct time. There's no button to press, no special viewing angle required, and most important, you don't need two hands to read the time.

Replace the battery yourself by just opening the battery compartment with a penny. Free batteries are provided whenever you need them during the five-year warranty.

A WORRY-FREE WATCH

Solid-state watches pose their own problems. They're fragile, they must be pampered, and they require frequent service. Not the Laser 220. Here are just five common solid-state watch problems you can forget about with this advanced space-age timepiece:

1. Forget about batteries The Laser 220 is powered by a single EverReady battery that will actually last years without replacement—even if you keep the 220 in complete darkness. In fact, JS&A will supply you with the few batteries you need, free of charge, during the next five years. To change the battery, you simply unscrew the battery compartment at the back with a penny and replace the battery yourself.

2. Forget about water Take a shower or go swimming. The Laser 220 is so water-resistant that it withstands depths of up to 100 feet.

3. Forget about shocks A three-foot drop onto a solid hardwood floor or a sudden jar. Sensor's solid case construction, dual-strata crystal, and cushioned quartz timing circuit make it one of the most rugged solid-state quartz watches ever produced.

4. Forget about service The Laser 220 has an unprecedented five-year parts and labor warranty. Each watch goes through weeks of aging, testing and quality control before assembly and final inspection. Service should never be required. Even the laser-sealed light source should last more than 25 years with normal use. But if it should require service anytime during the five year warranty period, we will pick up your Sensor, at your door, and send you a loaner watch while yours is repaired—all at our expense.

5. Forget about changing technology The Sensor Laser 220 is so far ahead of every other watch in durability and technology that the watch you buy today, will still be years ahead of all others.

THE ULTIMATE ACHIEVEMENT

Other manufacturers have devised unique ways to produce a watch you can read at a glance. The new $300 LED Pulsar requires a snap of the wrist to turn on the display, but the Pulsar cannot be read in sunlight. The new $400 Longine's Gemini combines both an LED and liquid crystal display. (Press a button at night for the LED display, and view it easily in sunlight with the liquid crystal display.) But you must still press a button to read the time. All these applications of existing technology still fail to produce the ultimate digital watch: one you can read under all light conditions without using two hands. Until the introduction of the Sensor.

PLENTY OF ADVANCED FUNCTIONS

Sensor's five time functions give you everything you really need in a solid-state watch. Your watch displays the hours and minutes constantly, with no button to press. But depress the function button and the month and the date appear. Depress the button again and the seconds appear. To quickly set the time, insert a ball-point pen into the recessed time-control switch on the side. It's just that easy.

Sensor's accuracy is unparalleled. All solid-state digitals use a quartz crystal. So does the Sensor. But crystals change frequency from aging and shock. And to reset them, the watch case must be opened and an airtight seal broken which may affect the performance. In the Sensor, the crystal is first aged before it is installed, and secondly, it is actually cushioned in the case to absorb tremendous shock. The quartz crystal can also be adjusted through the battery compartment without opening the case. In short, your watch should be accurate to within 5 seconds per month and maintain that accuracy for years without adjustment and without ever opening the watch case.

The new exclusive laser-sealed tritium and phosphor light source is a thin solid-state tube that automatically illuminates the display when the lights dim.

Would you do this with your solid-state watch? Of course not. Most solid-state watches require care and pampering but not the Sensor. You can dunk it, drop it and abuse it without fear during its unprecedented five-year parts and labor warranty.

STANDING BEHIND A PRODUCT

JS&A is America's largest single source of digital watches and other space-age products. We have selected the Sensor Laser 220 as the most advanced American-made, solid-state timepiece ever produced. And we put our company and its full resources behind that selection. JS&A will warranty the Sensor (even the batteries) for five full years. We'll even send you a loaner watch to use while your watch is being repaired should it ever require repair. And Sensor's advanced technology guarantees that your digital watch will be years ahead of any other watch at any price.

Wear the Laser 220 for one full month. If you are not convinced that it is the most rugged, precise, dependable and the finest quality solid-state digital watch in the world, return it for a prompt and courteous refund. We're just that proud of it.

To order your Sensor, credit card buyers may simply call our toll-free number below or mail us a check in the amount indicated below plus $2.50 for postage, insurance and handling. (Illinois residents add 5% sales tax.) We urge you, however, to act promptly and reserve your Laser 220 today.

Stainless steel w/leather strap $129.95
(Add $10 for matching metal band)
Gold plated w/leather strap........ $149.95
(Add $10 for matching metal band)

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WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE

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CONSTRUCTION ARTICLES

COLUMNS

PRODUCT TEST REPORTS

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Editorial

PROJECT KIT SUPPLIERS

When we publish articles about projects that the reader can build for himself, we often include (in the Parts List) a source from which complete kits or certain important items can be purchased. This is done for the convenience of readers who wish to be able to: (a) make a "one-stop" purchase of parts, (b) obtain devices not easily available, or (c) have a source for the completed printed circuit board.

The supplier of these items may be the experimenter who designed the project and hopes to add a few dollars to the article payment by selling parts out of his garage. On the other hand, he may be a professional whose business is selling electronic kits. Often, an experimenter/author will have a professional package the kit, garnering royalties on any sales. POPULAR ELECTRONICS, of course, does not participate in these sales. However, our editors often arrange for an experimenter/author and a kit supplier to get together, in which case, we act as unpaid go-betweens.

As it happens, the integrity of kit suppliers and the quality of material supplied vary. Some suppliers have provided poor delivery, others deliver with dispatch. Some issue magnificent assembly instructions, others simply throw the parts into a brown paper bag. Most, of course, are somewhere between these extremes. We try to handle things so that as high a level of supplier performance is maintained as is possible.

Since the mail-order business is now subject to some new Federal regulations, communications between seller and buyer should be good from here on. After all, sellers are liable for as much as $10,000 for each day of noncompliance with delivery, according to FTC rules.

Project kit/parts suppliers are carefully told of our requirements. In addition to the FTC's 30-day maximum shipment time (or notice of delay and option to cancel), they must make the kits available to readers for a minimum period of three months from the cover date of the issue in which it appeared, and hold their price for a minimum of 30 days.

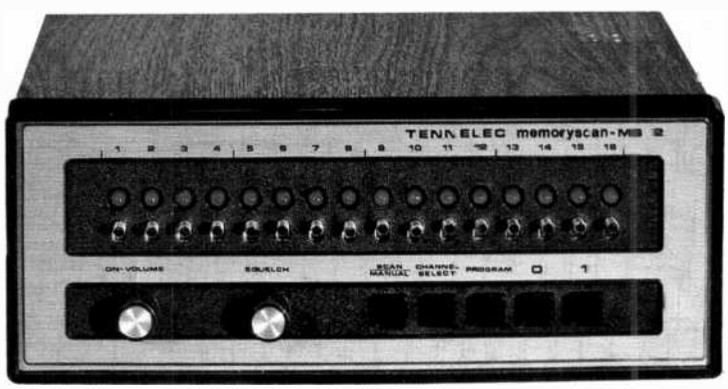
One frustrated reader recently complained that he requested a free pc foil pattern last month from a kit supplier, and was told that the patterns were no longer available. Well, the project was published more than a year ago, so we don't believe the supplier was being unreasonable in dropping the free patterns.

If the rules are broken, however, without a valid reason, we will no longer utilize the person or company as a supplier of project kits. But please, readers, we cannot become involved in wrong-part hassles and the like. There are always some understandable foulups. So one has to be reasonable, allowing for human error, work overload, etc.

Art Salsberg

This scanner doesn't have channel crystals. It has a brain.

The amazing Tennelec MS-2 Memoryscan®.



The MS-2 Saves You Money. The control center of this scanner is a digital brain that eliminates the need for channel crystals—ever. When you think of the thousands of authorized channels, each requiring the purchase of a channel crystal (which cost up to $5.00 each), you can visualize the money-saving potential of the MS-2.

Sophisticated Yet Easy To Operate.
Truly a product of advanced technology, the MS-2 is highly sophisticated, yet amazingly easy to operate. Using a simple codebook and two front panel buttons, you can program any of the 4,000 low, high and UHF frequencies you want to hear. The MS-2's panel lights provide exclusive visual verification of your selections. The super-selective filter provides crisp, clear reception. And the MS-2 is ready for the future, with a capability of receiving some 16,000 channels.

Hear The Action As It Happens.
Police. Fire. Weather. Marine. Highway Patrol. Rescue Squad. Be in on the action. Hear the news as it's being made. Be alerted to conditions that could affect your family's safety.

Take It With You. The MS-2 is mobile. It can go where you go. Simply add the optional bracket and mount it in your car. Your boat. Or keep it with you at home or office.

It's The Best-Seller In Crystal-less Scanners. The Scanner with the digital brain.
The amazing Tennelec MS-2.

$339.95

Write Today For Complete Information, Free Literature, and the Name of Your Nearest Dealer.*

☐ Send me full information on the MS-2. Tell me where I can buy it.

Name ______________________

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City __________ State __________ Zip __________

*If there is not a Tennelec dealer convenient to you, we will send you information on how you can order direct with full warranty.

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CIRCLE NO. 65 ON FREE INFORMATION CARD

Letters

MORE ON CB "BUZZ" WORDS

The article on CB "Buzz" words (January 1976) was great. The only thing I would like to pass on is that many truckers are now using channel 19. Their main reason for the change from channel 10 is to avoid interference with emergency channel 9. *Donald Pogoda, Lebanon, PA.*

A NEW PUBLIC SERVICE BAND?

Do you have any information about the receivers, frequencies, etc., for the Physicians Radio Network. It sounds like an interesting channel to monitor.—*Ken Greenberg, Skokie, IL.*

It is a confidential radio channel available only to physicians, not the general public.

A BUG IN DEBUGGING SOFTWARD

We found the "Computer Bits" column for September 1975 very interesting, but we found two errors during the course of debugging the software. One possible correction for these errors is:

1. Starting at label WRBST:

```
WRBST:  MOV    B, A (missing)
        CALL   WRTIM
        JZ     WRFIN
        CALL   WRTIM
        JNZ    WRBST+1
               (wrong location)
```

2. Starting at label RDSYN:

```
RDSYN:  CALL   RDCHA
        MOV    A, C
        CPI    XXSYN
        JZ     RDSYN (wrong
                instruction)
        CALL   RDCHA*
        MOV    A, C*
        CPI    XXSTX
```

With these corrections, the code seems to execute correctly. The instructions marked with an asterisk (*) are superfluous.—*John M. Harrison, Northeast Electronics, Concord, NH*

WHERE CAN I BUY . . .?

In the November 1975 "Computer Bits" column, Jerry Ogdin mentioned the availability of the new 6501 MPU by MOS Technology. I've checked all over for a vendor that handles this chip but had no success in locating one.—*Charles Greenwood Dunedin, FL*

The 6501 is marketed directly by MOS Technology, Inc. (950 Rittenhouse Rd., Norristown, PA 19401) for $20. (You might also be interested in the 6502, which sells for $25.) Descriptive literature is available on request to MOS. Also, for $5 each, you can get the hardware and software manuals that go with these chips.

HELP FOR CANADIAN READERS

The unavailability of many of the newer integrated circuits and components here in Canada is an ongoing problem. I have been fortunate, however, to find a Canadian supplier that has most of the latest devices. The supplier is R.W. McKay, RR#1, Site 21, Box 6, Creston, B.C. VOB 1GO.—*A Johnston, Invermere, B.C.*

RADIO ASTRONOMY REVISITED

As an amateur astronomer with an interest in radio astronomy, I enjoyed "An Introduction to Radio Astronomy" in the January 1976 issue. I might add that besides being used for noise detection from extraterrestrial objects, the receiver system described can also be used for the detection of meteors entering the earth's atmosphere. Meteors entering the atmosphere burn up and disintegrate, and, as they do, ionize the air around them. It is this ionization that can be detected.—*A. Brooks, Ottawa, Ontario, Canada*

In the radio astronomy story in the January 1976 issue, the plans in Fig. 2 seem to indicate that the antenna's overall length is in excess of 30'. Is this correct?—*Doug Samuels, Concordia, MO*

At 110 MHz, the antenna would be some 31.1' (9.48m) long, as indicated.

MAIL-ORDER HOUSE VS THE FTC

I read with interest the February 1976 "Editorial" titled "Good News for Mail-Order Buyers." I think it's about time the Federal Trade Commission (FTC) put teeth into any and all mail-order regulations.—*L.A. McPharlin, South Bend, IN*

Out of Tune

In "Build 'Pennywhistle,' The Hobbyist's Modem," (March 1976) the test frequency given at the center of column 2, page 47. should be 2125 Hz instead of 1170 Hz. The author informs us that the schematic he is supplying shows *R80* as 680 kilohms and it should be 6.8 kilohms.

In "How Multiplexed LED Displays Simplify Circuits" (March 1976, p 62), *IC2* should be a 74145 (not 74175) and *IC2* should be a 7448 (not 7447).

In "An LED-Readout Audio Power Meter" (March 1976, p 35), diodes *D1-D4* are shown in Fig. 2 with their polarities reversed. They should also be numbered *D3, D1, D2, D4* starting from the top. The polarity of *C1* is also shown reversed.

To SBE

tech·nol·o·gy

is not just another word

SBE brings computer-age technology to two-way radio communications in developing the newest, the most advanced, the most exciting personal communications equipment available today.

FORMULA D, for example, is SBE's sophisticated new 23-channel citizens band mobile AM two-way radio. With a single crystal, it offers advanced digital techniques, combined with phase-lock-loop (PLL) circuitry, to synthesize frequencies covering all 23 transmit and receive channels. Tolerances are closer. Stability is better. And performance exceeds the best that crystal-controlled two-way radio could ever provide.

FORMULA D is but the first of a whole new generation of sophisticated, digitally-synthesized personal communications equipment being developed by SBE to keep you ahead in the exciting new advances planned for citizens band communications.

The same creative approach to technology as exemplified by FORMULA D is reflected in other SBE products—a full line of communications equipment that includes citizens band, land mobile, marine and special application.

Discover how *you* can benefit from SBE's advanced technology.

SBE® Better Communications through Creative Technology

For information write: SBE, Inc., 220 Airport Blvd., Watsonville, CA 95076

INTERNATIONAL OFFICES: E.S. Gould Marketing Co. Ltd., Quebec, Canada/Linear Systems S.A. Geneva 1, Switzerland

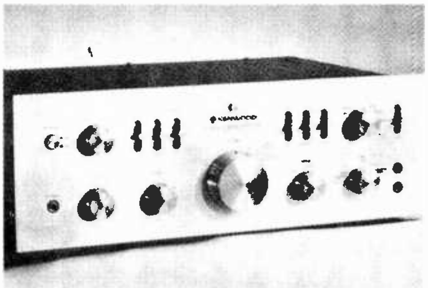
CIRCLE NO. 54 ON FREE INFORMATION CARD

MK II with elliptical styli for stereo play. Each of these induced-magnet cartridges feature the company's patented construction which is said to permit reduction of mass in the moving system, thus allowing the stylus tip to track the record groove with minumum force (as low as 0.75 g). Prices: $125.00, $100.00, and $75.00, respectively.

CIRCLE NO. 92 ON FREE INFORMATION CARD

KENWOOD PROFESSIONAL PREAMPLIFIER

The Model 700C preamp from Kenwood is designed with a variety of control and

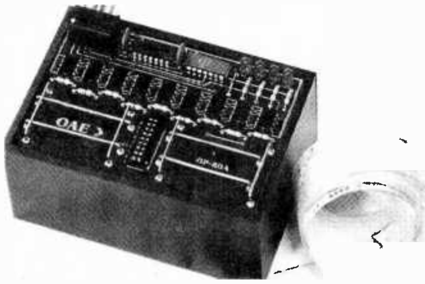


switching functions. It is said to handle a dynamic range in excess of 85 dB, referred to its nominal 1-volt output level and has low residual noise (50 µV). Phono cartridge input impedance is selectable (600, 30,000, or 50,000 ohms). Selectable low- and high-frequency filtering, audio muting, and a two-step loudness control are also included. A special "tape-through" circuit allows tape-to-tape dubbing to proceed while the system is simultaneously used to play any other program source.

CIRCLE NO. 93 ON FREE INFORMATION CARD

PAPER-TAPE-READER KIT

A low-cost paper-tape reader (OP-80A), made by Oliver Audio Engineering, reads punched tape as it is pulled through by hand at speeds up to 5000 characters per second. It includes a precision optical sensor array, high-speed data buffers, and required logic; and it will interface with an 8-bit µP I/O port. It can also be connected across a UART to load programs through a



TTY port. The OP-80A is said to be able to load 12K extended basic in 30 seconds. Price is $74.50 for the kit, $95.00 assembled.

CIRCLE NO. 94 ON FREE INFORMATION CARD

ROYCE THREE-PIECE CB TRANSCEIVER

The Royce Model 1-580 Mod-U-Lar mobile AM CB transceiver consists of a three-piece "system" that includes microphone/channel selector, separate control unit, and remote power pack/electronics package. The mike has Royce's Chan-L-Matic channel selector/readout that allows a driver to change channels without taking his eyes off the road. Not much larger than a king-size pack of cigarettes, the control unit contains the

volume and tone controls, PA/CB and hi/lo tone switches, S/r-f meter, and loudspeaker. It connects to the remote power pack (which also contains the rest of the circuitry) via a 9′ (3 m) or optional 18′ (6 m) cable. Placing the control and power pack units in different locations in a car can serve as a theft deterrent.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Motorola CB is here!

Introducing Mocat—The CB radio backed by Motorola's 40 years experience in professional radio communications. Great looks. Great performance. Everything you'd expect from a radio built by Motorola. Yet it comes at a very affordable price.

Designed and engineered in the USA, Mocat is a 100% solid-state Motorola CB radio with the very latest in technological advances, and exciting features.

Motorola CB means reliability. A digital phase lock loop synthesizer assures on-frequency performance on all channels.

Motorola CB means quality reception. Automatic gain control, cross modulation rejection circuit and optional "Extender" noise blanker circuit give Mocat superior receiver performance.

Motorola CB means power. All models feature a rugged plug-in mike with built-in amplifier for maximum transmit signal strength.

Motorola CB means good looks. Contemporary styling across the line. Selected models offer easy channel identification with high-intensity L.E.D. digital channel read-out and dimmer.

Motorola CB also means high performance and attractively styled antennas and accessories.

Motorola CB is the biggest news and greatest value in personal communications today. Mocat from Motorola. Now is the time to own a Motorola CB. For complete details, write us at Motorola, Inc., Dept. CB-700, 1301 East Algonquin Road, Schaumburg, IL 60172.

MOTOROLA

CIRCLE NO. 41 ON FREE INFORMATION CARD

New Literature

FM SUBCARRIER APPLICATIONS NOTE

EMR Telemetry offers a new 12-page applications note, "Amplitude Adjustment of FM Subcarriers." The note describes factors determining optimum setup of amplitudes of subcarriers in an FM multiplex system. General setup procedure is given with specific information on systems utilizing r-f links, telephone lines, cable transmissions, and tape recorder. Optimization methods and typical system performance guidelines are provided. Address: EMR Telemetry, Weston Instruments, Inc., Box 3041, Sarasota, FL 33578.

SEMICONDUCTOR FUSE ARTICLE

An article explaining considerations governing the selection of semiconductor fuses is available from the Semiconductor Division of International Rectifier Corp. The article, reprinted from *Electronic Buyer's News*, describes the various parameters used to specify fuses, indicating their relative importance. Copies of the monograph will be sent upon request. Address: Semiconductor Division, International Rectifier Corp., 233 Kansas St., El Segundo, CA 90245.

SMITH CHARTS

Analog Instruments offer a four-page, illustrated brochure of its line of Smith Charts. All forms have normalized impedance (or admittance) coordinates, title block and radial scales. Printed in red ink; green on negative charts. Also included in the catalog are computer-plotters, rubber stamps, mega-rules, vugraphs and laminated charts. Address: Analog Instruments Co., P.O. Box 808, New Providence, NJ 07974.

RFI SUPRESSION

"Radio Frequency Interference Suppression in Switched-Mode Power Supplies" is the title of a new, 8-page, illustrated report available from the Ferroxcube Corporation. The article discusses the main principles behind the suppression of RFI at the input terminals of switched-mode power supplies. These general principles are applicable to all forms of switched-mode power supplies. Address: Ferroxcube Corporation, Saugerties, NY 12477.

MODULAR CABINET CATALOG

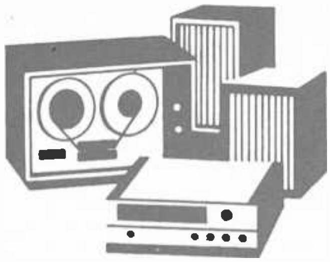
Insta Fab's Mod-U-Line series of modular instrument cabinets are presented in its new catalog. Cabinets are available in plain, rack-mount, multiple, and handle configurations. The products are made of aluminum, but steel units are available on special request. Various colors can also be specified. Also covered are various designs of Mod-U-Box sloping panel cabinets. Prices and available dimensions are listed. Address: Insta Fab, Inc., 425 Queens Lane, San Jose, CA 95112.

JENSEN TOOL CATALOG

"Tools for Electronic Assembly and Precision Mechanics" is a 112-page handbook describing over 2500 items offered by Jensen Tools and Alloys. Section headings include screwdrivers, files, and soldering equipment, along with other tools and accessories used by electronic technicians and engineers. Also, a full-color 16-page section features Jensen tool kits and cases, and a solder section lists tin-lead alloys. Address: Jensen Tools and Alloys, 4117 N. 44th Street, Phoenix, AZ 85018.

POPULAR ELECTRONICS 1975 INDEX

A complete editorial index of the magazine for the year 1975 (Vols. 7 and 8) is available for $1.50 from Popular Electronics Index, Box 2228, Falls Church, VA 22042.



Stereo Scene

By Ralph Hodges

THE WORLD OF SOUND CONTRACTING

ONE OF THE fastest growing career areas in electronics today is the field of sound contracting. Public consciousness of the importance of the acoustic specialist has been raised significantly by (for one thing) the spectacular sound systems that have been built for concerts by rock groups. (It seems top bands are always cancelling performances because they're not happy with the available audio system.) Also to be considered are such well-publicized acoustic fiascos as New York's Avery Fisher Hall. Now, as public spaces grow ever bigger and more acoustically complex, people are no longer satisfied with movie-theater sound systems that blur the dialog, airport PA systems that are unintelligible or inaudible, and sports-arena loudspeaker installations that rumble and bark incoherently.

Almost everyone is aware of the brute power that audio technology has lately put into our hands. We can, for example, zap a football stadium with sound levels sufficient to traumatize the first ten rows of the audience. But who, it is asked, has the expertise necessary to apply this power cheaply, efficiently, and with quality results? This is the gap that the better sound contractors are rushing in to fill.

Designing For Sound. The knowledgeable contractor today is able to approach his work with a system of mathematics and—finances permitting—a battery of instruments that literally put the task on a scientific basis. His objectives—for a reinforcement installation in an auditorium or church, say—are typically to cover and penetrate the full seating area with sound that is adequately loud (a function of the acoustic power available and the room's characteristics), clear enough for unlabored communication, and natural in its tonal balance and range. The latter is particularly important if the system is to be used for music as well as speech. In addition, it is desirable for the sound the audience hears to be associated with the location of the speaker on stage, not the location of the loudspeaker(s).

Working With Numbers. What is impressive about the professional sound business is that hard numbers are routinely attached to all these audio-system qualities, and the numbers are plugged into equations that predict final performance with remarkable accuracy in most cases. For example, it has been determined empirically that a signal-to-noise ratio of at least 25 dB at mid-frequencies is necessary for unimpaired intelligibility of speech. The noise level in the auditorium must of course be determined by an on-site measurement.

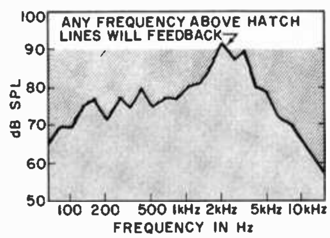


Fig. 1. Unequalized sound system.

However, with the data from this simple measurement and the relevant specifications from the loudspeaker manufacturer, you can travel via slide rule to an excellent estimate of what will happen when the sound system is installed.

First, working on the assumption that most of the auditorium's seating area will lie within the reverberant field (which is, by definition, steady and uniform), the nature of this field can be calculated once the volume of the space and the (estimated) absorption of the materials in it are known. The result leads directly to the reverberation time (RT) of the hall in seconds. (The RT is the amount of time required for a sound to die away to a level of −60 dB in the hall.) With RT and the volume (V) of the space known, they can be used with the Q or "directivity factor" of the loudspeaker (gleaned from the manufacturer's specifications or from your own tests) to compute the "critical distance" or D_c of the speaker. The formula is

$$D_c = 0.03121 \sqrt{(QV)/RT}$$

The D_c is the distance from the loudspeaker at which the level of the sound coming directly from it exactly equals the level in the reverberant field. Then, if you know the sensitivity of the loudspeaker and the amplifier power driving it, the inverse square law will tell you what the sound level would be at the critical distance. This is the sound level that will be achieved throughout the uniform reverberant field. If it exceeds the noise level by at least 25 dB, all is well in terms of the acoustic output of the system.

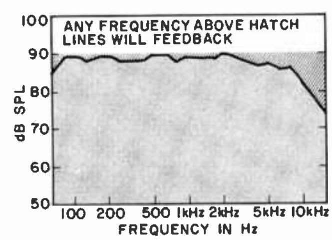


Fig. 2. Equalized sound system.

Articulation Loss. Beyond signal-to-noise ratio, there is an additional factor affecting speech intelligibility. It is known as "articulation loss of consonants in speech," and it is usually expressed as a percentage. Believe it or not, articulation loss (AL) is quantifiable (15% is adequate, 10% virtually ideal) and calculable. It relates to the ratio of direct to reverberant sound for any given listener in the auditorium. The general formula is

$\%AL = 641.81 D^2 RT^2/QV$, where D is the distance from loudspeaker to listener. To adjust for a satisfactory AL you can specify or design a loudspeaker with a larger Q, or you can treat the hall to reduce RT.

The concept of AL was worked out empirically by two Dutch researchers who published their conclusions in 1971. From the evidence to date, it seems to be one of the most powerful tools for sound-system design ever developed. In fact, with these two parameters (the AL and the required sound levels) under control, the hardware necessary for successful completion of the job is virtually

(Continued on page 22)

worked out for you. There remain only such considerations as the positioning and aiming of the loudspeaker (the rules for which are not difficult to master) and the equalization of the sound system.

Equalization. Most audiophiles are aware of the advantages of room equalization for home high-fidelity systems, as well as the drawbacks. The latter include the fact that, in most listening rooms, you can only equalize for one particular spot in the room. Move the measuring microphone a foot or so away from that spot and the system's response changes drastically. But in a larger space, such as an auditorium, this is not true. In general, if a room is large enough to provide a reverberation time of 1.6 seconds or more, it can support a true reverberant field; and the distinguishing characteristic of a reverberant field is its uniformity. In such a field, a sound system will measure the same no matter where you place the measuring microphone. This means that you can equalize the system and be sure that the entire audience will be getting the benefits. In fact, it is not unusual for a sound contractor to specify uniform level and frequency response within ±1 dB throughout the entire seating section of an auditorium and *meet* that spec. (Along with reverberant sound, each seat must also receive a certain amount of evenly distributed direct sound to provide intelligibility, but this requirement rarely complicates the equalization process.)

The means of equalization in common use are narrow-band filters spanning one-third octave or even less. (The Altec Acousta-Voicette is the equivalent in home equipment.) The filters may be designed individually for the specific job, or they may be incorporated in a ready-made filter set that covers entire audio range. Aside from adjusting the ultimate frequency response of the sound system (which may be convenient or even necessary, depending on circumstances), the filters play an even more important role in the design of a sound-reinforcement system. They maximize the acoustic output available from the system before feedback occurs.

In any sound system that employs a microphone in the same room as the loudspeakers, acoustic feedback is inevitable. However, in most auditoriums with unequalized sound systems, feedback begins at certain specific frequencies. Often the system is so ready to "take off" at these frequencies that the overall level you can use in the room is severely limited. But when you bring a filter set into the picture, you can frequently raise the usable level of the system to an astonishing degree. The procedure is as follows. Gradually increase the level of the sound system until feedback begins to occur at a certain set of frequencies. Knock those frequencies back with the appropriate filter. Raise the level further until another feedback mode crops up, and quash that in the same way. After you have proceeded in this fashion through a dozen or more sets of feedback frequencies, you will begin to approach a point where you have either run out of amplifier power or the system is being driven into feedback by many frequencies simultaneously. This is your goal. It is not unusual to obtain a 10-dB or more increase in usable system level from this process (see Figs. 1 and 2 on page 18).

Does equalizing for feedback conflict in any way with equalizing for uniform frequency response in an auditorium? The answer is apparently not; the "growth" of energy in a room at any one narrow band of frequencies corresponds to both an aberration in frequency response and a potential for acoustic feedback, so that response adjustment and feedback control generally lead to the same result from different directions. Assuming the microphone used is "flat," you can equalize for minimum feedback and also be assured that the frequency response you're obtaining is essentially flat.

I began this column by inviting you to contemplate the career possibilities in sound contracting, and I hope the above has demonstrated that it is a craft masterable by anyone who is willing to learn the basic rules. Where do you learn the rules? I can only recommend the source of my smattering of knowledge in the subject: Don Davis' excellent Synergetic Audio Concepts seminar, or "Syn-Aud-Con."

The Syn-Aud-Con seminars are conducted by Davis and his wife Carolyn in numerous cities throughout the country each year. They last three days—8:00 AM to perhaps 10:00 PM per day—and those days are packed. For a schedule of the seminars and information on registration and charges, write to Syn-Aud-Con, Box 1134, Tustin, CA 92680. ◈

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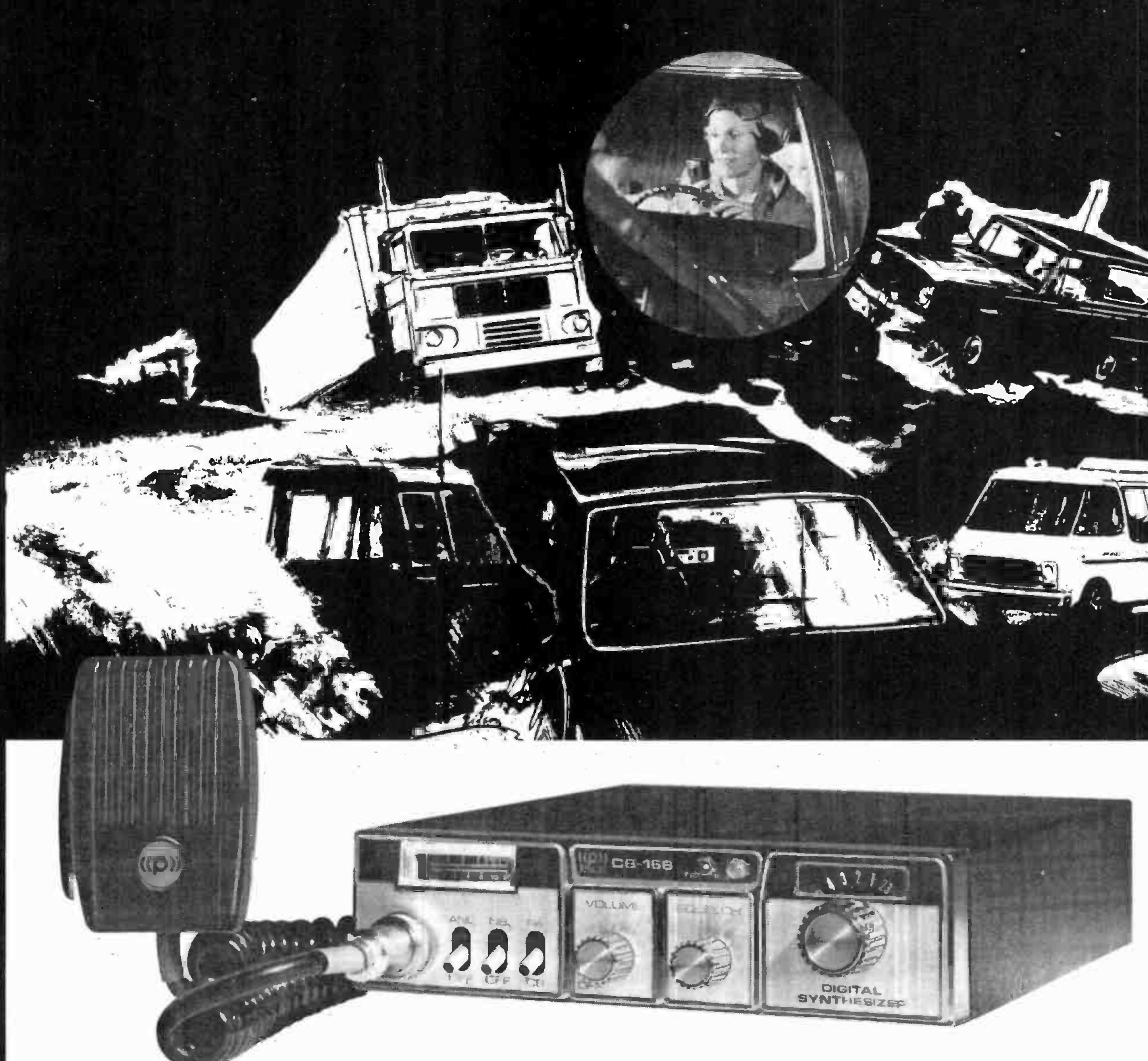

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news HIGHLIGHTS

A Talking Calculator

A new calculator with a vocabulary of 24 words enunciates—in clear electronic speech—each keystroke as it is made, followed by the correct answer. Speech Plus™, developed by Telesensory Systems, Inc. (Palo Alto, CA), enables the operator to know immediately if he has made the proper entry, without having to check its 8-digit visual display. The unit has the four basic functions, plus square root, percent, independent memory, and floating decimal point. The 17-oz portable comes with an earphone jack and battery charger. Price is $395.

Device Monitors Operation Time

Scheduling routine calibration checks for sensitive test instruments on the basis of actual usage rather than elapsed calendar time is possible with the Sentinel™, a device offered by Compuline, of Norristown, PA. The reminder, about the size of a matchbook, consists of a memory module with associated circuitry and a LED indicator that turns on when calibration is due. Furthermore, the light goes on and stays on as a constant reminder. Replacement is as easy as changing a fuse. Elapsed time of usage can be preset in increments from 20 to 2000 hours ±10 percent. The memory module (a three-element coulometric capsule) operates by electroplating away a specific volume of metal at a rate controlled by the current flowing through it. Though presented for an instrument calibration reminder, why not for an auto oil-change reminder?

A "Neck-Less CRT"

Engineers at the Air Force Systems Command's Avionics Laboratory (AFAL) are considering the use of liquid-crystal displays for cockpit instruments that must be read in strong sunlight. Unlike conventional LCD's, the crystals can be made to vary in several shades of gray so that, when combined in an array, a TV-like picture is obtained. Forty thousand picture elements ("pixels") can be used—10,000 on each of four 1" chips. Power requirements are low. Commercial applications are envisioned on portable electronic equipment and small computer terminals, where eliminating the neck of a CRT would be a real space saver.

The Sound Gallery

A futuristic audio-visual environment—The Sound Gallery—is expected to open at 127 Smith Place in Cambridge, Massachusetts. Billed as an entirely new way to educate the public about sound reproduction, the Gallery consists of two mini-theaters separated by a space-age control room housing a sophisticated computer which controls two presentations. Entitled "The Shiny Vinyl Grand Canyon Tour" and "Speakers and Spaces," these presentations guide the listener/viewer through the world of sound in a new, exciting way, including an ordinary record groove magnified thousands of times until it becomes a "Grand Canyon." On your next trip to the Boston area plan to stop by for a visit.

Brighter Green LED's

Siemens AG of West Germany has developed a new LED with a luminous intensity of 30 mcd at 10 mA, nearly double that of its predecessor. Since the new green diode (LD 57 C) is rated for up to 60 mA, it is said to be the first LED which not only makes itself visible as a light-spot, but can illuminate its surroundings. With this new brightness, it is possible to enclose the LED in a plastic capsule that is not dyed and has no diffusor.

Updated Glossary of Electronic Terms

A pocket-sized, 40-page glossary which lists over 425 commonly used electronic terms and acronyms ranging from "ACC" (Automatic Chroma Control) to "GIGO" (Garbage In, Garbage Out), has just been published by Lavin Associates, Inc., 12 Promontory Dr., Cheshire, Conn. 06410. A handy metric conversion chart has been included. Write the company for prices on quantity orders.

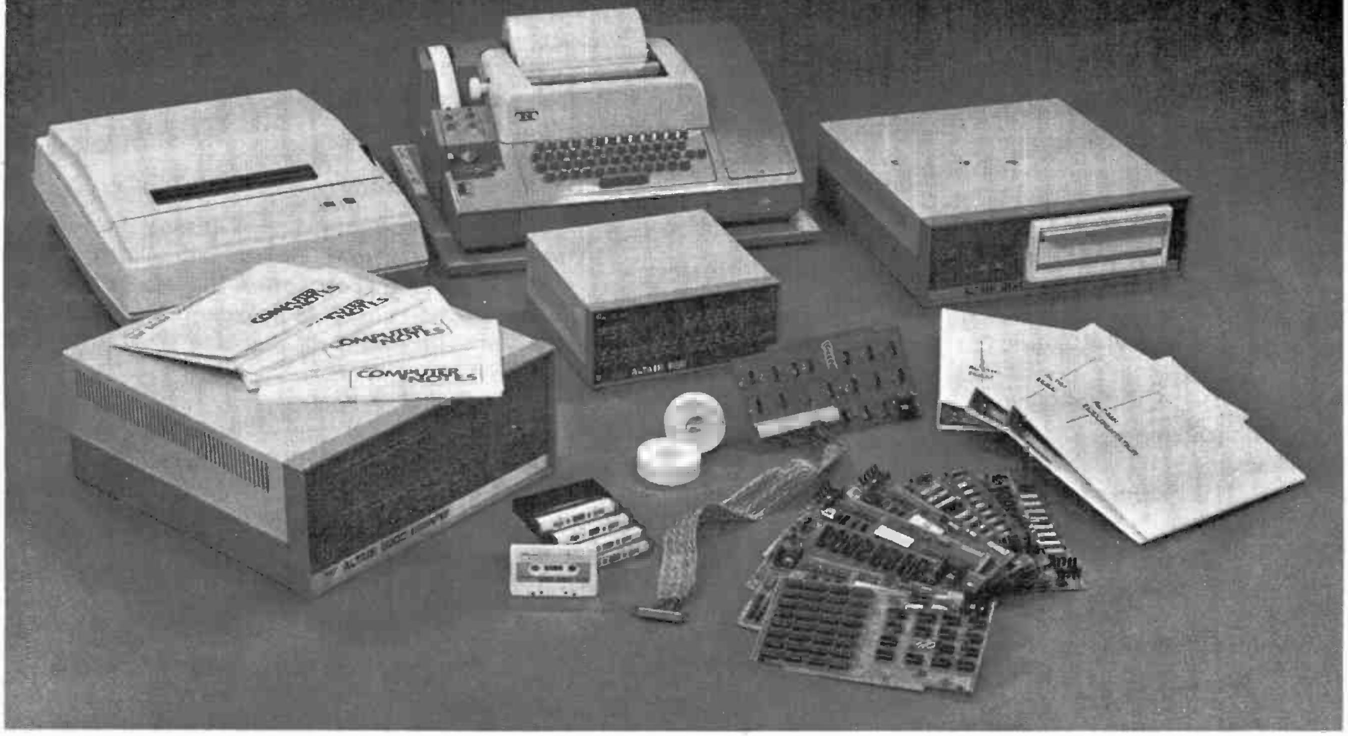
Computer Systems in the 1980's

The future is bright for computer systems in the U.S. in the 1980's, says Dr. Ruth M. Davis, Director of the Institute for Computer Sciences and Technology of the National Bureau of Standards. According to Dr. Davis, the 1980's will see computer networks containing computers and computer modules of all sizes, independent memories, and a large variety of access terminals and automated input devices. She sees a burgeoning market for individual users who want autonomous, dedicated computer systems which can, when needed, be interconnected to larger computer service networks or other individual customers. Predicted for the 1980's are automated reading or "wand" technology, and solid-state mass memory devices, such as CCD's, bubble memories, and read/write laser memories. Arthur D. Little, Inc. predicts that 1980 domestic installations of general-purpose computers will be worth over $60 billion. It's forecast that the sale of associated equipment will grow at a faster rate than that for the computers themselves.

LSI Chip For Singer Sewing Machine

Singer's Athena 2000 sewing machine uses a 40-pin, half-inch-square LSI chip to control all stitch and linear motor movement, including shifting from one pattern to another. The new unit, which replaces more than 8,000 transistors, can make 36,000 basic decisions during one hour's operation. Programmed into the chip are optimum stitch width, length and density. A Hall-Effect sensor is used to locate the needle's position in the machine.

Can anyone beat the Altair System?



We doubt it.

When it comes to microcomputers, Altair from MITS is the leader in the field.

The Altair 8800 is now backed by a complete selection of plug-in compatible boards. Included are a variety of the most advanced memory and interface boards, PROM board, vector interrupt, real time clock, and prototype board.

Altair 8800 peripherals include a revolutionary, low-cost floppy disk system, Teletype,™ line printer, and soon-to-be-announced CRT terminal.

Software for the Altair 8800 includes an assembler, text editor, monitor, debug, BASIC, Extended BASIC, and a Disk Operating System. And this software is **not just icing on the cake**—it has received industry wide acclaim for its efficiency and revolutionary features.

But MITS hasn't stopped with the Altair 8800. There is also the Altair 680—complete with memory and selectable interface—built around the new 6800 microprocessor chip. And soon-to-be-announced are the Altair 8800a and the Altair 8800b.

MITS doesn't stop with just supplying hardware and software, either. Every Altair owner is automatically a member of the Altair Users Group through which he has access to the substantial Altair software library. Every Altair owner is informed of up-to-date developments via a free subscription to **Computer Notes.** Every Altair owner is assured that he is dealing with a company that stands firmly behind its products.

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Hobby Scene Q&A

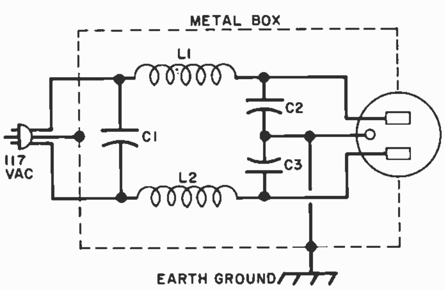
By John McVeigh

SW RECEIVER LINE FILTER

Q. ***Is there a filter I can make to clear up the interference on my shortwave receiver? Whenever a vacuum cleaner, shaver, or hair dryer is used, the entire dial is filled with "hash."***

—Mark Papuga, Park Ridge, IL

A. The line filter shown will help. *L1* and *L2* are 2-inch windings of 16-gauge enameled wire wound on a half-inch diameter form. *C1* through *C3* can be anywhere between 0.001- and 0.01-μF, 200-V disc ceramic capacitors (capacitance not critical, but use the same value for all three). Assemble the filter in a metal box and connect it to a good earth ground. Plug the filter into the wall, and connect the receiver line cord to the filter



socket. If this doesn't clear up the interference, try to isolate the appliance generating the noise and install the filter between it and the wall socket. Also, ground the receiver chasis.

RECORD STATIC

Q. ***Ever notice the crackling at your fingertips when you remove a record from your turntable? What's this static doing to my system's performance, and how do I get rid of it?***

—Keith Baumbach, Lodi, CA

A. A record can acquire a static charge when it rubs against its liner, when the stylus tracks across it, or when you rub it with a cloth to clean it. While the static in itself will have no effect on the cartridge's translation of the grooves into an electrical signal, it can (and does!) attract many small dust particles to the record surface. This dust gets in the way of the moving stylus, causing pops and other high-frequency noise. Static is most often a problem in winter, when we heat our homes and thereby lower the relative humidity inside. This inhibits the bleedoff of static, since the moisture which normally does the job isn't around. Perhaps the easiest way of reducing record static is to wipe the discs with a *damp* cloth. Also dampen the record mat on the platter. Many commercial record care products also contain anti-static chemicals. Two of the best known are the Watts line and the Discwasher. For an in-depth look at the static problem, see "Mac's Service Shop," POPULAR ELECTRONICS, June 1975.

SOLID-STATE VTVM CONVERSION

Q. ***I would like to replace the 6AL5 and 12AU7 tubes in my Heathkit VTVM with solid-state circuits. Any suggestions?***

—E. Lambert, Cocoa Beach, FL

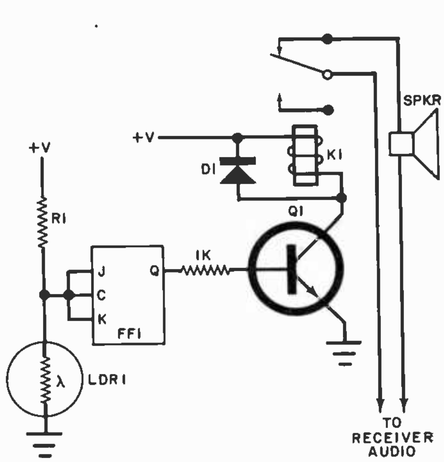
A. Heath has just introduced exactly what you want. Its new IMA-18-1 package consists of two plug-in cans containing FET's and diodes which fit exactly into the tube sockets. No rewiring is necessary. $16.95.

REMOTE-CONTROL COMMERCIAL CUTOFF

Q. ***Do you have a simple circuit for a remote-control audio cutoff for TV commercials?***

—Thomas C. Robinson, Ft. Wayne, IN

A. This scheme will work. When you want to cut off the sound, shine a flashlight at *LDR1* momentarily. The transition between the high and low states (and back again) will cause the flip-flop (*FF1*) to toggle. When the Q output goes high, *Q1* turns on and energizes the relay coil. The relay contacts open the circuit between the speaker and receiver audio output.



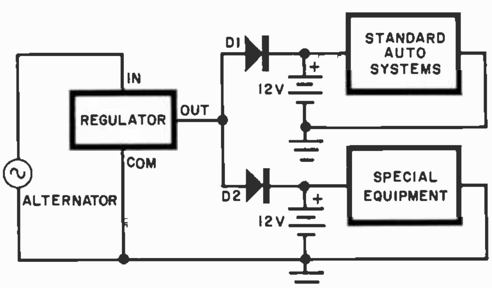
When the commercial is over, shine the light on *LDR1* for a second. The flip-flop will toggle again, cutting off *Q1*, in turn de-energizing the coil and completing the audio circuit. Parts are not critical. Select +V and *R1* to give a logic-one input to the flip-flop when *LDR1* is dark. Almost any photocell, flip-flop (JK), switching transistor, and diode can be used. Select a relay with sufficient dc resistance to keep within the collector current rating of *Q1*. Mount the photocell in a cardboard tube painted black so that background lighting won't toggle the flip-flop.

TWO-BATTERY AUTO SYSTEMS

Q. ***I want to install another battery in my camper to run an inverter and some accessories, but need an isolation circuit to prevent the starter battery from discharging when the engine is off.***

—Kevin Ayers, New London, CT

A. After you've installed a new alternator and regulator to handle the in-



creased current demand, connect diodes *D1* and *D2* as shown. They will prevent the batteries from discharging through the alternate circuits. Be sure to choose diodes that can handle the required currents.

INDUCTANCE FORMULA

Q. ***I need a formula relating the number of turns, spacing, and diameter of a home-wound coil to its inductance.***

—David Gardner, Baltimore, MD

A. The inductance of a coil is influenced by many factors, including what type of core it is wound on, its proximity to other inductors, etc. For single-layer, air-core inductors, the following approximation is useful:

$$L = a^2n^2/(9a + 10b)$$

where L is the inductance in microhenries, a is the coil radius in inches, b is the coil length in inches, and n is the number of turns. The use of ferrite cores will cause this expression to be multiplied by a constant.

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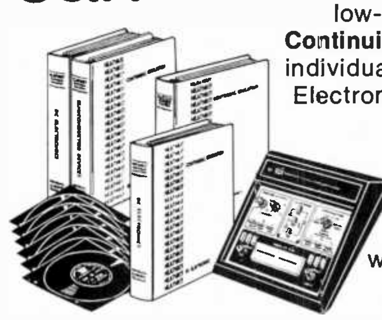

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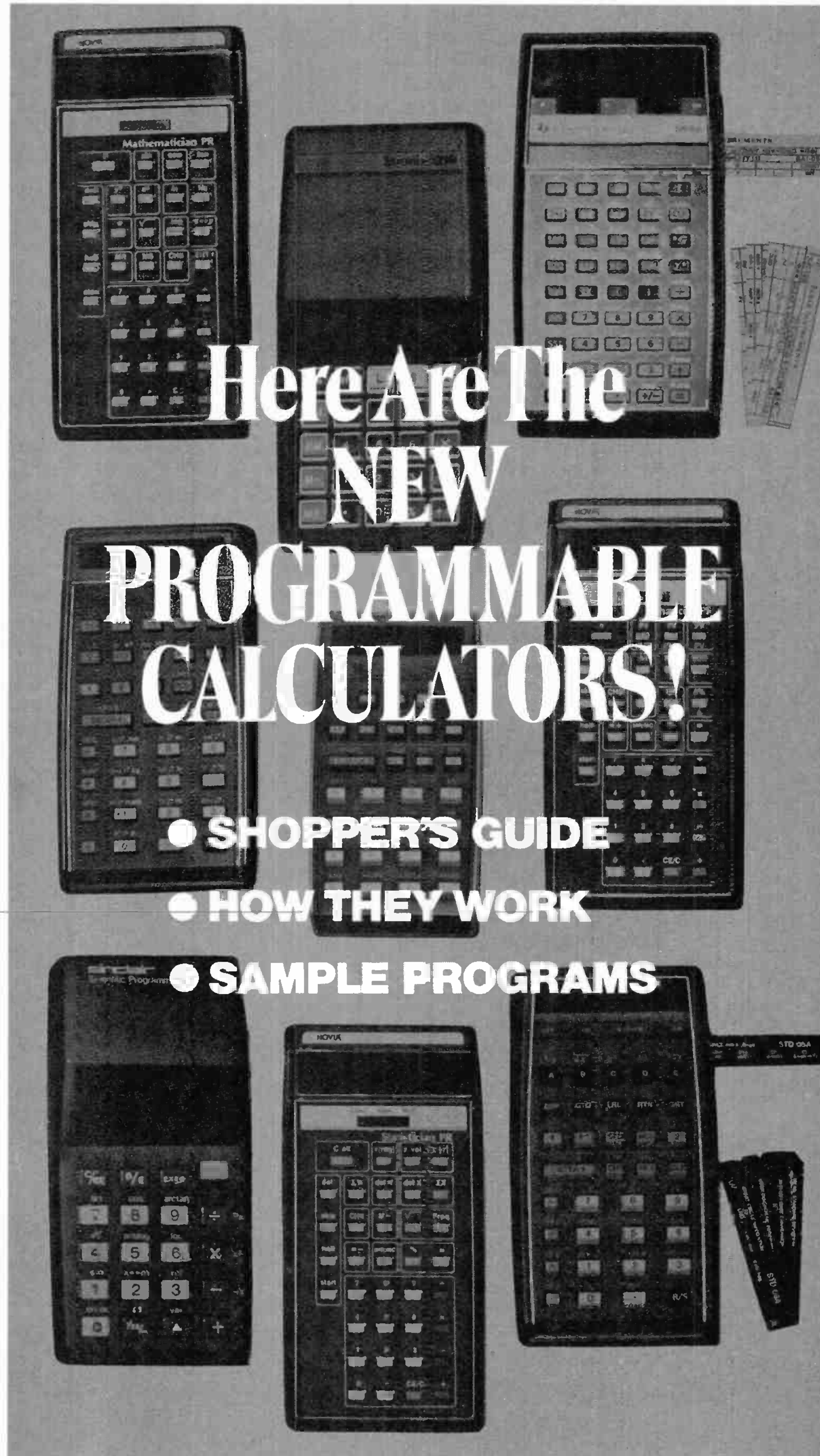
BY FORREST M. MIMS



COMBINE a handheld calculator with a fully addressable memory and you have one of the new programmable calculators. What makes the programmable calculator different from others is that the computer-like capabilities provide "learn" and "remember" keyed-in sequences that can be played back on command. This reduces the number of keystrokes required to solve the same problem for different variables. In addition, programmability (with programs written by experts) provides solutions to problems whose complexity would ordinarily be beyond your mathematical training.

As an example of the labor and time saved when solving repetitious problems, let us assume that you must calculate the resonant frequency of an LC circuit for different values of inductance and/or capacitance. The formula $f_0 = 1/(2\pi\sqrt{LC})$ would require the following sequence of keystrokes on a scientific calculator: 2, ×, π, [, (, at least one digit mantissa for L, EE, +/−, at least one digit mantissa exponent, ×, at least one digit mantissa for C, EE, +/−, at least one digit mantissa exponent,), $\sqrt{x}$,], =, 1/x. This adds up to no less than 20 keystrokes *every* time you change the value of L or C on an ordinary calculator. Although, initially, you have to key in the same number of keystrokes on a programmable, thereafter you key in only the variables, eliminating at least 11 keystrokes per repetition.

You don't have to be a mathematics genius to use one of these powerful programmable calculators. There are thousands of programs written by specialists to be used if you don't want to develop your own.

Here are some general information about programmable calculators and a brief rundown of the various types.

Methods of Entry. Before getting into what's available, let us review the two methods of keyboard entry used in programmable calculators: algebraic and reverse Polish notation (RPN).

Algebraic notation is the most widespread method of entry. It permits a problem to be entered exactly as it is written on paper. For example, 2 × 4 would be entered by pressing the keys in the sequence 2, ×, 4, =.

Many scientists and engineers prefer to use RPN, which requires that numerical entries be immediately followed by their operators. Therefore, 2 × 4 would be entered: 2, ENTER, 4, ×. Note that there is no need to press an = key. (There isn't any on an RPN calculator.) Pressing ENTER tells the calculator to total or subtotal immediately after the operator is pressed.

Let us consider a more difficult problem to illustrate the difference between the two methods of entry. If we were to calculate the result of (4 + 2) × (7 + 3) on an algebraic calculator, the keying sequence would be: (, 4, +, 2,), ×, (, 7, +, 3,), =. (We could reduce the number of entry steps by two by eliminating the first set of parentheses.) The keyboard entry sequence for solution of the same problem with an RPN calculator would be: 4, ENTER, 2, +, 7, ENTER, 3, +, ×.

Both methods of entry will yield the correct answer, 60. The algebraic approach appears to be the simpler of the two, if only because it follows the familiar method in which the problem is written. On the other hand, the RPN approach requires fewer keystrokes, which can be an important advantage when writing long programs.

The Litronix Model 2290 features a 10-step program memory and data memory to facilitate complex repetitive problems.

Since RPN requires a learning period, algebraic-entry calculators are initially easier to use. However, once you become accustomed to thinking in RPN, you will often find it a more versatile approach to problem solving.

Types of Programmables. There are some 10 different portable programmable calculators on the market, with more to be announced soon. The programmability of these calculators can be classified as elementary, intermediate, or full, offering the potential buyer a wide choice in selecting the one best for him.

All available programmable calculators store ("learn") keystrokes, but intermediate and fully programmable models provide a variety of editing and decision-making capabilities that greatly add to their power and versatility. Fully programmable machines, in fact, are almost like

PROGRAMMING THE PROGRAMMABLES

Programming a programmable calculator is a relatively simple task, once you familiarize yourself with the correct procedure detailed in the unit's operating manual. You need no prior experience to become a proficient calculator programmer. In a very short time, even a school child can learn to write simple programs and load fairly advanced ones.

You can learn simple programming in an hour or so on any programmable calculator, although fully programmable models offer more of a challenge than intermediate and elementary machines and thus become a continuous learning experience as you develop new techniques, routines, and tricks. Of course, if you don't wish to become a programmer, you can always use programs developed by experts to solve problems of immense complexity. There are thousands of such programs covering almost every subject in which mathematics is used, and more are being added to the list daily.

In this section, we focus on practical hands-on use of the programmable calculator. To do this, we will detail the keying sequence for four programs, three of which are relatively simple mathematic

Step	Function	Explanation
01	x^2	Square r
02	π	Enter pi
03	x	Multiply r^2 times pi
04	x	Multiply h times product of r^2 and pi
05	GTO 00	Return program to initial address and stop

Fig. 1. Program for determining the volume of a cylinder on the HP-25.

Step	Function	Explanation
01	1	Magnitude of incrementation
02	+	Add to previous magnitude (itself)
03	PAUSE	Pause to see result (optional)
04	GTO 01	Do it again

Fig. 2. Routine for incrementing a number

ultra-compact computers, since they can use subroutines and read programs from small magnetic cards. (It isn't necessary to use the programming features. All programmables can be used in the same manner as "ordinary" calculators for one-time-only jobs.)

Elementary programmables memorize or save keystrokes for later number processing, but lack such advanced features as conditional testing and branching. Typical elementary models permit you to store from 10 to 100 (maximum) program steps. After loading a program, you simply key in the appropriate numerical variables, press a RUN key, and the calculator automatically performs the steps in the program to provide the result. This type of calculator permits you to solve a routine equation that must be worked and reworked for different variables. You need enter only the new variables, rather than the entire equation, for each calculation.

The big difference between elementary and intermediate programmable calculators is the branching and conditional-comparison capabilities offered by the latter. Intermediate machines also offer complete editing capabilities. Briefly, here is what all this means to the calculator user:

Unconditional Branching. This feature is used for editing programs and setting up a "loop" within a program to permit a calculation to be worked until specified conditions are met. In the editing mode, you can order the calculator to advance to any desired step in the program memory by pressing a GTO (go to) key, followed by the appropriate address.

TI's SR-56 is a 100-step, 10-memory key programmable.

Conditional Branching. This powerful feature is what sets intermediate programmables apart from elementary machines. In a typical application, the calculator automatically transfers operation to a specified program address if and only if a logical comparison is true or false (your choice).

Conditional Comparisons. This is a valuable decision-making capability that permits the calculator to automatically branch to a specified step in its program if a logical comparison meets a specified condition. For example, consider the comparison "$x = 0$." In a typical intermediate programmable calculator, such as the HP-25, the program continues sequentially if the result of this test is true. If the result is false, the program counter automatically skips the next step and continues on to the second step beyond the comparison test.

There are many applications for conditional comparisons, one of which is automatically incrementing or decrementing variables in a program. For example, assume you need

equations and the fourth is a game of intermediate complexity you can play on your calculator.

(Note: The following programs are written for the intermediate level HP-25 programmable calculator, which uses RPN entry. These programs can easily be rewritten for algebraic entry.)

Volume of a Cylinder. Suppose you have several cylindrical containers and want to find the volume of each. The applicable formula for computing volume is $V = h \times (\pi r^2)$, where V is the volume, h is the height of the container, and r is the radius of the base of the container. The HP-25 lets you enter one and then another number and multiply the two after both have been entered into the calculator. Therefore, a simple way to solve the formula would be to enter h, followed by r and proceed with the calculation. The programming procedure for this formula is detailed in Fig. 1.

To use the program, load it into your calculator, switch to RUN, enter h and then r, and press the R/S (run/stop) key twice to start the program. In less than a second, the calculator will display the result and prepare to accept new data.

Counting. Programs for intermediate
continued on page 34

Step	Function	Explanation
01	1	Input 1
02	+	Add to previous number squared
03	x^2	Square the number
04	PAUSE	Pause to see result
05	LST X	Recall last number squared
06	RCL 1	Recall value for highest number to be squared
07	x = y	Has program reached value in R1?
08	GTO 00	If value in R1 is reached, go to 00 and halt
09	$x \rightleftarrows y$	If not, replace last number squared in display register
10	GTO 01	Go to step 01 and repeat

Fig. 3. Program for squaring consecutive integers with display of each result.

to calculate the squares of all integers between 1 and 15. Using the comparison "$x = 0$," we can write a simple program that squares 15, then 14, and so on down to 0, at which point the comparison "$x = 0$" is satisfied and the calculator comes to a halt.

By far the most exciting, and most expensive, handheld calculators on the market are those with full programmability. They have all the capabilities of the intermediate calculators plus flags, subroutines, user-defined keys, and a method of rapidly loading and storing programs.

If you're familiar with computers, you can appreciate the value of being able to do subroutines. A subroutine is actually a separate program stored in the memory along with the main program. When the main program requires the use of the subroutine to calculate an intermediate result or perform some other useful operation, an appropriate instruction is keyed into the program. The instruction is followed by a "label" that identifies the subroutine. The last step of a subroutine is normally "return," which causes the program to resume at the address immediately following the subroutine call. Subroutines can be labelled with the user-defined keys on both of the only two fully programmable calculators currently on the market. These keys can also be reserved for any desired routine or function and used like any other key on the calculator.

Flags are another powerful feature of fully programmable calculators. A flag is a simple "yes" or "no" signal that can be set by the user or by a program. The status of the flag can be used to cause a conditional branch.

What's Available. So far, the three manufacturers that make elementary programmable calculators are: Litronix, Inc. (19000 Homestead Rd., Cupertino, CA 95014); Sinclair Radionics, Inc. (375 Park Ave., New York, NY 10022); and the Novus Division of National Semiconductor (1177 Kern Ave., Sunnyvale, CA 94086). In order of increasing cost, here are the details on the elementary models available:

Litronix Model 2290. ($29.95). This low-cost calculator has a 10-step program memory and data memory, and comes with a one-year unconditional guarantee. It is available in a rechargeable version (Model 2290R) for $39.95.

The calculator's programming is controlled by three keys that are labelled L (learn), S (stop/execute), and E (execute/enter). Although this calculator's capability is rather limited, it is well suited to solving simple but repetitious problems at a reasonable cost.

Sinclair Scientific Programmable. ($79.95). In addition to such common scientific functions as sin, cos, arc tan, log, 10^x, and $\sqrt{x}$, this RPN calculator offers a 24-step program memory and a fully accessible memory register. Its three major assets are compact size, large easy-to-read green fluorescent display, and a generous program library. The program library consists of 50 cards that contain hundreds of programs ranging from the routine to the sophisticated. Program topics include general arithmetic, geometry, statistics, finance, radiation, propagation, electrostatics, electromagnetics, thermodynamics, and fluid mechanics.

An awkward feature of this calculator is the assignment of the all-

Fig. 4. Program for the Hi-Lo game is shown below and on opposite page.

Step	Function	Explanation
01	π	Steps 01-15 generate a random number between 0-99 and store the number in R1 (the calculator assumes honesty on the part of the game player; there is no provision for detecting unauthorized peeks at the contents of R1)
02	RCL 0	
03	+	
04	5	
05	y^x	
06	FRAC	
07	STO 0	
08	1	
09	0	
10	0	
11	x	
12	INT	
13	STO 1	
14	ENTER	
15	CL X	
16	R/S	Input guess
17	ENTER	
18	1	Steps 18-19: Guess Counter
19	STO+5	
20	ROLL	
21	x = y	Is guess correct?
22	GTO 26	If yes, go to step 26
23	x< y	If no, is guess too low?
24	GTO 35	If yes, go to step 35
25	GTO 40	If no, go to step 40
26	RCL 2	Signal correct guess ("1111111111. ")
27	PAUSE	Pause to see correct guess signal
28	PAUSE	
29	RCL 5	Display number of guesses
30	PAUSE	Pause to see number of guesses
31	PAUSE	

The HP-65 (left) and SR-52 are two fully programmable handheld calculators. Both incorporate a miniature magnetic program card reader.

important ENTER key to an upper-case function. Since a special shift key must be operated before ENTER can be pressed, entry of a number requires two additional keystrokes.

Novus Model 4515. ($79.95). Soon to be marketed as the new National Semiconductor Model 4615, this RPN programmable has a 100-step program memory. It features such important scientific functions as sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, y^x, e^x, ln, 1/x, π, $\sqrt{x}$, and log, plus a fully addressable data register.

[Note: All Novus programmable calculators include DEL (delete), SKIP, HALT, and START program keys.]

Novus Model 4525. ($99.95). This algebraic-notation programmable is designed specifically for common business and financial calculations. The 100-step built-in program memory is ideal for routine but repetitious calculations of simple interest, compound interest, accumulated savings, terms of mortgages and loans, and many other common business and financial problems.

Novus Model 6035. ($99.95). Like the Model 6025, this calculator is dedicated to a specific type of problem solving. It features algebraic entry, and its statistical capabilities are well suited to a wide range of common problems. The calculator has a 100-step program memory and a fully accessible data register.

• Hewlett-Packard (19310 Pruneridge Ave., Cupertino, CA 95014) and Texas Instruments, Inc. (P.O. Box 5012, MS/84, Dallas, TX 75222) market the only three intermediate programmable calculators currently available.

Texas Instruments Model SR-56. ($179.95). This 100-step programmable calculator employs algebraic notation, a three-level algebraic hierarchy, seven pending operations, more than

Step	Function	Explanation
32	CL X	Steps 32-33: Clear Guess Counter
33	STO 5	
34	GTO 01	Prepare for a new game
35	RCL 3	Guess too low; display 0.07
36	PAUSE	Pause to display inverted LO
37	PAUSE	
38	RCL 1	Retrieve number to be guessed and return
39	GTO 14	to step 14
40	RCL 4	Guess too high; display 14
41	PAUSE	Pause to display inverted HI
42	PAUSE	
43	RCL 1	Retrieve number to be guessed and return
44	GTO 14	to step 14

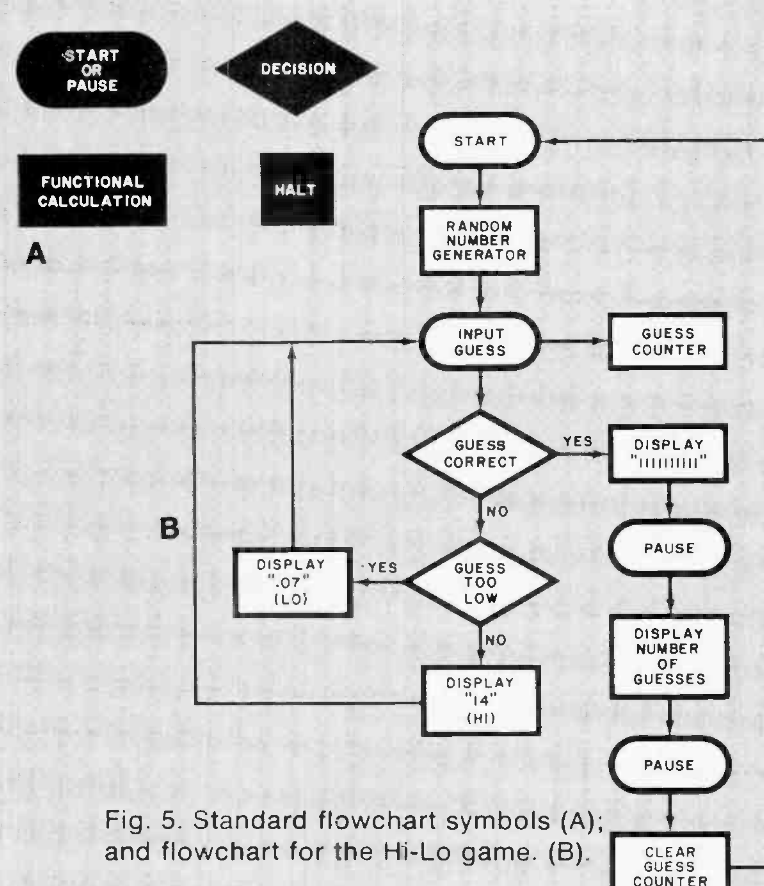


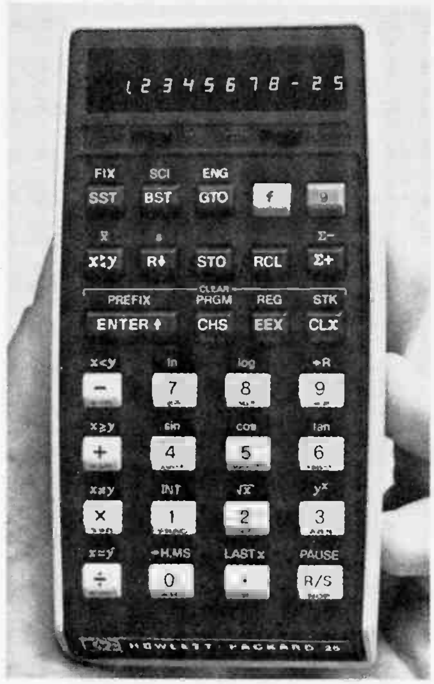
Fig. 5. Standard flowchart symbols (A); and flowchart for the Hi-Lo game. (B).

25 scientific and statistical functions, 10 levels of addressable memory, and nine levels of parentheses. In the programming mode, there are three unconditional and six conditional branches that include four levels of subroutines and two loop control instructions and full editing capability.

Two rather unique features are incorporated in the SR-56. One is an independent test register that permits comparisons with the number in the display at any point in a calculation without interfering with the processing in the progress. The other is a dual-function PAUSE key that allows the display to be on during program execution for 0.5 second or provide for automatic single-step program operation.

Hewlett-Packard Model HP-25. ($195.00). This is the smallest of the handheld programmables on the market. It manages to pack all the common scientific functions, eight conditional comparisons, and a fully editable 49-step program memory into its compact 6-oz (170-g) package. Other features include RPN entry, eight data registers, and a PAUSE key.

Another important feature of the HP-25 is merged key codes. Many of the functions that require several keystrokes are compressed into a single step of program memory, which results in considerable savings in available program memory.



The HP-25 is smallest programmable. Has 49 program steps, 8 conditional comparisons and full editing.

Hewlett-Packard Model HP-55. ($335.00). This RPN calculator has editing capability, two conditional comparisons, a full range of scientific and metric-conversion functions and a novel 100-hour digital clock. The crystal-controlled clock (actually a timer) has an accuracy of ±0.01% and can be used as a storage stopwatch with 0.01-second resolution. Any elapsed time indicated in the display can be stored in a data register for later evaluation simply by pressing one of the 10 digit keys. Another valuable feature of this calculator is its 20 addressable data registers.

•The fully programmable models are in the realm of the most powerful and sophisticated calculators on the market. Only Texas Instruments and Hewlett-Packard are currently supplying this market.

Texas Instruments Model SR-52. ($395.00). Employing algebraic entry, this calculator offers nine levels of parentheses, a 224-step program memory, and 72 labels. According to TI, the calculator has an impressive 20 registers of addressable memory, but it didn't take users long to discover that the main program is also addressable. As long as these registers

and fully programmable calculators often require that a specific number be incremented or decremented by a certain fixed value until a desired result is obtained. One simple way to increment a number by 1 is illustrated by the program in Fig. 2. This routine is useful because it stores the running total in a data register.

Although this program increments by 1 (0,1,2.....n), you can increment by any fixed value of your choice. You can count up (increment), count down (decrement), or multiply, divide, square, or perform any procedure you require.

Squaring Consecutive Integers. Let's suppose you have to make a list of the squares of each integer from 1 to 100. The program in Fig. 3 shows a typical procedure to accomplish this. Just store the maximum number you want squared (100 in our example) in register 1 and press the R/S key. The calculator will automatically display each consecutive square for about a second. (You can increase the length of time the result is displayed simply by adding extra "pause" commands to the program, which may prove useful when you're dealing with numbers that fill the entire display.)

The program will sequence through every number between 1 and 100. After the last square is displayed, the maximum number squared will appear in the display to notify you that the program has been executed.

"Hi-Lo" Game. The three simple programs detailed above illustrate basic programming techniques. Our last program is something fancier—a game that everyone will enjoy playing. To play Hi-Lo, you will need an intermediate or fully programmable calculator. The program in Fig. 4 is written for the HP-25, which means that it will have to be modified to use it in an HP-55, HP-65, SR-56, or SR-52.

After loading the program, the calculator uses a short routine to select a number at random between 0 and 99. You try to guess the number. If your guess is too high or too low, the display reads "HI" or "LO" when inverted. You should be able to *logically* guess the correct number in four to six tries.

To play the game, load the program into your calculator and switch to RUN. Then load the data registers with the following:

R0 Any decimal fraction
R1 (used by the calcultor)
R2 1111111111
R3 .07
R4 14
R5 (used by the calculator)

Note that any remaining registers are not used. After you load the registers, press the R/S key to initiate the game. As soon as "0.00" is displayed, key in your first guess and press the R/S key again. Continue guessing until the display flashes all 1's and the number of guesses you took to hit on the correct number. The calculator then selects a new number to start a new game.

"Mapping" Programs. If you're new to programming, the Hi-Lo game will probably appear totally confusing at first. An easy way to understand the program is to follow it through on a flowchart, a simple "map" that shows the logical flow of the program. The symbols most commonly used on a flowchart are shown in Fig. 5A and the flowchart for the Hi-Lo game in Fig. 5B, shown on the preceding page.

You'll find flowcharts very handy in developing programs of your own. The Hi-Lo program is not optimized; you might want to modify the flowchart to see if you can write the same program with fewer steps. ◈

are not loaded with program steps, they can be used as additional storage registers. This gives the calculator up to 49 data registers when used in a nonprogram mode. (The extra registers are 70 through 99.)

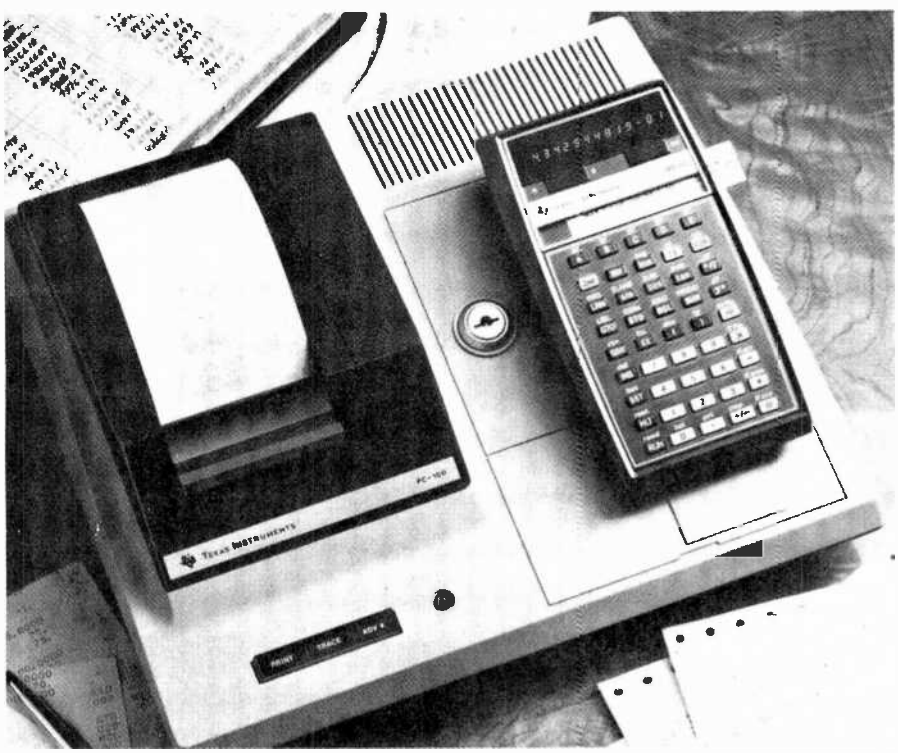
Other significant features of the SR-52 include 10 conditional tests and two levels of subroutines. Another powerful capability is indirect addressing, a sophisticated feature that permits enormous creativity and versatility in programming. For example, an indirect instruction specifies one of the 20 addressable data registers and the program interprets the number in the register as a new program address rather than as data. This may seem a little confusing and even redundant, since there is a much more straightforward way to transfer a program to a new address. However, because the contents of the memory register can easily be modified, a program can dynamically adapt itself to a problem by modifying its own instructions. A logical result of this capability is so-called "artificial intelligence," a cybernetic approach to problem solving and recreational applications.

Incidentally, Texas Instruments' Model PC-100 desktop printer ($295.00) is specifically designed for use with both the SR-56 and SR-52 programmable calculators to supply hard-copy data printouts of instructions and results without halting program execution. The printer uses a 2.5" (6.35-cm) wide thermal tape that allows 20 characters per line. Each character is formed from a 5 × 7 dot matrix. The printer is fully controllable from the calculator keyboard or card program.

Hewlett-Packard Model HP-65. ($795.00) Introduced about two years ago, this calculator is still a highly sophisticated machine. Some of its pioneering features (motor-driven card reader, magnetic program cards, user-defined keys, program storage slot, etc.) are imitated in TI's SR-52 calculator. As with all H-P calculators, the HP-65 features RPN formatting. It has a 100-step program memory, five user-defined keys, and seven conditional tests.

In many ways, the HP-65 and SR-52 are direct competitors and invite comparisons. There is, obviously, a big difference in prices. (Bear in mind that all prices stated in this article are manufacturers' suggested list. Many dealers offer discounts on all types of calculators, including programmables. You can get a better feel for actual market prices by looking through the ads in your local newspaper.)

In some ways, the SR-52 is a more powerful calculator than the HP-65, but a more subtle and equally important advantage of the latter is the availability of extensive software (program library). In addition to selling hundreds of prerecorded program cards packaged in various Application Paks, H-P publishes a listing of thousands of user-contributed programs in its "Catalog of Contributed Programs." The impressive programmability of the SR-52 will no doubt stimulate development of extensive software backing.



TI's PC-100 desktop cradle was designed for use with either the SR-56 or SR-52 calculators.

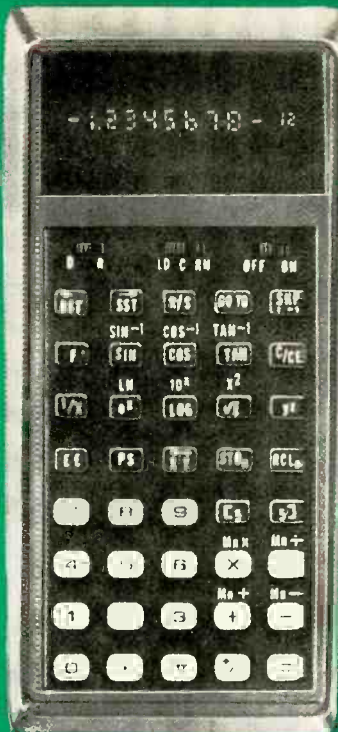
Making a Choice. The only practical advice to follow when considering buying a programmable calculator is to speak to people who own programmables to get their personal-use reactions and visit a dealer to make your own hands-on comparisons. Almost certainly, once you decide on the level of programmability you need, such things as methods of entry, the "feel" of the keys, and display legibility will play important roles in your selection.

As a rough guide, get only as much calculator as you currently need. All calculator prices are dropping, and new models are being added. If you buy a programmable calculator now and "use it up" in six months or a year, you'll find a wider range of prices and models from which to choose when upgrading.

An excellent way to keep up with developments in programmable calculators is to join the HP-65 Users Club. Originally organized for HP-65 owners, the club's monthly newsletter, "HP-65 Notes," contains lots of information on other programmables. For a brochure that describes the club, send a self-addressed stamped business-size envelope (plus a separate 13¢ stamp to cover the cost of printing) to Richard J. Nelson, Editor, HP-65 Notes, 2514 W. Camden Pl., Santa Ana, CA 92704. Include an additional 13¢ stamp for a sample copy of the HP-65 Notes newsletter.

Books are another good source of information on calculators. Four recent ones you might want to get are: *Electronic Calculators* by H. Edward Roberts (Howard W. Sams & Co., Inc.); *Scientific Analysis of the Pocket Calculator* by Jon M. Smith (John Wiley & Sons); *Calculator Dictionary and Users Guide* by Charles J. Sippl (Matrix Publishers); and *Advanced Applications for Pocket Calculators* by Jack Gilbert (Tab Books).

Finally, don't overlook the manufacturers of calculators for in-depth material on the calculators in their respective lines. ◈



NOW YOU CAN BUILD A Scientific Programmable Calculator

A low-cost kit with 72-step storage capacity.

BY MARTIN MEYER

WITH the introduction of programmability, a powerful new dimension has been added to handheld calculators. Now you can build a full scientific, 72-step programmable calculator at low cost.

The programmable calculator presented here features algebraic entry with as many as five levels of parentheses and 10 levels of memory; a 12-digit display (eight-digit mantissa, two-digit exponent, and separate minus-sign displays for mantissa and exponent); a full range of arithmetic and scientific functions; and low-battery indicator. These are supplemented by eight programming functions and storage capacity for 72 steps in the programming section. Power for the calculator is supplied by a 9-volt battery or ac adapter.

More Details. When used as a basic problem solver, without employing the programming section, the calculator operates like most other scientific calculators, except that it is more flexible for complex problem solving as a result of its nested parentheses and 10-level memory register. Single-key commands are provided for such transcendental functions as sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, common and natural logs and anti-logs, and y^x. Convenience functions include $1/x$, x^2, $\sqrt{x}$, degrees/radians select, factor reversal, π, and change sign (+/−). For maximum flexibility, six keys are assigned to the addressable memory section.

The programming keys include: R/S (run/stop), GO TO, SKP (skip), SST (single step), and BST (back step). A separate slide switch provides the run/clear/load (RN/C/LD) functions. All together, these functions provide a very powerful and versatile programming instruction set.

The GO TO key permits direct branching in a program, while the SKP key provides a branch on minus. Hence, programs can make decisions and cause changes in the program sequence. This is a form of conditional branching that is very useful for complex programs where decisions must be made to select a program that leads to the final result.

About the Circuit. Although the actual circuit for the calculator is extremely complex, the schematic diagram, as shown here, is relatively simple. Most of the complexity is contained inside three LSI chips. Calculator array *IC1* contains all the circuits for the arithmetic and scientific functions, while the 10-level memory register is in *IC3*. Key memory array *IC2* provides the programming.

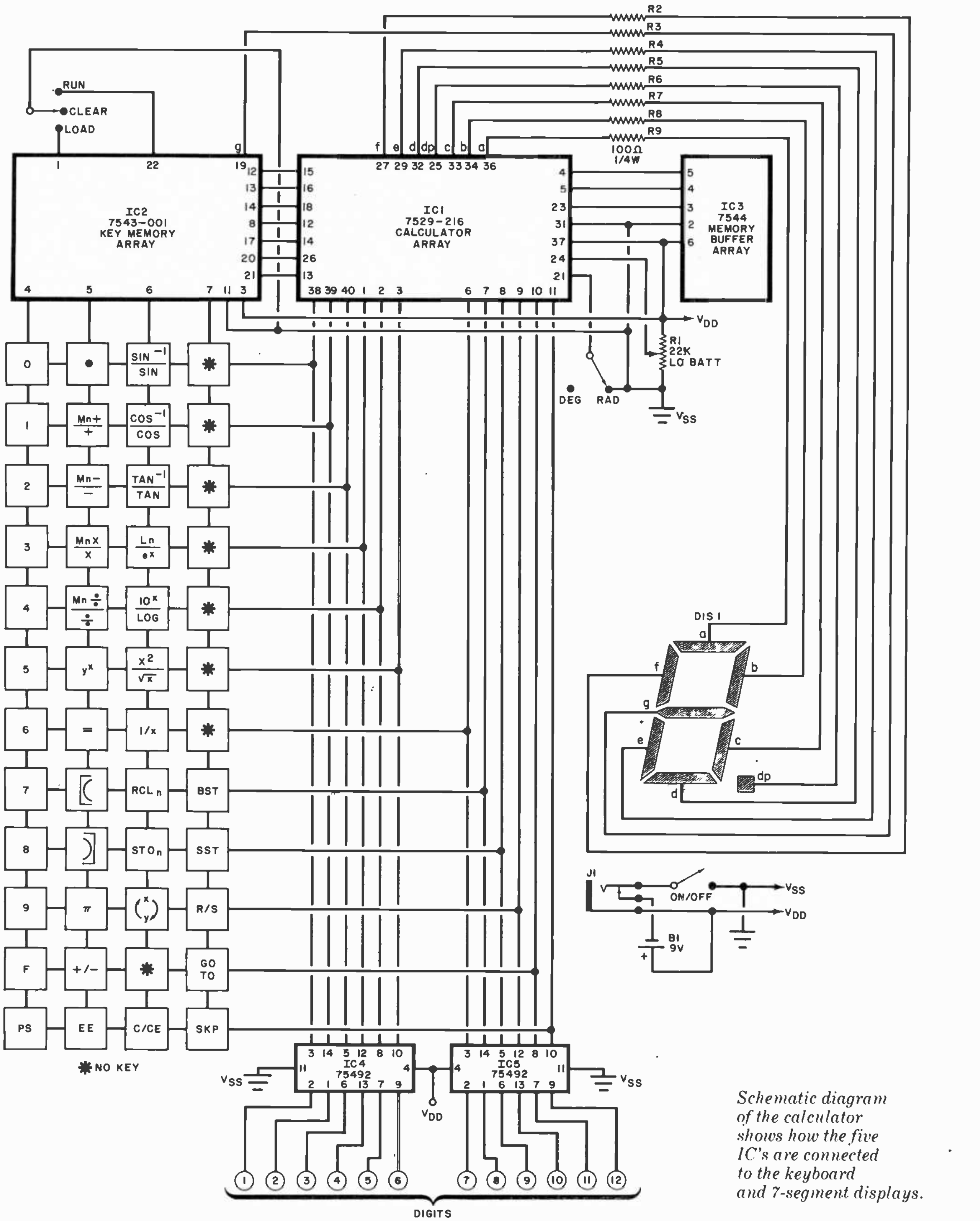
Integrated circuits *IC4* and *IC5* are buffer/drivers for the display-enable lines from *IC1*. The segment-enable outputs from *IC1* and *IC2* go directly to the segments in the display.

The keyboard consists of a 40-key matrix and slide switches for power ON/OFF, degrees/radians (D/R) select, and RN/C/LD select. Ten of the keys in the array are assigned two functions, the second function under the command of a special F (shift) key. For example, the primary function of the SIN key is to provide the sine of a number. By pressing F first, the arcsin (SIN^{-1}) function is provided instead.

There is a choice of three display formats. When no special commands are given, the decimal is fully floating. Scientific notation is obtained by pressing the EE (enter exponent) key. Finally, the decimal location can be fixed in the display by pressing PS (decimal point select) and then the numeral key that corresponds to the desired number of decimal places.

The 10-level memory register is accessed by operating the STO or RCL keys, (depending on whether you want to store a number in memory or recall it) and the numeral key that corresponds to the desired memory location. Memory locations can be accessed in any desired order. For extra versatility, the memory system is backed up by Mn+, Mn−, Mn×, and Mn÷ keys.

Operation. As mentioned earlier, the basic calculator can be operated in much the same manner as most other scientific calculators. However, the best way to describe the operation of the programming feature is to give



Schematic diagram of the calculator shows how the five IC's are connected to the keyboard and 7-segment displays.

PARTS LIST

B1—9-volt battery
DIS1—Miniature seven-segment LED display
IC1—7529-216 calculator array
IC2—7543-001 key memory array
IC3—7544 memory buffer array
IC4, IC5—75492 digit driver
J1—Miniature phone jack for 9-volt dc battery eliminator (optional)
R1—22,000-ohm miniature trimmer potentiometer
R2 through R9—100-ohm, ¼-watt, 10% resistor
Misc.—Keyboard with power, mode, and D/R switches; calculator case with display filter; printed circuit board; hardware; solder; etc.

Note: The following are available from Netronics Research & Development Ltd., Rte. 6, Bethel Meadows, Bethel, CT 06801: complete kit of parts, including calculator case, soft vinyl carrying case, assembly and operating instructions, at $65.00 plus $1.50 postage; optional battery eliminator for ac operation at $4.95; printed circuit board at $6.00; LED display assembly at $19.50; keyboard assembly at $15.00. Connecticut residents, please add state tax.

examples of how the programming works.

First, when programming the calculator, the last three digits of the mantissa and both exponent digits are always active. The mantissa shows the number code assigned to whatever key is pressed. The number codes are different for each key function (e.g. 0 = 100, e^x = 42, GO TO = 93, etc.). The exponent gives the line number (step) in the program. The steps are arranged in numerical order from 00 to 71.

Once you decide on the key sequence to use for your program, set the slide switch to C and press R/S to clear all program memory lines. Then switch to LD in the proper sequence.

As an example, let's key in the program for the hyperbolic sine, which in equation form is: $\sinh(u) = \frac{1}{2}(e^u - e^{-u})$. The key sequence for the sinh program would be.

Enter Key Command	*Display Key Code*	*Line Number*
R/S (enter u)	90	00
STO	55	01
0	100	02
e^x	42	03
–	11	04
RCL	56	05
0	100	06
+/–	62	07
e^x	42	08
×	12	09
.	70	10
5	105	11
=	80	12
GO TO	93	13
0	100	14
0	100	15
R/S (HALT)	90	16

As each keystroke is entered during loading, the line number will increment one step. If you wish to see the actual key codes and line numbers, the entire program should first be entered and then return the program to line 00 after the last entry and single step through the program with the SST key with the slide switch in the LD position. Note that the HALT character at the beginning of the program allows data (in this case, the value of u) to be entered.

To execute the program, set the slide switch to RN and press SKP (or GO TO 00). Enter the value of u and then press R/S twice. The calculator will automatically step through the program and display the solution.

If you wish to alter the program—for example, remove the HALT from line 00—perform the following sequence. First, switch to RN and press GO TO. Switch back to C and press SST. Switch to RN and press GO TO 13. Then switch to LD and press R/S to put a HALT in line 13. Finally, switch to C and press SST twice to remove the GO TO numbers. The program can now be executed with the only change being that it will halt at line 13 instead of returning to line 00.

More conditional branching statements can be obtained by using the SKIP function. SKIP is defined as $x < 0$ (negative), where x (and y) is the variable being tested. The following sample sequence illustrates the basic SKIP function:

Key	*Line*
R/S (enter data)	22
LOG	23
SKP	24
GO TO	25
4	26
0	27
SIN	28
TAN	29

If the result at line 23 is a positive number, the next statement (GO TO 40) will be executed. If the result at line 23 is negative, the program will skip the GO TO 40 statement (lines 25, 26 and 27) and execute the following statement (SIN) next and thereafter continue the program in sequence.

In the following program, using the SKIP function, the program will solve the equation $x - 3 =$. After each solution, the value of x will be decremented by 1 until x becomes less than 3, at which time the result of $x - 3$ = will be negative. An incrementing counter counts the number of times the equation is solved to the point where the result is negative ($x < 3$). When the negative result is obtained, the SKIP function branches to display the number of times the equation was solved and then stops.

Enter	*Key Code*	*Line*
R/S (enter x)	90	00
STO	55	01
0	100	02
0	100	03
STO	55	04
1	101	05
RCL	56	06
0	100	07
–	11	08
3	103	09
=	80	10
SKP	96	11
GO TO	93	12
2	102	13
0	100	14
RCL	56	15
1	101	16
R/S	90	17
1	101	18
F, Mn+	50	19
1	101	20
1	101	21
F, Mn–	51	22
0	100	23
GO TO	93	24
0	100	25
6	106	26

If x = 5, the program will loop three times. Lines 00 through 10 compute the formula, 11 to 15 provide the SKIP and branching functions, 18 to 20 provide the incrementing counting, and 21 to 23 decrement x.

In our final example of programming, we'll use the quadratic equation $x^2 + 3x + 2 = 0$ to solve for x_1 and x_2, where the roots are: $x_1 = (-b + \sqrt{b^2 - 4ac})/2a$ and $x_2 = (-b - \sqrt{b^2 - 4ac})/2a$. First enter the program for x_1 as follows:

Enter	*Line*	*Enter*	*Line*
R/S (enter a)	00	4	19
STO	01	×	20
0	02	RCL	21
R/S (enter b)	03	0	22
STO	04	×	23
1	05	RCL	24
R/S (enter c)	06	2	25
STO	07	)]	26
2	08	)]	27
RCL	09	$\sqrt{x}$	28
1	10	÷	29
+/–	11	2	30
+	12	×	31
[(	13	RCL	32
RCL	14	0	33
1	15	=	34
F, x^2	16	GO TO	35
–	17	0	36
[(	18	0	37

As written, the program will solve for x_1. To make it solve for x_2, you must change line 12 to a –. Using the above program for a = 1, b = 2, and c = 3, x_1 will be –1 and x_2 will be –2. You can verify these results by plugging them into the quadratic equation. In both cases, the answer will be 0.

The one way to become proficient at using a programmable calculator is to practice. Practice entering and executing programs and practice writing your own programs. In just a short time, you will find that using this calculator is as simple as using a nonprogrammable calculator. ◈

COLLECTING SHORTWAVE FOLK MUSIC

A fascinating and rewarding hobby for SWL's.

BY C. M. STANBURY, II

Above is souvenir pennant from Radio Clarin. The station features every kind of Latin American music and is easily heard throughout daylight hours on 11.700 MHz.

THE high-frequency broadcast bands are literally alive with music of every nationality. Aside from just listening to broadcasts of the music, a fascinating hobby is to make tape recordings of it, forming a collection for future listening pleasure and study of various trends in how folk music develops. While the reception on most shortwave receivers is not exactly high-fidelity, it is acceptable for the simple rhythms and harmonic structures of folk music. All you need to know is which stations and frequencies are best and have the patience to wait for a signal free of interference. Then you add a tape recorder and start your collection.

Folk music on shortwave is particularly interesting because you will hear two types. One includes pure, more-or-less traditional melodies indigenous to the country or area from which you are receiving them (such as music dating back to the Incas from stations in western South America). The other is that same music altered by recent cultural changes (such as the Latin American rock featured by the Venezuelan station, Radio Juventud, on 4.900 MHz). The cultural changes are similar to those that have produced folk rock and modern country and western from pure American folk music.

Equipment. One thing you should have if you want to make a collection of folk music is a phone jack on your shortwave receiver so that your tape recorder can be connected directly to the receiver. It is possible, of course, to record by placing a microphone in front of the receiver's speaker, but this adds ambient noise. If your shortwave receiver's phone jack automatically cuts off the receiver's speaker, the recorder should have its own monitoring facilities so that you can determine when a desired selection is finished or if the signal quality has dropped below an acceptable level.

There are two qualities of receivers that are of major importance. One is good image rejection. There is nothing so frustrating as finding a wanted signal on a clear frequency, only to have reception spoiled by interference produced within the receiver itself. For example, during the period around noon, Radio Iran often has traditional Persian music, with a strong, clear signal on 15.084 MHz. This is just below the 19-meter band and is thus usually free of interference (QRM). But if your receiver has poor image rejection, it may pick up radioteletype or other noise from 15.994 MHz.

Second, as most of your taping will be done within the interference-clogged SWBC bands themselves, the more selective your receiver, the better. As a general rule, two signals of equal strength, separated in frequency by 5 kHz, should not interfere with each other.

The Stations. To list every station which might conceivably broadcast a recordable selection of interest would require at least a small book. However, you'll probably be particularly interested in relays of home services which, for one reason or another, put strong signals into North America. This simplifies the task of listing stations.

However, it may just be a matter of time until all home-service relays from less-developed countries are forced off the major high-frequency bands by more powerful international relay networks. This makes a regional or "tropical," band such as 60 meters very important. Here, Radio Senegal is on 4.890 and Abidjan on 4.940 MHz, and sometimes, in the late afternoon, they put good signals into eastern North America. Another 60-meter African opening occurs periodically between 2200 and 0100 EST (1900-2200 PST). However, by this time of day, a myriad of Latin American stations will also have appeared on the band. Other promising African tropical-band outlets, as well as a few home service relays on the international bands, are listed in Table I.

In the second major tropical area, Latin America, every nation in Central and South America has its own particular variety of music. Unlike African music, however, almost all Latin American music was drastically altered many years ago by highly sophisticated European influences—mostly Spanish. You can hear and record this for yourself by tuning in Radio Clarin (Santo Domingo, Dominican Republic) during daylight hours on 11.700 MHz. Here again, we have a home service relay on an international band—or at least at the edge of a busy global band. Radio Clarin, which also can be received with strong, all-night signals on 4.850 MHz, often features music from every part of the Americas.

There is one part of the Americas where a good deal of pre-Columbian music remains intact. This includes the strip of the Andes that runs from Ecuador through Peru and into Bolivia. Surprisingly, one of the clearest signals, on occasion, is that of Radio Zaracay (Ecuador) on 3.390 MHz, in the 90-meter tropical band. The well-known missionary station HCJB also features some of this music on its various Spanish-language frequencies (such as 11.890 MHz).

Finally, to conclude this brief survey, we turn to Asia where one of the most interesting transmissions is Sri Lanka Broadcasting Corporation's All Asia Service on 11.800 MHz. It features the traditional music of the Indian subcontinent—with sitars, ragas, etc.—which influenced the Beatles and other rock groups in the 1960's. Sri Lanka is best heard before noon EST. Stations providing other music of the Far East, Near East, and Arab states of North Africa are listed in Table I.

International Rock. We have noted the influence of South Asian music on modern rock. In that case, the process was strictly one way, but there are other instances where rock has had a considerable influence on folk music.

The easiest way to hear this is by tuning to stations in Latin America, such as Radio Juventud. Peruvian stations, in particular, should be carefully monitored to find this mix of folk and rock. See Table II. Interestingly, Simon and Garfunkle's "El Condor Passe" ("I'd Rather Be a Hammer Than a Nail") was Peruvian inspired.

In Africa, local radio has played indigenous melodies alongside rock for many years, especially in such relatively sophisticated west Africa cities as Dakar (Senegal) and Lago (Nigeria). So, the stage is set in Africa for the emergence of a new "folk-rock" mixture. ◈

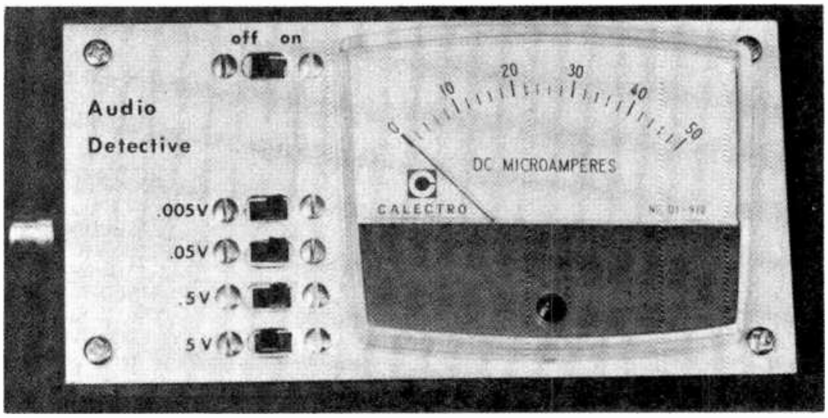
TABLE 1—FOLK-MUSIC STATIONS

Frequency (MHz)	Station
3.390	Radio Zaracay (Ecuador)
4.890	Radio Senegal
4.900	Radio Juventud (Venezuela) (Good for Latin American rock.)
4.910	Conakry, Republic of Guinea
4.920	Radio Porgreso (Honduras) (Good for Latin American rock.)
4.940	Abidjan, Ivory Coast
4.990	Nigeria Broadcasting Corp.
5.041	Radio Bissau (Guinea-Bissau)
5.047	Lome, Togo
6.195	Nigerian Broadcasting Corp. (Local station at Sokoto.)
6.205	Radio Nova International (Tentative Italian ID. Might instead operate from African waters.)
6.250	Radio Malabo (Equatorial Guinea)
9.022	Radio Iran
9.510	Radio Barquisimeto (Venezuela)
11.700	Radio Clarin (Dominican Rep.) (Plays all types of Latin American music.)
11.800	Sri Lanka Broadcasting Corp.
11.890	HCJB (Ecuador)
11.895	Radio Senegal
11.920	Abidjan, Ivory Coast
12.005	U.A.R. Broadcasting Service
15.084	Radio Iran
15.190	Brazaville, Congo
15.245	La Voix du Zaire (Also reported irregularly on 15.350.)
15.275	Voice of Malaysia

TABLE II—PERU: FOLK AND INTERNATIONAL ROCK MUSIC STATIONS

Frequency (MHz)	Station
3.240	Radio America
4.760	Radio Tingo Maria
4.780	Radio Atlantida
4.815	Radio Sameren
4.840	Radio Andahuaylas
4.845	Radio Sulana
4.935	Radio Tropical
4.995	Radio Andina
5.010	Radio Eco
6.045	Radio Santa Rosa
6.115	Radio Union
9.532	Radio Nacional
9.562	Radio Nacional

All stations normally heard only at night. More interference east of the Mississippi than in western U.S.



BUILD THE AUDIO DETECTIVE

Here's a sensitive troubleshooting meter for phono cartridges, microphones, and PA systems

BY RALPH TENNY

THE Audio Detective is a sensitive ac voltmeter which will prove to be especially useful in troubleshooting an audio system. On its lowest range (5 mV), it can be used to test microphones and many phono cartridges. It will also measure potentials up to 5 volts (50 volts, if a simple modification is made). The response of the meter is flat within 5% from 15 Hz to 20 kHz.

The instrument is battery-powered (1 mA current drain) and is conveniently small for portable use. A phono plug is used for the input and input resistance is 100,000 ohms.

Circuit Operation. The circuit made up of transistor *Q1*, *R19*, *C7*, and *D8* is a regulated power supply which provides 14 volts for *IC1* (Fig. 1). Due to the presence of *C7*, the supply turns on slowly to prevent capacitor charging currents on *C2*, *C3*, and *C4* from damaging the meter. Diode *D7* protects the circuit from an accidental reversal of battery polarity.

The network consisting of *R1*, *R2*, and *R3* sets the quiescent operating level of 7 volts at the output of *IC1A*. The dc interstage coupling through *R4*, *R7*, and *R10* maintains this voltage at the outputs of the three following stages. The high input impedance at the noninverting (+) input of *IC1A* prevents loading of the input attenuator. Diodes *D5* and *D6*, in conjunction with *R18*, are used to protect *IC1* from excessively high input voltages, which might damage it.

Sections B and C of *IC1* amplify the audio signal from section A with stage gains determined by the ratios of *R5* to *R6* and *R8* to *R9*. Capacitors *C2* and *C3* couple the ac currents to the common bus so that the ac output of each stage swings about the 7-volt dc operating level.

Section D of *IC1* is a precision rectifier and meter driver. The parallel combination of *R11* and *R13* establishes the gain of the stage. Varying the value of *R13* calibrates the meter so that the meter current is 50 microamperes (full scale) when 5 mV is applied to the (+) input of *IC1A*. Resistor *R12* and the combination of *C5* and *C6* shunt *R11* at the higher audio frequencies to adjust the frequency response near 20 kHz.

Construction. Circuit layout is not critical so perforated board and mounting clips or a printed circuit board can be used. It is advisable to use a socket for *IC1* to avoid possible heat damage during soldering.

Because of the low signal levels required by the measuring circuit, a single common bus is used. Tie all the circuit ground points to this bus and connect the bus to the case at only one point—preferably at the ground lug of *J1*. If *J1* is mounted on a metal panel, make no other connections to the metal portion.

Whatever the layout and case, the checkout of the circuit will be easier if one section is wired and tested before going to the next. Start with section D of the IC and the meter circuit. Since charging currents in *C2*, *C3*, and *C4* will cause current surges in the meter, the operating voltage must be applied slowly to avoid any possibility of meter damage. The test circuit shown in Fig. 2A is used to do this. The dc operating power can be a battery or power supply between 12 and 15 volts dc. Be sure the potentiometer is at the zero position before turning on the power. The signal generator should be capable of delivering a low-distortion, 1-kHz sine wave which can be set to zero output.

When wiring this first section, connect *R10* temporarily to point A of the test circuit. Turn on the power and slowly adjust the test circuit potentiometer to bring the voltage to between 12 and 15. As the voltage is increased, the meter action will be erratic and move upscale. When the power is fully on, the meter should settle back to zero.

Turn up the audio generator connected to the test circuit. As the generator output is increased, the meter will reach full scale when the generator is delivering 0.3 volts rms. Once this section is working properly, reduce the test circuit voltage and audio generator output to zero and remove the connection to *R10*.

PARTS LIST

B1, B2—9-volt battery
C1—0.1-µF, 50-V ceramic capacitor
C2,C3—100-µF, 25-V electrolytic capacitor
C4—22-µF, 25-V electrolytic capacitor
C5—100-pF capacitor
C6—47-pF capacitor (see text)
C7—47-µF, 25-V electrolytic capacitor
C8—225-µF, 25-V electrolytic capacitor
D1 to D7—1N4148 diode
D8—15-V zener diode (HEP Z0225)
IC1—Integrated circuit (National LM324)
J1—Standard phono jack (RCA)
M1—0-50-µA meter (Calectro DI-910 or similar)
Q1—2N5449 or T1S98 transistor
Following resistors are ¼-W:
R1, R2—47,000 ohms
R3—1.2 megohms
R4, R7, R10—1000 ohms
R5, R8, R18—10,000 ohms
R6, R9—1500 ohms
R11, R12—5600 ohms
R13, R19—(see text)
R14—91,000 ohms (see text)
R15—9100 ohms (see text)
R16—910 ohms (see text)
R17—100 ohms (see text)
S1 to S5—Spdt switch
Misc.—Suitable chassis (Calectro H4-722), battery holder, mounting hardware, etc.

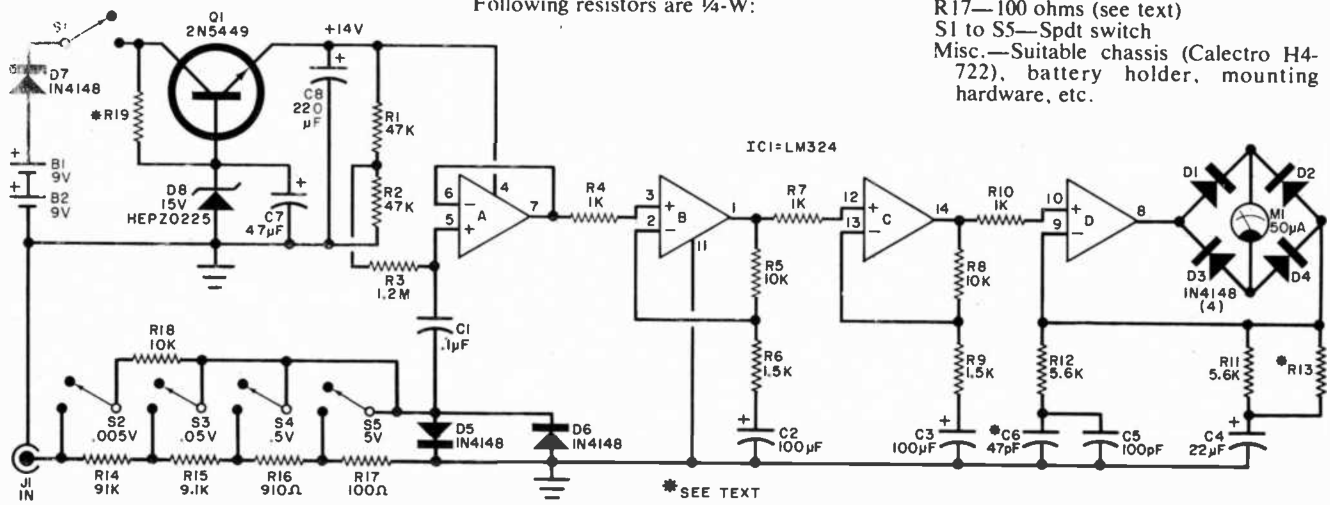


Fig. 1. The first three op amps in IC1 form a sensitive ac amplifier and the fourth drives the meter.

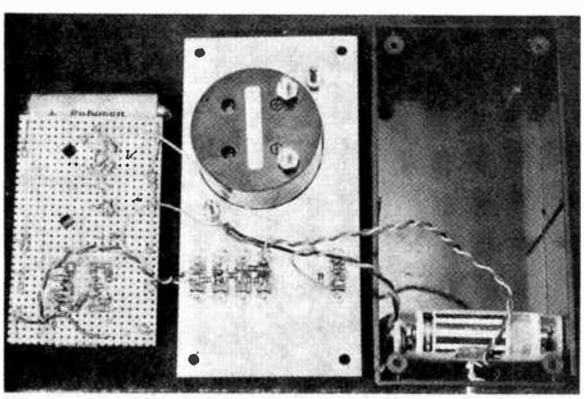
Now wire up the rest of the circuit (sections, A, B, and C of *IC1*). Perform the above test again and note that the inputs to sections A and B are 5 mV rms for a full-scale meter indication.

Assemble the power supply portion, using 150,000 ohms for *R19*. The time constant for *R19* and *C7* determines how fast the operating power comes up. Select the value of *R19* so that the circuit comes into full operation without violently "pegging" the meter. On the prototype, the meter settled back to zero about seven seconds after power was turned on.

Complete the assembly, wiring up the input attenuator. The resistors used in the attenuator can be conventional 5% types or they can be selected with a resistance bridge to be as close to the stated values as possible. The more accurate the resistor value, the better the meter readings.

Turn on the power and apply an audio signal of about 5 mV rms at 1 kHz to *J1* to get a full-scale reading on the meter. When the next higher scale is switched in, the meter should indicate about 1/10 of full scale. Bring the meter to full scale by adjusting the audio source. Switch to the next higher scale (0.5 V) and note that the meter goes down to 1/10 of full scale. Repeat the adjustment and check the next range.

Either a laboratory calibration standard or a dc-coupled scope can be used for final calibration and frequency-response checking. If a scope is used, start with the calibration. Use a new flashlight battery (1.55 volts). Set the scope to 0.2 volts per division, and connect the battery to the scope vertical input. Adjust the scope vertical gain until the trace is 7¾ divisions from its zero position. If



View of interior of the Audio Detective as assembled in the author's prototype.

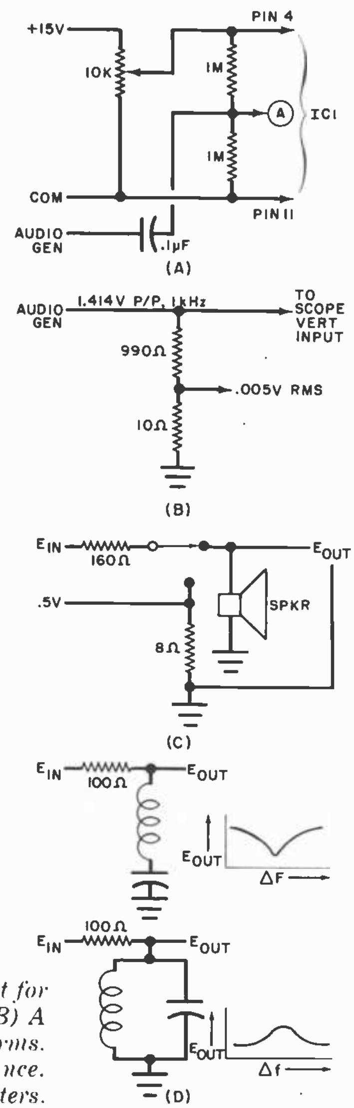


Fig. 2. (A) Test circuit for stage-by-stage checkout. (B) A source of 0.005-volt rms. (C) Measuring speaker impedance. (D) How to check filters.

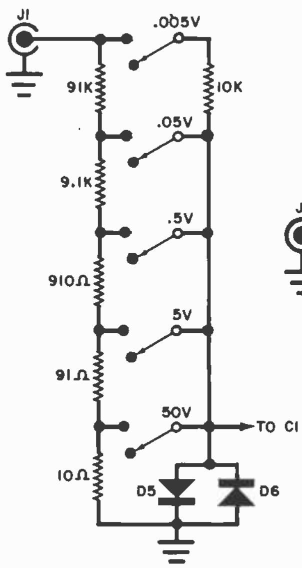
the scope has a different vertical range, use a range that produces a nearly full-scale deflection.

Carefully select the two resistance values shown in Fig. 2B and apply 1.414 volts peak-to-peak at 1 kHz as shown. Connect the 0.005-volt rms output of this voltage divider to *J1* of the Audio Detective, with the attenuator set for 0.005 V.

Select a value for *R13* that will give a full-scale meter indication. Keeping the output of the audio generator at this constant level, reduce the frequency until the meter indicates 0.0047 volt. The generator frequency should be lower than 20 Hz. If a slower roll-off is desired, increase the value of *C1*. In this way, it is possible to bring the flat response down to 10 Hz. If a lower frequency is required, it is necessary to increase the values of *C2*, *C3*, *C4*, and *C7*, and lower the value of *R19*.

With the output of the audio generator held at 1.414 V peak-to-peak, increase the generator frequency to 20 kHz. If the meter indicates too low a value, the high-frequency response must be adjusted. This is done by adding more capacitance across *C6*. Be careful not to add too much compensation, which will result in a "hump" near the 20-kHz point.

Like all ac voltmeters, the Audio Detective will respond to almost any waveform. However, it is calibrated for a sine wave and other waveforms will produce erroneous meter readings. For example, a 9-volt peak-to-peak sine wave will read 3.2 V on the Audio Detective. A 9-volt square wave would show up as 5 volts. However, as long as the waveform remains the same, relative measurements of nonsinusoidal waveforms can be made.



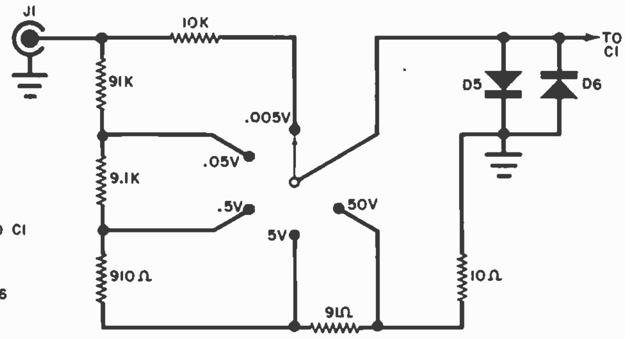


Fig. 3. To add a 50-volt range to the Audio Detective use either a rotary or discrete switches as shown here. Note the changes in the bottom two resistors as compared to Fig. 1.

Uses. The Audio Detective can be used to troubleshoot a PA system. Plug the microphone to be used into *J1* (with the correct adapter) and speak into the mike. A dynamic mike should have an output of about 1 mV, and a condenser (electret) mike should generate between 4 and 5 mV. The Audio Detective can then be connected to the mixer output to test that stage. The procedure is continued through the audio system to the speaker outputs. The signal level will get progressively higher. At the speaker outputs, five volts on an eight-ohm line indicates just over three watts.

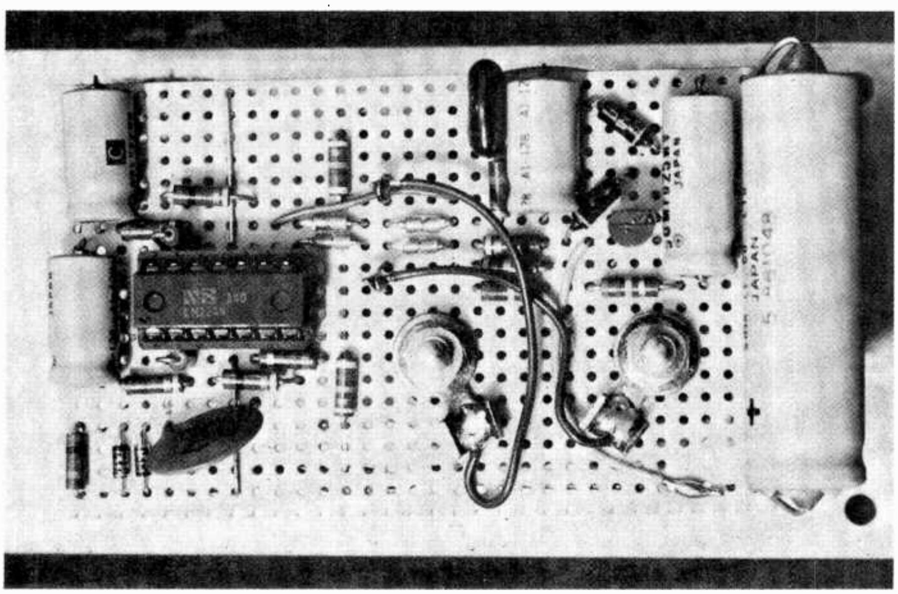
To determine the gain of an amplifier, use the Audio Detective to measure the input and output voltages. The gain is simply the output voltage divided by the input.

To test the frequency response of a tape recorder, apply a 1-kHz tone to the recorder's auxiliary input and select a level that gives a comfortable playback volume with the volume control set at midrange. Record several different frequencies at this same level. Terminate the external speaker output with an 8-ohm resistor and monitor the voltage generated across the resistor at each frequency. (For component tape decks, monitor the line output unterminated.) Plot the output voltage as a function of frequency.

To determine speaker impedance, use the circuit shown in Fig. 2C. Select E_{in} so that 0.5 volt is generated across the 8-ohm resistor. Switch to the speaker and measure E_{out}. The speaker impedance at that frequency is $(Z_{out}/0.5) \times 8$. For example, if Z_{out} is 0.45 volt, the speaker impedance is $(0.45/0.5) \times 8$ or 7.2 ohms.

You can check the frequency response of a filter by using the circuit in Fig. 2D. Holding the input constant, vary the frequency and plot E_{out} as a function of frequency. Figure 2D also shows typical response curves for both series and parallel resonant circuits.

Modifications. The schematic in Fig. 1 shows the input attenuator spanning four ranges from 0.005 to 5 volts. If you want to extend the upper limit, use the attenuator shown in Fig. 3. Two versions are shown—one using five slide switches and one using a rotary switch. Either will extend the range to 50 volts. ◈



Components assembled on the perforated board.

BY ROBERT W. LLOYD

SEVERE WEATHER WARNING ALERTER

Low-cost add-on to weather receiver sounds the alarm if a weather "alert" is broadcast

TORNADOES, hurricanes, and other severe weather disturbances often strike in the middle of the night or at times when most people are not normally listening to the radio or watching TV. Consequently, they receive no advance warning and are unaware of the impending danger.

Residents of areas where disturbances often occur have taken to listening to transmissions from the National Weather Service stations operating on 162.40 or 162.55 MHz in most parts of the country. The receivers used for this purpose generally range from low-cost battery-powered units to vhf/FM scanners. There are also some expensive receivers with special circuitry to alert police stations, etc., to a forthcoming severe-weather announcement by the NWS.

The under-$15 circuit described here will enable you to duplicate the special alert provisions of the costlier NWS receivers. It decodes the 1050-Hz warning tone used for the alert (when it occurs) and automatically activates the normally quiet receiver. This puts your low-cost unit in the same class as the professional weather warning systems.

Circuit Operation. The circuit (Fig. 1) is essentially a controller for relay *K1*, whose normally open contacts are between the receiver audio output transformer (secondary) and the loudspeaker. Thus the speaker is normally disconnected and resistor *R1* provides a substitute load. Capacitor *C1* is used to isolate diodes *D1* and *D2*, which provide signal clipping to prevent overdrive of *IC1*. Capacitor *C2* isolates the diode clip-

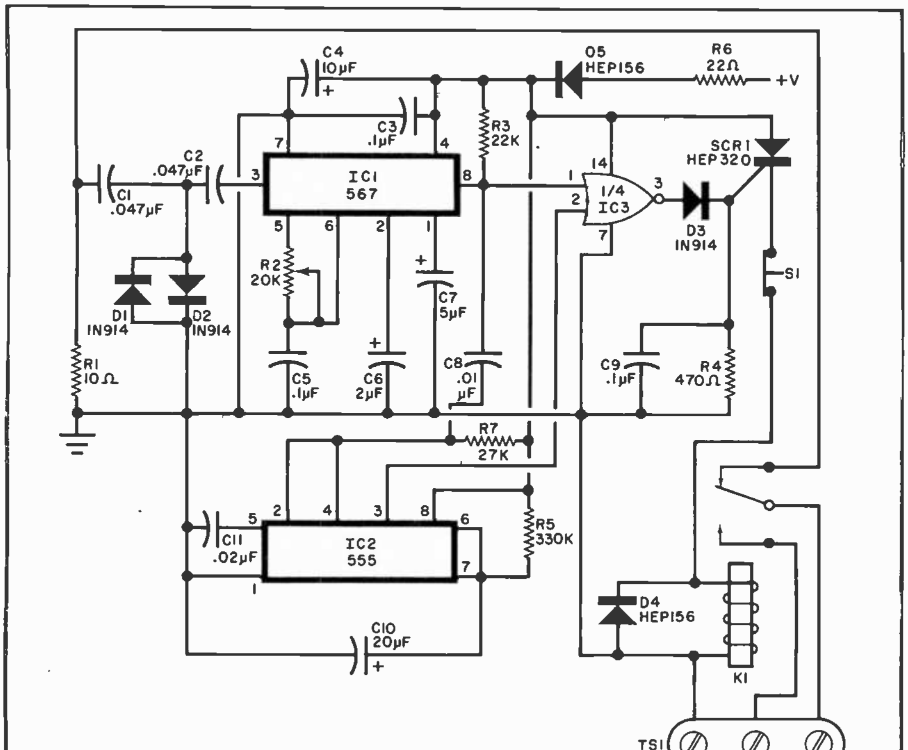


Fig. 1. When IC1 receives the alert and IC2 times out, the SCR turns on the speaker.

PARTS LIST

C1, C2—0.047-μF Mylar capacitor
C3,C9—0.1-μF disc capacitor
C4—10-μF, 15-V electrolytic capacitor
C5—0.1μF Mylar capacitor
C6—2-μF, 15-V electrolytic capacitor
C7—5-μF, 15-V electrolytic capacitor
C8—0.01-μF disc capacitor
C10—20-μF, 15-V electrolytic capacitor
C11—0.02-μF disc capacitor
D1,D2,D3—1N914 diode
D4,D5—HEP156 rectifier diode
IC1—567 phase-locked loop
IC2—555 timer
IC3—4001 CMOS
K1—6-12-V, 500-ohm coil, spdt relay (Radio Shack 275-004 or similar)
R1—10-ohm, 5-W resistor
R2—20,000-ohm trimmer potentiometer
R3—22,000-ohm, ½-W resistor
R4—470-ohm, ½-W resistor
R5—330,000-ohm, ½-W resistor
R6—22-ohm, 1-W resistor
R7—27,000-ohm, ½-W resistor
S1—Normally closed pushbutton switch
TS1—Three-connector terminal strip
Misc.—Suitable enclosure, power supply (see text), mounting hardware, IC sockets, etc.

per from *IC1*, since any dc component at the input to *IC1* could cause false decoding.

Trimmer potentiometer *R2*, in conjunction with *C5*, determines the decoding frequency (1050 Hz) while *C6* determines the bandwidth and *C7* sets the decoder timing. When not decoding, the output of *IC1* (pin 8) is high. When *IC1* receives a tone within its locking range, the output drops low. This output is applied to one input of a gate in *IC3*. The output is also coupled through *C8* to trigger *IC2*, a 555 timer.

The timer is required because false alarms can be produced by random receiver noise or voice announcements which occasionally are at 1050 Hz. Since the signals producing false alarms are usually of short duration, but the real alert tone is transmitted for at least 15 seconds, some form of timing circuit is needed.

The output of *IC1* is connected to pins 2 and 4 of *IC2*. When a pulse appears, *IC2* resets and starts its timing cycle. Resistor *R5* and capacitor *C10* set the length of the cycle (about 10 seconds). When *IC2* times out, its output (pin 3) goes low and is applied to the input of *IC3*. When (and only when) the two inputs of *IC3* are both low, its output goes high.

As long as the 1050-Hz tone is not present at the input of *IC1*, the circuit idles, with *SCR1* not conducting and the relay deenergized. When the 1050-Hz signal is received from NWS, the output of *IC1* goes low and *IC2* starts timing. At the end of the timing cycle, the output of *IC3* goes high and *SCR1* starts to conduct through the relay coil. Then the loudspeaker is connected to the receiver's audio output and the weather bulletin is heard. Diode *D4* reduces the back emf generated across the coil and *D5* prevents damage due to application of reverse power supply. Pushbutton switch *S1* is used to reset the decoder and turn off the speaker.

Construction. Parts placement is not critical and the circuit can be assembled on perforated board or a pc board. Sockets for the IC's are suggested. Do not install the IC's before reading the following instructions on tuning. Any enclosure of suitable size can be used.

The circuit operates from a 6-12 volt dc supply. In the nondecoding state, the current requirement is about 12 mA at 6 V. If your receiver power supply is in this voltage range, uses a negative ground, and can tolerate the current drain, you can power the alarm circuit from this source. If you have a battery-operated receiver, build a low-power dc supply between 6 and 12 volts.

If you have a transformer-operated, tube-type receiver, consider picking off the 6.3-volt filament supply (if one side is grounded) and using a silicon rectifier diode and a filter capacitor (about 1000 μF).

Testing. Start with the IC's out and the circuit not connected to the receiver.

Install *IC1* in its socket and connect a dc voltmeter between pin 8 and ground (positive side to pin 8). Turn on the dc power and note that the voltmeter indicates close to the supply voltage. Connect an audio signal generator ground to the circuit ground and the hot side to the TRANS terminal on *TS1*. With the relay deenergized, you should now have a signal on the input of *IC1*.

Set the signal generator as close as possible to 1050 Hz. Adjust *R2* until the voltmeter reading drops to near zero, indicating that *IC1* is decoding. Remove the signal generator, and the voltmeter should go back to the supply voltage reading. Perform this step several times to make sure that *IC1* is operating with each application of 1050 Hz. Turn off the audio generator and the dc power.

Remove IC1 from its socket and install *IC2* in its socket. Connect the dc voltmeter between pin 3 of *IC2* and ground. Turn on the dc power. Connect a jumper to circuit ground and touch the other end to pin 2 of *IC2*. Note that the voltmeter reading is the supply voltage. After about 10 seconds, the voltmeter should drop back to near zero, indicating that *IC2* has

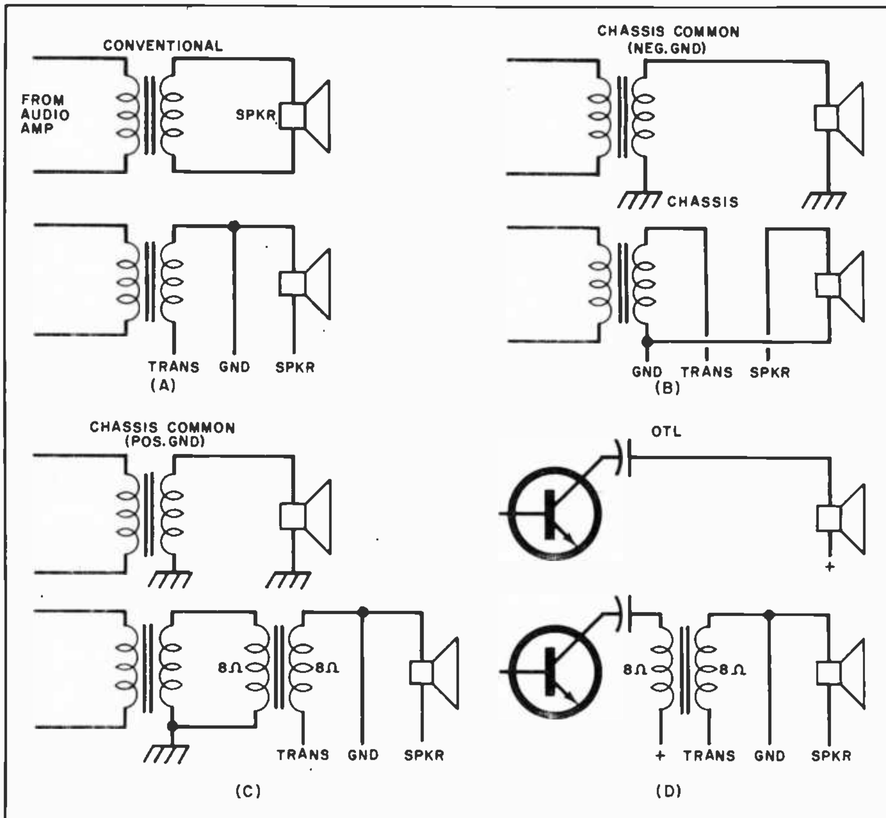


Fig. 2. Typical connections to the weather receiver speaker.

timed out. If the timing is too short, increase the value of *R5*. Conversely, if it is too long, reduce the value of *R5*. Check the timing cycle several times to make sure it is in a range of 7 to 14 seconds. Turn off the power supply and remove the jumper.

Remove *IC2* from its socket, and install *IC3* in its socket. Connect one end of a jumper to circuit ground and the other end to pins 1 and 2 of *IC3* simultaneously. Relay *K1* should close and lock in. Remove the jumper, depress *S1*, and note that the relay opens. Repeat this operation, ending with the relay closed. Remove the jumper, and connect it between the supply and either pin 1 or 2 of *IC3*. Depress *S1* and note that the relay opens and remains open after the switch is released. Remove the jumper and the dc supply.

Once all tests have been made, install all of the IC's. Apply the dc supply and put the 1050-Hz signal from the audio generator on the input. After *IC2* has timed out, the relay should close. Remove the signal input, depress *S1*, and the relay should open and remain open. The circuit is now ready for installation.

Installation. Connections to the weather receiver will vary depending on the receiver. Some typical connections are shown in Fig. 2. Note that a 1:1 8-ohm transformer is used for isolation in case the chassis of the receiver is used as the positive side of the supply (especially if you use the receiver power supply for the alerting circuit). The isolation transformer is also used in case the circuit is OTL.

If the receiver is used for other than weather reception, install a switch across the SPKR and TRANS terminals on *TS1*. Then be sure the switch is open to use the alerting circuit.

Operation. Turn on the weather radio. Tune it to your local NWS station and allow it to warm up so that it doesn't drift (assuming it doesn't have afc). Depress *S1* and you are ready to receive an alert warning. Since the speaker is now silent, you can turn up the volume to make sure that, if the alarm comes during the night, the sound will be sufficient to awaken you.

If you leave the receiver and the alerting circuit on 24 hours a day, it will be triggered between 10 and 11 a.m. each weekday when the NWS test signal is transmitted.

When a severe weather alert is broadcast, it is repeated every 10 minutes until the alert is over. This means the alarm will sound each time until you shut down the system. ◈

ELECTRICAL GROUNDS FOR ELECTRONIC EQUIPMENT

Your high-frequency gear will work better when you use good grounding techniques.

BY HECTOR FRENCH

ESTABLISHING a good low-resistance earth ground can solve many of the problems commonly encountered with high-frequency (particularly radio communication) equipment. For example, proper grounding can solve the problems of low sensitivity (assuming the equipment has a high sensitivity to begin with), harmonic generation, cross-modulation effects, and detection of unwanted signals.

As a general rule, an all-metal cold-water plumbing system is often the best access you have to a true, low-resistance earth ground in any given location. (Don't count on the "ground" conductor in a three-wire electrical system as being at earth ground. As often as not, the "ground" conductor is really nothing more than the "common" bus for the system.)

In this article, we will discuss how to make a good electrical/mechanical connection to an existing and accessible earth ground, the procedure to use to establish a good earth ground where a cold-water pipe isn't available, and how to deal with the problems you might encounter.

Making Ground Connections. Many earth-ground systems are poor due to the connections made to them. Unless a ground connection is made electrically (and mechanically) sound, it can exhibit resistance, capacitance, and rectification, as illustrated in Fig. 1. This kind of ground often is the result of a dirty connection, whose characteristics change with time, temperature, and humidity. The rectifier is the result of dirt or rust that weren't cleaned away before the connection was made.

The rectifier is almost certain to be the cause of trouble. It can be the cause of harmonics, cross-modulation effects, and detection of unwanted signals. A typical example of such a problem is on a stereo FM tuner where interference occurs between two different local stations. If the interfering station appears at several locations on the dial, the ground rectifier is likely generating harmonics. If the interference is an all-the-time problem across the entire dial, the rectifier could be detecting the local signal and passing it directly into the tuner's or receiver's audio section.

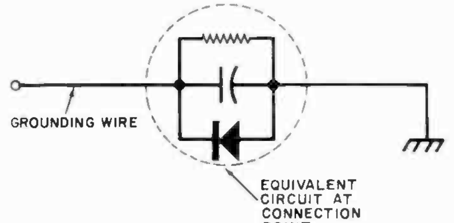


Fig. 1. Equivalent circuit of a poor ground connection, which can cause numerous problems.

The cure for a poor connection to ground is relatively simple. First, make certain that the tie point is clean (down to bare metal). Scrub away any dirt and grease, and use emery cloth or steel wool to remove rust or other oxides. Completely dry the cleaned area.

If you're lucky enough to have copper cold-water plumbing and have a high-wattage soldering iron or gun, you can wrap a length of wire mesh (a length of shield from a coaxial cable, for example) around the connection and solder it into place. Completely "wet" the mesh and tie point with solder to assure an electrically and mechanically sound joint. (It would help if you could shut off the water in the pipe and drain it to remove the heat-sinking action of the water and make soldering easier. Also, do *not* attempt to make your connection near a soldered joint in the plumbing; make it at least 12" away from any joints to prevent the possibility of water leaks when the water is again turned on.) After soldering the joint and connecting the grounding lead from the equipment to the mesh, coat the mesh and both joints with silicone seal or, better still, silicone rubber to weatherproof them.

If your plumbing is other than copper pipe, like galvanized iron, the best way of making the connection is with the aid of a grounding clamp or a pipe strap with slots in it that are turned in at the edges to bite into the connection point. Again, start with a clean, dry connection point. Slip on the clamp or strap and tighten it enough to assure good electrical and mechanical contact. Connect the grounding lead from the equipment to the clamp or strap, and weatherproof the connection.

"Perfect" Ground Problem. There is one situation where even a "perfect" ground can be a source of trouble. This is when your high-frequency gear is an odd number of quarter wavelengths away from earth ground. In this case, the odd number of quarter wavelengths produces a

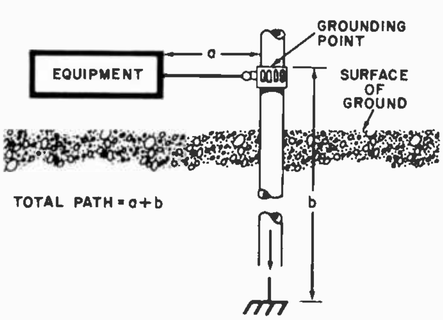


Fig. 2. Total distance to ground includes from equipment to pipe and length of pipe to true ground.

transformer action that results in a high impedance to ground. If you suspect that this might be your problem, try making your ground connection at a different place or using a different length of wire between equipment and ground connection.

You might have to do some experimenting to eliminate the "odd-number" problem, but it will be worth it if you clear up the difficulty. Just remember that the total path between equipment and earth ground is the length of the wire plus the length of the pipe between access point and true ground, as shown in Fig. 2.

Where No Access Exists. If you must operate your equipment in an area where no cold-water pipe provides an access to earth ground, you'll have to *make* access. The simple way to do this is to drive one or more 6' or 8' (1.83 or 2.44 m) metal rods or pipes into the ground and make your connection to it or them. One rod may not be enough; in which case, you might have to drive three or four rods into the ground 1 or 2 meters apart and tie them together with heavy-duty wire.

One or several short lengths of rod or pipe driven into the ground will usually do the job. If not, the reason is that the actual soil resistance varies from one location to another. The following list gives "typical" resistance figures for various types of soil, based on 1 ohm as the resistance of sea water:

Rich soil, plains	300 ohms
Hills, forest	750 ohms
Rocky, dry and sandy	2500 ohms
Industrial area	5000 ohms

Where poor soil conditions exist, you'll have to try a different approach for obtaining a low-resistance earth ground. A lot of work will be involved, but it will be worth it if you can solve all or most of your grounding problems. The trick here is to bury a few square feet of copper sheet or galvanized sheet metal to which are attached one or more lengths of grounding rod or pipe.

As a general rule of thumb, the deeper you bury the metal and/or the larger the area of the metal, the better will be the ground. But be practical. Try for a minimum depth of more than 1 meter (39.7") and a minimum area of about 0.37 sq. m (24" square) for the sheet metal. Before lowering the sheet metal into the hole, line the bottom of the hole with a mixture of charcoal and rock salt to a depth of about 15.2 cm (6"). Water down the charcoal/salt mixture. Then attach the rod or rods to the sheet metal and lower this into the hole, followed by a layer of the charcoal/salt mixture. Water the mixture. Then fill the hole with soil, tamping it down solidly. Water down the soil, but don't turn it to mud, to help in settling and assure good conductivity. (See Fig. 3 for details.)

After making your ground connec-

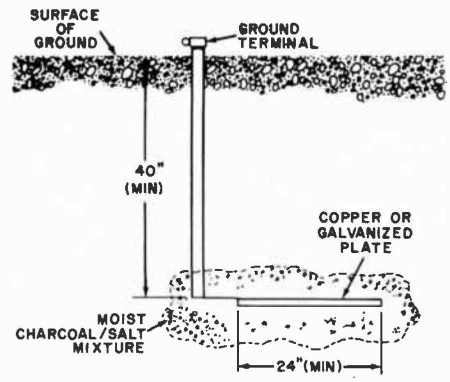


Fig. 3. Details of how to make a good earth ground by burying a metal plate several feet down.

tion to the rod or rods, water down the area periodically to prevent it from drying out and maintain good low-resistance earth ground contact.

Finishing Steps. Once you have a good connecting point for access to a low-resistance earth ground, you must give some consideration to the equipment itself and the area in which the equipment is to be operated. The first thing you should do, therefore, is set up the electrical environment.

If your equipment is on a metal table, ground the table. For a wood table, run a ground wire around the top or tack a metal screen to the bottom surface of the table top and connect the screen to ground. If you're operating your equipment in an area that's carpeted, a good practice is to put some wire screening under the carpet and ground it. Then connect the exposed metal part of each light fixture to ground through a separate grounding wire. Don't hook all fixtures up in series and run a single wire to ground. (Grounding lighting fixtures is a pretty good cure for fluorescent-light interference.) Finally, ground the frames of all electric motors that might be close enough to cause interference. Again, run a separate grounding wire to each motor.

The simplest way to ground your equipment is usually the best. If various pieces of equipment are physically close to each other, a single length of wire fastened to each of their chassis and to the grounding point will do.

Our closing advice is this: Once you have everything working properly, periodically check out your grounding system to make sure that its integrity is intact. This way, you'll be sure you get the most from your ground for many years to come. ◈

If you can't go to college for your career in electronics –read this!

CREI brings college-level training to you with eight educational advantages, including special arrangements for engineering degrees

The best way to qualify for top positions and top pay in electronics is obviously with college-level training. The person with such training usually steps more quickly into an engineering level position and is paid considerably more than the average technician who has been on the job several years.

A regular college engineering program, however, means several years of full-time resident training—and it often means waiting several years before *you can even start your career.* This, of course, is difficult if you must work full time to support yourself and your family.

If your career in electronics is limited without college-level training, take a look at the advantages a CREI home study program can offer you.

1. Convenient Training

CREI brings the college to you. Through the convenience of home study, you receive exactly the same level of training you will find in any college or university offering programs in electronic engineering technology. With CREI, however, you can "go to college" whenever you have spare time at home or on the job.

2. Specialized Programs

With CREI, you enjoy the advantage of *specialized* training. That is, your program will include only those courses directly applicable to your career in electronics. We omit such courses as English, social studies and other subjects, which are usually required in resident schools. Therefore, with CREI, you move ahead faster to the more interesting and useful part of your training.

3. Practical Engineering

CREI programs give you a *practical engineering* knowledge of electronics. That is, each part of your training is planned for your "use on the job." By using your training, you reinforce the learning process. And by demonstrating your increased knowledge to your employer, you may qualify for faster career advancement.

4. Engineering Degrees

CREI offers you a number of special arrangements for earning engineering degrees at recognized colleges and universities. You can earn college credit while you are taking your CREI program or apply later, whatever is best for your career plans.

Career Training at Home

5. Unique Laboratory

Only CREI offers you the unique Electronic Design Laboratory Program. This complete college laboratory makes learning advanced electronics easier and it gives you extensive practical experience in many areas of engineering, including design of electronic circuits. No other school offers this unique program. It is a better "Lab" than we have found in many colleges. And the professional equipment included in the program becomes yours to keep and use throughout your professional career.

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CREI gives you a choice of specialization in 14 areas of electronics. You can select exactly the area of electronics best for your career field. You can specialize in such areas as computer electronics, communications engineering, microwave, CATV, television (broadcast) engineering and many other areas of modern electronics.

7. Prepared by Experts

Experts in industry and technical organizations of government develop CREI programs. Each part of your training is developed by a recognized expert in that area of electronics. That means you get the most up-to-date and practical instruction for your career.

8. Industry Recognition

That CREI training is recognized by industry and government is evident from the fact CREI provides training to advanced technical personnel in over 1,700 technical organizations. Many subsidize the training of their employees with CREI. If there is any question about the advantages of CREI training for you, ask your employer or any engineer to evaluate the outline of a CREI program for you.

Other Advantages

Of course, there are many other advantages to CREI training. For example, throughout your training, CREI's staff gives you personal instruction for each step of your program. And in many industrial areas, both in the U. S. and abroad, CREI Field Service Representatives provide a number of important personal services for your training and your career.

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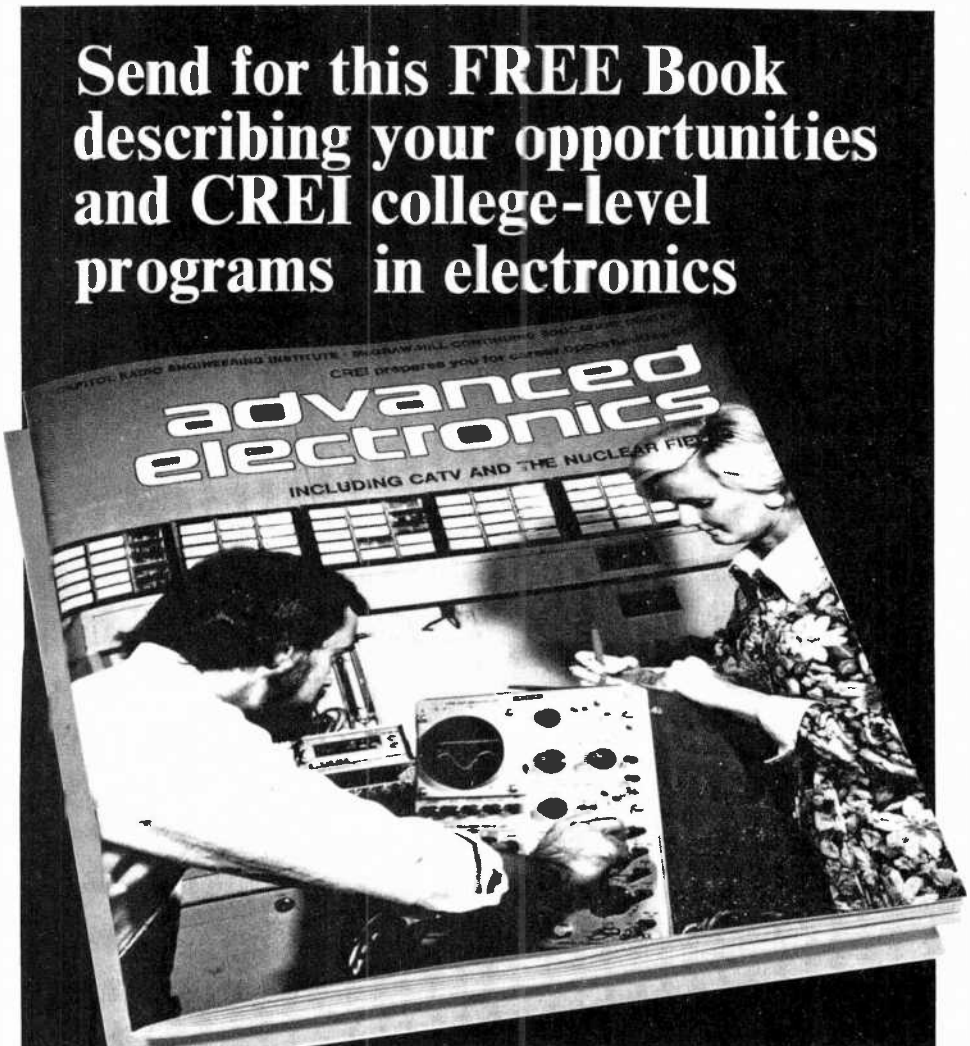

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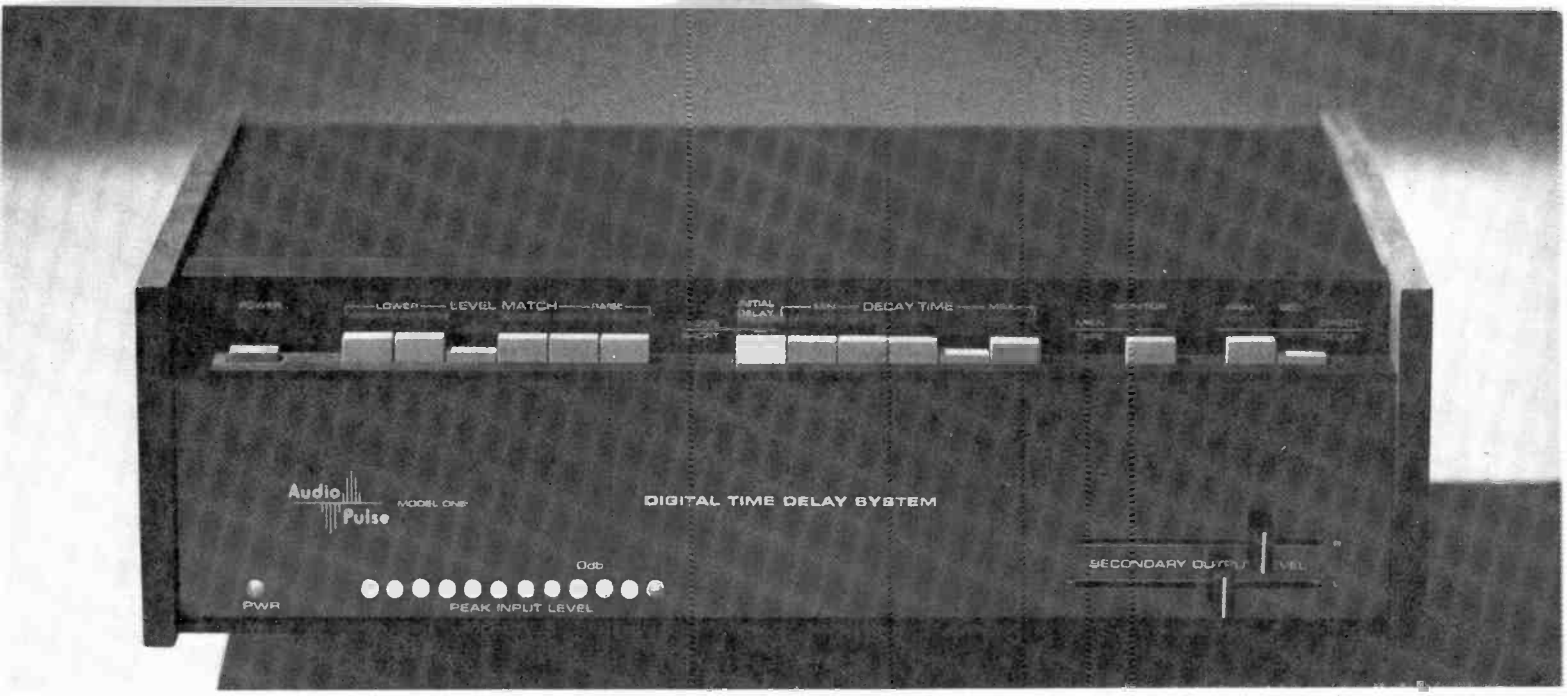

A New Audio "ROOM EXPANDER"

Digital Time Delay System produces controllable reverb.

BY LESLIE SOLOMON, Technical Editor

THE AUDIO world has generally been thought of as purely analog—about as far removed from digital electronics as one could get. There have been some attempts to produce digital power amplifiers; but, so far, digital circuitry has made no inroads on actual signal generation and reproduction. (The use of digital peripheral equipment such as level meters, timers, or counters is not actually part of the generation or reproduction of the audio signal.)

Things may be changing, however, with the advent of a new approach to reverberation called a "Digital Time Delay System" (also referred to as an acoustic room expander) introduced by Audio Pulse Div. of Hybrid Systems (Bedford Research Park, Crosby Dr., Bedford, MA).

In real acoustic space, the various reflected sounds arrive at the ear later than the primary (direct) sounds, and the larger the concert hall, the later the reflected sounds arrive. Obviously, this concept has been considered before. Former approaches to reverb have ranged from the use of mechanical springs to charge-coupled electronic devices. (Commercial time delays as used in recording studios are far too expensive for home use at present. The Audio Pulse Digital Time Delay System is $585.)

Digital Techniques. The technique used in the space expander involves the equivalent of 150,000 transistors (in IC form). The operation is accomplished by encoding each channel of a stereo pair into digital form (a series of pulses) and depositing the pulses in a shift register. The latter can be thought of as a long hollow tube in which different colored balls (representing the 1's and 0's of the digital logic) can be inserted in serial fashion. If the differently colored balls are inserted in a particular pattern, they will come out the far end of the tube in exactly the same order. The length of the tube determines the amount of time (delay) required for the balls to go from input to output. In the electronic shift register, a set of voltage levels represents the predetermined 1's and 0's, and a clock pulse steps them along. The number of "cells" in the register then determines the time required for the digital pulses to pass through the register.

The technique used is not pulse-code modulation, in which a group of pulses represent the instantaneous *amplitude* of the input signal. (This requires 10 to 12 pulses per group to reproduce wide-range musical signals.) Instead, the space expander uses "delta modulation" in a circuit that generates a continuous series of pulses whose rate reflects the moment-to-moment *changes* in the audio input level. This is an efficient method of encoding because only about half as many pulses are required per second.

A single time-delay system can accurately simulate only one reflected sound, or a single echo. To provide the ambiance created by the many reflected sounds in a concert hall and avoid the single echo effect, the space expander uses a cross-channel recycling loop technique. Each side of the stereo pair is not only delayed but recycled back to the opposite side at a reduced level that corresponds to the normal attenuation of a sound wave reflected and re-reflected. Consequently, the composite right and left audio output signals contain dozens of delayed signals decaying exponen-

PIONEER HAS DEVELOPED A RECEIVER EVEN THE COMPETITION WILL ADMIT IS THE BEST.

One look at the new Pioneer SX-1250, and even the most partisan engineers at Marantz, Kenwood, Sansui or any other receiver company will have to face the facts.

There isn't another stereo receiver in the world today that comes close to it. And there isn't likely to be one for some time to come.

In effect, these makers of high-performance receivers have already conceded the superiority of the SX-1250. Just by publishing the specifications of their own top models.

As the chart shows, when our best is compared with their best there's no comparison.

To begin with, the SX-1250 is at least 28% more powerful than any other receiver ever made. Its power output is rated at 160 watts per channel minimum RMS at 8 ohms from 20 to 20,000 Hz, with no more than 0.1% total harmonic distortion.

And, for critical listening, no amount of power is too much. You need all you can buy.

To maintain this huge power output, the SX-1250 has a power supply section unlike any other receiver's, with a large toroidal-core transformer and four giant 22,000-microfarad electrolytic capacitors.

But power isn't the only area in which the SX-1250 excels. The preamplifier circuit has an unheard-of phono overload level of half a volt (500 mV). This means that no magnetic cartridge in the world can drive the preamp to the point where it sounds strained or hard. And the equalization for the RIAA recording curve is accurate within ±0.2 dB. A figure unsurpassed by the costliest separate preamplifiers.

Turn the tuning knob of the SX-1250, and you'll know at once that the AM/FM tuner section is also special. The tuning mechanism feels astonishingly smooth, precise and solid.

FM reception is loud and clear even on weak FM stations because the tuner combines extremely high sensitivity with highly effective rejection of spurious signals.

Of course, the Pioneer SX-1250 carries a price tag commensurate with its position at the top. But if you seek perfection you won't mind paying the price.

If, on the other hand, you'd mind, look into the new Pioneer SX-1050 or SX-950. They're rated at 120 and 85 watts, respectively, per channel (under the same conditions as the SX-1250) and their design is very similar. In the case of the SX-1050, virtually identical.

That means you don't just come to Pioneer for the world's best.

You also come to us for the next best.

For informational purposes only, the SX-1250 is priced under $900. The actual resale price will be set by the individual Pioneer dealer at his option.

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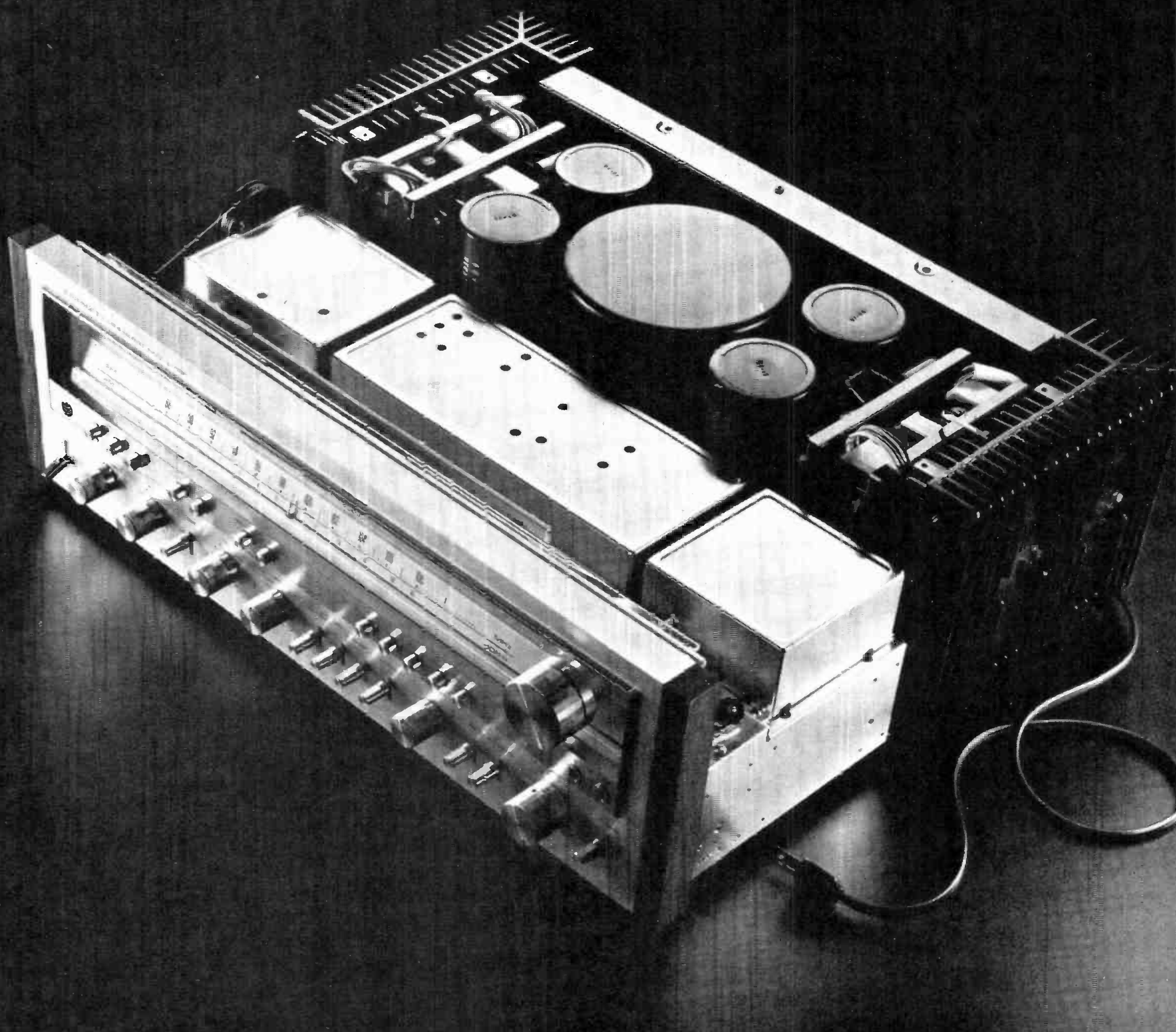
	PIONEER SX-1250	MARANTZ 2325	KENWOOD KR-9400	SANSUI 9090
POWER, MIN. RMS, 20 TO 20,000 HZ	160W+160W	125W+125W	120W+120W	110W+110W
TOTAL HARMONIC DISTORTION	0.1%	0.15%	0.1%	0.2%
PHONO OVER-LOAD LEVEL	500 mV	100 mV	200 mV	200 mV
INPUT: PHONO/AUX/MIC	2/1/2	1/1/no	2/1/mixing	1/1/mixing
TAPE MON/DUPL.	2/yes	2/yes	2/yes	2/yes
TONE	Twin Tone: Bass-Bass-Treble-Treble	Bass-Mid-Treble	Bass-Mid-Treble	Bass-Mid-Treble
TONE DEFEAT	Yes	Yes	Yes	Yes
SPEAKERS	A,B,C	A,B	A,B,C	A,B,C
FM SENSITIVITY (IHF'58)	1.5μV	1.8μV	1.7μV	1.7μV
SELECTIVITY	90 dB	80 dB	80 dB	85 dB
CAPTURE RATIO	1.0 dB	1.25 dB	1.3 dB	1.5 dB



A SIMPLE LOGIC PROBE

Few parts combined to provide a versatile logic state indicator.

BY ROBERT LEFFERTS

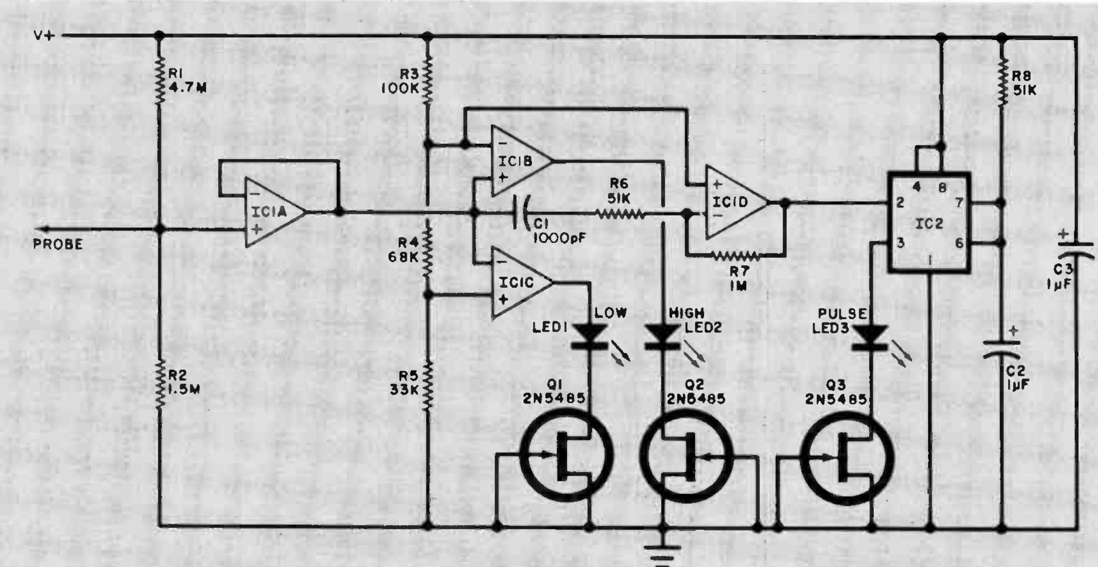
THIS circuit was inspired by R.M. Stitt's "Build a Direct Reading Logic Probe" in the Steptember 1975 issue of POPULAR ELECTRONICS. Although the seven-segment display technique used in that article was intriguing, I found that it could lead to some problems. For example, if a signal is oscillating between about 0.5 and 3 volts, at a frequency of, say, 100 Hz, the signal would appear to be low, high and a pulse—all at the same time! Either the digit "8" would be displayed or, if the monostable overrode the high and low displays, a "P" would appear. However, there would be no relative indication of duty cycle.

The probe presented here not only solves this problem, but is also useful with CMOS logic levels, as well as 555 and other timer outputs. It will operate on supply voltages ranging from 5 to 15 volts and draws less than 12 mA. Its op amp input circuit has high input impedance and low capacitance.

Further, three LED's display high, low and pulse levels and the approximate duty cycle (indicated by relative brightness). The possible states displayed range from all three LED's lit (a square wave with about a 50% duty cycle and high and low levels above and below V/2 and V/7, respectively) to only the PULSE LED glowing. This indicates a train of narrow, positive- or negative-going pulses riding on a level somewhere between the lower and upper switching thresholds, or some other oscillation with amplitudes between these two levels.

Voltage follower *IC1A*, one fourth of an LM324 quad op amp, isolates the probe from the rest of the circuit and passes the input signal to the low (*IC1C*) and high (*IC1B*) comparators, with thresholds of V/7 and V/2 furnished by the resistor string *R3-R5*. The input signal also drives *IC1D*, an ac amplifier with a gain of 20. This amplifier triggers *IC2*, a 555 one-shot with a pulse width of about 0.05 second. The state-indicating LED's are current limited by FET's *Q1*, *Q2*, and *Q3*.

Construction of the probe is a matter of taste, but most probably you'll want to assemble it in a cigar tube or a length of PVC tubing. Either pc or perforated board techniques can be used. LED size and color is left to the individual. Choose a distinctive color combination—possibly red for LOW, green for HIGH, and yellow for PULSE. After a few days of use, you'll probably agree that a versatile logic probe is very handy to have around. ◈

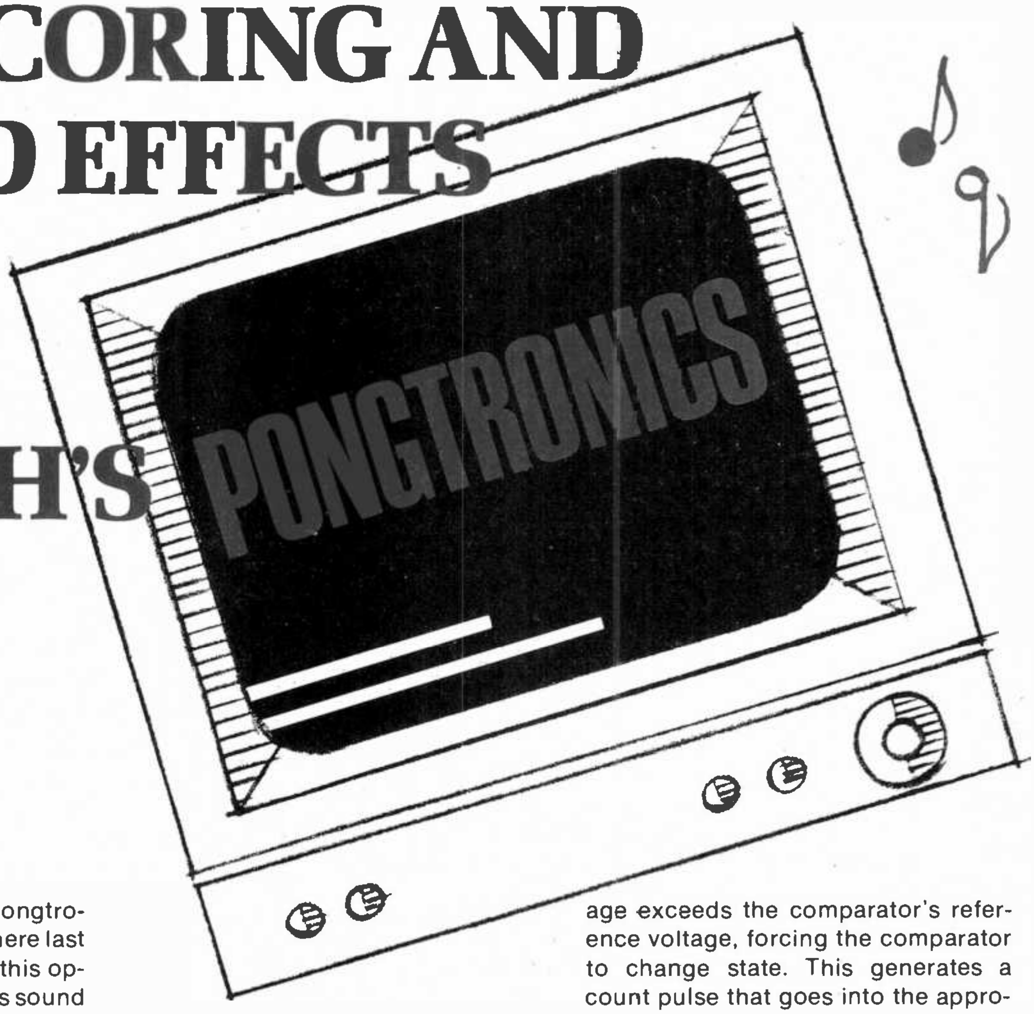


PARTS LIST

C1, C2—1-µF, 25-volt tantalum capacitor
C3—1000-pF disc capacitor
IC1—LM324 quad op amp
IC2—555 timer
LED1-LED3—20-mA light emitting diodes
Q1-Q3—2N5485, HEP F0021 field effect transistors
R1—4.7-megohm, ¼-W, 5% resistor
R2—1.5-megohm, ¼-W, 5% resistor
R3—100,000-ohm, ¼-W, 5% resistor
R4—68,000-ohm, ¼-W, 5% resistor
R5—33,000-ohm, ¼-W, 5% resistor
R6—51,000-ohm, ¼-W, 10% resistor
R7—1-megohm, ¼-W, 10% resistor
R8—51,000-ohm, ¼-W, 10% resistor
Misc.—Probe tip, case, pc or perforated board, solder, hookup wire, etc.

BY MITCHELL WAITE
AND LARRY BROWN

ADD SCORING AND SOUND EFFECTS TO LAST MONTH'S PONGTRONICS



This novel, low-cost circuit will provide greater interest to your TV table-tennis game.

TO ADD interest to your Pongtronics TV game (described here last month), you will want to build this optional assembly which provides sound effects and displays the score. It also serves the ball from the loser's side of the game court, with the speed of the serve determined by the BALL SPEED control on the main circuit board.

Scoring is displayed as two horizontal bars, one for each player, positioned just below the bottom court boundary. Two digital memories store the point information, while a simple D/A (digital-to-analog) converter generates the length-of-bar information. Every time the ball is missed, the loser's score bar lengthens in fixed increments. The game is over when a loser accumulates 12 misses. When the loser's bar extends completely across the playing court and the game ends, his paddle automatically disappears from the screen. (By using a bar-graph scoring approach instead of an on-screen numeric readout for the scoring, an expensive character generator is eliminated.)

The sound effects are generated by using ball-paddle and ball-wall coincidence signals to trigger an audio oscillator that emits a bongo-drum-like "bonk" tone. If a paddle misses the ball and the latter goes off-screen, another audio oscillator emits a horn-like "braap" sound. These sounds can be tailored to suit individual tastes by juggling the component values in simple RC networks.

Theory of Operation. Figure 1 is a block diagram of the sound/scoring system. The scoring circuit is initiated by depressing the START/SERVE switch on the main game board. This resets two four-bit binary counters which are right and left memories to zero and launches the ball.

The voltage that corresponds to the horizontal position of the ball is picked up from the main game board and fed to the right- and left-miss comparators. When the ball misses either paddle, the ball-position voltage exceeds the comparator's reference voltage, forcing the comparator to change state. This generates a count pulse that goes into the appropriate point memory.

The outputs of the point memories are summed in resistor-network D/A converters that produce an analog current proportional to the state of the counter at any given moment.

A seven-stage circuit counts the number of horizontal scan lines from the bottom of the lower court wall to produce the scoring bars at the bottom of the TV screen. After detecting the seventh scan line, the counter operates an analog switch, or transmission gate. In one state, the analog switch passes the left score information to a current-controlled comparator referenced to the horizontal ramp from the main game board. The switch remains in this mode for eight scan lines, at which point, the scanline counter turns it off. The length of the score bar is proportional to the current from the D/A network, which in turn is determined by the count stored in the memory.

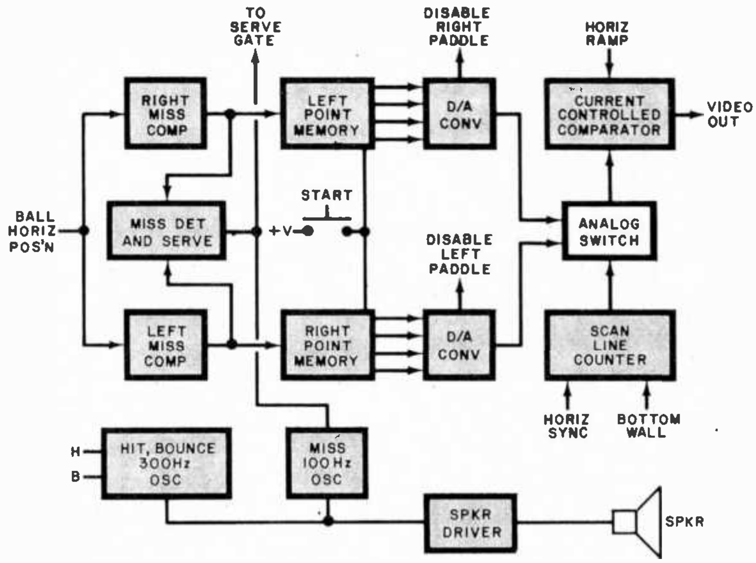


Fig. 1. Block diagram shows basic operation of the logic for the sound and scoring circuit.

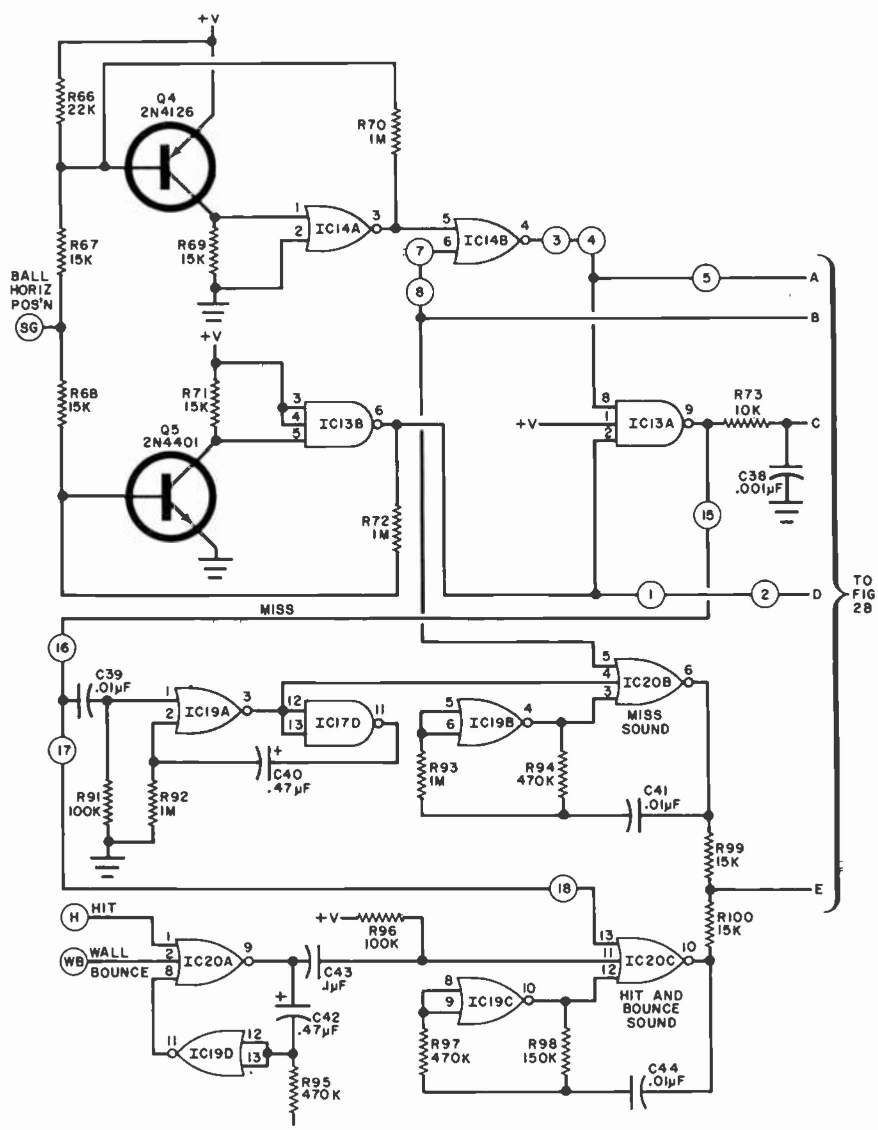
Eight more horizontal scan lines are counted to generate a space. Then the scan-line counter toggles the analog switch so that the right score data is introduced into the comparator. This score is also displayed in the following eight lines. Every 16.6 ms, or every vertical frame, the counter that controls the location of the scoring bar is reset, and the operation repeats.

When a score bar reaches a 12 count, the associated bar will have stretched across the screen. A gate then opens to blank out the losing paddle and lock up the serve gate, thus signalling the end of the game. To begin a new game, the SERVE/START button in the main circuit is pressed to repeat the cycle.

The hit and bounce "bonk" sound is produced by gating a 300-Hz oscillator for 8 to 10 ms. The miss "braap" sound

PARTS LIST

B2—9-volt battery
C38—0.001-μF, 10% Mylar capacitor
C39,C41,C44—0.01-μF, 10% Mylar capacitor
C40,C42—0.47-μF, 20% tantalum capacitor
C43,C47,C48,C49—0.1-μF, 10% Mylar capacitor
C45,C46—100-μF, 16-volt aluminum electrolytic capacitor
IC13—4023 triple three-input NAND gate
IC14,IC19—4001 quad two-input NOR gate
IC15—4007 dual transmission gate and inverter
IC16—4024 seven-bit binary counter
IC17—4011 quad two-input NAND gate
IC18—4520 dual four-bit binary counter
IC20—4025 triple three-input NOR gate
Q4,Q6—2N4126 transistor
Q5,Q7—2N4401 transistor
The following resistors are ¼-watt, 5% tolerance:
R66,R84,R85,R87—22,000 ohms
R67,R68,R69,R71,R99,R100,R102—15,000 ohms
R70,R72,R92,R93—1 megohm
R73—10,000 ohms
R74,R78—820,000 ohms
R75,R79—390,000 ohms
R76,R80,R82,R83—200,000 ohms
R77,R81,R91,R96—100,000 ohms
R88,R98—150,000 ohms
R89—4700 ohms
R94,R95,R97—470,000 ohms
R101—100 ohms
R103—33,000 ohms
R86,R90—50,000-ohm, ⅛-watt trimmer potentiometer
Misc.—Printed circuit board; sockets or Molex Soldercons* for IC's (optional); solid hookup wire for jumpers; solid or stranded hookup wire for between-board interconnections; solder; ¾" spacers; battery clip and mounting bracket; machine hardware, etc.



is produced by gating a separate 100-Hz oscillator for 300 ms.

How It Works. The complete circuit of the optional sound/scoring subassembly is shown in Fig. 2. Transistor *Q4* and integrated circuit *IC14A* make up a normally on comparator whose reference voltage is determined by the values of resistors *R66* and *R67*. Positive feedback to speed up switching time is provided by *R70*. Transistor *Q5* and integrated circuit *IC13B* make up another normally on comparator, with *R66, R67,* and *R68* determining the reference voltage. The inputs of both comparators receive the voltage that corresponds to the horizontal position of the ball from terminal SG on the main circuit board.

When the ball goes off-screen to the *left*, *Q4* cuts off and *IC14A* pulses *IC14B*. This is turn toggles and deposits a count in score counter *IC18B*. When the ball goes off-screen to the right, *Q5* and *IC13B* toggle left score counter *IC18A*.

When either comparator switches state, the output signal causes miss gate *IC13A* to change state. A slight delay, the result of *R73/C38*, is introduced into the signal applied to *IC13C*, which controls the serve gate on the main board. Hence, a miss with either paddle automatically initiates a new serve as well as stores a count in the proper counter.

Resistors *R74* through *R77* in the *IC18B* circuit convert the stored digital data into an analog current for the right signal. A similar function is served by *R78* through *R81* in the *IC18A* circuit as the left score keeper.

Used as an electronic switch to alternately multiplex the two bar scores on the TV receiver's screen, *IC15* is a dual CMOS transmission gate with an internal inverter. The switch is toggled back and forth by an output from horizontal scan-line counter *IC16*. For example, when one portion of *IC15* closes, the current from the right score resistor network is fed through *R82* to the base of *Q6*. Simultaneously, the other portion of the digital switch is open, disconnecting the left score information. The *Q6/IC14C* circuit forms a programmable comparator that mixes the resistor network current with the horizontal ramp determined by the current from *Q6* in conjunction with the settings of *R86* and *R90*. The settings of these trimmer potentiometers determine the length of each score increment by establishing the 0 starting and 12 ending points. NAND gate *IC17A* inverts the video score signal and, in turn, is enabled at the proper time by the horizontal scan line counter (*IC16*).

In the sound section, *C39* and *R91* differentiate the "miss" pulse and trigger monostable multivibrator *IC19A/IC17D*, which turns on the "miss" audio oscillator (*IC19B/IC20B*) for about 300 ms. The circuit generates the 100-Hz "braap" tone. The pin-5 input of *IC20B* goes to the "start" circuit to keep the "miss" oscillator off when the START button is pressed.

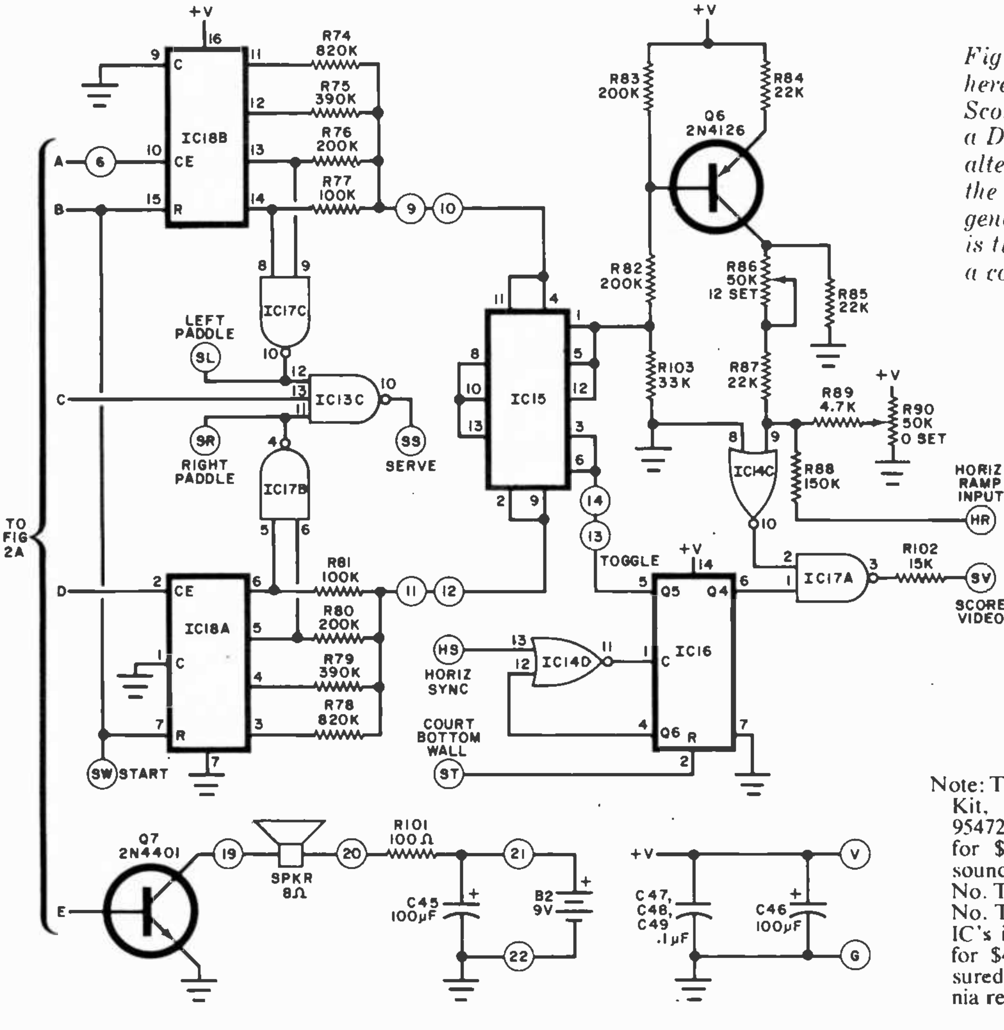
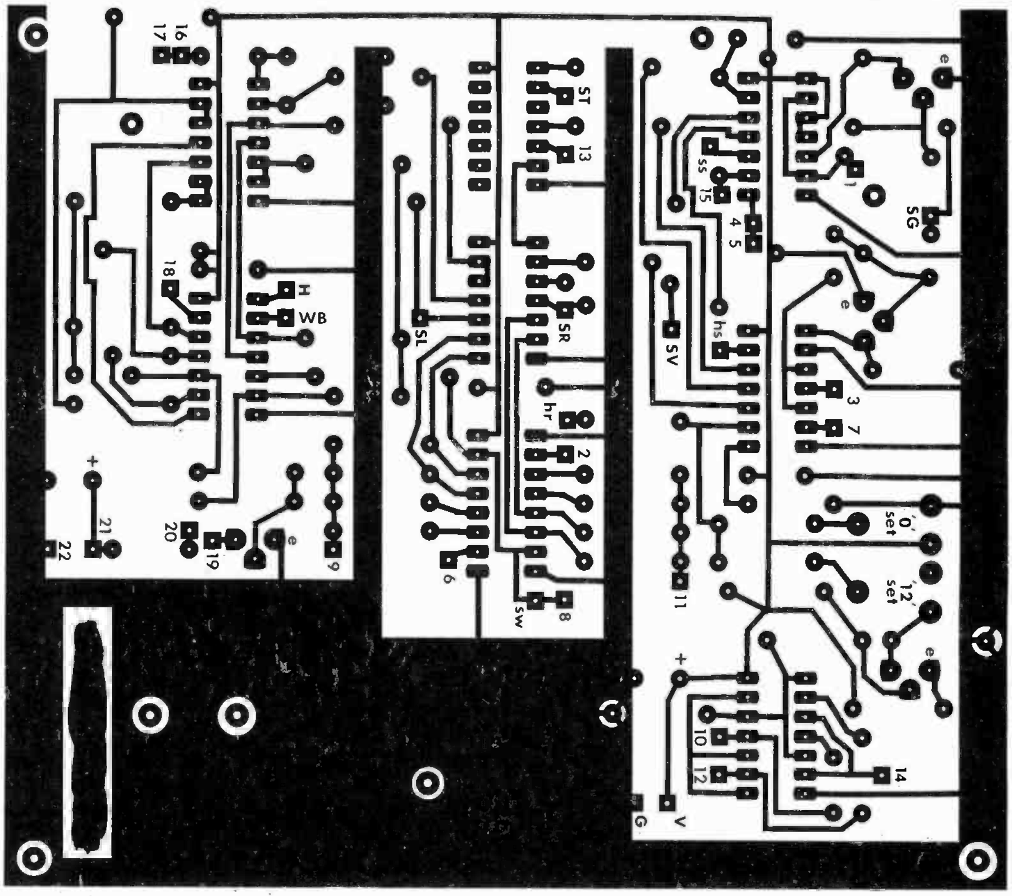
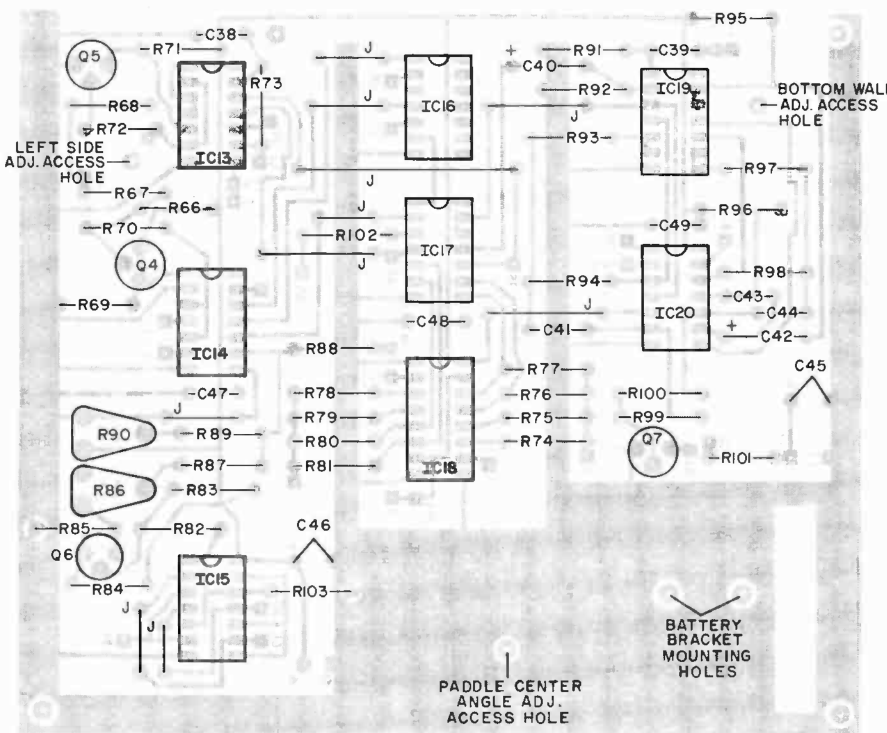


Fig. 2. Schematic is shown here and on opposite page. Scoring circuit consists of a D/A converter for each side, alternately switched into the Q6/IC14C comparator to generate bars. Sound circuit is two audio oscillators and a common audio amplifier.

Note: The following are available from Cal Kit, P.O. Box 877, Sebastopol, CA 95472: Printed circuit board No. TV-2 for $8.50; complete kit of parts for sound and scoring option (less battery) No. TV-4 for $33.00; IC13 through IC20 No. TV-7 for $12.50; Set of sockets for IC's in sound/scoring option No. TV-9 for $4.00. All items postpaid and insured. Add $1.00 for handling. California residents, add 6% sales tax.

Fig. 3. Actual-size etching and drilling guide is at right. Component layout below. Note three holes that provide access to main trimmer controls.





WIRING TABLE

The following interconnections are to be made from one point on the sound/score board to another point on the same board:

From	To	From	To
1	2	15	16
3	4	17	18
5	6	19	SPKR
7	8	20	SPKR
9	10	21	B2+
11	12	22	B2−
13	14		

All interconnections between the main game board and sound/score board are to be made from pads with letter legends on the one to the same lettered legends on the other. For example: SG to SG, HS to HS, etc.

The following list identifies the functions at each lettered pad:

SG	Ball horizontal position
HS	Horizontal sync
ST	Bottom wall of court
H	Paddle and wall "hit"
WB	Wall bounce
SW	Start gate
V	+5.5-volt bus
G	Ground bus
SS	Serve gate
SR	Right-paddle control
SL	Left-paddle control
SV	Score video
HR	Horizontal ramp

Hit and wall-bounce signals come from pads H and WB on the main board to toggle monostable pulse stretcher circuit *IC20A/IC19D*. When this circuit triggers on, *C43* and *R96* generate a pulse that turns on "hit-and-bounce" oscillator *IC19C/IC20C* for about 10 ms. This oscillator produces the brief "bonk" sound. The pin-13 input of *IC20C* goes to the output of miss gate *IC13A* to disable this tone generator when the ball is off-screen. Resistors *R99* and *R100* sum the two audio signals for delivery to audio output transistor *Q7*. The output circuit is powered by its own separate

9-volt battery ($B2$), with $C45$ and $R101$ providing decoupling.

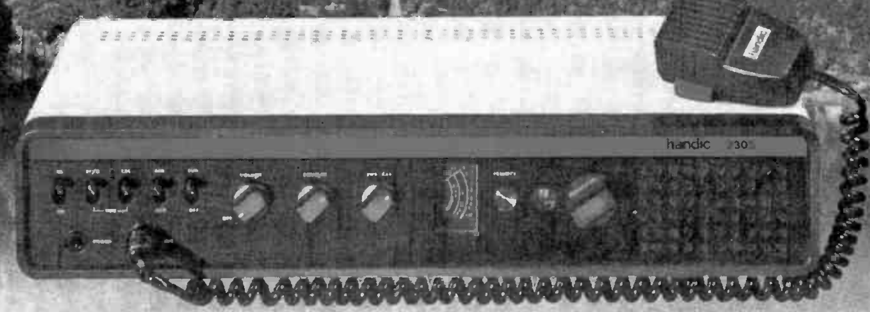
Construction. The sound/scoring assembly is designed to mount directly over the main game board with ¾" (1.9-cm) spacers to provide separation. Shown in Fig. 3 are the actual-size etching and drilling guide and component placement diagram. Whether you make your own pc board or buy one from the source given in the Parts List, you'll have to enlarge the indicated holes to provide screwdriver access to the main-board controls.

Once the components are installed on the board, refer to the Wiring Table to interconnect the sound/scoring board and the rest of the circuit. Don't forget to remove the appropriate links on the main board when making the interconnections. Refer to last month's issue for details.

Checkout and Alignment. The following presupposes that your basic Pongtronics project is operating properly. When you turn on the power, the court should appear as usual, but you should also see the two scoring bars near the bottom of the screen. If necessary, move the bottom boundary of the court up on the screen to allow room for the scoring bars.

Play the Pong game for deliberate misses on one side of the court. Listen for the distinctive "bonk" when the ball hits the paddle and court walls and the "braap" when the other paddle misses and the ball goes offscreen. At the same time you hear the "braap," the appropriate scoring bar should lengthen and continue to lengthen for each miss. Finally, make sure that the ball serves automatically to the winner of the last point.

Reset for a new game. The scoring bars should immediately drop to their minimum lengths at the left side of the screen. Now, adjust zero-set control $R90$ until the two bars just barely show. Play the game, making all hits with one paddle and all misses with the other, for a count of 12. Each miss will lengthen that paddle's scoring bar one increment. At the end of 12 misses, the bar will be at its maximum length, and the losing paddle will disappear from the screen. Without resetting for another game, adjust 12-set control $R86$ until the score bar just touches the right side of the screen. This completes the checkout and alignment procedure. ◈



A "JUNK-BOX" 5-VOLT POWER SUPPLY

BY R. C. FOSS

Discrete circuit made from spare parts gives IC-regulator performance.

WHEN a breadboard project calls for a regulated 5-volt supply, most experimenters instinctively reach for a 109-type IC. But suppose you're fresh out of 109's? The circuit described here can be built from junk-box parts, offers 0.15-volt stability, 5-mV noise and ripple, automatic current limiting, and an overload indicating light!

No transistor type numbers are shown in the schematic diagram, as almost any will do. The pnp series-pass transistor, *Q1*, is a power type with a rated BV_{CEO} of 15 volts, and a minimum current gain of about 30 at 1 A. If the power device you have on hand has a gain a bit lower than 30, *R3* can be reduced to compensate. Enough heat sink should be provided to dissipate 7 or 8 watts under worst-case overload conditions. As shown, the collector is the positive output rail. A piece of aluminum bolted to the + terminal will do nicely. If you want to use an npn power transistor, invert the entire circuit into its complementary form. Thus the transistor's case is conveniently grounded, and the chassis can be used for heat sinking. It's even possible to use a germanium transistor if *R2* is lowered to about 22 ohms to allow for the lower V_{BE}.

The other two transistors are general-purpose, small-signal silicon devices. Similarly, resistors are not critical. A two-watt wirewound component should be used for *R1*. A length of resistive wire wrapped on the body of a higher-value resistor can form *R1*. Resistor *R3* should be a carbon half-watt component.

About the circuit. The LED is used as a reference voltage source with an output of about 2 V. (The forward voltage drop of most GaAsP yellow, green, or orange LED's will vary from 2.0 to 2.2 volts. Select one with a V_0 close to 2.0 V.)

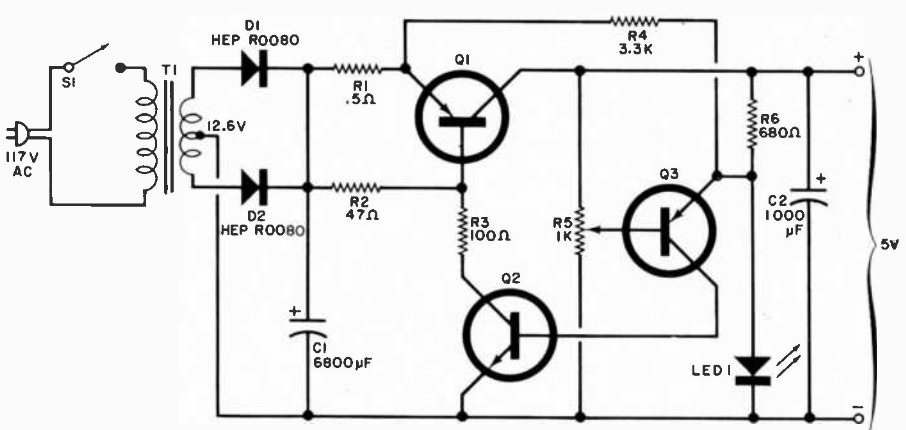
Feedback action sets the base of *Q3* to about one V_{BE} below the reference voltage on its emitter. So, *R5*, the 1000-ohm trimmer potentiometer, will generally be set about ¾ of the way "down" for a 5-volt output. Since the V_{BE} of *Q3* and the turn-on voltage of the LED usually have similar temperature coefficients, this simple reference-comparator combination works surprisingly well.

The collector provides base current for *Q2*. This transistor's collector resistor, *R3*, together with *R1* and *R2*, limit the maximum (overload) current of *Q1*. As more output is demanded, *Q3* and, in turn, *Q2* turn increasingly "on," grounding the bottom of *R3*. This action sets up a voltage divider, *R2* and *R3*, limiting base drive to *Q1*.

A variable resistor in series with *R3* can be inserted to set lower current limits. This is especially desirable when the supply is feeding easily damaged, low-power devices. Maximum current output of the series pass transistor is set by *R1* and *R2*, and *R3* limits the base current into it. Thus, there is current-limiting action.

Because *Q3* and the reference LED are fed from the stable side of the supply, the circuit gives excellent rejection of ripple and input variations. If *R4* is excluded, complete current shut-off will occur when the supply is short circuited. Although this is very desirable in protecting the load, it also means that the circuit will not self-start! At the specified value, *R4* bleeds enough current into the error amplifier (*Q3*) to allow start-up against a 5-ohm load. If desired, a normally open pushbutton switch can be placed in series with *R4* to get the best of both configurations.

The LED also acts as a pilot light—it will extinguish when the power supply is shut down by overload trip-out.



In this simple circuit, LED1 acts as a voltage reference and pilot light.

PARTS LIST

C1—6800-μF, 15-V electrolytic capacitor
C2—1000-μF, 15-V electrolytic capacitor
D1, D2—HEP R0080 rectifier or equivalent
LED1—See text.
Q1—Pnp power transistor. (See text.)
Q2, Q3—General-purpose silicon transistors
The following fixed resistors can be 5 or 10% tolerance.
R1—0.5-ohm resistor. (See text.)
R2—47-ohm, ½-W resistor
R3—100-ohm, ½-W resistor
R4—3300-ohm, ½-W resistor
R5—1000-ohm, linear-taper potentiometer
R6—680-ohm, ½-W resistor
S1—Spst switch
T1—12.6-volt, 3-A center-tapped transformer (Radio Shack 273-1511 or equivalent)
Misc.—Perforated or printed circuit board, machine hardware, hookup wire, binding posts, solder, line cord, suitable enclosure, etc.

Construction. The builder has as much flexibility in choosing construction techniques as he has in selecting semiconductors. Perforated or printed circuit board can be used. The project can be installed in any suitable enclosure. The only adjustment that must be made is the setting of *R5*. Adjust it so that the output is 5 volts. Once the setting has been determined, fixed resistors can be substituted for both sides of the potentiometer for stability. ◈

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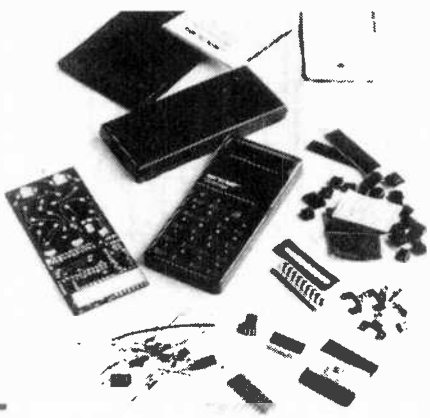

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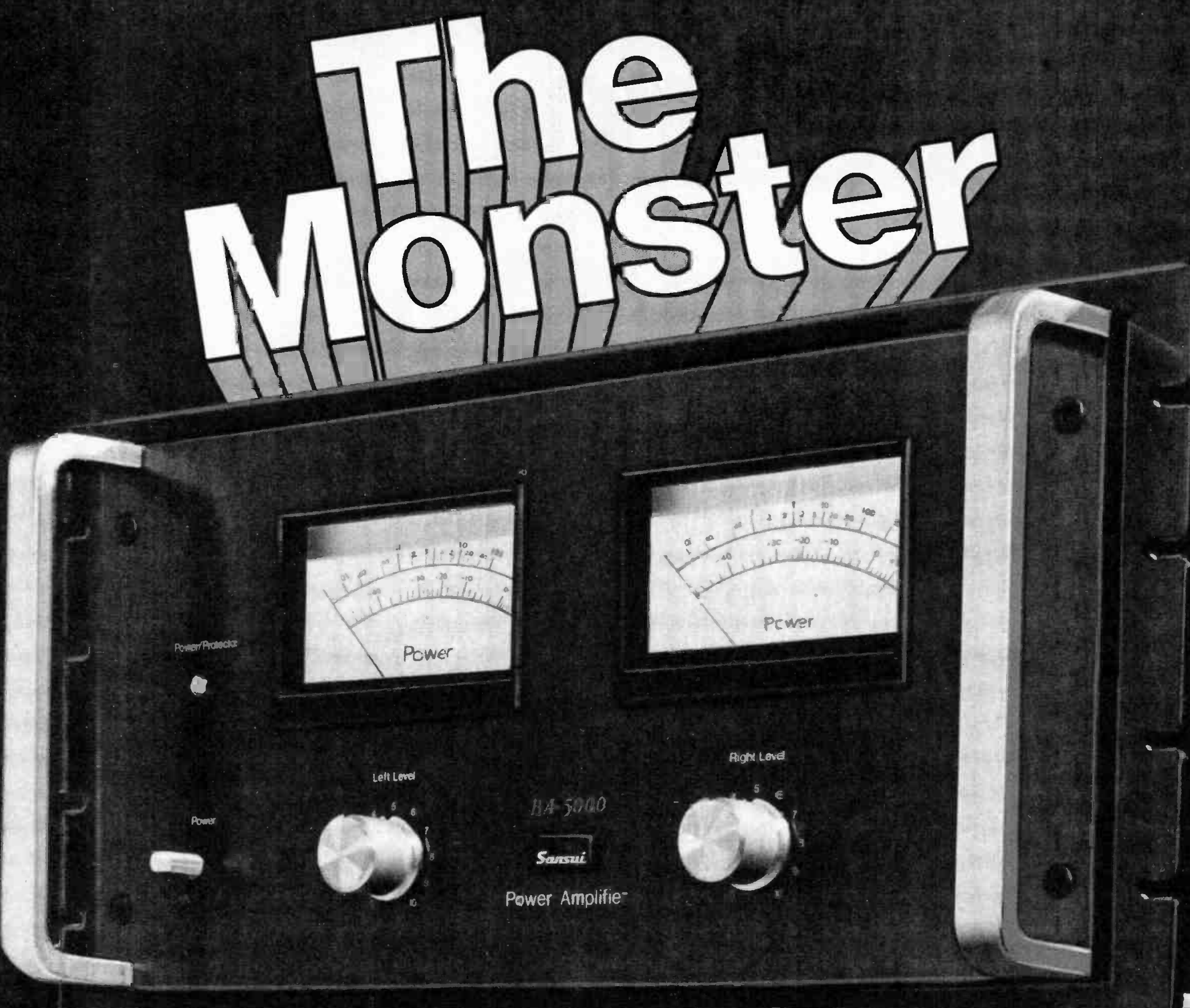

The new BA 5000 Power Amplifier from Sansui

The most dramatic component in Sansui's new "DEFINITION" Series, the BA 5000 solid-state power amplifier is capable of 300 watts min rms per channel into 8 ohms, both channels driven, from 20 to 20,000 Hz, with no more than 0.1% harmonic distortion in the stereo mode. What's more, the BA 5000 can be strapped for mono operation to deliver 600 watts rms under the same conditions.

A true monster amplifier.

But that's not all. Unlike other solid-state amplifiers, the BA 5000 has a huge, laboratory-quality output transformer, enabling it to deliver rated power into 2, 4 or 8 ohms plus 25 volt line output in stereo and 4, 8 or 16 ohms plus 70 volt line output in mono. A rating of 600 watts into a 16 ohm distortion, 20 to 20,000 Hz, is simply unprecedented in transistor equipment.

The "DEFINITION" series also includes the BA 3000, our junior Monster, and the CA 3000 a very high quality, low distortion preamplifier.

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Product Test Reports

ABOUT THIS MONTH'S HI-FI REPORTS

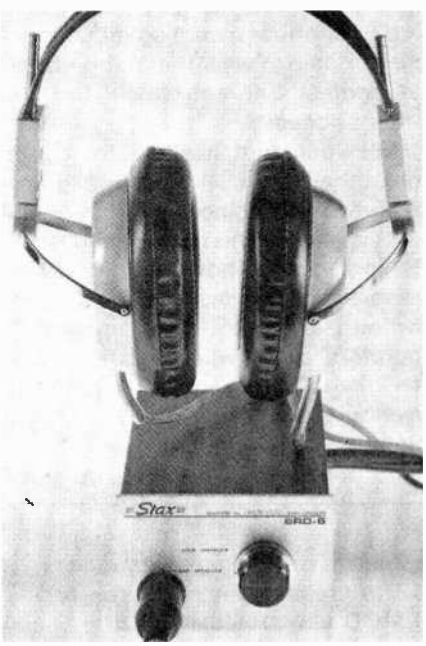
Electrostatic headphones, like loudspeakers of similar design, have long been recognized as accurate, wide-range devices. Their acceptance has been limited by the fact that most electrostatic headphones have been relatively bulky, heavy, and expensive, compared to dynamic phones. The Stax SR-5 electrostatic phones ("ear speakers," as Stax calls them) have eliminated at least two of these objections by virtue of their very light, comfortable construction. This has entailed no sacrifice of audio quality. The price is moderate, too.

The deluxe Model Four preamplifier from Epicure offers just about every performance feature one expects in a top-quality control center. The state-of-the-art performance of the Model Four is combined with an unconventional, yet extremely simple and logical, control layout.

—Julian D. Hirsch

STAX MODEL SR-5 ELECTROSTATIC HEADPHONES

Light weight, high performance.



HIRSCH-HOUCK LABS REPORT

The Japanese-made Stax electrostatic headphones, distributed here by American Audioport, have received high marks for sound quality. In the middle of the Stax line is the Model SR-5 "ear speaker," a very light, comfortable-to-wear headset that weighs only about 14 oz (390 g). For wearing comfort, the earcups are fitted with soft, fluid-filled cushions that completely surround the ear.

The phones are designed to be used with their companion Model SRD-6 adaptor, which contains a polarizing power supply and a step-up transformer in a 7⅝" × 3½" × 2½" (19.4 × 9 × 6.6 cm) box that weighs 2 lb 11 oz (1.2 kg). Lacking a power switch and consuming only about 0.1 watt from the power line, this adaptor can be safely and economically left powered all the time.

The adaptor connects to the speaker output terminals of an amplifier or receiver. It has outputs for both the Model SR-5 headphones and the speakers it replaces. The phones connect into the adaptor's front panel via a plug at the end of a 7½' (2.3-m) cord. A switch on the front panel of the adaptor has positions for routing the output from the amplifier to the phones or the speaker systems.

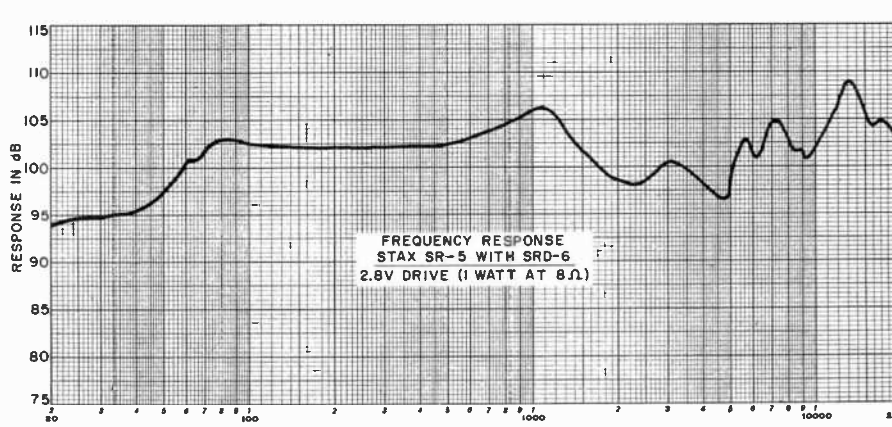
The published specifications for the headphones and adaptor are listed separately. As a result it is a bit difficult to interpret the signal drive and distortion figures for the phones/adaptor system. However, the input to the adaptor is rated at 8 watts maximum continuous power at 1000 Hz, with momentary peaks to 30 watts. The maximum sound-pressure level (SPL) from the phones is listed at 110 dB, while the rated frequency range (no tolerance stated) is 30 to 25,000 Hz.

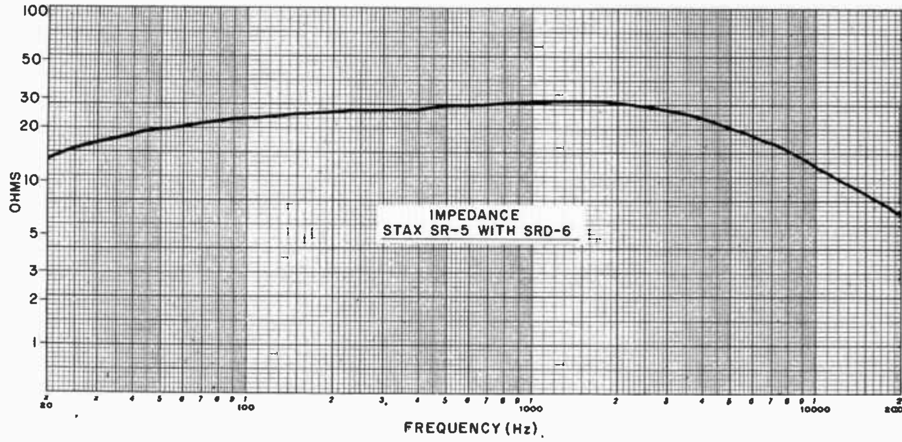
The distributor recommends that the phones be used with only the finest tube or transistor amplifiers for best results. Also, the user is cautioned against using the phones with amplifier output power levels substantially greater than 15 watts.

The Model SR-5 electrostatic headphones and Model SRD-6 adaptor come as a single package for $130.

Laboratory Measurements. Just as the measured frequency response of a loudspeaker is strongly influenced by the surrounding environment, the "response" of a headphone is a critical function of the coupler, or "artificial ear," on which it is mounted. There are usually severe irregularities in the measured response of a phone, even with a standard coupler, in the mid- and high-frequency ranges when the internal dimensions of the air cavity approach the wavelength of the sound. However, since couplers are more or less standardized, it is relatively easy to compare headphone responses measured in the same way.

We use a slightly modified ANSI coupler for our headphone measurements. The Model SR-5 phones were





driven with a constant 2.8 volts through the Model SRD-6 adapter, corresponding to 1 watt into an 8-ohm load. The frequency response was extremely flat from about 70 to 600 Hz. There were moderate irregularities at higher frequencies and a low-frequency drop of about 7 dB before changing to a flat response between 40 and 20 Hz. Overall, the response was ±6 dB from 45 to 20,000 Hz, a rather good performance for headphones measured in this manner.

The average midrange SPL was 102 dB at 1 watt, from which we can see that the rated 110 dB maximum could be developed with an input of just greater than 6 watts. This is consistent with the 8-watt rating of the system. Into the input of the adaptor, the impedance was about 30 ohms through the midrange and dropped off to 15 ohms at 20 Hz and to 8 ohms at 20,000 hertz.

The acoustic output harmonic distortion from the phones was very low, especially when compared with the finest loudspeaker systems. At 1000 Hz and with a 1-watt drive signal, the THD was 0.25% and principally third harmonic. At 10 watts, it actually decreased to 0.19% and was evenly divided between second and third harmonics. At 50 Hz, the distortion was higher—1.6% at 1 watt and 12.75% at 10 watts. The latter figure probably reflects the excessive diaphragm excursion needed to develop a large output at 50 Hz. This condition would almost certainly not be encountered under normal listening conditions.

At high frequencies, the measured THD varied somewhat with frequency. This is because of the response irregularities. It was between 0.23% and 1.45% in the range between 5000 and 10,000 Hz at a 1-watt input drive.

User Comment. Just as with a speaker system, a headphone is best judged by listening to it. However, an A-B comparison is difficult to make with phones, primarily because only one set can be worn at a time. Also, no comparison with a "live" reference program is possible. However, we did compare the Stax phones to a high-quality electrostatic phone and a number of excellent dynamic phones while using a sufficient variety of program material to draw some definite conclusions about sound quality.

We were immediately impressed by the exceptional comfort of the Stax while listening. Unlike most electrostatic phones, which tend to be heavy and bulky, these were like true featherweights. Even though cushions entirely surround the ears, they do not exert a tight pressure seal, nor do they entirely exclude outside sounds. In this respect, they would seem to be midway between tightly sealed and so-called "open-air" phones.

The sound quality is unequivocally excellent. Even at high listening levels, the phones retain their clarity and transparency. The drop in low-frequency response revealed by our coupler measurements may or may not exist in normal listening situations. Of course, below 50 Hz, sounds are as much sensed by the rest of the body as they are heard, which is an effect no headphones can duplicate. On the other hand, the subjective sound of the Stax phones appeared to be both wider and smoother than that of some of the finest speaker systems.

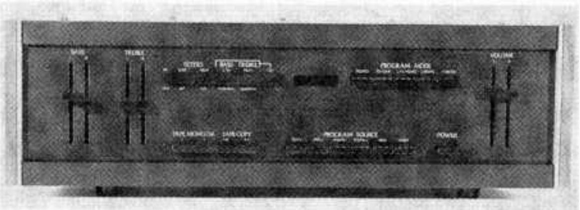
The only rival to the Stax phones with respect to sound quality were the other electrostatic phones to which we compared them. The sound of the Stax phones was distinctly more "open" and at least the equal of the other phones in clarity and definition. The Stax phones were so much more comfortable to wear that there was little contest between them and the other phones.

We would not hesitate to recommend the Model SR-5 phones to anyone who wants to hear in minute detail what is really on his records and tapes. Be forewarned, however, that these phones are merciless in exposing distortion and noise in the program. We therefore agree wholeheartedly with the distributor's recommendation to use these phones with only the finest high-quality equipment.

CIRCLE NO. 80 ON FREE INFORMATION CARD

EPICURE MODEL FOUR PREAMPLIFIER

Solid construction, high performance, and control flexibility.



HIRSCH-HOUCK LABS REPORT

The Epicure Model Four presents a striking and unusual appearance for a hi-fi preamplifier. Its panel and case are satin black, and the edges of the panel are accented with vertical walnut strips. All controls on the front panel are either slide-type potentiometers or pushbutton switches.

The preamplifier measures 18¼"W × 9½"D × 5½"H (46.4 × 24.1 × 14 cm) and weighs 9 lb (4.1 kg). Price is $450. A 19"W (48.3 cm) rack mount kit is available.

General Description. The vertical sliders for the preamp's bass and treble controls, each consisting of a pair of controls, are located on the left side of the front panel. Their center positions, labelled FLAT, are lightly but positively detented. On the right side of the panel are the two VOLUME and channel-balancing controls.

All other front-panel controls are pushbutton switches that are arranged in functional groups. The FILTERS and TONE CONTROLS grouping includes switches for the 50- and 7500-Hz low- and high-cut filters that have characteristic 12-dB/octave slopes. The tone control circuits can be completely switched out of the system by pressing in the BYPASS button. Alternatively, the turnover frequencies and maximum boost/cut can be altered by a button marked 9 dB/18 dB.

Below the first group of buttons are the four tape recorder controls, also pushbutton switches. Two tape decks can be connected to and controlled from the preamp. The playback from either deck can be monitored by pushing in the corresponding TAPE MONITOR button. In addition, the playback from either deck can be dubbed onto the tape on the other deck with the TAPE COPY buttons, simultaneously permitting the user to monitor from either deck.

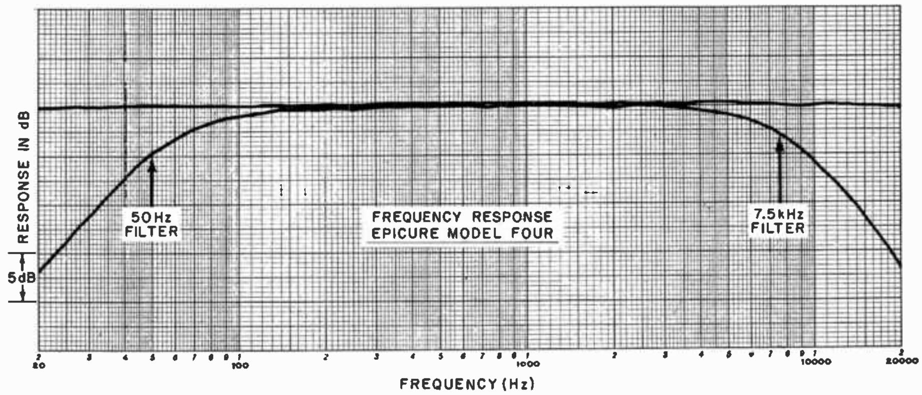
The PROGRAM SOURCE buttons (to the right of the tape control buttons) are for selecting inputs from TAPE 1, TAPE 2, PHONO 1, PHONO 2, AUX, or TUNER. These are followed by the POWER switch. (The "Epicure" logo on the front panel lights up when power is applied.) The last group of switches are the PROGRAM MODE selectors, offering a choice of STEREO, REVERSE stereo, MONO (L+R), and either L or R input appearing in both channels.

In addition to the various input and output jacks, there are four small control knobs for adjusting the phono sensitivity for each phono-input channel over a range of about 7 dB on the preamp's rear apron. These controls allow the playback levels from two different cartridges to be matched and permit balancing out any level differences between the two channels of each cartridge. Two of six accessory outlets on the rear are switched.

The published specifications for the preamp are quite comprehensive, in general reflecting state-of-the-art performance. The frequency response is stated at ±0.25 dB from 20 to 20,000 Hz through the phono and from 10 to 100,000 Hz through the high-level inputs. Phase shifts at 20,000 Hz are 2° through the low-level and 5° through the high-level inputs, and the A-weighted noise level is stated at better than 100 dB below a 10-mV phono input or a 1-volt high-level input.

Although the rated output is 2.5 volts, the maximum available output is greater than 5 volts. The phono-input overload is rated at 150 mV, while total harmonic distortion (THD) is rated at 0.05% or less in the audio range up to a 2.5-volt output. Even the input capacitance is specified—37 pF for the phono and 47 pF for the high-level input sections.

A time-delay relay allows 2.5 seconds pause for the power amplifier to stabilize before the preamplifier's outputs are activated.



Laboratory Measurements. As might be expected from the published specifications, measuring the performance of the preamp taxed the capabilities of our most advanced test instruments. At a 2.5-volt output, the THD was 0.03% at 20 Hz, 0.016% at 1000 Hz, and 0.042% at 20,000 Hz. However, our THD measurements include noise and hum that, low as they are, become comparable to the extremely low harmonic component levels and affect the meter readings. In addition, at 20 Hz, the residual distortion of our test generator is 0.02%, so that most of the measured distortion was present in the input signal.

With the aid of a Hewlett-Packard Model 3580A spectrum analyzer, we determined that the actual distortion present at 20 and 1000 Hz was the residual of the signal gererator at 0.02% and 0.0025%, respectively. The high-frequency distortion, measured at 15,000 Hz so that the third harmonic could be included in the 50,000-Hz range of the spectrum analyzer, was 0.025%. The output clipped at 8 volts, but even at 7 volts output, the distortion did not increase beyond the points at the 2.5-volt output level, except at 20,000 Hz where it was 0.14% at 7 volts output.

The intermodulation (IM) distortion was about 0.006% to 0.007% between 1 and 2.5 volts output. It was a mere 0.02% at 7 volts. At low outputs, it increased slightly to 0.09% at 80 mV.

At maximum gain, a 0.1-volt high-level input produced a reference 1-volt output. The wideband noise measurement, which included some r-f pickup from local broadcast stations, was 64.5 dB below 1 volt. With A weighting, the output noise was below our minimum measurement threshold of 100 µV, or better than 80 dB below 1 volt. Measurements through the phono inputs were identical to the high-level S/N measurements. The spectrum analyzer showed the power-line hum through the phono inputs (loaded by a magnetic cartridge) to be 65 dB below 1 volt. At minimum gain, the hum was 84 dB below 1 volt.

The phono sensitivity for a 1-volt output was between 0.65 mV and 1.5 mV, depending on the settings of the phono-sensitivity controls. The corresponding overload inputs were 85 and 190 mV. The measured crosstalk between channels was 70 dB down at 1000 Hz.

The frequency response, as rated, was flat to within ±0.25 dB from 20 to 20,000 Hz through the high-level and phono inputs. The phono equalization was virtually unaffected by cartridge inductance, with less than 1 dB of change up to 17,000 Hz. Through the high-level inputs, the frequency response was flat to the 5-Hz lower limit of our signal generator, down 1 dB at 58,000 Hz, and down 3 dB at 110,000 Hz. The slew rate of the preamp, rated at 4.8 volts/µs, was approximately 5 V/µs, making transient IM distortion an unlikely possibility.

Depending on the settings of the tone controls, the turnover frequencies could be varied from about 40 to 350 Hz in the bass range and from 1500 to 3000 Hz in the treble range. The filters had 3-dB down response frequencies of 65 and 6500 Hz.

User Comment. Listening tests are generally inconclusive where an electronic component with the nearly ideal performance of the Model Four preamplifier is concerned. Normally, since one cannot expect to hear any coloration from a virtually distortionless component, any qualities that appear to be audible can be traced to external causes. With this in mind, we connected the preamp to Epicure's matching Model One power amplifier and listened to both phono and FM tuner programs.

During our tests, we sensed a clarity and crispness that made even FM programs sound better through the Epicure components. However, realizing that the results of our laboratory tests might have colored our reactions to the Epicure system, we carefully compared it to several other high-quality systems. While we couldn't state with certainty that the Model Four sounded better or even different from other high-quality preamps, we are certain that we have never heard a preamp that sounded better or quieter (excluding preamps with special built-in noise-reduction circuits).

Besides being a superb performer, the Model Four is also built to rugged commercial standards. To this end, it uses a toroid-wound power transformer to minimize external hum fields, and it has three separately regulated power supplies.

Considering its quality of construction, performance, and control flexibility, the Epicure Model Four preamplifier is a genuine bargain for anyone who wants the finest performance.

KRIS VICTOR II AM MOBILE CB TRANSCEIVER

LED channel display and fine performance.

THE FRUSTRATING problem of not being able to see what channel you're on because of tiny numbers on a crowded selector dial has been solved in the Kris Victor II mobile AM CB transceiver. This 23-channel, crystal-synthesized rig features an easy-to-read 3/8" (9.5-mm) high LED display for easy readability up close, at a distance, and just about any angle off axis when mounted under the dash. In addition, large green and red lights signal when you are on receive and transmit, respectively.

Among the transceiver's more-or-less standard features are: volume control, variable squelch, PA operation, external-speaker jacks, illuminated S meter, switchable automatic noise limiter (anl), 13.8-volt dc nominal power requirement, reverse-polarity protection, supply line filter, and detachable push-to-talk dynamic microphone.

The transceiver measures 8½"D × 7⅝"W × 2³/₇"H (21.6 × 19.4 × 7.0 cm). It comes complete with mobile mounting hardware for $229.95. (The transceiver is also available without LED display as the Victor for $199.95.)

The Receiver. The double-conversion receiver's first i-f is 8.006 to 7.966 MHz, obtained by heterodyning the incoming signal with one of six crystal-controlled signals from the synthesizer in the 34.971-to-35.221-MHz range. The 455-kHz second i-f is produced by mixing the first i-f with one of four crystals in the 8.461-to-8.421-MHz range.

The digital numeric channel display is driven by IC decoder/drivers that are programmed by the channel selector switch. The display consists of two decades, one each for the units and tens channels.

Bipolar transistors are used in the diode-protected r-f amplifier and mixers. The r-f amplifier employs only one tuned circuit, which (together with the bipolar design) yielded a 40-dB image rejection that isn't quite as high as usual but is nevertheless adequate. Sensitivity was up to standard, measuring 0.5 μV for 10 dB (S + N)/N with 100% modulation at 1000 Hz. I-f signal rejection was a good 80 dB, while other unwanted spurious-signal rejection in the area around the CB range was 40 to 60 dB.

A mechancial filter at the i-f input is backed by an interstage ceramic filter to provide selectivity. Adjacent-channel rejection was 70 dB, at which point desensitization began.

The anl is a series-gate configuration. The amplified agc system was unusually uniform in the low-microvolt region. It maintained the audio output to within 1 dB with a 20-dB r-f input change at 1 to 10 μV. The output variation was 9 dB for a 60-dB input change at 10 to 10,000 μV. A 300-μV input signal was needed to register S9 on the meter.

The squelch threshold range was 0.5 to 30 μV. The output power from the class-B push-pull audio amplifier, using a 1000-Hz test signal, was nominally 1 watt with 10% THD into 4 or 8 ohms on both receive and PA. Overall audio response, including the i-f passband, was nominally 500 to 3000 Hz at the 6-dB down points.

The Transmitter. The carrier for the transmitter section is generated by mixing the appropriate synthesizer crystal frequency in the 34.9-MHz range with one of four crystal signals in the 8.006-to-7.966-MHz range. Spurious-response filtering circuits follow the mixer. The output of the mixer then goes to the usual three-stage r-f section that includes an r-f output power amplifier with its matching and filtering network and antenna switching relay. The modulation scheme is conventional, using the receiver section's audio system.

The r-f carrier output power measured 3.75 watts when we powered the transceiver from a 13.8-volt dc source. A 3.5% THD figure was measured with 100% sine-wave modulation using a 1000-Hz test signal. Because there is no automatic modulation control, raising the audio input about 6 dB above the level required for full modulation introduced clipping of both the negative and the positive peaks and a 13% THD figure. However, under normal voice operating conditions, splatter was held to nominally 50 dB down. The 6-dB audio response was 600 to 6000 Hz. The r-f frequency tolerance on any channel was within 0.002% at 80° F (27°C) ambient.

The reverse-polarity protection setup in this transceiver is rather unconventional. A diode is used in series with the supply line. It is polarized so that conduction is in the proper direction. Reverse connection simply doesn't permit current to flow through to the transceiver. With other protective methods that use a shunt-connected diode, you have the inconvenience of having to replace a blown fuse whenever the wrong-polarity hookups are made to the power source.

User Comment. The speaker is mounted on the left side of the transceiver's case where it faces the driver of the vehicle for better intelligibility during reception. The numeric channel display is an especially nice touch. Unfortunately, the S meter is small and can be difficult to read (as in most units of this type).

The anl was extremely effective, attenuating impulse noise of 50 to 60 dB above 1 μV down to virtually zero in the presence of a 0.5-μV signal. This, coupled with other fine performance figures, convenience features, and clean styling, makes the Kris Victor II an attractive transceiver to own.

CIRCLE NO. 82 ON FREE INFORMATION CARD

B&K PRECISION MODEL 280 DMM

Under-$100, portable digital multimeter.

THE Model 280 digital multimeter from B&K Precision has the size, shape and functions of a traditional analog VOM. Only the fact that the display is numeric tells the user that this is indeed a modern DMM.

The Model 280 is priced at $99.95, which makes it an attractive alternative to the ordinary VOM. It has a full complement of functions and ranges and can be operated from batteries for maximum flexibility and convenience. And the DMM is equally at home on a test bench or out in the field. Its rugged, high-impact Cycolac[R] case will take a lot of abuse while protecting the circuitry from damage.

The case measures 6⅜"H × 4⅜"W × 2"D (16.2 × 11.1 × 5.1 cm). The DMM itself weighs 2 lb (about 1 kg).

General Description. The DMM is designed to measure ac and dc voltage, ac and dc current, and resistance. Its 5/16" (7.94-mm) high seven-segment LED display consists of three full decades of readout and polarity indicator. Both polarity and zeroing are automatic. In all, there are 22 function/range combinations.

The DMM measures dc voltage to 1, 10, 100, and 1000 volts on its four ranges, with typical accuracy of ±1% full-scale. Input resistance is specified at 10 megohms for minimum circuit loading. The input circuit is protected to 1000 volts dc and ac rms.

The ranges, input resistance (impedance), and protection specifications for the ac voltage function are the same as for the dc voltage function. Accuracy is stated at ±2% (except on the highest range, where it is ±2.5%), and frequency response is 50 to 200 Hz.

Four ranges are also available for each of the ac and dc current functions. They provide a test range of from 1 mA to 1 ampere full-scale, with a resolution of 1 μA. The input circuits are protected with fuses and diodes. The voltage drop during testing is on the order of 100 to 300 mV, while the ac frequency range is 50 to 200 Hz.

The resistance function has six ranges: 100, 1K, 10K, 100K, 1M, and 10M full-scale. Alternate ranges are either high (1-volt) or low (0.1-volt) power, as indicated by the legends H and L in a cutout area at the lower left of the range switch. The high-power ranges are for conventional resistance measurements. The low-power ranges are for taking measurements in circuits that contain semiconductors. (The 0.1-volt test potential is too low to cause the junctions of semiconductors to bias on.) The test currents are: 1 mA on the 100 and 1K ranges, 100 μA on the 10K and 100K ranges, and 1 nA on the 1M and 10M ranges. The circuit is fully protected against accidental connections. Accuracy is typically ±2%, except on the highest range, where it is ±2.5%.

The decimal point is automatically positioned in the display when the range switch is moved from one position to another. Should the input exceed the measuring range to which the instrument is switched, all three LED displays will flash on and off to indicate an overrange condition. If a dc input is properly polarized with respect to the color-coded input jacks (red for "hot" or +, black for common or −), a + sign is implied in the display. A reversed-polarity input will cause a − sign to be displayed to the left of the numerals in the display.

Power for the DMM can be supplied by four C-size carbon-zinc, alkaline, or nickel-cadmium cells. (The basic price of the Model 280 does not include batteries. A set of four optional rechargeable NiCd cells is available for $20.00.) The DMM can also be powered from the ac line by using an optional ($8.00) battery eliminator/charger.

User Comment. The most important test of a meter is to determine how accurately it performs the measurements for which it is designed. Hence, we ran our usual accuracy tests, using highly accurate voltage and current sources and 0.1% precision tolerance resistors. In all respects, the Model 280 DMM was well within the published specifications.

The next thing to look for is convenience of use. Since there are only two controls (the range and function switches) and only one pair of input jacks, the Model 280 is about as convenient to use as any conventional DMM.

The cost has been kept down by eliminating an extra position on the function switch for battery testing. Instead, the user simply touches the tip of the red test probe to a small area of bare metal, accessible through a small hole on the right side of the case, to complete the battery-test circuit.

Our one negative observation while using the DMM is relatively minor. The design of the case precludes setting the instrument upright on the service bench. This minor inconvenience can be solved with the use of the optional No. MS-28 ($3.00) wire tilt stand.

There are two more optional accessories for the Model 280 DMM. One is the No. PR-21 isolation/direct probe ($10.00) that prevents capacitive loading when measuring a dc level in r-f circuits. The other is the No. LC-28 carrying case ($6.00) that protects the DMM and has compartments for the test leads and ac adaptor/battery charger.

The Model 280 represents a good investment for the technician or hobbyist looking for relatively good accuracy, wide testing flexibility, and portability in a DMM.

CIRCLE NO. 83 ON FREE INFORMATION CARD

Solid State

By Lou Garner

A UNIVERSAL LIGHT EMITTING DIODE

IF YOU think of light emitting diodes (LED's) only as indicators, a new breed introduced by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051) may change your mind. Unlike standard LED's, which are useful only in dc circuits and require current limiting, the new type NSL4944 can be used with dc *or* ac, will operate over a wide range of voltages without external limiting devices, and can be the principal active device in a variety of interesting and useful projects. Compared to an incandescent lamp, the new LED might well boast, "anything you can do, I can do better."

Represented symbolically as a constant current source in series with a light emitting diode, Fig. 1A, the NSL4944 comprises an integrated circuit chip and a GaAsP high-intensity red LED in a single plastic package. The IC includes (Fig. 1B) a pnp pass transistor, a voltage reference network, a voltage comparator, and a series current reference resistor. Since most of the regulating circuit is not in series with the LED, the complete device requires only about 300 mV more than a standard red LED. Further, because all of the current is through the pnp transistor's emitter, the device can serve as a medium level rectifier and a constant current source *in addition* to its role as a lamp.

Physically, the NSL4944 is no larger than conventional LED's and, with only two leads, can be interchanged with these in most applications. Its cathode lead is identified by a flat area on the circular base. Equipped with a diffused lens, the device can be panel mounted by means of a standard two-piece plastic adaptor or can be installed directly on circuit boards for wrapped or soldered connections. It can be mounted vertically, or horizontally, as shown in Fig. 1C. The rated operating and storage temperature range is −55 to 100°C., but with linear derating of 0.125V/°C above 25°C.

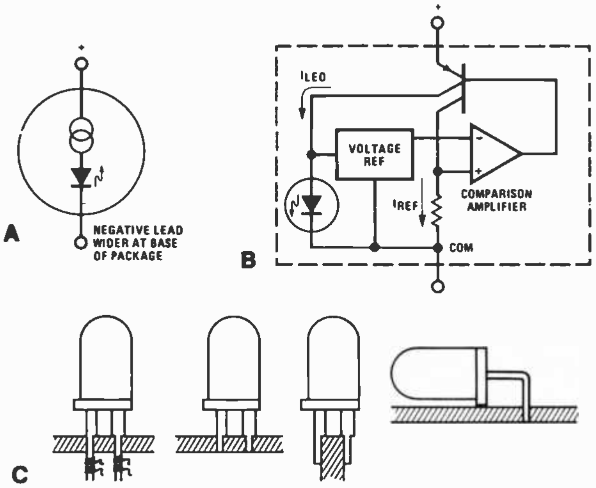


Fig. 1. (A) Schematic symbol for NSL4944. (B) Internal circuit. (C) Mounting methods.

The new device has an operating voltage range of (approximately) 2.0 to 18.0 volts and also can withstand reverse voltages up to 18.0 V. The light output remains essentially constant at (typically) 0.8 mcd from about 3 volts to maximum rated voltage. With a power dissipation rating of 300 mW at 25°C, the forward current varies from 12 to about 14 mA over the full voltage range. The device will operate at reduced intensity with sources of 1.6 to 1.9 volts capable of furnishing at least 8 mA, and can be switched on and off by any circuit capable of supplying 10 to 20 mA and a voltage swing of at least 1 volt. Typically, an applied voltage of 1.3 volts will result in little or no light output, while an increase to 2.3 volts will develop 70% to 90% of full light intensity.

National Semiconductor's specification sheet for the NSL4944 and a 4-page application note AN-153 suggest a number of practical circuits for the device.

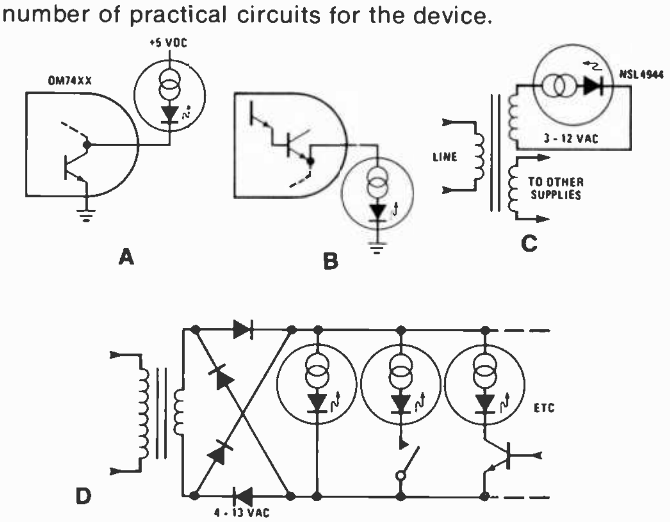


Fig. 2. NSL4944 applications: Low (A) and high (B) logic indicator; on ac (C) and dc (D) sources.

As a simple indicator, for example, the unit is ideal for applications ranging from digital logic designs to conventional pilot lamps. When driven by standard TTL devices, the NSL4944 can serve as a low or high status indicator, as suggested in Figs. 2A and 2B, respectively. The unit's ability to operate on ac as well as dc sources allows it to be used as a pilot lamp when powered by the low-voltage filament winding of a standard power transformer, as shown in Fig. 2C. When operated on ac, the unit's actual light intensity is halved, but the output level is more than adequate for most applications. The NSL4944 can also be used on unfiltered and unregulated dc sources, either alone or in conjunction with other components, such as switches, relays, or other solid-state devices (Fig. 2D).

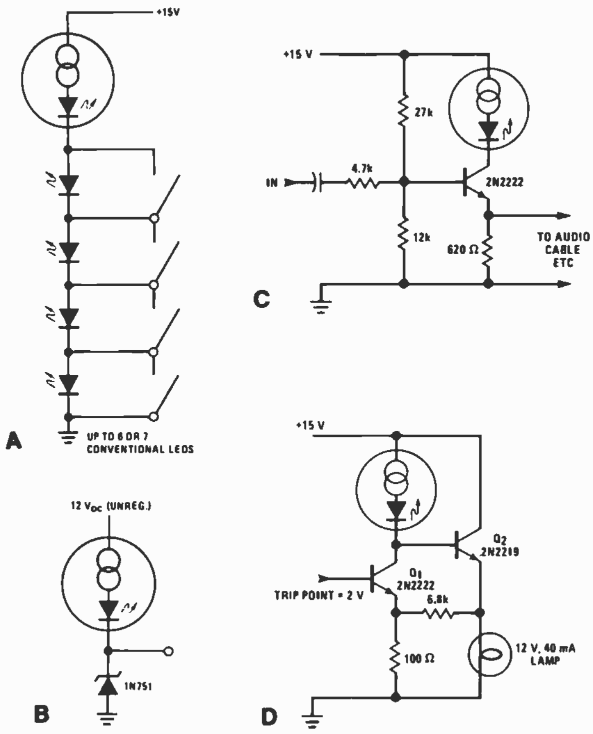


Fig. 3. Current source for LED's (A) and zeners (B). Load for line driver (C) and Schmitt lamp driver (D).

Another broad range of applications for the NSL4944 is when it is used as a constant current source. With a 15-volt dc supply, for example, it can furnish a controlled current for six or seven series-connected conventional LED's, (Fig. 3A). Shorting any number of the LED's in the string with switches, relay contacts, or other means will not affect the remainder, nor the NSL4944. Such an arrangement might be used, typically, to indicate relay, switch, or circuit-breaker closures. The device's constant current characteristic also is useful for operating a zener diode in voltage regulator circuits (Fig. 3B). If used in the collector circuit of an emitter follower preamp or line driver, as in Fig. 3C, the device will limit the output transistor's total current without affecting signal voltage swing, thus protecting the stage against damage due to line, cable or load shorts. Another application is shown in Fig. 3D. Here, the NSL4944 serves as an active load for a lamp driver circuit, increasing *Q1*'s useful voltage gain, but still permitting nearly full base bias on *Q2*. Substituting an LM195 for *Q2* and adding a 4.7-kilohm series base resistor will allow this circuit to handle 12-volt lamps rated at 1 ampere.

Several useful, easy-to-build projects featuring the NSL4944 are illustrated in Fig. 4. They include an ultra-simple "HI-LO" logic probe for TTL circuits, a time delay relay, and a small trickle charger for batteries (from 1.5 to 6 volts). The logic probe uses a pair of series-connected devices and is intended for use on standard 5-volt dc sources. The upper LED lights when the circuit test point is low, the lower LED when the TTL level is high. With a time delay of approximately six seconds, the relay circuit requires only two additional components, a large electrolytic capacitor and a sensitive high-impedance electromagnetic relay. The NSL4944's constant-current feature limits the timing variation to about 3% over a supply voltage range of 14 to 18 volts (much less than the variations due to temperature and capacitor tolerances). Finally, the simple trickle charger utilizes all three of the NSL4944's unique characteristics—as an indicator, a rectifier, and a constant

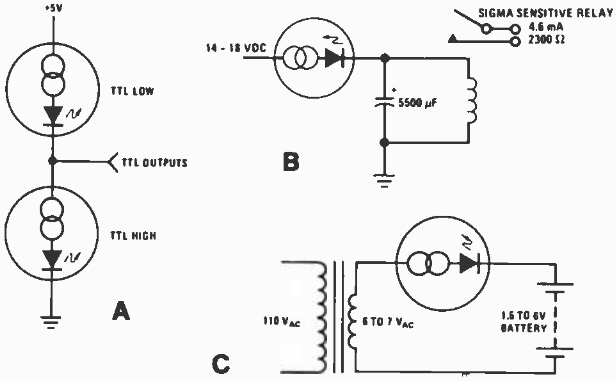


Fig. 4. Simple NSL4944 projects: (A) TTL probe; (B) time-delay relay; (C) trickle battery charger.

current source. Supplying a trickle charging current of 10 mA or more, the design requires only one additional electrical component—a small step-down transformer.

The circuit applications we've examined, although representative, are but a fraction of those possible with the versatile NSL4944. In addition, National Semiconductor suggests that the device can be used as a shorted SCR indicator in low-voltage circuits, a constant-current load for precision amplifiers, a reverse-voltage monitor for power supplies, a current limiter, and a regulated current source for voltage dividers or transducers, such as thermistors.

Right On! Although the bicentennial year has not yet run even half its course, a number of the predictions made in last January's column have materialized. At the Consumer Electronics Show in Chicago, Texas Instruments, Inc. (P.O. Box 5012, Mail Station 84, Dallas, TX 75222) introduced a line of electronic digital watches at suggested retail prices starting at $19.95, thus fulfulling my prediction of *digital electronic watches retailing for less than $25.00.* The watches TI-501 and TI-502, feature a five-function electronic module in black, brown, beige or white polysulfone cases (the impact-, heat- and abrasion-resistant material used in the visors of the Apollo Astronauts). A metal-cased version offered in chrome and gold tone, the TI-401, lists at prices starting at $29.95.

Another major manufacturer, Fairchild's Consumer Products Group (4001 Miranda Ave., Palo Alto, CA 94303) also has introduced a line of low-cost digital LED watches. Fairchild's new line *Timeband*™ features all metal cases with either gold or chromium finish, single-button five-function operation, and list prices starting at $29.95.

Another prediction, *a substantial drop in the prices of microprocessors and memory IC's,* has been fulfilled not only by substantial price cuts in older models but by the introduction of new devices at lower prices. Already within the budget limits of many hobbyists and experimenters, microprocessor and memory IC prices probably will drop even further before year's end.

Reader's Circuit. With potential applications as a digital logic clock, electronic metronome, wide-range test oscillator, harmonic generator, relay pulser, time marker generator, scope sweep oscillator, and frequency divider, the astable pulse oscillator circuit in Fig. 5 requires only two transistors, yet provides nine octaves of frequency coverage with a single control. Easily duplicated at home, the design was submitted by Peter Lefferts (1640 Decker Ave., San Martin, CA 95046).

Timing capacitor *C1* is charged slowly by the dc source, *B1,* through voltage-divider *R1-R2* until *Q1* is forward-biased and starts conducting. When this occurs, a forward base bias is applied to *Q2* through *Q1*'s split collector load *R3-R4.* As *Q2* starts conducting, a pulse is developed across its collector load, *R6,* which, coupled back to *Q1*'s base through capacitor *C2* and series resistor *R5,* drives *Q1* to a heavily conducting state, rapidly discharging *C1.* Then the cycle starts over. In essence, *Q1* and *Q2* form a high gain amplifier with *C2* providing positive feedback. Diode *D1* reduces feedback capacitor *C2*'s recovery time, while potentiometer *R8* establishes *Q1*'s base bias level and thus the point at which timing capacitor *C1* charges before feedback and capacitor discharge is initiated. The lower *Q1*'s initial base bias, the higher the circuit's repetition rate. Potentiometer *R8,* therefore, serves as the circuit's frequency control. Circuit power is supplied by dc source *B1,* controlled by a spst power switch, *S1.*

The circuit can be assembled using any standard construction method, provided good wiring practice is observed. Transistors *Q1* and *Q2* are types 2N1304 and 2N1372, respectively, while *D1* is type 1N34A. Except for the 10-kilohm potentiometer, *R8,* the resistors can be either 1/4 or 1/2 watt. Capacitors *C1* and *C2* are low-voltage ceramic, paper or plastic film units. Power switch *S1* can be any spst type. The circuit will operate with dc sources of 5 to 25 volts, but a 12-volt dc source is optimum.

Although designed primarily as a pulse generator, other waveforms may be obtained at various points in the circuit, including the *D1-C2-R5* junction and at *Q1*'s collector. A sawtooth signal suitable for use as a linear scope sweep is

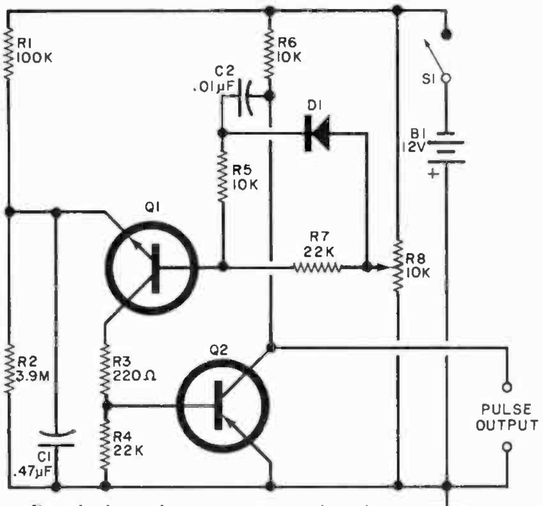
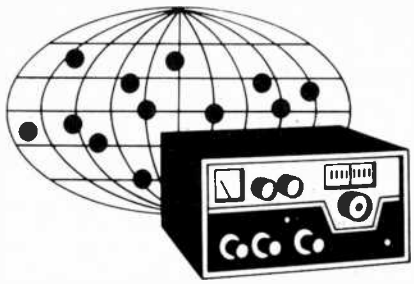


Fig. 5. Reader's pulse generator circuit.

available across *C1*. For frequency-divider, sweep-generator, and time-marker applications, synchronization pulses can be applied to *Q1*'s base through a small coupling capacitor. The circuit's frequency range can be shifted by using other values for *C1* and *C2*. With values of 100 μF for *C1* and 3 μF for *C2*, the circuit will operate down to approximately 1/20 Hz. Lower values than those given in Fig. 5 will permit operation at ultrasonic frequencies, but it may be necessary to reduce resistor values to 1/10 of those listed, except for *R3*, which should not be less than 100 ohms.

Device/Product News. In addition to its versatile NSL4944 universal LED, the National Semiconductor Corporation has introduced a number of new devices of interest, including a family of four Tri-State octal buffer IC's. The buffers, types DM81LS95, DM81LS96, DM81LS97 and DM81LS98, offer typical power consumptions of under 80 mW and propagation delays of less than 14 ns. Each device provides eight 2-input buffers in a single package, with one of the two inputs to each buffer used as a control line to gate the output into a high-impedance state and the other to pass data into the buffer. Types DM81LS95 and 97 present true data at their outputs, while the DM81LS96 and 98 invert the data. In the DM81LS95 and 96, all eight Tri-State enable lines are common, with access gained through a two-input NOR gate. In the DM81LS97 and 98, four of the eight buffers are enabled by one common line, the other four through another common line.

A TTL-compatible NMOS digital frequency synthesizer for use in CB, marine and avionics transceivers as well as digital TV tuners has been announced by Nitron, a division of the McDonnell Douglas Corporation (10420 Bubb Road, Cupertino, CA 95014). The new IC, type NC6400, requires only a reference oscillator, a VCO, an appropriate data input and an optional prescaling counter to form a complete digital frequency synthesizer system. The device is internally programmable to provide up to 80 channels with different transmit and receive frequencies available for each. The frequency desired is called up by keying the appropriate channel number into either a 3 × 4 matrix keyboard or by presenting it in BCD code on a four-line data bus. Decoded seven segment (or 4-line BCD) outputs are provided to display the number of the channel called up, plus three additional outputs which can be programmed to indicate illegal channel entry, emergency channel, or similar information. ◈



DX Listening

By Glenn Hauser

FREQUENCY MEASUREMENT

THE search for frequency accuracy on a shortwave receiver involves a number of steps. First, you find the right meter band—perhaps a bit offset from where it should be on the receiver dial. Then you reach the stage where it's important to separate frequencies to the nearest 5 kHz—the standard spacing of SW stations. Once you're deeply involved in DX listening, you're concerned with "splitting" frequencies down to 1 kHz, or even a fraction of 1 kHz. Even direct frequency readout receivers are not precise enough for this.

Building or buying a frequency counter is the best—but not the only—solution. Operating a frequency meter requires laboriously constructed calibration charts. Crystal calibrators give markers at 10, 25 or 100 kHz intervals; the circuit is simple and plans are frequently published. But there are other, devious ways to measure frequencies with equipment you may already have!

Let's begin with the big steps and refine them as we go. It could be that your receiver is so poorly calibrated that you're not sure which MHz is which—especially toward the top end of the dial. Any two receivers will interact with each other, and we can put this seeming liability to good use.

Any old AM radio will do—even a portable. We assume the intermediate frequency is 455 kHz. If not, the principle still applies, but the figures will be different. Place the AM radio near your DX receiver, and tune the AM radio to 545 kHz. This means it is oscillating (and radiating) at 545 + 455 kHz = 1000 kHz. You can tell when it's exactly on 545 by *zero-beating* it against a 1000-kHz station on the DX receiver. Now, use the AM radio as a '1000-kHz calibrator' on up the dial every 1000 kHz (1 MHz). Or, go even higher in 2-MHz steps by tuning to 1545 kHz for 2000 kHz oscillation. Check the accuracy of your setting against WWV. Once you're satisfied, mark in the true MHz steps on the dial for future reference.

Now, say you're hearing a SW station whose frequency you wish to determine. If you know your way around the AM dial, and there's a station on almost every channel (especially at night), start at the top end of the AM dial and work downward till a beat first crosses the SW signal. Tune back and forth carefully till it's zero-beat. Now read off the AM frequency as accurately as possible, add 455, and multiply by an integer. One of the products (*which* one should be obvious) will give you the SW frequency—not with great precision, but perhaps more exactly than you could have determined it otherwise.

Depending on the stability of the AM radio, the "calibration carrier" it produces can also serve as a BFO to demodulate CW or SSB signals. If you have a second SW receiver, you can get a more stable but much stronger beat (perhaps *too* strong) by tuning 455 kHz away from the BFO frequency. This same principle of beating one receiver against another applies in many other combinations. For instance, before detent uhf tuning was available, one could easily tell TV channel 82 from 83 by beating an FM receiver against TV!

You can also turn the annoying "double i-f images" to an advantage. These occur 910 kHz above or below the true frequency in single-conversion receivers. Say you're hearing a ham station just between Spain and Switzerland's images on the 14-MHz band. You know the true frequencies are 15130 and 15140 kHz—so the ham must be 910 kHz lower, or at about 14225 kHz.

A conventional way to measure frequencies is to construct a calibration chart using known stations. By graphing the known frequencies on one axis against dial readings on the other, you can interpolate and extrapolate where other frequencies should appear. Most tuners are *not* linear. If your receiver is general-coverage, but with bandspread calibrated only on the ham bands, you can adapt it to broadcast bands by assigning different values to the bandspread's interval markers.

At a much more precise level, if you know the frequency of one station, and another is heterodyning it (producing an audible tone—usually less than 5000 Hz), you can easily compute the frequency of the off-channel station by measuring the tone on a musical instrument, such as a piano, guitar or pitch pipe. Be sure you're on the right octave and interpolate if necessary on the accompanying table. The *separation* between the two frequencies is exactly the same as the pitch of the audio tone they produce. This method is known as inferential frequency measurement by heterodyne analysis. Certain risks and limitations apply; the reference station must be one known to stay very close to its nominal frequency. Sometimes the two are so close that it is hard to tell which station is on which side.

Musical Notes and Corresponding Heterodyne Frequencies

A	.110	.22	.44	.88	1.76	3.52
B♭	.117	.23	.47	.93	1.86	3.73
B	.123	.25	.49	.99	1.98	3.95
C	.131	.26	.52	1.05	2.09	4.19
C#	.139	.28	.55	1.11	2.22	4.43
D	.147	.29	.59	1.17	2.35	4.70
E♭	.156	.31	.62	1.24	2.49	4.98
E	.165	.33	.66	1.32	2.64	
F	.175	.35	.70	1.40	2.79	
F#	.185	.37	.74	1.48	2.96	
G	.196	.39	.78	1.57	3.14	
G#	.208	.42	.83	1.66	3.32	

Frequencies are in kHz; based on standard tempered scale wherein A above middle C equals 440 Hz. Notes other than A are not precise, but rounded. The third digit in the first octave explains the rounding in higher octaves.

Now to the most precise level—subaudible heterodynes (SAH), produced when two signals mix within 15 Hz of each other. Unless they are on *exactly* the same frequency, the difference causes the S-meter to oscillate at regular intervals. Sometimes you can *hear* this regular "swish" but not the audio pitch involved. The SAH is strongest when two signals are of equal strength. Sometimes there is too much propagational fading overriding the effects of the SAH. With a stopwatch, or one eye on the clock and the other on the S-meter, count the number of fluctuations in a one-minute period, and then divide by 60. This gives you the number of cycles per second (Hz) of separation between the two signals.

One application of this is in determining which of two *audibly* heterodyning signals is 'on' frequency. It is extremely improbable that two signals will *happen* to land within "SAH range" of each other if both are drifting off their nominal frequency. So if there's a noticeable SAH (even without bothering to measure it or identify the sources), it's a very good bet that the SAH-ridden station is 'on' frequency and can be a realiable reference when measuring an audible heterodyne as described previously.

When dealing with such problems, you soon notice that some signals vary in frequency—some so rapidly that instead of a clean heterodyne tone, you hear an oscillating frequency. Others vary significantly over a period of hours or days. On mediumwave, some stations are slightly off-frequency *and* are so steady that, with the aid of precise frequencies published by the European Broadcasting Union, North American DX listeners can make a very reliable guess at what two stations they are receiving on a European "split" channel—simply by determining the SAH between them, even with little or no audio detected.

The exact frequency of a station is one of its most distinctive characteristics. Some "splits" are so well-established and steady that once you pin them down, no further re-identification is necessary. When reporting to DX bulletins or to a station for QSL, the more precisely you can specify the frequency, the better for the station and other listeners.

Video Signals Heterodyne Too. Figure 1 shows two channel 13 signals within 1 kHz of each other. Since one of the stations was nearby and its exact frequency known, the other DX station could be identified, since no others were operating on the same "offset" in the area affected by the unusual propagation.

Fig. 1. WJCT, ch 7, Jacksonville.


Fig. 2. WFLA, ch 8, Tampa.

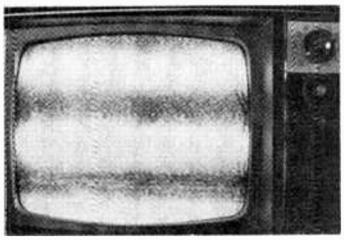


Fig. 3. WTVT, ch 13, Tampa. Interference with KETA, Okla. City.


Fig. 4. WJHG, ch 7, Panama City.

Sporadic E is the intense skip phenomenon (usually in the summer) that bounces CB, PSB, TV and FM signals all over the continent. Seldom does it reach much above the FM band (108 MHz), but on very rare occasions, it can hit the high vhf TV band of channels 7 to 13 (174-216 MHz). Figures 1 to 4 show the results of sporadic E I saw last summer in Oklahoma. It's too much to expect such rare openings to peak during ID times, but I was able to identify the stations based on circumstantial evidence (local programming, offset interference, etc.).

A careful watch on the highband channels during intense sporadic E openings this summer might reward you with such rare DX'ing. ◈

MAY-AUGUST ENGLISH-LANGUAGE SW B'CASTS by Richard E. Wood

TO EASTERN NORTH AMERICA

TIME—EDT	TIME—GMT	STATION	QUAL*	FREQUENCIES, MHz
6:30 a.m.-8:00 p.m.	1030-2400	**Montreal, Canada (Northern Service)	G	9.625, 11.72 (includes French, etc.)
7:00-7:25 a.m.	1100-1125	Tirana, Albania	F	9.48, 11.985
7:00-9:15 a.m.	1100-1315	London, England	G	15.07
7:00-10:00 a.m.	1100-1400	**VOA, Washington, U.S.A.	G	9.955, 9.73
7:15-8:15 a.m.	1115-1215	Montreal, Canada	G	5.97, 9.655
7:15-8:45 a.m.	1115-1245	Melbourne, Australia	G	9.58
8:00-8:30 a.m.	1200-1230	Jerusalem, Israel	F	11.655, 15.10, 15.487, 17.685, 17.815
8:00-8:55 a.m.	1200-1255	Peking, China	F	11.685
8:15-8:30 a.m.	1215-1230	HCJB, Quito, Ecuador	G	11.745
8:30-9:00 a.m.	1230-1300	Stockholm, Sweden	G	15.305
8:30 a.m.-12:30 p.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115 (Sun. 1600)
9:15-9:45 a.m.	1315-1345	Berne, Switzerland	G	15.14
9:15 a.m.-4:00 p.m.	1315-2000	**London, England	G	15.07
10:00-10:30 a.m.	1400-1430	Helsinki, Finland	G	15.185
		Stockholm, Sweden	G	15.305
11:00 a.m.-12:15 p.m.	1500-1615	London, England	G	17.84 (via Ascension)
1:00-2:00 p.m.	1700-1800	**Paris, France	G	9.74, 11.705, 11.89, 11.93, 11.965, 15.21, 15.30, 15.36, 15.425, 17.72, 17.80, 17.82, 21.62
1:00-2:15 p.m.	1700-1815	London, England	G	15.365 (via Sackville)
2:45-4:00 p.m.	1845-2000	**Abidjan, Ivory Coast	F	11.92 (Mon.-Sat.)
3:45-6:30 p.m.	1945-2230	**Delhi, India	F	9.525, 9.912, 11.62
4:00-4:30 p.m.	2000-2030	**Tehran, Iran	F	9.022
4:00-4:55 p.m.	2000-2055	Jerusalem, Israel	G	9.815, 11.645, 15.487
4:00-5:00 p.m.	2000-2100	**Brasilia, Brazil	G	15.24
4:00-5:15 p.m.	2000-2115	**London, England	G	11.75, 15.07, 15.26
4:45-5:00 p.m.	2045-2100	**Valletta, Malta	G	9.755 (Sat.)
5:00-5:50 p.m.	2100-2150	**Johannesburg, South Africa	G	5.98, 7.27, 11.90
5:15-6:45 p.m.	2115-2245	London, England	G	9.58 (via Ascension), 11.78, 15.26 (via Ascension)
5:30-6:50 p.m.	2130-2250	Hilversum, Holland	G	9.715, 11.73 (Sun.: Dutch)
5:45-7:00 p.m.	2145-2300	**Cairo, Egypt	G	9.805
6:00-6:15 p.m.	2200-2215	**Belgrade, Yugoslavia	F	9.62
6:00-9:20 p.m.	2200-0120	**Ankara, Turkey	F	9.515, 11.88
6:30-7:00 p.m.	2230-2300	Vilnius, U.S.S.R.	G	9.685, 9.735, 9.745, 11.75, 11.77, 11.79 (Sat./Sun.)
6:30-7:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 9.695, 11.90
6:45-8:30 p.m.	2245-0030	London, England	G	5.975, (from 2300), 7.325, 9.58 (via Ascension), 11.78
7:00-7:30 p.m.	2300-2330	Stockholm, Sweden	F	6.12, 9.605, 11.705
		Helsinki, Finland	P	15.185
7:00-7:50 p.m.	2300-2350	**Buenos Aires, Argentina	G	11.71 (Mon.-Fri.)
7:00-8:30 p.m.	2300-0030	Moscow, U.S.S.R.	G	5.905, 7.10, 7.11, 7.33, 9.635, 9.665, 9.685, 11.72, 11.75, 11.87, 12.00, 12.05, 15.21, 15.245, 17.72, 17.76, 17.90
7:00-9:00 p.m.	2300-0100	Montreal, Canada	G	6.085 (Mon.-Fri.)
7:45-8:00 p.m.	2345-0000	**Voice of the Org. of American States, Washington, U.S.A.	G	9.64, 11.74, 15.16
7:45-8:45 p.m.	2345-0045	Tokyo, Japan	F	15.27, 15.30
8:00-8:25 p.m.	0000-0025	Tirana, Albania	G	7.065, 9.78 (varies)
8:00-8:30 p.m.	0000-0030	Oslo, Norway	G	9.645, 11.86, 15.175 (Sun.)
8:00-8:55 p.m.	0000-0055	Peking, China	F	11.945, 15.06, 17.673
		Sofia, Bulgaria	F	9.70
8:00-9:00 p.m.	0000-0100	**Luxembourg	F	6.09
8:00-10:00 p.m.	0000-0200	**VOA, Washington, U.S.A.	G	6.13, 9.65, 11.83
8:00 p.m.-1:05 a.m.	0000-0505	**Montreal, Canada (Northern Service)	F	5.96, 9.625 (includes French, etc.)
8:15-8:30 p.m.	0015-0030	Athens, Greece	P	9.52
8:30-8:55 p.m.	0030-0055	Prague, Czechoslovakia	F	6.055, 9.54
8:30-9:00 p.m.	0030-0100	Kiev, U.S.S.R.	G	6.02, 9.50, 9.54, 9.60, 9.665, 9.72, 11.69, 11.72, 11.735, 11.85, 12.00, 12.05, 15.21, 15.245, 17.72, 17.76, 17.90 (Mon./Thur./Sat.)

		Vilnius, U.S.S.R.	G	9.685, 11.77, 11.79 (Sat./Sun.)
		HCJB, Quito, Ecuador	G	9.56, 11.915
8:30-11:30 p.m.	0030-0330	London, England	G	5.975, 7.325, 9.58 (via Ascension)
9:00-9:15 p.m.	0100-0115	Vatican City	G	5.995, 9.605, 11.845
9:00-9:20 p.m.	0100-0120	Rome, Italy	G	9.575, 11.81
9:00-9:45 p.m.	0100-0145	Berlin, Ger. Dem. Rep.	F	9.73
		Madrid, Spain	G	6.065, 11.88 (Mon.-Sat.)
9:00-9:55 p.m.	0100-0155	Peking, China	G	7.12, 9.78 (via Tirana), 9.94, 11.675, 11.945, 15.06, 17.855
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.74, 11.99
9:00-10:00 p.m.	0100-0200	Montreal, Canada	G	6.085, 9.655
		Moscow, U.S.S.R.	G	5.905, 7.10, 7.11, 7.33, 9.53, 9.60, 9.635, 9.665, 9.685, 9.70 (via Sofia), 11.72 (from 0130), 11.87, 12.00, 12.05, 15.21, 15.245, 17.72, 17.76, 17.90
9:00-11:00 p.m.	0100-0300	Melbourne, Australia	F	15.32, 17.795
9:00-11:30 p.m.	0100-0330	Havana, Cuba	G	11.725, 11.93
9:00 p.m.-3:00 a.m.	0100-0700	HCJB, Quito, Ecuador	G	6.095, 9.56, 11.915 (includes some Eskimo)
9:30-9:50 p.m.	0130-0150	Cologne, Ger. Fed. Rep.	G	6.01, 6.04, 6.10 (via Malta), 9.565, 9.69, 9.745, 11.865 (via Malta)
9:30-9:55 p.m.	0130-0155	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
9:30-10:25 p.m.	0130-0225	Bucharest, Rumania	F	5.99, 9.57, 9.68, 11.775, 11.94
9:45-10:15 p.m.	0145-0215	Berne, Switzerland	G	5.965, 6.135, 9.725, 11.715
10:00-10:30 p.m.	0200-0230	Budapest, Hungary	G	6.00, 6.115, 9.585, 9.833, 11.91, 15.22 (Ex. Sun.)
		Lisbon, Portugal	F	6.025, 11.935
		Oslo, Norway	F	6.18, 9.645, 11.86 (Sun.)
		Warsaw, Poland	P	6.095, 6.135, 7.27, 9.675, 11.815, 11.84, 15.12
10:00-10:45 p.m.	0200-0245	Madrid, Spain	G	6.065, 11.88 (Mon.-Sat.)
10:00-10:55 p.m.	0200-0255	Peking, China	F	9.94, 11.675, 15.06, 17.855
10:00-11:00 p.m.	0200-0300	Moscow, U.S.S.R.	G	5.905, 7.10, 7.11, 7.33, 9.53, 9.60, 9.635, 9.665, 9.685, 9.70 (via Sofia), 11.72, 11.87, 12.00, 12.05, 15.21, 15.245, 17.72, 17.76, 17.90
10:00-11:20 p.m.	0200-0320	Hilversum, Holland	G	6.165 (via Bonaire)
10:00-11:30 p.m.	0200-0330	Cairo, Egypt	G	9.475
10:30-11:00 p.m.	0230-0300	Beirut, Lebanon	P	9.67
		Lisbon, Portugal	F	6.025, 11.935
		Tirana, Albania	G	6.20, 7.30
11:00-11:30 p.m.	0300-0330	Budapest, Hungary	G	6.00, 6.115, 9.585, 9.833, 11.91, 15.22
		Kiev, U.S.S.R.	G	7.15, 9.61, 9.72, 11.69, 11.72, 11.77, 12.00, 12.05, 15.21, 15.245, 17.72, 17.76
11:00-11:35 p.m.	0300-0335	Warsaw, Poland	P	6.095, 6.135, 7.27, 9.675, 11.815, 11.84, 15.12
11:00-11:45 p.m.	0300-0345	Madrid, Spain	G	6.065, 11.88 (Mon.-Sat.)
11:00-11:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (via Tirana)
11:00-12 mdt.	0300-0400	Buenos Aires, Argentina	G	9.69 (Mon.-Fri.)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.74, 11.99
		Moscow, U.S.S.R.	G	5.905, 7.33, 9.53, 9.665, 9.685, 9.70 (via Sofia)
11:30-11:55 p.m.	0330-0355	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
11:30-12:30 a.m.	0330-0430	London, England	G	5.975, 9.58 (via Ascension)
11:30-12:50 a.m.	0330-0450	Havana, Cuba	G	11.725, 11.76, 11.93
12 mdt.-12:15 a.m.	0400-0415	Budapest, Hungary	G	6.00, 6.115, 9.585, 9.833, 11.91, 15.22 (Tue./Fri.)
		Jerusalem, Israel	G	5.90, 7.412, 9.009, 12.025
12 mdt.-12:25 a.m.	0400-0425	Bucharest, Rumania	F	5.99, 9.57, 9.68, 11.775, 11.94
12 mdt.-12:30 a.m.	0400-0430	Sofia, Bulgaria	G	9.70
12 mdt.-1:00 a.m.	0400-0500	Moscow, U.S.S.R.	G	5.905, 7.33, 9.53, 9.60, 9.665, 9.685, 9.72, 11.735, 11.77
12 mdt.-2:00 a.m.	0400-0600	Montreal, Canada	G	6.135, 9.655
12:30-1:00 a.m.	0430-0500	**London, England	G	6.005, 9.58 (via Ascension)
12:50-2:00 a.m.	0450-0600	Havana, Cuba	G	11.725, 11.76
1:00-2:00 a.m.	0500-0600	**London, England	G	6.005, 7.27, 9.60 (via Ascension)
1:00-4:00 a.m.	0500-0800	**Kuwait, Kuwait	F	15.345

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TO WESTERN NORTH AMERICA

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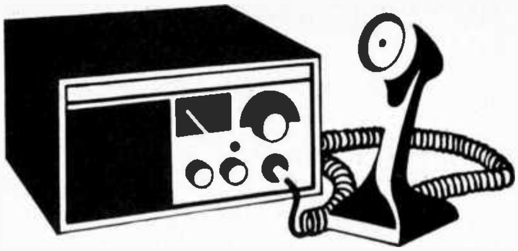
4:00-4:15 a.m.	1100-1115	Tokyo, Japan	G	5.99
4:00-7:00 a.m.	1100-1400	**VOA, Washington, U.S.A.	G	5.955, 9.73
5:00-5:15 a.m.	1200-1215	Tokyo, Japan	P	5.99
5:00-6:30 a.m.	1200-1330	London, England	G	5.99 (via Sackville)(opens 1300 Sun.)
5:15-9:30 a.m.	1215-1630	HCJB, Quito, Ecuador	G	11.745
6:00-6:15 a.m.	1300-1315	Tokyo, Japan	P	5.99
6:30-8:00 a.m.	1330-1500	**Delhi, India	F	11.81, 15.345
6:30-9:15 a.m.	1330-1615	**London, England	F	9.74, 11.75, 15.31 (via Tebrau)
7:00-7:30 a.m.	1400-1430	Tokyo, Japan	G	9.505
7:00-8:20 a.m.	1400-1520	**Hilversum, Holland	G	11.74 (via Talata)
7:00-9:55 a.m.	1400-1655	Manila, Philippines	F	9.58 (Closes 1555 Sun.)
8:00-8:15 a.m.	1500-1515	Tokyo, Japan	G	9.505
8:00-9:15 a.m.	1500-1615	London, England	G	17.84 (via Ascension)
9:00-9:15 a.m.	1600-1615	Tokyo, Japan	G	9.505
9:00 9:30 a.m.	1600-1630	Oslo, Norway	F	17.80 (Sun.)
9:45-9:51 a.m.	1645-1651	Hilversum, Holland	G	11.82, 15.19 (via Bonaire, Mon.-Fri.)
10:00-10:15 a.m.	1700-1715	Tokyo, Japan	G	9.505
10:00-11:30 a.m.	1700-1830	London, England	G	15.365 (via Sackville)
10:45 a.m.-2:15 p.m.	1745-2115	**London, England	F	11.82 (via Ascension)
11:00-11:15 a.m.	1800-1815	Tokyo, Japan	G	15.105
12 noon-12:07 p.m.	1900-1907	**Papeeté, Tahiti	F	11.825, 15.17 (exc. Sun.)
12 noon-12:15 p.m.	1900-1915	Tokyo, Japan	G	15.105
1:00-1:15 p.m.	2000-2015	Tokyo, Japan	G	15.105
1:00-1:55 p.m.	2000-2055	Jerusalem, Israel	F	11.645, 12.025, 15.487
1:00-2:20 p.m.	2000-2120	**Hilversum, Holland	G	11.73 (via Talata)
2:00-2:15 p.m.	2100-2115	Tokyo, Japan	G	15.105
2:15-4:00 p.m.	2115-2300	London, England	G	15.26 (via Ascension)
3:00 3:15 p.m.	2200-2215	Tokyo, Japan	G	15.105
3:00-5:00 p.m.	2200-0000	**VOA, Washington, U.S.A.	G	17.82, 17.895, 21.61
3:30-4:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 9.695, 11.90
4:00-4:30 p.m.	2300-2330	Tokyo, Japan	G	15.105
4:00-5:30 p.m.	2300-0030	London, England	G	6.175, 9.51 (via Sackville), 9.58, 15.26 (via Ascension)
		Moscow, U.S.S.R.	G	12.05, 15.21, 15.245, 17.72, 17.76, 17.90 (via Soviet Far East)
4:00-6:00 p.m.	2300-0100	Montreal, Canads	G	6.085 (Mon.-Fri.)
5:00-5:15 p.m.	0000-0015	Tokyo, Japan	G	15.105
5:00-7:00 p.m.	0000-0200	**VOA, Washington, U.S.A.	G	11.71, 15.205
5:30-6:00 p.m.	0030-0100	HCJB, Quito Ecuador	G	9.56, 11.915
5:30-8:30 p.m.	0030-0330	London, England	G	6.175 (via Sackville), 9.51 (via Greenville), 9.58 (via Ascension)
6:00-6:15 p.m.	0100-0115	Tokyo, Japan	G	15.105
6:00-8:00 p.m.	0100-0300	Moscow, U.S.S.R.	G	12.00, 12.05, 15.21, 15.245, 17.72, 17.76, 17.90 (via Soviet Far East)
		Melbourne, Australia	G	15.32, 17.795
6:00-12 mdt.	0100-0700	HCJB, Quito, Ecuador	G	6.095, 9.56, 11.915 (includes Eskimo)
6:30-7:30 p.m.	0130-0230	Tokyo, Japan	G	15.195, 15.39, 17.725, 17.825
7:00-7:15 p.m.	0200-0215	Tokyo, Japan	G	15.105
7:00-7:55 p.m.	0200-0255	Peking, China	G	11.675, 15.06, 17.855
7:00-8:50 p.m.	0200-0350	Taipei, Taiwan	G	11.86, 15.125, 17.72, 17.89
7:30-8:00 p.m.	0230-0300	Stockholm, Sweden	P	9.695, 11.705
8:00-8:15 p.m.	0300-0315	Tokyo, Japan	G	15.105
8:00-8:30 p.m.	0300-0330	Kiev, U.S.S.R.	G	12.05, 15.21, 15.245, 17.72, 17.76 (via Soviet Far East)
8:00-8:45 p.m.	0300-0345	Madrid, Spain	P	6.065, 11.88 (Mon.-Sat.)
8:00-8:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (via Tirana), 15.06, 15.385, 17.735, 17.855
8:00-9:25 p.m.	0300-0425	**Johannesburg, S. Africa	G	3.995, 4.875, 5.98, 7.27
8:00-9:35 p.m.	0300-0435	**San Jose, Costa Rica	F	6.175, 9.645
8:22-8:28 p.m.	0322-0328	Erevan, U.S.S.R.	G	11.96, 15.13, 15.18, 15.455, 17.90 (Sat./Tue./Wed./Fri., via Far East)
8:30-9:00 p.m.	0330-0400	Moscow, U.S.S.R.	G	6.02, 9.635, 11.96, 12.05, 15.13, 15.18, 15.21, 15.245, 17.72 (via Soviet Far East)

8:30-9:15 p.m.	0330-0415	Berlin, Ger. Dem. Rep.	P	9.73, 11.84, 11.89
8:30-9:30 p.m.	0330-0430	London, England	G	6.175 (via Sackville), 9.58 (via Ascension)
9:00-9:15 p.m.	0400-0415	Jerusalem, Israel	F	9.815
		Tokyo, Japan	G	15.105
9:00-9:30 p.m.	0400-0430	Sofia, Bulgaria	P	9.70
		Budapest, Hungary	P	6.00, 6.135, 9.585, 9.833, 11.91 (Tue., Fri.)
		Oslo, Norway	F	9.645, 11.86, 11.87 (Sun.)
9:00-10:00 p.m.	0400-0500	Moscow, U.S.S.R.	G	6.02, 9.635, 9.71 (from 0430), 11.96, 12.05, 15.10, 15.13, 15.18, 15.21, 15.245 (via Far East)
9:00-11:00 p.m.	0400-0600	Montreal, Canada	G	6.135, 9.655
9:15-10:30 p.m.	0415-0530	Bangkok, Thailand	P	9.655, 11.905
9:30-10:00 p.m.	0430-0500	Lisbon, Portugal	P	6.025, 11.935
		Berne, Switzerland	F	9.725, 11.715
		Vienna, Austria	P	6.015
9:30-10:00 p.m.	0430-0500	**London, England	G	6.005, 9.58 (via Ascension)
9:30-10:15 p.m.	0430-0515	**Cologne, Ger. Fed. Rep.	F	7.225 (via Kigali)
10:00-10:15 p.m.	0500-0515	Tokyo, Japan	G	15.105
10:00-10:30 p.m.	0500-0530	Seoul, Rep. of Korea	F	9.64, 15.335
10:00-11:20 p.m.	0500-0620	Hilversum, Holland	G	6.165, 9.715 (via Bonaire)
10:00 p.m.-12 mdt.	0500-0700	**London, England	G	6.005, 7.27, 9.60 (via Ascension)
10:00-12:30 a.m.	0500-0730	Moscow, U.S.S.R.	G	6.02, 9.635, 9.71, 11.96, 12.05, 15.10, 15.13, 15.18, 15.21 (via Soviet Far East)
10:30-10:50 p.m.	0530-0550	Cologne, Ger. Fed. Rep.	G	6.10 (via Malta), 6.185, 9.545
11:00-11:15 p.m.	0600-0615	Tokyo, Japan	G	9.505
11:00-11:30 p.m.	0600-0630	Oslo, Norway	P	11.87 (Sun.)
11:00-12 mdt.	0600-0700	Buenos Aires, Argentina	G	9.69 (Mon.-Fri.)
11:00 p.m.-1:45 a.m.	0600-0845	**Wellington, New Zealand	G	6.08, 9.54
11:30 p.m.-1:30 a.m.	0630-0830	Havana, Cuba	G	9.525
11:30 p.m.-1:55 a.m.	0630-0855	**Kuala Lumpur, Malaysia	G	11.90, 15.275
12 mdt.-12:15 a.m.	0700-0715	Tokyo, Japan	G	9.505
12 mdt.-12:30 a.m.	0700-0730	**London, England	G	6.005, 9.60 (via Ascension)
12:30-1:15 a.m.	0730-0815	**London, England	G	9.60, 11.86, 15.40 (via Ascension)
1:00-1:15 a.m.	0800-0815	Tokyo, Japan	G	9.505
2:00-2:15 a.m.	0900-0915	Tokyo, Japan	G	9.505
2:00-2:30 a.m.	0900-0930	Seoul, Rep. of Korea	F	9.64, 15.335
2:00-4:45 a.m.	0900-1145	**Wellington, New Zealand	G	6.08, 952
3:00-3:15 a.m.	1000-1015	Tokyo, Japan	G	5.99
3:00-3:50 a.m.	1000-1050	Pyongyang, D.P.R. Korea	G	9.42, 9.535

*Reception quality, East Coast (West Coast) location: G-good, F-fair, P-poor
**Not intended for North America, but receivable satisfactorily

Frequencies are accurate as of press time, but subject to change. Many stations broadcasting in English but not beamed to North America are often audible here depending upon conditions, locations, time, etc. Sometimes, they are more audible than those nominally beamed here. Beginning with this issue, to help readers and as a sampling of what can be heard, we have added a selection of interesting stations heard here in English. The fine programs from Paris and Brasilia are particularly recommended.



CB Scene

By Ray Newhall

CB FOR PLEASURE CRAFT

MANY boating enthusiasts have found that their craft mix as well with two-way radios as vodka does with vermouth! Informal polls indicate that CB is extremely popular with pleasure-craft owners.

Why CB and not vhf marine radio? Why not both? There are no stock answers to these questions. The conclusion each skipper reaches depends on his individual needs as a yachtsman, the type of boat he owns, and the area in which he sails. There are many advantages and drawbacks to each type of service, judged by the nautical community's standards. This month we'll discuss a few of these, based on our monitoring of Coast Guard and pleasure-craft communications on Long Island Sound, the body of water between New York's Long Island and New England.

The vhf Marine Radio Service has been carefully planned for nearly twenty years by the FCC and the Coast Guard. It's intended to provide the best possible service for a majority of vessels plying federally controlled waterways. The switch-over to vhf/FM from the old 2-MHz AM service was scheduled over an extended period to minimize financial losses to boat owners already equipped with MF marine radios. (Time runs out for the MF service on January 1, 1977.)

Accordingly, the Coast Guard is now firmly committed to vhf for all operations within a land limit of 20-miles. A great number of repeater stations have been installed at remote locations.

When vhf marine was being planned in the late 1950's (about the same time that Class D was authorized), there was no way that government officials could anticipate the tremendous growth in both small boating and the use of the Citizens Band. Also, it had not yet occurred to the small-craft owner that he could one day use an inexpensive, battery-powered radio to contact someone at home or call for help. As CB evolved, a *de facto* marine communications system was established, lacking one important ingredient—direct Coast Guard participation.

Coast Guard CB Policies. An independent study was conducted for the Coast Guard in 1968, more recently reviewed to determine if its findings were still valid. This study acknowledged the value of CB to the small-craft segment of the marine community, but concluded that CB was not an adequate or reliable substitute for the official Marine Radio Service. The conclusion was reenforced by the widespread rules violations on the Citizens Band, as well as the FCC's apparent inability to curtail them.

In 1968, the Coast Guard estimated that, for a minimal CB monitoring capability, it would require $1.5 million to set up and an additional $1.1 million annually to maintain and man. Budgetary considerations made this prohibitive, and the decision to proceed at full steam on the completion of vhf facilities was made. Also, recommendations were made that the Coast Guard rely primarily on organized CB "interface" facilities (such as REACT, REST Marine, etc.) to fill the gap in marine safety communications represented by boating CB groups.

Coast Guard Policy effective April 1975 states:

> "... The Coast Guard does not encourage the establishment of CB Marine nets or interface organizations. However where nets or interface organizations of this type already exist, Coast Guard is aware that information can be extracted from them to aid in our safety mission."

Officially, the Coast Guard Auxiliary follows policy outlined by the Coast Guard, but unofficially many auxiliary vessels monitor the CB channels and often utilize it for their own administrative purposes. In addition, many local Marine Police units use CB extensively. These organizations deal primarily with local yachtsmen, weekend fishermen, and the small-craft public which represent the majority of marine CB users. Consequently, CB is a basic communications medium for local public safety officials, and they generally cooperate fully with CB safety teams.

All of this means that there are many people, both official and unofficial, who are listening for your MAYDAY call on the Citizens Band. (In many areas, Channel 13 is used for this purpose.)

Which Service is Best? The advantages and disadvantages of vhf marine and Citizens Band radio for pleasure craft are listed in the Table. The primary reasons many mariners have selected CB appear to be its lower cost, ready availability, and multifunction applications. Regarding the latter, Class-D transceivers can be pulled from the boat at dockside and plugged into the car for use on the way home and during the week. Hand-held CB units can be carried along for the Sunday afternoon sailing race, or car-

COMPARISON OF TWO SYSTEMS

VHF/FM

Advantages

Excellent readability on "line-of-sight" range.
Quiet, noise-free, no skip.
Direct contact with Coast Guard.
Public correspondence (telephone).
High communications reliability.
Monitored by Coast Guard.
Weather broadcasts.

Disadvantages

Relatively high initial cost.
No personal ship-to-shore (direct).
Many small craft not equipped.
Major "gaps" in Coast Guard coverage.

CB

Advantages

Relatively low cost.
Phone patches permitted.
Highly versatile.
Many craft equipped.

Disadvantages

Noisy at times.
Congestion at times.
No "telephone" channel.
No direct Coast Guard communication.
No guaranteed monitor coverage.
Range fluctuates.
No channel designated for marine.
Little radio discipline.

ried by a shore party to communicate back to their boat at its mooring. A part-time fisherman can ask his wife at home when dinner will be ready through a phone patch.

But on vhf, these calls can only be made through the telephone company, which will charge upwards of $1.50 even for a local call. Privately owned shore stations are not permitted in the Marine Radio Service, except at yacht basins and commercial marine facilities.

The Coast Guard has extended the range of its coastal facilities to well beyond 20 miles by locating antennas atop high towers, and by installing automatic repeater stations in remote areas. However, there are still large portions of *inland* waterways which are not covered. In these areas, yachtsmen invariably resort to CB as the most useful service.

Comparative Range. The effective communications ranges offered by the two services are very similar, except that vhf's range is much more reliable. At these frequencies, communications are limited to the radio "horizon," which is very dependent on antenna height.

Recently, the FCC authorized CB'ers to raise *nondirectional* antennas up to 60 feet above the ground. This means that CB'er's will be able to contact boats at a distance of 20 miles or more across the water. But in this band, workable range is primarily governed by noise and interference from other stations. On quiet days, the useful range can extend well beyond the horizon, but under "worst-case" conditions, communications will be limited to five miles or less from the base station.

The maximum legal power that a CB transmitter can deliver to its antenna is 4 watts. The figure will always be somewhat lower, due to feedline losses and impedance mismatches. Every loss should be minimized to achieve as much radiated power as possible. A highly efficient antenna system is essential to any effective communications system.

On the other hand, the FCC permits a maximum of 25 watts of r-f power in a vhf marine installation, but antennas are not as "efficient" at these frequencies. Without delving into theory, for a given *field strength,* a half-wavelength antenna—say, a coaxial vertical—would extract only one-sixth of the signal that a half-wavelength CB antenna would. So things balance out in the long run.

Vhf signals are frequency modulated. In layman's language, this means that the frequency of the transmitted signal varies in response to the modulating voice signal. At the other end, the receiver will "track" the stronger of two signals received simultaneously. Practically speaking, the weaker signal is entirely overridden without those annoying heterodynes! This behavior is known as the FM "capture effect." ◈

Amateur Radio

By Herbert S. Brier

EMERGENCY COMMUNICATIONS AND THE AMATEUR

RADIO amateurs are justifiably proud of their record of supplying emergency communications during and after disasters of many types. Furthermore, this record is one reason valuable frequencies in the radio spectrum are allocated to radio amateurs. Most disasters disrupt normal communications; so in the first critical hours after disaster strikes, amateur radio provides one of the only means to get rescue operations started. Later, when normal communication channels start to be restored, they are pre-empted for official messages. Then, individual health and welfare messages—such as, I am worried. Are you all right? House damaged. We are safe.—begin to flow in and out of the disaster area via amateur radio.

If a sudden disaster struck your community tomorrow morning, leaving it without electrical power or communications to the outside world, how long would it take you to put a signal on the air and start handling emergency messages? Whom in the community would you tell about your services? Would you feel confident that you and your station could handle a constant stream of messages in and out of the area until relieved? Maybe not tomorrow, but before the end of the year, many amateurs will really face similar questions.

Sue Anderson, WB9EWP, at a station during Field Day in Baraboo, Wis.

Logically, the first step in preparing for a possible communications emergency is to join the Amateur Radio Emergency Corps (AREC). If you do not know how to get in touch with your local Emergency Coordinator (EC), write to your Section Emergency Coordinator or Section Communications Manager at the addresses that appear each month in "QST" or to the American Radio Relay League, Inc., Newington, Conn. 06111, for AREC registration forms and the name and address of your local EC. He should have liaison with local government offices and other organizations who need communications in emergency conditions and plans for supplying them when necessary. The EC can also tell you about local Radio Amateur Communication Emergency Services (RACES) and Military Affiliate Radio Service (MARS) groups who are also geared to provide message handling and emergency communications in time of need.

Emergency Power. Ideally, every amateur should have facilities for operating his station independently of the commercial power lines. A portable, gasoline or propane-gas generator capable of powering the radio equipment and a few lights is best. A modern transceiver/exciter that can operate from the commercial power lines or 12 volts, dc, can also do the job when the power lines go dead, as long as the storage batteries hold out. A mobile station can be quickly converted to a portable, emergency-powered station by parking the vehicle near a point where communications are needed, and erecting a portable antenna between two trees or other supports and connecting it to the transceiver in place of the mobile whip. (The mobile antenna will work, of course, but the portable antenna will give much better results.) Construction details for an efficient 80/40-meter portable antenna were published in the "Amateur Radio" column in the October, 1975, issue of POPULAR ELECTRONICS. Many amateurs who travel extensively in trailers or campers carry portable antennas and erect them as soon as they arrive at a campsite. They throw iron bolts tied to light lines over conveniently located tree limbs to pull up the heavier lines that support the antenna.

Traffic Nets and Emergency Messages. Any radio amateur worthy of the name is willing to handle emergency messages when he can. However, if message handling is not his regular cup of tea, he immediately finds that sending and receiving messages exactly as written under the stress of emergency conditions is much more demanding than casual ragchewing or DX chasing. Really, the only way to get proficient at handling messages is by practice. Fortunately, it is easy to get the practice. There are traffic nets in all 50 states on the amateur phone and CW bands up to at least 148 MHz that are part of the National Traffic System (NTS). You will hear many nets on the 80- and 75-meter bands between 4:00 and 8:00 p.m. local time. They are also plentiful on other bands and at various hours of the day and night.

A typical traffic net opens with the Net Control Station calling "CQ the XY net, which meets regularly on this frequency to handle traffic. This is a directed net." The NCS then calls the roll of regular net members and lists the number of messages they report. Next, he stands by for latecomers and newcomers. He then instructs the stations that reported traffic to send their messages to designated stations for delivery or relay to their destinations. Liaison stations bring messages from other nets and pick up traffic for them. After all the formal traffic is passed, the NCS dispatches informal messages between net members and finally closes the net. The better the net, the more disciplined it is while there is traffic to be passed, but it changes quickly to an informal group of friendly people after net business is completed. Listen to a few net sessions to learn the ropes. Then call the NCS when he stands by for newcomers, if it seems like a net that you would like to join and make a contribution. After reporting to the net regularly a few times, you will be automatically added to the roll call.

The booklet *Operating an Amateur Radio Station*, published by the American Radio Relay League, Inc., as well as the ARRL *Radio Amateur's Handbook* and the back pages of the ARRL logbook contain information about writing and handling messages. And the ARRL Net Directory, available on request accompanied by a large return envelope with two units of first class postage, is the most complete list of amateur nets available. Incidentally, not all the nets listed are traffic nets. Some of them are ragchewers nets, missionary nets, bible-reading nets, country-hunters nets, etc; but they all become emergency nets when the chips are down.

Self training is obviously an important part of traffic net operation; but the rewards from handling and delivering messages are as great as other amateurs get from working new states or countries. Admittedly, many of the messages handled are not of world-shaking importance; but how would you rate the messages handled by the daily "Eye-Bank Net?" Since 1962, it has arranged for the transfer of over 7500 human eye corneas from the eye-bank centers to the people needing them.

Field Day. June 26 and 27 are the dates of the 1976 Field Day. From Saturday afternoon until Sunday evening, over 10,000 amateurs will set up approximately 1100, emergency-powered amateur stations under field conditions and contact each other. Some groups will number over 100 members and will operate 10 to 20 separate stations simultaneously. Others will operate one, two, or three stations; still others will be one-man shows. Big or small, and whether they make thousands of contacts or only a dozen, they will be preparing for a future disaster that all hope never comes. Write for your Field Day log and "dupe" sheets from ARRL, Newington, Conn. 06111. Don't forget the stamped return envelope. Start making plans. Incidentally, CW contacts will earn bonus points again this year.

If you are the vhf type, mark down June 12-13 for the ARRL spring vhf contest. Score sheets from the usual source. You do not have to leave home for this one; however, some contestants will climb the highest mountain to improve their scores. ◈

Electronics Library

ENCYCLOPEDIA OF ELECTRONIC CIRCUITS

by Leo Sands and Donald Mackenroth

Many different representative circuits are illustrated and analyzed, including a-f and r-f amplifiers, audio control circuits, biasing, control, and coupling circuits, frequency converters and multipliers, instrumentation and logic circuits, modulators and demodulators, power supplies, signal processors, and signal generators. Tube, transistor, and IC configurations are covered. Capsule descriptions for each entry appear in paragraph form.

Published by Parker Publishing Co., West Nyack, NY 10994. 288 pages, hard cover.

SEMICONDUCTOR FUNDAMENTALS

by R.F. Coughlin & F.F. Driscoll

As the title implies, this is a very basic book designed primarily for the beginning student in technical schools, junior colleges, or high schools. The authors have written under the assumption that all this material is new to the student and have treated each topic in depth. The text material is progressive, with the first eight chapters laying the groundwork for actual work with semiconductor devices as covered by later chapters. Diagrams, charts, and sketches are used lavishly as are examples, summaries, and self-check problems. For the reader with a tenuous grasp on semiconductor theory, this book should help strengthen his understanding.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 308 pages. $14.95 hard cover.

REFERENCE DATA FOR RADIO ENGINEERS, Sixth Edition

The new edition of this engineer's "bible" has been completely updated, revised, and enlarged to encompass material on the latest techniques in electrical and electronic engineering. Much of the material is too new to be found in many reference libraries. Subject areas that have been given major additions and/or revisions include: semiconductors and transistors, microminiature electronics, digital computers, electroacoustics, optical communications, navigation, transistor circuits, radio noise & interference, quantum electronics, optoelectronics, and filters. The material is broken up into 48 in-depth chapters and includes hundreds of charts, nomographs, diagrams, curves, tables, and illustrations.

Published by Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46206. Hard cover. More than 1300 pages. $30.00.

Computer Bits

By Jerry Ogdin

GAMES FOR LEARNING

LEARNING to program isn't difficult, but it does take experience. One of the biggest headaches in learning how to program is sample problem selection. Most text books illustrate problems that are either too simple, too complex, or too far afield for good learning experience.

We don't believe that the experience in converting traditional games to computer form is very enlightening. Some of the worst examples of coding are to be seen in some published game programs, often because they have been written by novices. One should wait to write programs like blackjack, poker, NIM and tic-tac-toe until he has more experience. The programming games I'm talking about are "games" for writing programs.

Reading Programs. Authors learn to write by reading good works. Composers who haven't heard good music can't compose very well. Programmers think that all they need to do is read the reference manual and they'll have everything they need. Well, it isn't so. You should read programs, too. The best way to glean experience from somebody else's hours of labor is to read their codes. Unfortunately, you'll have to read an awful lot before you can decide which is good and which is bad. Ideally, you should only read the good stuff.

The best way to attack a program reading exercise is to get a pad and pencil, and the program listing. Then start breaking the program into small "modules." You can usually discern a pattern of subroutines. Find all the instructions that refer to subroutines, and then locate all of the subroutines. Determine what each subroutine does and jot it down, you can make up a table of subroutine names, their intended functions and necessary data conditions for proper execution. After all the subroutines are defined, you can trace through the main program.

Sometimes you will run into a stone wall. If you can't figure out how something works, go back to the reference manual for the computer and work it through in detail. Manually, act like the computer, recording the register contents on paper so you can be certain you're following the operation in detail. Eventually, you'll discover how it works, and you'll have learned a new programming technique.

Steps in Programming. Programming is a mental activity. You have to think about it before you approach the computer. You should work out your understanding of the problem, and reduce it to some kind of written description. If you want to write a program that will help checkout the new terminal you've just attached to your computer, your stated goal might be:

Level 1: Write the letter "A" out to the terminal indefinitely.

Now, in successive stages, break this instruction into more detailed steps until you arrive at a point where you think you can write code. In this simple example, you might write:

Level 2: a. Put ASCII "A" in a register.
b. Send the register out to the terminal.
c. Go back to step a.

Now, translate these statements into a detailed form that takes cognizance of your particular computer and its environment:

Level 3: a. Put 0100 0001 (letter A in ASCII) into A-register.
b. CALL the TYPE subroutine.
c. JUMP back to step a.

Finally, you can write this in code for your particular computer. Novice programmers try to do all these steps in their heads; semi-experienced programmers start writing at Level 3. But, experienced programmers always try to start at Level 2, where their thinking processes are not limited by the idiosyncracies of the computer.

Once you have a clear, albeit informal, description of what you want the computer to do (Level 3), you can code it in assembly language or actual binary (or octal or hex), depending upon what form you feel most comfortable with. At long last, your program will be in memory and ready for execution.

It is not uncommon to spend ¾ of your time planning before you write your code.

Programming "Games." The easiest kind of "game," and one that programmers engage in all the time, is to write some specific program in a small number of instructions, regardless of execution time. Pick some function—say, editing a number from BCD into proper money notation with commas, decimal point and dollar sign. Or, try to write a program that will move any contiguous group of bytes to anywhere else in memory. Note that these programs have three important features: they are relatively small, easy to understand, and potentially useful to you in the future.

Now, write the program any way you can and demonstrate that it works. Here comes the challenge. Write it again, but this time set a goal of reducing the size of the program by some specific number of bytes. Also, set a time limit so you don't go on forever. If you have written a program of about 100 instructions or bytes of memory, you can set the goal of reducing the number of bytes by 10 per cent within two hours. With your goal—and the original program—in hand, go back to the programming reference manual for your computer and try to find some unique set of instructions that will help you write the program smaller and smaller. Stop only after you've achieved your goal or the time limit has passed. Then, test and debug your program again to be certain that it works.

If you have a programming pal, the educational experience can be improved even more. All experienced programmers have witnessed somebody demolish their well-polished code with a clever trick. Usually, you can do it right back! It is not uncommon for a small subroutine to be cut to a fourth of its original size by two people working back and forth in this challenging fashion. You'll certainly learn a lot about programming this way.

Next, write the same program, but make it your goal to write a program that executes faster than the smallest program you've written. You'll find that you generally can't optimize both size and execution time simultaneously, so your faster program may be larger than your smallest program. Again, challenge another programmer to beat your time—you may be surprised at the results. But, you can then go back and beat his time—and he'll be surprised.

From this set of exercises, you'll quickly learn that a program that works may not be enough. You may also have to rewrite and rewrite to make it fit within the resources you have available. You will also learn more about the computer and its instructions and how to exploit them. Finally, you should probably learn that no program is "best". Some programs are shorter than others, some are faster, and some offer more features or fewer restrictions.

After you've finished your programs, don't discard them. No matter how trivial the program may seem, keep it on hand for the day when you need it again. Get a strong three-ring notebook and file all your programs there. If you can't think up a good classification scheme, store them away in chronological order. You'll be amazed at how frequently you go back to crib something from earlier work.

Another challenging program is one that will completely clear all of storage to zero. This program must not only zero out all bytes of storage, but it must also destroy itself completely. On many computers, it can't be done (so far as anybody knows, anyway). However, you should see just how few bytes you have to leave in memory;

(**Editor's Note:** Someone once told us of a two-step program that will zero all memory except for addresses 0 and 1 on an Altair-8800. We have tried it and it works. After turning the main power on, resetting and stopping the computer, and before loading any bootstrap or the BASIC tape, deposit 063 (INX SP) at address zero, followed by Deposit Next 307 (RSTO). Re-examine address zero (063), then hit RUN. Allow the machine to run until the address LED's settle down, then hit STOP. Re-examine address zero and 1. There should be only one data LED on at each address, all other addresses should be dark. You may have to repeat the 063-307 program again. If you need to clear the two addresses, simply Deposit zero in each.)

like golf, the goal is to minimize the score.

This is a particularly nasty programming problem. Since the program wipes itself out of memory, you have to put it back into memory every time you use it. That is a nuisance, and so there is a definite incentive to do the program right the first time. Experienced competent programmers spend a lot of time "desk checking" their programs. They read and re-read the program until they're absolutely certain that it is completely correct. Only then do they submit the program to the computer. It is better than putting just any old program in memory to see if it'll work. This self-clearing program will show you just how important that desk-checking is, because if you don't do it right, you'll have to put the program back into memory time and time again.

By the way, it isn't considered fair to put the program in read-only memory and then clear only the read-write memory—the program must be in read-write storage, too. Send me your examples in source code form for your computer, and we'll publish the best ones for each popular model in a forthcoming issue. ◈

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Experimenter's Corner

By Forrest M. Mims

PULSE MODULATION & PHASE-LOCKED LOOPS

EXPERIMENTERS have tinkered with many different types of amplitude modulated (AM) optical communicators for many years. Although pulse modulation (PM) techniques offer many advantages over AM systems, such as good noise rejection, increased security, and immunity to fading, not many amateur PM communicators have been built.

But things are changing. Thanks to the versatile phase-locked loop (PLL), you can now experiment with a true PM communications system without building overly complex circuits. The specific designs presented here are for infrared communications, but they can be easily adapted to visible light, wire, or radio links.

Inside the PLL. If you read Herb Cohen's excellent tutorial on PLL's in the February 1975 issue of PE ("How Phase-Locked Loops Work"), you'll recall that the loop automatically locks onto and tracks a signal even though its frequency changes. The PLL does all this with the help of its phase comparator and a voltage-controlled oscillator (VCO). Specifically, the phase comparator compares the frequency of an input signal with that of the VCO and produces an error voltage directly proportional to the difference between the two. (For simplicity, we'll assume an intimate relationship between frequency and phase.)

This error voltage serves two purposes. As you can see in the loop's block diagram (Fig.1), the error voltage is fed back to the VCO and changes its frequency to match that of the input signal. This feedback enables the PLL to lock onto and track the signal. The error voltage is also a demodulated FM output since it varies directly with a shift in the input signal's frequency. Simply stated, the error voltage from the phase comparator permits the PLL to lock onto a carrier frequency, to track it continually over a given range, and filter out any superimposed information signal.

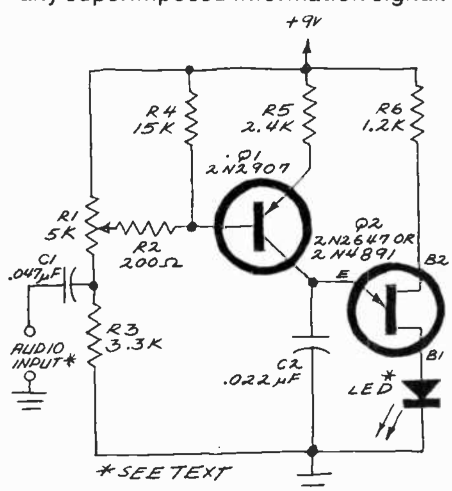

Fig. 2. PFM transmitter circuit.

A Simple PM System. Figures 2 and 3 show the circuits for a basic pulse frequency modulated (PFM) transmitter and receiver, respectively.

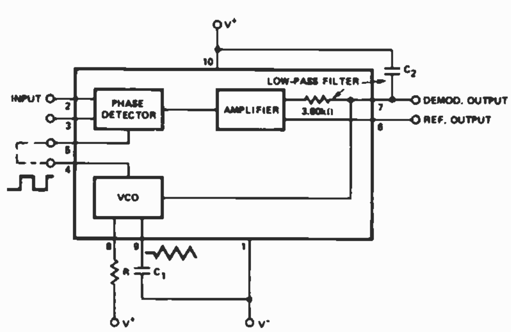

Fig. 1. Block diagram of PLL.

The transmitter is fairly straightforward. A unijunction transistor (UJT) relaxation oscillator, composed of *C2*, *Q2*, *R5* and *R6*, intensity (amplitude) modulates a LED at a constant subcarrier frequency until an input signal is applied to *Q1 via C1* and the attenuator *R1* and *R2*. Transistor *Q1* acts as a variable resistor which alters *Q2's* oscillation frequency when an input signal is applied.

The UJT applies a train of 1-microsecond pulses to the LED at a

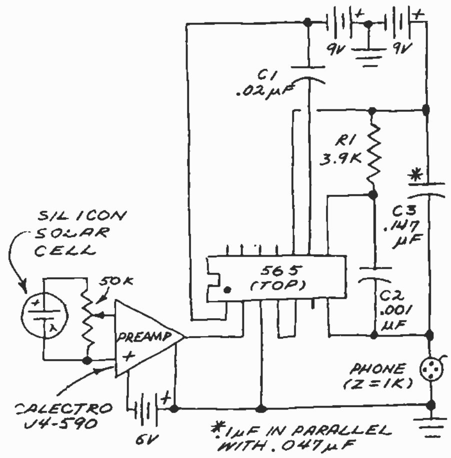

Fig. 3. PLL receiver circuit.

subcarrier frequency of about 10 kHz. (In this system, the subcarrier modulates the infrared carrier. When a 10-volt power supply is used, each pulse has an amplitude of about 150 mA. Average current drain depends on the modulation rate and ranges from 10 to 20 mA.

For best results, a preamplifier should be used with the transmitter. I happened to have a Calectro modular 1-watt unit (J4-590) and used it, but many other modules will work just as well. Refer to the instructions supplied with the module for interconnection information. If the amplifier has a low-impedance output (most do), use an audio output transformer as an impedance matcher. For example, if the amplifier output is 8 ohms, connect the 8-ohm secondary of the transformer to this output and the primary (a few thousand ohms) to the input of the modulator. The circuit *will* work without the transformer, but not as well.

It's wise to use a GaAsSi LED because GaAs LED's compensated with silicon are much more efficient then ordinary GaAs devices. I used a GE type SSL-55C LED due to its high efficiency (about 6 mW of 940-namometer infrared at 100 mA forward current), but other infrared types will also work. Check the ads in the "Electronics Marketplace" for sources.

The receiver circuit uses an inexpensive 565 PLL IC available from most parts dealers. A silicon solar cell (selenium devices *won't* work!), driving a modularized preamp—again, a Calectro type J4-590—detects the infrared carrier. The preamp output drives the PLL, which demodulates the subcarrier's information. Although the solar cell can be connected directly to the PLL input, using a preamp yields much better results.

Construction and Adjustment. Assemble the transmitter and receiver on separate perforated boards or on opposite sides (left and right) of an IC breadboard. It will probably be inconvenient to mount the amplifier modules directly on the boards. If so, use short lengths of hookup wire for interconnections. Aim the LED at the solar cell. Then adjust the transmitter's *R1* until a tone is heard in the receiver's earphone. You'll notice that the tone comes in at a high frequency, gradually falls to a low pitch, and then rises again as you adjust *R1*. The optimum point is when the tone is at the lowest possible pitch.

After the transmitter is adjusted, test the system by speaking into a microphone. You can use a standard tape recorder (dynamic) microphone with most amplifier modules. If reception is noisy, readjust *R1* while speaking into the mike. If this fails to correct the problem, reduce the receiver's preamp gain or shield part of the solar cell with masking tape. Incidentally, for these tests you can eliminate the transmitter preamp by using a transistor radio as a signal source. Just connect the audio output of the radio directly across the input of the modulator (between *C1* and ground).

Range. With suitable optics and lots of practice, this PFM infrared communications system will have a range up to 100 meters or even more. I've obtained ranges greater than a kilometer with a similar homebrew set-up. Try Edmund Scientific (300 Edscorp Bldg., Barrington, NJ 08007) for suitable lenses and reflectors. And see *Light Beam Communications* (F.M. Mims III, Howard W. Sams & Co., 1975) for more information on optical communications. ◈

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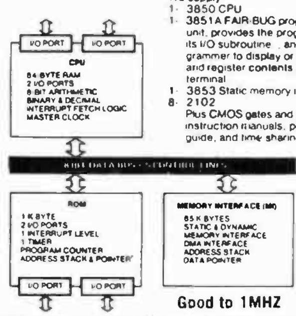

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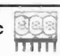

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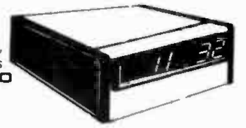

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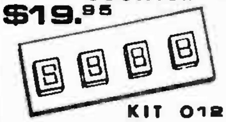

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One chip 4 digit decade counter kit, with both 7 segment and BCD output.
1. Chip features internal oscillator for scanning speed.
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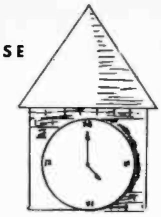
TIME BASE



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SN74LS74N	.42
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SN74LS90N	94
SN74LS93N	.94
SN74LS95N	1.30
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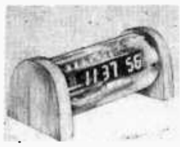

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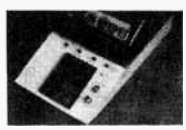

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SN7407N	.45	SN7473N*	.37	SN74160N	1.75
SN7408N	.25	SN7474N*	.32	SN74161N	1.45
SN7409N	.25	SN7475N*	.59	SN74163N*	1.35
SN7410N*	.16	SN7476N*	.32	SN74164N	1.65
SN7411N	.30	SN7479N*	5.00	SN74165N	1.65
SN7412N	.42	SN7480N	.50	SN74166N	1.70
SN7413N	.85	SN7482N	1.75	SN74167N	5.50
SN7414N	.70	SN7483N	1.15	SN74170N	3.00
SN7416N	.43	SN7485N	1.12	SN74172N	18.00
SN7417N	.43	SN7486N	.45	SN74173N	1.70
SN7420N	.21	SN7488N	3.50	SN74174N	1.95
SN7421N	.39	SN7489N	3.00	SN74175N	1.95
SN7422N*	1.50	SN7490N*	.49	SN74176N	.90
SN7423N	.37	SN7491N	1.20	SN74177N	.90
SN7425N	.43	SN7492N	.82	SN74180N	1.05
SN7426N	.31	SN7493N*	.57	SN74181N	3.55
SN7427N	.37	SN7494N	.91	SN74182N	.95
SN7429N	.42	SN7495N	.91	SN74184N	2.30
SN7430N	.26	SN7496N	.91	SN74185N	2.20
SN7432N	.31	SN7497N*	4.00	SN74186N*	5.00
SN7437N	.47	SN74100N*	1.00	SN74187N	6.00
SN7438N	.40	SN74107N	.49	SN74190N	1.50
SN7439N	.25	SN74121N*	.45	SN74191N	1.50
SN7440N	.21	SN74122N	.49	SN74192N*	1.19
SN7441N	1.10	SN74123N*	.70	SN74193N*	.99
SN7442N	1.08	SN74125N	.60	SN74194N	1.45
SN7443N	1.05	SN74126N	.81	SN74195N	1.00
SN7444N	1.10	SN74132N	3.00	SN74196N	1.25
SN7445N	1.10	SN74136N	1.80	SN74197N	1.00
SN7446N	1.15	SN74141N	1.15	SN74198N	2.25
SN7447N*	.79	SN74142N*	4.00	SN74199N	2.25
SN7448N	.99	SN74143N*	4.50	SN74200N	7.00
SN7450N	.26	SN74144N*	4.50	SN74279N*	.90
SN7451N	.27	SN74145N	1.15	SN74251N	2.50
SN7452N*	.27	SN74147N	3.00	SN74284N	6.00
		SN74148N	2.50	SN74285N	6.00

MANY OTHERS AVAILABLE ON REQUEST
20% Discount for 100 Combined 7400's

CMOS

CD4000	.25			74C04N	.75
CD4001	.25			74C10N	.65
CD4002	.25	CD4035	1.65	74C20N	.65
CD4006	2.50	CD4040	2.45	74C30N	.65
CD4007	.25	CD4042	1.90	74C42N	2.15
CD4009	.59	CD4044	1.50	74C73N	1.50
CD4010	.59	CD4046	2.51	74C74	1.15
CD4011	.25	CD4047	2.75	74C90N	3.00
CD4012	.25	CD4049	.79	74C95N	2.00
CD4013	.47	CD4050	.79	74C107N	1.25
CD4016	.56	CD4051	2.95	74C151	2.90
CD4017	1.35	CD4053	2.95	74C154	3.00
CD4019	.55	CD4060	3.25	74C157	2.15
CD4020	1.49	CD4066	1.75	74C160	3.25
CD4022	1.25	CD4069	.45	74C161	3.25
CD4023	.25	CD4071	.45	74C163	3.00
CD4024	1.50	CD4072*	.45	74C164	3.25
CD4025	.25	CD4081	.45	74C173	2.60
CD4027	.69	CD4511	2.50	74C193	2.75
CD4028	1.65	CD4518	2.50	74C195	2.75
CD4029	2.90	74C00N	.39	MC4044*	4.50
CD4030	.65	74C02N	.55	MC14016*	.56

LINEAR

LM300H	.80			LM1351N	1.65
LM301H	.35			LM1414N	1.75
LM301CN	.35	LM377N	4.00	LM1458C	.65
LM302H	.75	LM380N	1.39	LM1496N	.95
LM304H	1.00	LM380CN	1.05	LM1556V	1.85
LM305H	.95	LM381N	1.79	LM2111N	1.95
LM307CN	.35	LM382N	1.79	LM2901N	2.95
LM308H	1.00	NE501K	8.00	LM3065N	.69
LM308CN	1.00	NE510A	6.00	LM3900N	.55
LM309H	1.10	NE531H	3.00	LM3905N	.60
LM309K	1.25	NE536T	6.00	LM3909*	1.25
LM310CN	1.15	NE540L	6.00	LM5556N	1.85
LM311H	.90	NE550N	.79	MC5558V	1.00
LM311N	.90	NE553	2.50	LM7525N	.90
LM318CN	1.50	NE555V*	.45	LM7535N	1.25
LM319N	1.30	NE560B*	5.00	8038B*	4.95
LM319D	9.00	NE561B*	5.00	LM75450	.49
LM320K-5	1.35	NE562B*	5.00	75451CN	.39
LM320K-5.2	1.35	NE565H*	1.25	75452CN	.39
LM320K-12	1.35	NE565N*	1.25	75453CN	.39
LM320K-15	1.35	NE566CN*	1.75	75454CN	.39
LM320T-5*	1.75	NE567H*	1.25	75491CN	.79
LM320T-8*	1.75	NE567V*	1.50	75492CN	.89
LM320T-12*	1.75	LM703CN	.45	75494CN	.89
LM320T-18*	1.75	LM709H	.29	RCA LINEAR	
LM323K-5*	9.95	LM709N	.29	CA3013	1.70
LM324N	1.80	LM710N	.79	CA3023	2.15
LM339N	1.70	LM711N	.39	CA3035	2.25
LM340K-5	1.95	LM723N	.55	CA3039	1.35
LM340K-12	1.95	LM723H	.55	CA3046	1.15
LM340K-15	1.95	LM733N	1.00	CA3059	2.46
LM340K-24	1.95	LM739N	1.29	CA3060	2.80
LM340T-5	1.75	LM741CH	.35	CA3080	.85
LM340T-6	1.75	LM741CN	.35	CA3081	1.75
LM340T-8*	1.75	LM741 14N	.39	CA3082	2.00
LM340T-18*	1.75	LM747H	.79	CA3083	1.60
LM340T-12	1.75	LM747N	.79	CA3086	.59
LM340T-15	1.75	LM748H	.39	CA3089	3.25
LM340T-24	1.75	LM748N	.39	CA3091	8.25
LM350N	1.00	LM1303N	.90	CA3123	1.85
LM351CN	.65	LM1304N	1.19	CA3130*	1.49
LM370N	1.15	LM1305N	1.40	CA3600	1.75
LM370H	1.15	LM1307N	.85	RC4194	5.95
LM373N	3.25	LM1310N	2.95	RC4195	3.25

KITS EXAR ICS

XR-2206KA SPECIAL $17.95
Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB SPECIAL $27.95
Same as XR 2206KA above and includes external components for PC board.

TIMERS		**STEREO DECODERS**	
XR-555CP	$.69	XR-1310P	$3.20
XR-320P	1.55	XR-1310EP	3.20
XR-556CP	1.85	XR1800P	3.20
XR-2556CP	3.20	**WAVEFORM GENERATORS**	
XR-2240CP	3.25	XR-205	8.40
PHASE LOCKED LOOPS		XR-2206CP	4.49
XR-210	5.20	XR-2207CP	3.85
XR-215	6.60	**MISCELLANEOUS**	
XR-567CP	1.95	XR-2211CP	6.70
XR-2567CP	2.99	XR-2261	3.79
		XR4136	2.00

DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICS	$2.95
CMOS	Pin-out & Description of 4000 Series ICS	$2.95
LINEAR	Pin-out & Functional Description	$2.95

ALL THREE HANDBOOKS $6.95

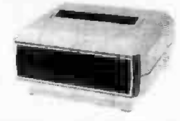
CONSUMER ELECTRONICS

DIGITAL WATCH

This watch is manufactured by National Semiconductor. It provides 5 functions: hours, minutes, seconds, date, A.M. indicator dot. Accuracy is assured to 5 seconds per month by precision quartz crystal. If something should go wrong with the watch, repair is assured within 48 hours after it is received. Complete with steel black leather band.

ES4-YS
3 MICRON GOLD PLATE BEZEL
$29.95
NOT A KIT

Novus



DIGITAL ALARM CLOCK

This 4 digit Novus Alarm Clock is a very reliable and smartly styled unit. It provides such features as an alarm settable to any minute of the day, a 7 minutes snooze alarm, a power failure indicator, and even an A.M., P.M. indicator.

NOT A KIT **$19.95**

OPTO ELECTRONICS

XCITON
LITRONIX
MONSANTO

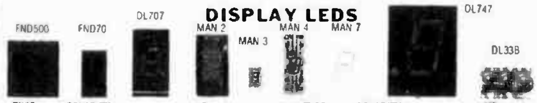
R - RED
G - GREEN
Y - YELLOW
O - ORANGE

DISCRETE LEDS

.125" dia.		.185" dia.		.190" dia.	
XC209R	5/$1	XC526R	5/$1	XC111R	5/$1
XC209G	4/$1	XC526G	4/$1	XC111G	4/$1
XC209Y	4/$1	XC526Y	4/$1	XC111Y	4/$1
XC2090	4/$1	XC5260	4/$1	XC1110	4/$1

.200" dia.		.200" dia.		.085" dia.	
XC22R	5/$1	XC556R	5/$1	MV50	
XC22G	4/$1	XC556G	4/$1	.085" dia. Micro	
XC22Y	4/$1	XC556Y	4/$1	red led	
XC220	4/$1	XC5560	4/$1		6/$1

DISPLAY LEDS



TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	COMMON ANODE	270	$3.25	MAN 74	COMMON CATHODE	.300	$1.50
MAN 2	5 x 7 DOT MATRIX	300	4.95	DL707	COMMON ANODE	.300	$1.50
MAN 3	COMMON CATHODE	125	.39	DL747	COMMON ANODE	.600	2.25
MAN 4	COMMON CATHODE	.187	1.95	DL750	COMMON CATHODE	.600	2.49
MAN 7	COMMON ANODE	300	1.50	DL33B	COMMON CATHODE	.110	1.25
MAN 7G	COMMON ANODE-GREEN	300	2.50	FND70	COMMON CATHODE	.250	.50
MAN 7Y	COMMON ANODE-YELLOW	300	2.50	FND500	COMMON CATHODE	.500	1.75
MAN 72	COMMON ANODE	300	1.50	FND507	COMMON ANODE	.500	1.75

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	.16	.15	24 pin	$.38	.37	.36
14 pin	.20	.19	.18	28 pin	.45	.44	.43
16 pin	.22	.21	.20	36 pin	.60	.59	.58
18 pin	.29	.28	.27	40 pin	.63	.62	.61
22 pin	.37	.36	.35				

SOLDERTAIL STANDARD (TIN)

14 pin	$.27	.25	.24	28 pin	$.99	.90	.81
16 pin	.30	.27	.25	36 pin	1.39	1.26	1.15
18 pin	.35	.32	.30	40 pin	1.59	1.45	1.30
24 pin	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
				40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

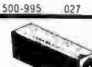
50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

		10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	
ASST. 1	5 ea.	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	1/4 WATT 5% = 50 PCS.
		68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	
ASST. 2	5 ea.	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	1/4 WATT 5% = 50 PCS.
		470 OHM	560 OHM	680 OHM	820 OHM	1K	
ASST. 3	5 ea.	1.2K	1.5K	1.8K	2.2K	2.7K	1/4 WATT 5% = 50 PCS.
		3.3K	3.9K	4.7K	5.6K	6.8K	
ASST. 4	5 ea.	8.2K	10K	12K	15K	18K	1/4 WATT 5% = 50 PCS.
		22K	27K	33K	39K	47K	
ASST. 5	5 ea.	56K	68K	82K	100K	120K	1/4 WATT 5% = 50 PCS.
		150K	180K	220K	270K	330K	
ASST. 6	5 ea.	390K	470K	560K	680K	820K	1/4 WATT 5% = 50 PCS.
		1M	1.2M	1.5M	1.8M	2.2M	
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	1/4 WATT 5% = 50PCS.

ALL OTHER RESISTORS FROM 2.2 OHMS 5.6M AVAILABLE IN MULTIPLES OF 5 ea.
5-25 PCS .05 ea. 30-95 PCS .04 ea. 100-495 PCS .03 ea. 500-995 .027 ea.

14 PCS. POTENTIOMETER ASSORTMENTS

ASST. A 2 ea. 10 OHM-20 OHM-50 OHM-100 OHM-200 OHM-250 OHM-500 OHM
ASST. B 2 ea. 1K, 2K, 2.5K, 10K, 20K, 25K, 50K
ASST. C 2 ea. 50K, 100K, 200K, 250K, 500K, 1M, 2M



$9.95 Per Asst.

Each assortment contains 14 pcs of 10 turn pots. All pots are available in single unit quantities, $.99 ea.

Astrisk Denotes Items On Special For This Month
Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax — Data Sheets 25c each
Send a 13c Stamp (postage) for a FREE 1976 Catalog

JAMES

P.O. BOX 822, BELMONT, CA. 94002
PHONE ORDERS — (415) 592-8097

74LS00 TTL

74LS00	.39	74LS55	.39	74LS151	1.55
74LS02	.39	74LS73	.65	74LS153	1.89
74LS03	.39	74LS74	.65	74LS157	1.55
74LS04	.45	74LS75	.79	74LS162	2.25
74LS05	.45	74LS76	.65	74LS163	2.25
74LS08	.39	74LS83	2.19	74LS164	2.25
74LS10	.39	74LS86	.65	74LS181	3.69
74LS13	.79	74LS90	1.25	74LS190	2.85
74LS14	2.19	74LS92	1.25	74LS191	2.85
74LS20	.39	74LS93	1.25	74LS192	2.85
74LS26	.49	74LS95	2.19	74LS193	2.85
74LS27	.45	74LS96	1.89	74LS194	2.25
74LS28	.49	74LS107	.65	74LS195	2.25
74LS30	.39	74LS112	.65	74LS257	1.89
74LS32	.45	74LS132	1.55	74LS260	.55
74LS40	.49	74LS136	.65	74LS279	.79
74LS51	.39	74LS138	1.89	74LS670	5.95

DIP SWITCH

These switches feature four SPST Rocker switches in a molded dip. They are ideally suited for microprocessor applications. $1.95

MINATURE TOGGLE

DPDT				JMT	1	2-9	10-29	30-99
	ON	OFF	ON	221	3.05	2.65	1.97	1.78
	ON	NONE	ON	223	2.85	2.28	1.88	1.61
	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	123	2.05	1.65	1.21	1.10

PUSH BUTTON

SPDT – SERIES PB, PB1

Maintained Action Switch: Push To Make Contact And Push Again To Reverse Action
Momentary Action Switch: Normally Open or Normally Closed. (For N.C. circuit use terminals 2 & 1; for N.O. 2 & 3; for N.C and N.O. 1, 2 & 3)

Model Number	1 Each	2-9	10-29	30-99
PB-123	$2.35	$1.95	$1.47	$1.30
PB-126	$2.35	$1.95	$1.47	$1.30

5 AMP RATINGS

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY
SF - Front Mount SR - Rear Mount

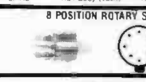
Part No	Description	Price
SF 12	Single Pole 10 Position	$2.50
SR 12	Decimal	3.00
SF 21	10 Position BCD only	2.50
SR 21	" "	3.00

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

ACCESSORIES

Part No	Description	Price	Part No	Description	Price
SF EP	End Plate (Pair)	$.50	SR EP	End Plates (pair)	$.50
SF DP	Divider Plate (each)	.40	SR DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40	SR BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40	SR HB	Half Body (each)	.40

8 POSITION ROTARY SWITCH



$.79

These switches are a 7 position, one position open rotary switch enclosed in a TO-5 can. They have a standard 8 pin configuration and will mount perfectly on printed circuit board.

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
IN746	3.3	400m	4/1.00	1N4005*	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006*	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N965B	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
IN485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	IN1186	200 PIV	35 AMP	1.80
1N4003	200 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00
1N4004	400 PIV	1 AMP	12/1.00				

TRANSISTORS

MPS A05	5/$1.00			PN4249	4/$1.00
MPS A06	5/$1.00	PN3567	3/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3568	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3569	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00	2N4409	5/$1.00
FN2415	5/$1.00	2N3707	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3711	5/$1.00	2N5087	4/$1.00
2N2906A	4/$1.00	2N3724	$.65	2N5088	4/$1.00
2N2907A	5/$1.00	2N3725	$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3903	5/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3904	4/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3905	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N3906	4/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N4013	3/$1.00	2N5951	5/$1.00
2N3392	5/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
2N3398	5/$1.00			2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.04	.035	
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1 35V	.28	.23	.17	1.5 35V	.30	.26	.21
.15 35V	.28	.23	.17	2.2 25V	.31	.27	.22
.22 35V	.28	.23	.17	3.3 25V	.31	.27	.22
.33 35V	.28	.23	.17	4.7 25V	.32	.28	.23
.47 35V	.28	.23	.17	6.8 25V	.36	.31	.25
.68 35V	.28	.23	.17	10 25V	.40	.35	.29
1.0 35V	.28	.23	.17	15 25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47 50V	.15	.13	.10	.47 25V	.15	.13	.10
1.0 50V	.16	.14	.11	.47 50V	.16	.14	.11
3.3 50V	.15	.13	.10	1.0 16V	.15	.13	.10
4.7 25V	.16	.14	.12	1.0 25V	.16	.14	.11
10 25V	.15	.13	.10	1.0 50V	.16	.14	.11
10 50V	.16	.14	.12	4.7 16V	.15	.13	.10
22 25V	.17	.15	.12	4.7 25V	.15	.13	.10
22 50V	.24	.20	.18	4.7 50V	.16	.14	.11
47 25V	.19	.17	.15	10 16V	.14	.12	.09
47 50V	.25	.21	.19	10 25V	.15	.13	.10
100 25V	.24	.20	.18	10 50V	.16	.14	.12
100 50V	.35	.30	.28	47 50V	.24	.21	.19
220 25V	.32	.28	.25	100 16V	.19	.15	.14
220 50V	.45	.41	.38	100 25V	.24	.20	.18
470 25V	.33	.29	.27	100 50V	.35	.30	.28
1000 16V	.55	.50	.45	220 16V	.23	.17	.16
2200 16V	.70	.62	.55	470 25V	.31	.28	.26

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case Style	Price
CY1A	1.000 MHz	HC33/U	$4.95
CY2A	2.000 MHz	HC33/U	$4.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18/U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

CLOCK CASES

Nicely styled cases complete with red bezel for use in such applications as desk clocks, car clocks, alarm clocks, instrument cases.
DIMENSIONS W-4", L-4½", H-2"

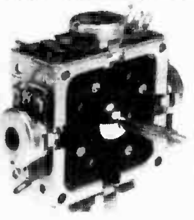
$5.95

64 Key Keyboard

$24.95

This keyboard is composed of 64 Magnetic Reed Switches, in one molded unit. It is unencoded with each SPST switch brought out to two pins.

HD0165 Keyboard Encoder ROM $7.95



JOYSTICK

These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

$9.95 ea

MOS LSI DEVICES

CLOCK CHIPS

MM5309	6 Digit, BCD Outputs, Reset PIN.	$5.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5313	6 Digit, BCD Outputs, 1PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit, Alarm, 1PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calander, Alarm, 12 or 24 Hour	6.95

CALCULATOR CHIPS

MM5725	6 Digit, Four Function, Less Decimal	$2.95
MM5738	8 Digit, 5 Function, +, −, ×, ÷, %	2.95
MM5739	8 Digit, 4 Function, Floating Decimal	2.95
CT5001	12 digit 4 Function	3.95
CT5005	12 digit 4 Function with Memory	5.95
CT5030	12 digit 4 Function and%	7.95

MISC. MOS

MM5320	TV Camera Sync Generator	19.95
MM5841	Video Generator For MM5318	18.00
MM5330	4½ Digit DVM Chip	9.95
MK5007	Complete 4 Digit Counter	$10.95
LD110/LD111	3½ Digital Voltmeter Chip Set	$25.00
MC1408L7	7 Bit Digital To Analog Conv.	9.95

DL728

The DL728 is a dual 0.5" common cathode red display. It is ideal for use with clock-chips, as segments are already multiplexed. $2.95

1/16 VECTOR BOARD

0.1" Hole Spacing P-Pattern

	Part No.	Length	Wideth	Price 1-19	Price 20-49
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 02XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

VECTOR WIRING PENCIL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self-contained replaceable bobbin, onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord. Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire $9.50

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

W36-3-A-Pkg. 3	250 ft. 36 AWG GREEN	$2.40
W36-3-B-Pkg. 3	250 ft. 36 AWG RED	$2.40
W36-3-C-Pkg. 3	250 ft. 36 AWG CLEAR	$2.40
W36-3-D-Pkg. 3	250 ft. 36 AWG BLUE	$2.40

1¼" x 1½" XFMERS P.C. Mount

That were designed for clock type applications. 110 Vac primary @ 60 Hz. Secondaries 8-10 Vac @ 30 mA-50 mA
50 Vac @ 30 mA-50 mA
Excellent for miniature power supplies & gas discharge displays

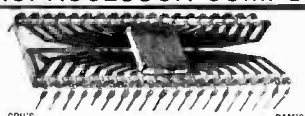
SPECIAL $.79

MOLEX PINS

PINS USED AS INEXPENSIVE SUBSTITUTE FOR SOCKETS
SPECIAL 100/1.49
SPECIAL 1000/12.00

MICROPROCESSOR COMPONENTS

8080 $24.95



8080A $39.95

CPU'S		
8008	8 Bit CPU	$19.95
8080	Super 8008	$24.95
8080A	Super 8008	$39.95
SR'S		
2504	1024 DYNAMIC	$9.00
2518	HEX 32 BIT	7.00
2519	HEX 40 BIT	4.00
2524	512 DYNAMIC	2.95
2525	1024 DYNAMIC	6.00
2527	DUAL 256 BIT	3.95
2529	DUAL 512 BIT	4.00
2532	QUAD 80 BIT	3.95
2533	1024 STATIC	7.95
3341	FIFO	6.95
74LS670	16X4 REG.	3.95
UART'S		
AY-5-1013	20K BAUD	$6.95
ROM'S		
2513	CHAR. GEN.	11.00
7488	RANDOM BITS	3.50

RAM'S			
1101	256X1	STATIC	$2.25
1103	1024X1	DYNAMIC	2.95
2101	256X1	STATIC	6.95
2102	1024X1	STATIC	2.49
2107	4096X1	DYNAMIC	19.95
2111	256X4	STATIC	7.95
7010	1024X1	MNOS	29.95
7489	16X4	STATIC	2.49
8101	256X4	STATIC	7.95
8111	256X4	STATIC	7.95
8599	16X4	STATIC	3.49
91L02	1024X1	STATIC	2.75
74200	256X1	STATIC	6.95
93410	256X1	STATIC	1.75
5262	2048X1	DYNAMIC	2.95
PROMS			
1702A	2048	FAMOS	15.95
5203	2048	FAMOS	14.95
82S23	32X8	OPEN C.	5.00
82S123	32X8	TRISTATE	5.40

BUILD YOUR OWN JOLT MICROCOMPUTER IN JUST 3 HOURS OR LESS FOR $159.95.

A COMPLETE MICROCOMPUTER IN A SINGLE CPU KIT INCLUDES: • An MOS Technology MCS6502 NMOS microprocessor • 512 bytes of program RAM, and 64 bytes of interrupt vector RAM • 1K bytes of mask programmed ROM containing DEMON, a powerful debug monitor • 26 programmable I/O lines • Internal RC clock, or crystal controlled clock with user supplied crystal • Serial I/O ports for use with a teleprinter current loop drive/receiver, or an EIA standard driver/receiver • Expandable address and data buses • Hardware interrupt • Control panel interface lines available on card connector • Complete assembly manuals and sample programs

JOLT ACCESSORY KITS

JOLT RAM Card — Fully static 4,096 bytes of RAM with 1 microsecond access time and on-board decoding **$199.95**

JOLT I/O Card (Peripheral Interface Adapter) — 2 PIA LSI chips, 32 I/O lines, four interrupt lines, on-board decoding and standard TTL drive. Fully programmable. **$95.50**

JOLT Power Supply — Operates at +5, +12 and −10 voltages. Supports JOLT CPU, 4K bytes of RAM and JOLT I/O card — or, CPU and 8 I/O cards **$99.95**

JOLT +5V Booster Option — Fits onto JOLT Power Supply card. Supports CPU, 8K bytes RAM and 8 I/O CPU and cards **$24.95**

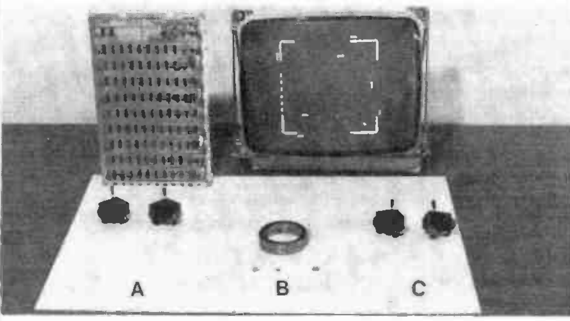
JOLT Universal Card — Same size (4½" x 7"), same form factor as other JOLT cards. Completely blank, drilled to accept 14, 16, 24 or 40 pin sockets. **$24.95**

JOLT Accessory Bag — Contains enough hardware to connect one JOLT card to another, flat cable, connectors, card spacers, hardware, etc. **$39.95**

JOLT Resident Assembler — Fully symbolic, single pass resident assembler, all mnemonics compatible with timesharing assemblers. Delivered on four 1702A PROMs, ready for plugging into JOLT PROM card. **$149.95**

JOLT 1702A PROM Card — Sockets for 2,048 bytes of PROM memory. Place anywhere in memory with jumper selectable addresses. **$99.95**

NOW: YOUR OWN VIDEO GAME FOR THE ENTIRE FAMILY



This game comes pre-tested with two **PROFESSIONAL** Kraft joysticks. Joysticks allow 2 dimensional player control (rather than only one dimension, such as up and down.) If you require more than two players, order extra joysicks. All that's required is a 5V/2A power supply, a harness, and speaker. Comes with schematics, wiring information, and all necessary documentation. Game gives 1V composite video output, perfect for any TV monitor. Game designed so one, two, three, or four players can play at the same time. You can even play against the HOUSE. Score for each person is shown on TV set. These boards are production over runs of a well known video game manufacturer, and are not rejects, or in any way inferior to one presently being sold in games for over $1,000.00.

KIT A — $179.95 **PROFESSIONAL** game P.C. board, and 2 **PROFESSIONAL** joysticks. P.C. board size is 10½" x 17". This is the same **PROFESSIONAL** game as seen in commercial establishments. Don't confuse it with the simple games sold in stores, or with analog kits.

ACCESSORY B — $3.95 Six feet of ribbon cable, three SPST switches (coin simulator, house/player, and start switch), for those of you who don't have extra wire or switches to build the harness.

ACCESSORY C — $39.95 Two additional **PROFESSIONAL** Kraft joysticks, for third and fourth player.

DIGITAL CLOCK KIT — 3½ INCH DIGITS

This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" x 3½" x 1½", and the 4 digit is 18" x 3½" x 1½". Kits come complete with all components, case and transformer.
Specify 12 Or 24 Hr. When Ordering

4 DIGIT KIT $49.95 — 4 DIGIT ASSEMBLED $59.95
6 DIGIT KIT $69.95 — 6 DIGIT ASSEMBLED $79.95

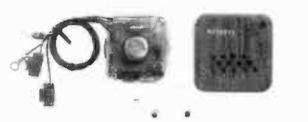
Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax — Data Sheets 25c each
Send a 13c Stamp (postage) for a FREE 1976 Catalog

JAMES

P.O. BOX 822, BELMONT, CA. 94002
PHONE ORDERS — (415) 592-8097

AUTOTEL ™

WARNING LIGHTS ARE NOT ENOUGH



AN AUDIBLE ALARM INDICATING POTENTIAL ENGINE DAMAGE

AUTOTEL is an effecient (15 ma current standby) device by which every owner of an automobile, truck or vehicle equipped with indicator lights for temperature and oil pressure can be assured of a reliable warning before an impending failure.

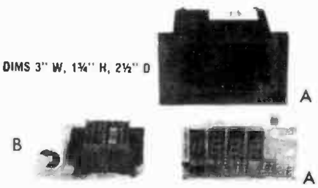
AUTOTEL, by means of an audible signal 70 db pulsing) immediately forewarns the vehicle operator of a malfunction or failure, allowing time to correct and prevent major engine failures. It is programmed so there is no sound during normal operating conditions.

AUTOTEL features CMOS circuitry, packaged in a 2½" sq. x ⅞" case. The kit comes complete with all components, hardware and case to hook directly into your car's warning light system.

$9.95 Per Kit — $14.95 Assembled

IMC 3½ DIGIT DVM KIT

DIMS 3" W, 1¾" H, 2½" D



This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case $49.95
B. 5V Power Supply $14.95

JE700 CLOCK

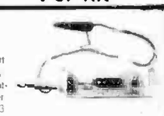
The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2¼" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

12 or 24 Hour

115 VAC— $17.95 Per Kit

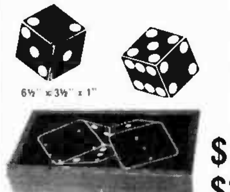
JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.



$9.95 Per Kit
printed circuit board

ELECTRONIC CRAPS

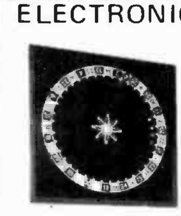


6½" x 3½" x 1"

Electronic craps is an entirely electronic game featuring a dice "roll down", 14 LED's form two dice that roll when activated by a push botton. Dimensions are 6½" x 3½" x 1½".

$19.95 Per Kit
$24.95 Assembled

ELECTRONIC ROULETTE



This kit comes complete with all components, including the case and line cord. Electronic Roulette, is entirely electronic, and features 32 LED's that form a wheel, that is activated, by a push botton switch. Dimensions are 6½" x 6½" x 1½".

$29.95 Per Kit
$34.95 Assembled

Continental Specialties

PROTO BOARD 100

A low cost, big 10 IC capacity breadboard kit with all the quality of QT sockets and the best of the Proto Board series . . . complete down to the last nut, bolt and screw. Includes 2 QT-35S Sockets; 1 QT-35B Bus Strip; 2 5-way binding posts; 4 rubber feet; screws, nuts, bolts; and easy assembly instructions.

$19.95

MAY SPECIALS

POCKET CALCULATOR
5 function plus constant — addressable memory with individual recall — 8 digit display plus overflow — battery saver — uses standard or rechargeable batteries — all necessary parts in ready to assemble form — instructions included.

Calc. Kit. Kit only	$10.95
Batteries (alkaline, disp.)	2.00
Adapter 60Hz	3.95
Kit, Batteries & Adapter	15.95

ALARM CLOCK CHIP
MM5375AA 4-6 digit, 12 hour, 60Hz snooze alarm, brightness control capability, alarm tone output 24 pin DIP
$4.95

8038 FUNCTION GENERATOR
Voltage controlled oscillator — sine, square, triangular output. 16 pin DIP with data **$3.95**

7001 CLOCK CHIP
4-6 digit, 12-24 hr. alarm, timer and date circuits — with data **$6.95**

UNIVERSAL BREADBOARD
Silver plated copper circuit board 3-3/16" x 5-1/16". 2 rows of 27 holes for DIP IC's • space for transistors, resistors & capacitors. Versatile and simple for breadboarding IC circuitry **$1.50 ea.**
50 pcs. **1.00 ea.**

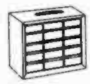
UV ERASABLE PROM
1702A — 2048 bit static PROM 256x8 elect programmable & erasable TTL/DTL comp. **$14.95**

741 Comp Op Amp mDIP .26

CT5005 CALCULATOR CHIP
12 digit — 4 function with memory — chain operation **$1.39**

6 DIGIT LED CLOCK KIT
INCLUDES:
MM314 clock circuit
6 FND70 LED displays (.250" red 7 segment)
All necessary transistors, resistors & capacitors
1 double sided PC board accommodates LED's & clock circuitry
Schematic & instructions
Does not include 12V-300 ma transformer, switches & case **$11.95**

RESISTOR KIT



CARBON FILM ± 5%
¼ OR ½ WATT
455 RESISTORS 44 VALUES
SUPPLIED IN A 15 DRAWER, 60 COMPARTMENT STORAGE CABINET — TABLE OR WALL MOUNT. READY TO USE

¼ WATT — 0125S
½ WATT — 0150S

$24.95 ea.
+ $1.00 SHIPPING & HANDLING
SHIPPED VIA UPS OR PARCEL POST

RESISTOR ASSORTMENT R (OHMS)

R	QTY	R	QTY	R	QTY	R	QTY	R	QTY	R	QTY
1.5	5	68	5	1.0K	20	10K	20	100K	20	1.5M	5
3.3	5	100	10	1.5K	10	15K	10	150K	10	2.2M	5
6.8	5	150	10	2.2K	20	22K	10	220K	10	3.3M	5
10	10	220	10	2.7K	10	27K	10	270K	5	4.7M	5
15	5	270	5	3.3K	10	33K	20	330K	10		
22	5	330	10	3.9K	10	39K	10	470K	10		
33	5	470	20	4.7K	20	47K	10	680K	10		
47	10	680	10	6.8K	10	68K	10	1.0M	20		

NEW ITEMS

TTL

74132	$ .89
74H101	.58
74H102	.58
74H103	.63
74H106	.63
74H108	.63

SCHOTTKY

74S00	$ .38
74S02	.45
74S03	.38
74S04	.45
74S08	.52
74S10	.38
74S20	.38
74S22	.38
74S32	.52
74S74	.38

LOW POWER SCHOTTKY

74LS00	$ .36
74LS02	.36
74LS04	.36
74LS08	.38
74LS10	.36
74LS20	.36
74LS32	.38
74LS40	.45
74LS42	1.40
74LS74	.59
74LS90	1.30
74LS93	1.30
74LS95	2.09
74LS107	.59
74LS164	2.20
74LS193	2.50
74LS197	2.20

METAL FILM RESISTORS
±1% ¼ WATT

QTY	PRICE EACH	PRICE MINIMUM 10 PER VALUE	PRICE MINIMUM 100 PER VALUE
0 - 10	$.20		
10 - 100	.20	$.15	
100 - 1000		.10	$.09
1000 -		.10	.08

RESISTANCE (OHMS)

22.6	71.5	182	887	11.8K	40.2K
23.7	78.7	187	1.15K	13.0K	45.3K
25.5	84.5	191	1.5 K	15.0K	48.7K
30.9	105	205	2.49K	18.2K	54.9K
34.8	110	232	3.57K	19.1K	60.4K
40.2	115	243	4.75K	19.6K	64.9K
45.3	137	499	5.49K	22.6K	69.8K
51.1	147	604	6.04K	24.9K	84.5K
61.9	158	715	7.15K	28.0K	
64.9	178	806	8.25K	37.4K	

TANATLUM CAPACITORS
SOLID-DIPPED ±20%

.1 mfd	35V	.25 ea.	6.8 mfd	6V	.30 ea.
.33 mfd	35V	.25 ea.	6.8 mfd	50V	.40 ea.
1 mfd	35V	.25 ea.	10 mfd	25V	40 ea.
2.2 mfd	20V	.25 ea.	15 mfd	10V	40 ea.
2.2 mfd	35V	.30 ea.	33 mfd	10V	40 ea.
4.7 mfd	16V	.30 ea.	47 mfd	6V	.40 ea.

MISC. DEVICES

546	AM radio receiver subst. DIP	$ .75
733	Diff. video AMPL TO-5	.89
2513	64 x 8 x 5 character generator	$11.00
MC1456	Int. compensated Op Amp mDIP	1.59
7525	Dual core mem. sense AMPL DIP	.98
CA3046	Transistor array 14 pin DIP	.89

TTL

		[illegible]	.97
		7492	.71
7400	$ .14	7493	.60
7401	.16	7494	.94
7402	.15	7495	.79
7403	.16	7496	.79
7404	.19	74100	1.30
7405	.19	74105	.44
7406	.35	74107	.40
7407	.35	74121	.42
7408	.18	74122	.45
7409	.19	74123	.85
7410	.16	74125	.54
7411	.25	74126	.63
7413	.55	74141	1.04
7416	.35	74145	1.04
7417	.35	74150	.97
7420	.16	74151	.79
7422	.26	74153	.99
7423	.29	74154	1.25
7425	.27	74155	1.07
7426	.26	74156	1.07
7427	.29	74157	.99
7430	.20	74158	1.79
7432	.23	74160	1.39
7437	.35	74161	1.25
7438	.35	74162	1.49
7440	.17	74163	1.39
7441	.98	74164	1.59
7442	.77	74165	1.59
7443	.87	74166	1.49
7444	.87	74170	2.30
7445	.89	74173	1.49
7446	.93	74174	1.62
7447	.89	74175	1.39
7448	1.04	74176	.89
7450	.17	74177	.84
7451	.17	74180	.90
7453	.17	74181	2.98
7454	.17	74182	.79
7460	.17	74184	2.29
7464	.35	74185	2.29
7465	.35	74187	5.95
7470	.30	74190	1.35
7472	.30	74191	1.35
7473	.35	74192	1.25
7474	.35	74193	1.19
7475	.57	74194	1.25
7476	.39	74195	.89
7483	.79	74196	1.25
7485	1.10	74197	.89
7486	.40	74198	1.79
7489	2.48	74199	1.79
7490	.59	74200	5.90

Data included with order on request. Add $.30 ea. if item is priced below $1.00 ea. Add $.50 ea. if item is not ordered.

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LINEAR CIRCUITS

300	Pos V Reg (super 723)	TO-5	$ .71
301	Hi perf op amp	mDIP	.29
307	Op AMP (super 741)	mDIP	.26
308	Micro Pwr Op Amp	mDIP	.89
309K	5V 1A regulator	TO-3	1.35
310	V Follower Op Amp	mDIP	1.07
311	Hi perf V Comp	mDIP	.95
319	Hi Speed Dual Comp	DIP	1.13
320T	Neg Reg 5, 12, 15, TO-3		$1.39
320K	Neg Reg 5.2, 12 TO-3		1.39
324	Quad Op Amp	DIP	1.52
339	Quad Comparator	DIP	1.58
340K	Pos. V reg. (5V, 6V, 8V, 12V, 15V, 18V, 24V)	TO-3	1.69
340T	Pos. V reg. (5V, 6V, 8V, 12V, 15V, 18V, 24V)	TO-220	1.49
370	AGC/Squelch AMPL	DIP	.71
372	AF-IF Strip detector	DIP	2.93
376	Pos. V. Reg	mDIP	2.42
380	2w Audio Amp	DIP	1.13
380-8	.6w Audio Amp	mDIP	1.52
381	Lo Noise Dual preamp	DIP	1.52
550	Prec V Reg	DIP	.89
555	Timer	mDIP	.89
556A	Dual 555 Timer	DIP	1.49
560	Phase Locked Loop	DIP	3.95
562	Phase Locked Loop	DIP	3.95
565	Phase Locked Loop	DIP	2.38
566	Function Gen	mDIP	2.25
567	Tone Decoder	mDIP	2.66
709	Operational AMPL	DIP	.26
710	Hi Speed Volt Comp	DIP	.35
723	V Reg	DIP	.62
739	Dual Hi Perf Op Amp	DIP	1.07
741	Comp Op Amp	mDIP	.32
747	Dual 741 Op Amp	DIP	.71
748	Freq Adj 741	mDIP	.35
1304	FM Mulpx Stereo Demod	DIP	1.07
1307	FM Mulpx Stereo Demod	DIP	.74
1458	Dual Comp Op Amp	mDIP	.62
1800	Stereo multiplexer	DIP	2.48
3900	Quad Amplifier	DIP	.35
8038	V contr. osc	DIP	4.95
8864	9 DIG Led Cath Drvr	DIP	2.25
75150	Dual Line Driver	DIP	1.95
75451	Dual Perepheral Driver	mDIP	.35
75452	Dual Peripheral Driver	mDIP	.35
75453	(351) Dual Periph. Driver	mDIP	.35
75491	Quad Seg Driver for LED	DIP	.71
75492	Hex Digit Driver	DIP	.80

MEMORIES

1101	256 bit RAM MOS	$ 1.50
1103	1024 bit RAM MOS	3.95
2102	1024 bit static RAM	5.55
5203	2048 bit UV eras PROM	17.95
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5261	1024 bit RAM	2.69
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7489	64 bit ROM TTL	2.48
82S23	Programmable ROM	3.69
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MM5738	8 DIG 5 funct K & mem	5.35
MM5739	9 DIG 4 funct (btry sur)	5.35
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MM5312	24 pin 1 pps BCD 4 dig mux	3.95
MM5313	28 pin 1 pps BCD 6 dig mux	4.45
MM5314	24 pin 6 dig mux	4.45
MM5316	40 pin alarm 4 dig	5.39

LED'S

MV10B	Red TO 18	$ .22
MV50	Axial leads	.18
MV5020	Jumbo Vis. Red (Red Dome)	.22
	Jumbo Vis. Red (Clear Dome)	.22
ME4	Infra red diff. dome	.54
MAN1	Red 7 seg. .270"	2.19
MAN2	Red alpha num .32"	4.39
MAN4	Red 7 seq. .190"	1.95
MAN5	Green 7 seg. .270"	3.45
MAN6	.6" high solid seq.	4.25
MAN7	Red 7 seq. .270"	1.19
MAN8	Yellow 7 seq. .270"	3.45
MAN64	.4" high solid seq.	2.95
MAN66	.6" high spaced seq.	3.75
MCT2	Opto-iso transistor	.61

CMOS

		4015A	1.49	4049A	.59
		4016A	.56	4050A	.59
4000A	$ .26	4017A	1.19	4066A	.89
4001A	.25	4020A	1.49	4068A	.44
4002A	.25	4021A	1.39	4069A	.44
4006A	1.35	4022A	1.10	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.79	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4081A	.26
4012A	.25	4030A	.44	4082A	.35
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IN5224B	2.8	.45	.40	IN5247B	17	.45	.40
IN5225B	3.0	.45	.40	IN5248B	18	.45	.40
IN5226B	3.3	.45	.40	IN5249B	19	.45	.40
IN5227B	3.6	.45	.40	IN5250B	20	.45	.40
IN5228B	3.9	.45	.40	IN5251B	22	.45	.40
IN5229B	4.3	.45	.40	IN5252B	24	.45	.40
IN5230B	4.7	.45	.40	IN5253B	25	.45	.40
IN5231B	5.1	.45	.40	IN5254B	27	.45	.40
IN5232B	5.6	.45	.40	IN5255B	28	.45	.40
IN5233B	6.0	.45	.40	IN5256B	30	.45	.40
IN5234B	6.2	.45	.40	IN5257B	33	.45	.40
IN5235B	6.8	.45	.40	IN5258B	36	.45	.40
IN5236B	7.5	.45	.40	IN5259B	39	.45	.40
IN5237B	8.2	.45	.40	IN5260B	43	.45	.40
IN5238B	8.7	.45	.40	IN5261B	47	.45	.40
IN5239B	9.1	.45	.40	IN5262B	51	.45	.40
IN5240B	10	.45	.40	IN5263B	56	.55	.50
IN5241B	11	.45	.40	IN5264B	60	.55	.50
IN5242B	12	.45	.40	IN5265B	62	.55	.50
IN5243B	13	.45	.40	IN5266B	68	.55	.50
IN5244B	14	.45	.40	IN5267B	75	.55	.50
IN5245B	15	.45	.40				

7400N TTL

	1-9	10up		1-9	10up		1-9	10up
7400N	.14	.13	7470N	.40	.30	74152N	1.04	.94
7401N	.18	.16	7472N	.40	.30	74153N	.85	.75
7402N	.18	.16	7473N	.42	.38	74154N	1.08	.94
7403N	.18	.16	7474N	.44	.40	74155N	1.02	.92
7404N	.21	.19	7475N	.55	.50	74156N	1.02	.92
7405N	.20	.19	7476N	.44	.40	74157N	.90	.80
7406N	.36	.28	7480N	.80	.72	74158N	1.50	1.30
7407N	.36	.28	7481N	1.30	1.25	74160N	1.02	.92
7408N	.24	.21	7482N	.98	.96	74161N	1.10	1.00
7409N	.28	.21	7483N	.82	.76	74162N	1.40	1.30
7410N	.22	.19	7484N	1.80	1.70	74163N	1.00	.90
7411N	.26	.20	7485N	1.20	1.08	74164N	1.16	1.05
7412N	.34	.32	7486N	.44	.40	74165N	1.20	1.10
7413N	.45	.42	7489N	2.20	2.10	74166N	1.20	1.10
7414N	.98	.95	7490N	.56	.51	74167N	5.00	4.50
7416N	.35	.32	7491N	.84	.76	74170N	2.00	1.80
7417N	.35	.32	7492N	.56	.50	74173N	1.66	1.50
7418N	.30	.27	7493N	.62	.56	74174N	1.00	.90
7420N	.15	.14	7494N	.88	.80	74175N	.96	.90
7421N	.30	.26	7495N	.80	.72	74176N	1.08	1.00
7422N	.50	.45	7496N	.75	.68	74177N	1.08	1.00
7423N	.37	.36	7497N	5.00	4.50	74178N	1.42	1.30
7425N	.30	.23	74100N	1.10	1.00	74179N	1.80	1.70
7426N	.28	.26	74104N	1.00	.90	74180N	1.12	1.02
7427N	.28	.25	74105N	1.00	.90	74181N	3.00	2.70
7428N	.40	.33	74107N	.40	.36	74182N	1.00	.90
7430N	.26	.20	74109N	.40	.36	74184N	2.80	2.50
7432N	.32	.30	74110N	1.00	.90	74185N	3.00	2.70
7433N	.44	.40	74111N	1.00	.90	74188N	5.00	4.80
7437N	.29	.20	74116N	2.00	1.80	74190N	1.20	1.10
7438N	.29	.27	74118N	2.20	2.00	74191N	1.20	1.10
7439N	.44	.40	74119N	4.00	3.60	74192N	.98	.90
7440N	.17	.16	74121N	.60	.54	74193N	.92	.88
7441N	.85	.83	74122N	.48	.43	74194N	1.36	1.23
7442N	.40	.39	74123N	.68	.62	74195N	.75	.70
7443N	.72	.65	74125N	.50	.45	74196N	1.40	1.30
7444N	.72	.65	74126N	.50	.45	74197N	1.40	1.30
7445N	.90	.81	74128N	.50	.45	74198N	1.40	1.30
7446N	.90	.81	74132N	.92	.85	74199N	1.40	1.30
7447N	.98	.90	74136N	.80	.72	74200N	9.00	8.00
7448N	.98	.90	74141N	1.70	1.50	74221N	1.36	1.25
7450N	.14	.13	74145N	1.10	1.00	74247N	2.40	2.20
7451N	.14	.13	74147N	1.90	1.70	74251N	1.90	1.80
7453N	.14	.13	74148N	1.50	1.35	74278N	2.90	2.50
7454N	.14	.13	74150N	1.52	1.40	74279N	.66	.60
7459N	.20	.18	74151N	1.02	.92	74298N	2.00	1.80
7460N	.14	.13						

HIGH SPEED TTL

74H00N	.33	74H20N	.33	74H52N	.36	74H73N	.80
74H01N	.25	74H21N	.33	74H53N	.36	74H74N	.80
74H04N	.33	74H22N	.33	74H54N	.36	74H76N	.75
74H05N	.33	74H30N	.33	74H55N	.36	74H102N	.75
74H08N	.40	74H40N	.36	74H60N	.36	74H103N	.90
74H10N	.33	74H50N	.36	74H71N	.75	74H106N	.95
74H11N	.33	74H51N	.36	74H72N	.75		

LOW POWER TTL

74L00N	.24	74L10N	.24	74L51N	.34	74L90N	1.62
74L02N	.24	74L20N	.33	74L73N	.43	74L93N	1.51
74L03N	.39	74L42N	1.33	74L74N	.90	74L95N	1.62
74L04N	.33						

74LS00

	1-9	10up		1-9	10up		1-9	10up
74LS00N	.36	.35	74LS55N	.39	.38	74LS161N	3.00	2.70
74LS01N	.44	.40	74LS73N	.58	.55	74LS162N	3.06	2.80
74LS02N	.36	.35	74LS74N	.56	.54	74LS163N	3.00	2.70
74LS03N	.45	.43	74LS76N	.65	.64	74LS170N	5.80	5.30
74LS04N	.44	.40	74LS78N	.92	.90	74LS174N	2.20	2.00
74LS05N	.45	.44	74LS95N	2.08	2.00	74LS175N	2.40	2.20
74LS08N	.38	.37	74LS107N	.59	.58	74LS181N	3.69	3.68
74LS09N	.44	.40	74LS109N	.92	.86	74LS190N	2.85	2.70
74LS10N	.36	.35	74LS112N	.58	.55	74LS191N	2.85	2.70
74LS11N	.46	.42	74LS113N	.92	.85	74LS193N	2.50	2.40
74LS15N	.58	.54	74LS114N	.92	.85	74LS194N	2.25	2.20
74LS20N	.44	.20	74LS123N	1.60	1.50	74LS195AJ	2.40	2.20
74LS21N	.58	.54	74LS138N	1.89	1.80	74LS196AJ	2.76	2.50
74LS22N	.58	.54	74LS139N	2.00	1.80	74LS197AJ	2.20	2.10
74LS27N	.44	.40	74LS151N	1.68	1.50	74LS251AJ	2.08	1.90
74LS30N	.39	.38	74LS153N	1.80	1.79	74LS253AJ	2.42	2.20
74LS32N	.45	.44	74LS157N	1.55	1.54	74LS257AJ	1.89	1.80
74LS38N	.58	.53	74LS158N	1.68	1.60	74LS258AJ	2.06	1.90
74LS51N	.39	.38	74LS160N	3.00	2.70	74LS260AJ	.44	.40
74LS54N	.58	.54						

SCHOTTKY TTL

74S00	.44	74S32	.80	74S113	1.50	74S174	3.30
74S01	.76	74S40	.65	74S114	1.20	74S175	2.90
74S02	.60	74S50	.76	74S133	.80	74S181	6.00
74S03	.75	74S51	.80	74S138	2.20	74S189	4.40
74S04	.55	74S60	.80	74S139	2.20	74S194	3.30
74S05	.76	74S64	.80	74S140	.80	74S195	3.30
74S08	.80	74S65	.80	74S151	2.20	74S251	2.20
74S09	.76	74S74	.90	74S153	3.40	74S253	2.40
74S10	.55	74S76	1.15	74S157	2.40	74S257	2.40
74S11	.65	74S78	1.16	74S158	2.00	74S258	2.40
74S15	.76	74S85	6.10	74S160	3.90	74S260	1.20
74S20	.65	74S86	2.50	74S161	4.70	74S280	5.70
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9311PC	2.30	9340PC	5.00	93L12	1.80	93L40	6.50
9312PC	1.20	9341PC	4.10	93L14	1.70	93L41	6.50
9314PC	1.30	9342PC	1.15	93L16	3.20	93L60	3.00
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LM114H	3.00	LM311M	1.75	LM711CH	.90
LM300H	1.20	LM312N	1.75	LM711CN	.90
LM300N	1.20	LM318H	1.50	LM715CH	3.50
LM301AH	.50	LM318M	2.40	LM715CD	4.60
LM301AM	.80	LM324N	1.90	LM723CH	.60
LM301AN	1.10	LM331N	1.25	LM723CN	.65
LM301M	.95	LM336K	2.40	LM725CH	1.50
LM302N	1.30	LM339N	2.20	LM725CD	5.00
LM302H	1.40	LM320-5K	2.90	LM733CH	1.40
LM304H	1.20	LM320-5T	2.50	LM733CD	3.50
LM305H	.85	LM320-12K	2.90	LM733CN	1.30
LM305AH	1.05	LM320-12T	2.50	LM741CH	.40
LM305N	1.00	LM340-5K	2.60	LM741CD	1.25
LM306N	.95	LM340-6K	2.60	LM741CM	.39
LM307H	.60	LM340-8K	2.60	LM747CH	.75
LM307M	1.50	LM340-12K	2.60	LM747CN	.90
LM308H	.85	LM340-15K	2.60	LM748CM	.55
LM308AH	5.00	LM340-18K	2.60	LM777CH	2.15
LM308D	2.25	LM340-24K	2.60	LM777CM	2.10
LM308M	1.00	LM555CM	.70	LM3046CN	.95
LM309H	1.75	LM556CM	1.30	LM3054CN	1.50
LM309K	1.50	LM567CM	1.70	SG4501T	2.40
LM310H	1.50	LM709CH	.75	SG4501N	2.40
LM310M	1.80	LM709CN	.75	LM5000K	7.50

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P/N	1-9	10up	P/N	1-9	10up	P/N	1-9	10up
4000AE	.24	.23	4027AE	.55	.53	4070AE	.60	.59
4001AE	.24	.22	4028AE	.95	.88	4071AE	.25	.23
4002AE	.24	.22	4029AE	1.25	1.22	4072AE	.34	.31
4004AE	4.00	3.99	4030AE	.44	.40	4073AE	.38	.35
4006AE	1.30	1.20	4033AE	2.00	1.94	4075AE	.38	.35
4007AE	.24	.23	4035AE	1.25	1.14	4076AE	1.24	1.22
4008AE	1.79	1.65	4040AE	1.58	1.50	4077AE	.70	.69
4009AE	.59	.51	4041AE	1.82	1.75	4078AE	.38	.35
4010AE	.50	.49	4042AE	.78	.75	4081AE	.25	.23
4011AE	.24	.23	4043AE	.85	.80	4082AE	.34	.31
4012AE	.24	.22	4044AE	.80	.75	4095AE	2.00	1.99
4013AE	.45	.40	4047AE	2.75	2.70	4098AE	1.30	1.29
4014AE	1.45	1.34	4048AE	1.43	1.42	4099AE	2.90	2.89
4015AE	1.24	1.23	4049AE	.58	.53	4507AE	.60	.55
4016AE	.50	.49	4050AE	.58	.53	4508AE	2.20	2.19
4017AE	1.15	1.07	4051AE	1.49	1.48	4510AE	1.45	1.44
4018AE	1.24	1.23	4052AE	1.49	1.48	4514AE	5.00	4.99
4019AE	.50	.49	4053AE	1.49	1.48	4515AE	5.00	4.99
4020AE	1.45	1.34	4055AE	1.95	1.94	4516AE	1.75	1.74
4021AE	1.38	1.25	4056AE	1.99	1.98	4518AE	1.28	.98
4022AE	1.05	.99	4063AE	2.50	2.49	4520AE	1.28	.98
4023AE	.24	.22	4066AE	1.10	1.09	4528AE	1.59	1.45
4024AE	.88	.80	4068AE	.50	.49	4585AE	2.05	1.89
4025AE	.24	.22	4069AE	.44	.43	4901AE	.43	.36
						4911AE	.43	.36

INDUSTRIAL QUALITY COMPONENTS

What is more important?
QUALITY
or
PRICE?
We have decided to offer only the highest quality components. When quality counts, you can count on Ancrona

FIRST QUALITY ONLY

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WIRE-WRAP GOLD DIP

PIN	1-24	25	100
14	.45	.41	.37
16	.54	.49	.44

SOLDER - GOLD DIP

PIN	1-24	25	100
14	.34	.31	.28
16	.37	.34	.31

TEFLON TO-5

3 PIN	.55 EA
4 PIN	.65 EA
6 PIN	.90 EA
8 PIN	1.10 EA
10 PIN	1.40 EA

PLASTIC TO-5 8 PIN $.40

SOLDER-TIN DIP

PIN	1-24	25	100
8	.21	.19	.17
14	.25	.22	.20
16	.28	.25	.23
18	.34	.31	.28
22	.37	.36	.35
24	.47	.43	.40
28	.88	.80	.70
36	1.09	.98	.89
40	1.24	1.12	.90

INTERSIL 8038 PRECISION WAVEFORM GENERATOR & VCO

For simultaneous sine, square and triangular waveforms <.001 Hz to 1MHz.

Part No.	1-9	10 up
8038CCPD	$3.90	$3.70

1-AMP RECTIFIERS

	10	100	1000
1N4001	1.00	7.00	60.00
1N4002	1.10	8.00	70.00
1N4003	1.20	9.00	80.00
1N4004	1.30	10.00	90.00
1N4005	1.40	11.00	100.00
1N4006	1.50	12.00	110.00
1N4007	1.60	13.00	120.00

HYBRID POWER AMPLIFIERS

SI-1010G	10W	$6.40
SI-1020G	20W	9.90
SI-1030G	30W	18.70
SI-1050E	50W	24.90
SI-1050G	50W	24.90

HIGH VOLTAGE TRANSISTORS

BU204	3A	1300V	$4.14
BU205	3A	1500V	4.95
BU206	3A	1700V	5.94
BU207	6A	1300V	5.85
BU208	6A	1500V	6.93
BU209	6A	1700V	8.64

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THE SMALLEST AC/DC POWER SUPPLY EVER!
Only 1.70"x1.00" x 0.85", output preset ±5%, 9 models:

5	140
8	115
10	100
12	90
15	70
18	50
20	35
22	25
24	15

$39.80 each

POWER SUPPLIES

ADTECH

Model No.	Output Vdc	Output Amps	1-4	5 up
APS5-3	5	3.0	$29.95	$28.60
APS12-1.6	12	1.6		
APS15-1.5	15	1.5		
APS24-1	24	1.0		
APS28-0.8	28	0.8		
APS5-6	5	6	$48.45	$46.05
APS12-4	12	4		
APS15-3	15	3		
APS24-2.2	24	2.2		
APS28-2	28	2		
APS5-10	5	10	$72.25	$68.65
APS12-7	12	7		
APS15-6	15	6		
APS24-5	24	5		
APS28-4	28	4		

MICROPROCESSOR SPECIAL

8080A $34.90

MICROPROCESSOR COMPONENTS

RAM'S

	1-9	10up
P1101A	2.20	2.10
P1101A1	3.50	3.30
P1103	2.90	2.70
P2101	5.00	4.80
P2101-1	5.10	4.85
P2101-2	5.20	4.90
P2102	2.48	2.30
P2102-1	2.80	2.65
P2102-2	2.70	2.60
P2102A	2.90	2.70
P2102A-2	3.00	2.80
P2102A-4	2.95	2.75
P2111	5.70	5.50
P2111-1	5.80	5.60
P2111-2	5.90	5.70
P2112	5.90	4.70
P2112-2	6.00	4.80
P2401	9.90	9.80
P2405	8.80	8.00
2602B	2.48	2.30
2602-1B	2.80	2.65
2602-2B	2.70	2.60
IM7552CPE	2.48	2.30
IM7552-1CPE	2.80	2.65
IM7552-2CPE	2.70	2.60
TMS4035NL	2.48	2.30
TMS4034NL	2.70	2.60
P8101	5.00	4.80
P8101-2	5.20	4.90
P8102	2.48	2.30
P8102-2	2.70	2.60
P8111	5.70	5.50
P8111-2	5.90	5.70
AM9101APC	3.50	3.30
AM9101BPC	3.90	3.80
AM9101CPC	5.50	5.30
AM9101DPC	7.80	7.00
AM9102APC	2.70	2.60
AM9102PC	3.00	2.80
AM9102BPC	4.90	4.50
AM9102CPC	6.20	6.00
AM9102DPC	7.80	7.00

LOW POWER RAM'S

AM91L02PC	2.75	2.70
AM91L02APC	3.90	3.70
AM91L02BPC	5.00	4.40
AM91L02CPC	7.00	6.00

PROMS

1702A	15.95	14.50

SHIFT REGISTER

	1-9	10up
P2401	23.00	19.00
P2405	10.85	9.90
P2505K	3.70	3.30
2512K	4.30	4.05
2521V	2.50	2.20
2524V	2.40	2.20
2525V	3.60	3.50
2533V	10.50	8.50
AM2802PC	4.40	3.50
AM2803PC	4.40	3.50
AM2804PC	4.40	3.50
AM2805HC	3.70	3.30
AM2806HC	7.00	5.60
AM2807PC	2.40	2.20
AM2808PC	3.60	3.50
AM2809PC	2.50	2.20
AM2810DC	10.00	8.00
AM2812ADC	24.00	19.20
AM2812DC	21.00	16.80
AM2813ADC	24.00	19.20
AM2813DC	21.00	16.80
AM2814DC	12.45	9.15
AM2825PC	18.75	15.00
AM2826DC	22.50	18.00
AM2827PC	18.75	15.00
AM2833PC	10.85	8.70
AM2841APC	10.50	8.40

SHIFT REGISTER

	1-9	10up
AM2841PC	8.25	6.55
AM2847PC	5.00	4.50
AM2855PC	7.15	5.75
AM2856PC	7.15	5.75
AM2857PC	7.15	5.75
AM2896PC	5.00	4.50
AM3341PC	8.25	6.50
AM3347PC	6.40	5.10
AM4025D	73.00	58.40

AMD-MSI

AM2501DC	9.00
AM2502PC	9.50
AM2503PC	9.50
AM2504PC	16.05
AM2505PC	15.00
AM2506PC	8.80
AM25L02PC	10.70
AM25L03PC	10.70
AM25L04PC	16.05
AM25L05PC	15.00
AM25L06PC	8.80
AM25S05PC	19.00
AM25S07PC	3.78
AM25S08PC	3.51
AM25S09PC	5.40
AM25S10PC	4.50
AM25S18PC	5.40
AM25LS07PC	2.79
AM25LS08PC	2.76
AM25LS09PC	3.49
AM25LS14PC	31.00
AM25LS15PC	2.14
AM25LS138PC	2.12
AM25LS139PC	2.12
AM25LS151PC	2.14
AM25LS153PC	2.14
AM25LS157PC	1.54
AM25LS158PC	1.54
AM25LS160PC	2.94
AM25LS161PC	2.94
AM25LS162PC	2.94
AM25LS163PC	2.94
AM25LS174PC	3.10
AM25LS175PC	2.76
AM25LS181PC	8.00
AM25LS190PC	3.87
AM25LS191PC	3.87
AM25LS194APC	2.62
AM25LS195APC	1.77
AM25LS251PC	2.66
AM25LS253PC	2.66
AM25LS257PC	2.00

COMPUTER INTERFACE

DM8820N	2.40
DM8820AN	6.90
DM8830N	2.40
DM8831N	5.20
DM8832N	6.00
N8T26B	4.40
9600PC	1.30
9601PC	1.20
9602PC	1.95
9614PC	2.30
9615PC	2.40
9616PC	5.00
9617PC	3.50
9620PC	4.00
9621PC	4.00

75107

75107BN	2.60
75108BN	2.30
75109N	2.20
75110N	2.20
75115N	2.25
75138N	2.95
75150N	3.10
75154N	4.10

75107

75208N	2.70
75234N	2.50
75450N	1.25
75451N	1.00
75452N	1.00
75453N	1.00

7520 SERIES SENSE AMPS

7520N	4.00
7521N	2.00
7522N	4.25
7523N	1.75
7524N	2.00
7525N	4.50

TWO-PHASE MOS CLOCK DRIVER

MH0026CN	5.50

MM

MM404H	12.00
MM405H	23.00
MM406H	6.50
MM407H	6.50
MM451H	11.40
MM454F	18.00
MM500H	2.00
MM506H	3.20
MM507H	3.20
MM550H	5.90
MM551H	5.60
MM555H	5.60

MOS-LSI

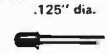
1402AN	3.80
1403AH	4.00
1403AN	3.80
1404AH	4.50
1404AN	2.90
1405A	4.00
1406	8.40
1407	8.40
1506	3.00
1507	3.00
1602	33.00
TMS3114J	9.40
TMS3120JC	7.00
TMS3120NC	6.00
TMS3133NC	7.50
3341ADC	8.00
3341APC	7.00
3347DC	5.80
3347PC	4.60
4102	4.95
7552	4.95
7552-1	5.40
7552-2	5.50
MM4055D	12.00
MM4056H	9.70
MM4057D	13.00
MM5025N	20.00
MM5026N	20.00
MM5027N	20.00
MM5055N	5.50
MM5056N	5.50
MM5057N	5.50
MM5058N	5.50

BIPOLAR MEMORY

C3101	6.50
P3101	4.90
C3101A	7.30
P3101A	5.80
IM5501CDE	7.30
IM5501CPE	5.80
MM5560D	7.30
MM5560N	5.80
DM8599N	5.80
93403PC	5.80

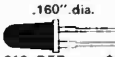
LEDs

.125" dia.



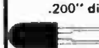
209	RED	$.25
209	YELLOW	.35
209	GREEN	.35

.160" dia.



216	RED	$.25
216	YELLOW	.30
216	GREEN	.30

.200" dia.



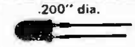
220	RED	$.25
220	YELLOW	.30
220	GREEN	.30

LOW PROFILE

.200" dia.

226	RED	$.25
226	YELLOW	.30
226	GREEN	.30
226	ORANGE	.30

.200" dia.



5053	RED	$.35
5053	YELLOW	.40
5053	GREEN	.40
5053	ORANGE	.40

MV50 RED $.30

216 = MV5024
5053 = MV5053

DISPLAYS

0.6" IN.

EP62R	RED	3.00
EP62G	GREEN	3.60
EP62Y	YELLOW	3.60

Data sheet for EP62 $.25

LARGE 1"

EP1000 RED	5.50
3 pcs EP1000	15.00
5 pcs EP1000	22.50

Data sheet for EP1000 $.25

XCITON

XAN72	RED	2.00
XAN52	GREEN	2.00
XAN82	YELLOW	2.00

LITRONIX

DL80	RED	6.00	DL44	RED	6.00
DL81	RED	6.00	DL402	RED	4.00
DL10	RED	6.00	DL701	RED	3.40
DL10A	RED	4.00	DL704	RED	2.25
DL101	RED	4.90	DL707	RED	2.35
DL57	RED	9.90	DL747	RED	2.50
DL61	RED	12.00			
DL33	RED	4.00			

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MCT2	.60

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ILD74	1.00
ILQ74	3.40

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3Q4	6AX5	6EM7	12AV6
4BC5	6AY3	6GF7	12BE6
4BN6	6BA6	6GH8	12BH7
4BU8	6BG6	6K6	18FW6
4BZ7	6BJ8	6K11	25L6
5V6	6BQ6	6LB6	35EH5
6AF4	6BZ6	6SN7	36AM3
6AG5	6CB6	6T8	50A5
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M252B1AA
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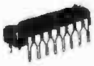

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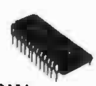
M253B1AA
12 programmable rhythms (also available in combination) $19.50



24-PIN

ABSOLUTE MAXIMUM RATINGS

V_{GG}*	Source supply V	−20 to 0.3	V
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T_{op}	Operating temp.	0 to 70	°C

*With respect to V_{SS} pin voltage

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Popular Electronics

MAY 1976

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P-2

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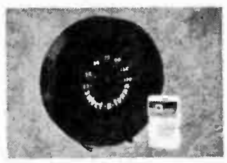

New antenna assist turns a tiny transistor into a tiger, has pulled in stations up to 1000* miles away! Just set beside radio (no wires, clips, grounding) and fine-tune Select-A-Tenna's dial to same frequency — "gangbusters"! Great for clearing weak signals in radio depressed areas, off-coast islands, crowded frequency stations. Solid state—uses no electricity, batts., tubes.

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No. 1668 (9½×5⅝×4¼") . . . . $149.95 Ppd.
LOW COST STARTERS' UNIT (PORTABLE)
No. 71,809 AV (4½×2¾×4¼") . . . . $55.00 Ppd.

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New 3-Channel Color Organ adds to music listening pleasure, lets you modulate 3 independent strings of colored lamps with intensity of your music to create an audio "light show." They flash, vary in brightness related to music's rhythm, pitch, volume—pulsating lighting performance to music! Fully assembled & priced half that of others, the Edmund Sound To Light Control is a terrific value. Plug in, turn on!

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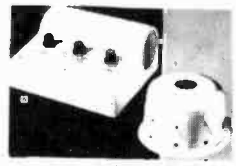

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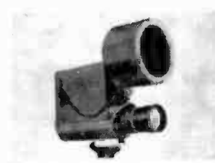

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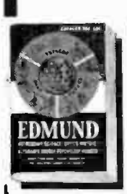

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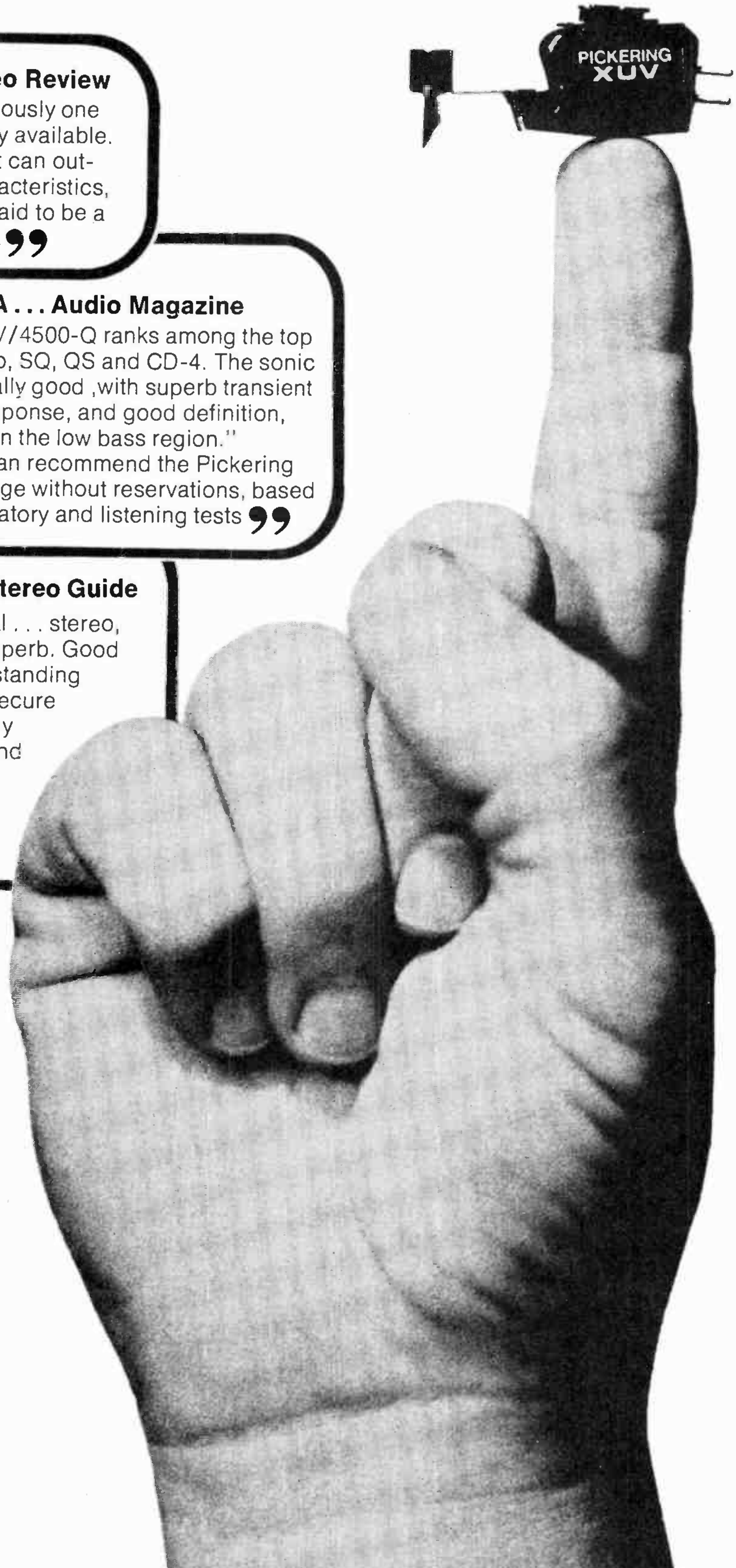

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Hi-Fi Stereo Buyers Guide

"In both stereo and CD-4 one of the most outstanding under any program conditions. Sound so clean and crisp it almost hurts."
"This pickup is a perfect example of why measurements cannot truly express the sound quality from a transducer; though the measurements are good, the sound quality was rated by the entire listening panel as superb."

The specifications of the XUV/4500-Q are so exciting that we hope you will write to Pickering and Company, Inc., Dept. PE, 101 Sunnyside Blvd., Plainview, New York 11803 for further information.

PICKERING

"for those who can hear the difference"

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CIRCLE NO. 47 ON FREE INFORMATION CARD

Before you buy your next turntable, consider why you want a new one.

In letters and warranty cards from new Dual owners, we find that some had owned manual turntables and came to prefer the convenience and safety of automatic start and stop. Others also wanted to be able to play records in uninterrupted sequence. And a few gave reasons that modesty makes us hesitate to quote: "I wanted the best!" or "Everyone recommends Dual."

Whatever your reason may be for wanting a new turntable, consider your purchase carefully. Your record collection probably represents a bigger investment than all your other components combined. And your turntable is the only component that handles your records.

Although the overall appearance and feel of a turntable's controls can tell you something about its quality, appearances can be deceptive. For example, curved tonearms may appear interesting, but their unnecessary mass and increased resonance can only detract from the quality of music reproduction. All Dual tonearms follow a straight line from pivot to cartridge holder for maximum rigidity and lowest mass.

Some tonearms apply stylus pressure by unbalancing the tonearm. This results in tracking which is adversely affected by record-warp conditions and turntable level. In every Dual, stylus pressure is applied around the vertical pivot via a long coiled spring. This maintains tonearm balance throughout play, and tracking is unaffected even if the turntable is tilted substantially.

Other Dual features and refinements include: cueing damped in both directions to prevent bounce; pitch-control; anti-skating separately calibrated for all three stylus types. And internally: motor rotors and drive pulleys individually machined and tested with precision instruments to assure perfect concentricity.

All the above contribute importantly to quality performance.

Now, while you should never compromise with quality, convenience is a matter of choice. Which is why Dual quality comes in a variety of models: semi-automatic, single-play; fully-automatic single-play; single-play/multi-play. Seven models in all as described below.

Dual 1225. Fully automatic, single-play/multi-play. Viscous-damped cue-control, pitch-control. 10⅝" platter. Less than $140, less base. Dual 1226, with cast platter, rotating single-play spindle. Less than $170. Dual 1228 with gimballed tonearm, synchronous motor, illuminated strobe, variable tracking angle. Less than $200.

Dual 1249. Fully automatic, single-play/multi-play. Belt drive. 12" dynamically-balanced platter. Less than $280, less base. Full-size belt-drive models include: Dual 510 semi-automatic. Less than $200; Dual 610, fully automatic. Less than $250. (Dual CS601, with base and cover. Less than $270.)

Dual CS701. Fully automatic, single-play. D.C. brushless, electronic direct drive motor; tuned anti-resonance filters. Less than $400, including base and cover.

Dual 1225

Dual 1249

Dual CS701

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