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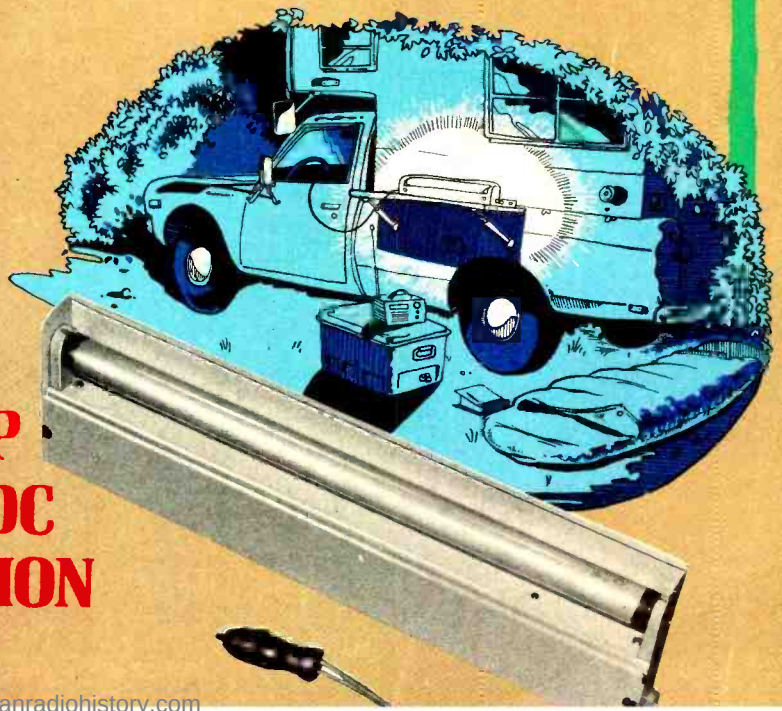

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CIRCLE NO. 11 ON FREE INFORMATION CARD

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Security is Mallory.

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CIRCLE NO. 30 ON FREE INFORMATION CARD

SWTPC announces first dual minifloppy kit under $1,000

Now SWTPC offers complete best-buy computer system with $995 dual minifloppy, $500 video terminal/monitor, $395 4K computer.

$995 MF-68 Dual Minifloppy
You need dual drives to get full benefits from a minifloppy. So we waited to offer a floppy until we could give you a dependable dual system at the right price.

The MF-68 is a complete top-quality minifloppy for your SWTPC Computer. The kit has controller, chassis, cover, power supply, cables, assembly instructions, two highly reliable Shugart drives, and a diskette with the Floppy Disk Operating System (FDOS) and disk BASIC. (A floppy is no better than its operating system, and the MF-68 has one of the best available.) An optional $850 MF-6X kit expands the system to four drives.

$500 Terminal/Monitor
The CT-64 terminal kit offers these premium features: 64-character lines, upper/lower case letters, switchable control character printing, word highlighting, full cursor control, 110-1200 Baud serial interface, and many others. Separately the CT-64 is $325, the 12 MHz CT-VM monitor $175.

$395 4K 6800 Computer
The SWTPC 6800 comes complete with 4K memory, serial interface, power supply, chassis, famous Motorola MIKBUG® mini-operating system in read-only memory (ROM), and the most complete documentation with any computer kit. Our growing software library includes 4K and 8K BASIC (cassettes $4.95 and $9.95; paper tape $10.00 and $20.00). Extra memory, $100/4K or $250/8K.

Other SWTPC peripherals include $250 PR-40 Alphanumeric Line Printer (40 characters/line, 5 x 7 dot matrix, 75 line/minute speed, compatible with our 6800 computer and MITS/IMSAI); $79.50 AC-30 Cassette Interface System (writes/reads Kansas City standard tapes, controls two recorders, usable with other computers); and other peripherals now and to come.

Enclosed is:

_____ $1,990 for the full system shown above (MF-68 Minifloppy, CT-64 Terminal with CT-VM Monitor).
_____ $995 for the Dual Minifloppy
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OCTOBER 1977
VOLUME 12, NUMBER 4

Popular Electronics®

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Editorial

THE FUTURE OF HOME COMPUTERS

It has been almost three years since POPULAR ELECTRONICS introduced the first powerful, low-cost microcomputer mainframe. In this short time, many changes have taken place in the field. For example, then you could only buy a home computer by ordering it through the mail, sight unseen. Now there are many hundreds of retail computer stores where prospective buyers can observe computers in action and ask questions about their operation before making a purchase. Soon there will be even more such stores (in the thousands) with Radio Shack's and Heath's recent announcements of computer models joining the fold.

Other changes are evident, too. Whereas virtually every home computer purchased a few years ago was in kit form, sales of factory-assembled versions are growing. Moreover, we used to have just mainframes with separate peripherals; now we can buy single-board computers and mainframes incorporating terminals. For storing programs, the use of paper tape programs is giving way to audio cassette systems, with many a computer buff hoping for a floppy disc under his Christmas tree . . . BASIC in ROM is "in," if only because more and more electrical blackouts are anticipated . . . computer clubs are springing up all over the country as if they were fast-food operations.

Naturally, the question arises: "Where are non-commercial computers headed?" Undoubtedly, computers will one day reach the mass market; but when and where will they be merchandised? Here, views are divided.

Many people think computers will be sold by mass-market merchandisers, such as the large department stores. Supporting this view, a spokesman for Commodore Business Machines indicated that its personal computer (not yet available for sale) will indeed be sold by department stores, starting with the California division of R.H. Macy & Co. "In about five years or so, it'll be just like the calculator market is today," one computer hobbyist opined.

I don't agree.

Right now, we have virtually no true personal computer systems. Rather, we have a hobbyist and small-business market, as opposed to the appliance-type of computer. The field for the latter is bound to grow, of course. However, I don't believe that the *general public* is ready to plunk down $600 or more for a computer system that is largely based on playing games, doubling as a hand-held calculator, and maintaining the family checking account. It's a nice thought, but, in my view, an over-optimistic one. This is an area which will appeal to the hobbyist, who will take the time to learn what the machine can do, explore different ways in which to expand the computer's utility, join computer clubs, etc. This person is not the button pusher.

Furthermore, I cannot visualize computers being sold in great numbers in a general type of retail outlet where one cannot even get the attention of a clerk to pay a bill, let alone obtain counsel. It's the *specialist* store that will be best equipped to move computer merchandise in the foreseeable future. I draw a parallel here with stores that merchandise hi-fi components and photography equipment. Sure there are department stores that sell such equipment, but most of it is sold in specialty stores whose sales personnel can hold a customer's hand while he makes a buying decision and support him after the sale is made. And that's the computer or electronic retail store.

The mass appeal of computers to the public will likely take place when a terminal can be used in the home for a variety of pushbutton applications: shopping for and buying merchandise in various stores while sitting at home, selecting video presentations of material from newspapers and reference books in libraries, and so on. When this comes to pass (in the 1990's?), I'm confident that the terminals will be supplied initially by the "phone company" or IBM, rather than the comparatively small computer manufacturer. The latter is more likely to enter the competition after the former has established a major market by installing fibre optic cable lines to carry digital data, contracting with sellers, and offering the public a line of terminals for home use (with a monthly rental fee, of course).

Meanwhile, I anticipate the continued, burgeoning growth of the hobbyist and small business computer field for the next decade.

Art Salsberg

B&K-PRECISION's new 3½ digit DMM

For over two years, our competition has been trying to figure out how B&K-PRECISION could sell a full-feature 3-digit DMM for only $99.95. They've dissected it, analyzed it, and some even asked us how we did it. Well, they can start all over because we did it again!

B&K-PRECISION's new Model 2800 portable DMM features 3-1/2 digit display, auto-zeroing and 100% overrange reading for only $99.95. Basic DC accuracy is 1%. Twenty-two ranges read up to 1000 volts DC or AC, 1000mA and 10 megohms.

All ranges are well protected against overloads. Even if you should accidentally apply +1000VDC to the 2800 while switched to an ohms range, no instrument damage will result. All DC and AC voltage ranges are protected up to ±1000 volts DC or AC. The current ranges receive the double protection of diodes and a series fuse.

For accurate in-circuit resistance measurements, the 2800 measures with high- or low-power ohms ranges. At low-power ohms, less than 0.2 volt is developed across the measured resistance. To forward bias semiconductor junctions, the high-power ohms ranges develop about 2 volts.

B&K-PRECISION also has a full complement of optional accessories for the 2800. Accessories include a carrying case, wire tilt stand, AC adapter/charger, high-voltage probe, direct/isolation probe NiCad Batteries and 10-amp current shunt.

The B&K-PRECISION 2800 may be a mystery to our competitors, but for you—it takes all the mystery out of which DMM to buy.

See your local distributor for immediate delivery.

B&K PRECISION DYNASCAN CORPORATION

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TEACHING DEVICE · ARCADE GAME · MUSICAL INSTRUMENT · HOME COMPUTER

Home Library Computer

The handsome and highly styled Bally Library Computer is made of high impact clear plastic and imitation walnut with gold trim. It measures 5" x 11" x 15" and weighs five pounds.

The new Bally Library Computer provides more entertainment and services than man has ever dreamed possible from a single consumer product.

This is the story of an incredible product. So incredible that we know of no future consumer product that will have such a far-reaching technological impact on society.

The Bally Library Computer is a small console unit that resembles a programmable TV game but whose computing capabilities resemble that of the IBM 5100 currently selling for $10,000. This calculating power and its present and future programs will provide more convenience and benefits than any other recent electronic product.

ELECTRONIC PRINTING CALCULATOR

Imagine the computer as a printing calculator with ten separate memories. You enter the data on the unit's keyboard, but instead of a paper tape, you use your TV screen to scroll out the answers similar to the credits on a movie screen. You can balance your checkbook and then double check your calculations by scrolling back to your first entry. By comparison, an electronic calculator with ten memories alone would cost what this entire computer costs—but there's much more.

A CHALLENGING TEACHING TOOL

Your child inserts a cartridge in the Bally console. Three random math table problems are then flashed on your TV screen. Depending on the speed and accuracy with which those problems are answered, the Bally automatically programs the computer with your child's math level. Problems in addition, subtraction, multiplication and division are then flashed on the screen for the next three minutes, and the computer continually adjusts to a level slightly better than the math level indicated by the previous three answers. The math tables, therefore, remain a challenge no matter how good your child becomes. Psychologists, who were consulted by Bally, helped design the cassette. They stated that the cassette should stimulate math learning and improve grades.

On the same math cartridge is a two player game called Math Bingo. It adjusts to each player's ability so a parent can play against a child or two children can compete against each other at their own math levels—both with an equal opportunity to win. You first answer a math table problem similar to the first exercise; and with a pistol-grip pointer you move a square on your TV screen to the correct answer position on your TV bingo card. The game involves both math skill and dexterity. Each game is totally different since the bingo cards have a million different possibilities. Scoring is constantly displayed, and a typical game lasts approximately three minutes. You can play as many consecutive games as you wish. However, to start the score over, you press the reset button.

FUN AND ACTION ARCADE GAMES

Picture nine baseball players running out on your TV screen to the sounds of "Take Me Out to the Ball Game" as you step up to bat. That's the scene with Baseball, the arcade cartridge that plays two teams against each other with play so real that you hear all the music, sound effects and see all the action. There are walks, balls, and such realism that the pitcher covers first base when a ball is hit to right field—just like the real game. There are double plays, walks and errors—all part of nine innings of Baseball. On the same cartridge are several paddle ball games but with a new twist. Players can move the paddle, not only up or down like most TV games, but sideways and diagonally.

The Bally circuit board contains 34 integrated circuits including a Z80 microprocessor. This package represents more computing power in the hands of the consumer than was thought possible this early in the history of micro electronics. The mass production of these components and circuit board has made possible a quantum leap in lowering the cost of what normally would be a very expensive system.

Other popular arcade games include, Sea Wolf, Red Barron, Panzer Attack (similar to Tank) and dozens of games only previously available at arcades. These same games cost arcade owners up to $2,000 each.

MORE VALUE PER FEATURE

Let's quickly review the features—an electronic printing calculator with ten memories, a teaching machine that adjusts to your child's math level and an arcade center that replaces about $10,000 worth of electronic arcade games with just a few cartridges. Use any one of these features and you could justify buying this unit—but there's plenty more.

With all its sophistication, the Bally Library Computer was designed to keep current with advancing computer technology no matter how sophisticated the development. Bally has provisions in its present system for expansion modules. These devices will permit you to: 1) draw directly on your TV screen with an electronic wand in 32 different colors and eight shades of each color, 2) compose, record and playback music on an electronic synthesizer, 3) record your personal belongings and their value for security purposes and add or delete items while keeping the list in tact, 4) record all your phone numbers and then use the system to dial those numbers on your telephone, 5) play chess on the phone with another player and be able to see all the moves on your TV screen.

EXCELLENT BUSINESS TOOL

With these expansion modules, businessmen will be able to do all their bookkeeping functions, payroll, inventory control and billing. There will be printers, telephone modems and a variety of peripheral computer equipment that will turn your Bally Library Computer into a significant business tool. And, when used in your business, your Bally unit is depreciable like all your other capital equipment. Even large corporations can use the Bally for specific applications to avoid tying up their larger computer systems.

The Bally Library Computer will turn these incredible add-on features into reality in a planned program starting now. Each month, a new cartridge or accessory expanding the unit's capability will be announced. If you purchase your system from JS&A, you will be alerted to these new accessories by mail on a regular basis in advance of their availability and before any national announcement. You may then order the accessories directly.

Each new cartridge or accessory will offer you a new way to use your system—a way that would justify, by itself, the purchase of the entire system.

NOT JUST A TV GAME

Don't confuse the Bally Library Computer with the many inexpensive programmable TV games. The Bally computer is a powerful system using the Z80 microprocessor whose cost per byte (the measure of computer memory power) is even lower than a home computer. Yet it has 12,000 bytes of computer power in its most basic system and you are not just limited to teaching, music, entertainment or business applications. The Bally computer can be programmed to do anything any mini-computer can do. A programmable TV game at any price is (and will always be) just a programmable TV game. It cannot be expanded. The Bally Library Computer is actually a computer with a variety of expansion capabilities.

A COMPUTER IN EVERY HOME

This is the first time a full-scale computer has been offered to the consumer. The home hobbyist with his home computer started the revolution a few years ago. With the specific programs, software and accessories available

from Bally, the age of affordable consumer computer ownership is here now.

INTERNAL TASK LIBRARY

The computer you buy now has within its 34 integrated circuits an internal library of over forty tasks that it performs. With such an extensive internal library, your computing power is already in the unit you buy. This also means that the Bally unit is a smart computer. (There are such things as dumb computers.) A smart computer can complete a function faster and more efficiently because it depends less on the data it gets and more on what it can already do.

SAFE FOR YOUR TV

The task library includes a built-in electronic timer which determines the end of a game or program by either score or elapsed time. It also times the arcade games and automatically turns off your unit and blanks out your screen if it is left on too long. Most TV set manufacturers have excluded sets that use TV games from warranty coverage because of the possible lines that appear on the screen from sets left on too long with the same picture. This is impossible with the Bally.

If you get a phone call in the middle of a game, you press the pause control which lets you freeze the action right in the middle of a play and blanks out the screen so you won't damage your picture tube.

The library has sound effects so that each arcade game is complete—from the sound of a baseball bat to that of a torpedo hitting a submarine. It has a math program capable of turning your unit into a scientific, statistical or engineering calculator with the addition of the appropriate cartridge. The library contains the capability of creating patterns on your TV screen, playing music, and accepting typewriter entries. It even has an index that displays everything in your library.

The cassette cartridges add between eight to thirty-two thousand additional bytes of computer power to the basic 12,000 byte system. The pistol grip arcade accessory can be used to play all the arcade games.

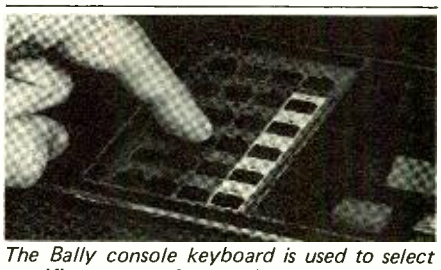
THE MAJOR BREAKTHROUGH IN BALLY'S COMPUTER

Its extensive internal library and the tremendous power in the computer are the big breakthroughs in the Bally unit. The internal computer has over 12,000 bytes with a minimum of 8,000 bytes in its cartridges. This puts more computer power in the hands of the consumer than six typical programmable TV games or an average hobbyist home computer. It has the computational capabilities of one $10,000 IBM 5100 computer, and each time you add a cassette cartridge you increase that capability.

Good resolution on your TV screen is one of the end effects of so much computer power. By comparison, the best programmable TV game image is projected on a screen composed of 64 dots wide by 64 dots deep or 4,096 total dots. The Bally unit is 160 by 100 or 16,000 dots—four times more—so the Bally image is sharper and has finer detail, better resolution, smoother motion, and clearer letters for math or text applications.

SIGNIFICANT EXPANSION MODULES

The most significant expansion accessory will be the dual magnetic tape decks with an alpha numeric (typewriter) keyboard. With this accessory package, which will cost under $500 and be introduced by JS&A next year, you can record data and software programs and do everything you can do on any main frame computer system within the data storage capacity of the Bally unit.



The Bally console keyboard is used to select specific programs from each cassette.

The implications of this add-on module are mind-boggling. First, it adds an additional 16,000 bytes of memory to the powerful 12,000 already in the basic system. Secondly, it provides not only more power and features than are presently available in any home computer, but it contains peripherals that would normally cost thousands of dollars extra and are considered accessories on all other mini-computer systems. Thirdly, it uses the computer basic language which is easy to understand. And finally, each cassette tape in the system will contain an additional one quarter million bytes of storage capability. With the tape decks and keyboard, the consumer will now own the equivalent of an entire computer system complete with peripherals, storage and memory.

HIGH SPEED PRINTER

A quality high-speed printer will also be available next year. This will give you written records from your storage tapes. Store your most frequently called phone numbers, your income tax figures, your savings account deposits, the value of your stocks and bonds or a net worth statement. Then, when you need the information, press a button for a printed record.

DIAL-A-BARGAIN® ORDERING SYSTEM

Our technicians have programmed JS&A's main computer so you can use the Bally to access our computer directly when Bally's dual tape decks become available. With a special module and cassette, you will be able to 1) call our computer on our toll-free number, 2) place an order, and 3) find out when it will be shipped. Since you communicate directly with our computer, your order is processed immediately and can be shipped within a few hours after receipt. To do this, JS&A engineers developed a $100 hardware ordering package that will be sent free to those customers who order the basic unit this year.

THE BIG DIFFERENCE

When you order the Bally computer today, you are making an investment in the future. The basic unit you receive, without a single accessory, will provide more benefits than any other product of its kind in history.

When you buy an expensive product, you must be absolutely satisified that you get the service and a solid company standing behind your purchase for many years to come. The Bally Library Computer is backed by a substantial company, Bally—in business since 1931 and now the world's largest manufacturer of coin-operated amusement games. JS&A is America's largest single source of space-age consumer products and also a substantial company—further assurance that your investment is well protected.

A FRANK DISCUSSION OF SERVICE

The Bally unit is a solid-state computer with its electronics condensed on 34 integrated circuits—all hermetically sealed and all pre-tested for a lifetime of service. The Bally Computer is also self-diagnostic. We have developed a cartridge that lets the unit itself check every integrated circuit and every solid-state component and which displays any malfunction on your TV screen. Then all you do is send the circuit board or your entire unit to JS&A's service-by-mail center for prompt replacement. The cartridge will be sent free-of-charge only to JS&A customers after you receive your unit.

Please don't think service requirements are common. They're not. But we wanted to assure you that service was such an important consideration in the Bally design that the unit practically repairs itself.

COMPLETE AS IT ARRIVES

Each unit comes complete with four pistol grips for use with the arcade and teaching games, an AC adapter (batteries are not required), three free arcade games, the calculator program, its internal library of tasks, complete easy-to-understand instructions and a one year parts and 90 day labor limited warranty—all for only $299.95.

The arcade games include 1) Gun Fight, in which two cowboys shoot at each other around cactus, covered wagons and other obstacles, 2) Checkmate, a one to four player game in which you build walls around your opponent to win and, 3) Scribbling, a one to four player game that utilizes the pistol grip to droodle different designs on your TV screen (in color with a color set).

A keyboard lets you use your printing memory calculator and a special scroll button lets you scan your entries up or down to review or check your calculations. You may also order with your unit the Baseball and Paddle Games cartridge for $24.95 or the Math Table/Math Bingo cartridge for $19.95. A bulletin will accompany your unit listing all the other cartridges and accessories that are available or will be available in the near future.

We feel so positive about this product that we will 1) not charge you anything for postage and handling and 2) give you a 30 day extended trial period to prove that the Bally is everything you expected after reading this article. When you receive your unit, reconcile your checkbook with the calculator, let your child practice with the math programs or have your entire family play the arcade games. After you have used the system under your own conditions and have personally experienced its fun and benefits, then decide if you want to keep it. If not, return it within our 30 day extended trial period for a prompt and courteous refund. You can't lose.

JS&A is marketing a product that will not only greatly influence the future of the computer industry, but will dramatically add consumer conveniences never before dreamed possible. Order your Bally Library Computer, at no obligation, today.

Unit pending FCC approval—allow 4 weeks delivery.
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Learn to service Communications/CB equipment at home...with NRI'S COMPLETE COMMUNICATIONS COURSE

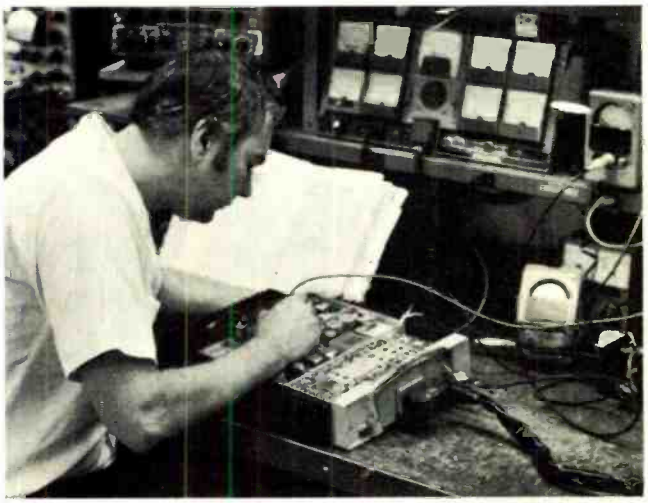
Learn design, installation and maintenance of commercial, amateur, or CB communications equipment.

The field of communications is bursting out all over. In Citizens Band alone, class D licenses grew from 1 to over 2.6 million in 1975, and the FCC projects about 15 million CB'ers in the U.S. by 1979. That means a lot of service and maintenance jobs . . . and NRI can train you at home to fill one of those openings. NRI's Complete Communications Course covers all types of two-way radio equipment (including CB), AM and FM

Transmission and Reception, Television Broadcasting, Microwave Systems, Radar Principles, Marine Electronics, Mobile Communications, and Aircraft Electronics. The course will also qualify you for a First Class Radio Telephone Commercial FCC License or you get your tuition back.

Learn on your own 400-channel digitally-synthesized VHF transceiver.

You will learn to service all types of communication equipment, with the one unit that is designed mechanically and electronically to train you for CB, Commercial and Amateur communications: a digitally-synthesized 400-channel VHF transceiver and AC power supply. This 2-meter unit gives you "Power-On" training. Then we help you get your FCC Amateur License with



special instruction so you can go on the air.

The complete course includes 48 lessons, 9 special reference texts, and 10 training kits. Included are: your own electronics Discovery Lab, Antenna Applications Lab, CMOS Frequency Counter, and an Optical Transmission System. You'll learn at home, progressing at your own speed, to your FCC license and into the communications field of your choice.

NEW CB SPECIALIST COURSE NOW OFFERED

NRI now offers a special course in CB Servicing. You get 37 lessons, 8 reference texts, your own CB Transceiver, AC power supply and multimeter . . . for hands-on training. Also included are 14 coaching units to make it easy to get your commercial radio telephone FCC license—enabling you to test, install, and service communications equipment.

NRI offers you five TV/Audio Servicing Courses

NRI can train you at home to service TV equipment and audio systems. You can choose from 5 courses, starting with a 48-lesson basic course, up to a Master Color TV/Audio Course, complete with designed-for-learning 25" diagonal solid state color TV and a 4-speaker SQ™ Quadraphonic Audio System. NRI gives you both TV and Audio servicing for hundreds of dollars less than the two courses as offered by another home study school.

All courses are available with low down payment and convenient monthly payments. All courses provide professional tools and "Power-On" equipment along with NRI kits engineered for training. With the Master Course, for instance, you build your own 5" wide-band triggered sweep solid state oscilloscope, digital color TV pattern generator, CMOS digital frequency counter, and NRI electronics Discovery Lab.

™Trademark of CBS Inc.

NRI's complete computer electronics course gives you real digital training.

Digital electronics is the career area of the future . . . and the best way to learn is with NRI's Complete Computer Electronics Course. NRI's programmable digital computer goes far beyond any "logic trainer" in preparing you to become a computer or digital technician. With the IC's in its new Memory Kit, you get the only home training in machine language programming . . . experience essential to trouble shooting digital computers. And the NRI programmable computer is just one of ten kits you receive, including a TVOM and NRI's exclusive electronics lab. It's the quickest and best way to learn digital logic and computer operation.

You pay less for NRI training and you get more for your money.

NRI employs no salesmen, pays no commissions. We pass the savings on to you in reduced tuitions and extras in the way of professional equipment, testing instruments, etc. You can pay more, but you can't get better training.

More than one million students have enrolled with NRI in 62 years.

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Letters

EMERGENCY CALL SIGN "STANDARD"

In the May 1977 "CB Scene" it was stated that the PURAC was considering the 0911 number for an Emergency Call Sign. Within the past year, most single-sideband clubs in Ohio have adopted the Emergency Call Sign of 999, which is quickly being adopted throughout the U.S. On SSB, we use the "Q" signals, which many SSB clubs have adopted, to cut down on air time. (Q signals do not have an emergency call as is the case with the 10 Code.) I suggest that if an emergency call is made, it should coincide with one that has already been voluntarily adopted by CB'ers. *—Denton C. Rastall, President, USB, Willowick, OH*

COMPREHENSIVE, GENERAL, AND SPECIFIC

"FM Tuner Ratings and Measurement" by Julian Hirsch in the April 1977 issue was very informative. The article was comprehensive enough to be specific and general enough to be applied to just about any FM tuner available. After reading this article, I took a check, as suggested, of my tuner and compared the results I obtained to the results obtained from a test of a friend's FM tuner. I noted a substantial difference between the two sets of results. Finally, when playing the two tuners side by side, we could hear the difference. *Cary R. Patten, Northville, MI*

WORD SPACING IS VERY COMMON

I question the statement in "Morse Code Automatic Readout On a TV Screen" (May 1977) that "word spacing is rarely sent in Morse Code." After the original "Morse-A-Letter" project appeared in the January 1977 issue of POPULAR ELECTRONICS, I made my own interface that produces perfect word spaces. I send the parallel data out to my video terminal in RS-232 via a UART. I would have submitted a photo of a full "page" of a news broadcast that shows perfect word spacing were it not illegal. Except in the case of crude or unusual keying, I find word spacing is very common, even if it does occur naturally rather than intentionally. After all, any pause longer than a character will register as a word space. *—Joseph A. Maddox, Cincinnati, OH*

HOW ABOUT A TRANSLATION?

I enjoyed "How To Program Calculators for Fun and Games." However, the programs given are in Reverse Polish Notation (RPN) and not suitable directly for use with my algebraic-entry calculator. Needless to say, I had difficulty in trying to decipher and rewrite the programs. I hope that next time POPULAR ELECTRONICS publishes programs they are listed in a form that will make it easier to program any calculator. *—Marc Wester, Burlingame, CA*

We'll try.

ANOTHER COUNTING APPROACH

With reference to the June 1977 "Out Of Tune" for the "Westminster Clock" that appeared in the November 1976 issue, I had the same problem in getting *IC18* to count from 1 to 12 properly. It took me several weeks of learning about MOS to find the fault. In my studies, I learned about a different approach to use to get my clock working. To obtain a positive pulse to reset *IC18* at 1 o'clock, I connected *IC2*, pin 12, to the spare inverter in *IC5* (pins 12 and 13) and *IC5*, pin 11, to *IC18*, pin 15, and eliminated *C3* and *R9*. Pins 23 and 37 of *IC13* (output common source and unblanking, respectively) require a positive supply.

This was the best project yet. It made me learn something about CMOS.—*K.G. Burnett, Errington, B.C., Canada.*

MORSE CODE DETERRENT

I read the November 1976 Editorial with interest and would like to state that amateur radio operators should remember that they are

FREQ. OUT.

CSC's done it again.

Broken the price and performance barriers with new MAX-100. The multi-mode, professional portable frequency counter that gives you more range, visibility, accuracy and versatility than any comparable unit at anywhere near its low, low price.

MAXimum performance. MAX-100 is a cinch to use. It gives you *continuous readings* from 20Hz to a *guaranteed 100MHz*, with 8-digit accuracy. Fast readings with 1/6-sec. update and 1-sec. sampling rate. Precise readings, derived from a crystal-controlled time base with 3ppm accuracy. High-sensitivity readings from signals as low as 30 mV, with diode overload protection up to 200V peaks.

Input signals over 100MHz automatically flash the most significant digit. And to indicate low-battery condition and extend remaining battery life, the *entire* display flashes at 1Hz.

MAXimum versatility. Wherever and whenever you need accurate frequency readings, MAX can do the job. Use it with clip-lead cable supplied. Mini-whip antenna. Or low-loss in-line tap with UHF connectors. For AM or FM; CB, ham, business radio and R/C transmitter or receiver alignment. Monitoring audio and RF generators. Checking computer clocks and other digital circuits. Repair of depth sounders and fish spotters. Troubleshooting ultrasonic remote controls. For these, and hundreds of other applications, you'll find it indispensable.

MAXimum visibility. MAX-100 features a big, bright 0.6" multiplexed *8-digit* LED display, with leading-zero blanking. So you don't have to squint, or work up close. And, MAX's flip-up stand is *built-in*.

MAXimum flexibility. MAX-100 operates from *four* power sources, for use in lab or field. Internal alkaline or NiCad batteries. 110 or 220V with charger/eliminator. 12V with automobile cigarette-lighter adapter/charger. And external 7.2-10V supply.

MAXimum value. With all its impressive specs, you'd expect MAX to cost a lot more than a low $134.95, complete with clip-lead cable and applications/instruction manual. But that's another nice thing about MAX: though it's accurate enough for lab use, it's well within the reach of hobbyists' and CB-ers' budgets.

Try MAX for yourself at your CSC dealer—or contact us for full specs and your local dealer's name. Once you see how handy MAX is, you'll want to "freq out" too. With CSC

Specifications.

Range: 20 Hz to 100 MHz, guaranteed. **Gatetime:** 1 sec. **Resolution:** 1 Hz. **Accuracy:** ± 1 count + time base error. **Input Impedance:** 1 MΩ/56 pF. **Coupling:** AC. **Sine Wave Sensitivity:** 30 mVRMS @ 50 MHz. **Internal Time Base Frequency:** 3.579545 MHz crystal osc. **Setability:** ± 3 ppm @ 25°C. **Temp-Stability:** Better than 0.2 ppm/°C, 0-50°C. **Max. Aging:** 10 ppm/year. **Display:** Eight .6" LED digits; anti-glare window. **Lead-zero blanking:** decimal point appears between 6th and 7th digit when input exceeds 1 MHz. **Overflow:** with signals over 99,999,999 Hz, most significant (left hand) digit flashes, allowing readings in excess of 100 MHz. **Display update:** 1/6-second plus 1 sec. gate time. **Low Battery Indicator:** When power supply falls below 6.6 VDC, all digits flash @ 1 Hz rate. Flashing display extends battery life. **Power:** 6 AA Alkaline or NiCad cells (internal); **External:** 110 or 220/VAC Eliminator/charger; Auto cigarette lighter adapter; 7.2-10 VDC ext. supply; **Bat. Charging:** 12-14hr. **Size (HWD):** 1.75"x 5.63" x 7.75" (4.45 x 14.30 x 19.69 cm.) **Weight:** Less than 1.5 lb. (0.68 kg) w/batteries. **Accessories Included:** Clip-lead input cable; manual.

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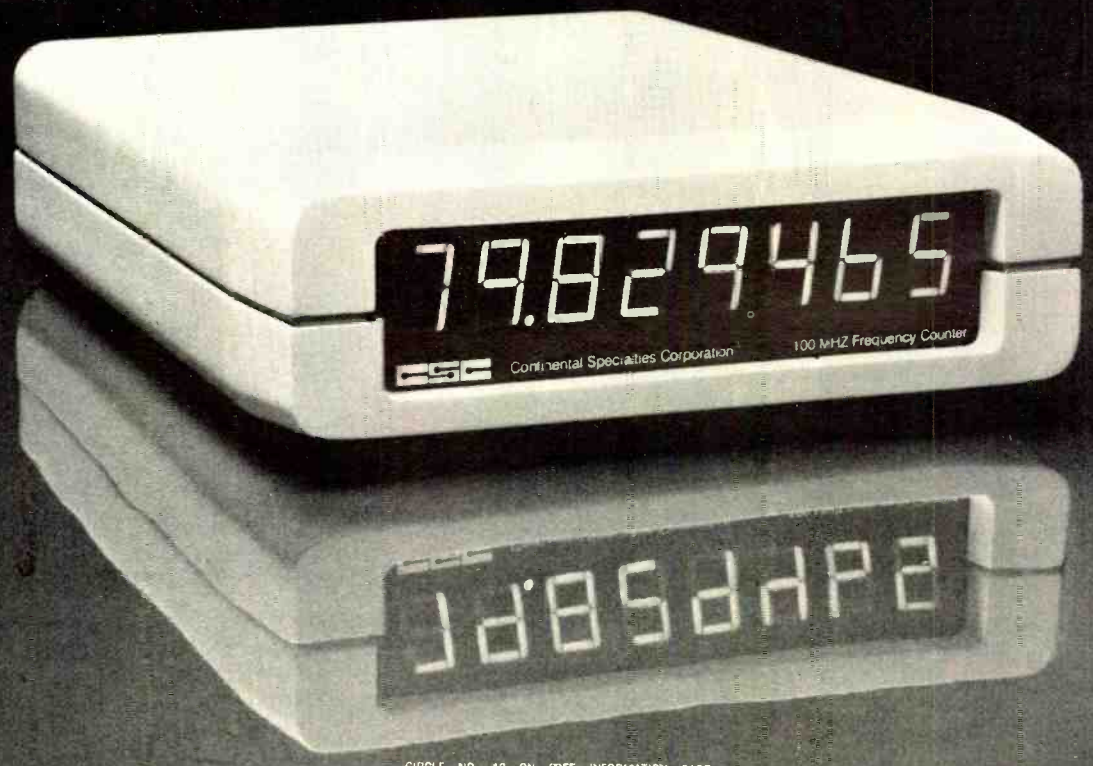


an elite group by our choice, not theirs. I have worked in industrial electronics with hams and found them to be a good group of guys who know their electronics and their equipment very well. I, too, have been interested in ham radio, but I decided to pass on it because of the Morse Code requirement, which I do not understand and do not like. I feel the code requirement is a deterrent to highly qualified electronics technicians who simply can do without. Letting technicians into ham radio would be an enhancement, not a dilution.—*Gil Duddles, Princeton, IL.*

VALUABLE TEST INSTRUMENT

I recently built the "Automatic Diode Checker" featured in the June 1976 issue of POPULAR ELECTRONICS. It proved to be the most valuable test instrument I have ever seen. It is so simple and effective that I cannot help but wonder if the same principle could not be applied to the testing of transistors, inasmuch as they are basically a couple of diodes connected back-to-back. I service quite a few electronic photoflash units and since diodes and transistors are trouble spots in them, I know the diode tester will become an indispensable troubleshooting tool.—*Edward A. Bollinger, Satellite Beach, FL.*

SOLAR CONTROLLER KIT

I read with interest "Build a Solar Controller" (July 1977), and while this device is suitable for actuating attic ventilators, it does have some deficiencies when used to control solar collection systems. Because the circuit provides no hysteresis, the system will cycle on and off at the same temperature difference between the sensors. Most solar controllers (or differential thermostats) are designed to turn on only when collector temperature exceeds the storage temperature by 20° F and then cycle off when this temperature difference falls to 3° F. This prevents rapid cycling of the system in early morning and late afternoon when only marginal solar energy is available, resulting in greater overall efficiency.

Our company offers a complete solar controller kit for less than $30. It includes the turn-on hysteresis, as well as freeze protection circuitry. This enables the controller to turn on the circulation system when the outside temperature falls to 36° F, thereby warming the collectors and preventing freezing when water is the circulating fluid.—*Charles Morton, Wind Sun Systems, 5209 Ave. H, Austin, TX 78751*

Out of Tune

In "How To Convert a 'Four Banger' For Stopwatch Functions" (August 1977), the identifications of IC2 and IC3 should be interchanged in the component installation diagram on page 57.

The Touch by Regency is the first fully synthesized, 16 channel scanner to put over 15,000 action radio frequencies at the command of a fingertip.

There's no complicated programming to do. No crystals to buy.

Simply tap out the frequency number you want on the pressure sensitive touch pads, and you're there.

Touch SC, and scan your 16 possible stored frequencies.

Or search for the unknown by pressing SS. The Touch seeks out frequencies you may never know existed. When you find new action, The Touch tells you what you've found with the exact frequency number in LED display.

If you think that's the ultimate in scanning, wait. There's more.

One. You're never more than 1.2 seconds away from your favorite channel. The Touch lets you set up Channel 1 as a priority receiver; and it samples that frequency every 1.2 seconds. So you never miss a call.

Two. You'll also never miss a severe weather warning. Just set Channel 16 to the National Weather Service emergency frequency, if available in your area. The Touch automatically alerts you to any severe weather broadcast.

Three. Our mobile filter screens out code noises from car telephones. Completely. Automatically. So all you hear is full, clear action.

See your Regency dealer for a demonstration. It's an experience you'll want to take home with you.

The Touch by Regency. The Ultimate Scanner.

Introducing the Ultimate Scanner.

New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer at the address given.

DYNACO STEREO OCTAVE EQUALIZER

Dynaco's stereo octave equalizer, SE-10, has 10 slide controls for each channel, one control for each octave of frequency. Equalizer range is ±12dB from 30 Hz to 15 kHz. THD is said to be typically less than 0.01%, while hum and noise is rated 85 dB below two volts. The SE-10 has eight integrated circuits, two FET's, five transistors, and an IC-regulated power supply. A three-transistor circuit electronically prevents switch pops. Other features include independent channel gain control from −12 to +6 dB; low impedance (600 ohm) output; and 16 amplifiers in the four low-frequency sliders of both channels. An independent source/tape switch enables equalization of a second program. Factory assembled $349, kit $249.

CIRCLE NO. 88 ON FREE INFORMATION CARD

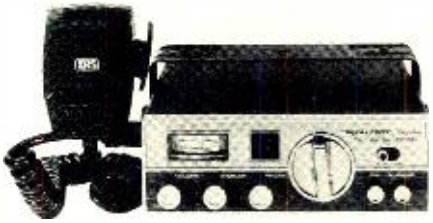
TAU EXPONENTIAL VCO AND VCF KITS

The Tau Systems Model 1050 vco kit features 1-volt/octave response over a full 10-octave range. Accuracy is claimed to be better than 1% over the range of 10 to 20,000 Hz. The vco generates up- and down-ramp and width-modulated pulse outputs of 10 volts peak-to-peak. The Model 1010 vcf kit offers a 24-dB octave response over the entire audio range, in addition to providing 10-octave exponential, 1-volt/octave control characteristics. The vcf has adjustable Q (resonance control) and can be made to generate what is claimed to be a very pure sine wave over the entire audio range. Both kits should be of particular interest to those involved in electronic music, artificial voicing, instrumentation, spectrum analysis, and sweep generation. Model 1050, $32.50; Model 1010, $47.00.

CIRCLE NO. 89 ON FREE INFORMATION CARD

REALISTIC MOBILE CB AM TRANSCEIVER

Radio Shack has introduced the Realistic TRC-424 as its top-of-the-line 40-channel mobile. It features PLL circuitry, an automatic modulation gain control circuit for 100% modulation, and r-f power output of 4 W. Other features include an r-f gain control, delta tuning switch, switchable noise blanker, LED digital readout, r-f/S meter, and PA capability. It operates on 12 V dc, positive or negative ground, and comes with mounting bracket and detachable mike. Measures 8½" × 6⅝" × 2 3/16" (21 × 17 × 6 cm). $169.95.



CIRCLE NO. 91 ON FREE INFORMATION CARD

POLY 88 SYSTEM SIXTEEN COMPUTER

The POLY 88 System Sixteen from Poly-Morphic Systems is a ready-to-run computer system that can be used to solve home finance problems, perform statistical analysis, and provide a host of challenging games. The 16k system features a high-speed video display and alphanumeric keyboard. Cassette tapes are used for permanent program storage. Programming is made simple by a BASIC software package. PLOT and TIME are unique features that rely on the video graphics and real-time clock. Other features include VERIFY that tells when a tape is good before another is loaded. Scientific functions, formatting options, and string capabilities are also included. $2250; kits start at $735.

CIRCLE NO. 92 ON FREE INFORMATION CARD

YAMAHA STEREO RECEIVER

The Model CR-2020 is Yamaha's top-of-the-line stereo receiver, rated at 100 watts/channel into 8 ohms at less than 0.1% THD, 20 to 20,000 Hz. Specifications include: 10 to 100,000 Hz ±2.5 dB audio frequency response; 35-45 dB stereo separation; 1.8 μV FM sensitivity; 1.0 dB capture ratio; 80 dB usable selectivity; 73 dB S/N; 30 to 15,000 Hz ±0.5 dB FM frequency response. Features include dual output power meters; signal and FM tuning meters; selectable turnover frequencies; bass, presence and treble tone controls; selection of three pairs of speaker systems; Dolby FM selection; audio muting; FM blend switch; choice of phono input levels; and low and high filter switches. Dimensions: 21¼"W × 16 5/16"D × 6 9/16"H (540 × 415 × 167 mm). $700.

CIRCLE NO. 93 ON FREE INFORMATION CARD

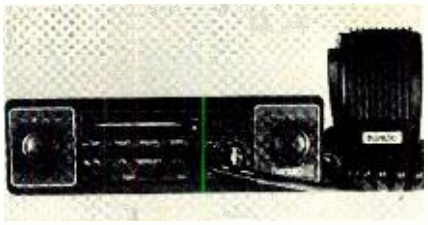
EV•GAME CB/AM/FM ANTENNA

"Breaker Beam" From EV•Game Inc. is a fully automatic, motor-driven CB/AM/FM antenna that is claimed to provide an exclusive "fail-safe" mast nesting function with ignition switch off. It also provides a transmit-actuated neon lamp that glows when the transmitter to which it is connected is keyed. The automatic fail-safe nesting action is said to ensure automatic retraction of the antenna mast into its housing mount as soon as the vehicle ignition or the transmitter/transceiver is turned off. The glowing neon lamp atop the antenna is easy to see by other CB'ers at night. The antenna extends to 40" (1 m) and has a loading coil on the fourth section of its five-section whip. The SWR is claimed to be extremely low, made possible with a fine-tuning, signal-splitting coupler that uses a CB tuning/trimmer capacitor. $79.00.

CIRCLE NO. 94 ON FREE INFORMATION CARD

HANDIC CB TRANSCEIVER/STEREO RADIO

Handic-USA's Model 240, is a 40-channel CB transceiver and AM/stereo FM receiver combination. The transceiver features PLL synthesizer, digital LED channel readout, r-f/S meter, TX and RX indicator light, radio/CB select switch, standby/on/off switch for monitoring CB while listening to the radio, and anl. The radio has a tone control system, stereo balance control, AM/FM band select switch, and MPX/Mono switch. The entire unit is designed for in-dash installation. $259.95.



CIRCLE NO. 95 ON FREE INFORMATION CARD

WAWASEE CB FREQUENCY DISPLAY

The latest in Wawasee Electronics' line of CB accessories is a compact frequency counter, Model JB 1004 FC, that displays the operating frequency of CB and ham transceivers. It has a specified frequency range of from 100 Hz to 50 MHz, with a display accuracy of 100 Hz and a 50-mV sensitivity. Designed to be operated from 12-volt dc sources, the system's power requirements are said to be minimal because the leading zeroes of the 0.5" (12.7-mm) displays come on only when the

transceiver's microphone is keyed. Mounting is via Velcro-type "spots." The size of the counter is 4½"W × 3⅞"D × 1¾"H (11.4 × 9.8 × 4.4 cm). $99.95.

CIRCLE NO 96 ON FREE INFORMATION CARD

MULTICORE EMERGENCY SOLDER

Multicore Solders has introduced a new tape-like solder strip, called Emergency Solder, that requires only an ordinary match or candle flame to melt and form a solder joint. The Emergency Solder strip contains multiple cores of rosin flux, which is noncorrosive and can safely be used in electronic circuits. In use, the strips are loosely wrapped around the joint to be soldered and an open flame is moved back and forth until the solder flows into the joint. To solder sheet metal, the solder is placed either between or on the metal parts to be connected and heat from a candle or soldering gun is applied as the parts are held together. Available from Multicore Solders, Westbury, NY 11590.

AUDIOANALYST SPEAKER SYSTEM

Model M6 is one of a new group of speaker systems called PhaseMatrix ™ introduced by Audioanalyst, Inc. It is an 8-ohm system that has a specified frequency response of 30 to 20,000 Hz ±3 dB and a maximum power handling capability of 150 watts. Minimum driving power is rated at 15 watts. The three-way speaker system has crossovers at 700 and 2000 Hz. It uses a 10" (25.4-cm) woofer,

4½" (11.4-cm) midrange driver, and 1" (2.54-cm) tweeter. The system is housed in a lacquer-finished walnut-veneer cabinet that measures 24⅜" × 13¾" × 11¾" (61.9 × 34.9 × 30 cm) and weighs 47 lb (21.3 kg). Behind the removable black fabric grille are three-position midrange and high-frequency controls that provide nine different contour setting combinations.

CIRCLE NO 97 ON FREE INFORMATION CARD

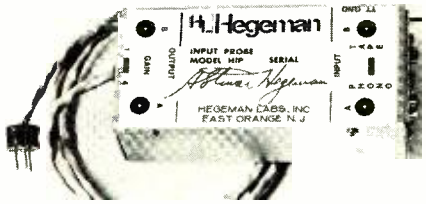
HF TRANSMITTER MONITOR

The Model WM-1000 by Communications Power, Inc. monitors transmitter performance in the 1.8-to-30-MHz frequency range. It contains three separate meters—an r-f wattmeter, an SWR meter, and a modulation level meter. The wattmeter reads either average or peak power output on 20-, 200-, and 1000-watt scales. Wattmeter operating mode (average or peak) and scale are selected by front-panel switches. The SWR and modulation meters have front-panel calibration controls and function with power levels of 1 to 1000 watts. The SWR meter employs a 30-dB directional coupler for improved accuracy at low SWR levels. Modulation level is measured by a full-wave circuit which functions over the full modulation wave form. The unit also features a built-in battery check circuit and automatic shut-off.

CIRCLE NO 98 ON FREE INFORMATION CARD

HEGEMEN PRE-PREAMP

Hegemen Input Probe (HIP) is a low-noise, wide-band preamplifier designed to mount next to a phonograph or tape deck. HIP is said to provide an audible increase in high-frequency detail, dynamic range, dimen-



sional perspective and a reduction in record surface noise. It works directly from either a tapehead or phonograph cartridge and is battery-powered to avoid hum pickup. Technical specifications include frequency response of 2 Hz to 350 kHz ±1dB, 0.1% harmonic distortion, 60 dB channel separation. Dimensions: 6" × 2⅝" × 1½" (15.5 × 6.5 × 3.7 cm), (battery pack) 5½" × 5" × 1½" (14 × 12.5 × 3.8 cm). $135.

CIRCLE NO 99 ON FREE INFORMATION CARD

AVANTI CB BASE ANTENNA

The new Saturn antenna by Avanti Research and Development, Inc. is an omnidirectional base station antenna with switchable horizontal or vertical polarization. Overall height is 22' (6.7 m), radials measure 9' (2.7-m), and the antenna weighs 25 lb (11.3 kg). The Model AV-501 switchbox for remote polarization selection is included.

CIRCLE NO 100 ON FREE INFORMATION CARD

CORRECTION

In the September issue, the price of the McKay Dymek DR-22 Receiver was incorrectly given as $2900. It should have been $995.

New Literature

CB ACCESSORIES CATALOG

The Magitran Co. offers an 8-page catalog of its line of citizens band radio accessories. Included in the listing are anti-theft alarm systems, an antenna matcher, power supply, power regulator-booster, receive signal booster/attenuator, remote/PA speakers, and a radio check monitor. Each piece of equipment is illustrated and technical specifications are provided. Address: The Magitran Co., 311 E. Park St., Moonachie, NJ 07074.

NBS SMOKE DETECTOR PAMPHLET

The Commerce Department's National Bureau of Standards is offering a guide to homeowners who are interested in purchasing a smoke detector. Titled "Smoke Detectors . . . What They Are and How They Work," the pamphlet describes the two types of smoke detectors; ionization chamber and photoelectric; and answers questions most commonly asked about selection and placement of the detectors in the home. Address: "Detectors," Consumer Information Center, Pueblo, CO 20234.

REPLACEMENT ANTENNAS CATALOG

Russell Industries has a six-page brochure illustrating its line of "Rubber Duckie" antenna replacements for 2-way communications and scanner applications. Categories include citizens band, uhf, vhf, ham and business band radios, and walkie talkies. Address: Russell Industries, 3069 Lawson Blvd., Oceanside, NY 11572.

CHROME TAPE PAPER

A report on chromium dioxide cassette tape, "The Advent Chrome Paper," is available from Advent Corp. It discusses chromium dioxide tape, which was introduced in 1970, and compares it to other iron-oxide cassettes on the market. Address: Advent Corp., 195 Albany St., Cambridge, MA 02139.

SMALL-COMPUTER CATALOG

A 22-page Small Computer Catalog by Processor Technology describes the company's line of computers, computer systems, personality modules, software, memories, disk storage, interfaces and peripherals. Performance and application information is provided, with charts and illustrations. Address: Processor Technology Corp., 6200 Hollis St., Emeryville, CA 94608.

Go after the best of everything.

Don't settle for less. Especially when it comes to electronics training . . . because everything else in your life may depend on it. That's why you ought to pick CIE!

You've probably seen advertisements from other electronics schools. Maybe you think they're all the same. They're not!

CIE is the largest independent home study school in the world that specializes exclusively in electronics.

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Meet the Electronics Specialists.

When you pick an electronics school, you're getting ready to invest some time and money. And your whole future depends on the education you get in return.

That's why it makes so much sense to go with number one . . . with the specialists . . . with CIE!

There's no such thing as bargain education.

If you talked with some of our graduates, chances are you'd find a lot of them shopped around for their training. Not for the lowest priced but for the best. They pretty much knew what was available when they picked CIE as number one.

We don't promise you the moon. We do promise you a proven way to build valuable career skills. The CIE faculty and staff are dedicated to that. When you graduate, your diploma shows employers you know what you're about. Today, it's pretty hard to put a price on that.

Because we're specialists, we have to stay ahead.

At CIE, we've got a position of leadership to maintain. Here are some of the ways we hang onto it . . .

Our step-by-step learning includes "hands-on" training.

At CIE, we believe theory is important. And our famous Auto-Programmed® Lessons teach you the principles in logical steps.

But professionals need more than theory. That's why some of our courses train you to use tools of the trade like a 5 MHz triggered-sweep, solid-state oscilloscope you build yourself—and use to practice troubleshooting. Or a beauty of a 19-inch diagonal Zenith solid-state color TV you use to perform actual service operations.

Our specialists offer you personal attention.

Sometimes, you may even have a question about a specific lesson. Fine. Write it down and mail it in. Our experts will answer you promptly in writing. You may even get the specialized knowledge of all the CIE specialists. And the answer you get becomes a part of your permanent reference file. You may find this even better than having a classroom teacher.

Pick the pace that's right for you.

CIE understands people need to learn at their own pace. There's no pressure to keep up . . . no slow learners hold you back. If you're a beginner, you start with the basics. If you already know some electronics, you move ahead to your own level.

Enjoy the promptness of CIE's "same day" grading cycle.

When we receive your lesson before noon Monday through Saturday, we grade it and mail it back—the same day. You find out quickly how well you're doing!

CIE can prepare you for your FCC License.

For some electronics jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of your specific knowledge and skills!

More than half of CIE's courses prepare you to pass the government-administered exam. In continuing surveys, nearly 4 out of 5 CIE graduates who take the exam get their Licenses!

For professionals only.

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Stereo Scene

By Ralph Hodges

THE BIG JUNE TRIAL BALLOON

Well, it's come and gone—another June Consumer Electronics Show in Chicago. This year's JCES was marked by two developments of note. The first was a concession on the part of show management to the demands of audio exhibitors for listening facilities. Several floors of meeting rooms in the McCormick Inn (across the street from the McCormick Place convention center that formerly hosted the entire show) were made available, thus greatly expanding the scope and sprawl of the affair. Second, in what almost seemed a counter-concession, a number of prominent very-high-end audio manufacturers left their aeries in the renegade Bismarck Hotel (one of the few large hotels not affiliated with the show) and moved their exhibits closer to or actually into CES territory. (Not that this "sank" the Bismarck; the vacancies were promptly usurped by a whole new generation of little companies looking to make their marks.)

Both developments dramatize the new importance of audio—and, recently, high-end audio—to the show's well-being. More than ever, high-end was the big game at JCES, and almost everybody played.

The Heavy Hitters. If pure power grabs you, you will not be immune to the Marantz Model 2500, the show's most powerful receiver, with a continuous (FTC) rating of 250 watts per channel. This receiver also re-introduces Marantz's small front-panel scope, a popular feature on previous deluxe models from the company. The continuous-power rating of Hitachi's SR-2004 receiver is a "mere" 200 watts per channel. However, since the amplifier section operates in Hitachi's novel Class G, it is said to be entitled to a short-term ("music power," if you will) rating of 400 watts per channel. Several other receiver manufacturers are now crowding the 200-watt mark, such as Technics by Panasonic (with 165 watts) and Nikko (175 watts).

Where does this power escalation put separate basic amplifiers? Well, you can get up to 500 watts per channel with the Rotel RB-5000. This product, incorporating enough transformer iron to pose a serious threat to any sidewalk on which it may be dropped, has a glorious brutality to its appearance that devotees of high power will appreciate on sight.

Many of the other major manufacturers now seem inclined to eschew brute force for its own sake and adopt the "purist" attitude that characterizes the audiophile-oriented smaller companies. Pioneer, for example, which retains its credentials in the high-power club (its new SPEC 4 power amplifier is rated at 150 watts per channel), has chosen to lead this year with the M-22 Class-A power amplifier ($650) at 30 watts per channel. Onkyo's outlook on high-end equipment is similarly conservative, as exemplified by the P-303 preamplifier and M-505 power amplifier introduced earlier this year. Nikko established itself as a leader in Class-A power amplifiers some time ago. This year the company presents the Alpha V stereo power amplifier, featuring a healthy 100 watts per channel and a healthier price of $3,000.

Meantime, integrated amplifiers evolve in their own fascinating ways. Kenwood believes in isolated power supplies, and the new 90-watt-per-channel KA-9100 has three: one for each output section and a third for the preamplifier. Sansui believes in wide bandwidth—not necessarily for the preamplifier section, where it may cause trouble, but certainly for the power-output stages. The AU-717 ($450) and AU-517 ($370) pursue this philosophy.

The Innovators. Soundcraftsmen's major contribution to the show was a claim for a new mode of amplifier operation, "Class H." Like Class G, Class H employs two power-supply voltages for the output stage, the lower voltage being active most of the time and the higher voltage coming into use only on large waveform peaks. But Class H dispenses with Class G's two sets of output transistors and simply switches the supply voltages fed to one set. As in Class G, the object is to keep the output stage in the most efficient mode of operation possible, no matter what power level is being delivered to the load. Soundcraftsmen's initial Class-H offerings are the MA5002 power amplifier at 250 watts per channel, and a smaller Class-H power amplifier, the EA5003, with a built-in octave-band equalizer.

In the DL-2, Crown introduces the preamplifier it says it has always wanted to build. It is in three pieces: a power supply, a phono-preamplifier module designed to be located close to the record player, and a "switching module" (the DL-2 itself). This sports a complex-looking panel, with digital readouts of gain settings and a forest of controls. But inside, all is said to be simplicity itself, with none of the special control functions allowed to intrude on the signal path unless "enabled" by means of digital switching circuitry that operates high-quality relays.

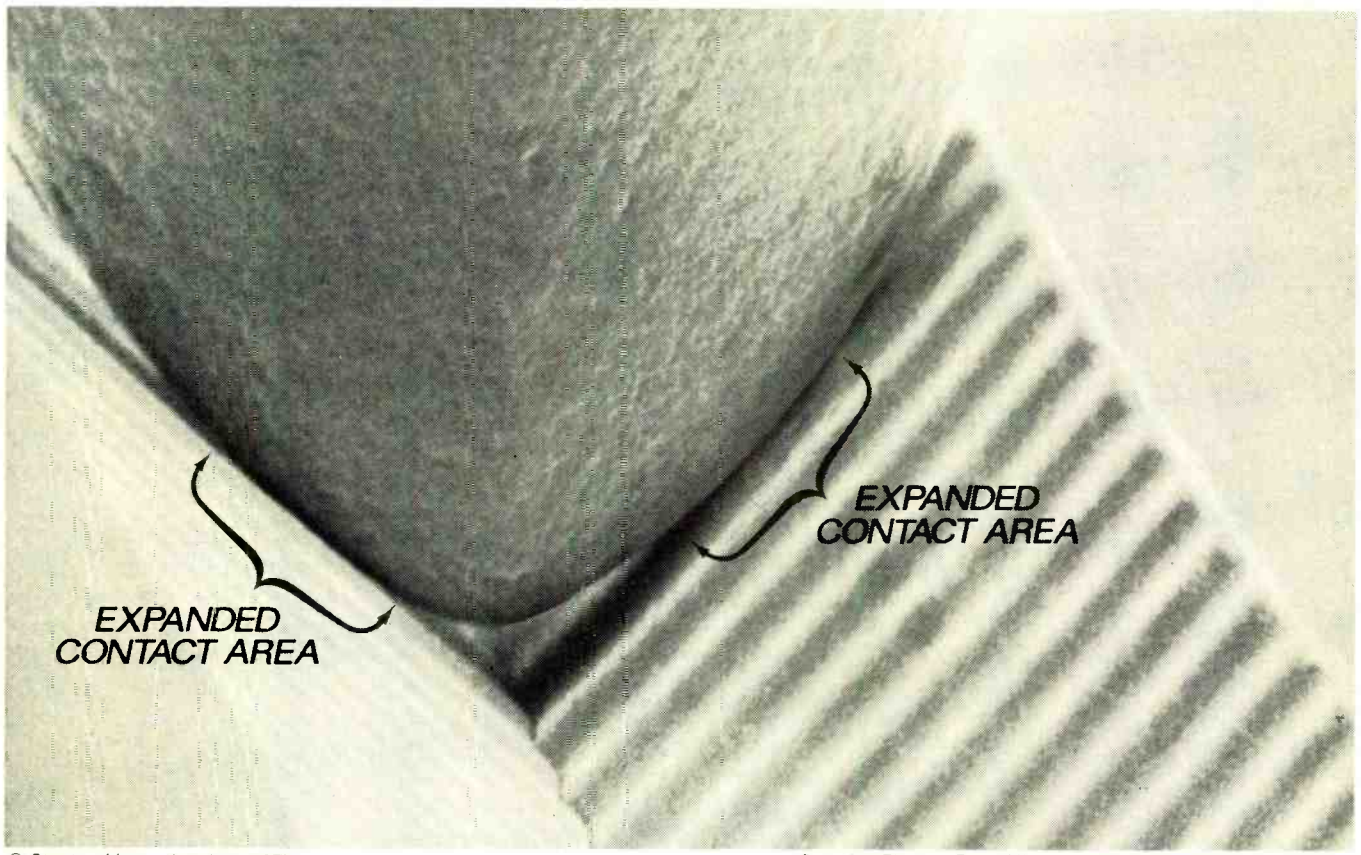
A digital-readout frequency-synthesyzing tuner is built in to the Setton RCS-X-1000 preamplifier/control center. The unit has throttle-like controls for gain and LED indicators for virtually everything. For remote control use, much of its circuitry is contained in a separate "black-box" module with generously long cable connection.

A little outboard air compressor is the key feature in the Infinity Black Widow "Air-Table." The Compressor floats the belt-driven platter on a compressed-air "bearing."

The Elaborators. While we're on the subject of turntables, you may recall ADC's digitally controlled Accutrac 4000. This year brings a changer version, the Accutrac +6, with the likable ability to return any records that have been "dropped" to the platter ("gently escorted" is a more accurate expression in this case) back up to the spindle-supported stack for another go-round. This is accomplished by punching appropriate buttons on the control panel (or on an ultrasonic remote controller), and the Accutrac +6 retains all the other automatic programmable features of the 4000.

In its MT-6225, Fisher has developed a new configuration for a direct-drive turntable motor. Its drive signal is de-

Better records are the result of better playback pick-ups



Scanning Electron Beam Microscope photo of Stereohedron Stylus; 2000 times magnification. Brackets point out wider contact area.

Enter the New Professional Calibration Standard, Stanton's 881S

Mike Reese of the famous Mastering Lab in Los Angeles says: "While maintaining the Calibration Standard, the 881S sets new levels for tracking and high frequency response. It's an audible improvement. We use the 881S exclusively for calibration and evaluation in our operation"

The recording engineer can only produce a product as good as his ability to analyze it. Such analysis is best accomplished through the use of a playback pick-up. Hence, better records are the result of better playback pick-up. Naturally, a calibrated pick-up is essential.

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Marantz 2500 AM/Stereo FM Receiver is rated at 250 watts per channel.

Pioneer M-22 Power Amplifier is rated at 30 watts per channel.

Kenwood's KA-9100 Integrated DC Stereo Amplifier has three separate power supplies.

Model C-939 Cassette Deck from Dual has automatic reversing in both recording and playback.

rived from a 120-pole rotor (part of the platter) which amplitude-modulates a 60-kHz oscillator signal that passes through sensing coils in close proximity to the rotor. The back-EMF from the motor itself is routed through the motional-feedback circuit, where it is compared with a stable dc reference voltage.

I'm personally glad to note some new developments in tonearms, prominent among which is the Technics EPA-100, offered on the new SL-1000 Mark II direct-drive turntable. The EPA-100 is a damped arm designed to accommodate itself to almost any cartridge. The arm has "dynamic damping" which not only dulls arm/cartridge resonance, but adjusts to match cartridge compliance. Very-low-mass arms continue to appear, the latest being the LMF from ADC, offered with and without detachable headshells. The LMF has a tapered carbon-fiber shaft and an appearance of high precision.

Dual's Model C-939 cassette deck offers automatic reversing in both recording and playback, and it introduces the erase head as a tape-editing feature. A unique control admits continuously variable erase current to the head, where it can be used to create fade-outs, fade-ins, or total obliteration of a previously recorded signal.

The Upstarts. With so many pursuing the serious-audiophile segment of the market, where does that leave the devotedly audiophile-oriented companies? More rarefied than ever. Threshold, which in its short history has established itself as one of the country's most prominent manufacturers of Class-A power amplifiers, introduced this year a preamplifier, the NS 10, with a response that extends to 5 MHz. The Van Alstine Model One preamplifier handily matched this feat by playing a color TV set through its circuits. While you recover from the shock of these revelations, you might want to contemplate the limited-bandwidth school of preamplifier design. The Apt Corporation's Holman Preamplifier will have nothing to do with ultrasonic or infrasonic signals. Tom Holman's arguments for eliminating out-of-band information are sophisticated and persuasive. Some would call his preamplifier radical for its inclusion of tone controls and other amenities that have been rapidly disappearing from such products.

Vacuum tubes, until recently so beloved by the audiophile "fringe" for their alleged sonic superiority, are gradually passing away as more and more designers work out transistorized circuits that can suit their purposes. But the end of tubes is not here yet, as witness the remarkable Audionics BA-150 power amplifier with a transistorized front end and tube output stages. The chunky unit is rated at 200 watts per channel, which is very substantial. As for heat and its pernicious effect on tube life, this has been thwarted by "floating" bias and operating voltages that are under the benign governance of high-speed digital control circuitry. I expect this amplifier was a lot of fun to design.

The Indefatigables. The untiring

Powerful in computing muscle, yet small in physical size, the Altair™680b offers many special features at an affordable price. Based on the 6800 microprocessor, the 680b comes with 1K of static RAM, Serial I/O port, PROM monitor and provisions for 1K of PROM as standard components. It's good thinking, when you're interested in making a modest investment on a highly reliable computer, to consider the Altair 680b.

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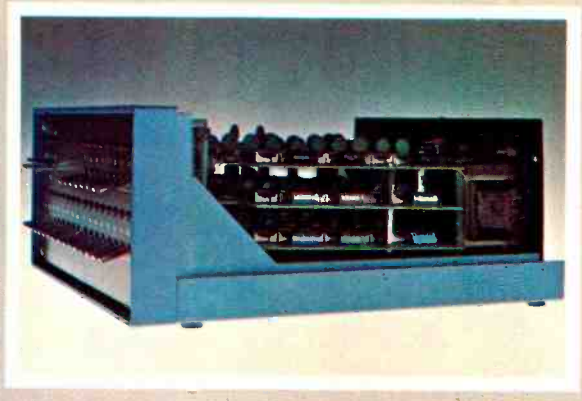

Available in either full front panel or turnkey models, the Altair 680b presents many computing capabilities at a low cost—without skimping on performance. See it today at your local Altair Computer Center or contact the factory for further details.

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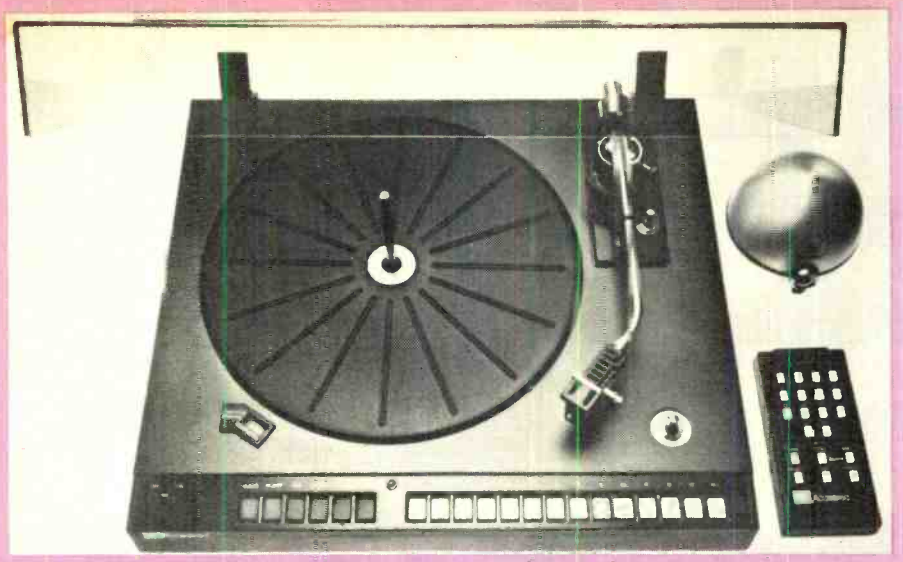
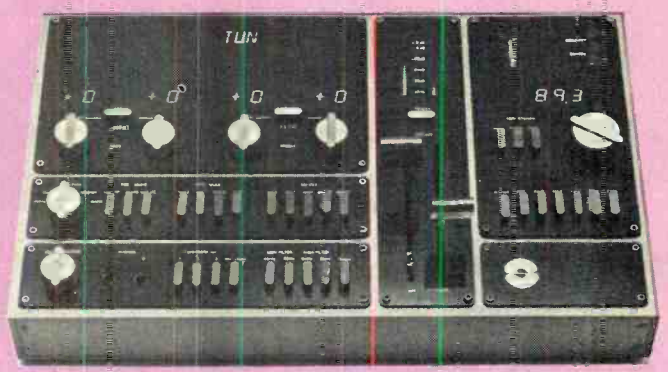


The Accutrac +6 Turntable has the automatic programmable features of its predecessor, the 4000, and also can be set to return a record to the stack on top of the spindle.

A digital-readout frequency-synthesyzing tuner is built in to the Setton RCS-X-1000 preamplifier/control center.



Crown's DL-2 preamplifier has a "switching module" with all of the controls and a phono-preamp module (right) to be located close to the record player.

search for perfection in phono cartridges continues, and you can now pay $325 for a Satin moving-coil cartridge with Shibata stylus and beryllium cantilever. The Satin cartridges remain the only moving-coil designs with user-replaceable styli, and among the few such designs with output sufficient to drive most phono preamplifiers without assistance from a transformer or intermediate gain stage. So far as I know, Satin commands the top price point in phono cartridges today, but others are not too far behind. The Model 9210SG from RAM Audio Systems, a strain-gauge pickup is $300 with the necessary external power supply. The Micro-Acoustic 530-mp is $200. And the Stanton 881S is $150.

Nor is there a lack of associated equipment for these new cartridges. The precision phono preamplifier for moving-coil and other pickups is now an established product. The Accuphase C-220 Stereo Disc Equalizer is designed to load and equalize any cartridge properly, supply gain that is immaculate in terms of noise and distortion, and balance the outputs of the two channels. A&E Technical Research offers a similar product, with elaborations that include a front-panel meter to read levels.

A year ago the manufacturers of the new sub-woofers were speaking out loudly for attention. Since then, several prophets have asked the question: "With a good sub-woofer, who needs a woofer?" And it's proved to be a good question. Audio enthusiasts around the country have been combining the phenomenally good (but bass-lacking) mini-speakers from ADS, Braun, and Visonik, among others, with sub-woofers from Janis, Dahlquist, etc., to produce full-range biamplified speaker systems for the home. They often sound as good as the best while costing little more than the mediocre. Janis has even devised an accessory to facilitate this—a stereo electronic crossover combined with a single-channel, 70-watt amplifier for the woofer. The phase relationship between the low- and high-frequency signals is continuously variable.

This year's new wave in four-channel sound will come from the Tate SQ decoder, now finally completed and encapsulated in three integrated circuits. The decoder boasts remarkable specifications, and the demonstration I heard left little doubt in my mind that many of the claims made for it are justified. The Tate people intend to offer the decoder to amplifier and receiver manufacturers, among which licensees are now being gathered. (Audionics has already announced its Tate decoder.)

The End. The end, obviously, is not yet in sight. More than anything else, this year's JCES was erected on shaky foundations laid down some years ago that have become much firmer in the intervening period. The serious audiophile is once more at the top of the heap, and his requirements are being elaborately—even extravagantly—catered to. In coming months this should lead to a vast proliferation of products that are claimed to "sound good." Ultimately, with luck, it will result in a whole community of products that "sound better." ◇

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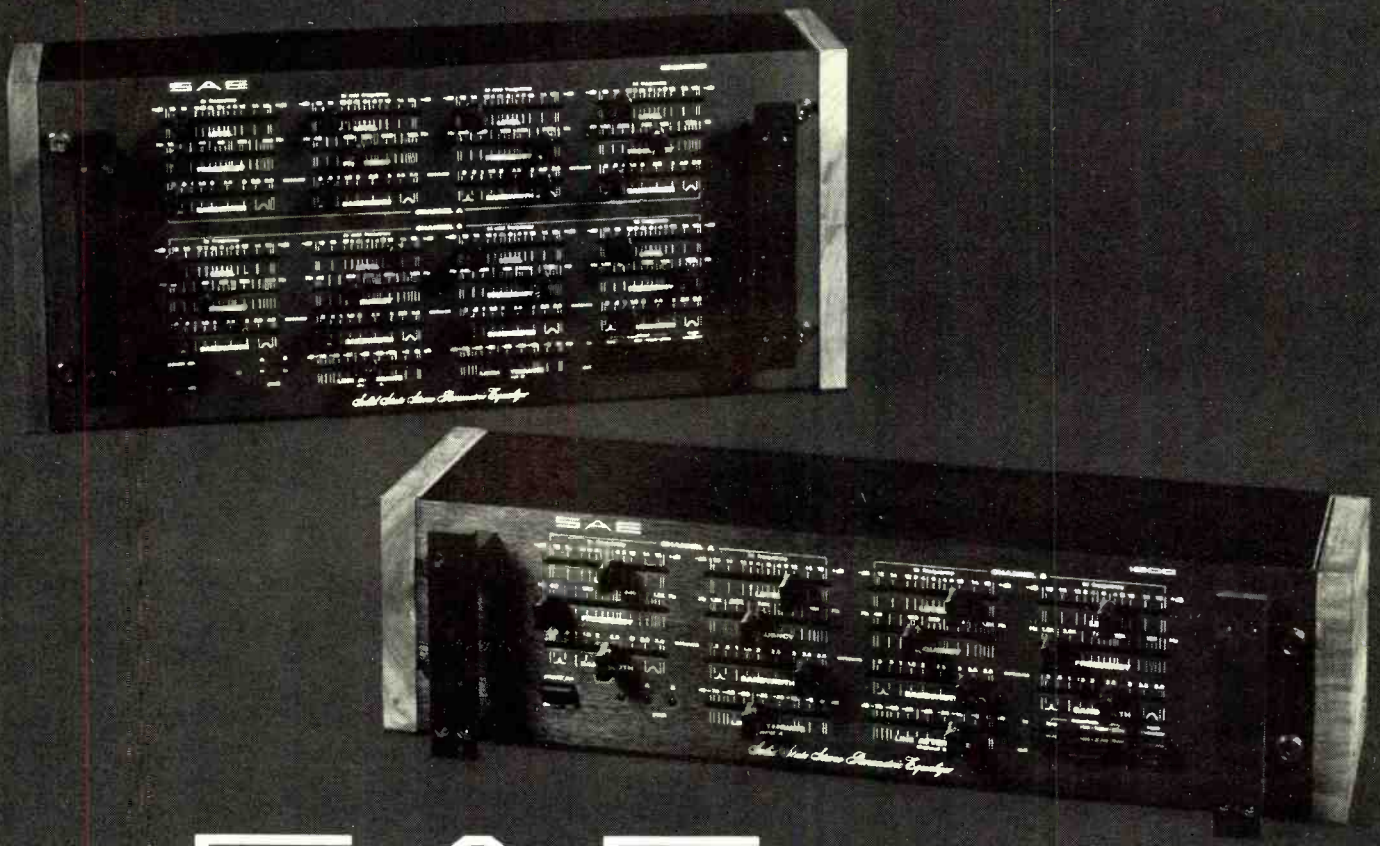

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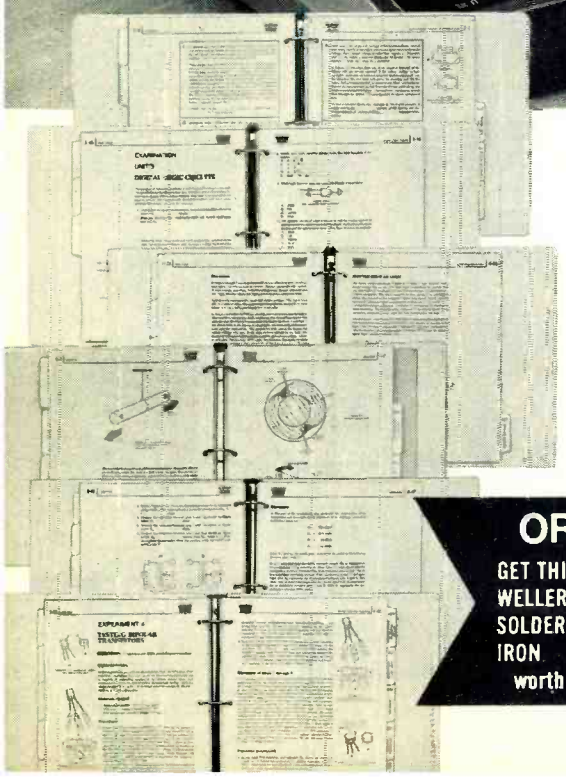

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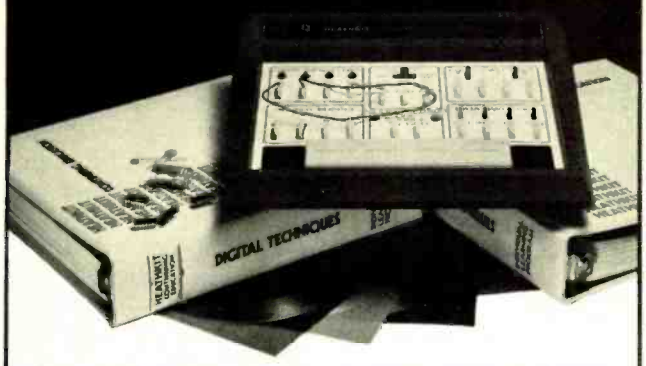

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Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

THE ELCASET HAS ARRIVED

MORE than a year ago, the Elcaset was announced to the high-fidelity audio world. Its name is derived from "large cassette," which is a fairly accurate description of this new tape format as far as its physical shape is concerned. Developed by a consortium of Japanese manufacturers—including Matsushita (Technics), Sony, and Teac—it is intended to bridge the gap between the standard cassette and the open-reel formats, with the convenience of the former and the performance of the latter. In addition, the Elcaset has a few advantages peculiar to itself. At present, all Elcaset tapes are made by Sony, but each of the participating manufacturers and some of their subsidiaries and affiliates produce their own competitive lines of tape decks based on their tapes.

The Elcaset itself is considerably larger than the conventional compact cassette. Resembling the cassette in general configuration, the Elcaset measures 6" × 4"D × ¾"H (15.2 × 10.1 × 1.9 cm), making it slightly larger than an 8-track tape cartridge pack. The Elcaset is loaded with standard ¼" (6.4-mm) tape, which can be recorded in four parallel tracks, two in each direction just as with the standard cassette. In addition, the Elcaset has provisions for recording two narrow control tracks between the pairs of signal tracks. These two extra tracks can be used for controlling slide projectors or for operating sophisticated signal processors when an Elcaset deck is used with devices designed to use the control feature.

At present, Elcasets are available in LC-60 and LC-90 versions. The two versions hold 30 and 45 minutes of program material on each side.

Unlike the standard cassette, with its 1⅞-inch/second (4.8-cm/s) tape speed, the Elcaset is designed to operate at 3¾ ips (9.5 cm/s). The combination of nearly double the tape width and double the tape speed gives the Elcaset a powerful advantage over the standard compact cassette in its freedom from high-frequency tape saturation (which is perhaps the most serious fundamental limitation of cassettes). Another unique feature of the Elcaset is that the tape is withdrawn from the cassette housing and passed over fixed heads in the tape deck, just as in an open-reel tape deck. This makes possible almost any type of head configuration. This contrasts sharply with the standard cassette, which requires the heads to be moved to make contact with the tape within the cassette housing and where a third head can be used only by exercising considerable design ingenuity.

The Elcaset housing contains a number of notches and holes that give it a potential capability for almost totally automatic selection of operating parameters. For example, three types of Elcaset have been announced or are contemplated, each with a different formulation that requires its own particular bias and equalization adjustments. Type I tape is a low-noise ferric-oxide type that is currently used in Sony's SLH. Type II is Sony Ferrichrome (FeCr), while Type III is a chromium-dioxide formulation. Holes near one corner of the Elcaset's housing can identify the type of tape contained in the Elcaset so that, in a tape deck equipped to make use of this feature, the bias and equalization could automatically be selected as the tape is inserted. Other breakout tabs similar to those used for standard cassettes for recording lockouts are used for switching in Dolby noise reduction system decoders when a tape has been Dolbyized.

Like the cassette, the Elcaset can be made to prevent accidental recording over a piece of tape whose contents are to be preserved. Instead of breaking out a tab, however, one moves a slide near one corner of the Elcaset housing to its safety position. If it is desired to rerecord over a protected portion of tape, the slide can easily be returned to its original, or "unprotected," position. (The Elcaset's design makes accidental movement of the slide impossible.)

The internal tape reels are locked in place when the Elcaset is removed from the recorder to prevent the creation of tape slack in shipping and handling. Hinged protectors minimize the likelihood of the tape being pulled from the housing accidentally. When the Elcaset is inserted into the tape deck, the hinged protectors move aside to allow the tape to be withdrawn and brought into contact with the tape heads. From then on, tape handling is completely automatic as the deck's controls are operated.

(Audio Test Reports start on page 34.)

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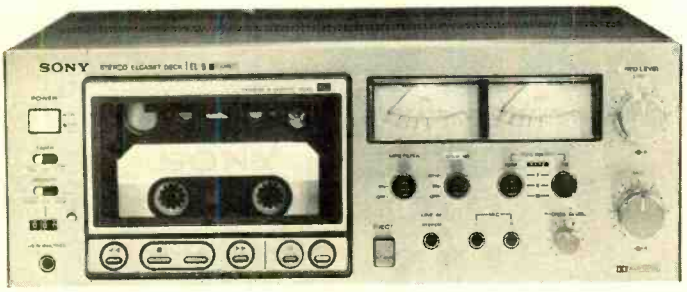
SONY MODEL EL-5 ELCASET TAPE DECK

Offers the convenience of a tape cartridge with performance of open reel.



HIRSCH-HOUCK LABS REPORT

In physical appearance, the Sony Model EL-5 Elcaset deck resembles a front-loading cassette deck. The Model EL-5 is a relatively simple, basic deck, with no automatic parameter selection features. It uses a two-head configuration with a combined recording and playback head. (Although the Elcaset design makes three-head transports a practicality, the EL-5 uses only two heads, but Sony does make another model that offers the three-head feature.)

The Model EL-5 measures 17"W × 12 5/8"D × 6 3/4"H (43 × 32 × 17 cm) and weighs 23 lb (10.5 kg). Its nationally advertised value is $599.50.

General Description. The Elcaset loads into the Model EL-5 vertically in a transparent hinged door that is opened by pressing an EJECT button. Below the door are light-touch pushbuttons that control the transport functions through solenoids and include rewind, fast forward, play, record, and pause functions. Colored symbols above the buttons glow to indicate the operating mode of the deck. A logic system allows the buttons to be operated in any sequence without damaging the tape.

To the left of the Elcaset door is a pushbutton POWER switch, and two three-position levers that control the TIMER and MEMORY functions. The TIMER switch can be used to start the deck with an external clock timer in the power line, in either the recording or the playback mode. The MEMORY circuit can be set to stop the tape in rewind when the counter returns to 000, or to go into PLAY automatically at that point if desired. Below the MEMORY switch are the index counter and its reset button and a headphone jack for low-impedance phones.

Across the upper right of the panel are two large illuminated VU meters and a red REC light. Below these are four lever switches, two of which separately control the recording bias and equalization for the three types of Elcaset tape. A third switch controls the Dolby system, with an extra position for recording Dolby FM broadcasts. In the DOLBY FM mode, the tuner's deemphasis time constant is changed to the required 25 μs, and the recording level is set by a pair of controls in the rear of the machine so that the Dolby level tone transmitted by some FM stations gives a 0-dB meter reading on the EL-5. The signal is recorded in its Dolbyized form, and the recorder's Dolby circuits are placed in the playback path, where it is monitored with the correct frequency response and noise level, and heard in that form when subsequently played through the recorder with its Dolby system on. The fourth switch turns on the MPX filter that removes the 19-kHz pilot carrier from signals being recorded with Dolby.

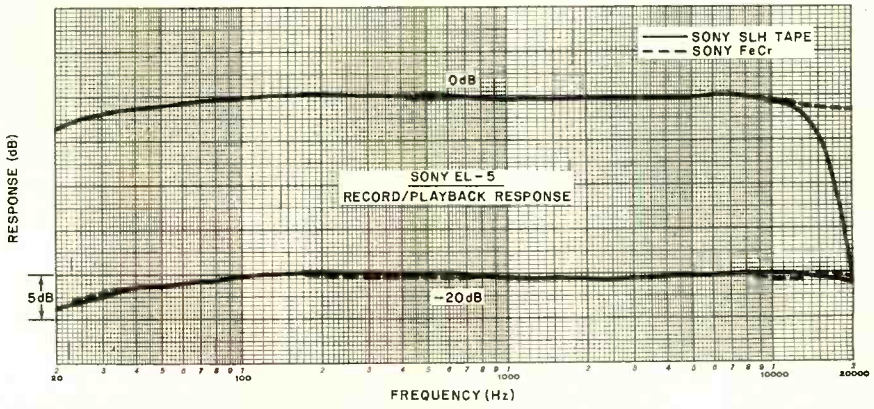
At the right of the panel are concentric recording level controls for the LINE and MIC inputs, which can be mixed. Across the bottom of the panel are the two microphone jacks, a stereo LINE input jack that replaces the normal LINE jacks on the rear apron when a plug is inserted, and a small knob that controls the playback level through the headphone jack.

The rear panel contains the LINE input and output jacks, a LEVEL adjustment for the LINE outputs, two FM CAL level controls, a socket for an optional REMOTE CONTROL accessory, and one switched and one unswitched accessory outlet.

Laboratory Measurements. The Model EL-5 Elcaset deck we tested came with a prerecorded demonstration tape and samples of Type I and Type II blank Elcasets. (Type III is not yet available.) Since there are no standard test tapes as yet for the Elcaset, we made all our measurements by recording and playing back the same tape.

With the Type I (Sony SLH) tape, the record/playback frequency response at a −20-dB level was within ±0.5 dB from 60 to 20,500 Hz. It was down 4 dB at 20 and 22,400 Hz. At a 0-dB recording level, the playback output dropped rapidly above 10,000 Hz, due to tape saturation. The superior high-frequency qualities of Type II (FeCr) tape were dramatically demonstrated by its frequency response, which was within ±0.5 dB from 60 to 24,000 Hz at −20 dB, down 4 dB at 20 and 26,200 Hz. Even at 0 dB, the Type II tape revealed little evidence of tape saturation, with a response within ±2 dB from 20 to 21,500 Hz. The MPX filter, which operates only during recording and had no effect up to 15,000 Hz, cut the 19,000-Hz response by at least 25 dB.

To reach a 0-dB recording level, a LINE input of 56 mV or a MIC input of 0.145 mV was needed. The resulting playback level was about 650 mV. The microphone preamplifier overloaded at a 70-mV input. The superior tape headroom of the Elcaset format was further demonstrated by very low distortion at a 0-dB recording level of only 0.08% with Type I and 0.28% with Type II tape. To reach a 3% playback distortion level, we had to record the tapes at +10 and +12 dB, respectively. The unweighted S/N



Record/playback response for two kinds of tape at 0 and −20 dB.

ratio, without Dolby, was 47.5 dB with Type I and 50 dB with Type II. With the Dolby system switched in, and using the CCIR weighting recommended by Dolby Laboratories, the S/N figures were improved to 67.7 and 70.5 dB. Through the microphone inputs, at maximum gain, the noise increased by 8.5 dB. The Dolby circuits tracked closely between recording and playback modes. The Dolby system changed the overall record/playback frequency response by no more than 1 dB at levels from −20 to −40 dB.

The unweighted rms wow and flutter was only 0.07%. An LC-60 Elcaset was moved from end to end in the fast speeds in about 76 seconds. The VU meters were slower in their response than a true VU meter. They reached 65% to 70% of their steady-state readings on 0.3-second tone bursts. The headphone volume was good with 8-ohm phones but was rather low with 200-ohm phones.

User Comment. There can be no doubt that the Elcaset, especially with the Type II (FeCr) tape, is a vastly superior medium to the compact cassette, especially with respect to high-frequency recording headroom. It is not inferior to cassettes in *any* of its performance characteristics. This is not surprising, given the Elcaset's 3 3/4 ips and 1/4-inch tape. A more dramatic contrast is that it matches the performance of the many open-reel decks that operate at 7 1/2 ips. Of course, much of the credit for this must go to the FeCr tape, which is not generally available for open-reel machines (nor are such decks, with the exception of one or two Sony models, equipped to use FeCr tape).

Judged solely on its own merits, the Elcaset, even in the modestly priced Model EL-5 deck appears to be a no-compromise high-fidelity recording medium for the home recordist. Used with extreme care, only the best cassette recorders can approach the overall performance of the Elcaset, and this is possible only by careful control of recording levels. (Such machines, incidentally, are considerably more epensive than the model EL-5.)

We found the Model EL-5 to be a very easy deck to use, too. The absence of a third head for monitoring caused us some concern at first, but we soon found that the entire recording process was so noncritical that there was little need to monitor while recording.

The Elcaset is as easy to handle as a regular cassette (perhaps easier, due to its larger size). Presumably, it could be spliced and edited like open-reel tape, although we would have misgivings about withdrawing any substantial amount of the tape from an Elcaset housing.

Like most people closely involved with high-fidelity matters, we have given considerable thought to the place of the Elcaset in the hi-fi picture. Our first reaction to its announcement was one of skepticism. After all, who needs a "better" cassette? Having lived with the Model EL-5 for some time, we appreciate how much of a "better cassette" it really is. The Type II Elcaset (and probably the Type III, when it becomes available), is really a full equivalent of 7 1/2-ips open-reel tape in sheer quality. In contrast to the clumsiness of handling open-reel tape, the Elcaset offers all the convenience of use that has helped make the compact cassette so popular. Further, the Elcaset recorder is closer in size and weight to a cassette deck than to the open-reel machine. We understand, too, that the Elcaset tapes will be priced comparably to open-reel tapes.

One should be aware that, for dubbing most phonograph records and FM broadcasts, the Elcaset does not offer any quality advantage over the compact cassette. Only when the dynamic range of cassettes is inadequate or marginal, as in the case of almost all "live" recording, does the Elcaset clearly demonstrate its superiority. There are no commercially recorded Elcasets on the market, and we would not expect any significant number to be produced. The Elcaset is strictly for the "do it yourself" tape enthusiast who does not intend to do much editing but wants the convenience of a tape cartridge with the performance quality of an open-reel tape deck.

CIRCLE NO. 101 ON FREE INFORMATION CARD

H.H. SCOTT MODEL R376 STEREO RECEIVER

More receiver than modest specifications imply.

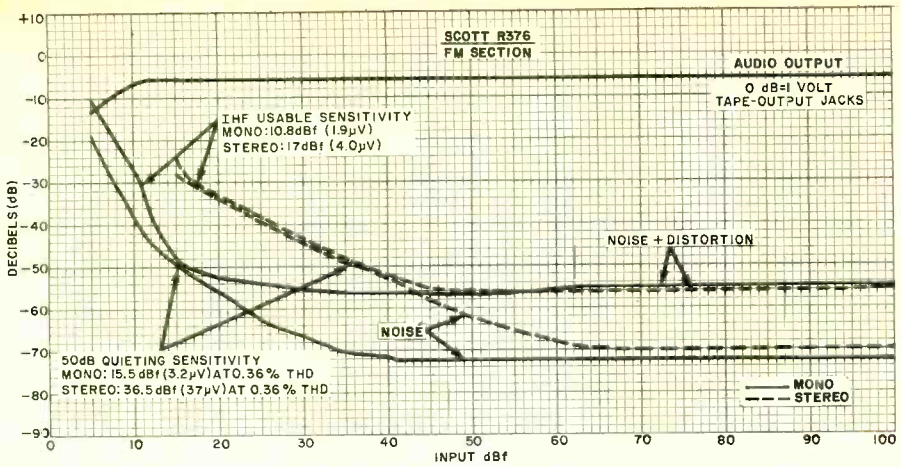
HIRSCH-HOUCK LABS REPORT

The Model R376 AM/stereo FM receiver, which heads the current line from H.H. Scott, is rated to deliver 75 watts/channel into 8-ohm loads at less than 0.2% THD. Manufactured in Japan to Scott's specifications, this receiver features contemporary styling with a distinct European touch in its panel markings.

The satin-finished silver-colored front panel has a large, clear glass window, behind which is a similarly finished dial scale, tilted slightly back for better visibility. Above the dial scales are five colored lights that indicate which input has been selected and separate tuning meters for relative signal strength on AM and FM and center-channel tuning on the latter.

The receiver is supplied with a walnut finished wooden cabinet. It measures 19 3/8″W × 15 7/8″D × 5 3/4″H (49 × 40 × 14.4 cm) and weighs 30.8 lb (14 kg). Price is $549.95.

General Description. The input SELECTOR switch has positions for AM and FM tuners, magnetic PHONO cartridge, dynamic MIC (through a jack on the front panel), and high-level AUX program source. The BASS, MIDRANGE and TREBLE controls each have 11 detented positions. The POWER/SPEAKERS switch can be set to connect to the amplifier, ei-



Noise and sensitivity curves for FM section of receiver.

ther, both, or neither of two pairs of speaker systems.

The VOLUME and BALANCE controls are concentric. The VOLUME control has 41 detented positions, while the BALANCE control is a standard potentiometer with a detented center position. A pushbutton switch activates the LOUDNESS compensation that works with the VOLUME CONTROL. Two other pushbuttons are used to switch in and out the LOW and HIGH audio FILTERS. Pushbuttons also switch in and out the FM MUTING and select STEREO/MONO modes.

The only remaining controls are the large TUNING knob and two three-position lever switches for the tape recording functions. One of the switches for the tape recording functions is a COPY switch that cross-connects two tape decks for dubbing from either machine to the other. The other switch is labelled MONITOR and is used for connecting either the selected source or the playback output from either tape deck to the receiver's audio amplifiers.

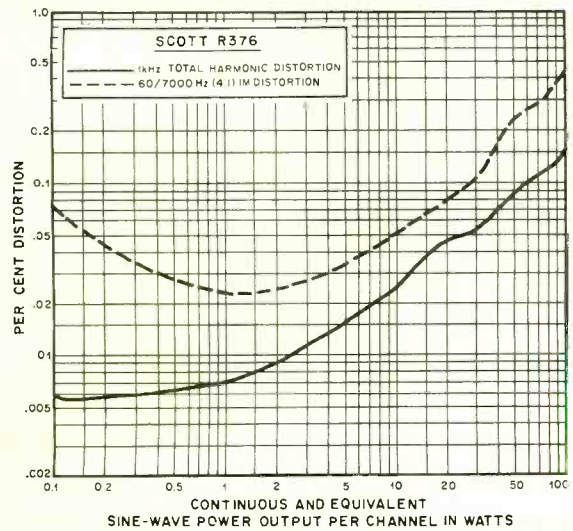
On the rear apron are phono jacks for the various signal inputs and outputs, a DIN socket that duplicates the TAPE 1 functions, and insulated spring clips for the speaker connections. Binding posts are used for the antenna connections, and there is a hinged AM ferrite-rod antenna. Slide switches are provided for selecting 25-, 50-, or 75-μs FM deemphasis time constants and high and low sensitivities to accommodate high- and low-output phono cartridges. One of the two accessory ac outlets on the rear apron is switchable.

Laboratory Measurements. Although the rear apron of the receiver became quite hot during the one-hour preconditioning period at one-third rated power and subsequent tests, the rest of the receiver's exterior remained cool. Driving 8-ohm loads with both channels at 1000 Hz, the output clipped at 109 watts/channel. Into 4 and 16 ohms the clipping power was 96 and 75 watts, respectively.

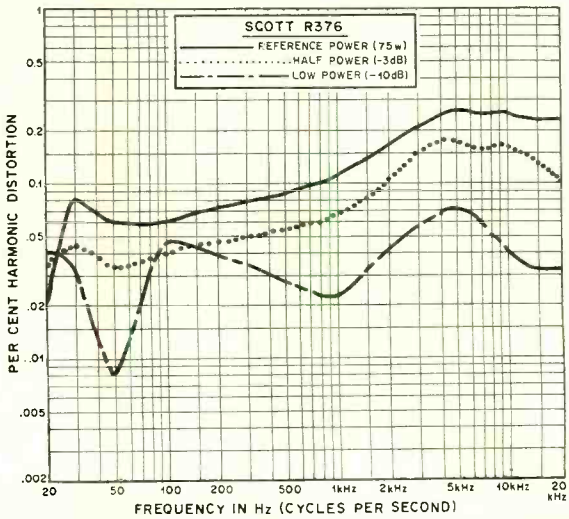
The 1000-Hz THD was very low at all usable power levels. It increased smoothly from 0.006% at 0.1 watt to 0.11% at the rated 75 watts and to 0.16% at 100 watts. The IM distortion was less than 0.075% from 0.1 to 20 watts output and increased to about 0.3% at 75 watts and to 0.42% at 100 watts. At the rated 75-watt output into 8 ohms, the THD was typically between 0.06% and 0.1% from 20 to 1000 Hz. It rose to 0.27% at 5000 Hz, after which it remained at about 0.27% all the way up to 20,000 Hz. At lower power levels, the shape of the distortion curve was similar, but the values were considerably lower. (At 7.5 watts output, distortion was under 0.07% from 20 to 20,000 Hz.)

To develop a reference output of 10 watts, a high-level input of 50 mV or a phono input of 0.82 mV (1.9 mV with the lower input sensitivity switch setting) was required. The S/N was roughly the same for all inputs at about 72 dB, referred to 10 watts. The phono overload input was a very safe 130 mV (290 mV with the lower sensitivity setting).

The bass tone control had the usual sliding turnover frequency characteristics. It varied from about 100 to 700 Hz as the control was moved from its center position. The treble response curves were "hinged" at about 1000 Hz. The midrange control affected most of the audible range, its maximum effect being between 1000 and 2000 Hz. The maximum range of this control was about ± 6 dB, making it unlikely to produce bizarre effects if used incautiously. The filters had the highly desirable (and rare) 12-dB/octave slopes, although Scott does not mention this in the specifications. The −3-dB response frequencies of the filters were 120 and 3700 Hz. The loudness compensation boosted both low and high frequencies at reduced volume control settings. The RIAA phono equalization was very accurate, within ± 0.5 dB of the extended ideal characteristic from 20 to 20,000 Hz. The interaction



Total harmonic distortion and 60/7000-Hz distortion.



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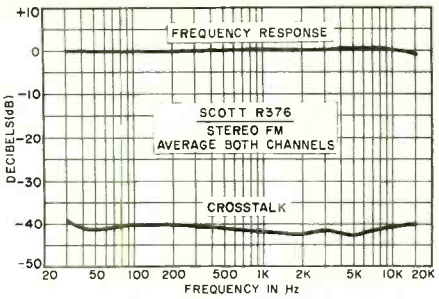


Frequency and crosstalk averaged for both channels.

with phono cartridge inductance was slight, producing a drop of about 1 dB in response between 10 and 20 kHz.

The FM tuner section generally met or surpassed its specifications, within normal measurement tolerances. The IHF usable sensitivity was 10.8 dBf (1.9 μV) in mono and 17 dBf (4 μV) in stereo. The 50-dB quieting sensitivity was 15.5 dBf (3.2 μV) in mono and 36 dBf (37 μV) in stereo, both with only 0.36% THD. The distortion at 65 dBf (1000 μV) input was 0.19% in mono and 0.16% in stereo, and the respective S/N figures were 72 and 69.5 dB. In stereo, the THD at 65 dBf with a L − R modulating signal was 0.45% at 100 Hz. It was a very low 0.075% at 1000 Hz, 0.08% at 6000 Hz.

The FM frequency response was flat within ±0.5 dB from 30 to 15,000 Hz, yet the 19-kHz pilot carrier was suppressed to a barely measurable −85 dB. This implies either an unusually effective low-pass filter or some form of pilot cancellation circuitry in the multiplex section. There was no mention of such special features in the instruction manual, and no schematic was included, so we can only conjecture as to how this remarkable performance was achieved. The stereo channel separation was equally impressive, almost perfectly uniform at 39 to 42.5 dB from 30 to 15,000 Hz, and practically the same in both channels. This type of performance suggests the use of a phase-locked-loop (PLL) stereo demodulator, but there is no specific information on that subject.

Other FM performance specifications were generally of the same caliber. The capture ratio was 0.8 dB at 45 dBf and 1 dB at 65 dBf. AM rejection was an acceptable 56 dB at 45 dBf, improving to a very good 70 dB at 65 dBf input. The image rejection was 78.5 dB, and alternate channel selectivity was identical above and below the receiver's center frequency, measuring 72.3 dB. Adjacent-channel selectivity was 4.9 dB. The factory settings of the muting and stereo thresholds were identical, at 12 dBf (2.2 μV).

In view of Scott's former reputation for exceptional AM tuner quality, we were somewhat disappointed to find that the AM section of the Model R376 was very ordinary in its frequency response. The response was down 6 dB at 3000 Hz, although it was maintained at full level down to 20 Hz.

User Comment. The performance specifications of the Model R376, whether published by Scott or the results of our measurements, leave no doubt that this is a fine receiver. As often occurs, the bare measurements do not adequately define the true quality of a product. For example, instead of the distortion remaining low until the amplifier clips abruptly and the distortion rises rapidly, in this receiver, the distortion increases so gradually that the clipping point is not at all obvious from the distortion measurements. This soft clipping characteristic is recognized as being the best way for an amplifier to overload, since it does not tend to produce very-high-order harmonics that are unpleasant to the ear. In spite of its rather modest (by today's standards) 75-watt power rating, the Model R376 could fairly be described as a 100- or 110-watt receiver. It will deliver that much power without sounding unpleasant. (Its distortion is almost all second- and third-harmonic.)

The real quality of the FM tuner section may not be apparent to anyone who has not made measurements on a number of tuners. In almost every case, one must make allowances for departures from ideal performance, so that the tuning is adjusted for minimum distortion rather than for a center indication on the tuning meter. One also expects the tuning setting for minimum distortion or maximum separation to be quite critical (and not necessarily the same). Also, virtually all i-f response characteristics are asymmetrical so that selectivity measured above and below the set frequency will be different, requiring the two values to be averaged to obtain a final figure. These conditions are so "normal" that the IHF measurement standard defines the methods necessary to derive numerical results from sometimes ambiguous measurements.

All of this leads us to the fact that the FM tuner in the Model R376 had both minimum distortion and maximum separation at the same tuning point, which happened to coincide with a center meter indication. Tuning was not critical, which means the average user should have no difficulty realizing the same kind of performance we measured. The FM muting was both positive and noise-free.

Although it probably has little to do with actual performance (except as an indicator of how well the receiver is put together), we noted that the flywheel tuning mechanism would cover the entire band with one spin of the knob.

The receiver's top-notch electrical performance was unfortunately not completely matched by its human engineering aspects. If we seem to be nit-picking here, it is only because of the contrast between the two. For example, the antenna terminals are too close together and are smooth (non-knurled) binding posts, creating difficulty in connecting the antenna. This was in sharp contrast to the excellent speaker connectors. In another area, the unusually long (9 1/4 inch) dial scale should have made accurate tuning a simple matter, but the dial markings at 1-MHz intervals would require a degree of care in interpolation to set the tuning to a known frequency within the required 200-kHz accuracy.

Aside from these minor criticisms, we found the Model R376 to be a thoroughly enjoyable receiver to use. Its sound is faultless and its appearance and "feel" are what one would expect from a company's top receiver. And as we discovered, the R376 is more receiver than its modest specifications imply.

CIRCLE NO. 102 ON FREE INFORMATION CARD

SHURE MODEL 516EQ MICROPHONE

Has four built-in equalizer filters centered on 190, 560, 1650, and 4950 Hz.

HIRSCH-HOUCK LABS REPORT

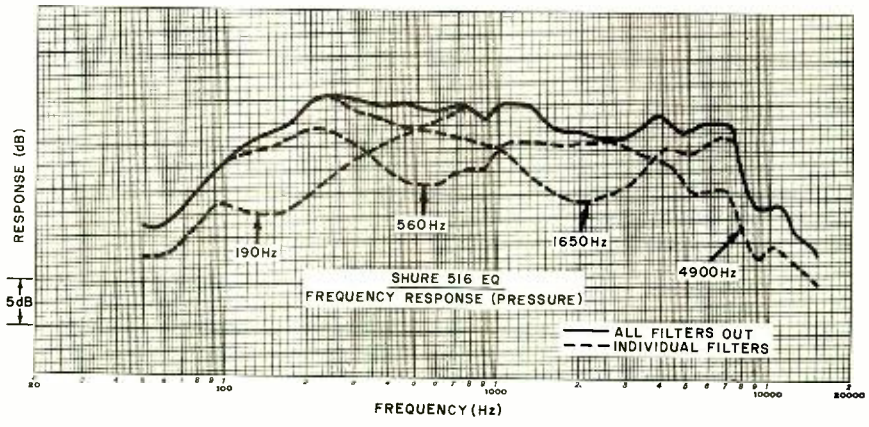
A "flat" microphone frequency response is not always ideal for making a live tape recording. The placement of the microphone relative to the performers, the acoustic properties of the room, and one's personal taste, among other factors, may make it desirable to modify the overall frequency response. ("Graphic equalizers," so popular among amateur recordists, are often used for this purpose.) There are many situations that call for equalization in which one does not have access to a graphic equalizer or its equivalent. Shure's Model 516EQ "E-Qualidyne" microphone is a novel and effective answer to that problem for the amateur tape recording enthusiast.

This unidirectional (cardioid) dynamic microphone has a nominal rated impedance of 150 ohms. It is compatible with microphone inputs having rated impedances between 25 and 3000 ohms, which encompasses the majority of home-type open-reel or cassette recorders. The 1000-Hz output level, for one microbar of pressure, is rated at −81 dBV, or 0.09 millivolts. A three-pin male connector in the tapered end of the microphone's body mates with the furnished cable or any other cable fitted with a Cannon XL, Switchcraft A3, or equivalent plug. The cable supplied with the microphone is 4.6 meters (15 feet) long, and has a metal-bodied 6.3 mm (¼ inch) phone plug at its free end. A 36" (0.91-m) adapter cable is supplied so that the microphone can be used with recorders equipped with miniature phone jacks for their microphone inputs.

The novelty of the Model 516EQ lies in its integral four-band equalizer that is controlled by four tiny switches recessed into the body of the microphone. Each switch introduces a broad response notch, nominally 6 dB deep, with center frequencies of 190, 560, 1650, and 4950 Hz. The 16 possible combinations of switch settings permits the response of the microphone to be tailored for a wide variety of circumstances. The instruction leaflet shows typical response curves for each of the switch combinations and describes the sonic effect of each.

The Shure 516EQ is supplied in a rugged plastic storage case, with signal cable, mini-plug adapter, wind screen, and swivel adapter for stand mounting. For stereo recording, one can buy the Model 516EQ-PR that contains two complete Model 516EQ systems in a single carrying case. The price of the Shure Model 516EQ is $75.

Laboratory Measurements. A rigorous measurement of microphone frequency response requires elaborate and specialized test facilities. Fortunately, it is also possible to make less exact measurements that show the microphone's effective response and how it compares to other microphones measured in the same manner. We use the same basic setup employed for speaker system testing. A speaker system, driven from the swept frequency output of a General Radio response plotter, is used as a sound source. First, the output of the speaker is plotted through our calibrated laboratory microphone at a distance of about 15" (38.1 cm) from the grille and on the central axis of the drivers. Then the test microphone is substituted for the reference microphone, making sure that both are positioned identically relative to the speaker. The swept measurement is



Frequency response (pressure) with all filters out and with individual filters in.

repeated on the same chart paper. The frequency response of the reference microphone is known (and is flat within better than 1 dB to beyond 10,000 Hz), so the difference between the two curves is taken as the response of the test mike.

The curve we obtained in this manner from the Shure Model 516EQ microphone (with all four filters OUT) has less high-frequency emphasis than was shown on Shure's "typical response" curves, but it was otherwise fairly similar. It was flat within ± 3 dB from 110 to 7500 Hz, dropped about 9 dB in the 9000-to-11,000-Hz range, and fell more rapidly at higher frequencies. The low-frequency response followed Shure's curve closely, rolling off below 200 Hz to −13 dB in the 50-to-60-Hz range.

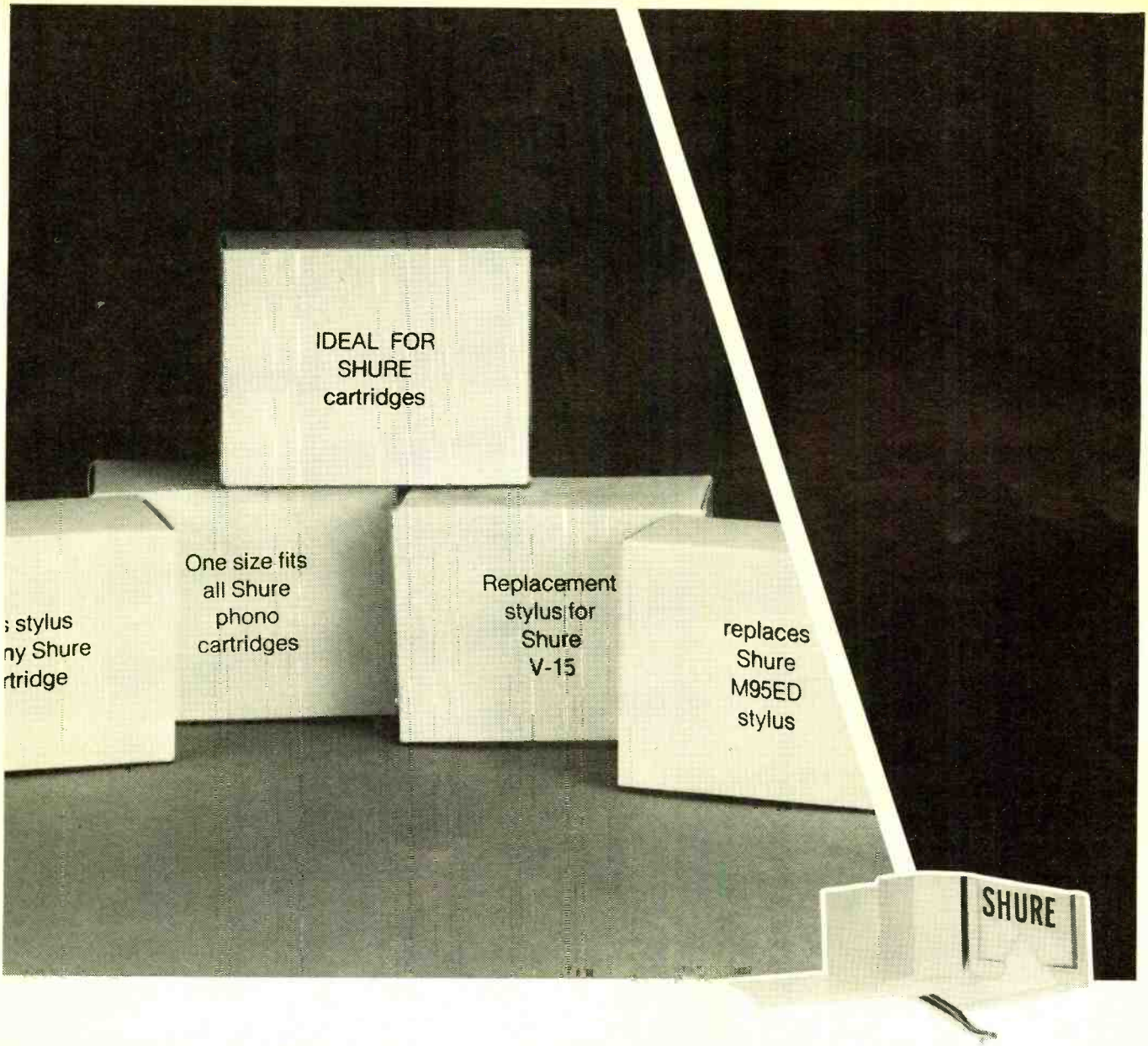
We repeated the response measurements using the filters, one at a time, and plotted the effect of each filter on the same coordinates used for the equalized response curve. Each filter had the specified effect, although the attenuation was usually closer to 8 or 10 dB than the nominal 6 dB, which will vary with load impedance. (We used a high-impedance load in our tests).

User Comment. The effect of the filters on the sound of the microphone can best be judged by making a recording (of one's own voice, for example), using all possible combinations of switch settings. We would suggest that one keep a small screwdriver or a pencil handy for operating the equalizer switches.

It was soon apparent that the microphone can be adjusted to sound like almost anything from a nasal constricted "telephone" sound to an excellent wide-range response very close to that of our calibrated capacitor microphone. We did not use the microphone in the field for live recordings, but our experience with it suggests that the built-in equalizers should be able to cope with many of the acoustic problems one might encounter.

This is one of the least expensive microphones we have seen whose sound quality is reasonably well matched to that of a modern cassette deck. Other microphones may come closer to utilizing the full capability of such a recorder, but they will probably cost more than the Model 516EQ and will not have its equalizing ability. Although we could not make meaningful measurements of the sensitivity of the Model 516EQ, its output was compatible with the requirements of several good cassette decks with which it was used.

CIRCLE NO. 103 ON FREE INFORMATION CARD



Needle in the hi-fi haystack.

Even we were astounded at how difficult it is to find an adequate other-brand replacement stylus for a Shure cartridge. We recently purchased 241 random styli that were not manufactured by Shure, but were being sold as replacements for our cartridges. Only ONE of these 241 styli could pass the same basic production line performance tests that ALL genuine Shure styli must pass. But don't simply accept what we say here. Send for the documented test results we've compiled for you in data booklet #AL548. Insist on a genuine Shure stylus so that your cartridge will retain its original performance capability–and at the same time protect your records.

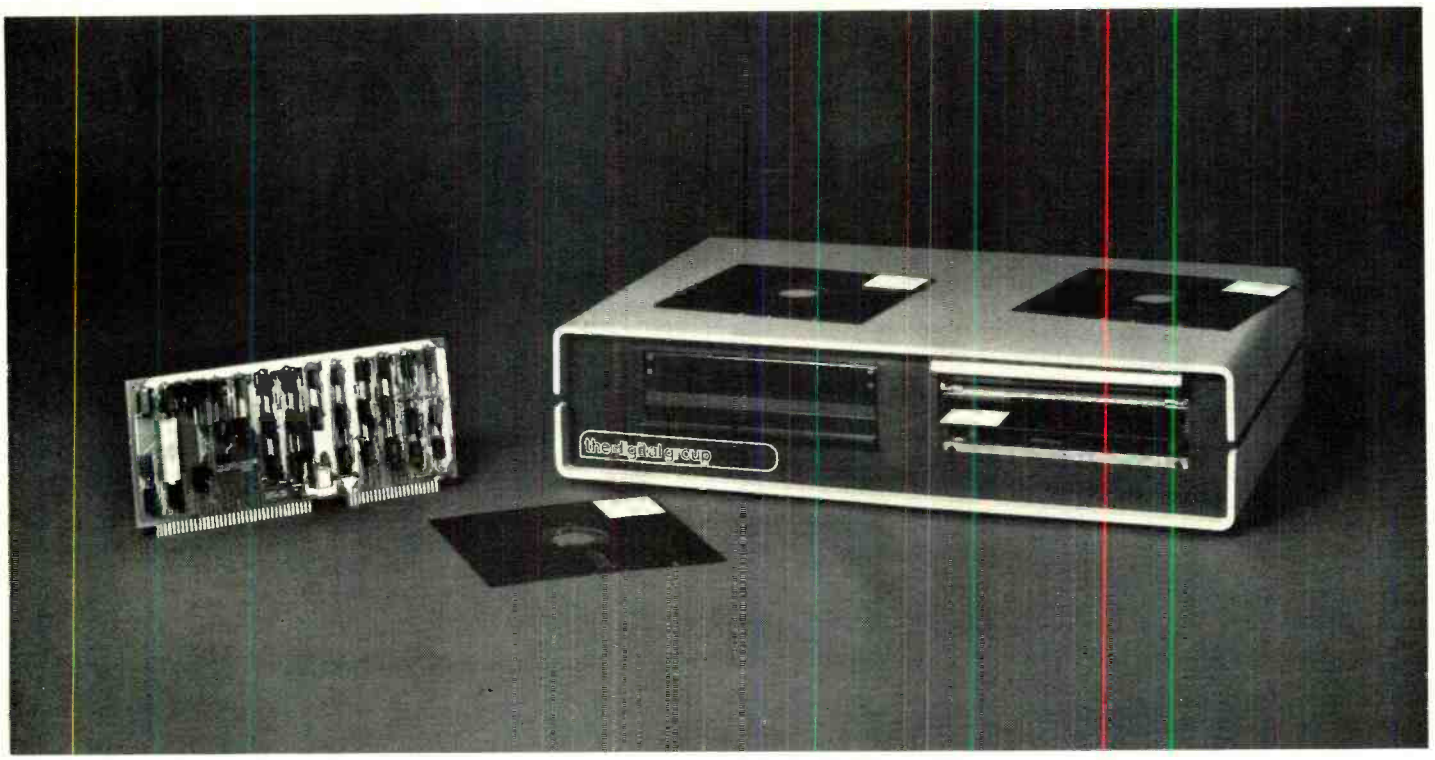
Shure Brothers Inc.
222 Hartrey Ave.,
Evanston, IL 60204
In Canada:
A. C. Simmonds & Sons Limited

TECHNICORNER
The criteria for these tests involved the eight standard production line inspections used for all Shure styli: Visual and mechanical inspection, tip configuration, trackability, vertical drift, 1,000 Hz output level measurement, channel separation at 1,000 Hz, channel separation at 10,000 Hz, and frequency response.
Only genuine Shure styli have the name SHURE on the stylus grip and the words "This Stereo Dynetic® stylus is precision manufactured by Shure Brothers Inc." on the box.

® SHURE

Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

NOW, DISKS TOO!



(And they're **Disk**-tinctly Digital Group.)

With the addition of our all-new Disk Subsystem, the Digital Group becomes the only manufacturer of microprocessors to offer you a real choice. Tape or disk. Or both. Whatever *you* want.

We spent a lot of time designing and testing our new Disk Subsystem, and it shows in the result. The Subsystem is highly flexible. . . gives you direct access to data. . . and completes your Digital Group System.

Here's what the Disk Subsystem consists of:

Disk Interface Card--provides the electrical interface between the disk drives and the computer.

Disk Power Supply--provides all power required for up to 2 drives.

Disk Cabinet and Cables--cabinets provide housing for 1 to 2 drives plus the power supply; assembled cabling is provided for connection between all system components.

Disk Drives--the Digital Group Disk Subsystem supports standard 8" floppy disk drives from a number of manufacturers. Drives can be mixed, and in addition, mini-floppy drives are available for the function of a disk at minimum cost.

Documentation and Software--the Digital Group's standard documentation includes construction guides, maintenance manual, theory of operation and other useful information to help you get the fullest value from your new Disk Subsystem. And there's also software to provide initial support.

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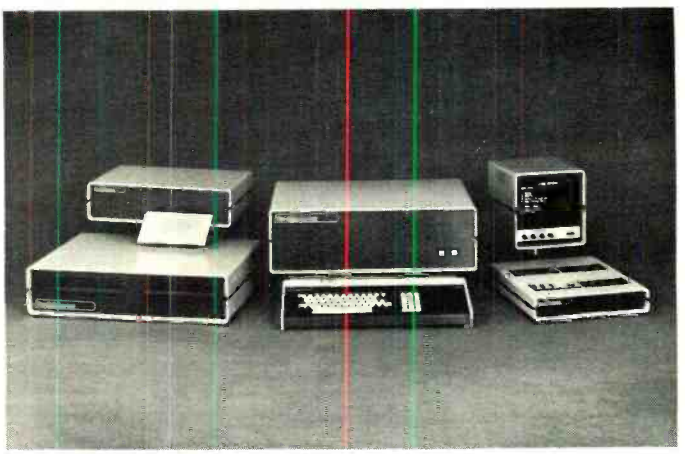
For only $745, you can get a standard 8" floppy drive and an interface card. A complete single-drive Disk Subsystem with interface, power supply, cabinet, and cables is as low as $995.



Now the Digital Group system is really complete. If you don't own it all yet, take another longing look. In addition to our CPU, keyboard and video monitor, you can add an impact printer and the cassette storage system. All in our beautifully coordinated custom cabinets. All unmistakably Digital Group.

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CIRCLE NO. 16 ON FREE INFORMATION CARD

BY LARRY KAHANER

How RTTY equipment works and how to get started using it.

TELETYPEWRITER FUNDAMENTALS FOR HAMS, SWL'ers & COMPUTER HOBBYISTS

HAVE you ever wondered about those strange "deedle-deedle" signals on the shortwave bands? They are actually radioteletype (RTTY) transmissions. You can receive them using your communication receiver and readily available teletypewriter equipment. In this article, we will cover the basics of radioteletype and detail how to set up an RTTY listening post at home.

The Teletype Code. All teletypewriters, whether they communicate by radio or land-line links, "talk" to each other in a language called Baudot, or five-level code. Each character (letter, numeral, punctuation mark) in the Baudot code is uniquely defined by a sequence of five time slots, or *elements*, each of which contains a *mark* or a *space*. For example, the letter A is "mark-mark-space-space-space." When the teletypewriter is operating at 60 wpm (words per minute), each mark or space is exactly 22 milliseconds (ms) long.

A sixth slot is added to the basic five-level code to act as a "flag" that indicates the end of a character. To make this stop flag stand out from the others, its interval is 31 ms instead of 22 ms. Still another time slot is placed at the beginning of each character to give the teletypewriter time to prepare itself for a new character. This is the "start" slot. The 31-ms stop slot contains a mark, while the 22-ms start slot contains a space. A complete character, therefore, consists of seven slots, six 22-ms intervals and one 31-ms interval for a total of 163 ms (see Fig. 1).

The Equipment. A complete station for transmitting and receiving radioteletype signals is shown in Fig. 2. The transmitter and receiver are of conventional "communication" design. The teletypewriter is a combination keyboard/printer. On transmit, the keyboard drives a keyer that, in turn, modulates the transmitter. On receive, signals are coupled from the communication receiv-

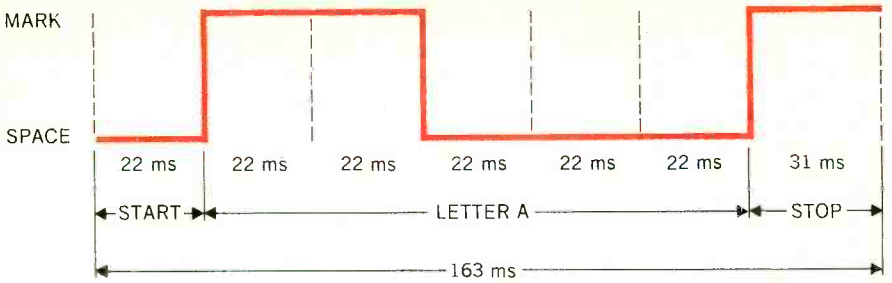


Fig. 1. Waveform showing the pulse sequences that make up the letter "A".

er to the demodulator or terminal unit (TU), which drives the printer.

Now let us examine each component in the system in detail:

Keyboard. A mechanical teletypewriter keyboard resembles the keyboard on a conventional typewriter, but its operation is quite different. When a key is operated, it selects mechanical levers that produce mark and space pulses that correspond to the key's character. Also, there are no lower-case letters—all are capitals. To type punctuation marks, the SHIFT key is pressed first, followed by operation of a key that corresponds to the character you wish to type.

The diagram in Fig. 3 illustrates how one keyboard might work. Each key has a notched lever, which when pressed down can touch five "fingers" that will be either depressed or not, depending upon the notch positions of the lever.

After the key is pressed and the mark and space levers have moved accordingly, a wiper arm sweeps across the mark levers but cannot touch the space levers. An electrical connection is made between the wiper arm and mark fingers, but no current can flow on the spaces. The motion of the wiper arm is controlled by a motor so that it touches each lever for exactly 22 ms. This results in the five-element code described above. Start and stop commands are generated automatically by the keyboard.

The above process is typical of keyboard operation, but it is not absolute. There are variations in keyboard design from one teletypewriter to another. The latest generation of teletypewriters, however, uses electronic instead of electromechanical means for generating the Baudot code. Digital matrix keyboards with clock-controlled digital IC's that generate precisely timed code elements have recently become common.

Transmitter Keying. Dc pulses produced by the keyboard drive a keyer that, in turn, modulates the transmitter. Most often used is frequency shift keying (FSK), a form of frequency modulation. Transmission of FSK signals allows the use of FM demodulation techniques so that there is some discrimination against noise.

When a transmitter is FSK modulated, two output frequencies result, one at the carrier frequency and the other at a slightly lower frequency. The simplest way to accomplish the frequency shift is to add more capacitance to the transmitter's vfo tank circuit or in parallel with the oscillating crystal. In practice, the dc pulses from the keyboard control a relay or solid-state switch that rapidly connects and disconnects the additional capacitor. Hence, the transmitted frequency varies in step with a character's mark and space code.

Most commercial systems employ a 425-Hz shift. A 170-Hz shift is common on the hf amateur bands, but FCC regulations allow use of any shift up to 900 Hz. For example, if the carrier frequency is 15.000000 MHz and the shift is 425 Hz, the output frequency will alternate between 15.000000 and 14.999575 MHz. By convention, the space is the lower and the mark the higher frequency. In this example, marks appear at 15.000000 MHz and spaces appear at 14.999575 MHz.

Receiving FSK. A bfo (beat frequency oscillator) is commonly used for CW reception. The bfo generates a signal that beats against the incoming CW signal to produce an audible tone. If the frequency of the bfo's output is variable, the frequency of the audible tone can be changed. In RTTY communication, signals are received as in ordinary CW, but the bfo is tuned to provide 1275- and 1700-Hz tones, which are 425 Hz apart.

The reason for using 1275- and 1700-Hz tones is that a terminal can demodulate only one pair of frequencies at a time. This pair was chosen by TU

The new breed of teleprinter equipment: Morse and RTTY keyboard (left), demodulator (right bottom), video display unit (right top) and video monitor (top center). Courtesy HAL Corporation.

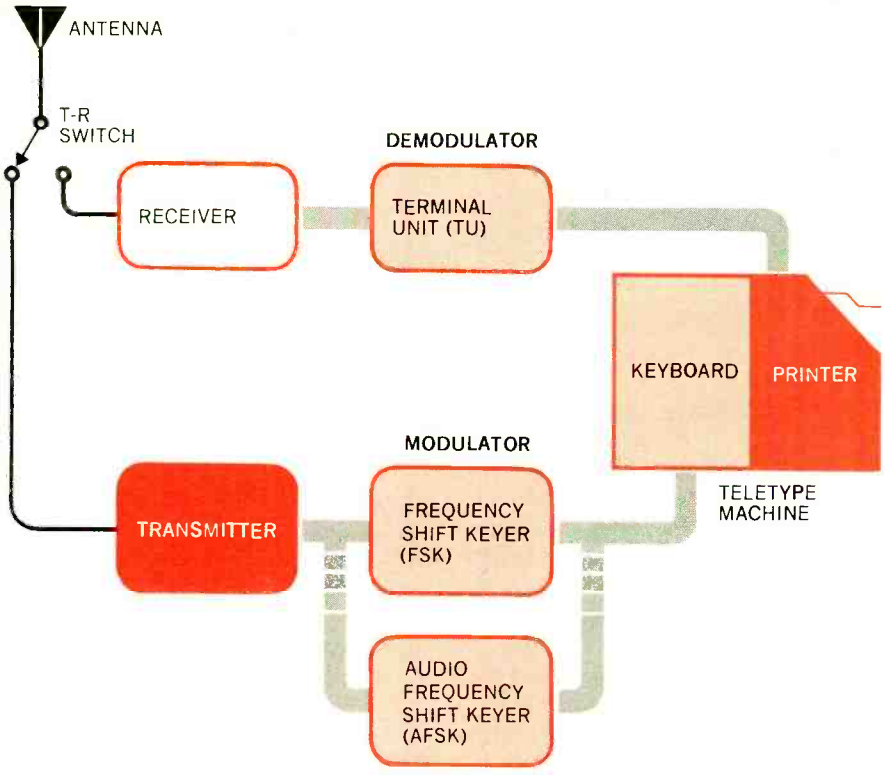


Fig. 2. Block diagram of the equipment in a complete RTTY station.

manufacturers for demodulation of a 425-Hz shift. (However, you can adjust the bfo or the main tuning knob if the bfo is fixed to produce any pair of tones your TU can demodulate.) Other shifts and tone pairs used in RTTY communication are listed in Table I.

An RTTY terminal unit looks and acts like an FM receiver, but it accepts audio signals. Called an *audio TU*, its block diagram is shown in Fig. 4. The limiter accepts the audio outputs of the receiver and amplifies and clips them to keep the signal level fairly constant. Mark and space filters remove any extraneous signal content. The two filtered tones are converted into dc pulses by the audio discriminator. Any ripple on the dc pulses is smoothed by the low-pass filter. The dc pulses are then applied to the keyer, which uses them to generate commands for the printer's magnets.

TABLE I—STANDARD SHIFTS AND TONE PAIRS (Hz)

Shift	170	425	850
Space	1275	1275	1275
Mark	1445	1700	2125
OTHER PAIRS IN USE			
Space	2125	2125	2125
Mark	2295	2550	2975

AFSK. Another method of keying is audio-frequency shift keying, or AFSK. It produces a result similar to FSK but is derived in a different manner. Two audio tones, separated by the frequency shift, modulate an AM or an SBB transmitter. The low-distortion sine-wave tones are applied to the transmitter's microphone input.

If the output from the transmitter is conventional AM, no bfo is required in the receiver. The detected envelope is coupled to the TU from the receiver's audio output. If, on the other hand, SSB equipment is used, the receiver must be carefully tuned for the correct output frequencies and allowances must be made in the transmitter for a 100% duty cycle. As in FSK, the two tones commonly used are 1275 and 1700 Hz.

The Printer. Although printer design varies from one machine to another, the following description is representative of printer operation. A simplified printer is shown in Fig. 5. The selector magnet is energized by each mark pulse. This closes the relay that corresponds to a moving cam connected to each mark and space lever. At the proper time, the cam either pulls down or does not affect the lever. Each lever is connected to a bar with many notches, which are placed at different intervals along the bar.

In the illustration shown in Fig. 5, the first, third, and fifth levers are pulled by the cam. The other levers remain in their original positions. After a character is completed (all five pulses received), one set of notches lines up directly under the appropriate character's striker. (Strikers are in a row, as in a regular typewriter.) When the stop pulse is received, a hammer hits all strikers, but only the one with the lined-up notches moves and imprints the paper. After the strike occurs, the bars and their notches return to their original positions.

The new teletypewriter printers literally do not print at all. They are actually special types of TV receivers that process the dc pulses and apply control signals to form letters on-screen. The advantages of screen printers are that they are quiet, clean, and have no moving

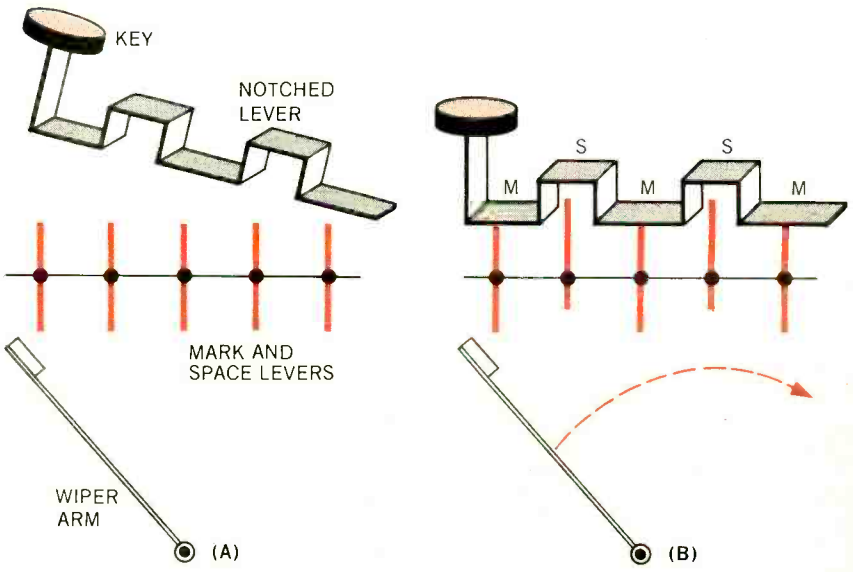


Fig. 3. Simplified diagram shows how key depresses levers at (B).

parts to wear out. Some screen printers have memories that allow storage and playback of messages. These "glass teletypewriters" cannot produce "hard" copy on paper; for this, you must use a regular teletypewriter printer.

Some teletypewriters have perforators that punch holes in 1" (25.4-mm) wide paper tape. The holes in the tape correspond to character codes. Tapes can be made from either an incoming signal or from a message typed on the machine's keyboard. To play back the message, you feed the tape through a tape reader called a transmitter-distributer (TD). The teletypewriter then prints the message. You can also transmit taped messages over the air.

The most commonly used speed is 60 wpm, but stations also transmit at 66, 75, and 100 wpm. To receive different speeds, no changes need be made in the terminal unit, but the printer must be altered. Printers rely on gears to set the speed. Changing gears allows the machine to print at different speeds. TV teletypewriters usually accommodate many speeds with just the turn of a switch.

The number of words per minute tells you only part of the printer's story because each speed requires different slot lengths. A slot for 60-wpm copy is not the same length as one at 100 wpm. So, another word—"baud"—was invented to take slot length into account. The baud is a measure of the rate at which data is sent and is defined as a rate of one pulse (of the shortest duration used in the system) per second. The baud rate is calculated by finding the reciprocal of the shortest slot length. For 60 wpm, the shortest length is 22 ms or 0.022 s; the baud rate is 1/0.022 = 45.5 baud. Other baud rates are detailed in Table II.

When printer gears are changed, the baud rate is altered. The printer's magnets sweep the levers in step with the length of each pulse and, hence, the baud rate.

Equipment Considerations. Any good communication receiver can be used for receiving RTTY. Due to the small, critical frequency shift, however, stability is essential. If your receiver's CW filter bandwidth is 400 Hz, it will probably be suitable for shifts up to 425 Hz. It might not work well with wider shifts, such as 850 Hz, especially if signals are weak. Of course, the SSB filter can be used if the received shift is too great for the CW filter.

Your choice of TU's hinges on your needs and your budget. (Sources of teletypewriter gear are listed in Table III.) One inexpensive approach is to build your own TU. A simple two-chip TU can be built for less than $20. Alternatively, you might decide that a more sophisticated demodulator with built-in oscilloscope tuning indicator and sharp filtering and a choice of shifts fills your needs. Plans for many different TU's can be found in published literature.

If you prefer not to build your own TU, you can buy factory assembled units. Some features to look for here are a choice of shifts, reverse/normal switching, filtering, tuning indicator, baud-rate selection, adequate loop current for the printer magnets, and selectivity.

Most RTTY enthusiasts buy "surplus" printer/keyboard combinations. After these machines are used commercially, surplus dealers buy, recondition, and resell them. Old teletypewriters are rugged and, if properly reconditioned, should last a long time. Prices range from $50 to $250, depending on model, age, and condition. New machines are quite expensive and can cost as much as $2000.

TABLE II—RATES AND SLOTS

Bauds	Words/Min.	Millisec./ Pulse
45	60	22.0
50	66	20.0
57	75	17.57
74	100	13.47
100	132	10.0

You might wish to buy a video monitor instead of a mechanical printer. (Of course, you can modify an old TV receiver for use as a monitor.) A video monitor requires the use of a visual display unit (VDU), which converts the dc pulses from a TU into a form suitable for onscreen display. VDU's cost $350 to $600. You can, however, build your own VDU from plans that have been published in the literature.

If you are a computer hobbyist, consider using your existing monitor and VDU. Be aware, of course, that computers use ASCII, an eight-level computer code, rather than the five-level Baudot code used in RTTY. Baudot signals must be converted to ASCII before reaching the VDU. Baudot-to-ASCII converters are commercially available, or you can make one yourself.

Making Connections. If you buy a teletypewriter, be sure you get the manual, because it contains the machine's wiring diagram and color code. Each machine is wired differently. Bear in mind that, in spite of the jungle of wires inside the teletypewriter, only six wires are necessary for RTTY operation. Two are for the motor, two for the printer magnets, and two for the keyboard. Once you locate the appropriate wires, the hookup necessary to put the tele-

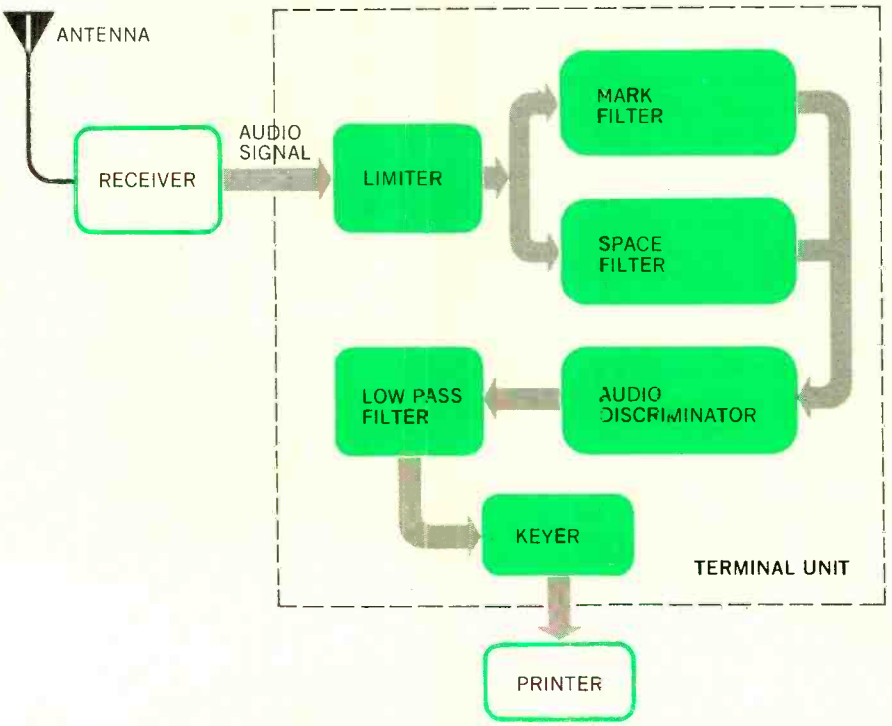


Fig. 4. Block diagram of typical audio terminal unit.

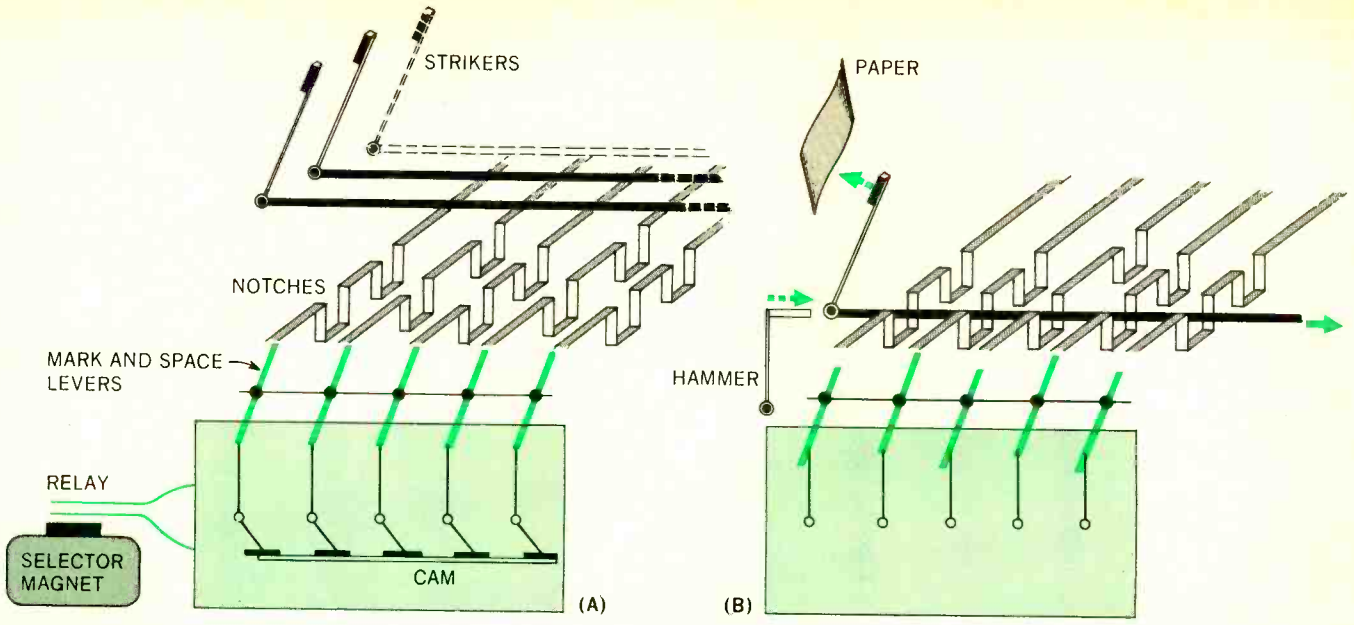


Fig. 5. Typical printer action. At (A), before letter is sent, notches are in random order. At (B), after letter is sent, one set of notches lines up under the correct striker.

typewriter in service is easily accomplished.

Local copy (typing on the keyboard and obtaining a print-out but no transmission) can be accomplished with the circuit shown in Fig. 6. Many teletypewriters employ two selector magnets (check your manual on this) that are connected either in series or in parallel with each other. Use an ohmmeter to check the resistance of the magnet circuit. Each magnet has approximately 100 ohms of dc resistance; so, an ohmmeter reading of 200 ohms indicates a series connection, while a 50-ohm reading indicates a parallel hookup. Because each magnet requires about 30 mA of current, parallel wiring calls for 60 mA in the loop circuit, while series wiring requires 30 mA in the loop. Adjust the series resistor for the proper magnet current.

Turn on the motor by applying 117 volts ac to its winding. With proper magnet current flowing and the motor running, you should be able to type on the keyboard and obtain a printed hardcopy message. If you have trouble obtaining local copy, check your wiring. Garbled or no printing at all could also be caused by poor adjustment of the "range selector."

Sometimes, distortion occurs in RTTY transmissions. Pulses often become longer or shorter because of propagation conditions. To counteract this, machines are designed to respond to only a small section in the middle of the pulse width. The exact location of this "window" is controlled by the range selector, a movable arm that has graduations from 0 to 120.

To test the range selector, type the letters RY. These letters, when alternately typed, produce a mark pulse in each of the five slots. Move the range selector toward 0. As you approach 0, the teletypewriter will begin to lose intelligibility and print random characters. Note the setting at which this occurs. Then increase the setting until the machine's printer "locks up," again noting the setting. Set the range selector midway between these two points.

The terminal unit should be connected as shown in Fig. 7. TU's vary in design, but some share basic characteristics. For example, they all have a method for adjusting the shift frequency, which is usually a variable inductance. And they all have controls for adjusting printer current, usually via a potentiometer. Both controls must be properly adjusted for correct TU operation.

TABLE III—SOURCES OF RTTY EQUIPMENT

Alltronics-Howard
Box 19
Boston, MA 02101

Atlantic Surplus Sales
3730 Nautilus Ave.
Brooklyn, NY 11224

Dovetron
627 Fremont Ave.
S. Pasadena, CA 91030

Fair Radio Sales
Box 1105
Lima, OH 45802

Teletype Corp.
5555 Touby Ave.
Skokie, IL 60076

Typetronics
Box 8873
Fort Lauderdale, FL 33310

Nat Stinette Electronics
890 Virginia Ave.
Tavares, FL 32778

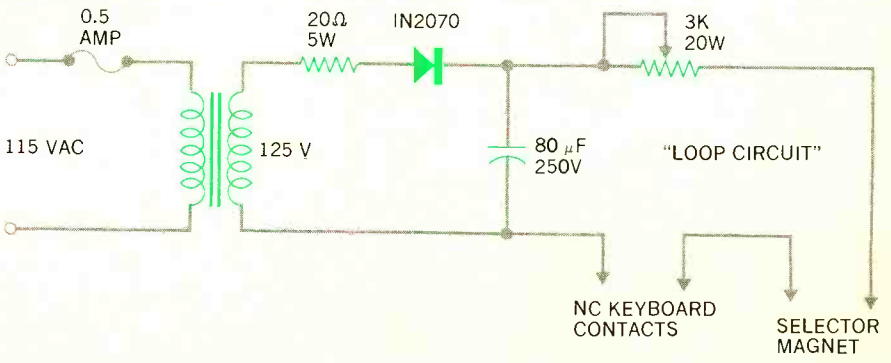


Fig. 6. Local copy can be obtained using the loop circuit shown here.

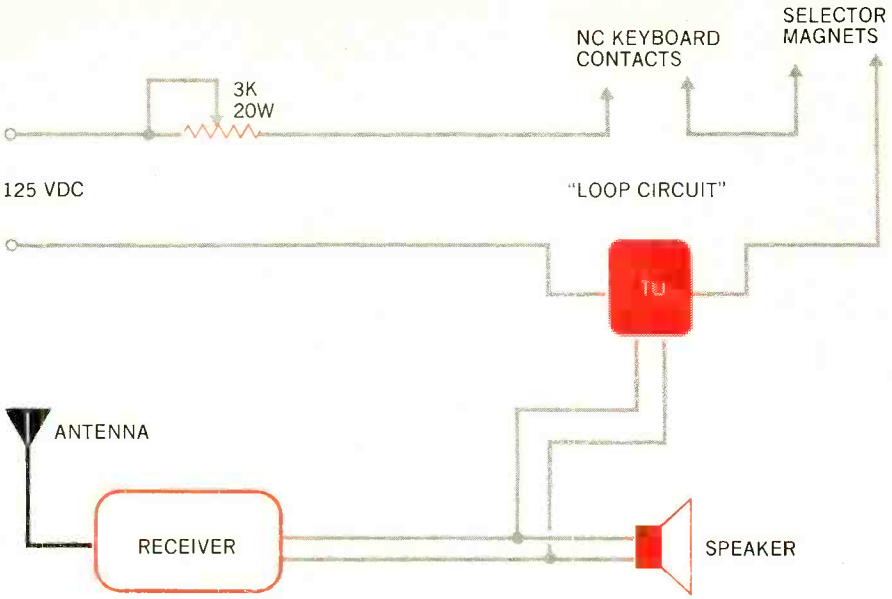


Fig. 7. How to set up an RTTY receiving station with a terminal unit.

Connect the TU to the receiver's audio output, keeping the speaker online so that you can hear the incoming signals. Find an RTTY station and tune it in carefully, using the TU's tuning indicator for accuracy. Because tuning in RTTY stations is tricky, you may get garbled copy until you become accustomed to tuning. Some operators tune until legible copy appears, while others can tune in the proper tones by ear. Either method is fine, but do not expect to be able to emulate this right away. It takes lots of practice.

If you get garbled copy, it may be due to one of several causes. The most common is that the station is transmitting at a different shift or speed from your settings. Again, experienced operators can "hear" different speeds and shifts. You will, too, after a while.

A station might be transmitting in reverse shift, with the space high and the mark low. Switching sidebands on your receiver or shifting the bfo output to the other side of zero beat will compensate for this. Many TU's have a reverse/normal switch that accomplishes the same thing. Military stations often transmit secret cipher messages that look like gibberish. If you are not aware of this practice, you can go crazy trying to copy them.

Listening. At least 200 stations, excluding radio amateurs and the military, transmit RTTY (see Table IV). Most use shifts of 425 to 850 Hz and speeds of 60 to 100 wpm. By tuning to them, you can receive news reports, weather forecasts, and commercial radiograms, as well as conversations between radio amateurs and military traffic. However, you should read Section 605 of the Communications Act of 1934 that concerns secrecy of communications.

In brief, the Act prohibits a listener from divulging to a third party or using for his own or a third party's benefit the contents of any interstate or foreign communication by radio or wire. Note, however, that this section does not apply to the contents of any radio communication broadcast or transmission by radio amateurs or others for use of the public or relating to ships in distress.

TABLE IV—RTTY STATIONS

Call	Frequency (MHz)	Location	Service
9PX29	6.910	Barbados	Reuters
WFK80	10.7535	New York	Reuters
RVW57	12.315	Moscow	Tass (some English news
WER73	13.480	New York	UPI
WER24	14.770	New York	UPI
WEY45	15.914	New York	AP (some English news)
SOP29	15.989	Poland	Polish Press (some English news)

Note: Most ham operators use a 170-Hz shift at 60 wpm near 3.620, 7.040, and 14.090 MHz.

TABLE V—REFERENCE LIST

Confidential Frequency List
By Robert E. Grove
Pub. by Gilfer Assoc.
Box 239
Park Ridge, NJ 07656
(Extensive lists of stations transmitting RTTY. Updated periodically.)

The New RTTY Handbook
73 Publishers
Peterborough, NH 03458
(Good for beginners, slanted for hams.)

RTTY News
Canadian Amateur Radio Teletype Group
Gwen Burnett
85 Fifeshire Rd.
Willowdale, Ont., Can. M2L 2G9
(Technical information and amateur operating news.)

Teleprinter Handbook
By D. L. Goacher & J. G. Denney
Radio Society of Great Britain
35 Doughty St.
London, WC1N 2AE, England
(Thorough treatment of RTTY. Large section on machine repair and maintenance.)

RTTY Journal
P. O. Box 837
Royal Oak, MI 48068
(Published 10 times per year. Slanted for the ham, but has classified ads, technical pieces, and a DX-RTTY column. Publishers of *The Beginner's RTTY Handbook*.)

The Radio Amateur's Handbook
and
Specialized Communications Techniques for the Radio Amateur
American Radio Relay League
225 Main St.
Newington, CT 06111

Getting Help. Besides the books listed in Table V, there are other sources of information and help to which you can turn. Although relatively few shortwave listeners use RTTY, many hams transmit and receive radioteletype messages. Most of them will be glad to show you the "tricks of the trade" they use to obtain perfect copy. Also, many computer hobbyists use teletypewriters to get hard copy or punch tape. ◇

Hex-to-ASCII Converter for your TVT-6

Simple module produces op-code display for entire computer.

BY DON LANCASTER

THE LOW-COST "Hex-to-ASCII Converter" described here allows you to simultaneously display the contents of every register, stack location, and memory slot in your microcomputer. The converter fits easily between the TVT-6 (July 1977) or most any other TVT and the μC with which it is working.

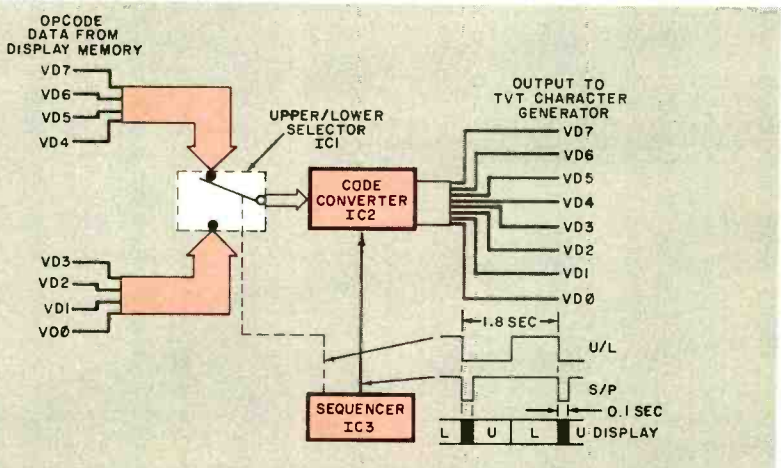


Fig. 1. Block diagram of system. Op code is displayed as brief blank, followed by upper then lower hex character.

In operation, the video monitor used in the system automatically converts and displays the hex op codes for the ASCII character set. This allows your TVT to act as a super "front panel" that permits you to check as many memory locations as there are in your system. This includes all registers, accumulator, stacks, RAM and ROM programs, I/O, or anything else connected to the system. Properly used, the converter is also an excellent debugging tool.

The complete hex-to-ASCII converter is built on a single compact printed circuit board. The circuit itself consists of three low-cost IC's and only five other parts.

About the Circuit. As shown in Fig. 1, the eight input lines from the display memory that normally drive the TVT character generator are intercepted and split into upper- and lower-case charac-

(Continued on page 51)

WORD	NOTES	8/7	7/6	6/5	5/4	4/3	3/2	2/1	1/0
0	Blank	□	□	□	□	□	■	□	□
1	"	□	□	□	□	□	■	□	□
2	"	□	□	□	□	□	■	□	□
3	"	□	□	□	□	□	■	□	□
4	"	□	□	□	□	□	■	□	□
5	"	□	□	□	□	□	■	□	□
6	"	□	□	□	□	□	■	□	□
7	"	□	□	□	□	□	■	□	□
8	"	□	□	□	□	□	■	□	□
9	"	□	□	□	□	□	■	□	□
10	"	□	□	□	□	□	■	□	□
11	"	□	□	□	□	□	■	□	□
12	"	□	□	□	□	□	■	□	□
13	"	□	□	□	□	□	■	□	□
14	"	□	□	□	□	□	■	□	□
15	"	□	□	□	□	□	■	□	□
16	0	□	□	□	□	■	■	□	□
17	1	■	□	□	□	■	■	□	□
18	2	□	■	□	□	■	■	□	□
19	3	■	■	□	□	■	■	□	□
20	4	□	□	■	□	■	■	□	□
21	5	■	□	■	□	■	■	□	□
22	6	□	■	■	□	■	■	□	□
23	7	■	■	■	□	■	■	□	□
24	8	□	□	□	■	■	■	□	□
25	9	■	□	□	■	■	■	□	□
26	A	■	□	□	□	□	□	■	□
27	B	□	■	□	□	□	□	■	□
28	C	■	■	□	□	□	□	■	□
29	D	□	□	■	□	□	□	■	□
30	E	■	□	■	□	□	□	■	□
31	F	□	■	■	□	□	□	■	□

0-WHITE; 1-BLACK

Fig. 3. Truth table for PROM IC2.

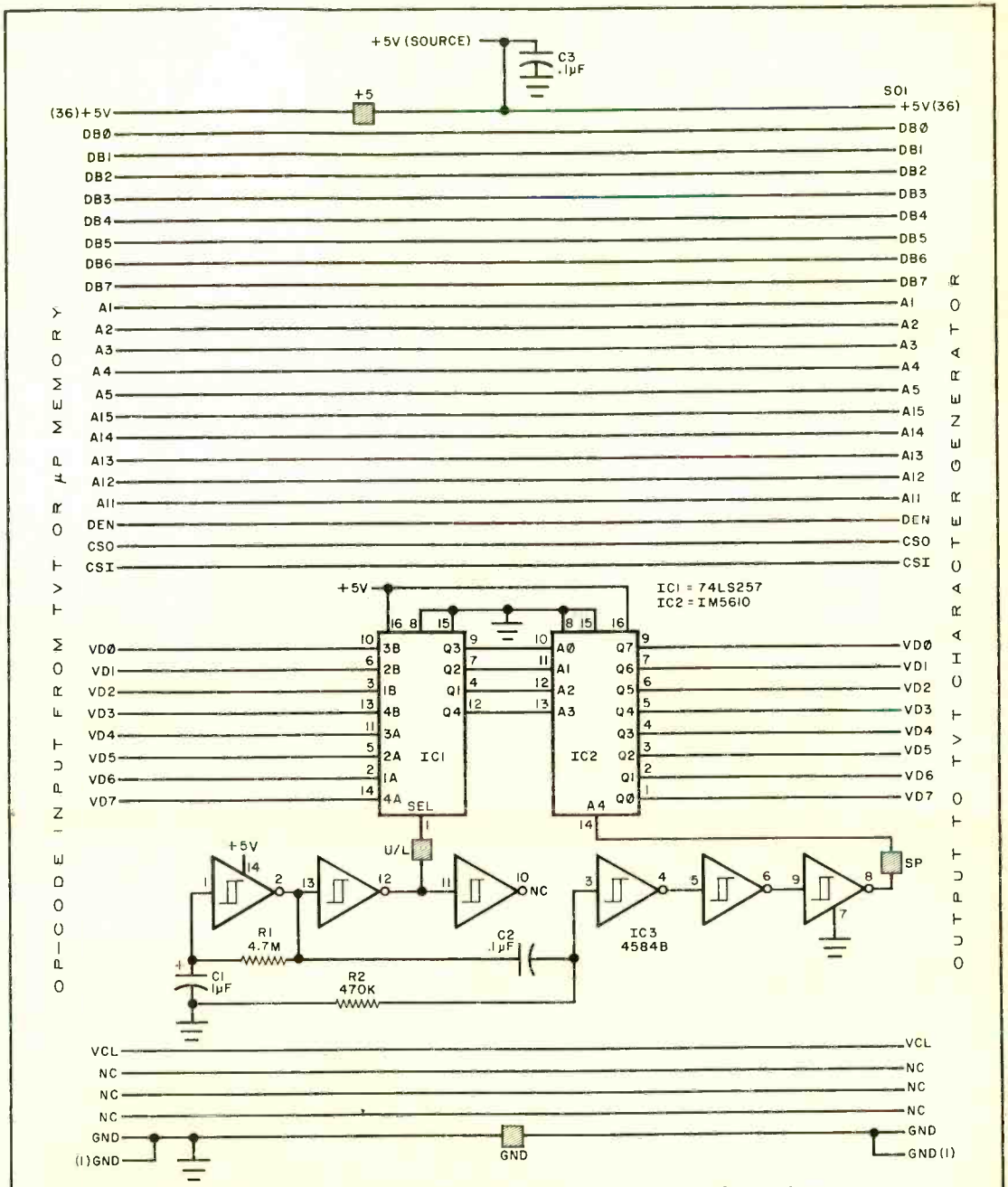
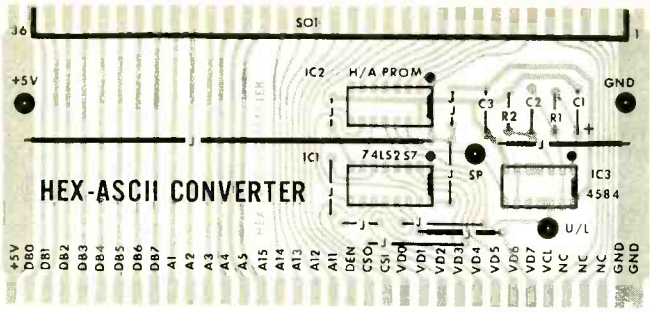


Fig. 2. Oscillator IC3 is circuit timer for upper/lower display and interbyte pause.



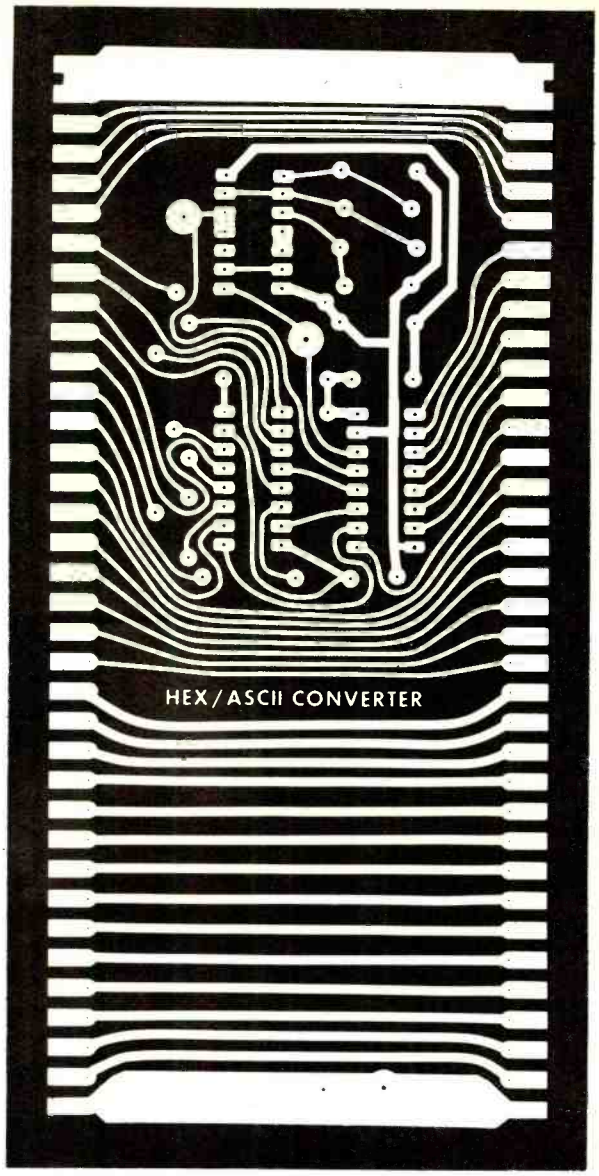


Fig. 4. Actual-size etching and drilling guide (right) and component layout (above) for the pc board. The board is connected between the TVT-6 and the KIM-1 microcomputer.

PARTS LIST

C1—1-μF, low-leakage tantalum electrolytic capacitor
C2,C3—0.1-μF Mylar capacitor
IC1—74LS257 quad 1-of-2 data selector
IC2—IM5610 or similar 32X8 bipolar tristate PROM (programmed in accordance with Fig. 3)
IC3—4584B CMOS hex Schmitt trigger
R1—4.7-megohm, ¼-watt resistor
R2—470,000-ohm, ¼-watt resistor
SO1—36-contact, single-entry edge connector with contacts located on 3.96-mm centers
Misc.—Sockets for IC's (one 14-pin, two 16-pin); press-fit test point terminals; printed circuit board; jumper wire; insulated sleeving; solder; etc.
Note: The following items are available from PAIA Electronics, Box 14359, Oklahoma City, OK 37114: No. HAC-1B etched and drilled pc board for $4; No. HAC-1P programmed IC2 for $5; No. HAC-1K complete kit of all parts for $14.95. All prices postpaid.

(Continued from page 49)

ters of four bits each. These two hex characters are alternately routed to a PROM that converts the hexidecimal input code to the equivalent ASCII output. The resultant display alternately flashes the upper hex character and then the lower hex character, with both appearing on-screen at the same location. Each character is displayed for slightly less than a second. A brief space command is sent to the PROM during the transition from the lower character of one set to the upper character of the following set.

To identify the memory locations, an overlay can be used on the CRT screen of the video monitor, or a china marker can be used to label the operating registers and other important slots with which you are working. If the TVT-6 is being used with the "Cruncher the Bear" mode in the August 1977 issue, it is possible to simultaneously display the 4096 hex characters that result from the 2048 op-code words simultaneously.

The complete schematic diagram of the converter is shown in Fig. 2 and the coding for the 32 × 8 code-converter PROM is shown in Fig. 3.

Integrated circuit *IC1* (Fig. 2) is used as a four-pole, double-throw data selector that drives *IC2*, the code converter. The hex CMOS Schmitt trigger (*IC3*) serves as a symmetrical oscillator that is used for automatically selecting the upper and lower character and to generate the brief blanking pulse that indicates a new character display.

Construction. The converter circuit is best assembled on a printed circuit board. The etching and drilling and components placement guides for the pc board are shown in Fig. 4.

Note on the components placement guide that 10 jumpers are used to interconnect various pads on the board. Only two of these jumpers, indicated by heavy lines, require insulated sleeving to be slipped over them before installation to preclude the possibility of accidental short circuits.

Install and solder into place press-fit terminals at the four test points labelled +5, GND, SP, and U/L. Then install and solder into place the three capacitors, two resistors, and the 36-contact connector. Sockets are recommended for the three IC's. Once the sockets are installed and soldered into place, install the IC's in their respective locations, taking care to properly orient them.

Checkout. To initially check out the converter, connect the TVT-6 to the KIM-1 microcomputer and use the

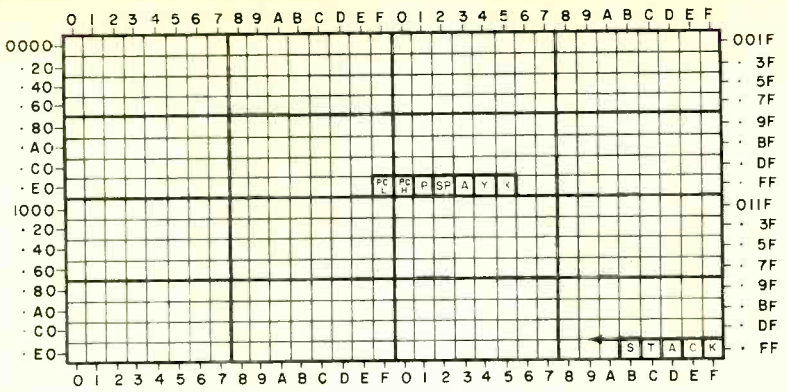


Fig. 5. Overlay mask for the KIM-1. All internal registers are displayed simultaneously with the entire stack.

512-character, page 2 and page 3 display of Table II in the August 1977 TVT-6 article. Make sure that the system is operating properly. Then remove the power and connect the hex-to-ASCII converter between the TVT-6 and μC. Power up again, reload the program, and run the computer. The original ASCII display should now appear in hexidecimal op code.

Test point U/L should have a 1.8-second square wave, while test point SP should be high for 1.7 seconds and low for 0.1 second. It is possible to "force feed" control signals into these test points. Connecting test point SP to +5 volts displays the characters; grounding SP blanks the screen. Connecting test point U/L to +5 volts displays the lower four bits, while grounding it displays the upper four bits.

Operation. If you are planning to run Table II from the August 1977 TVT-6 article, the usual display is of pages 02 and 03. This can be converted to a page 00 and 01 display by changing instruction 17AA to 82 and 17d2 to 80.

An overlay that identifies the stack and all important machine registers is shown in Fig. 5. The physical size of the overlay, of course, depends on the size of the CRT used in the monitor. A sharp china marker can alternatively be used as a low-cost, workable substitute for the overlay.

To debug a program, simply use the hex-to-ASCII converter with the KIM-1 operating system in the single-step mode. Each time the operating system returns to the keyboard display mode, all registers have their values reloaded into the proper slots shown in Fig. 5.

Hit AD 17 80, switch to SST OFF, and press GO to view the accumulator, stack pointer, program counter, status register, and the X and Y index registers simultaneously. To return to the keyboard display mode, simply press ST.

The Hex-to-ASCII converter can be used between memory and the character generator of many other TVT systems as long as an 8-bit word is used in the TVT's page memory. You can ignore the "Pass-through" lines on the converter, or you can redefine them in any way you need. The converter's processing delay is about 100 ns, which is fast enough usually to be ignored. ◇

Rechargeable Batteries for Consumer Products

THE USE of batteries to power electrical and electronic devices is on the rise. As more and more such products are introduced, the consumer is faced with the problem and cost of constant replacement of batteries.

General Electric has introduced an alternative with two new lines of rechargeable batteries and cells. A nickel-cadmium line consists of the most common-size cells and batteries used in such low- and medium-power items as handheld calculators, photoflash camera units, and portable receivers. A sealed lead-acid (SLA) cell line is designed for devices that require medium-to-high-power, such as alarms, emergency lighting, and computer memory systems.

The new sealed lead-acid cells are designed to be completely maintenance-free. They can be used in any position without posing a problem with electrolyte spillage. The outer metal case of the cell is electrically isolated from the power-carrying plates. Both the positive and the negative terminals are at the top of the cell. A special glass fiber separator used in construction permits the cell to withstand high temperatures without suffering damage.

The discharge characteristics and cycle life of the SLA cells duplicate or exceed those of other lead-acid cells. The SLA cells are said to have a charge/discharge life of about 300 cycles, which favorably compares with the life of nickel-cadmium cells whose life is typically about 1000 cycles.

The internal resistance of the SLA cell is 10 milliohms (0.01 ohm). This low value makes possible high charge/discharge rates with minimum danger of overheating the cell. A resealable safety vent in the cell prevents cell bursting under extreme abuse.

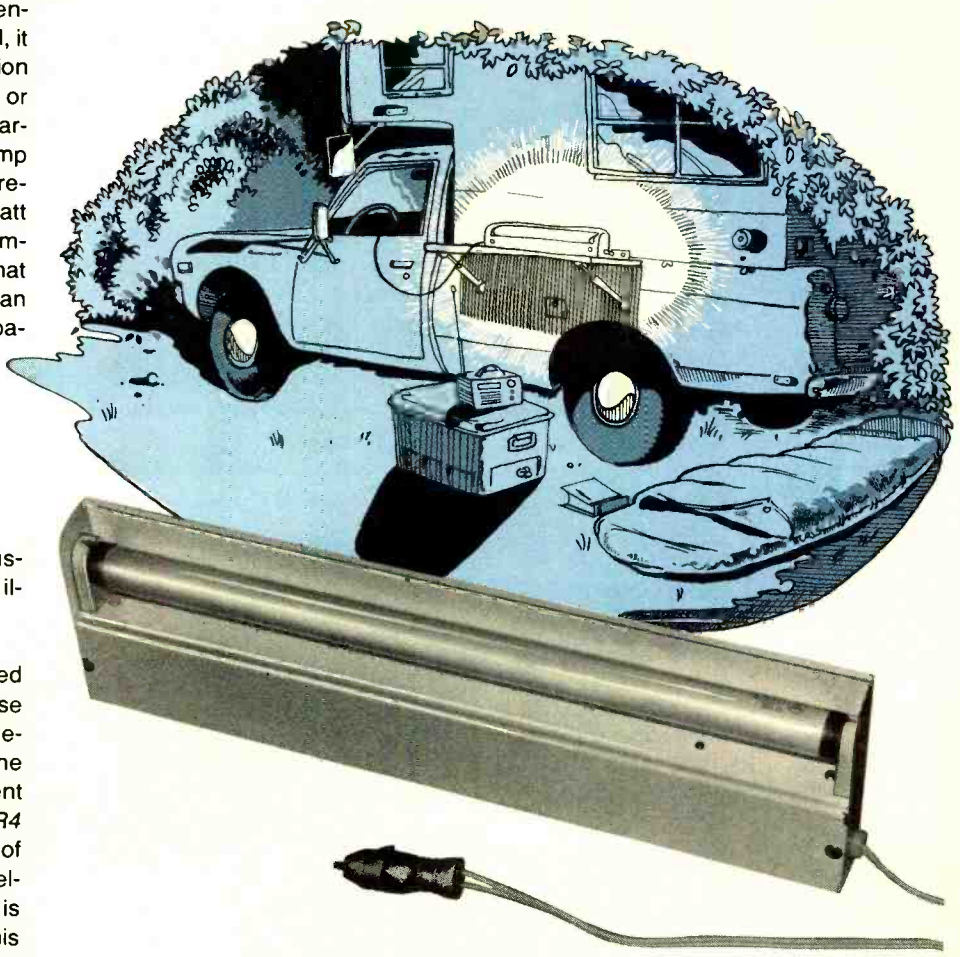
The first of the new SLA cells to come on the market is a cylindrical D cell. It is designed to deliver 2.5 ampere-hours at a 250-mA discharge rate. The cell is capable of delivering up to 40 amperes of continuous current and 75 amperes of momentary (1-second) current. The line of SLA cells will eventually include batteries rated at 6 and 12 volts and 2.5 AH.

The rechargeable nickel-cadmium battery system consists of AA, C, and D cells and a 9-volt transistor size battery, each of which is available separately or packaged with its appropriate snap-on module that connects it to the Model BC3 miniature charger. The rechargeable NiCd cells and batteries are designed for any application where ordinary carbon-zinc batteries are used. They are directly interchangeable with other AA, C, and D cells and 9-volt transistor batteries. ◇

Build a FLUORESCENT Utility Lamp

Operates from 12-volt dc source.

BY JOE DUNCAN



A PORTABLE, battery-powered emergency lamp can be a life-saver on the highway and a great convenience at camp sites. To be truly useful, it should provide reasonable illumination without quickly depleting the battery or confining its light output within too narrow a beam. The utility fluorescent lamp described here satisfies these requirements. It uses a conventional 15-watt fluorescent tube and drive circuitry compact enough to fit in the fixture that houses the tube. Operating power can be drawn from any 12-volt source capable of delivering 2 amperes continuously. Thus, the lamp can also be used to illuminate the inside of a camper.

Circuit Operation. Timer integrated circuit *IC1* in Fig. 1 serves as a pulse generator whose output frequency is determined by *R1*, *R2*, and *C3*. When the output of *IC1*, at pin 3, goes low, current flows from the base of *Q2* through *R4* and *R5* and then to ground via pin 1 of the 555 timer. The voltage drop developed by the load current across *R3* is applied to the base of *Q1*, turning on this transistor, while part of the load current from *R4* and *R5* flows through transistor *Q1* to ground.

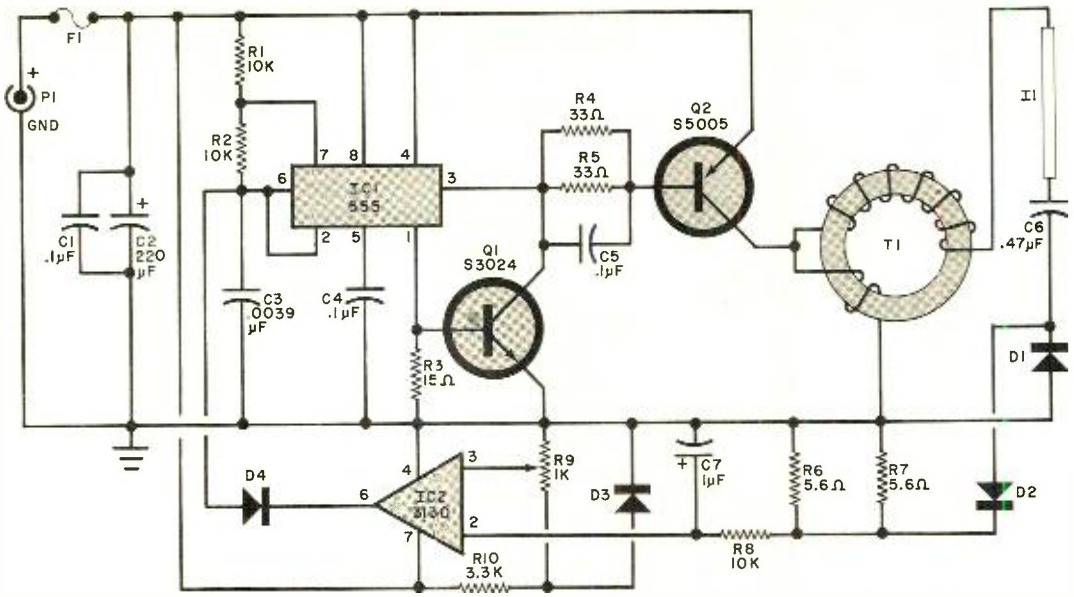


Fig. 1. The 555 oscillator drives Q2 which causes a high voltage across the lamp through T1. The IC2 circuit is a form of voltage regulator.

PARTS LIST

C1,C4,C5—0.1-μF, 50-V disc capacitor
C2—220-μF, 50-V electrolytic capacitor
C3—0.0039-μF silver-mica or polystyrene capacitor
C6—0.47-μF, 200-V capacitor
C7—1-μF, 35-V electrolytic capacitor
D1,D2—1N4001 (1-ampere, 50-PIV) rectifier diode
D3,D4—1N914 or similar switching diode
F1—3-ampere fuse
I1—F15T8 15-watt fluorescent lamp (with fixture. Sears Model 8934 or similar)
IC1—555 timer
IC2—CA3130 op amp (RCA)
P1—Auto lighter accessory plug (Radio Shack No. 274-331 or similar)
Q1—HEP S3024 transistor (Motorola)
Q2—HEP S5005 transistor (Motorola)
R1,R2,R8—10,000-ohm, ¼-watt resistor
R3—15-ohm, ½-watt resistor
R4,R5—33-ohm, 2-watt resistor
R6,R7—5.6-ohm, ½-watt resistor
R9—1000-ohm trimmer potentiometer (Radio Shack No. 271-227 or similar)
R10—3300-ohm, ½-watt resistor
T1—See text (No. T-184-2 ferrite core available for $3.50, including postage and handling, plus 6% tax for California residents, from Amidon Associates, 12033 Ostego St., N. Hollywood, CA 91607)
Misc.—In-line fuse holder for F1; 18' No. 20 enamelled wire; 126' No. 26 enamelled wire; 18' conventional twin-lead lamp cord; machine hardware; hookup wire; solder; etc.

When the output of *IC1* goes high, the voltage drop across *R3* is very low. This turns off *Q1* and the transistor increases the current-drive capability of *IC1* without altering the output wave-shape.

The current-boosted output of *IC1* is applied to switching transistor *Q2*, which drives step-up transformer *T1*. The transistor for *Q2* has an 80-volt breakdown rating and can handle 8 amperes. In operation, fluorescent lamp *I1* requires 1.75 amperes, and the peak current flowing through *Q2* is slightly greater than 6 amperes.

During the first few moments of operation and before the fluorescent lamp strikes, the rapidly changing magnetic field of *T1* produces voltage pulses in excess of 600 volts. It is these pulses that are applied to the lamp to cause it to conduct. After the lamp starts, it serves as the load for *T1* and limits the output potential of *T1* to about 90 volts. The time between power-on and lamp lighting is about a second.

A vehicle's electrical system voltage might vary by 15% or more, depending on whether or not the engine is running and also on the condition of the battery. In the utility light circuit, a 15% input voltage variation could mean low lamp brightness and might cause *Q2* to burn out. The *IC2* circuit is used to obviate these possibilities. Operational amplifier *IC2* functions as a current regulator that maintains a constant light level over the range of battery voltages usually encountered in mobile electrical systems.

The voltage drop across *R6* and *R7* is proportional to the current through the fluorescent lamp. This voltage is filtered and smoothed by *C7* and *R8* before being applied to *IC2*. The op amp then compares the filtered voltage from *C7* with a reference voltage that is preset by *R9*. The output of *IC2* then develops a correction signal that is fed to *IC1* to vary the oscillator's frequency and pulse

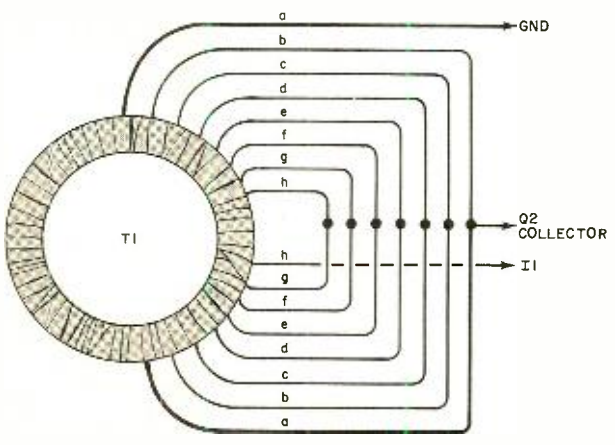


Fig. 2. Wiring diagram for T1. Conductor "a" is No. 20 wire. Others are No. 26.

width as required to maintain a constant current and lamp brightness.

During operation, the potential at pins 2 and 3 of *IC2* is only on the order of 0.5 to 0.6 volt above ground, which is sufficient to drive the FET input stage of the CA3130 used for *IC2*. This potential, however, is too low to drive other op amps, such as the 741, that do not have FET input stages.

Construction. With the exception of *F1*, *Q2*, and *T1*, all components should be mounted on a small piece of perforated board or a printed circuit board of your own design. The circuit board assembly and other components then mount inside the selected fluorescent lamp fixture. Hence, select the fixture before making the board assembly so that you are sure the latter has space to fit inside the fixture. Also, select a metal fixture so that it can serve as a heat sink for *Q2*. The fixture should have at least a 2½" (6.4-cm) wide by 1" (2.54-cm) deep channel to accommodate the board assembly and *T1* (see Fig. 3). If the selected fluorescent fixture has a ballast and starter, remove them.

Transformer *T1* must be home fabricated by winding enamelled wire on a ferrite core. Cut an 18' (5.5-m) length of No. 20 enamelled wire and seven 18' lengths of No. 26 enamelled wire. Form the eight wires into a single bundle and temporarily tie one end to a door knob or other support. Liberally coat the bundle with contact cement. The easiest way to do this is to pour a small amount of the cement into the palm of your hand and pull your hand along the length of the bundle. Leave one end of the bundle attached to the support as you coat it with enough cement to make all wires adhere to each other. Remove the contact cement from your hand with acetone or nail polish remover. Allow the cement on the bundle to dry before removing it from the support.

The wire bundle forms about 75 turns around the ferrite toroid core specified in the Parts List. Before proceeding, carefully scrape away about ½" (12.7 mm) of the enamel coating from all wire ends. Then, referring to Fig. 2, locate one end of the No. 20 wire and attach a tag labelled GND to it. Now, using an ohmmeter, identify and label all remaining wire ends for quick identification.

Once the No. 26 wires have been identified, connect them in series exactly as shown in Fig. 2. As you twist together and solder each wire connection, be sure to insulate the connection. Note that the unconnected end of the wire labelled *h* goes to the fluorescent lamp and that the junction where the heavy *a* and lighter *b* wires meet connects to the collector of *Q2* This method of winding produces the tight coupling required to prevent high-voltage switching transients from appearing at the collector of *Q2*. The finished transformer can be mounted in the trough of the fixture with silicone rubber or urethane adhesive.

Transistor *Q2* mounts on the metal fixture so that it makes thermal but not electrical contact. Use a mica insulator and silicone heat-transfer compound to assure good heat-sinking action. A typical installation of the components in the central channel of the light fixture is shown in Fig. 3.

Test and Adjustment. You can test the utility lamp by applying 12 volts dc to the power input before final mounting of all elements. Fuse *F1* goes in an in-line fuse holder located in the power cable. The free end of the cable can be terminated with an automobile cigarette lighter plug or some other type of connector that mates with its counterpart in an electrical system. Make certain that the correct polarity is observed when connecting the power line leads.

There is only one adjustment that need be made to get the lamp operating properly. This is to set the current drawn by the lamp by adjusting *R9*. To do this, it is necessary to measure the current to the lamp. Set your multimeter to the 2- or 5-ampere range and connect it in series with the fuse holder. (If your meter does not have a 2- or 5-ampere measuring capability, temporarily connect a 0.1-ohm resistor in series with the fuse holder and measure the voltage across it. The current is then this voltage divided by 0.1.)

Set *R9* to midscale when you initially power up the utility lamp. As you adjust the setting of *R9* to both sides of its center position, you will note that the meter indication will vary from a low of about 0.5 ampere to a high in excess of 2 amperes. Adjust *R9* for a 1.75 ampere indication (0.175 volt across the 0.1-ohm resistor). Once *R9* is properly set, daub some nail polish on its rotor to fix the setting. If you used a 0.1-ohm resistor in series with the fuse holder, remove it. The lamp is now ready to use.

One word of caution is necessary at this point: DO NOT plug the utility light into a power source unless a fluorescent lamp is in the circuit. Without the lamp serving as a load, high voltage switching transients are likely to destroy *Q2*. ◇

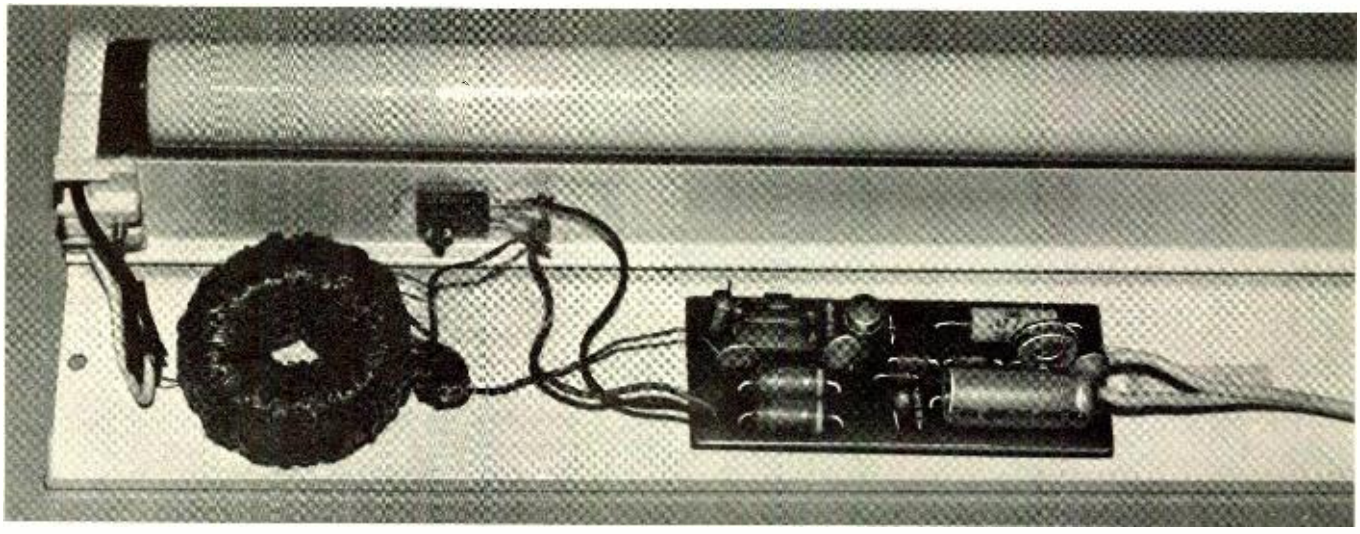


Fig. 3. Photo shows author's prototype. Note how fixture is used (with insulation) as heat sink for Q2.

HOW TO DESIGN TTL DIGITAL SYSTEMS

BY JIM HUFFMAN

tips for the circuit designer on using the popular Transistor-Transistor Logic family

DIGITAL circuits and techniques are finding their way into all areas of electronics, including many of the "all-linear" circuits of just a few years ago. Because of this ever-increasing popularity, it behooves the electronics experimenter to sharpen his knowledge of digital circuits and devices. The focus here is on the popular and low-cost transistor-transistor logic, or TTL, family of digital integrated circuits.

The TTL Family. The transistor-transistor logic family uses built-in transistors both as electronic switches and gates, is highly immune to noise, and has very fast operating speeds. The most common forms of the TTL family are the industrial-grade 7400 and military-grade 5400 series. Some manufacturers have 8000 and 9000 series of TTL devices. There is no relationship between the type of IC function and the last two digits in the IC's identifying number. A 7400 is a quad NAND gate, while a 7490 is a decade counter.

Within the 7400 series, letter designations are often added to further identify the type of IC. For example, the 7400 is a standard four-input NAND gate, but the L in 74L00 identifies the IC as a low-power four-input NAND gate. To get this characteristic, one sacrifices speed. The H in 74H00, on the other hand, tells us that this is a high-power version of the same IC. Its output stage can drive higher current loads and is capable of driving normal loads faster because of its ability to charge the inherent output capacitance at a faster rate.

The 74S00 is a fairly high-power device that is extremely fast because its inputs are clamped by Schottky diodes. These diodes have very fast switching characteristics and thus make the 74S00 series the fastest of the TTL devices. The Schottky diode approach has been combined with the low-power approach to produce the 74LS00 series. The typical 74LS00, for example, consumes very little power, yet it operates at speeds as high as the conventional 7400 device.

Each of the types of TTL devices described above has its place in your circuit designs. Your choice of devices will be dictated by the power and speed requirements of your specific project.

Application. TTL IC's have very good noise immunity characteristics and operate with a good tradeoff in speed. Even so, they must be used with some care in circuit design to minimize interaction between elements. For example, in Fig. 1, gates A and B can suffer from unwanted coupling through the invisible but very real inductance of the common ground lead that ties the two gates to the negative side of the power supply line and the input to buffer C that is not supposed to operate at this time.

When gate A discharges the stray capacitance at its output, an erroneous signal appears because of the ground inductance at gate B. These undesirable outputs are commonly called "glitches." They can be eliminated mostly through proper circuit layout. The way to do this is illustrated in Fig. 2. Here the ground interconnection between the two gates is a "bus" lead.

Assume that gate A in Fig. 2 is a low-power 74L00 series IC and that buffer B is a high-power 74H00 device. As soon as the high-power stage switches on, a high-speed, high-current switching transient is generated and causes a voltage drop through the resistance of the ground or V+ bus. This voltage is applied to the input of the low-power gate, which "sees" it as a real signal. The usual remedy for this situation is to use bypass capacitors directly at the V+ and ground pins of the IC's. Proper circuit layout, however, can minimize glitches in the wiring without the need for bypass capacitors.

An example of bypassing is shown in Fig. 3. Note that there still exists a slight variation in the power supply along the bus and that although the transients (compared to Fig. 2) are almost eliminated by the bypass capacitors, the high current drain will still affect the voltage at one end of the bus. The point to remember in designing TTL circuits, and any other logic system, is that it is best to know what will be the effect of an action taken rather than attempt to make up for inadequacies after the fact.

The best way to lay out a TTL logic system is to use the V+ bus and ground-plane approach. Ideally, it would be best to have all V+ points in the circuit on one side of the board and all ground points on the other side. Unfortunately, circuit considerations dictate otherwise, since interconnections between elements must be made somewhere. However, it is possible to simulate the V+/ground bus approach by using the layout illustrated in Fig. 4. IC's can be

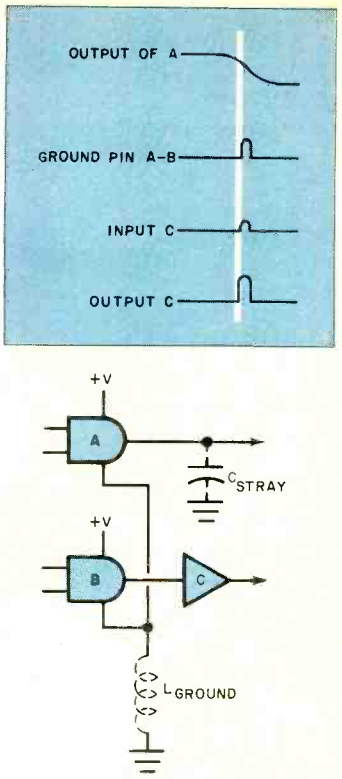


Fig. 1. Common ground inductance and stray capacitance cause "glitch" at output gate of C.

distributed along this bus system. Each of the two buses appears on both sides of the board. It matters little that each bus begins on one side of the board and ends on the other; electrically, each is a continuous bus.

The Fig. 4 approach lessens the effect of distributed capacitance, while the capacitors at the points where the buses cross over through the printed circuit board are adequate for bypassing. If this type of layout is not possible, it is best to locate the ground bus entirely on one side of the board and the V+ bus entirely on the other side of the board.

High-current devices should be located as close as possible to the V+ and ground bus connections. This will assure a minimal effect by these devices on the more sensitive, lower-current devices in the circuit. Bypassing at the input stages will then have greater effect.

Once you have fabricated a pc board for a certain digital function, you may find it necessary to include more than one pc board assembly in your finished system. In this case, each pc assembly must be designed to minimize the inherent stray inductance and capacitance and heavy bus structures should be used to connect the V+ and ground lines to all boards. In some cases, it may even be necessary to use separate ground leads to high-power circuits.

Design Hints. The first step in designing a logic system is to lay it out on paper. The next is to breadboard your layout. While you are breadboarding the circuit, try to use the same physical layout you plan to use in the finished project. This will reduce the chances of any surprises after you etch a pc board and are committed to a given layout.

In the breadboarding stage, there are a few things to keep in mind. The popular "solderless" breadboard has a distinct problem—there is very high capacitance between the interconnecting strips within the socket. At high frequencies and at very fast switching speeds, capa-

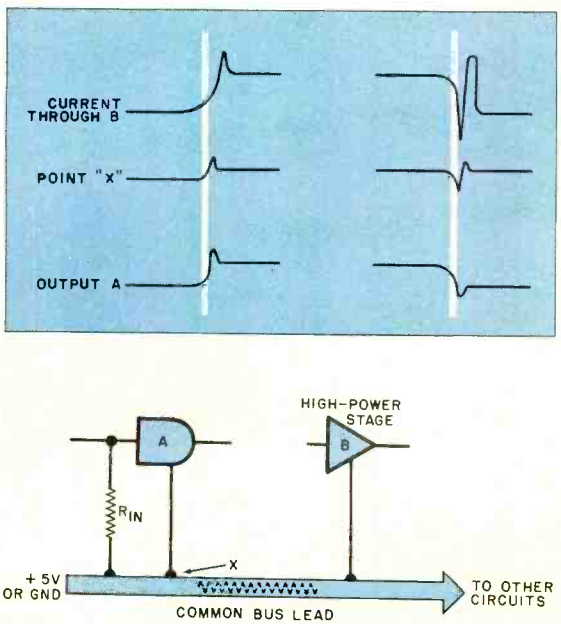


Fig. 2. Both glitch and voltage drop can occur along a common bus lead as shown here.

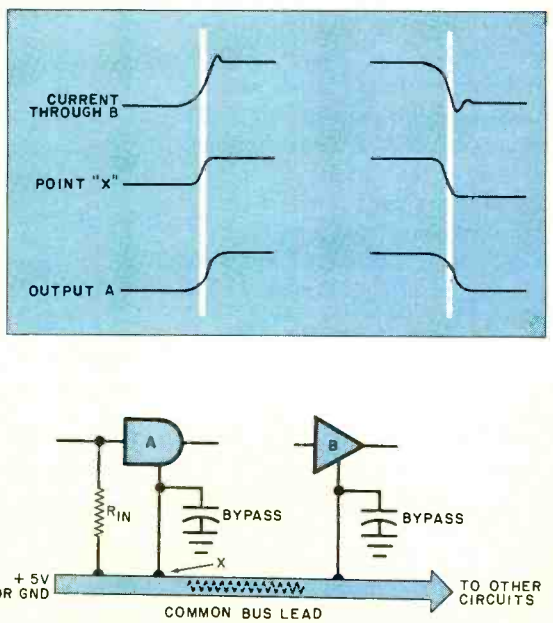


Fig. 3. Bypassing can eliminate glitch but not voltage change which produces erroneous signal.

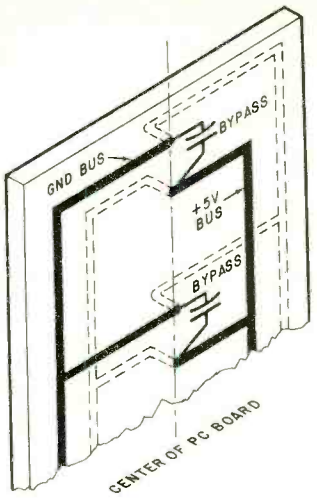


Fig. 4. Ground plane simulation where buses start on one side of board and cross to other side, with bypassing at crossovers.

citive coupling may occur between the closely spaced internal "tracks" or between the holes on the board. Do not use these breadboards for high-frequency circuits. They are, however, adequate for breadboarding low-frequency circuits in which the switching speeds are low.

The last and perhaps most important design stage is to debug the circuit you set up on the breadboard. To do this, you will need certain test equipment, such as an oscilloscope or logic probe. The logic probe is handy to have in cases where your scope has a limited bandwidth that prevents it from registering on-screen fast pulses. Almost any type of multimeter can be used to check for the presence of the proper dc voltages on the various IC pins.

Typical Design. To illustrate the general procedure to use in designing a TTL system, let us work up a six-decade decoder/driver/display system for a 30-MHz frequency counter. Since operation is to 30 MHz, we can use standard 7490 decade counters and 7447 decoder/drivers for the seven-segment LED displays. We will also use separate 5-volt supplies for the display system and IC portion of the circuit.

First, we would start by laying out on paper the basic circuit configuration. Then, we circle the portions of the system that draw high current, as shown in Fig. 5. The areas of highest current demand are the outputs of the 7447 LED drivers and the LED displays, neither of which are required to do high-speed switching. The highest speed device in this circuit is *IC1*, which must operate at frequencies up to 30 MHz. Consequently, this IC must be located at the point of least possible noise and bus glitches. By using independent V+ and ground leads at the input of *IC1*, there is no need for bypass capacitors.

The next step is to breadboard the circuit and debug it. Once this is done, a printed circuit board can be made. An actual pc assembly for this circuit is shown in Fig. 6. Note that the pc board has copper traces on both sides of the board, which eliminates the need for separate wire jumpers to interconnect all points in the circuit.

Closing Remark. As you can see from the foregoing, designing with TTL is relatively easy—if you give careful attention to circuit layout. One way you can get a "feel" for proper design is to experiment with the various types of TTL IC's available at low cost from the advertisers in the back of this magazine. ◇

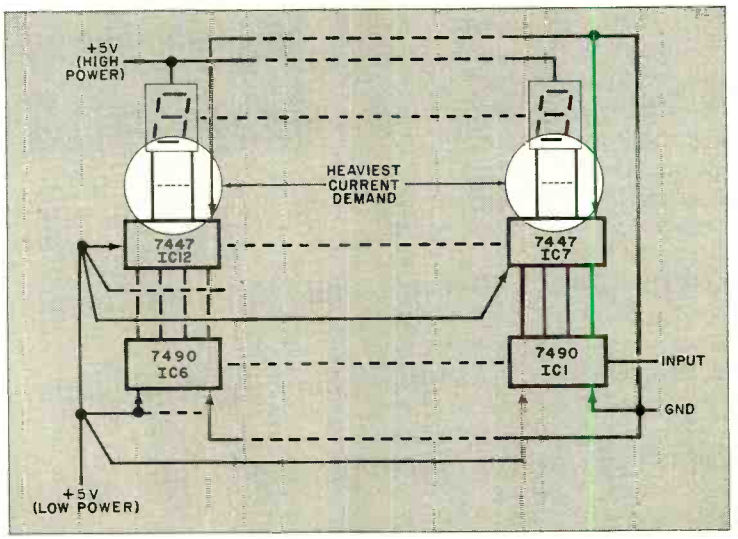
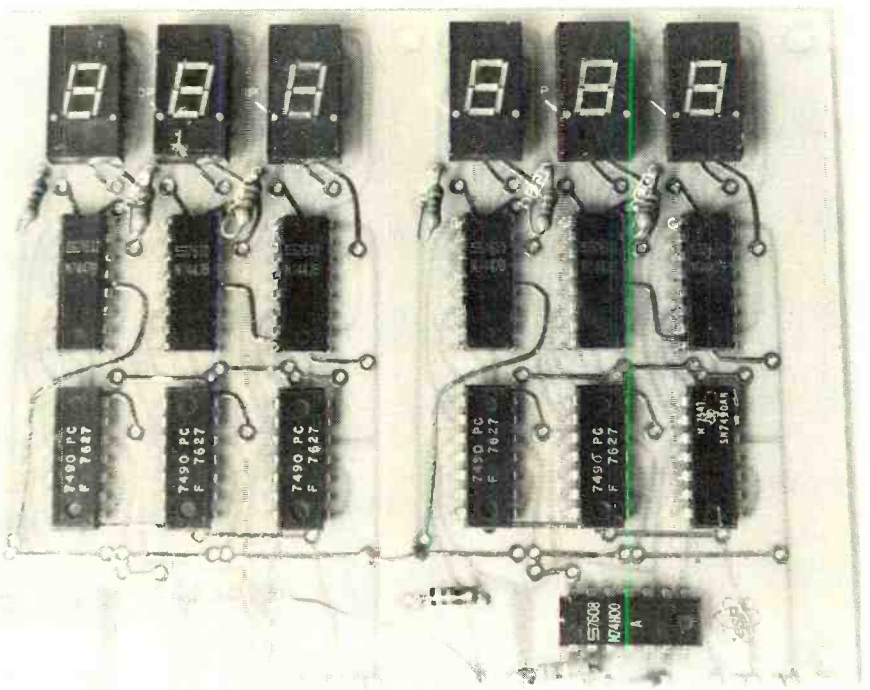


Fig. 5. Sample circuit has independent grounds and supplies to reduce glitches. Circled areas have own supply leads.

Fig. 6. The final layout of the decade counter follows the general outline suggested in Fig. 5.



HIGH SENSITIVITY SWR Meter for Low-Power Communications Equipment

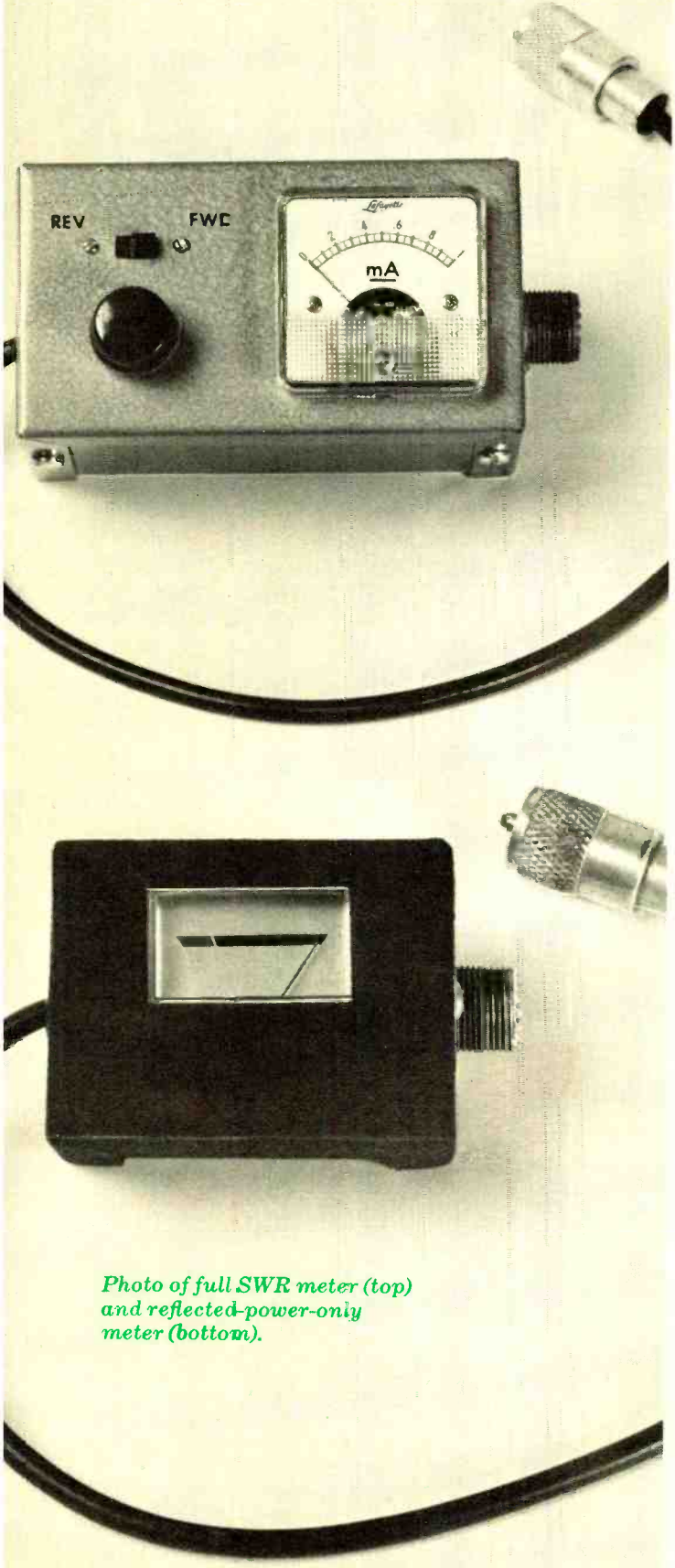


Photo of full SWR meter (top) and reflected-power-only meter (bottom).

Easy-to-build instrument uses a ferrite toroid coil for accurate readings at low power levels.

BY WILLIAM VANCURA

LOW-POWER communications gear such as CB transceivers and amateur QRP rigs have no r-f output to spare. So it's especially important to make maximum use of available power (as well as receive capability) by properly tuning the antenna system. These adjustments are most often made with an SWR meter, such as the instrument described here.

This SWR meter is easy to build and inexpensive. Moreover, it features a ferrite toroid pickup coil to achieve high sensitivity. This makes it possible to get an accurate SWR reading even at low r-f power levels.

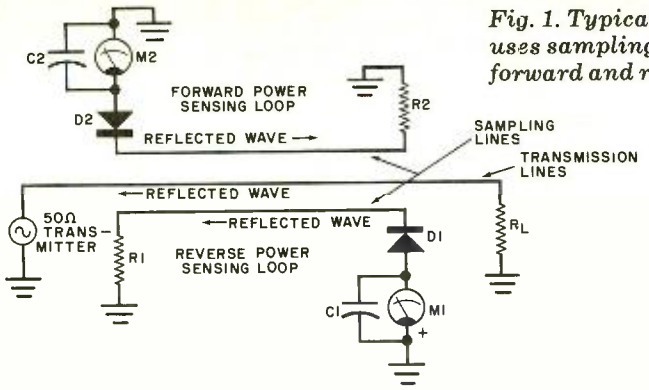


Fig. 1. Typical SWR meter uses sampling lines to detect forward and reflected waves.

How It Works. The SWR meter indicates the relative amplitudes of the forward and reflected waves travelling on the transmission line. (These two combine to create a standing wave.) When the line is connected to a perfectly matched load, no standing wave exists. The forward-going wave will travel down the line and will be completely transferred to the load. A mismatched load, however, will not accept all of the energy from the line. It will reflect a portion back toward the source, causing a standing wave to appear on the line.

The forward and reflected waves must be isolated to effect their measurement. This is done by sampling lines (Fig. 1) that are properly terminated at one end and mismatched at the other. When energy is coupled to a sampling line, the mismatched termination will reflect some portion toward the proper termination, just as the transmission line will. However, the reflection produces a travelling wave on a sampling line, as opposed to the standing wave on the transmission line. This travelling wave corresponds to either the forward or reflected component of the energy on the transmission line.

Figure 1 shows that the two sampling lines are identical except for the physical locations of the matched (resistors) and mismatched (diodes, capacitors, and meters) terminations with respect to the transmission line. The reflected waves on these lines travel from the mismatch to the matched terminations, and are therefore moving in opposite directions. But only one is travelling in the opposite direction of the reflected wave on the transmission line. Thus, reflected waves on the sampling lines are out of phase.

When the reflected waves on a sampling line and the transmission line are moving in the same direction, the reflected component on the sampling line is reinforced and the forward component is cancelled. This occurs in the reverse power sensing loop, and *M1* will display the relative magnitude of the reflected wave on the transmission line. When the reflected waves are travelling in the same direction, the reflected component is cancelled, leaving the forward wave for display by *M2*

In this project, a toroid coil is used in place of the sampling lines, greatly simplifying construction and increasing sensitivity as compared to standard "trough line" designs. Two SWR meter configurations are presented. The first, shown schematically in Fig. 2, is the simpler of the two. It is intended for CB applications where the only requirement is to measure SWR on a line with a fixed input power of four watts. The meter reads only reflected power. A zero indication suggests a perfect match, and any reading above half scale points to a bad mismatch that should be corrected.

The second configuration (Fig.3) is more flexible, containing a switch and a sensitivity control to allow measurements of both forward and reflected power. It is more at home in amateur operations where power levels are commonly varied. To obtain a meaningful reading, the sensitivity control must be adjusted each time the meter is used.

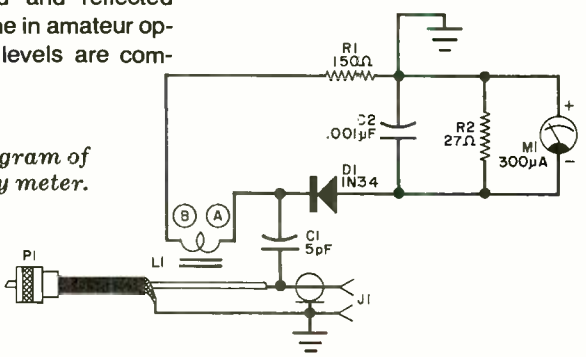


Fig. 2. Schematic diagram of reflected-power-only meter.

Construction. Decide which circuit you will build, and select a suitable meter for *M1*. The one used in the author's reflected-power-only prototype is a 300-μA meter, while the meter in his full-SWR prototype has a 1-mA movement. Any meter from 50 μA to 1 mA can be used with good results. The project should be housed in a metal enclosure just large enough to accommodate the meter, switch, potentiometer (if used) and SO-239 coaxial connector. A 4" x 2⅛" x 2⅛" (10.2 x 5.4 x 5.4 cm) aluminum utility box can be used for the full-SWR meter.

Attach a PL-259 connector to one end of an 18-to-36-inch (45.7-to-91.4-cm) length of RG-58-U cable. Remove 1" (2.54 cm) of the cable's black vinyl outer jacket, and comb out the exposed braid. Twist the combed braid to form one large stranded conductor. Then remove ¼" (6.4mm) of the insulation around the inner conductor. Drill a hole on one side of the enclosure to accommodate the coaxial cable. Mount a rubber grommet in the hole and push the coax through it. Drill holes for an SO-239 coaxial connector on the opposite side of the enclosure and mount the connector and a solder lug as shown in Fig. 4.

Pass the inner conductor through a ferrite toroid (see parts list) before soldering the coaxial conductors to the con-

PARTS LIST

C1—5-pF, 500-volt disc ceramic or silver mica capacitor
C2—0.001-μF, 500-volt disc ceramic or silver mica capacitor
D1—1N34 or 1N914 diode
J1—SO-239 coaxial connector
L1—Two turns of No. 26 enamelled copper wire on a Fair-Rite Products Corp. 638MT-L (No. 5963000301) ferrite toroid. See note.
M1—300-μA or 1-mA meter (see text)
P1—PL-259 coaxial connector
R1—150-ohm, 10%, ½- or¼-watt carbon composition resistor
R2—27-ohm, 10%, ½- or ¼-watt carbon composition resistor *OR* 100-ohm trimmer or panel-mount potentiometer (see text)
S1—DPDT switch
Misc.—RG-58-U coaxial cable, No. 26 enamelled copper wire, insulated sleeving, solder lug, terminal strip, suitable enclosure, rubber grommet, machine hardware, solder, etc.
Note: Ferrite toroids for *L1* are available for $1.00 each from William Vancura, 4115 35th Ave., Moline, IL 61265. Include a stamped, self-addressed envelope.

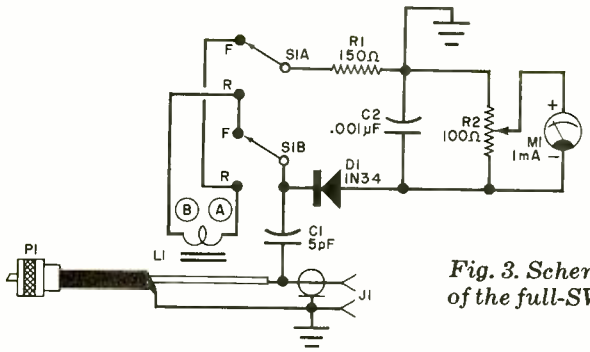


Fig. 3. Schematic diagram of the full-SWR meter.

nector and solder lug. Prepare a 6" (15.2-cm) length of No. 26 enamelled copper wire and wrap two turns around the toroid *exactly* as shown in Fig. 4. Mount the meter (and switch and potentiometer, if used) on the front of the enclosure. Follow the appropriate schematic (Fig. 2 or Fig. 3) and wire the circuit, using the switch lugs and meter terminals as tie points. You can also use a terminal strip to provide circuit tie points and mechanical support for components. Use insulated sleeving, if necessary, to prevent accidental shorting between leads, and keep all leads as short as possible. Be sure to scrape ¼" (6.4 mm) of enamel from the end of each lead of the pickup coil before soldering. Observe the lead designation in Fig. 4 when soldering these leads to the rest of the circuit.

Testing the Meter. Fashion a dummy load by soldering a 50-ohm, 2-watt carbon resistor between the inner and outer conductors of a PL-259 coaxial connector. Insert the dummy load into the SO-239 connector on the meter enclosure, and attach the PL-259 on the length of cable from the meter to the antenna output jack of the transmitter or transceiver. Then close the PTT microphone switch or telegraph key.

If you built the full-SWR meter, switch *S1* to the FORWARD position, adjusting *R2* for a full-scale reading. Then switch *S1* to the REVERSE position. The meter needle should barely move, if at all. If you built the reflected-power-only meter, key the transmitter briefly. Similarly, the meter needle should barely move, if at all. Do not apply r-f to the dummy load for more than a few seconds, however, to avoid overheating.

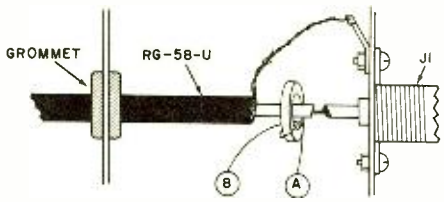


Fig. 4. Detail of toroid coil.

Replace the dummy load resistor with an 18-ohm, 2-watt carbon component. Key the transmitter briefly. The meter should read about half-scale. If the full-SWR meter was built, recalibrate by adjusting *R2* for full-scale FORWARD deflection before taking a REVERSE reading. If the reflected-power-only meter was built—and a meter movement other than 300 μA used—consult Fig. 5. A small trimmer potentiometer is included in this alternate meter wiring to compensate for different movement sensivitities. Reverse toroid leads *A* and *B*, and adjust *R2* for full-scale deflection as the transmitter is keyed. Then reverse leads *A* and *B* once more, taking care not to disturb the setting of *R2*.

Using the Meter. The SWR meter will not read SWR directly, but will indicate the reflection coefficient ρ. The SWR is related to ρ by the equation $SWR = (1 + \rho)/(1 - \rho)$. The following is a list of various values of ρ and SWR.

Reflected Meter Reading (% of full scale)	SWR
0	1:1
10	1.22:1
20	1.5:1
30	1.85:1
33⅓	2:1
40	2.33:1
50	3:1
60	4:1
66⅔	5:1
70	5.66:1
80	9:1
90	19:1
100	∞

If desired, a new scale for the meter can be drawn and glued onto the faceplate to read SWR directly. At any rate, a reading of 25% of full scale (SWR 1.7:1) or less means the antenna is closely matched to the transmission line. Readings greater than 33⅓% of fullscale (SWR 2:1) indicate a mismatch that should be investigated.

In practice, the short length of coax from the SWR meter is connected to the antenna output jack on the transceiver, and the feedline from the antenna is connected to the coaxial jack on the meter enclosure.

Antenna Tuning. The SWR meter can be used to adjust a CB antenna for resonance. Antenna tuning should be done in a clear, open area, away from any substantial metallic objects. Keep your hands and tools away from the antenna when checking the SWR. Connect the meter to the transceiver and the antenna, and momentarily key the transmitter at both edges of the band (channels 1 and 23 or 1 and 40, depending on your transceiver's capabilities). Note the meter readings.

If the needle stays below 25% of full scale at both band edges, the antenna is

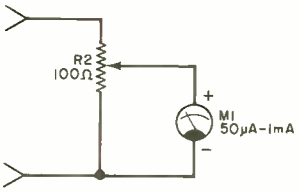


Fig. 5. Alternate meter wiring.

already properly tuned. A reading at the band center (channel 13) should show an even smaller meter deflection. When the meter reads above 25% at either end, the antenna is either too short or too long. If the deflection is greater at channel 1, the antenna is too short. A larger meter reading at channel 23 or 40 implies that the antenna is too long.

Most mobile CB antennas have provisions (usually a set screw) for length adjustment. Loosen the set screw and shorten or lengthen (whichever is required) the antenna by about ¼" (6.4 mm). Take new readings at the band center and edges. Continue this procedure until an acceptable match exists across the band. Most loaded antennas are very sensitive to length adjustments, especially when they are near resonance. Accordingly, determining the "right" setting requires patience.

Some full-size antennas don't have a length adjustment and will have to be cut to resonance. *Never* cut off more than ¼" at a time—you can't lengthen a short antenna! Remember that it's not absolutely necessary to have a 1:1 SWR. You will rarely achieve this ideal in practice. In fact, you won't measure much under 2:1 with mobile miniwhips. Thus, your antenna adjustments goal should be for a tolerable *minimum* SWR. The high sensitivity of this SWR meter project will pinpoint this reading with high accuracy. ◇

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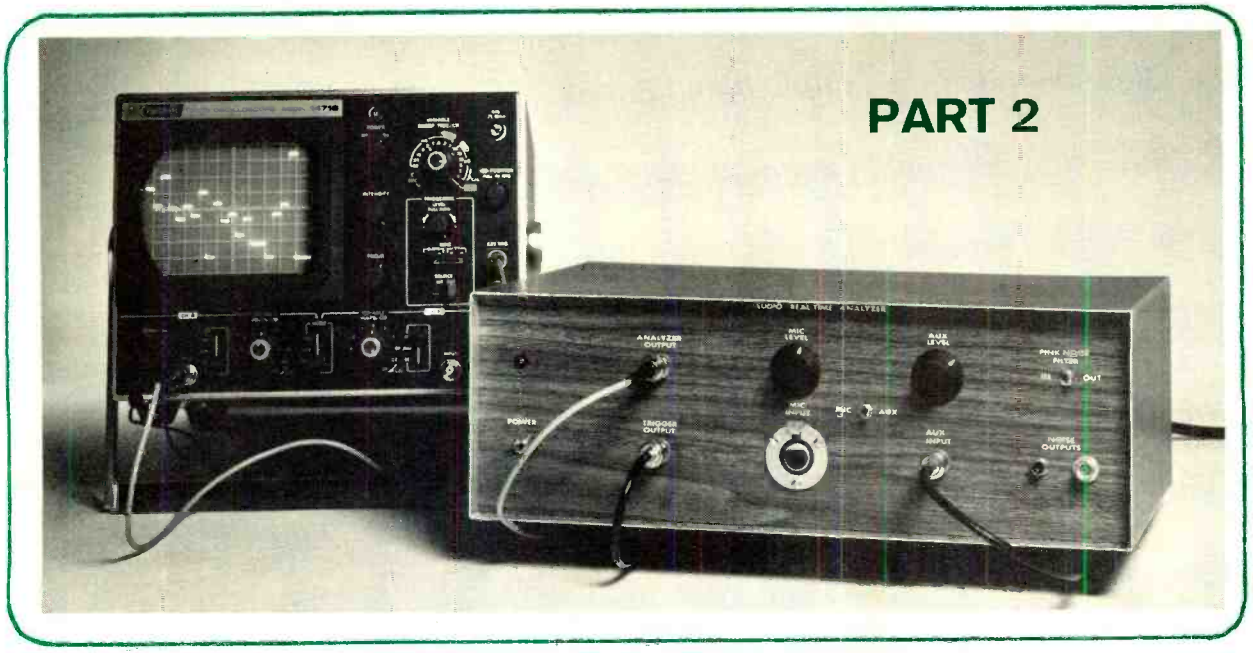


Test and calibration procedures, typical applications and how to add an optional logarithmic converter.

BY BOB JONES AND RICHARD MARSH

LAST month, we discussed the circuitry of the Real Time Analyzer, examined overall system operation, and presented construction details. Now we'll describe the optional Logarithmic Converter and outline test and calibration procedures. Also, typical applications for the Analyzer will be suggested.

The Log Converter, shown schematically in Fig. 11, is a useful accessory which allows display of amplitude variations on the scope directly in dB. The heart of this linear-to-logarithmic converter is *IC36*, a 76502 integrated circuit. One half of *IC35A* is used as a buffer for log converter *IC36*. This buffer is powered by a bipolar 5-volt supply, so its output (and thus the input to *IC36*) is limited to +5 volts maximum. The ORIGIN ADJUST control (*R144*) and op amp *IC35B* determine the amount of dB per division of scope display. Stages *IC37A* and *IC37B* provide gain and rectification, respectively. The rectifying action of *IC37B* prevents any negative voltages from reaching the scope's vertical input. However, "negative" outputs are generated by *IC36* whenever its input signal drops below the ORIGIN level.

Power for the log converter is derived from the RTA, with zener diodes *D26* and *D27* providing the required ±5 volts dc. Etching and drilling and parts placement guides for the log converter pc board are shown in Fig. 12. Use IC sockets or Molex Soldercons to facilitate installation of the integrated circuits. Pay attention to pin basing and polarities.

Tests and Calibration. With all IC's removed from their sockets (except the voltage regulators), plug the line cord into a wall socket and close *S2*. Measure the following regulated dc voltages: +5 volts across *C112*; −15 volts across *C111*; +15 volts across *C110*. Then see if *LED1* lights. If not, check the polarity of the LED. If all is well, turn off the ac power and insert all IC's.

If you are installing the optional log converter, perform the following steps (1) through (7). Otherwise, they can be bypassed.

(1) Decide how many dB/division you want displayed on the scope, and determine how many dB will be shown in a full-scale deflection. For example, if the vertical scale of the scope is 6 cm and 4 dB/cm is desired, 24 dB will be displayed full-scale.

(2) Calculate the origin voltage. (See Table II.) The maximum permissible input to the log converter chip (*IC36*) is one volt. In our example, −24 dB referenced to one volt is 0.063 volt.

(3) Apply 0.5 volt dc across the converter input and adjust *R140*, the INPUT LEVEL control, so that the voltage at *TP1* equals the calculated origin voltage.

(4) Adjust *R144*, the ORIGIN ADJUST potentiometer, for zero volt (±0.1 volt) at *TP2*. This is a sensitive adjustment.

(5) Increase the dc voltage applied across the input to 1.5 volts. Then adjust *R140* so that 1.0 volt appears at *TP1*. Monitor the converter output on your oscilloscope and adjust *R148*, the SLOPE ADJUST control until full-scale deflection of the scope trace occurs. Set the scope's vertical sensitivity to whatever value is most suitable for adjustment.

(6) Repeat steps (3), (4), and (5) until all adjustments are correct.

(7) Adjust the INPUT LEVEL control, *R140*, so that the signal voltage at *TP1 never* exceeds one volt. The RTA's maximum level reference (which appears at the Analyzer output at clock pulses 23 and 24) is 10 volts. You can use this as the signal applied to the converter input for this adjustment. But be sure to back down on *R140* before you apply 10 volts at the converter input. When *R140* is properly adjusted, the 10-volt reference from the RTA will cause full-scale deflection.

Next, adjust all LEVEL ADJUST controls (*R75* through *R94*) on the filter boards to

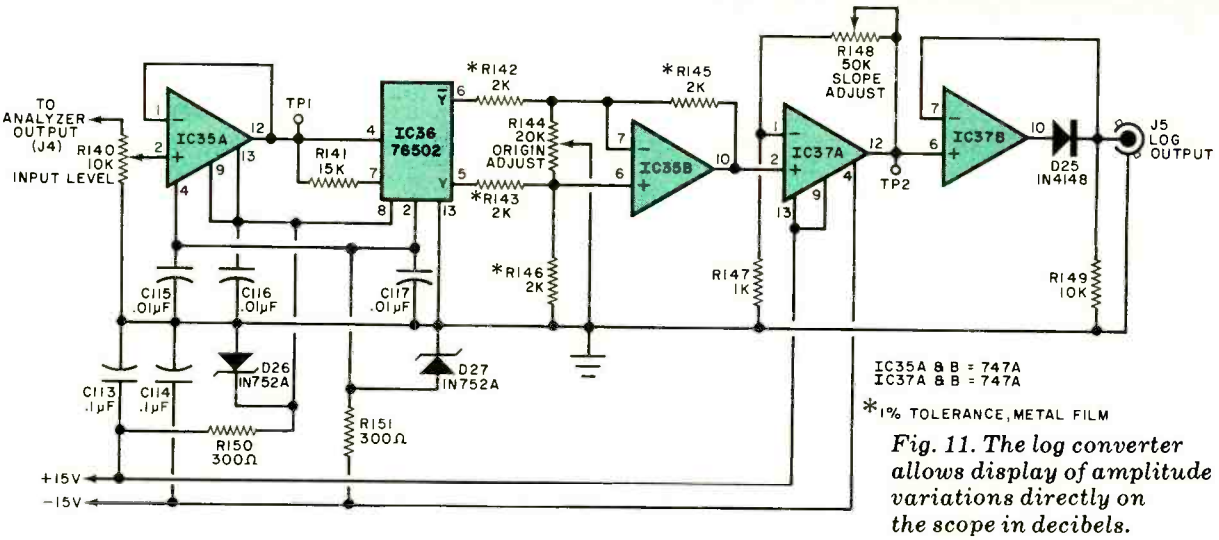


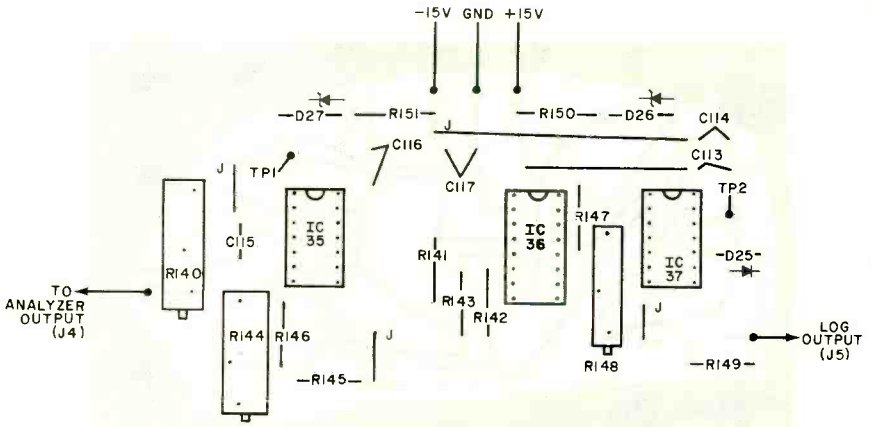
Fig. 11. The log converter allows display of amplitude variations directly on the scope in decibels.

LOG CONVERTER PARTS LIST

C113, C114—0.1-μF, 50-volt disc ceramic capacitor
C115 through C117—0.01-μF, 50-volt disc ceramic capacitor
D25—1N4148 silicon diode
D26, D27—5.6-volt, 4-watt zener diode (1N752A, HEP Z0212 or equivalent)
IC35, IC37—LM747A dual operational amplifier IC
IC36—SN76502 linear-to-logarithmic converter IC (Texas Instruments)**
J5—BNC connector
The following fixed resistors are 5% tolerance, carbon composition components.
R141—15,000 ohms, 2 W
R147—1,000 ohms, 2 W
R149—10,000 ohms, 2 W
R150, R151—300 ohms, 4 W
The following fixed resistors are 1% tolerance, 1-watt metal film components
R142, R143, R145, R146—2000 ohms
The following resistors are multi-turn, 6-watt Cermet trimmer potentiometers (Spectrol type 43Y or equivalent).*
R140—10,000 ohms
R144—20,000 ohms
R148—50,000 ohms
Misc.—Printed circuit board, IC sockets or Molex Soldercons, hookup wire, pc board spacers, coaxial cable, machine hardware, solder, etc.
Note: The following is available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216: etched and drilled pc board LC-2b for $3.25 ppd.
*Available through distributors such as Allied Radio or Newark Electronics.
**Consult a Texas Instruments local distributor or sales representative.

their maximum or full clockwise positions, and all Q ADJUST potentiometers to their minimum or full counterclockwise positions. Apply ac to the RTA by closing *S2*. Connect your dc-coupled oscilloscope to the RTA output. Set the front panel AUX LEVEL potentiometer to its full clockwise position. Adjust the scope's vertical sensitivity for approximately ⅔-scale display of the 10-volt reference signal from the RTA. Place *S1* in the AUX position, and apply a 0.1-volt rms, 22.4-Hz sine wave to the AUX input.

Adjust *R15* (the Q ADJUST potentiometer for filter one) until an increase in dc level occurs. (There may have already been a dc level at the RTA output if there was an offset at *IC31*.) As the control is



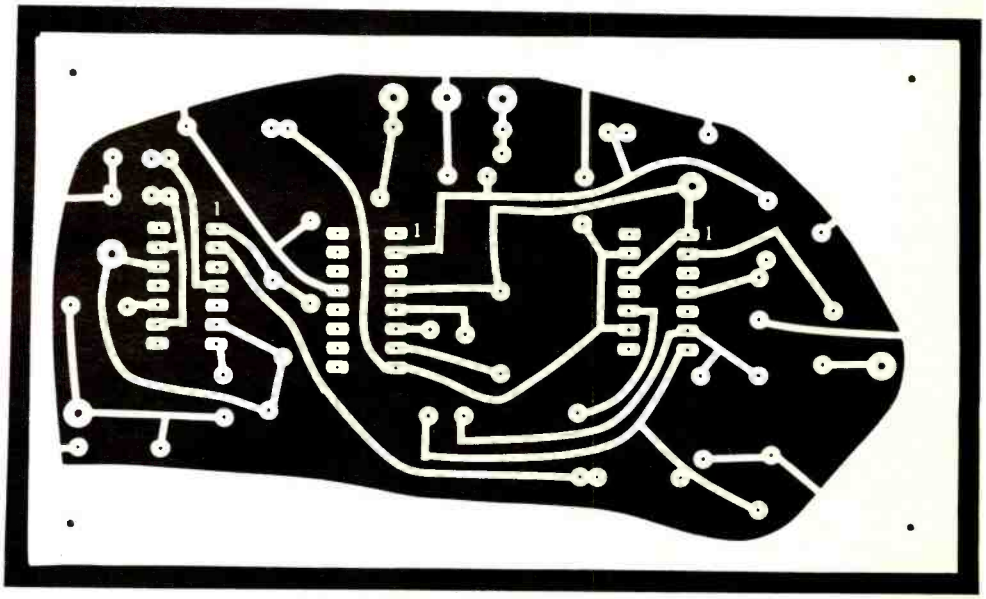


Fig. 12. Etching and drilling guide for the pc board is at right. Component layout shown above.

further adjusted and filter Q increased, the dc level will rapidly increase. Eventually, if the Q is set to high, the filter will break into oscillation. When you notice the increase, retune the sine-wave oscillator for a peak dc reading. Read the frequency off the oscillator control dial or with a frequency counter. This is the true center frequency of the filter. It may be somewhat different from the calculated f_C due to component tolerances.

As the Q increases, it will be more difficult to locate the center frequency. The band-pass slope will become very steep, so vary the oscillator frequency very slowly to be sure you are on the very top of the filter peak. Note the voltage level on the scope and adjust the vertical position control so the trace is at some convenient reference position. Retune the oscillator so that it is one-quarter octave above the center frequency you have just measured. The output voltage should decrease.

TABLE II—SELECTING LOG CONVERTER ORIGIN POINT

Total cm on Scope Face	dB/cm Desired	Total dB	Origin Voltage (volts)
10	2	20	0.100
10	3	30	0.031
8	3	24	0.063
8	4	32	0.025
6	4	24	0.063
6	3	18	0.126

Origin volts = 1/antilog(total dB/20)
Example: Scope has 6-cm vertical scale.
4 dB/cm desired yields 24 dB total.
Origin volts = 1/antilog (24/20)
= 1/antilog 1.2 = 1/15.8
=0.063 V or 63 mV

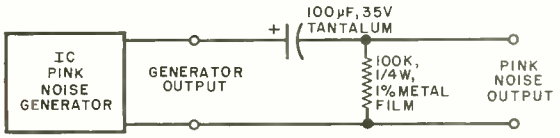


Fig. 13. Modifying the IC pink noise generator for use with the RTA.

Now, adjustments will be made so that the output will be more than 12 dB below that at the center frequency. The ideal value is −18 dB, but it is more critical to adjust the filter for the necessary response. Also, it will then be close to oscillating or ringing when excited by a steep input signal.

Alternately set the oscillator output frequency to the center frequency of the filter and at a frequency one-quarter octave away. Each time you retune the oscillator, trim the Q ADJUST potentiometer to obtain the desired response. You will find that varying this control will change the center frequency gain. Therefore, be sure to reset the center frequency output level to your reference position and/or note the new level. Keep in mind that −12 dB is 0.251 times the center frequency output level, −14 dB is 0.199, −16 dB is 0.159, and −18 dB is 0.128. When the first filter is properly adjusted, move on to the next and repeat the procedure for each remaining filter.

If the log converter has been installed and calibrated, you can use the calibrated dB (vertical) scale on your oscilloscope. Adjust the center frequency output level to equal the maximum reference level at bands 23 and 24 on the right side of the scope trace. Then tune half-way toward the next filter's center frequency and trim the Q for −12 to −18 dB as read directly on the scope. Try to adjust all filters to the same Q or bandwidth, preferably at −18 dB.

Next, the filter output LEVEL ADJUST potentiometers will be trimmed. The best way to do this is to apply pink noise to the AUX input and set the LEVEL ADJUST controls (*R75* through *R94*) to obtain a flat, horizontal scope trace. You can use the pink noise generator which appeared in the July 1977 issue of POPULAR ELECTRONICS, or one of the test records available which have a pink noise cut. If you use the pink noise generator, you must add a high-pass filter (a 100-μF tantalum capacitor and a 47,000-ohm resistor) as shown in Fig. 13. This filter will block the 8.5-volt dc level at the noise generator output, but its cutoff frequency is so low that the spectral content of the pink noise will not be disturbed.

If you don't have a pink noise generator or a suitable test record, here's a "ballpark" adjustment procedure. Find the one-half octave filter center frequency with the *lowest* output level and adjust the other filter output levels so they equal this minimum. (The variation in filter gain is partly due to the roll-off at high frequencies of the operational amplifiers' open-loop gains.)

Using the RTA. Now that you've built the RTA, how is it used? First of all, you will need a signal or sound source. This can be a frequency-swept oscillator or a wideband noise generator. There are two types of wideband noise. White noise is defined as having equal energy at all frequencies, and is thus represented on a frequency vs. amplitude plot as a straight horizontal line. Pink noise, on the other hand, is wideband noise with an amplitude characteristic that decreases 3 dB per octave.

This Analyzer is a "constant percentage bandwidth" type. That is, the bandwidth of each filter is an unchanging percentage of its center frequency. This implies that, as the center frequency increases, so does the bandwidth. If a white noise input is applied to the RTA, the "flat" signal will show a rising amplitude characteristic (see Fig. 14) as the multiplexer samples the output of higher-frequency filters. However, pink noise has a complementary decreasing characteristic (−3 dB/octave) that produces a flat display on the scope. Pink noise also more closely approximates the energy distribution of natural sounds, and thus is a more accurate source for measurements.

You will also need a microphone to pick up the sounds you want to analyze. (A microphone stand or camera tripod is very useful.) One microphone characteristic that must be known is its random-incidence response. This describes the output signal voltage generated by the

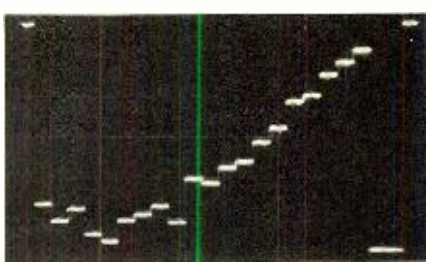


Fig. 14. Typical RTA output on a dc-coupled oscilloscope when "semi-white" noise from an FM tuner is applied to the Analyzer.

microphone when it is placed in a diffuse sound field—the most common type due to the effects of nearby reflecting surfaces. In such a field, the flow of sound energy in any direction is (almost) equally probable.

Several companies, such as General Radio and Bruel & Kjaer, supply microphones with flat random-incidence response, as well as flat 0° (perpendicular) or flat grazing (90°) incidence responses. These measurement microphones are omnidirectional. Unfortunately, most other manufacturers only supply the on-axis (0° incidence) responses of their omnidirectional microphones. This is fine if you want to perform, say, loudspeaker measurements when most of the sound comes from one direction—in the outdoors or in an anechoic chamber. Otherwise, the random-incidence response should be known.

For a high quality, wide bandwidth, omnidirectional microphone, the 70°-incidence response closely approximates the random-incidence response. Suitable dynamic measurement microphones include the AKG Model D160E (calibration curve $10 extra), the Beyer Model 101 (calibration curve included), the Electro-Voice Models RE55 and 654A (calibration curves $15 extra), the Shure Model SM76 (no charge for calibration curve) and the Sennheiser Model MD 21N (calibration curve $1 extra).

Experience has shown that rooms are best equalized first by employing acoustic methods, followed by graphic equalizer adjustments. For example, you should first try repositioning the loudspeakers, modifying the absorption coefficients in the room, and adjusting the loudspeakers' crossover level controls. Only after these steps are taken should you begin to compensate with the equalizer.

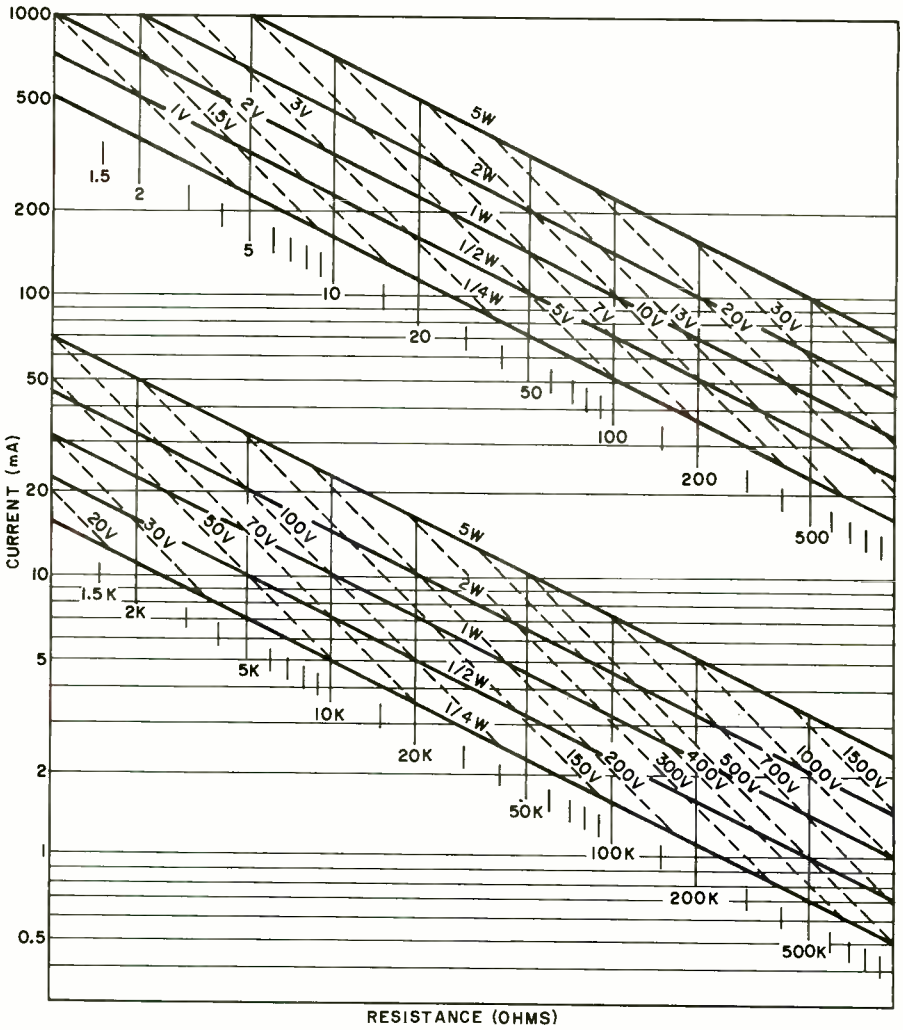
Most often, a lack of deep bass and extreme highs will show up on the scope trace. This is usually due to the limitations of dynamic drivers, and is less severe when sub-woofers and electrostatic or piezoelectric tweeters are employed. Don't use your equalizer to try to force flat response at these audio extremes. The results of such attempts frequently include overloaded amplifiers, excessive distortion, and blown voice coils. Remember—equalization should be used only as a last resort, and must not be used with a heavy hand.

There are many other uses for the RTA, as mentioned earlier. Avenues of RTA-aided research include noise pollution analysis, psychoacoustics, and circuit design. ◇

A POWER NOMOGRAPH

BY MARK L. McWILLIAMS

THE NOMOGRAPH shown here can be quite a time saver when designing and/or breadboarding a circuit. It shows at a glance the maximum resistance required to safely pass a given current as well as the minimum resistance required for a given voltage drop to be applied safely across it. In addition, the nomograph tells what the wattage rating for a given resistor should be, given the voltage and current.

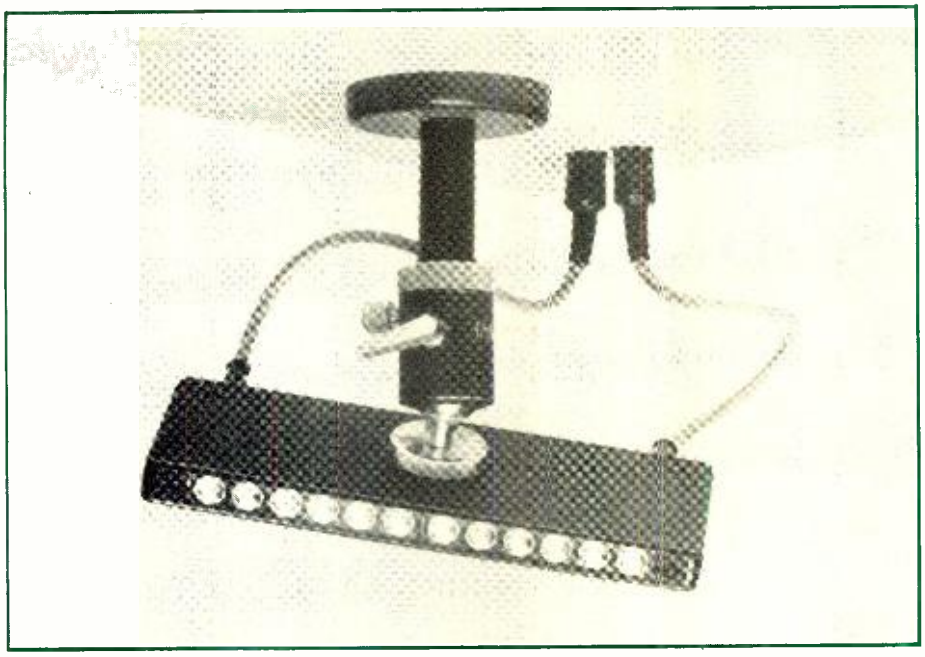


The nomograph is used as follows. Assume a 10-mA current is to be passed through a ½-watt resistor. Referring to the nomograph, we can see that the maximum allowable resistance is 5000 ohms. This would be a 50-volt drop across the resistor. Using another example, if 100 volts were to be applied across the ½-watt resistor, we can see that the minimum allowable resistance must be 20,000 ohms. This means that 5 mA of current would flow through the 20,000-ohm resistor at 100 volts.

Other combinations of voltage, current, resistance, and power rating, keeping two figures constant and determining the third figure, are possible.

The seemingly linear plot of the nomograph can be explained by the fact that the plot is made on log-log paper. From Ohm's Law, $P = I^2R$ (P is power in watts, I is current in amperes, and R is resistance in ohms). Hence, I versus R on log-log paper is a straight line with a slope of $-\frac{1}{2}$. This greatly simplifies plotting and makes it easy to use the nomograph in calculations. ◇

Infrared Systems for Wireless Stereo



Siemens infrared radiator for ceiling mounting.

IR technology and how receivers and transmitters are used in audio.

BY ARTHUR MAKOSINSKI

UNTIL a couple of years ago, infrared communication devices were almost unheard of in high-fidelity electronics. Then, the availability of relatively inexpensive IR light-emitting diodes that could be conveniently and easily amplitude, frequency, or pulse modulated started manfacturers on a whole new line of audio products for hi-fi. With the introduction of the first IR products, a heretofore untapped area of electronics technology began to create a revolution in hi-fi listening.

In this article, we will briefly discuss the history of IR communication and the devices that made it possible. Then we will detail some of the audio IR products that have been developed and marketed during the past two years.

A Brief History. Experiments in data transmission and communication using light beams can be traced back to 1880 and Alexander Graham Bell. But modern work in this area has been concentrated mostly on the use of infrared radiators in line-of-sight communication systems. Early experimental infrared data transmission and voice communication suffered from complexity and high cost insensitive IR detectors and inefficient radiators that often had to be liquid-helium cooled.

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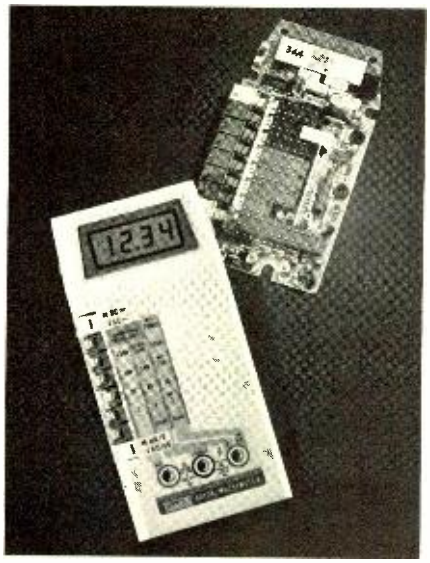

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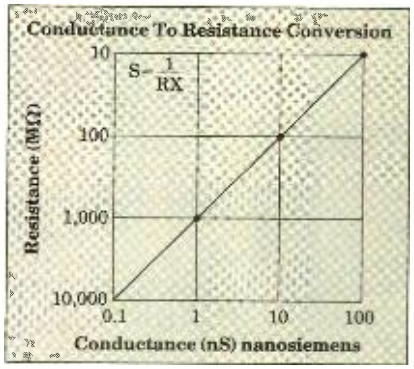

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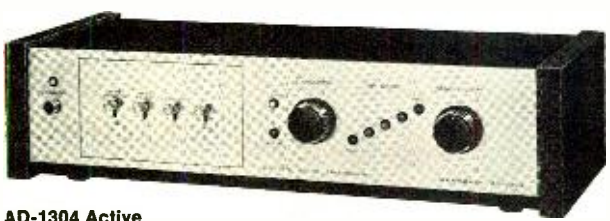

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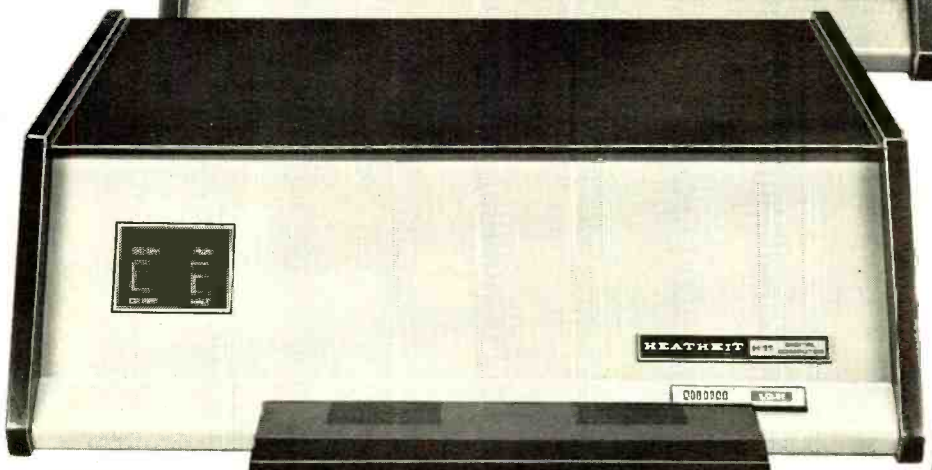

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CIRCLE NO. 5 ON FREE INFORMATION CARD

The new era dawned with the development of an infrared laser but only as far as the scientific community was concerned. What was perhaps an even greater step forward was the development of inexpensive light-emitting diodes. Here at last was a relatively inexpensive source of stable infrared radiation that could be powered even by a D cell. Even more important is the fact that a LED can be conveniently amplitude, frequency, or pulse modulated.

With the appearance of the IR LED in 1963, sophisticated infrared line-of-sight communicators soon became available. Then, starting in about 1975, commercial IR communication devices that are not restricted to line-of-sight communication became available. These devices use modulated and diffused IR radiation fields as information carriers. As a result, these nondirectional communicators created an alternative to the use of radio frequencies for short-range communication and control systems. They also made possible the new concepts being applied to hi-fi products.

IR LED Radiators & Detectors. Almost any type of IR LED can be used as a radiator for communication purposes. Two important factors about IR LED's that should be borne in mind are the radiant output power, which is the radiated output at a given fixed dc power level, and efficiency. The Texas Instruments TIL32 IR LED, for example, has a 1.2-mW radiant output power and a 5% efficiency. This LED, therefore, requires 24 mW of input power.

Like most other IR LED's, the TIL32 can be switched at rates approaching 1 MHz and radiates at a wavelength of 940 nanometers (nm). Many other IR LED's available today are capable of much greater radiated output power, a few of which exceed the 200-mW mark. If greater powers are desired, single-diode laser LED's that can be pulsed at powers approaching 100 watts are available. The drawback here, however, is that the duty cycle is 0.1% or less, making the average radiated output power quite low. Furthermore, if a laser LED is to be used in a diffused IR system, some optical means for spreading the light must be used for the system to work properly.

Over the years, as the applications of IR widened, many different types of detectors for the radiation were developed. They range from simple thermocouples to exotic gold-doped germanium detectors that must be operated at cryogenic temperatures.

The two most practical and accessible detectors for communication purposes are the reverse-biased silicon solar cell and the PIN photodiode. Reverse-biasing a silicon solar cell minimizes the effect of large junction capacitance. By maintaining the input impedance of the detector circuit at a low value, a bandwidth of 1 MHz can be achieved for a cell with an area of 1 cm^2.

The PIN photodiode is a far more sensitive detector than the solar cell. It is also capable of much wider bandwidths. One such photodiode is the Siemens BPW34, which has an effective area of 9 mm^2, less than 40 pF of capacitance when reverse biased, and a cost of approximately $4.00. Its sensitivity peaks at 850 nm, which is conveniently within the radiation spectrum of modern infrared LED's.

Since its introduction in early 1975, the BPW34 photodiode has sparked a great deal of interest in the European electronics industry and has been responsible for the introduction of several new consumer products. Late last year, Siemens introduced the BP104, which is specially made for IR communication applications and features lower capacitance to facilitate higher receiver frequencies that are necessary for stereo reception. It also has its own built-in infrared color filter.

New Applications. As early as May 1975, Zenith Radio Corp. published information on a projected infrared wireless speaker system for its new 4-channel hi-fi system. Though the two front speakers in this system were to be connected to the amplifier by the usual wires, the two rear speakers were to be completely independent, consisting of separate IR receivers, power amplifiers, and speakers. Super-wide-band transmission of IR radiation served as the communication link.

In the Zenith system, a single IR LED on the transmitter generated a beam that was focused by a lensing system on a solar cell 30' (9 m) away. The solar cell was connected to a simple pulsecounting receiver on the rear of the speakers. A signal-to-noise ratio (S/N) of greater than 85 dB and a distortion of less than 1% were achieved with this simple but high-quality communication system.

In the latter part of 1975, Sennheiser introduced to the European market its Model MDI 416 wireless infrared headphones. Not much larger than a stethoscope, the headphones house an IR FM receiver with built-in sensor, volume control, NiCd cell and charger. It sold for less than $100. The companion Model S1406 IR transmitter could be driven by any audio source. Sennheiser has also focused its sales of IR devices on wireless TV sound devices. Both the headphones and TV-sound systems were introduced in the U.S. in 1976.

As the infrared technology was gathering momentum, European manufacturers like Grundig, Philips, Normende, Lowe-Opta, and Telefunken, began installing permanent IR radiators in their TV receivers. This offers the buyer a private wireless sound option.

Beyer's Model IE 76 is a compact IR receiver that can be hung from the user's neck and connected to existing headphones. The small Model 1S76 IR transmitter can accommodate any audio source. The system is rated to provide a low 1.5% distortion figure.

The Model DT444 Infraphone is another Beyer IR product. It contains the entire IR receiver, plus batteries, in a pair of headphones. AKG has a similar receiver housed in a modified version of its Model K140 headphones. Its Model G-20 wL companion transmitter can also be connected to line or speaker outputs and provides 100 mW of radiated power and a 30-to-12,500-Hz bandwidth.

Recently, a number of sophisticated FM infrarec TV remote control systems and coded garage-door openers have shown up on the European market.

IR Transmitters and Receivers. Low frequencies are used as carriers for diffused-field FM transmissions in the IR medium. This is because of the capacitance limitations of the broad-area PIN

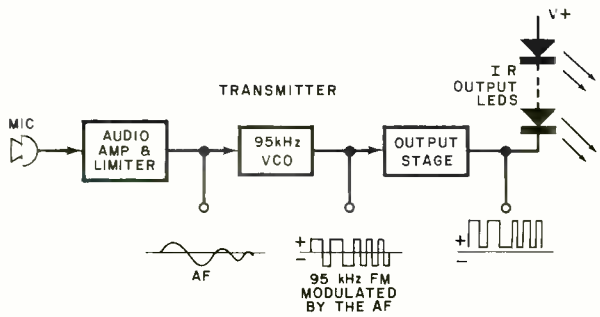

Fig. 1. Typical IR transmitter uses multiple output LED's.

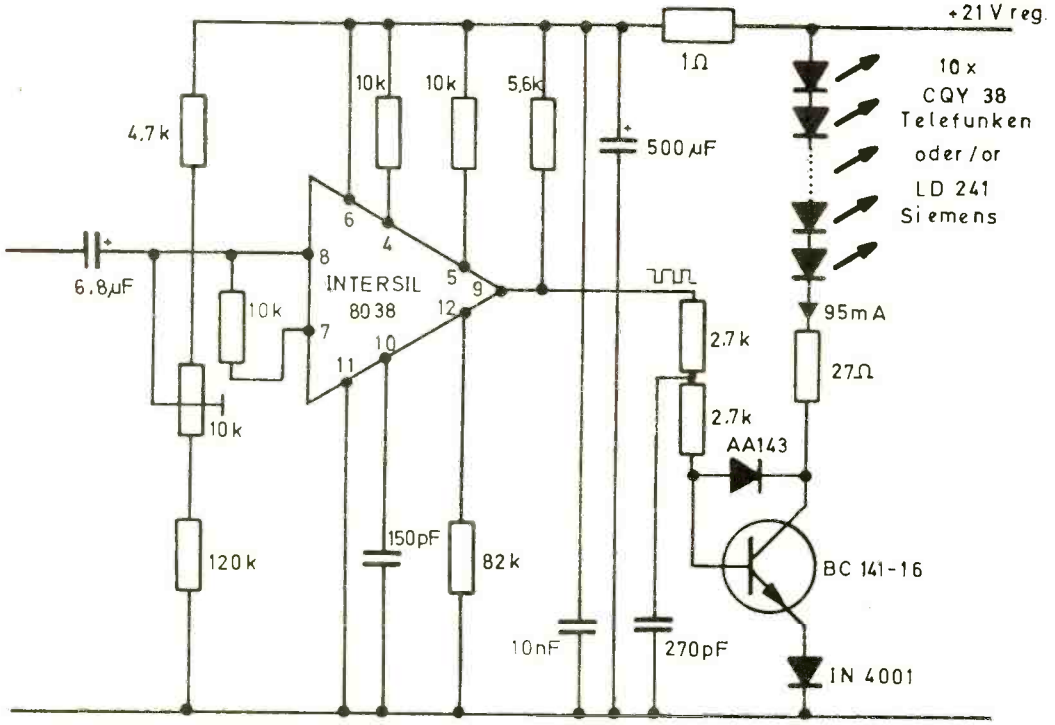

Fig. 2. Schematic diagram of the infrared FM transmitter modulator recommeded by Sennheiser.

photodiode, switching limitations of most LED emitters, and practical circuit considerations. Very wide frequency deviation is used to maximize the S/N at the audio end.

There are several approaches to designing IR transmitters. Basically, however, all IR transmitters consist of an audio preamplifier, a voltage-controlled oscillator that operates at the center frequency of the transmitter (95 kHz for mono), and a power-output stage that drives the IR LED's (Fig. 1). The output transistor is a class-D amplifier stage. For maximum efficiency, several LED's are connected in a series. Usually, as many LED's as are required are used to maintain a particular average drive current. The pulse duty cycle in most commercial transmitters is 50%, although a narrower pulse can be used to save power. The circuit shown in Fig. 2 has a continuous pulse-width potentiometer control for experimental applications.

The radiation angle of the transmitter LED's is critical in the range of the transmitter shown schematically in Fig. 2. Commercial transmitters using such standard LED's as the TIL32, CQY38, or LD242 utilize the relatively wide radiation angles of the diodes, which may vary between 30° and 60°. Sometimes, however, additional metallic reflectors are used to focus the beam of IR energy.

Recently, Siemens announced production of the Q62902-B137, a combined reflector/heat sink for use with its new LD242 IR LED that was specially designed for IR communication.

For particularly long distance communication, standard lenses or parabolic reflectors can be used to prefocus an IR beam for line-of-sight communication over distances of up to several miles. In diffused-radiation transmission, where sound quality rather than long distance is of utmost importance, a number of IR LED's are used to broaden the energy diffusion angle and improve the S/N at the receiver.

A practical IR transmitter might have eight to 12 standard LED's in series, 0.5 watt of input power, and 25 mW of IR output power. This low output power can carry a high-quality audio signal across a room up to 20 meters long, depending on the reception angle.

Construction of an FM receiver for IR communication applications is greatly simplified, thanks to the many IC FM demodulation circuits on the market today. A block diagram of the typical IR receiver is shown in Fig. 3. It consists of a preamplifier, wideband FM discriminator, and low-pass filter. The last section may or may not contain a deemphasis network, depending on whether or not preemphasis is used in the transmitter.

An example of the design approach used in FM IR receivers is shown in Fig. 4. The circuit employs the Siemens BPW34 photodiode as the pickup.

An inductor in series with the photodiode minimizes the saturation effect under bright ambient lighting conditions. Without the inductor, the self-capacitance of the diode would be greatly increased, causing attenuation of the FM carrier signal. Care and some experimentation are required in selecting the FM limiter/amplifier/detector that will operate at 100 kHz, since most such circuits are designed to operate at 455 kHz or 10.7 MHz.

The S/N in infrared systems can be increased by the simple expedient of preemphasizing the modulating signal in the transmitter and deemphasizing the received signal. Some commercial IR systems, for example, operate with a 50-µs emphasis/deemphasis figure.

IR Stereo. In April of last year, a European standardization committee made recommendations for IR devices. Following these recommendations, Sennheiser, AKG (Telefunken), and Beyer introduced stereo IR systems to the European consumer market. At least one of

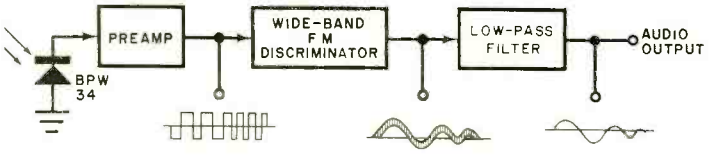

Fig. 3. Block diagram of a typical infrared FM receiver. Preemphasis and deemphasis may be used in transmitter and receiver.

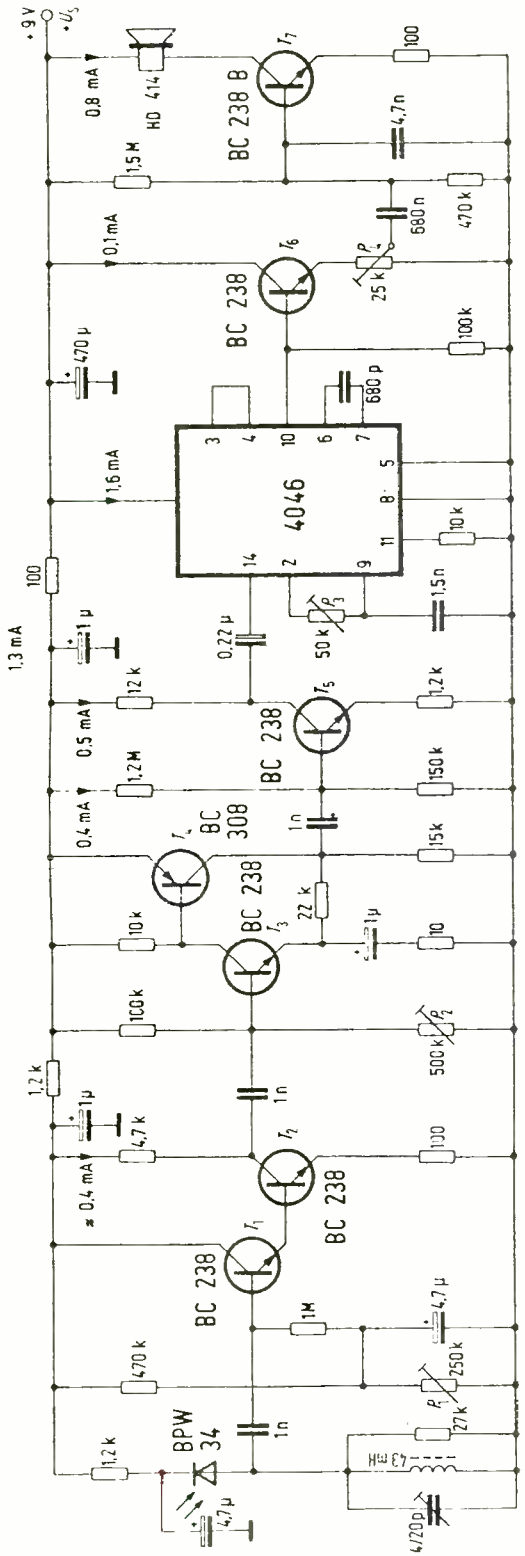

Fig. 4. The Siemens FM infrared receiver uses a 4046 integrated circuit as a wide-band FM demodulator.

these systems has made it to the U.S. market.

All commercial IR stereo systems intended for the stereo enthusiast are relatively inexpensive. They also conform to the recommended standard—95-kHz and 250-kHz carrier frequencies for the left and right channels, each of which can be deviated by ±50 kHz. (Mono systems use a 95-kHz carrier and ±50-kHz deviation.) Each system uses a stationary IR transmitter that connects to the line output jacks of a stereo system and a portable receiver that can be carried around by the user.

The IR stereo transmitters are, in fact, two transmitters in a single case. One operates at 95 kHz and carries the left-channel signal, while the other operates at 250 kHz and carries the right-channel signal. The LED radiators that are driven by the transmitters are housed in the same case that houses the transmitter.

The receiver in the case of Beyer's Model DT444 and Sennheiser's Model HDI434 IR stereo phones is built right into the phones themselves. A small lens on one of the earcups focuses the IR energy intercepted onto a BPW34 photodiode that serves as a common receptor for both channels. Circuitry within the headphones themselves demodulates the signal to separate out the two channels. Then the left and right channel signals are amplified to drive the phones.

The headphones also have built into them rechargeable nickel-cadmium cells that power the receiver circuitry. Even with the built-in circuitry and power sources, the IR stereo headphones are about the same size and weight of conventional headphones.

Testing the Sennheiser Model AD416 IR stereophones at a distance of 4 meters from a 60-mW radiated IR transmitter in a room 5 × 4 × 3 meters with light colored walls and a flat ceiling, we obtained a 53-dB S/N in daylight (200 Lux). Under worst-case conditions, with the receiver's pickup facing away from the transmitter's IR radiators, the S/N degraded to 40 dB. Needless to say, IR stereo headphones offer an attractive and practical alternative to conventional phones. They typically have good S/N characteristics and wide frequency response. (Beyer, for example, rates its IR phones at 20-to-20,000 Hz frequency response).

Closing Comment. Infrared radiation radiated by LED's in an IR audio system scatters and is reflected and diffused by the room's walls and ceiling. Some materials in a listening room reflect IR energy better than do other materials. Hence, the mixture of materials found in a typical home environment may cause signal dropouts when the receiving element of the IR receiver is facing away from the transmitter.

One drawback for the IR system is that the receiver's sensitivity to the transmitted signal is reduced in the presence of an additional high-level IR source, such as a tungsten lamp or the sun. Strong incandescent lamps, too, can add noise, obscuring the signal. Even so, the advantages to using IR phones are so great that they far outweigh the disadvantages of conventional phones with their trailing cords. ◇

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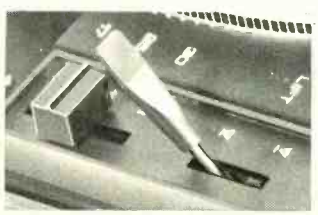

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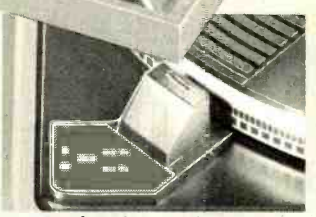

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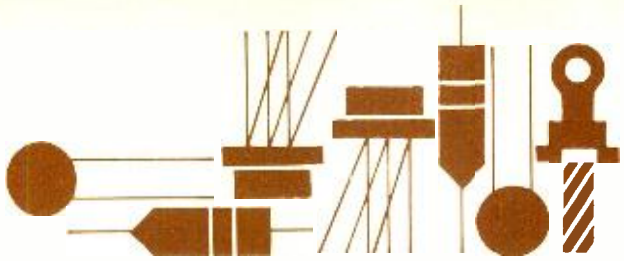

Solid State

By Lou Garner

HOORAY FOR ARRAYS!

COMBINING the flexibility and versatility of discrete devices with the economy and minimum space requirements of integrated circuits, semiconductor *arrays* offer the best features of both classes. Suitable for a wide range of experimenter and hobbyist projects, arrays consist of two or more devices or circuits in a single package. Each unit in the package may be as simple as a diode or as complex as an operational amplifier. The individual devices may be completely independent, even though assembled on the same substrate, or share an element or connection, such as a common anode, cathode, emitter, collector, power source, or ground terminal.

By strict definition multiple logic circuits, such as dual or quad NAND or NOR gates, flip-flops, latches and multiplexers, may be considered arrays. However, the term generally is reserved for packages containing discrete devices such as diodes and transistors, amplifiers, special function circuits such as timers and comparators, and combinations of these. Semiconductor arrays are available from virtually every major semiconductor manufacturer, including Fairchild, Motorola, National, RCA, Signetics, Siliconix, Intersil, Texas Instruments, Plessey, Sprague, Raytheon, Teledyne and Harris.

Depending on specific type and manufacturer preferences, semiconductor arrays are offered in 8-pin miniDIP's, 8-to-12-pin cylindrical cases, or 14- and 16-pin DIP's, with the latter the most popular. The maximum number of individual devices which can be contained in a single packaged array depends on the number of electrodes per device and on the total number of terminals available. For example, a maximum of seven independent diodes can be provided in a 14-pin DIP, but as many as thirteen may be included if there is a common cathode (or anode) connection. Similarly, only five transistors can be supplied in a 16-pin DIP, but up to seven can fit in the same package if there is a common emitter (or collector) terminal.

Typical diode array package diagrams are shown in Fig. 1. RCA's CA-3039, Fig. 1A, offers six diodes in a 12-pin TO-5 style package, while the firm's CA3019, Fig. 1B, includes a four-diode, full-wave bridge and two independent diodes in a 10-pin case. Ten diodes are grouped as five pairs, three with common cathodes, two with common anodes, in a 16-pin DIP as RCA's CA3141, Fig. 1C. Fairchild's FSA2619M, Fig. 1D, is a typical monolithic diode arrangement in a 16-pin DIP, offering 8 independent diodes similar to the 1N914 and 1N4148. Thirteen diodes are supplied in the FSA2565M, a 14-pin DIP (Fig. 1E), by using a common-cathode connection. Common-anode diode arrays are also available, not only from Fairchild, but from most other manufacturers. Diode arrays can be used in test and musical instruments, communications equipment, control systems, and computers. They are especially useful as part of the drive circuitry for core and matrix memories.

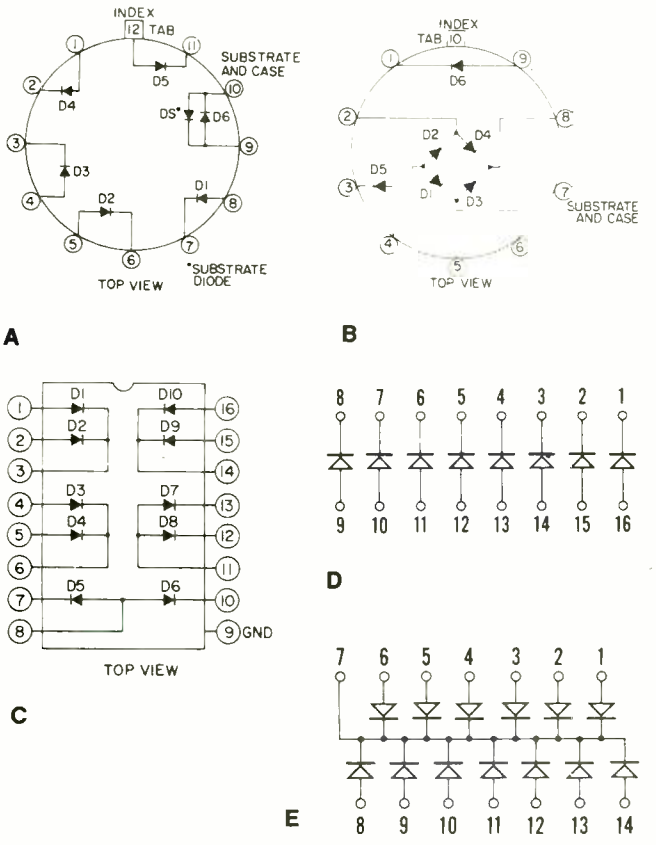

Fig. 1. Typical diode arrays: (A) CA3039; (B) CA3019; (C) CA3141; (D) FSA2619M; (E) FSA2565M.

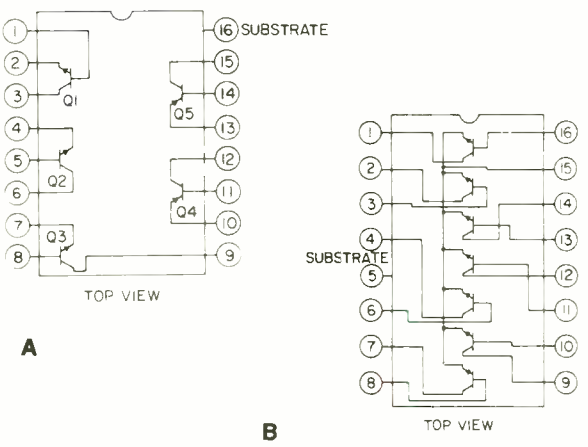

Fig. 2. Transistor arrays: (A) CA3096; (B) CA3081.

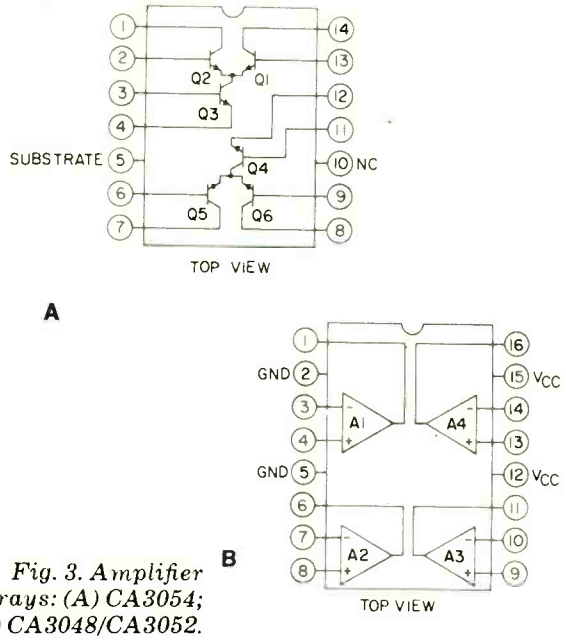

Fig. 3. Amplifier arrays: (A) CA3054; (B) CA3048/CA3052.

Representative transistor arrays in 16-pin DIP's are shown in Fig. 2. Three npn (*Q1*, *Q2*, and *Q3*) and pnp (*Q4* and *Q5*) types are offered in RCA's 5-transistor CA3096, Fig. 2A, while seven npn types are included in the CA3081 by using common-emitter connections, as shown in Fig. 2B. Where independent units are furnished, they can be used in practical applications as if they were discrete devices, provided maximum ratings are observed. In addition, one or more transistors can be connected as a diode if needed to meet circuit requirements. Where there is a common connection between devices, on the other hand, this must be considered when designing circuits using the array. Common-emitter and common-collector arrays are used extensively as 7-segment LED display drivers, but also can be used in multiple filter, distribution, and output applications.

Semiconductor arrays can feature multiple amplifiers as well as simple discrete devices. Dual differential amplifiers, each consisting of three npn transistors, are offered in *RCA*'s types CA3054 (Fig. 3A), CA3026, CA3049, and CA3102. Of these, types CA3026 and CA3049 are supplied in 12-pin round cans, while types CA3054 and CA3102 are furnished in 14-pin DIP's. Supplied in 16-pin DIP's, similar arrays CA3048 and CA3052 each contain four independent ac amplifiers, as shown in Fig. 3B. Versatile quad op amp arrays, generally in 14-pin DIP's, are available from many sources. Popular types include the LM124/LM224/LM324, LM148/LM248/LM348, and LM2900/LM3900 families, the TL084 series, and the HA4741.

Except where common power and ground connections may cause cross-coupling or feedback problems, the separate units of an amplifier array can be used in the same applications as their individual counterparts. Amplifier arrays are particularly valuable for multi-channel equipment designs, such as stereo and quadraphonic audio systems, color organs, and instrument recorders.

The special semiconductor arrays illustrated in Figs. 4 and 5 are samples of the scores of types offered by various manufacturers. RCA's CA3095, supplied in a 16-pin DIP (Fig. 4A), includes three independent npn transistors (*Q6*, *Q7* and *Q8*)

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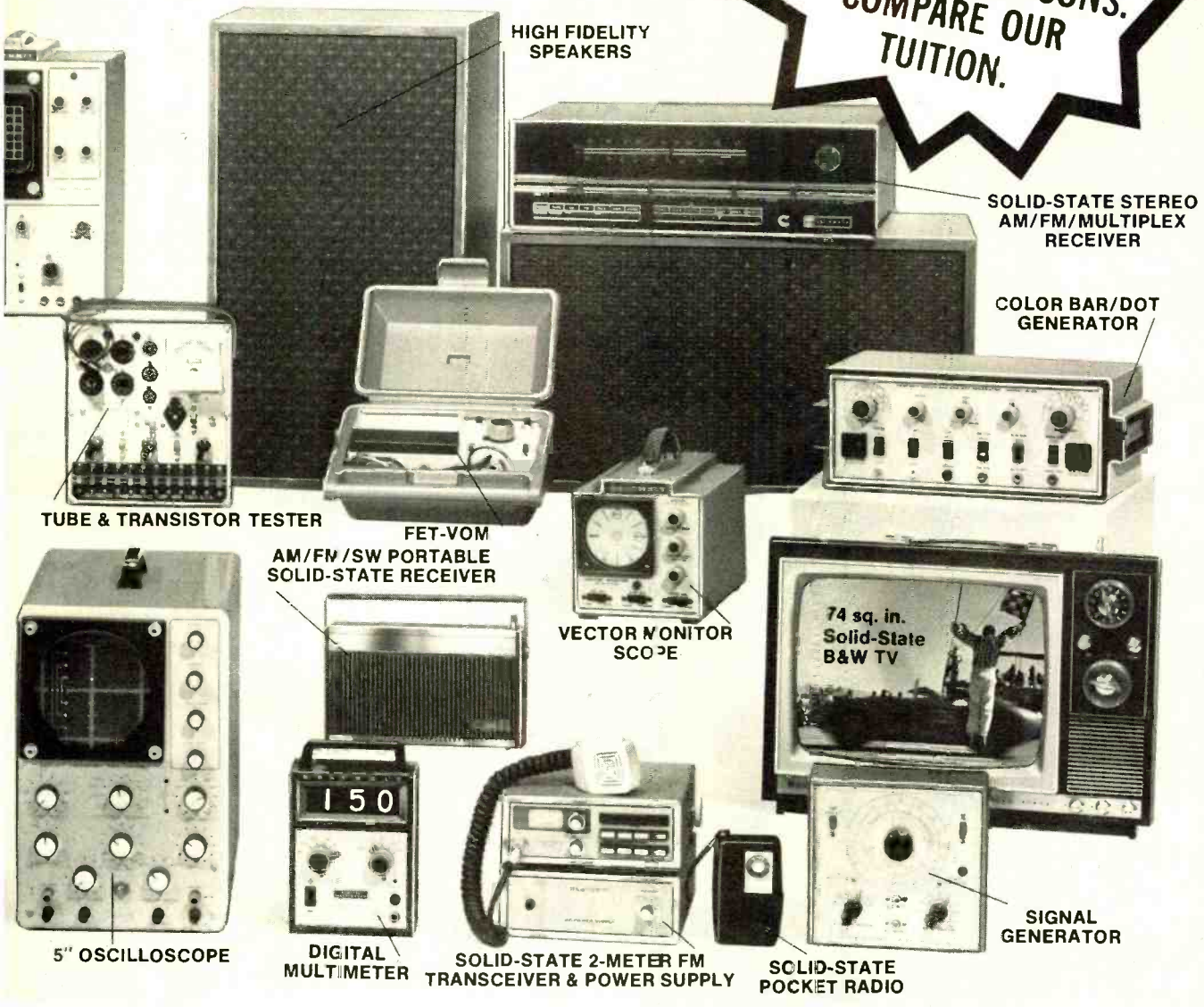

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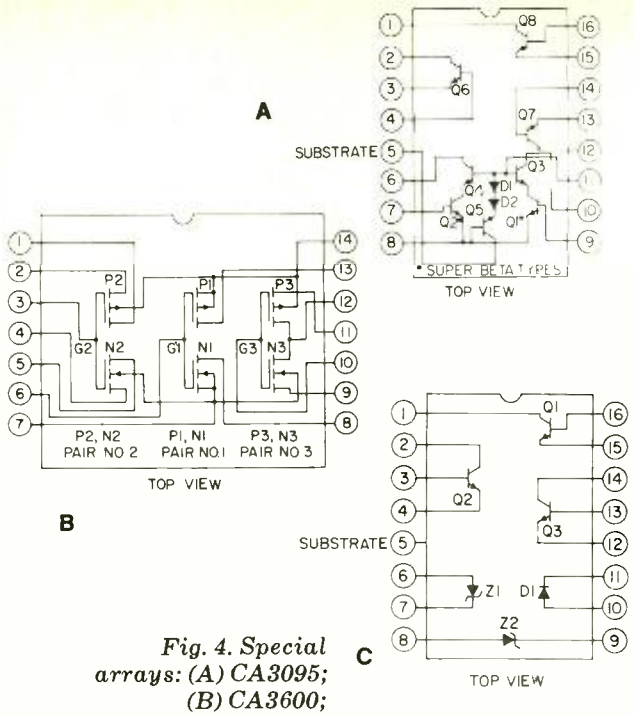


Fig. 4. Special arrays: (A) CA3095; (B) CA3600; (C) CA3093.

and a differential cascode amplifier using super-beta devices. It is especially useful as a high impedance transducer amplifier or in long-interval timer applications.

Three COS/MOS transistor pairs are featured in the CA3600, Fig. 4B, with each stage offering a typical gain of 32 dB and an input impedance of 100 Gohms. The CA3093, Fig. 4C, contains three npn transistors, *Q1*, *Q2*, and *Q3*, two 7-volt zeners, *Z1* and *Z2*, and a general-purpose diode, *D1*.

Each member of *Motorola*'s MC1411 array family (MC1411/12/13/16) comprises seven npn high-gain Darlingtons with integral suppression diodes in a 16-pin DIP, as shown in Fig. 5. With relatively high voltage and peak current ratings, these arrays can be used as drivers for incandescent lamps, relays or printer hammers. Finally, Hewlett-Packard's HCPL-2770 array offers four independent optocouplers in a single 16-pin package. Each section has a 1500-V dc insulation voltage rating and requires an input current of only 0.5 mA. The input elements are GaAsP LED's and the outputs are photodiodes coupled to modified high-gain npn split Darlington pairs.

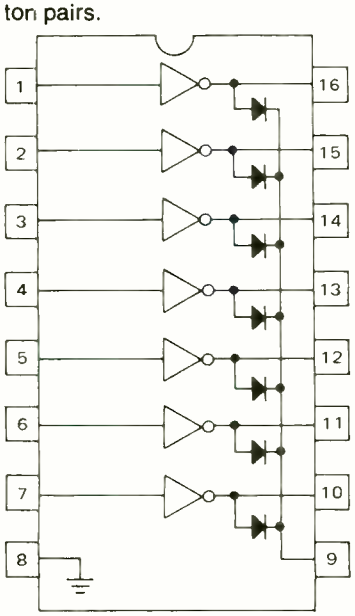
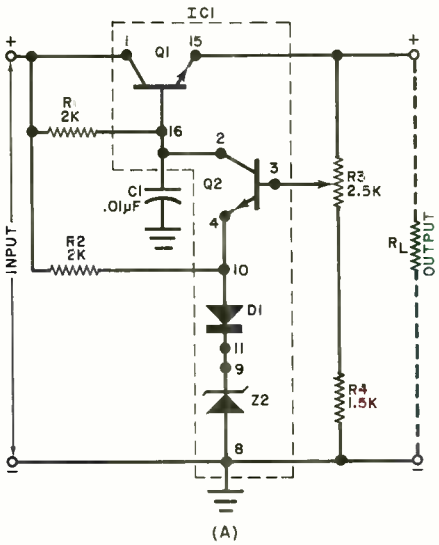


Fig. 5. Another special array: the MC1411 family.

Array Applications. The potential applications for semiconductor arrays are virtually unlimited. Generally, the separate elements of such arrays can be used in the same applications as their corresponding discrete or individual IC counterparts as long as maximum ratings are observed. However, arrays usually require less space and volume than their discrete counterparts and are frequently less expensive. In addition, the special combinations found in some arrays offer unique project possibilities. Representative of the hundreds of designs possible with semiconductor arrays are the circuits shown in Fig. 6.



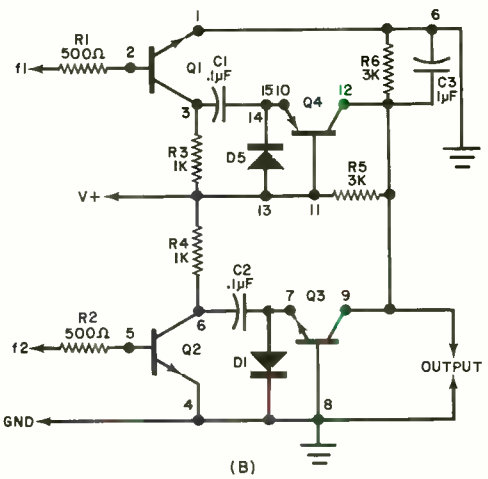


Fig. 6. Array applications: (A) Temperature compensated series regulator; (B) Frequency comparator.

Featuring a CA3093 (*IC1*), the temperature-compensated series voltage regulator in Fig. 6A requires only five additional components—three half-watt resistors, a low voltage ceramic capacitor, and a potentiometer. Designed to accept an unregulated dc input of 18 volts, the regulator can supply a regulated output of 8.5 to 15 volts, depending on the setting of *R3*. If adjusted for 12 volts output, the temperature regulation is 0.009%/°C, while the load regulation is ±0.4% from 0 to 40 mA and the typical line regulation is ±0.45%/V. The circuit can be used as part of an overall power supply design or assembled as an "add-on" accessory for an existing supply.

An audio frequency comparator circuit (Fig. 6B) using the CA3096 5-transistor array is designed for operation on a 10-V dc supply. Accepting input signals up to 10 kHz (f1 and f2), the circuit develops an output voltage which varies from a median level of 5 volts proportionally to the relative difference in frequencies. In operation, the output remains at 5 volts if the two input signals have the same frequency, rising if f1 is greater

than f2 and dropping below this level if f2 is greater than f1. Four of the transistors in the array (*Q1*, through *Q4*) serve as conventional amplifiers with the fifth (*Q5*) used as a diode by connecting its collector (pin 15) and base (pin 14) terminals together. One external diode, *D1* (type 44003), is required to complete the circuit. Among its possible applications, the frequency comparator can be used in test instruments, as a second demodulator in FM/FM telemetry systems, and in communications equipment.

Reader's Circuit. Intended for checking TTL circuits, the logic test probe shown in Fig. 8 was contributed by reader David K. Merriman (Lockheed Electronics Co., Las Cruces, NM 88001). The probe will provide a visual readout of a low logic state as a "0" and of a high logic state as a "1," while identifying a pulse train as "P."

Easily assembled in a single evening, the project requires one section of a 7402 quad NOR gate, *IC1*, a 7-segment numeric LED display, two half-watt resistors, *R1* and *R2*, plus mounting hardware, wire, etc. The unit derives its dc operating power from the equipment under test, as do most logic probes. Terminal 1 is connected to display segments a, b, f and g, while terminal 2 is connected to segment e, or vice versa, depending on whether a common-cathode or common-anode type display is used.

The series current limiting resistor values (*R1* and *R2*) are calculated by dividing the difference between the dc supply

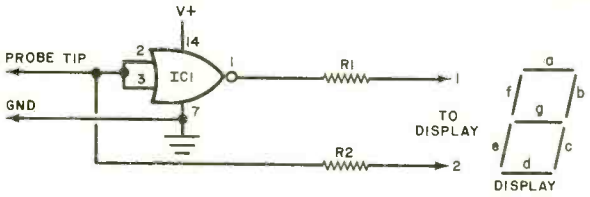


Fig. 8. Reader's logic probe circuit.

voltage (generally 5 V) and the rated display voltage by the total drive current required by the LED segment(s). These currents range, typically, from less than 5 to as much as 20 mA per segment, depending on the display used. The lower current types are preferred to avoid overloading the NOR gate or test circuit.

In operation, the display is connected so that segments a, b, f and g are activated when a logic zero level is applied to the probe tip, forming a 0, with segment e activated when a high logic level is applied, forming a 1. When a pulse train is applied, the 0 and 1 segments are activated alternately, with persistance of vision blending the two together to form a P.

Device/Product News. If you're working with high-frequency circuits, you should be interested in the new products recently announced by the Amperex Electronic Corporation (Hicksville, NY 11802). First, the firm has introduced a new line of uhf power transistors. Types BLW79, BLW80 and BLW81 offer r-f power gains of 10, 9 and 7 dB with power outputs of 2, 4 and 10 watts, respectively. Each transistor can withstand VSWR's of 50:1 with high line voltage and 20% overdrive at a heatsink temperature of 70°C. All three are for operation in the mobile frequency band of 380 to 512 MHz at collector voltages of 12.5 volts. Available in either flange or stud packages, unit prices range from $5.25 to $7.90.

Amperex is also offering a new line of vhf amplifier modules containing internal matching networks for broadband applications. Identified as types BGY32 and BGY36, the units are de-

(Continued on page 118)

Experimenter's Corner

By Forrest M. Mims

IC VOLTAGE REGULATORS

Batteries are ideal for powering portable electronic equipment, but you should think twice before using them to power anything within reach of an ac power outlet. Why? To save money! Electricity from batteries is much more expensive than electricity from a wall socket.

Batteries are rated in ampere-hours (AH). A 1-AH battery, for example, can deliver a current (I) of 1 ampere for 1 hour before its voltage (E) falls below a specified level. If the battery puts out 1 ampere at 1 volt, it delivers 1 watt of power (P=EI).

Now let's convert this analysis into dollars and cents by applying it to a typical 1.5-volt alkaline "C" cell rated at 5 AH. You can buy such a cell at a discount house for about 65¢. Neglecting any internal voltage drop, the cell has a potential power output of 7.5 watts over its useful life. This means an equivalent cost of $86.67 per kilowatt-hour for electricity from the battery! That's over a thousand times more costly than electricity supplied by power companies.

There are at least two ways to avoid the high cost of battery power. One is to use rechargeable nickel-cadmium or lead-acid storage cells instead of the expendable variety. You can charge the cells with a commercial charger or with solar energy. (See "Experimenter's Corner," November 1976.) Another alternative is to use one of the inexpensive, unregulated power supply adapters designed for radios, tape recorders, shavers, and calculators. These adapters are compact—usually housed in a molded enclosure with the ac power plug—and are ideal for applications requiring unregulated voltage at moderate current levels. Most adapters have output leads terminated with some type of small plug. If you attach appropriate jacks to each of your projects, you can use the same adapter to power each project. What's more you can quickly disconnect the adapter from one circuit and apply it to another by unplugging the output leads from one and and plugging it into the other.

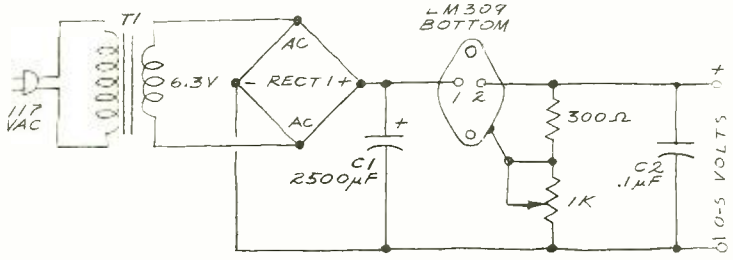


Fig. 2. Five-volt TTL power supply.

There's a third alternative which can even be used to improve the operation of the first two. It's the integrated circuit voltage regulator. Many computer hobbyists and manufacturers place several IC voltage regulators "on-card" to provide regulated power for each of several circuit boards in a computer system. IC voltage regulators are also useful as power supplies for solderless prototyping breadboards.

IC voltage regulators are ideal for use even with comparatively simple circuits and projects. Many have only three connection terminals or pins: input, output, and common. This makes them easy to use—even though the IC chip may contain dozens of transistors, resistors, and diodes. For example, Fig. 1 shows the amazing simplicity of a typical IC voltage regulator circuit. Anyone who has tried to design and build a precision regulator with an automatic shutdown capability can appreciate the engineering sophistication provided by these chips.

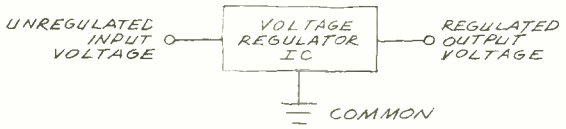


Fig. 1. Basic 3-terminal IC voltage-regulator power supply circuit.

5-Volt TTL Supply. Some TTL devices (the 7441 decoder for example) are designed to tolerate as much as 70 volts on their output lines, but all TTL chips require a single power supply voltage of 5 volts, plus or minus a quarter of a volt.

Several IC voltage regulators are designed to deliver a regulated 5-volt output. One is the LM309, a readily available regulator which can accept up to 35 volts at its input. The LM309 is available in both TO-39 and TO-3 cases. The latter package will dissipate more than 3 watts at room temperature without a heatsink and more than 10 watts with the addition of a Wakefield 680-75 heatsink. If these power levels are exceeded, an automatic sensor circuit will detect the resultant increase in chip tem-

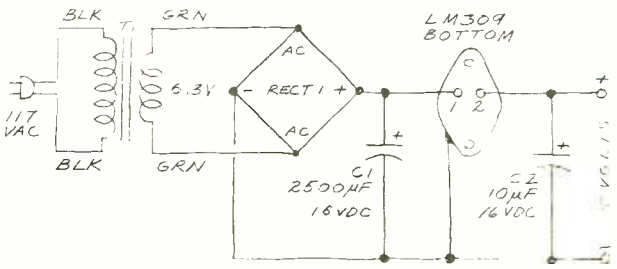


Fig. 3. Variable 0-5-volt power supply.

perature and shut down the regulator to protect it from damage.

Figure 2 shows how to use the LM309 in a simple TTL 5-volt power supply. Transformer *T1* is a 6.3-volt filament transformer which reduces the line voltage to a practical level and provides line isolation. Modular bridge rectifier *RECT1* converts alternating current into pulsating direct current. Any 60-to-200-PIV bridge, such as Radio Shack 276-1147 can be used. Capacitor *C1* filters the rectifier output into a reasonably ripple-free voltage which is applied to the input of the regulator IC. The regulated voltage appearing at the IC's output pin is 5.05 volts plus or minus 0.2 volt.

You can assemble this circuit on a small perforated board in under an hour using readily available components. Since the circuit is line powered, use care in connecting the power supply cord to the primary (black) leads of *T1*. You'll have a safer circuit if you mount *T1* on the board with 6-32 hardware. Insert the free end of the power cord through a hole drilled in the board near *T1*, and tie a knot a few inches from the end of the cord. Then solder the free end of the cord to the two black leads of *T1* and carefully insulate the connections with heat-shrink tubing or several layers of black electrical tape.

Variable-Voltage Supply. You can convert the fixed 5-volt supply in Fig. 2 to a variable 0-to-5-volt supply by adding a voltage divider as shown in Fig. 3. The result is handy for experimenting with LED's and other low-voltage components and circuits.

Other IC Voltage Regulators. IC voltage regulators with outputs of from 5 to 24 volts are readily available from many of the parts suppliers who advertise in POPULAR ELECTRONICS. Chances are one of these regulators can be used to power almost any IC circuit or project you have in mind. For example, the 78L12 will deliver 12 volts plus or minus half a volt at a current up to 100 milliamperes. The 78L12 is part of a series of three-terminal regulators with a wide range of regulated voltage outputs.

You can get lots of design tips and application ideas about using voltage regulator IC's from manufacturer's data sheets and the excellent data books which are available. One such book is National's "Voltage Regulator Handbook." You'll soon find that IC voltage regulators can increase the reliability of your circuits while saving you a bundle of battery money. ◇

Hobby Scene

By John McVeigh

Have a problem or question on circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

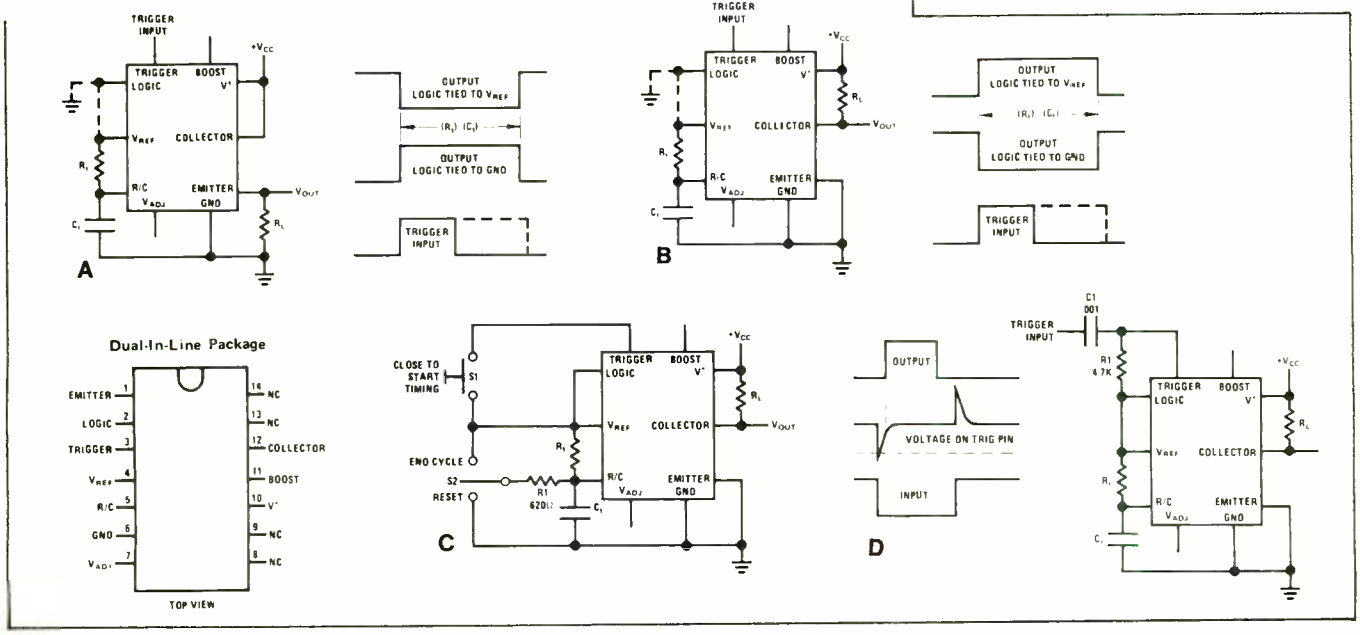
TIMER IC INFO

Q. Can you provide any information on using the LM322 precision timer?—Rene Buteau, Quebec, Canada.

A. The LM322 can operate with unregulated supplies from 4.5 to 40 V, maintaining constant timing over a wide range of periods. The output of the timer is a floating transistor with current limiting. It can drive either ground- or supply-referenced loads up to 40 V and 50 mA. This floating output offers the user great flexibility in circuit design. Also included is an on-chip "logic reverse" circuit that can be programmed by the user to have the output transistor either on or off during the timing period. The trigger input has a 1.6-volt threshold (independent of supply voltage), but is protected against inputs as large as ±40 volts, even when a 5-volt supply is used. The IC reacts only to the rising edge of the trigger signal, and is immune to any trigger pulse during the timing period.

An internal 3.15-volt regulator keeps the timing period independent of supply fluctuations and provides the user with a convenient reference. External loads drawing up to 5 mA can be driven by the regulator. An internal 2-volt divider between the reference and ground provides a timing period of T = RC. This timing period can be voltage controlled by driving the divider from an external source through the V_{ADJ} pin. Timing ratios of 50:1 can be achieved. The LM322's internal comparator has a 300-pA typical input bias current over a common-mode range of 0 to 3 volts. A boost terminal allows the user to increase comparator operating current for timing periods less than 1 millisecond. This allows the timer to function over a 3-μs to multi-hour timing range.

Some circuits using the LM322, from the National Semiconductor catalog, are shown. At A, is a basic timer with the output taken at the emitter of the floating transistor. A basic timer with collector output is shown at B. A timer with collector output and manual reset and cycle end is illustrated at C, and a timer triggered by the negative edge of the trigger pulse is shown at D.



FINDING VARIABLE CAPACITORS

Q. I have searched high and low, but have not been able to find anyone who stocks or manufactures three-section, 10-to-365-pF "variable condensers." I'm very surprised by this. A few years ago I could find these condensers anywhere. Do you know of any parts distributors who carry them?—Jerry John Raimondo, Astoria, NY.

A. Variable capacitors are getting very scarce. Many of the companies that used to make them (e.g. Hammarlund) are no longer in business. Accordingly, you'll have the greatest chance of finding the parts you're looking for at a surplus outlet. (Since you are near Manhattan, try the electronics dealers on Canal Street or Barry Electronics at 512 Broadway.) Also, procure a copy of the catalog published by Fair Radio Sales Co., 1016 E. Eureka Street, Box 1105, Lima, OH 45802. Fair Radio carries a large line of surplus equipment and components.

ADJUSTABLE REVERB

Q. I am building an electronic organ and need adjustable reverberation in the audio output. I would appreciate your help with a circuit diagram using the new "bucket brigade" IC for this application.—Colin Nusum, Willowdale, Ontario, Can.

A. The "Bucket Brigade" Audio Delay Line in the June 1976 issue is well suited for this application. It employs the Matsushita MN3001 dual 512-stage analog shift registers. Total delay time depends on various resistor values. A table is included for component selection.

Product Test Reports

HY-GAIN MODEL 2716 MOBILE AM CB TRANSCEIVER

Calculator-type keyboard controls remote transceiver.

DURING the past year or so, a number of mobile CB transceivers have been designed to be operated by remote control, with the transceiver itself located somewhere other than under the dashboard. The operating controls for such rigs are on the case of the microphone, which generally serves as the speaker, and is connected to the transceiver via a detachable cable. This type of setup permits the transceiver to be installed in a hidden location to minimize the possibility of theft.

The Hy-Gain Model 2716 40-channel rig is this type of remotely controlled AM mobile transceiver, but with a new twist. It differs from the usual control scheme in that instead of rotary controls and switches, the microphone housing has a calculator-like keyboard to control all (14) functions except power on/off. Moreover, a number of unusual functions are provided. Among these are a LED clock display; two independent channel memories; and S/r-f numerical LED indicators. Other facilities include digital frequency synthesis; VOLUME, SQUELCH, and CHANNEL up/down control buttons; channel 9 override key; switchable noise blanker; and PA operation. All functions are operated by depressing pushbutton keys.

The main transceiver unit includes an automatic noise limiter, external-speaker jacks; 13.8-volt dc, negative- or positive-ground operation; reverse-polarity protection; and line filter.

The main transceiver unit measures 7½" × 6½" × 2¼"(19.1 × 16.5 × 5.7 cm). The entire system carries a price tag of $249.95, with mounting hardware, microphone, and cables for "up-forward" installations. An extension-cable pack for trunk installation is available at additional cost.

General Description. The main transceiver unit has only the necessary connectors and speaker jacks mounted on its simple plastic housing. It also has flanges for convenient installation. A 5′ (1.5-m) control cable can be installed on an L-shaped bracket (supplied) and mounted on a dashboard or transmission hump. The mike cable is then plugged into it.

The case of the microphone is somewhat similar to a telephone handset. The numeric display "window" is located at the top of the housing, the 12 calculator-type pushbutton "keys" are in the middle, and the microphone/speaker is at the bottom. The push-to-talk lever is on the left side of the mike's housing, and the power on/off switch and mike hanger clasp are on the rear of the housing.

Neither the volume nor the squelch operate continuously. They function at a fixed step each time the appropriate button is pressed. The VOLUME steps are about 3 dB each. CHANNEL selection, in either direction, can be stepped sequentially one at a time or continuously when the up or down button is tapped or held down, respectively.

A MEMORY button permits a channel in use to be stored so that the operator can quickly return to the original channel (by pressing MEMORY again) after checking out other channels. Another button, labelled EMERG CH-9, instantly goes to Channel 9 when pressed.

Separate buttons switch in and out the noise blanker. Setting the hours and minutes for the clock is accomplished with the same buttons used for the noise blanker after first pressing a special F button. This same button switches between CB and PA operation after the F button is first tapped.

The S/r-f readings appear in place of the channel numerals in the display each time a button labelled # is pressed. A green indicator lights during receive. A red indicator comes on on transmit.

Technical Details. The double-conversion receiver, which includes the usual r-f and mixer stages and a noise blanker, provides i-f's of 10,695 and 455 kHz. Selectivity is obtained with a 455 kHz ceramic filter. The remainder of the receiver section includes a diode detector, agc, series-gate anl, and squelch. A single IC contains the entire audio section, including the power-output stage, which doubles as the modulator for the transmitter.

The digital frequency synthesis system utilizes the usual phase-locked-loop (PLL) principle in which a voltage-controlled oscillator (vco) provides the heterodyning frequencies required to produce the 10,695-kHz i-f at the first mixer. A 10,240-kHz crystal oscillator converts the first i-f to 455 kHz at the second mixer. The standard-reference signal is also derived from this oscillator.

In the transmitter section, the carrier is obtained at a mixer by combining the vco frequency with that from a 10,695-kHz crystal-controlled oscillator. Following a spurious-noise-rejection filter are predriver, driver, and the r-f power-amplifier stages. A multi-section network matches the output of the r-f power amplifier to 50-ohm loads and minimizes harmonics. Collector modulation includes automatic modulation control

(amc). Transmit/receive switching is accomplished electronically.

Laboratory Measurements The sensitivity of the receiver section of the transceiver is rated at 0.7 μV for 10 dB (S + N)/N. We measured a 0.5-μV sensitivity on our test transceiver, using a 1000-Hz test tone and 30% modulation. The range of the squelch threshold was 0.5 to 200 μV. The agc system held the change in audio output to 10 dB with a 26-dB r-f input signal change at 0.5 to 10 μV. The change was held to 5 dB with an 80-dB input-signal change at 1 to 10,000 μV. A nominal 50-μV signal registered S9 on the S meter numeric display.

Adjacent-channel rejection and desensitization were 50 dB. Image and i-f rejection measured 70 dB, while other unwanted or spurious signals were down 50 to 60 dB.

The audio output of the transceiver measured 2.5 watts at less than 1.5% THD, using a 1000-Hz test tone and an 8-ohm load. The overall 6-dB response was 275 to 1850 Hz (+1 dB at 700 Hz). Using a 1000-Hz test tone and an 8-ohm load, the output power on PA measured 5 watts at 1.1% THD. At 400 Hz on PA, the power was down to 4.5 watts and the THD was up to 2.2%.

Powering the transceiver from a nominal 13.8-volt dc source, the transmitter's carrier output measured 4.5 to 4.75 watts, depending on the channel in use. The modulation held to up to 100% with only an occasional spill-over, even with mike input levels 16 to 25 dB greater than required for 50% modulation. The THD under these conditions was less than 3% and 5% at 1000 and 500 Hz, respectively. Adjacent-channel splatter with a test tone and with voice was 50 to 55 dB down at ±5000 to 10,000 Hz from the carrier frequency. The overall 6-dB audio response was 440 to 3600 Hz (375 to 5300 Hz at −10 dB).

User Comment. The Model 2716 represents the exciting new breed of CB transceivers coming to the fore that takes fuller advantage of modern solid-state technology. For example, the MEMORY function enables a CB'er to recall at the push of a button a channel that's been stored instead of going through the cycle of up to 40 channels to locate it. This proved to be a boon to us during our road test, when we quickly switched directly to channel 10 from channel 19 as we turned from one highway to another. The same convenience factor (and safety consideration) held true when switching to channel 9, where there is a separate emergency channel override key.

The "hide-away" aspect of the 2716 is most welcome as a theft preventive measure, of course. Besides this, the transceiver section does not usurp leg room in an auto. Owing to its shallowness, it can be mounted on the auto's firewall, where it will not be in the way of a passenger and is virtually invisible.

The use of a keyboard-type control system is most interesting. Whereas other types of microphone control systems offer severely limited controls, this one has almost a plethora of functions. As a result, one has to have some practice with the control head in order to use it effectively. Since the keys are not illuminated, handling them at night requires greater familiarity with the keypad layout than one would ordinarily expect. Since CHANNEL selector, VOLUME and SQUELCH buttons are located at the right side of the handset's control panel and arranged in logical order, the positions are rather easy to memorize for one-hand operation.

There are a few other minor discomforting factors with this new control facility, most of them due to basic unfamiliarity with the system—which should be simple to overcome. For instance, one cannot see where the VOLUME and SQUELCH controls are set since they are electronically stepped controls. The S/r-f display, too, operates in a different manner. It's in whole numbers, which precludes being able to read in-between values. In addition, the signal-strength reading comes up for the level only at the particular instant it is called up and remains the same for any given signal level as long as the display is on. The numbers do not change in step with the changes in signal level as they do with a conventional meter. Even so, the disadvantages in the display are not really important. After all, the object is to adequately hear a signal, not look at it.

The built-in digital clock functions continuously as long as the microphone is plugged in, even when the vehicle is not in use. However, disconnecting the mike interrupts the clock's operation. Therefore, it is necessary to reset the clock when the mike is disconnected and again plugged into its connector. (The current drain with just the clock in operation is about 200 mA, which makes it desirable to disable the mike when the vehicle is not to be used over an extended period of time.)

The main transceiver unit features a phono jack that can be used with certain

Hy-Gain AM/FM radios to permit reception of the broadcast bands when the CB rig is squelched. The CB signal has priority in this case so that when a signal is detected, the AM/FM radio is automatically squelched to allow the CB to come through. This is a nice touch, though we did not have an opportunity to test it out.

In addition to providing certain conveniences as well as minimizing the possibility of theft, this transceiver provides good overall performance. Particularly impressive is its ability to suppress noise via its full-time anl system. In our noisy test vehicle, we seldom had to add the noise blanker. In any case, weak signals could be easily copied without adverse deterioration of the S/N ratio.

The small calculator-size LED numeric displays used for indicating the channel are bright and readable even in sunlight. This contrasts sharply with the large-size displays normally used, which readily wash out in bright light.

Our overall personal reaction to this transceiver is very good, except for the lack of illumination for the control buttons at night. For anyone with especially small hands, though, one-hand operation was sometimes cumbersome, inasmuch as the width of the handset's case is about 3" (7.6 mm).

Of special import is the high quality of reception and reported transmission signals. The mike-contained speaker is driven very well by the transceiver's audio amplifier, producing a loud, clear signal. Furthermore, we had no difficulty contacting CB'ers a few miles away on the lower 23 channels, whereas a pre-40-channel unit could barely reach out one mile in the testing area. On a channel-32 contact, we reached out an extra mile, which says a lot for the advantage of communicating on the 17 new channels.

CIRCLE NO. 104 ON FREE INFORMATION CARD

CONTINENTAL SPECIALTIES MODEL MAX-100 FREQUENCY COUNTER

No-controls counter indicates frequency to 100 MHz with 8 digits.

FEW TEST instruments are as simple to operate as the Model MAX-100 frequency counter from Continental Specialties Corp. It is devoid of all controls except a power on/off switch. You simply turn on the power and connect the instrument's input cable to the circuit under test. Unlike most other low-cost counters that have a frequency range of 30 MHz and a four- or six-digit numeric display, the MAX-100 goes out to 100 MHz and indicates the frequency directly on its eight-digit display.

The frequency counter can be operated from any of three possible power sources. In its basic configuration, the MAX-100 is powered by alkaline cells (or optional rechargeable nickel-cadmium cells). For on-the-bench use, an optional battery charger/eliminator allows operation from 117/220-volt ac line power sources. And for extended field use, another optional charger/eliminator allows operation from mobile electrical systems.

The MAX-100 comes in a modernistic package. It measures 7.75"D × 5.63"W × 1.75"H (19.7 × 14.3 × 4.5 cm) and weighs 1.5 lb (0.68 kg), less batteries. The price of the basic MAX-100 frequency counter, which includes the input cable, is $134.95. Optional accessories include: the ac and mobile battery charger/eliminators mentioned above; a mini-whip antenna for inductively coupling in r-f signals; and a low-loss tap-off for physically coupling to an r-f line under test.

General Description. The MAX-100 has a guaranteed specified frequency range of 20 Hz to beyond 100 MHz (110 MHz typical). Its rated sine-wave input sensitivity is 30 mV for frequencies up to 50 MHz, 100 mV between 50 MHz and 80 MHz, and 300 mV beyond 80 MHz. The crystal-controlled time base accuracy is specified as ±1 count. Overload protection is provided for potentials up to 200 volts between 10 and 500 Hz; 100 volts between 500 and 1000 Hz; 75 volts between 1000 Hz and 10 MHz; and 50 volts between 10 and 100 MHz.

The eight-digit display consists of 0.6" (15.2-mm) high red seven-segment numerals. There is no leading-zero blanking for all but the least-significant digit. When the display indicates greater than 1 MHz, a decimal point automatically appears between the sixth and seventh digits. When the instrument is operated on battery power, if the potential drops to less than 6.6 volts, all eight numerals in the display flash once per sec.

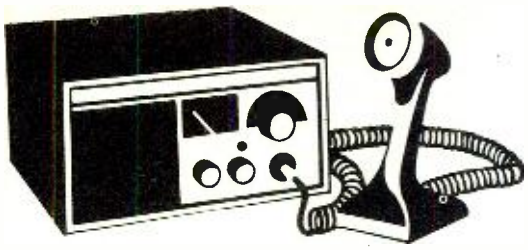
Alkaline cells (six AA size) can power the MAX-100 for about three hours under continuous use or up to eight hours of intermittent use conditions. When operation is from NiCd cells, up to three hours of continuous use or six hours of intermittent use can be expected. Using the optional recharger, the NiCd cells can be fully charged in 12 to 14 hours.

User Comment. The only practical way of evaluating the performance of a frequency counter is to measure a number of signal frequencies of known accuracy across the instrument's entire response range. Bench tests verified that the MAX-100 very accurately indicated the full range of frequencies down to the single hertz. Our test counter was able to measure frequencies well beyond 100 MHz and maintain its basic accuracy. When we did measure frequencies beyond 100 MHz, the display (which has a maximum count range of 99.999999) indicated the proper frequencies and flashed the most-significant digit at the far left to indicate an overflow condition.

We also made a series of sensitivity tests, again covering the entire frequency range of the instrument. In direct physical connections, the MAX-100 was considerably more sensitive than its published ratings. The same held true for our inductively coupled signal tests. We used a relatively low-powered signal generator (a grid-dip meter) at a distance of a couple of inches away from the r-f connector for the inductive-coupling test and obtained excellent results.

We particularly like the no-controls approach to the operation of the MAX-100. This plus its large, bright displays and relatively low price should make it a popular counter.

CIRCLE NO. 105 ON FREE INFORMATION CARD



CB Scene

By Ivan Berger

TRENDS IN CB

WITH ALL of the publicity that CB radio has garnered in the past few years, you'd think it would have dominated the Consumer Electronics Show last June. It didn't. (Audio did!) But, then, CB radio has its own show going for it—the Personal Communications Show, held a few months earlier. Nonetheless, there were still plenty of CB rigs displayed at the gigantic CES show, and it was most interesting to observe new trends in equipment.

For example, the outstanding developments last year were in the use of phase-locked-loop circuitry (PLL) and theft-proofing accessories. This year, everyone utilized PLL circuits, a not-surprising fact in view of the new 17 channels added to the CB band. Anti-theft movement was in two areas: new antennas and remotely located CB transceivers.

Manually retractable AM/FM/CB antennas were shown by Tenna, Shur-Lok and SparkOmatic, pointing to those people who can't afford the power types that proliferated last year. Shur-Lok's (also available in a CB-only version) can also be roof-mounted, which permits the user to retract or remove it from the inside of the car. Antenna Systems' "Automatch" antenna is a nonretracting "disguise" type with a matching box beneath it. When the user transmits on a new channel, a motor in the box adjusts a matching network to retune the antenna to that channel to maximize radio power output. A few companies also exhibited networks which use the car's whole body as an antenna.

New designs, which included remotely located CB transceivers with microphone control systems, were given heavy emphasis this year. Hy-Gain set the pattern for this type of transceiver design last year with its 23-channel Hy-Gain 9. At this year's CES, I observed new versions from Hy-Gain, as well as remotes from Audiovox, Boman, Clarion, Johnson American, Medallion, Pace, Panasonic, SBE, Sharp, SparkOmatic, Surveyor and Texas Instruments (not yet FCC type accepted at show time), among others. As you'd expect, each company has added a few ideas to the basic theme.

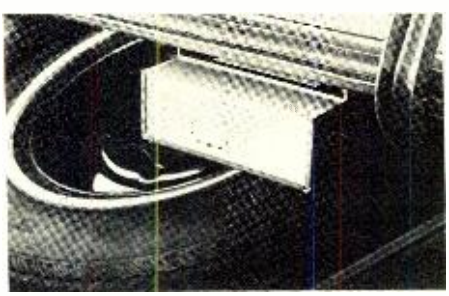
One interesting new feature is the linking of a CB transceiver to a car's stereo system with a "stand-by" switch so that one can monitor a channel and listen to stereo at the same time. When a CB signal overrides the squelch level, the stereo source is automatically cut off and the CB communication comes through. The stereo sound also cuts off when transmitting, of course. It appears that Audiovox and SBE units work this way with any car-stereo unit, while Clarion, Hy-Gain and SparkOmatic interface with specific car stereo models of their own. Kraco has one built into a car radio. There are also combination AM/FM/CB in-dash units with controls in the mike head and the channel display on the radio itself from Clarion, Cobra, JIL, Kraco, Medallion, and Superscope, among others. (Note that using a car's stereo speakers does not necessarily mean clearer CB sound since stereo speakers cover a wider frequency range than CB produces and might, therefore, reproduce noise of higher frequency than CB speakers will.)

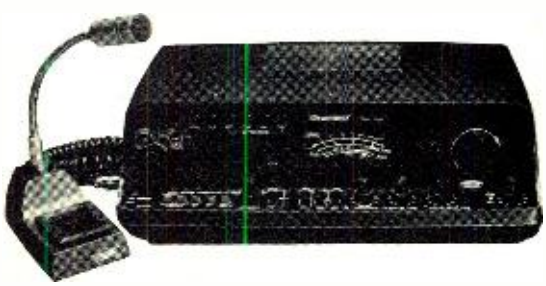
Most remote control CB transceivers use the microphones as speakers, too, though most also have jacks for external speakers. But those from Johnson American, Sharp, and Texas Instruments employ speakers that are not contained in the mike. These speakers are located in the small junction boxes that the microphone/control units plug into, generally at a location under the dashboard and near the driver. Though this does not necessarily make for better sound quality, the mike unit can be made smaller for easier handling.

In one of Sharp's models, the box also has a big signal/r-f meter on its face. Johnson's box, which also contains the digital channel readout can be mounted above or below the dash.

Some microphones used as speakers lack top-quality sound performance. Even the full-size speakers of under-dash rigs may not produce audio as well as they might because the sound waves go way down to the floor carpeting and bounce back up to you. There were a lot of external speakers at CES to solve these problems. I also noted external speaker models with built-in tone controls from SparkOmatic and Kraco, as well as AFS's flush-mounted CB radio speaker. The latter saves space, and helps to conceal the fact that you have a

Panasonic's "Big Mike Model RJ-3450 with microphone control system (left) and remotely located transceiver (below).





Superscope Aircommand Model CBB-1050 base station with channel 9 scan.

CB unit in the car (assuming you've hidden the transceiver and the antenna). Still another method to enhance sound was offered by Prime Electronics with its PR-1000 Variable Audio Filter. The filter's center frequency and bandwidth can be varied to exclude as much or as little sound as one likes. It's for 115-V ac operation.

Digital Designs. Digital channel display is a great advance, especially for mobile CB use. It's far easier to read one big number than a cluster of little ones around a dial.

The early digital-display units had little else digital about them. Now digital circuitry is showing up in a number of new ways. For example, the displays themselves are giving more than just the channel number. Hy-Gain's new 2716 remote unit and Pace's 8092 mobile have digital clocks built-in, and both the 2716 and the new Texas Instruments SSB base and remote display signal strength and r-f output digitally. (Many Johnson American models and SBE's Stowaway" remote unit take a different approach to this: a line of LED's above the digital channel display serves as an S/r-f "meter.")

Texas Instruments' SM-172 mobile unit and matching SM-173 base also display SWR when a keypad button is depressed. But more important is TI's automatic SWR monitor that automatically shuts down the transmitter when it senses that the SWR is approaching the point where transmitter damage might occur. In this event, the user is alerted by the display, "AAAAA."

Monitoring SWR is just one of several functions handled by a microprocessor built into TI's main circuit module. The processor also controls a variable-bandwidth filter that narrows when adjacent channels are busy. And when talking to another TI set on SSB, the same filter shifts frequency as well, acting as an automatic clarifier.

Microprocessors are also built into the Hy-Gain 2716 and the SBE Key-Com. Others are sure to follow suit.

Smarter Tuning. Microprocessors and other digital techniques are changing the way we tune our transceivers—and for the better. Most of the new digital sets have two-button tuning—one button to scan up the scale, and the other to scan down. (An improvement I'd like to see here is the inclusion of a soft beep each time the channel changes, so a driver could count how many channels he's shifted without taking his eyes off the road. With a nondigital set, one can count clicks.)

Several SBE and SparkOmatic transceivers have two-speed tuning, so you can zip quickly to the other end of the "dial" (more time on 40 than on 23 channels), then slow down so as not to overshoot your mark. Panasonic's RJ-3450 "Big Mike" model, SBE's colorful Key-Com and TI's units scan the band to find clear channels (if you want to move your conversation to a less crowded one) or to find active ones (if you're looking for someone to talk to). SBE's version of this feature scans the whole band for an open channel and scans the 10 stations you use most (and have stored in its memory) for activity, on the assumption that you're looking for someone specific to talk to. TI's clear-channel scan returns you to the channel you were originally talking on so you can tell the other party to your conversation what channel you should both switch to.

In emergencies, you can jump directly to channel 9 by hitting just one switch or button on CB transceivers from a growing number of manufacturers, including

Johnson 4330 has remote control mike with speaker and channel indicator in separate box.

SBE Key-Com 1000 has built-in microprocessor and a calculator type keyboard channel selector.

Cobra 45XLR combines 40-channel CB with AM/FM/stereo FM.

Texas Instruments' Model SM-172 has remote computer control.

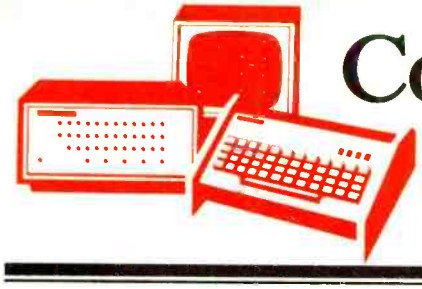
Hy-Gain, Pace, Panasonic, SBE, Sharp, and Superscope "Aircommand." To jump directly to any other station, calculator-type keyboards are used to punch in the number on many rigs: SBE's Key-Com (again), Pace's 8117 base station and the TI units, for example. The latter also have a unique, keyboard-operated selective-call system. Select a 5-digit number and a channel, tell you friends with TI units what your number is, and your receiver section will be silent until they "dial" you. Unlike most selective-call systems that use tones, the TI sets can access up to 100,000 CB "phone numbers" for each AM or SSB channel and store the five most frequently called numbers in a memory, to be recalled at the touch of a key.

Interestingly, there's a move afoot at the Electronic Industries Association to standardize selective calling signals for CB radio use. The purpose is to head off incompatibility among products of different manufacturers.

Rigs That Remember. Memory—another digital feature—is found on many of the latest transceivers. Sharp's IMC and Hy-Gain's 2716 remote models are examples of CB transceivers that remember which channel you last used so you don't have to re-tune to it when you turn the unit on again. The 2716 also remembers other settings when it's in "stand-by" mode. SparkOmatic has a model with a 5-channel memory. You can use its scanning feature or manual tuning to search through all 40 channels or just through the 5 channels you use most in search of activity. Pace's 8047 can scan channel 9, 19 and any other channel you choose and its 8117 base station has a 10-channel memory that can be scanned as does SBE's Key-Com mobile. Both Sharp and Superscope Aircommand have models that monitor channel 9 as well as the channel you're using.

These weren't the only CB products at CES of course; just some of the ones with the most exotic features. Furthermore, not all CB manufacturers exhibited at CES. And at least one who did—Motorola—held off introducing new CB models so that it could show them for the first time a few weeks later at a distributor's convention. Here it introduced a 40-channel base station with an automatic "on-setting" digital clock function (Model 4025) and an under-dash "public safety" monitor mobile (Model 4009) with dual receivers that features a channel 9 crystal that can be replaced by another channel's crystal.

About the only other possible trend observed was the growing number of CB in-dash "entertainment centers" available. That is, CB transceivers combined with AM, stereo FM and a choice of cassette or 8-track tape units. ◇



Computer Bits

By Leslie Solomon

MORE GOOD NEWS FOR THE COMPUTER GROUP

THE NUMBER and variety of hardware and software items available to computer hobbyists continue to increase—with no end in sight at present. Let's take a look, then, at a few of the "goodies" that have come across our desk in the last several weeks. First, the hardware items.

Radio Shack Too! The latest entry into the hobby computer scene is from Radio Shack. Packaged in an attractive and functional plastic case only 16½" by 8" by 3½" are a 53-key ASCII keyboard, a Z80 microprocessor and support logic, a video display unit, 4k of ROM and 4k of RAM (internally expandable to 12k ROM and 16k RAM), and a cassette interface. Soon to be available at most Radio Shack outlets, the wired and tested TRS-80 Microcomputer can be purchased for $399.95. An associated 12" video monitor and cassette recorder package is also available to create a complete personal computing system for $599.95.

The video display is memory mapped with graphics and alphanumerics (upper case) controlled by BASIC commands. Cursor control and automatic scrolling are also featured. Connections to the cassette recorder and the video monitor are made via rear-apron connectors. Also on the rear apron is a small door that, when opened, exposes a bus connector that is used for system expansion. Although the computer can physically hold only 16k of RAM, it has a total memory capacity of 62k by using its bus connector.

The video display is 16 lines of 64 characters but can be software controlled for 32 characters per line. The video graphics are formed on a 128 (horizontal) by 48 (vertical) matrix and both graphics and text can be interspersed in any manner by software.

The BASIC software comes in ROM and features floating point arithmetic; numeric, array, and string variables; video graphic commands; and cassette save and load commands. The software

Radio Shack's TRS-80 microcomputer system.

level is between "tiny" BASIC and "regular" BASIC and includes the special commands used for graphics.

Along with the computer, the customer will be supplied with a free cassette that "plays" blackjack (with graphics) and backgammon. Other available cassettes provide a 15-person payroll program ($19.95), a Math-1 package that teaches multiplication, addition, and subtraction, and includes a teacher's guide ($19.95 for a three cassette portfolio); a kitchen program that covers menus, conversion tables, a computer directory, and a message center ($4.95); and a personal finance program for $14.95 which includes a seven-cassette portfolio.

Radio Shack intends to support its new baby and plans to introduce Extended BASIC (more memory is required), a disc and DOS system, a hard-copy printer, an expansion unit for additional circuit boards (connecting the expandor bus), and a modem.

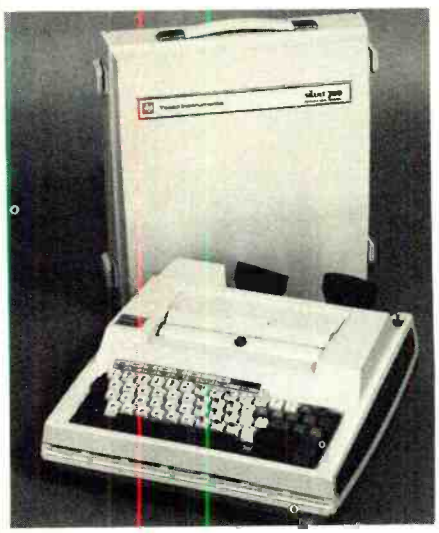
A number of interesting software packages have also been promised for the near future with the hope of making the TRS-80 a useful hobby and personal computer.

For Fans of the Z80. If you are interested in the Z80 processor, you should be aware of the Martin Research (3336 Commercial Ave., Northbrook, IL 60062; tel: 312-498-5060) MIKE-8 Model 882. It sells assembled for $895. The 882 has 4k of RAM, a 1k monitor program in PROM, and a "console" board with a calculator-type of keypad and six 7-segment LED displays. Besides the usual functions, the monitor offers advanced debug features, RAM test, signal-step, and trap setting. The system also includes a 2708 PROM programmer and a UV erase lamp. The Model 882 is mounted on a base and has its own switching regulator power supply. The firm's Microcomputer Design book fills out the package.

PROM Programming. Oliver Audio Engineering (7330 Laurel Canyon Blvd., North Hollywood, CA 91605; tel: 213-765-8080), which introduced the low-cost optical tape reader some time ago, has now introduced a new PROM programmer, the OAE PP-2708/16. (As a kit, it is $249; wired and tested, it's $299.) Containing address counters, timing and control logic, switching voltage regulator, and a zero-insertion-force socket, this new programmer can handle either the 1k 2708 or the new 2k 2716 PROM's. A simple parallel interface connects the programmer to almost any microcomputer and very little software is required to support the system. You just dump the data via the output port into the PROM. The system comes with one 8-bit I/O port and three switch-programmable status lines, with all lines TTL compatible. A 5-foot, flat ribbon cable is provided.

Cassette Interface. Compatible with the Altair/S-100 bus, the Universal Cassette Recorder Interface (UCRI) is now available from Dajen Electronics (7214 Springleaf Ct., Citrus Heights, CA 95610; tel: 916-723-1050) for $135 in kit form, $175 assembled and tested. Using bi-phase recording and having no adjustments, the UCRI can operate from 520 to 41,000 baud—switch selectable. There is also a switch-selectable board address, and independent selection of transmit and receive data inversion for use with different recorders. A level-indicator light comes on at correct levels, and a sync indicator light shows reception of the sync byte. User selectable sync character, under software control allows Tarbell, KC or other sync character format. Relay options for control of two recorders are available. An independent latched input port can be used for a keyboard. Output connectors for recorder and parallel port, recorder cable, IC sockets, pre-recorded cassette with sync, and a full manual are included.

Super Hobby Terminal. If your dreams include a super hard-copy terminal, take a look at the new Texas Instruments Silent-700 Model 765 Portable Memory Terminal or the Model 763 Memory Send-Receive Terminal. About the size of an office typewriter, the 765 is designed for portable use and includes a



TI's Silent 700 Terminal.

built-in carrying case and a phone coupler. The 763 is for use where portability is not required.

Each of these new terminals comes with 20k characters of nonvolatile bubble memory expandable to 80k. A 9900 processor controls the system. Both units include a keyboard with upper and lower case, a built-in calculator-type numeric keypad cluster, and a quiet 30-character/second nonimpact printer. Both models have file management systems, and an operator command mode to allow the user to select the communications mode, configure memory, and enter or edit text. The Model 765 is $2995 and the 763 is $2695.

Economical Terminal. If you have a computer, the next thing you need is a CRT-type terminal so you can "talk" to your machine. Southwest Technical Products (219 W. Rhapsody, San Antonio, TX 78216), the producer of the CT-1024 terminal, has announced its CT-64 CRT Terminal ($325 in kit form, with assembled CT-VM Video Monitor $175). This new terminal features 16 lines of 32 or 64 characters per line, scrolling or page operation, upper and lower case, reversed character printing, full cursor control, and complete character decoding. The kit includes power supply, keyboard, serial I/O, beeper, chassis, and cover.

6800 Software. Impro Micro Systems (Box 7776, Van Nuys, CA 91409) recently announced its MIKADOS+D (mini instant keyboard assembler, debug, operating system + disassembler) package. The $17.95 software package occupies only 3k of RAM and with 4k bytes, 1k is still left for user programs and the label table. The assembler generates object code for the 72 basic variable-length 6800 instructions with all addressing mode variations—a total of 197 different instructions. The assembler generates object code for user-entered mnemonics, enters them into memory, and outputs formatted object code and address on the same line as user input. Relative addressing for branch instructions with symbolic labels are resolved,

Martin MIKE-8 882 processor.

and a label table is maintained. There are 18 useful directives on line at all times including ASCII character I/O, hex character input formatted hex character output, disassembly of object code into source code with complete instruction mnemonics and absolute branch addresses, label table formatted output, data transfer from one memory area to another, clearing all or part of memory, controlling execution of user programs, setting and clearing breakpoints, and setting and clearing monitor points.

Another 6800 software producer, TSC (Technical Systems Consultants, Box 2574, W. Lafayette, IN 47906) has announced its Text Editing System (stock number SL68-24 at $23.50) which supports many of the standard commands such as PRINT, INSERT, DELETE, FIND, REPLACE, and VERIFY. It also provides file TOP and BOTTOM, an APPEND command allowing any string to be added to any or all lines starting in a specified column, text block COPY and MOVE, and an extensive CHANGE command that allows changing any or all specified occurrence of one string into a second string. Other features include TAB, SET, NUMBERS, EXPAND, NEXT, RENUMBER, STOP, LOG, and OVERLAY that allows line changing by typing over an existing line. There is a HEADER command, a ZONE feature and, for tape users, READ, WRITE, and SAVE.

6502 Software. If you are more concerned with the 6502, you should know that Microcomputer Associates Inc. (2368-C Walsh Ave., Santa Clara, CA 95050; tel: 408-247-8940) has a new 6502 RAP (resident assembler program) and Tiny BASIC on ROM. The two 2k ROM's house the 1.75k resident assembler and the 2.2k Tiny BASIC. RAP is a single-pass resident assembler. Statements are entered either from paper tape or from a terminal keyboard, and RAP generates a listing and places object code into RAM for immediate execution. A minimum of 4k RAM is needed in the user's computer. Tiny BASIC statements include LET, IF, THEN, INPUT, GOTO, GOSUB, RETURN, END, REM, CLEAR, LIST, RUN, RND, and USR (user subroutine). The ROM software has been designed so that most I/O devices can be used. The RAP/Tiny BASIC package (SW101) is $200 with full documentation. Tiny BASIC is available in paper tape format (SW300) for $25, or in nine 1702A PROM's (SW202) for $275.

Altair 680 Doings. If you have an Altair 680b, you should be aware that MITS has introduced the 680b-KCACR Audio Cassette Interface for this machine. Using the KC Standard, the device features a digital demodulator, CMOS logic, motor control for starting and stopping tape motion, test points at all key circuits, and sockets for all IC's. BASIC Version 1.2 is available on cassette and includes all standard functions, plus the capability of storing and loading software through the KCACR.

Three-Dimensional Graphics. Sublogic Co. (Box 3442, Culver City, CA 90230) has a new software package that will provide 3-dimensional graphics for microcomputers. With it, you can view two-dimensional perspective projections of three-dimensional scenes from any location in space. A minimal subset BASIC version of the package, for $22 is for general-purpose, slow-speed graphics on any system. Another version, the 6800, at a slightly higher price, has optimized assembly language with dynamic graphic capabilities for advanced simulation and complex graphics. Driving and flying simulations, artistic projections, design projections, engineering analysis, and advanced games are possible uses. ◇

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High Band	148—174 MHz
UHF Band	450—470 MHz
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Audio Output
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U bands slightly less

Selectivity
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Published by Scientific Research Institute, Box 2096, Ashland, VA 23005. Vol. I, 292 pages. Vol. II, 243 pages. Both soft cover, $24.95 each.

HOBBY/EXPERIMENTER GUIDES

In *Electronic Components* ($5.25, 104 pages), author M.A. Colwell details the different types of electronic components, what they are and what they do, and how to choose the right component for the job. The lineup includes all the commonly used components, including electromechanical and electromagnetic types. The text tells how to recognize faults and how to prevent breakdowns. Photos and drawings help to identify the various components. *Electronic Diagrams* ($4.95, 104 pages), also by Mr. Colwell, takes the reader through the logical steps of building up circuit diagrams from elementary circuit symbols. Illustrations and descriptions explain how to read circuit diagrams, block diagrams, flow charts, graphs, and oscillograms. *Printed Circuit Assembly* ($4.50, 88 pages), by M.J. Hughes and M.A. Colwell, describes the characteristics of the various bases used in printed-circuit systems and guides the reader through the stages of translating diagrams into pc layouts. Image transfer, etching, milling, and trimming methods are described.

Distributed by Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. Soft cover.

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by A. Malvino and D. Leach

This book introduces the reader to digital electronics through a historical discussion, and examination of logic families, number systems, binary codes, Boolean algebra, arithmetic circuits, and sequential logic. Logic simplification, registers, counters, D/A and A/D converters, I/O devices, and memories are explored. Revisions of the book include new chapters on Karnaugh mapping and computer organization, discussions of TTL, ECL, and CMOS logic, material on discrete, dot- and bar-matrix displays, and standard SSI, MSI and LSI circuits. An understanding of semiconductors and electronics is advised. Summaries, glossaries, review questions and problems appear at the end of each chapter.

Published by McGraw-Hill Book Co., 1221 Ave. of the Americas, New York, NY 10020. 436 pages. $13.95 hard cover.

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Paco Model S-50 push-pull oscilloscope. Schematic and/or service calibration data. David N. Tenney, Apt. C, 1528 Lee St., Charleston, WV 25311.

RCA Model 1-MBT-6, S/N RVU-006521 "Strato World" radio. **Chrysler** Model S/N MB 174 auto radio. Schematics needed. Jose Varas, 515 4th St., Union City, NJ 07087.

Heathkit Model OM-3 oscilloscope. Operating and assembly manuals needed. M. Chadwick, 1465 Stuckert Rd., Warrington, PA 18976.

Heathkit Model FMO-1 FM oscillator. Manual needed. C.E. Garrison, Meadowvale Rt.3, Warrenton, VA 22186.

Heathkit DX100. Instruction manual and wiring harness hookup information. A.B. Coleman, 3396 Via Arnez, Lompoc, CA 93436.

Knight-Kit wireless broadcaster amplifier. Schematic and/or parts list. John S. Williams, Rt.1 Box 312 E, Zanesville, OH 43701.

Sylvania Model CTR-175W stereo cassette recorder with AM-FM radio. Schematics and operation manual. Stan Pittman 110 Michigan #115, Lawrence, KS 66044.

Precise Model 30 oscilloscope. Need operating instructions. Anthony Vilale, 5222 9th Ave., Brooklyn, NY 11220.

Stephens "Truphonic" midrange horn system. Need hookup data and parts source. Frank J. Burris, 35640 Avenue F, Yucaipa, CA 92399.

SCM Marchant Model "Cogito" 240 SR calculator. Logic, schematic and wiring diagrams and operating manual. Dan Entingh, 511½ Colorado Ave., La Junta, CO 81050.

Signal Corp. U.S. Army BC-348-P receiver. Operator's manual needed. Owen Scotland, Box 356, Cayman Islands, B.W.I.

Sierra Model 121A wave analyzer. Schematic and/or service manual. Charles H. Scholten, 1313 Marshall St., Manitowoc, WI 54220.

Precision Apparatus Series 10-54 tube and set tester. Operating instructions, schematic and servicing instructions. Martin A. Weiner, 16 Judith Lane, Monsey, NY 10952.

Superior Model 85 tube tester. Tube chart needed. C.A. Harris, Box 20 C, Glasgow A.F.B., MT 59231.

Radio Apparatus Model M-51A 30-50-MHz receiver. Schematic and/or service manual. David Roe, 631 N.W. 22, Oklahoma City, OK 73103.

Dumont Type 304A oscilloscope. Technical information or instruction manual. Glen A. Kilts, 8214 McClelland Pl., Alexandria, VA 22309.

Kinsman Duchess Model E electronic organ. Need diagram of generator. W.H. Weiss, 1208 Greenhill Dr., Wausau, WI 54401.

Jackson Electronic Model 641-A FM-AM signal generator. Schematic and alignment information. Bob DeVance, Box 13038, Omaha, NB 68113.

Panoramic Model PCA-2 T200 panadaptor. Operator or service manual. **Servo** Model R5200 receiver. Operator or service manual. John W. Schwerdtfeger, 5361 Westminster, Austin, TX 78723.

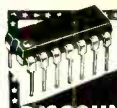
Hallicrafters Model SX-71 shortwave receiver. Operating manual or any available information. Jeff Cherry, 603 S. Cedar, Brea, CA 92621.

Pilot Model R-700 stereo receiver. Tape monitor switch and balance control or schematic. Richard K. Shadduck, 209 Camelford Rd., McMurray, PA 15317.

Hallicrafters Model S-40A receiver. Schematic and manual. John Myers, 138 W. Harrison St., Alliance, OH 44601.

Grundig Model 2220-U AM/FM/SW radio (circa 1955). Schematic needed. Al Cowan, 3101 Lorna Rd., #1824, Birmingham, AL 35216.

(continued on page 120)



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74LS02	.28	74LS37	.33	74LS93	.57	74LS160	1.02	74LS253	.84
74LS03	.28	74LS38	.33	74LS107	.39	74LS161	1.02	74LS257	.75
74LS04	.29	74LS40	.28	74LS109	.39	74LS162	1.02	74LS258	.75
74LS05	.29	74LS42	.67	74LS112	.39	74LS163	1.02	74LS266	.39
74LS08	.29	74LS47	.79	74LS113	.39	74LS164	1.02	74LS283	.79
74LS09	.29	74LS48	.77	74LS114	.39	74LS168	1.14	74LS290	.65
74LS10	.28	74LS51	.28	74LS125	.49	74LS169	1.14	74LS293	.65
74LS11	.28	74LS54	.28	74LS126	.49	74LS170	1.73	74LS365	.67
74LS12	.28	75LS55	.28	74LS132	.81	74LS173	1.34	74LS366	.67
74LS13	.47	74LS73	.39	74LS136	.39	74LS174	1.06	74LS367	.67
74LS14	1.02	74LS74	.39	74LS138	.73	74LS175	.84	74LS368	.67
74LS15	.28	74LS75	.53	74LS139	.73	74LS190	1.18	74LS386	.39
74LS20	.28	74LS76	.39	74LS151	.75	74LS191	1.18	74LS670	2.34
74LS21	.28	74LS78	.39	74LS153	.75	74LS196	.86	81LS95	.77
74LS22	.28	74LS83	.79	74LS154	1.10	74LS197	.86	81LS96	.77
74LS26	.33	74LS86	.39	74LS155	.75	74LS247	.79	81LS97	.77
74LS27	.33			74LS156	.75			81LS98	.77

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7400	.21	7476	.32	74181	2.15	4012	.23	4520	1.14
7401	.21	7480	.70	74182	.79	4013	.40	4527	1.68
7402	.21	7482	.70	74184	2.19	4014	.96	4528	.88
7403	.21	7483	.70	74185	2.19	4015	.96	4585	1.23
7404	.21	7485	.89	74188	3.50	4016	.40	2102-1	1.79
7405	.21	7486	.28	74189	3.50	4017	1.05	8080A	12.95
7406	.25	7489	2.19	74190	1.23	4018	1.05	CA3046	.75
7407	.25	7490	.44	74191	1.23	4019	.23	LM2111N	1.25
7408	.21	7491	.70	74192	.88	4020	1.14	LM309K	1.80
7409	.21	7492	.44	74193	.88	4021	1.14	LM324A	1.28
7410	.21	7493	.44	74194	.88	4022	.96	LM340T-5	1.25
7411	.21	7494	.70	74195	.88	4023	.23	LM340T-6	1.25
7412	.21	7495	.70	74196	.88	4024	.84	LM340T-8	1.25
7413	.25	7496	.70	74197	.88	4025	.23	LM340T-12	1.25
7414	.89	74100	1.28	74198	1.49	4026	1.68	LM340T-15	1.25
7416	.25	74107	.30	74199	1.49	4027	.40	LM340T-18	1.25
7417	.25	74109	.33	74251	1.09	4028	.89	LM340T-24	1.25
7420	.21	74121	.35	74279	.55	4029	1.14	LM3900N	.88
7421	.25	74122	.61	74365	.67	4030	.23	LM3909N	.69
7423	.35	74123	.61	74366	.67	4033	1.51	MC1456V	1.00
7425	.35	74125	.40	74367	.67	4034	3.50	MC1458V	.53
7426	.25	74126	.40	74368	.67	4035	1.14	MC3302P	1.15
7427	.33	74132	.70	8093	.40	4040	1.14	NE536T	3.24
7428	.28	74141	.88	8094	.40	4041	.79	NE540L	2.04
7430	.21	74143	.70	9095	.67	4042	.70	NE555V	.48
7432	.25	74147	1.63	8096	.67	4043	.70	NE556A	.88
7433	.30	74148	1.30	8097	.67	4044	.70	NE560B	3.83
7437	.25	74150	1.16	8098	.67	4046	1.86	NE561B	3.83
7438	.25	74151	.70	75150	1.16	4049	.40	NE562B	3.83
7440	.21	74153	.65	75450	.88	4050	.40	NE565A	1.25
7442	.53	74154	1.03	75451	.61	4051	1.26	NE566V	1.28
7443	.63	74155	.70	75452	.61	4052	1.26	NE567V	1.36
7445	.70	74156	.70	75453	.61	4053	1.26	uA709CV	.44
7446	.70	74157	.70	75454	.61	4060	1.58	uA710CA	.44
7447	.70	74160	.88	75491	.81	4066	.79	uA711CA	.53
7448	.70	74161	.88	75492	.84	4071	.23	uA723CA	.60
7450	.21	74162	.88	75493	1.09	4072	.23	uA733CA	.75
7451	.21	74163	.88	75494	1.19	4073	.23	uA741CV	.44
7453	.21	74164	.96	82525	2.19	4075	.23	uA747CA	.70
7454	.21	74165	1.15	4000	.23	4081	.23	uA748CV	.49
7459	.21	74166	1.26	4001	.23	4082	.23	uA7805CU	1.25
7460	.21	74170	2.64	4002	.23	4502	.79	uA7806CU	1.25
7470	.30	74173	1.42	4006	1.23	4510	1.14	uA7808CU	1.25
7472	.30	74174	.98	4007	.23	4511	1.05	uA7812CU	1.25
7473	.30	74175	.93	4008	.79	4514	2.80	uA7815CU	1.25
7474	.30	74176	.79	4009	.44	4515	2.80	uA7818CU	1.25
7475	.49	74177	.79	4010	.44	4516	1.23	uA7824CU	1.25
		74180	.70	4011	.23	4518	1.14		

MPS918	.16	1.55/10	MPS3640	.16	1.55/10	PN5133	.16	1.55/10
MPS930	.16	1.55/10	MPS3641	.16	1.55/10	PN5134	.16	1.55/10
MPS2222A	.16	1.55/10	MPS3643	.16	1.55/10	PN5137	.16	1.55/10
MPS2369A	.16	1.55/10	MPS3646	.16	1.55/10	PN5138	.16	1.55/10
MPS2712	.16	1.55/10	2N3904	.16	1.55/10	PN5139	.16	1.55/10
MPS2907A	.16	1.55/10	2N3906	.16	1.55/10	2N5210	.16	1.55/10
MPS3392	.16	1.55/10	2N4124	.16	1.55/10	DK3055	.68	6.59/10
MPS3393	.16	1.55/10	2N4126	.16	1.55/10	2N3055	.99	9.20/10
MPS3394	.16	1.55/10	2N4401	.16	1.55/10	MJ2955	.99	9.20/10
MPS3395	.16	1.55/10	2N4403	.16	1.55/10	MJE102	.36	3.35/10
MPS3563	.16	1.55/10	2N4410	.16	1.55/10	2N5457	.48	4.50/10
MPS3565	.16	1.55/10	2N5087	.16	1.55/10	MPSA13	.28	2.60/10
MPS3638	.16	1.55/10	2N5089	.16	1.55/10	MJ2955	.99	9.20/10
			PN5129	.16	1.55/10	TIP120	.99	9.20/10

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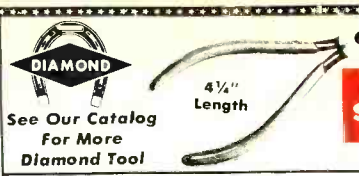
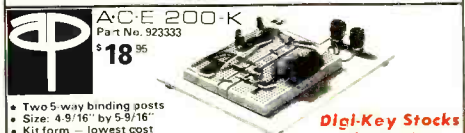


See Our Catalog For More Diamond Tool

MS54 $6.58



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1X Scale PC Design Template

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No. 3365 $12.50

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NSN374 .3" Dual Digits, CA		$2.20
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NSN584 .5" Dual Digits, CA		$2.60
NSN783 .7" Dual Digits, CC		$3.00
NSN784 .7" Dual Digits, CA		$3.00
NSL5053 T-1¾ Lamp	$1.80/10	$16.00/100
NSL5056 T-1¾ Lamp	$1.80/10	$16.00/100

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The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

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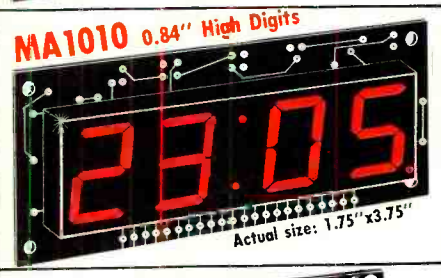
MA1002A SET	Module with Trans former & Switches	$13.95	MA1010A SET	Module w/Transformer & Switches	$16.45
MA1002C	.5" LED 24 Hour Clock Module	$10.50	MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1002C SET	Module w/Transformer & Switches	$13.95	MA1010C SET	Module w/Transformer & Switches	$16.45
MA1003	12 Volt Car Clock with Switches	$24.95			

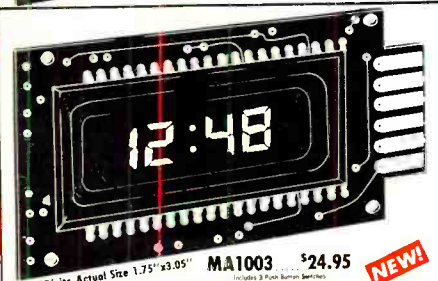
MA1002 0.5" High Digits

Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits



Actual size: 1.75"x3.75"



0.3" Digits Actual Size 1.75"x3.05"

MA1003 $24.95 Includes 3 Push Button Switches

NEW!

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS	AXIAL LEADS		VALUE	RADIAL LEADS	AXIAL LEADS	
.47/50V	.08	.65/10	.11	.90/10			
1/50V	.08	.65/10	.11	.90/10	100/50V 21	1.17/10	.29	2.30/10
2.2/50V	.08	.65/10	.12	.90/10	220/10V 13	1.08/10	.18	1.42/10
3.3/50V	.08	.65/10	.12	1.00/10	220/16V 15	1.16/10	.20	1.55/10
4.7/35V	.08	.65/10	.12	.95/10	220/25V 21	1.71/10	.29	2.35/10
4.7/50V	.08	.68/10	.12	1.00/10	220/35V 25	2.03/10	.35	2.79/10
10/16V	.08	.65/10	.11	.90/10	220/50V 29	2.35/10	.40	3.23/10
10/25V	.08	.65/10	.12	1.00/10	330/6V 14	1.12/10	.19	1.48/10
10/35V	.09	.70/10	.13	1.10/10	330/10V 15	1.16/10	.21	1.64/10
10/50V	.10	.75/10	.14	1.15/10	330/16V 21	1.66/10	.31	2.45/10
22/16V	.08	.67/10	.12	1.00/10	330/25V 23	1.86/10	.38	3.07/10
22/25V	.09	.70/10	.13	1.05/10	330/35V 33	2.66/10	.43	3.43/10
22/35V	.11	.85/10	.15	1.19/10	330/50V 54	4.30/10	.60	4.81/10
22/50V	.12	1.00/10	.17	1.32/10	470/6V 15	1.21/10	.20	1.61/10
33/16V	.09	.75/10	.12	1.00/10	470/10V 21	1.71/10	.31	2.45/10
33/25V	.10	.81/10	.14	1.15/10	470/16V 23	1.81/10	.33	2.66/10
33/35V	.13	1.05/10	.17	1.34/10	470/25V 29	2.35/10	.43	3.43/10
33/50V	.14	1.13/10	.19	1.52/10	470/35V 41	3.27/10	.47	3.78/10
47/10V	.09	.71/10	.13	1.04/10	470/50V 54	4.30/10	.75	6.03/10
47/16V	.10	.81/10	.14	1.15/10	1000/6V 22	1.90/10	.35	2.76/10
47/25V	.13	1.05/10	.17	1.30/10	1000/10V 24	1.96/10	.38	3.07/10
47/35V	.14	1.13/10	.19	1.51/10	1000/16V 29	2.35/10	.43	3.43/10
45/50V	.15	1.21/10	.21	1.71/10	1000/25V 42	3.33/10	.68	5.42/10
100/10V	.10	.77/10	.14	1.13/10	1000/35V 60	4.81/10	.75	6.03/10
100/16V	.11	.85/10	.17	1.30/10	2200/6V 36	2.86/10	.43	3.43/10
100/25V	.13	1.10/10	.20	1.55/10	2200/10V 42	3.33/10	.60	4.81/10
100/35V	.17	1.41/10	.25	1.93/10	2200/16V 54	4.30/10	.68	5.42/10

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28 Pin Solder	.45	4.25/10
40 Pin Solder	.63	6.00/10
8 Pin W-W	.24	2.30/10
14 Pin W-W	.26	2.50/10
16 Pin W-W	.30	2.85/10
18 Pin W-W	.60	5.70/10
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28 Pin W-W	1.12	10.00/10
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24 ga PVC	2.10/100'	8.50 500'
26 ga PVC	2.10/100'	8.50 500'

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470 pf	.40/10	3.50/C
.001 uf	.40/10	3.50/C
.0022 uf	.40/10	3.50/C
.0047 uf	.40/10	3.50/C
.01 uf	.45/10	3.65/C
.022 uf	.50/10	4.00/C
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.1 uf	1.35/10	11.50/C

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1N5231B	5.1v	.15	$11/C
1N5232B	5.6v	.15	$11/C
1N5233B	6.0v	.15	$11/C
1N5234B	6.2v	.15	$11/C
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1N4006	.90/10	7.75/C	$77/M
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4-40 1/2 Screw	.60/C	4.05/M
6-32 1/4 Screw	.65/C	4.40/M
6-32 1/2 Screw	.75/C	4.85/M
8-32 3/8 Screw	.90/C	5.85/M
8-32 5/8 Screw	.99/C	7.00/M
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7401	.21	7448	1.15	74121	.55
7402	.21	7450	.26	74122	.49
7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

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74L30	.33	74LS20	.39	74LS174	2.50
74L42	1.50	74LS51	.39	74LS386	5.50
74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.65	74S387	1.95

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74H00	.33	74H11	.33	74H53	.39
74H01	.33	74H20	.33	74H55	.39
74H04	.33	74H21	.33	74H73	.59
74H05	.35	74H30	.33	74H74	.59
74H10	.33	74H40	.33	74H76	.65

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MC790P	1.50	MC1595L	6.25
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MC844	1.25	MC1810P	1.25
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MC876P	2.25	MC3007P	2.25
MC1004L	1.25	MC3021L	2.15
MC1010L	1.25	MC3060L	2.65
MC1305	1.95	MC3062L	3.00
MC1352P	1.55	MC4024P	2.20
MC1357	1.70	MC4044P	4.80
MC1371	1.85	MC14507CP	1.25
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4002AE	.29	4024AE	1.50
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4010AE	.58	4028AE	1.60
4011AE	.29	4029AE	2.90
4012AE	.29	4030AE	.65
4015AE	1.25	4037AE	4.50
4016AE	.65	4040AE	2.40
4018AE	1.10	4044AE	1.50
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75452BP	.39	LM309K	1.25	LM748H	.45
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75454BP	.39	LM318N	1.50	N5556V	1.50
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75492BP	.85	LM351AN	.65	NE555V	.60
CA3005	1.60	LM370N	1.25	NE556	1.50
CA3006	3.50	LM380N	1.45	UA702	.80
CA3018	1.10	LM566	2.25	UA703CH	.45
CA3018A	1.60	LM711CH	.60	UA709CH	.30
CA3026	1.50	LM723H	.75	UA749CH	.45
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				LM340T0-6	1.75
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				LM340T0-18	1.75
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2SA495	1.65	2SC380	.70	2SC781	3.00	2SC1317	.60	2SD201	1.95
2SA496	1.15	2SC381	.70	2SC784	.70	2SC1318	.70	2SD213	3.75
2SA497	1.00	2SC382	.70	2SC785	1.00	2SC1327	.70	2SD218	4.75
2SA562	.70	2SC387	.70	2SC788	2.15	2SC1342	.50	2SD223	4.50
2SA564	.50	2SC394	.70	2SC789	1.00	2SC1347	.80	2SD234	1.00
2SA606	4.25	2SC403	.65	2SC790	1.75	2SC1359	.65	2SD235	1.00
2SA628	.65	2SC454	.65	2SC793	2.50	2SC1377	5.50	2SD257	2.00
2SA634	1.25	2SC458	.70	2SC798	3.10	2SC1382	1.00	2SD261	.80
2SA636	1.25	2SC460	.70	2SC799	3.50	2SC1383	.75	2SD287	4.00
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2SA679	3.75	2SC484	3.75	2SC829	.75	2SC1449	1.30	2SD313	1.10
2SA680	3.75	2SC485	3.25	2SC830	1.60	2SC1475	1.50	2SD314	1.10
2SA682	.85	2SC493	2.75	2SC838	.70	2SC1507	1.25	2SD315	.75
2SA683	.90	2SC494	3.50	2SC839	.85	2SC1569	1.25	2SD318	.95
2SA684	.95	2SC495	1.10	2SC853	1.00	2SC1675	1.75	2SD325	1.25
2SA699	1.30	2SC496	1.15	2SC866	5.85	2SC1678	5.50	2SD330	1.50
2SA699A	1.45	2SC497	1.60	2SC871	.70	2SC1679	4.75	2SD331	.90
2SA706	.55	2SC502	1.50	2SC900	.70	2SC1728	2.15	2SD350	3.25
2SA733	.65	2SC509	1.25	2SC922	.55	2SC1730	.60	2SD360	1.50
2SA777	.90	2SC515	.80	2SC929	.70	2SC1756	1.25	2SCF8	3.50
2SB22	.65	2SC517	4.25	2SC930	.65	2SC1760	2.15	2SCF6	1.25
2SB54	.70	2SC535	.75	2SC938	.65	2SC1816	4.50	2SF8	3.00
2SB56	.70	2SC536	.65	2SC945	.65	2SC1908	.70	HEPS3001	3.25
2SB77	.70	2SC537	.70	2SC1000	.65	2SC1909	4.75	JSP7001	.75
2SB175	.55	2SC808	4.90	2SC1013	1.50	2SC1957	1.50	MRF8004	3.00
2SB186	.60	2SC809	4.90	2SC1014	1.50	2SC1964	4.75	MPS8000	1.25
2SB187	.60	2SC614	3.80	2SC1017	1.50	2SC1973	1.50	MPS8001	1.25
2SB324	1.00	2SC619	.70	2SC1018	1.50	2SC1974	4.90	MPSU02	.50
2SB337	1.75	2SC620	.80	2SC1034	3.50	2SC1975	4.90	MPSU31	4.00
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2SB407	1.65	2SC674	.60	2SC1080	3.75	2SC2029	4.75	SK3048	3.25
2SB415	.85	2SC708	3.00	2SC1096	1.20	2SC2034	3.00	SK3049	4.75
2SB435	.75	2SC710	.70	2SC1098	1.15	2SC2074	3.00	SK3054	1.25
2SB461	1.25	2SC711	.70	2SC1115	2.75	2SC2075	5.50	2SK19	1.75
2SB463	1.65	2SC712	.70	2SC1116	4.00	2SC2091	1.10	2SK30A	1.00
2SB474	1.50	2SC715	.70	2SC1124	1.25	2SC2092	4.75	2SK33	1.20
2SB481	2.10	2SC730	.65	2SC1166	.70	2SC2166	4.75	2SK41	1.75
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2SC116	3.00	2SC735	.70	2SC1209	.75	2SD81	3.25	4004	3.00
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2N173	1.75	2N1907	4.10	2N2906	.25	2N3563	.20	2N3955	2.45	2N4443	1.35
2N338A	1.05	2N2102	.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55
2N404	.75	2N2160	.70	2N2907	.25	2N3638	.20	2N3958	1.20	2N5061	.30
2N443	2.50	2N2218	.25	2N2907A	.30	2N3642	.20	2N4037	.60	2N5064	.50
2N508A	.45	2N2218A	.30	2N2913	.75	2N3643	.20	2N4093	.85	2N5130	.20
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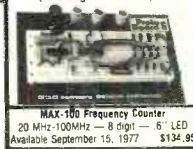

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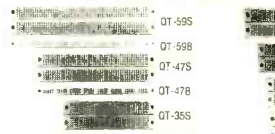

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- Doze Button
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- AM-PM Indicator
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- Three Stopwatches in One Times Single Event — Split & Taylor
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This 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.

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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 2½" x 1". It utilizes a MAN72 high brightness readout and the MM5314 clock chip.

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115 VAC
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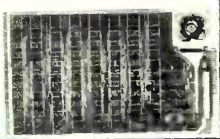

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Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16"

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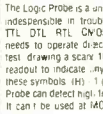
$9.95 Per Kit
printed circuit board



T²L 5V 1A Supply

This is a Standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only

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SN7402N	.21	SN7470N	.45	SN74155N	.99
SN7403N	.16	SN7472N	.39	SN74156N	.99
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SN7406N	.20	SN7475N	.50	SN74161N	.99
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SN7408N	.25	SN7479N	5.00	SN74164N	1.10
SN7409N	.25	SN7480N	.50	SN74165N	1.10
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SN7440N	.15	SN74126N	.60	SN74193N	.89
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CD4002	.25	CD4040	2.45	74C04N	.75
CD4006	2.50	CD4042	1.90	74C10N	.65
CD4007	.25	CD4044	1.50	74C20N	.65
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CD4019	.55	CD4060	3.25	74C151	2.90
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CD4022	1.25	CD4069	.45	74C157	2.15
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CD4025	.25	CD4081	.45	74C163	3.00
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LM307CN	.35	LM381N	1.79	LM3053	1.50
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LM320K-12	1.35	NE565N	1.75	75453CN	.39
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LM320T-5	1.75	NE567H	1.95	75491CN	.79
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LM340K-8	1.95	LM741CH	.35	CA3080	.85
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LM340K-18	1.95	LM747H	.79	CA3083	1.60
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LM340T-6	1.75	LM748N	.39	CA3091	10.20
LM340T-8	1.75	LM1303N	.90	CA3053	1.50
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LM340T-15	1.75	LM1305N	1.40	CA3123	2.15
LM340T-18	1.75	LM1307N	.85	CA3130	1.59
LM340T-24	1.75	LM1310N	2.95	CA3140	1.25
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74LS00	29			74LS139	1.95
74LS02	29	74LS74	49	74LS151	1.55
74LS03	29	74LS75	69	74LS153	1.89
74LS04	35	74LS76	49	74LS157	1.55
74LS05	35	74LS83	1.75	74LS162	2.25
74LS06	29	74LS85	2.49	74LS163	2.25
74LS10	29	74LS86	49	74LS164	1.95
74LS13	69	74LS90	1.25	74LS174	1.95
74LS14	1.75	74LS92	1.25	74LS181	3.69
74LS20	29	74LS93	1.25	74LS190	2.85
74LS26	39	74LS95	1.95	74LS191	2.85
74LS27	39	74LS96	1.89	74LS192	2.85
74LS28	39	74LS107	59	74LS193	2.85
74LS30	29	74LS109	59	74LS194	1.89
74LS32	39	74LS112	59	74LS195	1.89
74LS40	39	74LS132	1.25	74LS251	1.75
74LS51	29	74LS136	59	74LS260	.55
74LS55	29	74LS138	1.89	74LS279	.79
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XC209	Orange	4/$1	XC22	Yellow	4/$1	XC556	Yellow	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC22	Orange	4/$1	XC556	Orange	4/$1	XC111	Orange	4/$1
	.200" dia.		XC22	RT	4/$1	XC556	Clear	7/$1		.085" dia.	
XC22	Red	10/$1	XC526	Red	5/$1				MV50	Red	6/$1
XC22	Green	4/$1	XC526	Green	4/$1						
XC22	Yellow	4/$1	XC526	Yellow	4/$1						
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INFRA-RED LED
⅛ x ⅛ x 1/16
Flat **5/$1.00**

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DL707 — UL338

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MAN 7	Common Anode	.300	1.25	DL707	Common Anode	.300	.99
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MAN 52	Common Anode-green	.300	.99	DL 747	Common Anode	.600	2.25
MAN 64	Common Anode-red	.400	.99	DL 750	Common Cathode	.600	2.49
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NEW! 25 Pin Version with colon & am/pm indicator

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- ⅛" ht. • Common Cathode Red
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- 7 segment Monolithic
- Dip Package

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3 Digit .89	.79
4 Digit .99	.89
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18 pin	.29	.28	.27	40 pin	.63	.62	.61
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18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

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50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$10.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1977A Catalog
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- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)

Complete with built-in bit and sleeve

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

$11.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.45 ea.**
- Cuts wire to desired length
- Strips 1" of insulation

Specify — Blue-Yellow-White-Red

B&K PRECISION **New**

3½-Digit Portable DMM

- Overload Protected • .3" high LED Display
- Battery or AC operation • Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution • Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage: ±0-1000V/AC Voltage: 0-1000V Freq. Response. 50-400 HZ/DC-AC Current: 0-1000mA Resistance: 0-10 meg ohm
Size: 6.4" x 4.4" x 2"

Comes with test leads, operating manual and spare fuse.

Model 2800	**$99.95**
AC Adapter BC-28	**8.00**
Rechangeable Batteries BP-28	**20.00**
Carrying Case LC-28	**6.00**

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

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	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
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
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
1N485A	180	10m	6/1.00	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	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

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
2N2484	4/$1.00	2N3707	5/$1.00	2N5086	4/$1.00
2N2906A	4/$1.00	2N3711	5/$1.00	2N5087	4/$1.00
2N2907A	5/$1.00	2N3724	$ .65	2N5088	4/$1.00
2N2925	5/$1.00	2N3725	$1.00	2N5089	4/$1.00
2N3053	2/$1.00	2N3903	5/$1.00	2N5129	5/$1.00
2N3055	$ .89	2N3904	4/$1.00	2N5138	5/$1.00
MJE3055	$1.00	2N3905	4/$1.00	2N5139	5/$1.00
MJE2955	$1.25	2N3906	4/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N4013	3/$1.00	2N5951	5/$1.00
2N3398	5/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
		2N4123	10/$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	.05	.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

EDMUND SCIENTIFIC
AUTUMN VALUES

NEW WIDE FIELD TELESCOPE

Astroscan lets you enjoy clear, bright, wide-angle views of stars, moon, comets, etc. Completely portable, this unique 4¼". f/4 Newtonian reflector houses top quality optics. Designed for ease of handling and use, Astroscan weighs only 10 lbs. and stands 17" high. What an instrument!

No. 2001 .....

$149.95 Ppd.

CLOSE ENCOUNTERS... THE UFO CONTROVERSY!

• 20 SLIDES W/ CASSETTE

Descriptive set compiled by noted astronomer Dr. J. Allen Hynek, professor at Northwestern U. Discusses UFO sightings occurring very close to witnesses. Describes three aspects of UFO phenomena.

No. P-42,594 .... **$14.95** Ppd.

SEE SOLAR ENERGY IN ACTION

Convert light into actual kinetic energy with this fascinating solar-powered, electric demonstrator. Interesting curio for desk or windowsill. Silicon cells powering the propeller are the same found in large solar panels. Spins whenever sun shines! Plastic cube.

No. 42,287 .....

$29.50 Ppd.

Free Catalog

FLYWHEEL GENERATOR FLASHLIGHT

$14.95 Ppd.

Never needs batteries, uses a flywheel generator to keep light bright. Each squeeze of handle gives 2 sec. flash of light. Continuous squeezing keeps light shining. Only 6-oz.

No. 61,086 ....

PROFESSIONAL TIMING ACCURACY

Hand-held electronic digital stopwatch counts up, down, and sounds alarm. Full range (9 hr. 59 min. 59 sec.); bright LED display; matrix keyboard; start/stop reset buttons. Batteries. Size: 2¾ x 4¼ x 1⅛".

No. 1692 .....

$59.95 Ppd.

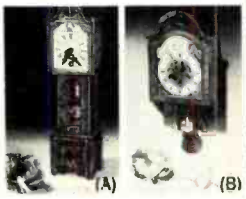
Free Catalog

BUILD A MINIATURE WORKING CLOCK

Everything you need to build these fine wooden clocks. Each contains a pre-assembled movement from Germany's Black Forest.

(A) Grandfather Clock (7x1¾x1½")
No. 72,225 .. **$10.00** Ppd.

(B) Wall Clock (8⅛x3½x1⅞")
No. 72,226 .. **$10.00** Ppd.



BUILD A WORKING STEAM ENGINE

Exact 6x8¼" replica of Single Acting Engine can power erector set assemblies, runs on dry fuel; you control speed, make whistle blow. Adult supervision. 35 parts.

No. 72,202 ...

$34.50 Ppd.

SUPER POWER FOR ANY AM RADIO

Antenna assist has pulled in station 1,000 miles off! No wires, clips, grounding. Solid state — no batteries, tubes, plugs.

No. 72,095 ...

$19.95 Ppd.

Free Catalog

Send for your FREE 164 page Edmund Scientific Catalog with over 4500 bargains

GIANT MAGNET, LITTLE PRICE!

Tie a line to our over-150 lb.-lift ceramic magnet and haul up treasure from the sea. 4 ceramic magnets, in series, between steel plates. A 1-lb. "giant"!

No. 42,318 (1x1¼x4⅜") ....

$11.95 Ppd.

FREE CATALOG

EDMUND SCIENTIFIC CO.
Dept. AV20, Edscorp Bldg.
Barrington, New Jersey 08007

Send GIANT 164 Page Catalog packed with unusual bargains.

Name _____

Address _____

City _____

State _____ Zip _____

Charge My ☐ Amer. Exp ☐ BAC (VISA) ☐ MC

Interbank # _____ Acct. # _____

Card # _____ Exp. Date _____

Sig. _____

30 DAY GUARANTEE
You must be completely satisfied with any Edmund item or return it within 30 days for a full refund

EDMUND SCIENTIFIC CO.
Dept. AV19, Edscorp Bldg.
Barrington, N.J. 08007

☐ Please send me the following items I have indicated below:

Stock No.	Qty.	Price
	Handling	$1.00

Name _____

Address _____

City _____ State _____ Zip _____

HOT NEWS!

FEATURING THE BARGAINS OF THE MONTH!!!!

POLY PAKS® IS THE WORLD'S LARGEST ELECTRONIC DISCOUNT **SUPERMARKET**

OCT. 77 - POP. ELECTRONICS SPECIALS

RCA High quality "POCKET" VOM

- **1000 ohms per volt**

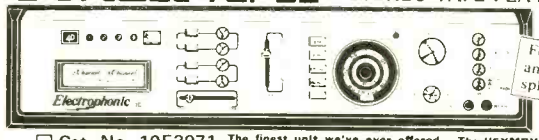
Model WV-539A. Features 1% precision, movements diode protected against burnout. Measures DC volts 0-15-150-1000; AC volts 0-15-150-1000; DC current 0-150ma; resistance X1000. Sensitivity 1000 ohms/volt AC-DC. Uses penlite cell, not included. Size 2 3/8 x 3 1/2 x 1 3/4". Wt. 5 ozs. **Cat. No. 10E3921**

$8.88

QUAD AM-FM-MPX TUNER AMP

Save $10 Now

BUILT-IN QUAD STEREO TAPE PLAYER

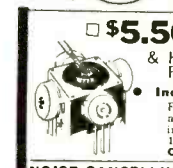


This Month Only... **69.95** ☐ Cat. No. 10E3971

Reg. $79.95 at Poly Paks!

- 5 watts per channel x 4 RMS, 20W total.
- Psychedelic panel lighting effect.
- Brushed aluminum Streamlined styling.

The finest unit we've ever offered. The "SYMPHONY" plays quad 8-track tapes in full dimension quad. Also features Matrix-Quad, derives quad sound from stereo records, tapes and FM (36° phono input cables and has outputs for 4 speakers, jacks for "Quad tape-output", and terminals for external FM antenna. Fits easily into wall, console, or cabinet of your own design. FM stereo indicator. Pushbutton switches select stereo, matrix, 4D discrete, power On/Off. Bass and treble slide control. Additional multifunction switch selects AM, FM, FM-MPX, phono, tape; blue panel lights indicate these functions. Master slide volume control with individual balance controls for each channel. Output jacks for quad headphones. Tape deck panel light indicates when a quad tape is inserted. Other lamps indicate the track being played. 115 VAC. Size: 22 x 5 x 6" deep. Wt. 9 lbs.



$5.50 TV GAME & HI-FI JOY STICK

- **Includes four 100K pots**

For TV & computer games, and quadrophonic balancing! 1 1/8 x 1 1/2 x 1". With 1" handle. Wt. 6 ozs. **Cat. No.10E3808**

NOISE-CANCELLING CB-HAM MIKE

Cuts noise of machinery, highway for clear transmission!

- **Fits virtually all rigs, everywhere!**

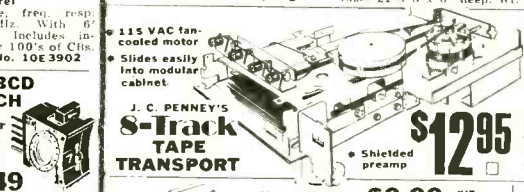
Lo-impedance, freq. resp. 300-5000 Hz. With 6' coiled cord. Includes instructions for 100's of CBs. Wt. 20 ozs. **No. 10E3902**

$6.66

EECO 10-POSITION BCD THUMBWHEEL SWITCH

1-2-4-8 BCD encoding! Positions labeled 0-7, F, L (F coded for 8, L coded for 9). White numerals on a black background. Eeco 900 series. 1 3/4 x 1 3/4 x 1/2". **Cat. No. 10E3846**

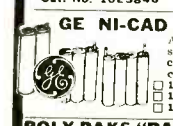
3 for $4. $1.49



J. C. PENNEY'S **8-Track TAPE TRANSPORT**

$129.95

Excellent replacement or design your own quality tape system! Automatic or manual track selection with program indicator lights. Player shuts off automatically when tape is removed. Built-in low-distortion preamp and wow free motor. With input & output cables. Requires external power supply. With instructions. Size 9 x 6 x 3 1/2". Wt. 4 lbs. **Cat. No.10E3010**



GE NI-CAD POWER PAKS

AA penlite cells, ganged in series! 1.25V each cell. Rechargeable! Wt. 2 oz. per cell.

No.	Cells	Volts	Sale
☐ 10E3688	2	2.5	$2.50
☐ 10E3689	3	3.75	3.50
☐ 10E3690	4	5.	4.50

POLY PAKS "RAMS" 2102-1 PRICES

New from top U.S.A. makers. Tested for 500 nsec. speed. **Cat. No. 10E3548**

8 FOR $9.95

Your choice **$8.88** KIT ea.

1-AMP REGULATED POWER SUPPLY

New! Easy to assemble! Uses LM340K positive voltage regulator. Reverse leads for a negative supply. Buy 2 for a ± power supply! With transformer, regulator, PC board & all components. Complete kit, nothing else to buy. Wt. 4 lbs.

2 for $15.95

Cat. No.	Volts
☐ 10E3854	5
☐ 10E3857	12
☐ 10E3858	15

$4.95

DUAL 6-WATT STEREO AMP

LM-379 ..... for AM-FM's, phonos, tape recorders, & more!! 6 watts x 2 RMS into 8 ohms, 0.5% THD, AVO 90 db type, 75 db channel separation. Supply 10-35 VDC. With specs. 2 for

Cat. No. 10E3447 ☐ $9

$3.95

MOTHERBOARD **EDGE CONNECTOR**

106 pins (53 each side). Use with IMSAI & ALTAIR! 0.125" pin ctrs, goldplated 3/8" wire wrap leads. Open ends, fit wide PC boards. 8 ozs. **Cat. No. 10E 3987**

The "Satellite" TRW 900 MHz UHF POWER TRANSISTOR

2 for $9.

NPN! CB'ers, Hams take note! Replaces many transmitter driver and output transistors. TO-131 case, 3/8" dia. with 1/2" leads. Two emitter leads. BVceo 25 V, life (beta) 30-60. Ic max 1.25 amps. **$4.95**

No. 10E3942

TTL'S We know we have the lowest prices!!

BUY 10 **15% OFF**

BUY 100 **25% OFF**

Order by Cat. No. 10E1981

Type	Sale
☐ SN7400	$0.14
☐ SN7401	.14
☐ SN7403	.14
☐ SN7404	.17
☐ SN7405	.18
☐ SN7406	.19
☐ SN4707	.24
☐ SN7410	.14
☐ SN7411	.19
☐ SN7413	.39
☐ SN7414	.61
☐ SN7416	.24
☐ SN7417	.24
☐ SN7420	.14
☐ SN7423	.26
☐ SN7427	.26
☐ SN7430	.14
☐ SN7432	.24
☐ SN7437	.24
☐ SN7438	.24
☐ SN7440	.14
☐ SN7441	.79
☐ SN7442	.49
☐ SN7443	.61
☐ SN7444	.61
☐ SN7445	.69
☐ SN7447	.69
☐ SN7450	.14
☐ SN7451	.14
☐ SN7453	.14
☐ SN7454	.14
☐ SN7455	.14
☐ SN7460	.20
☐ SN7462	.14
☐ SN7464	.14
☐ SN7465	.14
☐ SN7470	.28
☐ SN7471	.69
☐ SN7472	.26
☐ SN7473	.31
☐ SN7474	.31
☐ SN7475	.48
☐ SN7476	.33
☐ SN7478	.79
☐ SN7480	.33
☐ SN7482	.59
☐ SN7483	.69
☐ SN7485	.88
☐ SN7486	.29
☐ SN7488	2.95
☐ SN7490	.69
☐ SN7491	.63
☐ SN7492	.45
☐ SN7493	.45
☐ SN7494	.69
☐ SN7495	.69
☐ SN7496	.69
☐ SN7498	.69
☐ SN74107	.29
☐ SN74112	.19
☐ SN74113	.19
☐ SN74114	.19
☐ SN74121	.31
☐ SN74123	.49
☐ SN74125	.39
☐ SN74126	.39
☐ SN74132	.83
☐ SN74140	1.00

& Type No	
☐ SN74141	.92
☐ SN74145	.89
☐ SN74148	1.25
☐ SN74153	.63
☐ SN74154	.99
☐ SN74155	.78
☐ SN74156	.88
☐ SN74157	.64
☐ SN74160	.89
☐ SN74161	.87
☐ SN74163	.87
☐ SN74164	.95
☐ SN74165	.95
☐ SN74166	1.15
☐ SN74173	1.19
☐ SN74174	.93
☐ SN74175	.88
☐ SN74177	.77
☐ SN74179	1.49
☐ SN74180	.69
☐ SN74181	1.95
☐ SN74182	.69
☐ SN74190	1.15
☐ SN74191	.99
☐ SN74192	.83
☐ SN74193	.83
☐ SN74194	.83
☐ SN74195	.75
☐ SN74197	.75
☐ SN74199	1.69
☐ SN74200	5.50
☐ SN74251	1.39
☐ SN74284	4.25
☐ SN74285	4.25

BARREL KITS

TEST 'EM YOURSELF 'N SAVE!

EXCLUSIVE GUARANTEED 50% YIELD ON UNTESTED.....

Buy 10 BARREL KITS AND CHOOSE THE 11TH KIT Free

BARREL KIT #203 CALCULATOR KEYBOARDS

10 for $1.98

It's true! 20-key, 4 function keyboards at ridiculous give-away. Wt. 12 ozs. **Cat. No. 10E 3524**

BARREL KIT #253 LINE CORDS

8 for $1.98

100's of AC power uses! Heavy-duty, 6-ft. long, 18 gage. White vinyl insulation & molded plug. Wt. 8 ozs. **Cat. No. 10E3843**

BARREL KIT #200 6 DIGIT READOUT MODULES

5 for $1.98

Barrels and barrels and no time to test. Calculator and driver chips beneath epoxy on back. Wt. 6 ozs **10E3515**

BARREL KIT #244 HOBBY 1702A ROMS

3 for $1.98

Hobby fallouts of the famous erasable programmable ROM. 2048 bit. **Cat. No. 10E3729**

BARREL KIT #264 PRE-CUT'N'TINNED HOOKUP WIRE

200 lengths* $1.98

Breadboarders note. #22 wire, precut into 4" to 8" lengths. Asst. color plastic jackets. Wt. 12 ozs. *200 ft. approx. **No. 10E3959**

BARREL KIT #221 IC SOCKETS

8 for $1.98 hobby

Mfr unlonded! Four 14-pin, four 18-pin. Solder tail, lo-profile. **No. 10E3621**

BARREL KIT #205 MINI BLOCK CAPACITORS

50 for $1.98

Unbelievable! Worth $50. High precision submini caps for all applications. Wt. 3 ozs. **No. 10E 3528**

BARREL KIT #201 6V INDICATORS w/leads

15 for $1.98

Test lamp manufacturer dumps inventory! Worth 69¢ ea. Like grain-o-wheat. **Cat. No. 10E 3526 hobby**

BARREL KIT #194 10 AMP INLINE BRIDGES

20 for $1.98

Factory dumped in barrels. We can't test 'em, but for the price you can't go wrong. Hobby. Wt. 8 ozs. **Cat. No. 10E3475**

BARREL KIT #188 400 PARTS

$1.98

Includes resistors, caps, diodes, IC's, for PC work, some on PC boards. Dumped into barrels by factories! 100% material. Wt. 12 ozs. **Cat. No. 10E 3401**

BARREL KIT #184 ¼-WATT METAL FILM

150 for $1.98

100% metal film resistors. Long leads. **10E3413**

BARREL KIT #239 SHIELDED CABLE

40-ft. $1.98

For mikes, stereos: 1-cond. plus shield, 22 ga, vinyl jacket. Wt. 1 lb. **Cat. No. 10E 3577**

BARREL KIT #182 JUMBO RED LEDS

15 for $1.98

100% material, user cancellation from factory dumps. 3V 10 mils. For 100's of projects, red lens. **Cat. No.10E3369**

BARREL KIT #225 SOUND TRIGGERS

3 for $1.98

"Hand clap" sensitizes crystal mike amplifier, triggers SCR. Use for alarms, etc! Wt. 6 ozs. **No. 10E3625**

BARREL KIT #161 'POP' PLASTIC TRANSISTORS

25 for $1.98

Calculator maker dumps 2N3904's with some 2N3906's of 100% material. TO-92. Preformed. **Cat. No. 10E 3343**

BARREL KIT #160 HOBBY VOLTAGE REGULATORS

10 for $1.98

LM-309K TO-3 barreled, but by the pound, but who wants to check 'em? Your gain. Wt. 20 ozs. **10E 3330**

BARREL KIT #138 PANEL SWITCHES

30 for $1.98 9 ozs.

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BARREL KIT #127 AXIAL ELECTROS

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Asst. capacities and voltages **Cat. No.10E 3227**

BARREL KIT #126 UPRIGHT ELECTROS

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Popular germanium and silicon TO-3's, factory "off-spec" and fallouts. 100% hobby, no opens, no shorts! Wt. 16 ozs. **Cat. 10E2618**

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470 ohm	27K ohm
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1K ohm	39K ohm
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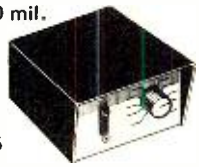

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Complete except for line cord

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7401	.17	74H74	.45
7402	.17	7474	.35
7403	.17	7475	.55
74H04	.25	7476	.35
74S04	.30	7480	.45
7404	.17	7483	.76
7406	.25	7485	.89
7408	.17	7486	.35
7409	.17	7490	.71
7410	.17	7491	.71
7411	.25	7492	.71
7413	.45	7493	.67
7420	.17	7494	.90
7421	.17	7495	.71
7423	.35	7496	.85
7425	.27	74100	.96
7426	.25	74121	.31
7427	.17	74123	.61
7430	.25	74125	.44
7432	.30	74141	.71
7437	.35	74145	.97
7438	.35	74151	.71
7440	.17	74153	.81
7442	.60	74154	.97
7443	.60	74161	.91
7444	.65	74163	1.05
7446	.85	74164	1.05
74L47	1.75	74174	.91
7447	.81	74175	1.40
7448	.81	74180	.76
7450	.20	74181	2.25
7451	.17	74191	1.20
7453	.17	74192	1.20
7454	.17	74193	.95
7470	.35	74S195	1.05
7472	.21	74195	.65

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74LS00	.26	74LS145	1.00
74LS02	.26	74LS151	.70
74LS03	.26	74LS153	.70
74LS04	.30	74LS155	.69
74LS05	.32	74LS156	.76
74LS08	.26	74LS157	.95
74LS09	.26	74LS158	.85
74LS10	.26	74LS160	.85
74LS11	.35	74LS161	.85
74LS13	.58	74LS162	.85
74LS14	1.05	74LS163	.85
74LS15	.26	74LS168	.85
74LS20	.24	74LS169	.85
74LS21	.35	74LS170	2.00
74LS22	.35	74LS173	1.10
74LS26	.35	74LS174	1.00
74LS27	.35	74LS175	1.00
74LS30	.34	74LS190	.95
74LS32	.35	74LS191	.95
74LS37	.33	74LS192	.95
74LS38	.38	74LS193	.95
74LS40	.34	74LS194	.95
74LS42	.80	74LS195	.95
74LS51	.26	74LS196	.85
74LS54	.26	74LS197	.85
74LS55	.26	74LS251	.85
74LS73	.75	74LS253	.85
74LS74	.49	74LS257	.85
74LS76	.49	74LS258	.85
74LS86	.45	74LS260	.26
74LS90	.85	74LS266	.26
74LS92	1.00	74LS279	.55
74LS93	1.00	74LS290	.75
74LS109	.49	74LS293	.75
74LS112	.49	74LS295	.95
74LS113	.40	74LS298	.95
74LS114	.40	74LS365	.55
74LS125	.55	74LS366	.55
74LS126	.65	74LS367	.55
74LS132	1.00	74LS368	.55
74LS133	.35	74LS390	1.75
74LS136	.39	74LS393	1.45
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CD4011	.16
CD4012	.16
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CD4014	.75
CD4015	.75
CD4016	.29
CD4017	.80
CD4018	.80
CD4019	.39
CD4020	.85
CD4021	.90
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CD4030	.16
CD4034	2.30
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CD4040	1.00
CD4041	.69
CD4042	.59
CD4043	.60
CD4044	.59
CD4046	.90
CD4047	.59
CD4049	.35
CD4050	.35
CD4051	.90
CD4053	.90
CD4056	1.00
CD4058	.90
CD4060	1.00
CD4066	.69
CD4069	.30
CD4071	.16
CD4076	.99
74C04	.29
74C107	.29
CD4116	.39
CD4507	.40
CD4512	.50
CD4516	.85
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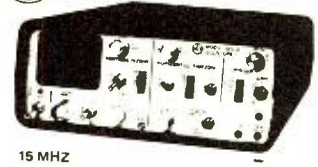

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14 Pin	19	18	17
16 Pin	21	20	19
18 Pin	28	27	26
20 Pin	34	33	32
22 Pin	36	35	34
24 Pin	37	36	35
28 Pin	44	43	42
36 Pin	59	58	57
40 Pin	62	61	60

STANDARD, SOLDER, TIN

8 Pin	25	23	22
14 Pin	27	25	24
16 Pin	30	27	25
18 Pin	35	32	30
22 Pin	70	65	60
24 Pin	49	45	42
28 Pin	99	90	81
36 Pin	1.39	1.26	1.15
40 Pin	1.59	1.45	1.30

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8 Pin	30	27	24
14 Pin	35	32	29
16 Pin	38	35	32
18 Pin	52	47	43
22 Pin	70	63	57
24 Pin	70	63	57
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36 Pin	1.75	1.40	1.26
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Specify color.

Jumper X-100W Mini Hook to Stacking Banana Plug

Order No.	Length	Price
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Specify color.

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Specify color.

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50V CERAMIC DISC $1.00 Per Package

5pf	9/pkg	300pf	7/pkg	.0047mfd	9/pkg
15pf	9/pkg	330pf	7/pkg	.005mfd	9/pkg
25pf	9/pkg	390pf	7/pkg	.01mfd	9/pkg
27pf	9/pkg	470pf	7/pkg	.015mfd	8/pkg
47pf	8/pkg	560pf	7/pkg	.02mfd	8/pkg
68pf	8/pkg	680pf	7/pkg	.022mfd	8/pkg
100pf	8/pkg	.001mfd	9/pkg	.03mfd	8/pkg
150pf	8/pkg	.0015mfd	9/pkg	.039mfd	7/pkg
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270pf	7/pkg	.003mfd	9/pkg	.1mfd	6/pkg

PLESSEY POLYESTER MINI BOX

MF	V	S	MF	V	S	MF	V	S
001	1000	.14	012	630	14	15	100	.20
.0012	1000	.14	015	400	15	18	100	.21
.0015	1000	.14	018	400	15	22	100	.23
.0018	1000	.14	.022	400	15	27	100	.26
.0022	1000	.14	.027	400	15	33	100	.30
.0027	1000	.14	.033	250	15	39	100	.33
.0033	1000	.14	.039	250	15	47	100	.36
.0039	630	.14	.047	250	15	56	100	.44
.0047	630	.14	.056	250	15	.68	100	.47
.0056	630	.14	.068	250	.15	.82	100	.54
.0068	630	.14	.082	250	.17	1.0	100	.60
.0082	630	.14	.1	100	17			
.01	630	.14	.12	100	18			

MATSUO DIPPED TANTALUM

MF	V	$	MF	V	$	MF	V	$
1	35	.33	2.2	20	.33	10.0	35	.90
1.5	35	.33	2.2	35	.40	15.0	20	.45
2.2	35	.33	3.3	35	.42	15.0	35	1.32
3.3	35	.33	4.7	35	.45	22.0	16	.45
4.7	35	.33	6.8	16	.40	33.0	20	1.32
6.8	35	.33	6.8	35	.45	47.0	20	1.53
1.0	35	.33	10.0	16	.42	68.0	16	1.62
1.5	35	.40	10.0	25	.45			

1% MICA 500V

51 PF	.29	220 PF	.41	1500 PF	.60
62 PF	.29	240 PF	.46	2000 PF	.90
75 PF	.29	300 PF	.50	2200 PF	.94
82 PF	.29	390 PF	.50	4700 PF	1.80
100 PF	.30	470 PF	.50	5100 PF	1.80
120 PF	.32	620 PF	.52	10000 PF	3.60
150 PF	.35	820 PF	.53		
180 PF	.41	1000 PF	.60		

ALUMINUM ELECTROLYTIC (RADIAL LEAD)

MF	V	$	MF	V	$	MF	V	$	MF	V	$	MF	V	$
1	10	12	10	16	15	33	25	22	100	35	30	330	50	55
1	16	13	10	25	18	33	35	24	100	50	35	470	10	35
1	25	14	10	35	22	33	50	30	220	10	23	470	16	40
1	35	15	10	50	26	47	10	17	220	16	25	470	25	45
1	50	16	22	10	15	47	16	18	220	25	35	470	35	60
5	10	13	22	16	16	47	25	24	220	35	40	470	50	80
5	16	14	22	25	21	47	35	25	220	50	50	1000	25	65
5	25	17	22	35	23	47	50	32	330	10	30	1000	35	80
5	35	20	22	50	28	100	10	18	330	16	33	1000	50	120
5	50	24	33	10	16	100	16	20	330	25	40	2200	25	130
10	10	14	33	16	17	100	25	26	330	35	45	2200	35	160
												2200	50	250

RESISTOR KITS 5% CARBON FILM RESISTORS

COMPLETE WITH STORAGE BIN

1/4 WATT KIT
42 Different Values (68Ω to 4.7 MΩ)
20 Each Value

1/2 WATT KIT
42 Different Values (68Ω to 4.7 MΩ)
20 Each Value

1/4W — $24.90 PER KIT
1/2W — $25.90 PER KIT

CARBON FILM RESISTORS (5%)

Only in Multiples of 100 pcs per value (ohms)
¼W . . . $1.69 per 100
½W . . . $1.79 per 100

10	100	1.0K	10K	100K	1.0M
11	110	1.1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1.3M
15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1.8M
20	200	2.0K	20K	200K	2.0M
22	220	2.2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2.7K	27K	270K	2.7M
30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3.3M
36	360	3.6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3.9M
43	430	4.3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5.1K	51K	510K	5.1M
56	560	5.6K	56K	560K	5.6M
62	620	6.2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
75	750	7.5K	75K	750K	7.5M
82	820	8.2K	82K	820K	8.2M
91	910	9.1K	91K	910K	9.1M

RESISTOR ASSORTMENTS

Each assortment contains 5 pcs each of 10 different values
Values included are shown in (Ohms)

¼W,5% (50 pcs total) . . $1.75 / ½W,5% (50 pcs total) . . $1.85

Asst.1: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56 ohm
Asst.2: 68, 82, 100, 120, 150, 180, 220, 270, 330, 390 ohm
Asst.3: 470, 560, 680, 820 ohm, 1K, 1.2K, 1.5K, 1.8K, 2.2K, 2.7K
Asst.4: 3.3K, 3.9K, 4.7K, 5.6K, 6.8K, 8.2K, 10K, 12K, 15K, 18K
Asst.5: 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K
Asst.6: 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K
Asst.7. 1M, 1.2M, 1.5M, 1.8M, 2.2M, 2.7M, 3.3M, 3.9M, 4.7M, 5.6M (¼W Assortment No. 7 doesn't include 5.6M)
Asst.8R: (All seven assortments above) ¼W 5% 350 pcs total $10.95 ¼W 5% 350 pcs total $11.55

SANKEN HYBRID AUDIO POWER AMPLIFIERS

SANKEN Series SI-1000G amplifiers are self-contained power hybrid amplifiers designed for Hi-Fi, stereo, musical instruments, public address systems and other audio applications. The amplifiers have quasi-complementary class B output. The circuit employs flip-chip transistors with high reliability and passivated chip power transistors with excellent secondary breakdown strength. Built-in current limiting is provided for SI-1050G and all devices can be operated from a single or split power supply.

SI-1010G (10W output) . . . $ 6.90
SI-1020G (20W output) . . . $13.95
SI-1030G (30W output) . . . $19.00
SI-1050G (50W output) . . . $26.80

Data Sheet Application Notes — $0.50

74L'S

74LS00N	.36	74LS83N	1.36	74LS181N	4.92
74LS01N	.44	74LS85N	1.40	74LS190N	1.50
74LS02N	.32	74LS86N	.46	74LS191N	1.50
74LS03N	.32	74LS90N	.84	74LS192N	1.20
74LS04N	.36	74LS92N	.86	74LS193N	1.21
74LS05N	.33	74LS93N	.86	74LS194N	1.32
74LS08N	.36	74LS95N	1.00	74LS195N	.99
74LS09N	.44	74LS96N	1.24	74LS196N	2.76
74LS10N	.32	74LS107N	.46	74LS197N	2.84
74LS11N	.32	74LS109N	.46	74LS221N	1.76
74LS15N	.44	74LS112N	.64	74LS241N	3.00
74LS20N	.32	74LS113N	.64	74LS251N	1.10
74LS21N	.44	74LS114N	.92	74LS253N	1.10
74LS22N	.44	74LS123N	1.10	74LS257N	.95
74LS26N	.33	74LS125N	.60	74LS258N	1.10
74LS27N	.44	74LS132N	1.44	74LS260N	.44
74LS28N	.33	74LS136N	.74	74LS261N	1.90
74LS30N	.32	74LS138N	.99	74LS266N	.72
74LS32N	.36	74LS139N	.99	74LS273N	2.66
74LS33N	.56	74LS145N	1.64	74LS281N	7.60
74LS37N	.50	74LS148N	3.45	74LS283N	2.00
74LS38N	.58	74LS151N	.88	74LS290N	1.76
74LS40N	.44	74LS153N	.88	74LS293N	1.76
74LS42N	.92	74LS155N	1.50	74LS299N	6.14
74LS51N	.44	74LS157N	.88	74LS365N	.70
74LS54N	.44	74LS158N	.99	74LS367N	.70
74LS55N	.44	74LS160N	1.25	74LS374N	3.21
74LS73N	.46	74LS161N	1.25	74LS375N	.82
74LS74N	.46	74LS162N	1.25	74LS378N	1.60
74LS75N	.70	74LS163N	1.25	74LS381N	4.56
74LS76N	.56	74LS164N	1.50	74LS386N	.72
74LS78N	.92	74LS170N	3.20	74LS399N	2.15
		74LS174N	.80	74LS670N	3.95
		74LS175N	.80		

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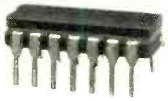
Top quality devices, fully functional, carefully inspected. Guaranteed to meet all specifications, both electrically and mechanically. All are made by well known American manufacturers, and all have to pass manufacturer's quality control procedures. These are not rejects, not fallouts, not seconds. In fact, there are none better on the market! Count on Radio Shack for the finest quality parts.



TTL Digital ICs

First Quality Devices Made by National Semiconductor and Motorola

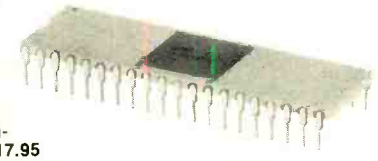
Type	Cat No	Last Year	NOW ONLY
7400	276-1801	$ .49	35¢
7402	276-1811	$ .49	39¢
7404	276-1802	$ .59	35¢
7406	276-1821	$ .69	49¢
7410	276-1807	$ .49	39¢
7413	276-1815	$1.19	79¢
7420	276-1809	$ .49	39¢
7427	276-1823	$ .69	49¢
7432	276-1824	$ .69	49¢
7441	276-1804	$1.59	99¢
7447	276-1805	$1.99	99¢
7448	276-1816	$1.99	99¢
7451	276-1825	$ .49	39¢
7473	276-1803	$ .79	49¢
7474	276-1818	$ .79	49¢
7475	276-1806	$1.19	79¢
7476	276-1813	$ .79	59¢
7485	276-1826	$1.59	1.19
7486	276-1827	$ .69	49¢
7490	276-1808	$1.19	79¢
7492	276-1819	$1.19	69¢
74123	276-1817	$1.69	99¢
74145	276-1828	$1.49	1.19
74150	276-1829	$1.79	1.39
74154	276-1834	$1.79	1.29
74192	276-1831	$1.69	1.19
74193	276-1820	$1.69	1.19
74194	276-1832	$1.69	1.19
74196	276-1833	$1.69	1.29
74C and 4000 Series CMOS ICs			
74C00	276-2301	$ .69	49¢
74C02	276-2302	$ .69	49¢
74C04	276-2303	$ .69	49¢
74C08	276-2305	$ .69	49¢
74C74	276-2310	$1.29	89¢
74C76	276-2312	$1.59	89¢
74C90	276-2315	$2.29	1.49
74C192	276-2321	$2.49	1.69
74C193	276-2322	$2.49	1.69
4001	276-2401	$ .69	49¢
4011	276-2411	$ .69	49¢
4013	276-2413	$1.29	89¢
4017	276-2417	$2.49	1.49
4020	276-2420	$2.49	1.49
4027	276-2427	$1.29	89¢
4049	276-2449	$ .99	69¢
4050	276-2450	$ .99	69¢
4511	276-2447	$2.69	1.69
4518	276-2490	$2.49	1.49

Linear ICs

First Quality Devices by National Semiconductor and Motorola

Type	Cat. No.	Last Year	NOW ONLY
301AH	276-017	$ .69	49¢
324N	276-1711	$1.99	1.49
339N	276-1712	$1.99	1.49
386CN	276-1731	$1.99	99¢
555CN	276-1723	$1.49	79¢
556CN	276-1728	$2.79	1.39
566CN	276-1724	$2.99	1.69
567CN	276-1721	$2.99	1.99
723CN	276-1740	$ .99	69¢
741CN	276-007	$ .69	49¢
741H	276-010	$ .69	49¢
3900N	276-1713	$1.39	99¢
3909N	276-1705	$1.29	99¢
3911N	276-1706	$2.19	1.99
4558CN	276-038	$ .99	79¢
75491	276-1701	$1.49	99¢
75492	276-1702	$1.49	99¢
7805	276-1770	$1.59	1.29
7812	276-1771	$1.59	1.29
7815	276-1772	$1.59	1.29

Microcomputer Chip

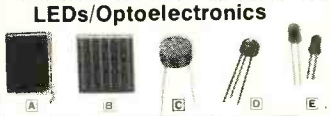


8080A Microprocessor. With a 16-bit address bus capable of addressing up to 65k bytes of memory and up to 256 I/O ports. "TRI-State" data bus gives it DMA and multiprocessing capability. All buses TTL compatible. Up to 244 variable length instructions, with 6 general purpose registers plus an accumulator. 40-pin DIP. *100% Prime.* **276-2510** **17.95**

RS2102 Static RAM. 1024-word by one bit random access read/write memory. Under 750 nS access. Single +5V power supply. **276-2501** ..... **2.49 each or 8/14.95**

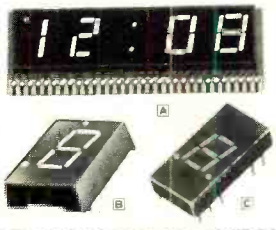
17.95

LEDs/Optoelectronics



Item	Cat. No.	Reg.	Now Only
A Solar Cell	276-115		1.59
B Silicon Solar Cell	276-128		1.99
C Photocell	276-116		99¢
D FPT-100	276-130		79¢
D Lg Red LED	276-041	2/69¢	2/49¢
E Lg Clr LED	276-047	2/69¢	2/49¢
E Med Red LED	276-026	2/69¢	2/49¢
E Med Clr LED	276-040	2/69¢	2/49¢
E Sm Red LED	276-042	2/69¢	2/49¢

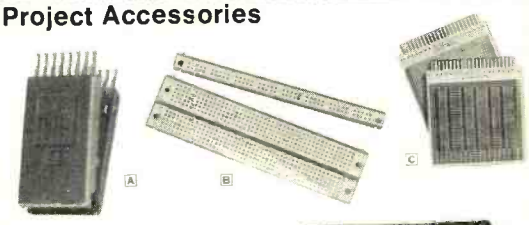
Digital Displays



Digits	Size	Drive	Cat. No	Last Year	NOW ONLY
A 4	0.5"	Anod.	276-1201	$9.95	6.95
A 4	0.5"	Cath.	276-1202	$9.95	6.95

Digits	Size	Drive	Cat. No.	Last Year	NOW ONLY
B 1	0.6"	Anod.	276-056	$3.99	2.99
B 1	0.6"	Cath.	276-066	$3.99	2.99
C 1	0.3"	Anod.	276-053	$2.99	1.99
C 1	0.3"	Cath.	276-062	$2.99	1.99
C 1	0.3"	Anod.	276-1210	4/$8.97	4/6.99
C 1	0.3"	Cath.	276-1211	4/$8.97	4/6.99

Project Accessories



A IC Troubleshooting Test Clip. Test up to 14 pins with probes or clips. Reg. 4.59. **276-1950** ..... **Sale 2.99**

A IC Troubleshooting Test Clip. Test up to 16 pins with probes or clips. Reg. 4.99. **276-1951** ..... **Sale 3.49**

B Experimenter Socket. 2x47 rows of 5 connected tie points. **276-172** **9.95**

B Bus Strip. 2x40 connected tie points. Clips to socket above. **276-173** **1.99**

C Standard Edge-Card Board. 22-pin. 1295 mounting holes. **276-152** **2.99**

C 2-Voltage Source Edge-Card Board. 1368 mounting holes. **276-154** **2.99**

C 3-Voltage Source Edge-Card Board. 1368 mounting holes. **276-153** **2.99**

D 22-Pin Edge-Card Board Connector. 44-terminals. **276-1551** **2.99**

D 100-Pin Edge-Card Board Connector. For standard S-100 hobby computer bus. **276-1554** ..... **4.99 each or 5/19.95**

E DIP Header. 16-pin spacing. **276-1980** **1.29**

F Right Angle IC Socket. Mount LED's vertically. 16-pin spacing. **276-1985** **1.49**

G Metal Cabinet. 3¼x2⁹/₁₆x4". **270-251** **2.59**

G Metal Cabinet. 4x2⅝x6". **270-252** **3.49**

G Metal Cabinet. 6¼x2¾x7¼". **270-253** **4.49**

Transformers

6-3 Volts 1.2 Amps. 1¼x1⁵/₁₆x1⁹/₁₆". **273-050** **2.29**

6-3 Volts, 3 Amps. 2⁵/₁₆x2x1¾". **273-1510** **3.99**

12 Volts 5 Amps. 4x2x2½". Reg. 8.95. **273-1513** ..... **Sale 6.95**

18 Volts (Center Terminal), 4 Amps. Ideal for 5V (using CT), or 12V solid-state regulators. 4x2x2½". Reg. 8.95. **273-1514** ..... **Sale 6.95**

Selected Diodes

Type	Cat. No.	Last Year	Now Only
1N4001	276-1101		2/39¢
1N4003	276-1102	2/59¢	2/49¢
1N4004	276-1103	2/69¢	2/59¢
1N4005	276-1104	2/79¢	2/69¢
1N4735	276-561		2/89¢
1N4739	276-562		2/89¢
1N4742	276-563		2/89¢
1N4744	276-564		2/89¢
Trigger Diode	276-1050	$.49	39¢
1N5401	276-1141		2/69¢
1N5402	276-1142	2/89¢	2/79¢
1N5403	276-1143	2/99¢	2/89¢
1N5404	276-1144	2/$1.19	2/99¢
PTC205	276-1114		3/1.39¢

SCR's and Triacs

Device	Rating	Cat. No	Last Year	Now Only
LASCR	200V 1.6A	276-1095	$1.59	99¢
SCR	200V 6A	276-1067	$1.39	89¢
SCR	400V 6A	276-1020	$1.49	99¢
Triac	200V 6A	276-1001	$1.39	89¢
Triac	400V 6A	276-1000	$1.49	99¢
BR	50PIV 1.4A	276-1151		79¢
BR	100PIV 1.4A	276-1152		99¢
BR	100V 4A	276-1171		1.49
BR	200V 4A	276-1172		1.69
BR	400V 4A	276-1173		1.89
BR	50PIV 6A	276-1180		1.99

Digital Car Clock Module

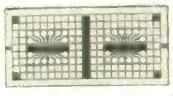
Just add switches and install! Type MA1003, with MOS/LSI clock circuit chip, green fluorescent display with four 0.3" digits. Has 2.09 MHz crystal, blinking colon activity indicator. Six-pin edge-connector. For any 12VDC source. **277-1003** **24.95**

Low-Profile DIP Sockets

8-Pin. 276-1995. Reg. 2 for $.69 . **2/59¢**
14-Pin. 276-1999. Reg. 2 for $1.19 **2/89¢**
16-Pin. 276-1998. Reg. 2 for $1.19 **2/89¢**
28-Pin. 276-1997. Reg. $1.19 Each . **89¢**
40-Pin. 276-1996. Reg. $1.39 Each . **99¢**

Experimenter's PC Board

Simplifies IC Projects



Ideal for two-circuit projects. Fire-retardant copper-clad board is only 2½x5x1/16". Really simplifies integrated circuit projects by extending leads for easy soldering. **276-151** **2.99**

IC Socket Wrapping Tool

For making superior, precision connections — without soldering. Wraps, unwraps, and strips 30-gauge wire. Modified wrap for extra security. No bits, sleeves or special skills needed. Balanced, 4½" long. All-metal. **276-1570** **6.95**

14-Pin Wire-Wrapping Sockets. 276-1993 ..... **Pk. 2/1.29**

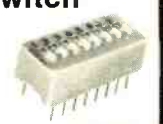
16-Pin Wire-Wrapping Sockets. 276-1994 ..... **Pk. 2/1.39**

50' Red Wire. #30 Gauge Kynar. **278-501** **1.99**

50' White Wire. #30 Gauge Kynar. **278-502** **1.99**

50' Blue Wire. #30 Gauge Kynar. **278-503** **1.99**

8-Rocker DIP Switch



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Z-80 CPU BOARD

From the same people who brought you the $89.95 4K RAM KIT. We were not the first to introduce an Imsai/Altair compatible Z-80 Card, but we do feel that ours has the best design and quality for the lowest price! The advance features of the Z-80 such as an expanded set of 158 instructions, 8080A software compatibility, and operation from a single 5VDC supply, are all well known. What makes our card different is the extra care we took in the hardware design. The CPU card will always stop on an M1 state. We also generate TRUE SYNC on card, to insure that the rest of our system functions properly. Dynamic memory refresh and NMI are bought out for your use. Believe it or not, not all of our competitors have gone to the extra trouble of doing this. As always this kit includes all parts, all sockets, and complete instructions for ease of assembly. Because of our past experience with our 4K kit we suggest that you order early. All orders will be shipped on a strict first come first served basis. Kit includes Zilog Manual and all parts. Kit shipped with 2 MHZ crystals.

Z–80 Chip & Manual – $49.95; Add $5.00 for Z–80A
Z–80 Manual – $7.50 Separately.

Complete kit - $149.

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IMSAI AND ALTAIR 8080 PLUG IN COMPATIBLE. USES LOW POWER STATIC 21L02 – 1 500ns. RAM's. FULLY BUFFERED, DRASTICALLY REDUCED POWER CONSUMPTION, ON BOARD REGULATED, ALL SOCKETS AND PARTS INCLUDED. QUALITY PLATED THROUGH PC BOARD. For 250 ns RAM's add $10.

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CAR/BOAT KIT **$34.95** *New Item!*
Music to your Ears!

MUSICAL HORN

Musical Horn kit for car, boat or home. Plays any tune from Mozart to Led Zeppelin. Change tunes in seconds; complete solid state electronics. Standard or custom tunes available at $6.95 each. (You supply the sheet music – we supply electronics for your favorite tune.) One song supplied with original order. Standard tunes available: DIXIE – EYES OF TEXAS – ON WISCONSIN – YANKEE DOODLE DANDY – NOTRE DAME FIGHT SONG – PINK PANTHER – AGGIE WAR SONG – ANCHORS AWAY – NEVER ON SUNDAY – BRIDGE OVER RIVER QUI – CANDY MAN– Standard 2 inch 8 ohm speaker supplied. Power horn available for car/boat kit.

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Kit includes speaker which operates from your door bell. When door bell is pushed your favorite tune is played. Car/boat kit includes speaker which operates from car/boat horn ring. Allow 4 weeks delivery on both kits.

Limited Quantity!
$9.95 kit

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We made a fantastic kit even better. Redesigned to take advantage of the latest advances in IC technology. Features: Litronix Dual ½" displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Greatly simplified construction. More reliable and easier to build. Kit includes all necessary parts (except case). For P.C. board add $3.00; AC XFMR add $1.50. Do not confuse with Non-Alarm kits sold by our competition! Eliminate the hassle – avoid the 5314!

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1000 MFD Filter Caps	SLIDE SWITCH Assortment	POWER RESISTOR 15 OHM 25W BY CLAROSTAT	RESISTOR ASSORTMENT	P.C. LEAD DIODES 1N4148/1N914	THERMISTORS MEPCO – NEW! 1.5K OHM	DISC CAP ASSORTMENT
Rated 35 WVDC Upright style with PC leads. Most popular value for hobbyists.	Our best seller. Includes miniature and standard sizes, single and multi-position units. All new.		¼W 5% & 10% PC leads. A good mix of values! Special!	1N4002 - 1A 100 PIV		P.C. Leads. At least 10 different values. Includes .001, .01, .05 plus other standard values.
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28 PIN SOCKETS 3 for $1.00	39 MFD 16 V Mallory Electrolytic 15 for $1.00

FACTORY PRIME! 21L02-1

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IC's from XEROX

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MH0025CN – 55c

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7402 – 9c	7440 – 9c	74121 – 22c
7404 – 9c	7437 – 10c	74123 – 32c
7406 – 11c	7438 – 10c	74151 – 9c
7407 – 11c	7451 – 9c	74155 – 22c
7410 – 9c	7474 – 16c	74193 – 35c
7416 – 13c	7475 – 24c	8233 – 35c
7420 – 9c	7486 – 16c	Intel – 1302 – 45c

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Complete Kit, TD-1 ..... $4.95

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Complete Kit, BL-1 ..... $2.95

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A super-sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as a general purpose test amplifier. Full 2 watts of output, runs on 6 to 12 volts, uses any type of mike. Requires 8-45 ohm speaker.
Complete Kit, BN-9 ..... $4.95

MUSIC LIGHTS KIT
See music come alive! 3 different lights flicker with music or voice. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300 watts. Great for parties, band music, nite clubs and more.
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Produces upward and downward wail characteristic of police siren. 200mw audio output, runs on 3-9 volts, uses 8-45 ohm speaker.
Complete Kit, SM-3 ..... $2.95

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CT-50, 60MHz Counter Kit $79.95
CT-50WT, 60 MHz counter, wired and tested $159.95
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Sensitivity: less than 25MV
Frequency range: 5Hz to 60MHz, typically 65MHz
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Accuracy: 10 ppm, .001 ppm with TV time base!
Input: BNC, 1 meg ohm direct, 50 ohm with prescale option
Power: 110 VAC 5 watts or 12 VDC @ 1 Amp
Size: Approx. 6" x 4" x 2", high quality aluminum case
Color burst adapter for .001 ppm accuracy available in 6 weeks. CB-1, Kit $14.95

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A compact 5 x 10-inch PC card that requires only an ASCII keyboard and a TV set to become a complete interactive terminal for connection to your microprocessor asynchronous interface. Its many features are single 5-volt supply, crystal controlled sync and baud rates (up to 9600 baud), 2 pages of 32 characters by 16 lines, read to and from memory, computer and keyboard-operated cursor and page control, parity error display and control, power-on initialization, full 64-character ASCII display, block-type see-thru cursor. Keyboard/computer control backspaces, forward spaces, line feeds, rev. line feeds, home, returns cursor. Also clears page, clears to end of line, selects page 1 or 2, reads from or to memory. The card requires 5 volts at approx. 900 ma and outputs standard 75 ohm composite video.

TH3216 Kit $149.95
TH3216, Assembled and Tested $239.95
VD-1, Video to RF Modulator Kit ..... $ 6.95

600 mHz Prescaler

Fully assembled and tested.
Extend the range of your counter to 10 times higher in frequency. Works with any counter. High sensitivity input with built-in on-chip pre-amp.
PS-1B,—10 ..... $59.95

SIX DIGIT 12/24 HR CLOCK KIT

Want a clock that looks good enough for your living room? Forget the competitor's kludges and try one of ours! Features: jumbo .4" digits, Polaroid lens filter, extruded aliminum case available in 5 colors, quality PC boards and super instructions. All parts are included, no extras to buy. Fully guaranteed. One to two hour assembly time. Colors: silver, gold, black, blue and bronze (specify).

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Alarm Clock, DC-8, 12 hr. only $24.95
DC-5 with 10 min. ID time/ $25.95
Mobile Version, DC-7 ..... $25.95
Assembled and tested clocks available, add $10.00 to kit price.

741 MINI DIP, house marked ..... 10/$2.00

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12/24-Hour 12-Volt AC or DC
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- Easy, no-polarity hookup
- Display blanks with ignition
- Case, mounting bracket included
- Super instructions

Complete Kit, DC-11 ..... $27.95

AUTO-DIMMER $2.50
Automatically adjusts display brightness according to ambient light level. For DC-11 Car Clock.

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SN7403N	.14	SN7470N	.26	SN74142N	3.70	SN74191N	1.04
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SN7407N	.25	SN7475N	.46	SN74147N	1.58	SN74195N	.54
SN7408N	.17	SN7476N	.30	SN74148N	1.19	SN74196N	.87
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SN7413N	.39	SN7484AN	1.50	SN74154N	.95	SN74246N	1.95
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SN7417N	.29	SN7489N	1.85	SN74157N	.59	SN74249N	1.75
SN7420N	.14	SN7490AN	.43	SN74159N	2.50	SN74251N	1.05
SN7421N	.20	SN7491AN	.59	SN74160N	.85	SN74259N	1.35
SN7422N	.20	SN7492AN	.44	SN74161N	.85	SN74265N	.85
SN7423N	.25	SN7493AN	.44	SN74162N	.85	SN74273N	1.35
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SN7438N	.21	SN74109N	.47	SN74174N	.94	SN74298N	1.64
SN7440N	.14	SN74110N	.52	SN74175N	.84	SN74351N	1.92
SN7442N	.37	SN74111N	.69	SN74176N	.77	SN74365N	.65
SN7443N	.68	SN74116N	1.50	SN74177N	.76	SN74366N	.65
SN7444N	.85	SN74120N	1.40	SN74178N	1.19	SN74367N	.65
SN7445N	.65	SN74121N	.34	SN74179N	1.49	SN74368N	.65
SN7446AN	.70	SN74122N	.38	SN74180N	.67	SN74376N	.75
SN7447AN	.59	SN74123N	.48	SN74181N	1.94	SN74390N	1.40
SN7448N	.69	SN74125N	.40	SN74182N	.59	SN74393N	1.40
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CD4011BE	.16	CD4071BE	.24
CD4012BE	.16	CD4072BE	.29
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CD4014BE	.74	CD4075BE	.29
CD4015BE	.74	CD4076BE	.98
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CD4017BE	.79	CD4081BE	.24
CD4018BE	.79	CD4082BE	.29
CD4019BE	.38	CD4085BE	.75
CD4020BE	.84	CD4086BE	.75
CD4021BE	.89	CD4502BE	1.15
CD4022BE	.89	CD4507BE	.39
CD4023BE	.16	CD4510BE	1.05
CD4024BE	.67	CD4511BE	1.25
CD4025BE	.16	CD4512BE	.69
CD4026BE	1.39	CD4514BE	2.50
CD4027BE	.38	CD4515BE	2.50
CD4028BE	.74	CD4516BE	.84
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CD4035BE	.98	CD4526BE	1.50
CD4040BE	.99	CD4527BE	1.50
CD4041BE	.67	CD4528BE	1.20
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CD4043BE	.45	CD4539BE	1.20
CD4044BE	.45	CD4555BE	.75
CD4046BE	2.45	CD4556BE	.75
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CD4049BE	.34	CD4582BE	.95
CD4050BE	.34	CD4585BE	1.80
CD4051BE	.89		

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74C85/40085PC	1.20
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74C161/40161PC	1.50
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74C163/40163PC	1.50
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74C175/40175PC	1.40
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74C193/40193PC	1.50
74C194/40194PC	1.40
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RC4195T	2.35	Fixed ±15V Dual Tracking Regulator T05
RC4195TK	3.15	Fixed ±15V Dual Tracking Regulator T066
78H05KC	6.35	5 Amp 5 Volt Positive Regulator T03
7800 Series	.99	Positive Voltage Regulators (Plastic) 1 amp 5, 6, 8, 12, 15, 18, 24 Volts
T0-220 / LM340T		
78M00 Series	1.39	Positive Voltage Regulator 1/2 Amp
T0-5 / LM340H		5, 6, 8, 12, 15, 18, 24 Volts
7800 Series	1.49	Positive Voltage Regulator 1 Amp
T0-3 / LM340K		5, 6, 8, 12, 15, 18, 24 Volts
78L00 AWC Series	.29	Positive Voltage Regulator 100 MA
T0-92		2.6, 5, 6.2, 8.2, 12, 15 Volts
7900 Series	1.25	Negative Voltage Regulator 1 Amp
T0-220 / LM320T		5, 6, 8, 12, 15, 18, 24 Volts
79M00 Series	1.35	Negative Voltage Regulator 1/2 Amp
T0-5 / LM320H		5, 6, 8, 12, 15, 20, 24 Volts
7900 Series	1.75	Negative Voltage Regulator 1 Amp
T0-3 / LM320K		5, 6, 8, 12, 15, 18, 24 Volts
78MGT2C	1.20	Dual In Line Adjustable 4 Terminal Positive Voltage Regulator
79MGT2C	1.20	Dual In Line Adjustable 4 Terminal Negative Voltage Regulator
78GU1 T0-220	1.45	1 Amp Adjustable Positive Voltage Regulator
79GU1 T0-220	1.25	1 Amp Adjustable Negative Voltage Regulator
78GKC T0-3	1.80	1 Amp Adjustable Positive Voltage Regulator
79GKC T0-3	2.10	1 Amp Adjustable Negative Voltage Regulator

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SOLID STATE

(Continued from page 87)

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Motorola Semiconductor Products, Inc. (P.O. Box 20294, Phonenix, AZ 85036) has introduced its own line of wideband r-f amplifier modules. Designed for radio and cable communication systems as well as r-f instrumentation, the Motorola units have a source and load impedance range of 50 to 100 ohms and offer a typical power gain of 36 dB. Types MHW590 and MHW592 are designed for operation on 24-volt dc power sources and cover the ranges of 10 to 400 MHz and 1.0 to 250 MHz, respectively. Types MHW591 and MHW593 require 13.6-volt dc supplies and cover the ranges of 1.0 to 250 MHz and 10 to 400 MHz, respectively. All four modules are designed for operation with a bar-type heatsink for optimum thermal charteristics.

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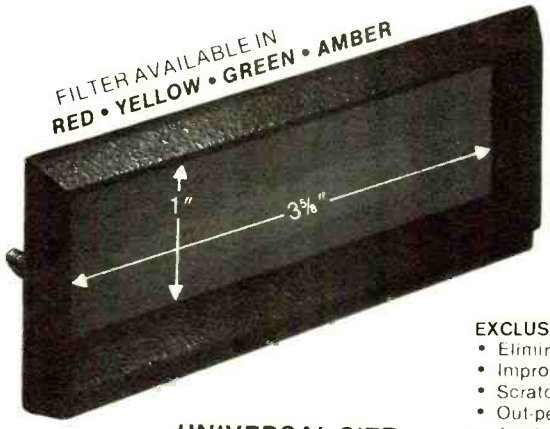

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Philco Model 39-35 radio. Need schematic, parts list and operating instructions. J.M. Dubiel, 1129 Marion St., Peckville, PA 18452.

Lincoln Model L 2000A, Class D CB transceiver. Schematic and any available information. E.O. Kirkwood, Sr., 137 Snow Hill Dr., Charleston, WV 25311.

Heathkit Model MW-33 CB transceiver. Schematics or manual. Fred J. Winkler, 315 Nashua Dr., Port Richey, FL 33568.

Knight Model T-60 transmitter. Schematic and operators manual. Richard L. Schaut, 1218 Marshall Ave., Green Bay, WI 54301.

Fluke Model 102 VAW meter and **Tektronix** Model 536 oscilloscope. Need service manuals. Bernard Budny, 434 E. Wilbur Ave., Milwaukee, WI 53207.

Scott "Philharmonic" receiver. Schematic, operating instructions and any available restoration information. Douglas Lake, Box 5101 Station F, Baseline Rd., Ottawa, Ontario, Canada K2C 3H4.

Hallicrafters Model S-107. Manual and/or service information. **Hart** Model 75 shortwave receiver. Schematic and manual and/or service information. Daniel W. Kelly, Box P, Middleton, MA 01949.

Lafayette Model HE-10 or KT-200 receiver. Need alignment procedure information. P. Kaeding, 3917 Kipling Ave. So., St. Louis Park, MN 55416.

Wurlitzer Model 2910 phonograph juke box. Need technical manual. J. Chadek, 2609 River Hills Rd., Two Rivers, WI 54241.

Hammarlund Model HQ-110. Schematics and any available information. Steve Ruten, 3513 57th, Lubbock, TX 79413.

Commercial Trades Institute Model SC30 oscilloscope. Built from a kit as part of electronics course. Schematics or other available information. Ronald M. Kardos, 2703 Parkland Dr., Brighton, MI 48116.

Precise Model 300B oscilloscope. Schematic and manual. Frank Doering, 6878 S.E. Division, Portland, OR 77206.

LLoyd Model 9M39W-94A solid-state FM multiplex stereo. Need schematic. Dan Viscogliosi, 32 Cresthill Rd., Brighton, MA 02135.

National Model NC-303 receiver. Need instructions and/or schematic. **Dumont** Model 208-B oscilloscope. Schematic or any available information. Brian Matheny, 7933 Russell Rd., Alexandria, VA 22309.

Dumont Type 274 oscilloscope. Need schematic, service manual and/or operating manual. Stacey Marsella, 27 Hudson Hill Rd., Cranston, RI 02905.

U.S. Navy Type CV-57 teletype demodulator. Operators manual or schematic. Mark A. Vargas, 260 Ft. Wash Ave., New York, NY 10032.

Grand Model FP 1211-G 5-band radio. Need dial stringing

instructions or diagram. Bernard Grupe, 3012 Highland Dr., Cary, IL 60013.

ET/D Tekfax. Diagrams wanted, prior to #1294 (May 1970). Donald R. Hicke, 11381 Bootes St., San Diego, CA 92126.

Knight-Kit Model 83 YZ 945 lab oscilloscope. Operation manual and/or schematic. P.J. Strimple, Rt. 1, Box 1091, Bay City, TX 77414.

Precision Model E200-C signal generator. Schematic needed. Harold McCann, 803 South Oak, 3D, Ottawa, KS 66067.

Hammarlund Model BC779 general coverage receiver. Schematic and owner's manual and/or alignment information. Daniel Ginsberg, Box 163, Albion, CA 95410.

Philco Model 37-630. Need schematic diagram. Danny Tovar, 4700 Rockmoore Ln, Fort Worth, TX 76116.

Sears Model 562-41920101 portable color television. Need service manual. George Comber, 122 Maine Ave., Cherry Hill, NJ 08002.

Motorola Model DS9660-B Conelrad receiver. Operating manual, schematics and crystal. D. Smith, 1369 Tree Garden Place, Concord, CA 94518.

Zenith Model 7G605 5-band shortwave radio. Need any information. Bruce Kahn, 2034 Ramlow Place, St. Paul, MN 55116.

Motorola Model HI3-11AH SP2 "Handie-Talkie." Schematic and operations manual. Also plug-in modules for unit. David Moody, 4305 S. 8th St., Terre Haute, IN 47802.

U.S. Navy Surplus signal generator, military designation TS-413C/U. Covers 10 kHz to 40 MHz. Schematic, tech manual, or any other available information. Jack Rutherford, Box 3124, Burlington, NC 27215.

Philco Models 16; 37-62; PT-38; 46-132; 40; 120 radios. Schematics or any available information. Martin Nevers, 850 Main St., Oxford, FL, 32684.

Lago Model C86 (serial no. C860001110) desk calculator. Schematic, parts list and manual. Charles Dawson, 10503 Kibbee Ave., Whittier, CA 90603.

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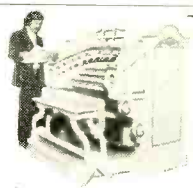

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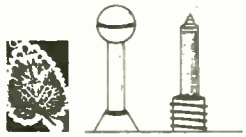

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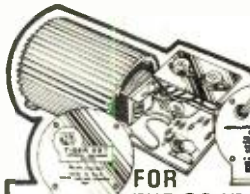

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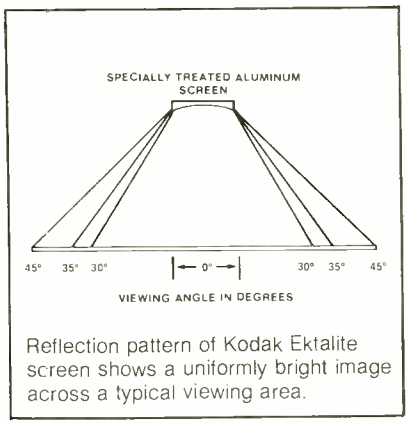

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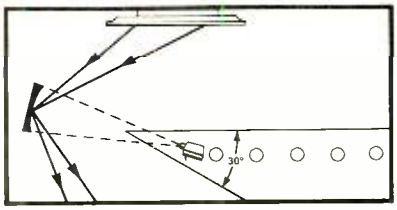

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Kodak

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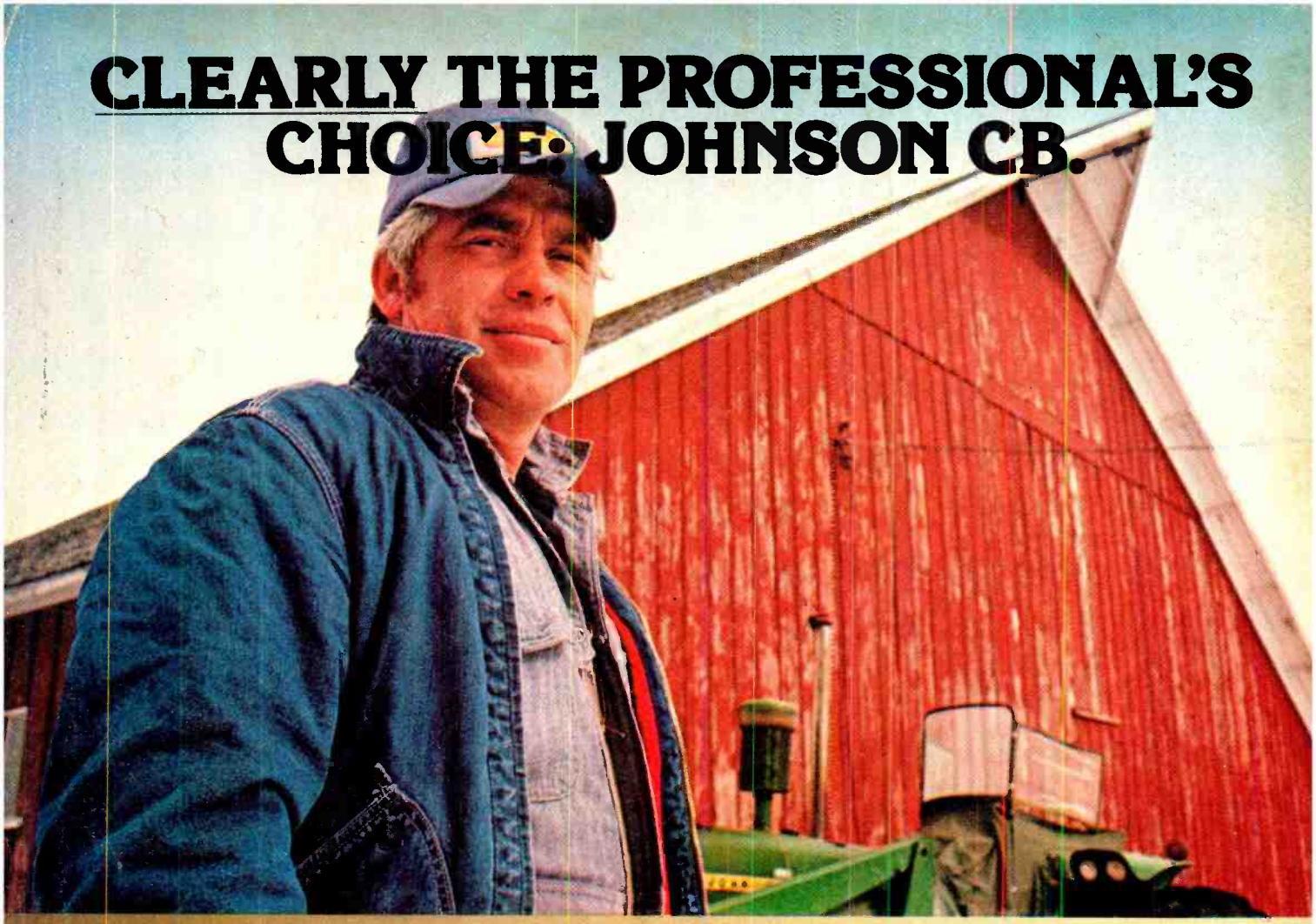

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