IC FUNCTION GENERATOR EXPERIMENTS—BUILD A 2650 COMPUTER

$1.00 ■ MAY 1977

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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frequency divider

automatic color TV
HEATH PROGRAMMER
changes channels for you

get your ears on
CB PREAMPLIFIER
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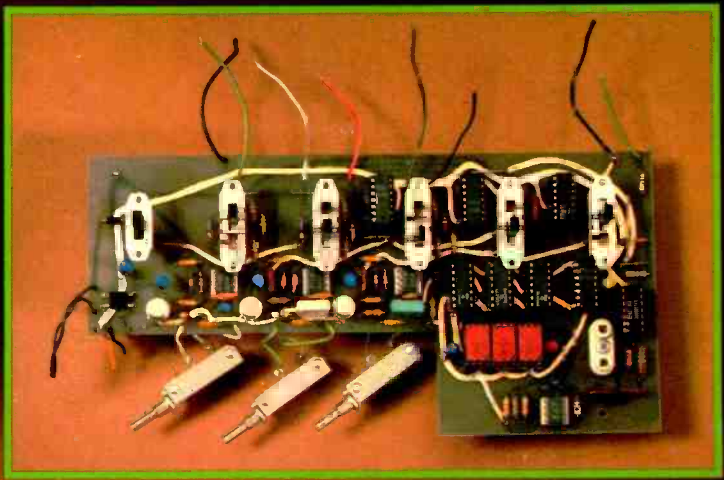
can affect you



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Bally
FIREBALL!
PLAYERS
1 2 3 4
SCORE
293250
BALL IN PLAY
100
100
Bally

Pinball Computer

Your home, apartment or office can become an action entertainment center with America's first commercial-home pinball machine.

It's you against a computer. And the action and excitement from Fireball, your own computerized pinball machine, is nothing short of spectacular.

Fireball's computer replaces many of the mechanical, scoring, conventional electronics and sensing devices of a standard pinball machine. It's a dramatic change in pinball devices and the start of a new consumer electronics revolution.

DESIGNED FOR ACTION

Fireball contains flippers, bumpers, thumpers, flashing lights, sounds and a full-sized playfield. The glass covering the playfield is safe, shatterproof and specially tempered.

From one to four players can compete. Turn the unit on and simply program the computer with the number of players by pressing the start button up to four times. Each player's score is kept separately in a memory and appears on the display for each player's turn and at the end of the game.

The ball is automatically ejected and you pull the plunger to project it into action. The ball bounces from side to side from bumper to thumper. Lights flash and the scoring begins. You use the separately controlled flippers by pressing the flipper controls on the sides of the playfield which are low enough so that even a five year old can reach them.

Flip a switch and Fireball can be programmed for beginner or advanced skills although pinball is the only game everybody knows how to play within seconds after they step up to a machine.

"WE'RE IN THE MONEY"

The thrill of winning a bonus score or extra ball is enhanced by Fireball's songs and scoring tones. The computer's synthesizer plays seven songs—everything from "We're in the Money" when an extra ball is awarded to "The Party's Over" when the game ends. Various scores sound five additional tones making the game a total sight and sound experience. A volume control lets you keep it loud at a party or turned down in quieter surroundings.

COMMERCIAL PARTS AND FEATURES

Fireball contains the same heavy-duty devices and scoring features as a commercial pinball machine. The game has a tilt feature—tilt Fireball and a tilt sign glows and the scoring stops. The full-sized, full-color commercial playfield even has a special friction silk-screened surface so the ball will roll and not slide. Fireball differs from an arcade unit only by the start button which has replaced the coin slot and its new electronics. In fact, all future commercial machines will resemble Fireball within a year.

MANY NEW FEATURES

Fireball's computer is as powerful as the million dollar IBM computer sold in 1964. The solid-state LED scoreboard replaces the old electromechanical pinball scoring wheels so Fireball's backboard is thinner and its scoring more reliable. Its memory not only keeps track of everybody's score but the exact playfield configuration and extra bonus balls—something present arcade games can't do.

The American-made Bally Fireball—the first computer pinball machine designed for both home and office entertainment centers.

Although the playfield is just as large as the commercial machines, the entire unit has less weight, less bulk, and practically no service requirements making it ideal for the home or office. It takes up a space 2 feet by 4 feet and weighs 160 pounds.

HOW TO JUSTIFY PINBALL (TAKE THIS TEST)

If you paid more than $600 for either your TV set, stereo system or pool table—you should consider a pinball machine. You'll have more fun and action than watching TV, listening to your stereo or playing pool.

And when guests pop in, your Fireball will be the talk and highlight of their visit. Your TV and stereo are used primarily for private viewing or listening. Your pinball machine is for all times—from your personal family enjoyment to big parties. It's the great new idea in home entertainment.

TAX DEDUCTIBLE

Consider Fireball for your office as either an executive toy or a free new benefit for your office or factory employees during their breaks. You get both an investment tax credit and depreciation. Fireball combines participation, action and entertainment. A pinball machine is so intriguing that people pour dollars into them at arcades. It requires skill, sharpens responses and can become the single most talked about entertainment product in your home or office.

LASTING PLAY VALUE

Fireball, unlike the new TV games, is partially a game of chance and thus can never be mastered. Even an experienced professional can lose to a youngster. A daughter can beat her father, grandma can beat grandpa and the surprise of an upset is what adds to the long lasting play value. A professional pinball machine is an amusement game that you rarely get tired of—no matter how good you get, no matter how long you've played. Ask any arcade operator. His customers will tire of his video games which he continually rotates with newer models but his pinball machines are played and played and played.

Don't be confused. There are other games made by toy designers selling for one half the price. Fireball is not a toy and is built by a company that specializes in pinball machines. With all its sophistication it is the most service-free, quality pinball machine ever produced.

When you buy an expensive product you must be absolutely satisfied that you get the service and a solid company standing behind your purchase for many years to come. Fireball 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 assurances that your investment is well protected.

A FRANK DISCUSSION OF SERVICE

Fireball is a solid-state computer with its electronics condensed on integrated circuits—all hermetically sealed and all pre-tested for a lifetime of service. Fireball is also self-diagnostic. Let us say something goes wrong with the system. Simply press the test button on the back panel of your machine and the exact problem is displayed on your scoreboard in digits. Check the instruction booklet and simply remove the designated plug-in circuit board, light bulb or part and send it to the service department closest to you for a brand new replacement. Even your TV or stereo isn't that easy to repair.

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 its design that Fireball practically repairs itself. And any defective component will be replaced free-of-charge during its one year limited warranty.

SHIPPING AND THE TRIAL PERIOD

Each Fireball comes in two sections with four metal legs. The two sections quickly bolt together with the top portion also plugging into the bottom to make all electrical connections. Within minutes after it arrives, your unit is ready to operate.

Attach the metal legs, plug it in and start playing. Don't even read the instructions on how to play it—you should know how within minutes. Then after you've played Fireball for awhile, go to your local arcade and play a standard $1500 pinball machine. It's only then that you'll realize how much more value you are getting with Fireball.

But let's be realistic. What if you don't like what you get? Simple. A toll-free call to JS&A and we'll arrange for the pick-up of your unit and we'll pay all the pick-up and return costs. And you can play Fireball for one month before you make up your mind.

A GUARANTEE OF SATISFACTION

The cost for your own pinball machine is $795 (Illinois residents add $39.75 sales tax) plus the freight which you pay upon receipt and which will run approximately $34 from our facilities in Northbrook to Los Angeles or less if you live closer. You can order Fireball with any major credit card by calling our toll-free number or you can send your check for $795 to the address shown below. We will then promptly ship your unit and advise you.

We back Fireball with an outstanding service program made possible by plug-in commercial components. We provide the opportunity to use Fireball for one month without obligation and if 1) it does not live up to every one of your expectations 2) for any reason you get tired of playing it, or 3) you don't find it more challenging after one month than when you first played it, give us a call and we'll pick it up at your door at our expense and refund your money. We provide fast service turnaround time should service ever be required and we have been in business for over a decade providing the same conscientious service that has built our company into America's largest single source of quality space-age products.

Why not let the fun and action of your very own pinball machine add to your home or office entertainment picture? We'll make just trying Fireball the best entertainment move you've ever made. Order one at no obligation today.

JS&A NATIONAL SALES GROUP

Dept. RA One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-9000

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In Illinois call .... (312) 498-6900

There's more to Realistic® 40-channel CB than just 17 added channels...

there's 17 years of know-how!

With so many new and unproven brands on the CB bandwagon, the reasons for buying Realistic are clearer than ever. Seventeen years' experience and sales of a million sets annually have shown us what it takes to be a leader:

Intelligent, reliable engineering. Easy-to-find sales and service — to the tune of 4800 Radio Shacks in the USA alone. And low prices that are possible only because Radio Shack is a do-it-yourself company, from factory to warehouse to sales counter.

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Illuminated signal strength/RF output meter and channel selector, LED modulation indicator — conveniences that make your CB easier and more fun to use. With dynamic plug-in microphone, adjustable mobile bracket, and power cables for any vehicle with 12 VDC positive or negative ground.

Come in today and see the TRC-467. Designed, manufactured and sold only by "the" CB experts — Radio Shack. Just 119.95*.

These two credit cards honored at most Radio Shacks.
*Prices may vary at individual stores and dealers.

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Electronics publishers since 1908

MAY 1977 Vol. 48 No. 5

BUILD ONE OF THESE

GENERAL ELECTRONICS

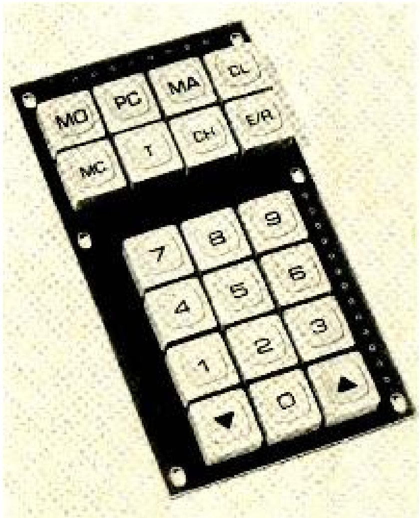
HI-FI STEREO

TELEVISION

DEPARTMENTS

ON THE COVER

Programmable divider provides a wide range of frequency division by using three cascaded 555-timer IC stages. The divisor is selected by three 10-turn potentiometers and indicated by an LED readout. Complete story starts on page 37 of this issue.



THIS KEYBOARD CONTROLS channel selection and programs a new TV set to automatically switch channels for you. It's an important part of Heath's programmer system. For full details turn to page 49.

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looking ahead

Microwaves and health: Government and private agencies are trying to determine what actually is a "safe" dose of microwaves—a subject in the spotlight since the discovery that the American Embassy in Moscow was being bombarded with low-intensity microwaves. The only existing standard today for safe exposure is 10 milliwatts-per-square-centimeter, established by the American National Standards Institute. Some tests indicate that this might be too high.

Is public health endangered by broadcast and other microwave transmissions? Initial results of studies indicate it is not. At ground level in immediate vicinity of broadcast transmitters at Mount Wilson, California (where the antennas of all Los Angeles TV stations are located), one study showed the maximum ambient radiation was four milliwatts and that the principal source of microwave radiation is UHF broadcast stations. If the safe level is found to be much lower than 10 mW, officials of the government's Office of Telecommunications Policy say some stations may be required to reduce their power. However, at present, experts feel that hazardous exposures are found only in occupational situations where people work on microwave-emitting equipment.

Backtalk on the cable: A major experiment in two-way cable TV will start this year in Columbus, Ohio. Warner Cable will offer the service to almost 100,000 homes there. It will feature a 7 × 6 × 2-inch home terminal that will permit subscribers to select programs, play interactive games, take tests, register their opinions instantly and "actually participate at home in TV programs and events." Warner Cable President Gustave Hauser says he expects to "see people participating in game shows, schools competing against other schools, communities against communities and so forth." Warner, which recently acquired video game producer Atari Inc., declined to give further details.

2-way game, 1-way cable: But you don't necessarily need a two-way cable system to play an interactive CATV game. Ralph Baer of Sanders Associates, who is regarded as the inventor of the video game, told a recent meeting of Gametronics in San Francisco that tests on cable TV systems in Boston and Akron showed several ways in which video games could interact with cable.

One experiment involved the CATV transmission of a colorful hockey playing field with four players moving at random—two goalies and two forwards. Game equipment developed by Sanders recognized the field and players, introduced them into the game logic circuitry and permitted interaction between the transmitted symbols and the viewer-manipulated locally generated players. He said CATV could also be used with microprocessor games, with digital data on game rules, character symbols and the like transmitted to storage equipment at the receiver terminal—in effect, programming the game via CATV. Another possibility would be viewer participation in quiz games sent over one-way cable.

Baer also forecast two-way game playing between homes by telephone connection and prerecorded home VTR or videodisc programs for interactive games. He predicted that game-playing capability would eventually be built into every home VTR or videodisc player.

CB stability promised: CB manufacturers and dealers are still reeling from the rough transition from 23- to 40-channel units, which caused severe dislocations and even a few bankruptcies. Now they're apprehensive that just when things get going again they'll be clobbered by new FCC efforts to move CB to a permanent home upstairs in the higher frequencies. But FCC Chief Engineer Ray Spence recently told the PC 77 trade show that the industry can "look forward to a period of stability with no new surprises." Other FCC spokesmen conceded the Commission was making long-range studies for new personal communication spectrum space, but said no action was planned which would eliminate the current 27-MHz band.

The FCC has proposed a ban on linear amplifiers in the 25–35-MHz band. These devices, designed for amateur radio, are being used illegally to boost power in CB equipment. The FCC has made no proposal to ban linear amplifiers in other ham bands, but it did propose a type-acceptance program for all amateur radio equipment, presumably to help block the manufacture of amplifiers that could easily be modified for CB use. The FCC proceedings are expected to be protracted, with amateur radio groups strongly opposed.

Another major problem faced by the CB industry is trying to convince prospective customers that 40-channel transceivers have as much "talk power" as the 23-channel transceivers. All manufacturers agree that rumors are rampant that the FCC rules make 40-channel transceivers less powerful. It's not true, but, like many rumors, it has some basis in fact. This is that some CB manufacturers lacking in engineering resources have reduced the percentage of modulation in order to meet the Commission's new tighter specifications. But the vast majority of well-known brands are said to provide full power and full modulation in their new transmitters. The entire problem—if you can call it a problem—undoubtedly has been exaggerated by dealers stuck with large quantities of 23-channel transceivers who have been bad-mouthing the 40-channel gear.

VTR fever rises: In a series of fast-breaking developments, the home videocassette recorder has taken a giant leap toward becoming the next major mass-market consumer electronic product in the United States, and the search for a "standard" system was sharply narrowed down:

continued on page 94

Digital Watch Breakthrough

There are several big changes taking place in digital watches. Here are all of them in one product.

Your digital watch is either too thick, uses up batteries quickly, has just a few functions or is hard to read under certain lighting conditions. You still have to press a button, flick your wrist, or hold your watch at just the right angle to read the time.

The digital watch industry has gone through four years of rapid change, but the disadvantages cited above have finally been resolved in one totally new product—the Sensor Laser 440 Digital. The Laser 440 is so different that it represents a dramatic departure from conventional digital watches.

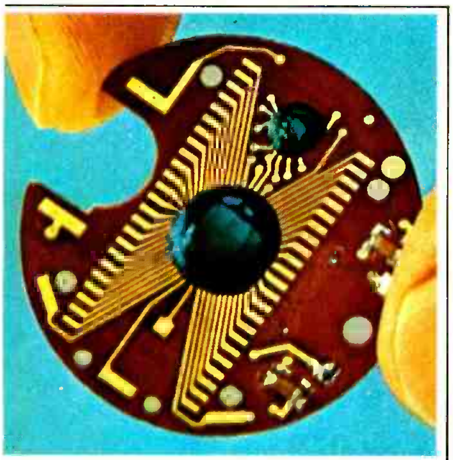
NO BUTTON TO PRESS

There is no button to press since the display glows in the dark. A glass ampoule, charged with tritium and phosphor and sealed by a laser beam, is placed behind the new CDR (crystal diffusion reflection) display. When room lights dim, the self-contained tritium light source will compensate for the absence of light by glowing brightly and illuminating the display.

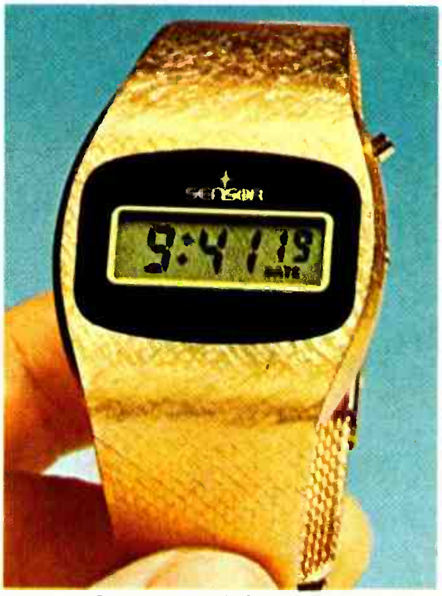
No matter when you wear your watch—day or night—just a glance will give you the correct time. There's no button to press, no special viewing angle required, and most important, you don't need two hands to read the time.

CHANGE YOUR OWN BATTERIES

The Laser 440 is only 8 millimeters thick—thinner than many of the so called thin digitals being advertised today. The new CDR display draws 100,000 times less current than an LED watch when displaying the time so your single commercially-available Union Carbide battery lasts years longer. In fact, part of our warranty includes all the batteries you'll ever need, free of charge, for five full years. To replace a battery, simply open up the battery hatch on the back of your watch, tap out the old battery and drop in the new one.



Most digital watches have dozens of electronic components. The Laser 440 has only six—two integrated circuits, a crystal and three microcapacitors. All components are bonded directly on the printed circuit board. By hermetically sealing the integrated circuits and using fewer components, the Laser 440 is considerably more reliable than other watches that do not yet have this complete integration.



The new Sensor Laser 440 digital watch glows in the dark so there's never a button to press to read the time in darkness or in sunlight.

THE ULTIMATE ACHIEVEMENT

Other manufacturers have devised unique ways to produce a watch you can read at a glance. The $300 LED Pulsar requires a snap of the wrist to turn on the display, but the Pulsar cannot be read in sunlight and its display uses 100,000 times the current of the Sensor display. The $400 Longine's Gemini combines both an LED and liquid crystal display. (Press a button at night for the LED display, and view it easily in sunlight with the liquid crystal display.) But you must still press a button to read the time. All these applications of existing technology still fail to produce the ultimate digital watch: one you can read under all light conditions without using two hands. Until the new Laser 440.

And if you've owned a digital watch for a year, chances are you've had it in for repair more than once—a very common consumer complaint. The Laser 440 is so service-free and has such high quality that it should rarely, if ever, require service. It is backed by a solid five-year warranty—your assurance of our commitment to this outstanding new product.

The Laser 440 has both time and stop watch functions. Six digits are on display—four large digits and two small ones. You choose between hours, minutes and seconds or hours, minutes and date by pressing a button. The Laser memory remembers the number of days in a month and resets automatically on the first day of the new month.

The 440 is also available in an 11 function chronograph (stop watch) and is truly the ultimate Laser timepiece. You can time two separate laps of a multilap race keeping one lap in memory. You can accumulate time; you can view the time of one lap while continuing to time a lap stored in memory. As a business executive, you can time long distance phone calls and interviews. Lawyers can keep track of their services, and doctors can time the vital signs of their patients. Even while the chronograph is functioning, you can still view the time—something even many of the expensive digital chronographs cannot do.

BUILT DIFFERENTLY

All wires have been replaced with circuitry printed on one single thin surface. On this same surface are two integrated circuits which use gold contacts and are hermetically sealed to protect their several thousand micro components. The American-made Laser is shock resistant and uses a tough mineral glass crystal to protect the rugged electronics from the everyday water and humidity tortures normally given any watch.

NEW QUARTZ BREAKTHROUGH

Digital watch accuracy depends on the quartz crystal. Even the best crystals change frequency with shock or age (especially when first produced). The Laser 440 uses the new and very expensive, tuning fork crystal. It is first aged to not shift frequency more than five parts per million per year (more accurate than most radio or TV time signals) so the extreme accuracy you expect is built into your watch from the first day you wear it. The crystal is cushioned and solidly bonded to the crystal carrier eliminating all fine wires that may break from shock. In short, the advanced design of the crystal will assure guaranteed accuracy greater than 5 seconds per month—year after year after year.

The Laser 440 is ideal for pilots because of its cockpit visibility and chronograph functions, perfect for the businessman who depends on his watch for split-second accuracy and the ultimate watch for anybody who wants unquestionably the finest digital watch ever offered at any price.

The Laser 440 is not only thin but is designed to conform to the contour of your wrist. A bulky digital watch can become annoying to wear—especially if you have a thin wrist.

HOW WE PROVIDE THE FINEST SERVICE

Can our company provide better service than even your local jeweler? We think so. If your Laser malfunctions during its unprecedented five-year warranty, just call us on our toll-free line. We have made arrangements with United Parcel Service to pick up your Laser at your door, at our expense, and we give you a loaner watch to use while your Laser is repaired. You pay nothing to have your watch serviced during its five-year warranty (that is if service is ever required) and we are as close as your phone or door.

WHO WILL BACK YOUR 5 YEAR LIMITED WARRANTY

Two solid companies are behind your new Laser. JS&A is America's largest single source of space-age products—a substantial company and a leader in electronics for over a decade. Our commitment to the consumer and to service is a matter of record. Check with the Better Business Bureau in your very own community, the Northbrook, Illinois Chamber of Commerce (312) 498-5555, or any of the 100 national magazines and newspapers in

new & timely

Zworykin elected to Inventors Hall of Fame

DR. VLADIMIR K. ZWORYKIN as he appeared when he invented the tube he is holding—the iconoscope that made our present television transmitting technology possible.

Dr. Vladimir Kosma Zworykin, television pioneer, has been elected to the National Inventors Hall of Fame, joining such notables in the communications world as Marconi, Bell, Morse, and Edison, and the three inventors of the transistor.

Vladimir Zworykin was graduated in 1912 from the St. Petersburg Institute of Technology, where he made his first contact with television as student-assistant to Professor Boris Rosing. Afterward he did post-graduate work at the College de France in Paris, returning to Russia at the outbreak of war in 1914.

Coming to the United States after World War I, he first worked for Westinghouse, and received his Ph.D in Physics from the University of Pittsburgh in 1926. In 1929 he joined RCA as director of the Electronic Research Laboratory. In 1947 he was elected a vice president and consultant for RCA Laboratories, and after his retirement in 1954 was made an honorary vice president and provided with an office at the David Sarnoff Research Center

Infrared light controls home slide projectors

In keeping with the trend toward the use of infrared light for remote control of electronic domestic equipment, Siemens says, they have come up with an idea for controlling home slide projectors. The simplicity of slide projectors makes circuitry much less complex than for, say, a TV set. Only four channels are needed, two to move the slide cassette forward and back, one for the projection lamp and one to control room lighting (a floor or table lamp is hooked into the circuit).

The Siemens device uses pulses transmitted sequentially on a fundamental frequency of 31.25 kHz. The pulse lengths, starting at 1.5 ms, are staggered by 0.5 ms from one channel to the next. Three infrared output diodes are driven by a Darlington circuit. Range is about 15 meters, and the low power consumption permits sending 30,000 instructions with a single 9-volt battery.

NEW INFRARED REMOTE CONTROL. Channels are *Lamp* (electric light for room illumination) *Projector, Forward* and *Back*.

In the receiver, a photodiode, a tuned circuit and transistor pick up the infrared signals and pass them to an integrated circuit that was originally developed as a video IF amplifier and is thus a low-priced item. A decoder then suppresses all pulses of less than 1 ms to clear out interference and noise. The individual signal lengths are then examined and allocated to their correct channels.

Engineering Consortorium offers computer courses

The 1977 Professional Growth in Engineering Spring Program of the National Engineering Consortorium features *Minicomputer, Microcomputer* and *Modern Signal Processing* as well as *Design and Production of Hybrid Circuits*. Eight programs are being presented during the week of May 22–27, 1977, at Pheasant Run Lodge, St. Charles, IL.

continued on page 12

Where do the pros get their training?

Almost half of the successful TV servicemen have home study training and with them, it's NRI 2 to 1.

It's a fact! Among men actually making their living repairing TV and audio equipment, more have taken training from NRI than any other home study school. More than twice as many!

new & timely

continued from page 7

Introduction to Micro/Minicomputers, May 22–24.

Microcomputer Basics and Programming, May 22–24.

Successful Design/Project Management of Micro/Minicomputer Systems, May 22–24.

Modern Signal Processing Design Techniques, May 22–24.

Microcomputer Architecture Interfaces and System Design, May 25–27.

Micro/Minicomputer Software Development and Systems Diagnostics, May 25–27.

Minicomputer Architecture, Interfaces Programming and Applications, May 25–27.

Design and Production of Hybrid Circuits, May 25–27.

The National Engineering Consortorium, Inc., is a nonprofit educational group serving the engineering community. Registration fee for each program is $395, for two programs $595. The registration fee includes the notes, lunch and dinner. Interested individuals may write the NEC Registrar, 1211 West 22nd St., Oak Brook, IL 60521, or phone (312) 325-5700.

INTERNATIONAL EXCHANGE OF IDEAS

AUSTRALIAN ABORIGINE, on visit to the University of Kansas, after demonstrating the art of the boomerang (and the ceremonial decoration required with it) to students of the William Allen White School of Journalism, learns something of American television technology using an Asian (Sony Videocorder) camera.

H. Potts, J. Peelee, R. Kulp are Gernsback Award winners

Harold R. Potts, Jr., John Peelee and Raymond B. Kulp, all correspondence students of the Capitol Radio Engineering Institute, are the Gernsback Award winners this month. The Gernsback Memorial Award is a check for $150 presented to an outstanding student in each of eight leading electronics home-study schools each year. Through the generosity of manufacturers, two supplemental awards of test instruments are given to the second-place and third-place student in each school.

Mr. Potts of Havelock, NC, says:

"My background goes back to my high school days. I was introduced to the world of electronics with a course in Basic Electricity. I enrolled in Electronics II the next year. But when I graduated, I realized I couldn't afford college right away. My alternative was to join the services, attend their schools and gain practical experience, then attend college under the GI Bill after my discharge. In 1974 I enlisted in the Marines with guaranteed training in electronics.

"Since then I have attended Basic Electronics classes for three weeks, and the Precision Measurement Equipment Calibration and Repair School in Denver, for 33 weeks. At my present duty station I have taken various classes on test equipment.

"I am currently involved with the core program of CREI and intend to go on to as many electives as I can. I receive technical training once a week at my laboratory and now I even instruct on some of them."

Mr. Peelee, of Springfield, VA, also started electronics as a freshman in high school, supplementing school courses with a night course in black-and-white and one in color TV repair, both given by the Fairfax Co. schools adult education division. At the end of his junior year, he worked part time for a local repair company. He started with CREI half way through his senior year, and on graduation started his own repair business. Now an electrical engineering student at the University of Virginia, he says "I am fixing electronic equipment this summer (1976), taking two electives at George Mason University, finishing CREI and getting a first class radiotelephone license. I will be graduated from UVA with a BSEE next May."

Raymond Kulp, second runner-up, works for Ford Aeroneutronics in Lansdale, PA. He reports:

"My CREI course has helped me in my work many times, especially the lessons on solid-state devices. An example is a problem we were having with a power supply. There was a Zener diode regulating a supply that always caused an FM oscillation problem. I found the Zeners used were the soft-knee type and the Zener point at the high end was right on the knee of the curve, giving little regulation on the high end. We have since gone to a sharp-knee Zener and the problem has virtually disappeared."

Mr. Potts receives the $150 Scholarship Award, Mr. Peelee a digital multimeter from B & K, and Mr. Kulp a Special Service Multimeter from VIZ.

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letters

DIGITAL ALARM CLOCK

I built the "Digital Alarm Clock" that appeared in the November 1976 issue. Works fine and I am pleased. I used the complete kit of parts and "case" that were available.

I made a few changes that might interest you. They were improvements, naturally. I mounted a normally-open pushbutton on top in place of S2, the snooze switch. I mounted S1 and S3 on the rear of the PC board and added a 2 × 6 × 8-inch wooden base to hold the clock upright. I used the vacant space left by moving S2 to add a SPST switch (RUN-STOP) in series with the lowest position of S3 (FUNCTION). Now when I turn the alarm off, I don't accidentally put the clock in stop mode. Lastly, I found the display brightness excessive at night although the automatic brightness feature was working correctly. I added a switch in series with the + lead of C4, the +95 volt filter. Opening this produces some display flicker but greatly reduces the brightness by cutting the display duty-cycle even further. Hence I now have six brightness levels in two ranges.

Too bad the cost of this circuit is so high. It has all the features I wanted so I paid my money and got what I wanted; alarm, snooze, seconds display but smaller than the rest of the display, automatic brightness control, no LED's, and visible at night (no LCD). I may switch to a transformer for the +17-volt supply to cut the power consumption a bit.

The only gripe relates to the oxidized leads on the Mostek MK50252 chip and no socket. Either leads should be solderable or sockets should be used. A bit of sandpapering solved the problem, but not without fear of zapping the chip.

O. C. BARR
Richland, WA

AUTOMOBILE PROJECTS

As one of millions of tinkering hobbyists, I enjoy both automotive and electronic pursuits. I have been meaning to write you to thank you for the Electronic Ignition I found in your May 1976 issue.

However, that only whet my appetite! I began searching the library's stacks for digital speedometers, tachometers, etc., and came away disappointed. Available plans featured dissimilar displays, too few common parts and no common power supply seemed adaptable.

So, I have a suggestion for you! How about a series of construction articles for the following projects: Digital speedometer, digital tachometer, digital odometer, digital clock (with digital stopwatch, rally & race), water temperature gauge with LED display, transmission oil temperature with LED display, oil pressure gauge with LED display, ammeter with LED display, manifold vacuum gauge with LED display, LED display ignition monitor (displaying kV output from the coil), LED display digital dwell meter (unless you can arrange a diode and LED triggered replacement for the points in your ignition system), a central computer with exhaust emissions monitor to diagnose and troubleshoot problems.

The reason I mention a series of articles on these is simply that budget constraints preclude the purchase of all the parts in one lump sum. Monthly purchases would be most amiable.

An LED-tuned AM/FM Stereo and CB Monitor radio would be ideal as an addendum to these, especially with low-distortion op-amp construction.

As to construction techniques, I recommend Vector board, breadboarding and/or wire-wrapping followed by immersion in clear epoxy for heat sinking and vibration proofing.

You could continue the series with radar and laser speedtrap detection devices, anti-theft and alarm devices, (to protect our investments), navigation-type computers for us rally nuts, accelerometers for us drag racing nuts (accelerating and braking both), accelerometers to measure side G-forces, an on-board computer terminal, computer and microprocessor and the list is endless.

Pardon my verbosity but I want my own digital dashboard (and have wanted for so long) and the juices flow when I think too long on the subject.

JON CUMMINGS
Colorado Springs, CO

We agree! However, the one never-ending problem plaguing construction articles of this type is in the area of transducers. No one seems to be supplying transducers of this type to hobbyists. We would like to hear from any readers with ideas on this subject.—Editor

OOOOPS!

It was unfortunate to see our 23-channel CB Analyzer model GN-1375B in the New Products section of your February 1977 issue of **Radio-Electronics.**

Nikoltronix Co. was the first company to produce CB analyzers (1975) and the 23-channel CB Analyzer has established itself as the most compact, complete, and contemporary CB analyzer on the market. Since 1975, the 23-channel CB Analyzer has been continuously modified so as to meet the needs and requirements of the changing CB market; it is now equipped to service 40-channel CB radios since No-

continued on page 16

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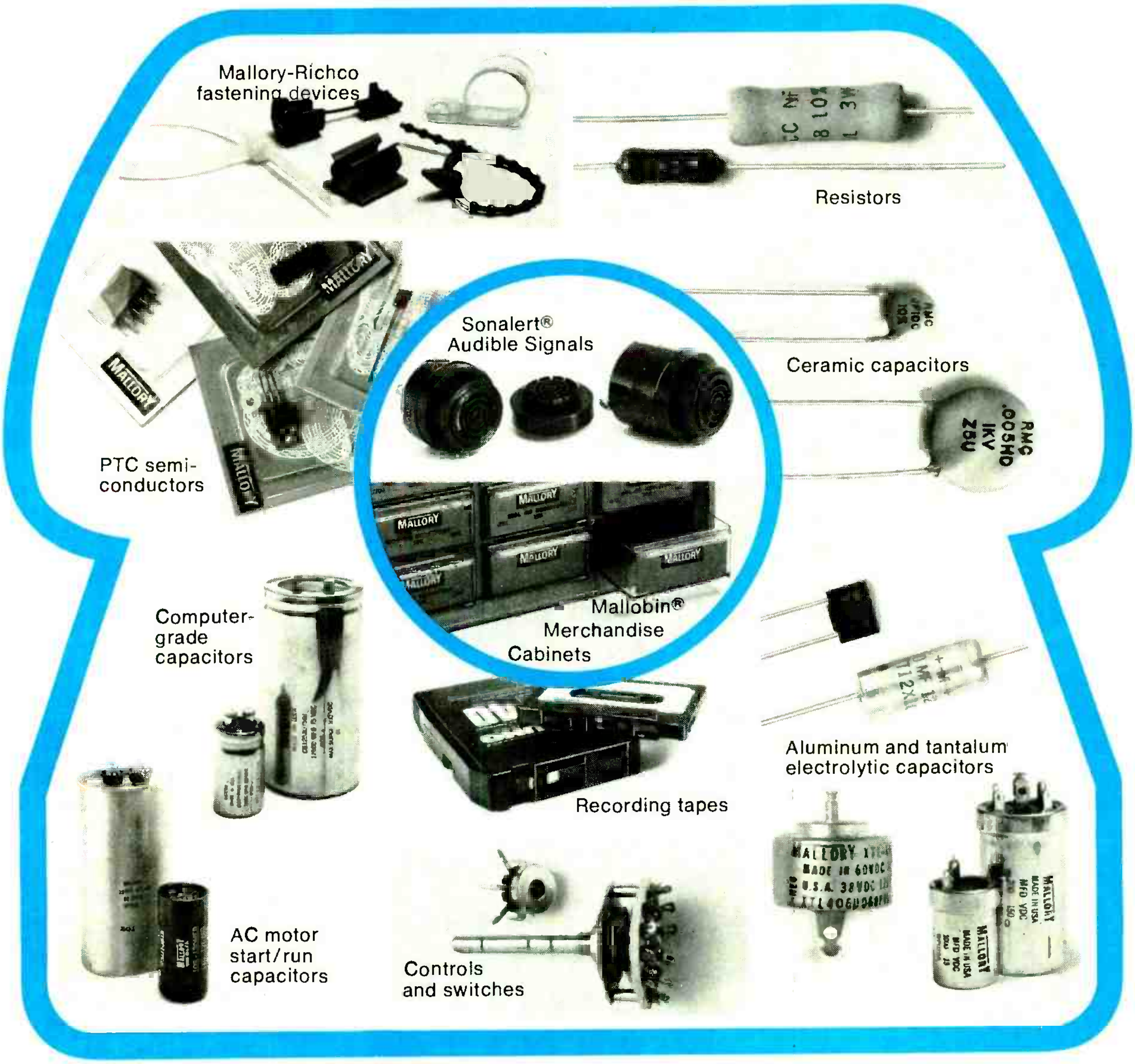

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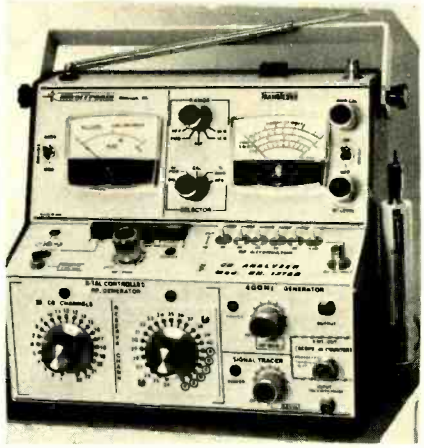
LETTERS
continued from page 14

vember 1976 (a photograph of the new 40 channel CB Analyzer model GN-1375B is enclosed).



Thus, it is apparent that the 23-channel GN-1375B does not belong in the New Products section of your magazine.

Your mistake, although unintentional, has caused great confusion among those who are familiar with our products and reputation as the originator and leader in CB Analyzers.

Hopefully, we have eliminated the confusion and misunderstanding.
GEORGE D. NIKOL
Nikoltronix Co.
Chicago, IL

GI VIDEO GAME IC

I really enjoyed the article "IC Application of the Month" in the January 1977 issue. This was a very timely article as many of us would like to have a TV game but can't afford one of the commercial versions. Please publish more articles such as this one. Better yet, make it a regular feature.

However, there is one problem. Where can one purchase the AY-3-8500-1 IC? I've tried all the supply houses in the Colorado Springs and also in Denver, but no one has the IC nor does anyone know of a source for the IC. Would you please publish the price and the address of a source? Also, in the future please publish a source for some of the more difficult to get parts, please.

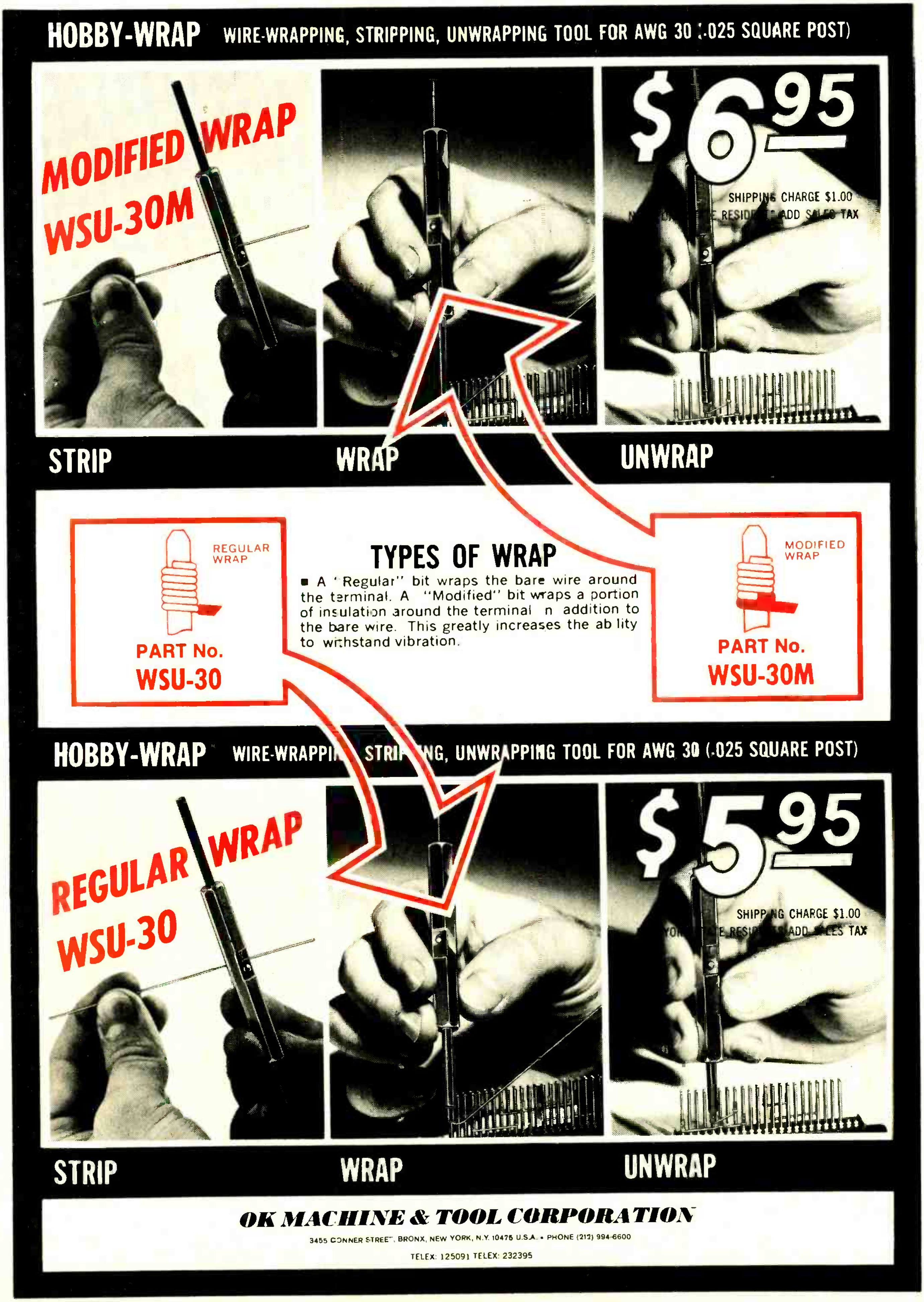
Keep up the great work.
KARL S. PERRY
Widefield, CO

Check the advertisements in the back of this issue for a supplier. We know James Electronics has some in stock. Check their ad for price and ordering information. There may be other suppliers as well.—Editor

BIC FORMULA

The article on the BIC Formula 7 Monitor Series Speaker in the February 1977 issue is of interest. I would hasten to

continued on page 22



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LETTERS
continued from page 16

point out that an SPL meter in the actual sound field is inherently better than any built-in audio power monitoring system. Room effects such as the carpet, drapes, furniture, number of people, etc., all alter the developed SPL which cannot be estimated solely at the speaker terminals. Resonance effects play a large part as an elementary study of room acoustics will show.

Thus an SPL meter in the field is worth more than two audio power meters at the source (for stereo systems). Furthermore, a modern SPL meter can cost less than the electronics presented for the BIC system. While audio power level monitoring is generally a good idea to protect speaker systems and people from gross overdrive, a field SPL meter is cheaper in this case and provides a much better estimate of the amount of ear damage anticipated in the listening environment.

There is a great tendency these days to digitize everything in sight, including now, the speaker power-input level with blinking LED displays. A pointer reading VU meter and single op-amp driver can do the same job here cheaper and probably better.

RALPH W. BURHANS
Ohio University
Athens, OH

R-E

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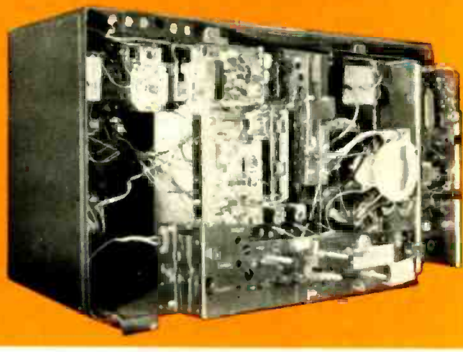

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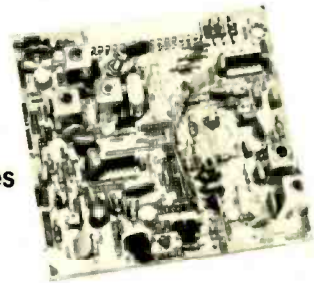

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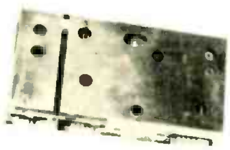

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KOMPUTER KORNER

PETER R. RONY, DAVID G. LARSEN, and JONATHAN A. TITUS*

IN THIS COLUMN, WE WILL INTRODUCE YOU TO additional details concerning the operations of an 8080A-based microcomputer that are controlled by software. It is the software instructions, or steps, that actually indicate to the microcomputer the tasks that it must perform. Just as you may start the day with a list of things to be done and a sequence in which they should be accomplished, the microcomputer, too, must be provided with a sequential list of program steps.

In general, we may not be familiar with what each microcomputer instruction does within the microprocessor chip. This does not deter us, however, from using them in all of our programs. Many of us are not familiar with the inner workings of an internal combustion engine, an automatic transmission, or a Xerox machine; our lack of knowledge does not prevent us from using them daily.

All of our programs are stored in fast semiconductor memory, either read/write memory or programmable read-only memory. The microprocessor IC *fetches* an instruction byte from the memory and then executes it. Each software instruction requires at least one fetch-and-execute action. Software instructions that contain several instruction bytes require two or three sequential fetch-and-execute actions. Again, exactly what is done within the microprocessor IC is not of interest to us, only the overall effect. All software is executed sequentially, one step after another, unless we purposely transfer control to instruction bytes located elsewhere in memory.

To conveniently handle the large number of software instructions in the 8080A microprocessor instruction set, it is customary to group them into several instruction groups. The Intel *8080 Microcomputer Systems User's Manual* subdivides the instruction set into five groups:

- Data Transfer Group—these instructions move data between registers or between memory and registers
- Arithmetic Group—add, subtract, increment or decrement data in registers or in memory
- Logical Group—and, or, exclusive-or, compare, rotate or complement data in registers or in memory
- Branch Group—conditional and unconditional jump instructions, subroutine call instructions and return instructions
- Stack, I/O and Machine Control Group—includes I/O instruc-

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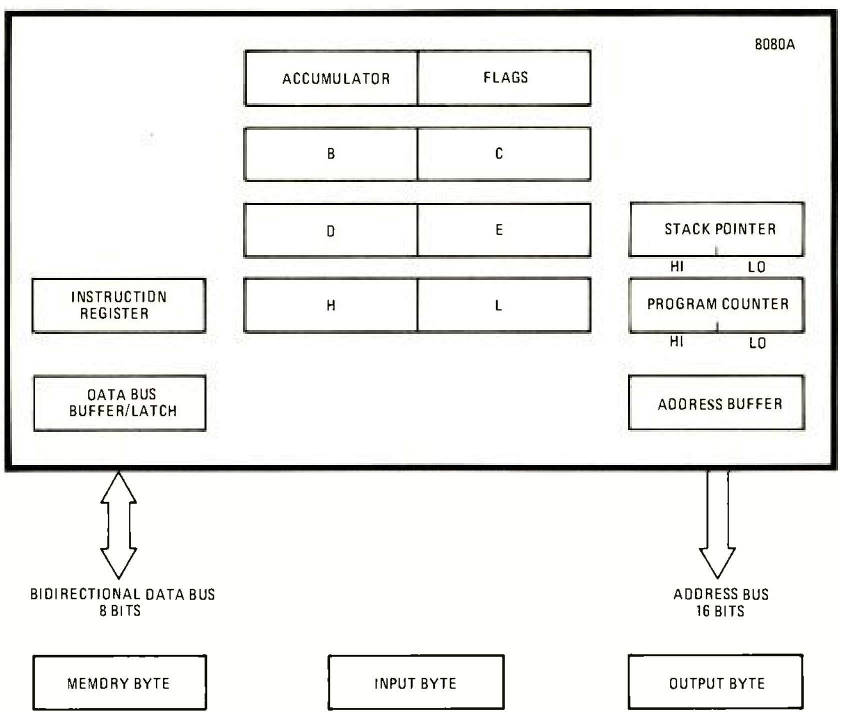

FIG 1

* Mr. Titus is president of Tychon, Inc., a microcomputer consulting firm in Blacksburg, Virginia. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University.

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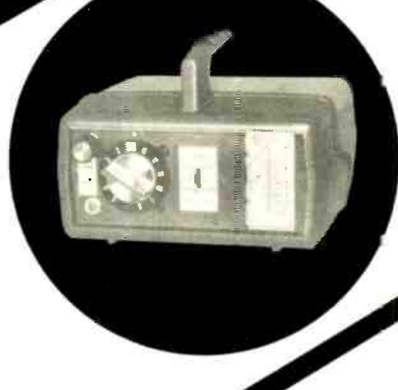

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KOMPUTER KORNER

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tions, as well as instructions for maintaining the stack and internal control flags

Before we can make much sense of these instructions, we must know more about the internal architecture within the 8080 itself. We shall present such information in steps, since it can be overwhelming if tackled all at once.

Shown in Fig. 1 is a schematic diagram that depicts the significant aspects of the internal architecture within an 8080 or 8080A IC. Our emphasis in the diagram has been an accessible 8-bit and 16-bit *registers* that store information within the IC. You should exclude from consideration the Data Bus Buffer/Latch and the Address Buffer, which we show here to make the point that these are internal circuits that interface the internal digital circuitry with the outside world, i.e., the 8-bit *bidirectional data bus* and the 16-bit *address bus*. As you learn about the 8080, you will be specially interested in the *accumulator, flags, program counter, stack pointer*, and *general purpose registers* that are designated B, C, D, E, H, and L.

We will not say much about the *instruction register*, since its function is automatic and we have little control over it. The function of the instruction register can be best understood with the aid of Fig. 2, which shows that it is an 8-bit register that temporarily stores the 8-bit instruction code for an instruction that is to be executed. Within the microprocessor IC, an instruction decoder converts the instruction code into a series of actions that, together, cause a microcomputer operation to occur. The individual actions are clocked by the ϕ_1 and ϕ_2 clock signals that are input at pins 22 and 15, respectively, on the 8080 IC.

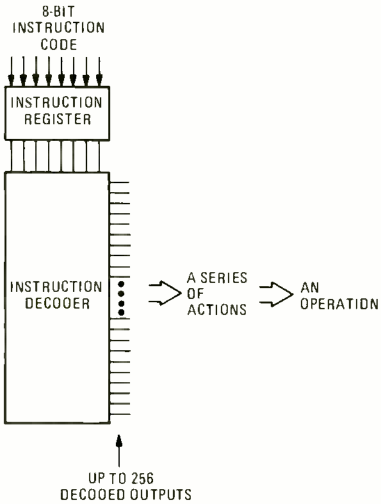

FIG 2

The general purpose registers B, C, D, E, H, and L are used for many varied purposes, *e.g.*, the storage of an 8-bit constant, the storage of a 16-bit pointer address, the storage of an intermediate result in an addition or subtraction, etc. Each general purpose register contains eight bits and can exchange data directly with the 8-bit external bidirectional data bus. Simple 8080 instructions permit you to transfer eight bits of data from one register to another; from a pair of registers to the program counter; from a register to the accumulator; and from a register to a memory location, and *vice versa*. You can use the contents of a register to perform addition, subtraction, and, or, exclusive-or, and compare operations with the contents of the accumulator. The contents of each register can be incremented or decremented. Register pairs, such as register H and register L, can be incremented or decremented as a 16-bit word.

The accumulator also acts as a general purpose register, but it has some special characteristics not possessed by the other six registers. The result of any arithmetic or logical operation is stored in the 8-bit accumulator. The I/O instructions (IN and OUT) transfer data only between the accumulator and external I/O devices. The contents of the accumulator can be transferred to any other general purpose register or to a memory location, and *vice versa*.

The five flags—zero, carry, parity, sign, and auxiliary carry—are flip-flops that indicate that certain conditions have arisen during the course of an arithmetic or logical instruction. Such flags are used by the microcomputer in making decisions, *i.e.*, with conditional jump, call, and return instructions; in multiple-precision arithmetic operations; and in logical masking operations.

The program counter is a 16-bit register in the 8080 IC that contains the address of the

continued on page 28

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KOMPUTER KORNER

continued from page 26

next instruction byte that must be executed in a program. You can load the program counter register either from a register pair or, more likely, from two instruction bytes in sequence located in memory.

The stack pointer is a 16-bit register that contains the address of the last byte that has been placed on the stack. The stack is a region of memory that is allocated for the storage of temporary information, usually the contents of the internal registers within the 8080 IC.

This summarizes our brief discussion of the internal architecture of the 8080 microprocessor. Keep in mind that there are seven 8-bit registers, two 16-bit registers and five flags, *the contents of which you can control using software*. Much of what an 8080 microcomputer does is to move 8-bit bytes from one location to another. This will become more apparent in subsequent columns. **R-E**

DEFINITIONS

accumulator—The register within a computer where the results of all arithmetic and logical operations are placed.

address bus—A unidirectional bus over which digital information appears to identify either a particular memory location or a particular I/O device.

bidirectional data bus—A data bus in which digital information can be transferred in either direction. With reference to an 8080A-based microcomputer, the bidirectional data path by which data is transferred between the microprocessor chip, memory, and input-output devices.

fetch—In a computer, the collective actions of acquiring a memory address and then an instruction or data byte from memory.

flag—A single flip-flop that indicates that a certain condition has arisen as, for example, during the course of an arithmetic or logical operation in a computer program.

general purpose registers—In the 8080 microprocessor, the 8-bit B, C, D, E, H, and L registers.

program counter—In a computer, the register that contains the address of the next instruction byte that must be executed in a computer program.

register—A short-term digital electronic storage circuit the capacity of which is usually one computer word or byte.

software—The totality of programs and routines used to extend the capabilities of computers. Examples include compilers, assemblers, narrators, routines, and subroutines.

stack—A region of memory that stores temporary information, usually the contents of the internal registers within a microprocessor chip.

stack pointer—A register that contains the address of the last byte that has been placed on the stack in an 8080 microcomputer.

Original operators celebrate 50 years of overseas phone

Two retired overseas telephone operators commemorated a half century of transatlantic telephone service with a call placed January 7, 1977, exactly 50 years after the first overseas phone call got through.

Ms. Rose de Palma, 73, one of the four original transatlantic operators for AT&T's Long Lines, called Ms. Isabel Ivy Baker, with whom she had worked from the earliest days of the transatlantic telephone. Ms. de Palma, brought from Florida to make the historic call, had retired from the Bell System in 1966 after 46 years of service. Ms. Baker, now 74 years old, left the British Post Office in 1940 and now lives in Thornton Heath, Surrey, England.

The two old-time operators reminisced before turning the phones over to dignitaries of AT&T in New York and its opposite number, the British Post Office in London.

The 1977 call was dialled by International Direct Distance Dialing, a service that permits one-fourth of all Bell System subscribers to dial direct to as many as 36 countries. There have been a few other changes in 50 years. The cost of a three-minute call in 1927 was $75 (equivalent to about $250 in 1977 dollars). The same three-minute call can be placed today for $4.05.

Computers now made useful for small-business man

Altair Software Distribution Co. is putting out software packages to fit the needs of retail stores, small wholesale distribution centers, industrial users and professional firms, among others. Altair is a subsidiary of MITS, microcomputer manufacturer of Albuquerque, NM.

The packages are designed to allow a purchaser to select the components of a system that will fit his needs closely. The accounting system, for example, is composed of four packages, *General Ledger, Payroll, Receivables* and *Payables*. The *Word Processing* package is a flexible text editor system that allows contracts or other lengthy documents to be stored, edited and printed. Documents can call for inserts from other files, making repetitive letters, etc., easy to produce.

The *Inventory Management* package is a flexible data-base management system that allows a business to keep complete inventory records "on line." In its off-the-shelf form, it is structured for a typical retail store whose inventory reorder policy is based on minimum reorder points. **R-E**

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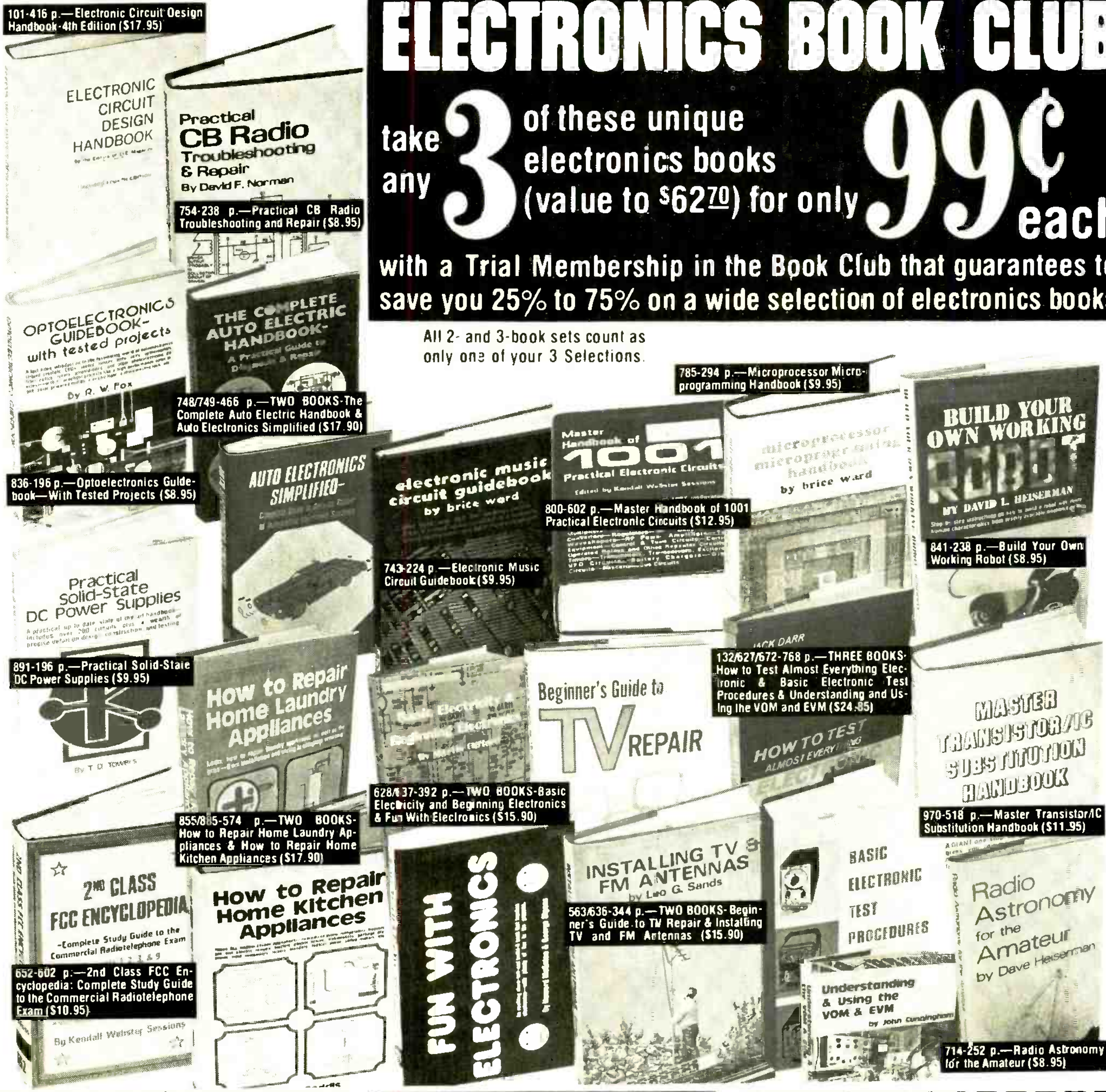

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equipment report

VIZ WR-549A Pulse Generator

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EVERYTHING IS GOING DIGITAL LATELY. SO, for design work or servicing of digital equipment, a reliable source of controllable pulses is needed. All digital circuitry works on pulses of varying shapes, widths and frequencies. Test equipment must be capable of developing the exact one needed for, a given circuit. VIZ Manufacturing Co., 335 E. Price St., Philadelphia, PA 19144, has introduced their *WR-549A* pulse generator that meets all of these requirements.

It's a tiny thing, but versatile. It can develop pulses that are continuously variable over a range from 5 Hz to 5 MHz. Pulse width and repetition rate are independently adjustable. The output is TTL compatible and also suitable for CMOS. The output has a range up to 15 volts P-P, and an impedance of 100 ohms. The risetime of the pulses is held to 20 nanoseconds on all ranges. Frequency can be set to within ± 5% of the dial setting with the two front-panel controls set to their CAL (counter clockwise) positions.

A novel method of pulse generation is used in the *WR-549A*. It uses two separate one-shots. Each of these is timed independently of the other by a selector switch and a set of precision capacitors. Each one-shot triggers the other. So, both pulse-widths may be adjusted independently from 100 nanoseconds to 0.1 second. To achieve maximum sharpness of the pulse (minimum risetime), edge-triggering is used. The trailing edge of the pulse from the first pulse-generator fires the second one. In turn, the trailing edge from the second generator is coupled back to the first, which sets this one off again, completing a cycle.

The outputs of the two generators are combined in a buffer amplifier. The front-panel LEVEL control sets the P-P voltage of the pulses, having no effect on their frequency or duty-cycle.

The first pulse-generator one-shot determines the duration of the positive-going pulse, and the second determines the duration of the off-time between two successive positive going pulses.

Precision timing capacitors are used for each generator, Two 6-position rotary switches select the capacitors. These go from 100 nanoseconds to 10 milliseconds. A continuously-variable control can be used to set the pulse-width exactly.

The *WR-549A* is AC powered with a tightly regulated DC power supply, and complete isolation from the line. Standard IC's and transistors are used. The instruction manual gives full and simple directions for checking the calibration, and adjustment if necessary. A troubleshooting chart is also provided.

This can be a very handy instrument, not

continued on page 32

Unique full-function 8-digit wrist calculator... available only as a kit.

A wrist calculator is the ultimate in common-sense portable calculating power. Even a pocket calculator goes where your pocket goes—take your jacket off, and you're lost!

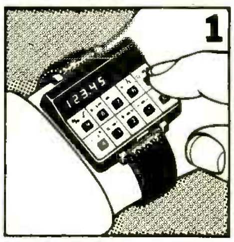
But a wrist-calculator is only worth having if it offers a genuinely comprehensive range of functions, with a full-size 8-digit display.

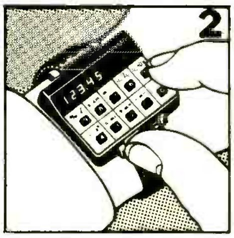
This one does. What's more, because it *is* a kit, supplied *direct* from the manufacturer, it costs only a very reasonable $19.95. And for that, you get not only a high-calibre calculator, but the fascination of building it yourself.

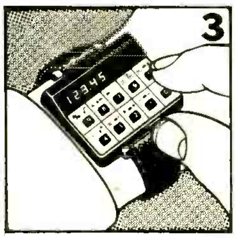
How to make 10 keys do the work of 27

The Sinclair Instrument wrist calculator offers the full range of arithmetic functions. It uses normal algebraic logic ('enter it as you write it'). But in addition, it offers a % key; plus the convenience functions $\sqrt{x}$, 1/x, x^2; plus a full *5-function* memory.

All this, from just 10 keys! The secret? An ingenious, simple three-position switch. It works like this.







1. The switch in its normal, central position. With the switch centered, numbers—which make up the vast majority of key-strokes—are tapped in the normal way.

2. Hold the switch to the left to use the functions to the left above the keys . . .

3. and hold it to the right to use the functions to the right above the keys.

The display uses 8 full-size red LED digits, and the calculator runs on readily-available hearing-aid batteries to give weeks of normal use.

Assembling the Sinclair Instrument wrist calculator

The wrist calculator kit comes to you complete and ready for assembly. All you need is a reasonable degree of skill with a fine-point soldering iron. It takes about three hours to assemble. If anything goes wrong, Sinclair Instrument will replace any damaged components free: we want you to enjoy assembling the kit, and to end up with a valuable and useful calculator.

Actual Size

Contents

Case and display window.
Strap.
Printed circuit board.
Switches.
Special direct-drive chip (no interface chip needed).
Display.
Batteries.

Everything is packaged in a neat plastic box, and accompanied by full instructions. The only thing you need is a fine-point soldering iron.

All components are fully guaranteed, and any which are damaged during assembly will be replaced free.

The wrist-calculator kit is available only direct from Sinclair Instrument. Take advantage of this 10 day money-back offer.

Send the coupon today.

Sinclair Instruments Inc.
6 Commercial Street
Hicksville, N.Y. 11801

To: **Sinclair Instruments Inc.** RE-5
6 Commercial Street
Hicksville, NY 11801

Please send me

_____ Sinclair wrist calculator kit(s) at $19.95 $_____

Sales tax (NY residents) _____

Shipping & handling ($2.50 per unit) _____

Enclosed is check/MO (payable to Sinclair Instruments Inc.) TOTAL $_____

Name _____

Address _____

City _____

State _____ Zip _____

I understand that you will refund the purchase price of the kit in full if I return it in saleable conditiion within 10 days of receipt.

---

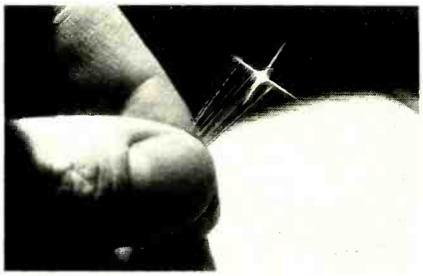
only for digital work but for general servicing as well. It is an excellent source of very accurate squarewaves for audio test work and can be used for ringing tests of coils, transformers, and so on. It can also be used as a source of a clock signal for digital circuitry. As I discovered, it is also nice for checking other things. After connecting it to a scope getting a set of L-shaped things for a trace, I found out that someone had been dinkering with the frequency compensation of my scope-probes! Quite a lot of useful things in a compact package. **R-E**

Lightguide telephone system evaluated

A cable of hair-thin glass fiber lightguides is being run under Chicago streets to test the transmission of telephone-customers' voice, data and video signals under actual working conditions. In 1976 a similar system was checked out in Atlanta, GA, under simulated field conditions. The present test, evaluating more accurately the potentialities of the new technology, will help determine how near it is to being economically and technically practical.

A lightguide cable will carry voice, video and data signals about 0.8 kilometers (one-half mile) from the Brunswick Building in Chicago's Loop to the Franklin central office of Illinois Bell, and from there 1.4 kilometers (about nine-tenths of a mile) to the Wabash central office.

The fiber lightguides, approximately 0.005 centimeters (about 2 mils) in diameter, are made of extremely pure silica-glass coated to protect them from mechanical injury and combined into flat ribbons of 12 fibers. Two of these ribbons are enclosed in the cable that protects them in under-street installations. Each pair of fibers can carry 576 simultaneous telephone conversations or their equivalent in video or data channels.

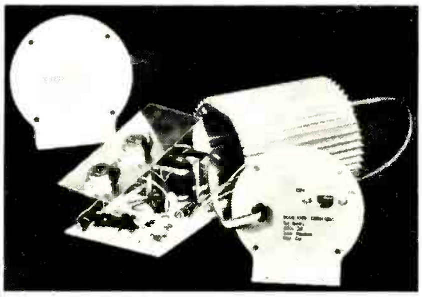


TWENTY-FOUR SLIM LIGHTGUIDES arranged in two ribbons of twelve each in a specially designed cable, will be used as the understreet lightguide conduit in the 1977 tests in Chicago.

The signals are fed into the cables by gallium-aluminum-arsenide lasers made by Bell Labs. Light-emitting diodes will also be used. Though not as powerful sources as lasers, they are expected to be adequate over the short distances involved in the Chicago tests.

Reception is with a special silicon "avalanche" photodetector that is part of a

continued on page 34



Performance features at a price you can afford- and fully backed by Tektronix

Only Telequipment offers you:

TEKTRONIX GUARANTEE

The Telequipment family of oscilloscopes is fully guaranteed by Tektronix, the world's leading oscilloscope manufacturer. This guarantee means that during your first year of ownership, if there are any defects in Telequipment parts or workmanship, you can bring your oscilloscope to any of 35 Tektronix Service Centers across the United States for fast repair by experts—free of charge.

PERFORMANCE FEATURES YOU NEED AT A PRICE YOU CAN AFFORD

Model D61a Designed for portability and easy operation, the D61a is a dual trace 10 MHz 'scope for only $595. For easy, accurate viewing, the D61a features automatic triggering and bright, stable waveforms on an 8 x 10 cm display.

Model S61 NEW from Telequipment, the S61 is a 5 MHz single trace oscilloscope featuring automatic triggering and 8 x 10 cm display for $375. This lightweight (14 lb.) instrument has a straightforward, easy to read front control panel—well suited for education applications.

Model D32 When you demand an extremely portable 'scope, the D32 is ideal. Battery or ac line operated, this 10 MHz dual trace 'scope weighs only 10 lbs. An optional shoulder strap or attaché carrying case can be used to take your 'scope into the field. The $750 price includes batteries and probes.

IDEAL FOR MANY APPLICATIONS

If you're servicing pocket calculators, TV, radio, microwave ovens, alarm systems or dozens of other consumer products, Telequipment 'scopes can do the job for you. Easy viewing and operating make Telequipment ideal for classroom use too.

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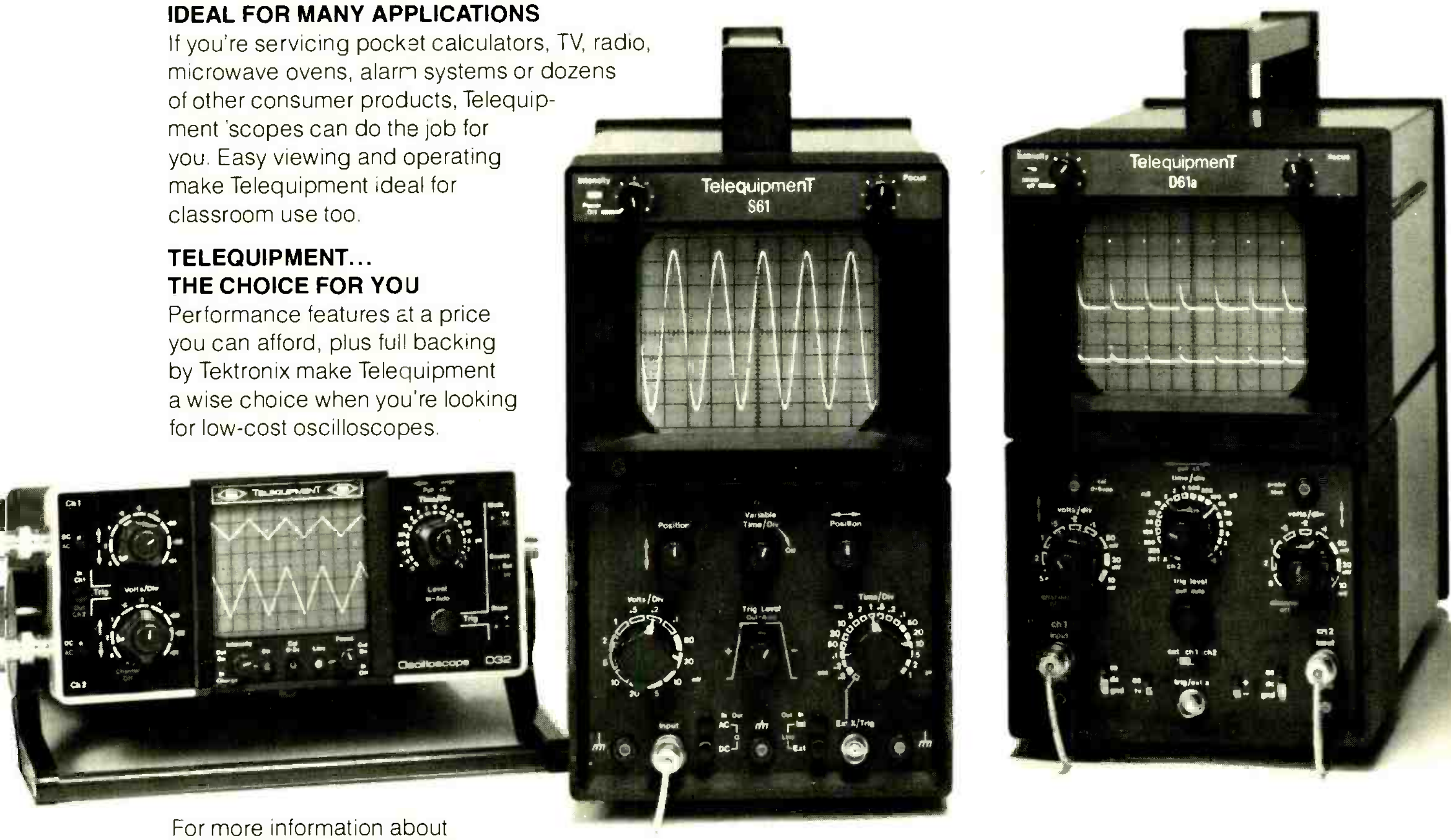

For more information about Telequipment oscilloscopes, contact your nearest Tektronix Field Sales Office, or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. For immediate information, call Bill Glaze at Tektronix: (503) 644-0161, extension 7163.

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CIRCLE 39 ON FREE INFORMATION CARD

receiver module with circuitry to process the signals for transmission through the regular telephone network. Transmission is in the infrared, at 0.82 micron, and losses through the lightguide are about 6 dB-per-kilometer, or about 10 dB-per-mile. The modulator circuit can turn the laser transmitters completely on and off 44.7 million times a second, giving a 44.7-megabit digital information rate.

More shows and conferences for computer hobbyists

The magazine *Personal Computing* is sponsoring three computer conference-shows this Spring, and is planning more shows for later in the season.

The Western Personal Computer Show was held on March 19 and 20, in Los Angeles. The Eastern show is May 7 and 8 in Philadelphia, and the New England show is June 18 and 19 in Boston. Exhibitions, seminars, special presentations and tutorial workshops will be featured at all the conferences.

Later shows are being planned for the South, Southwest, Canada and Europe.

Special areas of the exhibition halls are being set aside for personal computing in education, in the home, in ham radio and in small businesses.

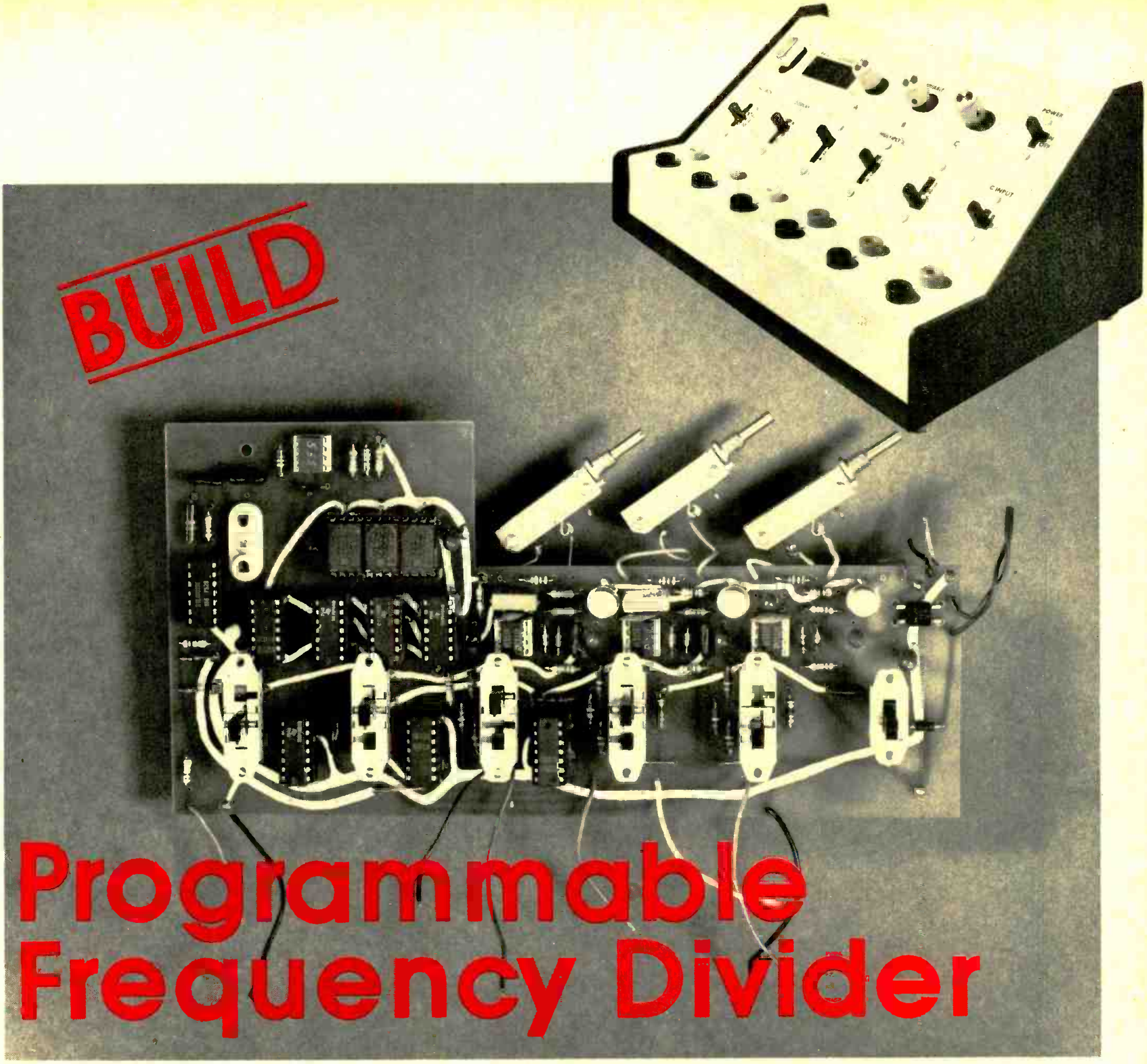
Court upholds Magnavox video games patents

The United States District Court for the Northern District of Illinois has ruled that the Magnavox patent on coin-operated video games is valid and that the rights of Magnavox, a subsidiary of North American Philips, have been infringed. The ruling was against the Chicago Dynamics Industries and Seeburg Corp.

In previous suits against Atari, Inc., and Midway Mfg. Co., consent judgments were entered and the two companies entered into licensing agreements with Magnavox. Further suits are pending against Allied Leisure Industries, Inc., for both its coin-operated and home video game units; and against the Radio Shack division of Tandy Corporation that sells home video game units to consumers.

CB COMES TO TOWN IN TEXAS

"WE MONITOR CHANNEL 19," announces a motor inn in Fort Worth. The insert shows a desk clerk acknowledging a room reservation request from a motorist. The CB radio is a wall-mounted *Realistic* TRC-30A.



BUILD

Programmable Frequency Divider

Wide range of frequency division is made possible by three cascaded 555-timer IC stages. The divisor is selected by three 10-turn pots and indicated on an LED display

GEORGE BAUMGRAS

FREQUENCY DIVIDING CIRCUITS ARE WIDELY USED FOR TIMEBASES, test equipment functions, music synthesizers and digital applications to name but a few. If we want a specific output, a crystal oscillator/digital counter combination affords the best accuracy, usually at the price of high package count and limited choice. The programmable version offers considerable improvement in choices available, but the price goes up—many switches and a long list of codes are necessary. A properly calibrated wave generator is an alternative, except that accuracies better than ±3% usually cannot be expected unless monitored by an expensive digital counter. The circuits described here do nothing new; rather, they perform this common task at a fraction of the usual complexity without sacrificing accuracy. A few design applications and the construction of a multi-purpose test instrument will be described—many other unique applications in your field of interest should become obvious.

The basic circuit (Fig. 1-a) is a very simple, stable and reliable means of dividing fixed frequencies with absolute accuracy, using the versatile 555 timer IC. Depending on the R1 and C1 values selected, the input will be divided by some whole number from 2 to at least 500 with off-the-shelf components. With selected parts, careful layout and a well-regulated power supply, much higher divisors are practical. Figure 1-b is a flexible 1-second timebase which demonstrates package count reduction to an absolute minimum. The line frequency can be any commonly available, and by adjusting the value of the 50K potentiometer, the output can be adjusted to 0.5 Hz, 2 Hz or any of several other choices.

By comparison, the conventional TTL timebase requires at least one transistor and two IC's to accomplish the same purpose. You can try out this circuit very quickly on a prototype breadboard, or even on a TTL IC tester if you can isolate pins 2, 6 and 7 from the LED logic-state indicators. Figure 1-c shows the input and output waveforms for a ÷4 using a 555 timer. The values of R and C can drift slightly due to temperature and aging without affecting operation; also long-term supply-voltage variations have no effect.

How the basic circuit works

A 555 timer IC connected in the familiar monostable configuration (Fig. 1-a) will output a positive voltage at pin 3 for a selectable time period, if pin 2 is briefly triggered below ⅓ of the supply potential. The duration of this pulse is approximately equal to R1 × C1 × 1.1, provided pin 2 remains high. Adding C2, R2, R3, D1 and D2 changes this circuit to an efficient divider. When a negative-going pulse through C2 drops the voltage across R2, pin 2 goes low because of the decreased current through R3 and triggers the internal comparator. Pin 3 now flips to near the power-supply level and most of this voltage is fed back to pin 2 through D2 and across R3 which prevents triggering during the time T.

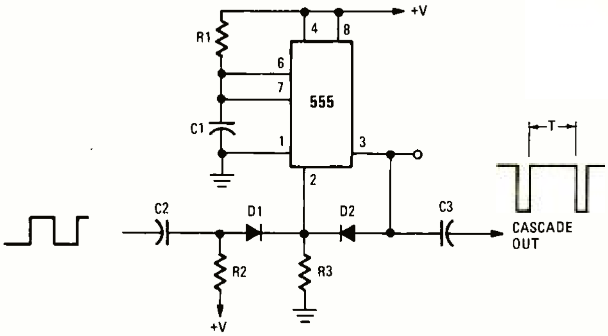
When C1 discharges enough, pin 3 drops to the low level, pin 2 is clamped at about half the supply due to the voltage divider R2, D1 and R3, and cannot be triggered until the next pulse comes along. During time T, the IC will not respond to an input pulse and thus divides by responding to only 1-of-N trigger commands. The rate of division (N) can be calculated by: f_{in} (Hz) × T (secs).

The value of R1 can be varied by means of a potentiometer and a few switched resistors so that a wide range of divisors may be continuously selected, using one capacitor. If a multi-turn potentiometer is used for R1, resolution is excellent and the output pulse width can be varied considerably. If various values of C1 are also switchable, one divider can be set up to handle any input up to at least 1 MHz. If a single output is wanted, however, cascaded variable-R1 dividers are more useful. If three are cascaded, the output is determined by: $f_{in} \div (N \times N \times N) = f_{out}$.

The variable modulo test unit

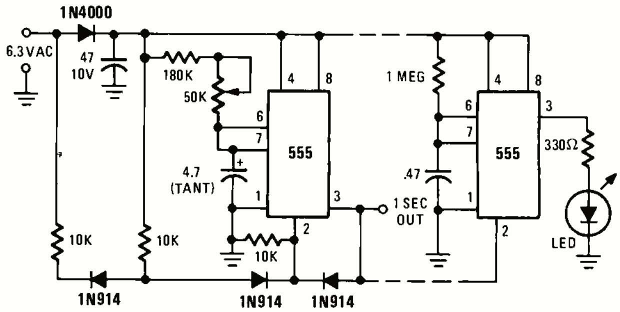
The schematic in Fig. 2 uses the basic principle of Fig. 1-a for each of its three cascaded sections. The divisor for each is selected by a 10-turn panel-mounted potentiometer, a four-position range switch and a single capacitor. The internal frequency is generated by IC1-b and IC1-c, controlled by a plug-in crystal which can be any conceivable value to 1 MHz. This is fed to the NAND Schmitt triggers IC2-a and IC2-d. The external input goes to the high impedance input of IC1-a and to IC1-d, limited to TTL levels. This source is also conditioned by IC2-b and IC2-c.

Both sources are selected with S1, and either one may be prescaled by IC3, a divide-by-10 counter, if desired. The output pins of S1 go to S2 and the first variable modulo divider, IC4. The output of IC4 carries to IC5 and from there to IC6—all three outputs are also routed to panel output jacks.



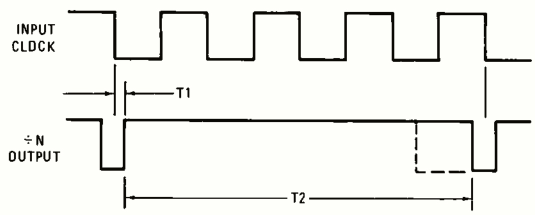
THE BASIC DIVIDING CIRCUIT. ÷N = f_{IN} X T, T = R1 X C1 X 1.1.
C1 SHOULD BE AS SMALL AS PRACTICAL, BUT NOT LESS THAN 500pF.

a



A LINE FREQUENCY TIME BASE USING ONE IC. OUTPUT MAY BE CALIBRATED WITH A PERIOD METER, OR BLINKER LED IN OPTIONAL ADD-ON CIRCUIT MAY BE COMPARED WITH THE SECONDS READOUT OF A DIGITAL CLOCK.

b



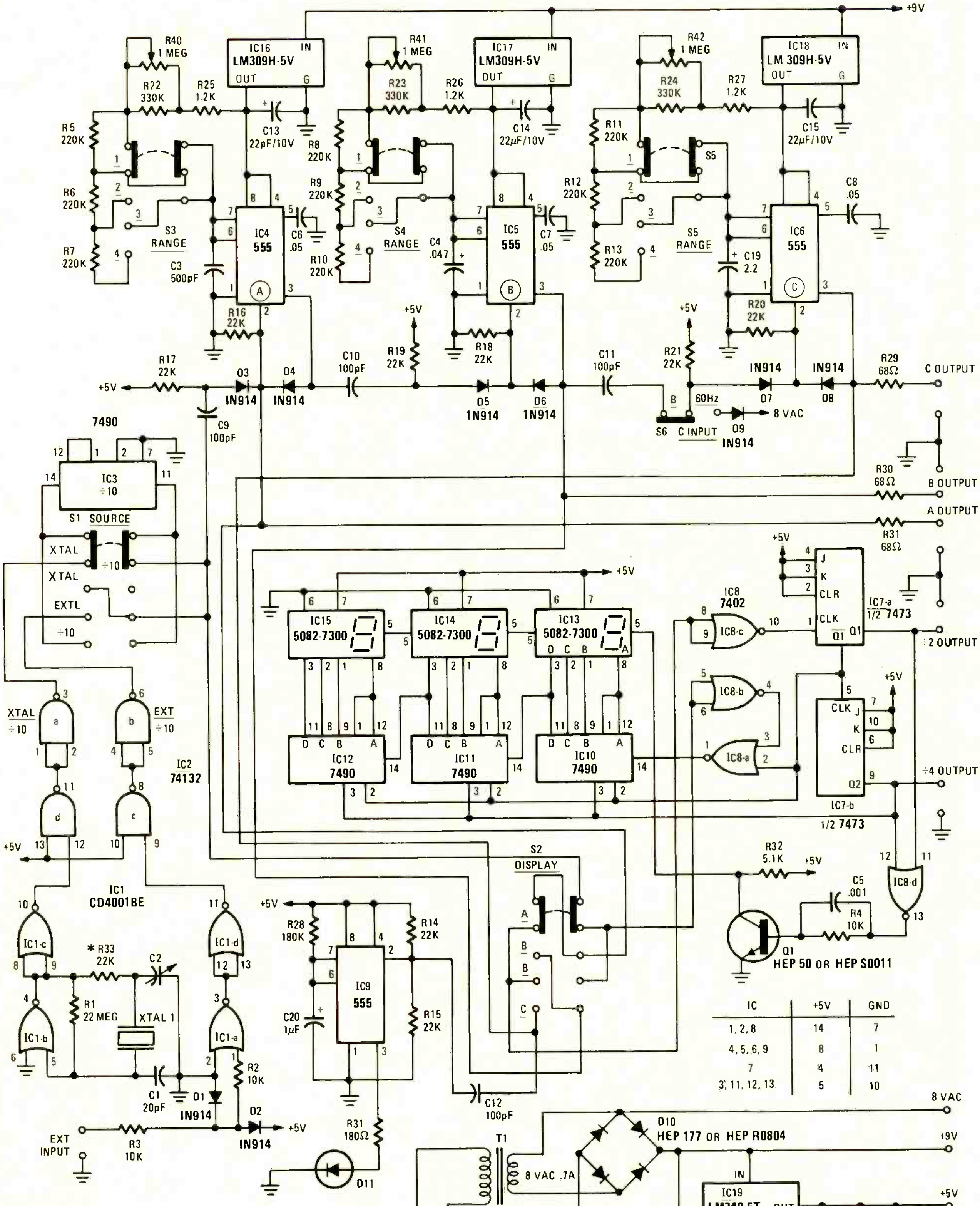
SYNCHRONIZED TRIGGERING.
TIMING FOR ÷4 IS SHOWN. T1 IS THE TRIGGER TIME FOR THE 555, LESS THAN 1 μSEC. T2 IS THE PIN 3 "ON" TIME ESTABLISHED BY R AND C, WHICH CAN VARY AT LEAST 1/2 CLOCK CYCLE WITHOUT AFFECTING THE OUTPUT RATE.

c

FIG. 1—FREQUENCY DIVIDER circuits using the 555-timer IC. The basic frequency divider is shown in *a*. A 1-second timebase circuit that divides the line frequency is shown in *b*. Input and output waveforms for a ÷ 4 circuit using a 555 is shown in *c*.

PARTS LIST

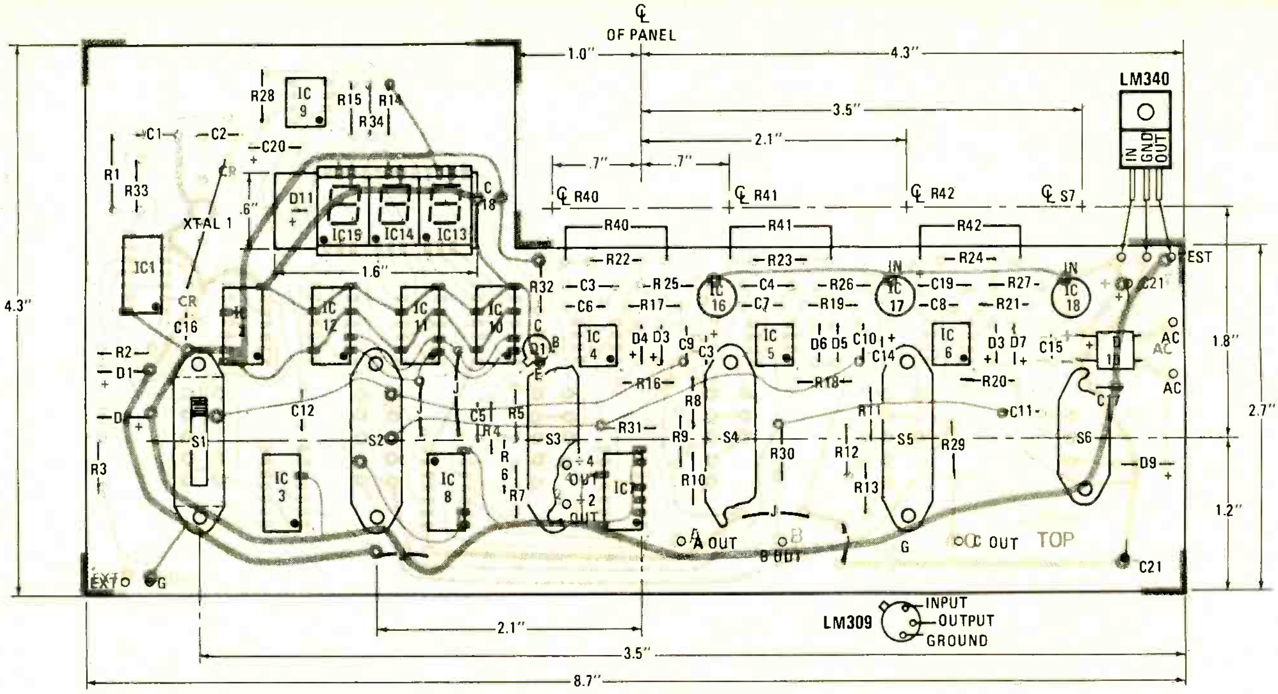
Resistors all 5% ¼-watt unless noted
R1—22 megohms, ½ watt, 10%
R2, R3, R4—10,000 ohms
R5 thru R13—220,000 ohms
R14 thru R21—22,000 ohms
R22, R23, R24—330,000 ohms
R25, R26, R27—1200 ohms
R28—180,000 ohms
R29, R30, R31—68 ohms
R32—5100 ohms
R33—22,000 ohms (see text)
R34—180 ohms
R35 thru R39—not used
R40, R41, R42—1 megohm variable (Beckman Helipot model 57 with shaft attached or equal)
Cl—20-pF disc
C2—30-pF disc (or optional 4-40 variable)
C3—500-pF mica, 5%
C4—0.047-μF disc
C5—0.001-μF disc
C6, C7, C8—0.05-μF disc
C9, C10, C11, C12—100-pF disc
C13 thru C18—22-μF, 10V, tantalum
C19—2.2-μF, 10V, tantalum
C20—1-μF, 10V, tantalum
C21—4000-μF, 15V, electrolytic (0.9" diameter x 2" maximum)
D1 thru D9—1N914 or 1N4148
D10—HEP177 or HEPR0804
D11—LED, 0.18" diameter
IC1—CD4001BE quad 2-input NOR gate
IC2—74132 quad NAND Schmitt trigger
IC3, IC10, IC11, IC12—7490 decade counter
IC4, IC5, IC6, IC9—555 timer
IC7—7473 dual JK flip-flop
IC8—7402 quad 2-input NOR gate
IC13, IC14, IC15—5082-7300 (or -7302) decoder/latch/display (Hewlett-Packard)
IC16, IC17, IC18—LM309H 5V regulator
IC19—LM340-5T 5V regulator
Q1—HEP50 or equal
S1, S2, S3, S4, S5—double pole, 4-position slide (Continental Wirt or equal) PC type
S6, S7—SPDT slide (Continental Wirt or equal) PC type
T1—power transformer: primary 117 VAC; secondard 8V, 0.7A
XTAL1—1 MHz, plug-in type (see text)
One IC socket, 24-pin Wire-Wrap type
Eight IC sockets, 14-pin Wire-Wrap type
Four IC sockets, 8-pin Wire-Wrap type
Crystal socket type HC6U (.05" pins spaced .487")
Eight Banana sockets, black
Eight Banana sockets, colored
Cabinet, LMB 007-946 or equal
Circuit board
AC line cord
Three Knobs for ⅛-in. shaft
Plastic window, 1 x 2 x 0.05"
No. 22 stranded insulated wire
Grommet for line cord
Assorted hardware
Solder



IC	+5V	GND
1, 2, 8	14	7
4, 5, 6, 9	8	1
7	4	11
3, 11, 12, 13	5	10

NOTES:
*SELECT VALUE FOR R33 SO THAT ALL XTALS USED WILL OSCILLATE AT TURN ON.
C2 MAY BE 4-40pF VARIABLE TO TRIM XTAL.
SHORTEN UNUSED SWITCH PINS.
REMOVE UNUSED SOCKET PINS WHERE REQUIRED.
HEAT SINK REQUIRED FOR IC19

FIG. 2—PROGRAMMABLE FREQUENCY DIVIDER has 3-digit LED display to indicate the divisor of the three 555 divider stages.



NOTE: DIMENSIONS ARE FOR CIRCUIT BOARD SIZE AND PANEL LAYOUT

C21 MOUNTED ON UNDERSIDE OF BOARD

COMPONENT PLACEMENT diagram showing PC board dimensions.

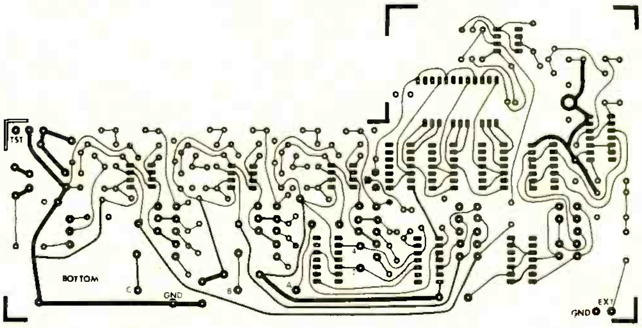
Divider C can be switched by S6 to either the carry output of B or to a 60-Hz half-wave source, but in the latter mode, divider C will not show its divisor in the display. To use this option, divide 1 MHz by (100 × 100 × 100) for a 1-Hz output at C. Change the C input switch to the 60-Hz position and the output will remain 1 Hz. Similarly, for a 2-Hz output, divide by 100 × 100 × 50, or for a 0.5-Hz output divide by 100 × 100 × 200 and so on. This arrangement provides a separate selectable timebase which remains constant while A and B are varied.

The display will directly read the divisor for each section, except as noted above, which makes a frequency counter unnecessary. However, a pocket calculator will be helpful. Since the readout is a ratio rather than a frequency, display updating, for simplicity, must occur at a rate proportional to the output of the section being read. For this reason a dual flip-flop, IC7, is used to sequence the count, latch and reset functions in order to provide the minimum time slot for each.

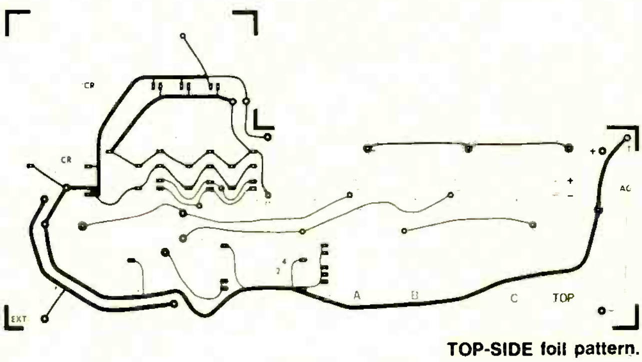
The divide-by type of readout is preferred since it is much simpler to build-in than a counter capable of reading from 500 kHz to 0.1 Hz and requires only three digits without decimal points. Also, the time between pulses out may be read directly, because the readout is reciprocal. If, for example, the input is 1 MHz and the display reads 100, then the output is 10 kHz and the pulses are 100 μs apart. An LED blinker next to the display is actuated by the C output and IC9 and conveniently indicates visually the slower rates only. When setting the larger divisors for C it may take around 20 seconds for the display to update, which occurs after every fourth blink, and this indicator can be very helpful.

The symmetrical squarewave ÷ 2 and ÷ 4 outputs from IC7 are connected to panel jacks and subdivide the output of the section being read; the divisor for these outputs is determined by mentally doubling or quadrupling the readout. This arrangement makes possible nine related output frequencies at any setting of the variable controls by selecting display switch positions, or five frequencies output simultaneously without switching.

The input and output lines for either A, B or C are selected by S2. The selected output is buffered and inverted by IC8-c and drives the clock input of IC7-a which in turn causes $\bar{Q}1$ to go low, toggle IC7-b and enable IC8-a (Table 1). The selected input is buffered and inverted by IC8-b and IC's 10, 11 and 12 start to accumulate the count from IC8-a. Another output



BOTTOM-SIDE foil pattern.



TOP-SIDE foil pattern.

pulse from IC8-c again clocks IC7-a, disabling IC8-a and stopping the count. The Q outputs of IC7-a and IC7-b are now at logical 0 and IC8-d applies a positive voltage to the base of the transistor through R4 and C5, where it is inverted to a logical 0 at the latch inputs of the display IC's, and update occurs.

The next output pulse causes IC7 to go into a holding mode and the latch enable goes high. The final output pulse of this sequence again clocks IC7-a, causing the Q1 output of IC7-a and the Q2 output of IC7-b to go to a logical 1 and reset the decade counters. Each set of four pulses repeats the process to keep the display updated as the divisor is varied by the control knob.

The power supply uses a full-wave rectifier to improve filtering by capacitor C21. IC19 supplies regulated voltage to all IC's except IC4, IC5 and IC6. These are individually regulated by IC16, IC17 and IC18 to avoid voltage variations originating elsewhere in the circuit that can cause poor resolution and instability. Capacitors C16, C17 and C18 are located on the board for a similar purpose.

Construction details

The three variable potentiometers should each be checked for smooth and gradual resistance change as the shaft is rotated the final two turns on each end. Select the best one, marking the "good" end, and use it for divider A. The other two are not as critical, but do use the same end when wiring them for B and C. It makes no difference which way the knobs turn to set the divisor, but they should all be the same.

The single circuit board mounts nearly all the components on its top surface, capacitor C21 mounts on the bottom side and IC19 is bolted to the cabinet rear panel. Brass nuts (No. 3-56) soldered to the six switch mounting plates attach the assembled board to the panel rear surface and spaces it ⅝-inch away. The enclosure can be a cabinet 9 × 6 × 3-inches minimum, or the type noted in the parts list. Raise the display IC's (and the LED) from the board surface just enough to contact the back side of the plastic window by means of a 24-pin wire-wrap socket, which also permits soldering on both sides of the board.

All of the 14-pin sockets are also the wire-wrap type. Raise them just enough to allow soldering, then clip off the excess pin length. Insert the switches in the board and screw them to the front panel to insure proper alignment and height before soldering them in place. Once the fit is established, assemble the remaining sockets and parts, then solder capacitor C21 to the bottom of the board.

Wire leads for the input, 5 outputs, 2 grounds, 3 potentiometers and IC19 should be installed next (a total of 17 wires), leaving them long enough for connection later on. After installing the IC's, test the circuit in case there is an accidental short somewhere, using a variable regulated power supply. Attach the positive lead to IC19's regulator output connection (marked TEST) and the negative lead to one of the ground wires, then gradually apply a maximum of +5 volts. The display should light at least partially, and current drain should be about 350 mA. If a crystal is plugged in, IC1 should oscillate and the waveform at pin 10 can be observed on an oscilloscope. At this time it is also advisable to test the other crystals to be used. If any of them do not work, try a smaller value for R33, or replace IC1. One of the crystals can be trimmed by the optional capacitor C2 at a later time.

The assembly can now be mounted to the machined, painted and lettered cabinet. Install the 3 potentiometers and 12 banana jack sockets and wire them to the board, keeping the leads as short as practical. The regulator, IC19, is attached to the rear panel for grounding and heat-sinking and connections completed. Splice extra wire to the transformer leads if necessary and assemble it. Connect the power switch and line cord to the primary and the secondary leads to the board. If all has gone well, the Variable Modulo Frequency Divider is now ready for use.

Using the dividers

Each divider section should be considered as a separate unit that performs best at the frequency for which it was designed. Although the total package can, for example, divide 1 MHz by many whole numbers from 2 to more than 10,000,000, not all the divisors in between can be obtained.

The reason for this is simple: specific values of R and C establish a time period which remains constant regardless of the input, while the ratio of input to output varies with frequency. The method of determining any output is: $f_{in} \div N = f_{out}$, as demonstrated by the following example: 1 MHz ÷ (100 × 100 × 100) = 1 Hz. If we change the divisor of A (or B) then the divisor of B (or C) will also change because of the fixed time period as in the next examples: 1 MHz ÷ (200 × 50 × 100) = 1 Hz, or 1 MHz ÷ (100 × 200 × 50) = 1 Hz.

It is nearly impossible to state how many different outputs can be obtained from the cascaded dividers because of the many factors and options involved—only guidelines may be given. To begin with, the basic plan is to extract 1 Hz from 1 MHz, or divide by 1,000,000 as in the above examples. If each section divides by 100, then A input is 1 MHz, B input is 10 kHz and C input is 100 Hz. But also any section will divide its stated input by anything from 2 to 500.

Accordingly there must be initially 4500 choices available, some of which are duplicates. Several thousand more may be added by varying the original ÷ 100 to some odd higher or lower value for A (or B) to result in a new input to B (or C). We can again add many thousands of choices to the list by changing crystals, best done by using odd values. A 971.52 kHz crystal is a good choice for one of these, as explained further on. The prescaler can be easily reconnected as a ÷ 9 or ÷ 7 to add still another option.

Instead of the crystal oscillator, we can use an existing TTL source, or a wave generator, prescaled if necessary, but regardless of the source, accuracy will be the same as the input. Based on these calculations, the availability of something close to what we want becomes dependent on the number of odd-ball crystals on hand plus a little ingenuity in setting the divisors—perhaps 100,000 choices might be a reasonable estimate.

Applications

One interesting use for this project, and the basic circuit, is in the field of music synthesis. Using the 971.52-kHz crystal mentioned earlier, set the dividers at A = ÷ 232, B = ÷ 8 and C = ÷ 8, which will result in nine octaves of note C present or selectable at the five outputs, as shown in Table 1. The outputs must of course be further processed to become usable. The frequencies given do not necessarily hold true for all scales and instruments, and are stated only as typical.

TABLE I

OCTAVE #	OUTPUT AT	f_{out}	f_{true}*
8	A	4187.5	4186.0
7	A ÷ 2	2093.7	2093.0
6	A ÷ 4	1046.8	1046.5
5	B	523.44	523.25
4	B ÷ 2	261.72	261.63
3	B ÷ 4	130.86	130.81
2	C	65.43	65.40
1	C ÷ 2	32.71	32.70
0	C ÷ 4	16.35	16.35

*For note C. Equally tempered music scale

The wide range of available outputs is very useful for calibrating tone generators and other frequency sources, as well as for tuning tank circuits, notch filters and the like. Assembly manuals for kits usually specify the use of an accurate frequency source for calibrating (oscilloscopes, counters, etc.). If one output is made to gate a strobe lamp, very accurate RPM measurements can be simplified. Motor speeds (where RPM depends on frequency) can be continuously varied over a wide range. **R-E**

HI-FI

New Way To

Graphic equalizers are commonly used to tailor from Shure Brothers permits rapid

NOW THAT AUDIO AMPLIFIERS, PREAMPLIfiers, FM tuners and even phono pickups have been refined to the point that they deliver ruler-flat frequency response at barely measurable distortion levels, the audio industry has turned its attention to the final pair of culprits in the quest for uniform frequency response—the loudspeaker and your own listening room. By far the worst offender of the two is the listening room itself, although there are still plenty of "hi-fi" speakers around that have dips and bumps in their response curves even when measured in an anechoic chamber (which is, admittedly, not the way most of us listen to music).

To solve the problem of speaker response and room acoustics, the audio industry has suddenly discovered a device that professional sound contractors have been using for many years—the graphic equalizer. The reasoning goes something like this: if we acknowledge the fact that no speaker actually delivers "flat response" from 20 Hz to 20,000 Hz and, if we also admit that our listening rooms emphasize certain frequency bands while attenuating others (depending upon their dimensions, furnishings, surface absorption coefficients and a host of other variables), why not introduce the inverse of the "actual" net response curve into the electronics of the system and thereby create a total system (room included) that will "sound" absolutely flat?

Equalizers

It was clear at the outset that the conventional bass and treble controls, long a fixture on hi-fi amplifiers and receivers, were not up to the job. These controls operate over nearly one-half of the audio spectrum each. The bass control alters response from around 500-Hz downward, while the conventional treble control boost or cuts all frequencies above around 1,000 Hz. It is fairly obvious that this kind of tonal adjustment cannot possibly eliminate the narrow-band bumps and valleys that often exist in a high fidelity system.

Having tested and measured a number of graphic equalizers on the test bench, I have long been convinced that using this type of product in a home hi-fi system can result in audibly improved musical reproduction in just about any listening room. Unfortunately, having visited a number of dealers and friends who own octave and third-octave equalizers, I must confess that in most cases the devices are not achieving their desired results. The problem seems to be that most users of graphic equalizers are tuning them by ear. Some graphic equalizers are supplied with special test records that are supposed to help you to set up the device for the flattest overall response. But again, unless you have a perfectly "calibrated ear", the final settings of those slide levers or knobs becomes largely a hit-and-miss proposition. Of course, professional sound installers often use real-time analyzers and calibrated microphones to "tune" a room and a system to within a few decibels of "flat", but such equipment, until recently, has cost several thousand dollars.

I recently became aware of a product developed by Shure Brothers, Inc. that, from its description, seemed able to do a good job of "room tuning" and costs under $500.00. Since I had always been somewhat in doubt about the response of my own reference listening set-up, I decided to attempt to equalize it. Some of the things I learned are worth repeating.

Actual response

Just to prove a point that has been made many times before, I decided to examine the response of my total system (including the room) by sweeping single-tone frequencies, from 20 Hz to 20 kHz, through my system and picking up the results by means of a calibrated microphone positioned where I normally sit when listening to music. The "sad" results are shown in the spectrum analyzer photo of Fig. 1. Hardly anything to be proud of. Besides the obvious and severe roll-off beginning just above 5 kHz or so, the series of "holes" at the low end of the response curve (some of which were greater than 20 dB in amplitude) seemed incurable. And even in the region above 500 Hz, where the "average" response settles down to a reasonable degree of flatness, there are multiple narrow-bandwidth peaks and valleys that ride up and down over a range of more than 10 dB. So much for single-tone testing of room acoustics!

Happily, our own human hearing comes to the rescue here. It has been proven that when we hear a very narrow

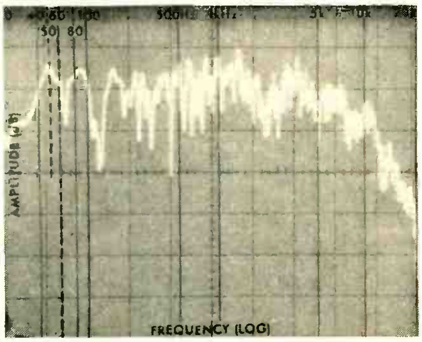


FIG. 1—TOTAL FREQUENCY RESPONSE of hi-fi system, including listening room.

"peak" or "valley" in the response curve (some say that one third of an octave is the limit), we do not aurally perceive it as an abberation in frequency response flatness. For this reason, such frequency response tests are best performed using "pink noise" instead of sweeping, single tones.

So, with that in mind, I borrowed a pair of Shure *SR-107* octave-band equalizers (see Fig. 2), and the same company's newly developed *model M615* equalization analyzer, shown in Fig. 3.

The analyzer kit includes a calibrated microphone, *model ES 615* and the analyzer itself. The analyzer contains a internal source of pink noise, whose

Room Equalization

the response of the hi-fi/listening room combination. A recent introduction adjustment of the graphic equalizer to obtain an overall flat response

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

level can be adjusted, a microphone amplifier and a series of octave-wide amplifiers that are used to activate two rows of LED indicators, one above the octave notations and one below. The pink noise source is fed to the system under test. Pink noise, when listened to over loudspeakers, sounds a bit like the rushing noise you hear when you tune between FM stations, except that it is carefully tailored to contain equal energy in each octave of the audio spectrum. The microphone is positioned where you would normally listen to your hi-fi equipment. An additional control, known as a HI-LO ENVELOPE control on the analyzer determines the amplitude "window" of the system.

If the energy of a given octave is louder than the nominal average level, the LED above that octave number will light, while octaves of energy that are lower than average will cause an LED below the octave numbers to light. When the envelope control is rotated fully clockwise, the spread between lower LED illumination and upper LED illumination is ±6 dB. Thus, even with no equalizer in your system, if its response was within ±6 dB from 32 Hz to 16 kHz, all the lights would be off. The procedure involved in proper equalization involves reducing the setting of the envelope control and, as various lights come on (either on the "high" or "low" side), appropriate controls on your equalizer are tweaked until the lights go off. If you are able to gradually rotate the HI-LO ENVELOPE control fully counterclockwise and succeed in getting all the lights to extinguish, the response of your system (on an octave by octave basis) as heard at the microphone's position, would be flat within ±1 dB.

Just for fun, I rotated the envelope control fully counterclockwise before inserting the equalizers into the system. Sure enough, the light indicators gave me a good clue as to how far things were off. In Fig. 4, the 32-Hz octave shows up as being deficient in energy content, the 63, 125, 250, 500, 1K and 2K lights show too much energy in those bands, while the 4-kHz light is off (showing correct "average" level) and the 8-kHz and 16-kHz lights show that energy in those octaves is too low. Before even attempting to add correct amounts of equalization, I carefully rotated the envelope control clockwise, to determine approximately how much equalization would be needed for each octave. Since the envelope control is roughly calibrated in dB, I was able to plot the approximate octave response of my system prior to equalization, as shown in Fig. 5.

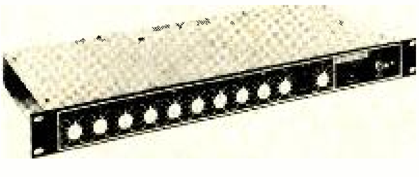


FIG. 2—SHURE MODEL SR107 octave equalizer.

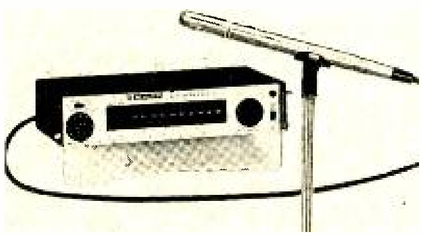


FIG. 3—SHURE MODEL M615 equalization analyzer.

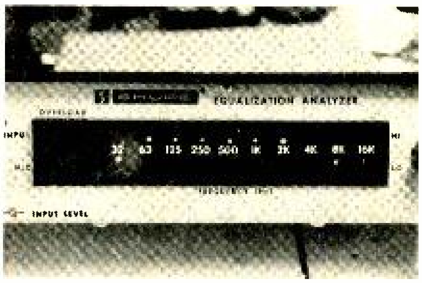


FIG. 4—EQUALIZATION ANALYZER shows the total frequency response of hi-fi system prior to equalization.

Equalizer set-up

Next came the job of actual equalization. It came as no surprise to me that the equalization settings required for the left channel differed in several respects from those required for the right channel. This also suggested the importance of having a graphic equalizer with separate levers or controls for each channel (not all equalizers are so built). The best I was able to do resulted in the individual octave settings shown graphically in Fig. 6. Figure 6-a shows the plotted settings applicable to the left channel and Fig. 6-b shows the settings for the right channel.

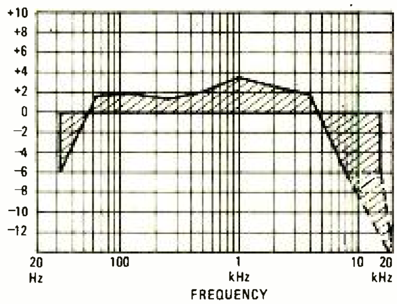


FIG. 5—APPROXIMATE OCTAVE RESPONSE of hi-fi system prior to equalization.

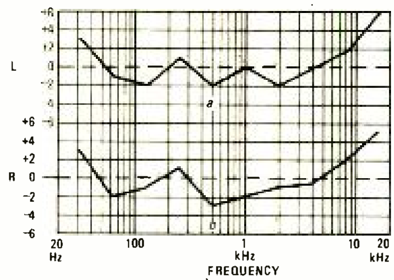


FIG. 6—CONTROL SETTINGS of equalizer. The front-panel control settings for the left channel is shown in *a* and the right channel in *b*.

At this point, I decided to find out what the actual response of the two graphic equalizers were. So I connected them to the spectrum analyzer which was swept from 20 Hz to 20 kHz in the usual log-sweep mode. The resultant response curve of the left-channel equalizer is shown in Fig. 7, and it

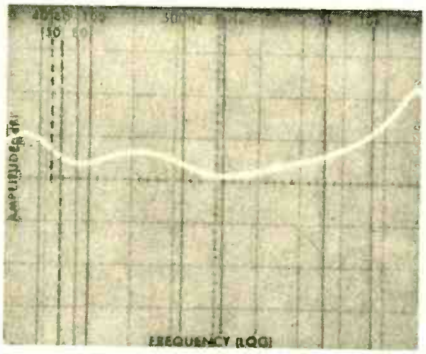


FIG. 7—ACTUAL EQUALIZER RESPONSE with the control settings shown in Fig. 6-b.

corresponds quite closely to the point-by-point or octave-by-octave settings shown of Fig. 6-a.

Connecting the equalizers into the audio chain and, again using pink noise, I observed the face of the Shure analyzer and noted that all lights were extinguished with the exception of the 32 Hz and 16 kHz indicators. (The 63 Hz indicator blinked every now and again, briefly, as I moved about the room, but was off when I returned to my "listening" chair.) The indicator lights are shown in the photo of Fig. 8.

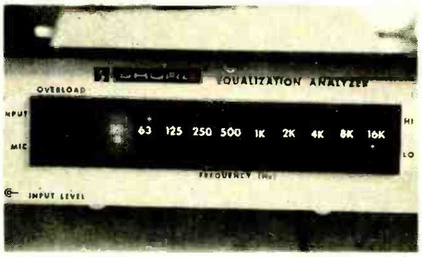


FIG. 8—EQUALIZATION ANALYZER shows total frequency response of hi-fi system after equalization.

Having a good source of pink noise at my command, I decided to measure overall response using this form of wide-band noise and the sweep filters of the spectrum analyzer (which were set to their narrowest bandwidth). First, I measured overall response with the equalizers bypassed. The results are shown in the upper trace of Fig. 9. Then the sensitivity of the analyzer was lowered (but with levels unchanged) so that a second trace could be displayed without superimposing it on the first sweep, and both left- and right-channel equalizers (preset as outlined before) were switched into the system and the sweep was repeated. The much improved results are shown in the lower trace of Fig. 9.

Still aware that single-tone sweeps have their problems, I nevertheless

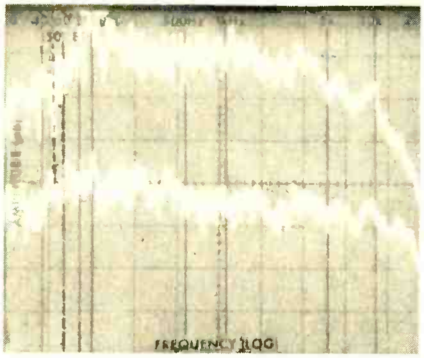


FIG. 9—TOTAL FREQUENCY RESPONSE of hi-fi system without equalization is shown in upper trace. Lower trace shows response after equalization.

decided to have another go using this method and, while those narrow-band bumps and valleys still showed up in Fig. 10, a comparison between Fig. 10 and Fig. 1 shows that even using this crude measurement approach, a great amount of improvement is evident.

You may recall that I never did succeed in bringing the 32 Hz and 16 kHz octaves to a "flat" response. Referring to Fig. 6 once more, you will also note that I settled for only +6 dB at the highest octave and less than +4 dB at the lowest octave. Perhaps you are wondering why I didn't crank these end-octave controls up to their full +12-dB capability. This brings us to a possible trouble area caused by equalization.

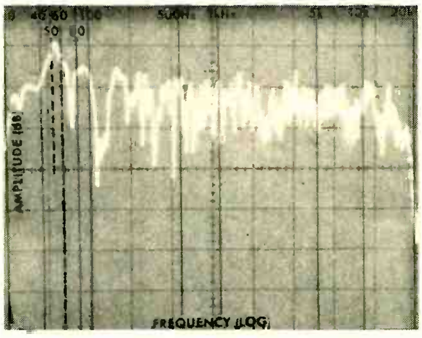


FIG. 10—SINGLE-TONE FREQUENCY RESPONSE of hi-fi system after equalization.

Moderate amounts of equalization can do wonders for the sound of your hi-fi system and, indeed, having now heard the difference between a *properly* equalized system and one which is not, I would not be without an equalizer from this point onward. But improper use of an equalizer can cause real havoc with your system. Suppose, for example, that my system had been perfect even without equalization except for those end upper and lower octaves. I might have pushed the 32 Hz and 16 kHz levers up to their extremes, but if I had done so, my amplifier would probably clip and distort at those extreme frequencies.

If I was lucky enough to hear the distortion before my tweeter burned out (or my woofer-cone ruptured), I would have had to "back off" on my volume control or lowered the effective power output *average* of my entire system by an enormous factor. Table I shows the *effective* available amplifier power of different amplifiers having different nominal power ratings when one or more equalization levers are set to different degrees of boost in an attempt to flatten the response of a system. Note that if a mid-frequency lever is boosted only 3 dB for example, the effective power available from the system (without clipping) becomes half of the amplifier's actual power rating. And, in an extreme case where 10 dB of boost at some specific frequency is required, a 200-watt amplifier becomes, effectively, no more powerful than a 20-watt amplifier with a flat response.

So, while we are convinced that system equalization can do wonders for a hi-fi system when used in moderation, over equalization to compensate for system deficiencies that are beyond helping can cause more damage and grief than no equalization at all.

The experience gained with the Shure equalization analyzer also convinced us that despite our long years of listening to hi-fi systems, attempting to equalize a system "by ear" can be a hopeless task. We hope that now that correct procedures are available as inexpensively as they are, that more and more audio dealers will offer in-home equalization service to serious audiophiles when they buy a graphic equalizer. Once we became familiar with the analyzer, actual correct setting of our equalizer controls took no more than about five minutes, and, despite the fact that none of the controls for either channel was set more than 6-dB away from "flat" (and most were displaced considerably less than that), we could not help marvelling at the improvement we heard. **R-E**

TABLE 1—EFFECTIVE AMPLIFIER POWER (watts) based upon various amounts of boost (dB).

AMPLIFIER RATING (WATTS)	+1 dB	+2 dB	+3 dB	+4 dB	+6 dB	+8 dB	+10 dB
20	15.8	12.6	10.0	7.96	5.0	3.16	2.0
30	23.7	18.9	15.0	11.94	7.5	4.74	3.0
50	39.5	31.5	25.0	19.90	12.5	7.90	5.0
100	79.0	63.0	50.0	39.80	25.0	15.80	10.0
150	118.5	94.5	75.0	59.70	37.5	23.70	15.0
200	158.0	126.0	100.0	79.60	50.0	31.60	20.0

Build 2650-Based Microcomputer System

Part II. Built on a single printed-circuit board, this 2650 microcomputer contains a video and cassette tape interface and resident supervisor program. Add a keyboard, video monitor, cassette tape recorder and power supply for a complete working system

JEFF ROLOFF

LAST MONTH, A DESCRIPTION INCLUDING specifications and schematic appeared.

This month, an in-depth look at the troubleshooting procedures plus the component placement diagram is given.

Troubleshooting

After applying power to the PC board, the first thing to check is the power-supply voltage. If the output of an adequate (5 volts, 3 amperes) power supply is pulled down by connecting it to the board, there is either an IC put in backwards (if the supply is not pulled completely to ground) or else the power-supply lines are shorted somewhere on the board. If an IC is plugged in backwards, it will become very warm immediately after the power is applied. If the supply is actually shorted to ground, the process is much more tedious since you must inspect both supply lines to discover the point of the short. If quality IC's were purchased, the majority of problems are caused by solder or etch shorts. For this reason, it is a good idea to check the whole board for little solder spatters.

Logic and display circuits

The logic section of the board is the next part of the board to test. You need a scope for this part, and its bandwidth should be above 10 MHz. (You can also send the board into Central Data to have a trained technician test it for $15.00 an hour.) Connect the scope to the composite video signal that appears on plug 5, pin 5, of the board. Observe the sync pulses that appear at the zero-volt level. There should be one short sync pulse (down from 0.5 volt) every 63.5 μs, and one long pulse every 16.667 ms. If either of these two trains of pulses are not there, or have the wrong frequency, you must check the Timing Chain and Sync Generator section of the circuitry.

The Timing Chain and Sync Generator circuit contains a crystal-oscillator as the basic timing source. (A complete schematic appears in last month's issue of **Radio-Electronics.**) This is a standard oscillator with the 14.192640-MHz crystal used as the main feedback element. The signal from this oscillator is buffered using three other inverters from IC53. The first divider network that this signal goes to is formed by IC50, IC51 and IC52. These three IC's are used to divide the master clock down to a signal that has a period of 63.5 μs. The three counters are all fed by the same clock, so that all of the outputs change state at the same instant. The enable pins of the two low-order counters are fed from the previous counter stage(s) in an arrangement that forms a 10-bit syncronous binary counter. Pins 1, 2 and 13 of IC54 monitor the states of this counter. When all three of the monitored lines are high, the clear line is activated which resets all of the counters.

The D1, D2 and D4 outputs of IC52 provide the first three binary divisions of the master clock. Since the characters are eight-dots wide, output D4 has the width of one character (it is the divide-by-eight output). The last output of this counter, along with all of the outputs of IC50 and IC51 (designated the 'C' outputs) provide a count of the current character position on the display. While it is counting from 0 to 79, the characters are actually appearing on the screen. While counting from 80 to 112 (during which the counters are reset), the display is in the process of horizontal blanking.

The horizontal sync signal is generated by IC62-a. The sync signal is eight character-spaces wide, which is about 4.5 μs. Also, the three dot signals that come from IC52 (D1-D4) are all OR'ed together to form the $\overline{\text{LOR}}$ signal that is used in the Display Generator circuit to load the data from the character generator into the shift register once for every character. The $\overline{\text{LOR}}$ signal has a duty cycle of ⅛ (negative duty cycle, that is), and it goes low for this one dot period at the very beginning of each character.

Now that the signals are defined for all of the areas of each scan line, the up and down position on the screen must be defined. The three other counters

(IC55-IC57) serve this function, IC55 is used to count down by 12 and the other two are connected to count down by 21. The input that enables the first counter is the $\overline{\text{EOL}}$ signal that reset the previous counters at the end of a scan line. The output of this counter is monitored at pins 3 and 4 of IC54, to determine when 12 scan lines have been counted. When this event has occurred, its output at pin 6 drops and resets the counter. The reason that it counts to 12 is that there are 12 scan lines for each character line on the screen (i.e., vertically there are 12 dots for each character). The L1, L2, L4 and L8 outputs of this counter are used to determine which scan line of a character line is currently being displayed. From lines 0 to 7, the display section is actually displaying a character (since the actual character size is eight-dots tall), while from lines 8 to 11, the display is blanking between lines.

The reset line for IC55 is used to clock the next two counters that determine the character line being displayed. The counters (IC56 and IC57) are both reset by IC54-b when a count of 21 character lines is reached. From character lines 0 to 15, the display is actually showing characters on the screen (or at least it can be), while from character lines 16 to 21, the vertical blanking is in effect. Vertical sync is generated in this time period by IC62-b. Pins 4 and 5 of IC64-a are inputs to the gate that mixes the vertical and horizontal sync signals to form the composite sync signal.

The video-blanking signal is composed of a horizontal blanking and vertical blanking signal. The horizontal blanking signal is generated by IC64-b and IC66-b. The output of IC66-b is high when C64 and C16 are both high (at character position 80) and later changes back to low when $\overline{\text{EOL}}$ is present. Any of the four inputs to NOR gate IC70 indicate that the screen should be blank when they are high. So there are three other signals that indicate that the screen should be blanked and all of them are OR'ed together to form the master blanking signal. The vertical-blanking area is indicated by LN16. Any one of the four scan lines between character lines is indicated by L8. The DISPMEM line is high whenever the processor is accessing the display RAM. Wrong character patterns would appear when the display RAM is accessed, so we just blank the screen during this small interval to cover up the few out of place dots. The DISPLAY ACCESS signal is low whenever the screen is to be blanked. This signal is delayed one more character time (to make up for the delay in accessing the RAM and character generator in the Display Generator circuit) by IC65, using pins 2 and 5. If the processor is accessing display memory, pin 8 of IC65 is low and is a one character-time delayed version of the DISPLAY ACCESS signal. This in turn keeps $\overline{\text{BLANK VIDEO}}$ (pin 5 of IC65) low a little after DISPLAY ACCESS disappears to make up for the recovery time required by the RAM. The $\overline{\text{BLANK VIDEO}}$ signal goes to the output shift register and keeps the output data low by clearing the register.

If these circuits are operating correctly, a good video signal should be present that can be connected to a video monitor. Figure 1 shows the composite-video

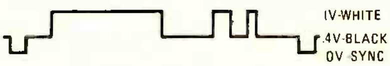


FIG. 1—COMPOSITE VIDEO SIGNAL supplied to video monitor.

signal. If the sync signal is correct, the monitor should immediately lock onto the video signal and display a stable picture. If the picture does not lock-in, try lowering the value of the 330-ohm resistor (R9) in the video output stage (such as 220 ohms) and lower the value of the 100-ohm resistor hooked to the base of the two transistors. This will adjust the sync level and the total video-output level to suit your monitor. If you have a standard monitor, you will not have to do this since the output signal is standard.

If the characters on the screen waver, there is still a problem with the Timing Chain and Sync Generator circuit. Check this circuit out again, looking for any imperfections in the signals that indicate a bad IC or a shorted line. This probably won't happen, since a fault in the circuit usually causes major problems and not just a little wavering on the screen.

Now that a pattern appears on the screen, it must be identified. If it is a prompting character (a period) and the cursor appears in the upper left corner of the screen, the whole system is probably working. All that is needed is to hook up an ASCII keyboard and tape recorder to the correct plugs and see if commands can be entered into the monitor. (The procedure for testing the cassette interface is given later.) If you have either random characters on the screen or just 16 solid horizontal bars, the processor section of the board is probably not working. This prevents the supervisor program from being read in and thus the screen is not cleared.

Processor

The Processor and Bus Driver circuit divides the master clock by 12 to obtain the CPU clock. The divide-by-6 counter IC58 starts its count at 10 and counts up to 15. After the count of 15, inverter IC53-a connected to the carryout line and load input is used to load the 10 and start the division again. Flip-flop IC66 divides this carry signal by 2 to obtain the square CPU clock. The

PARTS LIST

All resistors 1/4 watt, 5%.
R1-R6, R14, R18—10,000 ohms
R7, R8, R16, R17—1000 ohms
R9—330 ohms
R10—150 ohms
R11—82 ohms
R12—100 ohms
R13—620 ohms
R15—470 ohms
R19—20,000 ohms
R20—68,000 ohms
R21, R22—20,000-ohm trimmer potentiometer
C1, C2, C11—100 pF, disc
C3, C14—100 μF, 16 volt, electrolytic
C4, C8—0.01 μF, disc
C5, C6, C7, C9, C15-C29—0.1 μF, disc
C10—0.0022 μF
C12, C13—0.056 μF, ±10% polyester film
D1, D2—1N914 diode
D3—1N4729 Zener
D4, D5—1N4148 diode
Q1, Q2—2N5139 transistor
IC1—2650 microprocessor (Signetics)
IC2-IC10, IC21, IC22, IC78, IC79—74126
IC11, IC64, IC69—7408
IC12—7414
IC13, IC17—3624, pre-programmed PROM containing supervisor program
IC14-IC16, IC18-IC20, IC48—3624, PROM (see text)
IC23, IC24, IC65, IC75, IC77—7474
IC25, IC71, IC76—7400
IC26—9344, 4-bit by 2-bit multiplier (Fairchild)
IC27-IC29—74157
IC30-IC45—2102-1, RAM (Signetics)
IC46, IC47—74125
IC49—3624, pre-programmed PROM character generator, upper case
IC50-IC52, IC55-IC58—74163
IC53—74S04
IC54—7410
IC59—7432
IC60—74166
IC61, IC68—7411
IC62—7420
IC63, IC67—7404
IC66—74109
IC70—7425
IC72—555, timer
IC73—74123
IC74—CA3130
XTAL1—14.192640 MHz series-resonant crystal
MISC.—One 40-pin DIP socket for IC1, six 16-pin DIP sockets and printed-circuit board.

The following parts may be ordered from: Central Data Company, P.O. Box 2484, Station A, Champaign, IL 61820.

IC49—3624, pre-programmed PROM character generator, upper case, $27.

IC13, IC17—3624, pre-programmed PROM containing supervisor program, $27 each.

PC board, predrilled and etched, $30.

An assembled and tested microcomputer board, $325.

frequency of this clock is about 1.183 MHz, and if the faster version of the 2650 is put into the board, the counter's inputs can be changed to increase this frequency. The CPU clock signal is gated through IC11-a with the STOP CLOCK signal that allows you to externally stop the clock by bringing the line low. The timing relationships of the microprocessor is shown in Fig. 2.

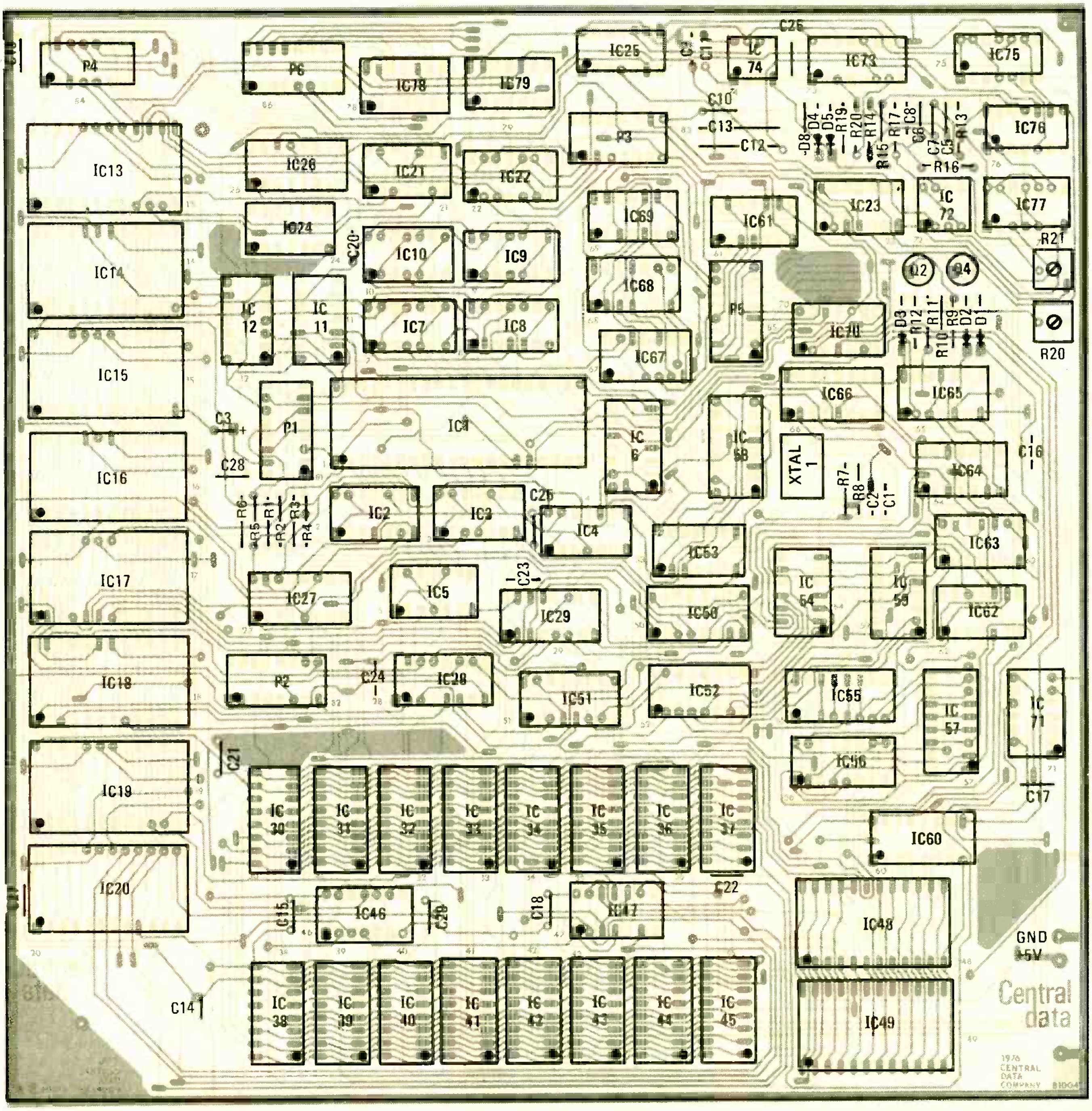
Pin 16 of the 2650 is the reset input, and the RESET signal is generated using a Schmitt trigger and an R–C time constant. Capacitor C3 is initially discharged and the RESET line is therefore high. As the capacitor charges through resistor R6, the output of the inverter will change to a low level allowing the processor to operate—starting at address zero in memory. All of the outputs of the processor, except for RUN/WAIT, are buffered with tri-state drivers or an inverter in the case of the serial output line.

The tri-state drivers have their enable pins available for data bus override operations. For instance, bringing the ADDR DISABLE line low causes all of the address buffers to be disabled. This allows another device to take control of the address bus. The same is true for the data and control buses. So, by bringing these three enable lines low, you can effectively disconnect the 2650 from any external memory.

The SERIAL INPUT and SERIAL OUTPUT lines come directly from pins on the processor that can be inspected or set by special processor instructions. This allows the system to get by without a UART and also allows high flexibility as far as output rates and formats.

The data bus buffers are tri-state buffers, with either the in or the out buffers being enabled at one time. If the R/W line is low, the processor is reading data, so the input buffers are enabled. If this line indicates that the processor is outputting data to the data bus, then the output buffers are enabled. Although buffers are not needed, they were put in so that any memory added to the system would not need to have its own set of buffers.

In the area of expansion, Central Data offers a S100 compatable bus board. It generates signals derived from



COMPONENT PLACEMENT diagram

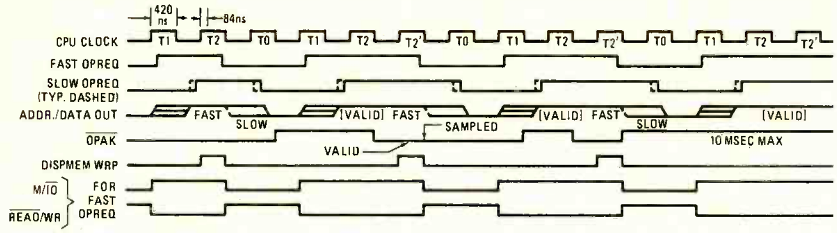


FIG. 2—2650 MICROPROCESSOR timing relationships.

the 2650 board that will interface directly with any standard 8080 static RAM board or I/O board. The board has room for five edge connectors, and is plug expandable with extender boards.

Locating a problem in the Processor and Bus Driver circuit requires inspection all of the address and data-bus lines to be sure that all of the signals are at standard TTL levels. If one line is stuck either high or low, carefully clip the pins of the IC's that this line runs to until the problem clears. The last pin that was clipped is the one holding the line, so replace the IC. Before cutting the IC pins, check the power supply on all of the IC's that the line runs to. Also, if any of the IC's are tri-state buffers, check to be sure that they are not gating data onto the line at the wrong time (an enable pin may be stuck in the enable state.)

If the processor's bus checks out, then you check to be sure that the RAM interface to the processor is working since that would also cause the random characters to appear on the screen. Initially, when the supervisor program is executed (right after reset), it clears the screen by sending the ASCII code for a blank (H20) on the data bus to the RAM, and then sequentially accessing all of the display positions and writing the data. Therefore, right after a reset, the DISPMEM line should undergo many transitions. If it doesn't, check out gates IC61-a and IC69-a that are used to generate this signal from the address lines. Note that the DISPMEM line indicates what page the processor is accessing—if it is the 4K page where the display RAM resides, this line is high.

If the DISPMEM line checks out, then look at the write-pulse generating circuitry. IC61-a (pins 1,2,12 and 13), along with flip-flop IC23-a, is used to generate a signal that is high at pin 5 of IC23-a for the first CPU clock cycle following the low to high transition of the OPREQ-signal. This is gated with R̄/W line and the CPU clock by IC61-b. This signal finally goes through one last gate that turns on the write line of the RAM's if the processor is accessing the display memory page. This write line should have high activity right after the power is tuned on.

If these signals check out, then check the data-bus drivers IC46 and IC47. They are used to gate data from the display memory onto the data bus so that the processor can read the contents of the RAM. It is helpful to have a dual-trace scope for this, so that the input to the buffers and the output can be observed at the same time. Then check to see that the input and output of the buffers are the same when the enable is high.

There is almost nothing that can go wrong with the character generators, their operation is simple. IC49 is the one that is used for the normal operation of the board, with IC48 being an optional character generator for lower case, graphics, or other characters. Therefore, when supervisor program is the only thing that is running, it only selects character generator IC49. For this reason, the chip enable on IC49 (pin 20) should be low whenever the video is not blanked. This is easily checked with a dual-trace scope. If the other character generator is selected, and it is absent, a block of all on dots will appear on the screen. So, if you have several of these selections in a line, you will have a big horizontal bar on the screen rather than characters. Two of the output lines of the RAM may also be shorted, which would cause some characters not to be displayed. Again, a dual-trace scope is needed to check the data-out lines against one another to see if any look shorted.

The output shift register is IC60. It is loaded with the character generator's outputs at the first horizontal-dot position of each character, and then sends the eight-bit word out serially at the master-clock rate. Note that the clear line on IC49 is driven by the $\overline{\text{BLANK VIDEO}}$ line from the Timing Chain and Sync Generator circuitry.

The addresses for the display RAM are multiplexed by the Display Memory Address Switch. If the DISPLAY ACCESS line is low, the processor's address lines are selected to address the display RAM. This is the case when the display is being blanked (and thus the processor tries to access the display memory, raising the DISPMEM line and dropping the DISPLAY ACCESS line). The other case is when the display RAM is addressed by the Timing Chain. The signals C1 to C64 are gated in, along with LN1 to LN8, to select the correct address.

If the gating circuit for the ROM is not working properly, the supervisor program will not run. The output at pin 12 of IC-67 goes low whenever the ROM is selected. When using the supervisor program, this line will always be low when the DISPMEM line is also low. In other words, the supervisor only has two places to operate from, it will always be selecting one of these places.

The I/O ports 8 are also enabled using a good deal of gating circuitry. If the data bus doesn't have the right signal levels, check the two groups of data-bus buffers to be sure that they are not gating data onto the bus. This could happen if the enable pins are locked in a high state. Either a write data or a write control instruction will access the output port.

If the circuitry checks out, the supervisor program must be working for all of the operations except the tape routines. It is a simple matter to set up the cassette-tape interface and once it is set, it will stay perfectly aligned until it is changed. The potentiometer for the 555-timer should be adjusted so that the output of the 555 is a 4800-Hz squarewave. This is divided by two by the first flip-flop (pins 3 and 5 of IC77), and again by the second half of this same IC. The serial output line is clocked through part of IC75, and then this output is used to gate on one of the two frequencies. The R—C network at the output of IC76 (pin 11) is used to decrease the output-voltage level and change it into a more rounded signal. The demodulator section is just a monostable and operational amplifier.

continued next month

NOAA updates list

The National Oceanic and Atmospheric Administration (NOAA) National Weather Service has updated its list of stations to about the end of last year. The network is the sole government operated system for communicating weather, disaster or other warnings direct to the public. Weather receivers are available at most electronic stores.

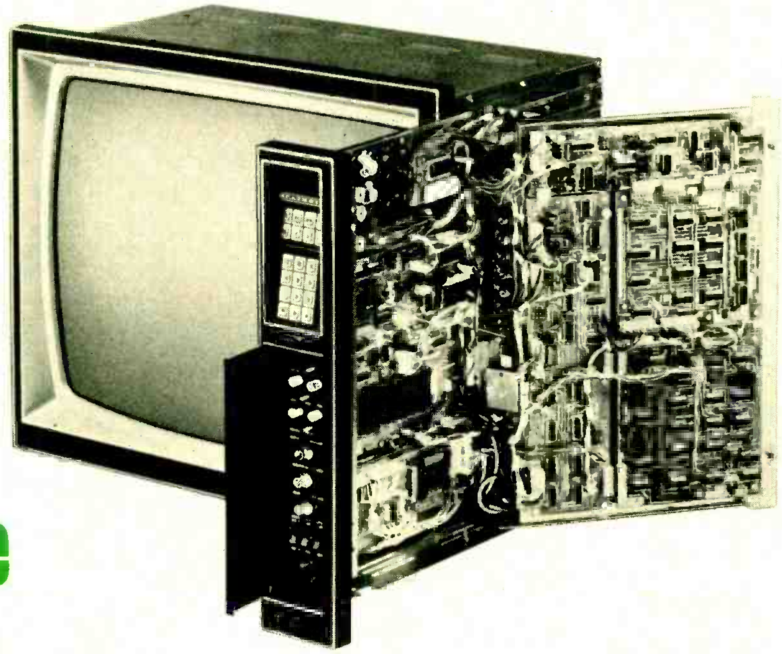
The broadcasts are at 162.40, 162.475, or 162.55 MHz. A listing (by state, call letter and frequency) of the stations in service available free by writing to the National Weather Service, Silver Spring, MD 20910.

Zenith gets a patent for improved electron gun

Zenith's EFL (Electrostatic Focus Lens) has received Patent No. 3,995,194, granted to Zenith research and development engineers Allen Blacker and James W. Schwartz.

The EFL gun extends the focusing action over a longer distance by using four electron lens elements, instead of only two as in most electron guns. This concentrates the beam to produce a spot size as much as 60 percent smaller than in conventional gun systems. The new in-line gun is housed in the narrow neck of the company's 19-inch 100-degree picture tube. **R-E**

HEATHKIT GR - 2001



Programmable Color TV

It's the first set on the market with programmable automatic channel selection. Enter a series of time/channel combinations on the keyboard, and the set automatically switches to the channel at the programmed time

ART KLEIMAN
MANAGING EDITOR

BACK IN 1974, THE HEATH COMPANY SHOOK the foundations of the TV industry with the introduction of the GR-2000 color TV receiver. That set contained unique features found in no other set at the time, including silent all-electronic varactor tuning, touch-to-tune channel selection, touch volume control, on-screen digital channel readout, on-screen digital clock readout and a fixed L-C IF bandpass filter. (See the February 1974 issue of **Radio-Electronics** for a full report on the GR-2000.)

Heath's latest introduction—the GR-2001—contains features that set it apart from the rest of today's industry. This is the first TV set to feature programmable automatic channel selection and automatic antenna rotator control. With the programmable channel selection feature (offered as an optional accessory, the GD-1185), the user programs a time/channel combination and the TV set automatically switches to that channel at the programmed time. Two blocks of 16 (for a total of 32) time/channel combinations can be programmed at any one time. The automatic antenna rotator control, also offered as an option, automatically orients the antenna to a programmed direction when a channel is selected. It replaces the control portion of a standard antenna rotator system.

The GR-2001 includes all the features that made the GR-2000 unique. In fact, the two receivers are basically the same. One difference that is immediately apparent is the method of channel selection. On the GR-2000, two pushbuttons scan the channels up and down until the desired channel is reached. The new GR-2001 has a 3 × 4 calculator-type keyboard containing the numerals 0–9. Channel selection is accomplished by entering two digits on the keyboard. The remaining two keys function the same as on the GR-2000—they scan the channels.

As far as the chassis is concerned, it remains basically the same as the GR-2000. Some modifications have been made for improved performance. Heath redesigned the audio circuitry for better sound and included phase-locked-loop circuitry to eliminate the vertical and horizontal hold controls.

The programmable automatic channel selection feature really caught our attention. This one feature sets this set aside from all others on the market. The circuitry for this optional accessory is complex, containing 60 IC's mounted on four printed-circuit boards, not counting the on-screen digital clock option that must be included for this accessory to function. Since the feature is unique, let's take a look at how the channels are programmed.

Channel programming

In addition to the 3 × 4 keyboard used for channel selection, there are 8 pushbuttons and a rocker switch used for operating the programmer. Three of these pushbuttons are used for mode selection and the other five are used for entering data into the programmer.

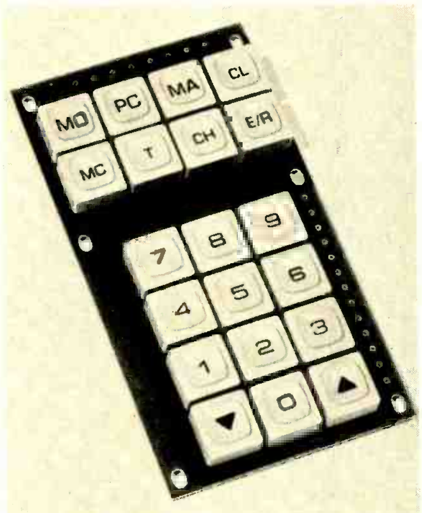


FIG. 1—NUMERICAL KEYBOARD is used for channel selection. The eight keys located above the numerical keyboard are used to control the automatic channel selection feature. Channels can also be scanned using the two keys with the arrowhead designations.

Figure 1 shows the layout of the keyboard and eight pushbuttons. The rocker switch selects between two memory banks and is located behind a door on the front panel.

Programming the time/channel data is a matter of manipulating the mode, data entry and channel selection keys. First, the programmer must be switched to the memory-access mode by depressing the MA key. A front-panel MA indicator light verifies this. To program the time, the T key is depressed. The on-screen display now reads "00:00:" and the numerical keys on the keyboard are used for entering the desired time. As the time is entered, the on-screen display simultaneously shows it. If a mistake is made in entering the time, it can be corrected by simply re-entering the correct time. The channel information is entered next by depressing the CH key and entering the channel on the numerical keys. When the CH key is depressed, the on-screen display converts to six digits for simultaneous display of the programmed time and channel. If the time/channel combination entered is correct, it is transferred to memory by depressing the E/R key. The on-screen display is blanked except for the two colons to verify storage of the data in memory. Depressing the E/R key a second time displays the stored time/channel combination.

To program another time/channel combination, the MC key is depressed. This steps the memory through the 16 locations. The on-screen display shows the data in each location as the memory is stepped. When an appropriate memory location is found (one not containing a desired time/channel combination), a new time/channel combination can be programmed as previously described.

The data in a memory location can be changed by accessing that location using the MC key and entering a new time/channel combination. If no new data is to be entered, that memory location can be cleared by depressing the CL key. The on-screen display is blanked and the TV set will not respond to this memory location.

The memory is divided into two sections, each has a capacity of storing 16 time/channel combinations. A front-panel rocker switch is used to select between the two memory banks. When all the desired time/channel combinations have been programmed, the PC mode key is depressed. This turns control of the TV set over to the programmer and channel changes are made according to the programmed data. A front-panel PC indicator light verifies that the TV set is under the control of the programmer.

It is not necessary to program the time/channel combinations in sequential order. When the PC mode key is depressed, a memory-access cycle is initiated. All 16 memory locations are scanned and a channel change corresponding to the programmed time that is previous to and closest to the actual time is made. The memory is again accessed for the channel corresponding to the next latest time. When the actual time equals the programmed time, the channel change occurs.

The TV set can be returned to manual operation by depressing the MO mode key. A front-panel indicator light verifies that the TV is in the manual mode. The channels can now be selected by using the numerical keys or the up- and down-scan keys. The on-screen display shows the selected channel and time. The TV set can also be returned to manual operation automatically by the programmer. This is accomplished by

TABLE I—PROGRAMMING SEQUENCE for automatic channel selection feature.

PRESS KEY	ON-SCREEN DISPLAY	REMARKS
MA	Shows last instruction executed.	MA lamp lights.
MC	Changes as memory is cycled.	Will continue to cycle memory until a location is reached which is empty or which contains an instruction that is no longer needed.
CL	All six digits blank.	This operation is optional.
T	00:00:	Time shift register is now cleared.
7	00:07:	
0	00:70:	
0	07:00:	This time is now in the time shift register.
CH	07:00:00	Channel shift register is now cleared.
1	07:00:01	
6	07:00:16	Channel 16 is now in the channel shift register.
E/R	: :	Instruction is entered into memory.
E/R	07:00:16	Instruction is read out of the memory. This operation is optional.
MC	Changes as memory is cycled.	Cycles memory until a suitable location is found.
CL	: :	This operation is optional.
T	00:00:	
8	00:08:	
1	00:81:	
4	08:14:	
CH	08:14:00	
9	08:14:09	
9	08:14:99	
E/R	: :	
E/R	08:14:99	
MC	Changes as memory is cycled.	
CL	: :	This operation is optional.
CH	: :00	The channel may be entered before the time, if desired.
1	: :01	
1	: :11	
T	00:00:11	
1	00:01:11	
2	00:12:11	
3	01:23:11	
0	12:30:11	
E/R	: :	
E/R	12:30:11	This operation is optional.
PC	Shows actual time from Clock Accessory	Channel changes are made according to stored instructions. PC lamp lights.

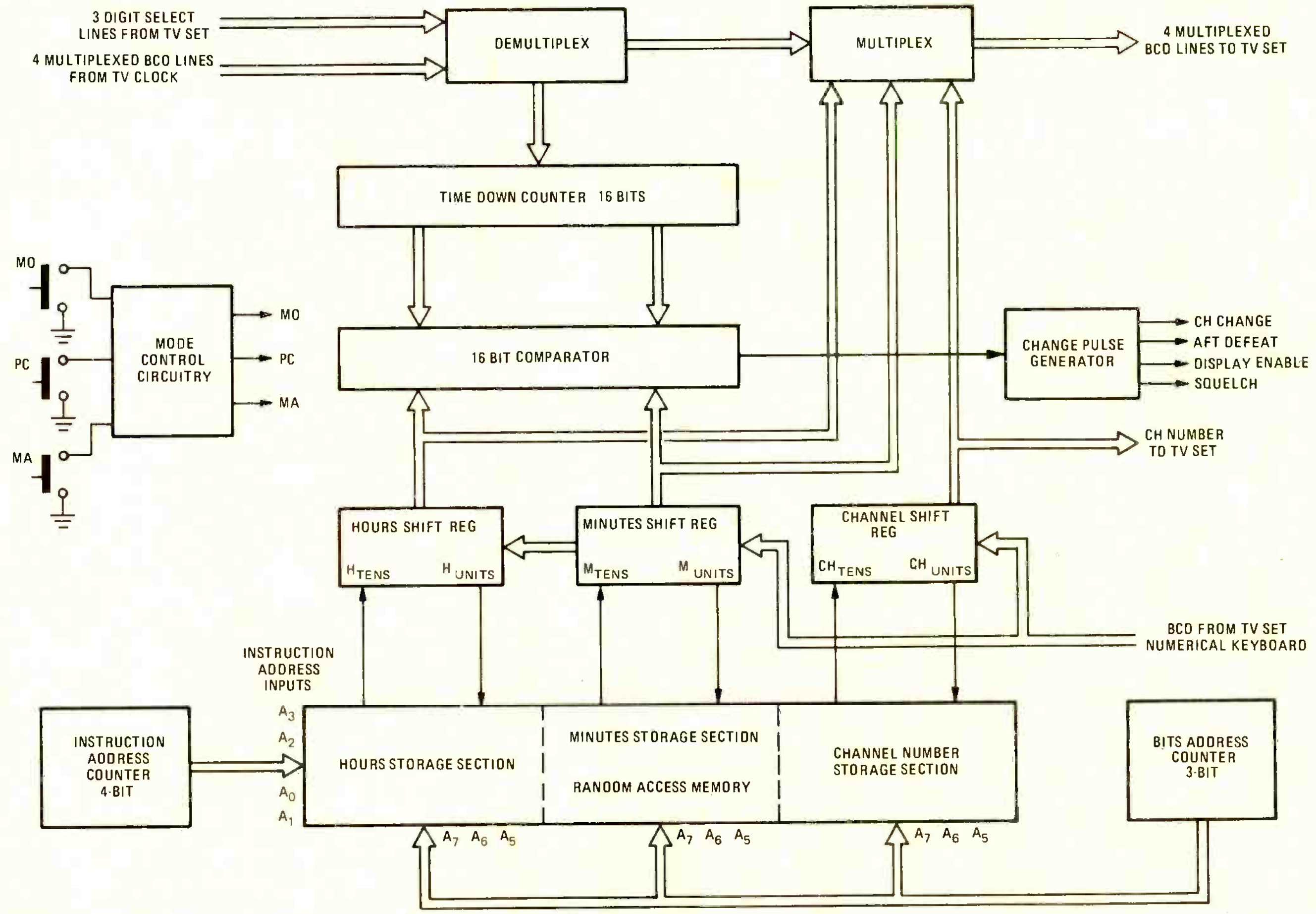
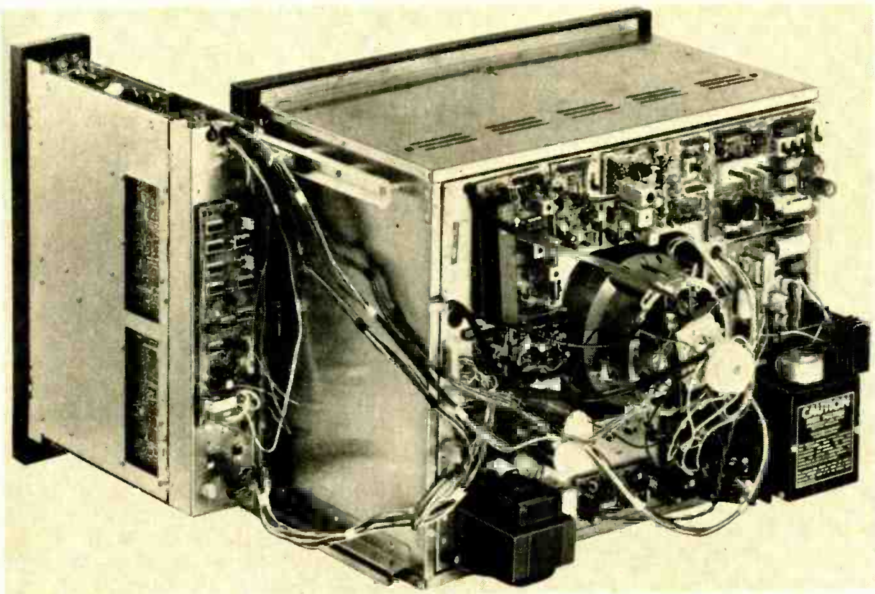


FIG. 2—PROGRAMMER changes channels automatically in accordance with programmed time/channel combination stored in random access memory.



HEATHKIT MODEL GR-2001 color TV set.

programming in the desired time and the code "99" as the channel. The TV set will return to manual operation at the programmed time and remain in the manual mode until a programmed channel change occurs. Table 1 lists a typical programming sequence.

How it works

Figure 2 shows a block diagram of the programmer. To program a time/channel combination, the programmer is set to the memory access mode by depressing the MA key. The programmed time in the form of BCD data from the numerical keyboard is temporarily stored in the hours and minutes shift-registers after the T key is depressed. Channel information is stored in the channel shift-register after the CH key is depressed. The outputs of the shift registers are connected to a multiplexer circuit for on-screen display of the programmed time and channel.

If the programmed time/channel combination is correct, it is stored in the random-access memory by depressing the E/R key. The memory location is determined by the front-panel selector switch and the 4-bit number in the instruction address counter. Any memory location can be selected by depressing the MC key, which increments the instruction address counter. Depressing the E/R key a second time retrieves the contents of the memory location and stores it in the shift registers. The data is now displayed on the TV screen and can either be updated by programming a new time/channel combination or cleared by depressing the CL key. The CL key clears both the shift registers and the memory location.

Automatic channel selection takes place when the PC mode switch is depressed. The BCD data representing the actual time is demultiplexed and each time a change in the minute digit is detected, the data is stored in the time-down counter. Also, the time/channel combination in the first memory location is transferred to the respective shift registers. The actual time and the programmed time are compared by the 16-bit comparator. If the actual time and programmed time are equal, the

continued on page 93

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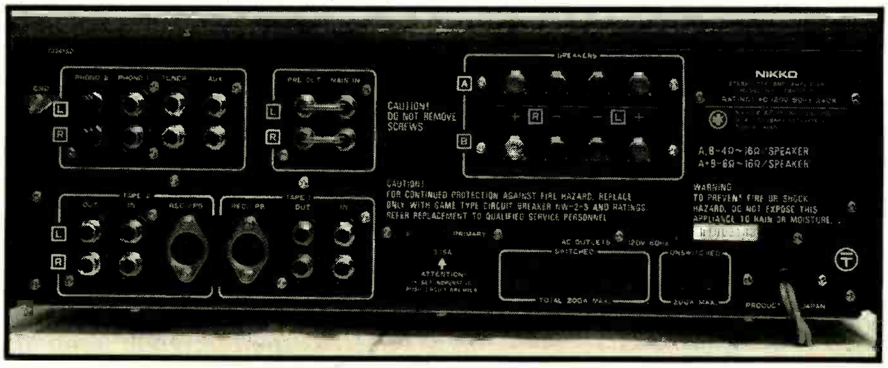
Radio-Electronics Tests Nikko TRM-750 Integrated Amplifier

1

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE NIKKO *MODEL TRM-750* INTEGRATED AMplifier, shown in Fig. 1, is a medium powered combination preamplifier, control center and power amplifier that could well serve as the central electronic component in a moderately priced high-fidelity system. Its front panel simplicity belies the fact that the unit has a great deal of control flexibility. Starting at the upper left, a rotary switch selects main or remote speakers and includes an OFF position for headphone-only listening. A series of four pushbuttons follow, including HIGH- and LOW-cut filter switches, a MONO/STEREO switch and an audio MUTING switch that reduces output levels by a fixed 20 dB for listening interruptions such as phone or doorbell answering without having to alter preferred settings of the huge step-type VOLUME control just to the right of it. Notations around the perimeter of this knob indicate dB's of attenuation, relative to the maximum clockwise setting.

A pair of three-position lever-type switches, located to the right of the volume control, handle selection of the two available tape monitor circuits and tape dubbing from either of two connected tape decks to the other. This dual-switch arrangement for tape monitoring and tape dubbing is by far the easiest for a user to understand. In our opinion, this arrangement is superior to those multi-position rotary switches that are sometimes used for these functions and can be quite confusing. A program SELECTOR switch with settings for two phono and auxiliary inputs plus a tuner input is located at the upper right of the panel. Controls along the panel's lower section include a toggle switch for power ON/OFF, BASS and TREBLE rotary controls, a LOUDNESS switch, rotary BALANCE control and a MIXING-LEVEL control that adds selectable amounts of microphone signal to other program sources. The microphone jack associated with this control is located at the lower-right corner of the panel, while the usual PHONE jack is over at the left, near the POWER switch.



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The rear panel of the *TRM-750* (see Fig. 2) contains the appropriate input jacks for PHONO, TUNER, AUX and TAPE, corresponding sets of tape-out jacks (as well as paralleled DIN sockets), a ground (GND) terminal, three convenience AC outlets (two switched, one unswitched) and conventional knurl-screw terminals for speaker wire connections. In addition, there are preamplifier-output and main-amplifier input jacks that are interconnected by stiff-wire jumpers which can be removed when separate use of the two major portions of the unit is desired. Instead of a fuseholder, there is a tiny circuit-breaker reset button to restore amplifier operation in the event of an overload condition.

Figure 3 shows the variety of components (including two turntable systems) that may be interconnected with the *TRM-750* amplifier. While no schematic diagram of this amplifier was supplied with the owner's manual, some idea of layout and internal construction may be obtained by referring to the photo in Fig. 4. Since readers may mistakenly conclude that the speaker outputs are capacitively coupled (since only one large filter-capacitor can is visible in the photo), we should clarify that the single capacitor-can actually houses two separate capacitors, each of which filters one polarity of the dual-polarity output supply required for direct speaker coupling at the output stages.

Most of the circuit components are mounted on a single major circuit board that is screened with component designations for ease of identification and servicing. What appears to be an ample heat-sink structure is vertically mounted and separated from the main circuit board. Wiring is carefully harnessed and dressed, and low-level preamplifier circuitry is as far removed from the power-supply transformer area as is physically possible within the dimensional limitations of the amplifier.

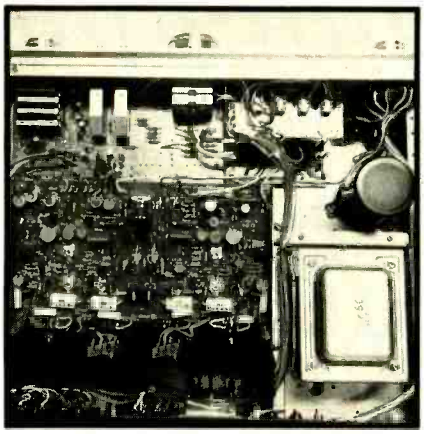
Laboratory measurements

The amplifier was able to produce 60 watts of continuous sinewave power per channel, driving 8-ohm loads with a 1 kHz test signal. Considering the fact that the FTC rating for this product is only 45 watts-per-channel, that constitutes a very considerable extra margin of power. Even at the frequency extremes of 20 Hz and 20 kHz, power output was 55 watts for the rated harmonic distortion figure of 0.15%. These and other measured results are summarized in Table I. Actual frequency limits at which rated power could be attained at rated distortion were 11 Hz and 47 kHz—far beyond the 20 Hz to 20 kHz power bandwidth specified by Nikko in their owner's manual.

RIAA phono equalization was within 1 dB of the specified curve from 30 Hz to 15 kHz. Maximum voltage to the phono input before overload distortion was observed measured an adequate 150 mV, while the signal-to-

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Rated Power Output: 45-watts per channel into 8-ohm loads. **Power Bandwidth:** 20 Hz to 20 kHz. **Rated Harmonic Distortion:** 0.15%; less than 0.1% at 1-watt output level. **Rated IM Distortion:** Less than 0.2%; less than 0.1% at 1-watt output level. **Damping Factor:** 50 at 1 kHz into 8-ohm load. **Input Sensitivity:** Phono 1 & 2, 2.5 mV; Aux, Tuner and Tape, 180 mV; Mike, 2.5 mV; Main Amplifier, 1.3 volts. **S/N Ratio:** Phono, 72 dB (IHF A-weighted); Aux, Tuner and Tape, 95 dB (IHF A-weighted). **Bass Control Range:** ±12 dB at 70 Hz. **Treble Control Range:** ±10 dB at 10 kHz. **Filter Response:** low, −8 dB at 70 Hz; high, −7 dB at 10 kHz. **Audio Muting:** −20 dB. **Maximum Power Consumption:** 240 watts. **Dimensions:** 15-3/4 W × 5-5/8 H × 12-3/16-inches D. **Net Weight:** 23.1 lbs. **Suggested Retail Price:** $249.95.



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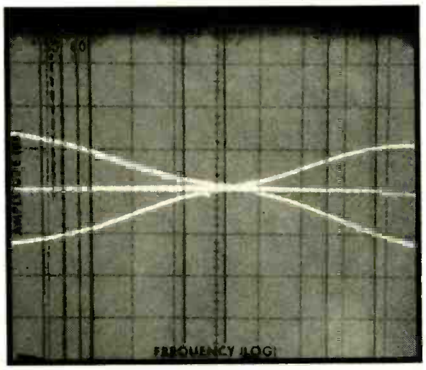
noise ratio was 71 dB referenced to an input sensitivity of 2.5 mV. Using an A-weighting filter for the signal-to-noise measurement, we obtained a better reading of 77 dB.

Tone-control range of the BASS and TREBLE controls is shown in the scope photo of Fig. 5, in which a frequency plot was made from 20 Hz to 20 kHz for flat and extreme settings (boost and cut) of the two tone controls.



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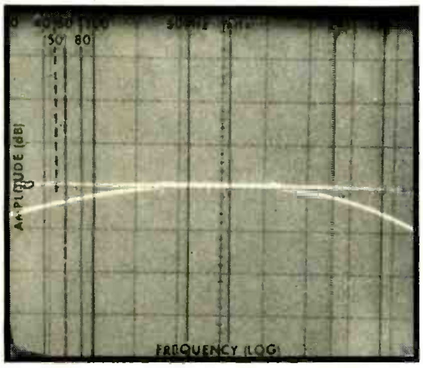
High- and low-cut filters are of the 6 dB-per-octave type and, while they provide very little noise reduction at the frequency extremes, their −3 dB points are sufficiently removed from critical center frequencies so that their use does not materially affect much of the musical program content (see Fig. 6).



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In measuring the action of the LOUDNESS control (see Fig. 7), we were impressed with the fact that the dB notations around the VOLUME control were quite accurate, so that we had only to set the control for 0 dB, −10 dB, −20 dB, etc., to obtain the traces shown in Fig. 7, which are 10 dB apart. Significant bass- and treble-loudness compensation does not begin until the VOLUME control is some 20-dB below its maximum setting, and then remains fairly constant at all lower volume

TABLE I
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Nikko** Model: **TRM-750**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	60	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	55	Excellent
RMS power/channel, 8-ohms, 20 kHz (watts)	56	Excellent
Frequency limits for rated output (Hz-kHz)	11-47	Superb
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.022	Excellent
Intermodulation distortion, rated output (%)	0.055	Excellent
Harmonic distortion at 1-watt output, 1 kHz (%)	0.043	Very good
Intermodulation distortion at 1-watt output (%)	0.028	Excellent
DAMPING FACTOR, AT 8 OHMS	53	Excellent
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± __dB)	1.0	Good
Maximum input before overload (mV)	150.0	Very good
Hum/noise referred to full output (dB) (at rated input sensitivity)	71	Very good
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± __dB)	7–40, 3	Excellent
Hum/noise referred to full output (dB)	80	Very good
Residual hum/noise (min. volume) (dB)	90	Very good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 5	Very good
Action of low frequency filter(s)	See Fig. 6	Poor
Action of high frequency filter(s)	See Fig. 6	Poor
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5/2.5	
Input sensitivity, auxiliary input(s) (mV)	200	
Input sensitivity, tape input(s) (mV)	200	
Output level, tape output(s) (mV)	200	
Output level, headphone jack(s) (V or mW)	0.467/8 ohms	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Excellent
Adequacy of input facilities		Excellent
Arrangement of controls (panel layout)		Very good
Action of controls and switches		Excellent
Design and construction		Very good
Ease of servicing		Very good
OVERALL AMPLIFIER PERFORMANCE RATING		Excellent

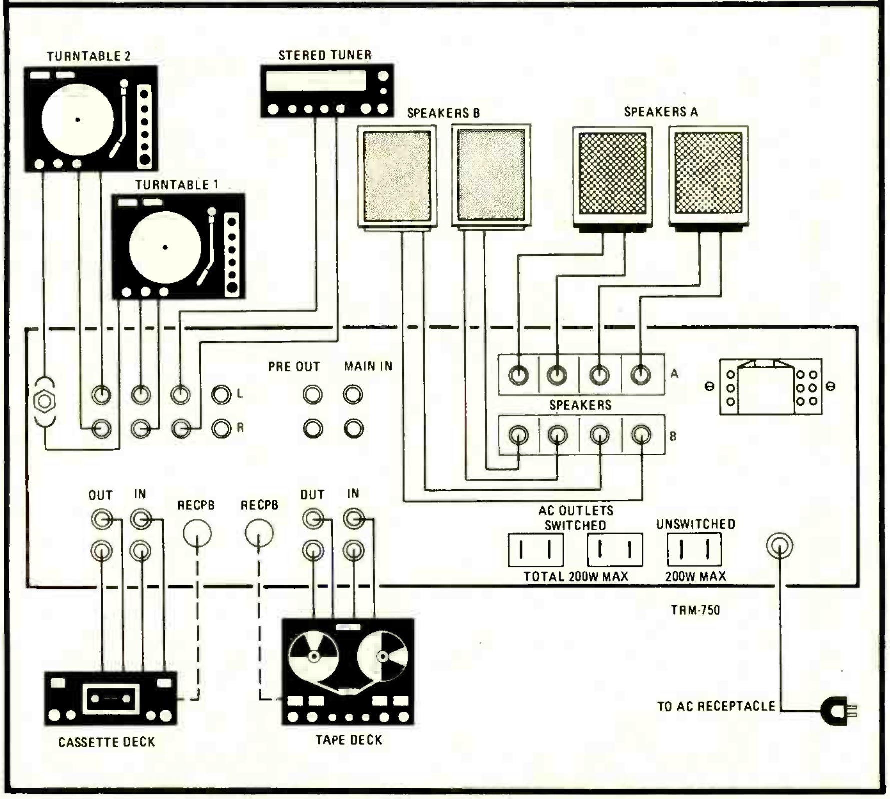

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TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

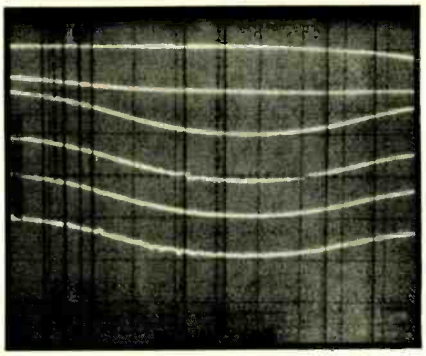
Manufacturer: **Nikko** Model: **TRM-750**

OVERALL PRODUCT ANALYSIS

Retail price	**$249.95**
Price category	**Low**
Price/performance ratio	**Excellent**
Styling and appearance	**Very good**
Sound quality	**Excellent**
Mechanical performance	**Very Good**

Comments: The Nikko *model TRM-750* belongs to that special group of separate components which disproves the theory that it is necessary to expend an enormous amount of cash to put together a system consisting of a separate tuner and amplifier. If you were to add a tuner in the $150.00 to $200.00 price range to this amplifier, you would come up with a system having a suggested retail price of between $400.00 and $450.00—not very much more than you might expect to pay for an all-in-one receiver in the same power category. Nor are you likely to find such a receiver with all the control features and flexibility (microphone input-mixing, tape dubbing and monitoring in either direction and dual phono inputs), since receiver manufacturers tend to down-grade control features as power ratings are lowered. We were impressed with the quality of construction of this unit, and with its very conservatively rated specifications, all of which were met or exceeded. Ability to separate the preamplifier and main-amplifier sections makes this an ideal unit for driving speakers in a multi-amplifier (electronic crossover) system. In such systems, the included main-amplifier section would be perfect for driving midrange or tweeter elements, where a larger power amplifier is used for woofer powering. Used as the sole amplifier in a stereo system, driving medium efficiency speakers, the *TRM-750* provided clean tight sound with no trace of clipping distortion or overload even at 110-dB sound-pressure levels in our 20 × 14-ft listening room. On the test bench, after having been subjected to high-powered tests and FTC preconditioning tests, thermal conditions were stable and there was no overheating of the output circuitry or power transformer. All in all, a neatly executed amplifier design.

settings. Additional flexibility is provided by the −20 dB MUTING switch. If a user finds that the program-source signals are so great that too much loudness compensation is present, he or she can turn the MUTING switch ON. This will require a higher setting of the



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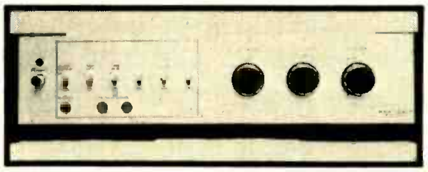
master VOLUME control, but less loudness compensation will result. It's somewhat like having two input sensitivities for all the program sources connected to the amplifier—each 20-dB apart.

Summary and listening tests

Comments regarding the overall performance of the Nikko *model TRM-750* will be found in Table II along with our brief overall product analysis and evaluation. In our view, the Nikko *model TRM-750* offers good value for its price and includes control features equal to those found on many higher-powered integrated amplifiers selling for considerably more money. Especially for the audiophile who has no desire to use FM as a program source (at least initially), the *TRM-750* offers a good alternative to an integrated receiver of similar power rating at considerably less cost. **R-E**

Heath AP-1615 Preamplifier

WHILE MORE AND MORE MANUFACTURERS seem intent upon designing and manufacturing so-called "high end" separate components at escalating prices, the Heath Company of Benton Harbor, Michigan, goes about its merry way introducing product after product that offer amazingly good performance quality at a price that amazes even the experts. The latest of these to pass through our test laboratory is the simple looking, straightforward preamplifier shown in Fig. 1. At first glance, you might guess that some knobs and switches are missing. The fact is that the *model AP-1615,* like many other new control centers, is devoid of frills and even lacks bass and treble controls. A growing group of audio buffs believes that in a properly matched component



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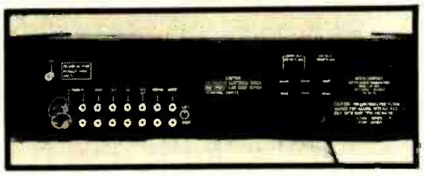
system there should be no need for bass and treble controls at all and, as Heath suggests in their advertising copy, if you do require tonal compensation you can do a much better job of tonal tailoring with their matching *model AD-1305* five-band, two-channel graphic equalizer (tested for **Radio-Electronics** in the December 1976 issue) or with any other of the many equalizers which have been appearing on the market lately.

MANUFACTURER'S PUBLISHED SPECIFICATIONS:
Rated Output: 1.5 V. **Input Sensitivity:** Phono, 2.0 mV; High Level, 180 mV. **Input Overload:** Phono, 100 mV; High Level, over 10 volts. **Hum and Noise:** Phono, 65 dB; High Level, 85 dB. **Frequency Response:** Phono (RIAA), ±0.5 dB; High Level, ±0.2 dB, 20 Hz to 20 kHz. **Harmonic and IM Distortion:** Less than 0.05% from 20 Hz to 20 kHz. **Channel Separation:** 50 dB at 1 kHz. **Filter Cutoff Points:** Low, –3 dB at 15 Hz; High, –3 dB at 7 kHz, both 12 dB-per-octave. **Power Requirements:** 120/240 VAC, 50/60 Hz. **Dimensions:** 17½ W × 4-$\frac{9}{16}$ H × 8-⅛-inches D. **Shipping Weight:** 12 lbs. **Price:** Kit only, $129.95.

The major rotary controls seen at the right of the front panel of the *model AP-1615* are the BALANCE control, the SELECTOR switch (with provision for two sets of PHONO inputs, TUNER, AUX and TAPE inputs) and the master VOLUME control. A series of six two-position toggle switches at the left of the panel handle HIGH- and LOW-cut FILTERS, mono L+R reproduction, TAPE DUBBING (accompanied by front panel TAPE-OUT and TAPE-IN jacks), TAPE MONITORING and output cut-off or DEFEAT. A phone jack is included below the OUTPUT DEFEAT switch that permits headphone listening while input to the power amplifier and speakers is shut off. The POWER on-off pushbutton and the POWER indicator light are located at the extreme left of the panel.

The rear panel of this preamplifier (see Fig. 2) is equipped with two unswitched convenience AC receptacles, one switched receptacle, a line fuse, a chassis-ground terminal and the necessary input and output jacks associated with the selector and tape-monitoring positions on the front panel. Since only one set of tape-monitor jacks is



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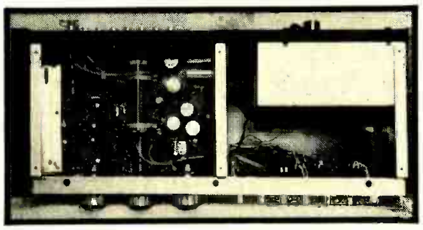
provided, if a graphic equalizer is used, it must be connected between the main outputs of the preamplifier and the inputs to an associated power amplifier.

Figure 3 shows the internal layout of the *AP-1516*. All power-supply parts, including the power transformer, are well shielded in a separate housing seen



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at the upper right corner of the chassis. Virtually all other electrical components are mounted on a large printed-circuit board that occupies the entire right section of the chassis. The two rotary potentiometers associated with the BALANCE and master VOLUME controls are mounted directly to the PC board while the SELECTOR switch has its wafers positioned so that they are closest to the circuit points on the main PC board with which they are involved electrically. Visible just behind the BALANCE control is a relay unit for turn-on delay of the audio signals after the POWER switch is depressed to prevent thumps from reaching (and possibly damaging) loudspeakers.

We were supplied with a wired unit for test purposes, but the *model AP-1615* is available only in kit form to the general public. While our sample unit was not accompanied by Heath's construction and owner's manual, we can attest to the fact that layout of the unit makes assembly and wiring extremely simple. Components used are of the highest grade and a minimum of point-to-point wiring is involved in the construction of this product. We would estimate that an experienced kit-builder might be able to complete the construction of this control center in two evenings or so, while the novice might require a third session.

Laboratory measurements

Table I summarizes measured results obtained with the *model AP-1615*. Although phono overload capability was better than claimed, with readings of 120 mV (as against 100 mV claimed), it was not considered to be outstanding compared with some of the overload figures we have been obtaining lately on the current crop of preamplifiers and amplifiers. Still, it is unlikely that

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TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Heath** Model: **AP-1615**

PREAMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurements	R-E Evaluation
RATED OUTPUT LEVEL REFERENCE: 1.5 volts		
DISTORTION MEASUREMENTS		
Rated output, 20 Hz (%)	0.008	**Excellent**
Rated output, 1 kHz (%)	0.006	**Excellent**
Rated output, 20 kHz (%)	0.015	**Very good**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± _ dB)	0.2	**Excellent**
Maximum input before overload (mV)	120	**Good**
Hum/noise referred to full output (dB) (at rated input sensitivity)	70	**Very good**
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± _ dB)	20-20, 0.2	**Excellent**
Hum/noise referred to full output (dB)	85	**Very good**
Residual hum/noise (minimum volume) (dB)	87	**Good**
TONAL COMPENSATION MEASUREMENTS		
Action of low frequency filter(s)	See Fig. 5	**Excellent**
Action of high frequency filter(s)	See Fig. 5	**Very good**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1 (mV)	2.0	
Input sensitivity, auxiliary input(s) (mV)	185	
Input sensitivity, tape input(s) (mV)	185	
Output level, tape output(s) (mV)	185	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Fair**
Adequacy of input facilities		**Good**
Arrangement of controls (panel layout)		**Very Good**
Action of controls and switches		**Very good**
Design and construction		**Excellent**
Ease of servicing		**Excellent**
OVERALL PREAMPLIFIER PERFORMANCE RATING		**Very good**

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Heath** Model: **AP-1615**

OVERALL PRODUCT ANALYSIS

Retail price	**$129.95**
Price category	**Low**
Price/performance ratio	**Very Good**
Styling and appearance	**Excellent**
Sound quality	**Excellent**
Mechanical performance	**Very good**

Comments: Whenever a new trend becomes apparent in the world of audio, the Heath Company seems able to come up with a product to further that trend along almost as quickly as anyone else, and that's no small feat when one considers that besides coming up with a new design, the company has to translate that design into a unit that can be successfully built even by a novice kit-builder. There have been several examples of "straight-line" preamplifier-control units recently, in which all frills are eliminated and emphasis is placed upon pure performance and ultra-low distortion. The model AP-1615 preamplifeir is just such a unit and, as such, it will appeal to the purists among audiophiles who would rather not have built-in tone controls and a profusion of other knobs or controls. Compared with other examples of such preamplifiers, the pricing of the model AP-1615 is extremely attractive, even when one considers that it is supplied only in kit form. As has been our experience with Heath products in the past, all specifications were either met or exceeded by some margin. As for the sound reproduced by the model AP-1615, we could detect no audible distortion under all listening conditions, nor was there any coloration caused by abberations in the frequency response, which is extremely wideband. As usual, construction is straightforward and should pose no problems for kit-builders. The front-panel dubbing jacks will be appreciated by tape recording enthusiasts who are in the habit of copying tapes from a friend's machine. Such extras as are provided are not apparent from the front panel but manifest themselves in the actual performance of the preamplifier unit itself (e.g., the delayed turn on which prevents "pops" and "thumps" from reaching your speakers before supplies have stabilized). The Heath model AP-1615 certainly provides the means whereby serious audio enthusiasts can create a true system of separates with barely a dent in their pocketbooks.

BUILD

Amplifier For Hands-Off Telephone

Simple add-on accessory allows you to converse Acoustic coupling eliminates direct

JULES GILDER

NO DOUBT YOU'VE HAD OCCASIONS WHEN YOU PLACED A CALL to, or received a call from, someone you haven't spoken to for a long time, and other members of the family want to speak also. Or you were busy doing something and got annoyed because you had to drop everything and talk to someone on the phone for half an hour.

A speaker phone telephone amplifier can be useful in both these situations. No longer need members of your family argue to talk first on the phone. Now everyone can sit around the telephone and talk together with whomever is on the other end. The speaker phone will also allow you to carry on a conversation while you're still busy moving furniture or painting the walls.

And like most of the other projects in this series of articles, the speaker phone requires no direct electrical connection to the telephone line. All coupling is made either by acoustic or magnetic means.

How it works

The heart of the speaker phone is a three-transistor amplifier that takes the millivolt level signals produced by the telephone pickup coil and amplifies them to room-filling volume. The schematic is shown in Fig. 1. The power supply is shown in Fig. 2.

Just about any telephone pickup coil can be used for the speaker phone, but one of the newer ring-shaped devices is recommended because this particular coil gives a stronger signal. The coil is designed so that it will fit snugly over the receiver portion of the telephone handset, where it will pick up the audio signals to be amplified by induction.

The induced signals are applied to the volume control and then to the voltage amplifier made up of transistors Q1 and Q2. The amplified signal is applied to Q3 where the current, and hence the total power level of the signal, is increased. Power transistor Q3 is capable of handling large currents. The need for an output transformer is eliminated by Q3 because its large current-handling capability means that it can interface directly with a speaker.

So far we have talked about picking up a signal and amplifying it so that everyone in the room can hear it. That constitutes only half of the speaker phone. The other half of the speaker phone requires that people be able to talk into the phone from a remote location. This can be done in two ways. The first is by using another amplifier to pick up the sound generated in a room via a microphone. The second is to acoustically design the speaker phone so that sound focused in the direction of the device will be concentrated and fed into the mouthpiece of the telephone.

The first approach is most desirable but leads to many problems, the biggest of which is feedback oscillation. This of course could be eliminated by using voice-controlled switches, but that would mean conversations would have to be carried on in an artificial manner where one person would have to wait until the other stopped talking before he could be heard.

Simultaneous conversation with an amplified input is possible, but it requires complex circuit design and would considerably raise the cost and difficulty of construction.

To keep things simple, we'll do what most of the manufacturers of speaker phones do, and design the unit so that sound focused in the direction of the speaker phone is concentrated and directed towards the microphone of the telephone. This is not as difficult as it may sound. It is simple and involves constructing the enclosure so sound is deflected upwards.

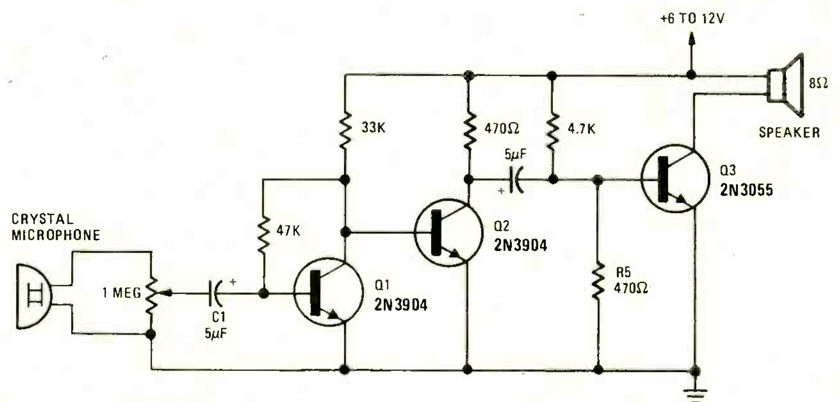
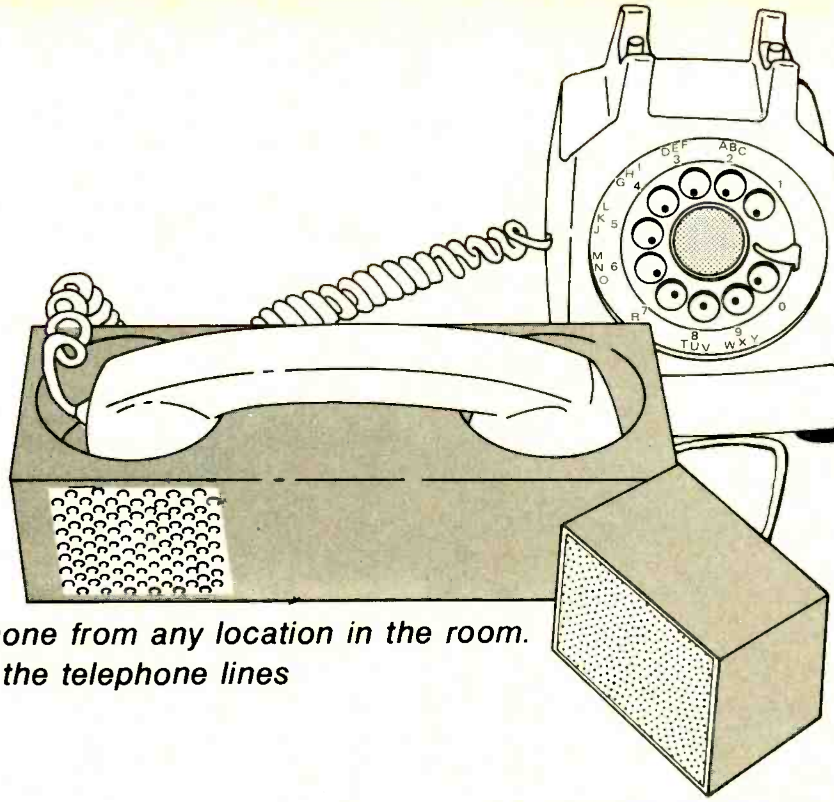


FIG. 1—THREE-STAGE AMPLIFIER raises the level of signals picked up by an induction coil—not a microphone, the mike symbol is an error—to room-filling level.



on your telephone from any location in the room.
connection to the telephone lines

Construction

The enclosure for the speaker phone is very important, for it is more than a case to hold the electronic circuit. It is a functional part of the design of the device.

To start with, build a thin, plywood box 10 inches wide, 4 inches deep, and 2½ inches high. Cut two holes in the top 3¼ inches in diameter and made on center lines that are located 2 inches from each end.

These holes will be used to allow the handset to drop into the speaker phone and properly position it. With the box assembled and these two holes cut, mark one hole, either one, "microphone" and the other one "receiver." This can be done lightly in pencil and is only necessary to make instructions easier. On the front vertical wall of the box on the microphone side, draw a rectangle that measures 3¼" × 2" and place the rectangle so that it is ¼ inch from each of the three edges. Once marked, use a saber saw to cut out that rectangle.

This is the opening that will be used to direct sound into the microphone of the telephone. If you want, you can put a piece of grille cloth over the opening to improve its appearance, but make sure it is thin so that it will not severely attenuate the voice signals entering.

Next, 3½ inches from the inside of the microphone end of the box, place a barrier made from a piece of wood 4" × 2½". This will prevent sound entering the microphone opening from being dispersed throughout the box. To further concentrate the sound, take a thin piece of flexible plastic and cut it into a rectangle 3¼" × 5". This is the deflecting plate and should be inserted in the microphone compartment on a diagonal whose bottom is in the front of the box (where the rectangular opening is) and whose top is at the back of the box. The deflecting plate will need to be bent to be inserted. Bend it so the curvature of the plate is toward the bottom of the box.

Now, any sound entering the microphone compartment will be deflected upward toward the mouthpiece of the telephone. If done properly, you'll be surprised at just how effective this acoustic coupling can really be.

Proceed to the receiver end of the box. Here work is less critical. Mount a piece of thin plywood, cut into a 3¼-inch square, directly underneath the receiver hole so that when the receiver is placed in it, the surface of the wood is parallel to the receiver of the handset. The square can be held in position by fastening it to spacers, dowels, or wooden blocks. Next, mount the pickup coil on the top of the wooden square so that when the receiver is placed in the box, it will come into contact with the coil.

That's the hard part. The easy part is to fabricate the printed circuit–or use perfboard if you wish–and construct the three-transistor amplifier. Mount the volume control at a convenient spot on the front panel along with an on/off switch. Mount the circuit board, on spacers, at another convenient location. At a third convenient location mount a battery holder for the six penlight batteries.

The output of the amplifier should be fed to a miniature jack located on the side of the case. The speaker is in a little enclosure of its own and connected to the amplifier via a shielded cable and a miniature plug.

Installation and operation

To install the speaker phone, it is simply necessary to place the handset of the telephone into the device, making sure that the microphone and receiver portions are inserted into the proper holes. Turn the unit on. You should immediately hear the dial tone coming through the speaker. If you don't, check the volume control and the coupling between the induction coil and the receiver.

Phone a friend and talk to him using the speaker phone. Try standing at various distances and at various angles from the microphone opening. Ask him to tell you which positions are best. **R-E**

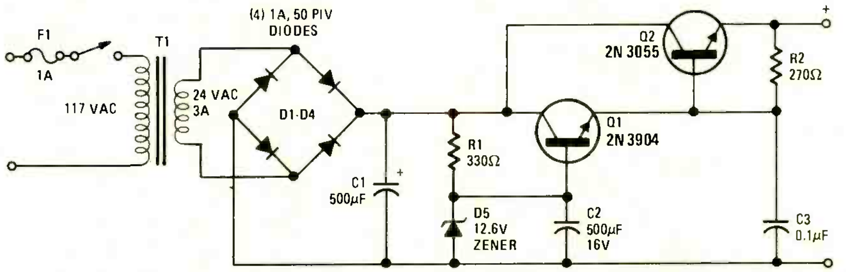


FIG. 2—OPTIONAL POWER SUPPLY FOR TELEPHONE AMPLIFIER. Output voltage is determined by Zener diode. Power is taken from 117 VAC line.

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Career Training at Home

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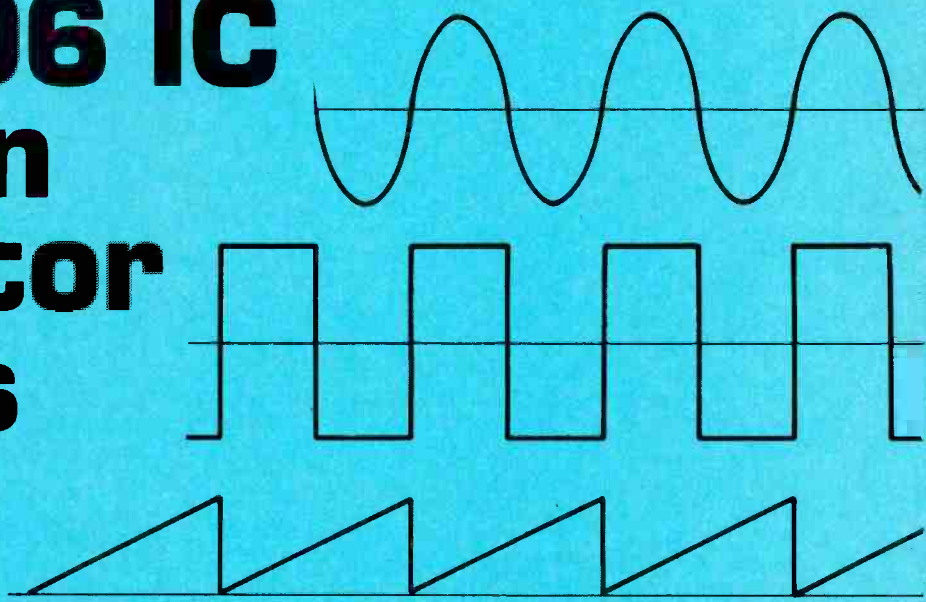
XR-2206 IC Function Generator Circuits



Part II. The XR-2206, IC is a versatile function-generator with many applications. Here are some of the more interesting circuits you can try.

R. M. MARSTON

LAST MONTH. WE LOOKED AT THE PERFORMance characteristics of the XR-2206 IC and its application in sine, triangle and squarewave applications.

This month, we'll look at pulse, ramp, AM and FM applications.

Function generators

The circuits shown in Figs. 2 thru 8 can be combined in a variety of ways to make different types of waveform generators. Figure 9, for example, shows how some of the circuits can be combined to make a simple fixed-amplitude function generator that provides sine, triangular and square waveforms. Here, the squarewave output is taken directly from pin 11 of the IC, and is produced simultaneously with the sine or triangular waveform at pin 2, which are selected by switch S1.

Alternatively, Fig. 10 shows how some of the circuits can be put together to help make a low-cost high-performance function generator that covers 1 Hz to 200 kHz in five switched ranges. Frequencies are selected by RANGE switch S1 and FREQUENCY control R1. Each range of S1 covers a full decade plus 100% overrange at its upper frequency. The circuit has THD adjustment of the sinewave, and produces a typical distortion of 0.5%.

The sine/triangular output of the IC is taken from pin 2, and all outputs are fed to a simple variable attenuator network via the Q1–Q2–Q3 buffer stage. The sine/triangular output can be centered on precisely zero volts using OFFSET control R8, and R3 sets the maximum sinewave output level, which should be set at 2 volts RMS.

The procedure for initially setting up the circuit when it is first built is as follows. First, set the attenuator controls to give maximum output, set the circuit to the sinewave mode at about 1 kHz, and then adjust R8 to give zero offset of the output signal. To do this, connect a 0–2.5 volt DC meter to the output of the circuit, and then adjust R8 for zero reading. Next, connect a 0–2.5 volt AC meter to the output of the circuit, and adjust R3 to give a sinewave output of approximately 2 volts RMS. Finally, adjust R4 and R6 to give minimum distortion of the sinewave, as previously described, and then recheck the DC offset and output amplitude. The setting up procedure is then complete and the circuit is ready for use.

Pulse and ramp waveforms

Figure 11 shows the practical connections for using the XR-2206 as a variable-slope ramp generator circuit. Here, the squarewave output (pin-11) is connected to the FSK input (pin 9) of the IC. The circuit action is such that, when pin 11 is high, timing capacitor C1 charges via R1 until a threshold voltage is reached, at which point pins 11 and 9 switch abruptly to the low state. When this happens, the timing capacitor recharges in the reverse direction via R2 until pins 11 and 9 go high again. The process then repeats. The circuit, therefore, automatically switches between timing resistors on alternate half cycles, and produces a linear ramp output waveform at pin 2. The risetime and falltime are independently controlled by R1 and R2. The operating frequency of the circuit is given as:

$$f = \frac{2}{C1\ (R1 + R2)}$$

The circuit shown in Fig. 11 develops a variable duty-cycle squarewave at pin

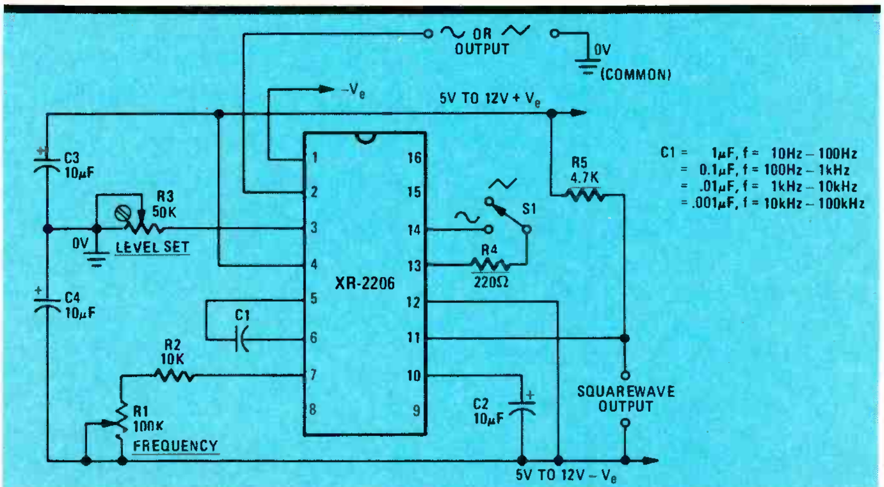


FIG. 9—SIMPLE FUNCTION GENERATOR provides sinusoidal, triangular and square waveforms.

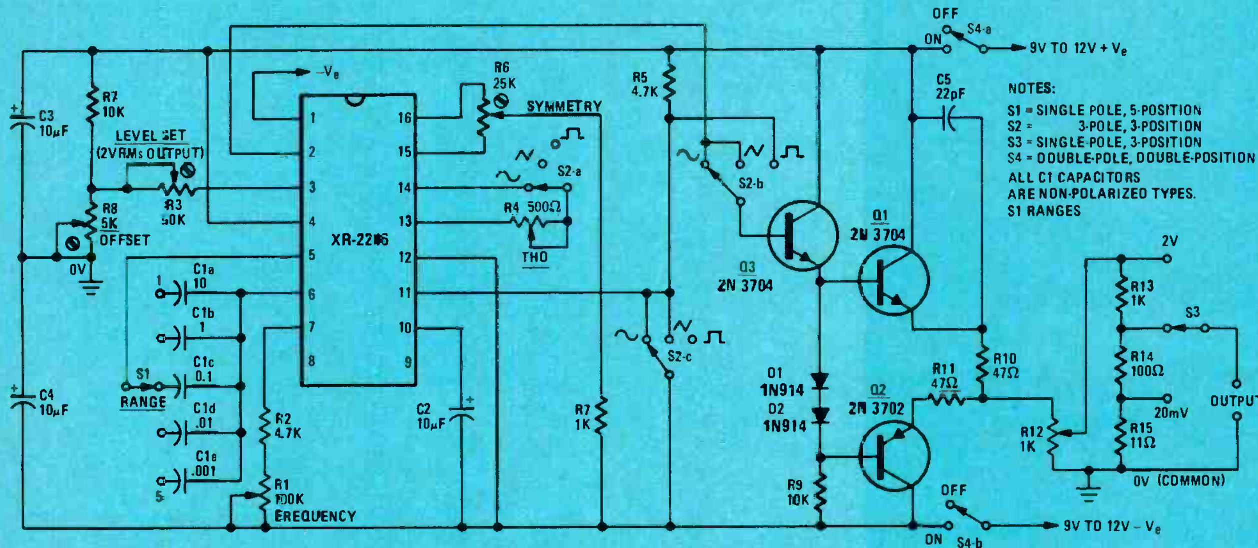


FIG. 10—HIGH-PERFORMANCE FUNCTION GENERATOR has a frequency range of 1 Hz to 200 kHz. The sinewave output has a distortion of 0.5 percent and an amplitude of 5.6-volts P-P maximum. The triangular waveform has a linearity of 1 percent and a maximum peak-to-peak amplitude of 12 volts. The squarewave output has a risetime of 200 ns, a falltime of 100 ns, and a maximum output of 16 volts P-P.

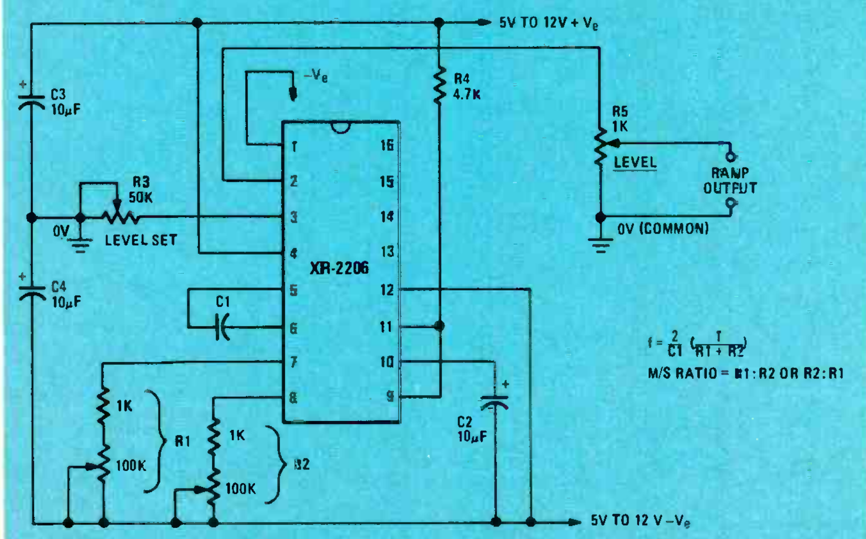


FIG. 11—RAMP GENERATOR provides variable-slope output signal.

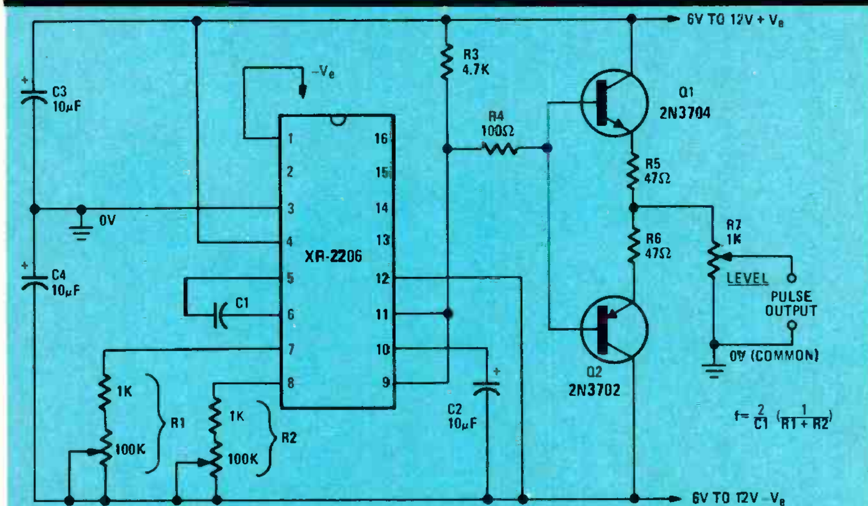


FIG. 12—PULSE GENERATOR provides variable duty-cycle output signal and has an output buffer.

11 simultaneously with the ramp waveform. The squarewave, however, is of fixed amplitude and is not suitable for directly driving low-impedance external loads. If required, the XR-2206 can be used specifically as a pulse or variable duty-cycle squarewave generator as shown in Fig. 12. Here, the SET-LEVEL control is eliminated from the pin-3 terminal of the IC, and the pulse signal at pin 11 is made available to external loads by the Q1–Q2 emitter-follower stage and LEVEL control R7.

Alternatively, the circuits shown in Figs. 11 and 12 can be combined to form a practical variable pulse or ramp generator by using the connections shown in Fig. 13. Here, the desired waveform can be selected by S1, the waveform shapes are varied by R1 and R2, and the waveform amplitudes are controlled by R8.

The versatility of the Fig. 13 circuit can be increased, if desired, by replacing the existing pulse output stage with the one shown in Fig. 14. This circuit enables either positive, negative or symmetrical output pulses to be selected by S2, a 2-pole 3-position switch. Here, load resistor R4 is replaced by a pair of 2.7K, 5%, resistors. With switch S2 in position 1, the pulse output of the circuit is effectively taken from the junction of these two resistors, so the output switches between the fully positive and the half-supply or zero voltage levels. The circuit, therefore, provides positive output pulses. In position 2 of S2, the output is effectively taken from pin 11 of the IC and symmetrical output pulses are available. In position 3, the output is again taken from pin 11 of the IC but the top end of R4 is connected to the zero-voltage line. The output switches between the zero and negative supply voltage, and negative output pulses are available from the circuit.

FSK modulation

When the FSK input terminal of the XR-2206 IC (pin 9) is open circuit or externally biased above 2 volts with respect to the negative supply voltage, the pin-7 timing resistor is automatically selected and the circuit operates at a frequency determined by the timing capacitor and the pin-7 timing resistor. When pin 9 is connected to the negative supply voltage or is biased 1-volt below the negative supply voltage rail, the pin-8 timing resistor is automatically selected and the circuit operates at a frequency determined by the timing capacitor and the pin-8 timing resistor. The XR-2206 IC can thus be frequency-shift keyed (FSK) by simply applying a suitable keying or pulsing signal between pin 9 and the negative supply. Figure 15 shows the practical connections for making a simple FSK modulated sinewave generator or 'warble-tone' generator.

If required, the keying signal can be referenced to the ground or zero-volt line by using the 3-transistor add-on circuit shown in Fig. 16. Here, with the keying signal at the zero-volt level, all three transistors are cut off. When this occurs, pin 9 of the IC is effectively open circuit, and the output frequency is controlled by timing resistor R1. When the FSK input keying signal is high, transistors Q1 and Q2 conduct, causing Q3 to saturate. When Q3 saturates, pin 9 shorts to the negative supply and the output frequency is controlled by R2. The FSK facility controls both signals appearing at the pin 2 and pin 11 output terminals.

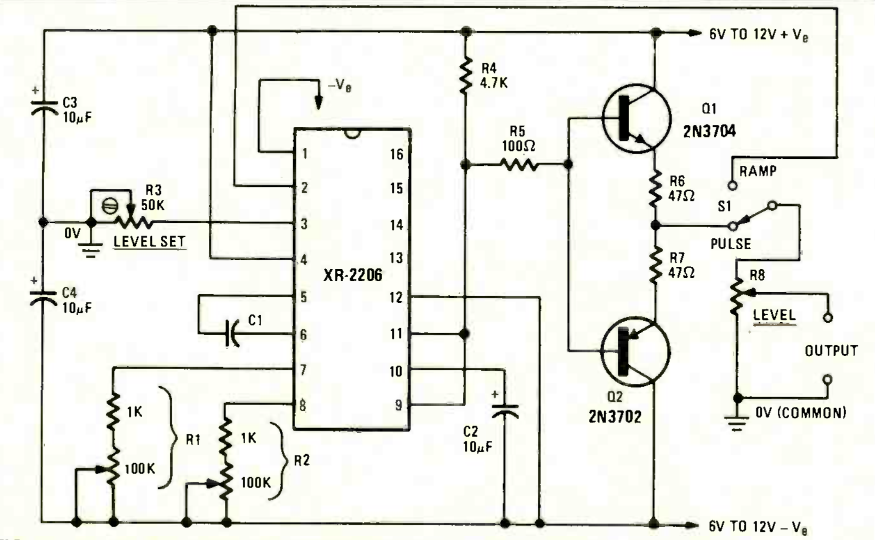


FIG. 13—PULSE AND RAMP WAVEFORM generator provides variable output signals.

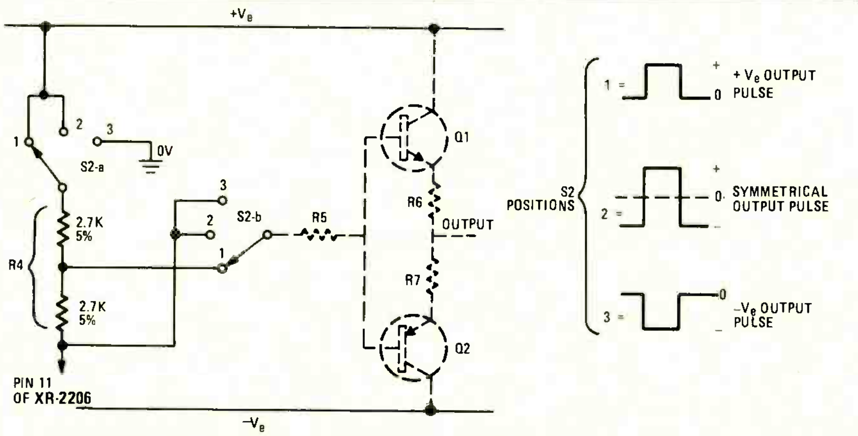


FIG. 14—MODIFIED OUTPUT STAGE for circuit shown in Fig. 13 provides either positive, negative or symmetrical output pulses.

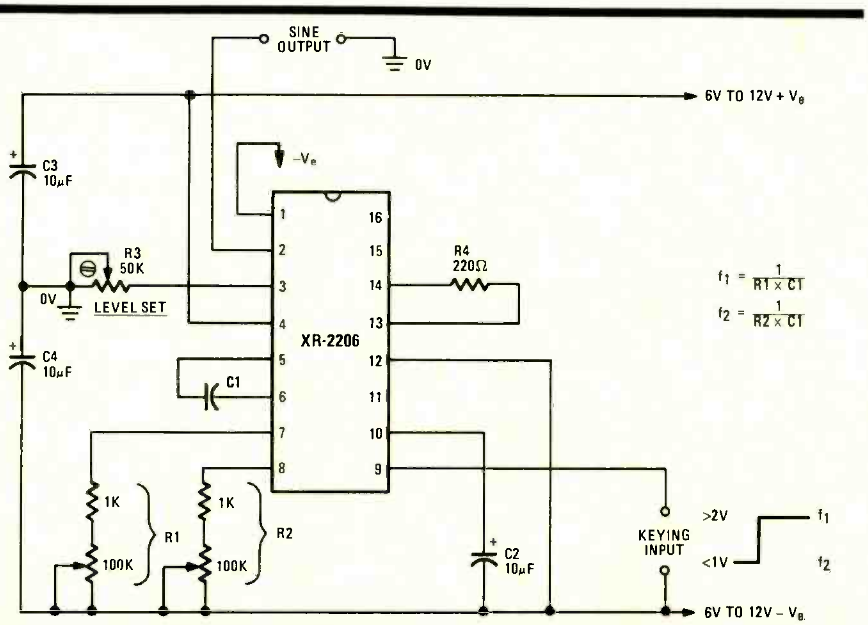


FIG. 15—BASIC FSK sinewave generator.

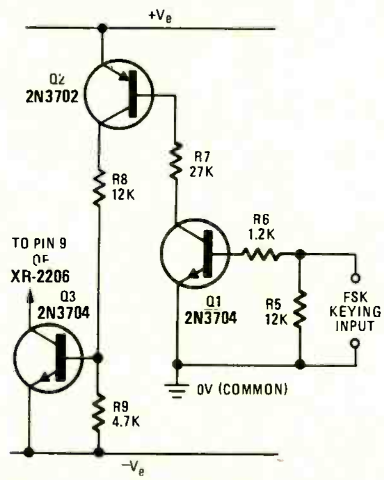


FIG. 16—FSK MODIFICATION to the circuit shown in Fig. 15 references the FSK input to the common or ground line.

Amplitude modulation

The output-signal amplitude at pin 2 of the XR-2206 can be modulated by applying a DC bias and a modulating signal to pin 1, as shown in Fig. 17. The internal impedance at pin 1 is approximately 200K ohms, so this pin should be connected to the negative supply to prevent unwanted pick-up when the AM facility is not in use.

The signal amplitude varies linearly with the applied voltage at pin 1 when this voltage is within 4 volts of the half-supply value. In split-supply circuits, of course, the half-supply value equals zero volts. When pin 1 is at the half-supply value, the amplitude of the signal at pin 2 is approximately zero. When the pin-1 voltage is increased above the half-supply value, the signal at pin 2 rises in direct proportion. When the pin–1 voltage is reduced below the half-supply value, the pin–2 signal again rises in direct proportion, but the phase of the output signal is reversed. This last-mentioned feature can be used for phase-shift keyed (PSK) and suppressed-carrier AM generation.

The pin-1 terminal can also be used to facilitate gate-keying or pulsing of the output signal at pin 2. This can be achieved by biasing pin 1 at approximately half-supply voltage to give zero output at pin 2, and then imposing the gate or pulse signal on pin 1 to raise the pin 2–signal to the required turn-on amplitude. The total dynamic range of amplitude modulation is approximately 55 dB.

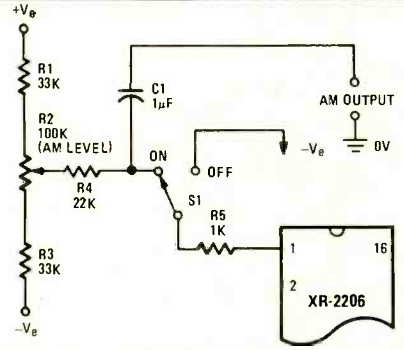


FIG. 17—AMPLITUDE MODULATION is accomplished with this add-on circuit.

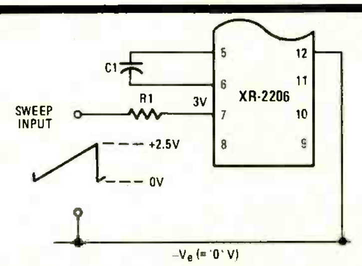


FIG. 18—FREQUENCY-SWEEP CONNECTION provides a 6:1 frequency range.

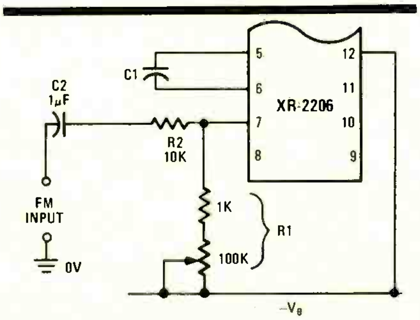


FIG. 19—FREQUENCY MODULATION connection for the XR-2206.

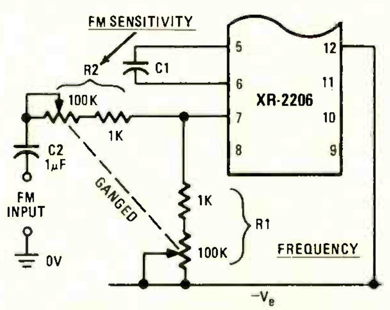


FIG. 20—CONSTANT-SENSITIVITY FM connection.

Frequency modulation

The output frequency of the XR-2206 is proportional to the total timing current (I_T) drawn from pin 7 or 8, and is given by:

$$f = \frac{320 \times I_T}{C} \text{ Hz}$$

where I_T is in milliamperes and C, the timing capacitor, is in microfarads. Pins 7 and 8 are low–impedance terminals and are internally biased at +3 volts with respect to pin 12. The frequency varies linearly with I_T over the range of 1 µA to 3 mA. The frequency can be varied either by wiring a variable current-determining resistor between pin 12 and the timing terminal, or by applying a variable voltage in the range 0 to +3 volts between pin 12 and the timing terminal using a current-limiting resistor, or by a combination of these two techniques.

Figure 18 shows the basic connections of a simple frequency-sweep circuit with a 6:1 frequency range. Here, a sawtooth frequency-sweep signal that has a peak amplitude of 2.5 volts is applied between pin–12 and pin–7 timing terminal. When the instantaneous peak value of the sawtooth voltage is zero, 3 volts is developed across R1, and the frequency is the same as in the case of a simple resistance-controlled XR-2206 oscillator. When, on the other hand, the instantaneous peak value of the sawtooth voltage is 2.5 volts, only 0.5 volt is developed across R1, and the R1 current and, therefore, the frequency is reduced to only ⅙th of that of the case we have just looked at.

Figure 19 shows the essential connections of a simple FM generator. Here, in the absence of a modulating signal, the output frequency is determined by R1 and C1, as in the case of a conventional XR-2206 oscillator. When the modulating signal is connected to the FM input, the timing currents and, therefore, the output frequency of the circuit are modulated.

A weakness of the simple circuit shown in Fig. 19 is that, for a given amplitude of the modulating signal, the percentage of frequency deviation varies with the setting of the R1 FREQUENCY control. This snag is overcome in the constant-sensitivity circuit of Fig. 20. A dual-ganged potentiometer is used with one arm used as the R1 frequency-determining control and the other arm as the R2 FM-SENSITIVITY control, so that the sensitivity is automatically adjusted to track with the frequency setting.

It should be noted that the frequency-sweep and frequency-modulated signals appear at both pins 2 and 11.

Power supplies

Finally, a few notes on choosing power supplies for the XR-2206 IC. It should be noted that the XR-2206 has built-in voltage regulation circuitry controlling the VCO, and that the amplitude of the output signal at pin 2 is not significantly influenced by variations in circuit supply voltage. Consequently, there is little advantage in using higher supply-voltages than are absolutely necessary for correct operation. In most cases, single-ended or split 12-volt supplies are adequate.

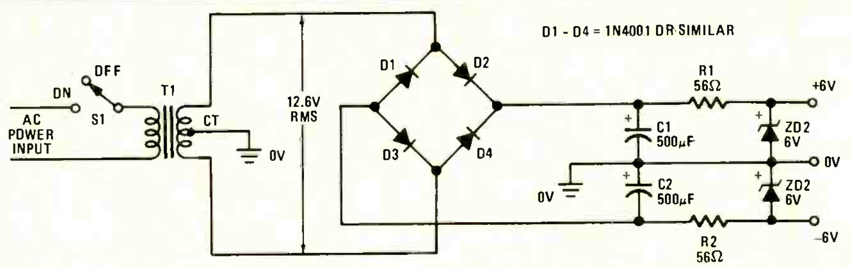


FIG. 21—REGULATED SPLIT-VOLTAGE power supply provides a 6V-0-6V output.

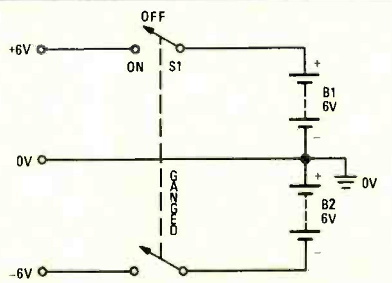


FIG. 22—BATTERY SUPPLY with split 6V-0-6V output.

Figure 21 shows the practical circuit of a line powered Zener-regulated 12-volt split-supply (6V—0—6V) circuit. Figure 22 shows the alternative connections for using a battery power supply. The XR-2206 draws a typical current of about 15 mA when used with these supplies. R-E

CB PROJECT

Preamplifier For Long Distance Reception

Pull in those weak signals with this add-on device for your CB transceiver

GEORGE SANTE

A CB TRANSCEIVER IS A COMBINATION OF A receiver and a transmitter. The transmitter power output is limited to 4 watts, so the only thing you can legally do to improve the transmitted signal is to improve the antenna system.

The receiver portion is a horse of another stripe. Chances are that when you originally shopped for a transceiver, you learned that it was in the receive functions that the money-making differences occurred. A straight receiver with only a volume control and squelch costs a lot less to produce than one with noise limiting, noise blanking, and an RF amplifier. These additional circuits, while they improve the reception con-

PARTS LIST

All resistors are 1/4-watt, 5%, unless otherwise noted.

R1—1200 ohms
R2—5100 ohms
R3—8200 ohms
R4—1500 ohms
R5—100 ohms
R6—560 ohms
R7—27 ohms
R8—270 ohms
R9—150 ohms
R10—1 megohm
R11—1000 ohms
C1, C2, C5, C6—.001 μF disc
C3—25 μF, 12 volt, electrolytic
C4—.01 disc
C7—100 μF, 3 volt, electrolytic
D1, D4—1N4001
D2, D3—1N914
Q1, Q2—2N3563
Q3—2N4123
RY1—DPDT relay, 320 ohm, 12 volt DC

The following parts are available from Guardsman Electronics, Box 215, Brooklyn, NY 11207.

Etched and pre-drilled printed circuit board, $4.00 postage prepaid.

Complete parts kit, including PC board, all components, and case, $14.95 postage prepaid.

New York State residents add state and local sales tax as applicable.

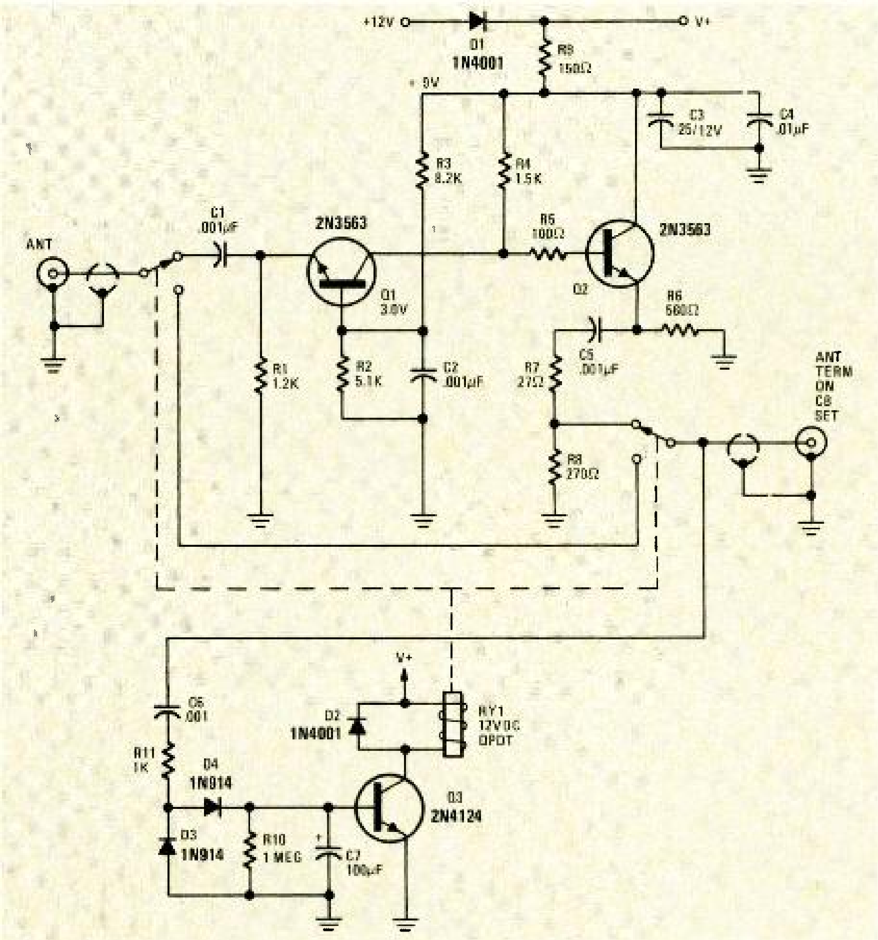


FIG. 1—CB RF PREAMPLIFIER connects between antenna and antenna terminal on CB transceiver.

siderably, can add appreciably to the cost. However, here's one way that the receiver portion of your transceiver can be upgraded so that the down-in-the-mud signals come through loud and clear, crisp and healthy. This add-on RF preamplifier makes any receiver really pull in the signals.

The RF preamplifier connects between the antenna and the antenna terminal on the transceiver. It has no switches or controls, so it can be mounted out of the way. The unit is powered by the 12-volt electrical system in your car.

Figure 1 shows a schematic diagram of the preamplifier. Circuit operation is as simple as it looks. Transistor Q1 is the preamplifier stage. Emitter-follower Q2 is used for impedance matching purposes. When the transmitter is switched on, the preamplifier is bypassed so that the output signal is connected directly to the antenna. Diodes D3 and D4, and associated components monitor the signal level from the antenna terminal of the transceiver. When a high-level signal is detected, Q3 is driven into saturation which energizes relay RY1 to bypass the preamplifier.

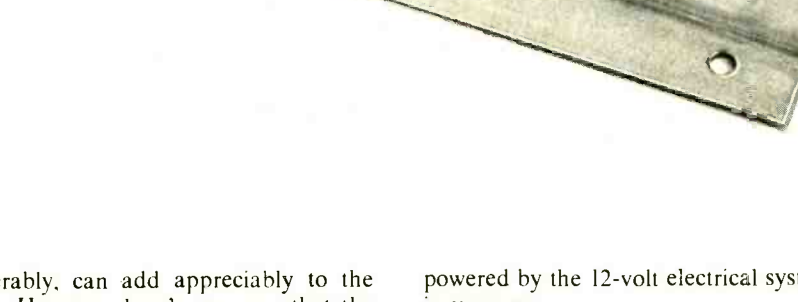


FIG. 2—FOIL PATTERN, shown full-size.

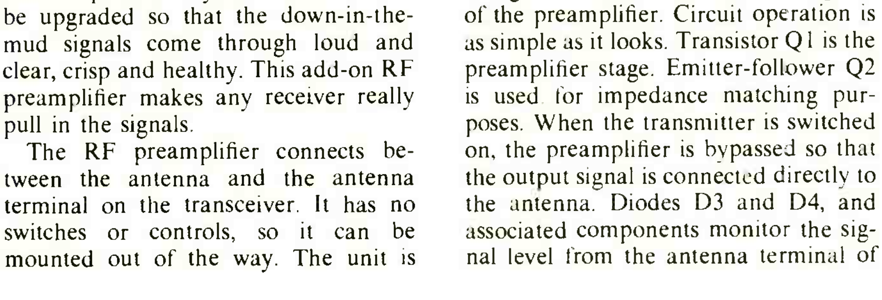


FIG. 3—COMPONENT PLACEMENT diagram. Resistor R8 mounts on foil side of PC board.

Construction

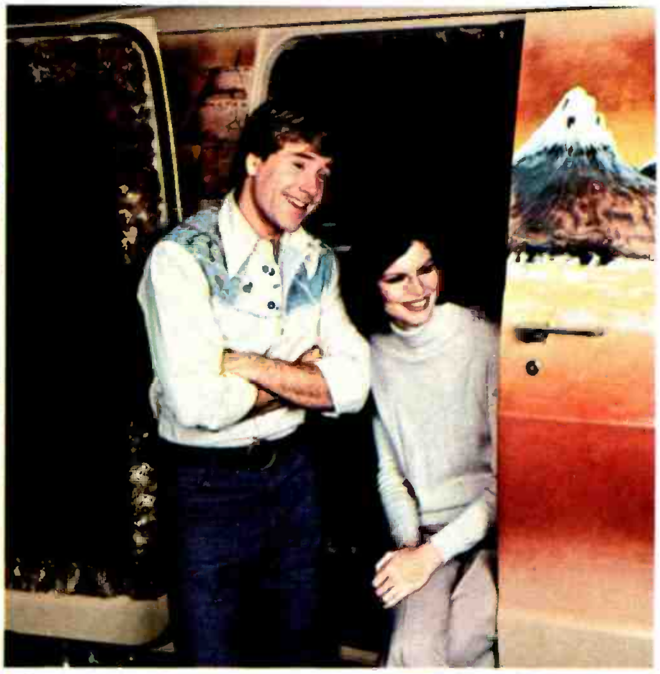
Building the preamplifer is easy as all the components are mounted on a PC board. For those who like to roll their own, the foil pattern is shown in Fig. 2. If you prefer, you can purchase a ready-to-use PC board for $4.00 (see parts list) and save yourself the work.

Begin the assembly by mounting all of the components to the PC board and soldering them in place, removing excess leads. The component placement diagram is shown in Fig. 3. The pre-drilled pre-etched PC board is treated with solder resist where solder is not to be used, however, caution must be taken to avoid solder bridges from the foil paths to other paths. A good way to work is to put a component in place, solder the leads carefully, then check to see that no unintended shorts occur and remove all solder splashes. Clip the lead wires close to the board surface, then install the next component.

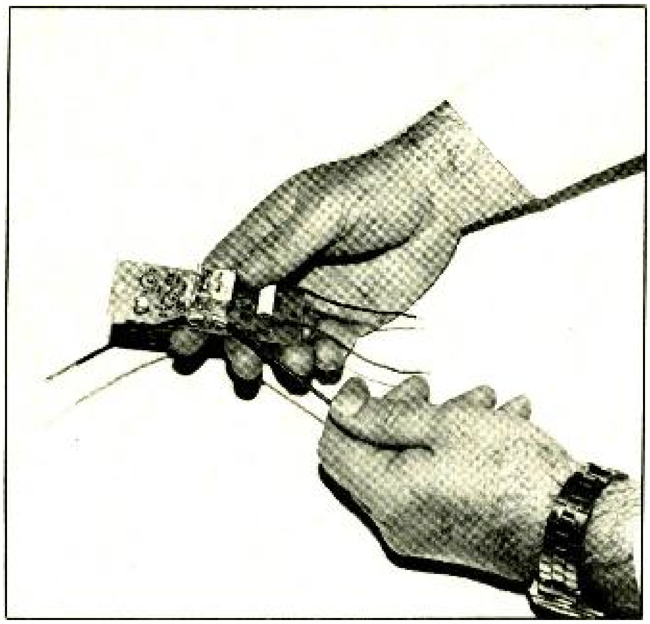
Now there's been one design change in this unit, and correcting for it is no problem at all. However, it's a change that you should make for better operation.

Resistor R8 should *not* be connected to its indicated position on the circuit board. Leave it till last, then bend the wire leads at right angles to the resistor body, and connect this resistor on the foil side of the board to ground near the emitter lead of transistor Q3 and the

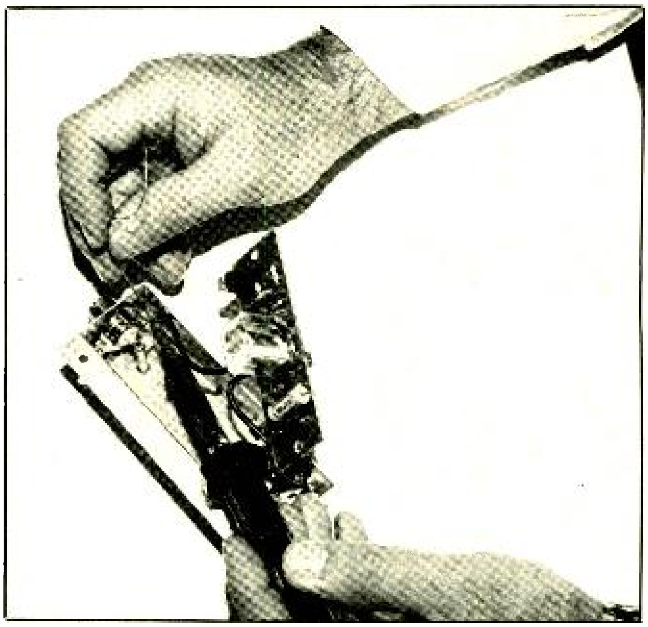
Go after the best of everything.



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!



CB PREAMPLIFIER assembles on a single PC board. Coaxial cable is used to connect the PC board to the antenna input and output jacks.



CIRCUITRY AND COAXIAL CONNECTORS are neatly installed in a 5 × 1½ × 1½-inch sheet metal case.

nearest terminal of resistor R7, as shown in Fig. 3. The correct connection for this resistor is also shown on the schematic.

When you've got the board fully wired, mount the power input terminal-strip and the two coaxial connectors to the chassis. Before putting the board in place, wire the leads to the proper terminals as this will be easier to accomplish before the board is put in place.

Now check the board once again, then set it, component side down, foil side up, on the stand-offs and fix it in place with the two screws. Place the cover in position and fasten it with sheet metal screws.

To install the unit, connect a short length of coaxial cable from the transceiver to the preamplifier, then connect the transceiver's antenna to the other end. The unit requires a switched source of 12-volts DC. The best place to pick this up in a mobile rig is to connect the red, or positive lead, to the hot side of the switch on your transceiver's volume control. In this way, the preamplifier will be on only when the transceiver is turned on. The black lead can be connected to any convenient ground.

There are several means for mounting that are available for consideration. If your transceiver has its antenna connector on one side, a right-angle coaxial connector can be used to connect the preamplifier and support it at the same time, concealing it behind the transceiver. If you prefer, or if this is not available to you, try to locate a couple of sheet metal screws on the back of your transceiver and use these to mount the preamplifier.

Remember too, that you are effectively adding length to your transmission line, and it's a good idea to check the VSWR after installation. **R-E**

Police to get radios, funding for highway safety program

A new program, National Emergency Aid Radio (NEAR), will make Federal Highway Safety funds available for the purchase of radios for installation in state police base stations, highway patrol cars and other state agency vehicles. Volunteer CB emergency groups are to be included in the program if federal funding is to be made available. However, no funding is to be made to volunteer groups.

Besides the purchase of equipment, existing Highway Safety funds may be applied, under the program, for planning and organizing, training and training material, public information and education, and statistical data gathering and evaluation, including operating costs, expenses and staff.

This new program of the U.S. Department of Transportation has been warmly welcomed by the organized CB'ers. REACT (*R*adio *E*mergency *A*ssociated *C*itizens *T*eams), possibly the largest of the emergency-oriented CB associations with over 1,500 affiliated local volunteer emergency teams, states: "We foresee this cooperation as strengthening the role of local REACT teams."

Since the states will be required to include public service groups in the planning of the program and its implementation, and REACT is a national volunteer organization closely meeting the requirements of the NEAR program, organization spokesmen feel that cooperation between the two will ease and accelerate the process of setting up an efficient system. "The development of State councils of REACT teams in over half the states provides a direct representative input to the state NEAR organization," REACT says.

Microprocessor courses offered by National Semiconductor

Courses in Microprocessor Fundamentals will be given at National Semiconductor's Western Microprocessor Training Center, 1333 Lawrence Expressway, Santa Clara, CA, June 6–9. A course in Advanced Programming will be given May 9–12.

Courses in the application of National's PACE microprocessor will be offered at the Center, June 13–16. SC/MP (*S*imple, *C*ost-effective *M*icro*P*rocessor) application courses will be given May 2–5 and June 20–23. Class hours are 10 am to 5 pm.

The fee for the four-day courses is $395. Registration information is obtainable from local National Semiconductor sales offices or from National's Western Microprocessor Training Center in Santa Clara, CA, (408) 247-7924.

TV games *vs* tube damage

A suggestion that some TV games could be harmful to the picture tubes of TV sets was hotly challenged by Gary Blondefield, marketing manager for National Semiconductor's game components, at least insofar as his products are concerned.

National's *Adversary* game, now in volume production, uses the MM57100 video game circuit and the LM1889 TV modulator circuit. Mr. Blondefield stated that these combine to form a sophisticated computer-like system that provides a consistent video presentation when the television set is changed from the broadcast TV signal to the signal generated by the game. The presentation is so consistent, Mr. Blondefield stated, that none of the controls on the set need to be changed when switching from one signal to the other. "If the set is adjusted to receive a good-quality broadcast signal, the game colors and intensities will also be very good," he said. **R-E**

1979 WORLD RADIO CONFERENCE

How It Will Affect You

The World Administrative Radio Conference will convene in Geneva in 1979 to discuss possible changes in the allocation of the entire radio spectrum—including the hobby services. Any action taken could directly affect hams, CB'ers and broadcasters.

STANLEY LEINWOLL

ON SEPTEMBER 24, 1979, WHAT MAY BE THE most important radio conference ever held is scheduled to begin in Geneva, Switzerland. The World Administrative Radio Conference (WARC-79) will be convened by the International Telecommunication Union (ITU) and will meet for ten weeks to review and revise the provisions of the Radio Regulations dealing with the allocation of frequency bands for the entire radio spectrum, from 10 kHz to 40,000 MHz, and beyond.

The last international conference to deal with the electromagnetic spectrum on so broad a scope took place in 1947, and it is likely that WARC-79 will be the last conference of the twentieth century with the authority to change frequency allocations so extensively.

During those momentous ten weeks every service using radio waves will come under scrutiny by the conference delegates, who will represent some 150 countries. Although more than two years remain before WARC-79, extensive preparations for this vital conference have been under way in many countries. Here in the United States, preparatory work began in late 1975, and will continue into 1979.

It now appears that WARC-79 will make extensive revisions affecting all or most services using the electromagnetic spectrum, including the hobby services, international broadcasting, amateur radio, and possibly Citizens Band (CB) radio. Since the changes involving these services could be significant, the remainder of this article will attempt to assess the nature of possible WARC-79 action, and the impact it could have on these services.

Current allocations

Table I shows how short-wave frequencies in the 3 to 30 MHz range are allocated under current regulations. Twelve different services are assigned groups of frequencies in various regions of the short-wave spectrum to permit selection of optimum frequencies for different propagation conditions. (For example, during periods of darkness, lower frequencies are more commonly used than during daylight hours; frequency requirements also change from season to season, as well as over an 11-year sunspot cycle.)

It can be seen from Table I that in the Western Hemisphere, a total bandwidth of 2150 kHz is allocated solely to international broadcasting. Radio amateurs have been assigned a bandwidth of 2800 kHz exclusively, and another 500 kHz on a shared basis. Some of the shared bands are allocated to two or more services simultaneously. One notable example of such sharing involves the 7-MHz (41-meter) band, which is used by broadcasters in Europe, Africa and Asia, and amateurs in North and South America. The 400 kHz used by CB'ers is

TABLE I—ALLOCATIONS of the high-frequency spectrum. Radio Regulations, Geneva, 1959.

	Radio Service	Total Bandwidth Allocated Exclusively (kHz)*	Total Bandwidth Allocated on a Shared Basis (kHz)*
1.	Fixed	10,173	6147†
2.	Maritime Mobile	3850	
3.	Aeronautical Mobile (R)	1105	150
4.	Aeronautical Mobile (OR)	695	150
5.	Land Mobile		1985
6a.	Mobile (except aeronautical mobile)		2907
6b.	Mobile (including aeronautical mobile)		800
7.	Broadcasting	2150	
8.	Tropical Broadcasting		500
9.	Amateur	2800	500
10.	Standard Frequency	50	30
11.	Meteorological Aids		500
12.	Space and Earth-Space		30

* Allocations are for Region 2 (Western Hemisphere). Allocations for Region 1 (Europe, Asiatic U.S.S.R., the Near East, Africa) and Region 3 (Central and South Asia, Australia) are slightly but not significantly different.

† Aeronautical fixed circuits can be assigned within the fixed bands. In addition, 300 kHz has been specifically allocated to aeronautical fixed circuits on a shared basis with other services.

actually part of the spectrum allocated to the fixed and mobile services, and assigned by the FCC to CB radio.

International broadcasting

Of all the services using the short-wave spectrum, international broadcasting is in the most difficulty at present. Over 80 countries operate more than 1,500 transmitters carrying broadcasts to an estimated quarter of a billion listeners. Currently, more than 22,000 frequency-hours are scheduled daily in the seven bands allocated between 5950 and 26,100 kHz.

The amount of spectrum allocated to broadcasting can handle about half the assignments on the air today. The situation is even worse than that because during prime-time listening hours, the spectrum is even more severely overloaded.

This situation has resulted in very serious interference. This can be seen from Fig. 1 which is a spectrum usage chart for the 6-MHz band prepared by technical monitors operating at various locations in central Europe. The frequency in 5 kHz increments is shown on the left and time is shown across the top. Broadcasters using frequencies in the 6-MHz band are indicated by the heavy horizontal lines and are identified in accordance with standard abbreviations.

Inspection of the chart indicates that during peak listening hours in the European area, the 6-MHz band is vastly overloaded. Two broadcasters operating simultaneously on some frequency is commonplace, and the broadcasts are spaced only a few kHz apart. All of these broadcasts reach European receivers, resulting in extensive mutual interference.

Figure 1 is indicative of conditions that exist today throughout much of the world in most of the bands allocated to international short-wave broadcasting. Because the bands are overcrowded, interference levels are intolerably high, and near-chaos exists in many areas of the world. In some parts of the spectrum, there are times when reception comes through as a barrage of meaningless jibberish.

The growth of broadcasting

With the advent of the cold war, many countries recognized that short-wave radio represented the most economical means of reaching great masses of people in most of the world. As the struggle for governmental power increased, even greater emphasis was placed on radio as a means of providing free access to information in totalitarian societies. The Soviet Union, on the other hand, expanded its propaganda efforts and rapidly increased the number of transmitters it had on the air.

As the number of transmitters in use grew and interference levels mushroomed, broadcasters began seeking means of strengthening their services. The most obvious remedy was to use more powerful transmitters and higher-gain antennas. Fifteen years ago there were approximately twenty 250-kW transmitters in operation. Today there are over three-hundred transmitters with power ranging from 250 to 1000 kW.

In many cases, interference levels were so great that even high power was ineffective, and broadcasters, attempting to capitalize on whatever good frequencies they had, began to synchronize transmitters. Some broadcasters presently use as many as three transmitters simultaneously on a single frequency, each beamed in a different direction. Such techniques were made possible through the use of high-gain narrow-beam antenna systems developed after World War II.

These techniques did not help, and in desperation, another solution was found by a number of broadcasters—they moved out-of-band. As indicated previously, the services using the short-wave spectrum are allocated discrete bands of frequencies. Table II shows the bands currently allocated exclusively to international broadcasting.

TABLE II—INTERNATIONAL BROADCASTING frequencies in kHz.

5950—6200
9500—9770
11700—11975
15100—15450
17700—17900
21450—21750
25600—26100

Frequencies outside these bands are not assigned to broadcasting, and any country adhering strictly to the Radio Regulations would not consider use of such frequencies for broadcasting. However, there is a section of the Radio Regulations, Paragraph 115, that allows for the possibility of such use, as follows:

> "Administrations of the Members and Associate Members of the Union shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations given in this Chapter or the other provisions of these Regulations, except on the express condition that harmful interference shall not be caused to services carried on by stations operating in accordance with the provisions of the Convention and of these Regulations."

Paragraph 115 gives countries the right to use *any* frequency in the spectrum for *any* service, provided it does not cause harmful interference to the service operating in accordance with the regulations.

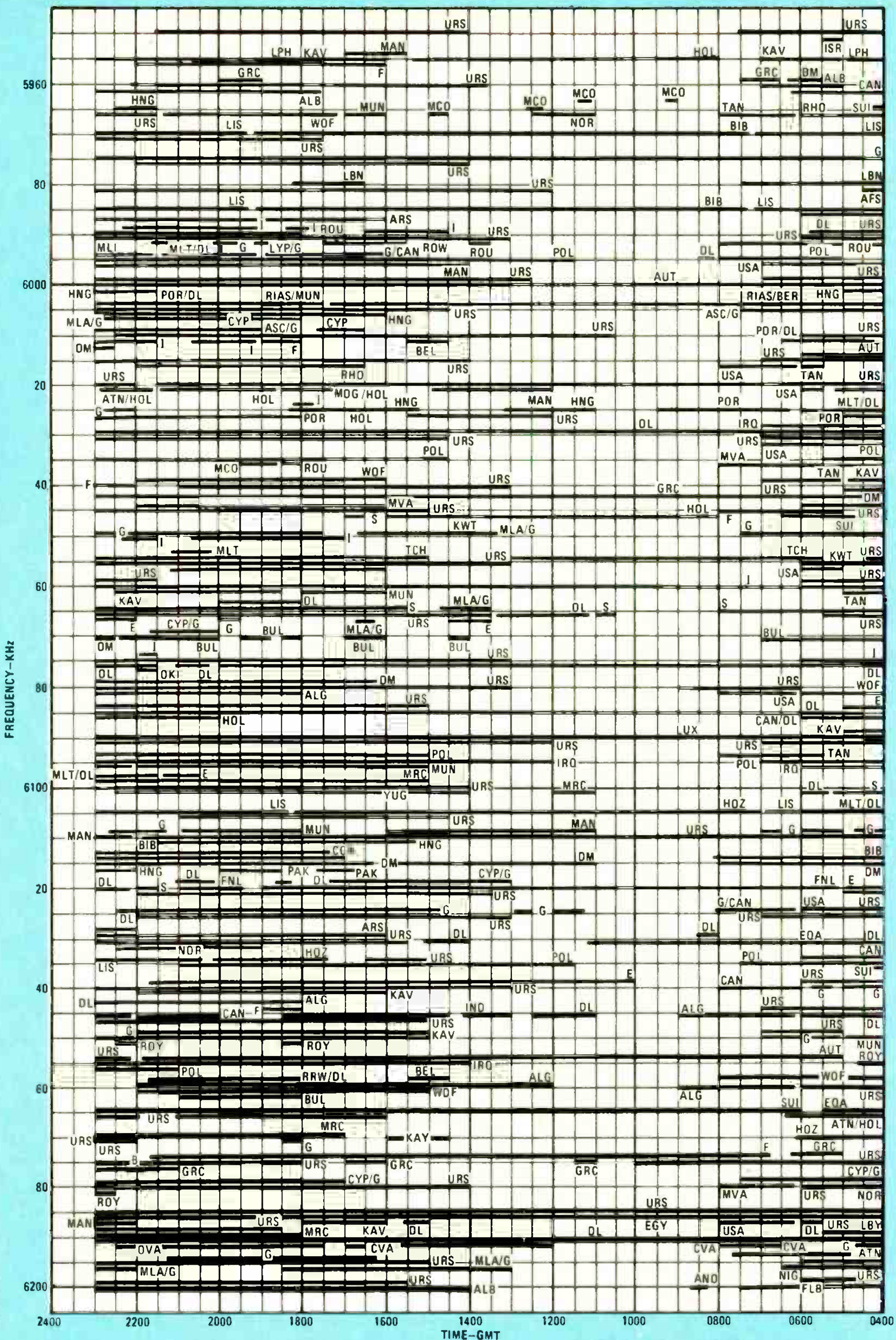
Fortunately, there has been a sharp reduction in the use of frequencies in the fixed services—that is, point-to-point communication via teletype, facsmile, telephone, data, etc. This has come about because of the advent of satellite communications as well as the expanded use of cable facilities to carry traffic generated by the fixed services. RCA Global Communications, Inc., for example, has shut down virtually all of its domestic short-wave plants and has discontinued its high-frequency operations. So, the combination of decreased

BROADCAST NETWORKS

BBC	BRIT. BROADCASTING CORP.		
		G	GREAT BRITAIN
		ASC	ASCENSION ISLAND
		CYP	CYPRUS
		MLA	MALAYA
VOA	VOICE OF AMERICA		
		COL	COLOMBO
		MVA	MONOVIA-LIBERIA
		MAN	MANILA-PHILIPPINES
		MUN	MUNICH
		OKI	OKINAWA
		RHO	RHODES-GREECE
		KAV	KAVALLA
		TAN	TANGER
		WOF	WOOFFERTON
RFE	RADIO FREE EUROPE		
		BIB	BIBLIS
		HOZ	HOLZKIRCHEN
		LIS	LISBON
RLN	RADIO LIBERATION NETWORK		
		BAR	BARCELONA
		LPH	LAMPERTHEIM

COUNTRY SYMBOLS

AFG	AFGHANISTAN
AFS	SOUTH AFRICA
AGL	ANGOLA
ALB	ALBANIA
ALG	ALGER
AND	ANDORRA
ARG	ARGENTINA
ARS	SAUDI ARABIA
ATN	NETHERLANDS ANTILLES
AUS	AUSTRALIA
AUT	AUSTRIA
B	BRAZIL
BEL	BELGIUM
BGD	BANGLADESH
BOL	BOLIVIA
BUL	BULGARIA
CAN	CANADA
CBG	KHMER REPUBLIC
CHL	CHILE
CHN	CHINA-NATIONAL
CHP	PEOPLE'S REP. OF CHINA
CLM	COLOMBIA
CLN	SRI LANKA
CME	CAMEROON
CNR	CANARY ISLANDS
COG	CONGO REPUBLIC
CTI	IVORY COAST
CTR	COSTA RICA
CUB	CUBA
CVA	VATICAN STATE
CYP	CYPRUS
DAH	DAHOMEY
DL	GERMANY-WEST
DM	GERMANY-EAST
DNK	DENMARK
DOM	DOMINICAN REPUBLIC
E	SPAIN
EGY	EGYPT
EQA	ECUADOR
ETH	ETHIOPIA
F	FRANCE
FNL	FINLAND
G	GREAT BRITAIN
GAB	GABON
GHA	GHANA
GRC	GREECE
GRL	GREENLAND
GTM	GUATEMALA
GUI	GUINEA
HNG	HUNGARY
HOL	NETHERLANDS
HTI	HAITI
I	ITALY
IND	INDIA
INS	INDONESIA
IOB	GRENADA
IRN	IRAN
IRQ	IRAQ
ISL	ICELAND
ISR	ISRAEL
J	JAPAN
JOR	JORDAN
KOR	KOREA-SOUTH
KRE	KOREA-NORTH
KWT	KUWAIT
LBN	LEBANON
LBR	LIBERIA
LBY	LIBYA
LUX	LUXEMBOURG
MCO	MONACO
MDG	MALAGASY REPUBLIC
MEX	MEXICO
MLA	MALAYSIA
MLI	MALI
MLT	MALTA
MNG	MONGOLIAN PEOPLE'S REPUBLIC
MOZ	MOZAMBIQUE
MRC	MOROCCO
NCG	NICARAGUA
NIG	NIGERIA
NOR	NORWAY
NZL	NEW ZEALAND
OCE	TAHITI



COUNTRY SYMBOLS (CON'T)

PAK	PAKISTAN
PHL	PHILIPPINES
POL	POLAND
POR	PORTUGAL
PRG	PARAGUAY
PRU	PERU
QAT	QATAR
ROU	RUMANIA
RRW	RWANDA
S	SWEDEN
SDN	SUDAN
SEN	SENEGAL
SEY	SEYCHELLES
SLV	EL SALVADOR
SNG	SINGAPORE
SOM	SOMALIA
SUI	SWITZERLAND
SWN	SWAN ISLAND
SYR	SYRIA
TCH	CZECHOSLOVAKIA
TGK	TANZANIA

COUNTRY SYMBOLS (CON'T)

TGO	TOGO
THA	THAILAND
TUN	TUNISIA
TUR	TURKEY
URG	URUGUAY
UAE	UNITED ARAB EMIRATES
URS	USSR
USA	UNITED STATES OF AMERICA
VEN	VENEZUELA
VTN	VIETNAM
YEM	YEMEN
YMS	PEOPLE'S REPUBLIC OF SOUTH YEMEN
YUG	YUGOSLAVIA
ZAI	ZAIRE
ZMB	ZAMBIA
AOE	SAHARA (SPANISH)
SRL	SIERRA LEONE
SWZ	SWAZILAND

FIG. 1—SPECTRUM USAGE CHART for 6-MHz international broadcasting band for the winter 1976 period.

use of the fixed bands, and Paragraph 115, gave broadcasters entrance into what would have been forbidden territory.

Broadcasters have been quick to fill the spectrum void as other services vacated it. At present, the number of broadcasters moving into bands allocated to other services is increasing rapidly, although many countries such as the Federal Republic of Germany and Portugal, for example, have interpreted the Radio Regulations more rigidly, and have refused to permit operation in bands other than those specifically allocated to broadcasting. At present, the United States operates only in-band.

For these countries, in-band interference continues to be severe, and the only hope for improving their services is for a formal expansion of the bands allocated to international broadcasting by WARC-79. What are the prospects for such an expansion? They appear to be good.

TABLE III—CURRENT ALLOCATIONS, needed allocations and a prediction of what is to come out of WARC-79.

Present (kHz)	Needed (kHz)	WARC-79 Projection (kHz)
5950—6200	5750—6200	5750—6200
	7300—7700	7100—7500
9500—9770	9400—9900	9400—9800
11,700—11,975	11,500—12,000	11,600—12,000
	13,600—14,000	
15,100—15,450	15,050—15,700	15,050—15,600
17,700—17,900	17,500—18,000	17,600—18,000
21,450—21,750	21,450—21,850	21,450—21,850
25,600—26,100	25,600—26,100	25,600—26,100

TABLE IV—AMATEUR RADIO ALLOCATIONS requested by ARRL and current allocations.

Worldwide Allocations Requested by ARRL for WARC-79 (in kHZ)	Actual Allocations to Amateur Radio, U.S. (in kHz)
3500—4000	3500—4000
7000—7500	7000—7300
10,100—10,600	
14,000—14,500	14,000—14,350
18,100—18,600	
21,000—21,500	21,000—21,450
24,000—24,500	
28,000—29,700	28,000—29,700

The outlook

There appears to be universal acceptance of the fact that the short-wave broadcasting bands are severely congested, and that at the same time point-to-point use of the fixed bands is decreasing. The principal resistance to this concept comes from military representatives, who claim that even though satellite and other modern methods of long-range communication have largely replaced the need for high-frequency circuits, the frequencies are nevertheless required for use in emergency situations. Defending this position will be difficult. Extensive monitoring operations in the fixed bands to determine usage is now under way. It is showing that large portions of these vitally needed bands are either now in use by broadcasters, or lying dormant, unused by anyone. In light of this, many broadcasters have begun to contact, educate, and work for support among other non-committed countries for expansion of the bands at WARC-79.

It is reasonable to expect that WARC-79 will expand the bands by approximately 50%. This will *not solve* the problem, but it will *remedy* it. Hopefully, WARC-79 will also provide for the broadcasters to continue to move into the spectrum allocated to the fixed services, as the role of satellites continues to increase in the future. This could be done by continuing Paragraph 115 and by allocating the space immediately adjacent to the broadcast bands to services that are most likely to benefit from expanded availability of satellites and cables.

Table III repeats what is currently allocated, and indicates what is needed to improve the broadcasters situation, as well as a prediction of what is apt to come out of WARC-79 for international broadcasting. The table lists only the bands that are shared, such as 80 and 41 meters. A new broadcasting band in the region between 13,600 and 14,000 kHz is proposed because the spread between the 11- and 15-MHz bands is too great to permit smooth operational transition during sunrise and sunset periods.

Amateur radio

Amateur radio has its own severe congestion problems. The number of amateurs now operating in the United States is close to 300,000, and growing. In the short-wave portion of the spectrum, the amateurs have only five bands (80, 40, 20, 15, and 10 meters), and during certain periods interference levels are extremely high. It is obvious that relief would be most welcome.

The American Radio Relay League, the official amateur organization in this country, has requested new allocations at WARC-79. These requests as well as the present amateur allocations in the U.S. are listed in Table IV.

If the allocations requested by the ARRL are approved, the total bandwidth for the amateur service will be over 5 MHz, or approximately 19% of the entire short-wave spectrum. Although this appears high, it must be remembered that the requested space will have to serve the group for the remainder of the 20th century. Many people believe that as more sophisticated methods of communication become available (including higher capacity satellites), decreasing use of the short-wave spectrum will occur by all services other than broadcasting—amateurs and CB'ers. In light of this, the request for over 5 MHz of spectrum does not appear unreasonable.

Current sentiment appears to be running against the amateurs. This is unfortunate, because the list of accomplishments to the radio art by this group can fill a book, and its contributions include pioneering discoveries, training much needed technical manpower, and untiring and dedicated service to humanity during times of great disasters.

There are two serious problems, however, that the amateurs must overcome to protect their interests. First, the number of amateurs varies significantly from country to country. The bulk of the world's amateurs are in only two countries, the United States and Japan. In many countries the number of amateurs is in the tens or hundreds, and many foreigners have called amateur radio an American hobby. Consequently, considerable anti-amateur sentiment has been developing, particularly among Third-World countries.

The United States, long a staunch supporter of amateur radio, will have only one vote at WARC-79. Although it will have the right to reserve—that is, refuse any part of the new regulations that are unacceptable—its influence will be limited. As a result, amateur radio could be dealt a severe blow if WARC-79 sentiment runs against it.

The second problem facing the amateurs is more restricted, dealing with the 41-meter band. The band is shared, as we have indicated before, being allocated to amateur radio in this hemi-

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R-E's Service Clinic

Your service shop

How does it rate?

JACK DARR
SERVICE EDITOR

HERE'S A DO-IT-YOURSELF TEST FOR FINDing out just how smart you really are (without letting anyone else know, even your wife). It has nothing to do with your competence as an electronics technician; that is taken for granted. The test tells you how *efficient* you are—how much you get out of each hour in your working day. If you're a one-man-gang, like so many of us, you're the only producer on the force. So, if you want to get the best results, your efficiency rating must be high. Anything that reduces your efficiency reduces your output and your income.

Efficiency involves nothing but good common sense. Like all other successful processes, it was worked out over a period of a good many years by trial and error. In other words, I learned all about this by first doing it wrong and then finding out how to do it right. In many cases, I had to try quite a few wrong ways before I found one that worked much better. As far as I know, I have made all of the possible mistakes. If I left out any, let me know and I'll try them too. This evaluation will work with electronics shops from the one-man shop on up. I can guarantee one thing from several years of experience in finally doing it right: it *will* work and it will make life easier.

To begin take a close look at the working area—the bench. Are all of the necessary and frequently-used test instruments set up so that you can reach them easily, read them and use them? If the answer is yes, add 10 points. If the answer is no—if you have to get up and move to reach an instrument used often—take off 10 points.

Now how about your most frequently used hand-tools? Are they placed on the bench where you can get them quickly when needed? Yes? Add another 10 points. If you have to move to get them, or dig them up where you dropped them after the last job, deduct 10 points. In the same category, how about the special tools? For one very good example, where's that extra long Spintite wrench you need to get the tuner out of certain TV sets very quickly? There are several of these. If you don't have any of them, take off another 10; if you do, and have them where they can be gotten quickly, add 10.

How about service data? Check the bench and the rest of the shop. Are your Sams *Photofact* folders all over the place? If you find them lying on the bench and the set for which they were pulled has been delivered some time ago, take off 10 points for each one. This applies to factory and all other data. If all data folders are properly filed except those on sets currently being worked on, add 10.

Still on the bench: Are there any repair parts *stored* on the bench, where access to them can be blocked by sets being repaired? If so, take off 10 points. If the parts are neatly stored on the side of the shop opposite the bench, where you can get them by just turning around, add 10.

Staying with the parts stock for a while, do you have a full stock (say at least two each) of all stock EIA values of resistors and capacitors filed by size and working voltage, wattage, and so on in cabinets so that you can find the size you need in the least possible time? This applies to resistors and capacitors, but could be used for tubes and transistors as well. If you do, add 10 points. If your stock is incomplete, so that you have to stop work and run all over town to find a 0.0039 μF capacitor, take off 25 points. (That'll teach you to keep up a good working stock.)

Now back to the bench itself. If this is at least 20-feet long, how many sets (radio or TV, etc.) are on it at the present? If the bench is at least 20-feet long, and it is set up so that all the test equipment used for TV is at one work-position, and the test equipment used for radio, audio, etc., is at another, add 25 points. Now comes a stinger.

How many of the sets on the bench are being worked on? If there are only two, add another 25 points. If there are *any* sets on the working surface that are waiting for parts, take off 50 points. Check to see how long each one has been there; take off 10 points for each day. All units waiting for parts should be taken out of the work area, plainly tagged, and stored in a special place. While you're at it, check the tags. If all sets in the shop have plainly written tags, with all the necessary information, add 25 points. If there are any sets without tags of any kind, take off 25 for each one.

Now let's check the overall layout of

This column is for the service technician's problems—TV, radio, audio or industrial electronics. We answer all questions submitted by service technicians on their letterheads individually, by mail, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. If return postage is not included we cannot process your question. Write: Service Editor, Radio-Electronics, 200 Park Avenue South, New York, NY 10003

the shop. If you have a work area that includes the bench, parts and service-data storage; plus two storage areas (one for incoming sets and the other for finished jobs waiting for delivery) and a smaller area for sets awaiting parts, add 100 points.

Check the "in-shop mobility" of the work. If each set is on a wheeled cart of the same height as the bench so that one man can move it easily from storage area to work area, add another 50 points. If sets are stacked on top of each other, or chassis laid out on the floor, take off 25 points. (That should be a −50 pointer, but I'm beginning to feel sorry for you.)

One more little but handy one. If each set being worked on or awaiting parts has all of the knobs, bolts, loose parts and defective parts removed and neatly stored in a small box with the set, add 20 points. If parts are scattered on the bench, take off 20; and if parts are on the floor, take off 30.

Finally, check the record-keeping system. If your shop tags are designed so that you can get all of the data you need from them instantly, without a lot of scratch-paper bits and pieces, add another 50 points. Finished jobs awaiting pickup or delivery should have the job ticket filled out with the price, labor done, parts replaced and everything else pertaining to that job.

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SERVICE CLINIC
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Here's one more. If you have a habit of getting into long discussions with customers (or friends or passers-by, etc.) and spending half an hour or more telling jokes, discussing competitors, tough-dog service jobs, the state of the economy, etc., etc., take off 100 points! Save this for service meetings and coffee-breaks.

These are simple things. It does not take up much time to set up your shop so that you get the maximum return from the time you spend in it. It does take quite a lot of will-power. I can vouch for this personally. It's so easy to be sloppy. However, an efficient shop is a heck of a lot easier to work in, and you'll get a much greater return for the *time* you spend on each job. When you find an area where efficiency can be improved, do it; stop and fix it just as if it was a flat tire (which it is, when you think of it).

The plus and minus "points" are more of a gag than anything else. However, if you will give your shop this test and keep a scratch pad score, it can help. If you come out with a pretty good score on the plus side, good for you. If you come out with a score that is all on the minus side, boy are you sloppy!

Be just as honest in evaluating yourself as you are in analyzing a case of TV trouble. It'll pay off in increased income, reputation and customer satisfaction. (They get their sets back faster.) **R-E**

reader questions

TRANSISTOR VOLTAGES

After an arc in the focus circuit of this solid-state set, I'm having a lot of other problems. There is a raster, but it's blank. The collector voltage on the first video amplifier is zero and the DC voltages on the AGC transistors are all the same. My ohmmeter shows a good junction on all of them. The DC voltage on both sides of the video detector are also the same.—B.C., Thurmont, MD.

After an arc, you can have all kinds of problems in solid-state circuitry, often in places far from the location of the arc. Here are some hints: A transistor, like your first video transistor, with the collector going to ground through a resistor, should have some DC voltage if it is conducting. No voltage and the transistor is cut off or open.

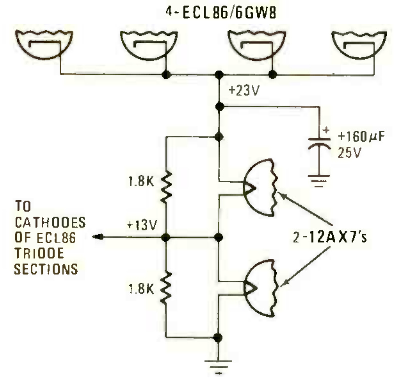
DC voltages the same on all three elements of a transistor usually means that it is shorted; you may be reading the junction of the gate diode that is shunted across it—same for the video detector diode. The cure is the same for all; take them OUT of the circuit and repeat the checks.

12AX7 TUBES BLOW OUT

The owner brought this Pilot 610 amplifier in saying that he'd replaced both 12AX7 driver tubes. Within a few minutes, the new tubes flashed up and went out. These tubes use a DC heater voltage. I checked the circuitry; it didn't seem that the voltage went up, it actually dropped a little. This problem is in both the left- and right-channel driver tubes. I don't understand it. Any advice would be appreciated.—R.Z., Glenside, PA.

To put it mildly, this is an odd circuit. The use of DC heater voltages on preamp and driver tubes to avoid hum isn't uncommon, but this is the first time I've ever seen them get this DC voltage from the cathode circuit of the output tubes. (See diagram.) Never afraid to make obvious statements, I'd say that the reason for the burnout was that too much current was being drawn through the tubes. Since the source of this current is the (common) cathodes of the ECL86 tubes, I would check the bias voltages on them as well as checking all four of the output tubes for possible internal shorts.

There are two 1800-ohm resistors shunted across the 12AX7 heaters. Be sure that these are OK. It would be a very good idea to break this circuit and hook in a DC milliammeter (on the 0–1000 mA scale). Now plug the amplifier into a variable-voltage transformer and bring the line voltage up slowly. Normal



current for the 12AX7 heaters is 150 mA. Since they are in series, the current would be the same in each. Watch the current; if it goes above 150 mA with the line voltage well below normal, the fault is still there.

Incidentally, the Mullard data sheet shows the ECL86 as a 9-watt output type. Maximum plate currents for both sections is only 42.7 mA. They are being pushed pretty hard with +320 volts on the plate and screen; this might have caused an internal short. **R-E**

WARC-79
continued from page 80

sphere, and to broadcasting in Europe, Asia, and Africa. Many European communicators with whom I have spoken feel that 41 meters should be allocated exclusively to broadcasting on a worldwide basis, and they can be expected to fight to accomplish this at WARC-79. As previously indicated, the United States could reserve on such an act, but the best that could be hoped for would be continued amateur use in this country but with increasing levels of interference as Europeans use 41-meter frequencies to transmit to the Americas. Hopefully, a compromise solution can be found, in which both the broadcasters and amateurs are assigned 41-meter channels exclusively, at the expense of the fixed services. Such an arrangement could result in the assignment of 6800–7300 kHz to the broadcasters, as an example.

In addition to expanded and exclusive use of 41 meters, the amateurs are asking for three new bands—10, 18, and 24 MHz—to accommodate their growing needs. This request is certain to bring the requirements of the broadcasters, with an estimated quarter of a billion listeners worldwide, into conflict with those of the less than one million amateurs in the world.

Amateurs and CB'ers

The United States will strongly support amateur radio at WARC-79. In addition to the great contributions made by the group, economic and political considerations are also a factor. The electronics industry provides equipment and supplies for some 300,000 American hams, giving this industry a substantial boost. The amateurs in this country are well organized and represent a significant voting bloc—factors that assure continued U.S. support of the group.

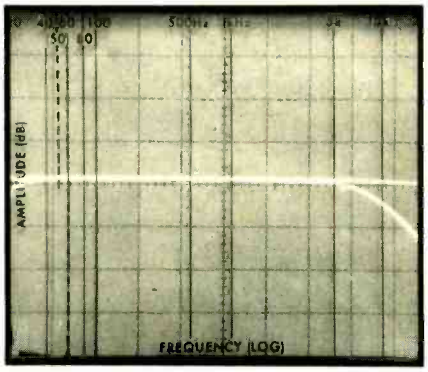
Although the survival of amateur radio is not at stake, there appears to be little likelihood that the amateurs will obtain any additional spectrum space. Furthermore, the loss of the 41-meter band is a possibility, and this is a contingency the amateurs will have to be prepared to cope with in Geneva.

On the other hand, Citizens-band radio is safe and will not be affected by WARC-79, unless the portion of the band (26 and 27 MHz) currently allocated to the fixed and mobile services are unexpectedly reassigned. This is highly improbable. Furthermore, the manner in which CB radio has mushroomed has made it a major economic and political factor, even more so than amateur radio. It seems inconceivable, therefore, that the frequencies currently allocated by the FCC to CB radio will be affected by WARC-79. **R-E**

R-E TESTS HEATH

continued from page 59

medium output cartridges would ever deliver greater transient peaks than 100 mV even when playing highly modulated discs and so this does not constitute a limitation in performance. On the other hand, it was virtually impossible to overload the high-level input stages of the unit as we ran out of voltage from our signal source at an input level of 10 volts with still no evidence of first-stage



4

distortion. The subsonic filter action is barely visible in our spectrum analyzer scope photo of Fig. 4 (sweep extends from 20 Hz to 20 kHz whereas the subsonic filter has a −3-dB point of 15 Hz). However, the action of the high-cut filter is clearly visible and is seen to have the 12 dB-per-octave slope and the 7-kHz rolloff or −3-dB point, as claimed. The −70-dB signal-to-noise ratio in phono is referred to the actual input sensitivity of 2.0 mV and is an unweighted measurement—not as high as measured for some of the new superpriced preamplifiers but high enough so that record listening is not marred by audible noise, or hum.

Our overall product analysis and summary comments for the Heath *model AP-1615* are contained in Table II. Whether you choose to build a matching power amplifier from Heath (they suggest their *model AA-1640*, a powerful 200 watt-per-channel unit that sells in kit form for $449.95 less meters, $499.95 with power meters) or plan to use any other high-quality ready-made power amplifier, the Heath *model AP-1615* is certainly worth its modest price—even if you figure in your own labor rate. **R-E**

new products

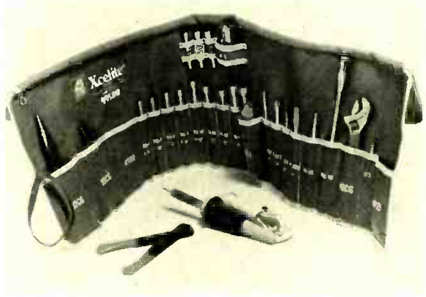
More information on new products is available from the manufacturers of items identified by a Free Information number. Free Information Card follows page 98.

DIGITAL MULTIMETER, *model LM-40,* is a full 4-digit DMM. Sensitivity for DC and AC volts is as great as 100 mV, and for resistance, sensi-

tivity is 100 milliohms. DC voltage accuracy is 0.1%. AC and DC voltage ranges of 1, 10, 100 and 1000 volts are provided. Resistance ranges include 1, 10, 100, 1000 and 10,000 kilohms. Fuseless protection on ohms and optional current shunts are available for AC and DC current measurements providing ranges of 0.1, 1, 10, 100, 1000 and 2000 milliamperes. The instrument comes complete with test leads, rechargeable batteries and a charger, and features automatic zeroing. The unit measures 1.9 × 2.7 × 4 inches. Power consumption is less than 3 watts. Priced at $190.00.—**Non-Linear Systems, Inc.,** P.O. Box N, Del Mar, CA 92014.

CIRCLE 76 ON FREE INFORMATION CARD

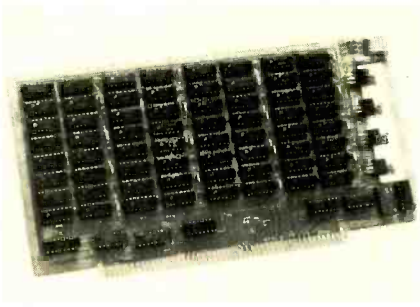
SERVICE KIT, *model 99SMW,* is a 26-piece tool kit for electronics technicians, featuring a wire stripper/cutter and 25-watt soldering iron. The tool set fits into a roll-up, plastic-coated canvas case and also includes long nose and diagonal cutting pliers, adjustable wrench, and an assortment of the *Series 99* quick-change regular and stubby blade screw and nut drivers, plus both



regular and stubby handles, extension blade and reamer.—**Weller-Xcelite Electronics Div.,** The Cooper Group, Apex, NC 27502.

CIRCLE 77 ON FREE INFORMATION CARD

8K STATIC MEMORY BOARD. Altair and Imsai compatable. Access time of 500 ns maximum. Current required, less than 200 mA/1024 words maximum. Memory chip is AMD 91L02 APC or equivalent. Voltage supply: +5 volts to +10 volts. Address select: DIP switch accessable from top of board—no need to remove board to relocate. Power regulators: 4 each 7805. Wait states: none. CPU runs at maximum speed.



Buffered address and data out lines buffer disable line for transparent loader. Priced at $239.00 for kit; $335.00 assembled.—**Vector Graphic Inc.**, P.O. Box 4785, Thousand Oaks, CA 91359.

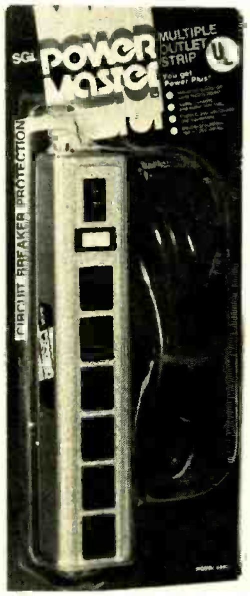
CIRCLE 78 ON FREE INFORMATION CARD

FUNCTION GENERATOR, *model 12*, has external frequency control VCO, DC to 1 MHz.

Remote frequency-shift keying, frequency modulation, remote tone bursts, simultaneous sine, triangle and squarewaves. Has a selectable function output—continuously adjustable amplitude and DC offset. 1 Hz to 1 MHz. Priced at $79.95 for the kit and $124.95 for wired.—**A E Corp.**, 65 Wellesley Ave., Needham, MA 02194.

CIRCLE 91 ON FREE INFORMATION CARD

ELECTRICAL OUTLET STRIP, *SGL Power Master*, instantly multiplies the number of available electrical outlets at any given location. Handy

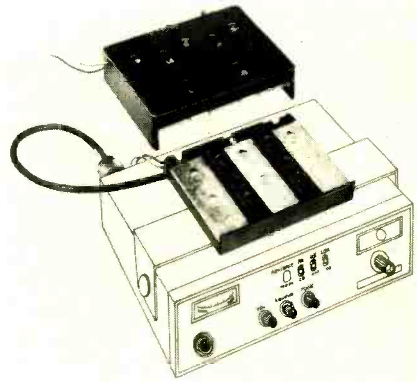


and ready to use; just plug in. Saves hours and effort of wiring a work area. Especially designed for the handyman's workshop, it can be used in any part of the home, apartment or garage.

Available in two lengths and from three to eight outlets, the strip features a 15-ampere circuit breaker that shuts off power on overloads or short circuits. All models include both mechanical and electrical grounding, "U"-grounded outlets, 6-ft 3-wire jacketed power cord and a 15-amp, 125-volt rating. Most models available with master switch and pilot light.—**SGL Waber Electric,** 330 Harvard Ave., Westville, NJ 08093.

CIRCLE 80 ON FREE INFORMATION CARD

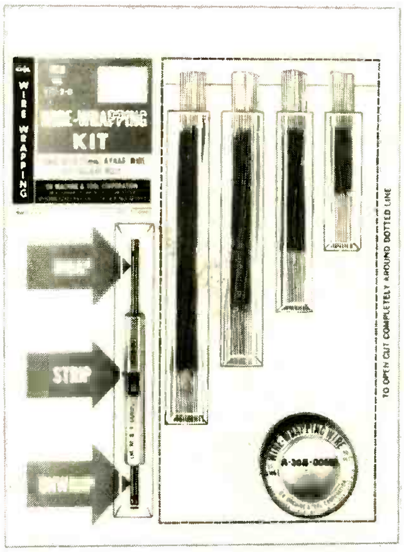
MAGNETIC CB RADIO MOUNT is especially designed for two-way communications equipment. The *"Easy Mount"* uses three permanent magnets to make positive contact, assuring maximum signal transfer with perfect VSWR match. The unit can be installed under the dash or on the transmission hump. All necessary hardware and instructions are included. Additional optional top sections permit the user to transfer the transceiver from vehicle to vehicle or to a boat, trailer, office, or home. Weight, 1.25 pounds; Profile, 1 1/8 inch; Mounting Area, 4 3/8



inches wide by 3¼ inches deep.—**Cornell-Dubilier Electronics**, 150 Avenue L, Newark, NJ 07101.

CIRCLE 79 ON FREE INFORMATION CARD

WIRE-WRAPPING KIT, *model WK-2-B*, includes wire-wrapping tool *WSU-30* that wraps and unwraps 30 AWG wire on .025-inch square pins,



it also strips AWG wire, using handy built-in stripper. The wire is insulated silver-plated copper. Supplied in the kit are a 50-foot roll plus precut and stripped wire in insulated lengths from 1 to 4 inches, stripped 1 inch on each end. Available with blue wire as *model WK-2B*, white wire as *WK-2W*, yellow wire as *WK-2Y*, and red wire as *WK-2R*.—**OK Machine and Tool Corp.,** 3455 Conner Street, Bronx, NY 10475.

CIRCLE 82 ON FREE INFORMATION CARD

CB/RF GENERATOR, *model 256*, is designed for 40-channel transceivers. Five-band frequency tuning covers Channels 1 through 40 on an expanded tuning range for easy, precise channel selection. Frequencies of 100 kHz through 16 MHz are covered on the other four bands to provide all IF requirements including: 455 kHz, 10.7 MHz, and any other, current or future. A calibrated/attenuated output control provides RF signal output of 100,000 μV down to less than 1 μV for receiver sensitivity checks. The attenuated output is variable in 20-dB steps and by a 20-dB continuously-variable control calibrated in microvolts. Internal modulation at a

frequency of 1 kHz is variable from 0 to 100%, calibrated at 30%. Priced at $199.00—**Hickok Electrical Instrument Co.,** 10514 Dupont Ave., Cleveland, OH 44108.

CIRCLE 83 ON FREE INFORMATION CARD

new lit

More information on new lit is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 98

ELECTRONICS CATALOG, 148-page illustrated catalog is specially tailored for the radio/TV service technician, electronic technician, CB user and hobbyist. Included are test equipment, CB equipment, tools, service and repair kits, tubes, phono cartridges and needles, speakers and microphones, antennas, components and many other servicing aids. Free copies of the catalog are available on request.—**Fordham Radio Supply Co.,** 855R Conklin St., Farmingdale, NY 11735

CIRCLE 85 ON FREE INFORMATION CARD

AR GUIDE TO LOUDSPEAKERS, 36-page book describing manufacturer's line of speakers, including the *AR-10π, AR-11, AR-12, AR-14,* and *AR-16.* In addition, the booklet describes AR's philosophy of music reproduction and explains what goes into the design, production and testing of these features. It is available for $1.00 from the manufacturer, or free from AR dealers. The dealers' list will be sent free on request.—**Acoustic Research,** 10 American Dr., Norwood, MA 02062

CIRCLE 86 ON FREE INFORMATION CARD

HEATH COLOR TV

continued from page 51

generator to issue signals to change the channel, defeat the automatic fine tuning, activate the squelch circuitry and activate the on-screen display for displaying the new channel and time.

If the programmed time and actual time are not equal, then the instruction address counter is incremented to the next memory location. The programmed time/channel combination in the second memory location is stored and compared to the actual time.

After the programmed time in all 16 memory locations is compared to the actual time, the time-down counter is decremented so that the BCD data in it represents a time that is one minute earlier than the actual time. The programmed time in all 16 memory locations is compared to the new time in the time-down counter. If equality is detected, the process stops.

The process of decrementing the time-down counter and comparing it to the programmed time continues until equality is detected. When the process stops, the BCD data in the shift registers represent the time that the TV set made the last channel change and the channel to which the change was made. This data is displayed on the TV screen when the MA key is depressed. R-E

LOOKING AHEAD

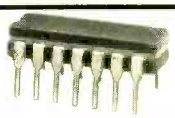
continued from page 4

(1) Sony formally unveiled its new two-hour Betamax (you read about it in last December's **Radio-Electronics**), which gets double the playing time from a standard Betamax cassette (492 feet of half-inch tape). (2) Zenith announced it would put its own-brand home VTR on the market this year, using the new Sony format and, at least initially, buying decks from Sony. (3) The two developers of the V-Cord II format, Sanyo and Toshiba, announced they would switch over to the new Betamax, and both plan to market decks here this year. (4) RCA said it would also offer a home VTR this year, but was silent as to which format it would use.

The new Betamax deck resembles the current one. A one- and two-hour switch permits it to play back tapes recorded in the current one-hour mode, or to record in the one-hour mode if desired. For two-hour recording, tape speed has been cut in half to 0.785 IPS, track width has been halved to 29.2 micrometers and new noise-reduction circuitry has been added that is claimed to make possible the same 250-line color resolution and 45-dB color signal-to-noise ratio as the current model. The net result is a machine that overcomes the earlier model's deficiency of short playing time, and which, in effect, cuts tape costs in half—since a $16 cassette will now record and play for two hours instead of one. **R-E**

SHOP YOUR NEARBY RADIO SHACK FOR QUALITY PARTS AT LOW PRICES!

Top quality devices, fully functional and 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.

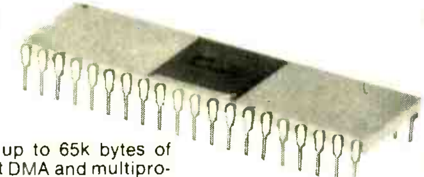


TTL Digital ICs

First Quality Devices Made by National Semiconductor and Motorola

Type	Cat. No.	Reg.	SALE
7400	276-1801	$ 49	29¢
7402	276-1811	$ 49	29¢
7404	276-1802	$ 59	29¢
7406	276-1821	$ .69	39¢
7408	276-1822	$ 49	29¢
7410	276-1807	$ 49	29¢
7413	276-1815	$1 19	69¢
7420	276-1809	$ .49	29¢
7427	276-1823	$ 69	39¢
7432	276-1824	$ 69	39¢
7441	276-1804	$1.59	89¢
7447	276-1805	$1 99	89¢
7448	276-1816	$1 99	89¢
7451	276-1825	$ 49	29¢
7473	276-1803	$ .79	39¢
7474	276-1818	$ 79	39¢
7475	276-1806	$1 19	69¢
7476	276-1813	$ 79	49¢
7485	276-1826	$1.59	99¢
7486	276-1827	$ .69	49¢
7490	276-1808	$1 19	69¢
7492	276-1819	$1 19	69¢
74123	276-1817	$1 69	89¢
74145	276-1828	$1 49	1 19
74150	276-1829	$1 79	1 39
74154	276-1834	$1.79	1 19
74192	276-1831	$1 69	99¢
74193	276-1820	$1 69	99¢
74194	276-1832	$1 69	1 19
74196	276-1833	$1 69	1 19
74C and 4000 Series CMOS ICs			
74C00	276-2301	$ 69	39¢
74C02	276-2302	$ 69	39¢
74C04	276-2303	$ 69	39¢
74C08	276-2305	$ 69	39¢
74C74	276-2310	$1 29	59¢
74C76	276-2312	$1.59	69¢
74C90	276-2315	$2 29	99¢
74C192	276-2321	$2 49	1.29
74C193	276-2322	$2 49	1 29
4001	276-2401	$ 69	39¢
4011	276-2411	$ 69	39¢
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

8080A Microcomputer Chip



Direct Plug-In Replacement for Intel 8080A **17.95**

A CPU 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, and all buses are TTL compatible. Handles up to 244 instructions of variable length, with 6 general purpose registers plus an accumulator. 40-pin DIP. *100% Prime.* **276-2510** **17.95**

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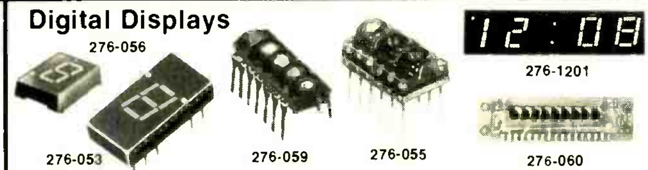
M Red LED	276-026	2/99¢	2/69¢
M Clr LED	276-040	2/99¢	2/69¢
S Red LED	276-042	2/99¢	2/69¢
Infrared Det	276-140	$1 19	
Infrared Em.	276-141	$1 19	
Solar Cell	276-115	$1.49	
Photocell	276-116	$ 99	
FPT 100	276-130	$ 79	

Digital Displays

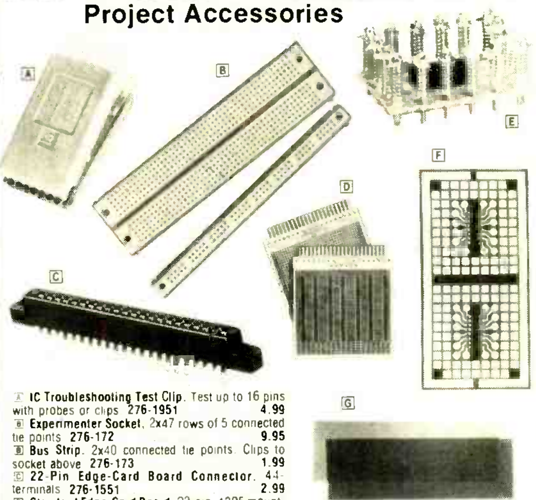


276-056 276-053 276-059 276-055 276-1201 276-060

Digits	Size	Drive	Cat No.	Reg.	SALE
1	0.3"	Anod	276-053	$2.99	1 99
1	0.3"	Cath.	276-062	$2 99	1.99
1	0.3"	Anod	276-1210	4/$8.97	4/6 95
1	0.3"	Cath	276-1211	4/$8 97	4/6.95
1	0.6"	Anod.	276-056	$3.99	2.99
1	0.6"	Cath	276-066	$3 99	2.99

Digits	Size	Drive	Cat No	Reg.	SALE
3	0 120"	Cath	276-055	$1 49	99¢
5	0 110"	Cath	276-059	$1.99	1 49
9	0 150"	Cath	276-060	$2.99	1.99
4	0.5"	Anod.	276-1201	$9.95	7.95
4	0.5"	Cath	276-1202	$9 95	7.95

Project Accessories



A IC Troubleshooting Test Clip. Test up to 16 pins with probes or clips 276-1951 ..... 4.99
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C 22-Pin Edge-Card Board Connector. 44-terminals 276-1551 ..... 2.99
D Standard Edge-Card Board. 22-pin 1295 mounting holes 276-152 ..... 2.99
D 2-Voltage Source Edge-Card Board. 1368 mounting holes 276-154 ..... 2.99
D 3-Voltage Source Edge-Card Board. 1368 mounting holes 276-153 ..... 2.99
E Solderless IC Experimenter Kit. For 8, 14 or 16-pin IC's 277-101 ..... 2.99
F Experimenter's PC Board. Mount 2 IC's, 8, 14 or 16-pin 276-151 ..... 2.49
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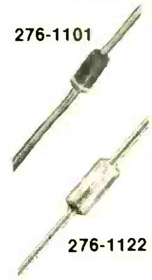
18 Volts (Center Terminal). 4 Amps. Ideal for 5V (using CT) or 12V solid-state regulators 4x2x2½" 273-1514 ..... 8.95

Selected Diodes



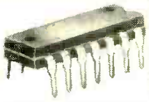
276-1101 276-1122

Type	Cat. No.	Reg.	SALE
1N4001	276-1101	2/$.39	2/29¢
1N4003	276-1102	2/$.59	2/39¢
1N4004	276-1103	2/$.69	2/49¢
1N4005	276-1104	2/$.79	2/59¢
1N4735	276-561	2/$.89	2/69¢
1N4739	276-562	2/$.89	2/69¢
1N4742	276-563	2/$.89	2/69¢
1N4744	276-564	2/$ 89	2/69¢
1N5401	276-1141	2/$.69	2/59¢
1N5402	276-1142	2/$.89	2/69¢
1N5403	276-1143	2/$.99	2/79¢
1N5404	276-1144	2/$1.19	2/89¢
1N914/4148	276-1122		10/99¢

SCRs and Triacs

Device	Rating	Cat. No.	Reg.	SALE
SCR	50V, 6A	276-1089	$ .99	69¢
SCR	100V, 6A	276-1090	$1.29	79¢
SCR	200V, 6A	276-1067	$1.39	89¢
SCR	400V, 6A	276-1020	$1.49	99¢
Triac	50V, 6A	276-1003	$ .99	69¢
Triac	100V, 6A	276-1002	$1.29	79¢
Triac	200V, 6A	276-1001	$1.39	89¢
Triac	400V, 6A	276-1000	$1.49	99¢

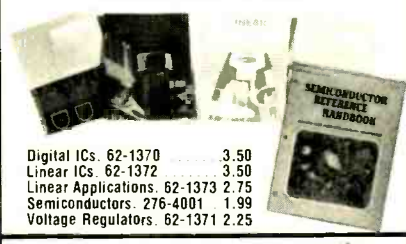
Linear ICs



First Quality Devices by National Semiconductor and Motorola

Type	Cat. No.	Reg	SALE
301AH	276-017	$ 69	29¢
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	89¢
556CN	276-1728	$2.99	1.29
566CN	276-1724	$2 99	1 29
567CN	276-1721	$2.99	1 99
723CN	276-1740	$ 99	59¢
723H	276-009	$ 99	59¢
741CN	276-007	$ .69	35¢
741H	276-010	$ 69	35¢
3900N	276-1713	$1 99	59¢
3909N	276-1705	$1 29	99¢
3911N	276-1706	$2.19	1 99
4250CN	276-1732	$1 99	1 19
4558CN	276-038	$ 99	69¢
13741H	276-1733	$2 59	1 49
75491	276-1701	$1 49	69¢
75492	276-1702	$1.49	69¢

Reference Books



Digital ICs. 62-1370 ..... 3.50
Linear ICs. 62-1372 ..... 3.50
Linear Applications. 62-1373 2.75
Semiconductors. 276-4001 . 1.99
Voltage Regulators. 62-1371 2.25

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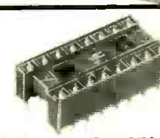

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	84P44 062	4.50	8.50	2.56	2.31
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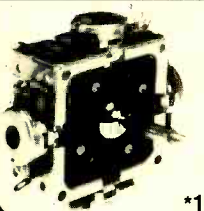

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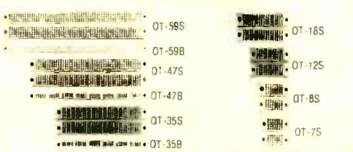

QT type	# holes	price
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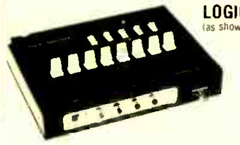

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Kit includes case, bracket and all components — complete. Nothing else to buy! 12 Volt NEG GRD

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Elapsed Timer: Hrs. Mins and Secs
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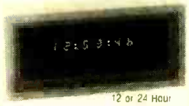
12 or 24 HOUR MODE

Kit: $29.95

Assembled: $39.95

CASE ONLY (includes hardware, mounting bracket and bezel) **$6.50**

JE700 CLOCK

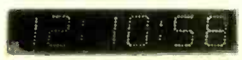


12 or 24 Hour

115 VAC

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

$17.95



DIGITAL CLOCK KIT — 3½ INCH DIGITS

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$9.95 Per Kit

printed circuit board

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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

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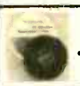
- Crimp Stations (7mm Auto — 22-20 to 12-X0 elect.)
- "Up-Front" Wire Cutting
- Scissors Action Stripping (No. 22-20 to No. 10)
- Crimp Stations — insulated (2w-20 to 12-10 elect.)

Actual Size - 8¼" length **$8.50**

Permacel Electrical Tape



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SN7430N	.26	SN74107N	.39	SN74188N	3.95
SN7432N	.31	SN74121N	.39	SN74190N	1.19
SN7437N	.27	SN74122N	.39	SN74191N	1.25
SN7438N	.27	SN74123N	.50	SN74192N	.89
SN7439N	.25	SN74125N	.60	SN74193N	.89
SN7440N	.15	SN74126N	.60	SN74194N	1.25
SN7441N	.89	SN74132N	1.09	SN74195N	.75
SN7442N	.59	SN74136N	.95	SN74196N	1.25
SN7443N	.75	SN74141N	1.15	SN74197N	.75
SN7444N	.75	SN74142N	4.00	SN74198N	1.75
SN7445N	.75	SN74143N	4.50	SN74199N	1.75
SN7446N	.81	SN74144N	4.50	SN74200N	5.59
SN7447N	.69	SN74145N	1.15	SN74279N	.90
SN7448N	.79	SN74147N	2.35	SN74251N	1.79
SN7450N	.26	SN74148N	2.00	SN74284N	6.00
SN7451N	.27	SN74150N	1.00	SN74285N	6.00
SN7453N	.27	SN74151N	.79	SN74367N	.75
SN7454N	.20	SN74153N	.89		

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

CMOS

CD4000	.25	CD4035	1.85	74C04N	.75
CD4001	.25	CD4040	2.45	74C10N	.65
CD4002	.25	CD4042	1.90	74C20N	.65
CD4006	2.50	CD4044	1.50	74C30N	.65
CD4007	.25	CD4046	2.51	74C42N	2.15
CD4009	.59	CD4047	2.75	74C73N	1.50
CD4010	.59	CD4049	.79	74C74	1.15
CD4011	.25	CD4050	.79	74C90N	3.00
CD4012	.25	CD4051	2.95	74C95N	2.00
CD4013	.47	CD4053	2.95	74C107N	1.25
CD4016	.56	CD4060	3.25	74C151	2.90
CD4017	1.35	CD4066	1.75	74C154	4.00
CD4019	.55	CD4069	.45	74C157	2.15
CD4020	1.49	CD4071	.45	74C160	3.25
CD4022	1.25	CD4081	.45	74C161	3.25
CD4023	.25	CD4511	2.50	74C163	3.00
CD4024	1.50	CD4518	2.50	74C164	3.25
CD4025	.25	MC14566	3.00	74C173	2.60
CD4027	.69	74C00N	.39	74C193	2.75
CD4028	1.65	74C02N	.55	74C195	2.75
CD4029	2.90			MC4044	4.50
CD4030	.65			MC14016	.56

LINEAR

LM300H	.80	LM370N	1.15	LM1351N	1.65
LM301H	.35	LM373N	3.25	LM1414N	1.75
LM301CN	.35	LM377N	4.00	LM1458C	.65
LM302H	.75	LM380N	1.39	LM1496N	.95
LM304H	1.00	LM380CN	1.05	LM1556V	1.85
LM305H	.95	LM381N	1.79	LM2111N	1.95
LM307CN	.35	LM382N	1.79	LM2901N	2.95
LM308H	1.00	NE501K	8.00	LM3065N	.69
LM308CN	1.00	NE510A	6.00	LM3900N	.55
LM309H	1.10	NE531H	3.00	LM3905N	.60
LM309K	.99	NE536T	6.00	LM3909	1.25
LM310CN	1.15	NE540L	6.00	LM5556N	1.85
LM311H	.90	NE550N	.79	MC5558V	1.00
LM311N	.90	NE555V	.39	LM7525N	.90
LM318CN	1.50	NE560B	5.00	LM7535N	1.25
LM319N	1.30	NE561B	5.00	8038B	4.95
LM320K-5	1.35	NE562B	5.00	LM75450	.49
LM320K-5.2	1.35	NE565H	1.25	75451CN	.39
LM320K-12	1.35	NE565N	1.25	75452CN	.39
LM320K-15	1.35	NE566CN	1.25	75453CN	.39
LM320T-5	1.75	NE567H	1.95	75454CN	.39
LM320T-5.2	1.75	NE567V	1.50	75491CN	.79
LM320T-8	1.75	LM703CN	.45	75492CN	.89
LM320T-12	1.75	LM709H	.29	75494CN	.89
LM320T-15	1.75	LM709N	.29	RCA LINEAR	
LM320T-18	1.75	LM710N	.79	CA3013	2.15
LM320T-24	1.75	LM711N	.39	CA3023	2.56
LM323K-5	9.95	LM723H	.55	CA3035	2.48
LM324N	1.80	LM723H	.55	CA3039	1.35
LM339N	1.70	LM733N	1.00	CA3046	1.30
LM340K-5	1.95	LM739N	1.00	CA3059	3.25
LM340K-6	1.95	LM741CH	.35	CA3060	3.25
LM340K-8	1.95	LM741CN	.35	CA3080	.85
LM340K-12	1.95	LM741-14N	.39	CA3081	2.00
LM340K-15	1.95	LM747H	.79	CA3082	2.00
LM340K-18	1.95	LM747N	.79	CA3083	1.60
LM340K-24	1.95	LM748H	.39	CA3086	.85
LM340T-5	1.75	LM748N	.39	CA3089	3.75
LM340T-6	1.75	LM1303N	.90	CA3091	10.20
LM340T-8	1.75	LM1304N	1.19	CA3102	2.95
LM340T-12	1.75	LM1305N	1.40	CA3123	2.15
LM340T-15	1.75	LM1307N	.85	CA3130	1.39
LM340T-18	1.75	LM1310N	2.95	CA3140	1.25
LM340T-24	1.75			CA3600	1.75
LM350N	1.00			RC4194	5.95
LM351CN	.65			RC4195	3.25

74LS00 TTL

74LS00	.29	74LS74	.49	74LS139	1.95
74LS02	.29	74LS75	.69	74LS151	1.55
74LS03	.29	74LS76	.49	74LS153	1.89
74LS04	.35	74LS83	1.75	74LS157	1.55
74LS05	.35	74LS85	2.49	74LS162	2.25
74LS08	.29	74LS86	.49	74LS163	2.25
74LS10	.29	74LS90	1.25	74LS164	1.95
74LS13	.69	74LS92	1.25	74LS175	1.95
74LS14	1.75	74LS93	1.25	74LS181	3.69
74LS20	.29	74LS95	1.95	74LS190	2.85
74LS26	.39	74LS96	1.89	74LS191	2.85
74LS27	.39	74LS107	.59	74LS192	2.85
74LS28	.39	74LS109	.59	74LS193	2.85
74LS30	.29	74LS112	.59	74LS194	1.89
74LS32	.39	74LS132	1.25	74LS195	1.89
74LS40	.39	74LS136	.59	74LS257	1.75
74LS51	.29	74LS138	1.89	74LS260	.55
74LS55	.29			74LS279	.79
74LS73	.49			74LS670	3.95

CLOCK CHIPS

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

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

DISCRETE LEDS

.125" dia.			.190" dia.		
XC209	Red	10/$1	XC111	Red	10/$1
XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC111	Orange	4/$1

.200" dia			.185" dia.			.200" dia.			
XC22	Red	10/$1	XC526	Red	10/$1	XC556	Red	10/$1	.085" dia. MV50 - Red 6/$1
XC22	Green	4/$1	XC526	Green	4/$1	XC556	Green	4/$1	INFRA RED LED
XC22	Yellow	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1	
XC22	Orange	4/$1	XC526	Orange	4/$1	XC556	Orange	4/$1	
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Clear	7/$1	Flat 5/$1.00

SPECIAL * — XC556 Red 100/$8.00 1000/$60.00 — SPECIAL *

DISPLAY LEDS

DL707 DL338

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	270	2.95	MAN 3640	Common Cathode-orange	300	1.75
MAN 2	5 x 7 Dot Matrix	300	4.95	MAN 4710	Common Anode-Red	400	1.95
MAN 3	Common Cathode	125	3/1.00	DL701	Common Anode-red	300	.99
MAN 4	Common Cathode	187	1.95	DL704	Common Cathode	300	.99
MAN 7	Common Anode	300	1.25	DL707	Common Anode	300	.99
MAN 7G	Common Anode-green	300	1.95	MAN 4740	Common Anode-Red	400	.99
MAN 7Y	Common Anode yellow	300	1.95	DL741	Common Anode	600	1.50
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
MAN 74	Common Cathode	300	1.50	DL 338	Common Cathode	110	.50
MAN 82	Common Anode-yellow	300	.99	FND70	Common Cathode	250	.75
MAN 84	Common Cathode-yellow	300	.99	FND503	Common Cathode	500	1.00
MAN 3620	Common Anode-orange	300	1.75	FND507	Common Anode	500	1.00

FACTORY REJECTS ATARI GAME BOARDS

BOARD A — 8½" x 16" — **$6.95 ea.**
Over 60 each reusable IC's. Misc. Transistors, Resistors, Diodes, Caps, Crystals, Switch, etc. ONLY 500 EA. AVAILABLE

DELUXE BOARD B — 11½" x 18" — **$9.95 ea.**
Over 100 each reusable IC's. Misc. Transistors, Resistors, Diodes, Caps, Crystals, Switches, LEDS, etc. ONLY 500 EA. AVAILABLE

NEW AY-3-8500-1 TV GAME CHIP

28 Lead Dual In Line

- Score display
- Selectable angles, speed and bat size
- Auto or manual ball service
- Realism sounds
- 6 Games — tennis, hockey, soccer, squash, pelota practice and two rifle games

The circuit is intended to be battery powered. Minimum number of external components required for complete system.

$24.95

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin	$.27	.25	.24	28 pin	$.99	.90	.81
16 pin	.30	.27	.25	36 pin	1.39	1.26	1.15
18 pin	.35	.32	.30	40 pin	1.59	1.45	1.30
24 pin	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

Plastic Push Button Switch

- 18 AWG Solid Wire - 5" Long
- .50 (wide) X .60 (high) ⅜-27 Thread
- 8 AMP @ 14 Volt - 1 AMP @ 110 Volt

		1-9	10-Up
J-188-1	Push On-Push Off	.59	.49
J-188-2	Normally Open	.59	.49
J-188-3	Normally Closed	.59	.49

MINATURE TOGGLE SWITCH

JMT-221	DPDT	on/off/on	$1.95
JMT-223	DPDT	on/none/on	$1.75
JMT-121	SPDT	on/off/on	$1.50
JMT-123	SPDT	on/none/on	$1.25

CLIPLITE 8/$1.49

LED MOUNTING SYSTEM use with XC556 LEDS

Specify Colors — Red - Green - Amber - Yellow

DIP SWITCHES

SPST Slide Action

#206-4 (8 pin dip) 4 switch unit $1.75 ea.
#206-7 (14 pin dip) 7 switch unit $1.95 ea.
#206-8 (16 pin dip) 8 switch unit $2.25 ea.

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

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

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			PN4250	4/$1.00
2N2219A	3/$1.00	PN3567	3/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3568	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	PN3569	4/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3704	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3705	5/$1.00	2N4409	5/$1.00
2N2484	4/$1.00	2N3706	5/$1.00	2N5086	4/$1.00
2N2906A	4/$1.00	2N3707	5/$1.00	2N5087	4/$1.00
2N2907A	5/$1.00	2N3711	5/$1.00	2N5088	4/$1.00
2N2925	5/$1.00	2N3724	$.65	2N5089	4/$1.00
2N3053	2/$1.00	2N3725	$1.00	2N5129	5/$1.00
2N3055	$.89	2N3903	5/$1.00	2N5138	5/$1.00
MJE3055	$1.00	2N3904	4/$1.00	2N5139	5/$1.00
MJE2955	$1.25	2N3905	4/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N3906	4/$1.00	2N5951	5/$1.00
2N3398	5/$1.00	2N4013	3/$1.00	C106B1SCR	2/$1.00
		2N4014	3/$1.00	2N5432	$2.00
		2N4123	10/$1.00		

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

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7406	.20	7470	.30	74160	1.23
7407	.28	7472	.30	74161	.97
7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
7411	.25	7476	.30	74165	.99
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

LOW POWER

74L00	.29	74L51	.29	74L90	1.40
74L02	.29	74L55	.29	74L91	1.20
74L03	.23	74L71	.29	74L93	1.50
74L04	.29	74L72	.45	74L95	1.50
74L06	.29	74L73	.56	74L98	2.25
74L10	.29	74L74	.56	74L164	2.25
74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

LOW POWER SCHOTTKY

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

HIGH SPEED

74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.58
74H10	.25	74H52	.25	74H102	.58
74H11	.25	74H53	.25	74H103	.60
74H20	.25	74H55	.25	74H106	.72
74H21	.25	74H60	.25	74H108	.72

SCHOTTKY

74S00	.59	74S08	.68	74S22	.65
74S02	.59	74S10	.65	74S32	.68
74S03	.59	74S20	.65	74S74	.68
74S04	.72				

8000 (NATIONAL)

8091	.61	8220	1.49	8811	.65
8092	.61	8230	2.19	8812	1.02
8095	1.25	8288	1.49	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8552	2.19	8831	2.19
8200	2.31	8563	.62	8836	.29
8214	1.49	8810	.70	8880	1.19

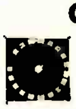
8000 (SIGNETICS)

8263	5.79	8267	2.59

9000

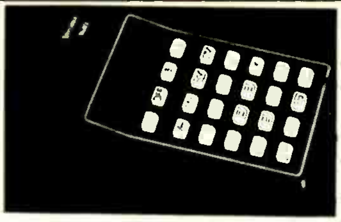
9002	.40	9309	.79	9601	.61
9301	1.01	9312	.79	9602	.79

ELECTRONIC GAMES




We have available in kit form **Electronic Roulette** and **Electronic Craps.** Both kits contain P.C. boards, LED's, all necessary components, transformer, case and instructions for easy assembly. Included with each kit is a 55 page booklet explaining the entire game.

Electonic Roulette Dimensions 6½" x 6½" x 1½" **$23.95**
Electronic Craps Dimensions 6½" x 3½" x 1½" **$14.95**



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4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
4006A	1.35	4022A	.94	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		

74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
74C42	1.61	74C160	2.48	80C97	.96
74C73	1.04	74C161	2.49		

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HP5082-7414	4 digit .11 red LED	1.25
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MAN 5	2.25		
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MAN 66	2.25	MV10B	.25
MAN 72	1.25	MV50	.12
MAN 3620	1.50	NSL100	.12
FND 359	.95		
FND 500	1.89	MV5020	
FND 507	.95	RED	.15
DL10A	2.19	CLEAR	.15

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1702A	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
2102	1024 bit RAM static 16 pin	1.95
5203	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
5260	1024 bit RAM MOS dynamic 16 pin	1.95
5261	1024 bit RAM MOS dynamic 16 pin	1.95
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82S23	256 PROM-SCHOTTKY 16 pin	3.69
F93410	256 bit RAM bi-polar 16 pin	1.95
74187	1024 bit ROM TTL 16 pin	5.75
74200	256 bit RAM tri-state 16 pin	5.45

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MM5312	4 digit multiplexed BCD, 7 seg, lpps, 12-24 Hr, 50-60 Hz — 24 pin	3.95
MM5314	6 digit multiplexed 12-24 Hr, 50-60 Hz 24 pin	4.45
MM5316	4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	4.95
5375AA	4-6 digit, 12 hour, 60 Hz snooze alarm brightness control capability, alarm tone output — 24 pin	4.95
CT7001	6 digit, 12-24 Hr, 50-60 Hz, alarm, timer and date circuits — 28 pin	6.95

CALCULATOR CHIPS

CT5002	12 digit, 4 function fixed decimal battery operation — 40 pin	1.95
CT5005	12 digit, 4 function plus memory, fixed decimal — 20 pin	2.49
MM5725	8 digit, 4 function, floating decimal 18 pin	1.98
MM5736	6 digit, 4 function, 9V battery operation — 18 pin	2.95
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation — 24 pin	3.95
MM5739	9 digit, 4 function, 9V battery operation — 22 pin	3.95

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MCD2	Opto isolator diode	1.09
MCT2	Opto isolator transistor	.70

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MM5016	500/512 bit dyn. 8 pin	1.59
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2504	1024 bit multiplexed dyn 8 pin	3.95

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16 pin	.22	40 pin	.69
18 pin	.29		

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ULN2208	FM Gain Block 34db (typ) mDIP	1.18
ULN2209	FM Gain Block 48db (typ) mDIP	1.35
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3046	Transistor Array DIP-14	.73

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20 KEYS
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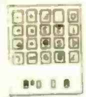

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301	Hi Perf Op Amp mDIP TO-5	.29
302	Volt follower TO-5	.53
304	Neg V Reg TO-5	.80
305	Pos V Reg TO-5	.71
307	Op AMP (super 741) mDIP TO-5	.26
308	Micro Pwr Op Amp mDIP TO-5	.89
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
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320T	Neg Reg 5, 12, TO-220	1.39
320K	Neg Reg 5.2, 12 TO-3	1.39
322	Precision Timer DIP	1.70
324	Quad Op Amp DIP	1.52
339	Quad Comparator DIP	1.58
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1.69
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372	AF-IF Strip detector DIP	2.93
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380	2w Audio Amp DIP	1.30
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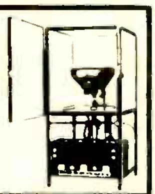

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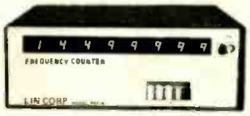

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2SA673	.85	2SB463	1.65	2SC620	.80	2SC1096	1.20	2SD180	2.75
2SA679	3.75	2SB471	1.75	2SC627	1.75	2SC1098	1.15	2SD201	1.95
2SA682	.85	2SB474	1.50	2SC642	3.50	2SC1115	2.75	2SD218	4.75
2SA699	1.30	2SB476	1.25	2SC643	3.75	2SC1166	.70	2SD300	2.50
2SA699A	1.75	2SB481	2.10	2SC644	.70	2SC1170	4.00	2SD313	1.10
2SA705	.55	2SB492	1.25	2SC681	2.50	2SC1172B	4.25	2SD315	.75
2SA815	.85	2SB495	.95	2SC684	2.10	2SC1209	.55	2SD318	.95
2SA816	.85	2SB507	.90	2SC687	2.50	2SC1213	.75	2SD341	.95
		2SB511	.70	2SC696	2.35	2SC1226	1.25	2SD350	3.25
2SB22	.65			2SC712	.70	2SC1243	1.50	2SD352	.80
2SB54	.70	2SC206	1.00	2SC713	.70	2SC1293	.85	2SD380	5.70
2SB56	.70	2SC240	1.10	2SC732	.70	2SC1308	4.75	2SD389	.90
2SB77	.70	2SC261	.65	2SC733	.70	2SC1347	.80	2SD-390	.75
2SB128	2.25	2SC291	.65	2SC739	.70	2SC1383	.75	2SD437	5.50
2SB135	.95	2SC320	2.00	2SC715	1.75	2SC1409	1.25		
2SB152	4.50	2SC352	.75	2SC762	1.90	2SC1410	1.25	MPS-U31	4.00
2SB173	.55	2SC353	.75	2SC783	1.00	2SC1447	1.25	MPS8000	1.25
2SB175	.55	2SC371	.70	2SC784	.70	2SC1448	1.25		
2SB178	1.00	2SC372	.70	2SC785	1.00	2SC1507	1.25		
2SB186	.60	2SC394	.70	2SC793	2.50	2SC1509	1.25		

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BU205	1500V	4.70	BU208	1500V	6.25	2SC1308	1100V	4.95
BU206	1700V	5.90	2SC1170	1100V	4.00	2SC1325	1100V	4.95

OEM SPECIALS

1N270	.10	2N960	.55	2N2219A	.30	2N2913	.75	2N3740	1.00	2N4401	.20
1N914	.10	2N962	.40	2N2221	.25	2N2914	1.20	2N3771	1.75	2N4402	.20
		2N967	.50	2N2221A	.30	2N2916A	3.65	2N3772	1.90	2N4403	.20
2N173	1.75	2N1136	1.35	2N2222	.25	2N3019	.50	2N3773	3.00	2N4409	.20
2N178	.90	2N1142	2.25	2N2222A	.30	2N3053	.30	2N3819	.32	2N4410	.25
2N327A	1.15	2N1302	.25	2N2270	.40	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1305	.30	2N2322	1.00	2N3055	.75	2N3856	.20	2N4441	.85
2N336	.90	2N1377	.75	2N2323	1.00	2N3227	1.00	2N3866	.85	2N4442	.90
2N338A	1.05	2N1420	.20	2N2324	1.35	2N3247	3.40	2N3903	.20	2N4443	1.20
2N398B	.90	2N1483	.95	2N2325	2.00	2N3250	.50	2N3904	.20	2N4852	.55
2N404	.30	2N1540	.90	2N2326	2.85	2N3375	6.50	2N3905	.20	2N5061	.30
2N443	1.75	2N1543	2.70	2N2327	3.80	2N3393	.20	2N3906	.25	2N5064	.50
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.17	2N3925	3.75	2N5130	.20
2N501A	3.00	2N1549	1.25	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5133	.15
2N508A	.45	2N1551	2.50	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5138	.15
2N555	.45	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5198	3.75
2N652A	.85	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5294	.50
2N677C	6.00	2N1557	1.15	2N2712	.18	2N3442	1.85	2N3958	1.20	2N5296	.50
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5306	.20
2N706B	.40	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5354	.20
2N711	.50	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.20	2N5369	.20
2N711B	.60	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.20	2N5400	.40
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	2N5401	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.15	2N4142	.20	2N5457	.35
2N720A	.50	2N2102	.40	2N2906	.25	2N3645	.15	2N4143	.20	2N5458	.30
2N918	.35	2N2218	.25	2N2906A	.30	2N3646	.14	2N4220A	.45	C103y	.25
2N930	.25	2N2218A	.30	2N2907	.25	2N3730	1.50	2N4234	.95	C103d	.40
2N956	.30	2N2219	.25	2N2907A	.30	2N3731	2.75	2N4400	.20	C106b1	.50
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2N2647	.60	2N4891	.50
2N6027	.55	2N4892	.50
2N6028	.70	2N4893	.50
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2N2160	.65	MU10	.40
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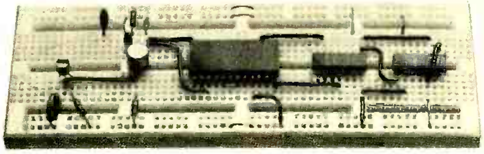

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7402	.20
7403	.20
7404	.20
7405	.20
7406	.24
7407	.24
7408	.20
7409	.20
7410	.20
7411	.20
7412	.20
7413	.24
7414	.88
7416	.24
7417	.24
7420	.20
7421	.24
7423	.34
7425	.34
7426	.24
7427	.32
7428	.27
7430	.20
7432	.24
7433	.29
7437	.24
7438	.24
7440	.20
7442	.52
7443	.62
7445	.69
7446	.69
7447	.69
7448	.69
7450	.20
7451	.20
7453	.20
7454	.20
7459	.20
7460	.20
7470	.29
7472	.29
7473	.29
7474	.29
7475	.48
7476	.31
7480	.69
7482	.69
7483	.69
7485	.89
7486	.27
7489	2.18
7490	.43
7491	.69
7492	.43
7493	.43
7494	.69
7495	.69
7496	.69

74100	1.27
74107	.29
74109	.32
74121	.34
74122	.43
74123	.60
74125	.39
74126	.39
74132	.69
74141	.87
74145	.69
74147	1.62
74148	1.29
74150	1.15
74151	.69
74153	.64
74154	1.02
74155	.69
74156	.69
74157	.69
74160	.87
74161	.87
74162	.87
74163	.87
74164	.95
74165	1.14
74166	1.25
74170	2.63
74173	1.41
74174	.97
74175	.92
74176	.78
74177	.78
74180	.69
74181	2.14
74182	.78
74184	2.18
74185	2.18
74188	3.49
74189	3.49
74190	1.22
74191	1.22
74192	.87
74193	.87
74194	.87
74195	.87
74196	.87
74197	.87
74198	1.48
74199	1.48
74251	1.08
74279	.54
74365	.66
74366	.66
74367	.66
74368	.66
8093	.39
8094	.39
8095	.66
8096	.66
8097	.66
8098	.66

75450	.87
75451	.60
75452	.60
75453	.60
75454	.60
75491	.80
75492	.83
75493	1.08
75494	1.18
82S25	2.18

CMOS

4000	.22
4001	.22
4002	.22
4006	1.22
4007	.22
4008	.78
4009	.43
4010	.43
4011	.22
4012	.22
4013	.39
4014	.95
4015	.95
4016	.39
4017	1.04
4018	1.04
4019	.23
4020	1.13
4021	1.23
4022	.95
4023	.22
4024	.83
4025	.22
4026	1.67
4027	.39
4028	.87
4029	1.13
4030	.22
4033	1.50
4034	3.49
4035	1.13
4040	1.13
4041	.78
4042	.78
4043	.69
4044	.69
4046	1.85
4049	.39
4050	.39
4051	1.25
4052	1.25
4053	1.25
4060	1.57
4066	.78
4071	.22
4072	.22
4073	.22
4075	.22
4081	.22
4082	.22
4502	.78
4510	1.13
4511	1.04
4514	2.79
4515	2.79
4516	1.22
4518	1.13
4520	1.13
4527	1.67
4528	.87
4585	1.22

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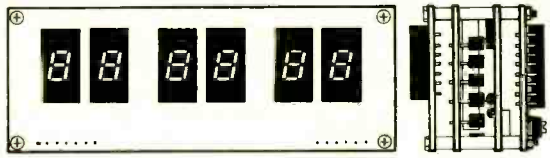

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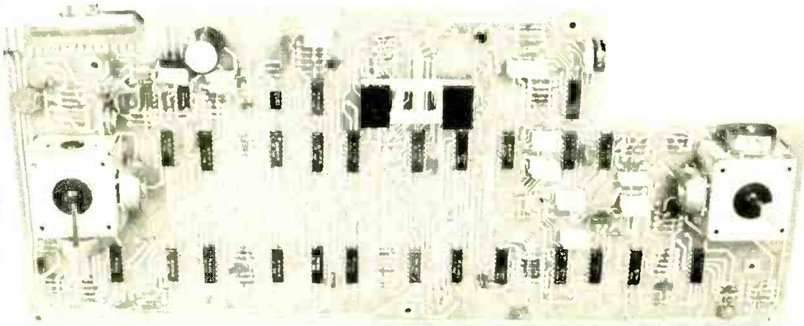

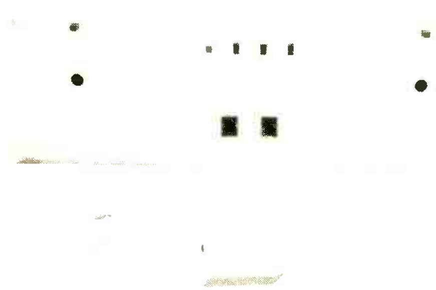

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The soccer game is played the same as above, except that the ball goes as if it were kicked each time it touches a player. Scoring and skill is controlled the same as the hockey game above.

We provide the logic board, shown in the upper left photo, the LED READOUTS,the power transformer, the speaker, the line cord, the case and interface cube, shown in the photo to the right. The interface cube is actually a miniature TV transmitter, which puts the games on your TV set. This interface meets FCC requirements. In short, we provide everything you need to put this game on your TV set. An hour with some wire, solder and soldering iron is all you need We have about 2000 sets, but only about 1000 bases for the case, so the first 1000 orders get the base. Otherwise, you will need a piece of masonite or ply wood 7½"x 17 5/8"

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200	.70	1.10	1.75	.60	.70	1.60
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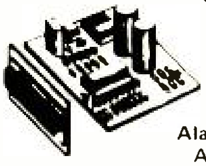

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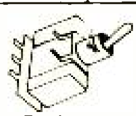

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