Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

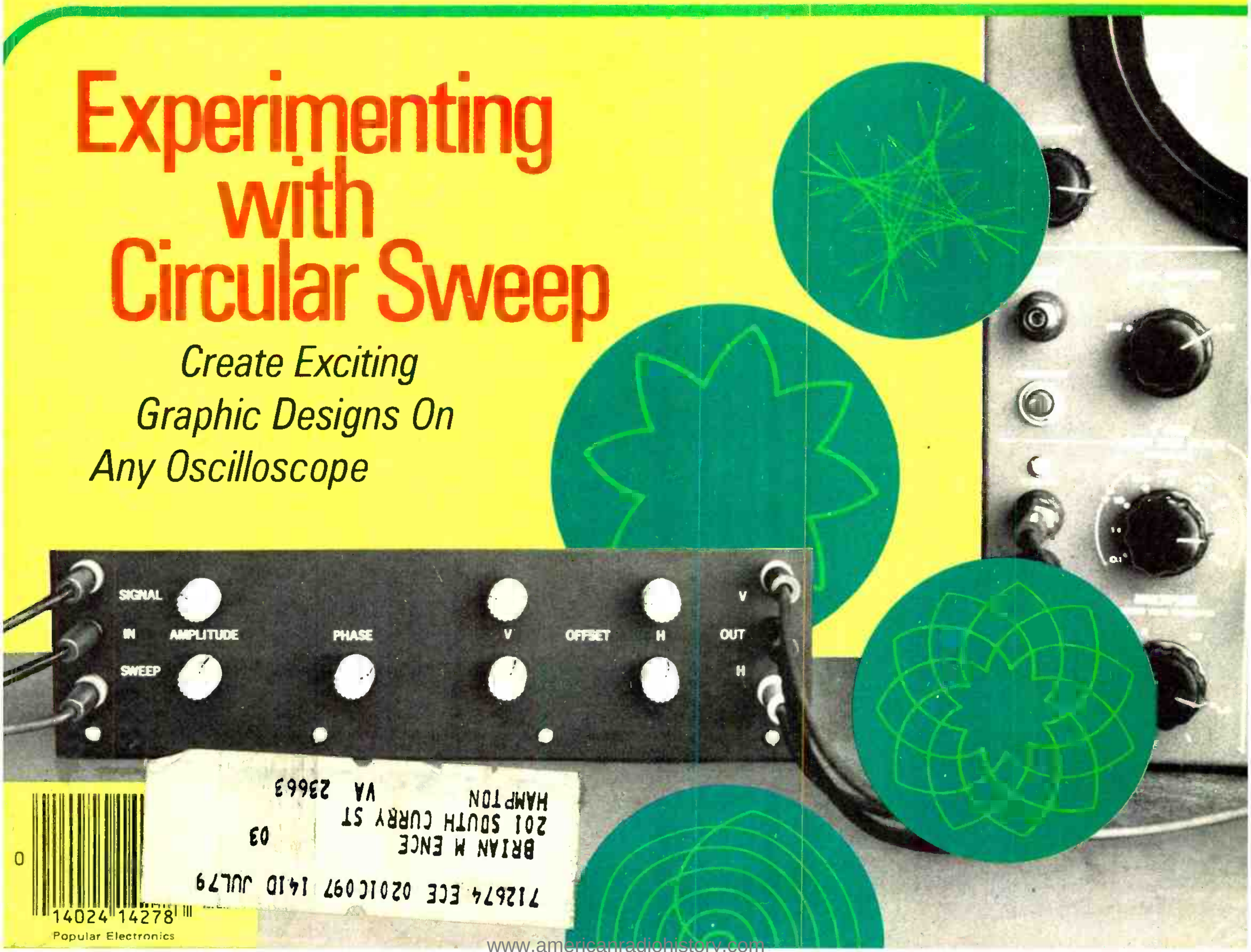
MARCH 1978/$1

How To Build a Digital Phototachometer
A Practical Guide to Multitrack Tape Recording
Microprocessor Microcourse, Part I

Test Reports: *Sony PS-X5 Turntable, JVC P-3030 Stereo Preamplifier, Dahlquist DQ-1W Low-Bass Module, B&K 1820 Frequency Counter*

Experimenting with Circular Sweep

Create Exciting Graphic Designs On Any Oscilloscope



The Cobra 50XLR CB has it all. AM/FM Stereo. Cassette. And CB. All in one compact unit. All engineered to bring you the same loud and clear sound Cobra is famous for.

The remote mike houses the channel selector, squelch control, and channel indicator. So all you need for talking CB is right there in your hand. The cassette player features through the dial loading and four-way fader control.

Because they're only five inches deep, there's a Cobra in-dash radio to fit almost any car with little or no modification to the dash. This feature, plus the step-by-step Installation Manual and Universal Installation Kit makes them the easiest in-dash radios to install. And our Nationwide network of Authorized Service Centers makes them the easiest to service.

There are four Cobra in-dash models to choose from including AM/FM/Stereo/8-track/CB. But no matter which you choose you can be sure of getting the best sounding radio going. The ultimate car radio.

The Cobra.

Cobra®

Punches through loud and clear.

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CIRCLE NO. 7 ON FREE INFORMATION CARD

THE ULTIMATE CAR RADIO.

Where superior technology makes the musical difference: Sansui's new DC integrated amplifier and matching tuner.

Sansui is proud to introduce the new AU-717 DC integrated amplifier and matching TU-717 tuner, designed for your greatest listening pleasure. We are proud of the superlative specifications that our sophisticated research has achieved. The finest available at any price.

But the best specs alone don't always mean the finest music reproduction. And so we are proud that our precision engineering and superior circuitry design create pure and brilliantly clean tonal quality that's distinctly superior.

Listen to what we offer: Frequency response of the AU-717 from main in, 0Hz to 200kHz (+0dB, −3dB), (the widest of any DC integrated amplifier available), gives you sharp, clean transients and greatly reduced phase shift problems. Total harmonic distortion is astoundingly low, less than 0.025%, from 10-20,000Hz 85 watts/channel min. RMS, both channels driven into 8 ohms.

Dual independent power supplies provide truest stereo separation and a large power reservoir. For uncolored phono reproduction equalization is within ±0.2dB (20-20,000Hz, extended RIAA curve). And the calibrated-attenuator level control guarantees volume precision.

The matching TU-717 tuner features dual IF bandwidth to let you select for lowest distortion (0.07% mono, 0.07% stereo) or maximum selectivity (80dB). S/N is excellent: 80dB mono, 77dB stereo.

In addition, the AU/TU-717's are elegantly styled, offer rack mounting adaptors and are most attractively priced. Less than $450* for the AU-717 and less than $320* for the TU-717.

Listen to these brilliant new components at your franchised Sansui dealer today. When you hear the new Sansui AU/TU-717's, you will never again want to settle for less than the best.

Sansui. A whole new world of musical pleasure.

*Approximate nationally advertised value. The actual retail price will be set by the individual dealer at his option.

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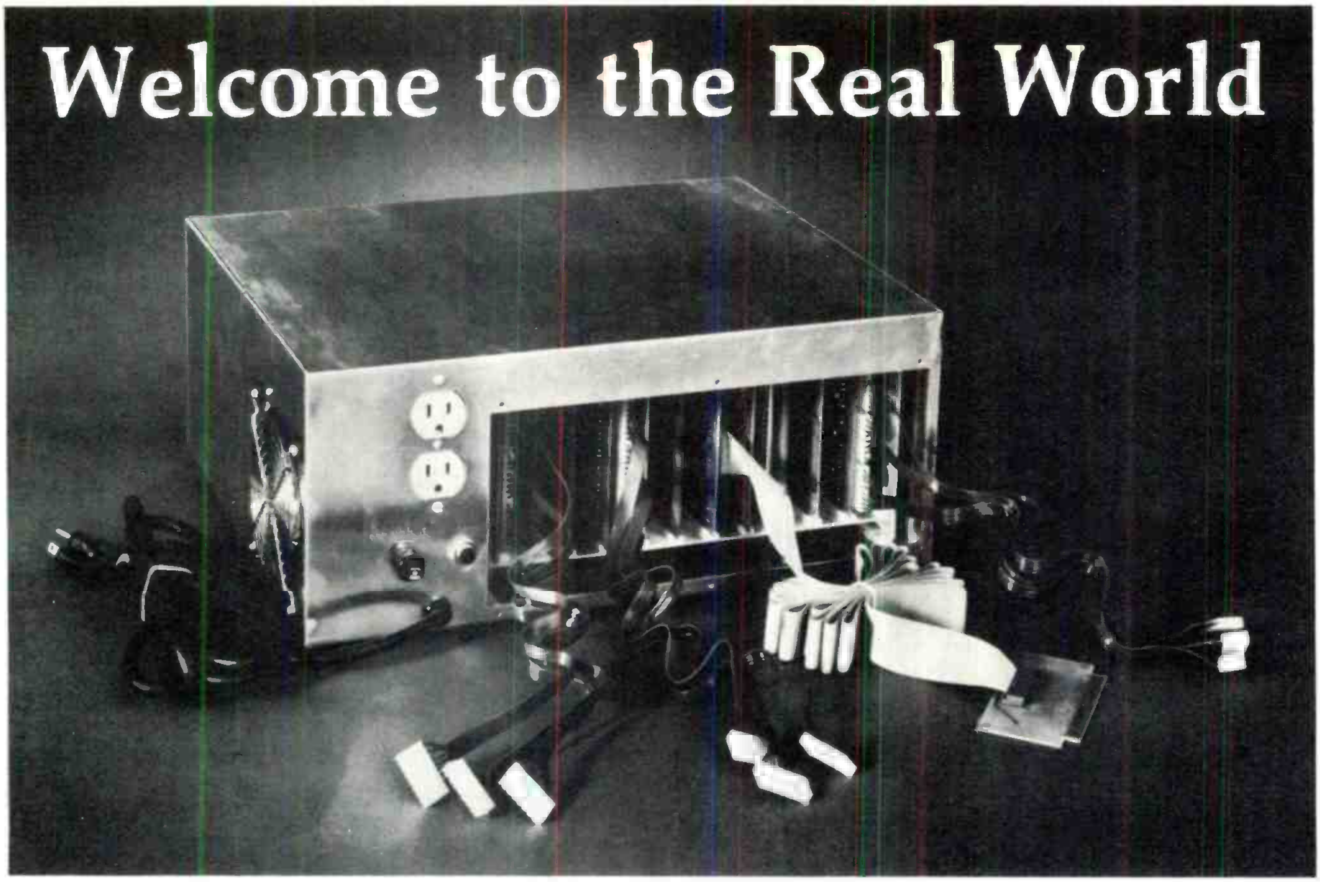

with the Real-World Interface from The Digital Group

A computer should have a purpose. Or as many purposes as you can imagine. Because a computer belongs in the real world.

And now, the Digital Group introduces the Real-World Interface. A system component that's actually a system in itself, and specifically designed to help you get your computer to control all those tasks you know a computer can control so well.

Automate your sprinkler system. Heat and cool your home. Guard against burglars. Shut off lights . . . It's all a part of the Real World, easily controlled with the Digital Group Real-World Interface.

Our Real-World Interface is initially made up of three basic components — motherboard and power supply, parallel CPU interface and cabinet — plus three types of plug-ins: AC controller, DC controller and prototyping card. The recommended software packages are Convers, Assembler or Maxi-Basic, in that order.

Some of the features include:

Motherboard & Power Supply
- 12 slots — 11 control cards, one for the interface card
- +5V DC±5% @ 1A, +12V DC ±5% @ 1A, -12V DC ±5% @ 1A contained on board
- May be free-standing (with care)

Parallel CPU Interface
- All buffering for Data Out (25 TTL loads), Address (25 TTL loads) and Data In (10 TTL loads)
- Includes cable and paddlecard for connection to dual 22 on Digital Group CPU back panel. Two 22-pin edge connectors included
- Requires two output ports and one input port

AC Controller
- Eight output devices (2N6342A-2N6343A, -12 amp Triacs); Each output 240V AC max, 12A max RMS
- Control AC motors, lamps, switches, etc.
- Opto-isolated (MCS-2400 or equivalent)

DC Controller
- Eight output devices (2N6055) each output up to 50V and up to 5A
- Control DC motors, switches, solenoids, etc.
- May use internal +12V DC for load or external DC up to 50V DC

Price
- For the motherboard and power supply, parallel CPU interface and cabinet, our kit price is only $199.50, or $260 assembled. Now *that*'s down to earth.

We've only just begun our Real-World Interface System. There are many more plug-ins and applications coming along soon. So write or call The Digital Group now for complete details.

And welcome to our world.

the digital group

P.O. BOX 6528 DENVER, CO 80206 (303) 777-7133

CIRCLE NO. 13 ON FREE INFORMATION CARD

MARCH 1978

Popular Electronics®

VOLUME 13, NUMBER 3

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Coming Next Month

- SPECIAL FOCUS ON CB RADIO
- MICROPROCESSOR MICROCOURSE, PART 2
- HOW TO DESIGN & BUILD POWER SUPPLIES

TEST REPORTS
- Sharp Model RT-3388 Cassette Deck
- Harman-Kardon Model 730 AM/Stereo FM Receiver
- Superscope Aircommand Model CB-640 CB Transceiver

Feature Articles

Construction Articles

Columns

Julian Hirsch Audio Reports

Electronic Product Test Reports

Departments

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Editorial

WHO ARE YOU?

Every year I look forward to receiving the results of an in-depth study of PE readers' attitudes on our editorial content. I find it to be a vital editorial management tool because it tells me about you in a scientific manner—what you like about PE, suggestions for improvements, subjects you want more or less coverage on, etc. In most cases, it reinforces the personal information I glean through correspondence and telephone conversations with readers all through the year. So my gut feelings are largely in the right ballpark. However, the study also shields me from over-reacting to an energetic minority who might want more coverage in a special area of electronics. And it places an indisputable number on factors that can be compared to reader responses in previous years. Answers to questions such as how many readers want more coverage on projects, what types of projects, and so on, are at my fingertips.

Here are some interesting facts from our latest study. See how you compare to the typical PE readers:

- Median age: 31 years.
- College educated: 67.8%.
- Time reading an issue: 2 hours, 19 minutes (median).
- Keep entire issue: 83.7%.
- Most popular columns and departments (19 listed): "New Products," "Experimenter's Corner," "Hobby Q&A" and "Solid State."

There were no startling revelations in the above. But comparing results to past years, I know that our typical reader is getting a little younger (while I'm slightly older) and has gone farther in formal education than ever before. Also, Forrest Mims' "Experimenter's Corner" was obviously a welcome addition to our pages since it now ranks #1 among columns in the first year in which it was included in our study.

From the survey, PE subscribers tend to be most involved in electronic experimentation (64.9%), kit building (63.8%), audio/tape recording (58%) and microcomputers (36.7%). Considering the broad range of special interests available within the electronics field, the typical reader participates in three of them simultaneously. But figures such as these can be deceiving since almost 25% participate in five or more areas. So careful analysis of averages, both mean and median as well as other breakdown categories, is necessary.

Another salient point emphasized by the results of this and other studies is the enormous number of PE readers who are involved in electronics as a career as well as a hobby or in an employment area where such knowledge is valuable (81.4%), as well as studying electronics in schools (6.1%). So it's no surprise that 48.7% of respondents replied, "Yes," when asked if they're involved in company electronics purchasing.

The voluminous computer readout of the study's reader responses was reduced to 37 pages of final results. It will certainly help us to plan future issues, and I'd like to thank all the readers (chosen on a random basis from our subscriber list) who received the five-page questionnaire for their wonderful cooperation.

Art Salsberg

Get Ready

There are hundreds of new micro-electronic products about to enter the consumer market. Here is how readers of Popular Electronics can discover them.

If you thought the pocket calculator started a revolution in 1971, just wait.

In the next twelve months more micro-electronic products will be introduced to the consumer than in any other phase of the micro-electronic revolution. Many of these products will 1) come from companies you've never heard of, 2) represent breakthroughs in micro-electronic technology, and 3) provide more conveniences and benefits than ever dreamed possible.

JS&A has been the company most sought after to introduce these new products. Our national advertising campaigns and our system of selling directly to the consumer give high technology companies the opportunity to introduce new products to the marketplace in the most economical, quickest and most efficient manner.

This article, written for readers of *Popular Electronics,* will tell you how we select products at JS&A. It will give you tips on how you can evaluate a new product, and it will give you an insight into how you can keep abreast of all new and important product developments.

AN INDUSTRY LEADER

Our role in micro-electronic marketing is a matter of record. We introduced the first pocket calculator, and we were largely responsible for creating a new industry. We were the first company to nationally introduce the LCD digital watch, and we are at the forefront of every major new product introduction including a few you will see in this issue.

To achieve these results, we have concentrated our efforts on doing only one thing and doing it well—selling micro-electronic products directly to consumers through full-page advertisements in national magazines and newspapers.

HOW WE SELECT A PRODUCT

We have a comprehensive checklist that we go through for each product we select. The questions we ask ourselves include:

1) Does the product use an integrated circuit? (This has been the primary area in which we have concentrated.)

2) Is the product a major breakthrough or a new application of existing technology? (Both are acceptable.)

3) Is the manufacturer a solid, honest company providing honest value?

4) Is the new technology in the product different enough to require the detail we supply in one of our advertisements? (If it is not, then our pioneering efforts are not required, and the product may not be that innovative.)

5) Does the product have advantages over the conventional version? Does it do its job more efficiently, faster and for less money? ("Less money" is the most important key.)

6) Can the consumer figure out how to operate it without reading the instructions? If not, how badly is the consumer willing to read the instructions?

7) Is the warranty and back-up service well thought out in advance?

8) Is the product at least one year ahead of all other similar products currently on the market?

9) Is the product a gimmick or an honest and useful contribution to new technology?

10) Can our company sell enough of the product to make a decent profit? (If the product appeals to too narrow a population segment, then we cannot sell enough of a product to keep our margins low enough to provide good value.)

DISCOVER OUR PRODUCTS

How do you find out about these products? Until now, to follow our company and its product introductions, you had to be a reader of *Popular Electronics* or any of 50 national publications we advertise in or be one of our existing customers.

JS&A will produce its second major catalog listing the newest consumer micro- electronic products that we feel represent the best contributions to micro-electronic technology.

If you are a JS&A customer, you will automatically receive one. If you are not, we will be happy to send it to you. It is called "products that think"—a collection of the most advanced micro-electronic consumer products. If you wish to receive one, simply send a postcard or a letter to: Catalog Section, JS&A National Sales Group, One JS&A Plaza, Northbrook, Illinois 60062.

On the following four pages in this issue of *Popular Electronics* are also a few of the products we are proud to introduce for the first time—products that we feel represent the quality, value and the innovation associated with our company.

Finally, we owe a debt of gratitude to our customers and to micro-electronics—the science of the future. We are proud of our position in this field, and we hope our contribution has helped further this new technology and made possible the many conveniences now available to consumers.

JS&A® NATIONAL SALES GROUP

Jogging Computer

Make jogging fun in the privacy of your home with a new space-age indoor exercise system.

The JS&A Jogging Computer is a total system of physical fitness and conditioning.

It's a fact. You reach your physical peak at age 25 and your mental peak at age 40. From then on it's downhill. But it needn't be. A 50 year old who exercises regularly can be healthier and in better physical shape than the average 25 year old.

When you're physically healthy, you are alert and better able to handle stress. You are better motivated and just plain happier. Jogging can keep you in good physical shape.

THE ADVANTAGES OF JOGGING

Jogging as a regular exercise has gained in popularity because it does three things for you. 1) It improves the functioning of the heart, lungs, blood vessels and lymph glands. 2) It helps control your weight without resorting to starvation diets, and 3) It is one of the few safe, strenuous exercises that creates the exertion necessary for good physical conditioning.

A NEW JOGGING COMPUTER

There is now a new, fun way to jog. The new JS&A Computer is a solid-state system that lets you jog in place in the comfort of your own home. It's fun, easy to use and convenient.

You simply set the distance and pace you wish to run and press the start button. An audible beep tone sounds and you jog in place to its rhythm. Each stride is registered on a large LED readout in the control unit so you can see how far you've run.

You jog on a large pad with sensors which register each stride. The pad is designed to feel like grass or soft earth so you can run either barefooted or with gym shoes. The idea is to gradually increase your distance and speed each day to build up your endurance.

Getting yourself to start jogging is often the hardest step. That is why the JS&A Jogging Computer is an ideal system for both the beginner and the experienced jogger.

FOR THE BEGINNER

The first time you step on the Jogging Computer, you run at a pre-selected pace and distance for approximately five minutes. (A chart will show you which speed to select based on your sex and age.) You then take your pulse rate for one minute by touching your wrist. The pulse/rate chart determines the settings and distance you should run the next time you jog.

You could be in poor, average or good shape, and this simple five minute test will accurately tell you. Start the jogger at the distance indicated on the chart, and gradually build up a little each day. In just one week you'll notice the difference, feel great, have greater endurance, and you won't tire as easily. That is what's so nice about the system–how easily and quickly it puts you into better shape.

FOR THE EXPERIENCED

If you jog regularly, you know the many benefits of jogging. But you also know the disadvantages–all overcome by owning a Jogging Computer. For example:

Forget about the ritual You wake up early, drive to your favorite indoor track, change clothes, and you're ready to run. With the Jogging Computer, just step out of bed and start running. The time you save in preparing to jog can be substantial.

Forget about the boredom Running around a track can be quite boring. And if you count laps, how many times have you lost your count? With the Jogging Computer, you can forget about counting, as the unit does it automatically for you. You can concentrate on problems or take flights of fancy–all while you strenuously exercise.

Forget about the weather Even in summer, there are days when you can't jog outdoors. And in a daily exercise program, you must resort to the indoor track. Not so with the Jogging Computer. It's always there when you need it–portable and ready to operate.

Forget about jogger's heel If you've run on indoor tracks, you know the pain of jogger's heel caused by leaning in around those curves. Jogging in place is easier on your whole body and eliminates this common jogging problem.

BRING IT ANYWHERE

The Jogging Computer is powered by four "C" cell batteries and requires no AC power so it goes anywhere–on your patio, in the garage or basement, or at your office. The control unit can be propped up with its built-in easel or placed on a wall using the four foot expansion cord. It's portable, so after you've run a few miles, just turn it off and put it away. There's no large exercise device to take up space.

QUALITY THROUGHOUT

The JS&A Jogging Computer is all solid state, and the 17"x 22" pad was pre-tested to take years of constant, hard pounding under all conditions. Service should never be required, but if anything ever does go wrong, JS&A's service-by-mail center will have it repaired and back to you in a matter of days. Be assured that we stand solidly behind our product's quality, construction and design. JS&A is America's largest single source of space-age products. We've been in business over a decade–further assurance that your modest investment is well protected.

We suggest that you order the JS&A Jogging Computer and use it for 30 days. Jog each day when you get up in the morning or before dinner. Enjoy the thrill of feeling your endurance build. Experience the convenience and fun. See how much better you feel and how much sharper you think. Then after 30 days, measure your progress. If you don't find the JS&A indoor jogger a convenient and fun way to stay trim and healthy, then return your unit for a complete and full refund including the $3.00 charge for postage and handling. You can't lose.

Simply send your check for **$149.95** plus $3.00 postage and handling (Illinois residents add 5% sales tax) to the address below or call our toll-free number. By return mail, we will send you the complete jogging computer system with instructions, charts, personal score card and a one year limited warranty.

Start today on an organized physical fitness program using the latest in solid-state, space-age technology. Order your JS&A Jogging Computer at no obligation today.

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

HATS OFF TO IBM

Printer Break-through

A new 10-digit display calculator with the world's first dual-element integrated printing head will revolutionize the printing calculator.

The full-featured $89.95 Canon P10-D with its one-year parts and labor limited warranty is the greatest printer value ever offered by JS&A.

Hats off to IBM. Their single-element typing system did away with typewriter keys and started a new technology.

The new Canon P10-D printing calculator starts another new technology. Their dual-element printing system does away with the standard printing head which required a separate disc for each column. The Canon has only two discs–one with digits and the other with symbols.

The P10-D head weighs only ½ ounce compared to 31 ounces in a typical printing head. Its motor weighs only nine ounces–again much less than the heavier conventional motors required to drive larger heads. The Canon motor is smaller, lighter and more efficient because it moves less weight.

THE MOST EFFICIENT SYSTEM

The printing head is controlled by an LSI (large scale integrated circuit). As you press a key, a pulse is generated from this circuit and sent to the motor which does two things: 1) positions the two discs to print the numbers or symbols and 2) glides the numeric disc across the ten column width of the paper.

Conventional printers print from metal discs through thick fabric ribbon onto paper. The Canon system prints directly on paper so each impression is sharp, clear and easy to read. The synthetic polymer disc is first inked by a special cartridge before it prints. Each ink cartridge is easily replaceable. The cartridge lasts for more than 15 rolls of paper at a cost of 17¢ per roll–far less than any other system.

PLAIN PAPER PLUS

Using standard paper tape is only one of several advantages that make the Canon a truly spectacular value. Here are some other exciting new features:

Dual Power Operate the Canon from either your AC outlet or its built-in rechargeable batteries. It's totally portable, yet it also makes a handsome desk calculator.

Dual Display Just flip a switch and the 10-digit large green fluorescent display can be used with or without the printer.

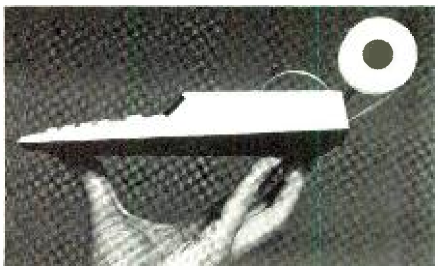
Space-Age Styling Compare the sleek appearance of the Canon with any other printer. It's small enough to fit in your briefcase and large enough to use as a space-saving desk unit. It measures only 1¾" x 4¼" x 8½", weighs only 24 ounces and the paper tucks into the body of the unit–perfect for travel.

Buffered Keyboard If you enter your problems faster than the printer can print them out, don't worry. The unit's memory stores your keystrokes and prints them out in rapid succession.

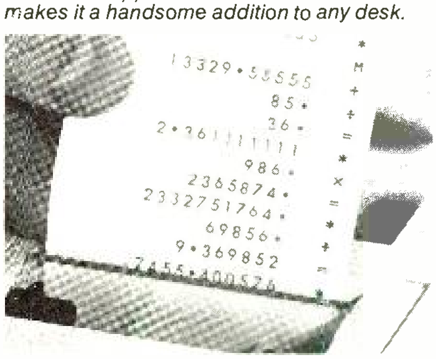
We have always looked at small printers as gimmicks–calculators that lack many important features. We were surprised with the Canon. It has features that far exceed most printers costing hundreds of dollars more.

The following is a list of those features: 10 digit capacity • full four-key memory • addition, subtraction, multiplication and division • percentage key • add-on and discount calculations • power and reciprocal calculations • repeat calculations • add-mode • switch for full-floating or second and third fixed decimal positions • round off or round down switch • paper tape advance.

There are other convenient features that make it perfect for people who spend hours at their calculators. There's a three-digit item counter that counts and prints out the number of entries while printing your total. The symbols on the right side of the tape tell you the nature of each entry. Even in its battery operated position, you could print out more than half a roll of tape before the unit signals you that its batteries are low.



The sleek appearance of the Canon P10-D makes it a handsome addition to any desk.



The direct-impression dual discs print cleaner and sharper on conventional paper tape.

A NEW WAY TO BUY

JS&A offers you a new way to buy your 10-digit Canon P10-D. First we give you the opportunity to use one for 30 days. Carry it in your briefcase. Put it on your desk and see how handy it becomes and how little space it takes up. Check the paper tape and see how clear and easy-to-read it is. Bring it home and let the whole family use it.

Then, within 30 days, decide. If the Canon is not perfect for you, return it for a prompt and courteous refund. And if you do return it, not only will we still consider you one of our good customers, but we will also refund your $2.50 postage, let you keep the paper tape, and thank you for giving us the opportunity of showing it to you. We couldn't be more positive about the quality and value of this incredible new product.

JS&A is America's largest single source of space-age products. We have been in business for over a decade–further assurance that your modest investment is well protected. Canon is one of the world's largest manufacturers of cameras and precision quality instruments and is highly respected as a quality manufacturer of electronic products.

The Canon costs only **$89.95** plus $2.50 for postage and handling and includes a free roll of tape, one ink cartridge, rechargeable batteries and a power cord/charger. It's an incredible value thanks to its new technology. To order, send your check to the address below (Illinois residents add 5% sales tax) or credit card buyers may call our toll-free number.

Space-age technology has produced another major product breakthrough. Order your Canon P10-D at no obligation today.

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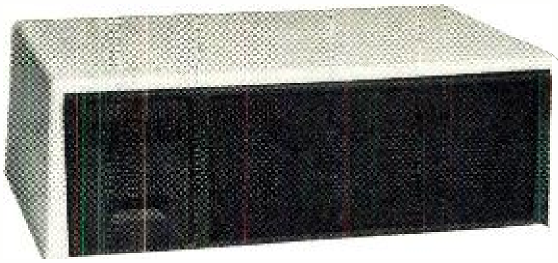
Burglar Alarm Breakthrough



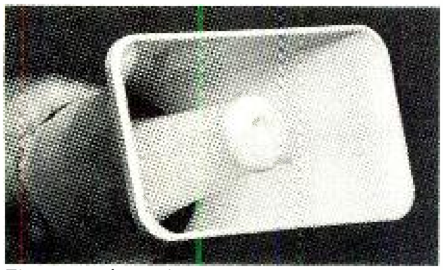
A new computerized burglar alarm requires no installation and protects your home or business like a thousand dollar professional system.

The Midex security computer looks like a handsome stereo system component and measures only 4"x 10½"x 7."

It's a security system computer. You can now protect everything—windows, doors, walls, ceilings and floors with a near fail-safe system so advanced that it doesn't require installation.

The Midex 55 is a new motion-sensing computer. Switch it on and you place a harmless invisible energy beam through more than 5,000 cubic feet in your home. Whenever this beam detects motion, it sends a signal to the computer which interprets the cause of the motion and triggers an extremely loud alarm.

The system's alarm is so loud that it can cause pain—loud enough to drive an intruder out of your home before anything is stolen or destroyed and loud enough to alert neighbors to call the police.



The powerful optional blast horns can also be placed outside your home or office to warn your neighbors.

Unlike the complex and expensive commercial alarms that require sensors wired into every door or window, the Midex requires no sensors nor any other additional equipment other than your stereo speakers or an optional pair of blast horns. Its beam actually penetrates walls to set up an electronic barrier against intrusion.

NO MORE FALSE ALARMS

The Midex is not triggered by noise, sound, temperature or humidity—just motion—and since a computer interprets the nature of the motion, the chances of a false alarm are very remote.

An experienced burglar can disarm an expensive security system or break into a home or office through a wall. Using a Midex system there is no way a burglar can penetrate the protection beam without triggering the loud alarm. Even if the burglar cuts off your power, the four-hour rechargeable battery pack will keep your unit triggered, ready to sense motion and sound an alarm.

DEFENSE AGAINST PEEPING TOMS

By pointing your unit towards the outdoors from your bedroom and installing an outside speaker, light, or alarm, your unit can sense a peeping Tom and frighten him off. Pets are no problem for the Midex. Simply put them in one section of the house and concentrate the beam in another.

When the Midex senses an intruder, it remains silent for 20 seconds. It then sounds the alarm until the burglar leaves. One minute after the burglar leaves, the alarm shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away. When your neighbors hear it, they'll know positively that there's trouble.

PROFESSIONAL SYSTEM

Midex is portable so it can be placed anywhere in your home. You simply connect it to your stereo speakers or attach the two optional blast horns.

Operating the Midex is as easy as its installation. To arm the unit, you remove a specially coded key. You now have 30 seconds to leave your premises. When you return, you enter and insert your key to disarm the unit. You have 20 seconds to do that. Each key is registered with Midex, and that number is kept in their vault should you ever need a duplicate. Three keys are supplied with each unit.

As an extra security measure, you can leave your unit on at night and place an optional panic button by your bed. But with all its optional features, the Midex system is complete, designed to protect you, your home and property just as it arrives in its wellprotected carton.

The Midex 55 system is the latest electronic breakthrough by Solfan Systems, Inc.—a company that specializes in sophisticated professional security systems for banks and high security areas. JS&A first became acquainted with Midex after we were burglarized. At the time we owned an excellent security system, but the burglars went through a wall that could not have been protected by sensors. We then installed over $5,000 worth of the Midex commercial equipment in our warehouse. When Solfan Systems announced their intentions to market their units to consumers, we immediately offered our services.

COMPARED AGAINST OTHERS

In a recent issue of a leading consumer publication, there was a complete article written on the tests given security devices which were purchased in New York. The Midex 55 is not available in New York stores, but had it been compared, it would have been rated tops in space protection and protection against false alarms—two of the top criteria used to evaluate these systems. Don't be confused. There is no system under $1,000 that provides you with the same protection.

YOU JUDGE THE QUALITY

Will the Midex system ever fail? No product is perfect, but judge for yourself. All components used in the Midex system are of aerospace quality and of such high reliability that they pass the military standard 883 for thermal shock and burn-in. In short, they go through the same rugged tests and controls used on components in manned spaceships.

Each component is first tested at extreme tolerances and then retested after assembly. The entire system is then put under full electrical loads at 150 degrees Fahrenheit for an entire week. If there is a defect, these tests will cause it to surface.

PEOPLE LIKE THE SYSTEM

Wally Schirra, a scientist and former astronaut, says this about the Midex 55. "I know of no system that is as easy to use and provides such solid protection to the homeowner as the Midex. I would strongly recommend it to anyone. I am more than pleased with my unit."

Many more people can attest to the quality of this system, but the true test is how it performs in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail-safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones.

Use the Midex for protection while you sleep and to protect your home while you're away or on vacation. Then after 30 days, if you're not convinced that the Midex is nearly fail-safe, easy to use, and can provide you with a security system that you can trust, return your unit and we'll be happy to send you a prompt and courteous refund. There is absolutely no obligation. JS&A has been serving the consumer for over a decade—further assurance that your investment is well protected.

To order your system, simply send your check in the amount of **$199.95** (Illinois residents add 5% sales tax) to the address shown below. Credit card buyers may call our toll-free number below. There are no postage and handling charges. By return mail you will receive your system complete with all connections, easy to understand instructions and a one year limited warranty. If you do not have stereo speakers, you may order the optional blast horns at **$39.95** each, and we recommend the purchase of two.

With the Midex 55, JS&A brings you: 1) A system built with such high quality that it complies with the same strict government standards used in the space program, 2) A system so advanced that it uses a computer to determine unauthorized entry, and 3) A way to buy the system, in complete confidence, without even being penalized for postage and handling charges if it's not exactly what you want. We couldn't provide you with a better opportunity to own a security system than right now.

Space-age technology has produced the ultimate personal security computer. Order your Midex 55 at no obligation, today.

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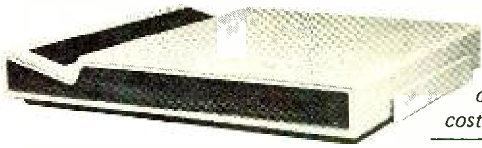
Computer Scale

Add some fun to losing weight with a new, extremely accurate and easy-to-read digital scale.



The world's first bathroom digital computer scale is simple to operate, fun to use and costs only $49.95.

It's fun to weigh yourself on a computer. Just step on the Counselor computer scale and your exact weight in pounds is flashed on the display in bright red numbers.

Losing weight is not easy. Ask anyone.

One of the few pleasures of losing weight is stepping on your bathroom scale and seeing positive results. Your bathroom scale is like a report card—a feedback mechanism that tells you how well you've done.

The new American-made Counselor 77 platform scale is the newest and best way to weigh yourself. In the first place, it's accurate to within one pound. (Most platform scales are accurate to within three pounds.) Secondly, it has an easy-to-read, large LED (light-emitting diode) display. There are no balance beams or fine lines to interpret. And finally, it is easy to use—just step on it and read your weight. There's no guessing as your weight, up to 300 pounds, is flashed on the display.

EASY TO USE

Simply tap the activator bar in front of your scale with your toe and the unit turns on. Step on the scale, and read your weight. Fifteen seconds later, the scale shuts off automatically.

By sliding a switch you can weigh yourself in kilograms—an important feature since the US is changing over to the metric system.

The accuracy is not affected by temprature nor humidity like other scales since the Counselor 77 spring is precalibrated and sealed at the factory. This is important, for it means that each time you step on the scale, you'll know what you've lost is weight and not your scale's accuracy.

SEE THE DIFFERENCE

The best way to see the difference a really good scale makes in your weight reduction program is to try a Counselor scale for one month. We give you that opportunity with our free 30 day trial period. Weigh yourself every day. See how easy it is to read your exact weight loss on a daily basis. Soon, stepping on your scale becomes a fun experience for your whole family, and everybody starts watching his or her weight.

If you purchase the Counselor for your company lunch room for use by your employees, the purchase is deductible as a business expense.

Service should never be required (other than yearly battery replacement) but JS&A's prompt service-by-mail facility is always ready to handle any service requirements.

The Bearly Company, manufacturers of the Counselor, is the largest manufacturer of bathroom scales in the United States. JS&A is America's largest single source of space-age products, further assurance that your modest investment is well protected.

You can order your platform computer scale by sending your check for $49.95 plus $2.50 for postage and handling or $350 for the Hospital Computer scale (we pay the freight) to the address below, or credit card buyers may call our toll-free number. Illinois residents should also add 5% sales tax.

By return mail, you'll receive your scale, four pen-light batteries, and your 90-day limited warranty. If you do not find that the Counselor scale is the best way to weigh yourself—far better than any scale you presently have in your home—then return it within thirty days for a prompt and courteous refund which will include your $2.50 postage. You can't lose, even if you just try the scale.

The age of weighing yourself by computer is here now. See how much fun losing weight can be with your own solid-state digital scale. Order one at no obligation today.

Hospital Computer Scale

Counselor also makes a Hospital Computer scale for $350. It's an extremely accurate system that weighs you to within one tenth of a pound up to 400 pounds. Since many consumers have also bought them from JS&A, we have decided to offer both in our program.

WORKS LIKE A COMPUTER

You press a button to electronically register a true zero position. You then step on the scale and your body weight causes a minimum friction disc to rotate. Two photo transistors sense the speed of the disc and its direction and feed this information into the unit's computer. The computer then interprets this data to within a tenth of a pound accuracy and activates the large eight tenths of an inch LED read-out display located directly in front of you.

The entire process takes a fraction of a second and is the fastest way to accurately read your weight. The only moving part, the rotating disc, is heat treated to last a lifetime so there are no parts to wear out nor is there any maintenance required except for yearly battery replacement. The Hospital Computer scale comes complete with four nine-volt batteries.

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CIRCLE NO 25 ON FREE INFORMATION CARD

Letters

MORE DX PUBLICATIONS

I'd like to add the following to the September "DX Listening" list of available publications. The IRCA (International Radio Club of America) can supply reprints of BCB DX articles. Also, the club offers the IRCA Foreign Log and Sunrise-Sunset Maps for the serious DX'er, as well as a bulletin, "The DX Monitor," issued 34 times a year. For a free list, write: IRCA Goodie Factory, P.O. Box 17088, Seattle, WA 98107, enclosing a SASE—*Don Davis, Warner Robins, GA.*

ANOTHER POWERFUL MICROPROCESSOR

I feel that "Basic Guide to Computer Buying" (December 1977) is one of the finest articles of its type to appear in a noncomputer hobby magazine. The research on the article was excellent. However, the author failed to mention the most powerful microprocessor on the market, the Texas Instruments TMS 9900. We incorporate this μP in our Super Starter System and, to date, have more than 1000 users. (This is the same processor used in TI's 990/4 computer. It is also to be used in 1979 Chrysler vehicles and is the only μP approved for space flight use.) If you were to make comparisons, you would find that the 9900 is closer to an IBM 360 than it is to the 8-bit controller processors discussed in your article. —*Bill Regan, Pres., Technico Inc., 9130 Red Branch Rd., Columbia, MD 20145.*

HP-25 CLOCK/TIMER ADDENDUM

"The HP-25 as a Digital Clock and Timer" (August 1977) fails to mention several things, to wit: Register 1 should be cleared or set before each run. The display lags by one second because it shows 0.0000 *after* the first second. (The remedy is to start from step 04 on each run or put a GTO 05 at the beginning of the program and move everything else down one step, changing the last step to GTO 02. The extra step, executed only once, will not significantly affect the time.) Before adding or subtracting the timing adjustment number to or from the original time base (1/3600), one must divide by 10,000 to compensate for the position at which the seconds are displayed. When using a starting time of exact hours, the conversion to decimal hours is not necessary.

The following program is for a count-down clock. The program starts itself properly and stops on zero. The extra steps (except 02) will not affect timing because they are executed only once. Step 02, however, must be accounted for in the time-base correction. It should make the timer run slow.

01	GTO 07	07	RCL 2
02	RCL 1	08	STO − 1
03	g, x, 0	09	GTO 02
04	GTO 10	10	CLX
05	f, H.MS	11	GTO 00
06	f, PAUSE		

Certain time-base corrections cause the timer to display a small number in scientific notation just before stopping at zero. It may also appear in place of 1 second. Nothing can be done about this without program modification, so the best thing to do is use it as zero or one when it occurs.

My correction was on the order of three times those necessary for the count-up timer because of the repeatedly executed extra step. Compute the correction and approximately triple it and experiment to find an accurate combination.—*Tony Wichersham, Laramie, WY.*

Out of Tune

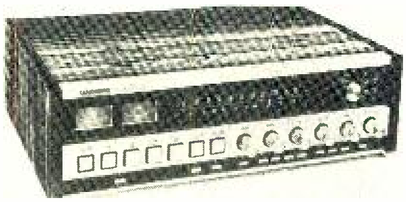
In "Build 'Charge!'" (January 1978), transistor Q2 should have been shown in Fig. 1 as an npn D42C3. The Parts List was correct.

New Products

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

Tandberg AM/ Stereo FM Receiver

Tandberg has announced the Mk II version of its TR-2075 AM/stereo FM receiver. Power has been increased to 75 watts rms per channel into 8 ohms, at 0.05% THD and IM distortion, says the manufacturer.

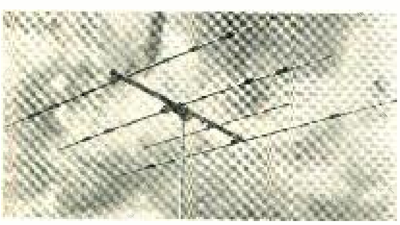


Specifications claimed are: ultimate FM quieting, 75 dB in stereo; capture ratio, 0.9 dB; phono section S/N, 89 dB; sensitivity (50 dB quieting, mono), 3 μV. Features include Varactor-diode tuning, a toroidal power transformer, signal-strength and tuning meters, facilities for two turntables, two tape monitors, and three pairs of speakers. Front-panel controls and switches include a midrange tone control, high and low filters, and 25-μs pushbutton switch. $1100.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Cushcraft Ham Base Antenna

The Cushcraft ATB-34 is a 4-element beam antenna for the 10-, 15- and 20-Meter amateur bands. Forward gain is rated at 7.5 dB referenced to a half-wave dipole; front-to-back ratio is rated at 30 dB,



and VSWR at 1.5:1 (or less) at resonance. Feed is 52 ohms through a supplied 1:1 balun. The antenna has high-Q coaxial traps rated for 2-kW PEP power handling. It has an 18′ (5.48 m) boom and a maximum element length of 32′ 8″ (9.95 m); tuning radius is 18′ 9″ (5.71 m). Wind surface area is 5.4 sq ft (0.50 m²), and estimated wind survival is 90 mph (144 km/h).

CIRCLE NO. 94 ON FREE INFORMATION CARD

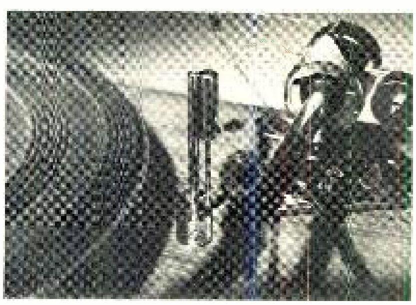
Midland CB/AM/Stereo FM Radio

The Midland Model 77-907 combines a 40-channel, full-power CB transceiver with digital channel indicator and an AM/stereo

FM radio in a dashboard-mounted unit. Features of the CB section include front-panel controls for mike gain and squelch, plus switchable PA function and r-f gain. A standby switch allows the user to monitor incoming CB calls while tuned to an AM or FM station. Other features include station presets (2 for AM, 3 for FM), a stereo indicator light, a local/distant switch, and both tone and stereo balance controls. A built-in meter indicates signal strength and modulation in B mode, or acts as a tuning meter for AM and FM listening. $319.95.

CIRCLE NO 95 ON FREE INFORMATION CARD

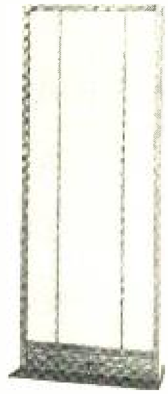
Stylift "Automates" Manual Arms



The "Stylift" is a simple device which automatically raises manual tonearms at the end of the record. There is no drag on the arm during play; but when the arm moves in far enough to contact the Stylift, it overbalances the device's counterweight, which then revolves to lift the arm off the record surface. $19.95. Address: Audio Source, 1185 Chess Dr., Foster City, CA 94404.

Magnepan Magneplanar Loudspeaker

Magnepan Inc.'s Magneplanar MG-I is, like the company's previous units, a thin-panel (2″ thick) dynamic, two-way speaker. Frequency response is rated by the manufacturer at ± 4 dB from 50 to 16,000 Hz; maximum power-handling capacity is 200 W rms per channel, with 40 W/ch minimum power recommended. The woofer and tweeter panels crossover at 2400 Hz; and

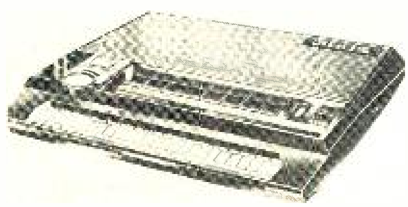


impedance is claimed to be a purely resistive 6 ohms at any frequency. The system is 60″ H x 22″ W x 2″ thick (152.4 x 55.9 x 5 cm), stands on a 24″ x 14″ (61 x 35.6 cm) base, and weighs 35 lb. $495 per pair.

CIRCLE NO 96 ON FREE INFORMATION CARD

Portable Mini-Synthesizer

The Stylophone 350S is a battery-operated musical instrument the size of a portable typewriter. Sliding a pencil-like stylus across a printed "keyboard" produces 44 notes over a 6½-octave range. Two styli can be used at once to create harmony. Tone switches allow the simulation of specific instrument sounds; while other



switches control vibrato, fade-out, crescendo and reiteration. Hand placements above a light-sensitive cell also affect the tone quality. The unit has a built-in speaker and an output for use with external amplifiers. It weighs less than 5 lb with batteries. Address: Audio Arts, 5615 Melrose Ave., Hollywood, CA 90038.

Nakamichi "BlackBoxes"

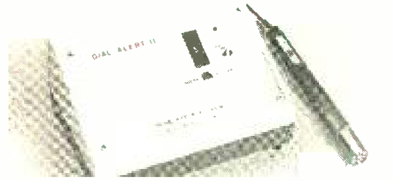
Nakamichi has announced a series of specialized accessory components for use with audio systems. The new BlackBox Series includes: the SF-100 Subsonic Fil-

ter ($70), which can provide either a 50-dB cut at 10 Hz or a slight boost of +5 dB at 30 Hz; the LA-100 Line Amplifier ($70), which provides 0, +6 dB, +12 dB or +18 dB gain to compensate for preamplifier-amplifier level mismatches; the MB-150 Moving-Coil Booster Amplifier ($100) for use with moving-coil phono cartridges; the BA-150 Bridging adapter ($60) to bridge both channels of Nakamichi power amplifiers for higher-powered, monophonic use; the EC-100 Electronic Crossover ($100); the MZ-100, 3-input microphone mixer ($80); and the PS-100 ±10-V power supply ($70).

CIRCLE NO 97 ON FREE INFORMATION CARD

Telephone Alert Burglar Alarm

Seaboard Electronics announces availability of its Dial-Alert II burglar alarm, which plugs into a telephone jack. When triggered by any of twelve sensors, it calls a pre-programmed telephone number. The person who picks up the phone first hears a coded signal identifying the alarm location. Then a microphone relays intruders' conversations or audible movements, the sound of breaking glass, audible signals from smoke or fire alarms, etc. Once answered, the alarm can be remotely shut off. A 16-digit memory holds the telephone



number including area code, access code, and foreign exchanges. Optional sensors include a Doppler-shift radar prowler detector; smoke, toxic-gas, freeze, glass-break and refrigerator-temperature sensors; two pressure sensors (one for use under valuable objects, the other for use under carpets); and a pocket-size wireless alarm for remote triggering. $269.50 (sensors extra). Address: Seaboard Electronics Co., 70 Church St., New Rochelle, NY 10805.

Sanyo Direct-Drive Turntable

Sanyo's Model TP-20 direct-drive turntable is semi-automatic, with automatic arm return. The drive system includes a 24-pole,

CIRCLE NO 8 ON FREE INFORMATION CARD

30-slot brushless dc motor with electronic servo speed control, ± 3% speed adjustment for pitch control, and a 2.2-lb, die-cast aluminum platter. Other features include a mirror for stylus inspection, plug-in headshells, and viscous-damped downward cueing. Specifications are: 0.05% wow and flutter, 60 dB S/N, −60 dB weighted rumble (DIN B). Minimum tracking pressure is said to be 1 g, and tracking error is ± 1.5%. With hinged dust cover and base, dimensions are 17¾" W x 15" D x 9¾" H (45.1 x 38.1 x 24.8 cm). $129.95.

CIRCLE NO. 98 ON FREE INFORMATION CARD

President SSB Mobile CB Transceiver

The President "Adams" AM/SSB transceiver has pushbutton selection of channel 9 or channel 19, plus a scanning circuit which constantly monitors channels 9, 19, and any other channel of the user's choice. Other features are an S/r-f meter that also measures SWR, a 40-channel LED digital readout, a panel dimmer, and controls of microphone and r-f gain, plus a tone control. Manufacturer's claimed specifications include: 65 dB of spurious and harmonic suppression; sensitivity for 10 dB S+N/N of better than 0.5 μV for AM, better than 0.25 μV for SSB; adjacent channel rejection of 70 dB, and cross-modulation suppression of 60 dB. $369.95.

CIRCLE NO. 99 ON FREE INFORMATION CARD

ESS Transar Speaker

The Transar from ESS Inc., is an amplified speaker system using a woofer that is somewhat similar in principle to the Heil "air-motion transformer" (which is used as Transar's midrange/tweeter unit). The woofer consists of a 32-inch vertical stack of lightweight, rigid diaphragms interconnected by carbon-fiber drive rods. A single voice coil drives the interconnected diaphragms up and down, while 45-degree reflector plates re-direct the sound to front and rear. Claimed advantages of the system include low mass (for low inertia and good transient response) and the elimination of diaphragm resonance effects. The system also includes a built-in amplifier with electronic crossover at 1000 Hz rated at 200 watts per channel into 8 ohms with less than 0.1% distortion. The system is 50" W x 40" H x 6" D (127 x 101.6 x 15.2 cm) and is available in a variety of finishes. The price of $3,250 per pair, includes assembly, installation and real-time-analyzer adjustment in the buyer's home.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Stereo-System Remote Control

The Ster-A-Mote system of control panels and adapters adds remote-control facilities to new and existing stereo component systems. It consists of a power supply, control decoder, function selector, and speaker muting protection circuit. Any one of four stereo source inputs can be selected; and it can independently control volume and switch speakers in any room. Additional accessories include an add-on FM memory tuner, with six remotely selected station presets that connect to the i-f section of existing FM tuners and receivers. Prices vary with system components. Address: Ster-a-Mote, Inc. 1790 Flatbush Ave, Brooklyn, NY 11210.

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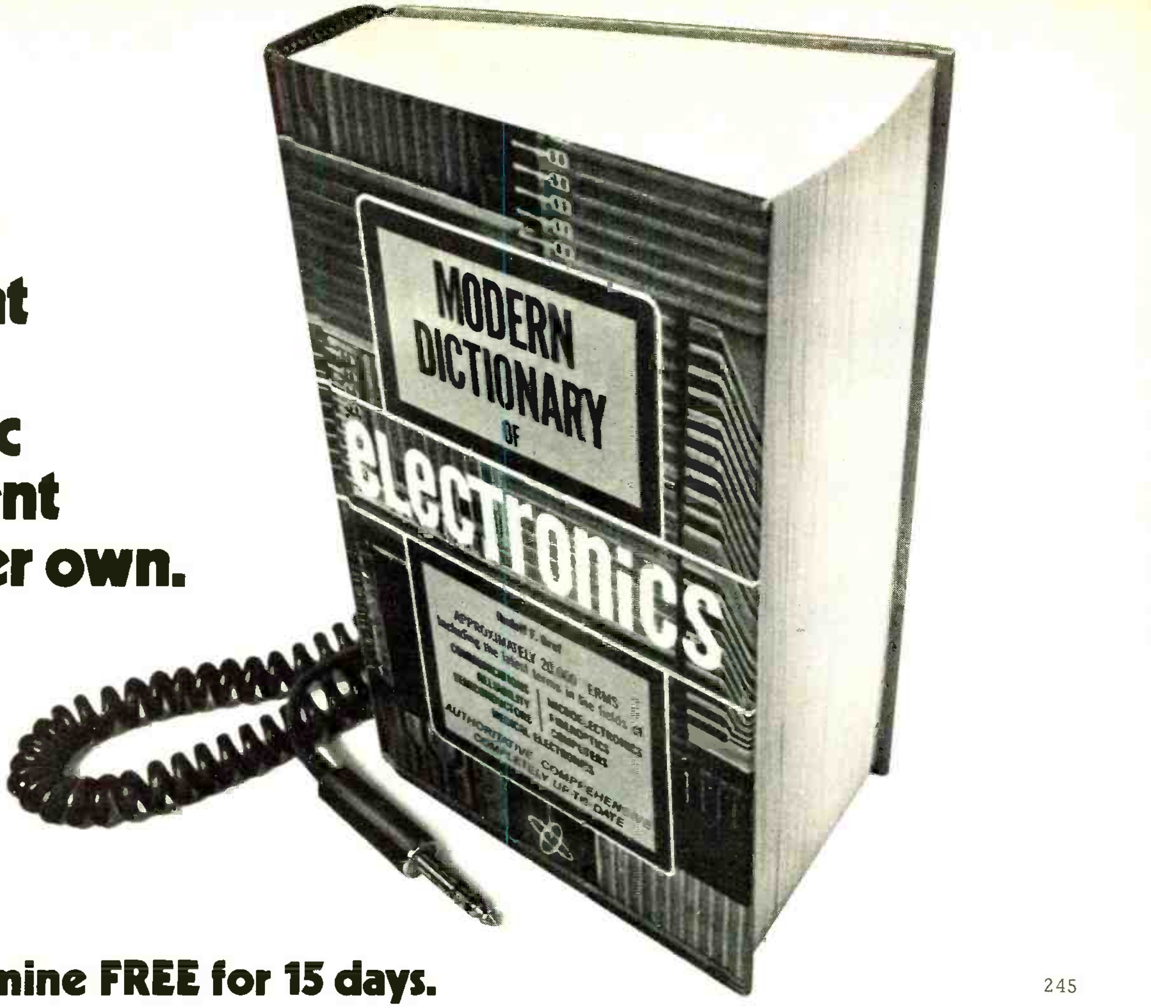

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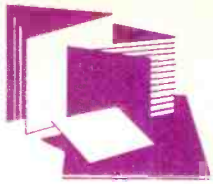

New Literature

SWITCHCRAFT CONNECTOR BROCHURE

A new, 8-page brochure from Switchcraft describes the Quick Ground Professional (QGP) audio connector line. Designed for professional use, the QGP line offers such benefits as nonreflective finish to prevent glare where bright lights are used, gold-plated contacts and pins and re-inforced plastic insulation. Address: Switchcraft, 5555 North Elston Avenue, Chicago, IL 60630.

LEADER TEST INSTRUMENT CATALOG

This 48-page catalog presents features, applications, and specifications of five product lines. Featured products include oscilloscopes, vectorscopes, multimeter and millivoltmeters, audio analyzers, digital frequency counters, signal and sweep marker generators, and a wide range of communications test gear. Address: Leader Instruments Corp., 151 Dupont Street, Plainview, NY 11803.

SYLVANIA ECG CB REPLACEMENT GUIDE

Sylvania ECG semiconductor replacement guide lists 5000 part numbers for CB equipment. Included are diodes, integrated circuits, modules, rectifiers, and transistors used in 73 different brands of CB equipment. It also contains a section cross referencing equipment brand names. Part numbers listed in the guide are found in all types of CB equipment. Address: General Telephone & Electronics, Public Affairs Department, One Stamford Forum, Stamford, CT. 06904.

AR LOUDSPEAKER CATALOG

"Truth in Listening," from Acoustic Research, defines the characteristics of accurate sound reproduction and describes the expanded AR high-fidelity speaker line. Charts, photos, and artwork are provided. Complete specifications are included for all seven AR speakers. Other information helpful to the prospective loudspeaker buyer is given. Address: Acoustic Research, 10 American Drive, Norwood, MA 02062.

ANTENNA REFERENCE CHART

Now available from Antenna, Inc. is a new reference chart describing antennas with various mounting configurations for the 25-30, 30-36, 36-42, 42-50, and 130-174 MHz ranges. The chart includes information on mobile, quarter wave-length, monitor, and base station antennas. A section describing the company's antenna accessories is also included. Address: Antenna, Inc., 23850 Commerce Park Road, Cleveland, OH 44122.

GE MINIATURE LAMP CATALOG

This catalog from General Electric features 70 new additions to their line of miniature lamps of all types, including 38 halogen-cycle lamps, and 19 wedge-base lamps. It has a numerical index, table of applications and design considerations as aids in lamp selection. Address: Miniature Lamp Products Department, General Electric, #3382, Nela Park, Cleveland, OH 44112.

CEI EQUIPMENT AND KIT CATALOG

The new 36-page catalog from Caringella Electronics describes its line of electronic products, which are available in assembled or kit form. Included are a WWV/CHU standard-time receiver, panel-mount digital clocks, a 3½"-high digital wall clock, audio compressors, electronic security alarms, and electronic test equipment. Technical specifications, photos, application information, schematics, and a description of each product are featured. Address: Caringella Electronics, Inc., Box 727, Upland, CA 91786.

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Stereo Scene

By Ralph Hodges

THE FUROR OVER (GULP!) CABLES

SOME YEARS ago, while visiting the JVC Research Center outside of Tokyo, I was given a pair of curious-looking loudspeaker hook-up cables by JVC's chief of tuner design, who then proceeded to extol their audible virtues at some length. I found it unaccountable that a major engineering representative of a generally conservative and highly respected audio manufacturer should be dispensing this brand of snake oil; particularly when at his elbow, indicating tacit agreement, sat T. Inoue, developer of the CD-4 system and an audio researcher of vast reputation.

The cables consist of about eight pairs of black and red insulated strands, plaited and brought out into tinned pigtails at either end.

(I have since learned that they are called in English—the printing on my package was all in Japanese—JVC "Super Cord.") I brought them home with me and displayed them before the wise old heads that speak authoritatively about audio in this country. The typical reaction was hilarity. Yes, the cables' performance might very well follow the general trend of JVC's graphical data, they allowed (Fig. 1), but only at frequencies well into the r-f range.

A few simple measurements were made. Capacitance appeared to be about 0.002 microfarad, which was deplored (an equivalent length of No. 18 zip cord is almost an order of magnitude lower), while dc resistance seemed to be comparable to that of zip cord. It can probably be assumed that the self-inductance of the JVC cable is low because of its inductance-cancelling construction. Its other attributes were generally thought to be of dubious value.

Ah, but how did the cables affect sound? I wish I could say. They turned out to be too short to make the run from my equipment cabinet to my speakers, and in the absence of any agreed-upon technical justification for them I was at a loss to figure out how to extend them without possibly interfering with their intended performance. I also felt, quite frankly, that I probably had more pressing matters to attend to. But here I may have been hasty, because the JVC cables have suddenly acquired a number of vigorous supporters and competitors.

The Cable Question. As best I can determine, the subject of connecting cables really began to enter the U.S. audiophile consciousness with the advent of discrete 4-channal cartridges, the increase in popularity of moving-coil phono cartridges and the simultaneous boom in CB, which brought to light interference problems. Suddenly there was a real job to be done in properly shielding and grounding low-level, high-gain, audio-frequency circuits, and companies like Verion and, more recently, Teac began to respond with suitable products. However, there is nothing in Verion's approach that doesn't conform to accepted engineering practice. The idea is to supply top-grade triaxial cables (the outer shield does not carry signal) with high-quality phono-plug (epoxy sealed and secured) terminations. Spade lugs at both ends of every cable length connect to chassis ground points or to heavy-duty grounding strips available from the manufacturer. Fully outfitting a system with Verion connectors turns out to be rather expensive, but at least you can appreciate the rationale behind it, and you know what results to expect. Can the same be said for the presently proliferating "exotic" speaker cables?

Reports from the field seem to vary. I have seen some correspondence from consumers who have purchased the cables and experienced no audible change whatsoever. They are naturally in high dudgeon over having spent not less than $1 per foot for nothing. On the other hand, I have heard from an audio dealer who has sold any number of sets of the Polk SoundCable (similar in many respects to the JVC Super Cord) on a money-back basis and has never had a single set returned to the store. His customers claim to hear such things as increases in overall system gain, dynamic range, subjective high-frequency response, and "definition" (for want of a more descriptive word).

The Theory. Those eager to make a case for the exotic cables offer a number of explanations for what they hear as an improvement. First and foremost they talk about ac impedance (as opposed to dc resistance) and the associated phenomenon of "skin effect" or "surface effect" in a conductor. The result of this is said to be a general rise in impedance with frequency, which is less than ideal, particularly if the loudspeaker system exhibits a relatively low impedance at high frequencies (not by any means always the case, of course, but a possibility if multiple tweeters are used). Some phase shift occurs as well—not enough to have been of great concern up to now, but enough to be visible on a high-frequency square wave (Fig. 2). Observation of these effects seems to have led to the popularity of Litz wire

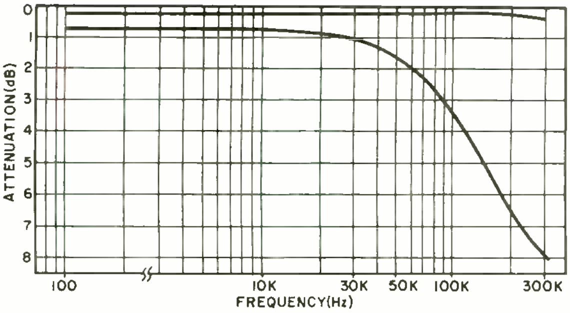


Fig. 1. JVC's data contrasting performance of 14 meters of Super Speaker Cable (upper curve) to that of 14 meters of No. 18 zip cord.

(bundles of thin, individually insulated conductors) in the super cables of today.

Another goal of these cables is the minimizing of self-inductance. The flat-braid construction of the JVC cables seems to have that in mind, as does the counter-spiraling makeup of the Polk cables. As for capacitance, both seem to be somewhat of a step backward from the zip cord more commonly in use, but whether that will pose a problem of any magnitude probably depends on the characteristics of the particular sound system with which they are used. There is every evidence that quite a number of popular amplifiers can be induced into oscillation if a certain value of capacitance—generally not too small nor too big—appears at their outputs. If the speaker cable adds enough capacitance to exceed that value, everything should be all right. However, if it adds just enough to attain it, well. . . .

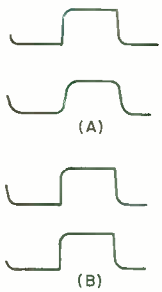
The metallic purity of the conductor also comes up for question. Some people object to tinned copper wires or wires that contain even trace amounts of magnetic material. Even the insulating material of the conductors has been singled out as an area requiring much further study. And as you might anticipate, the audio "quality" of associated solder joints and connectors is also being exposed to a fresh round of criticism.

The Practice. Even the most serious theorists freely admit the cable question is far from being pinned down. However, it's hard to argue with the enthusiasm that even comparatively casual listeners have worked up for some of the new speaker wires. Many of my personal acquaintances who have either managed to swing the not-inconsiderable investment or have been able to borrow a cable set are now complete converts. On the other hand, some very serious audiophiles within my circle of friends have noticed no changes in their systems. There is also another side to the matter.

Not long ago I was commissioned to design a demonstration for a major audio manufacturer's press conference in a posh New York hotel. The heart of it was to be a sound system that would be exotic and expensive enough to attract some attention, loud enough to serve an audience of about 70, and sufficient in quality to permit fairly meaningful comparisons of different recording media to be made. Because exotic and expensive were among the criteria—and because I was curious—I asked for some Polk cables to be on hand for experimentation.

Verion cables and grounding strips comprised the lash-up right up to the power-amplifier inputs, and it was in-

Fig. 2. A 20-kHz square wave shows some rounding after passage through standard zip cord (A). An equivalent length of JVC cable leaves square wave comparatively intact as at (B).



deed gratifying to discover how quiet the final system was, even with the Empire State Building's formidable antenna mast looming over our shoulders. And then, at the eleventh hour, when the system had been playing happily and thunderously for the whole evening and the demonstration had been rehearsed several times, we decided to substitute the Polk cables for our heavy-gauge zip cord, just to see what would happen. The results were dramatic to say the least. Within a moment of turn-on—and with no audio signal as yet—amplifier channels began falling like dominos, so that within sixty seconds we were completely shut down.

By relating this anecdote I don't mean to indict either the cables or the amplifiers, both of which have obviously performed creditably under other circumstances. But I do wish to underline the apparent fact that audio remains fraught with some great unknowns and some remarkable surprises even today. ◇

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Julian Hirsch Audio Reports

FIDELITY—OR BELIEVABILITY?

THE TERM "high fidelity" means different things to different people. For me, it is easier to list some of the things it is *not* than to attempt to define it specifically. It is *not* superwide frequency response, from 20 to 20,000 Hz or far beyond. It is *not* a ruler-flat response within the audio range. It is *not* the absence of nonlinear distortion (harmonic, IM, TIM, or what have you). It is *not* the absence of phase or time delay distortions or of any other form of transient distortion. It should be clear that, in my opinion, while all the above qualities and many others are desirable in themselves, they are neither necessary nor sufficient to create a high-fidelity listening experience. I believe that no purely objective measurement or combination of measurements can be used, at this time with today's equipment, to define "hi-fi" sound in an unambiguous manner.

For me, the "hi-fi" quality of musical reproduction is a function of its *believability*. "Believable" is not the same as "real" or "live" or "natural." All of these criteria imply a comparison of the reproduced sound to the original sound, which is a fundamental impossibility in almost every case. It is possible to stage such a comparison, in the same listening environment, but this is a highly artificial condition. Such tests are usually conducted by speaker manufacturers, and may in fact prove something about the quality of their speaker systems. On the other hand, speaker systems that do an almost perfect job of imitating the live sound in such a test do not necessarily sound as "perfect" in the typical home listening environment. They may even sound much less pleasing (or believable) than other speaker systems that do not fare nearly so well in a "live-versus-recorded" test.

It would be most convenient if objective measurements could actually define the sound of a component or a system. It would take a lot of the controversy out of audio, since there would no longer be any arguments over whether a component with 0.001% "distortion" really sounds better than one with 0.01% "distortion," and so forth. Sad to say, things do not work out that way, and we must ultimately rely on each individual's perception of the sound. Since likes and dislikes in the world of hi-fi vary widely from listener to listener, the evaluation process leaves much to be desired.

"Believability" as used here means that the total effect of the reproduced sound should be consistent with the effect one expects from a real performance. The listener should be able to accept it as sounding like some hypothetical "live" performance, albeit one he may never have heard. To understand what this entails, let us consider a few of the attributes of a live musical performance. First and foremost, it has *no* nonlinear distortion. (Even if it is electronically created or amplified, as from a synthesizer or electronic instrument, the "distortion" in the sound is by definition a part of the original sound.) Second, the program dynamics are unmodified. What we hear is the full dynamic range of the original instruments, with no limiting, clipping, or compression.

One of the most important ingredients of believability is a natural *ambience*. This is the sense of air and space that exists in every concert hall. If it is present in the reproduced sound, one can come very close to believing that he is hearing a real performance. It has been claimed that certain amplifiers and phono cartridges are superior to others in the degree of ambience they impart to the reproduced sound, but these effects are so subtle that their very existence is open to question. Much less arguable is the ambience contributed by some speaker systems, especially those with omnidirectional or quasi-omnidirectional characteristics. Their ambience is derived from the listening room rather than the concert hall, but it is still much better than nothing. In any event, the contribution of the speaker system to overall believability, though greater than that of the other system components, is a very small part of the necessary total. The place where this quality is injected into or subtracted from the program is in the recording itself.

A record made in a "dead" environment, or created by multiple recording techniques, will never sound convincingly "live." No matter how much reverberation is introduced by the recording engineer, no one will always be fooled into thinking he is hearing a recording of a live performance. On the other hand, a skillfully made recording, in which the ambience of a good concert hall has been captured and which has been subjected to a minimum of signal processing, can sometimes sound startlingly "real." The effect is not the "reality" of the listener's presence in the concert hall and certainly not of the performer's being

transported to the listening room (a highly artificial condition, suitable only for small groups and soloists). Rather, it is the sense that one is hearing music made by real instruments and played in a real hall, together with much of the emotional and physical stimuli that accompany such an experience.

If this quality comes almost entirely from the recording process, what is the place of the high-fidelity music system in recovering it? Ideally, instead of adding some magical quality of its own, the music system should do a minimum of damage to the overall sound effect. Any form of *nonmusical* distortion, from any source, can destroy the illusion of reality. Moderate amounts of low-order harmonic distortion may do little more than alter the tonal character of instrumental sounds and may in fact be totally inaudible to the average listener. High-order harmonics and certain IM products are strongly nonmusical and cannot be tolerated at any audible level. Even these can often be masked by the program to the extent that they are difficult to hear. The kind of distortion that is unmistakable and intolerable is the mistracking of a phono cartridge (a "shattering" sound). Similar effects can be created by the voice coil of a speaker reaching the limits of its allowable excursion, or by clipping in an amplifier—especially if the amplifier's stability is imperfect.

Noise can be considered as a form of distortion. It becomes unacceptable just as soon as it intrudes upon our consciousness, perhaps even before then, since removing noise of which one was not consciously aware can sometimes make a dramatic improvement in the sound. Hum, hiss, and other noises have no place in a real performance and are just as out of place at home. Certain transient sounds, such as ticks and pops from dusty or scratched records, may be quite audible, yet no more disturbing than the rustling programs and coughing that afflict concert audiences during quiet moments in the program.

All of this may be self-evident, but the point is that the believability of a really good recording will come across to the listener through even a reasonably competent music system, whereas even the most exotic and expensive system will not restore quality to a recording that is lacking in the first place. There is a possible exception to this rule in the form of the time-delay accessories that have appeared in the past year or so from several manufacturers. Properly used, these can go a long way toward restoring a missing ambience to a recorded program. They are far from being panaceas, however, and are quite expensive. One should not expect any audio component to work miracles and transform a poor or mediocre sound into a thrilling experience. For that, you must start with a record that has the necessary information in its grooves from the beginning. *(Continued on page 30)*

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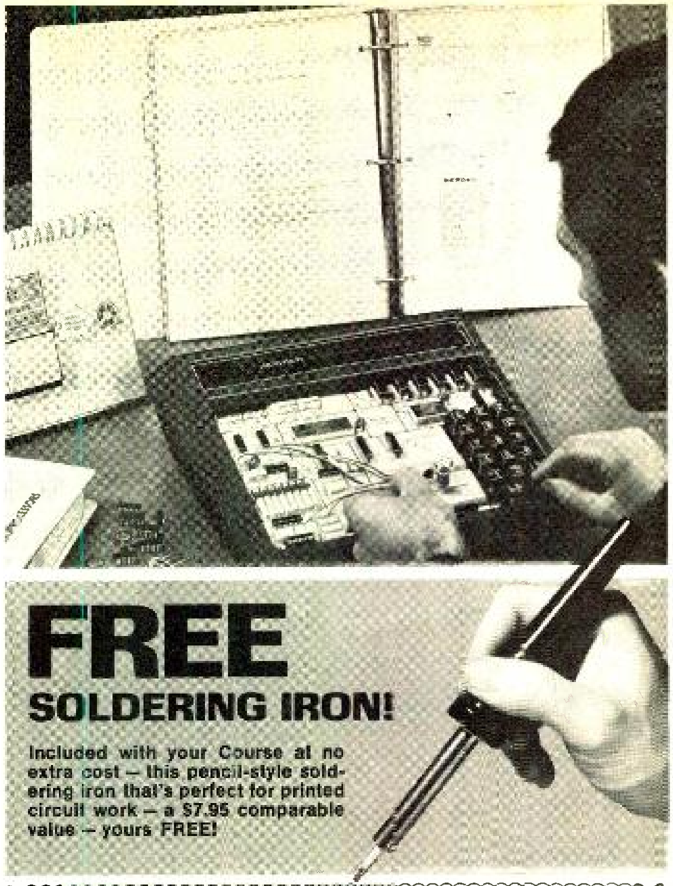

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SONY MODEL PS-X5 TURNTABLE

Quartz crystal controls direct-drive dc servo for low speed error.

HIRSCH-HOUCK LABS REPORT

The Sony Model PS-X5 is one of a new series of automatic single-play turntables whose direct-drive dc servo motors are controlled by quartz crystal oscillators. This gives them a speed error of less than 0.003% at the nominal 33⅓ and 45 rpm speeds. A magnetized ring inside the rim of the platter generates the feedback control voltage in a fixed eight-pole magnetic head assembly. The tonearm automatically indexes for 7", 10", and 12" (17.8-, 25.4-, and 30.5-cm) records. It can also be used manually if desired. The entire player shuts off automatically at the end of a record. The basic operating controls are located on the front of the base, where they are accessible with the cover lowered.

The Model PS-X5 tested here measures 17½" W × 14¾" D × 5⅞" H (44.5 × 37.5 × 14.9 cm) and weighs 22½ lb (10.3 kg). Manufacturer's suggested retail price is $230.

General Description. The dark gray base of the player is molded of an acoustically "dead" compound. The entire record player is supported on four soft rubber feet that are internally damped with a viscous gel. A removable hinged clear plastic dust cover is included. Holes on the motorboard provide storage for a 45-rpm adapter and for two additional headshells with cartridges.

Stroboscope markings for the two speeds are cast into the outer rim of the aluminum-alloy platter. They are illuminated by a neon lamp just outside the rim of the platter. The operating speeds are selected by two pushbuttons near the platter. A knob at the right of the motorboard selects the index diameter for the tonearm or places the player into its manual mode.

The other operating controls are a pushbutton POWER switch and two light-touch pushbuttons for the START/STOP and REPEAT functions. After power is applied, a touch of the START/STOP button turns on the motor, indexes the arm to the selected diameter, and lowers the arm to the record surface. After playing a record (or at any time the START/STOP button is touched while a record is being played), the arm returns to its rest and the motor shuts off. When the REPEAT button is engaged, a record is replayed indefinitely, until the player is manually shut off.

The tonearm is formed of an S-shaped aluminum tube. It has a light aluminum headshell and a rotating counterweight on which is located the tracking force scale. An auxiliary lateral balance weight extends from the arm pivot support. The antiskating dial and cueing lever are built into the base of the tonearm. The capacitance of the output signal cables is rated at 70 pF/channel.

The installation instructions specify a 49-mm distance from the stylus to the reference mounting surface of the headshell. The headshell is a four-pin bayonet locking type. A stylus protractor is also supplied to allow the user to verify that the tracking error is at a minimum near the inner diameter of a record.

Laboratory Measurements. Although we installed several types of cartridges in the player for our listening tests, our measurements were made using a Shure Model M95ED cartridge. The installation was straightforward, and the resulting tracking error was well less than 0.5°/in. over the useful surface of a 12" record. When we initially balanced the arm horizontally, as recommended, the actual tracking force was about 10% greater than the scale indication.

The measured unweighted rumble of −33.5 dB was mostly at frequencies below 5 Hz. With ARLL weighting, the rumble was −61 dB. The unweighted rms flutter and wow were 0.035% and 0.05%, for a combined total of 0.06%, mostly in the vicinity of 5 Hz. The speeds were exact and were not affected by large changes of line voltage or load (such as record cleaning brushes). The "tightness" of the servo system was dramatically demonstrated by the ability of the 4-lb (1.8-kg) turntable to change speed, in either direction, in less than 0.5 second.

The automatic mode of operation worked smoothly, with about 9 seconds elapsing from the touch of the START/STOP button to the stylus reaching the lead-in groove. At the end of a record, the shut-off cycle was about 4 seconds.

The mass of the tonearm, including the headshell but without a cartridge, measured 15.4 grams. This is slightly lower than the mass of most comparable arms that we have tested. With the compliance of the Model M95ED cartridge, this mass resonated at 8 Hz, with an amplitude of 5 dB. The antiskating compensation was correct, producing equal distortion in both channels when the dial was set to match the tracking force. The capacitance to ground in either channel, including both signal cable and arm wiring, was 85 pF.

The soft mounting feet proved to be quite effective in decoupling the player from vibration. The measured isolation was about 10 dB better than that of typical direct-drive record players, with the maximum transmission occurring at about 30 Hz.

User Comment. As our measurements reveal, the Model PS-X5 is a first-rate record player in every respect. It handles as smoothly as its precision appearance suggests and had no flaws or "bugs" that we could find.

Since the speeds are not adjustable in any way, and are controlled with precision far beyond any normal user's requirements, the very presence of a stroboscope system on the turntable is rather difficult to explain. The only possible deviation from correct speed would come with total loss of servo control, which would make itself known without recourse to stroboscope marks.

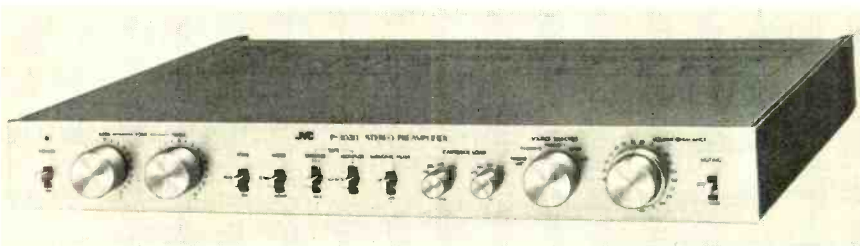
The cueing device worked well, with only a slight outward drift during its descent, repeating a couple of seconds of the record. However, the location of the cueing lever on the base of the tonearm prevents the record player from being fully controllable without lifting the cover.

Perhaps the most impressive thing about this Sony record player is its price. Only a year ago, quartz-controlled turntables were selling for twice its price or more, yet this player is competitive with most good belt-drive players and record changers. Even if the performance advantages of quartz crystal control are not necessarily audible (and they are not), the sheer perfection of the system is impressive, and all the more so in this very moderately priced record player.

CIRCLE NO. 101 ON FREE INFORMATION CARD

JVC MODEL P-3030 STEREO PREAMPLIFIER

Compact unit provides near-perfect distortion characteristics.



HIRSCH-HOUCK LABS REPORT

The new JVC Model P-3030 stereo preamplifier is noteworthy for its virtually ideal, distortion-free electrical performance, above-average phono acccommodation flexibility, and compact dimensions. Its minimal panel height allows room for only a single row of operating controls, which have been incorporated without any cluttering or crowding.

By omitting some features commonly found on control amplifiers (such as loudness compensation and elaborate filter or tone-control configurations), JVC has been able to incorporate all the really important features of a stereo preamplifier into a limited space. Separate front-panel controls are provided for selecting four phono cartridge load resistances (100, 33,000, 47,000, and 100,000 ohms) and four capacitances (100, 220, 330, and 470 pF). In addition, the preamp has a separate "preamplifier" and an input position for low-output, moving-coil cartridges.

The overall dimensions of the Model P-3030 are 16½" W x 12⅞" D x 2 5/16" H (41.9 x 32.7 x 5.9 cm). It weighs approximately 14½ lb (6.6 kg). The suggested retail price is $399.95.

General Description. The preamplifier is attractively finished in silver gray, with plastic guards extending from the rear to protect the connectors. The power is controlled by a lever switch at the left of the panel, with a red LED pilot lamp above it. Similar switches in the center section of the panel bypass (DEFEAT) the tone control circuits, connect the amplifier in its STEREO or MONO MODE, and switch in and out a SUBSONIC FILTER that has a slope of 6 dB/octave below 18 Hz. Two switches control taping operation for two tape decks. One switch cross-connects the decks for dubbing from either deck to the other. The second switch is for monitoring the playback output of either deck or for connecting the normally selected program source to the preamplifier outputs. A switch at the far right of the panel (MUTING) drops the gain 20 dB for temporary interruptions.

The separate BASS and TREBLE tone controls each have 11 detented positions. To the right of the central group of lever switches are two small CARTRIDGE LOAD knobs. To their right is the SOURCE SELECTOR (which has positions for TUNER and AUX high-level sources) and three PHONO inputs. Two of the phono inputs are for conventional moving-magnet cartridges and the third is for low-output moving-coil cartridges, the latter through the built-in preamplifier. To the right of this switch is the VOLUME control, behind a center-detented concentric BALANCE control ring. The VOLUME control has 22 detented positions, calibrated in decibels of attenuation. On the rear apron of the preamplifier are the various inputs and outputs. Also provided on the rear apron are three ac outlets, two of which are switched.

In line with a trend we have noticed on recent "high-end" audio products, the top cover of the Model P-3030 carries a functional block diagram showing the circuit position of each control and the distribution of gain and operating levels. The rear connectors are also identified on the top plate, simplifying their use if the rear apron of the preamplifier is not readily accessible.

Although no schematic was supplied with the preamp, the instruction manual states that it has "input capacitorless" FET stages in all input circuits. The VOLUME control, which is a true step switch instead of a potentiometer with mechanical detents, is in two sections located before and after the tone control stages. This gives optimum noise-level and overload characteristics.

The preamp uses discrete devices throughout (no IC's), with a complement of 26 FET's, 41 bipolar transistors, and 19 diodes. A low-profile toroidal power transformer makes the compact dimensions practical, with no induced hum from stray magnetic fields.

After the power is applied, there is a time delay of several seconds before the signal outputs are energized to keep turn-on transients from reaching the power amplifier and speaker systems. JVC suggests that the 47,000-ohm and 100-pF loads be used with most magnetic cartridges, since the 150 to 200 pF added by a typical record player and the connecting cables will result in the 250 to 300 pF of total capacitance that is optimum for most cartridges. Of course, the load can be adjusted to suit one's listening taste or the recommendations of a cartridge manufacturer. (Shure and Ortofon, for example, whose cartridges give their flattest response with loads of 400 to 500 pF.) The 100-ohm setting is meant for use with high-output moving-coil cartridges, such as the Satin and Dynavector models, that do not require the extra gain of the pre-preamplifier.

Laboratory Measurements. With its output connected to a typical high-impedance load, such as that presented by any power amplifier, the preamplifier can deliver the greatest undistorted output voltage of any preamplifier known to us. It is rated at 20 volts, but in our tests the 1000-Hz output clipped at 27 volts. When it is loaded by 600 ohms, the rated output is reduced to 1 volt; the clipping level was 3.85 volts.

The distortion, under any condition we could devise, was unmeasurable. Our readings followed the residual distortion characteristics of our Radford signal generator, with the 1000-Hz distortion reading 0.0022% to 0.003% from 0.1 to 25 volts output. The IM distortion followed a similar pattern, with the 0.006% reading at 0.1-volt output being mostly noise in our Crown IM analyzer. The measured IM was from 0.001% to 0.004% at outputs that ranged from 0.3 to more than 20 volts.

Driving 1 volt into 600 ohms, the harmonic distortion measured 0.04% and 0.02% at 20 and 30 Hz (the residual of the generator), 0.0025% from 100 to 5000 Hz, and 0.0043% at 20,000 Hz. At a 10-volt output into a high-impedance load, the readings were generally similar, except that the high-frequency distortion was only 0.0022% at 20,000 Hz. So far as we are concerned, the preamp can legitimately be described as distortionless under practical conditions.

For a reference output of 1 volt (high-impedance load), the high-level inputs required 0.13 volt at 1000 Hz. The unweighted S/N ratio referred to the 1-volt level was unmeasurable, with the total noise being below the 100-μV(−80 dBV) minimum reading of our meter. The PHONO sensitivity was 1.7 mV, with an unweighted S/N of 73.5 dB. The PHONO 3 (moving-coil) input required only 66 μV for a 1-volt output and had a 67.3-dB S/N. There was a considerable variation in the latter reading with different input terminations (neither a shorted nor an open condition was best) so that the actual S/N will probably depend on the details of a specific installation. The phono overload levels were very high at 350 mV for the PHONO 1 and 2 and 16 mV for PHONO 3 inputs.

The frequency response was within the ±0.25-dB tolerance of our test equipment from 20 to 20,000 Hz (tone controls defeated). It was down 3 dB at 130,000 Hz, and the subsonic filter, which affected the response by only 2 db at 20 Hz, dropped it to −10 dB at 5 Hz. The tone controls had a moderate range of about ±10 dB, with a sliding turnover frequency on the BASS control and the TREBLE response being hinged at about 3000 Hz. The RIAA record equalization was within ±0.5 dB over the range from 20 to 20,000 Hz. There was no interaction with the inductance of phono cartridges, other than a slight rise of about 1 dB at 20,000 Hz.

User Comment. The Model P-3030 preamplifier is about as nearly perfect in its frequency response and distortion characteristics as the state of the art allows. Its noise levels are well below audibility under any realistic operating conditions. It would appear that the appeal of this impressively compact control center to any individual would have to be on the basis of its control features, unless someone is able to hear qualities in it that we did not. To our ears, it was a completely inaudible component, except for intentional effects created by the tone controls.

Comparing the controls of the Model

P-3030 to those of some other preamplifiers or integrated amplifiers, it is clear that the tone-control functions have been kept to a minimum (although they are as effective as any *basic* tone-control system can be). Those who use tone controls rarely, if at all, will not require more flexibility than is provided by the Model P-3030. Except for the really useful subsonic filter, such circuits are conspicuous by their absence, and will not be missed by most people.

Perhaps the most obvious omission in the preamp is "loudness compensation." Restrictions on panel size, and probably design philosophy, have led JVC to leave this feature out entirely. However, we have commented many times on the futility of trying to achieve satisfying results with a conventional loudness/volume control combination, so the omission is not drastic.

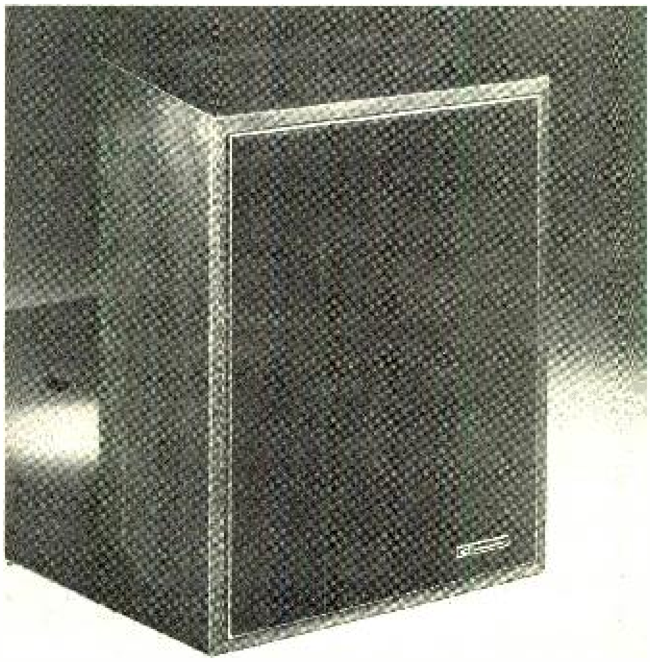
The enormous output voltage capability of the Model P-3030 and its literally undetectable distortion will probably be considered a case of "overkill." No power amplifier requires more than a volt or two to drive it to clipping, and few have a distortion level comparable to that of the Model P-3030. Nevertheless, the extra headroom and general conservatism of the design can certainly do no harm.

The JVC Model P-3030 is not inexpensive, and it is probably not everyone's ideal preamplifier. However, for those who prefer to have as little as possible between the recorded program and their ears, this is an excellent choice.

CIRCLE NO 102 ON FREE INFORMATION CARD

DAHLQUIST MODEL DQ-1W LOW-BASS MODULE

Extends flat bass response down to as low as 20 Hz.



In recent years, the hi-fi lexicon has been enriched by a new component called the "subwoofer." This is a loudspeaker designed to operate only in the low-bass range where the response of conventional woofers begins to fall off. The Dahlquist Model DQ-1W Low-Bass Module is a typical example of the subwoofer. It was originally introduced to augment the performance of the company's Model DQ-10 speaker system below 60 Hz. It is equally suited to extending the response of other types of speaker systems.

Dahlquist makes both active and passive crossover networks for matching its subwoofer to existing speaker systems. The Model DQ-LP1 active network requires a separate power amplifier to drive the subwoofer, but it provides greater flexibility than the Model DQ-MX1 passive network. The Model DQ-MX1 measures 8 ¾" W × 3 ⅜" H × 7½" D (22.3 × 8.6 × 19 cm) and is designed for crossover between a pair of 8-ohm speaker systems and the Model DQ-1W at either 60 or 80 Hz. The Model DQ-LP1 measures 13½" W × 2¼" H × 5¼" D (34.3 × 5.7 × 13.3 cm). It provides complete control of levels and continuously variable crossover frequencies from 40 to 400 Hz. The Model DQ-1W subwoofer measures 26" H × 18½" W × 14¾" D (66 × 47 × 37.5 cm) and weighs about 65 lb (29.5 kg). Suggested retail prices of the Models DQ-1W, DQ-LP1, and DQ-MX1 are $275, $300, and $135, respectively.

General Description. The subwoofer resembles a conventional medium-size floor-standing speaker system. Removing the grille from the fully sealed, walnut-finished wooden cabinet reveals a single driver in the center of the front board. Dahlquist claims a 13" (33-cm) diameter for the driver, but we measured 11½" (29.2 cm) effective diameter, which included the rubber edge surround. The 4" (10.2-cm) voice coil and compliant surround imply that this is a heavy-duty, long-throw woofer. The system is rated at a nominal 8 ohms.

The simplest and least expensive way to add a subwoofer to an existing system is to use the Model DQ-MX1 passive crossover network. The amplifier outputs and leads to the pair of stereo speaker systems and the subwoofer connect to insulated spring clips on the back of the crossover network. With this arrangement, the Model DQ-1W is driven by the sum of the two channels, which is a mono signal. (There is no sense of localization at the frequencies radiated by this speaker so that no dilution of the stereo effect results from the mixing.) A switch on the rear of the crossover network is provided for selecting either a 60- or 80-Hz crossover frequency. Another switch allows reversal of the woofer phase to match that of the woofers in the stereo speaker systems. It is assumed that the speaker systems are of average efficiency and have an 8-ohm impedance. The only means of matching the level of the subwoofer to the higher frequency level is with a three-position toggle switch on the crossover network.

A more versatile arrangement employs the Model DQ-LP1 active filter for the crossover and an additional amplifier for driving the subwoofer in a biamplified arrangement. The active filter is placed between the preamplifier and the main power amplifier. It has a simple single-section RC network in each output to drop the response to the main speaker systems by 3 dB at 60 Hz. This applies only when the power amplifier has a typical input resistance of 75,000 to 100,000 ohms. If the crossover is to be at some other frequency or the input resistance of the amplifier is substantially lower or higher than 75,000 to 100,000 ohms, it is necessary to change the value of the internal capacitors of the filter or to add resistance across the filter's outputs. An assortment of suitable parts is supplied with the filter, together with instructions for making the change.

The active portion of the filter rolls off the signal to the subwoofer's amplifier at a 12-dB/octave rate above a frequency that is continuously variable from 40 to 400 Hz. Calibrated crossover frequency dials are on the front panel of the filter. Also on the panel are low-frequency EQ adjustment controls that can boost the subwoofer's response at 20 Hz by as much as 5 dB when set to maximum. These plus the subwoofer's level controls are duplicated for the two channels so that the filter can be used to drive two subwoofers with a stereo power amplifier. If a single subwoofer is to be used, center-channel outputs are also available (with an L + R signal) for driving either one or two subwoofers. Buttons on the front panel of the filter permit disabling the subwoofer outputs for making in/out comparisons.

Dahlquist recommends that the subwoofer be driven by an amplifier rated at 50 to 200 watts. The speaker is protected by a 2½-ampere AGC fuse.

Laboratory Measurements. Measured without an equalizer or crossover network and with the microphone in the plane of the speaker mounting board, the frequency response of the subwoofer was very flat. It was within ±1.5 dB from 70 to 1800 Hz. It rolled off at a 12-dB/octave rate at lower frequencies, to −10 dB at 25 Hz. This represents the anechoic response of the woofer, which would normally be enhanced in a live room by placement of the speaker near a wall or a corner.

More impressive than the smooth response was the low distortion of the woofer. At a 1-watt drive level, the distortion was nearly constant with frequency, reading 0.8% at 100 Hz and 1.9% at 20 Hz! The latter was by far the lowest distortion we have ever measured from a speaker at that frequency. At a 10-watt drive level, distortion was 2.2% from 100 to 40 Hz and only 5.3% at 20 Hz.

The speaker impedance was at its minimum of 8 ohms at 20 Hz and between 100 and 300 Hz. It rose to a peak of 18 ohms at the 42-Hz bass resonance and climbed smoothly to 45 ohms at 20,000 Hz. The sensitivity (efficiency) of the subwoofer was surprisingly high, requiring only 1 watt at 100 Hz to deliver a sound pressure level of 95.5 dB at a distance of 1 meter.

Measurements on the Model DQ-LP1 active filter/crossover network confirmed the calibration accuracy of the crossover frequency dials. The LO output was down 3 dB at exactly the frequency to which the dial was set. Dahlquist states that the response of this filter is flat within 3 dB from 1 Hz to the selected crossover frequency. Measurements confirmed that it was certainly as flat as we could measure, down to the 20-Hz limit of our test setup.

At its maximum setting, the EQ control's system began to boost the response below 100 Hz, to a maximum of +5 dB at 20 Hz. The gain of the filter is unity when its level controls are set to reference dots on the panel. An additional 15 dB is provided beyond that point. At maximum gain, the output voltage clipped at 9 volts with a 100-Hz input. The distortion was almost entirely third harmonic. It decreased with amplitude from 0.12% at 0.1 volt output to less than 0.003% at 9 volts (just before clipping occurred).

User Comment. We operated the subwoofer with a pair of high-quality compact speaker systems (the Visonik David 100). These wide-range systems have a useful response down to about 50 or 60 Hz, and thus were ideal candidates for upgrading with a subwoofer. At first, we used the passive crossover network, which worked fairly well but left us less than satisfied with the balance between the extreme bass and the higher frequencies radiated by the 4-ohm Visonik speaker systems.

We then changed over to the active crossover filter, using a 200-watt amplifier to drive the subwoofer. (A 200-watt/channel stereo amplifier drove the Visonik speaker systems.) After experimenting with levels and crossover frequencies, we achieved a satisfactory balance and began to learn for ourselves just how effective the combination of small, high-quality stereo speaker systems can be with the aid of a good subwoofer. One is never aware of the subwoofer as a sound source. Only by feeling the cabinet or removing the grille can one be sure it is working. The effect is mostly of a solid "floor" to the music, occasionally becoming room shaking when organ or bass drum sounds are reproduced.

It is necessary to exercise restraint when adjusting the bass level, since it is easy to overdo it and add an unnatural heaviness or boominess to the sound. Ideally, there should be no change in the sound of a male voice when the subwoofer is switched in and out. When we used that criterion for adjustment, the overall results were splendid. This is similar to the problem of adjusting the level with a time delay accessory—if you can hear it, it is too loud!

We also found it disturbingly easy to blow the fuse on the subwoofer. Dropping a phono pickup or even lowering it carelessly to the record with the gain at normal levels is almost guaranteed to blow the fuse when a 200-watt amplifier is used. Nevertheless, we would not wish to use an amplifier with significantly lower power, since we often used the full output in achieving the most natural results even at fairly "normal" listening levels. It is amazing to discover how much energy is required in the deep-bass range for a realistic effect.

From an economic viewpoint, the use of a subwoofer such as this, especially with an active crossover and another amplifier, is not always easy to justify. It is more likely to warrant its expense when a passive crossover network can be used successfully, such as (we presume) with the Dahlquist model DQ-10 speaker systems. However, the model DQ-1W subwoofer and DQ-LP1 active filter can be combined with a pair of the tiny high-quality speakers systems sold by ADS, Braun, and Visonik, among others, to create a formidable high-fidelity speaker system whose sound can hold its own against just about any pair of conventional stereo speaker systems of the same total cost. The big difference is that the small speaker systems can be literally concealed on a bookshelf or behind a vase. The only visible part of the system is the subwoofer itself, which can be placed almost anywhere in the listening room.

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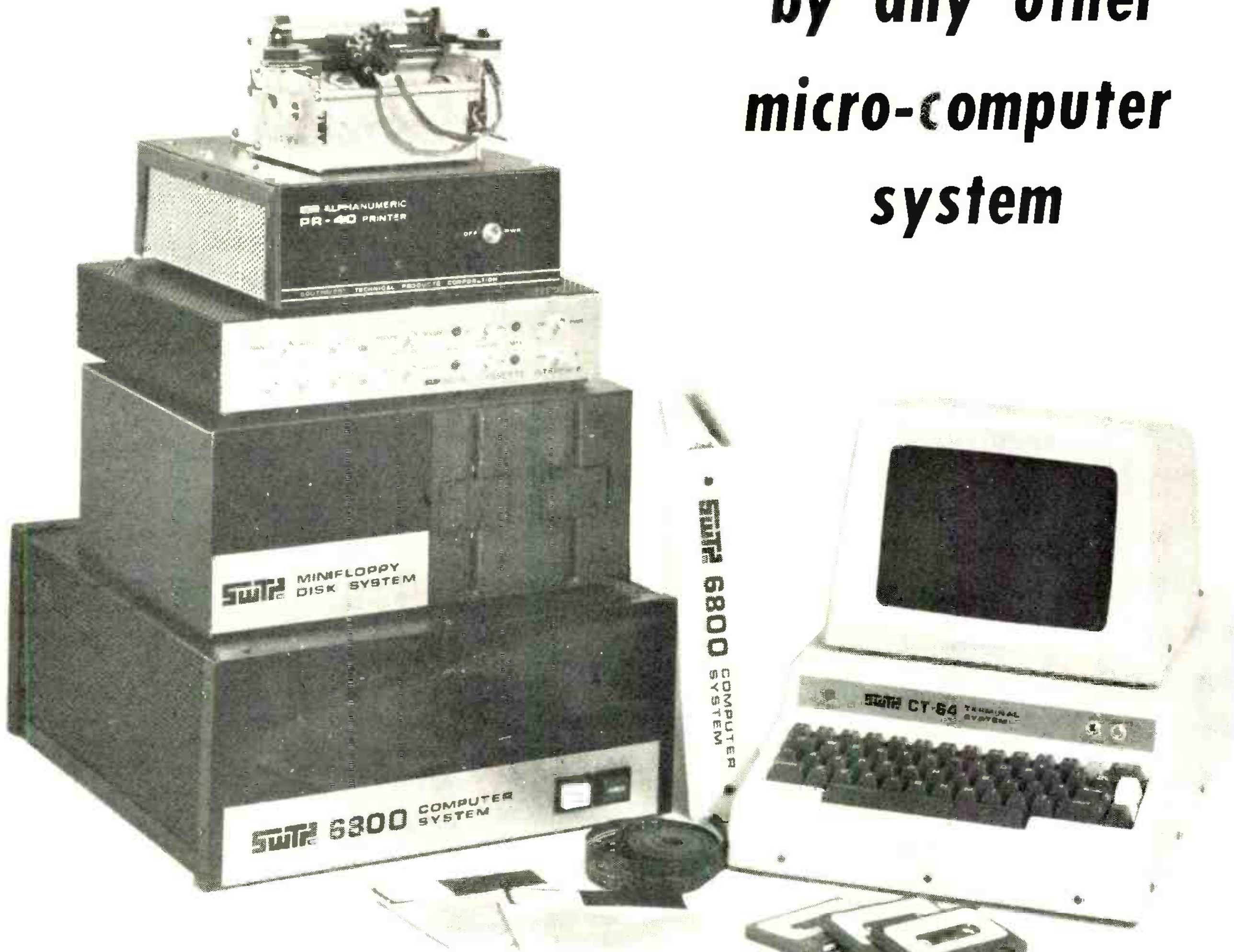

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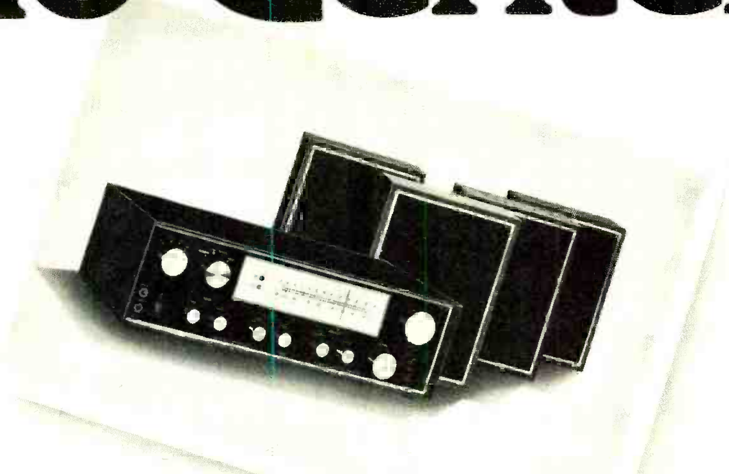

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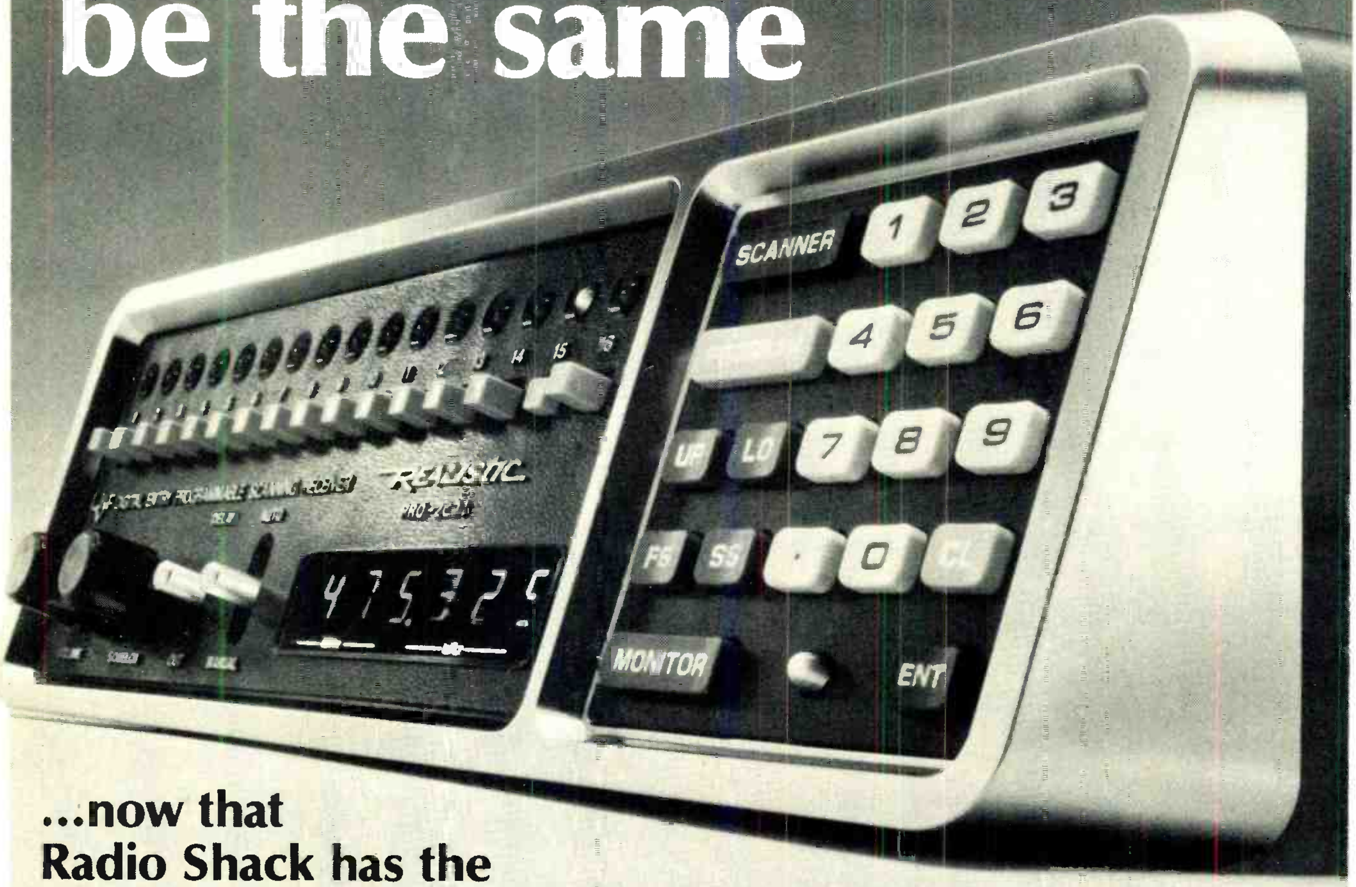

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EXPERIMENTING WITH CIRCULAR SWEEP

Circular-sweep converter provides fascinating scope displays.

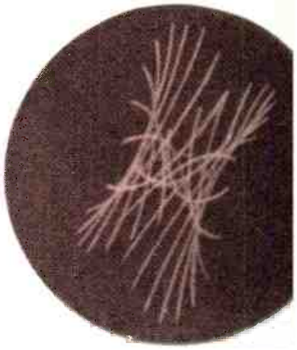
BY RANDALL K. KIRSCHMAN

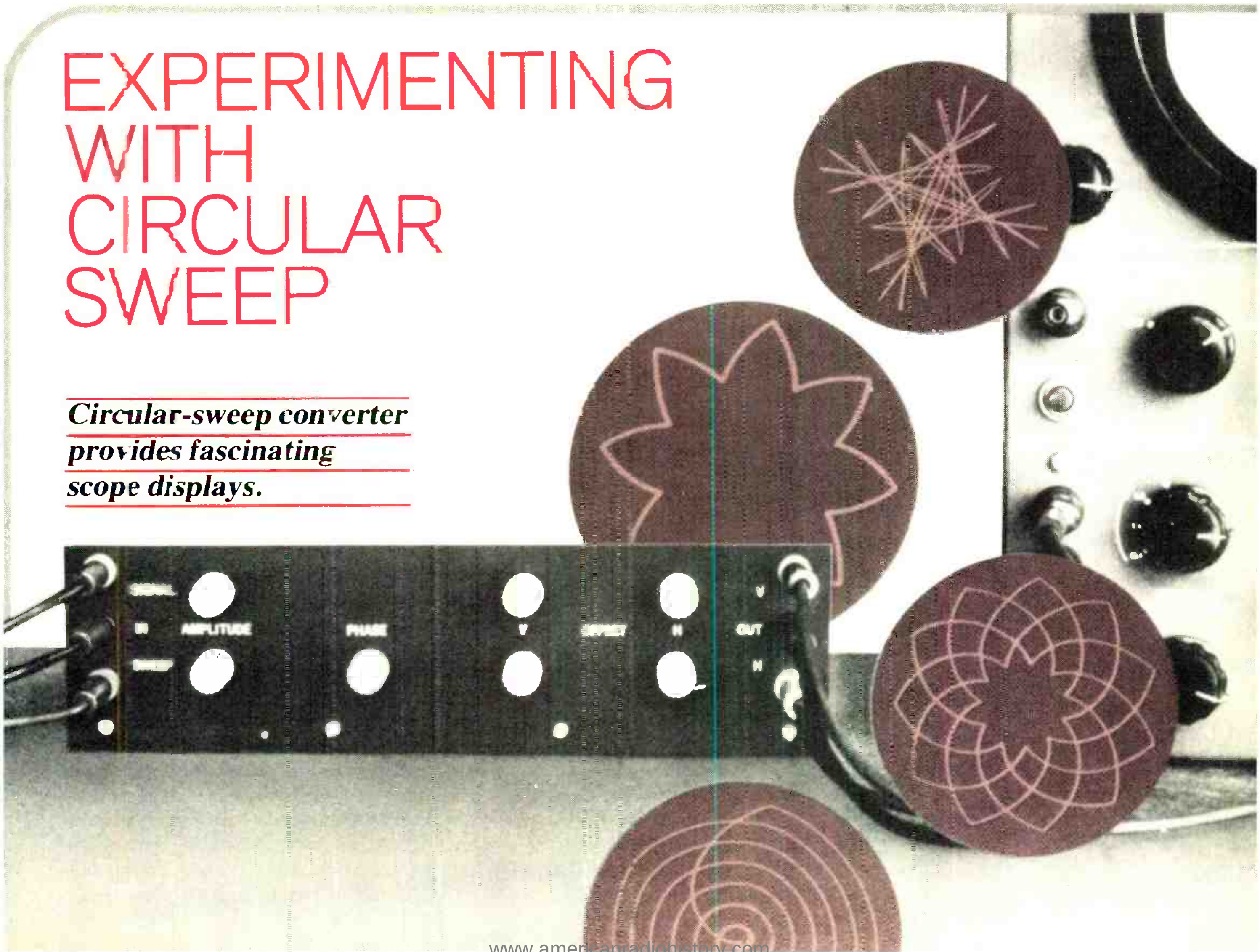
THE USUAL method of displaying waveforms on an oscilloscope is to sweep the beam horizontally to provide a linear time-base and then deflect it vertically with the waveform to be displayed. In this article, we will discuss another type of display—one in which the beam is swept in a circle and deflected radially (inward and outward from the center) by the waveform to be displayed. This method, called "circular sweep," has some practical advantages. Since the sweep baseline is a closed circle, there is no retrace; and, compared with linear sweep, the baseline can be made longer for an oscilloscope screen of a given size. However, in the author's opinion, practical considerations are of secondary importance to the fact that displaying waveforms with circular sweep creates all sorts of fascinating patterns and effects.

The circular-sweep technique has been used for many years, but early methods were usually limited in performance or were too impractical for the average experimenter. Now, however, with just four IC's, you can make a high-quality circular-sweep converter that connects to the input terminals of a conventional oscilloscope. No modifications of any kind need to be made to the scope.

How It Works. To move the oscilloscope beam in a circle and form the sweep baseline, two sine waves having a 90° phase difference are applied to the two inputs (horizontal and vertical) of the scope. The signal to be displayed is then combined with these two sine waves so that it deflects the beam in a radial direction. This is done with two analog multiplier IC's, as shown in Fig. 1.

An *analog multiplier* (or *operational multiplier*) is a circuit whose output voltage is the product of the two voltages fed into its inputs. The multipliers used here are of the *four-quadrant* type, which means that they can accurately





multiply for all combinations of positive and negative input voltages, a necessary feature for the converter circuit.

To understand how the converter works, think of each multiplier as an amplifier whose gain for the sweep sine wave passing through it is proportional to the voltage fed into its input (in other words, a voltage-controlled amplifier or VCA). The signal to be displayed, plus a constant dc voltage, is also fed to this input. Thus, if the signal is zero, the dc voltage will result in a fixed gain, causing the sine waves to be passed (point A in Fig. 2). This produces a circular baseline on the scope screen.

If the signal voltage increases in a positive direction, the gain of each multiplier is increased, causing the circle to become larger so that the trace is displaced outward from the baseline position (point B). On the other hand, if the signal goes negative, the gain is decreased, causing the trace to move inward (point C). The inward and outward displacement is proportional to the voltage level of the input signal. Thus the beam moves radially in correspondence with the instantaneous voltage of the input waveform, tracing out the waveform as it sweeps around the circle. The result is a circular-sweep display.

Another way of looking at the operation of the circuit, is to realize that each multiplier is acting as a modulator. The sweep sine wave is the "carrier" which is amplitude-modulated by the signal to be displayed. The situation is unusual in that the modulating signal has a *higher* frequency than the carrier for most displays. Also, because four-quadrant multipliers are used, they can "overmodulate" without causing trouble. Instead of clipping the waveform, overmodulation causes the trace to go through the center and come out the other side, as will be shown later.

Circuit Description. The complete circuit of the converter is shown in Fig. 3. A 741 operational amplifier (*IC1*) amplifies and buffers the input signal, which is then fed to one of the "X" inputs of each multiplier (pins 3 of *IC3* and *IC4*). The constant dc offset is added by introducing an offset current into each multiplier (through *R14* and *R15* for *IC3*, *R20* and *R21* for *IC4*).

The sweep sine wave is inverted by another 741 op amp (*IC2*) and applied to the "Y" input of one of the multipliers (pin 5 of *IC4*). The direct sweep input and its inversion drive a phase-shifter consisting of *C5* and *R7* to produce a

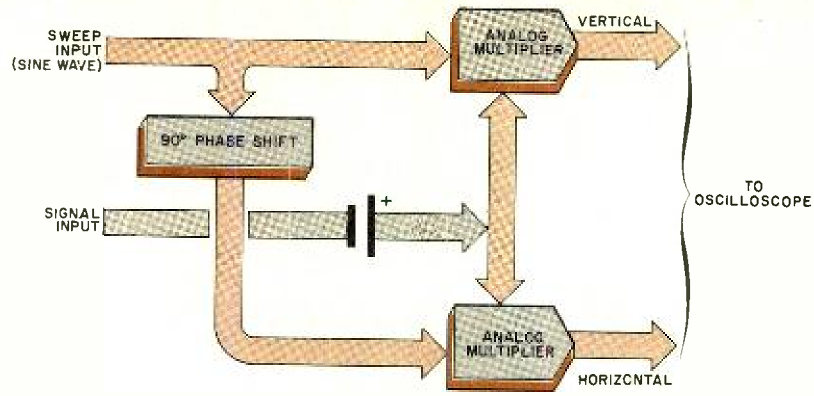


Fig. 1. Block diagram illustrates the basic operation of the circular-sweep converter.

sine wave shifted by 90°, which is then applied to the "Y" input of the other multiplier (pin 5 of *IC3*).

The output of each multiplier (pins 1 and 2 of *IC3* and *IC4*) is connected in a differential configuration to the input of an op amp which is contained in the same IC as the multiplier. The op amps provide amplification and level shifting. The output of each op amp is connected to the corresponding output of the converter. The signal path is entirely dc coupled to display signals with frequencies as low as a fraction of a hertz.

Construction. The converter can be built on perforated board, or assembled bread-board style like the prototype shown in Fig. 4. In either case, leads should be kept fairly short and neatly arranged to avoid high-frequency feedback through the multiplier IC's which have a bandwidth extending to several megahertz. All capacitors, except *C1* and *C2*, should be connected close to the multiplier IC's.

Parts values are not critical, but *R5* and *R6* should be the same value, as should *R22* and *R24*, *R23* and *R25*, *R26* and *R28*, and *R27* and *R29*. Also, the corresponding parts associated with *IC3* and *IC4* should be the same values (*C6* and *C8*, *C7* and *C9*, *R8* and *R9*, *R10* and *R16*, etc.) so that the vertical and horizontal channels of the converter will be matched. Resistors *R25* and *R29* should not be wired in permanently since their values may have to be adjusted slightly as explained in the next section. If sweep frequencies differing appreciably from 60 Hz are used, the values of *C5* or *R7* may have to be changed to get the proper phase shift of 90°. Though the XR-2208 IC is available in several versions, the least expensive, XR-2208CP, was used in the prototype.

The breadboard should be attached to a front panel similar to that shown in Fig. 4, with the appropriate markings. (Use press-on type or some similar means of identification.)

A dual power supply, such as that whose circuit is shown in Fig. 5, is required. Although the prototype used ±12 volts, any supply from ±10 to ±15 volts will work. The converter requires about 20 mA from each side of the supply. Batteries (9 V) can be used for testing purposes.

Checkout and Adjustment. After making sure that the power supply is generating the correct voltages, connect it to the main circuit. Set the SIGNAL AMPLITUDE (*R1*) and SWEEP AMPLITUDE (*R4*) controls for minimum resistance and the four OFFSET controls (*R12*, *R15*, *R18*, and *R21*) at approximately their midrange positions.

Measure the dc voltage between the V OUT connector and ground (center connector) and note that it should be under

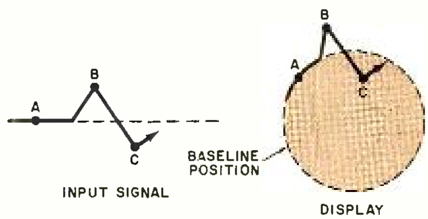


Fig. 2. Converter changes input (left) into circular display.

a few tenths of a volt, either plus or minus. If not, alter the value of *R25* until the minimum is obtained. Repeat this procedure for the H OUT connector, adjusting *R29* if necessary.

Connect the V and H OUT and center ground connectors to the vertical, horizontal and ground connectors, respectively, on the oscilloscope. Almost any scope will suffice if it has a vertical and

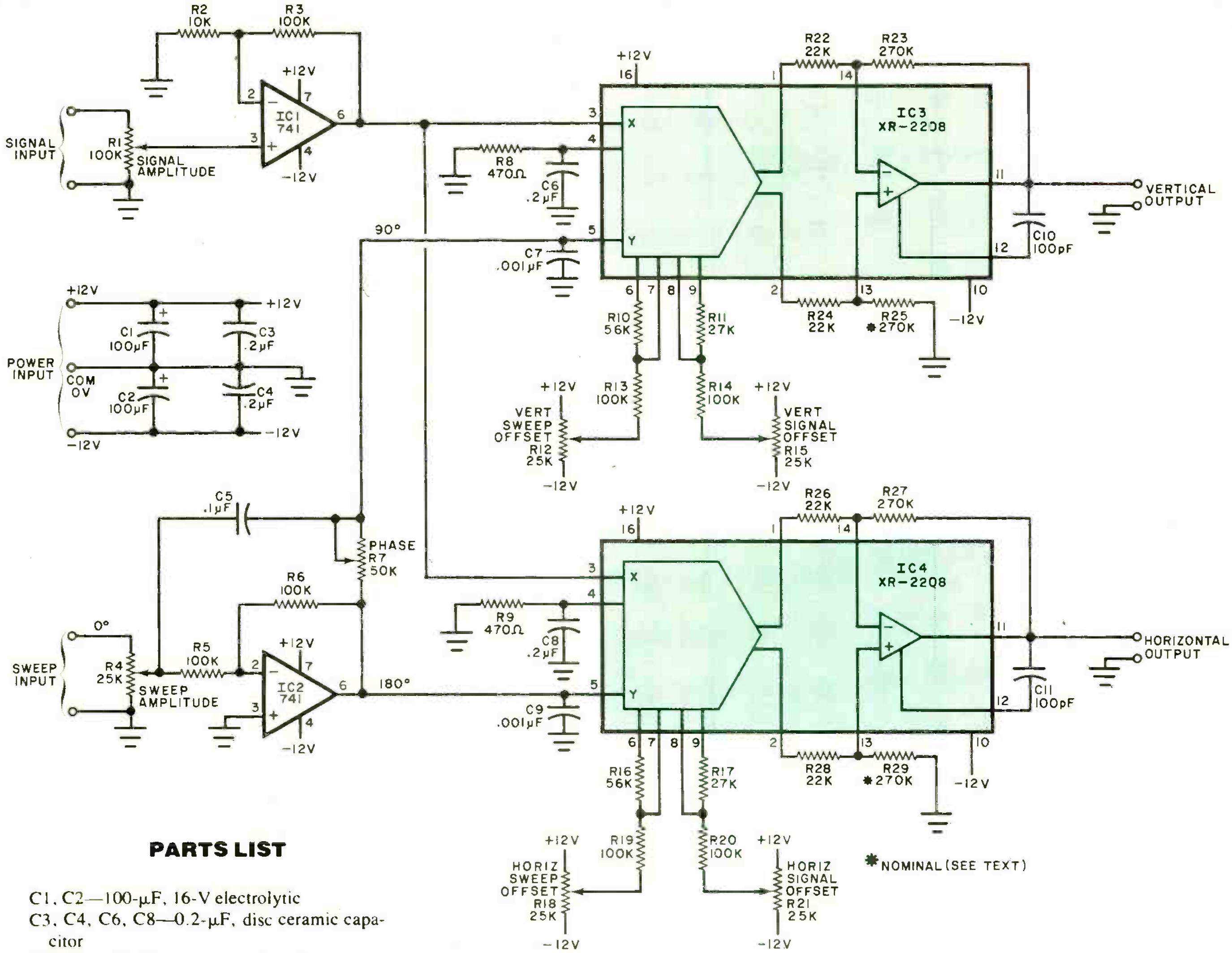


Fig. 3. Input is passed to two four-quadrant multipliers while sweep input to each multiplier is applied 90° out of phase.

PARTS LIST

C1, C2—100-µF, 16-V electrolytic
C3, C4, C6, C8—0.2-µF, disc ceramic capacitor
C5—0.1-µF, Mylar capacitor (not disc ceramic)
C7, C9—0.001-µF, disc ceramic capacitor
C10, C11—100-pF, disc ceramic capacitor
IC1, IC2—741 operational amplifier (or one 747 dual op amp)
IC3, IC4—XR-2208 operational multiplier (Exar)
Unless otherwise noted, the following are ¼-W, 10% resistors:
R1—100,000-ohm potentiometer
R2—10,000 ohms
R3, R5, R6, R13, R14, R19, R20—100,000 ohms
R4, R12, R15, R18, R21—25,000-ohm linear-taper potentiometer
R7—50,000-ohm potentiometer
R8, R9—470 ohms
R10, R16—56,000 ohms
R11, R17—27,000 ohms
R22, R24, R26, R28—22,000 ohms
R23, R25, R27, R29—270,000 ohms (see text regarding R25 and R29)
Misc.—Circuit board; chassis or cabinet; IC sockets; knobs; binding posts or jacks; hardware; etc.

horizontal bandwidth of 50 kHz or more. If your scope has dc coupling, you can work with waveforms having very low frequencies. Ac coupling will, of course, still work. Set the scope vertical and horizontal sensitivities to about 0.4 V/cm (1 V/in.).

Apply the signal to be displayed and the sine-wave sweep to the appropriate input connectors on the converter front panel. The signal to be displayed can be obtained from any waveform source, such as an audio oscillator. Its frequency should be five or ten times that of the sweep. The sweep sine-wave source can be from a conventional 6.3-V transformer or from an audio generator set to approximately 60 Hz. In either case, a good-quality sine wave should be used for best results. Keep both signal and sweep voltages between ±10 volts peak to avoid possible damage to the input integrated circuits.

Keeping the SWEEP AMPLITUDE (*R4*) at a minimum, turn up the SIGNAL AMPLITUDE (*R1*). This will probably produce a line on the scope screen. If excessive input amplitude is used, the converter will be overdriven and abrupt "glitches" will appear on the CRT. Adjust the V OFFSET sweep control (*R12*) and H OFFSET sweep control (*R18*) to reduce the line to a point.

Turn the SIGNAL AMPLITUDE (*R1*) to its minimum position, and adjust the SWEEP AMPLITUDE (*R4*) about half-way up (avoid overdrive). Then adjust the V OFFSET signal control (*R15*) and H OFFSET signal control (*R21*) near their maximums. Adjust PHASE (*R7*) and the scope vertical and horizontal gain controls until a circle approximately one third of the CRT diameter is formed on the screen.

Leave SWEEP AMPLITUDE (*R4*) where

it is, and adjust SIGNAL AMPLITUDE (*R1*). One of two things should occur. You will get either a circular sweep pattern or a diamond-shaped pattern similar to that shown in Fig. 6. If you get the diamond pattern, adjust *R21* to the opposite end of its range to get the circular pattern. This pattern may not be symmetrical. If not, adjust the V OFFSET signal control and the scope vertical gain control (or the H OFFSET signal control and scope horizontal gain).

The PHASE (*R7*), V OFFSET (*R12*) and H OFFSET (*R18*) may also need touching up. Experimenting with the converter front-panel controls will establish the best settings for maximum symmetry and minimum distortion. The "double star" pattern formed by a triangular waveform (Fig. 8C) is a good pattern to use for final adjustments.

When the above steps have been completed, the converter is properly adjusted for circular sweep.

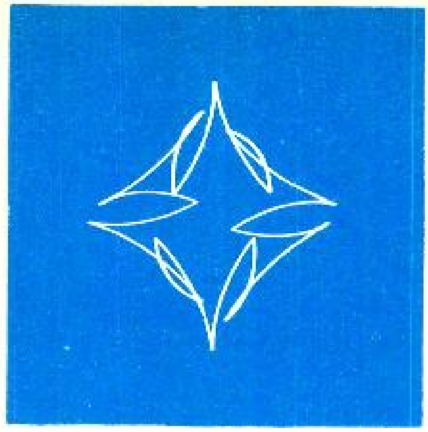


Fig. 6. Diamond-shaped pattern results when offset controls are at opposite settings.

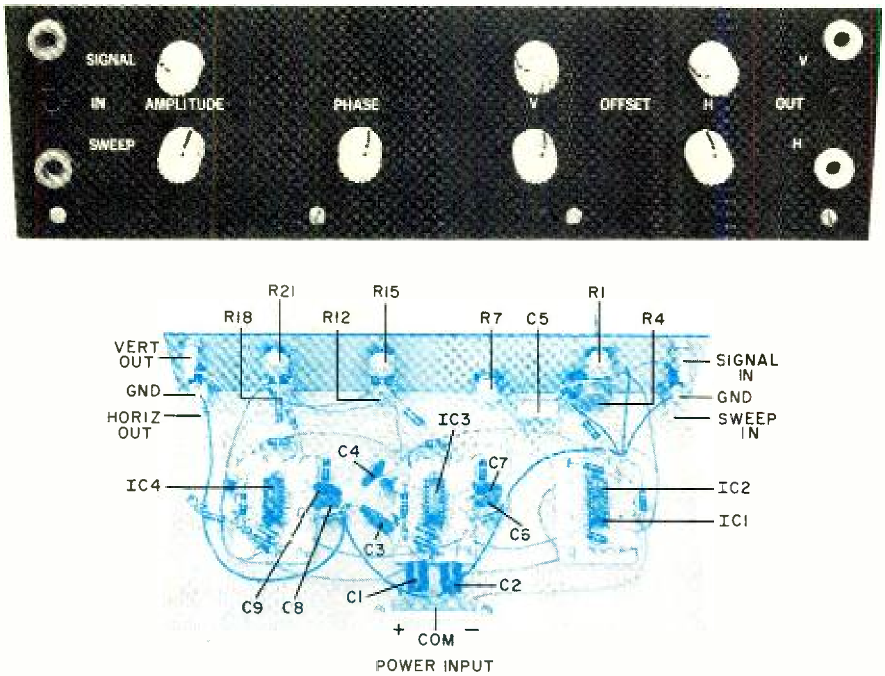


Fig. 4. Photo at top shows front panel of prototype. Below is prototype breadboard. Pc board can be used.

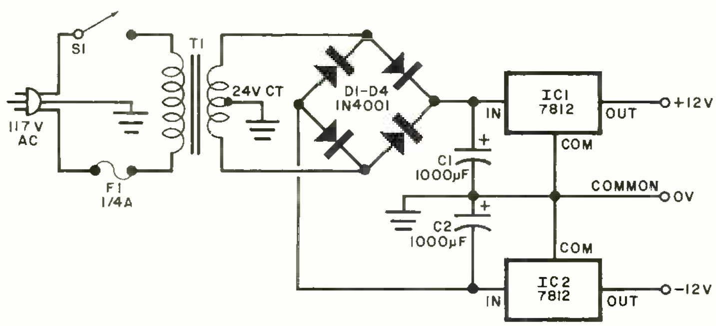


Fig. 5. The dual power supply uses both positive- and negative-voltage regulator integrated circuits.

POWER SUPPLY PARTS LIST

C1, C2—1000-µF, 25-V electrolytic
D1 through D4—Rectifier diode (1N4001 or similar)
F1—¼-A fuse
IC1—Positive 12-V, 100 mA or greater voltage regulator (7812 or equivalent)
IC2—Negative 12-V, 100-mA or greater voltage regulator (7912 or equivalent)
S1—Spst power switch
T1—24-V center-tapped, 100 mA or greater transformer

Use. Some familiar waveforms displayed with the circular sweep converter are shown in Fig. 7. In each case, the waveform frequency was adjusted to give a pattern with a whole number of cycles. The waveforms are sine (Fig. 7A), triangle (Fig. 7B), sawtooth (Fig. 7C), and square (Fig. 7D). As the amplitude of the waveform is increased, the inside of the trace will meet at a point in the center (if the converter has been adjusted properly), as illustrated in Fig. 8A for the triangle waveform. Increasing the amplitude further causes the trace to go through the center and come out the opposite side as shown in Fig. 8B (even number of cycles) and Fig. 8C (odd number of cycles).

The pinwheel pattern in Fig. 9A and the spiral in Fig. 9B are both made with sawtooth waveforms. In Fig. 9A, the waveform amplitude is adjusted so that the traces meet in the center. In Fig. 9B, a low-frequency sawtooth is used. All the patterns illustrated in this article were made using a 6.3-V filament transformer to supply the 60-Hz sweep. The waveforms were obtained from a 8038 waveform generator IC, hooked up as shown in Fig. 10. Hundreds of other patterns can be produced with these basic waveforms. If you exhaust those possibilities, try mixing the outputs of two (or more) waveform generators.

One of the most fascinating displays is that made by music waveforms. Whatever else you do with the converter, be sure to try this. Simply connect the audio from a radio, tuner, phono, etc. to the SIGNAL IN jack. The result is a kaleidoscopic succession of patterns synchronized to the music. No examples are shown because the patterns and effects cannot be satisfactorily captured by still

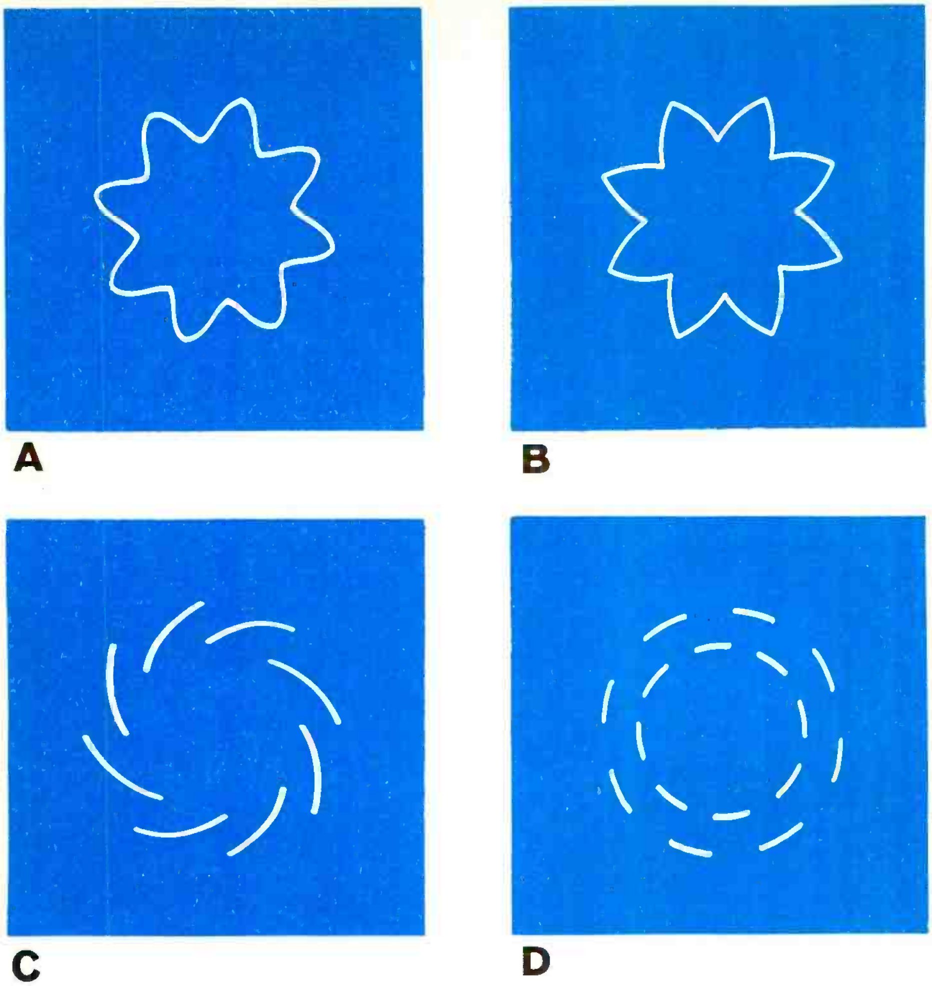
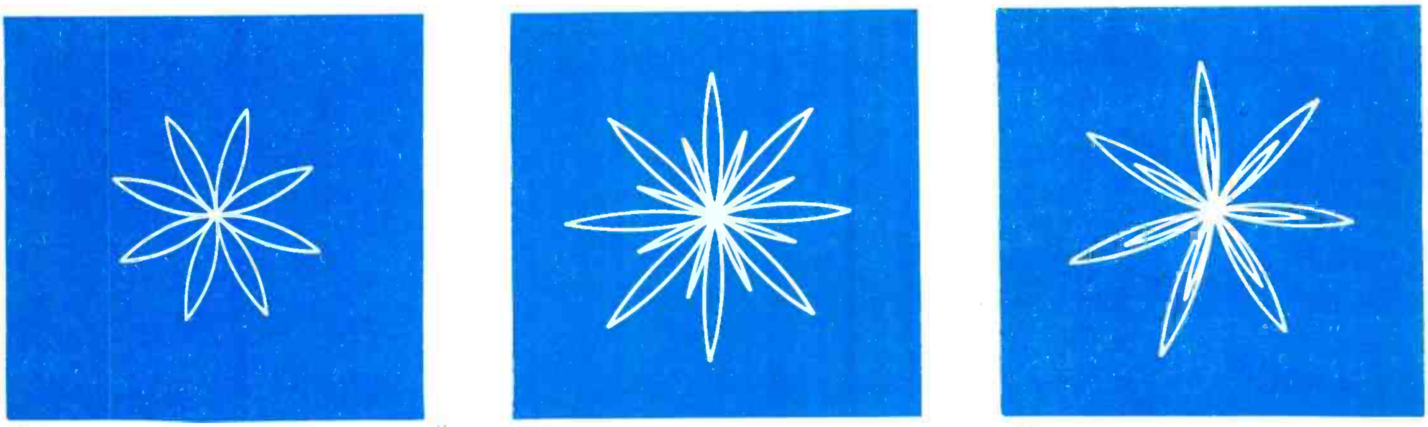


Fig. 7. Appearances of sine (A), triangle (B), sawtooth (C), and square (D) waveforms as displayed by circular-sweep converter system.

Fig. 8. Increasing the amplitude of a triangle waveform causes trace to meet in center (A) and come out opposite side with even number of cycles (B) and odd number of cycles (C).



A B C

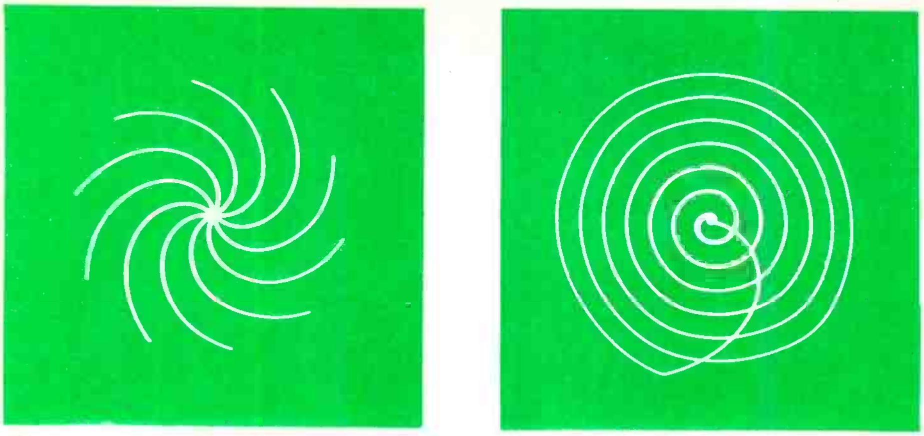
photography. If you use an FM station as the source you may need to insert a low-pass filter (Fig. 11) between the source and SIGNAL IN to eliminate the multiplex and SCA subcarriers. Speech also makes an interesting display.

Frequency Comparison. Using an oscilloscope in the conventional manner, the frequencies of two waveforms can be compared with Lissajous figures. In an analogous way, frequencies can be compared using circular sweep. For example, the traces in Fig. 7 all show eight complete cycles of the waveform, which means that the signal goes through eight cycles while the sweep goes through one cycle. Since a 60-Hz sweep was used, the signal frequency must be 8 times 60 Hz, or 480 Hz. Fig. 9B shows almost the opposite situation. Here the sweep goes through seven cycles while the signal goes through only one cycle. The signal frequency is thus 60 Hz divided by 7, or about 8.43 Hz.

Sometimes the pattern will be more complicated, like the one shown in Fig. 12. It is still relatively easy to determine the frequency as illustrated by the following analysis of the pattern. Starting at one peak on the waveform and following the trace, the next peak that we come to is the fourth one over from the starting point. This means that the sweep goes around four times to make one complete pattern. Note also that there are 11 peaks in all, which means that there are 11 cycles of the triangle waveform in the pattern. Thus, the sweep-to-signal frequency ratio is 4:11. Since a 60-Hz sweep was used, this gives a signal frequency of (11/4) × 60 = 165 Hz.

The frequencies thus determined are exact only if the pattern is stationary. A rotating pattern indicates a slightly higher or lower frequency, depending on the direction of rotation.

Besides circular sweep, the converter can be used for other types of displays which may be less practical and more difficult to analyze, but are just as interesting. For example, you can adjust *R15* (or *R21*) to the opposite end of its range to get the diamond-shaped display mentioned earlier (Fig. 6). For even more variety, all seven controls on the converter can be varied. Combine this with all the different waveforms and combinations which can be used as the signal or sweep and you should be kept busy for a while. Figure 13 illustrates a few possibilities. But be warned—you may become so engrossed that you abandon your color organ, computer graphics, and even television! ◇



A B

Fig. 9. Pinwheel (A) and spiral (B) patterns are produced by sawtooth waveforms of different frequencies.

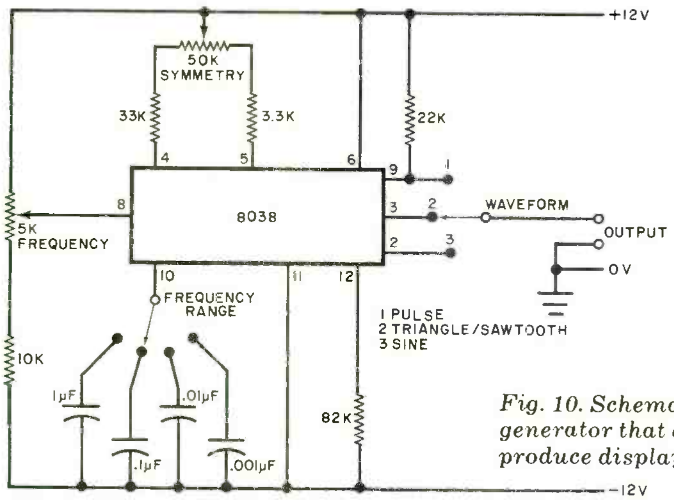


Fig. 10. Schematic of waveform generator that can be used to produce displays shown here.

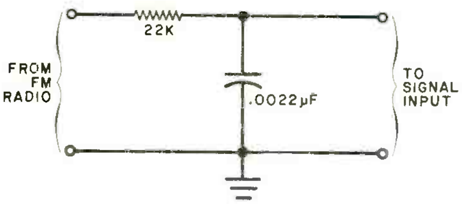


Fig. 11. Filter can be used to remove subcarriers when audio from FM stations is displayed.

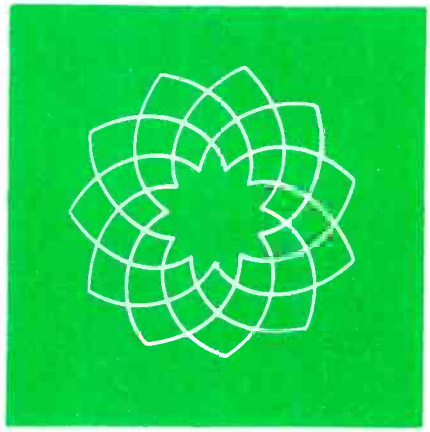


Fig. 12. Frequency comparison with circular sweep. Ratio of triangle to sine sweep is 11:4.

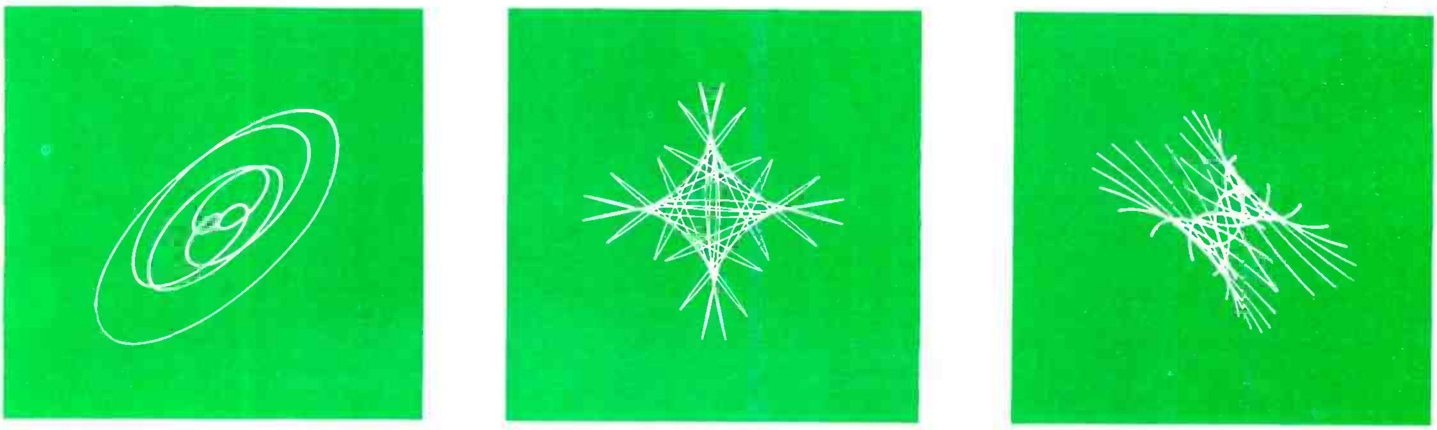


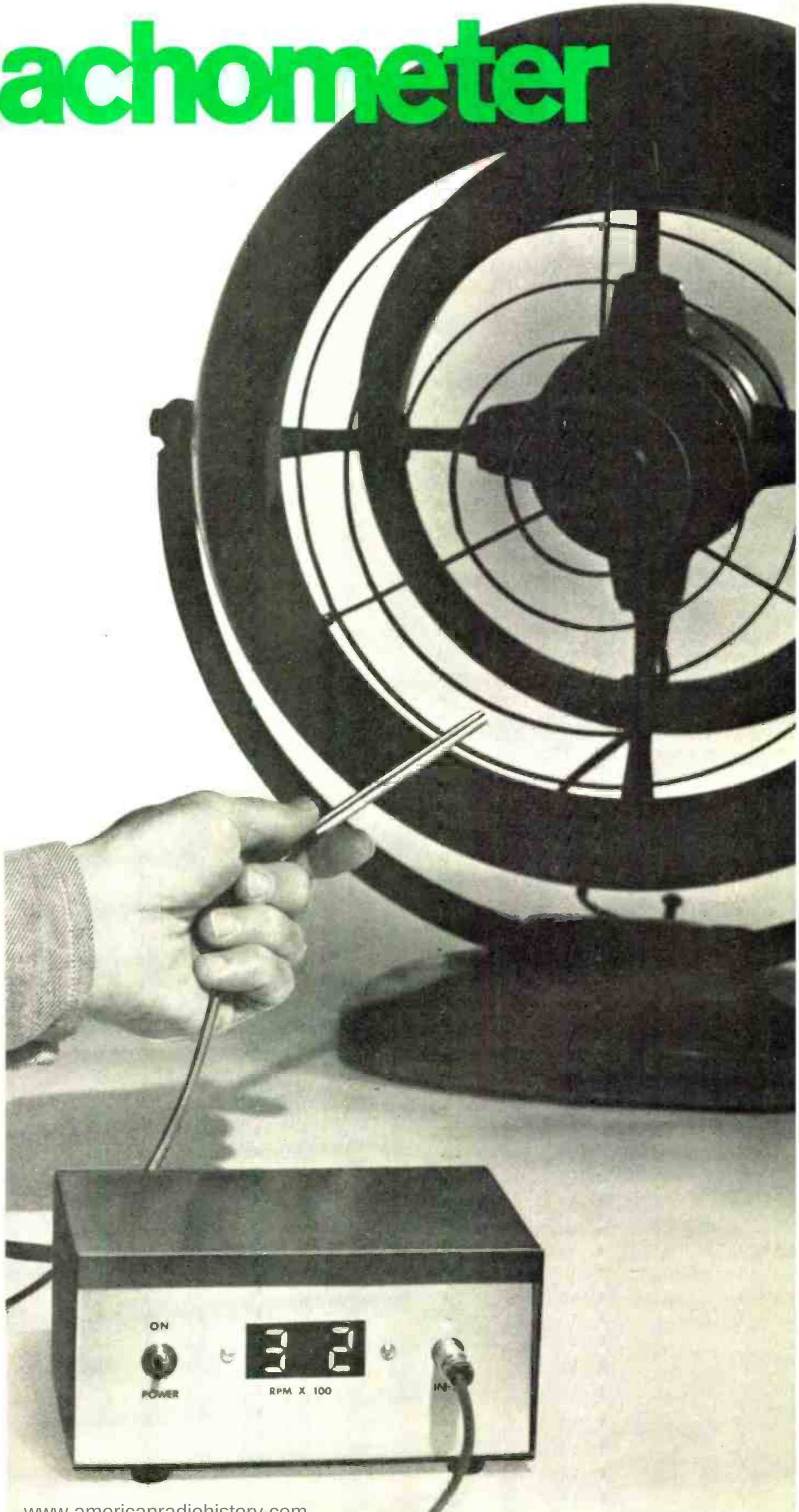
Fig. 13. Three imaginative examples of the thousands that can be generated with the circular-sweep converter.

BUILD A

Digital Phototachometer

By Walter Sikonowiz

Low-cost unit measures rotational speeds by optical coupling.



MOST ANALOG and digital tachometers require a mechanical or electrical interface with a rotating shaft. By contrast, this project, a digital phototachometer, measures rpm by optical means. It features a two-digit LED readout to display rotational speeds from 100 to 9900 rpm and a time base derived from the 60-Hz ac line, obviating the need for calibration adjustments.

Stability of the time base is good enough so that tach readings are accurate to the usual ±1-count uncertainty in the least significant digit. Modifications of the counting circuitry or sensing system can extend the measuring range one decade above 9900 or below 100 rpm, respectively. Total project cost is about $30.

Optical Sensing. As its name implies, the photo tach measures rpm by

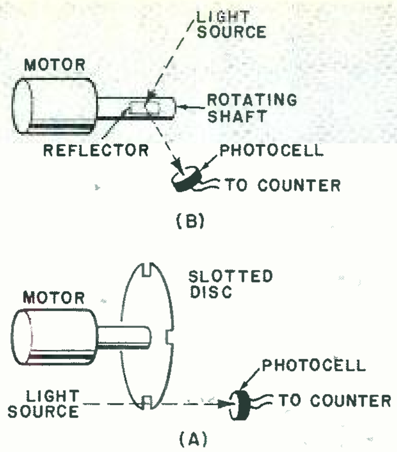


Fig. 1. Transmissive (A) or reflective (B) mode can be used to chop light for photosensor.

optical interaction with a rotating device. Measurements can be made by either of two basic means, which we'll call the transmissive and reflective modes. In the transmissive mode, the rotating device momentarily interrupts the optical path between a light source and a photosensor (Fig. 1A). This mode has limited usefulness. Although it's ideal for measuring the rotational speed of a fan or similar device, there are many situations in which it cannot be used. The transmissive mode requires a light chopper such as fan blades or a notched disc mounted on the motor shaft. If there isn't room enough to accommodate the chopper, this mode is impracticable.

The reflective mode is illustrated in Fig. 1B. A small strip of reflective tape is mounted on the motor shaft. If necessary, contrast can be increased by darkening the shaft background with black paint or tape. The light source and photo sensor are arranged so that light is reflected from the foil and toward the sensor as the shaft rotates.

About the Circuit. The schematic diagram of the phototach is shown in Fig. 2. Phototransistor *Q1*, the optical sensor, is connected to the rest of the project by a short length of shielded cable terminated with *P1*, an RCA phono plug. When *Q1* is illuminated by a chopped light beam, it alternately turns on and off. The resulting waveform at the collector of *Q1*, which approximates a square wave when the light beam is sharply chopped, is coupled by *C1* to *IC1*, a comparator used as a Schmitt trigger. Feedback provided by *R6* establishes the hysteresis that is characteristic of Schmitt trigger behavior.

Resistors *R2* through *R5* are close-tolerance components that maintain nearly equal biasing on the inverting and noninverting inputs of *IC1*. The output of the Schmitt trigger is a square wave compatible with the TTL integrated circuits forming a two-decade frequency counter.

Output pulses from *IC1* are gated by flip-flop *IC2*. The control signal for *IC2* is the time-base waveform, which is generated from the 60-Hz line in the following manner. Transformer *T1* and diodes *D2* and *D3* form a full-wave rectifier which develops a 120-Hz output. Diode *D4* isolates the cathodes of *D2* and *D3* from filter capacitor *C5*. The full-wave rectified sinusoid at the cathodes of the rectifier diodes is coupled to the base of *Q2* by *R11*.

This transistor saturates so easily that it converts the input waveform into a square wave appearing at its collector. The 120-Hz square wave is applied to *IC6*, a TTL ÷12 counter. Output signals from *IC6* are applied to *IC7*, another ÷12 counter. The net result is a square wave with a 50% duty cycle and a 1.2-second period. This is the time base that controls the gating and counter IC's.

Flip-flop *IC2* performs the gating function in a synchronous manner so that no spurious pulses reach the counters as a result of the gating process itself. The K input of the flip-flop is permanently grounded. Its J input is driven by the time-base signal, and output pulses from Schmitt trigger *IC1* are applied to the clock input. During the 0.6-second interval when the time base is at logic 1, pulses from *IC1* are gated to counter *IC3*. When the time base returns to logic 0, no more pulses are passed to the counter circuit.

The two-decade counter and readout comprises *IC3*, *IC4*, and *LED* displays *DIS1* and *DIS2*. TTL 74143 counter chips are employed in this project. They contain BCD decade counters, latches, and decoder/drivers. Current limiting is built in, so that the chips can be directly connected to the DL-747 common-anode displays.

Counter *IC4* counts the overflow pulses of *IC3*. The negative transition of the time-base waveform, which appears at the end of the 0.6-second counting interval, triggers one half of *IC8*, a 74123 dual monostable multivibrator. A negative-going, 100-microsecond wide pulse appears at pin 12 of *IC8*. This strobe pulse causes the transfer of data from the counter outputs into the latches. When pin 12 of *IC8* returns to logic 1, the second one-shot in *IC8* is triggered. A second negative-going pulse is generated, this time at pin 4 of *IC8*, which clears counters *IC3* and *IC4*. When the time base returns to logic 1, pulses are gated to the counter to repeat the process.

If more than 99 pulses are applied to *IC3* and *IC4* during the counting interval, the BCD outputs of both counters return to 0000 and *IC5* catches the overflow pulse from *IC4* in the following manner. Assume that the clear pulse has just appeared. This pulse not only clears the counters, but resets one half of *IC5*, a 7474 dual D flip-flop, so that the Q output (pin 5) is at logic 0. When the time base returns to logic 1, *IC3* and *IC4* begin to count. If more than 99 pulses are received, a positive transition occurs at pin 22 of *IC4*. This pulse is applied to the clock input of the first D flip-flop, causing the Q output to go to logic one.

The strobe pulse at pin 12 of *IC8* clocks the second flip-flop in *IC5* after the counting interval is over. This flip-flop's D input is connected to the Q output of the other flip-flop in the *IC5* package. If the Q output (pin 5) is at logic one when the strobe pulse appears at the second flip-flop's clock input, a logic 0 appears at pin 8, the second flip-flop's $\overline{Q}$ output. This causes the decimal points on both displays to glow, indicating the overflow condition. The clear pulse then resets the first flip-flop, but the overflow information remains safely stored in the second flip-flop.

The power supply furnishes both a regulated dc voltage and, as mentioned earlier, a full-wave rectified sinusoid which is converted into the time-base waveform. Transformer *T1* and diodes *D2* and *D3* form a full-wave rectifier whose output is applied to switching transistor *Q2* and to filter capacitor *C5*. Diode *D4* isolates the signal driving the base of *Q2* from the filtering effect of *C5*. The stable +5 volts dc required by the TTL integrated circuits is provided by regulator *IC9*. Capacitors *C6* through *C9* shunt any noise on the +5-volt line to ground, and improve the IC regulator's transient response.

Construction of the photo tach is straightforward because circuit layout is not critical. Suitable pc etching and drilling and parts placement guides are shown in Fig. 3. Molex Soldercons or sockets can be used with the IC packages. Be sure to observe pin basing and polarity of all semiconductors and electrolytic capacitors. Mount regulator *IC9* on the project's metallic enclosure for

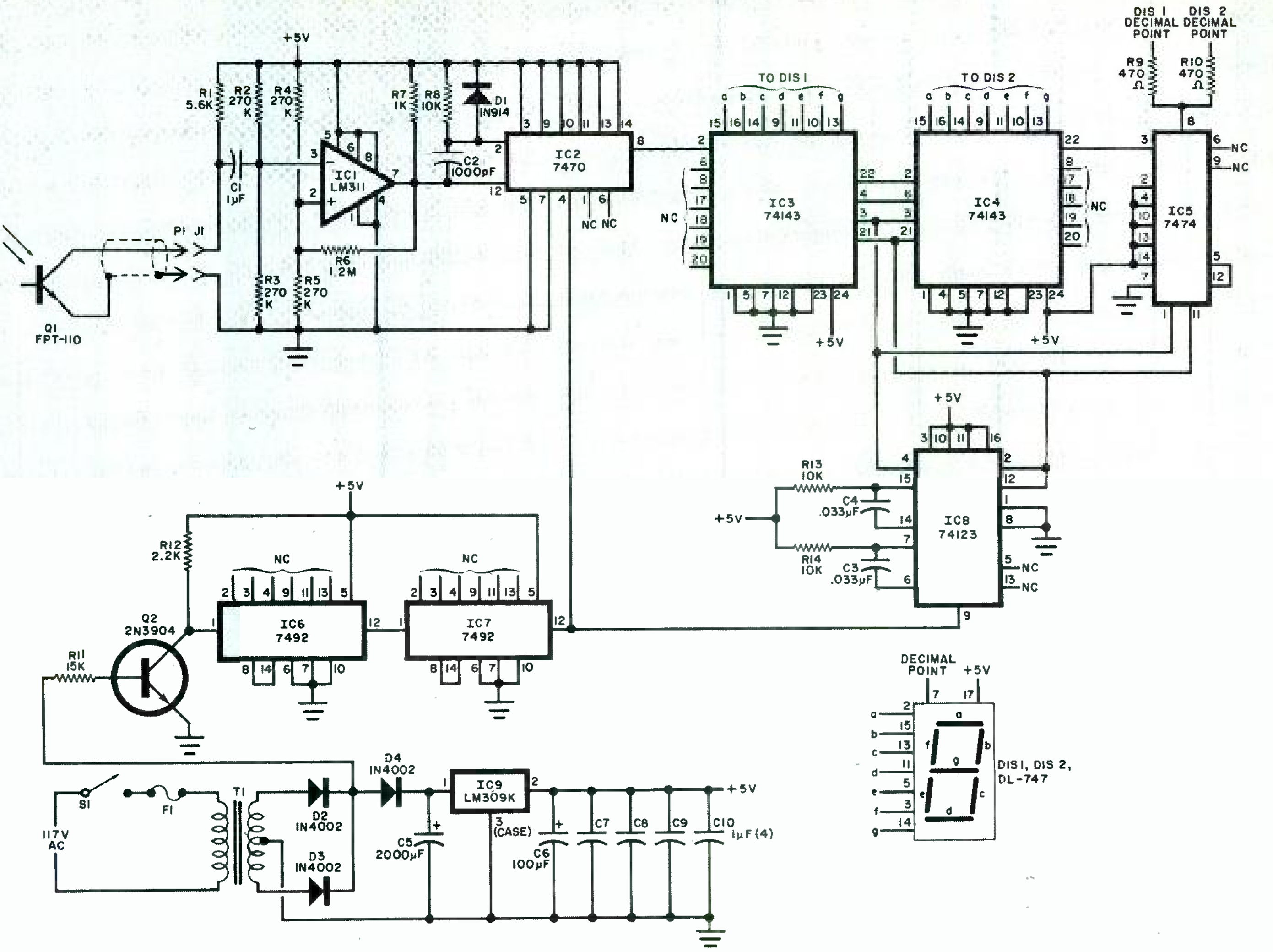


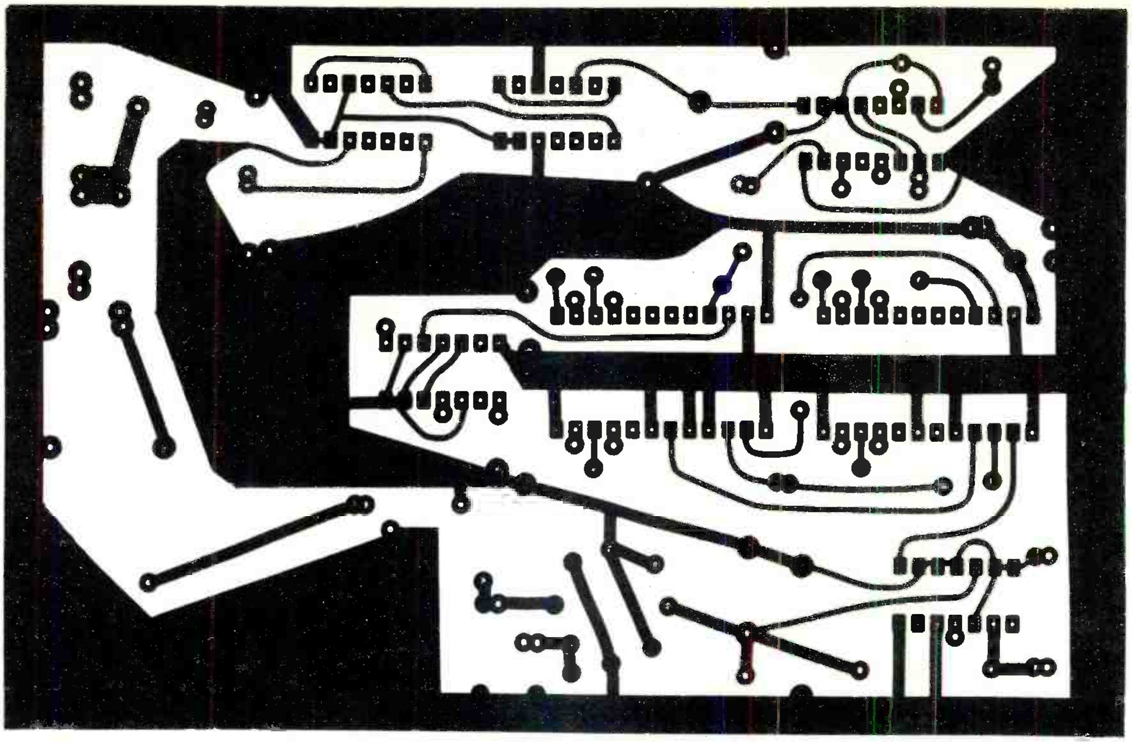
Fig. 2. Schematic diagram shows how pulses from sensor Q1 are squared up by IC1, gated by IC2, and counted by IC3 and IC4.

heat sinking. Spread a thin layer of silicone heat-sink compound on the bottom of the TO-3 can before mounting it. This will ensure a good thermal bond between the IC and the enclosure.

The seven-segment displays should be mounted on a small piece of perforated board installed upright inside the enclosure. Interconnect the displays and integrated circuits with short lengths of hookup wire. Insulated hookup wire should also be used for the eight jumpers on the pc board. The power transformer, switch, and phono jack fuseholder for *F1* are mounted off the board. A probe assembly must be fabricated to house transistor *Q1*. The plastic barrel of a spent ballpoint pen provides a good basis for the probe. Discard the point and exhausted ink tube. Then prepare the phototransistor by clipping its base lead (see Fig. 4). Remove 1″ (2.54 cm) of the vinyl jacket from one end of a suitable length of RG-174-U or RG-58-U coaxial cable. Comb out the braid and

PARTS LIST

C1—1-µF Mylar capacitor
C2—1000-pF polystyrene
C3, C4—0.033-µF Mylar
C5—2000-µF, 35-volt electrolytic
C6—100-µF, 16-volt electrolytic
C7, C8, C9, C10—0.1-µF disc ceramic
D1—1N914 signal diode
D2, D3, D4—1N4002 rectifier diode
DIS1, DIS2—DL-747 common-anode, seven-segment LED display
F1—¼-ampere fuse
IC1—LM311 comparator
IC2—7470 J-K flip-flop
IC3, IC4—74143 decade counter/decoder/display driver
IC5—7474 dual-D flip-flop
IC6, IC7—7492 ÷12 counter
IC8—74123 dual monostable multivibrator
IC9—LM309K 5-volt regulator
J1—RCA phono jack
P1—RCA phono plug
Q1—FPT-110 phototransistor (Fairchild)
Q2—2N3904 npn silicon transistor
The following are ½-watt, carbon composition resistors with 10% tolerance unless specified otherwise:
R1—5600 ohms
R2 through R5—270,000 ohms, 5%
R6—1.2 megohms
R7—1000 ohms
R9, R10—470 ohms
R8, R13, R14—10,000 ohms
R11—15,000 ohms
R12—2200 ohms
S1—Spst switch
T1—16-volt center-tapped, 1-ampere transformer (Signal No. 241-5-16)
Misc.—Suitable enclosure, printed circuit board, hookup wire, RG-174-U or RG-58-U coaxial cable, solder, machine hardware, display bezel, etc.
Note—Phototransistor *Q1* is available (No. 22A21011-6) for $3.50 from Burstein-Applebee, 3199 Mercier, Kansas City, MO 64111. Decade counter/decoder/display drivers *IC3* and *IC4* are available for $3.25 (each IC), from James Electronics, 1021 Howard Avenue, San Carlos, CA 94070. Transformer T1 is available from Signal Transformer Co., 500 Bayview Avenue, Inwood, NY 11696 for $5.50. Postage and sales tax (if applicable) extra.



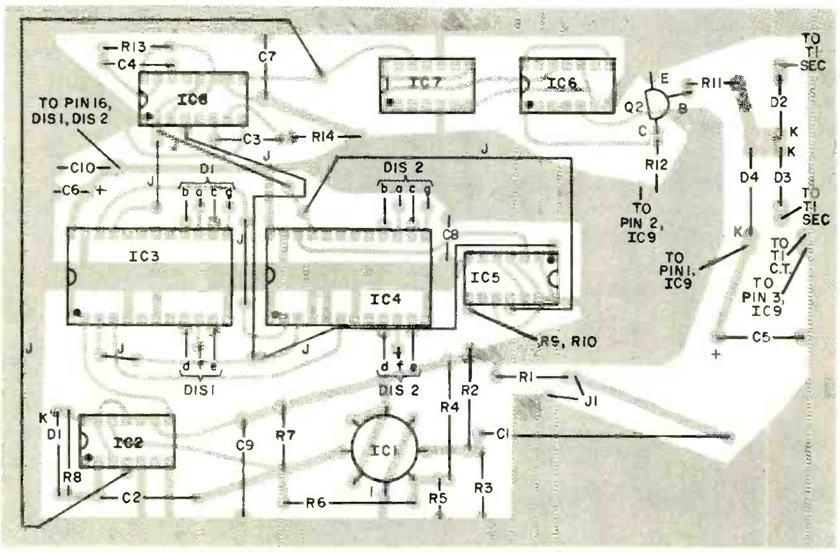


Fig. 3. Full-size etching and drilling guide for pc board is shown above with parts placement guide at left.

twist the strands together. Expose ¼" (6.3 mm) of the inner conductor. Tin the inner conductor and braid with a small amount of solder.

Feed the coax through the pen barrel until the prepared leads extend through the other end. Then attach the inner conductor to the collector of the phototransistor and the braid to the emitter. Pull the coax so that the phototransistor retracts into the barrel, stopping when the light-sensitive surface of *Q1* is recessed about 1" (2.54 cm). Cement or otherwise secure the phototransistor in place, and apply silicone glue where the coax leaves the barrel. Finally, terminate the free end of the cable with an RCA phono plug.

Checkout. No calibration of the photo tach is necessary. With *P1* (the phono plug at the end of the probe cable) removed from *J1*, apply power to the photo tach. Two digits may flash on, but will disappear in about a second. No input pulses are being received, and the outputs of the counters are 0000. Automatic ripple-blanking is built in to the IC counters, so the readouts are darkened and do not display "00."

Apply a 60-Hz, 2-volt p-p sine wave to *J1*. Use either a signal generator or the circuit shown in Fig. 5 as a test source. If the project is functioning properly, "36" will be displayed by the LED readouts. This corresponds to an input of 60 Hz or 3600 rpm.

The operation of the overflow indicator can be verified by either applying a 2-volt p-p sine wave at a frequency of 167 Hz or more, or by optically coupling the probe to an object rotating at 10,000 or more rpm. Both display decimal points will glow, indicating an overflow.

Extending the Range. The photo tach can be modified to measure rotational speeds greater than 9900 rpm by inserting another decade of counting and display between *IC3* and *IC4*. Sever the following connections: pin 22 of *IC3* to pin 2 of *IC4* and pin 4 of *IC3* to pin 6 of *IC4*. Pins 2 and 6 of the additional decade counter should be connected to pins 22 and 4 of *IC3*, respectively. Also, pins 22 and 4 of the additional decade counter should be connected to pins 2 and 6

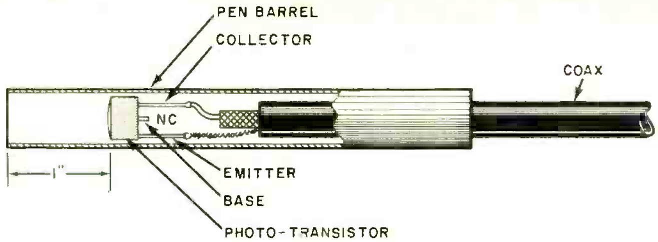


Fig. 4. To make probe, phototransistor is mounted in an old pen barrel and connected to a coaxial cable.

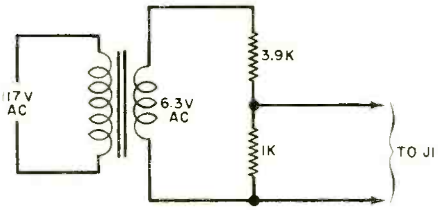


Fig. 5. Schematic diagram of a suitable test source to verify proper circuit operation.

of *IC4*, respectively. Of course, the new counter must be a 74143 IC, and it should be connected to an additional DL-747 display and to the positive supply and ground in the same manner as *IC3* and *IC4*. When this modification has been made, *IC3*'s count will represent hundreds of rpm, the newly installed counter thousands of rpm, and *IC4* tens of thousands. The project's power supply has enough reserve to handle the extra components' demand without any strain.

It is also possible to obtain resolution smaller than hundreds of rpm. If ten light pulses occur during each shaft resolution, the bit significance of each decade of the display is reduced by a factor of ten. Let's consider a specific example. To measure the speed of a slowly turning power drill, a circular disc of metal or plastic should be formed. Ten slots should be punched out at equal intervals along the perimeter and a hole drilled through the center of the disc. Then pass a bolt through the center hole, secure with a nut, and install the entire assembly in the drill's chuck. The rotational speed will then be measured using the transmissive mode and displayed in hundreds and tens of rpm. The addition of another decade of counting and display, as described earlier, can be combined with this multiple triggering technique to display thousands, hundreds, and tens of rpm.

Using the Tach. The optical mode used in a given situation will depend largely on practical considerations. In any event, avoid using fluorescent bulbs as light sources because they are strong electrical noise generators. Ordinary 75- or 100-watt frosted incandescent lamps are well suited for use with the photo tach, as is sunlight. Just remember, however, that if you're checking the speed of a four-blade fan, the actual rate of rotation is one-fourth of what is displayed by the readouts. ◇

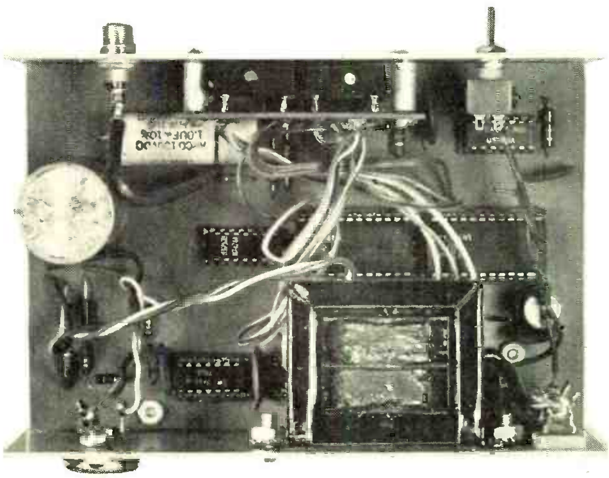


Photo of author's prototype shows layout of components in chassis.

Micro-
PROCESSOR MICROCOURSE

PART 1. NUMBER SYSTEMS

A series devoted to understanding and working with these omnipresent digital devices.

THE MICROPROCESSOR has ushered in a new era of electronics. Just as the transistor conquered the vacuum tube and the integrated circuit replaced a handful of transistors, the microprocessor can replace dozens or even a hundred or more IC's.

The conventional digital logic circuit is "hardwired" and its operation cannot be easily altered after it's built. The microprocessor, however, is functionally equivalent to the central processing unit of a digital computer. Add some memory and the microprocessor can be programmed to function as a digital controller, calculator, computer, or a dedicated logic circuit. Merely replacing the instructions in the memory with new ones will completely change the role of the microprocessor.

Most electronics enthusiasts, from professionals to hobbyists, are aware of microprocessors and some of the things they can do. Computer hobbyists are particularly close to microprocessors since inexpensive hobby computers were first made possible by the Intel 8008 and 8080 microprocessors.

However, microprocessors are so new and different that many of those who are interested in electronics have not yet become familiar with their basic operating principle, much less their programming requirements. The POPULAR ELECTRONICS "Microprocessor Microcourse" is a series of articles that reviews many of the basic operating principles of digital logic circuits and culminates with a detailed description of the architecture and operation of PIP-2, a simple tutorial microprocessor.

The simplest digital logic elements operate on the basis of the presence or absence of an electrical signal. This two-state situation can be used to represent numbers and implement operations in the two-digit binary number system. We'll learn more about the devices and circuits that perform the functions later. First, let's review the basics of binary and a few other number systems.

If you learn how microprocessors work, you'll understand their role in microwave ovens, CB transceivers, autos and computers.

Number Systems. The ten-digit decimal number system is very easy to learn and use. At least that's what most of us were taught in school. But think about decimal arithmetic for a moment. To add any two decimal numbers, for example, you must first have memorized 100 individual addition rules!

What are these rules? They're numerical relationships like 1 + 1 = 2; 4 + 5 = 9; 3 + 7 = 10; etc. Simple? Yes, almost transparently so, but only because we have already memorized them.

As you can see, the "simple" decimal number system isn't very simple at all. And we haven't even covered the rules required to subtract, multiply and divide decimal numbers. In all, there are literally *hundreds* of individual rules for performing the various operations of decimal arithmetic.

It took you five or six years to master the rules of decimal arithmetic, but you can master the rules of binary arithmetic in only five or six *minutes*. The binary system has only two digits or *bits*, 0 and 1, so only a few rules are necessary for performing binary arithmetic.

Here, for example, are the rules for binary addition:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 0, carry 1 or 10
1 + 1 + 1 = 10 + 1 = 11

You can use these five rules to add any two binary numbers. There are equally simple rules for binary subtraction. And since multiplication and division can be accomplished by, respectively, repeated addition and subtraction, the rules for binary arithmetic are far simpler than those for decimal.

You can also use the binary addition rules to count in binary. Start with 0, add 1, and continue adding 1 to consecutive sums. This procedure is called incre-

BY FORREST M. MIMS

menting, and it allows us to quickly generate the first sixteen binary numbers:

0	100	1000	1100
1	101	1001	1101
10	110	1010	1110
11	111	1011	1111

Computer specialists frequently refer to binary numbers like these as *words* or *bit patterns* since they are often used to represent computer instructions and other nonnumerical functions. Words having eight bits are commonly used; they are called *bytes*. A word having four bits is a *nibble*.

Though binary arithmetic is easy to learn, the binary number system has a major drawback from the human perspective. Binary numbers (or words) are often long and cumbersome, difficult to remember, prone to transpositional errors, and difficult to vocalize. For example, a decimal number that uses only a digit or two will require from one to seven bits when expressed in binary. The decimal number 99 is easy to pronounce and remember. Its binary counterpart is an awkward 1100011.

Computer enthusiasts have invented several handy shortcuts and tricks for remembering binary numbers and converting them into their decimal counterparts. These methods are going to become almost second nature to the microprocessor generation, so let's have a look at them.

Converting Binary to Decimal. Converting binary numbers to their decimal equivalents is easy once you know how to expand an ordinary decimal number into its component parts. For example, 653 is 600 + 50 + 3.

The position of the digits in a number like 653 determines the power of ten by which the respective digits are multiplied. Thus,

$$\begin{aligned} 653 = 6 \times 10^2 &= 600 \\ 5 \times 10^1 &= 50 \\ 3 \times 10^0 &= 3 \\ &\overline{653} \end{aligned}$$

Binary numbers can be expanded using this same method—and in the process converted into their decimal counterparts. Since the binary system has only two bits, the position of a bit in a binary number determines by which power of *two* the bit is multiplied. Thus,

$$\begin{aligned} 1001 = 1 \times 2^3 &= 1000 \\ 0 \times 2^2 &= 0000 \\ 0 \times 2^1 &= 0000 \\ 1 \times 2^0 &= 0001 \\ &\overline{1001} \end{aligned}$$

We can carry this expansion one step further and convert 1001 into its decimal equivalent. Just convert the powers of two into their decimal values and add the products:

$$\begin{aligned} 1001 = 1 \times 8 &= 8 \\ 0 \times 4 &= 0 \\ 0 \times 2 &= 0 \\ 1 \times 1 &= 1 \\ &\overline{9} \end{aligned}$$

An even faster way to convert a binary number to its decimal form is to list the ascending powers of two over each bit in the number beginning with the least significant bit. Then add the powers of two over the 1 bits and ignore those over the 0 bits. Thus, to convert 1100110 to decimal:

64 32 16 8 4 2 1
1 1 0 0 1 1 0
64 + 32 + 4 + 2 = 102

Converting Decimal Numbers to Binary. A quick way to convert decimal numbers into their binary counterparts is to repeatedly divide the decimal number by two. The remainders of each division, which will always be 0 or 1, become the binary number. Let's convert 102 into binary using this method:

102/2 = 51, remainder 0
51/2 = 25, " 1
25/2 = 12, " 1
12/2 = 6, " 0
6/2 = 3, " 0
3/2 = 1, " 1
Final " 1
102 = 1 1 0 0 1 1 0

Octal and Hexadecimal Numbers. Often binary numbers are used to represent computer instructions and operations. For example, 01110110 is the binary equivalent of the decimal number 118. 01110110 is also the instruction code selected by Intel to represent the instruction HLT (halt) for its 8080 microprocessor.

Binary numbers are also used to represent memory addresses inside a computer. Thus 01110110 can represent the decimal number 118, the instruction HLT, or the 119th address in a computer memory (the first address being 00000000).

Since binary numbers play such an important role in microprocessors and computers, you'll want to learn about a couple of very handy time and space saving shortcuts called the *octal* and *hexadecimal* number systems.

Decimal numbers have ten as their base; therefore the largest decimal digit is 9. Octal numbers have eight as their base, and that means the largest octal digit is 7. Since the binary equivalent of the decimal digit 7 (which is equivalent to the octal digit 7) is 111, it's easy to convert any binary number into its octal counterpart by simply dividing the bits in the number into groups of three and converting each group into its decimal equivalent. Thus, the binary number 01110110 becomes 01 110 110 or 166 in octal.

When listing numbers having different bases, it's customary to indicate each number's base with a subscript. Therefore 166_8 is an octal number. Obviously 166_8 is much easier to remember than 01110110_2. And it's easy to convert 166_8 back to binary by simply writing out the binary equivalent for each digit:

1 =	01		
6 =		110	
6 =			110
	01	110	110

(continued overleaf)

Hexadecimal numbers have sixteen as their base. They're commonly used to simplify 8-bit bytes into easily remembered two-character numbers.

The hexadecimal digits are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. Don't let the letters A-F confuse you. There are more than enough decimal digits for the binary and octal systems, but not enough for all sixteen hexadecimal digits. The letters A-F complete the six digit spaces beyond the ten digits 0-9.

It's easy to convert a binary byte into hexadecimal or simply *hex.* First, divide the byte into two nibbles. Then assign the hex equivalent to each nibble. 1111_2 is F_{16} and 0110_2 is 6_{16}. Therefore, 11110110_2 is $F6_{16}$.

To convert a hex number to binary, just assign the binary equivalent to each hex digit. Thus $F6_{16}$ is 1111_2 and 0110_2 or 11110110_2.

Incidentally, though it's correct to identify a hex number with a subscript 16, it's not necessary to tag on the subscript if the number includes one of the six digits borrowed from the alphabet. Everyone seeing it will know it's hex. Also, some computer companies identify hex numbers with the $ sign. So F6E9 is the same as $F6E9.

Most of today's microprocessors use 8-bit address and instruction words, so you'll often see programs given in octal or hexadecimal. While it takes time to become used to these new number systems, especially hex, you'll find them very handy as you become more involved with microprocessors. The conversion table given below will help you

Decimal	Binary	Octal	Hexa-decimal
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

become more familiar with both octal and hexadecimal numbers. ◇

(Series continues next month)

LOW-COST EPROM PROGRAMMER

BY DAN VINCENT

PART 2 *Power supply, construction and checkout.*

Power Supply. The supply (Fig. 5) delivers approximately +75 volts to a transistor switch/current limiter consisting of *Q1*, *Q2*, *Q3*, *R1*, *R2* and *R3*. Transistors *Q4* and *Q5*, in conjunction with *D5*, *R6*, *R7*, and *R8* regulate the +75-volt output down to +47 volts. Diode *D6* and resistor *R5* provide the V_{BB} bias supply. Resistor *R9* insures a minimum load on the regulator and provides a path for the *D6* zener current. Capacitor *C2* and resistor *R20* prevent the high-gain circuit of *Q5* from oscillating.

Construction. Although the Program-

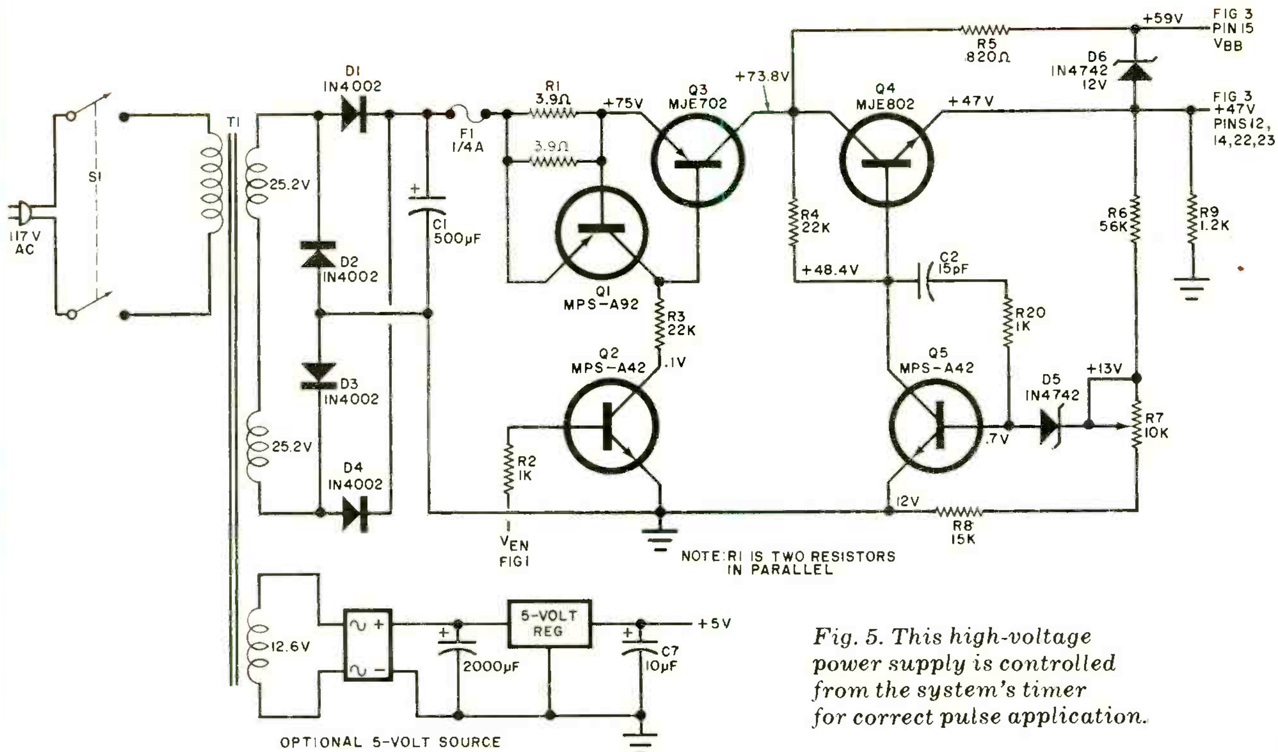


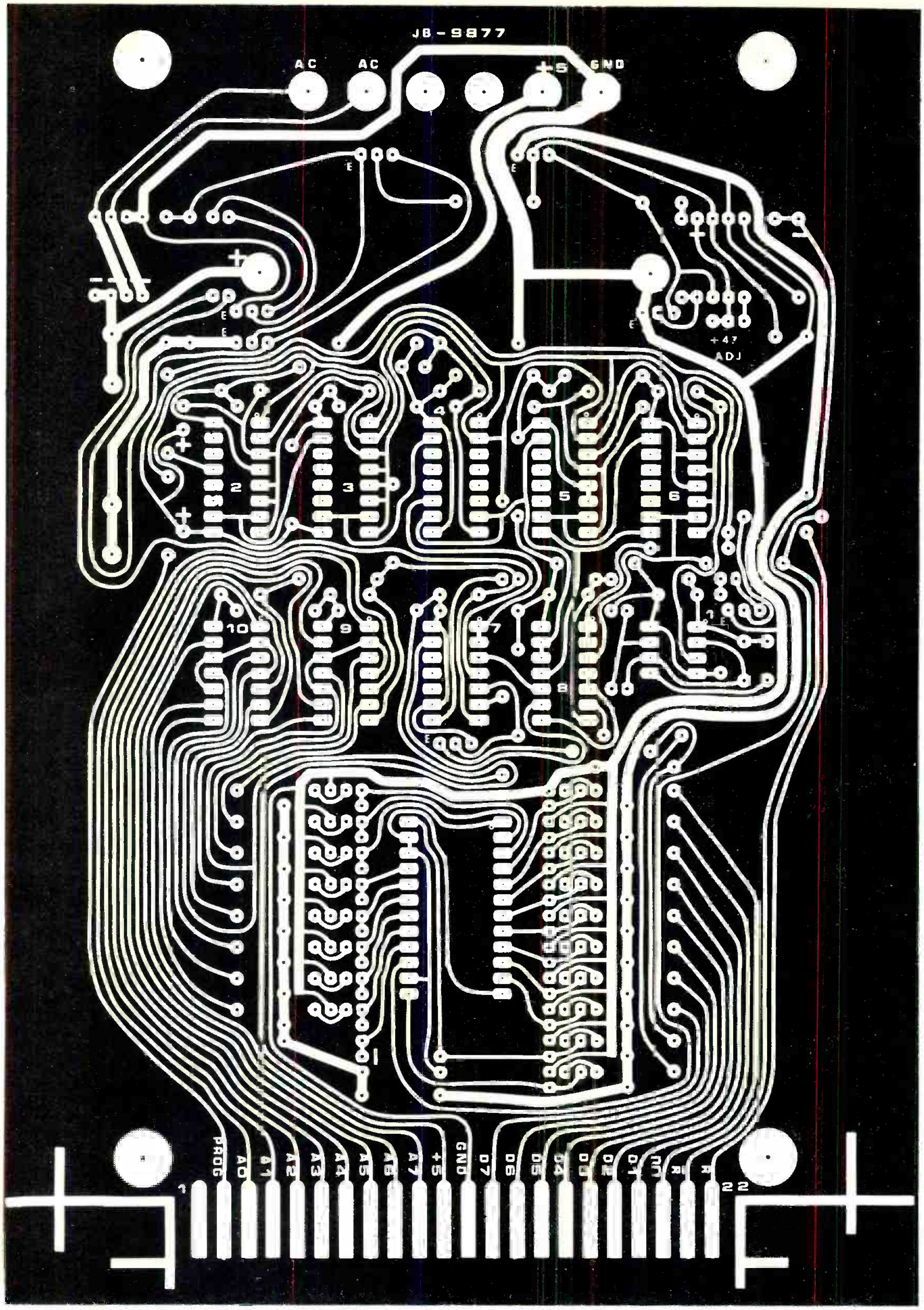
Fig. 5. This high-voltage power supply is controlled from the system's timer for correct pulse application.

PARTS LIST

C1—400-µF, 75-V electrolytic capacitor
C2—15-pF ceramic capacitor
C7—10-µF, 15-V electrolytic capacitor
D1 through D4—1-A, 200-V silicon diode (1N4002 or similar)
D5, D6—12-V, 1-W, 10% zener diode (1N4742 or similar)
F1—¼-A fast-blow fuse and holder
Q1—MPS-A92, 300-V silicon pnp transistor
Q2,Q5—MPSA42, 300-V silicon npn transistor
Q3—MJE702, 80-V silicon Darlington pnp transistor
Q4—MJE802, 80-V silicon Darlington npn transistor

The following are ¼-W, 10% resistors unless otherwise noted:
R1—1.9-ohm, 5%, 1-W resistor (two 3.9-ohm, ½-W, 5% in parallel)
R2, R20—1000 ohms
R3,R4—22,000 ohms
R5—820 ohms, ½-W
R6—56,000 ohms
R7—10,000-ohm, 10%, ½-W trimmer potentiometer (Bourns 3389 series)
R8—15,000 ohms
R9—1200 ohms, 2 W
S1—Dpdt, 1-A toggle switch
T1—2 each 25.2-V, 300-mA transformer with 5-V power-supply winding

Note—The following are available from DIA, Inc., Box 343, Dayton OH 45459: etched and drilled pc board at $8.95; basic 1702A EPROM Programmer kit (TTL option), including pc board and all components except power supply and connector, at $39.95; special transformer that also includes 5-volt power supply winding at $9.98; complete kit, including pc board and all components for stand-alone Programmer with switches, power supply, zero-insertion-force socket and case, at $79.95; complete stand-alone Programmer, assembled and tested, at $99.95. All prices postpaid. Check, money order, Visa, or Master Charge accepted. Ohio residents, please add 4½% sales tax.



mer can be built using any desired construction technique, a printed circuit board such as that shown in Fig. 6 is suggested. Observe the correct polarities when installing capacitors, diodes, transistors and IC's (using sockets, if desired). Do not install transistors *Q8* and *Q14* through *Q29* until after reading the checkout section of this article. Mount 1-inch by ½-inch thin metal heat sinks on transistors *Q3* and *Q4*. Using the fuse as a guide, install a fuseholder or fuse clips at the *F1* position. Do not install a socket at position *S02* or the LED for *LED1* if you are going to mount the board in an enclosure.

The component installation shown in Fig. 6 uses the TTL option so that the

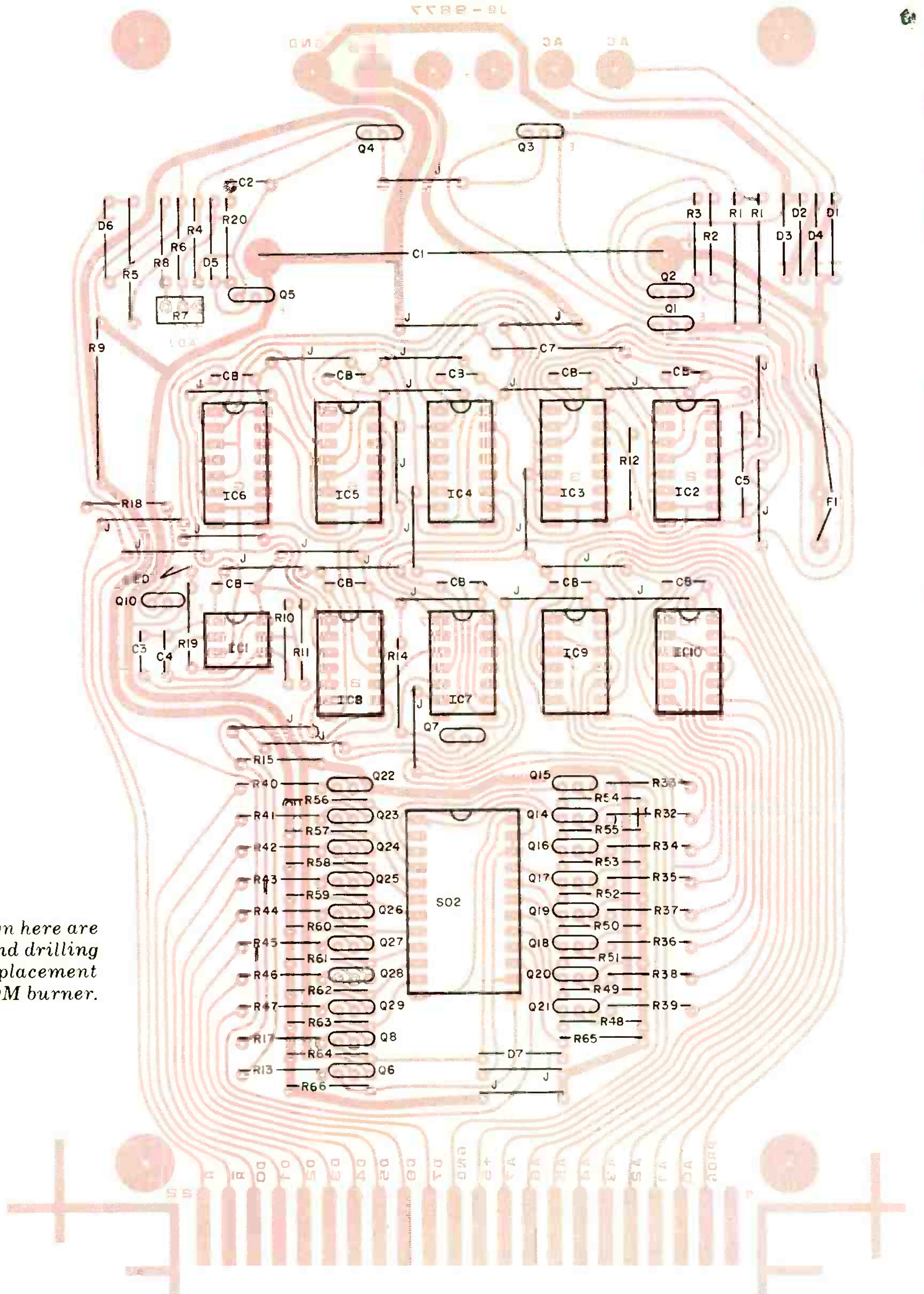


Fig. 6. Shown here are etching and drilling and component placement guides for PROM burner.

Programmer can be used with a computer at some later date.

Select a suitable enclosure whose front panel can support the eight address and write data switches in two rows (see photo). Also on the front panel are the on/off switch, the program pushbutton switch, *LED1*, and a zero-insertion-force 24-pin PROM socket. Identify the switches and controls properly.

Use a length of heavy bare wire to interconnect all of the upper lugs of the top row of address switches. Interconnect the bottom row of address switch lugs similarly. Use the same technique on the data switches. Using insulated wire, connect the upper lugs of the address switches to the upper lugs of the data switches. Do the same with the lower lugs—lower lugs to lower lugs.

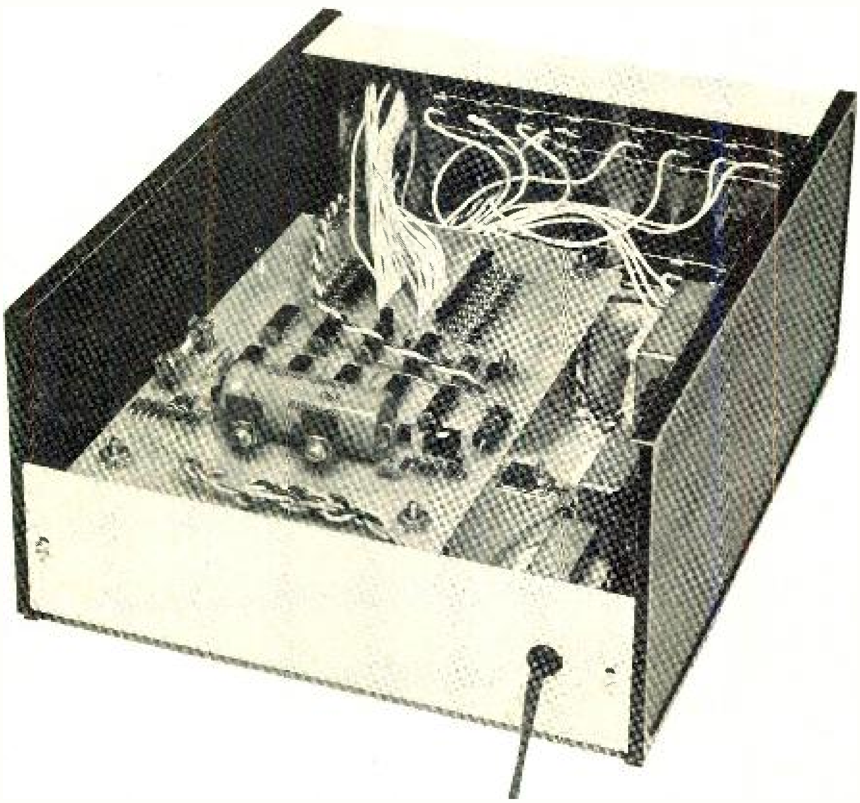
Using the small insert schematic of the *S18* circuit shown in Fig. 2, connect the normally closed contact of this switch to the top bare wire (gnd) of the address or data switches. Connect the two resistors and capacitor to the switch as shown, using the bottom lugs of either the address or data switches for the 5-volt connection.

Mount transformer T1 on one side of the chassis bottom plate. The rectifier, filter capacitor, and 5-volt regulator for this supply can also be mounted on the bottom plate of the chassis. The pc board will be mounted on spacers so that it will not contact the components mounted within the chassis. Using the four large corner holes in the pc board as a guide, and with the edge connector toward the front panel, mark and drill the four spacer mounting holes.

With the pc board held in its final mounting position (edge connector facing the front panel), cut lengths of insulated wire long enough to fit easily between the *S02* board position and the 24-pin front-panel socket. Do the same for the program switch and *LED1*. Make similar connections from the edge connector to the center lug of each of the address and data switches. A pair of wires will also be needed from the edge-connector 5-volt pad to the bottom lugs of the switches. You will also need insulated leads from the two ac-pads and the 5-volt ground pads (on the pc board edge opposite the connector) to interconnect to the power supply circuits.

Drill a hole in the rear apron of the chassis and put a grommet in it for the ac line cord. Make sure all ac connections are well insulated.

After all the wiring is installed, the board can be mounted on spacers. Do not tighten the mounting hardware, however, because the missing transistors will have to be installed after performing the following Checkout procedure.



The 5-volt supply is mounted under the pc board. With a little care, as shown here, a very professional look can be attained.

Checkout. Be sure transistors *Q8* and *Q14* through *Q29* and the +47-volt line connection are not installed until after the regulator checkout is complete.

After double checking the wiring (and pc board), adjust potentiometer *R7* to its maximum series resistance, then temporarily jumper the collector of *Q2* (Fig. 5) to ground to enable the regulator. Apply ac power to the high-voltage and 5-volt power supplies and check for the presence of +75-volt dc across filter capacitor *C1*. If necessary, reverse the secondary connections.

Using a dc voltmeter of known accuracy, monitor the voltage across *R9* (Fig. 5) and adjust *R7* to obtain +47 ±1 volts. Leave the voltmeter connected across the 47-volt line.

The current limiter is checked by *momentarily* shunting *R9* with a 68-ohm, 2-watt resistor. The voltage should drop to approximately 25 volts. If not, check *Q1*, *Q3* and *R1*.

Remove the temporary jumper from the collector of *Q2* and note that the output voltage drops to zero. If not, *Q2* is faulty or is being prematurely enabled by *IC7*. Between programming cycles, *IC7* should be completely cleared.

Using pushbutton switch *S1B* (Fig. 2), apply a pulse to the program command line and verify that the +47 volts occurs for about half a second. If it does, it is a good indication that the counters and clock are functioning normally.

The +47-volt line and the transistors can now be installed.

If you do not have a zero insertion-force socket, before installing the first PROM, loosen up the holes in the PROM socket using the leads of a ¼-watt resistor. This should be done since the pins of many 1702A PROM's are fragile and may be bent trying to force them into a tight socket.

With power applied, insert an erased EPROM in the socket, set the address and data switches in accordance with the first location of your truth table, and apply the programming command (*S18*). That location will be programmed within half a second. The optional LED programming indicator may be used to watch this timing.

You now have 255 more locations to go. If you use the microprocessor option (Fig. 3) and a suitable program, the EPROM can be programmed in just a few minutes. ◇

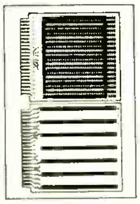
DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER

14-16 Pin Dip IC Inserter	INS-1416	$3.49

DIP/IC EXTRACTOR TOOL

Extractor Tool	EX-1	$1.49

P.C. BOARD



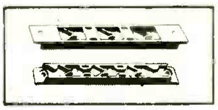
The 4 x 4.5 x 1/16 inch board is made of glass coated EPOXY Laminate and features solder coated 1 oz. copper pads. The board has provision for a 22/44 two sided edge connector, with contacts on standard .156 spacing. Edge contacts are non-dedicated for maximum flexibility.

The board contains a matrix of .040 in. diameter holes on .100 inch centers. The component side contains 76 two-hole pads that can accommodate any DIP size from 6-40 pins, as well as discrete components. Typical density is 18 of 14-Pin or 16-Pin DIP's. Components may be soldered directly to the board or intermediate sockets may be used for soldering or wire-wrapping.

Two independent bus systems are provided for voltage and ground on both sides of the board. In addition, the component side contains 14 individual busses running the full length of the board for complete wiring flexibility. These busses enable access from edge contacts to distant components. These busses can also serve to augment the voltage or ground busses, and may be cut to length for particular applications.

Hobby Board	H-PCB-1	$4.99

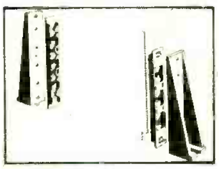
PC CARD GUIDES



Card Guides	TR-1	$1.89

QUANTITY – ONE PAIR (2 pcs.)

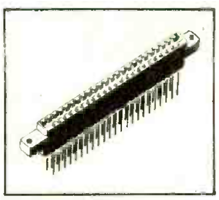
PC CARD GUIDES & BRACKETS



Guides & Brackets	TRS-2	$3.79

QUANTITY – ONE SET (4 pcs.)

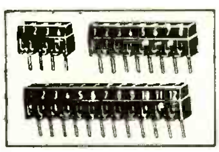
PC EDGE CONNECTOR



44 Pin, dual read out, .156" (3,96 mm) Contact Spacing, .025" (0,63 mm) square wire-wrapping pins.

P.C.. Edge Connector	CON-1	$3.49

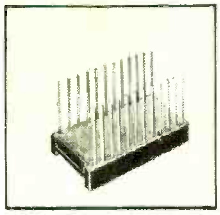
P.C.B. TERMINAL STRIPS



The TS strips provide positive screw activated clamping action, accommodate wire sizes 14-30 AWG (1, 8-0, 25mm). Pins are solder plated copper, .042 inch (1mm) diameter, on .200 inch (5mm) centers.

4-Pole	TS- 4	$1.39
8-Pole	TS- 8	$1.89
12-Pole	TS-12	$2.59

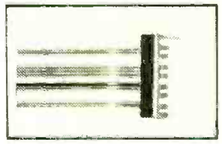
DIP SOCKET



Dual-in-line package, 3 level wire-wrapping, phosphor bronze contact, gold plated pins .025 (0,63mm) sq., .100 (2,54mm) center spacing.

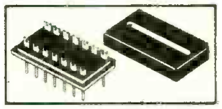
14 Pin Dip Socket	14 Dip	$0.79
16 Pin Dip Socket	16 Dip	$0.89

RIBBON CABLE ASSEMBLY SINGLE ENDED



With 14 Pin Dip Plug 24" Long (609mm)	SE14-24	$3.55
With 16 Pin Dip Plug 24" Long (609mm)	SE16-24	$3.75

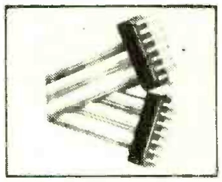
DIP PLUG WITH COVER FOR USE WITH RIBBON CABLE



14 Pin Plug & Cover	14-PLG	$1.45
16 Pin Plug & Cover	16-PLG	$1.59

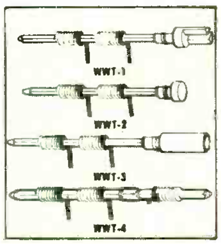
QUANTITY: 2 PLUGS, 2 COVERS

RIBBON CABLE ASSEMBLY DOUBLE ENDED



With 14 Pin Dip Plug - 2" Long	DE 14-2	$3.75
With 14 Pin Dip Plug - 4" Long	DE 14-4	$3.85
With 14 Pin Dip Plug - 8" Long	DE 14-8	$3.95
With 16 Pin Dip Plug - 2" Long	DE 16-2	$4.15
With 16 Pin Dip Plug - 4" Long	DE 16-4	$4.25
With 16 Pin Dip Plug - 8" Long	DE 16-8	$4.35

TERMINALS



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25 PER PACKAGE

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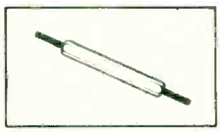
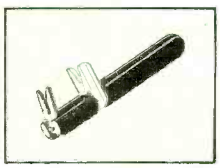


For inserting WWT-1, WWT-2, WWT-3, and WWT-4 Terminals into .040 (1,01mm) Dia. Holes.

INS-1	$2.49

WIRE CUT AND STRIP TOOL



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Strip length easily adjustable for your applications.

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26 ga. Wire Cut and Strip Tool	ST-100-26	[illegible]	—	1 11/16"	$ 8.75
26 ga. Wire Cut and Strip Tool	ST-100-26-875	7/8"	—	1 1/8"	$ 8.75
28 ga. Wire Cut and Strip Tool	ST-100-28	7/8"	—	1 1/8"	$11.50
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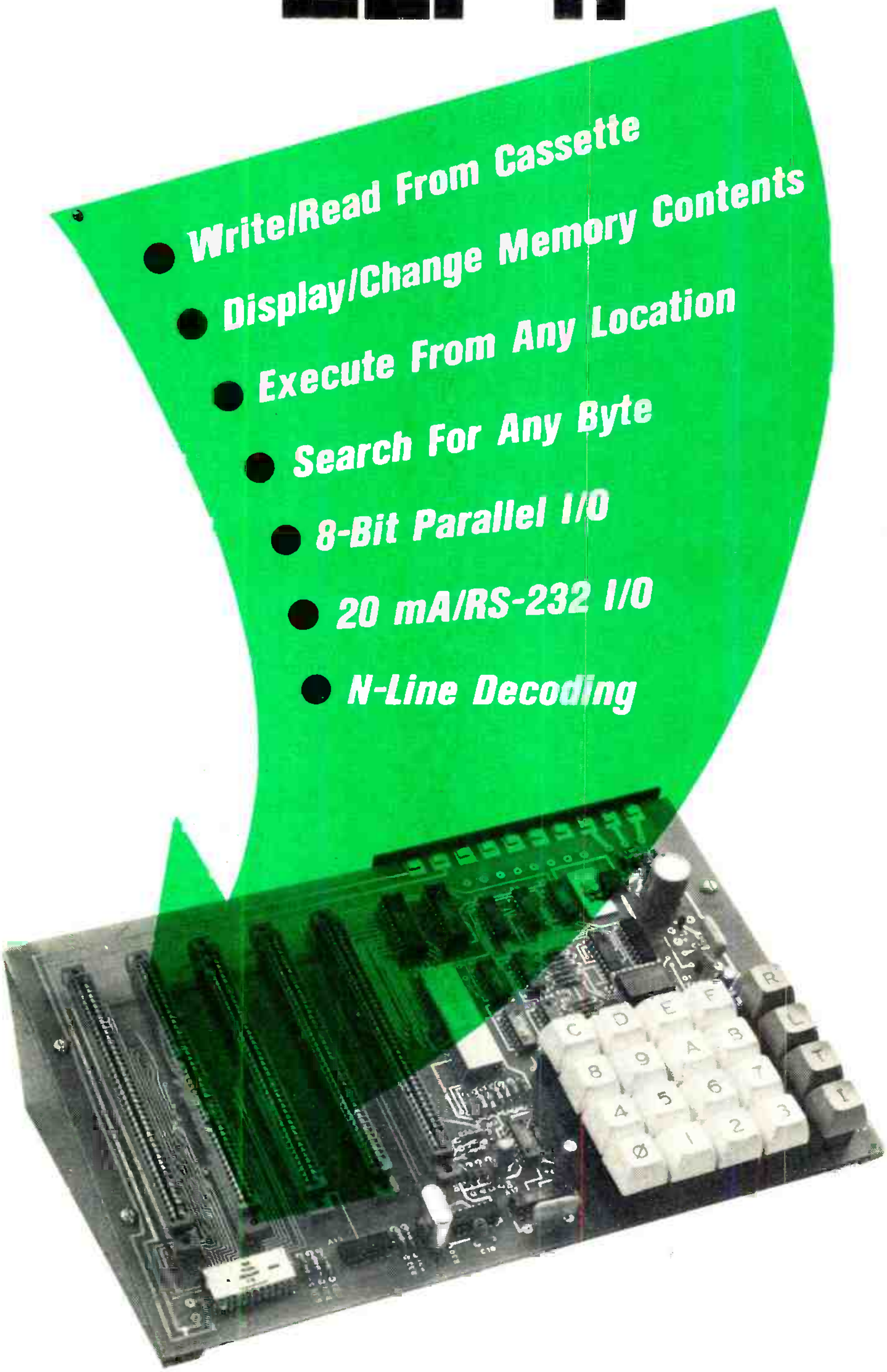
BY MARTIN MEYER

Expanding THE ELF II



LAST month, POPULAR ELECTRONICS described some hardware and software methods of upgrading a basic Elf microcomputer, based on the 1802 MPU. Here are plans to go beyond this, boosting an Elf from a microcomputer trainer to virtually a personal computer. Though based on an Elf II model (see "Build a Personal Microcomputer for $100" in PE's ELECTRONIC EXPERIMENTER'S HANDBOOK, 1978 Edition) from Netronics R&D, which includes a hex keypad, a bus structure and a pc board, the enhancements can be easily applied to any basic Elf.

The upgraded Elf II lends itself to especially easy expansion because of its bus structure. Since all of the 1802 signals, plus the power (+5 volts), ground, and 3.58 MHz from the clock oscillator are located on the bus, all that has to be done is to build an expansion circuit on a pc board having suitable dual-43-pin edge pads. Then a mating connector is mounted on the main Elf II pc board and the new board is plugged in.

All of the circuits shown in this article can be built on a single pc board. If desired, the newly created signals can be connected to the bus by using any of the odd-numbered bus lines. (Other than lines 1 and 3, none of the Elf II odd-numbered bus lines is currently used.) It is advisable to keep a record identifying each signal on the newly used lines.

The expansion system described here introduces a new monitor, located in ROM, that allows:

- Writing and reading from a cassette recorder.
- Displaying the address and contents of any memory location from 0000 to FFFF.
- Changing the contents of any memory location displaying both the address and the changed data.
- Execution of a program at any location.
- Scan entire memory for a specific byte.

Besides the hardware to implement the monitor, this article also describes the construction of an 8-bit parallel I/O port, interface for 20-mA/RS-232 peripherals, and the decoding of the three 1802 "N" lines to fully utilize all "6n" (I/O) instructions.

Monitor. The monitor program (overleaf) is stored in ROM *IC2* in the circuit shown in Fig. 1. The address of *IC2* corresponds to the hex address F0 00 where the most significant four bits of the high-order address are all high. The

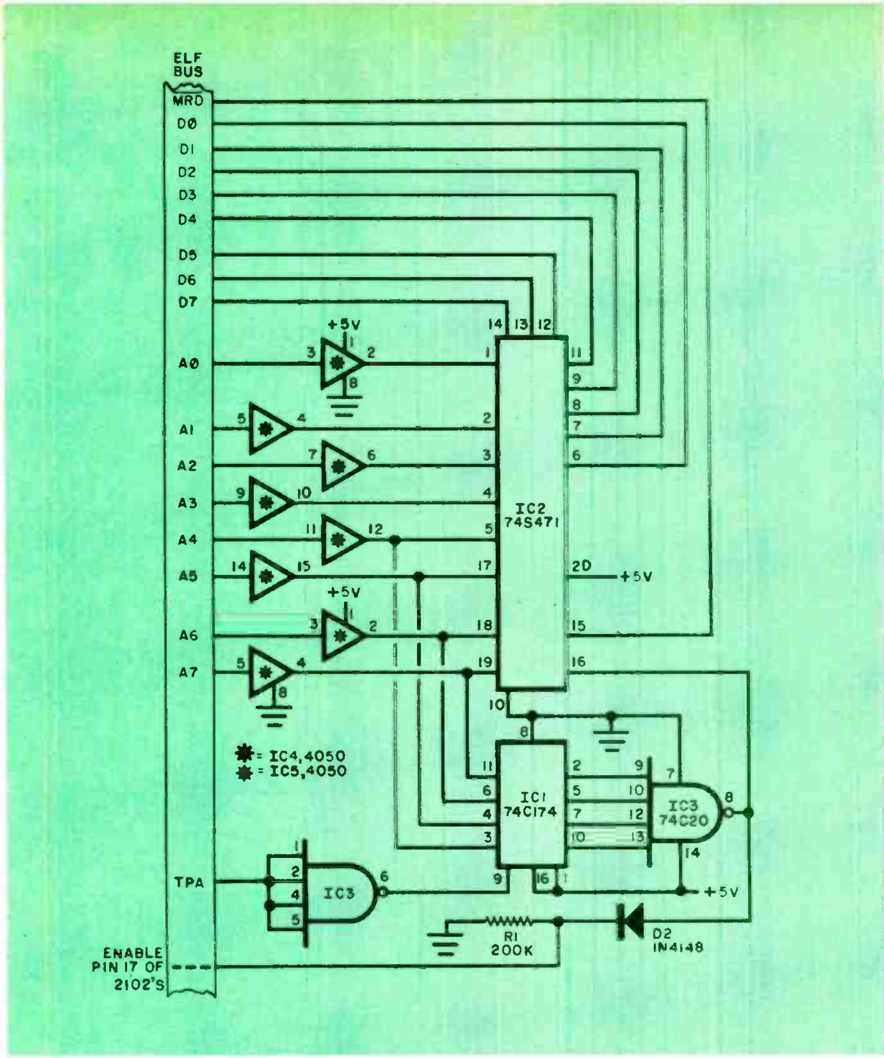


Fig. 1. The ROM (IC2) contains the monitor program and is addressed at F000 by IC1 and IC3.

four-bit latch in *IC1* decodes these four bits to drive 4-input NAND gate *IC3*. When the F000 address appears, the ROM is enabled via pin 16. The eight address lines from the bus are buffered by *IC4* and sections of *IC5*.

To use the monitor program, turn off the RUN, LOAD and M/P (memory protect) switches to reset the 1802. Place the LOAD switch in the on position and, using the keypad, enter C0 F0 00. Set the LOAD switch in the off position. When the RUN switch is on, the monitor will come into play. The next input will determine the monitor mode: 00 is execute, 01 is memory examine, 02 is memory change, 03 is cassette write, and 04 is cassette read.

To execute (run) a program from a memory location other than 0000, enter the monitor (C0 F0 00), then enter 00. Insert the two-byte address of the beginning location. When the INPUT switch is depressed, the program executes from the memory location specified.

To examine a memory location, enter

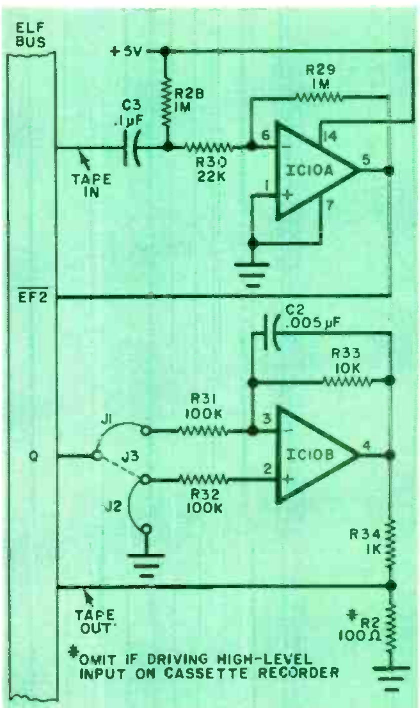


Fig. 2. Read and write circuits. Jumpers select signal polarity.

the monitor and key in 01. Insert the two-byte address of the memory to be examined, then depress and release the INPUT switch. The byte stored at that memory location will be displayed. Depress and hold the INPUT switch down and the low-order address of the next byte will be displayed, followed by the memory byte when the INPUT switch is released.

To change data at a memory location, enter the monitor then enter 02. Insert the two-byte address of the memory to be changed and note that the Q LED comes on. Enter the new data. Then depress and release the INPUT switch. The new byte will then be displayed. Note that the low-order address of the next byte is displayed if you hold the INPUT switch down. If desired, that byte can also be changed.

For cassette write, enter the monitor, then enter 03. Key in the starting two-byte address of the memory to be recorded, then the ending two-byte address. Place the tape recorder in the record mode, allow several seconds for the leader to pass the heads, then depress the INPUT key. The Q LED will extinguish when the recording is complete.

To perform a cassette read, enter the monitor and then enter 04. Enter the starting two-byte address of the memory to be loaded. Then enter the ending two-byte address. Put the cassette recorder in the playback mode and depress the input switch. Allow 2.5 seconds for each 256 memory bytes recorded. The display will increment the low-order address of memory being entered. When the display stops incrementing at the last low-order address, the playback is complete. The final digits in the display will show the low-order address of the data being written (recorded).

If you are in the monitor program and select an illegal operating code (other than those spelled out above), an EE will be displayed on the readouts and the Q LED will come on.

Cassette Read/Write. This simple circuit (Fig. 2) uses the Q and EF2 lines on the Elf II bus. When executing the tape write function, the monitor produces a 10-second train of sync pulses followed by the serial output of data (plus parity) on the Q line from the memory boundaries selected. Resistors *R34* and *R2* form an attenuator that provides adequate record level for the tape recorder used. If your tape recorder has a microphone input, the typical value for *R34* would be about 1000 ohms. If your

MONITOR PROGRAM

00	90	A1	B3	B4	B5	B6	B7	F8	FF	A2	E2	21	81	B2	80	52
10	F3	3A	0B	F8	38	A3	F8	29	A4	F8	33	A5	D3	3F	1D	22
20	8A	52	64	37	23	6C	30	1C	D3	3F	29	37	2B	6C	64	22
30	30	28	D3	22	52	64	30	32	D4	F8	4D	F4	A6	02	FD	05
40	33	47	F8	EE	D5	7B	00	D4	BA	D4	AA	06	A3	53	58	5D
50	78	C8	F6	9A	B0	8A	A0	E0	D0	4A	D5	30	58	7B	D0	D5
60	5A	1A	30	5D	D3	7B	F8	1D	3B	6D	F8	07	1D	52	FF	01
70	33	6E	39	64	7A	02	30	6E	F8	8D	A1	D4	73	D4	8A	F5
80	AC	12	9A	75	FC	01	BC	D0	F8	65	A6	81	A3	F8	80	BD
90	FF	00	D6	9D	3A	90	8A	D5	7B	4A	BB	FC	00	F8	09	AB
A0	AD	D6	2B	8B	32	AB	9B	FE	BB	30	A1	8D	F6	D6	2C	9C
B0	3A	96	D6	D6	D6	D6	30	38	1D	D3	F8	0D	35	BC	35	B8
C0	FF	01	33	BE	3D	C4	30	B9	F8	CD	A1	30	7B	F8	BA	A7
D0	F8	F9	BD	D7	3B	D0	9D	3A	D3	D7	33	D9	F8	01	BD	AD
E0	D7	9D	7E	BD	3B	E0	D7	8D	F6	33	45	9D	5A	8A	D5	1A
F0	2C	9C	3A	D9	30	38	D4	4A	F3	3A	F7	2A	9A	D5	30	58

tape recorder has an auxiliary (high-level) input, omit *R2*. You may have to experiment with the value of *R34* to arrive at the correct recording level.

When reading from a cassette, the serial data is fed to the EF2 line. Using an oscilloscope between the EF2 line and ground, adjust the volume control of the tape recorder until a good square wave is obtained on the EF2 line. If you get the square wave, note the position of the volume control for future use. If you cannot get a good square wave, adjust the recording level by decreasing the value of *R34* (in the tape write circuit).

If the read function does not work, it may be due to the cassette recorder's inverting the polarity of the signal. This can be corrected by removing jumpers *J1* and *J2* and connecting the Q signal to *R32* through *J3*.

PARTS LIST

C1, C3—0.1-µF, 100-V Mylar capacitor
C2—0.005-µF Mylar capacitor
D1,D2—1N4148 diode
IC1—74C174 hex latch
IC2—74S471 256x8 PROM
IC3—74C20 dual 4-input NAND gate
IC4, IC5, IC9—4050 hex buffer
IC6—1853 N-line decoder
IC7, IC8—1852 8-bit I/O port
IC10—LM3900 quad op amp
Q1, Q3—2N5232 transistor
Q2,Q4—2N5306 transistor
The following are ¼-W, 5% resistors unless otherwise noted:
R1—200,000 ohms
R2—100 ohms
R3, R11, R18—3900 ohms
R4—330 ohms
R5, R6, R10, R14—15,000 ohms
R7—300,000 ohms
R8, R9,R15,R16,R17,R34—1000 ohms
R12—47 to 250 ohms (value for 20 mA current loop)
R13—2200 ohms
R19 through R27, R30—22,000 ohms
R28,R29—1 megohm
R31,R32—100,000 ohms
R33—10,000 ohms
Misc.—Pc board with edge connectors to match Elf II bus, 86-pin connector, optional sockets for IC's, etc.
Note—The following are available from Netronics R&D Ltd., 333 Litchfield Rd., New Milford, CT 06776: complete set of parts including pc board, pre-programmed monitor PROM, less 86-pin connector for $39.95 plus $2 postage and handling; PROM IC2 available separately for $25 plus $1.50 postage and handling; 86-pin connectors for $5.70 each plus 30 cents postage and handling.

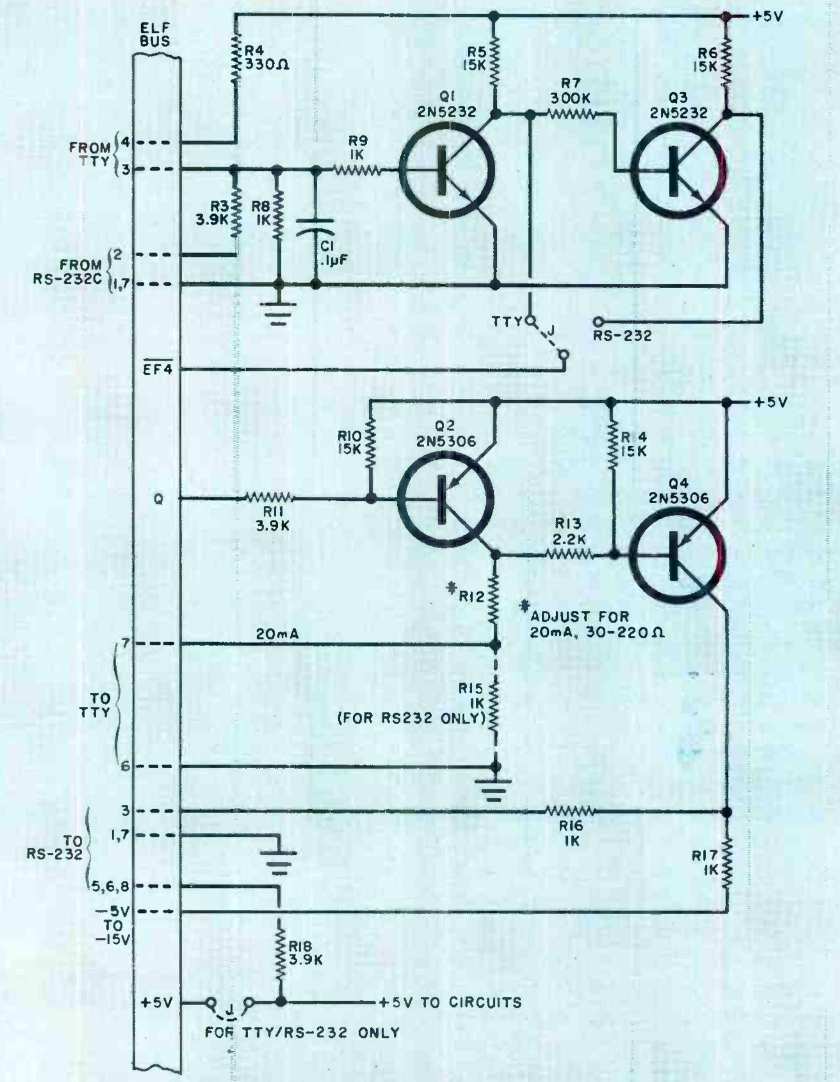


Fig. 3. Transistors Q1 and Q2 form the 20-mA current loop with Q3 and Q4 added to make up the RS-232 loop.

20-mA/RS-232 Interface. This circuit (Fig. 3) requires an external dc supply of −5 to −15 volts for the RS-232 section. To receive data from a 20-mA current-loop peripheral (such as a TTY), and if the peripheral requires an external current source, then connect the R4 line to the external device (on the TTY, this should be terminal 4). The current from the device (on the TTY, terminal 3) is fed to the *Q1* input circuit. The output of *Q1* is jumper-selected to drive the EF4 line on the bus.

To transmit data to the current-loop peripheral, the signal from the Q line drives constant current (20mA) source *Q2*. Resistor *R12* is adjusted to deliver a 20-mA current into the peripheral. Note that *R15* is not used in the current mode. On the TTY, the two terminals would be 6 and 7.

When using the RS-232 input mode, the signal is applied to *Q1* through *Q3*. The EF4 jumper is then set to the RS-232 position at the output of *Q3*.

To transmit data to the external RS-232 device, *R15* is inserted between *R12* and ground, and *Q4* is added to produce the correct output. Note that a negative voltage supply is required for RS-232 operation. A jumper, or switch, is optionally used to remove or turn power on to this circuit.

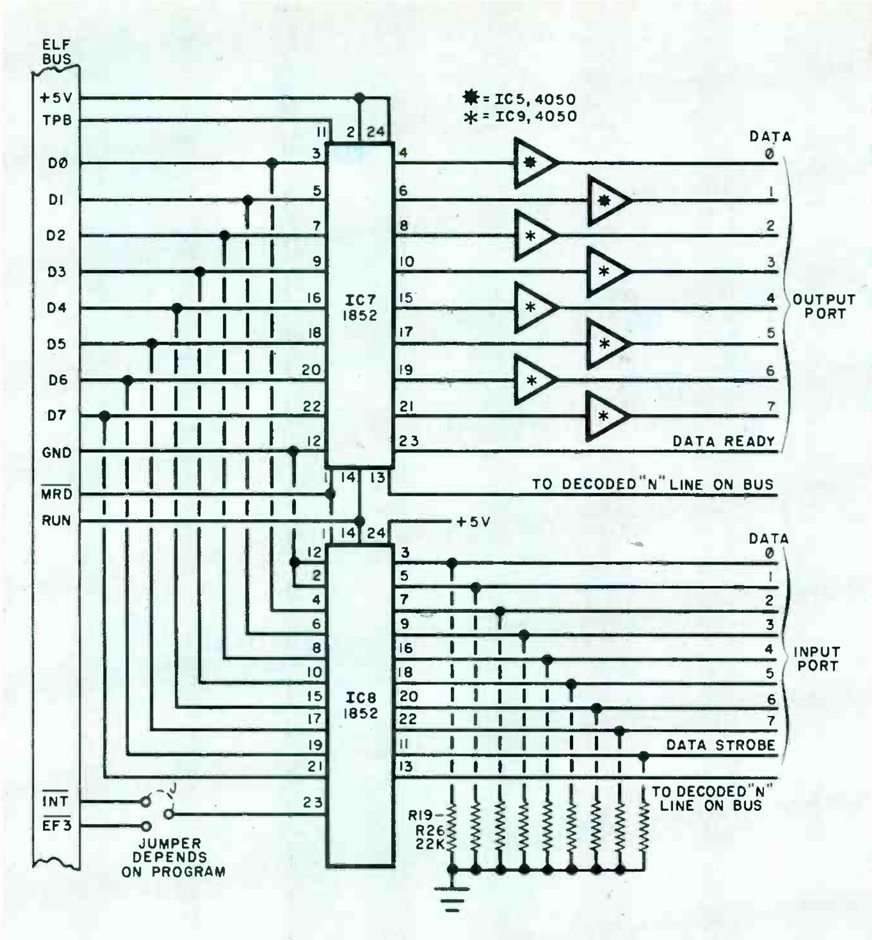


Fig. 5. Two IC's form 8-bit parallel input/output port. They use N-line from Fig. 4 determined by program.

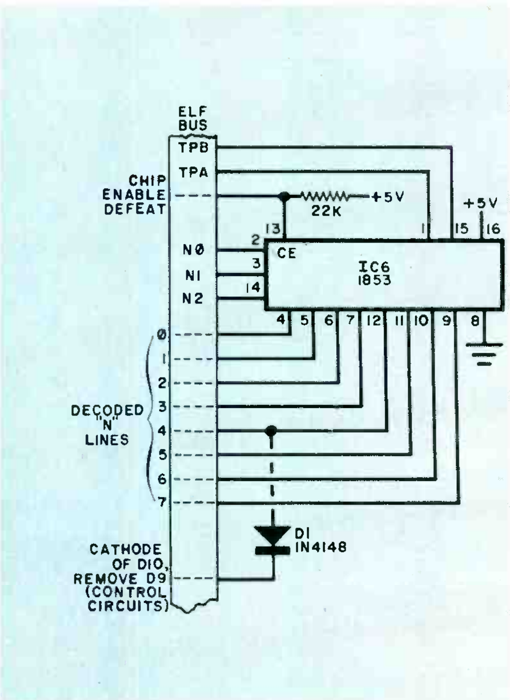


Fig. 4. The N-line decoder expands three lines from 1802 into eight.

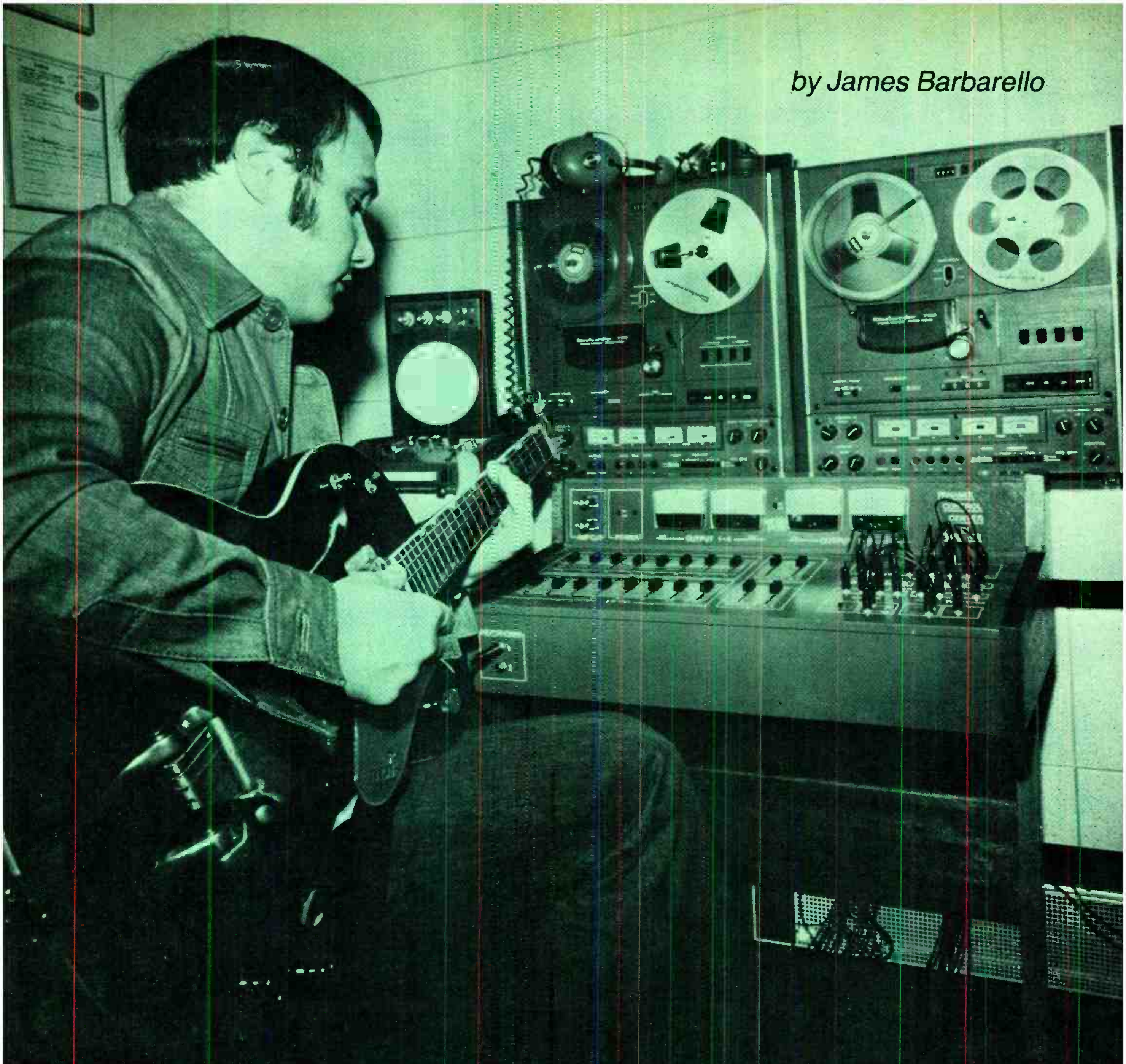
N-Line Decoder. The three N-lines (N0, N1, N2) of the 1802 can be decoded into eight separate instructions that can be used to control eight I/O (input/output) ports using the circuit shown in Fig. 4. The decoded outputs can be connected to unused lines on the bus for easy connection to any future I/O control inputs. Control line 4 is connected to the cathode of *D10* in the Elf-II (*D3* in the original Elf) with *D9* (D4 on the original) removed. This will allow the 6C and 64 instructions in the original programs to be executed properly.

I/O Ports. If you have a need to interface the Elf II to an external peripheral that requires parallel data (ASCII keyboard, for example), use the circuit shown in Fig. 5. Output port *IC7* has its data output lines buffered by *IC9* and sections of *IC5*. Pin 13 (CS2) of this stage can be connected to any of the decoded N-lines. When pin 2 (mode control) is high, the 1852 is configured into an output port. Data is strobed into the output port when pins 11 and 1 are high. The three-state output drivers are enabled at all times when the 1852 is used as an output port. The service request signal at pin 23 is generated at the termination of the pin 1 and pin 13 signals and will be present (high) until the following negative high-to-low transition of the clock pulse at pin 11. The signal at pin 14 resets the port's register and service request flip-flop.

The input port is formed by *IC8* with pin 2 low. The data input lines are held low by resistors *R19* through *R25*. Pin 13 is tied to the desired decoded N-line.

Data is strobed into the port's 8-bit register by a high on the clock (pin 11) line. The negative high-to-low transition of the clock sets the service request (pin 23) flip-flop to latch the data into the register. The service-request output at pin 23 signals the 1802 that data is ready to be transferred to the bus and can be connected to either the EF3 or INT lines, depending on program requirements. The 8-bit parallel input port can service an ASCII keyboard with use of the proper software control. ◇

by James Barbarello



A Practical Guide to Multitrack Tape Recording

SOPHISTICATED open-reel tape decks with four-channel capability enjoy a markedly higher degree of consumer acceptance than other quadraphonic components. The reason for this is that these decks provide the nucleus for a "home recording studio." Serious recordists have teamed multitrack tape decks with companders, mixers, quality microphones and sound-modifying electronics and now employ techniques previously confined to the professional recording studio. Here is an overview of the equipment and techniques employed by amateur recording engineers.

Multitrack recording has been used by professionals for years, with anywhere from 8 to 32 tracks commonly involved in the transcription of live performances. Recently, musicians such as Brian Eno, Mike Oldfield, Walter Carlos, Patrick Gleason and Isao Tomita have recorded music on a symphonic scale, even though only one artist was actually performing.

Techniques and equipment necessary for professional results at home.

This is the power that multitrack provides—each voice (instrumental or vocal) can be recorded separately. When mixing down the tracks, the performer becomes a "conductor" who has full control over the finished product. Each track can be positioned anywhere in a stereo field. The volume and timbre of each voice can be modified through the use of filters, graphic equalizers, echo devices, etc. Multitrack recording there-

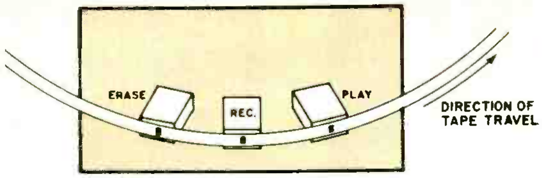


Fig. 1. Diagram shows arrangement of heads on a three-head deck.

fore allows a single performer to become a one-man band.

The Tape Deck in its latest incarnation is primarily responsible for bringing this exciting new development within reach of the consumer. Let's now examine the special features of today's machines that enable the serious home recordist to produce high-quality multitrack recordings.

A number of open-reel tape decks suitable for "home studio" use (a sampling of which is found in the box) is available to the consumer. The basic studio would employ one deck, and an expanded studio, two decks. The author's home sonic workshop includes two Dokorder Model 7140 tape decks. (This company's products are not being marketed in the United States at the present time.) The Model 7140 will be used as a representative deck in the basic and expanded studios, but other comparable machines could be used in its stead.

The Dokorder deck has three heads: one for record, one for playback, and one for erase. The heads are arranged as shown in Fig. 1. In the record mode, with the tape moving in the direction indicated, each tape track is erased. As the tape passes by the second head, the program material presented at the inputs of the record preamplifiers is impressed onto the tape. When the tape passes by the last head, the newly recorded program is available for playback.

In the normal multitrack recording process, a program source is recorded on one track, say, channel 1 (see Fig. 2A). Then another program is recorded on another track, in this example channel 2. The new material is monitored at the source or record preamp as it is being recorded and the program previously recorded on channel 1 is monitored at the playback head.

Although, during this last operation the information on tracks 1 and 2 might appear synchronized, playback will reveal that the program on track 1 leads that on track 2 by a time interval equal to the tape speed divided by the distance between the record and playback heads (see Fig. 3). This monitoring system, therefore, prohibits synchronous multitrack recording unless, of course, all the tracks are recorded simultaneously. However, there is a simple solution to this problem.

Rather than monitoring the track 1 material at the playback head, it can be accomplished at the *record* head. Because the program material on both tracks is monitored at the same head, the information recorded in this manner will be perfectly synchronized.

This technique (Fig. 2B), in which a portion of the record head is used for playback monitoring, is known by such names as Sel-Sync (short for selective synchronization), a term copyrighted by Ampex, Syncro-Trak (Sony from Superscope), Simul-Sync (Teac), and sync overdub. It is basically an arrangement of switches that transfers the pickup of previously recorded program material from the playback head to the record head. Usually, there is one switch for each channel.

There is one drawback to this system—the record head is not well-suited to playback applications. As a result, its output in the multisync mode has limited bandwidth and is at a much lower level than the output the playback head would provide. This is a minor point. The important thing is that track sync is maintained. Further, the fidelity of the *recording* process is not affected.

Each channel's program can be monitored with its TAPE/SOURCE switch in either position. This permits listening to either the program source or the material as recorded on the tape while making the recording. Essentially, all this switch does is connect a channel's monitor output jack to either the record or playback preamplifier. In synchronized multitrack recording, the material already recorded on the tape is always monitored with that channel's switch in the TAPE position and the material being recorded is monitored with that channel's switch in the SOURCE position.

Two sound processing techniques of interest to the home recordist are *sound on sound* and *sound with sound*. Many sophisticated consumer decks have provisions for one or both. There is often confusion as to the meaning of these terms, and they are sometimes used interchangeably. For our purposes, we will consider that sound on sound is basically a defeat of the erase head. Thus it is possible to superimpose one signal directly over one already impressed on the tape. Sound on sound affects the program material previously recorded on the tape because the high-frequency bias applied to the record head partially erases the original signal, especially its high-frequency content. This technique is an attempt to mix two or more sounds—something accomplished far better with a mixer if the sounds to be recorded are available simultaneously for one recording session.

Sound with sound can be accomplished on a tape deck having certain switching facilities. One signal is recorded on one track and later combined with another signal on a different track by a combined record/playback operation.

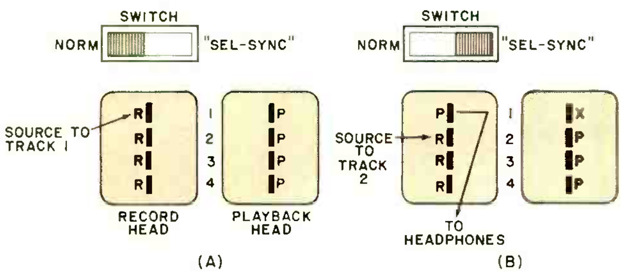


Fig. 2. In normal recording (A), track 1 is monitored by playback head. In (B), part of record head is used for playback monitoring.

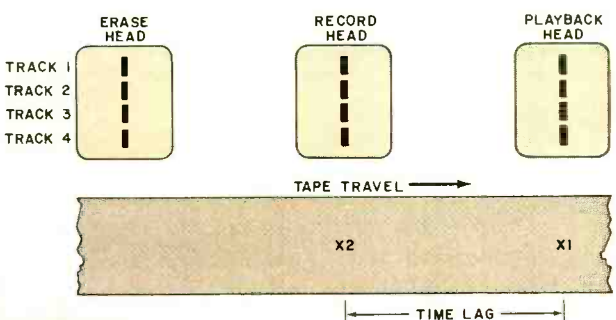


Fig. 3. Diagram shows how program on track 1 leads that on track 2 by a time depending on head spacing and tape speed.

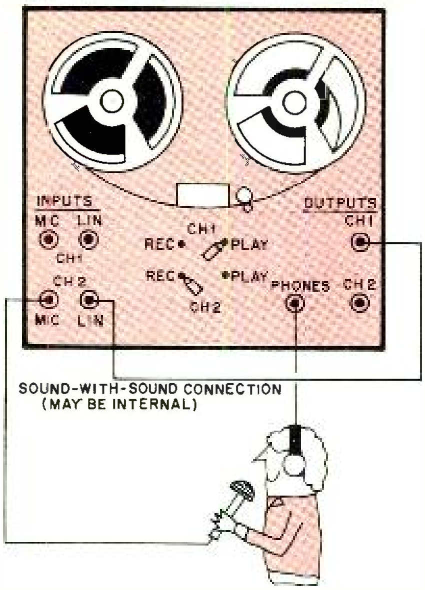


Fig. 4. Hookup for a simple sound-with-sound system.

Thus it is necessary that the deck be able to simultaneously record on one track and play back another.

A simple sound-with-sound hookup is shown in Fig. 4. Separate level controls for the microphone and line inputs comprise a simple two-channel mixer. A stereo deck employed in sound-with-sound recording as shown in Fig. 4 produces a monaural version on channel 2 of the live program material and that recorded on channel 1. Channel 1 can then be used for further sound-with-sound recording, combining the taped channel 2 program with live material. Of course, a four-channel deck in the home studio can be used in the sound-with-sound mode. Some decks have built-in switching specifically for this purpose. However, the process should be used sparingly because each time program material already on the tape is recorded, noise and distortion increase.

The final deck feature we will discuss is *electronic echo capability*, which is derived from the previously mentioned delay between the record and playback heads. Referring to Fig. 5, program material is recorded on a tape track and then, after a short delay determined by the tape speed and distance between the heads, is picked up by the playback head. A portion of this playback signal (determined by the setting of a potentiometer) is returned to the record head, where the process repeats itself to create a high-quality echo effect. Our reference tape deck includes an echo control (the potentiometer) that permits us to select the intensity and duration of the effect. This control is very useful in adding a spatial effect to the normally "dead" studio sound.

Monitor/Playback System. A basic home recording studio is shown diagramatically in Fig. 6. At its heart is a tape deck such as the Teac 3340S shown in Fig. 7. The monitor/playback system processes the monitored signals for reproduction through speakers or headphones. This system consists of what is commonly called a "control amplifier," speaker systems, and headphones. The control amplifier is simply an integrated preamplifier/amplifier as is found in many home stereo systems. Its inputs have different sensitivities.

Our requirements in this part of the studio are not critical. The control amplifier should have a tape-monitor input, a headphone jack, and 15 watts per channel or more of continuous output power. The control amplifier is not part of the recording system and, therefore, is not required to be equal in quality to the tape deck. It should be of equal sophistication with your listening tastes. The speaker systems should be of the same relative quality as the control amp, while the headphones should be a quality sealed pair. "Open-air" headphones should *not* be used—a high degree of sound isolation is important. Otherwise, the sounds coming directly from the live performers will be mixed with signals from the microphones and tape deck.

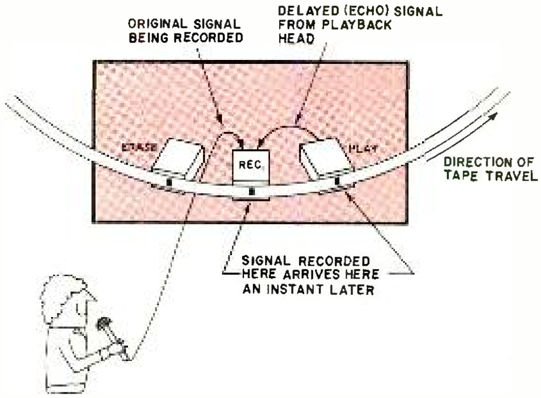


Fig. 5. Diagram showing how electronic echo effect is achieved.

Mixer and Patch Panel. A mixer with full panning capability is required for the proper monitoring and combination of the outputs from the tape deck, microphones, or electric and electronic musical instruments in both preliminary and final mixdowns. Well suited for this task is the five-channel panning mixer project in the October 1976 issue of this magazine. It contains five input channels, each with its own input level control, and

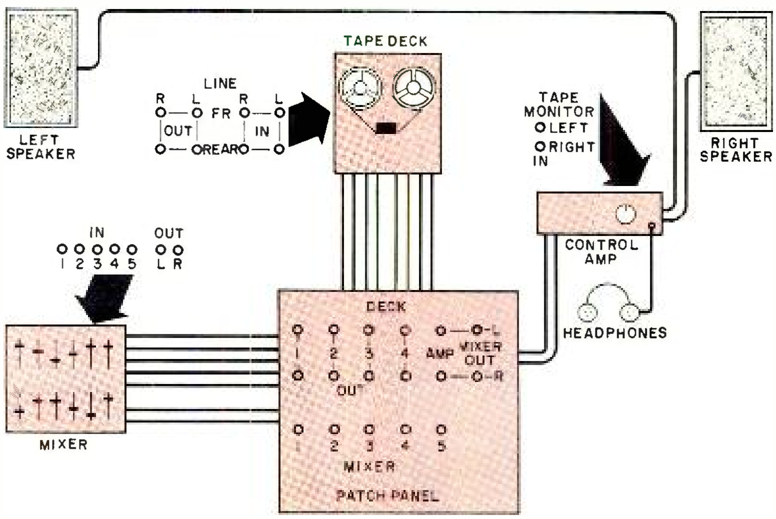


Fig. 6. Layout of a basic home recording studio. The most important part of the system is the tape deck.

two output channels, each with a master volume control. In addition, each channel is capable of being "panned," or placed anywhere within a 180° stereo field. Commercial mixers can also be used.

The tape deck has eight input/output connectors. The mixer has five input and two output connectors, and the control amplifier has two input connectors. These 17 hookup points must be interconnected in many different configurations during the recording process. To accomplish this with a minimum of effort, a patch panel is needed. The patch panel consists of a number of connectors mounted on a rigid panel, to which lengths of shielded audio cable are soldered. Each cable must be terminated with an appropriate plug to allow connection to the different components in the system. In addition, a number of patch cords consisting of short lengths of shielded audio cable terminated at both ends with plugs that mate with the patch-panel jacks are required. With this arrangement, any number of component connections can be accomplished in a matter of a few seconds. The patch panel can be home-made, or a commercial product such as that by Teac shown in Fig. 8 can be used.

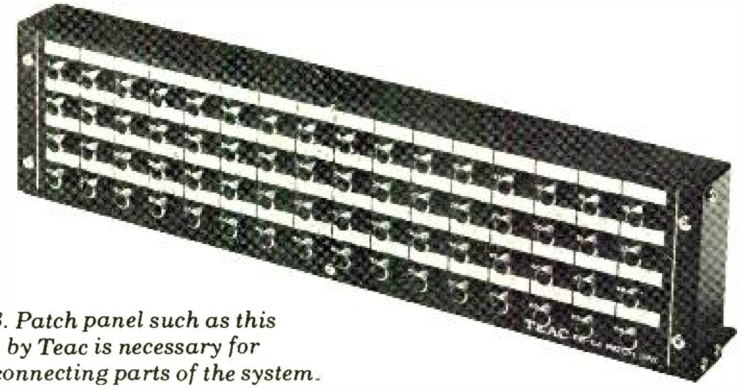


Fig. 8. Patch panel such as this made by Teac is necessary for interconnecting parts of the system.

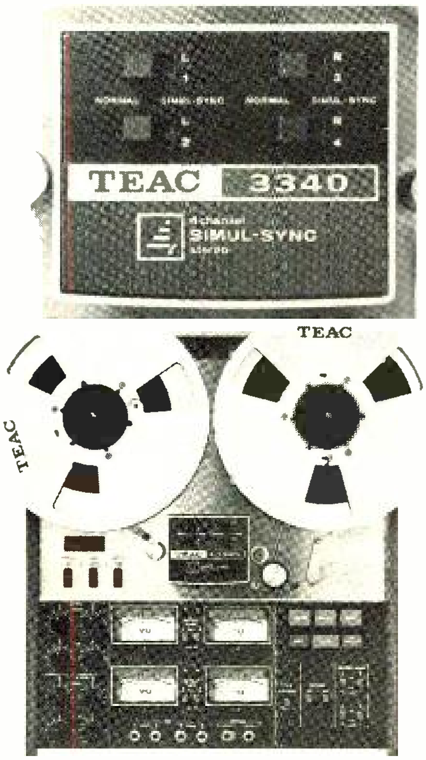


Fig. 7. The Teac 3340S multitrack deck. Inset shows Simul-Sync panel.

The Microphone. The microphone required for picking up voice and acoustical musical instruments can be either an electret condenser or a dynamic type. The choice you make is a subjective matter and a discussion that would do justice to the subject of microphones is beyond the scope of this article. Remember, however, that all impedances in the system should be matched. High-quality microphones have balanced, low-impedance outputs, but tape decks and mixers tend to have unbalanced, high-impedance inputs. Matching transformers may be required to interface such components. Generally, a medium-priced ($50-$100) mike will be sufficient for home studio recording.

Using The Basic Studio. Locate your studio in a room that is relatively free from outside noises and excessive reverberation. Room acoustics, like microphones, is a subject that requires much space for adequate coverage. Even scratching the surface of this topic is beyond the scope of this article. Suggested reading is listed in the box. For reference purposes, we will designate the four channels on the tape recorder so that front left becomes channel 1, front right becomes channel 2, rear left becomes channel 3, and rear right becomes channel 4.

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As an example of the operation of the basic studio, we will sequentially create a recording containing drums, bass guitar, rhythm guitar, lead instrument (a keyboard synthesizer), and a vocal trio. If each of the instruments and the trio were to be recorded on its own track, seven recording channels would be needed. Because we have only four channels available, some of the recording components will be combined using sound with sound.

The vocal trio is best suited for such treatment. Our total channel count is now down to five. Combining the drums and bass guitar by sound with sound allows us to reduce the requirement to the four channels we have available. This is a prime example of the planning required for any recording. The finished product must be thought out as a whole and as a sum of individual components. Only after this planning has been completed can the recording process begin.

Recording a multitrack piece is like building a house in that each part is constructed separately from the foundation up. In most compositions, the foundation is the percussion because it becomes the timing for all subsequent tracks. As it is the first track recorded, there is nothing to accompany the percussion line. The well-thought-out percussion is performed and recorded as you hum or otherwise keep track of its progress.

Percussion usually means a drum set, but for studio recording a rhythm unit is usually sufficient. The "Cabonga" Electronic Percussion Synthesizer featured in the August and September 1977 issues of this magazine is a good example of such a device. It was especially designed for this purpose and can be connected directly to the LINE input of the tape deck.

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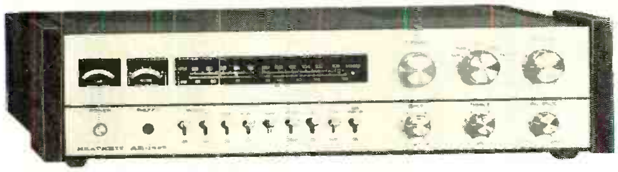

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CIRCLE NO. 5 ON FREE INFORMATION CARD

Whether you use a percussion synthesizer or drums to create the percussion line, the record level on the tape deck should be adjusted for an average 0-VU level, with instantaneous peaks to less than +3 VU. Percussion should be recorded on channel 3, with control settings as indicated in step one of Table I. When the percussion has been recorded, play it back. If you are satisfied, proceed to the next step.

Record the bass guitar on channel 4, along with the channel-3 drum track, using the sound-with-sound technique—the LINE OUTPUT of channel 3 connected to the LINE INPUT of channel 4. Then connect the bass guitar to the MIKE INPUT of channel 4. (Note that channel 3 is in the multisync mode.) Make a trial recording, adjusting both levels so that the two instruments are properly balanced and the average level is 0 VU and instantaneous peaks do not exceed +3 VU. When all levels are properly set, begin again to record the complete channel-4 program. Then play back channel 4. If it is acceptable, channel 3 can now be used for other program material.

The next step is to record the rhythm guitar on channel 3. While this is being done, monitor channel 4 in the TAPE position and the multisync mode. The LINE OUTPUT of each channel should be connected to an individual mixer input, the input levels of which should be adjusted so that all channels can be clearly heard through the monitor/playback system. Adjust the PAN controls as desired.

With the rhythm and percussion tracks recorded, you can begin to record the vocal trio. This is accomplished by the sound-with-sound technique described for the bass guitar and percussion. (Two tracks have now been recorded and two are still available. Because sound with sound requires at least two tracks, this is our last chance to employ the technique on this tape.) As shown in Fig. 3, vocal part one is recorded on channel 1. Then vocals one and two are combined on channel 2. Finally, vocals one, two, and three are again combined on channel 1. Echo is added to only the last track (channel 1 with vocals one, two, and three). In each case, the recorded information is played back before the next in succession is recorded. Do not proceed with recording until you are satisfied with each successive track.

With the completed vocal trio on channel 1, the final lead-instrument track can be recorded on channel 2. Use the LINE INPUT on the tape deck for the keyboard synthesizer. For other lead instruments, such as an electric guitar, the MIKE INPUT would be more appropriate.

TABLE I—TYPICAL RECORDING PROCESS FOR BASIC SYSTEM

Step	Channel 1	Channel 2	Channel 3	Channel 4	Tape/Source 1	2	3	4	Multisync 1	2	3	4	Notes
1	Blank	Blank	Drums (Mike or line)	Blank	T	T	S	T	O	O	O	O	Normal = O Multisync = X
2	Blank	Blank	Line Output	(line) + Bass Guitar (mike)	T	T	T	S	O	O	X	O	
3	Blank	Blank	Rhythm guitar (mike)		T	T	S	T	O	O	O	X	
4	Vocal, Part 1 (mike)	Blank			S	T		T	O	O	X	X	
5	Line Output	+ Vocal, part 2 (mike)			T	S	T	T	X	O	X	X	
6	Vocal, part 3 + (mike)	Line Output			S	T	T	T	O	X	X	X	Add echo to ch 1
7		Lead instr. (mike or line)			T	S	T	T	X	O	X	X	Add echo as desired
8					T	T	T	T	O	O	O	O	Mix down thru ch 1-4 of mixer

Notes: (1) In step 8, outputs of mixer can be applied to line inputs of another tape deck for a permanent two-track stereo recording.

(2) Step: 1 2 3 4 5 6 7 8
Channel being recorded: 3 4 3 1 2 1 2 None

(3) ( ) signifies the input connector to be used.

The composite music can now be played back and mixed down to taste. Mixing down involves the adjusting of the levels for each track so that a good blend is obtained. Also, adjust the PAN controls to accentuate the lead tracks, but do not overpower the background. As an example, assume a stereo field with the far left at 0°, center at 90°, and far right at 180°. Percussion could be placed at about 135° (midway between center and far right), rhythm guitar at 45° (midway between far left and center), and vocal trio at 90°.

For a permanent two-track recording, the output of the mixer can be connected to the inputs of another tape deck for recording. If another tape deck is not available, the mixer settings can be recorded on the tape box so that the selection can be played back at any time by simply adjusting the mixer controls in accordance with the written-down settings.

SUGGESTED READING

Microphones: Design and Application, by Lou Burroughs, 260 pages, $20 hard cover, $12.95 soft cover (postpaid). Sagamore Publishing Co., 1120 Old Country Road, Plainview, NY 11803.

Sound Recording, by John Eargle, 327 pages, $16.95 hard cover (postpaid on prepaid orders). Van Nostrand Reinhold Co., 450 W. 33rd Street, New York, NY 10001.

Handbook of Multichannel Recording, by Alton Everest, 322 pages, $10.95 hard cover, $7.95 soft cover (postpaid on prepaid orders). Tab Books, Blue Ridge Summit, PA 17214.

Modern Recording Techniques, by Robert Runstein, 368 pages, $9.95 soft cover plus $0.50 postage. Howard W. Sams & Co., Inc., 4300 W. 62nd Street, Indianapolis, IN 46206.

The Recording Studio Handbook, by John Woram, 496 pages, $35 hard cover (postpaid). Sagamore Publishing Co., 1120 Old Country Road, Plainview, NY 11803.

The Expanded System. With the addition of an identical tape deck to the basic system and expansion of the patch panel (if necessary) to accommodate the new deck, your recording capabilities can be greatly increased. The expanded system greatly reduces the need for sound-with-sound recording.

Using the same basic techniques applied for the basic system, an example of using the expanded system is shown in Table II. The voices on this recording include drums, bass guitar, "stereo" rhythm guitar, dual background instrumental, vocal trio, and lead instrument. There are 10 separate tracks of program material!

Let's call the two tape decks A and B. Starting with deck A, record the drums on channel 4 and the bass guitar on channel 3. Channels 1 and 2 can then be used to record the stereo guitar. A flanger (a variable analog electronic delay line), allows you to introduce an ef-

TABLE II—TYPICAL RECORDING PROCESS FOR EXPANDED SYSTEM

Step	Channel 1	Channel 2	Channel 3	Channel 4	Tape/Source 1 2 3 4	Multisync 1 2 3 4	Deck A	Deck B	Notes
1	Blank	Blank	Blank	Drums (mike or line)	T T T S	O O O O	●		Normal = O Multisync = X
2	Blank	Blank	Elec. base (mike)	↓	T T S T	O O O O	●		
3	Flanged Guitar: Guitar (mike)	Flanger output (Mike or Line)	↓	↓	S S T T	O O X X	●		Guitar input to ch 1 & flanger input
4	↓	↓	↓	↓	T T T T	O O O O	●	●	Ch 1-4, Deck A mixed down thru mixer. Out of mixer to line inputs of Ch 3 & 4, Deck B.
5	Vocal. Part 1 (mike)	Blank	Mixdown left	Mixdown right	S T T T	O O X X		●	
6	Line Output →	+ Vocal. Part 2 (mike)	↓	↓	T S T T	X O X X		●	
7	Vocal. Part 3 (mike) +	← Line Output			S T T T	O X X X		●	Add echo to ch 1
8	↓	Lead instr. (mike or line)			T S T T	X O X X		●	Add echo as desired Ch 1-4 deck B mixed down thru mixer. Output of mixer to line inputs of Ch 1 & 2, deck A.
9	↓	↓	↓	↓	T T T T	O O O O	●	●	

Notes: (1) In step 4, input guitar (thru preamp) to ch 5 of mixer. Monitor ch 3 & 4 of deck B in "Source".

(2) In step 9, monitor ch 1 & 2 of deck A in "Tape".

(3)

Step:	1	2	3	4	5	6	7	8	9
Channel being recorded:	4, A	3, A	1 & 2, A	3 & 4, B	1, B	2, B	1, B	2, B	1 & 2, A

(4) ( ) signifies the input connector to be used.

fect sounding like two individual performers located at opposite sides of a large reverberant room with the listener in the center. The sound produced also appears to "swirl" around you, creating a very pleasing effect. The guitar is connected directly to the inputs of deck A's channel 1 and the flanger. The output of the flanger is routed to the input of channel 2 on tape deck A. Both tracks are recorded simultaneously.

Now that all four of deck A's tracks are occupied, they can be mixed down and recorded on channels 3 and 4 of deck B to create a full stereo instrumental background. During the mixdown, an additional instrument is added by connecting it to the mixer's channel 5. Because the signal level at the channel-5 input will be about one-tenth the level at the outputs from deck A, some preamplification should be introduced. A suitable preamplifier is shown schematically in Fig. 9.

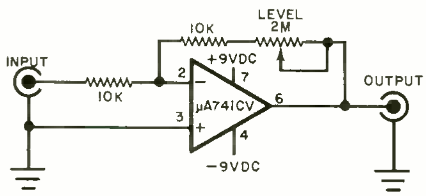

Fig. 9. Schematic of a suitable preamplifier circuit.

For our purposes, channel 5 will always be used in this mode, so the preamp can be permanently wired in the mixer.

Now, concentrating on deck B, the remainder of the tracks will be recorded. The vocal trio is recorded as in the basic system described above. The final lead instrument track can also include half of the dual instrumental background since both are never present at the same time. The other half of the dual instrumental background was recorded through channel 5 of the mixer during the mixdown from tape deck A.

Once completed, the performance can be mixed down to a two-track stereo format on deck A to create the finished product. Note that the final version is in full stereo and includes 10 separate performers. That's quite an accomplishment for a one-man band!

Closing Comment. The very nature of the intricate recording process makes it appear to be confusing at first glance. The sequential procedure we have outlined here can be used as a guide.

Always bear in mind that, with as many as 10 separate parts in the final recording, all parts must be balanced in volume and location in the stereo image. This can be accomplished with relative ease, but it requires practice. ◇

Solid State

By Lou Garner

DIGITAL METER CIRCUITS

ALTHOUGH the majority of analog meters (i.e., scale and pointer types) are not as expensive as corresponding digital instruments, the gap is narrowing; and in some categories, commercially manufactured digital meters are actually *less costly* than their analog counterparts, especially in the more sensitive models. For many experimenters and hobbyists, however, cost is not an overriding factor when considering a new project, as long as it is within their budgetary limits. A considerable number prefer to assemble equipment or instruments "from scratch" even though commercially built products with similar performance specifications are available for about the same prices (or even less). The real pleasure is perhaps more in building and debugging the project than in the final use of the completed equipment. If you're one of this group of enthusiasts and need a digital meter for one or more of your projects, chances are you'd prefer to "roll your own."

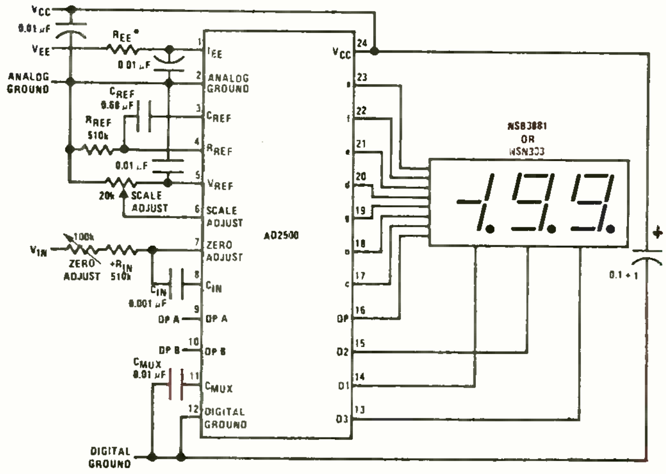

Fig. 1. Simple 2½-digit meter circuit suggested by National Semiconductor.

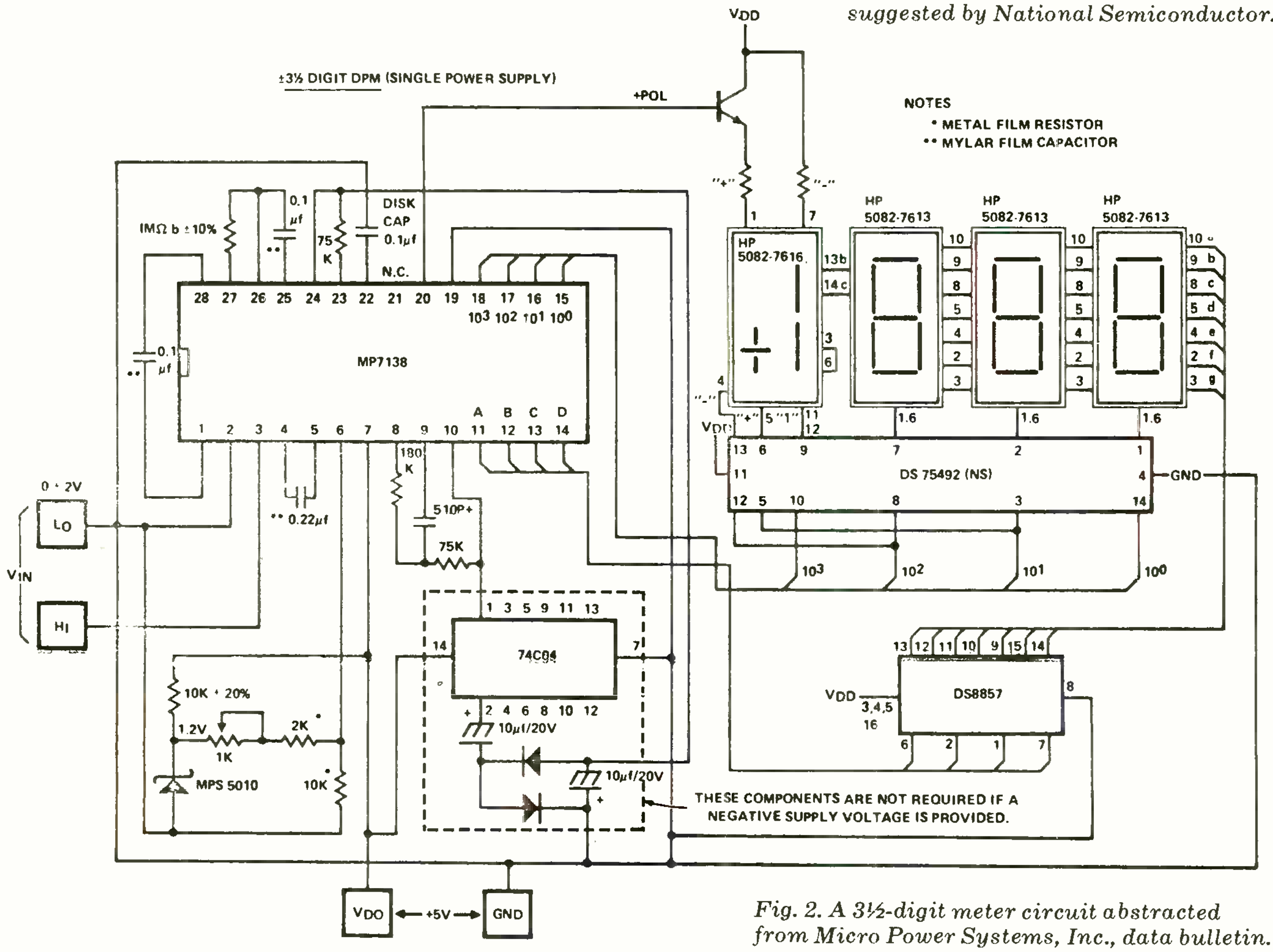

Fig. 2. A 3½-digit meter circuit abstracted from Micro Power Systems, Inc., data bulletin.

Typical 2½- and 3½-digit meter circuits suggested by various semiconductor manufacturers are illustrated in Figures 1 through 4.

A word about "½ digits." Normally, each digit in a readout display represents a significant figure and can be any number from "0" to "9." Thus, a 2-digit instrument can provide readouts from "0" to "99" or decimal fractions thereof, depending on the instrument's sensitivity, number of ranges, and decimal-point placement. Whether the displayed reading is .01, .09, .99, 9.9 or 99, however, there can be only two significant figures. By adding the "half" digit—in reality a "1" with, sometimes, a polarity sign—the readout will display up to three significant figures for most applications. While a 2-digit instrument can furnish readings of only 0 to 99, then, a 2½-digit design can display readings from 0 to 199. Generally, the added cost and circuitry required to supply the extra ½ digit is nominal compared to that of providing a full 0 to 9 digit, hence the popularity of ½-digit circuits.

Featured in a four-page data bulletin published by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051), the 2½-digit meter circuit shown in Figure 1 requires only two active devices: an ADD2500 (DS8700) single-chip meter IC and a common-cathode 2½-digit LED readout similar to the NSB3881 or NSN333. The design requires +5-V (V_{CC}) and −15-V (V_{EE}) dc sources for operation and, with the component values specified, has an input impedance of better than a half megohm while offering a full-scale reading of up to 1.99 volts at an accuracy of ±1%. Specified for operation over the range from 0°C to +70°C, the ADD2500 is supplied in either a side-brazed ceramic or Epoxy B plastic 24-pin DIP. It includes on-chip provisions for auto-polarity selection and identification, overrange and underrange output indication, LED segment and digit drivers, and programmable decimal-point selection. In addition, the device contains an internal clock and a built-in temperature-compensated reference source.

In operation, the ADD2500 utilizes a dual voltage-to-frequency (V/F) technique for analog-to-digital conversion. One V/F converter serves to develop a continuous signal with a frequency proportional to R_{IN}, C_{IN}, the *zero adjust* resistance, and the input voltage plus a fixed 3 volts. The second V/F converter acts both to provide a sample window and to determine the conversion rate for counting the input frequency. Since the output frequency of the first V/F converter is directly proportional to the input voltage, as modified by fixed constants, counting this signal for a known interval provides a digital signal which is also proportional to the input voltage. From this point, conventional digital logic is used to develop the output drive signals for the readout display. Auto-polarity selection is achieved by an offset counter controlled by analog inputs referenced to a −3-volt level, permitting the instrument to accept both positive and negative input voltages.

With neither layout nor lead dress overly critical, the digital meter circuit should not be too difficult a project for the average experimenter. The circuit can be assembled using either pc or perf board construction techniques. The data bulletin cautions, however, that a *single* connection point should be used for both the analog and digital grounds to avoid possible ground-loop problems. After assembly and check-out, the following calibration procedure is recommended:

1. Using an accurate voltmeter, adjust the SCALE ADJUST potentiometer for −3 volts at pin 5(V_{REF}).

2. With V_{IN} at analog ground, adjust the ZERO ADJUST potentiometer for a display of ".00."

3. With 1.90 volts applied to V_{IN}, readjust the SCALE ADJUST for a display of "1.90."

4. Repeat steps 2 and 3, as needed, to achieve an optimum balance between the two adjustments.

Offering a greater challenge for the more experienced hobbyist, the 3½-digit meter circuit shown in Fig. 2 was abstracted from a six-page technical brochure issued by Micro Power Systems, Inc. (3100 Alfred St., Santa Clara, CA 95050). Using an MP7138 monolithic CMOS A/D converter IC, the circuit is designed for operation on a standard single-ended, 5-volt dc power supply. Supplied in both plastic and ceramic 28-pin DIP's, the MP7138 includes an on-chip clock and all the circuitry needed to provide a multiplexed BCD output with auto-zero, auto-polarity, and display hold features, the latter implemented by applying a logic "0" to pin 21. The device is specified for operation from −40 to ±85 °C and needs only 10 mW, typical, in most applications. With an extremely high input impedance, the IC requires an input current of only 10 pA.

In addition to the MP7138, the digital meter circuit employs a DS-8857 BCD-to-7-segment LED driver, a DS75492 MOS-to-LED hex digit driver, four *HP* 5082 series LED displays, and a 74C04 hex inverter, plus an MPS5010 zener, a general-purpose npn transistor, and two general-purpose diodes. The 74C04 hex inverter, the two general-purpose diodes, and a pair of 10-μF, 20-V electrolytics are used as part of a negative voltage power supply which is not required if a dual ±5-V dc source is available.

The MP7138 utilizes a dual-slope analog-to-digital conversion technique. In principle, the dual-slope technique involves

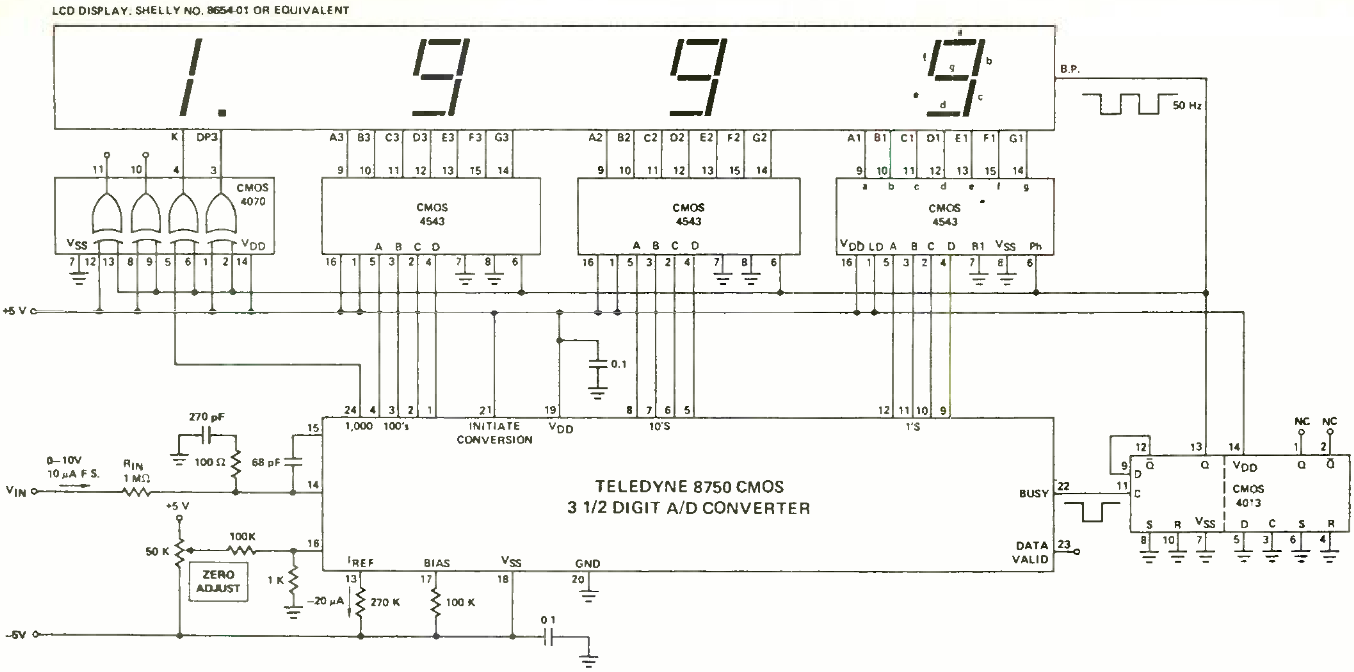

Fig. 3. Teledyne's 3½-digit meter circuit uses an LCD readout. Requiring only 20 mW, a full-scale reading indicates input of 10 volts.

the conversion of the input signal voltage to a proportional time interval, which is then measured digitally. This is accomplished by integrating the input signal for a fixed period and then applying a reference voltage of opposite polarity to the integration capacitor, causing it to discharge at a known rate. The discharge interval, converted to a digital number, is proportional to the average input signal voltage during the initial charge period. The conversion rate is determined by the circuit's clock frequency, with the MP7138 capable of making up to 15 conversions per second.

With the component values specified in Fig. 2, the meter has a full-scale range of 1.999 V, providing a typical accuracy of ±0.05% of reading. The display blanks automatically when the input voltage exceeds the full-scale range. If desired, the instrument's sensitivity may be increased to obtain a full scale range of 199.9 mV. This is achieved by replacing the capacitor between pins 1 and 28 with a 0.47-μF unit, by replacing the capacitor between pins 4 and 5 with a 0.47-μF unit, by replacing the resistor between pins 26 and 27 with a 100,000-ohm unit, and by readjusting the reference voltage applied to pin 6. For a nominal "2-volt" full-scale range, a 1.0-volt reference voltage is used (pin 6), while a 0.1-volt reference is used for a nominal "200 millivolt" range.

As the first circuit discussed, the 3½-digit meter may be assembled using the builder's choice of construction techniques, with both pc and perf board methods acceptable. Naturally, the customary precautions should be observed to avoid damage to the CMOS devices. After assembly and check-out, the only adjustment required is the reference voltage applied to pin 6, which should be set precisely for 1.0 V for a 1.999 V full-scale range or at 0.1 V for a 199.9 mV range. The negative voltage power supply (including the 74C04, two diodes and two 10-μF capacitors) may be omitted if a dual dc power supply is used by connecting the −5-V source to pin 24.

If your intended application requires the lower power consumption of an LCD readout as compared to an LED display, you may prefer the 3½-digit meter circuit illustrated in Fig. 3. Described in the 6-page data bulletin for the 8750 A/D converter IC published by Teledyne Semiconductor (1300 Terra Bella Ave., Mountain View, CA 94043), the circuit uses this device in conjunction with a Shelly No. 8654-01 readout, a 4013 dual D flip-flop, a 4070 quad 2-input exclusive-OR gate, and three 4543 BCD-to-seven segment latch/decoder/drivers. The 8750 is a CMOS device supplied in 24-pin ceramic or plastic DIP's. Requiring only 20 mW, typical, for operation, the A/D converter provides a full-scale reading with an input current of only 10 μA, permitting the user to change the voltage range simply by changing the value of the input scaling resistor. With the value specified in the diagram (R_{IN}, 1 megohm), a full-scale reading indicates an input of 10 volts. The device does not have an auto-polarity circuit and requires a *positive* input voltage with respect to circuit ground.

Within the 8750 device, the analog-to-digital conversion is achieved using an incremental charge balancing technique. In operation, an amplifier integrates the sum of the applied (input) current and pulses of a reference current for a fixed number of clock periods. The reference current is of opposite polarity compared to the input current. The number of reference current pulses (charge increments) needed to maintain the amplifier summing junction near zero during the conversion period is counted. At the end of conversion, the total count is latched into the digital outputs in a 3½-digit BCD format. The number of pulses needed to maintain the charge balance near zero during each conversion period is, of course, directly proportional to the input current (or voltage). The 8750 makes approximately 100 conversions per second.

Requiring a dual ±5-V dc power source for operation, the 3½-digit LCD meter circuit may be assembled using any standard construction technique, provided the usual care is exercised to avoid damage to the CMOS devices. The value of the input scaling resistor (R_{IN}) is determined by the full-scale voltage range required, based on an input of 10 μA for a full-scale readout. A precision resistor should be used for R_{IN} or, if preferred, a small potentiometer, permitting a precise adjustment of the full-scale reading. Other than the scaling resistor, the only other adjustment required is that for zero input, made with the ZERO ADJUST potentiometer.

Reader's Circuit. Peter Stys (44 Massey St., Brampton, Ontario, Can. L6S 2W3), an electric guitar enthusiast, was unhappy with the results obtained from various fuzz boxes he had tried with his instrument. None, he felt, provided the real "pro" sound he wished to achieve. So, he decided to tackle the problem head-on and design his own unit. His fuzz box circuit is illustrated in Fig. 4. Suitable for operation on dual dc power supplies from ±5 to ±18 volts, the design uses inexpensive, readily available, standard components and can be duplicated quite easily by the average hobbyist in one or two evenings. According to Peter, his unit changes the tones produced by an unaided electric guitar to sounds similar to those produced by an electronic music synthesizer.

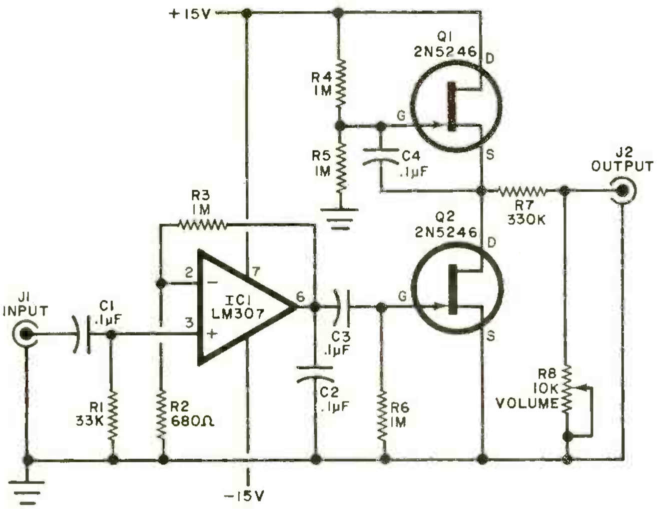

Fig. 4. Reader's fuzz-box circuit amplifies guitar's signal until clipping occurs and then overdrives output stage.

For the uninitiated, old timers, and classical music lovers, a "fuzz box" is not a care package for police officers but a device used to introduce distortion deliberately in a sound system in order to create special effects. The device may be as simple as one or two diodes used to clip the signal or as complex as a multistage amplifier. In operation, Peter's circuit achieves the desired effect by amplifying the signal from the guitar's pick-up until clipping starts to occur and then overdriving a dual JFET output stage.

Neither parts placement nor the wiring dress should be overly critical and, therefore, prospective builders can use their choice of construction techniques when duplicating Peter's design. Except for VOLUME control, *R8*, all resistors are half- or quarter-watt types, while the capacitors are all low-voltage ceramic or plastic-film units. Either an integral or separate dc source may be used as a power supply, at the builder's option. If a lower voltage (below ±15 V) supply is used, it may be necessary to reduce *R7*'s value for optimum performance. Although not shown on the schematic diagram, most builders probably will include a combination ON/OFF and system bypass switch in their models. In practice, the fuzz box is connected between the guitar's pick-up (microphone) and the audio amplifier's preamp (or input jack). ◇

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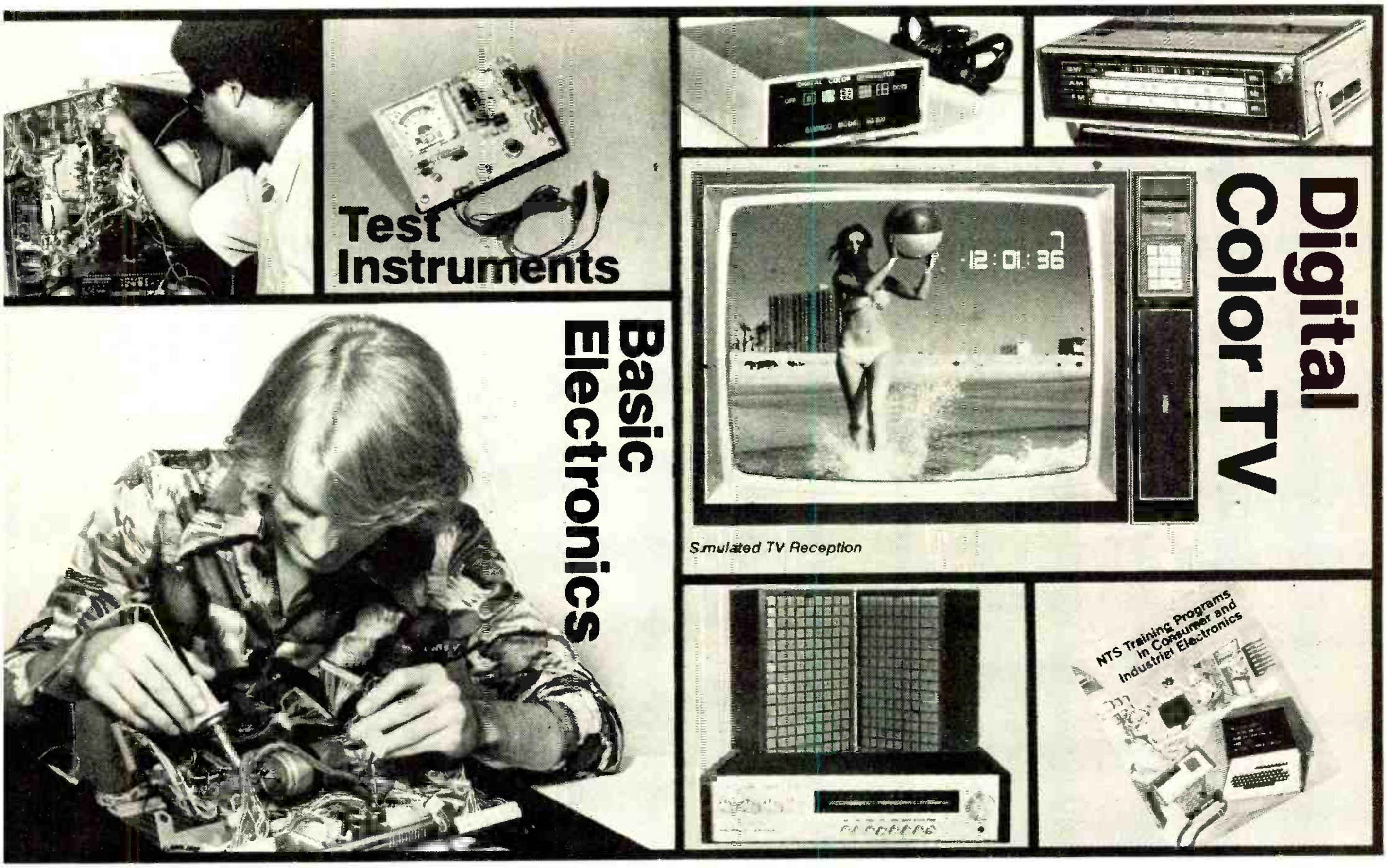

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Experimenter's Corner

By Forrest M. Mims

THREE-STATE LOGIC

IF YOU want to stay abreast of the latest developments in digital logic and microprocessor technology, you need to know something about three-state logic. This month, we're going to experiment with circuits that will teach you the basics of three-state logic in an hour.

Suppose you need to connect the outputs from two or more gates to a common terminal, perhaps the input to another gate. This is OK in the unlikely event *all* the outputs are consistently low or high; but what happens if the outputs are at different logic states? Obviously, it's not possible to place logic 0's and 1's on a common terminal without creating mass confusion—and possibly damaging one or more gates.

Three-state logic provides an efficient solution to this design problem. The output of a conventional logic gate is *always* low or high as long as power is applied. A three-state gate, however, employs a clever circuit that effectively isolates the gate from the output terminal. This requires that a special control terminal called the *enable input* be added to the gate.

Figure 1 shows two buffers with three-state outputs. When their enable inputs are activated, these buffers pass the logic state of their inputs to their outputs. When the buffers are not enabled, the outputs enter a high-impedance state. This high-impedance output state means the outputs of a dozen or more buffers (or any other three-state logic gate) can be connected to a common terminal if only one is enabled at any one time.

Many digital circuits, particularly microprocessors and memories, use common terminals called *buses* to transmit binary bits or words (a group of bits). Thanks to three-state logic it's possible to connect many different circuits to a common bus so long as one simple rule is followed: The output of only *one* circuit connected to a bus can be enabled at any one time. If more than one output is enabled, logic 0's and 1's will be placed on the bus at the same time, and we're back to the problem that first caused us to employ three-state logic.

We'll look at three-state buses again later. First, let's get some hands-on experience with a three-state buffer.

Three-State Buffer Demonstrator. Figure 2 shows a simple circuit you can quickly build on a solderless breadboard to demonstrate how three-state logic works. It uses one of the gates in a 74125 quad three-state buffer. The two LED's indicate the logic state applied to the input of the buffer when the enable input is at logic 0. When *LED1* is on, the input is low. When *LED2* is on, the input is high.

When the enable input is high, the output of the buffer enters and remains in the high-impedance state irrespective of the logic state at the buffer's input. Both LED's will then glow at about half their normal brightness, conducting a limited amount of current along the path between 5 volts and ground through the series resistors and the LED's.

Here's a truth table that sums up the operation of the demonstrator circuit:

Enable	Input	Output LED1	Output LED2
0	0	ON	OFF
0	1	OFF	ON
1	0	*	*
1	1	*	*

*Both LED's at half brightness.

Three-State Multiplexer. A multiplexer is a data selector. Apply an appropriate input select signal and one of several inputs will be applied to a single output. Figure 3 shows how you can make a 4-to-1-line multiplexer from a quad, three-state buffer like the 74125. The enable inputs of the buffers are used as the data select inputs. Remember, only one buffer can be enabled at any one time. With that in mind, here's the truth table for the multiplexer:

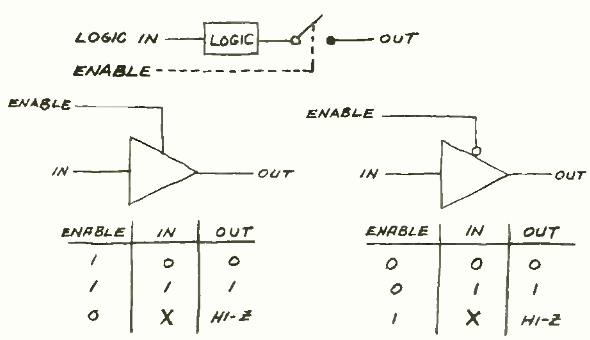
Data Inputs A	B	C	D	Data Select A	B	C	D	Output
0	X	X	X	0	1	1	1	0
1	X	X	X	0	1	1	1	1
X	0	X	X	1	0	1	1	0
X	1	X	X	1	0	1	1	1
X	X	0	X	1	1	0	1	0
X	X	1	X	1	1	0	1	1
X	X	X	0	1	1	1	0	0
X	X	X	1	1	1	1	0	1

Note: The X means "don't care"; the input can be either a 0 or 1.

If you build the circuit in Fig. 3, you can apply the data select inputs with a 4-position rotary switch (rotating contact connected to ground) or a 1-of-4 decoder like half of a 74139. The decoder will condense the data select inputs to four 2-bit addresses.

Three-State Bus Demonstrator. Figure 4 shows a simple circuit that will teach you how a three-state bus works. The circuit uses a 74173 4-bit data register with a built-in, three-state output buffer. This means you can connect both the inputs and outputs of the register to the same bus (!) *and* control the transfer of data into and out of the register by applying appropriate signals to the register's read and write inputs.

For best results, build this circuit on a solderless breadboard. Use four rows of adjacent terminal receptacles for the bus and an 8-position DIP switch for the data input and control switch. To write a data word into the register, place the word on the bus by loading it into the first



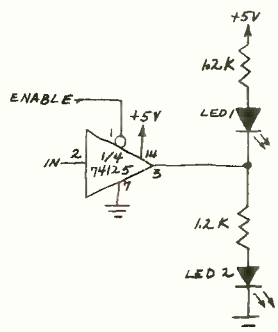


Fig. 1. Two three-state buffer configurations (left).
Fig. 2. Three-state buffer demonstrater (right).

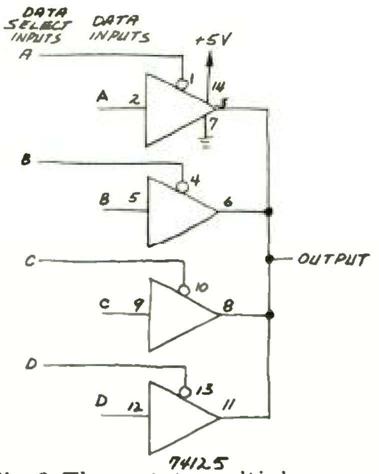


Fig. 3. Three-state multiplexer.

four poles of the DIP switch (let on = 1 and off = 0) and turning switch 8 on. The LED's will display the word you've switched into the input (LED one = logic 1 and LED off = logic 0).

The register will accept a data word from the bus when the WRITE input is low and the positive edge of a clock pulse arrives at pin 7. Prepare to load the data word into the register by turning switches 6 and 7 on. Then apply a clock pulse by turning switch 7 off. This disconnects the CLOCK input of the 74173 from ground, which is the equivalent of applying a positive pulse (unconnected TTL inputs go high). Don't worry about extra clock pulses from the bouncing that occurs when you throw the switch. The data word is copied on the first rising bounce, and any subsequent bounces simply recopy the same word.

After the data word is written into the 74173, turn switch 8 off to remove the input data from the bus. Then turn switch 6 off. To see the word stored in the register, just turn switch 5 on. This will activate the READ input of the 74173 and connect the register's output to the bus. This will display the stored word.

Going Further. You can expand the three-state demonstrator by adding a second 74173 to the data bus. You can connect the CLOCK input of the new register to the CLOCK input of the original 74173, but you'll need a couple of switches on a second DIP switch for the additional READ and WRITE inputs.

Can you think of a practical use for the three-state bus demonstrator? A bus system like this can send data between registers in *either* direction. Therefore, it's often called a *bidirectional data bus.* If that rings a bell, it's because the bidirectional data bus is used in most microprocessors. In fact the simple three-state bus demonstrator we've been experimenting with is functionally equivalent to part of a microprocessor.

In a real microprocessor, of course, the signals that activate the control inputs of the various registers and circuits are automatically supplied by a circuit called a *controller.* The signals from the controller are binary bit patterns called *microinstructions.* ◇

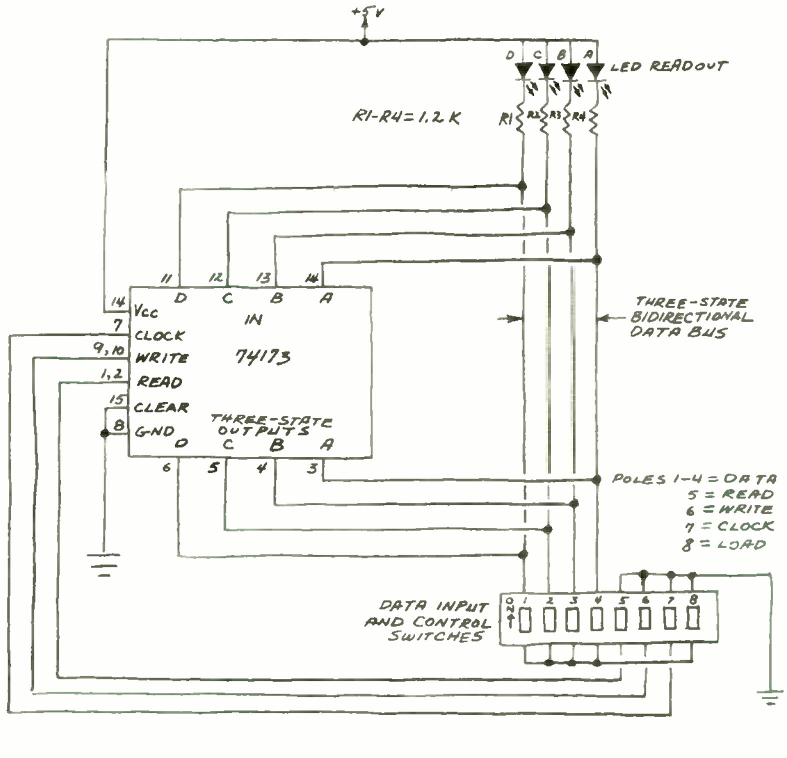


Fig. 4. Three-state bus demonstrater.

Hobby Scene Q&A

By John McVeigh

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

POPULAR ELECTRONICS

CIRCUITS FOR THE HANDICAPPED

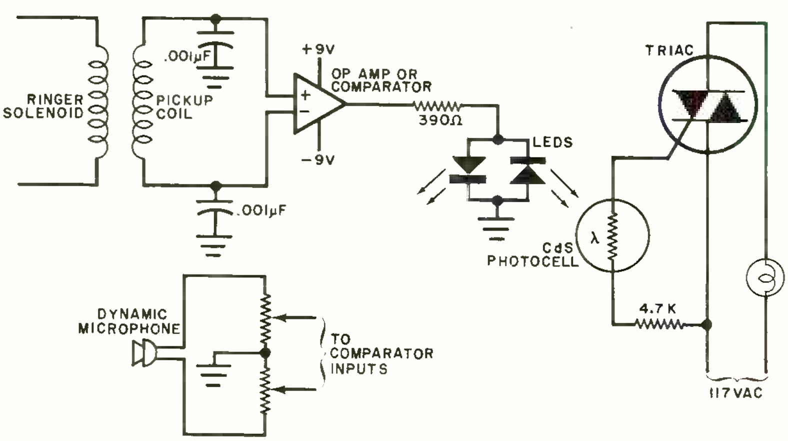
Q. ***I have been approached by a mute who needs a telephone-activated light. Mutes have teletype devices that they use for talking to each other, but do not like to leave them on unless they have a call. Can you suggest a circuit using a suction-cup telephone pickup coil that will light a lamp when the phone rings?—Walter H. Willey, Denver, CO.***

Q. ***Can you suggest a circuit that will turn on a triac when a digital alarm clock beeper is activated. It's not loud enough for those who are hard of hearing.—Steven Feinsmith, North Woodmere, NY.***

A. The circuit shown here will work with either a telephone pickup coil or a dynamic microphone. When the pickup coil is inductively coupled to the ringer solenoid, a voltage will be induced across it, and this across the inputs of the op amp or comparator. (Any common op amp should be suitable for this application.) The op amp will then cause the LED's to glow and the light from the LED's will decrease the resistance of the CdS photocell, turning on the triac and causing the lamp to glow. Alternatively, you could have light from the LED's turn on a phototransistor or LASCR which in turn could energize a relay coil.

The circuit can be modified slightly for use with a dynamic microphone as a sound sensor. You can also use a dual (ganged) potentiometer as a sensitivity control. Use a potentiometer with a resistance greater than or equal to the output impedance of the microphone.

If you want a hardwired circuit, refer to the Tone-Activated Relay in the February 1977 Hobby Scene. This circuit can be modified for triac switching. Replace the relay and diode with a series combination of a resistor and a LED. Connect the cathode of the LED to the collector of *Q1*, the anode to the resistor, and the other side of the resistor to +V. Choose the value of the resistor to limit the LED current to 15 mA or less: R = (+V − 1.7 V)/0.015. Couple the light from the LED to the photocell, taking care not to let ambient light reach the CdS cell. Connect the photocell, triac, and load as shown here.



LINE FREQUENCY AND CLOCK CHIPS

Q. ***Could you show me a circuit that will run a digital clock designed for use with 60 Hz off a 50-Hz line.—G.F. McGregor, Hamilton, Ontario, Can.***

A. There is no circuit that will do *exactly* what you want, because the counting and divide-by ratios in the chip's logic circuitry are set up permanently for 60 Hz. However, there is an inexpensive alternative. Several months ago, National Semiconductor introduced its MM5369 IC oscillator divider. This chip, when connected to a few external components, will provide a 60-Hz output. Consequently, many crystal-controlled time-base kits have appeared. Scan the Electronics Marketplace in any recent issue of POPULAR ELECTRONICS and you will find several dealers offering these time bases for about $5. The time base is in kit form and includes the IC, pc board, quartz crystal, resistors and capacitors.

Although the time base was designed with the 12-volt mobile environment in mind, there's no reason why you can't rectify the 50-Hz ac into the required dc levels, and use the output of the time base to drive the clock counters by applying it to the 60-Hz input pin of the clock chip.

NBS TIME STATIONS

Q. ***I read several years ago that WWV was building one or two vlf transmitters in the Boulder area to operate at 60 and 20 kHz. Whatever became of these two transmitters—are they still in operation, and if so, at what times?—Thomas Lohr, Biloxi, MS.***

A. You are referring to WWVB (60 kHz) and WWVL (20 kHz). WWVB is on the air, broadcasting time, and has a BCD format which can be used to make a nifty digital clock. All you have to do is receive the signal (a 565 PLL IC could be used as a synchronous detector without "tuned" circuits) and apply the BCD to a decoder/driver and display! As for WWVL, I'm not sure if it's still on, but think so. Complete information on the time and frequency services of the National Bureau of Standards can be found in NBS Special Publication No. 236, available for 25¢ from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Product Test Reports

B&K-PRECISION MODEL 1820 UNIVERSAL COUNTER

Counts to 80 MHz—doubles as period timer and events accumulator.

IN THE past, most frequency counters were either very expensive and provided a host of features and counting functions or relatively inexpensive and offered a minimum of features and functions. Now there are a number of moderately priced counters offering a good selection of counting modes and features. One of these is the B&K-Precision Model 1820 universal counter that can count up to 80 MHz.

The Model 1820 is actually four precision instruments in one. Its basic mode is frequency counting. In addition, the instrument can be used as a period counter, events accumulator, and as a highly stable crystal-controlled timer for external control functions.

The counter measures 11.6"W × 7.5"D × 3.25"H (29.5 × 19.1 × 7.3 cm) and weighs 2.6 lb (1.2 kg). Its suggested retail price is $260.

General Description. The Model 1820's input impedance is 1 megohm shunted by 25 pF on all functions. The instrument can tolerate inputs up to 200 volts from 0 to 500 Hz, up to 100 volts from 1000 Hz to 5 MHz, and up to 30 volts to 80 MHz. (All input specifications are for dc plus peak ac.)

The internal 10-MHz crystal-controlled oscillator has a line voltage stability of less than 1 ppm (part per million) with a 10% variation in line potential. The oscillator's temperature stability is rated at better than 0.001% (±10 ppm) from 0° to 50° C, and its maximum aging rate is listed at ±10 ppm/year and ±1 ppm/month. Settability is to ±1 Hz. (An external oscillator can be connected via a jack on the instrument's rear panel.)

The Model 1820 has a 7/16" (11.1-mm) high red LED display consisting of six seven-segment numeric indicators. All measurements are displayed on this LED array. In all operating modes, the decimal point, if used, is automatically positioned in the display. Separate discrete LED's come on in the kHz/μs and MHz/ms modes.

The frequency-counting mode has a range of 5 Hz to 80 MHz, with autoranging. Resolution in this mode is 0.0001% (1 ppm) on all ranges. The accuracy is specified as that of the time base ±1 count. Two gate times are provided: AUTO with 10 ms for MHz and 100 ms and 1 s for the kHz ranges, automatically selected by the counter circuit. In the 1-second mode, which is selectable via a switch on the front panel, resolution is specified at 1 Hz on the kHz range.

Although knowing a particular frequency is good, knowing the period of one cycle of a signal is better, since period measurement is much more accurate, especially at the lower frequencies. (Period is the reciprocal of frequency, or 1/f.) In the PERIOD mode, the kHz LED indicates the period in μs, while the MHz LED indicates in ms.

On the PERIOD and AUTO functions, the display is one period average (ms) and 10 and 100 period average (μs). In the 1 SEC mode, it is a 100-period average (μs indication with 1-ns resolution.) All period measurements are made with the built-in 10-MHz crystal-controlled oscillator. The minimum pulse width for reliable triggering is 200 ns. (The manual that accompanies the counter contains a number of tables for converting popular low frequencies to their corresponding periods. However, if you have a calculator, you can enter the numeric value of the period and press the calculator's 1/x key to obtain the frequency; press the key again, and you have the period.)

The ACCU (accumulate) mode permits measurement of electrical events that occur during a specific time period. It has a range of from 0 to 999999. To use this function, the input signal probe is connected to the source to be counted. Then, each time a signal occurs, it will update the displayed number by one.

The TIME mode allows the counter to display from 0.01 to 9999.99 seconds (2.77 hours) in 0.01-second increments. The circuitry in this mode can be toggled from a switch on the instrument's front panel or from an external TTL or contact closure. The triggering is activated on the rising or falling edge of the signal. A front-panel RESET switch is provided for resetting the display to zero to initiate a new count sequence.

The universal counter is designed to be powered from 105-to-130- or 210-to-260-volt ac, 50- or 60-Hz source. It has a built-on carrying handle that doubles as a tilt stand that can be locked in any of four detented positions for easier operating and viewing.

User Comment. After allowing the Model 1820 to warm up, we coupled to it an r-f signal generator that was zerobeat to WWV on 10 MHz. The counter accurately indicated the zerobeat, with good measurement repeatability. We did, however, note some slight drift after prolonged usage, due no doubt to continued warmup of the instrument. (Initially, we used the instructions provided in the manual to calibrate the counter's internal oscillator after warmup.)

The manual that accompanies the counter is well-written and well-illustrated. In addition to providing a complete discussion of the instrument's operation, it details operation on the various functions, complete with calibration and maintenance details; making debounce systems when using remote switching for elapsed-time measurements; and a number of frequency/period tables, including the even-tempered scale for tuning such musical instruments as electronic organs and synthesizers.

After several weeks of use, we have found the Model 1820 universal counter to be an excellent piece of test and measurement equipment, especially for its relatively low price for a full-feature counter. It is both reliable and accurate, which are exactly the attributes one most often requires of such an instrument for the work bench.

CIRCLE NO. 104 ON FREE INFORMATION CARD

SBE KEY/COM 1000 MOBILE AM CB TRANSCEIVER

Keyboard system provides scanning, channel selection, and memory capabilities.

BY TAKING advantage of modern technology, the SBE Key/Com 1000 40-channel mobile AM CB transceiver offers a variety of ways in which the channels can be set up. This is accomplished by a colorful calculator-like keyboard on the transceiver's control panel. You can instantly jump to any desired channel. Alternatively, you can step through all channels in either direction. In addition, the transceiver can be put into a scan mode in either direction at a rate of either four or eight channels per second, scan all channels and automatically stop at the first on which there is activity. It can scan as few as two or as many as ten preselected channels. Finally, you have instant access to channel 9 or you can set up on any priority channel in an alternate mode.

Other features include: large numeric LED channel display; r-f, audio, squelch, and delta tune controls; switchable automatic noise limiter (anl) with adjustable threshold and switchable noise blanker (NB); external-speaker jacks and PA operation; illumination dimmer; transmit and receive indicators; line filter; and operation from a nominal 13.8-volt dc, negative- or positive-ground, power source.

The transceiver measures 8¾"D × 7¾"W × 2½"H (32 × 27.4 × 6.4 cm). Manufacturer's suggested price, $279.95.

Technical Details. We did not receive a schematic diagram with our test unit. Hence, our circuit description is based on observation. The receiver employs double conversion to i-f's at 10,695 and 455 kHz. The selectivity at the second i-f is obtained with a ceramic filter. The PLL frequency-synthesis system employs the usual 10,240-kHz crystal-controlled oscillator from which the standard reference signal is derived and which is also used for the second-conversion oscillator.

The voltage-controlled oscillator (vco) at the first mixer operates at a frequency that is 10,695 kHz lower than the frequency of the CB signal. (The more common practice is to have it operate higher in frequency than the CB signal.) This provides somewhat better image rejection and lessens the chance of spurious radiation from the receiver in the vhf range. A microprocessor controls the channel selections and various channel-selection modes.

The transmitter employs the usual driver and power-amplifier stages, the latter terminating in a 50-ohm matching network that maximizes harmonic attenuation and other spurious radiation that can cause interference such at TVI.

The transmitter is modulated by the receiver's audio system, which contains a form of automatic modulation control.

Physically, the transceiver is all black and has a satin-finished chrome trim. The rotary controls are also chrome finished. Miniature toggle switches are provided for activating and deactivating the ANL and NB and for dimming the lights.

The meter movement has an edgewise design and is mounted vertically. A window for the mode indicators and LED channel display is located to the left of center on the panel. The numeric channel displays are very bright, providing much better than usual visibility under bright external-lighting conditions.

To the left of the indicator/display window is the keyboard that controls channel selection and operational mode. It consists of 11 keys, 10 of which are square and labelled with the numerals 0 through 9 and the last is oblong in shape and is labelled CHANNEL. The key buttons are backlighted so that their legends are easily readable under all lighting conditions. In addition to their 0 through 9 labelling, the square keys have labelling (letters and arrows) for their secondary functions. They also light up in different colors.

To directly set up or instantly jump to any desired channel, first the CHANNEL and then the number buttons that correspond to the number of the desired channel must be pressed. If an illegal channel is selected, the system automatically goes to channel 19, which also comes up first when the transceiver is turned on.

Scanning of all channels at a rate of eight channels/second is accomplished by holding down the 0 or 1 key, depending on which direction you wish the scan sequence to take. (The 0 button's secondary labelling is an open arrow that points upward for upward scanning, while the downward-pointing open arrow on the 1 button indicates a downward direction of scan.) To scan at four channels/second, you use the 2 and 3 keys, which are labelled with closed upward- and downward-facing arrows to indicate the direction of the scan.

To step through the channels one at a time, you momentarily tap 0, 1, 2, 3, etc., according to the desired progression.

To scan through all channels and stop at the first on which there is activity, the squelch is first adjusted to mute the background noise. Then you press the 7 key, which is alternately labelled with an N for normal, and the 5 key, which is also labelled S for scan. The scanning direction is then set by hitting the 0, 1, 2, 3, etc., key as desired.

To scan up to 10 preselected channels, stopping at the first active one, the desired channels are entered into memory by pressing the 8/M (M for memory) key and then the CHANNEL key. Then you enter the number of the channel via the numeric keyboard. Continue this sequence until all desired channels have been entered into memory. Once they are entered into memory, scanning is initiated by muting the squelch and then tapping the 8/M and 5/S keys.

When an incoming signal on a channel on which the scanner has stopped ceases, scanning can be resumed by tapping the 5/S key. To stop the scan at any point, simply tap the 8/M key. Also, if you wish to manually step through the channels in memory, you can repeatedly tap the 8/M key.

Anything that is in memory is erased when power is turned off. However, a terminal on the rear apron of the transceiver is provided for direct connection of the memory system to the 12-volt supply to prevent erasures from happening if this is desired.

Other transceiver functions are initiated by using the appropriate keys. Space does not allow us to enumerate all of them here, but here is a quick summary. Alternate scanning of two preselected channels is accomplished with the aid of key 6/A (A for alternate), or a priority channel can be set up with key 4/P (P is priority). Key 9/E (E for emergency) sets up channel 9 for instant access when the 9 key is pressed, at which time, all other functions are overridden.

Laboratory Measurements. The receiver sensitivity measured 0.55 μV for 10 dB (S + N)/N over most of the range. It was 0.8 μV at the lower end of the band. These results were obtained with a 1000-Hz test tone modulating the carrier 30%.

The threshold range of the squelch was 0.3 to 2000 μV. The S meter indicated a relative signal strength of S9 with a 100-μV signal. The meter pointer just started to move up-scale with a 0.5-μV input signal. The agc system held the audio output to within 6 dB with a 20-dB r-f signal variation at 1 to 10 μV. Audio varied by 12 dB with an 80-dB input change at 1 to 10,000 μV.

Image rejection measured an excellent 90 dB minimum. The i-f rejection was a good 70 dB, while spurious-signal rejection was a fine 65 to 70 dB. Adjacent-channel rejection and desensitization was 55 to 60 dB.

The overall audio response, referred to 1000 Hz, was +2, +4, +2, −2, −4, −6, and −10 dB at 260, 400, 750, 1200, 1500, 1800, 2400 Hz, respectively. The maximum sine-wave output power we measured was greater than we have become accustomed to, amounting to 8 watts at 7% THD with a 1000-Hz tone and 8% THD with a 400-Hz tone into 8 ohms. Using a 10% THD figure at 1000 Hz, we measured 10 watts of audio output with limiting.

The maximum attainable PA output, using the microphone supplied with the transceiver, was 6 watts. With a higher-output microphone, we expect that the output would have been greater.

Operating from the standard 13.8-volt dc power source, the transmitter delivered a carrier output of 3.75 watts into 50 ohms. Modulation reached 85% to 90% on the positive peaks and 100% on the negative peaks. At frequencies beyond 1400 Hz, the maximum attainable modulation dropped off gradually, to 50% at 2300 Hz.

Using a 1000-Hz test tone at levels 16 and 25 dB greater than that required for 50% modulation, the adjacent-channel splatter at more than 5000 Hz from the carrier frequency was down 60 and 55 dB, respectively. The THD in both cases was 6%. With voice maintained at a high average level, the splatter was at least 60 dB down, even though the negative peaks occasionally went a bit beyond 100% modulation. With heavy amc action, the voice quality was a little rough at low frequencies. Modulation and carrier shift were slightly upward.

The overall 6-dB response of the transmitter was 450 to 2250 Hz. The output frequency tolerance was −22 Hz on all channels.

User Comment. The operation of this transceiver sounds much more complicated than it is in actual use. One quickly gains familiarity with the various controls so that, in short order, operation becomes instinctive.

Our operational tests revealed that activated-anl dropped the overall signal level 5 to 10 dB with signals less than 1 μV and 4 to 6 dB with signals around 10 μV. This is of little concern since the actual sensitivity of the receiver is not altered. Besides, the signal-to-external-noise ratio is considerably improved; you just have to crank up the volume a bit. In this regard, the degree of attenuation depends on the threshold of the anl, at any setting of which we observed no adverse audio distortion either by ear or by oscilloscope observation.

Bench and on-the-road tests in a vehicle indicated the noise blanker to be more effective on certain types of noise, while the anl does a better job on other types. The latter was exceptionally effective on ignition noise.

In short, this advanced-type mobile rig provides fine overall performance in all departments—signal-handling ability, unwanted-signal rejection, clean and high average modulation, and high audio and PA output. Its other attributes make it an outstanding unit.

CIRCLE NO. 105 ON FREE INFORMATION CARD

Should your career in electronics go beyond TV repair?

CREI prepares you at home for broader and more advanced opportunities in electronics— plus offers you special arrangements for engineering degrees

There is no doubt television repair can be an interesting and profitable career field. TV repair, however, is only one of the many career areas in the fast growing field of electronics.

As an indication of how career areas compare, the consumer area of electronics (of which TV is a part) makes up less than one-fourth of all electronic equipment manufactured today. Nearly twice as much equipment is manufactured for the communications and industrial fields. Still another area larger than consumer electronics is the government area. That is the uses of electronics in such areas as research and development, the space program, and others.

Just as television is only one part of the consumer field, these other fields of electronics are made up of many career areas. For example, there are computer electronics, microwave and satellite communications, cable television, even the broadcast systems that bring programs to home television sets.

As you may realize, career opportunities in these other areas of electronics are mostly for advanced technical personnel. To qualify for these higher level positions, you need college-level training in electronics. Of course, while it takes extra preparation to qualify for these career areas, the rewards are greater both in the interesting nature of the work and in higher pay. Furthermore, there is a growing demand for personnel in these areas.

Unlike most other home study schools, CREI programs are devoted exclusively to preparing you for careers in advanced electronics. All of CREI programs are college level. And CREI gives you both theory and practical experience in advanced electronics.

Unique Design Lab

A unique feature of CREI training is its Electronic Design Laboratory Program, which trains you to actually design circuits. It also helps you understand the theories of advanced electronics and gives you extensive practical experience in such areas as tests and measurements, breadboarding, prototype construction, circuit operation and behavior, characteristics of electronic components and how to apply integrated circuits.

›areer Training at Home

Only CREI offers this unique Lab Program. It is a complete college lab and, we believe, better than you will find in most colleges. The "Lab" is one of the factors that makes CREI training interesting and effective. And the professional equipment in this program becomes yours to keep and use throughout your professional career after you complete the training.

Engineering Degree

CREI offers you special arrangements for earning credit for engineering degrees at certain colleges and universities as part of your home study training program. An important advantage in these arrangements is that you can continue your full time job while "going to college" with CREI. This also means you can apply your CREI training in your work and get practical experience to qualify for career advancement.

Wide Choice of Programs

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

FREE Book

In the brief space here, there isn't room to give you all of the facts about CREI college-level, home study programs in electronics. So we invite you to send for our free catalog (if you are qualified to take a CREI program). The catalog has over 80, fully illustrated pages describing your opportunities in advanced electronics and the details of CREI home study programs.

Qualifications

You may be eligible to take a CREI college-level program in electronics if you are a high school graduate (or the true equivalent) and have previous training or experience in electronics. Program arrangements are available depending upon whether you have extensive or minimum experience in electronics.

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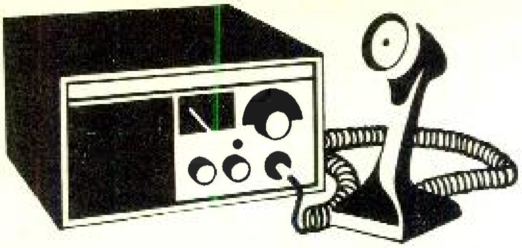
CREI programs are approved for training of veterans and servicemen under the G.I. Bill.



CB Scene

HANDLING RADIO-FREQUENCY INTERFERENCE

What can you do when a neighbor complains that your CB transceiver is interfering with his TV reception? In all probability you can get yourself off the hook because the odds are that the problem is not your fault. But if you want to stay on good terms with your neighbor, you will most likely have to show him that you are not the cause of the difficulty. For this reason, the FCC suggests that you take all steps possible to determine that your rig is not the cause of radio-frequency interference (RFI) as a result of a deviation from the technical requirements. Besides, a complaint to the FCC might result in your receiving a violation notice, forcing you to have technical tests conducted on your transceiver by a qualified technician.

Is It Really RFI? The first step when someone complains to you is to find out whether or not the problem is indeed caused by RFI. If the neighbor's TV receiver booms out, "What's your 20, Good Buddy?" CB transmissions are obviously involved. But many other symptoms are mistaken for CB-caused interference.

Randomly spaced lines of black and white spots crossing the picture tube of a TV receiver or sizzling or buzzing sounds in the receiver's sound are certainly RFI; but they are caused by electric motors, vehicle ignition systems, and similar electrical devices. They are *not* caused by CB or other radio equipment. Herringbone patterns in the TV picture are most likely caused by nearby FM stations (especially on TV channel 6), according to the FCC. But they can also be caused by CB or amateur-radio transmissions. If the pattern changes with the TV program's sound, however, it is more likely a problem in the TV.

RFI can also appear on a TV receiver's picture tube as a pattern of interference that shifts as the operator talks. Sometimes, the interfering signal will be audible through the TV receiver's speaker, but this is more likely to occur in high-fidelity systems.

If interference appears on TV channels 2, 5, 6, or 9 (especially 2 and 5), CB interference is the likely cause (but it may not be from your transmitter). If the interference appears on all TV channels, or on only one of the unmentioned channels, then CB transmitters can generally be ruled out as the offender.

Keep in mind that the 6-Meter ham band can cause TV channel-2 interference and that channel-6 interference would likely be limited to 40-channel CB rigs with transmissions on one of the 17 new channels.

Is It Your Rig's Fault? When you receive a complaint, the first step is to find out whether or not your CB rig is involved. A quick and easy way to accomplish this is to have your neighbor switch to TV channels on which he normally gets interference while you make brief transmissions on each of the channels you normally use. Keep in constant touch by telephone as you do this.

If the interference comes and goes as you key on and off your rig's microphone, your CB rig is definitely involved.

Your CB rig may be involved in causing your neighbor's TV receiver or hi-fi system to pick up interference, but it still may not be your fault. As long as your transmitter is operating properly, with no more than full legal output power and no excess harmonics, the legal responsibility for clearing up any RFI problems it causes rests with your neighbors who are suffering from them. This does not mean that you, as a good neighbor, cannot help solve their difficulties. Be sure you have their full cooperation, though.

You have the responsibility to ensure that your operation meets all legal requirements. All transmitters radiate harmonics, of course. Unfortunately, the strong second and third harmonics of transmissions on the 27-MHz band fall close to TV channel 2 (54 to 60 MHz) and channels 5 and 6 (76 to 88 MHz), while the seventh harmonic falls right in the middle of channel 9 (186 to 192 MHz). FCC regulations stipulate that today's 40-channel CB transmitters must attenuate these harmonics by at least 60 dB. (Transceivers built before January 1, 1977 must still attenuate the harmonics by at least 50 dB.) Operating a transceiver that radiates harmonics above these levels is illegal.

Sometimes, the cause of excessive harmonic radiation may be as simple as the accidental loosening of the screws that hold the CB chassis to its metal case. Here, a simple tightening of the hardware may be all that is required to effect a cure. If this does not work, try grounding the transmitter to a cold-water pipe or other good earth ground.

The next step is to try a 52-ohm low-pass filter between the transmitter and antenna. The filter will pass CB signals and effectively attenuate the higher harmonic frequencies that cause RFI. Such a filter can also serve as a diagnostic tool when used with a power or SWR meter. To do this, install the meter between the transmitter and a dummy load and measure the output power (or with an SWR bridge, adjust it to the calibration line). Then install the filter between the transmitter and meter and repeat the measurement without retuning the transmitter. If the meter reading decreases, harmonics may be present.

Harmonics may also escape through the power line. If this is the case, a line filter of two capacitors (0.001 microfarads each) will pass the r-f to ground and may prevent this radiation.

Overmodulation can cause RFI, too, since the resultant clipping of the r-f waveform produces a wealth of harmonic and spurious emissions that are commonly referred to as "splatter." This splatter also causes interference on adjacent CB channels. Therefore, the FCC requires that a modulation limiter be built into CB transmitters that are capable of delivering more than 2.5 watts of r-f output, which includes virtually all base and mobile rigs and many hand-held transceivers. It is more likely that overmodulation occurs with 23-channel rigs than with the new 40-channel rigs because manufacturers' CB models are now more closely inspected.

If you have any reason to suspect that your transceiver is overmodulating or radiating excessive harmonics, and if the elementary checks and solutions described above do not solve the problem, have your transceiver checked out by a person who holds a first- or second-class radiotelephone license.

Correcting the Fault. Demonstrating that your CB rig is doing nothing wrong will only partially mollify your neighbors. Helping them cure their problems can make your neighbors positively grateful.

RFI is most likely to enter a TV receiver through its antenna terminals. So, the first step is to look over the TV antenna, lead-in cable, and lightning arrestors (if any). Look for corroded connections and deterioration of the cable. Repair or replace any doubtful connections or cable.

If the RFI persists, check for a signal booster on the antenna mast or on the rear of the TV receiver and determine if the receiver is being fed from a distribution amplifier somewhere in the antenna system. (The amplifiers and high-gain antennas used to boost weak signals in fringe reception areas will also boost the received strength of any local CB harmonics.) If there is such an amplifier, removing it from the system may eliminate the RFI problem. If it does, reconnect the amplifier and ground it to a good earth ground. You may have to house it in a metal case, which can then be grounded. Alternatively, you can install a high-pass filter at the amplifier input.

In systems that use boosters, it is usually advisable to install a second high-pass filter near the TV receiver's antenna input terminals, unless the amplifier is right at the receiver. In systems that do not employ boosters, connect the filter to the receiver's antenna input terminals. Make certain that the filter has the correct impedance: 300 ohms for twin-lead, 75 ohms for coaxial cable.

If the filter's instructions state that the filter must be grounded, use a cold-water pipe or other good earth ground. Proceed with caution, however. If the TV receiver does not have an isolating power transformer, this ground connection must be made through a ceramic disc capacitor rated at 1600 volts or more. The capacitor will bypass the r-f to ground without affecting the ac line voltage on the chassis of the TV receiver.

If interference occurs on only channel 2, it may help to install a tuned filter (such as a 1-μH choke in series with a 2-20-μF ceramic trimmer capacitator) across the antenna terminals of the receiver. This filter should be tuned for minimum interference.

The quarter-wave tuned stub is another type of filter that can be installed across the TV receiver's antenna input terminals. Connect the antenna's down-lead and the stub to the antenna terminals. (With 75-ohm coax, this will require the use of a T connector.)

For 300-ohm systems, cut the stub to 48" (1.22 m), while for coaxial cable, it should be cut to 37" (0.94 m). Then, while the interference is occurring, trim ⅛" to ¼" (3.2 to 5.4 mm) at a time until the interference is eliminated.

If after you exhaust the various remedies enumerated here, the problem is not eliminated or radically reduced, the TV receiver may require internal modifications. These might include installation of an additional stub at the tuner or the addition of filters and/or shunts to certain circuits within the receiver. Since detailed knowledge of the particular TV receiver is required in each case, these modifications should be left to a qualified TV service technician.

Getting More Help The FCC has indicated it has hopes of increasing the harmonic attenuation requirement of CB transceivers from its present 60 dB to 100 dB. But this alone will not solve the interference problems. There has been little TV receiver improvement in combatting interfering signals in the past 20 years, noted Commissioner Robert E. Lee. With 53,292 reported cases of interference to TV receivers, mostly from CB transmissions, it seems that part of the problem rests with poorly designed TV receivers. Accordingly, the Commission is looking toward manufacturers of TV and audio equipment to upgrade their products' interference rejection capabilities. Meanwhile, if you need additional help for handling RFI problems, the FCC has prepared "How To Identify & Resolve Radio-TV Interference Problems," a handbook that is a good source of information. It is available for $1.50 (make your check or money order payable to the Superintendent of Documents) from the Consumer Information Center, Dept. 051F, Pueblo, CO 81009. Also, two Interference Handbooks—"TV Interference" and "Audio Rectification"—are available from the Consumer Electronics Group/Electronic Industries Association, 2001 Eye St., N.W., Washington, DC 20006.

In some areas of the country, there are now Local Television Interference Committees dedicated to resolving CB interference problems. You can obtain the address of the nearest Committee by writing to the International CB Radio Operators Association, Box 10-2, Roanoke, VA 24005. ◇

Computer Bits

By Hal Chamberlin

MICROCOMPUTER MEMORY

ALMOST from the start, memory has played a major, if not dominant, role in the practicality and cost of a hobbyist computer system. In the very early days (before 1972), the small "home brew" group of computer hobbyists used any type of memory that was available and relatively low in cost. Telephone relays, magnetic-tape loops, delay lines, salvaged memory drums, and of course core memory stacks were used. However, all of these devices were either extremely slow in speed, or were complex.

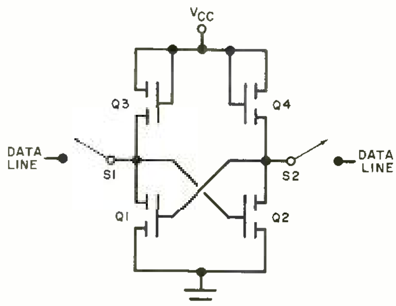
Along about 1972, semiconductor memories became low enough in price to be used by someone brave enough to tackle building a home computer. These memory devices were as easy to use as the rest of the logic within the system, thus adding to their appeal.

So, when the home computer revolution began in 1975 with the introduction of a low-cost microcomputer kit, semiconductor memories were right there along with the microprocessor chips. Even now, the main memory (as distinguished from external mass storage such as a cassette), is the dominant cost and performance factor in a home computer. The speed and sophistication of the MPU mean nothing if the main memory does not have ample capacity. Although some MPU's have more efficient storage of programs, when it comes to raw data storage, all systems are equal.

Types of Memory. Classical memory devices are divided into two distinct groups: random access and nonrandom access. A random access memory requires essentially the same amount of time to read or write a particular memory cell regardless of which cell is addressed, or the order of consecutive addresses. It literally means that a *random* sequence of addresses is handled just as fast as an ordered sequence.

The very earliest memory IC's were long shift registers that were serial access rather than random-access devices. When presented with a random address, a shift-register memory requires a variable access time depending on where the data is within the register. Today's systems use random-access memory exclusively for main memory.

Random-access semiconductor memories can be further broken down into *read-only*, *read-mostly*, and *read/write* classes. A read-only memory (ROM) can only be read. The information in the memory is placed there during manufacture and can never be changed. Read-only memories are typically used for unchanging system programs such as a monitor or BASIC interpreter. The advantage of permanent memory is that loss of operating power does not destroy the memory contents.



Six-transistor static memory.

The read-mostly kind of memory IC normally behaves just like a read-only memory but it is possible, using specialized equipment and a procedure called programming, to change the memory contents. Such memory devices are called Programmable Read-Only Memories or PROM's and the equipment is called a PROM programmer. One type of PROM is manufactured with all memory cells containing "0's". The programming procedure can change selected cells to "1's" to get the desired memory contents. The PROM can be programmed again later to write additional "1's" but once set, a cell can never return to a "0".

Another type of read-mostly memory IC can be *erased* to its all-"0" state and then completely reprogrammed as often as desired. These are called EPROM's for Erasable PROM. The erasure is usually accomplished with intense shortwave ultraviolet light, although a couple of types exist that can be erased with voltage pulses. The EPROM costs more than any other type of memory IC.

A read/write memory, which is usually called just a RAM, can be written into as quickly and easily as it can be read from. Most of the memory in a typical system is of this type because such a memory does not have to be dedicated to any single program or data table as ROM and PROM are. User programs and data are always stored in RAM and frequently many of the system programs such as the assembler and text editor are also stored there. Of course, the very flexibility, and ease of writing, makes RAM contents easily destroyed by errant programs or operating power failures.

Inside RAM. Since plain RAM is the most popular kind of memory, let's take a closer look at RAM operation and terminology. Two basic storage circuits are used in modern RAM's. The first type is a conventional flip-flop (as shown in the diagram) made from MOS transistors *Q1* and *Q2*. Transistors *Q3* and *Q4* function as high-value load resistors and are used because they are physically smaller than an equivalent resistor would be. Switches *S1* and *S2* connect the memory cell to the outside world and provide the read and write data path.

When the cell is unaddressed, both switches are open and the cell is isolated. To read, both switches are closed and the state of the flip-flop can be determined by sensing the voltage level on the data lines. To write, the switches remain closed and other circuitry forces the data lines to voltage levels that will cause the flip-flop to change state.

This type of cell is called *static* because once the flip-flop is set to a particular state, it will remain in that state until instructed to change, or the power supply voltage drops. Switches *S1* and *S2*, are in reality, MOS transistors and so the memory cell in Fig. 1 is a 6-transistor static memory cell.

Another common data storage circuit is just a capacitor and a switch which again is really a transistor. When the cell is unaddressed, the switch is open and the voltage level on the capacitor determines the cell's state. To read the cell, the switch (transistor) is closed thus discharging the capacitor into a sensing circuit connected to the data line. If a surge of current from the discharging capacitor is sensed, then a 1 was stored—no surge represents a 0. The data is then restored to the cell by applying a high voltage to the data line if a 1 had been previously sensed. When writing new data, the initially sensed data is ignored.

This cell is called *dynamic* because the charge will leak away from the capacitors if they are not written or read often enough. At room temperature, the charge remains for a second or so; but at the top end of the rated temperature range, the period may be only a few milliseconds. Actually, in a dynamic memory IC, the capacitor is really just stray capacitance. Thus the entire memory cell consists of just one transistor.

The small size of such memory cells allows as many as 16,384 of them to be placed on one chip, whereas only 4096 of the 6-transistor type are diffused on one chip. Even the lowest cost and most popular dynamic RAM's pack 4096 bits in a chip, whereas static types contain only 1024 cells.

Another advantage of the dynamic cell is that power consumption is very low. Cells just idling don't consume any power. The dynamic RAM consumes power only when being accessed while a static RAM constantly draws current to keep the thousands of internal flip-flops powered. It is not unusual to see a 32k static memory system require over 8 amperes while an equivalent dynamic memory system might require less than one ampere.

As previously mentioned, a dynamic memory system must read or write every cell occasionally to recharge the storage capacitors. Since this does not always happen during normal operation of the system, a separate *refresh* operation is usually performed. Refreshing is quite simple and amounts to nothing more than sequentially reading through a portion of memory using a counter to generate addresses. Due to the internal organization of the memory IC's, only 64 addresses really have to be read to refresh all the cells.

Early memory board designs using dynamic RAM's would periodically stop the MPU while refresh was being performed. Modern designs look at the state of the MPU and during those times when memory access is not required, a refresh cycle is slipped in.

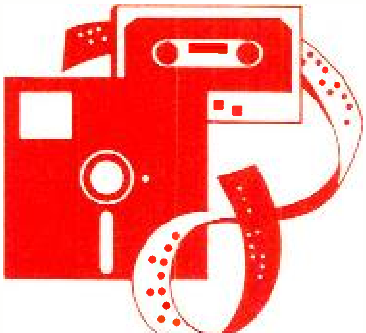
Memory Boards. There are certainly more different kinds of memory boards for hobbyist systems on the market than any other type of board. For Altair (S-100) bus systems, the earliest memory boards contained only 1024 bytes of static RAM. Later, MITS introduced its 4k dynamic memory board using 22-pin 4k RAM's. It was quite power conservative but priced fairly high. Refreshing was done by halting the MPU periodically. This opened the door for competing brands of memory boards which, in the interests of quick development and marketing strategy, used 1k-bit static RAM IC's and had a total capacity of 4k bytes. While they worked well and were low in cost due to intense competition, the much greater power consumption of static RAM's strained the computer's power supply and cooling system. Computer manufacturers responded with massive power supplies to satisfy customers who plugged 32k and more of memory into a system.

Later improvements in printed circuit board fabrication allowed as much as 8k on a board using the same 1k memory components. Finally, the IC manufacturers figured out how to put 4096 bits of static memory onto one chip and also cut the power consumption per bit by a factor of two to four. Thus, 16k static memory boards became available. Although more expensive per bit than the 4k or 8k boards, these larger units are becoming popular.

Finally, memory board designers have found ways to "hide" the refresh cycles of a dynamic memory in the MPU's idle time periods. Also, at the same time that 4k static-memory IC's became available, 16k dynamic RAM's also became available. Using these, it is now possible for 64k bytes to be put on a single board. The 16k IC's are still quite expensive, but an 8k version is being used in very cost-effective memory boards with a capacity of 32k bytes.

However the least expensive memory boards on today's market still use the same 22-pin 4k RAM's that were used in the original MITS 4k board. These have a 16k capacity, utilize hidden refresh, and are $300 to $400.

Memory costs are constantly decreasing. In two years it will be possible to buy a 64k memory board for what a 16k board costs now. Already the computer manufacturers are introducing systems that can address more than 64k of memory to make room for the never-ending memory capacity spiral. ◇

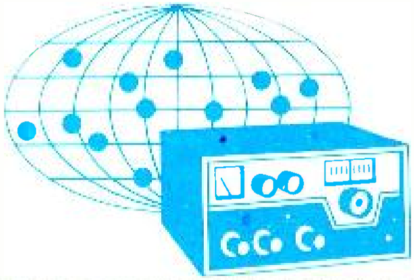


Software Sources

8080 Music System. This new music system for 8080/Z-80 computers includes a monitor, a text editor whose file structure is compatible with Processor Technology's ALS-8 Assembly Language Operating System, a high-level music-composing-language compiler, and an S-100 bus-compatible circuit board with components. The system requires close to 2k of memory and an external amplifier, speaker and connecting cable. Language capabilities include dotted notes, four-octave range, and staccato. The system generates complex tones, not simple sine waves. $24.50 Write: Software Technology Corp., Box 5260, San Mateo, CA 94402.

6502 Executive for KIM-1. Adaptable to any 6502-based system, this program is designed for KIM-1 with 4k or more and a TTY or TVT interface. It uses subroutines within the KIM monitor program. The program acts as a software system, controller, linker debugger, ASCII text editor and general programming aid. It includes a high-speed (213 bytes/s) cassette read-write program for saving and loading programs, plus manually loadable bootstrap in KIM format. Other functions include linkage between Kimex sub-programs and KIM monitor, trace program to display pertinent register data after instructions are executed or at selected breakpoints, binary-decimal conversion, memory test and content comparisons, memory move, and relative offset calculation for branch instructions. $25, including annotated listing and complete instructions. Sub-programs available separately for $5 each. Write: Innovative Software, Inc., 3107 Casa Bonita Dr., Bonita, CA 92002.

6800 Cross-Assembler. A two-pass cross-assembler permitting 6800 programs to be assembled on a CDC 6500 or PDP-11 recognizes hex, decimal, octal, binary and ASCII constants, as well as arithmetic operators. Addresses may be specified as expressions involving symbols. The program requires approximately 15k words of memory on a CDC6500 and 27k words on a PDP-11, depending on the size of the symbol table. The program, with manuals and one year's maintenance, is $600. User's manual is available separately for $5. Write: Wintek Corp., 902 N. 9th St., Lafayette, IN 47904.



DX Listening

By Glenn Hauser

SINGLE SIDEBAND BROADCASTING

ALTHOUGH SSB is the main mode used in hf amateur radio communications and is gaining acceptance on the Citizens Band, international broadcasters are slow to adopt what everyone agrees to be a system more efficient than AM. Actually, "AM" is a shorthand expression for the full-strength carrier, double-sideband mode of transmission, whether used on shortwave, longwave or mediumwave—despite popular usage equating AM only with mediumwave.

The arguments in favor of SSB broadcasting are cogent. It is a tremendous waste of resources—both energy and spectrum—to transmit two sidebands and a full-strength carrier. One sideband is redundant, and the carrier can be generated inside each receiver. Twice as many stations could fit into a present AM-only band. There would be less interference (if stations are properly spaced) and no heterodynes. Also, there would be no distortion due to selective fading. We tend to associate selective fading with shortwave, but actually it results from a combination of AM transmission and shortwave propagation. Upper and lower sidebands do not fade simultaneously, so that sometimes they cancel each other.

The main stumbling block is the fact that many shortwave receivers, especially low-priced ones, are not well-suited to receive SSB. Some of those that have a bfo lack the stability necessary to make listening to SSB broadcasts as easy as listening to AM.

If the receiver drifts more than a nominal amount, the pitch of the SSB audio changes, becoming unintelligible unless periodically retuned. This is more of a problem with music than speech. Fortunately, SSB broadcasts customarily retain a residual carrier. All we need for foolproof SSB listening are receivers with automatic frequency control circuitry that locks on the residual carrier.

Some receivers employ narrower bandwidth filters on SSB. This means that the reproduction of programming with high-frequency audio content, such as music, is degraded compared to that obtained on AM. On the other hand, selective fading is more annoying on music than on speech, and SSB would do away with it.

Considering these drawbacks, it looks as if SSB broadcasting is not likely to replace AM at any time in the near future. In fact, it's possible that the political problems presently preventing direct international broadcasting on FM from satellites will be resolved first. But in the meantime, a few stations are already experimenting with SSB broadcasting, giving us the opportunity to find out how it actually works in practice. Some are out-of-band, but others are within the AM shortwave broadcasting bands.

Chile seems to have established a regular evening service on 14,530 kHz with "Radio Colo Colo" programming. The purpose of this transmission is not clear, but it lets us listen to Chilean domestic radio on a clear frequency with generally good reception.

Some out-of-band SSB broadcasts are considered 'feeders' to relay stations, which of course have professional equipment that works well on SSB. Relay stations prefer SSB feeds over AM ones, which might also be available, because instead of the double selective fading experienced with an AM-to-AM relay, there is only single selective fading on the relay station's AM signal.

Chile, of course, owns no relay stations in other countries. But it often happens in Latin America that private stations relay the programs of others for reasons of their own—news coverage, or more often sporting events, on an irregular schedule.

Radiodifusora Nacional de Colombia used SSB for several months in 1977 within the 19-meter band, varying between 15,325 and 15,335 kHz. Then it went back to AM, but Richard Varron advised us that SSB broadcasts continued on 13,867 kHz all day. There is some doubt that Colombia's SSB on 19m was deliberate. Israel Radio uses SSB on some of its low-power transmitters, both in and out of band, sometimes seemingly unintentionally, as some of the transmitters were formerly used for point-to-point services.

Several international broadcasters employ SSB but do not have external relay stations. Nor do they publicize the SSB frequencies as for general public reception. The (North) Korean Central Broadcasting Station is one, with external-service SSB programming on 3560 and 3890 kHz. If it were not for the relatively small size of North Korea, one might surmise that these are feeders to various different transmitter sites within the country. This is surely the case with China's numerous SSB broadcasts, as well as those of the USSR. Each uses many different transmitter sites within the country, but has relays from one other country—Albania and Bulgaria, respectively.

Sweden has regular SSB broadcasts of its home service Program One via a transmitter at Varberg now rated at 100 kW. Initial experiments which included foreign service programs employed a 30-kW transmitter. This regularly scheduled service runs 16½ hours per day on several frequencies within the SWBC bands. It is admittedly not intended for the general public, but for Swedish diplomatic missions, ships, etc. However, Richard Wood caught an unpublicized SSB test on R. Sweden's English program at 0230 GMT on 9675 kHz. Radiodifusão Portuguesa uses SSB on 6185 kHz, presumably as a feed to the Azores Islands.

It is becoming more and more probable that any SSB transmissions you hear on the fixed service, as opposed to the amateur, maritime and aero bands, will be broadcast material. The reason is that an ever-increasing portion of two-way traffic is being routed via satellites at shf while international broadcasters continue to use hf circuits to feed programs to remote relay stations. The stations you are most likely to encounter are the Voice of America, Deutsche Welle, BBC, Radio Free Europe, Radio France International, and Radio Nederland. Some feed two programs simultaneously on independent upper and lower sidebands. However, the wave of the future is satellite feeds.

Radio Nederland was reportedly planning to abandon its hf feeders in favor of satellites exclusively during this broadcasting season. The BBC resorts to satellite links during periods of poor hf propagation. Deutsche Welle has been using them for some of its feeds to the Rwanda relay. And the VOA uses a satellite feed to its West Coast sites and to Kavala, Greece. No doubt this trend will continue, reducing the amount of SSB broadcasting on shortwave frequencies.

The Swiss Broadcasting Corporation considered the conversion of some transmitters to SSB for North American broadcasts beginning in March. Of course, it makes sense for broadcasters with sufficient equipment to do it both ways. SBC recently distributed a questionnaire to those listeners on its North American mailing list to obtain opinions on whether SSB broadcasting should be tried. North America is an ideal target for such an experiment, where SSB receivers are relatively widespread and SBC has reception problems.

An interesting approach is taken in the questionnaire. Listeners are asked to tune in existing SBC AM transmissions, but with receivers in the SSB mode, and to compare the reception quality on SSB with that on AM. If you would like to participate in the survey, write to the SBC European & Overseas Services, "SSB," Box CH-3000 Berne 15, Switzerland.

Latest DX News. Shortwave frequencies and schedules are constantly changing. By the time anything can be printed and distributed, it runs a high risk of being out-of-date. Monthly DX club publications and the listings published in this magazine serve a useful purpose in providing a periodic compilation of all these changes, but those impatient to keep up with what's happening rely heavily on several limited-circulation newsletters issued weekly or fortnightly. Even these require a significant delay between the actual observation and its arrival to interested DX chasers.

It would seem obvious that using the medium of shortwave itself would be the way to get DX news out as swiftly as possible. Yet, until last August, there was no North American station providing such a service! Now, thanks to the cooperation of Radio Canada International, I am providing a weekly report of timely DX news, which unlike most overseas DX programs is compiled only two days before broadcast, *and* welcomes contributions from individual listeners. You're invited to listen to this report on all RCI 30-minute English programs each Sunday, during the "DX Digest" program. There are two different reports in alternating broadcasts. One is in the programs at 1800, 1900 (to Europe), 2130, 0100, and 0300. The other is at 1900 (to Africa), 2000, 0200, and 0400 GMT. Please let RCI know if the report is of value to you. ◇

ENGLISH-LANGUAGE SHORTWAVE BROADCASTS FOR MAR. & APR.

by Richard E. Wood

TO EASTERN NORTH AMERICA

TIME-EST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
6:00-6:25 a.m.	1100-1125	Tirana, Albania	F	9.50, 11.985
6:00-8:00 a.m.	1100-1300	Melbourne, Australia	G	9.58
		London, England	G	5.99 (via Sackville) 6.195 (via Antigua), 15.07
6:00-9:00 a.m.	1100-1400	**VOA, Washington, USA	G	5.955, 6.185, 9.565, 9.73
6:05-7:35 a.m.	1105-1235	Trans-World Radio, Bonaire, N.A.	G	11.815
6:28-9:00 a.m.	1128-1400	**Montreal, Canada (Northern Service)	G	6.065, 9.625 (includes other languages)
7:00-7:30 a.m.	1200-1230	Jerusalem, Israel	G	11.655, 15.415, 17.815
7:00-7:55 a.m.	1200-1255	Peking, China	F	11.685
7:15-7:30 a.m.	1215-1230	Athens, Greece	F	11.73, 15.345, 17.83
		HCJB, Quito, Ecuador	G	11.745
7:30-8:00 a.m.	1230-1300	Stockholm, Sweden	F	15.305
7:30-9:30 a.m.	1230-1430	Trans-World Radio, Bonaire, N.A.	G	15.255 (Sat., Sun.)
7:30-11:30 a.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115
8:00-8:30 a.m.	1300-1330	London, England	G	5.99 (via Sackville), 6.195, 11.775 (both via Antigua), 15.07
		Helsinki, Finland	G	15.105 (Sun. to 1455)
8:15-8:45 a.m.	1315-1345	Berne, Switzerland	G	15.14
9:00-9:30 a.m.	1400-1430	Oslo, Norway	G	15.175 (Sun.)
		Stockholm, Sweden	F	15.305
9:00 a.m.-6:30 p.m.	1400-2330	**Montreal, Canada (Northern Service)	G	9.625, 11.72 (includes other languages)
10:00-11:00 a.m.	1500-1600	London, England	G	9.58 (via Sackville, Sat., Sun.)
10:45-11:00 a.m.	1545-1600	**Montreal, Canada	F	15.325, 17.82
11:00-11:30 a.m.	1600-1630	Oslo, Norway	G	15.175 (Sun.)
11:00 a.m.-12:09 p.m.	1600-1709	London, England	G	9.58 (via Sackville; Sat., Sun. to 1745)
12 noon-3:00 p.m.	1700-2000	**Kuwait, Kuwait	G	12.085
12:05-12:55 p.m.	1705-1755	**Paris, France	G	11.89, 11.93, 15.21, 15.30, 15.33, 15.425, 17.72
1:00-1:30 p.m.	1800-1830	**Montreal, Canada	F	15.26, 17.82
2:00-2:30 p.m.	1900-1930	**Montreal, Canada	F	11.865, 15.26, 15.325, 17.82
2:00-5:00 p.m.	1900-2200	**Jiddah, Saudi Arabia	F	11.855
2:30-3:00 p.m.	1930-2000	**Tehran, Iran	G	9.022 (Time may change after Mar. 20)
2:30-3:30 p.m.	1930-2030	**Baghdad, Iraq	F	9.745
3:00-3:30 p.m.	2000-2030	**Montreal, Canada	F	11.865, 11.945, 15.325, 17.82
		Jerusalem, Israel	G	7.412, 9.425, 9.815

3:00-4:15 p.m.	2000-2115	London, England	G	6.195 (via Antigua), 11.91 (via Montserrat) 15.26 (via Ascension), 15.42 (via Antigua)
3:10-3:50 p.m.	2010-2050	**Havana, Cuba	G	17.885
3:30-4:20 p.m.	2030-2120	**Hilversum, Holland	G	11.73, 15.22 (both via Talata), 17.81, 21.64 (both via Bonaire)
3:50-4:20 p.m.	2050-2120	**Havana, Cuba	G	11.865, 17.75, 17.885
4:00-4:50 p.m.	2100-2150	**Johannesburg, S. Africa	F	5.98, 9.585, 11.90
4:15-5:00 p.m.	2115-2200	London, England	G	5.975, 6.195 (via Antigua), 9.58, 11.75, 11.91 (via Montserrat)
4:30-5:00 p.m.	2130-2200	**Sofia, Bulgaria	G	7.115, 9.53
		**Montreal, Canada	F	11.945, 15.15, 15.325, 17.82
4:30-5:20 p.m.	2130-2220	Hilversum, Holland	G	9.715, 11.73 (exc. Sun.)
5:00-5:15 p.m.	2200-2215	**Belgrade, Yugoslavia	F	6.10, 7.24, 9.62
5:00-5:30 p.m.	2200-2230	Oslo, Norway	F	9.645 (Sun.)
5:00-5:45 p.m.	2200-2245	London, England	G	5.975, 6.195, (via Antigua), 9.58
5:00-6:15 p.m.	2200-2315	**Cairo, Egypt	F	9.805
5:00-7:30 p.m.	2200-0030	Ankara, Turkey	G	9.515, 11.88
5:30-6:00 p.m.	2230-2300	Jerusalem, Israel	G	7.412, 9.435, 9.815, 11.655
5:30-6:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 11.80, 11.90
5:30-8:30 p.m.	2230-0130	Moscow, U.S.S.R.	G	5.94, 7.105, 7.115, 7.13, 7.195, 7.205, 7.44
5:45-6:00 p.m.	2245-2300	London, England	G	5.975, 6.195 (via Antigua), 7.325, 9.58, 11.75
6:00-6:30 p.m.	2300-2330	London, England	G	5.975, 6.175, (via Sackville), 6.195, (via Antigua), 7. 325, 9.51 (via Sackville), 9.58 (via Ascension), 11.75
		Stockholm, Sweden	F	6.045, 6.12, 9.695
		Vilnius, U.S.S.R.	F	5.98, 7.15, 7.215, 7.36, 7.40
6:00-6:55 p.m.	2300-2355	**Buenos Aires, Argentina	G	11.71 (exc. Sat., Sun.)
6:00-7:50 p.m.	2300-0050	Pyongyang, P.D.R. Korea	F	9.977, 11.535
6:00-8:00 p.m.	2300-0100	Montreal, Canada	G	5.96 (exc. Sat., Sun.)
6:30-6:55 p.m.	2330-2355	Helsinki, Finland	P	11.755
6:30-7:30 p.m.	2330-0030	London, England	G	5.975, 6.175 (via Sackville), 7.325, 9.51 (via Sackville), 9.58, (via Ascension), 11.75 (via Montserrat)
6:30 p.m.-1:07 a.m.	2230-0607	**Montreal, Canada (Northern Service)	F	6.195, 9.625 (includes other languages)
6:45-7:45 p.m.	2345-0045	Tokyo, Japan	P	11.705, 15.27
7:00-7:25 p.m.	0000-0025	Tirana, Albania	G	7.065, 9.75
7:00-7:30 p.m.	0000-0030	Oslo, Norway	F	9.645 (Sun.)
7:00-7:55 p.m.	0000-0055	Sofia, Bulgaria	G	9.705
		Peking, China	F	11.945, 15.06, 15.52, 17.86
7:00-9:00 p.m.	0000-0200	**VOA, Washington, USA	G	6.13, 9.64, 11.74, 15.205
7:00-9:45 p.m.	0000-0245	**Luxembourg	F	6.09
7:15-7:30 p.m.	0015-0030	Athens, Greece	F	9.76, 11.73
7:15-8:00 p.m.	0015-0100	Brussels, Belgium	G	6.08 or 9.73
7:30-8:00 p.m.	0030-0100	London, England	G	5.975, 6.175, (via Sackville), 7.325, 9.51 (via Greenville), 9.58 (via Ascension), 11.75 (via Montserrat)
		Stockholm, Sweden	F	6.045, 9.62
		Kiev, U.S.S.R.	G	7.15, 7.215
7:30-8:30 p.m.	0030-0130	**Trans-World Radio, Bonaire, N.A.	G	11.925
7:40 p.m.-12 mdt.	0040-0500	HCJB, Quito, Ecuador	G	9.56, 11.915
8:00-8:15 p.m.	0100-0115	Vatican, City	G	5.995, 9.605, 11.80
8:00-8:20 p.m.	0100-0120	Rome, Italy	G	6.01, 9.575
8:00-8:30 p.m.	0100-0130	Montreal, Canada	G	9.535
8:00-8:45 p.m.	0100-0145	Berlin, Ger. Dem. Rep.	P	9.73
8:00-8:55 p.m.	0100-0155	Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 11.99
		Peking, China	G	7.12, 9.78 (both via Albania) 11.455, 11.945, 12.055, 15.06, 15.52, 17.68
8:00-10:00 p.m.	0100-0300	Melbourne, Australia	F	15.32, 17.795
8:00-10:30 p.m.	0100-0330	London, England	G	5.975, 6.12, (via Antigua), 6.175 (via Sackville), 7.325, 9.51 (via Greenville), 9.58 (via Ascension), 11.75 (via Montserrat)
8:00-11:00 p.m.	0100-0400	Madrid, Spain	G	6.065, 11.88 (exc. Sun.)
8:00-11:50 p.m.	0100-0450	Havana, Cuba	G	11.725, 11.93
8:10-8:30 p.m.	0110-0130	**Santiago, Chile	G	9.566, 11.705, 15.13, 15.15
8:30-8:50 p.m.	0130-0150	Cologne, Ger. Fed. Rep.	G	6.04, (via Antigua), 6.075, 6.085, 6.10 (via Malta), 9.545 (via Montserrat), 9.565 (via Germany and Malta) 9.605, 11.865 (via Malta)
8:30-8:55 p.m.	0130-0155	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
8:30-9:25 p.m.	0130-0225	Bucharest, Romania	F	5.99, 6.19, 9.57, 9.69, 11.77, 11.94
8:30-11:00 p.m.	0130-0400	Moscow, U.S.S.R.	G	6.07, 7.105, 7.115, 7.13, 7.195, 7.205, 7.44

8:45-9:15 p.m.	0145-0215	Berne, Switzerland	G	6.135, 9.70, 9.725, 11.715
9:00-9:25 p.m.	0200-0225	Budapest, Hungary	G	6.00, 9.585, 11.91, 15.255
9:00-9:30 p.m.	0200-0230	Montreal, Canada	G	6.185, 9.535
		Oslo, Norway	F	6.18 (Sun.)
		Warsaw, Poland	P	6.095, 6.135, 7.27, 9.525 11.815, 15.12
9:00-9:55 p.m.	0200-0255	Peking, China	P	11.455, 12.055, 15.06, 17.68
9:00-10:30 p.m.	0200-0330	Cairo, Egypt	G	7.12, 9.475
9:10-9:30 p.m.	0210-0230	**Santiago, Chile	G	9.566, 11.705, 15.13
9:30-9:55 p.m.	0230-0255	Tirana, Albania	G	6.20, 7.30
9:30-10:00 p.m.	0230-0300	Stockholm, Sweden	F	6.045, 9.695
9:30-10:15 p.m.	0230-0315	Berlin, Ger. Dem. Rep.	P	9.73
9:30-10:20 p.m.	0230-0320	Hilversum, Holland	G	6.165, 9.59 (both via Bonaire)
10:00-10:25 p.m.	0300-0325	Budapest, Hungary	G	6.00, 9.585, 11.91, 15.225
10:00-10:30 p.m.	0300-0330	Montreal, Canada	G	5.96, 6.185, 9.535, 9.605
		Warsaw, Poland	P	6.095, 6.135, 7.27, 9.525, 11.815, 15.12
		Lisbon, Portugal	G	6.025, 11.935
		Kiev, U.S.S.R.	G	7.215, 7.36, 7.40
10:00-10:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (both via Albania)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 11.99
10:00-11:00 p.m.	0300-0400	Buenos Aires, Argentina	F	9.69 (Exc. Sat., Sun.)
10:30-10:55 p.m.	0330-0355	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
10:30-11:30 p.m.	0330-0430	London, England	G	5.975, 6.175 (via Antigua)
10:30-11:50 p.m.	0330-0450	Havana, Cuba	G	11.725, 11.76, 11.93
11:00-11:30 p.m.	0400-0430	Montreal, Canada	G	5.96, 9.535
		Budapest, Hungary	F	6.00, 9.585, 11.91, 15.22 (Tues., Fri.)
		Bucharest, Romania	F	5.99, 9.57, 9.69, 11.77, 11.94
11:30 p.m.-12 mdt.	0430-0500	London, England	G	6.175 (via Antigua)
11:50 p.m.-1:00 a.m.	0450-0600	Havana, Cuba	G	11.725, 11.76
12:00 mdt.-12:15 a.m.	0500-0515	Jerusalem, Israel	G	5.90, 7.412, 9.82
12:00 mdt.-1:30 a.m.	0500-0630	London, England	G	6.175, 9.51 (both via Antigua)
12 mdt.-2:00 a.m.	0500-0700	HCJB, Quito, Ecuador	G	6.095, 9.56, 11.915
1:30-2:00 a.m.	0630-0700	London, England	G	6.175 (via Antigua)

TO WESTERN NORTH AMERICA

TIME-PST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
4:00-4:15 a.m.	1200-1215	Tokyo, Japan	P	5.99
4:15-4:30 a.m.	1215-1230	HCJB, Quito, Ecuador	G	11.745
4:30-6:30 a.m.	1230-1430	Trans-World Radio Bonaire, N.A.	G	15.255 (Sat., Sun.)
4:30-8:30 a.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115
5:00-5:30 a.m.	1300-1330	London, England	G	11.775 (via Antigua)
6:00-6:30 a.m.	1400-1430	Tokyo, Japan	G	5.99
7:00-7:15 a.m.	1500-1515	Tokyo, Japan	G	5.99
7:15-7:30 a.m.	1515-1530	Athens, Greece	P	11.73, 15.345, 17.83
8:00-8:15 a.m.	1600-1615	Tokyo, Japan	G	9.505
8:00-8:30 a.m.	1600-1630	Seoul, Rep. Korea	F	9.64
		Oslo, Norway	F	15.175 (Sun.)
9:00-9:15 a.m.	1700-1715	Tokyo, Japan	G	9.505
9:00 a.m.-12 noon	1700-2000	**Kuwait, Kuwait	G	12.085
10:00-10:15 a.m.	1800-1815	Tokyo, Japan	G	9.505
10:00-10:30 a.m.	1800-1830	Seoul, Rep. Korea	F	9.72 (variable)
		Oslo, Norway	F	15.175 (Sun.)
11:00-11:15 a.m.	1900-1915	Tokyo, Japan	G	9.505
12 noon-12:15 p.m.	2000-2015	Tokyo, Japan	F	9.505
12 noon-12:30 p.m.	2000-2030	Jerusalem, Israel	F	7.412, 9.425, 9.815
12 noon-1:15 p.m.	2000-2115	London, England	G	15.26 (via Ascension) 15.42 (via Antigua)
12:10-12:50 p.m.	2010-2050	**Havana, Cuba	G	17.885
12:30-1:20 p.m.	2030-2120	**Hilversum, Holland	G	11.73, 15.22 (both via Talata), 17.81, 21.64 (both via Bonaire)
12:50-1:40 p.m.	2050-2140	**Havana, Cuba	G	11.865, 17.75, 11.885
1:00-1:15 p.m.	2100-2115	Tokyo, Japan	G	15.105
1:40-2:40 p.m.	2140-2240	Taipei, Taiwan	F	9.685, 17.89
2:00-2:15 p.m.	2200-2215	Tokyo, Japan	G	15.105
2:00-4:00 p.m.	2200-2400	**VOA, Washington, USA	G	15.25, 17.82, 17.895, 21.61
2:30-3:00 p.m.	2230-2300	Jerusalem, Israel	G	7.412, 9.435, 9.815, 11.655
2:30-3:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 11.80, 11.90
2:30-4:00 p.m.	2230-2400	Moscow, U.S.S.R.	G	12.05, 15.14, 15.18, 15.455, 17.72
3:00-3:30 p.m.	2300-2330	Tokyo, Japan	G	15.105
		Vilnius, U.S.S.R.	G	11.69, 11.79, 15.00, 15.245, 17.87
3:00-4:30 p.m.	2300-0030	London, England	G	6.175, 9.51 (both via Antigua), 9.58, (via Ascension)
3:00-4:50 p.m.	2300-0050	Pyongyang, P.O.R. Korea	G	9.977, 11.535

4:00-4:15 p.m.	0000-0015	Tokyo, Japan	G	15.105
4:00-4:30 p.m.	0000-0030	Moscow, U.S.S.R.	G	12.05, 15.14, 15.18, 15.455
4:30-5:00 p.m.	0030-0100	Kiev, U.S.S.R.	G	11.69, 11.79, 15.10, 15.18, 17.87
4:30-5:30 p.m.	0030-0130	Moscow, U.S.S.R.	G	9.78, 12.05, 15.14, 15.455
4:30-7:30 p.m.	0030-0330	London, England	G	6.12 (via Antigua), 6.175 (via Sackville), 9.51 (via Greenville), 9.58 (via Ascension)
4:40-9:00 p.m.	0040-0500	HCJB, Quito, Ecuador	G	9.56, 11.915
5:00-5:15 p.m.	0100-0115	Tokyo, Japan	G	15.105
5:00-5:30 p.m.	0100-0130	Montreal, Canada	G	9.535, 11.94
5:00-5:55 p.m.	0100-0155	Peking, China	G	11.375, 11.455, 11.945, 12.055, 15.06, 17.68
5:00-6:00 p.m.	0100-0200	Taipei, Taiwan	F	15.345, 15.425, 17.89
5:00-7:00 p.m.	0100-0300	Melbourne, Australia	G	15.32, 17.795
5:30-6:00 p.m.	0130-0200	Moscow, U.S.S.R.	G	9.78, 11.86, 12.01, 15.14, 15.455
5:30-6:30 p.m.	0130-0230	Tokyo, Japan	G	11.84, 15.195, 15.42, 17.825
6:00-6:15 p.m.	0200-0215	Tokyo, Japan	G	15.105
6:00-6:30 p.m.	0200-0230	Montreal, Canada	G	6.185, 9.535
		Oslo, Norway	P	9.645 (Sun.)
6:00-7:00 p.m.	0200-0300	Moscow, U.S.S.R.	G	9.735, 9.78, 11.86, 12.01, 15.14, 15.455
6:15-6:30 p.m.	0215-0230	Athens, Greece	F	9.76, 11.73
6:30-7:00 p.m.	0230-0300	Stockholm, Sweden	F	6.045, 9.695
7:00-7:15 p.m.	0300-0315	Tokyo, Japan	G	15.105
7:00-7:25 p.m.	0300-0325	Budapest, Hungary	F	6.00, 9.585, 11.91, 15.225
7:00-7:30 p.m.	0300-0330	Montreal, Canada	G	5.96, 6.185, 9.535, 9.605
		Kiev, U.S.S.R.	G	9.58, 9.78, 11.86
7:00-7:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (both via Albania) 11.375, 11.65, 12.055, 15.06, 17.535, 17.65
7:00-8:00 p.m.	0300-0400	Buerno Aires, Argentina	F	9.69 (exc. Sat., Sun.)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 11.99
		Taipei, Taiwan	F	15.345, 17.89
7:10-7:30 p.m.	0310-0330	**Santiago, Chile	G	9.566, 11.705, 15.13
7:25-7:30 p.m.	0325-0330	Erevan, U.S.S.R.	G	9.735, 12.00, 15.18 (Tues., Wed., Fri., Sat.)
7:30-8:15 p.m.	0330-0415	Berlin, Ger. Dem. Rep.	P	5.955, 6.08, 9.73
7:30-8:30 p.m.	0330-0430	London, England	G	6.12, (via Antigua), 6.175 (via Sackville)
		Moscow, U.S.S.R.	G	7.13, 7.175, 7.26, 7.30, 9.54, 9.58, 9.61, 9.735, 9.78
7:30-10:00 p.m.	0330-0600	Havana, Cuba	G	11.76
8:00-8:15 p.m.	0400-0415	Tokyo, Japan	F	15.105
8:00-8:25 p.m.	0400-0425	Budapest, Hungary	P	6.00, 9.585, 11.91, 15.225 (Tues., Fri.)
		Bucharest, Romania	P	5.99, 6.19, 9.57, 9.69, 11.77, 11.94
8:00-8:30 p.m.	0400-0430	Montreal, Canada	G	5.96, 9.535
		Oslo, Norway	P	9.618, 9.645, (Sun.)
8:30-9:00 p.m.	0430-0500	Berne, Switzerland	G	6.045, 9.725
		Vienna, Austria	P	6.015
		London, England	G	6.175 (via Antigua)
8:30-11:30 p.m.	0430-0730	Moscow, U.S.S.R.	G	7.13, 7.175, 7.26, 7.30, 9.54, 9.58, 9.61, 9.735
9:00-9:15 p.m.	0500-0515	Jerusalem, Israel	F	5.90, 7.412, 9.82 (variable)
		Tokyo, Japan	F	9.505
9:00-9:30 p.m.	0500-0530	Lisbon, Portugal	F	6.025, 11.935
9:00-10:30 p.m.	0500-0630	London, England	G	6.175, 9.51, (both via Ascension)
9:00-11:00 p.m.	0500-0700	HCJB, Quito, Ecuador	G	6.095, 9.56, 11.915
9:30-9:50 p.m.	0530-0550	Cologne, Ger. Fed. Rep.	G	5.96 (via Antigua) 6.04 (via Montserrat), 6.10, 6.185, 9.545, 9.59, (via Montserrat)
9:30-10:20 p.m.	0530-0620	Hilversum, Holland	G	6.165, 9.715, (both via Bonaire)
10:00-10:15 p.m.	0600-0615	Tokyo, Japan	G	9.505
10:00-10:30 p.m.	0600-0630	Seoul, Rep. Korea	F	9.64, 9.675, 11.86 (variable)
10:00-11:00 p.m.	0600-0700	Buenos Aires, Argentina	F	9.69 (exc. Sat., Sun.)
10:30-11:30 p.m.	0630-0730	London, England	G	6.175 (via Sackville)
10:30 p.m.-12 mdt.	0630-0800	Havana, Cuba	G	9.525
11:00-11:15 p.m.	0700-0715	Tokyo, Japan	G	9.505
11:30 p.m.-12:20 a.m.	0730-0820	**Hilversum, Holland	G	9.715, 9.77 (both via Bonaire)
12 mdt-12:15 a.m.	0800-0815	Tokyo, Japan	G	9.505
12:30-1:20 a.m.	0830-0920	**Hilversum, Holland	G	9.715, (via Bonaire)
1:00-1:15 a.m.	0900-0915	Tokyo, Japan	G	9.505
2:00-2:30 a.m.	1000-1030	Tokyo, Japan	G	5.99
3:00-3:15 a.m.	1100-1115	Tokyo, Japan	P	5.99
3:00-4:50 a.m.	1100-1250	Pyongyang, P.D.R. Rep. Korea	G	9.977, 11.53

*Reception quality East Coast (West Coast) location G good, F fair, P poor
**Not intended for North America but receivable satisfactorily
Days refer to local date in target area

7400N TTL

Part	Price	Part	Price	Part	Price
SN7400N	.16	SN7472N	.39	SN74160N	1.25
SN7401N	.18	SN7473N	.39	SN74161N	.99
SN7402N	.20	SN7474N	.35	SN74162N	1.95
SN7403N	.20	SN7475N	.50	SN74163N	.99
SN7404N	.20	SN7476N	.35	SN74164N	.99
SN7405N	.20	SN7479N	5.00	SN74165N	.99
SN7406N	.35	SN7480N	.50	SN74166N	1.25
SN7407N	.35	SN7482N	.99	SN74167N	3.25
SN7408N	.20	SN7483N	.70	SN74170N	2.10
SN7409N	.25	SN7485N	.89	SN74172N	6.00
SN7410N	.20	SN7486N	.39	SN74173N	1.50
SN7411N	.30	SN7488N	3.50	SN74174N	1.25
SN7412N	.35	SN7489N	2.49	SN74175N	.99
SN7413N	.69	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.75	SN74177N	.79
SN7416N	.35	SN7492N	.49	SN74179N	2.49
SN7417N	.35	SN7493N	.49	SN74180N	.99
SN7420N	.20	SN7494N	.79	SN74181N	2.49
SN7421N	.39	SN7495N	.79	SN74182N	.95
SN7422N	.49	SN7496N	.79	SN74184N	1.95
SN7423N	.37	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	1.25	SN74186N	15.00
SN7426N	.29	SN74107N	.39	SN74187N	6.00
SN7427N	.37	SN74109N	.95	SN74188N	3.95
SN7429N	.42	SN74116N	1.95	SN74190N	1.79
SN7430N	.25	SN74121N	.39	SN74191N	1.25
SN7432N	.25	SN74122N	.39	SN74192N	.89
SN7437N	.35	SN74123N	.50	SN74193N	.89
SN7438N	.35	SN74125N	.60	SN74194N	1.25
SN7439N	.25	SN74126N	.60	SN74195N	.75
SN7440N	.21	SN74132N	1.25	SN74196N	1.00
SN7441N	.89	SN74136N	.95	SN74197N	1.00
SN7442N	.69	SN74141N	1.15	SN74198N	1.75
SN7443N	.75	SN74142N	2.95	SN74199N	1.75
SN7444N	.75	SN74143N	3.25	SN74200N	5.59
SN7445N	.75	SN74144N	3.00	SN74251N	1.79
SN7446N	.89	SN74145N	1.15	SN74279N	.90
SN7447N	.69	SN74147N	2.35	SN74283N	2.25
SN7448N	.89	SN74148N	2.00	SN74284N	6.00
SN7450N	.25	SN74150N	1.25	SN74285N	6.00
SN7451N	.25	SN74151N	.79	SN74365N	.75
SN7453N	.25	SN74153N	.89	SN74366N	.75
SN7454N	.25	SN74154N	1.25	SN74367N	.75
SN7459A	.25	SN74155N	.89	SN74368N	.75
SN7460N	.25	SN74156N	.89	SN74390N	2.25
SN7470N	.45	SN74157N	.89	SN74393N	2.25

20% Discount for 100 Combined 7400's

CMOS

Part	Price	Part	Price	Part	Price
CD4000	.23	CD4044	.89	CD4520	1.29
CD4001	.23	CD4046	1.79	MC14562	14.50
CD4002	.23	CD4047	2.50	CD4566	2.25
CD4006	1.19	CD4048	1.35	MC14583	3.50
CD4007	.25	CD4049	.49	**74C00 Series**	
CD4009	.49	CD4050	.49	74C00	.39
CD4010	.49	CD4051	1.19	74C02	.55
CD4011	.23	CD4053	1.19	74C04	.75
CD4012	.25	CD4056	1.49	74C10	.65
CD4013	.39	CD4059	9.95	74C14	3.00
CD4014	1.19	CD4060	1.49	74C20	.65
CD4015	1.19	CD4066	.79	74C30	.65
CD4016	.49	CD4068	.39	74C42	2.15
CD4017	1.19	CD4069	.45	74C73	1.50
CD4018	.99	CD4070	.55	74C74	1.15
CD4019	.49	CD4071	.23	74C89	4.00
CD4020	1.19	CD4072	.49	74C90	3.00
CD4021	1.39	CD4076	1.39	74C93	2.00
CD4022	1.19	CD4081	.23	74C95	2.00
CD4023	.23	CD4082	.23	74C107	1.25
CD4024	.79	CD4098	2.49	74C151	2.90
CD4025	.23	MC14409	14.95	74C154	3.00
CD4026	2.25	MC14410	14.95	74C157	2.15
CD4027	.69	MC14411	14.95	74C160	3.25
CD4028	.89	MC14419	4.95	74C161	3.25
CD4029	1.19	MC14506	.75	74C163	3.00
CD4030	.49	MC14507	.99	74C164	3.25
CD4035	.99	CD4508	3.95	74C173	2.60
CD4040	1.19	CD4510	1.39	74C193	2.75
CD4041	1.25	CD4511	1.29	74C195	2.75
CD4042	.99	CD4515	2.95	80C95	1.50
		CD4518	1.29	80C97	1.50

LINEAR

Part	Price	Part	Price	Part	Price
LM300H	.80	LM340T-8	1.25	LM739N	1.19
LM301H	.35	LM340T-12	1.25	LM741CH	.35
LM301CN	.35	LM340T-15	1.25	LM741CN	.35
LM302H	.75	LM340T-18	1.25	LM741-14N	.39
LM304H	1.00	LM340T-24	1.25	LM747H	.79
LM305H	.60	LM350N	1.00	LM747N	.79
LM307CN	.35	LM351CN	.65	LM748H	.39
LM308H	1.00	78MG	1.75	LM748N	.39
LM308CN	1.00	LM370N	1.15	LM1303N	.90
LM309H	1.10	LM373N	3.25	LM1304N	1.19
LM309K	1.25	LM377N	4.00	LM1305N	1.40
LM310CN	1.15	LM380N	1.25	LM1307N	.85
LM311H	.90	LM380CN	.99	LM1310N	2.95
LM311N	.90	LM381N	1.79	LM1351N	1.65
LM317K	7.50	LM382N	1.79	LM1414N	1.75
LM318CN	1.50	NE501K	8.00	LM1458CN	.59
LM319N	1.30	NE510A	6.00	LM1496N	.95
LM320K-5	1.35	NE529A	4.95	LM1556V	1.75
LM320K-5.2	1.35	NE531H	3.00	LM2111N	1.95
LM320K-12	1.35	NE536T	6.00	LM2901N	2.95
LM320K-15	1.35	NE540L	6.00	LM3053	1.50
LM320T-5	1.25	NE550N	1.30	LM3065N	.69
LM320T-5.2	1.25	NE555V	.39	LM3900N(3401)	.49
LM320T-8	1.25	NE560B	5.00	LM3905N	.89
LM320T-12	1.25	NE561B	5.00	LM3909	1.25
LM320T-15	1.25	NE562B	5.00	LM5556N	1.85
LM320T-18	1.25	NE565H	1.75	MC5558V	1.00
LM320T-24	1.25	NE565N	1.25	LM7525N	.90
LM323K-5	5.95	NE566CN	1.75	8038B	4.95
LM324N	1.80	NE567H	1.95	LM75450	.49
LM339N	.99	NE567V	1.49	75451CN	.39
LM340K-5	1.35	LM703CN	.45	75452CN	.39
LM340K-6	1.35	LM709H	.29	75453CN	.39
LM340K-8	1.35	LM709N	.29	75454CN	.39
LM340K-12	1.35	LM710N	.79	75491CN	.79
LM340K-15	1.35	LM711N	.39	75492CN	.89
LM340K-18	1.35	LM723H	.55	75494CN	.89
LM340K-24	1.35	LM723N	.55	RC4194	
LM340T-5	1.25	LM733N	1.00	RC4195	
LM340T-6	1.25				

74LS00 TTL

Part	Price	Part	Price	Part	Price
74LS00	.29	74LS76	.49	74LS155	1.25
74LS02	.29	74LS83	1.75	74LS157	1.50
74LS03	.29	74LS85	2.49	74LS160	1.95
74LS04	.35	74LS86	.49	74LS161	1.95
74LS05	.35	74LS90	.89	74LS162	1.95
74LS08	.29	74LS92	.89	74LS163	1.95
74LS10	.29	74LS93	.89	74LS164	1.95
74LS13	.69	74LS95	1.50	74LS175	1.95
74LS14	1.75	74LS96	1.89	74LS181	3.69
74LS20	.29	74LS107	.59	74LS190	2.49
74LS26	.39	74LS109	.59	74LS191	2.49
74LS27	.39	74LS112	.59	74LS192	2.49
74LS28	.39	74LS123	1.25	74LS193	2.49
74LS30	.29	74LS132	1.25	74LS194	1.89
74LS32	.39	74LS136	.59	74LS195	1.89
74LS40	.39	74LS138	1.25	74LS253	1.75
74LS42	1.25	74LS139	1.25	74LS257	1.75
74LS47	1.25	74LS151	1.25	74LS260	.55
74LS51	.29			74LS279	.79
74LS55	.29			74LS367	.99
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74LS74	.49			74LS670	3.95

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XC111 Orange 4/$1

.200" dia.
XC22 Red 5/$1
XC22 Green 4/$1
XC22 Yellow 4/$1
XC22 Orange 4/$1
SSL-22 RT 4/$1

.185" dia.
XC526 Red 5/$1
XC526 Red 100/$8
XC526 Green 4/$1
XC526 Yellow 4/$1
XC526 Clear 4/$1

.200 dia.
XC556 Red 5/$1
XC556 Red 100/$8
XC556 Green 4/$1
XC556 Yellow 4/$1
XC556 Orange 4/$1
XC556 Clear 7/$1

.085" dia.
MV50 Red 6/$1

INFRA-RED LED 1/4" x 1/4" x 1/16" Flat 5/$1.00

SALE — DISPLAY LEDS — SALE

TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95
MAN 2	5 x 7 Dot Matrix-red	.300	4.95
MAN 3	Common Cathode-red	.125	4/$1
MAN 4	Common Cathode-red	.187	1.95
MAN 52	Common Anode-green	.300	1.00
MAN 71	Common Anode-red	.300	1.25
MAN 72	Common Anode-red	.300	.79
MAN 74	Common Cathode-red	.300	1.50
MAN 81	Common Anode-yellow	.300	.79
MAN 82	Common Anode-yellow	.300	.79
MAN 84	Common Cathode-yellow	.300	.79
MAN 3620	Common Anode-orange	.300	.79
MAN 3630	Common Anode-orange ±1	.300	1.35
MAN 3640	Common Cathode-orange	.300	.79
MAN 4610	Common Anode-orange	.300	.79
MAN 4640	Common Cathode-orange	.400	.79
MAN 4710	Common Anode-red ±1	.400	.79
MAN 4730	Common Anode-red	.400	1.00
MAN 4740	Common Cathode-red	.400	.79
MAN 4810	Common Anode-yellow	.400	1.00
MAN 6610	Common Anode-orange-D.D.	.560	.79
MAN 6630	Common Anode-orange	.560	.79
MAN 6640	Common Cathode-orange-D.D.	.560	.79
MAN 6650	Common Cathode-orange ±1	.560	.79
MAN 6660	Common Anode-orange	.560	.79
MAN 6680	Common Cathode-orange	.560	.79
MAN 6710	Common Anode-red-D.D.	.560	.79
MAN 6730	Common Anode-red	.560	.79
MAN 6740	Common Cathode-red-D.D.	.560	.79
MAN 6750	Common Cathode-red ±1	.560	.79
MAN 6760	Common Anode-red	.560	.79
MAN 6780	Common Cathode-red	.560	.79
DL701	Common Anode-red ±1	.300	1.00
DL702	Common Cathode-red	.300	1.25
DL704	Common Cathode-red	.300	.99
DL707	Common Anode-red	.300	.99
DL741	Common Anode-red	.600	1.49
DL746	Common Anode-red ±1	.630	1.95
DL747	Common Anode-red	.600	1.49
DL749	Common Cathode-red ±1	.630	1.95
DL750	Common Cathode-red	.600	1.49
DL338	Common Cathode-red	.110	3/1.00
FND70	Common Cathode (FND359)	.250	.69
FND503	Common Cathode (FND500)	.500	.99
FND507	Common Anode (FND510)	.500	.99
5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
5082-7304	Overrange character (±1)	.600	15.00
5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

Part	Price	Part	Price
CA3013	2.15	CA3082	2.00
CA3023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3091	3.50
CA3053	1.50	CA3102	2.95
CA3059	3.25	CA3123	2.15
CA3060	3.25	CA3130	1.39
CA3080	.85	CA3140	1.25
CA3081	2.00	CA3401	.49
		CA3600	1.75

EXAR

XR-2206KB Kit $19.95 — XR-2206KA Kit $14.95

WAVEFORM GENERATORS
XR-205 $8.40
XR-2206CP 5.50
XR-2207CP 3.85

STEREO DECODERS
XR-1310CP $3.20
XR-1310EP 3.20
XR-1800P 3.20
XR-2567 2.99

MISCELLANEOUS
XR-2211CP $6.70
XR-4136 2.00
XR-1468 3.85
XR-1488 5.80
XR-1489 4.80
XR-2208 5.20

TIMERS
XR-555CP $.49
XR-320P 1.55
XR-556CP 1.85
XR-2556CP 3.20
XR-2240CP 4.80

PHASE LOCKED LOOPS
XR-210 5.20
XR-215 6.60
XR-567CP 1.95
XR-567CT 1.70

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
8 pin	$.40	.38	.35	22 pin	.95	.85	.75
10 pin	.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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.) **$9.95 ea.**

WIRE-WRAP KIT — WK-2-W
WRAP • STRIP • UNWRAP
- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

$11.95

WIRE WRAP TOOL WSU-30
WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG
25 ft. min. $1.25 — 50 ft. $1.95 — 100 ft. $2.95 — 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30
- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.45 ea.**
- Cuts wire to desired length
- Strips 1" of insulation — **Specify** — Blue-Yellow-White-Red

REPLACEMENT DISPENSER SPOOLS FOR WD 30
Specify blue, yellow, white or red — **$1.98/spool**

Prime Stock Inventory Clearance — STEWART WARNER — Special Offer

P/N	10(min.)	100	1000	P/N	10(min.)	100	1000
SW7401	$1.20/lot	$9.00/lot	$80.00/lot	SW7482	$4.90/lot	44.00/lot	430.00/lot
SW7407	2.20	19.00	180.00	SW7483	3.50	31.00	300.00
SW7416	2.20	19.00	180.00	SW7486	2.20	19.00	180.00
SW7417	2.20	19.00	180.00	SW7491	3.50	31.00	300.00
SW7420	1.30	11.00	100.00	SW7494	3.50	31.00	300.00
SW7423	2.20	19.00	180.00	SW7495	3.50	31.00	300.00
SW7425	1.70	14.00	130.00	SW7496	3.50	31.00	300.00
SW7427	1.50	12.00	110.00	SW74100	6.90	66.00	650.00
SW7430	1.50	12.00	110.00	SW74104	2.20	19.00	180.00
SW7432	1.50	12.00	110.00	SW74105	2.20	19.00	180.00
SW7437	1.50	12.00	110.00	SW74107	2.20	19.00	180.00
SW7438	1.50	12.00	110.00	SW74121	2.20	19.00	180.00
SW7440	1.20	9.00	80.00	SW74123	2.50	22.00	200.00
SW7443	3.50	31.00	300.00	SW74145	5.50	51.00	500.00
SW7444	3.50	31.00	300.00	SW74150	6.90	66.00	650.00
SW7445	3.50	31.00	300.00	SW74151	3.50	31.00	300.00
SW7446	4.00	36.00	350.00	SW74153	4.00	36.00	350.00
SW7450	1.20	9.00	80.00	SW74156	4.00	36.00	350.00
SW7453	1.20	9.00	80.00	SW74180	4.50	41.00	400.00
SW7454	1.20	9.00	80.00	SW74181	9.90	96.00	950.00
SW7460	1.20	9.00	80.00	SW74182	4.50	41.00	400.00
SW7472	2.20	19.00	80.00	SW9601	2.50	22.00	200.00
SW7475	3.50	31.00	300.00	SW9602	4.90	44.00	430.00
SW7480	2.90	26.00	250.00				

Pre-tubed • No mixing or combining prices

TV GAME CHIP SET — $9.95
Includes AY-3-8500-1 Chip and 2.010 mhz crystal
(2.010 crystal — $.99 ea/AY-3-8500-1 Chip — $9.95 ea.)

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
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	2N3638	5/$1.00	PN4250	4/$1.00
MPS A06	5/$1.00	2N3702	5/$1.00	2N4400	4/$1.00
2N918	4/$1.00	2N3704	5/$1.00	2N4401	4/$1.00
2N2219A	3/$1.00	2N3705	5/$1.00	2N4402	4/$1.00
2N2221	4/$1.00	2N3706	5/$1.00	2N4403	4/$1.00
2N2222A	5/$1.00	2N3707	5/$1.00	2N4409	5/$1.00
2N2369	5/$1.00	2N3711	5/$1.00	2N5086	4/$1.00
2N2369A	4/$1.00	2N3724	$.65	2N5087	4/$1.00
2N2484	4/$1.00	2N3725	$1.00	2N5088	4/$1.00
2N2906A	4/$1.00	2N3772	$2.25	2N5089	4/$1.00
2N2907A	5/$1.00	2N3903	5/$1.00	2N5129	5/$1.00
2N2925	5/$1.00	2N3904	4/$1.00	2N5138	5/$1.00
2N3035	2/$1.00	2N3905	4/$1.00	2N5139	5/$1.00
2N3055	$.89	2N3906	4/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N4013	3/$1.00	2N5210	5/$1.00
MJE3055	$1.00	2N4014	3/$1.00	2N5432	$2.00
2N3392	5/$1.00	2N4123	6/$1.00	2N5449	3/$1.00
2N3398	5/$1.00	PN4249	4/$1.00	2N5951	5/$1.00
PN3567	3/$1.00			C106B1SCR	2/$1.00
PN3568	4/$1.00			40409	$1.75
PN3569	4/$1.00			40410	$1.75

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

	1-9	10-49	50-100		1-9	10-49	50-100
.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

	1-9	10-49	50-100		1-9	10-49	50-100
.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	1-9	10-49	50-100	Radial Lead	1-9	10-49	50-100
.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

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax
Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
Dealer Information Available

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James ELECTRONICS

1978 CATALOG NOW AVAILABLE

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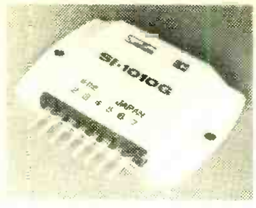
PHONE ORDERS WELCOME — (415) 592-8097
Advertised Prices Good Thru March



SANKEN Series SI-1000G amplifiers are self-contained power hybrid amplifiers designed for Hi-Fi stereo musical instruments public address systems and other audio applications. The amplifiers have quasi-complementary class B output. The circuit employs flip-chip transistors with high reliability and passivated chip power transistors with excellent secondary breakdown strength. Built-in current limiting is provided for SI-1050G and all devices can be operated from a single or split power supply.

SI-1010G (10W output) . . . $ 6.90
SI-1020G (20W output) . . . $13.95
SI-1030G (30W output) . . . $19.00
SI-1050G (50W output) . . . $27.80

Data Sheet with Application Notes $0.50

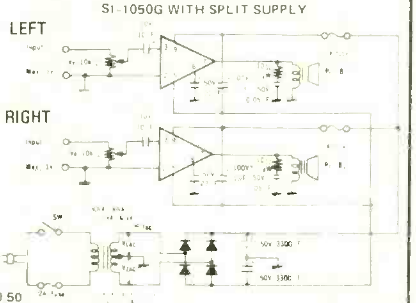
Sanken HYBRID AUDIO POWER AMPLIFIERS

SOCKET FOR SANKEN AUDIO AMPLIFIERS

FOR 10 & 20 W A SI 9 $.95
FOR 30 & 50 W A SI 10 $.95

- Multi-purpose linear amplifiers for comercial and industrial applicacations.
- Less than 0.5% harmonic distortion at full power level.
- 1/2 dB response from 20 to 100,000 Hz
- Single or split (dual) power supply
- Rugged compact and lightweight packages
- Built-in current limiting for SI-1050G and efficient heat radiating construction.

TYPICAL CONNECTIONS
SI-1050G WITH SPLIT SUPPLY



SOROC IQ 120 TERMINAL

FEATURES –

CURSOR CONTROL– Forespace, backspace, up, down, new line, return, home, tab, plus absolute cursor addressing.

TRANSMISSION MODES– Conversation (half and full Duplex) plus block mode–transmit a page at a time.

FIELD PROTECTION– Any part of the display can be "protected" to prevent overtyping. Protected fields are displayed at reduced intensity.

EDITING– Clear screen, typeover, absolute cursor addressing, erase to end of page, erase to end of line and erase to end of field.

DISPLAY FORMAT– 24 lines by 80 characters (1,920).

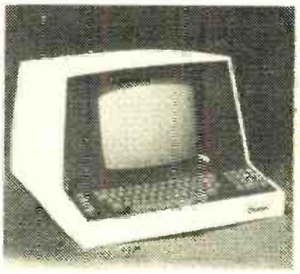
CHARACTER SET– 96 characters total. Upper and lower case ASCII.

KEYBOARD– 73 keys including numeric key pad.

REPEAT KEY– 15 cps repeat action.

DATA RATES– Thumbwheel selectable from 75 to 19,200 baud.

SCREEN– 12 inch rectangular CRT – P4 phosphor.



FULLY ASSEMBLED $995.00

50 VOLT CERAMIC DISC CAPACITORS

$1.00 Per Package

5pf 9/pkg	220pf 8/pkg	.001mfd 9/pkg	.015mfd 8/pkg
15pf 9/pkg	270pf 7 pkg	.0015mfd 9/pkg	.02mfd 8/pkg
25pf 9/pkg	300pf 7/pkg	.0022mfd 9/pkg	.022mfd 8/pkg
27pf 9 pkg	330pf 7 pkg	.003mfd 9/pkg	.03mfd 8/pkg
47pf 8/pkg	390pf 7/pkg	.0047mfd 9/pkg	.039mfd 7/pkg
68pf 8/pkg	470pf 7/pkg	.005mfd 9/pkg	.047mfd 7/pkg
100pf 8/pkg	560pf 7/pkg	.01mfd 9/pkg	.1mfd 6/pkg
150pf 8/pkg	680pf 7/pkg		

PLESSEY POLYESTER MINI-BOX CAPACITORS

$1.25 Per Package

MFD	QTY	MFD	QTY	MFD	QTY	MFD	QTY
.001	8/pkg	.0068	8/pkg	.039	7/pkg	.22	5/pkg
.0012	8/pkg	.0082	8/pkg	.047	7/pkg	.27	4/pkg
.0015	8/pkg	.01	8/pkg	.056	7/pkg	.33	4/pkg
.0018	8/pkg	.012	8/pkg	.068	7/pkg	.39	3/pkg
.0022	8/pkg	.015	7/pkg	.082	7/pkg	.47	3/pkg
.0027	8/pkg	.018	7/pkg	.1	7/pkg	.56	3/pkg
.0033	8/pkg	.022	7/pkg	.12	6/pkg	.68	2/pkg
.0039	8/pkg	.027	7/pkg	.15	6/pkg	.82	2/pkg
.0047	8/pkg	.033	7/pkg	.18	5/pkg	1.0	2/pkg
.0056	8 pkg						

CARBON FILM RESISTORS (5%)

Only in Multiples of 100 pcs per value (ohms)
¼W . . . $1.69 per 100
½W . . . $1.79 per 100

10	100	1.0K	10K	100K	1.0M
11	110	1.1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1.3M
15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1.8M
20	200	2.0K	20K	200K	2.0M
22	220	2.2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2.7K	27K	270K	2.7M
30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3.3M
36	360	3.6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3.9M
43	430	4.3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5.1K	51K	510K	5.1M
56	560	5.6K	56K	560K	5.6M
62	620	6.2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
75	750	7.5K	75K	750K	7.5M
82	820	8.2K	82K	820K	8.2M
91	910	9.1K	91K	910K	10.0M

STANDARD MICROSYSTEMS

DATA COMMUNICATIONS CIRCUITS

COM2017H	UART (High Speed)	$ 9.00
COM2017HP	UART (High Speed)	5.70
COM2017P	UART	5.70
COM2502H	UART (High Speed)	14.20
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COM2502P	UART	8.00
COM2601	USRT	30.00
COM5016	Dual Baud Rate Gen.	13.20
CRT5027	CRT Controller	50.00

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FREQ (MHz)	CASE	P/N	PRICE	FREQ (MHz)	CASE	P/N	PRICE	FREQ (MHz)	CASE	P/N	PRICE
1.00	HC33	CY1A	$9.50	4.9562	HC18	CY6A	$6.00	15.00	HC18	CY15A	$4.75
1.8432	HC33	CD1A	9.50	5.00	HC18	CY7A	6.00	18.00	HC18	CY19A	4.75
2.00	HC33	CY2A	8.25	5.068	HC18	CY5B	6.00	18.432	HC18	CY19B	4.75
2.4576	HC33	CY2B	8.25	5.7143	HC18	CB5C	6.00	19.6608	HC18	CY20A	4.75
3.2768	HC33	CY3B	6.00	6.00	HC18	CY6B	6.00	20.00	HC18	CY22A	5.25
3.579	HC33	CY3D	6.00	6.144	HC18	CY6C	6.00	23.684	HC18	CY23B	5.75
4.00	HC18	CY3A	6.00	8.00	HC18	CY8G	6.00	27.00	HC18	CY27A	8.15
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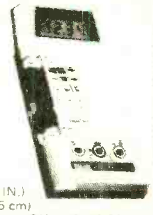

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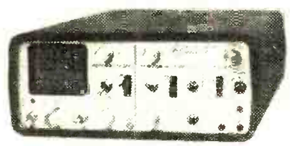
PORTABLE 15 MHz OSCILLOSCOPE



The MS-15 miniscope is only 2.7" x 6.4" x 7.5", and weighs only 3 lbs. Vertical bandwidth is 15 MHz. The graticuled rectangular viewing area is four divisions high by five divisions wide. Division spacing is 0.25 inches. Internal and external triggering, automatic and line synchronization modes, and a horizontal input are provided. There are 12 vertical gain settings from 0.01 V to 50 V per division, and twenty one time base settings from 0.1 μs to 0.5 μs per division. An optional 10 to 1 probe and a carrying case are also available. Power is provided by batteries or the 115 V, 60 Hz line.

MS-15	MINISCOPE	$289.00
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QUALITY PARTS

E-Z Hooks have been designed and field tested through the industry to save time and money in commercial electronic production and servicing. The spring loaded hook attaches firmly, yet so gently it will not damage components and frees hands while testing. Durably constructed and fully insulated to a single contact point assuring true readings. Meets exacting laboratory and space age computer technology requirements. AVAILABLE IN 10 RETMA COLORS. Red, black, blue, green, oragne, yellow, white, violet, brown or gray.

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XM Micro Hook (1.75" long <1 gram) for difficult IC Testing. Permits hookups to delicate wires where weight and leverage may damage component. $.95 ea

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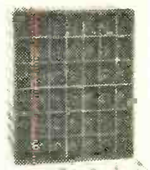

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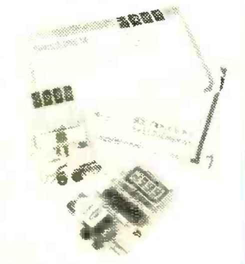

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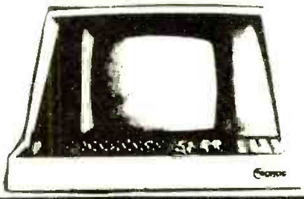

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8238	8 00
8251	12 00
8253	28 00
8255	12 00
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8259	25 00

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21L02	(250)	1 95	1 80	1 50
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2101 1		2 95	2 75	2 60
2102		1 25	1 15	1 00
2102 1		1 50	1 30	1 15
2111 1		4 00	3 50	3.25
2112 1		3 00	2 80	2 69
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MM5270	5 00
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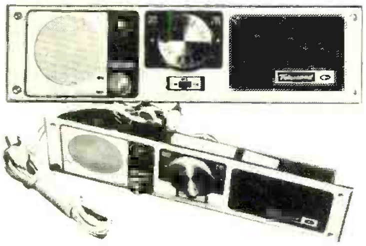

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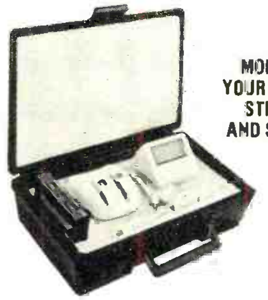

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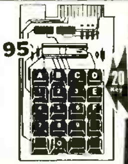

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Outputs standard 7 bit ASCII; interfaces with most data systems. Keyboard pre-assembled onto PC board. 2 key rollover. Electronic shift lock and carriage return. 4 modes: Normal, control, shift, shift/control. Additional functions can be assigned by user. +5, -12VDC, 200 ma. Negative or positive logic, jumper selectable. Exlcusive test feature...7 LED's display the ASCII code. Complete kit, nothing else to buy! Size: 13" x 5 1/2 x 1 1/4". 3 lbs.

- Uses MOS Encoder ROM!
- 7 LED Test Feature!
- 64 key keyboard!
- Encodes 128 ASCII Characters
- Interfaces with ALTAIR, IMSAI, and more!

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Type	Description	Sale
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□ 1103	1K Dyn RAM	1.29
□ 1702A	256 x 8 EPROM	5.95
□ 2102-L1	1K x 1 Lo-power RAM	1.69
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□ 2708	8K EPROM	19.95
□ MK4116	16K Dyn RAM	32.00
□ MK4200P11	4K x 1 Dyn RAM, 350nsec	3.95
□ MM5202	2K PROM	6.95
□ MM5203	2K EPROM	8.95
□ MM5260	1K Dyn RAM	.99
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□ 8212	8 bit I/O port	3.95
□ 8216	Bi-direct bus driver	3.95
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□ 15,000	12	1.50
□ 22,000	75	3.95
□ 24,000	30	2.50
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□ 74LS04	.35	□ 74LS139	1.24
□ 74LS08	.32	□ 74LS151	1.25
□ 74LS10	.32	□ 74LS153	1.25
□ 74LS11	.32	□ 74LS155	1.25
□ 74LS13	.64	□ 74LS160	1.47
□ 74LS20	.32	□ 74LS161	1.47
□ 74LS21	.32	□ 74LS162	1.47
□ 74LS22	.32	□ 74LS163	1.47
□ 74LS27	.39	□ 74LS168	1.68
□ 74LS30	.32	□ 74LS169	1.68
□ 74LS32	.39	□ 74LS173	1.68
□ 74LS37	.45	□ 74LS174	1.05
□ 74LS38	.45	□ 74LS190	1.77
□ 74LS42	1.19	□ 74LS191	1.75
□ 74LS47	.99	□ 74LS192	1.75
□ 74LS74	.49	□ 74LS193	1.75
□ 74LS90	.89	□ 74LS195	1.25
□ 74LS92	.89	□ 74LS197	1.25
□ 74LS93	.89	□ 74LS257	1.35
□ 74LS109	.58	□ 74LS266	.54
□ 74LS112	.58	□ 74LS366	.66
□ 74LS113	.58	□ 74LS368	.69
□ 74LS114	.49	□ 74LS390	2.95

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□ CD4001	.29	□ CD4023	.29
□ CD4002	.29	□ CD4024	.79
□ CD4006	1.19	□ CD4025	.34
□ CD4007	.29	□ CD4027	.69
□ CD4008	.79	□ CD4028	.89
□ CD4009	.59	□ CD4029	1.19
□ CD4010	.59	□ CD4030	.49
□ CD4011	.29	□ CD4033	1.60
□ CD4012	.29	□ CD4035	.99
□ CD4013	.69	□ CD4040	1.19
□ CD4015	1.19	□ CD4041	1.25
□ CD4016	.49	□ CD4042	.88
□ CD4017	1.19	□ CD4046	1.79
□ CD4018	1.19	□ CD4049	.49
□ CD4019	.49	□ CD4066	.79
□ CD4020	.99	□ CD4071	.29
□ CD4021	1.29		

TTL'S

Type	Sale
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□ SN7401	.14
□ SN7402	.17
□ SN7403	.14
□ SN7404	.17
□ SN7405	.18
□ SN7406	.19
□ SN7407	.24
□ SN7408	.18
□ SN7410	.14
□ SN7411	.19
□ SN7413	.39
□ SN7414	.61
□ SN7417	.24
□ SN7420	.14
□ SN7427	.26
□ SN7430	.14
□ SN7432	.24
□ SN7437	.24
□ SN7440	.14
□ SN7441	.79
□ SN7442	.49
□ SN7445	.69
□ SN7446	.79
□ SN7447	.79
□ SN7448	.75
□ SN7450	.14
□ SN7451	.14
□ SN7470	.28

□ SN7472	.26
□ SN7473	.31
□ SN7474	.31
□ SN7475	.48
□ SN7476	.39
□ SN7483	.69
□ SN7485	.88
□ SN7486	.29
□ SN7490	.69
□ SN7492	.45
□ SN7493	.45
□ SN74107	.29
□ SN74121	.31
□ SN74123	.49
□ SN74125	.39
□ SN74132	.83
□ SN74145	.89
□ SN74151	.63
□ SN74153	.63
□ SN74154	.99
□ SN74157	.64
□ SN74161	.87
□ SN74164	.95
□ SN74174	.93
□ SN74175	.88
□ SN74181	1.95
□ SN74190	1.15
□ SN74191	.99
□ SN74192	.83
□ SN74193	.83
□ SN74195	.75
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□ 200	.69	1.19	1.29	1.95
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Ohms
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□ 100
□ 500
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3/8" square, screwdriver shaft. 2% tol. 1/4 watt. Cermet. PC leads. Order by Cat. No. and value.

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□ LM307H, V, N	.25	□ LM380N	1.19
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□ LM309K	1.19	□ LM555V	.44
□ LM311H, V	.79	□ LM558V	.69
□ LM320T-5V	1.19	□ LM565N	.65
□ LM320T-15V	1.19	□ LM567V	1.40
□ LM320K-12V	1.19	□ LM703H	.39
□ LM320K-15V	1.19	□ LM709H, N	.22
□ LM340T-5V	1.19	□ LM710N	.99
□ LM340T-12V	1.19	□ LM723N	.42
□ LM340T-15V	1.19	□ LM741H, V, N	.29
□ LM340K-5V	1.19	□ LM747H, N	.59
□ LM340K-12V	1.19	□ LM1458V	.69
□ LM340K-15V	1.19	□ LM1800N	1.49
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□ 3E3669	3	.88
□ 3E3021	4	.99
□ 3E3670	5	1.19
□ 3E3671	6	1.29
□ 3E2677	7	1.79

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106 pins (53 each side). Use with IMSAI & ALTAIR! 0.125" pin ctrs, goldplated ⅝" wire wrap leads. Open ends, fit wide PC boards. 8 ozs. Cat. No. 3E3987

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□ 3E2379	1N4003	200	10 for .85
□ 3E2380	1N4004	400	10 for .99
□ 3E2381	1N4005	600	10 for 1.29
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1-2-4-8 BCD encoding! Positions labeled 0-7, F, L. (F coded for 8, L coded for 9). White numerals on a black background. Eeco 800 series. 1¼ x 1¼ x ½". Cat. No. 3E3846

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- Chrome handle and knob!

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- Top Quality!
- 3A, 125VAC contacts or better!
- Complete with mounting hardware!

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□ 3E4037	DPDT	1.45
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- 110VAC Primaries

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□	3E3412	12V	300ma	Open frame	$1.95
□	3E4029	12V	1A	Open frame	$2.49
□	3E4028	12V	1A	Metal encased	$2.95
□	3E3323	24VCT	300ma	Open frame	$1.95
□	3E3937	24V	1A	Open frame	$1.95
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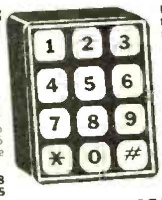
28^{88} □



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- 1000 ohms per volt

1% precision, movements diode protected against burnout. Measures DC volts 0-15-150-1000; AC volts 0-15-150-1000; DC current 0-150ma; resistance X1000. Sensitivity 1000 ohms/volt AC-DC. Uses penlite cell, not included. Size 2⅝ x 3½ x 1⅜". Wt. 5 ozs. Cat. No. 3E3921

$8.88 □

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as low as **17¢** ea.

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7401	.21	7448	1.15	74121	.55
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7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

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74L30	.33	74LS20	.39	74LS174	2.50
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74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.65	74S387	1.95

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

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MC790P	1.50	MC1595L	6.25
MC817P	1.30	MC1723CL	3.60
MC836P	1.35	MC1741CG	1.20
MC844	1.25	MC1810P	1.25
MC853P	2.25	MC3004L	2.25
MC876P	2.25	MC3007P	2.25
MC1004L	1.25	MC3021L	2.15
MC1010L	1.25	MC3060L	2.65
MC1305	1.95	MC3062L	3.00
MC1352P	1.55	MC4024P	2.20
MC1357	1.70	MC4044P	4.80
MC1371	1.85	MC14507CP	1.25
MC1439	2.65	MC14511CP	2.76
MC1458P	.50	MC14512CP	1.70

C MOS

4001AE	.29	4023AE	.29
4002AE	.29	4024AE	1.50
4007AE	.29	4025AE	.35
4010AE	.58	4028AE	1.60
4011AE	.29	4029AE	2.90
4012AE	.29	4030AE	.65
4015AE	1.25	4037AE	4.50
4016AE	.65	4040AE	2.40
4018AE	1.10	4044AE	1.50
4019AE	.65	4049AE	.75
4020AE	1.75	4050AE	.75
4021AE	1.50		

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75451BP	.39	LM307H	.35	LM747	.90
75452BP	.39	LM309K	1.25	LM748H	.45
75453BP	.39	LM311H	.90	LM1458N	.80
75454BP	.39	LM318N	1.50	N5556V	1.50
75491BP	.79	LM339N	1.85	NE5558	1.00
75492BP	.85	LM351AN	.65	NE555V	.60
CA3005	1.60	LM370N	1.25	NE556	1.50
CA3006	3.50	LM380N	1.45	UA702	.80
CA3018	1.10	LM566	2.25	UA703CH	.45
CA3018A	1.60	LM711CH	.60	UA709CH	.30
CA3026	1.50	LM723H	.75	UA749CH	.45
CA3046	.35	LM741CN	.45		

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MM3003 9.45

HALL IC:DN834 1.25 DN837 1.50

DN835 1.35 DN838(NEW)

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LM340K-18	1.95
LM340K-24	1.95
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LM340T0-6	1.75
LM340T0-8	1.75
LM340T0-12	1.75
LM340T0-15	1.75
LM340T0-18	1.75
LM340T0-24	1.75

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¼ Watt ± 5% Packed 5 of any one value .... $.25

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MINIMUM ORDER $5.00

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2.2MF50	Axial Leads	.15	30MF25	Axial Leads	.18
3.3MF10	Axial Leads	.15	47MF25	Radial Leads	.19
3.3MF10	No Polarity	.15	47MF50	Radial Leads	.24
10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
10MF150	Axial Leads	.20	500MF50	Axial Leads	.60
25MF35	Axial Leads	.18	1000MF35	Axial Leads	.65

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C1702A	9.95	2708	34.95	8008	19.95
2101	5.75	C5101-3	4.50	8080A	19.95
2102	1.75	MM5013	3.25	8224	10.45

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Regulated Power Supply Components Kit · Contains the components needed to build a fixed-voltage regulated supply including: 117/17V- 1 ampere Transformer, Bridge Rectifier, 2000 uF Capacitor, and a 1 ampere LM340 3-terminal IC Regulator. Makes a fine "on board" supply or use it for breadboarding. Components only. Specify 5, 6, 8, 12 or 15 volts. **NT525 $4.99**

Pioneer 6" Speaker - 7½-watt, 3.2-ohm speaker made the way speakers should be made. Has heavy-duty treated paper cone, protected magnet housing, and a ceramic terminal strip marked with polarity. A beautiful speaker at half the price you'd expect. **NT526 $2.39 Three for $6.00**

PC Boards - MIL grade, $^1/_{16}$" glass-epoxy boards with 2-ounce copper on one side.
NT521 6"x3" $.50, NT522 6"x6" $.90' NT523 6"x8" $1.20

Dry Transfer Patterns for PC Boards · Includes 0.1" spaced IC pads, donuts, angles, and 3-and 4-connector pads. Over 225 patterns on a 2" x 7¼" sheet. **NT520 $1.49**

3PDT - 24 Volt DC Relay · Potter & Bromfield KUP14D15. Each contact can handle 10 amperes at voltages to 240 Vac. Coil resistance is 450 ohms. A super buy! Limited quantities. **NT508 $.99**

5" Taunt-Band Meter - One milliampere full scale, 3½", scale length. Coil resistance 465 ohms. Made by Modutec for Bose. Meter scale in VUs (-20 to + 30). Meter is designed to be mounted coil up. Complete with "smoke" plastic cover. Over-all $5^1/_8$"x4". Meter face mounts in a $5^1/_8$"x$2^3/_8$" cutout: A beautiful meter. **NT539 $4.89**

Aluminum Knob · Solid machined aluminum knob with fluted sides made for Bose. Black front-face insert, black pointer line. Fits flat ¼" shaft, does not require set screws. .8 high, .7 diam. Easily worth $1.50 **NT540 $.82 2 for $1.50**

BOSE SPEAKERS

Bose has discontinued their original 301 System. New-Tone purchased the speakers remaining in inventory when the 301 was discontinued, and is offering them at prices that seem impossible. The speakers have been tested with the Bose "Tone Standard" as a reference and have been subjected to the Bose power-handling test which includes both fixed and sweep-frequency testing.

8-Inch Woofer (Bose Part No. 102606) has a free-air resonant frequency of 25-35 Hz., and has a 1.5", 8.5-ounce magnet. The upper tested-frequency is 4000 Hz.

3-Inch Tweeter (Bose Part No. 107376) has a free-air resonant frequency of 1200-1500 Hz., and has an upper tested-frequency of 16.5 kHz.

Supplies are limited. We urge you to take advantage of these prices and stock up for your future needs.

Sorry, we have no information about the Bose enclosures or the crossover networks, nor do we have more specs. Bose says these data are proprietary information.

8" Woofer NT541 $10.95

3" Tweeter NT542 $ 3.95

RECTIFIERS

	10 For	100 For
1N4001	.60	5.00
1N4002	.70	6.00
1N4003	.80	7.00
1N4004	.90	8.00
1N4005	1.00	9.00
1N4006	1.10	10.00
1N4007	1.20	11.00

UNIJUNCTIONS

2N2160	.65	MU4892	.50
2N2646	.45	MU4893	.50
2N2647	.55	MU4894	.50
2N4851	.75	2N6027	.55
2N4852	.75	2N6028	.70
2N4870	.50	D5E37	.35
2N4871	.50	MU10	.35
MU4891	.50	MU20	.40

HARDWARE - SOCKETS

Nylon Screws, Nuts and Rivets - 50 piece assortment		$1.99
MK 20 TO-3 Mounting Kit		5 for $.99
NT-505 Mica and bushing. Specify TO-3, TO-66 or TO-220		10 sets for $.99
IC Socket	14-Pin DIL	$.25 each
IC Socket	16-Pin DIL	$.27 each
Wire Wrap	16-Pin DIL	$.32 each

POPULAR JEDEC TYPES

1N34	.25	2N1540	.90	2N2712	.18	2N3394	.17	2N3856	.20	2N4402	.16
1N60	.25	2N1544	.80	2N2894	.40	2N3414	.17	2N3866	1.25	2N4403	.20
1N270	.25	2N1554	1.25	2N2903	3.30	2N3415	.18	2N3903	.16	2N4409	.20
1N914	.10	2N1560	2.80	2N2904	.25	2N3416	.19	2N3904	.16	2N4410	.16
1N4148	.25	2N1605	1.75	2N2904A	.30	2N3417	.20	2N3905	.16	2N4416	.75
1S1555	.35	2N1613	.50	2N2905	.25	2N3442	1.85	2N3906	.16	2N4441	1.00
		2N1711	.50	2N2905A	.30	2N3553	1.50	2N3954A	3.75	2N4442	1.15
2N173	1.75	2N1907	4.10	2N2906	.25	2N3563	.20	2N3955	2.45	2N4443	1.35
2N338A	1.05	2N2102	.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55
2N404	.75	2N2160	.70	2N2907	.25	2N3638	.20	2N3958	1.20	2N5061	.30
2N443	2.50	2N2218	.25	2N2907A	.30	2N3642	.20	2N4037	.60	2N5064	.50
2N508A	.45	2N2218A	.30	2N2913	.75	2N3643	.20	2N4093	.85	2N5130	.20
2N706	.25	2N2219	.25	2N2914	1.20	2N3645	.20	2N4124	.16	2N5133	.15
2N718	.25	2N2219A	.30	2N3019	1.00	2N3646	.14	2N4126	.16	2N5138	.15
2N718A	.30	2N2221	.25	2N3053	.30	2N3731	3.75	2N4141	.20	2N5294	.50
2N918	.60	2N2221A	.30	2N3054	.70	2N3740	1.00	2N4142	.20	2N5296	.50
2N930	.25	2N2222	.25	2N3055	.75	2N3771	1.75	2N4143	.20	2N5306	.20
2N956	.30	2N2222A	.30	2N3227	1.00	2N3772	1.90	2N4220A	.45	2N5400	.40
2N1302	1.25	2N2270	.40	2N3247	3.40	2N3773	3.00	2N4234	.95	2N5401	.50
2N1305	.75	2N2369	.25	2N3250	.50	2N3819	.40	2N4400	.16	2N5457	.35
2N1420	.20	2N2484	.32	2N3393	.20	2N3823	.70	2N4401	.16	2N5458	.30

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7404	276-1802	35¢
7406	276-1821	49¢
7410	276-1807	39¢
7413	276-1815	79¢
7420	276-1809	39¢
7427	276-1823	49¢
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7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
7474	276-1818	49¢
7475	276-1806	79¢
7476	276-1813	59¢
7485	276-1826	1.19
7486	276-1827	49¢
7490	276-1808	79¢
7492	276-1819	69¢
74123	276-1817	99¢
74145	276-1828	1.19
74150	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29

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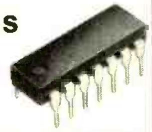

Type	Cat. No.	ONLY
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74C02	276-2302	49¢
74C04	276-2303	49¢
74C08	276-2305	49¢
74C74	276-2310	89¢
74C76	276-2312	89¢
74C90	276-2315	1.49
74C192	276-2321	1.69
74C193	276-2322	1.69
4001	276-2401	49¢
4011	276-2411	49¢
4013	276-2413	89¢
4017	276-2417	1.49
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4050	276-2450	69¢
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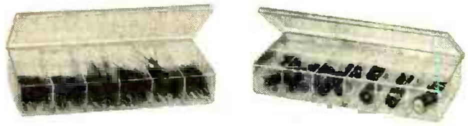
556CN	276-1728	1.39
566CN	276-1724	1.69
567CN	276-1721	1.99
723CN	276-1740	69¢
741CN	276-007	49¢
741H	276-010	49¢
3900N	276-1713	99¢
3909N	276-1705	99¢
3911N	276-1706	1.99
4558CN	276-038	79¢
75491	276-1701	99¢
75492	276-1702	99¢
7805	276-1770	1.29
7812	276-1771	1.29
7815	276-1772	1.29

Resistor and Capacitor Packs



Resistor and capacitor kits in handy plastic storage boxes you can use over and over again. Stock up!

½ Watt, 10% Tolerance Resistors. 271-601 .... **Pkg. of 350/9.95**
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Maximum capacity in smallest size. Low ESR, highly stable electrical characteristics and low leakage. Radial leads.

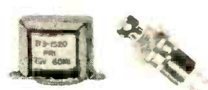
Cat. No.	μF	Each	Cat. No.	μF	Each
272-1401	0.1	39¢	272-1407	2.2	45¢
272-1402	0.22	39¢	272-1408	3.3	45¢
272-1403	0.33	39¢	272-1409	4.7	49¢
272-1404	0.47	39¢	272-1410	6.8	49¢
272-1405	0.68	39¢	272-1411	10.0	49¢
272-1406	1.0	39¢			

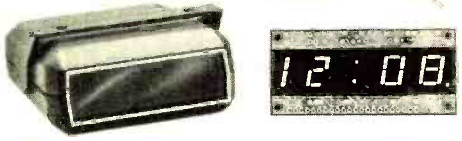
Nos. 1401-1408, 35WVDC; 1409-1411, 16WVDC.

PC Board Accessories

8-piece photographic PC board processing kit — fastest, easiest way to produce perfect printed circuit projects.
276-1560 .... **12.95**
Etch-Resist Marking Pen. 276-1530 .... **1.19**
Etchant Solution. 276-1535 .... **1.89**
PC Board Assortment. 276-1573 .... **1.98**

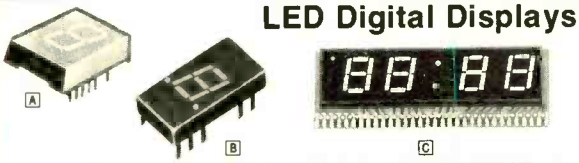
Build an LED Digital Clock





12-HR LED Clock Module. Just add a transformer and switches for a complete clock with 0.5" LED display. **277-1001** **14.95**
Transformer for above. 120VAC 60 Hz. **273-1520** **3.99**
SPST Miniature Pushbutton Switch. 275-1547 .... **5/1.99**
Display Case. $1\frac{13}{16}$x$3\frac{7}{8}$x$4\frac{7}{16}$". **270-285** **3.95**

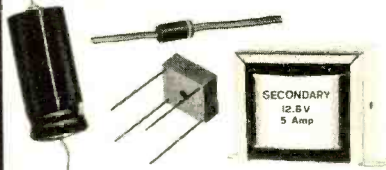
LED Digital Displays



Digits	Size	Drive	Cat. No.	ONLY
A 1	0.6"	Anod.	276-056	2.99
A 1	0.6"	Cath.	276-066	2.99
B 1	0.3"	Anod.	276-053	1.99
B 1	0.3"	Cath.	276-062	1.99

Digits	Size	Drive	Cat. No.	ONLY
B 1	0.3"	Anod.	276-1210	4/6.99
B 1	0.3"	Cath.	276-1211	4/6.99
C 4	0.5"	Anod.	276-1201	6.95
C 4	0.5"	Cath.	276-1202	6.95

Power Supply Parts



6-Amp Full-Wave Bridge Rectifier. 50 PIV.
276-1180 .... **1.99**
50V 3-Amp Power Rectifier. 300-A surge.
276-1141 .... **Pkg. 2/69¢**

Electrolytic Capacitors

3300 μF at 35V. 272-1021 .... **2.99**
5000 μF at 35V. 272-1022 .... **3.49**

Heavy-Duty Transformers. All for 120VAC, 60 Hz.

Cat. No.	Volts	Current	Size	Each
273-1512	25.2 CT	2A	$2\frac{3}{4}$x$2\frac{1}{4}$x2"	4.99
273-1513	12	5A	4x2x$2\frac{1}{2}$"	8.95
273-1514	18 CT	4A	4x2x$2\frac{1}{2}$"	8.95

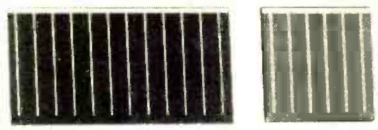
IC Accessories

A **Bus Strip. 276-173** **1.99**
B **Experimenter Socket. 276-172** **9.95**
C **DIP Switch. 275-1301** **1.99**
D **DIP Header. 276-1980** **1.29**
E **Right Angle 16-Pin Socket. 276-1985** **1.49**

F Low-Profile DIP Sockets

Pins	Cat. No.	Price
8	276-1995	2/59¢
14	276-1999	2/89¢
16	276-1998	2/89¢
28	276-1997	Ea. 89¢
40	276-1996	Ea. 99¢

Silicon Solar Cells



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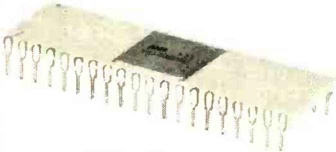
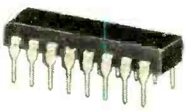
Computer Chips





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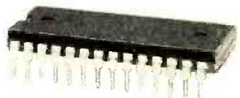
2102 Static RAM. 1024-word by one bit read/write memory. Under 600 nS access time.
276-2501 .... **2.49 Ea. or 8/14.95**

Clock Chips



50252. 12-hour clock, 24-hour alarm chip. With full specifications. **276-1751** **6.99**
7001. 12-hour calendar alarm clock IC. With all data. **276-1756** **10.95**

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- Excellent regulation up to ½ Amp
- Kit includes all components
- Drilled fiberglass P.C. Board
- Case included
- 4400 Mfd of filtering
- One hour assembly

VARIABLE POWER SUPPLY KIT NO. 2

Same as above but with a 1 Amp output, also with case
ONLY $13.95

This model will power a 5 watt transistorized CB Radio

LOOK AT THIS SPECIAL FROM RADIO HUT

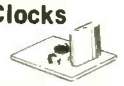
- Power Supply Kit 5V1 amp reg.
- Line regulation .005%
- Load regulation 50mV

Kit includes components PC board, transformer, fuse and pilot light. Line cord not included

Only $6.50

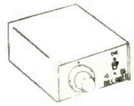
60 Hz. Crystal Time Base for Digital Clocks

$4.50
Buy 2 for $8.



A 60 Hz output with accuracy comparable to a digital watch
B Directly interfaces with all MOS clock chips
C Super low power consumption (1.5 ma type.)
D Uses latest MOS 17 stage divider IC
E Eliminates forever the problem of AC line glitches
F Perfect for cars, boats, campers, or even for portable clocks at ham field days
G Small size, can be used in existing enclosures.
KIT INCLUDES CRYSTAL, DIVIDER IC, P.C. BOARD PLUS ALL NECESSARY PARTS & SPECS

UNSCRAMBLER



$19.95

Plugs into earphone or external speaker of any Scanner or Monitor. Guaranteed to unscramble any 1085 call

- Easily tuned
- Full instruction included
- Drilled fiberglass P.C. Board
- One Hour Assembly
- Punched Case

7400 TTL DIGITAL CIRCUITS

7400	11	7430	13	7480	31	74153	61
7401	13	7432	23	7481	55	74154	98
7402	13	7433	26	7482	57	74155	89
7403	13	7437	23	7483	67	74156	89
7404	15	7438	23	7485	89	74157	55
74L04	29	7440	13	7489	1 25	74160	55
74S04	44	7441	76	7490	65	74161	65
7405	13	7442	47	7491	61	74163	65
7406	16	7443	59	7492	43	74164	85
7407	16	7444	59	7493	43	74165	89
7408	19	7446	68	7494	67	74174	85
7409	19	7447	68	7495	67	74175	85
7410	13	7448	71	7496	67	74180	67
7411	18	7450	13	74100	30	74181	1 93
7412	26	7451	13	74104	49	74182	68
7413	37	7453	13	74107	26	74191	98
7416	15	7454	13	74109	31	74192	79
7420	13	7460	13	74121	29	74193	81
7421	13	7470	27	74123	48	74194	81
7423	25	7472	25	74132	99	74195	69
7425	29	7473	29	74136	99	9316	85
7426	24	7474	29	745138	1 95	9601	3/$1
7427	19	7475	47	74141	75	9L04	35
7428	26	7476	31	74151	61		

74LS00 LOW POWER SCHOTTKY

74LS00	21	74LS47	73	74LS136	37	74LS258	71
74LS02	21	74LS51	26	74LS138	71	74LS260	26
74LS03	21	74LS54	26	74LS139	71	74LS266	26
74LS04	28	74LS55	26	74LS145	1 00	74LS279	55
74LS05	28	74LS73	35	74LS151	70	74LS290	75
74LS08	21	74LS74	35	74LS153	70	74LS293	61
74LS09	28	74LS76	49	74LS155	69	74LS295	95
74LS10	21	74LS83	73	74LS156	70	74LS298	95
74LS11	21	74LS85	1 35	74LS157	75	74LS365	55
74LS13	45	74LS86	36	74LS158	71	74LS366	55
74LS14	99	74LS90	55	74LS160	85	74LS367	55
74LS15	26	74LS92	55	74LS161	85	74LS368	55
74LS20	24	74LS93	55	74LS162	85	74LS390	1 75
74LS21	28	74LS109	38	74LS163	85	74LS393	1 45
74LS22	28	74LS112	38	74LS164	1.49	74LS670	2 30
74LS26	32	74LS113	38	74LS168	85	74LS192	95
74LS27	32	74LS114	38	74LS169	85	74LS193	95
74LS30	26	74LS122	49	74LS170	1.69	74LS194	95
74LS32	32	74LS124	99	74LS173	1 10	74LS195	85
74LS37	32	74LS125	47	74LS174	1.00	74LS196	85
74LS38	32	74LS126	47	74LS175	81	74LS197	85
74LS40	26	74LS132	79	74LS190	95	74LS251	85
74LS42	65	74LS133	35	74LS191	95	74LS253	81
						74LS257	71

74H SERIES TTL

74H00	18	74H21	29	74H53	29	74H73	39
74H05	29	74H40	29	74H61	25	74H74	39
74H20	29	74H50	20	74H72	45		

CMOS

CD400	19	CD4017	95	CD4040	1 00	CD4071	19
CD4001	19	CD4018	95	CD4041	69	CD4081	19
CD4002	19	CD4019	19	CD4042	69	CD4507	35
CD4006	1 20	CD4020	97	CD4043	60	CD4508	2.80
CD4007	19	CD4021	97	CD4044	60	CD4510	1 00
CD4009	47	CD4022	97	CD4046	1 39	CD4512	1 10
CD4010	39	CD4023	19	CD4047	1 50	CD4516	79
CD4011	19	CD4024	75	CD4049	35	CD4518	1 10
CD4012	.29	CD4025	.19	CD4050	39	CD4520	69
CD4013	32	CD4027	.39	CD4051	1 19	CD4528	85
CD4014	.78	CD4028	.85	CD4053	1.19	74C02	45
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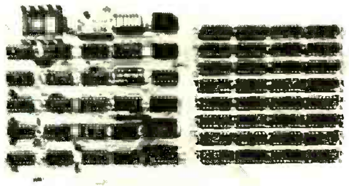

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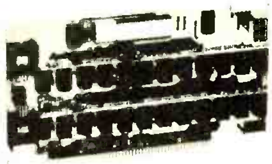

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Scanfax Systems duplicator Model 200, serial #200-000074. Any information needed. Rev. R.A. Elrod, Outreach Ministry, 800 Dunbar Rd., Fall, OH 44278.

I.T.T. instrument type PL-2 time base from precision X-Y display. Schematic, manual or manufacturer. Bob Ettare, 645 W. Garland Ter., Sunnyvale, CA 94086.

Wards Airline Model 62-256 AM/SW. Need schematic. David Warren, 117 Royal Crest, Los Alamos, NM 87544.

JBL SG 520 preamplifier, JBL SE 400S power amplifier. Service manuals. Jacob Landy, 111 Gardenia La., Hicksville, NY 11801.

Simpson oscilloscope Model #476. Schematic and operating manual. M. Riordan, 109 Cayuga St., San Francisco, CA 94112.

R.C.A. tube tester #156. Schematic diagram. David R. Ellis 138-C Welsh Dr., Lancaster, PA 17601.

Collins 75A4 receiver. Instruction manual and schematics. Allen Vinegar, 160 St.-Paul St., Brookline, MA 02146.

Precision Model E-450 dot and bar color generator. Instruction manual and schematic. McKay Bradley, 2324 N. Powhattan St., Arlington, VA 22205.

Hammarlund HX-500 transmitter. Alignment instructions. Warren Curry, Cabery P.O., Stelle, IL 60919.

(continued on page 118)

OPERATION ASSIST

(continued from page 117)

Hickok Model 288X signal generator. Schematic and/or operation manual needed. Guy Edwards, 104 Hancock St., San Francisco, CA 94114.

Silvertone stereo amplifier 528-69682. Schematic. T.L. Pettit, 113 Skyline Dr., Fairlea, WV 24902.

Precision Model 98VTVM. **Tektronix** 512 oscilloscope. Schematics. Don Maeyer. 12696 Greenhall Dr., Woodbridge, VA 22192.

Wurlitzer Model 4100 tube-type electronic organ. Need schematic. Also need source of tubes for radar module tube type 1B27. Neil A. Bensen, 8130 Pt. Douglas Dr., South #104, Cottage Grove, MN 55016.

Hickok Model 288X signal generator. **Supreme** Model 504 tube tester. Schematics and manuals. Arthur Gillman, 14 Pine St., Princeton, NJ 08540.

Shakard stereo cassette deck, solid-state, Model SCD-77X. Schematic needed. J. Beder, 95 East Wayne 101, Silver Spring, MD 20901.

Gonset "Super 12", 12-volt SW to BC converter, 12 volts input. Schematic, parts list, and data. Sam Thomas, 5901 SW 50th Ter., Miami, FL 33155.

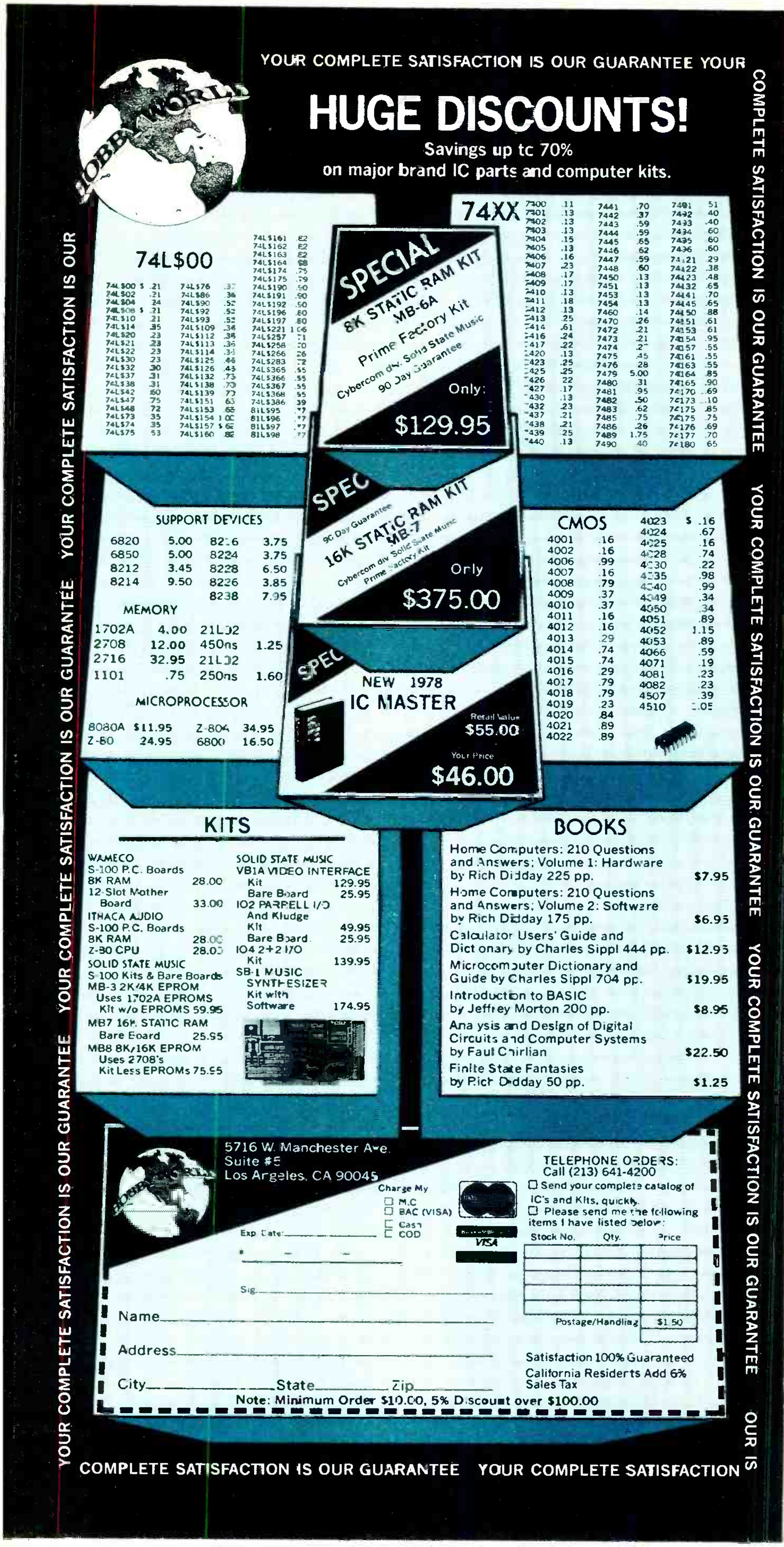
RCA military receiver, type R-978/GKA-5. Manual, schematic, crystals. Tom Sanor, 4940 Bedell Road, Roswell, GA 30075.

Hallicrafters S-53A receiver. Instruction manual. Michael McLaughlin, 15 W. Durham Street, Philadelphia, PA 19119.

Analab, dual-trace oscilloscope, type 1120. Require schematic. John Soha, 212 Courtright St., Pringle, PA 18704.

Bendix high-band FM transceiver. Model #1V14C. Schematic, operating manual or any other information. Lucille Moody, 8618 S. Jeffrey, Chicago, IL 60617.

(continued on page 120)



OPERATION ASSIST

(continued from page 118)

Hallicrafters Model SX 28 Super Skyraider. Schematic, operators manual or other information. John Basile, 204 South 9th Ave., Hopewell, VA 23860.

General Electric sweep generator ST-4A and marker generator ST-5A. Schematics, operating manuals. Richard Roggeveen, 5569 Dunsburry Ct., San Jose, CA 95123.

Hammarlund HQ-145 receiver. Schematic and/or service manual needed. Stanton Martin, 1950 Vauxhall Rd., Union, NJ 07083.

Hallicrafters Model S106 50-54 MHz receiver. Schematic and manual. Robert H. Clark, 709 Chrysler Ave., Newark, DE 19711.

Hammarlund HQ-110-C. Need operation manual. Douglas Deeds, 117 Meadow Ln., Marietta, OH 45750.

Johnson Viking Pacemaker transmitter. Manual, schematic or any information. Joe Planisky, WB8WTR, 13690 Diagonal Rd., Salem, OH 44460.

Air Castle 8-band receiver. Owner's manual and manufacturer's address. Scott Fletcher, Star Route Box 23, Lonsdale, AR 72087.

Estey Electronics Company, ORCOA Concert Electronic Organ, Model 552, serial 1815. Schematics alignment and service information. Richard D. Taft, 76 Alexander Ave., Parsippany, NJ 07054.

Hallicrafters SX-140 receiver and HT-40 transmitter. Instruction manual and schematics for both. David Hingst, Star Route Box 80430, 1/10 Mile Lyle Rd., Fairbanks, AK 99701.

Precision Apparatus Co., series 10-54 tube and set tester. Operating instructions, schematic. Martin A. Weinger, 16 Judith Ln., Monsey, NY 10952.

Heath TC-2 tube checker. Need operating manual. Blosser Diversified Industries, Box 21, Placentia, CA 92670.

Zenith Model #H500 trans-oceanic receiver. Instruction book, service notes, schematics, and parts source. C.L. Brown Jr., 2409 Bon Air Dr., Savannah, GA 31406.

Home Fuel Computer Model KI-1000. Schematics, parts list, and installation instructions. Joe M. Brignola, Box 267, New Haven, CT 06502.

International Crystal CB Model 750 or 750-H with remote control. Schematic and maintenance manual. H.N. Marble, 4529 Mokry Dr., Corpus Christi, TX 78415.

Lear Jet Model P-570 stereo 8-track. Schematic and parts list. Jim Kotarski, 571 Charles St., Luzerne, PA 18709.

Webcor Model 21-10 mono tape recorder. Schematic and/or service manual or any available information. Hansen Recording Service, 50 Enfield St., Enfield, CT 06082.

Zenith Model 6S152 AM/shortwave receiver. Schematic and wooden knob for sensitivity control. Paul Wojeik, 207 N. 18th St., Barrington, IL 60010.

Knight T-60 transmitter. Schematic and operation instructions. Grover E. Moates, Star Route, Box 24, Leonardtown, MD 20650.

Fisher Model X-101-B stereo amplifier. Schematic, operation manual and any other information. Also need power transformer. Dan Mahoney, 146 Sioux Ave., Civille, IL 60110.

Scott Radio Laboratories Marine Radio, Model SLRM. Schematic or service manual. W. Maciejewski, 1901 Croftdale, Florissant, MO 63031.

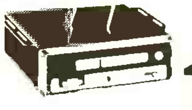
Teac TD-105 deck and AR-7E R/P preamps. Service manual. W.A. Edgecomb, 8324½ Kelvin Ave., Canoga Park, CA 91306.

Tektronix type 545 oscilloscope. Operation handbook. Ben Goble, 1980 Dris St., Lakewood, CO 80215.

Paco speed check tube tester model T-61. Current operating instructions. Nana Sam, 1424 W. 105th Pl., Chicago, IL 60643.

Sears Tower 6157 Geiger counter. Schematics and service manual. James Hudson, 1826 Elmwood Ln., Bettendorf, IA 52722.

Minshall organ, model E series. Schematic and manual. Ron Broadnax, Route 3, Box 117, Eden, NC 27288.



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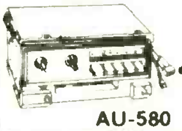

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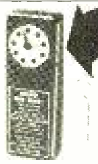

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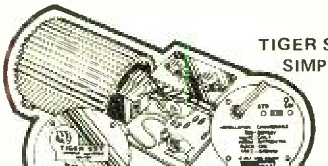

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EMPLOYMENT OPPORTUNITIES

ELECTRONICS/AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details FREE. Aviation Employment Information Service. Box 240E, Northport, New York 11768.

DO-IT-YOURSELF

MODULAR TELEPHONES now available. Sets and components, compatible with Western Electric concept. Catalog 50 cents. Box 1147W, San Diego, California 92112.

TAPE-SLIDE SYNCHRONIZER, lap-dissolve, multiprojector audiovisual plans $8.50. Free Catalog. Millers, 1896 Maywood, South Euclid, OH 44121.

REAL ESTATE

BIG...FREE...CATALOG! Over 2,500 top values coast to coast! UNITED FARM AGENCY, 612-EP, West 47th, Kansas City, MO 64112.

SERVICES

PRINTED CIRCUIT BOARD SERVICE. Design, Schematics, Tape Ups. Photography. Prototypes. Production. Project Boards. We sell material or build boards. Kraemer Gallery, 982 North Batavia. Orange, Calif. 92667.

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RUBBER STAMPS, BUSINESS CARDS. Many new products. Catalog. Jackson's, Dept. K, Brownsville Rd., Mt. Vernon, Ill. 62864.

MAGNETS

MAGNETS. All types. Specials-20 disc, or 10 bar, or 2 stick or 8 assorted magnets. $1.00 Magnets, Box 192-H Randallstown, Maryland 21133

BOOKS AND MAGAZINES

FREE book prophet Elijah coming before Christ. Wonderful bible evidence. Megiddo Mission. Dept. 64, 481 Thurston Rd., Rochester, N.Y. 14619.

POPULAR ELECTRONICS INDEXES For 1976 now available. Prepared in cooperation with the Editors of "P/E," this index contains hundreds of references to product tests, construction projects, circuit tips and theory and is an essential companion to your magazine collection. 1976 Edition, $1.50 per copy. All editions from 1972 onward still available at the same price. Add $.25 per order for postage and handling, $.50 per copy, foreign orders. INDEX, Box 2228, Falls Church, Va. 22042.

HOME ENTERTAINMENT FILMS

JUST OUT! 1976 World Series S-8/Snd 400' Eastman Color $46.95 ea sale price + $0.75 ship. "Grt Moments in Baseball" (memories galore) 400' S-8 B&W/Snd $36.95 ea sale price + $0.75 shipping. "Star Wars" 200' vivid color/sd $29.95 ea PPD. "Jesus Christ Superstar." legendary rock, 400' Color/Mag Snd, $44.95 ea sale price PPD. March BUDGET Specials. 1969 & 1970 Indy "500" Race Films, ea 200' St 8 color, only $12.95 ea + $0.75 shipping. "Miracle at Oakmont" (U.S. Open) 200' St 8 color (Johnny Miller) only $12.95 ea (save $7.00 per reel!) 54-page Columbia Pictures catalog, $0.85. New Universal 64-pg 4-color catalog, $0.95; Sportlite & Universal film lists, $0.35 ea. SPORTLITE FILMS, Elect-3/78, Box 24-500, Speedway, Indiana 46224.

ALTERNATE ENERGY

INDEPENDENT THINKER: You can become an Alternate Energy Systems Designer. Prestigious New Field Information Package $2.00. Energy Division, Valmont Enterprises, Box 186, Boone, North Carolina 28607.

SOLAR INTERMEDIATE AIR HEAT. Simple. Efficient — For New or Existing Structures. Information Package $2.00. Energy Division, Valmont Enterprises, Box 186, Boone, North Carolina 28607.

REPAIRS AND SERVICES

SERVICEMEN — Cleaners, Lubricants, Adhesives for all electronic repairs. Write for FREE catalog. Projector-Recorder Belt Corp., Box 176, Whitewater, WI 53190. 800-558-9572 except WI.

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KRIS BIG BOOMERS & others. Manuals, Parts, Repairs. Free information. G.P.E., P.O. Box 216PE, Watertown, WI 53094.

HYPNOTISM

SLEEP learning. Hypnotic method. 92% effective. Details free. ASR Foundation, Box 23429EG, Fort Lauderdale, Florida 33307.

FREE Hypnotism Self-Hypnosis, Sleep Learning Catalog! Drawer H400, Ruidoso, New Mexico 88345.

AMAZING self-hypnosis record releases fantastic mental power. Instant results! Free trial. Write, Forum (AA3), 333 North Michigan, Chicago 60601.

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FIND LOST coins, jewelry, gold, silver, relics! Find buried treasures of all sizes, but eliminate metal trash. Free information. GOLD MOUNTAIN, Box 40507-Y, Garland, TX 75040.

MISCELLANEOUS

MPG INCREASED! Bypass Pollution Devices easily REVERSIBLY!! Free details—Posco GEE3, 453 W. 256, NYC 10471.

MAGI. Now produce REAL smoke from fingertips. Amazing effect. Pro method merely $1.00. Manderson, B 788, Dept. B1, Sutton W., Ontario, Canada LOE 1RO. U.S. Inquiries Welcomed.

1978 Electronic Experimenter's Handbook

This latest edition includes a Hobbyist and Microcomputer Section! It also features a host of exciting construction projects with complete construction plans, parts lists and printed-circuit board patterns. PLUS —A complete Home Computer Buying Directory with product specifications, latest prices, and photos. Only $1.95 !

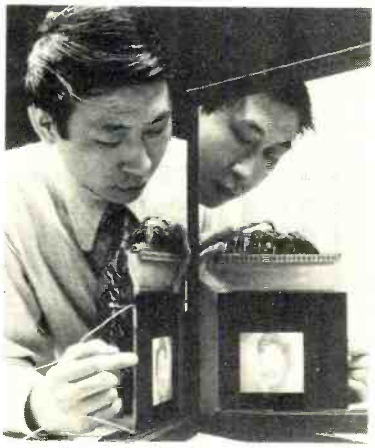
Order your copy from ELECTRONIC EXPERIMENTER'S HANDBOOK, P.O. Box 278, Pratt Station, Brooklyn, New York 11205. Enclose $2.50* ($1.95 plus 55¢ postage and handling). Outside U.S.A. $3.

*Residents of CA, CO, FL, IL, MI, MO, NY STATE, DC and TX add applicable sales tax (Postage and handling charges non-taxable).

ELECTRONICS WORLD® News Highlights in Brief

Picture-Thin TV Screen

You may be able to hang a TV screen on your wall in the near future if a lab-demonstrated device is developed further for the public. Real-time video on a thin-film transistorized electroluminescent (EL) panel that's no thicker than ordinary window glass has already been demonstrated at the Westinghouse Research Laboratories in Pittsburgh, PA. When first announced in October 1974, the 1/8-inch-thick display panel was primarily for digital alphanumeric use. The present panel, taking advantage of the EL's grey-tone operation capability, accepts signals directly from taped-video or commercial TV signals, producing excellent contrast with no flicker. The panel itself is actually an enormous integrated circuit, measuring six inches square, with 12,000 glowing picture elements. The elements are phosphor dots that light up when electricity passes through them, similar to those on the inside face of a TV picture tube.



Music Synthesizers for Rent

Professional electronic synthesizers are available for rent at $3.00 per hour at PASS (Public Access Synthesizer Studio, 135 W. Broadway, New York, NY 10013; Tel: 212-964-9891). They have put together ElectroComp and Electron Farm/CBS Buchla Series 100 synthesizers with accessory equipment including tape decks and electric pianos. A staff member and an electronic music tape library are also available for consultation.

Pulse Width Modulation

A device developed by a medical engineering team at the Hadassah Medical Center, Jerusalem, is said to introduce a new dimension to the control of pain in various parts of the body through transcutaneous nerve stimulation (TNS). Marketed by Agar Electronics, Ltd., of Israel, the portable, battery-operated therapeutic instrument weighs just 7 oz (200 g). In using the device, two vulcanized rubber electrodes are applied to affected parts of the body so that modulation pulses work on the blood flow and provide therapy to the muscle levels. The unit ($200 retail) operates on a fixed frequency so that no human variables are involved and it is said to give effective pain relief to areas of the back, elbows, knees, etc. Something like "electronic acupuncture?"

TV Servicing Cost Survey

According to a Connecticut-based TV service association (TELSA) survey, residents in Bridgeport, CT, pay an average of $19.00 for a color TV home service call, $64.55 for bench repair of a tube receiver with pickup and delivery, and $101.20 for solid-state color receivers (with PU), $42.10 for bench repair of color TV with customer carry-in, and an hourly bench rate for color TV of $21.45. Most other areas in Connecticut have service charges that are slightly lower, the exception being repair of solid-state color TV, which is dramatically lower ($55.40 in Hartford, for example).

Robot Guard

"Century I" is the name of a 7-ft, 650-lb bulletproof, computerized robot designed by Quasar Industries Inc. to be used as a security guard by the United States Army. Sensors in the robot can detect movement, body heat, or any noise caused by an intruder. Electronic circuits then cause the robot to "lock onto" the subject and follow it, issuing aural instructions to stop when the robot is about 8 feet from the intruder. If disobeyed, the robot is prepared to take measures to stop the intruder, such as emitting a high-frequency sound that causes extreme pain in the inner ear, a strobe light that temporarily blinds the intruder, etc. So far, there are no plans to equip the robot with lethal restraints. The Century I can roll along at 20 miles an hour in pursuit of an intruder.

Automatic Digital Audio Processor

A computer-based processor that eliminates unwanted noises from audio signals and recordings in real time has been developed by Rockwell International Corp. The Automatic Digital Audio Processor can be used either to "clean" an audio signal as it is being received or to enhance a recording already made. It can remove from 40 to 50 dB of highly correlated noise with what is said to be virtually no degradation in the desired voice signal. It removes two types of noise from voice tracks: additive sounds, generally music, traffic, or other background noises; and convolutional sounds such as resonances, room acoustics, or noises inherent in equipment.

Coast Guard Will Monitor CB

The U.S. Coast Guard recently announced that it will begin installing Citizens Band radio equipment at its Search and Rescue (SAR) stations throughout the United States in an effort to improve its communication link with the thousands of small-boat owners. A decision regarding which channel the Coast Guard will monitor has not been made at the time of this writing, but the CG intends to have Citizens Band service available in time for the 1978 recreational boating season. The CG noted that, "The current national maritime communication and distress system associated with vhf and 2182 kHz will continue to be the primary system."

$24.95 PROBE?

You bet! Meet CSC's Multi-family Logic Probe 2.

Wherever you need fast, safe, accurate digital testing—you need CSC's new LP-2. It's a compact, enormously versatile circuit-powered unit that's become indispensable. As a level detector. Pulse detector. And pulse stretcher.

Easier to use. Set LP-2's switch to the proper logic family, connect two clip-leads to the circuit's supply, touch the probe to the node under test—and you get an instant picture of circuit conditions. Separate LED's indicate logic "1", logic "0", and all pulse transitions. And a 300K-plus input impedance insures minimum circuit loading.

At just $24.95*, you don't have to think twice about owning the LP-2. Especially when you see how it simplifies testing, debugging and servicing all types of digital circuits.

Order today. Call 203-624-3103 (East Coast) or 415-421-8872 (West Coast): 9 a.m.-5 p.m. local time. Major credit cards accepted. Or see your CSC dealer. Prices slightly higher outside USA.

Logic Family Switch—TTL/DTL or CMOS matches Logic "1" and "0" levels for greater versatility. CMOS position also compatible with HTL, HiNIL and MOS logic.

PULSE LED—Indicates positive and negative pulse *and* level transitions. Stretches pulses as narrow as 300 nanoseconds to full 1/10 sec. (10Hz pulse rate).

HI/LO LED's—Display level (HI-logic "1", LO-logic "0") of signal activity.

Interchangeable ground lead connection—Provides ground-side input connection via optional cables.

Interchangeable probe tips—Straight tip supplied; optional alligator clip and insulated quick-connecting clip available.

Plug-in leads—24" supplied, with alligator clips. Virtually any length leads may be connected.

Specifications

Input impedance better than 300KΩ

Thresholds (switch selectable)	**DTL/TTL**	**HTL/CMOS**
logic 1 thresholds (HI-LED)	2.25V ± .10V	70% Vcc ± 10%
logic 0 thresholds (LO-LED)	0.80V ± .05V	30% Vcc ± 10%

Min. detectable pulse width 300nsec.

Pulse detector (PULSE LED) 1/10-sec. pulse stretcher makes high-speed pulse train or single events (+ or − transitions) visible

Input protection overload, ± 25V continuous; 117 VAC for less than 10 sec.; reverse-polarity, 50V

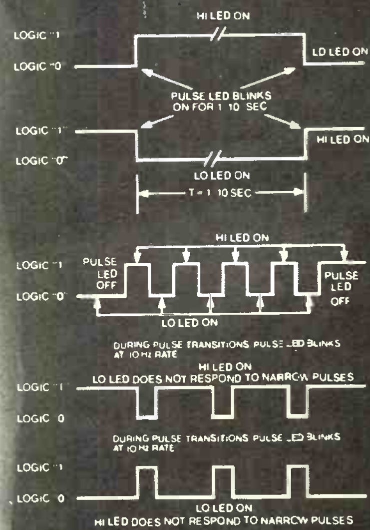
Power requirements 5-15 volts Vcc; 30mA max.

Operating temperature 0-50°C

Physical size (l x w x d) 5.8 x 1.0 x 0.7" (147 x 25.4 x 17.8mm)

Weight 3oz. (.085Kg)

Power leads detachable 24" (610 mm) with color-coded insulated clips; others available



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