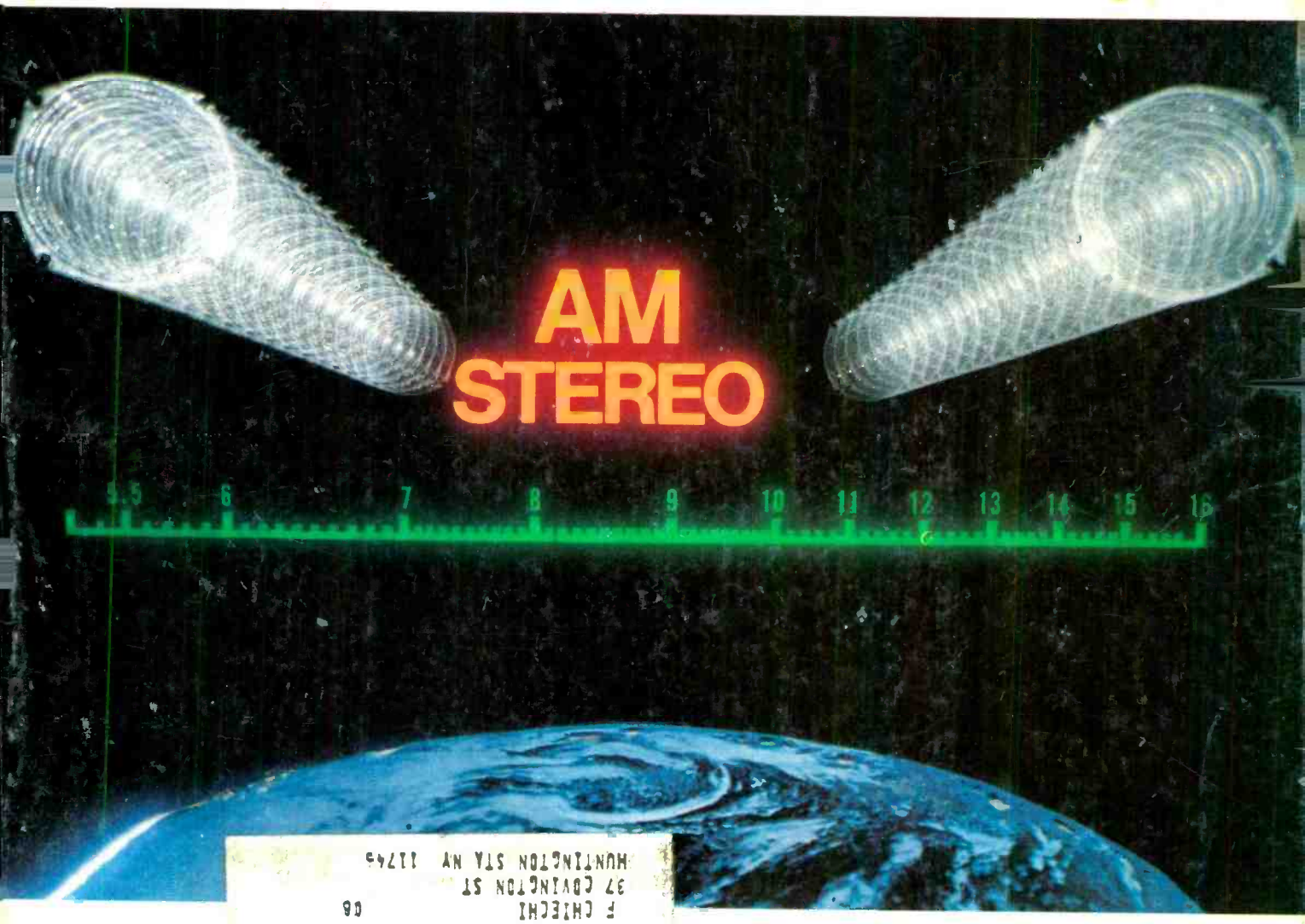
Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

AUGUST 1980/95¢

- Electronic Controller For Windshield Wiper
- A Low-Cost Analog-to-Digital Converter
- Latest High-Tech Communications Gear

AM Stereo Is Coming Your Way!



...tiss Tests
Zenith's 1981 Color
TV Chassis

The man, the lig

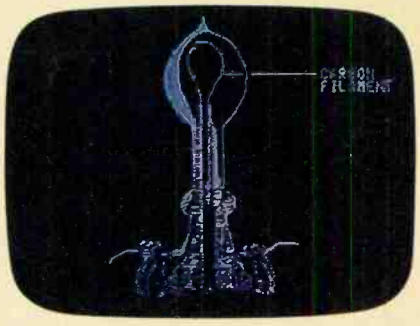
ht and the Apple.

If you could talk to Thomas Edison, he'd tell you what it was like to turn the lights on in 1879. You could tell him about some bright ideas of the 20th century... particularly, a technological phenomenon that can handle everything from solar heat control to lighting your home via voice command. The Apple personal computer.

Expand your own inventiveness with the always-expandable Apple.

Take a look inside your local computer store. There's a range of Apple systems for you... whether you want expansion capabilities of four or eight accessory slots... or memory expandable to 64K bytes or 128K bytes. With this kind of flexibility, the possibilities for creating your own computer system are endless.

Want to add an A to D conversion board? Apple makes it happen. Want to plug into time sharing, news and electronic mail services? Apple does it all. Because Apple is the most popular personal computer with the least complicated interface, over 100 companies supply peripherals for the Apple family... including an IEEE 488 bus for instant control.



With Apple, Edison could've written a program to determine why some filaments burned longer than others.

Disk drives, a tool kit and creativity in color.

Apple was one of the first to use disk drives for increased performance and application versatility. Today, our 5¼" disk drive offers high density (143K bytes), high speed and low cost. No wonder this drive is the most popular on the market.

But now Apple goes one better with the DOS Tool Kit. A series of utility programs, it gives you the freedom to easily design 280h x 192v graphic displays in a palette of living color... depending on your choice of Apple system.

Edison was first with the movie camera and projector. Now, with Apple's DOS Tool Kit, you can be first to work wonders with colorful creative animation.

Edison had the first movie camera... and Apple has the DOS Tool Kit that takes you into the colorful world of animation.

Imagine the broadest line of software programs ever.

Apple's broad line of peripherals is equalled only by the most extensive line of software you'll find in the personal computing world. Since more than 170 companies offer software for the Apple family, you can have one of the most impressive program libraries ever.

When you write your own programs, your Apple speaks creatively in BASIC, Pascal, FORTRAN, PILOT and 6502 assembly language. Use these languages to score a sonata. Apple will play back your musical masterpiece on its built-in speaker.

Edison listened to his voice on a revolutionary phonograph in the 1800s... now you can listen to the sounds of today with Apple's inventive family of personal computers.

Where to find even more illuminating Apple experiences.

There's always something new being invented at Apple to set your imagination soaring. And there's always an expert to tell you all about it in detail. Your Apple dealer. If you already own an Apple, there's a whole future ahead to challenge man, mind and machine.

If you're considering a personal computer, stop by the computer store and compare. Apple's reliability, proven performance and recognized technological leadership will help you see the light. Don't let history pass you by. Visit your nearest Apple dealer, or call 800-538-9696. In California, 800-662-9238.

apple® computer

CIRCLE NO. 6 ON FREE INFORMATION CARD

AUGUST 1980
VOLUME 18, NUMBER 2

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

About the cover:

Stereophonic broadcasting on the standard AM band has received the FCC's nod of approval. Magnavox's proposed system was chosen, and is described in detail in this issue.

Cover photo by Don Carroll

Focus on Communications

Feature Article

Construction Articles

Columns

Equipment Reviews

Departments

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Bone Fone™

A new concept in sound technology may revolutionize the way we listen to stereo music.

The Bone Fone surrounds your entire body with a sound almost impossible to imagine.

You're standing in an open field. Suddenly there's music from all directions. Your bones resonate as if you're listening to beautiful stereo music in front of a powerful home stereo system.

But there's no radio in sight and nobody else hears what you do. It's an unbelievable experience that will send chills through your body when you first hear it.

AROUND YOU

And nobody will know you're listening to a stereo. The entire sound system is actually draped around you like a scarf and can be hidden under a jacket or worn over clothes.

The Bone Fone is actually an AM/FM stereo multiplex radio with its speakers located near your ears. When you tune in a stereo station, you get the same stereo separation you'd expect from earphones but without the bulk and inconvenience. And you also get something you won't expect.

INNER EAR BONES

The sound will also resonate through your bones—all the way to the sensitive bones of your inner ear. It's like feeling the vibrations of a powerful stereo system or sitting in the first row listening to a symphony orchestra—it's breathtaking.

Now you can listen to beautiful stereo music everywhere—not just in your living room. Imagine walking your dog to beautiful stereo music or roller skating to a strong disco beat.

You can ride a bicycle or motorcycle, jog and even do headstands—the Bone Fone stays on no matter what the activity. The Bone Fone stereo brings beautiful music and convenience to every indoor and outdoor activity without disturbing those around you and without anything covering your ear.

SKI INVENTION

The Bone Fone was invented by an engineer who liked to ski. Every time he took a long lift ride, he noticed other skiers carrying transistor radios and cassette players and wondered if there was a better way to keep your hands free and listen to stereo music.

So he invented the Bone Fone stereo. When he put it around his neck, he couldn't believe his ears. He was not only hearing the music and stereo separation, but the sound was resonating through his bones giving him the sensation of standing in front of a powerful stereo system.

AWARDED PATENT

The inventor took his invention to a friend who also tried it on. His friend couldn't believe what he heard and at first thought someone was playing a trick on him.

The inventor was awarded a patent for his idea and brought it to JS&A. We took the idea and our engineers produced a very sensitive yet powerful AM/FM multiplex radio called the Bone Fone.

The entire battery-powered system is self-contained and uses four integrated circuits and two ceramic filters for high station selectivity. The Bone Fone weighs only 15 ounces, so when worn over your shoulders, the weight is not even a factor.

BUILT TO TAKE IT

The Bone Fone was built to take abuse. The large 70 millimeter speakers are protected in flexible water and crush resistant cases. The case that houses the radio itself is made of rugged ABS plastic with a special reinforcement system. We knew that the Bone Fone stereo may take a great deal of abuse so we designed it with the quality needed to withstand the worst treatment.

The Bone Fone stereo is covered with a sleeve made of Lycra Spandex—the same material used to make expensive swim suits, so it's easily washable. You simply remove the sleeve, dip it in soapy water, rinse and let the sleeve dry. It's just that easy. The entire system is also protected against damage from moisture and sweat making it ideal for jogging or bicycling.

The sleeve comes in brilliant Bone Fone blue—a color designed especially for the system. An optional set of four sleeves in orange, red, green and black is also available for $10. You can design your own sleeve using the pattern supplied free with the optional kit.

YOUR OWN SPACE

Several people could be in a car, each tuned to his own program or bring the Bone Fone to a ball game for the play by play. Cyclists, joggers, roller skaters, sports fans, golfers, housewives, executives—everybody can find a use for the Bone Fone. It's the perfect gift.

Why not order one on our free trial program and let your entire family try it out? Use it outdoors, while you drive, at ball games or while you golf, jog or walk the dog. But most important—compare the Bone Fone with your expensive home stereo system. Only then will you fully appreciate the major breakthrough this product represents.

GET ONE SOON

To order your Bone Fone, simply send your check or money order for **$69.95** plus $2.50 postage and handling to the address shown below. (Illinois residents add 5% sales tax.) Credit card buyers may call our toll-free number below. Add $10 if you wish to also receive the accessory pack of four additional sleeves.

We'll send you the entire Bone Fone stereo complete with four AA cell batteries, instructions, and 90-day limited warranty including our prompt service-by-mail address.

When you receive your unit, use it for two weeks. Take it with you to work, or wear it in your car. Take walks with it, ride your bicycle or roller skate with it. Let your friends try it out. If after our two-week free trial, you do not feel that the Bone Fone is the incredible stereo experience we've described, return it for a prompt and courteous refund, including your $2.50 postage and handling. You can't lose and you'll be the first to discover the greatest new space-age audio product of the year.

Discover the freedom, enjoyment, and quality of the first major breakthrough in portable entertainment since the transistor radio. Order a Bone Fone stereo at no obligation, today.

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Dept. PE One JS&A Plaza
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In Illinois Call ..... (312) 564-7000

POPULAR ELECTRONICS

Editorial and Executive Offices
One Park Avenue
New York, New York 10016
212 725-3500

Publisher
Joe Mesics
212 725-3568

New York Office
Advertising Manager:
Richard Govatski (725-3939)

Eastern Advertising Manager
Bonnie B. Kaiser (725-3580)
Richard B. Eicher (725-3578)

Midwestern Office
Suite 1400, 180 N. Michigan Ave.,
Chicago, IL 60601 (312 346-2600)
Sales: Ted Welch

Western Representative
Norman S. Schindler & Associates, Inc.
7050 Owensmouth Ave., #209
Canoga Park, CA 91303 (213 999-1414)
Sales: Norm Schindler, Jon Marshall

Representation In Japan
James Yagi
Oji Palace Aoyama
6-25, Minami Aoyama, 6 Chome, Minato-Ku
Tokyo, Japan (407-1930/6821, 582-2851)

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Editorial

Beyond The Standard Communications World

This month's special focus on communications pinpoints the giant strides made in radio-frequency technology and future trends.

Aside from this general coverage of the subject, some interesting sidelights have surfaced in recent months. One concerns underground (illegal) AM and FM radio broadcasts. You won't find these stations listed in your local paper, but they are indeed in full operation. Long Island, NY, alone is said to have about a dozen such unlicensed radio stations. Some broadcast regularly, others irregularly, while still others simply disappear from the air forever.

Traditionally, the undergrounders broadcast at or slightly above 1600 on the AM dial and within the lower end of the existing FM band, say, 88 to 92 kHz, where local college educational stations transmit from time to time. According to an article in a LI newspaper, *Newsday* (May 18), some undergrounders even have call letters: WJMP at 1600, "Big Apple Radio" at 1605, WONS at 1620, WXXX-FM at 88.6, and so on.

With so many readily available, low-cost surplus transmitters around for sale, it doesn't take much money at all to set up for this illegal venture, which is usually low powered. The undergrounders don't follow the program pattern set by legal stations. For example, they often play forefront music on obscure records. It's claimed that new-wave rock and even disco were introduced on illegal radio be- the FCC-licensed stations picked them up. Weekends and holidays are reported to be prime underground broadcast times because FCC agents are inactive then. Telephone "loops" are employed, too, for interactive programs. This makes it difficult for the FCC to trace calls.

Interestingly, the article reports that FCC agents have knocked on doors of these small, illegal broadcast stations, but simply admonished them or asked them to fall in line with regulations to avoid interfering with legitimate broadcasts by, perhaps, changing their frequency, lowering power or moving transmissions to another time slot.

There are also some TV undergrounders around. The article noted that some engineering students at Syracuse U. followed a "Saturday Night Live" program, when the local station switched off for the night, with a three-hour porno movie under the banner of "Lucky 7."

According to an article in *Electronic Mail & Message Systems* (EMMS), a newsletter, electronically transmitted pornographic material is appearing over Viewdata and similar home information services. The British Post Office, too, has been embarrassed by an offer over the British Prestel viewdata service of a "Dirty Books Guide." EMMS points out that MicroNet, a computer timesharing service, has a Pornotrap that detects obscenities used by computerist game players. Players are immediately cautioned on this when detected, and a reprimand is addressed to them on the service's electronic bulletin board. (If you'd like a free copy of its analysis of "Teleporn on Home Information Systems," write EMMS at 30 High St., Norwalk, CT 06851.)

The airwaves have long been a breeding ground for illegal activites, so the foregoing is not terribly surprising. European pirate stations have been operating for many years, as most of you know, broadcasting from ships outside territorial limits in the North Sea. They picked up on groups such as the Beatles, The Rolling Stones and others before the continental stations did.

So as you can see, there's more to communications than meets the eye and ear. Even r-f band designation by letters—P-Band, X-Band, V-Band, etc.—was started as a secret endeavor by the military in pre-World War II days. After the war, they were used for convenience purposes. Now, of course, they have been supplanted by Band Numbers, divided according to metric identification.

Good listening and viewing, you all.

Art Salsberg

The home computer you thought was years away is here.

C8P DF $2,895

Ohio Scientific's top of the line personal computer, the C8P DF. This system incorporates the most advanced technology now available in standard configurations and add-on options. The C8P DF has full capabilities as a personal computer, a small business computer, a home monitoring security system and an advanced process controller.

Personal Computer Features

The C8P DF features ultra-fast program execution. The standard model is twice as fast as other personal computers such as the Apple II and PET. The computer system is available with a GT option which nearly doubles the speed again, making it comparable to high end mini-computer systems. High speed execution makes elaborate video animation possible as well as other I/O functions which until now, have not been possible. The C8P DF features Ohio Scientific's 32 x 64 character display with graphics and gaming elements for an effective resolution of 256 x 512 points and up to 16 colors. Other features for personal use include a programmable tone generator from 200 to 20KHz and an 8 bit companding digital to analog converter for music and voice output, 2-8 axis joystick interfaces, and 2-10 key pad interfaces. Hundreds of personal applications, games and educational software packages are currently available for use with the C8P DF.

Business Applications

The C8P DF utilizes full size 8" floppy disks and is compatible with Ohio Scientific's advanced small business operating system, OS-65U and two types of information management systems, OS-MDMS and OS-DMS.

The computer system comes standard with a high-speed printer interface and a modem interface. It features a full 53-key ASCII keyboard as well as 2048 character display with upper and lower case for business and word processing applications.

Home Control

The C8P DF has the most advanced home monitoring and control capabilities ever offered in a computer system. It incorporates a real time clock and a unique FOREGROUND/BACKGROUND operating system which allows the computer to function with normal BASIC programs at the same time it is monitoring external devices. The C8P DF comes standard with an AC remote control interface which allows it to control a wide range of AC appliances and lights remotely without wiring and an interface for home security systems which monitors fire, intrusion, car theft, water levels and freezer temperature, all without messy wiring. In addition, the C8P DF can accept Ohio Scientific's Votrax voice I/O board and/or Ohio Scientific's new universal telephone interface (UTI). The telephone interface connects the computer to any touch-tone or rotary dial telephone line. The computer system is able to answer calls, initiate calls and communicate via touch-tone signals, voice output or 300 baud modem signals. It can accept and decode touch-tone signals, 300 baud modem signals and record incoming voice messages. These features collectively give the C8P DF capabilities to monitor and control home functions with almost human-like capabilities.

Process Controller

The C8P DF incorporates a real time clock, FOREGROUND/BACKGROUND operation and 16 parallel I/O lines. Additionally a universal accessory BUS connector is accessible at the back of the computer to plug in additional 48 lines of parallel I/O and/or a complete analog signal I/O board with A/D and D/A and multiplexers.

Clearly, the C8P DF beats all existing small computers in conventional specifications plus it has capabilities far beyond any other computer system on the market today.

C8P DF is an 8-slot mainframe class computer with 32K static RAM, dual 8" floppies, and several open slots for expansion.

C8P $950

Or get started with a C8P with cassette interface, 8K BASIC-in-ROM which includes most of the features of the C8P DF except the real time clock, 16 parallel I/O lines, home security interface and accessory BUS. It comes with 8K static RAM and Ohio Scientific's ultra-fast 8K BASIC-in-ROM. It can be expanded to a C8P DF later. Base price $950. Virtually all the programs available on disk are also available for the C8P cassette system on audio cassette.

Computers come with keyboards and floppies where specified. Other equipment shown is optional.

For literature and the name of your local dealer, CALL 1-800-321-6850 TOLL FREE.

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CIRCLE NO. 49 ON FREE INFORMATION CARD

Letters

Steam Trains and Whistles

In the article "Experimenting with a Sound-Effects Generator" (May 1980), circuit D, page 79, produces a steady tone (whistle) when the pushbutton is open and a whistle multiplexed with a steam train when the switch is closed. As a variation, to simulate a steam train when the switch is open and a steam train and whistle when the switch is closed, the other end of the 5,000-ohm resistor connected to pin 27 of the 76477 should be connected to +5 volts instead of ground.—*M. J. Murphy, Ann Arbor, MI 48104.*

Reverse Pin-out Problem

In your May, 1980 issue, in "Reverse IC Socket," by Gene Nelson, you provided a quite adequate solution to a problem that many hobbyists and professionals have (or probably will) encountered. However, there is an easier and faster way to solve the problem. Since integrated circuits are indifferent to the laws of gravity, simply bend each pin carefully by 180 degrees and the pin-out will then match the reversed socket. —*M. P. Buet-Saint-Upery, Greensboro, NC.*

Adjusting Tonearm Height

As mentioned in the April 1980 "Audio Report" on the Dual Model CS606 turntable with Ortofon ULM tonearm, I also found it frustrating to mount a conventional cartridge in the ULM tonearm—not only because of the size of the terminal clips, but also because the conventional cartridge, with the Dual adapter, is higher than the Ortofon. The arm and cartridge are thus tilted upward at the front, making the vertical tracking angle noticeably incorrect.—*H. Miller, Pasadena, CA.*

The discrepancy encountered in making this type of special installation is typically on the order of 0.5° and is thought, according to the manufacturer, to have negligible effect on the sound. If the user feels that the angle must be corrected, the cartridge can be fixed in a horizontal position by means of shims or wedges. ULM turntables from later production runs fit standard cartridges. An adapter (available on request) is used for ULM cartridges. Originally, the connectors were crimped to fit the smaller pins, but this function is now taken care of by the adapter.—Ed.

Alternate for Voltage Regulator

I have constructed the "Trouble Shooting Analyzer for Automobile Electric Systems" (January 1979). Since I was unable to acquire the UA78GU Fairchild voltage regulator, I substituted an LM340 5-volt regulator. I connected the ground terminal of the LM340-5 to the wiper of *R3* and installed a jumper in place of *R4*.—*Alan S. Speaker.*

In Favor of 900 MHz

With regard to your Editorial ("CB Radio—A Phoenixlike Future?) in the February issue, I would be interested in the creation of an additional Personal Radio Service—even more interested in the use of the 900-MHz band. I, for one, would gladly buy the equipment necessary.—*S. G. Stair, KA4FPW, KGM-2520. Russell Springs, KY.*

Argentina DX

In an issue of your magazine that I bought in Buenos Aires, in the "DX Listening" column, it was noted that "Argentina does not have a commitment to news, the station is hard to pick up and the country is in a state of chaos." Given the definition of the word "chaos," the country is as far from disorder or confusion as the columnist is from the truth.—*Georgi J. Cancellieri, Buenos Aires, Argentina.*

THE PHONE THAT LETS YOU CUT THE CORD.

Since its invention, the telephone has secured its reputation as one of mankind's most prized technological marvels.

The telephone cord, on the other hand, has been anything but marvelous.

All these years it's kept your phone from going places you go. The yard. The garage. The basement. And while the phone company's solution is to add more phones (and more monthly rental fees), you still find yourself scrambling to answer calls.

All because of a cord.

Well now, as in no other time in history, you have the chance to cut that cord. And free yourself with technology's newest marvel: the cordless Muraphone™300.

The world in your pocket.

Muraphone lets you instantly place or answer phone calls up to 400 feet away from your existing telephone. Meaning you can roam a full 10 acre area and never miss a call. And call out—to any corner of the world—from places phones-on-wires can't reach: by the pool, under the car, even at the neighbor's.

Just slip the trim remote handset into a pocket. Or clip it to your belt. The companion base unit (connected to your regular phone) will relay calls directly to the handset. And alert you with a soothing electronic tone, not the usual shock-provoking bell.

To dial out, use Muraphone as you would any pushbutton telephone. Then simply press the handset button to talk, release it to listen. This genius even remembers the last number dialed—and redials at the touch of a single button (we know of no other remote phone, at any price, providing this feature).

And its self-contained rechargeable battery provides up to 15 hours of operation. When not in use, simply slip the handset into the base unit's built-in recharger.

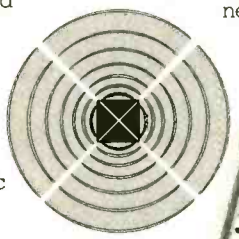
Talents no extension phone can match.

Your Muraphone 300 does a lot more than handle phone calls.

Someone at the base unit, for example, can contact a person with the handset at anytime using the system's own intercom channel—something no conventional extension phone can do. And it's independent of your phone company, so talk as long as you want, free of charge.

You can also use the intercom to screen incoming calls. A person at the base unit can receive the call first, put the caller "on hold," then privately page the handset (the same capability you find in most office systems—and never in an ordinary extension phone). If no one is at the base, the call can ring through directly.

Installing Muraphone is easy. Just connect the base unit to any standard wall outlet, and any modular phone jack (for those who don't have modular hook-up, jacks and adapters are available at all phone equipment stores).



Remote signal covers a full 10 acres. System includes 14 oz., 6½" × 2½" × 1½" handset and 7½" × 7" × 2" base unit (not shown).

FCC approved, Muraphone is compatible with all rotary and pushbutton systems; this one of a kind telephone is already saving people thousands of steps a day—in homes, offices and factories throughout the country.

A $149 surprise.

When we first heard about Muraphone 300's extraordinary features our reaction was the same as anybody's: How much?

Judging by its superior quality—and the high prices its few competitors were asking—we guessed $300.

We never dreamed we'd be offering it to you for only $149.

Still, we'd like you to try it out first—at our risk. With two weeks to enjoy, first hand, the luxury of cordless telephoning. If, within that time, you're not completely delighted, simply return it. The Sharper Image will refund your entire purchase price, including delivery.

But quantities are limited, so give us a call soon to insure early delivery. See why this exciting telephone outperforms all conventional extension phones. And why it pays to go cordless.

Feature booklet, convenient service-by-mail, and 90 day warranty included.

ORDER TOLL FREE.

Please order product #214. Credit card holders may use our toll-free number below. Or send check for $149 plus $3.50 delivery. Add $8.94 sales tax in California.

800 227-3436
In California 800 622-0733

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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 Free Information Card or write to the manufacturer at the address given.

KLH Speaker System

KLH's new Model KLH-4 speaker system uses polypropylene cones that are claimed to provide smoother, more accurate performance than other materials, while virtually eliminating a "cone sound" characteristic of plastic and paper. In addition, the system features low-frequency-response compensation for speaker positioning and acoustic treatment to reduce high-frequency diffraction effects. Bass response is down 3 dB at 63 Hz. Recommended amplifier power is 20 to 60 watts/channel. Size is 12½" × 8½" × 6" (318 × 216 × 152 mm). $290.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Modular Breadboarding System

Hobby-Blox® from AP Products Inc. is a solderless breadboarding system that can be customized to your specific needs. At the core of the system are separate starter packs for discrete-component and integrated-circuit projects. Each pack comes with a number of modules that fit into a tray, plus a project book that describes how to build 10 projects. The entire system includes 14 separate modules, most with suggested retail prices of less than $3.00 when purchased individually. Modular packs include tray, terminal strips, distribution strips, discrete strips, bus strips, display strips, LED strips, vertical tray, speaker panel, blank panel, binding-post

strips, and tray-extender clips. The system is compatible with all sizes of DIP ICs and will accept component lead diameters ranging from 0.015" to 0.032" (0.38 to 0.81 mm) in diameter. $7.00.

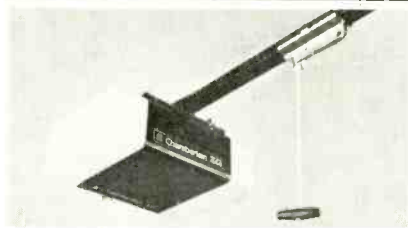
CIRCLE NO. 94 ON FREE INFORMATION CARD

Processor-Controlled DMM

B&K Precision's new Model 2845, a microcomputer-controlled hand-held 3½-digit digital multimeter (DMM), automatically selects proper range in ac or dc voltage, current or resistance. The "computer" instantly analyzes an input signal and selects the range that will provide greatest resolution. Dc and ac voltages are to 1000 V, and claimed dc accuracy is ±0.1% of reading ±1 digit on all ranges. Input impedance is 10 megohms on these ranges. Dc and ac current is measured to 1 ampere with a nominal 200-mV voltage drop. Claimed accuracies in these modes are ±0.75% of reading +1 digit on all dc ranges, and ±1% of reading ±3 digits on ac. Resistance is measured to 10 megohms with the appropriate range symbol displayed. Accuracy is reported to be ±0.3% of reading ±1 digit to 1 megohm, ±0.6% of reading ±1 digit on 10-megohm range. Settling time with automatic-range change is within 1.5 seconds. Other features include a range lock that holds any desired range and a defeatable audible alarm that sounds off when continuity measurements (179 ohms or less) are being made. Power is from a 9-volt battery or optional battery eliminator. $175.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Deluxe Electronic Garage-Door Opener



Chamberlain's Model 444 deluxe garage-door opener features a heavy-duty ⅓-hp motor, full chain drive, and radio control with 3,375 owner-selected frequency codes. Solid-state logic replaces trouble-prone electromechanical timing and control elements and contributes to making the transmitter and receiver more compact. Other attributes: lighted receiver button for fast switch location; keyswitch for opening door without the transmitter; automatic and manual light turn on/off; master-off vacation/security switch; automatic safety reverse; and constant door control.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Eumig Synthesized FM Tuner

Eumig's Model T-1000 digitally synthesized FM tuner offers station selection in either manual or memory mode. In manual, pressing either of two buttons causes the PLL-controlled digital synthesizer to scan up or down the FM band in 50-kHz

Attractive wood-grain unit adds to any decor and will Time Control your entire home Measures: 5¾"x5¼" x3 1/8"

TIME CONTROL

Now, a new computer development lets you control and time your entire home even when you're 1,000 miles away!

In the fall of 1978, an English company, BSR Electronics introduced a remarkable new product, the X-10 Space Controller. The X-10 allowed you to page up to 16 appliances and lights throughout your house remotely from any location. It was an instant success and rightly so. But the most vital part of the system was still in development. Not any more — with Time Control —the system is complete.

Now you can turn your lights or appliances on and off anytime, even when you're on vacation. It can program your TV or radio to wake you and start your coffee all before you get out of bed every day. These are just a few of many things that Time Control does to increase your security and convenience. It can do much more!

IT'S REALLY QUITE SIMPLE

BSR's X-10 Space Controller is really quite simple. It's made up of a central transmitter and receivers, all of which are plugged into your 110 volt wall sockets. You press a number on the calculator-type keyboard of the central control and an electronic signal is transmitted through your existing house wiring to remote modules in which lamps and appliances are plugged.

Simple plug-in modules. No wiring required. Operates over existing in-house wiring.

Outside or overhead lights are controlled by installing a wall switch module that also receives commands from the central controller. Each remote module has a numbered thumb dial. The digital controller activates only those modules set to the desired number. You can control one or up to 16 modules with the system. Time Control adds the missing dimension to Space Control.

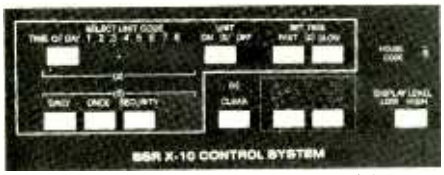
NOW THERE IS TIME CONTROL

Time Control consists of a computer memory and digital clock. You can now program the exact time you want a light or appliance to turn on or off. One mode allows you to even produce a random pattern automatically to make your home appear occupied when you're away.

SPACE AGE ROBOT

Time Control is your own space age robot with four-in-one modes for up to 16 separate functions in your home. Time Control will add conveniences and it may save you thousands of dollars when you're not at home.

• **Security Mode** is used primarily when you're away either one day or the entire summer. Selected lights and appliances are sequenced on and off to give that lived-in appearance. First, a light in one room and then another, a radio in a third, plus the den TV, all can be programmed to fool any would-be burglar "casing" your home. You just select the lights or appliances and the times you want each to be on. Time Control can be programmed in minutes using the calculator type keyboard. One avoided robbery and Time Control pays for itself many fold. Think of the increased peace of mind.



Easy to program Time Control keyboard times lamps, appliances and even outside or overhead lights.

• **Daily Timer** Select any one or all of 8 modules to time daily, then set in any time you want each to turn on and then off. Program your TV or radio to come on to wake you each morning. Turn the outside lights on at 7:00 p.m. and off at 6:30 a.m. Timed to the exact minute of each day automatically. Turn your coffee pot on each morning and shower while your coffee is brewing. Your life may never be the same again.

• **Quartz Clock** Digital Quartz accuracy in an attractive wood-grain finish. Attractive enough to add to the decor of any room. Accuracy unsurpassed by expensive chronometers costing $200 or more. With large easy to read green numbers. May be worth the price of the unit for this feature alone.

• **Panic Button** This bonus feature allows you to turn on all of your lights from your bedside to frighten away peeping toms or intruders. Further peace of mind when you're away and your spouse is home alone.

NO WIRES NEEDED

One of the nice features of time control is that no wires are required. All appliances and lamp modules simply plug into your wall sockets. For outside or overhead light control, you merely change your existing light switch with BSR's wall switch module. Time Control takes it from there.

BUILD YOUR OWN PERSONAL SYSTEM

If you already have a BSR X-10 Space Controller, all you may need is the timer at $74.99. If not, we recommend a starter kit at $119.95 consisting of the timer, two lamp modules and one appliance module. You save $6. We sell all BSR X-10 Accessories so you can add additional modules as you need them to Time Control your *entire* home.

30 DAY NO-RISK TRIAL

Test the Time Control for 30 days at no risk. If Time Control does not provide the convenience and peace of mind we say it can, or for *any* reason, return it to us. We will promptly refund your purchase price. What have you got to lose?

WARRANTED FOR ONE FULL YEAR

Time Control is an all solid state unit. It should provide you with many years of trouble-free service. If in the unlikely event anything should go wrong during one full year, it is factory warranted by a sizable company, BSR.

HURRY! QUANTITIES ARE LIMITED

When we were given the opportunity to introduce Time Control in this country, we jumped at the chance. We also knew quantites would be limited this year. BSR has set aside quantities of Time Controls for us. But there may not be enough. So to be assured of being one of the first to get your Time Control—Don't wait, order now!

TO ORDER your Time Control

Simply fill out the coupon and send it along with check or money order to the address below. For even faster service credit card customers can call: Toll Free **1-800-527-7066**; in Texas call collect: **1-214-349-3120**

MEDIA MARKETING
10155-9 Plano Road • Dallas, TX 75238

- YES! Send me_____Timer(s) only at $74.99, add $2.50 shipping, handling & insurance.
- **Save $6.00.** Send me_____Time Control Kit(s) at $119.95 (includes 1 timer, 2 lamp, and 1 appliance module). Add $3.50 shipping, handling & insurance.
- Send me the following modules. Add $1.00 shipping & handling.

_____Lamp Modules at $15.99
_____Appliance Modules at $15.99
_____Wall Switch Module at $17.99

Texas residents add 5% sales tax.

Ask for other BSR X-10 Accessory Prices

Name _____
Address _____
City _____
State_____Zip _____
Check or money order enclosed
Charge to Mastercharge Visa
Acct. # _____
Expires _____
Signature _____
Order Toll Free: **1-800-527-7066**
In Texas Call: **1-214-349-3120 collect**
MMI-1980 PE-8

CIRCLE NO. 40 ON FREE INFORMATION CARD

The easiest, least expensive way to generate spectacular multi-color graphics, sharp two-color alphanumerics: Your computer, a color tv set and the Percom Electric Crayon™.

Add the Electric Crayon™ to your system and your keyboard becomes a palette, the tv screen your medium.

You dab and stroke using one-key commands to create dazzling full-color drawings, eye-catching charts and diagrams.

Or you run any of innumerable programs. **Your own BASIC language programs** that generate dynamic pyrotechnic images, laugh-provoking animations.

From a combined alphanumerics-semigraphics mode to a high resolution 256- by 192-element full graphics mode, the microprocessor-controlled Electric Crayon™ is capable of generating **10 distinctly different display modes.**

Colors are brilliant and true, and up to eight are available depending on the mode.

As shipped, the Electric Crayon™ interfaces a TRS-80* computer via your Expansion Interface or Printer Adapter. It may be easily adapted for interfacing to any computer or to an ordinary parallel ASCII keyboard.

But that's not all

The Electric Crayon is not just a color graphics generator/controller.

It is also a **complete self-contained control computer**. With built-in provision for 1K-byte of on-board program RAM, an EPROM chip for extending EGOS™, its on-board ROM graphics OS, and a dual bidirectional eight-bit port — over and above the computer/keyboard port — for peripherals. The applications are endless.

Shipped with EGOS™, 1K-byte of display memory and a comprehensive user's manual that includes an assembly language listing of EGOS™ and listings of BASIC demo programs, the Electric Crayon™ **costs only $249.95.**

Options include:

- LEVEL II BASIC color graphics programs on minidiskette: $17.95.
- A 34-conductor ribbon cable to interconnect the Electric Crayon™ to a TRS-80*: $24.95.
- RAM chips for adding refresh memory for higher density graphics modes: $29.95 per K-byte.
- Electric Crayon™ Sketchpad, a sketching grid of proportioned picture elements (pixels) in a tv aspect ratio. For 128 x 192 or 256 x 192 graphics modes. 11-inch by 17-inch, 25-sheet pads: $3.95 per pad.

SYSTEM REQUIREMENTS: the video circuitry of the Electric Crayon™ provides direct drive input to a video monitor or modified tv set. An internal up-modulator for rf antenna input may be constructed by adding inexpensive components to the existing video circuitry.

Prices and specifications subject to change without notice.

™ = trademark of Percom Data Company, Inc.
* = trademark of Tandy Radio Shack Corporation which has no relationship to Percom Data Company.

PERCOM

PERCOM DATA COMPANY, INC.
211 N. KIRBY GARLAND, TEXAS 75042
(214) 272-3421

Get into computer color graphics the easy, low-cost way with a Percom Electric Crayon™. Available at Percom dealers nationwide. Call toll-free, 1-800-527-1592, for the address of your nearest dealer, or to order direct if there is no Percom dealer in your area.

CIRCLE NO. 54 ON FREE INFORMATION CARD

steps. In memory, a touch of any one of 10 buttons instantly tunes to the user-preselected station. A built-in Ni-Cd battery prevents station memory from being lost if power is inter-

rupted. Station frequency appears in a LED numeric display; an array of five LEDs indicates signal strength. Specifications: sensitivity for 50-dB quieting, 38.3 dBf stereo; frequency response, 15 to 16,000 Hz + 0.5/-1 dB: THD, 0.1% wide bandwidth, 0.2% narrow bandwidth stereo; alternate-channel selectivity, 80 dB; S/N, 65 dB stereo; AM suppression, 60 dB; stereo separation, 50 dB at 1 kHz; capture ratio, 0.8 dB. $795.

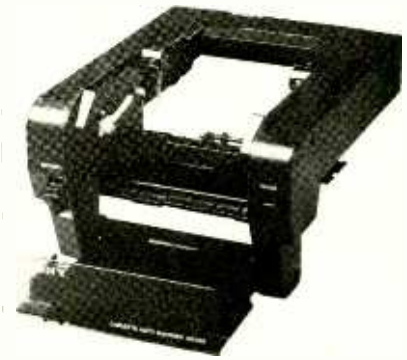
CIRCLE NO. 91 ON FREE INFORMATION CARD

Two-Speed, Metal-Ready Cassette Deck

B.I.C. has added metal-tape record/play capability to its two-speed cassette decks. Model T-3M, in the middle of the line, features a dual-capstan/three-head transport, record calibration, Dolby-FM copy feature, and LED bar-graph type recording-level display. A two-speed dc servo motor drives the dual-capstan transport. Dolby noise-reduction system is built-in. Technical specifications: speeds 1⅞ ips and 3¾ ips; frequency response 20 to 21,000 Hz ±3 dB at 1⅞ ips (20 Hz to 23,000 Hz ±3 dB at 3¾ ips); wow and flutter (wrms) 0.05% at 1⅞ ips, 0.03% (1⅞ ips) and 1.0% (3¾ ips); S/N 65 dB with Dolby, 57 dB without at 1⅞ ips (68 dB with Dolby, 61 dB without at 3¾ ips). Size is approximately 18″ × 10⅛″ × 6½″ (475 × 257 × 165 mm). $499.95.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Sony Videocassette Changer



Earlier Betamax owners can match longer play/record time of some later models by adding Sony's automatic videocassette tape changer device. It permits continuous recording and playback of up to three cassettes on Betamax Models LV-1901/D, SL-7200/A, SL-8200, and SL-8600. An easily installed accessory, the Model AG-200 changer offers a maximum recording capacity of 4.5 hours in the Beta-I mode or 9 hours in the Beta-II mode using three L-750 tapes. Manual operation (record, playback, stop, etc.), is also possible with the changer installed. $125.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Avanti Scanner Base-Station Antenna

Avanti's Model AV-801 Astro Scan is an omnidirectional base-station antenna for scanner monitoring applications on low vhf, high vhf, and uhf public service bands. It employs dc-ground construction for lightning protection and prevention of static build-up. Its cryogenic-aluminum-tubing construction is said to become stronger with decreasing temperature for resistance to damage during ice storms.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Wind Odometer/Speedometer

Aeolian Kinetics Wind Prospector 4000 is a modestly priced wind survey instrument that can measure both instantaneous and average wind speed. Speeds are displayed via a seven-digit numeric LED array. Operated in the odometer mode, it records total wind run and produces average wind speeds for user-defined cumulative time periods over a 0.01-to-9999.99-mile range. In speedometer mode, it gives instantaneous wind speed over a range of 1 to 99 mph ±1 mph. Operating temperature for the system is from −40° to 158° F (−43° to 70° C). The system is designed to operate for up to a year on four alkaline D cells with display off, but it can be ac powered with an optional ac adapter. Comes with anemometer and cable. $145 assembled, $118 kit; $21.50 ac adapter. A waterproof field case is available as an option.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Ortofon/SME Cartridge/Carrying Arm

Ortofon of Denmark and SME of England have teamed up to provide users of the SME Series III and IIIS tonearm with what is said to be the lowest moving mass in an available record playback system. The Model 30H low-mass integrated pickup and carrying arm directly replaces the standard Model CA-1 arm. Total mass of the 30H is 10.5 grams, with effective moving mass rated at 4.5 grams. Dynamic compliance is rated at 35 μm/nM and system resonance at 13 Hz. Other specifications include: 20 to 20,000 Hz frequency response; greater than 3 mV output at 1 kHz; greater than 25 dB channel separation at 1 kHz; 1.0 gram recommended tracking force; and 47,000-ohm, 400-pF recommended load. The stylus is a fine-line nude diamond.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Amerex Packaging Components

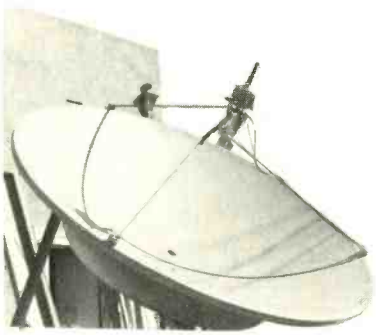
Unibox from Amerex is a versatile line of packaging components composed of thermoplastic boxes and a wide range of accessories that can be customized by the user. The boxes are available in six sizes (2¾″ × 2″ × 1¼″ to 5¼″ × 4″ × 2″) and five

For more information on advertised products, equipment tested, etc., circle appropriate number on postpaid Free Information Card.

color combinations. Custom epoxy-glass gridboards that accept IC sockets and discrete components can be mounted horizontally and vertically in the boxes. Two sizes of red and smoke-gray windows are available for use with LED, incandescent, and fluorescent displays and indicators. Also available are two sizes of opaque gray panels for mounting switches, controls, connectors, etc. Resilient nonmarring feet can be fitted to the bottom of the boxes. Boxes cost $2.95 to $4.95, windows and panels $1.39 to $2.39, gridboards $1.99 to $5.99. Address: Amerex, P.O. Box 2815, Riverside, CA 92516.

Home Satellite System

Satelco has introduced a "home" TV satellite receiving system that connects to a color-TV set. With this system it is possible to receive up to 70 stations from a host of U.S. and Canadian communication satellites. A



typical system consists of: low-noise amplifier (LNA), feed horn, fiberglass or aluminum dish antenna and mounting system, LNA power supply, 24-channel tunable receiver, r-f module (for connection to standard TV receivers), remote-controlled motor that positions the LNA for vertical and horizontal polarization, and all cables and plugs. System prices vary with antenna size: $12,500 for 20′ (6.1 m); $7995 for 16′ (4.9 m); $6995 for 10′ (3 m). Address: SATELCO, 5540 W. Pico Blvd, Los Angeles, CA 90019.

Nylon Assembly Aid

A new soft nylon tool for forming and bending circuit component leads has been introduced by Desco Industries. The Model 618 tool is flexible and durable and said to be soft enough to prevent scratching delicate components and circuit-board traces. One end has a flat screwdriver tip for bending leads flat to a pc foil trace, while the other end is pointed for probing or to act as a guide in component-lead bending. $2.45. Address: Desco Industries, Inc., 351 F Oak Pl., Brea, CA 92621.

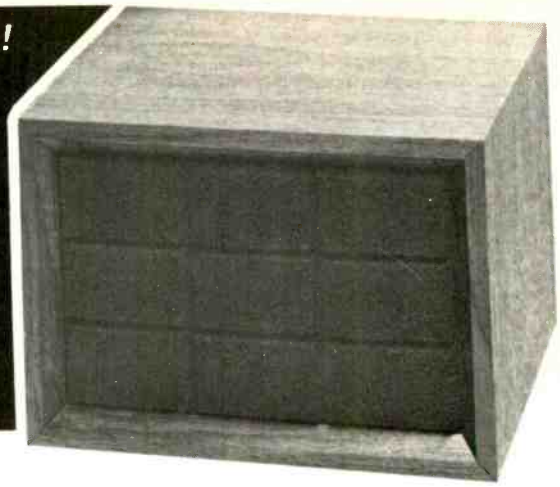
Not Just Another Limited Area Motion Detector!

guardex™

Protects Every Square Inch Of Your Building

Turns On Lights Automatically

Powerful Electronic Siren



The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6¾" × 9¾" × 8") and weighs less than 6½ pounds.

Low Cost Computerized Burglar Alarm System Home - Office - Business

NO INSTALLATION

Just plug the Guardex 8000 alarm system in, make two simple control adjustments to suit your particular building and it works! There are no other wires to run. This totally self-contained burglar alarm can completely seal off every square inch of the surface of your building. It protects doors, windows, and what most alarms miss... your roof, walls and floors.

HOW CAN ONE SMALL COMPUTER PROTECT MY WHOLE BUILDING?

Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

TURNS ON LIGHTS AUTOMATICALLY

When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected, (it can be only a second or two after the first break-in sound) the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.

The rear control panel contains two standard AC plug receptacles for a table lamp, spot lights, radio, etc.; terminals for connecting optional outside siren and back-up battery (not included); entry delay time control and sensitivity control.

EXIT AND ENTRY DELAY

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

BATTERY BACK-UP

Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

THE BURGLARY PROBLEM

The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from the main alarm, they are available with 50 feet of wire for $24.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

This is your opportunity to purchase an alarm system directly from the factory for only **$199.95**. Try it in your home or business for thirty days without risking one cent. Put our Guardex 8000 alarm to your own test. See for yourself! It will protect every window and door from break-in. If you are not completely satisfied, return the alarm within 30 days for a complete refund. To order your Guardex 8000 alarm, CALL TOLL FREE to charge your credit card or send your check to Guardian Electronics, Inc. in the amount of $199.95 plus $3.50 postage and handling. If you want the optional outside siren, add $24.95 (California residents add 6% sales tax.)

(If you require more information, call during California business hours, Monday - Friday).

VISA® master charge

Dealer Inquiries Invited

CALL TOLL FREE
(800) 423-5499

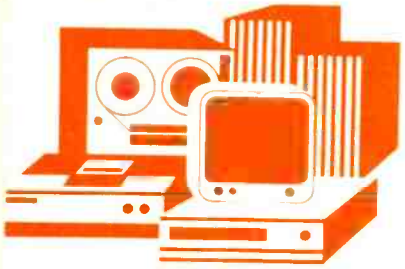
California residents:
(213) 889-1414 collect.

GUARDIAN ELECTRONICS, INC.

31117 Via Colinas, Dept. PE **Westlake Village, Calif. 91361**

Price subject to change without notice.

CIRCLE NO. 24 ON FREE INFORMATION CARD



Entertainment Electronics

By Harold A. Rodgers
Executive Editor

Miscellany

Metal Tape. What are the advantages of metal tape over lower-priced formulations for which you don't need a special cassette deck? One group of partisans would respond: "The difference in high-frequency headroom is like night and day. The highs are clearer and more detailed." (Or other words that amount to the same thing.) Their opponents would probably take the position that the difference doesn't amount to a hill of beans.

Well, there is some difference—one that can best be described as of the "small-but-significant" variety. Whether your appraisal of the difference will align you with one camp or the other will depend, in all likelihood, on what you are recording and when. Let's look at some of the facts.

From the Horse's Mouth. The data to be used in establishing the performance differences between the tape types was taken from a clinic/press demonstration given by TDK. It seems reasonable to accept the data as reliable since: (1) TDK would have no reason to make its metal tape look good at the expense of others, particularly when one of the others (SA) is a staple of its line and the second (SA-X) is a new introduction. (2) The general characteristics of the data suggest that the demonstration must have been set up with some care.

As the differences between metal tapes and quality high-bias tapes, such as SA and SA-X, are minimal in the customary −20-dB frequency response test, we will learn more by considering the behavior of the tape at a 0-dB recording level. (Frequency response at −20 dB depends considerably on how the bias is set on the particular deck being used for the test.) According to TDK's tests, MA, the metal-particle tape, has about 4 dB more headroom in the region between 8 and 20 kHz than SA-X, a new dual-layered using coatings of Super Avilyn particles of two different coercivities. SA-X, in turn is about 1 dB more sensitive than SA across the board, and its high-frequency headroom holds at about 1 dB extra as well.

But that's not the whole story. Analysis of the residual noise levels on the three tapes shows SA and SA-X in a dead heat, and MA about 2 dB noisier. Since to attain the same high-frequency S/N ratio with MA as with the other two tapes we would have to record it 2 dB harder, the same 2 dB will have to be deducted from its dynamic range. Thus, MA has about a 2-dB advantage over SA-X and a 3-dB advantage over SA.

Considering that MA costs roughly 20 percent more than SA-X, and SA-X about 15 percent more than SA, the differences in performance do not seem huge. But to conclude that they are unimportant without first examining how they interact with the application would be misleading.

At What Price Headroom? Headroom is primarily a safety factor in tape recording. It allows for the recordist's uncertainty about the dynamic range of the incoming program. Since a single overrecorded passage will ruin an otherwise excellent recording, the importance of headroom cannot be denied, especially in live recording, where the uncertainty about program levels is presumably greatest. When one is faced with the alternatives of either an excellent recording or one that is severely marred by a signal that overloaded the tape by 2 or 3 dB, the price of that much headroom—even if it is high—may seem very reasonable.

On the other hand, when one is dubbing material that has already been recorded, the levels of the program are known or knowable. Furthermore, if the tape is inadvertently overloaded during a dub, nothing is irretrievably lost. It is only necessary to readjust levels and begin again. In this case, abundant headroom, which may be wasted, can be considered luxury. A frugal recordist would use a tape of lesser capabilities and set his levels very carefully.

Adjustment of Levels. Conventional wisdom has it that, when recording onto a tape, it is best to use the maximum levels possible without overload. This may be appropriate for a live situation in which obtaining a recording with an optimum S/N ratio depends on the choice of microphones, their placement, the preamps they feed, the mixers used, and, perhaps, other factors as well; but it does not really apply to dubbing.

When a recording is duplicated, the copy cannot have an S/N ratio any better than that of the original, in fact, it will surely be worse. Therefore, if recording at a high level places the noise floor of the original significantly above the noise floor of the tape, dynamic range is wasted and high-frequency tape saturation is courted unnecessarily. A better solution is to adjust the record gain so that the noise floor of the program coincides with or falls just above the noise of the tape. Now the original noise will tend to mask that added by the tape as completely as possible and the maximum dynamic range is left for the program.

To set things up this way may require a bit of experimentation or trial and error, as few tape decks have metering systems that will tell you anything useful for this endeavor. On the other hand, the reward you will often get is an excellent copy of even a direct or digitally mastered disc—on a standard chromium dioxide (or high-bias ferricobalt) tape.

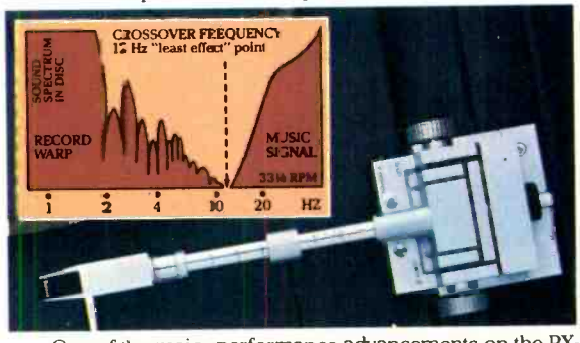
N-Rays, Golden Ears, and Black Cats. In the May issue of *Scientific American*, Irving M. Klotz tells the story of N-rays, a form of electromagnetic radiation "discovered" by the French physicist René Blondlot in 1903 or thereabouts. As it turned out, Blondlot was in error, and N-rays did not exist at all, but the story is interesting in that it points out how sincere, dedicated people can reach ridiculous conclusions through poor methodology.

Having established that the brightness of a spark gap was increased when the direction of the spark was aligned with the electric vectors of a train of polarized X-rays, Blondlot concluded that a similar increase in brightness upon exposure to a "radiation source" that could not be emitting X-rays must signal the presence of some other form of radiation.

(Continued on page 21)

Yamaha's PX-2 linear tracking turntable. A class of one.

Yamaha's new PX-2, the flagship of a remarkable new series of turntables from Yamaha, is destined to become the new standard of the audio industry. It is a masterpiece in the art of music reproduction. Totally in a class by itself.



One of the major performance advancements on the PX-2 is Yamaha's unique optimum mass straight tonearm assembly. This design concept is Yamaha's direct challenge to the industry trend of low mass tonearms. Among the most significant benefits of optimum mass is that it specifically addresses two of the most critical elements of music signal tonal quality—tonearm resonant frequency characteristics and high trackability with a wide range of cartridges. Tonearm mass is such a critical element in sound reproduction (especially in the low and high frequency ranges) that Yamaha has designed this optimum mass tonearm to insure its resonance frequency is at the "least effect" point. (See graph.) As a further benefit, the vast majority of available cartridges can be effectively matched with the Yamaha tonearm. Even MC types.

But the optimum mass tonearm is only one factor that puts the PX-2 in a class by itself. There's much more. Like an extraordinary 80dB S/N ratio, with incredibly accurate tangential tracking—constantly monitored by an opto-electronic sensor. The PX-2 is also a study in durability with its solid, anti-resonant monolithic diecast aluminum base. And the combined effect of the hefty platter and the heavy-duty DC motor depresses wow and flutter to below 0.01%.

Yet with all this performance, the PX-2 is deceptively easy to operate. All the microprocessor-activated controls are easily accessible—without lifting the dustcover.

The balance of the turntables in our new line (the P-750, P-550, P-450 and P-350) all incorporate this same optimum mass tonearm philosophy. Each will set new standards for performance per dollar invested.

Visit your local Yamaha Audio Specialty Dealer for a personal test of our remarkable PX-2 and the other superb turntables in our new series. You'll hear music that's truly in a class by itself.

For more information write us at Yamaha, Audio Division, P.O. Box 6600, Buena Park, CA 90622.

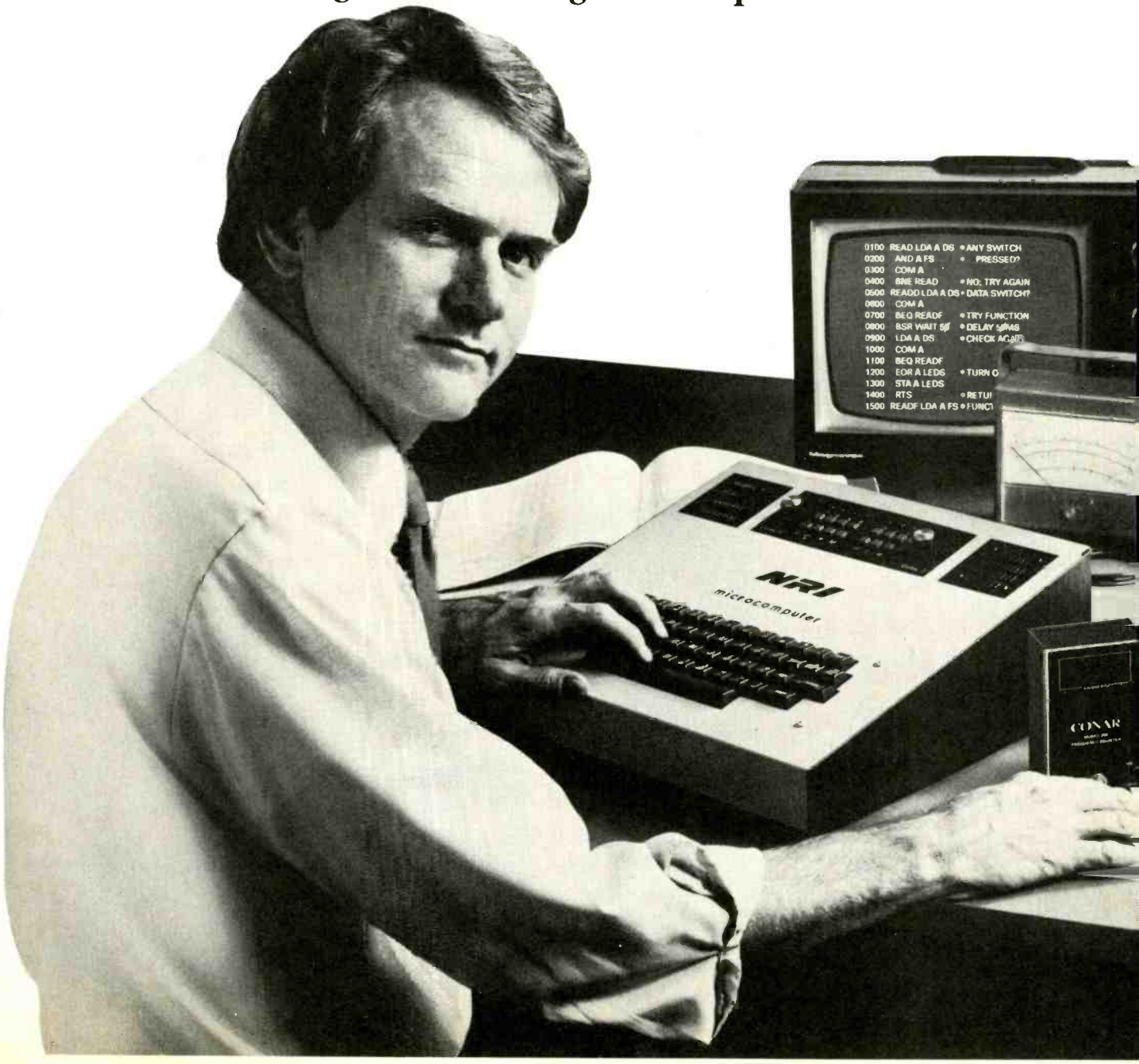
*Yamaha cartridges shown (MC-1X and MC-7) on both models are optional.

YAMAHA

CIRCLE NO. 61 ON FREE INFORMATION CARD

Microcomputers are here! Get in on the ground floor with NRI's new "at home" training in computer technology.

Only NRI Gives You "Hands-on" Experience as You Build Your Own Designed-for-learning Microcomputer



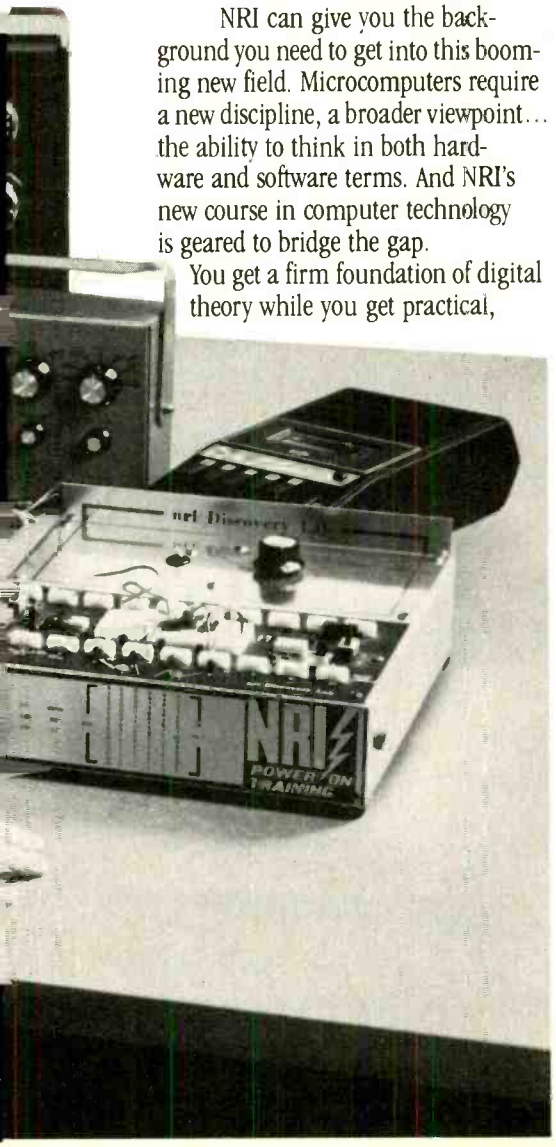
The microprocessor, that amazing little chip which shrinks electronic circuitry to microscopic size, has changed the world of the computer with dramatic speed. Now, big-performance computers are here in compact sizes...priced to make them practical for thousands of medium and small businesses, even homeowners and hobbyists.

Microcomputers are already being put to work on jobs like inventory control, payrolls, cost analysis, billing, and more. In homes, they're able to handle budgets and tax records, control environmental systems, index recipes, even play sophisticated games. And hobbyists across the country are expanding the state of the art while developing their own programs.

Become a Part of This Incredible World ... Learn at Home in Your Spare Time

NRI can give you the background you need to get into this booming new field. Microcomputers require a new discipline, a broader viewpoint... the ability to think in both hardware and software terms. And NRI's new course in computer technology is geared to bridge the gap.

You get a firm foundation of digital theory while you get practical,



"hands-on" experience working with the NRI Discovery Lab®, assembling test instruments you keep, and even building your own fully functional microcomputer.

Best of all, you do it at your own convenience. You learn at home with clearly written, "bite-size" lessons that carry you through the course in logical progression. There's no need to go to night school or quit your job...you progress at the pace that's most comfortable to you, backed by your personal NRI instructor and individual counseling whenever you want it.

Assemble an Advanced Microcomputer with Exclusive Designed-for-Learning Features

Only NRI trains you with a microcomputer that's specifically designed to teach you important principles as you build it. This state-of-the-art unit performs every function of comparable commercial units, has capabilities well beyond many. But each step of construction provides specific training, reinforces theory to make it come alive. And once you've finished, your microcomputer is ready to go to work for you. Or you can even sell it commercially.

You also assemble professional test instruments for use in your training. You get your own CMOS digital frequency counter and transistorized volt-ohm meter to keep and use in diagnosing problems and servicing computers. Together with up-to-the-minute lessons and NRI's 60-plus years of home study experience, you get the most in training and value.

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Even the servicing of home entertainment equipment has taken quantum jumps forward. NRI keeps you right up with the latest, with training in stereo, video tape and disc players, and the latest TVs. You even build your own 25" diagonal color TV, the only one complete with built-in digital clock, varactor tuning, and computer control that lets you program an entire evening's entertainment. In our complete communications course, you learn to service two-way radio, microwave transmitters, radar, AM and FM transmitters, CB radio, paging equipment, and more. And you build your own 2-meter transceiver or 40-channel CB while you learn.

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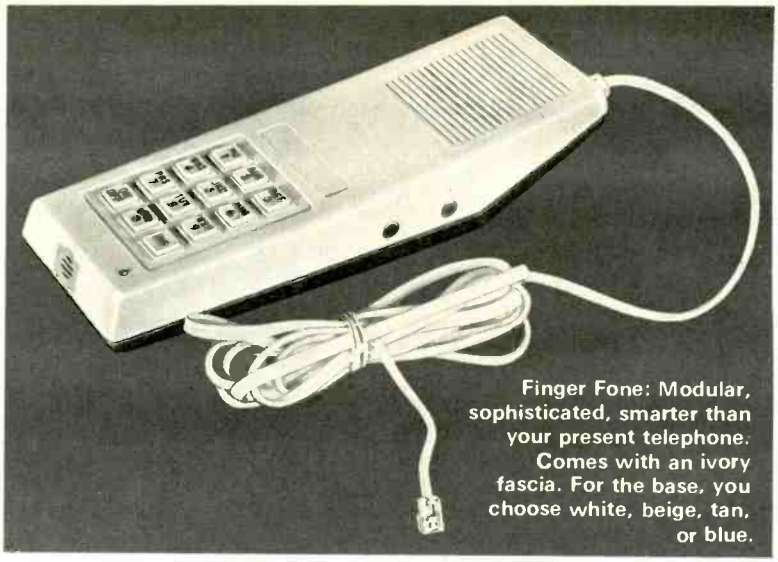
FINGER FONE™

The unique Finger Fone brings you advanced solid-state wizardry with a simple yet intelligent approach to using a telephone. It's the ideal communications instrument for home and office.



Finger Fone: Modular, sophisticated, smarter than your present telephone. Comes with an ivory fascia. For the base, you choose white, beige, tan, or blue.

Imagine you're a design engineer. You've just been assigned to come up with a smaller, simpler-to-use, more streamlined telephone with basic memory that can handle 99% of the ways people actually use a phone on a day-to-day basis.

You have a research laboratory with a support staff at your disposal. Plus access to the latest transistors, memory chips, and microprocessors. And you are given only one limitation: Keep the consumer's cost under $100.

Now, since you're something of a maverick, your mind is not trapped in the right way/wrong way syndrome. And you were too independent to take that job with the Bell System while back. Because you didn't want all your ideas to come out "Bell-shaped."

THE ANATOMY OF DESIGN

So you set to work -- but not with wires, bells and whistles. Because your approach is different: You're going to discover how people actually use a telephone today and then design the instrument from the outside in, basing your conception around real communication needs in a way quite unlike anything ever before achieved.

INTRODUCING THE FINGER FONE

When you're finished, you realize you've come up with a minor revolution in design! Your new instrument is actually a miniature telephone: the entire unit measures a scant 2¾" wide, 8¾" long, and 2¾" high (at the speaker end), scarcely any bigger than the handset on an ordinary phone. your Finger Fone has a nearly standard alphanumeric keyboard plus a couple of special benefits we'll get to in a minute. It also has an omnidirectional microphone, two microsensors on the side of the instrument to control the volume of incoming voices, and even a tiny red on-off light.

What's more, it plugs into the new mini-connector Ma Bell provides for all its phones these days -- with no additional wires for any other power source (which makes the Finger Fone unlike those other multi-wire "speaker-phones" that sell for more but do less).

WHY PICK A PHONE UP EVERY TIME IT RINGS?

Let's face it, your hands are often occupied when the phone rings. So to answer, you've got to stop at least half of what you're doing. With a Finger Fone, all you do is reach out and tap the "On" key with one finger. And since you needn't pick the instrument up, you can place it conveniently on a desk, counter, or table -- or hang it on the wall.

MORE FINGERTIP CONVENIENCE

When Finger Fone announces an incoming call with its pleasant electronic chirp, tap the "On" key and begin speaking. If the caller is someone the whole family wants to hear, simply pass a finger over the high volume sensor, and your caller's voice will be audible to everyone in the room. This benefit is great for the office as well, making it possible to replace an ordinary telephone, separate speakerphone, and their complicated controls.

If you wish to speak with complete privacy, pass a finger over the low volume sensor. Yes, for strictly private calls you'll have to hold Finger Fone up to your ear. You won't mind, however, because the entire unit is a mere 11¼ ounces, just a featherweight more than ordinary telephone handsets.

YOU HEAR THEM, THEY DON'T HEAR YOU

Need to put your caller on "hold" for a moment? Easy. Tap keys 1 and 2 simultaneously, and the red light will dim. The other person won't be able to hear you, but you'll be able to hear him or her. We recommend you tell people about this so they don't make unguarded comments they think you can't hear. When you're ready to resume your call, simply tap keys 1 and 2, the red light will brighten and you can continue.

BUSY SIGNAL? FORGET IT!

Because Finger Fone automatically remembers the most recently dialed "busy" number. When you want to call that number again, tap the "RE" (Recall) key once. Finger Fone dials the number for you, as often as needed until you get a clear line.

WHY WAIT FOR PUSH BUTTON DIALING?

Finger Fone is compatible in areas of the country where push-button dialing is already in use. But if you live in the 30% or so of the country where only rotary-dial phones can be used, wait no longer. Finger Fone automatically converts from musical tones to rotary-dial signals. This way, you can have the speed and advantages of push-button dialing without waiting for your local phone company to install central equipment.

NOW AVAILABLE AT INCREDIBLE LOW COST

Finger Fone costs only **$79.95** compared with prices of similar-looking telephones (but not similar in performance) costing $109, $130, or more. Want two? Then it's only **$74.95** each. Three? Save even more at **$69.95** each. Add a $2.50 charge to your total order for insured shipping, and if you live in New Jersey, include 5% tax.

MONEY-BACK GUARANTEE

You can try one or more Finger Fones in your own home for 30 days, protected by our unconditional money-back guarantee. If you're not satisfied with Finger Fone for any reason, simply return it (insured) for a full refund, no questions asked. Finger Fone is also covered by a 1-year parts and labor guarantee.

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To order Finger Fone, call toll-free now. We're open 24 hours a day. You can charge it on Master Charge, Visa, American Express, Carte Blanche or Diners.

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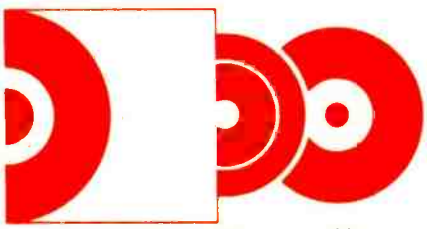
CIRCLE NO. 43 ON FREE INFORMATION CARD

Blondlot was on very shaky ground, for a great many other factors influence the brightness of a spark. When a skeptic indicated that he did not see the change in brightness that was supposed to occur, Blondlot and his colleagues countered that his eyes did not seem to be sufficiently sensitive. Actually, by surreptitiously removing a piece of apparatus that would invalidate the entire experiment (a darkened room was used) and noting that the results were not affected, the skeptic, the American physicist R.W. Wood, was able to demonstrate the falseness of the conclusion.

There is an interesting parallel between N-rays and some of the exotic sonic subtleties that some people attribute to various audio electronic equipment. A difference in "grain," "grit," "openness," or whatever is postulated, and if you can't hear it, there is something wrong with your ears, or you haven't trained yourself enough. But under controlled conditions, these differences mysteriously disappear, leading the faithful to conclude that the controls are somehow masking the difference. Logically, it would follow that you can't make any reliable objective determinations about the way equipment sounds. You can only take the word of the gurus.

Even in cases where it has been shown fairly definitively that certain audible differences do exist, it seems questionable whether they are worth bothering about. For example, it has been shown that some individuals, at least, are sensitive to polarity inversion in an audio signal. Yet, none of them seem to be able to say which polarity is correct. If the music doesn't sound better or worse either way, can it be worth the trouble to count up the number of inverting amplifier stages all the way through the recording/playback chain? In my view, the answer is a clear "no," but I would not care to predict what those philosophers whose specialty is finding black cats that aren't there in dark rooms will say. ◇



Audiophile Recordings

Specialty software for those having high-quality equipment and fussy ears has up to now been the bailiwick of a number of small companies. One result of this has been that many, though by no means all, of these recordings contain relatively uninspiring music, performances by relatively unknown artists, or both. But, with the entry of one of the giants of the recording industry into the market, audiophile software may take on a radically different look.

CBS Records has announced its new Master Sound Series of records and tapes. This will consist of discs mastered at half speed and cassettes with Dolby noise reduction duplicated on chromium-dioxide tape at 16 times normal speed, which is relatively slow as cassette duplication goes. Many of the master tapes will be digital, although some conventional masters will be reissued. The records, which come in special packages with static reducing sleeves, are being manufactured in a new plant by carefully optimized processes and subjected to rigorous quality control. Prices for both discs and tapes will be $14.98.

This raising of the ante as far as *what* is recorded is concerned, will probably put pressure on some of the specialist companies, who may not be able to afford the investment needed to record, say, major symphony orchestras. But it should provide audiophiles with some really satisfying music to listen to. All this assumes, of course, that CBS will be able to keep the sonic quality of the discs and cassettes in the right ballpark. Halcyon days may be ahead for persnickety lovers of recorded music, for should the first giant succeed, can the others afford not to follow?

SHOSTAKOVICH: ***Symphony No. 5.*** Leonard Bernstein and the New York Philharmonic. CBS Masterworks IM 35854. Like many conductors, Bernstein seems to get better as he ages. Whereas in the past, one might feel from time to time that he was being led a little off course by some of the surface features of the music, he now seems to go directly for the heart. In this recording, he projects a deep feeling for Shostakovich and for this symphony in particular, interpreting it with great solemnity and seriousness of purpose without making it oppressively heavy. The result seems unusually convincing.

Sonically, the disc is neither the best nor the worst of the audiophile genre. As befits its digital mastering, the disc has a very clear sound and wide dynamic range. It is pleasant indeed to hear lightly scored woodwind passages that have not been boosted to keep them above the noise. As the music proceeds toward the inner grooves, some of the inevitable degradation occurs, but it remains minor. Some of the specialty companies might not have recorded the disc as far toward the center, but they rarely release works as long as this. Overall, if this music has any attraction for you at all, this recording should give you goosepimples.

STRAVINSKY: ***Petrouchka (1947 Version).*** Zubin Mehta and the New York Philharmonic; Paul Jacobs, Piano. CBS Masterworks Cassette HMT 35823. Sonically, this tape is not quite the equal of the Shostakovich disc recording, but it comes close, and is far better than most prerecorded cassettes. Tape hiss is kept well out of the picture, and none of the other evils associated with the medium (tape skew, crosstalk, dropouts, high-frequency saturation, etc.) obtrude noticeably either. Comparisons of this kind are risky, but I believe I have heard digitally mastered discs that do not sound as good as this digitally mastered cassette.

Mehta and the orchestra give a spirited performance that makes much of the color and contrasts in the work while projecting a sense of energy. The overall result did not strike me as overwhelming, but this is a selection well worth hearing.

HONEGGER: ***Pacific 231, Pastorale d'été, Rugby, A Christmas Cantata.*** National Chorus and Orchestra of the O.R.T.F., Jean Martinon, conductor. Connoisseur Society Laboratory Series C 4011. This selection is recorded on chromium dioxide and replicated at *normal playing speed*, which is most unusual. Its ultimate source appears to be a conventional tape master; but from its excellent sound, one would suspect that it is several generations closer to the original than is normally the case. The sound is big where necessary, detailed where necessary, and encompasses a positively huge dynamic range, all without telltale signs of hiss or saturation. Abberation of the stereo image due to inaccurate phasing between the channels is notably absent. On the first side, the conductor and orchestra capture the brute force of "Pacific 231," the delicate beauty of "Pastorale," and the energy of "Rugby." "A Christmas Cantata," with seasonal tunes, contains some very sensitive singing.

HEART: ***Dreamboat Annie.*** Nautilus NR3/MRS 5005. Sensitive singing is a hallmark of this disc too. Ann Wilson, with a sound that is unusually clear and limpid among popular singers, does a fine job of stringing out some especially touching melodies and lyrics. The arrangements are elegant and well-played. This disc offers additional proof that a recording need not be digital or direct-to-disc to give good sound. The only exotic production technique alluded to in the information that comes with this album is half-speed mastering of the disc, but, presumably the master tape was prepared with great care—at least that's the way the disc sounds.

SONY INTRODUCES A CASSETTE DECK FOR PEOPLE WHO WOULD ONLY CONSIDER REEL-TO-REEL.

Until now the superiority of reel-to-reel tape decks to cassette decks has gone unquestioned.

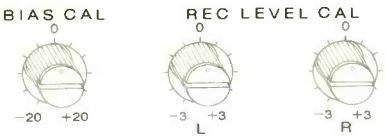
But Sony, renowned for its unique ability to perfect each link in the recording chain—microphones, motors, tape heads, even the tape itself—has just created the TC-K81. A cassette deck so advanced it delivers the kind of crisp, clear, unwavering sound reproduction you would only expect from reel-to-reel.

HEADS WITHOUT HEADACHES.

Just as in the best open reels, at the heart of the Sony TC-K81 cassette deck are three separate heads. One to erase, one to record and one to play back. This arrangement offers instantaneous "off-the-tape monitoring." Which means you can compare the quality of the recorded music to the quality of the original—while you're recording.

In addition, each head can be optimized for its own specific function.

Of course, fitting three heads into the tiny cassette shell openings, accurately, for years on end, is no small feat. Especially since the slightest alignment error can cause significant high-frequency loss. So to make sure you hear all the sound you're supposed to, Sony has created a major breakthrough in head design with a unique independent suspension system.



This remarkable system allows incredible precision and consistency in head alignment. And just as important, there's no longer the need for you to realign the heads from one tape to the next as in other cassette decks. Equally innovative is that only Sony uses heads that are a combination of Sendust and Ferrite. So you get the advantages of both, without the disadvantages of either.

TWO FUNCTIONS, TWO MOTORS.

Because tape-speed irregularities can affect your music, the K81 has two separate motors. One takes care of fast forward and rewind, while the other, combined with what we call "Closed-Loop Dual-Capstan Drive," moves the tape with absolute uniformity past the heads. There's no pulling, pushing or tugging.

This division of labor reduces the number of mechanical parts needed in the drive mechanism and virtually eliminates wow and flutter.

THE LAST WORD IN FINE TUNING.

All tape is not created equal. So the K81 features front-panel bias calibration controls. These allow the K81 to be hand-tailored in order to get the ideal high-frequency response out of each individual tape.

And to insure your recordings are made on a background of silence, free of annoying tape hiss, the K81 incorporates the Dolby® Noise Reduction System. But Sony goes one better with a foolproof record calibration device that insures the Dolby System will always work at its peak effectiveness.

Obviously we could fill pages on the technological advancements in the K81. Like the two 16-segment, LED Peak Program Meters. Or the special "Auto-Space Record Mute" which allows you to blank out commercials and other interruptions.

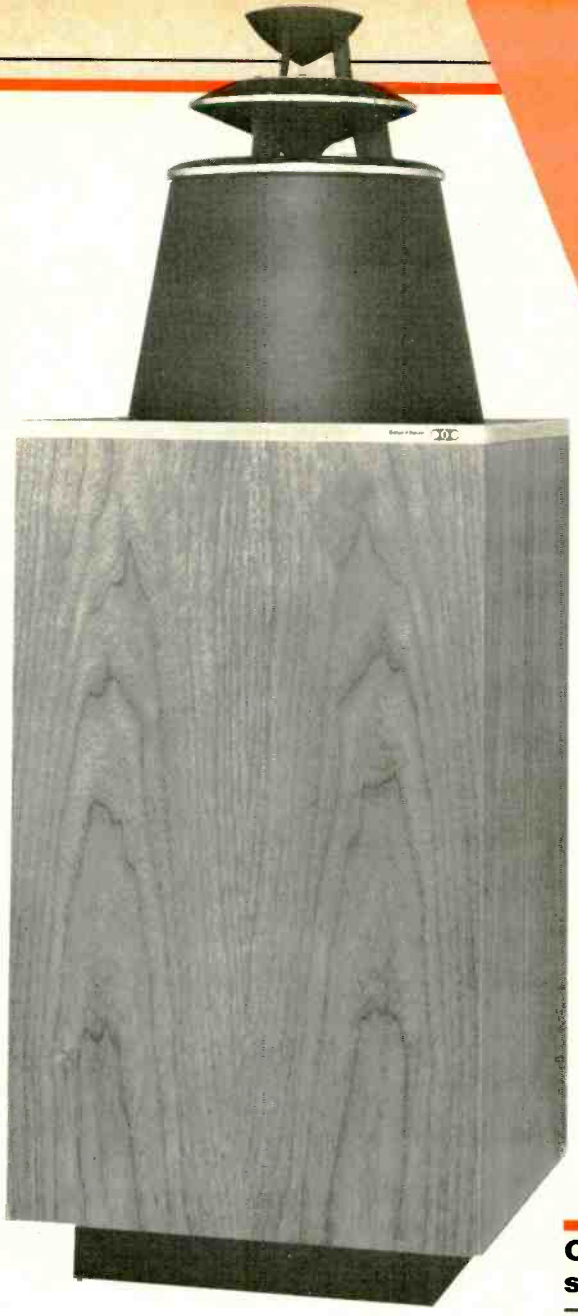
But you don't have to understand all the circuitry to know what makes the K81 superior.

When it comes to high fidelity there's only one thing you have to know. And that's Sony.

SONY®
High Fidelity

FEATURES AND SPECIFICATIONS: Independent-suspension three-head design with switchable tape-source monitoring/Metal tape recording and playback/Sendust and Ferrite record and play heads/Two-motor closed-loop dual-capstan tape drive/Microprocessor solenoid-logic transport with feather-touch controls/Bias and record level calibration with built-in test tones/16-segment LED Peak Program Meters/Auto-space record muting/Auto-play repeat capability/Optional remote control/Wow and flutter (WRMS) 0.04%/Frequency response (metal) 30 Hz-18 kHz ±3 dB/Signal-to-noise ratio (metal or FeCr, Dolby off) 60 dB.

CIRCLE NO. 57 ON FREE INFORMATION CARD



Audio Equipment Reviews

by Julian Hirsch

B.I.C. Model TPR600 Speaker System

Omnidirectional floor-standing system is rated at 130 watts

B.I.C.'s "SoundSpan" speaker systems are designed to distribute their radiation omnidirectionally in the horizontal plane while maintaining wide vertical dispersion as well. Heading the line is the TPR600 (the letters stand for "total power radiation"), a fairly large floor-standing speaker rated to handle up to 130 watts of program power and having nominal impedance of 6 to 8 ohms.

The walnut-grain vinyl veneered wooden base of the TPR600 stands about 27½" (688 mm) high, but with the black grille assembly in place on the base, the system stands 41¼" (1.03 m) high and is 15¼" (381 mm) square. Spring-loaded input connectors are hidden beneath the enclosure, which is finished on all visible surfaces. There are no user-adjustable balance controls. Weight is about 55 lb (25 kg). Price: $350 each.

General Description. The drivers are vertically aligned on the central axis of the system, with the tweeter and midrange driver facing upward and the woofer facing downward into the enclosure. Middle and upper bass frequencies radiate from the back of the woofer cone, and the bass enclosure is vented through a long narrow slot that opens under the bottom front edge of the cabinet. This is the B.I.C. "venturi" bass loading system that has been used for several years.

A conical metal deflector above the woofer directs its rear radiation into a vertical angle that roughly matches those of the higher-frequency drivers. The bass deflector and woofer basket are completely surrounded by a foam plastic collar that evidently loads the woofer in the upper part of its range.

Within the upper portion of the bass deflector is the upward-facing (and hidden) midrange driver, apparently a dome radiator. A curved metal deflector and phasing plug structure above it provide horn loading. Atop the stack is a ceramic tweeter, also facing upward into a deflector that acts as a horn for high frequencies. Crossover frequencies between drivers are not specified.

The distinctive structure consisting of the three drivers and their deflectors is located entirely in the clear top of the bass enclosure. When the cubical black grille is snapped into place it covers the assembly, but not entirely.

Laboratory Measurements. We placed the B.I.C. TPR600 speakers about 3 feet from the back wall and side walls of the room. Measurements in the far field gave virtually identical response curves for both speakers, as would be expected on the basis of

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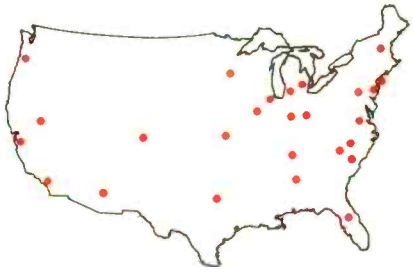

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ED-139

CIRCLE NO. 28 ON FREE INFORMATION CARD

their design. Close-miked woofer response was measured near the rear of the cone, and separately at the mouth of the bass port. Inaccessibility of the cabinet interior prevented us from measuring the vent dimensions, which are needed for summation of the cone and port radiation.

Woofer output peaked at 70 to 80 Hz, dropping off gently at higher frequencies and rapidly at lower frequencies. Port output was nearly uniform in the low bass, rising about 4 dB from 20 Hz to its maximum at 60 Hz and then dropping steeply at the higher frequencies.

Ignoring the output of the bass port, the splice of the woofer output curve to the smoothed middle- and high-frequency curve resulted in a response within ±3 dB from 55 to 13,500 Hz. The port radiation takes the lower frequency limit well below 55 Hz, but our measurements cannot tell just how far. Tweeter response rose steeply above 13 kHz so that output at 20 kHz was about 10 dB above the average midrange level.

System impedance was between 5 and 6 ohms in the frequency bands from 20 to 35 Hz, 100 to 300 Hz, and 2 to 4 kHz. Maxima were 25 ohms at 65 Hz, 11 ohms at 1 kHz, and about 10 ohms between 10 and 20 kHz.

Voltage drive equivalent to 1 watt into 8 ohms (2.83 V) elicited bass distortion of less than 1% from 100 to 55 Hz, 6% at 40 Hz, and 12% at 35 Hz. A 10-dB increase gave distortion readings of typically 2 to 4% between 100 and 50 Hz, and 12% at 40 Hz. Distortion measured close to the port was much less at the lower frequencies, suggesting that the TPR600's bass is clearer than our data can show. Since we could not determine the effective crossover frequency between the port and cone radiation, we could not fully evaluate the system's bass distortion characteristics.

Driven by 2.83 V of random noise in an octave centered at 1 kHz, the system delivers a sound pressure level of 88 dB to a microphone 1 meter from the edge of the cabinet at the level of the midrange driver. This is relatively high efficiency.

User Comment. The manufacturer recommends no particular placement of the speaker in the room, and, in fact, implies that almost any placement will be satisfactory. That may be true, but our experience with omnidirectional speakers suggests that some experimentation may be required for best results. As the radiation from such speakers is "sprayed" in all directions and a larger proportion of it is reflected from room surfaces and furnishings than with other designs, the environment into which omnis work can influence their sound markedly.

In our fairly "dead" room (with carpeted floor and sound-treated ceiling, but relatively "hard" and reflective walls), the overall balance of sound from the B.I.C. TPR600 was slightly bright. Bass sounded strong, down to at least 35 Hz or so, with no obvious sign of artificial heaviness from the slight peak we measured at 70 Hz. The high-frequency emphasis provided by the ceramic tweeter lies above most musical overtones and fundamentals, and is rarely audible as a tonal coloration. Only on a few selections could we detect its presence as an "edgy" quality.

Although it is difficult at best to predict the sound of any speaker in any arbitrary room, the TPR600 is best suited to a moderately large and well damped room, whose furnishings will absorb some of the acoustic output in the upper treble range. Under those conditions a pair of TPR600s give a well-balanced sound without obviously seeming to be the source of the program. Stero imaging is broad and diffuse rather than detailed, but it holds up well at locations throughout the listening area. If your taste and/or home furnishings militate in favor of omnidirectional speakers, this model is worth serious consideration.

CIRCLE NO. 101 ON FREE INFORMATION CARD

Rotel RP-9400 Record Player

Quartz-locked, direct-drive turntable has low-mass tonearm

THE Rotel RP-9400, a quartz-locked, direct-drive turntable combined with a low-mass tonearm, is designed to play single records automatically or manually. Its drive turns the platter at 33⅓ or 45 rpm.

The wooden base is attractively finished in a golden tone, with a satin aluminum front panel, and the entire record player is supported on four spring-mounted rubber feet. The hinged cover can remain fixed at positions intermediate between fully open and closed. The RP-9400 measures 17¾" W × 14"D × 6"H, and weighs 19 lb, 2 oz (8.7 kg). Its suggested retail price is $375.00.

General Description. Once the power switch of the Rotel RP-9400 has been turned on, the normal functions of the record player can be controlled from its front-panel buttons. The two vernier speed controls are flanked by pushbuttons that select the operating speeds and activate the quartz-lock circuitry. A red light shows when the speed is locked to the quartz-crystal oscillator frequency, but the operating speed can only be determined by a close inspection of the selector button to see if it is "in" or "out." To adjust the speed verniers, it is first necessary to disable the quartz-lock system. A band of stroboscope markings on the platter rim is lighted by an LED driven from the quartz reference oscillator.

Pushbuttons initiate the START and STOP functions. A touch on START turns on the motor, and the arm, driven by its own motor, moves to the position determined by the SIZE button and lowers to the record surface. After play, the arm lifts and returns to its rest, and the turntable drive motor halts. Touching STOP interrupts play at any time. Manual operation is initiated by picking up the arm (which turns on the platter motor) and cuing it to the record. However, the end-of-play shutoff is always effective. Two other pushbuttons engage the REPEAT function and select the record indexing diameter (SIZE). The latter has positions for 12- and 7-inch records. In the REPEAT, a record will be replayed indefinitely.

The tonearm of the RP-9400 is a straight tube with an offset headshell that plugs into the end and is retained by a thumb-screw. Smaller than most cartridges, Rotel's headshell has been designed for minimum mass. It has mounting slots that allow adequate adjustment of stylus overhang. The 16-mm overhang recommended in the instructions cannot be measured with the necessary accuracy, so installation has been simplified by an alignment gauge included with the turntable. On the circular arm base, together with

(Continued on page 29)

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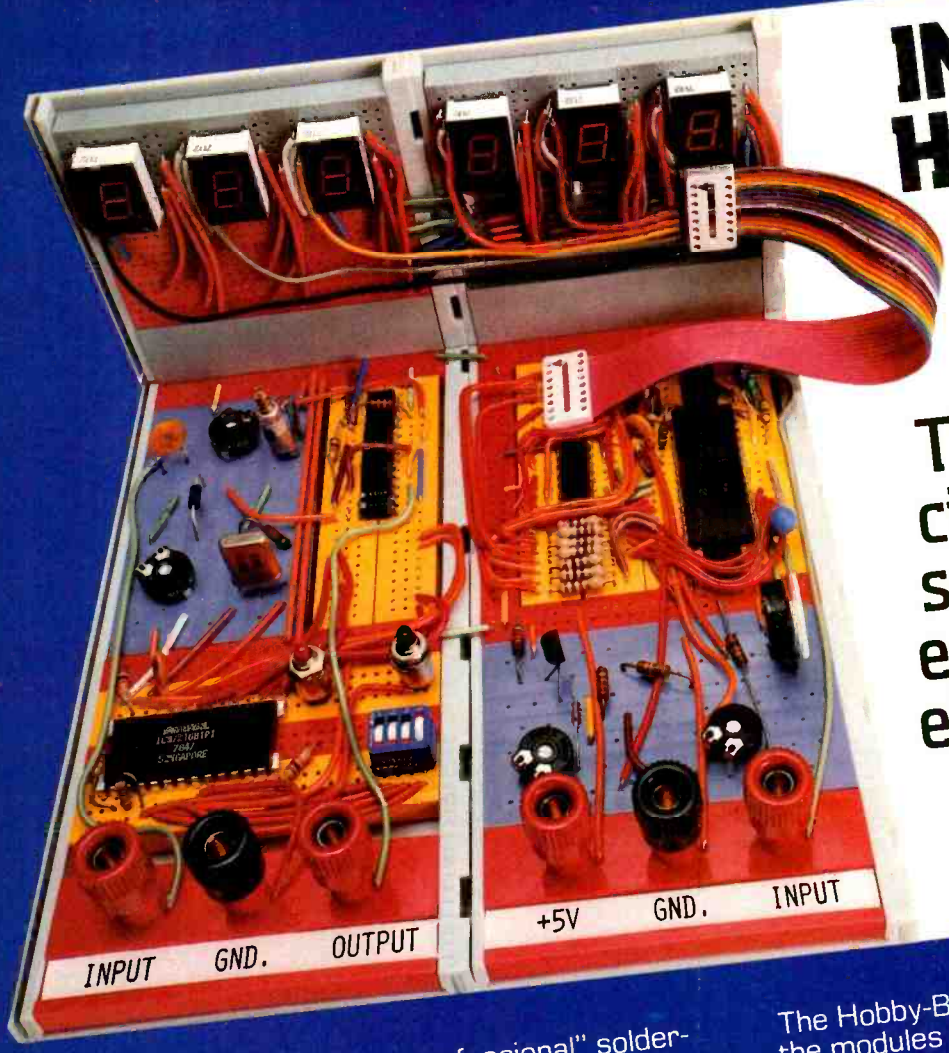

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(Continued from page 26)
an antiskating compensation dial is the cuing lever. The threaded counterweight assembly contains a tracking force scale.

Laboratory Measurements. The Rotel RP-9400 was tested with a Shure SC39ED cartridge. Except for the very tight fit of the connecting clips on the cartridge terminal pins, the installation was straightforward, as was the setting of the overhang with the aid of the alignment guage. Tracking error was about 0.3 degrees per inch when the arm had been adjusted for tangency at a 2⅜-inch (60.3-mm) radius. Tracking force was accurate within 0.1 gram.

Tonearm wiring capacitance was 156 picofarads on one channel and 160 picofarads on the other, with an interchannel capacitance of 7.5 picofarads. This, assuming a preamp input capacitance of 50 to 150 pF, is well suited to the Shure and most other fixed-coil cartridges.

The RP-9400 tonearm proved to be one of the lighter ones we have measured in recent months, with an effective mass (less cartridge) of only 8 grams. With the SC39ED cartridge, the low-frequency resonance was at 9 Hz, with a 7-dB amplitude rise. The anti-skating compensation was close to optimum, although we found a setting of 1.5 grams best with the 1-gram tracking force we used. The cuing system, although it had a damped action, tended to shift the descending arm outward and repeat about 12 seconds of the record each time it was used.

Rotational stability was very good, with a JIS (weighted rms) flutter of 0.065% and a DIN (weighted peak) flutter of 0.08%. Although flutter is specified with the quartz lock turned on, we found no difference with it on or off. (Rotel's flutter rating of 0.025% could not have been measured with any standard test record we know of—they all have sufficient warp and eccentricity to swamp such a low reading—so we assume that it was measured with an optical scan of the platter movement, or with a specially made record.) In our measurements, the major flutter rate was under 10 Hz, but a spectrum analysis showed smaller peaks between 45 and 50 Hz, 90 and 95 Hz, and at intervals of about 50 Hz up to about 300 Hz.

Rumble was low, especially in an unweighted measurement, where the −37-dB reading we obtained was unusually good. ARLL weighting lowered it to −60 dB, which is also very good. Its spectrum concentrated in the 5-to-10-Hz range, but included components at 30, 40, 75, and 90 Hz. Platter speeds were exact and unaffected by load or line voltage changes. Motor torque was sufficient to accelerate rotation from 33⅓ to 45 rpm in about 1 second, and return it in 3.5 seconds. The PITCH controls had a range exceeding the rated 3%, with the 33⅓-rpm adjustment covering +7.5 to −7.2%, and the 45 rpm setting adjustable over ±9.8%.

Conducted vibration in the audio range was well damped by the soft rubber feet of the RP-9400. In that respect it appeared to be about average for direct-drive turntables. But we found it especially insensitive to jarring and normal handling, which often tend to displace the tonearm on a softly sprung record player. From this, we infer that its infrasonic isolation is much better than the average.

Automatic arm cycle took about 10 seconds to place the pickup in the record groove after START was pressed. The return to the rest in the STOP cycle took about the same time, but another 5 seconds elapsed before the platter motor shut off. This is a longer than usual turn-off time, although the process can be speeded up by returning the arm to rest manually. Some mechanical sounds accompanied arm cycling, but operation was silent at all other times.

User Comment. The low-mass tonearm of the Rotel RP-9400 is certainly its most important and distinctive feature. It lets the unit play warped records that most tonearms simply cannot follow. The Rotel arm is obviously well designed, with the cartridge offset and shifted to one side so that the stylus is on the axis of the arm tube. With all these positive qualities, it was disappointing to find the cuing lift bar lacking enough friction to hold the arm at its horizontal position when it was raised and lowered.

The front-panel location of the controls was very convenient, although it would have been even better had the cuing control been accessible from the front. Our criticisms are few and may seem petty, but in fact they are all that stand between the RP-9400 and shining excellence. As matters stand, the Rotel is uncommonly handsome and full of advanced features—and at the "bottom line" of the phonograph balance sheet, it does a really fine job of playing records.

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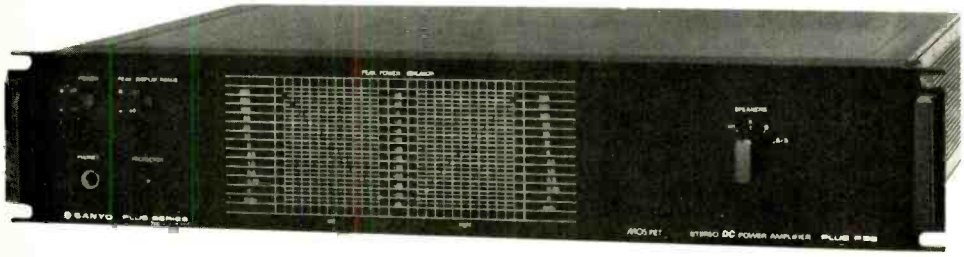


Sanyo Plus P55 Power Amplifier

MOSFET power output stages provide high power and overload protection

COMPACTNESS along with novel circuitry and mechanical features set the Sanyo PLUS P55 basic power amplifier apart from most of its competition. Rated at 100 watts per channel into 4- or 8-ohm loads, from 20 to 20,000 Hz, with no more than 0.009% total harmonic distortion, the fully direct-coupled amplifier uses power MOSFET output devices claimed to give it a slew rate of 150 volts per μs. The channels can be strapped to convert the unit to an 8-ohm-rated mono amplifier capable of 200 watts output at a distortion rating of 0.03%.

A peak responding power indicator covers the range from 25 milliwatts to the amplifier's maximum ratings. The amplifier is finished in black and measures 17⅜" W × 12½" D ×

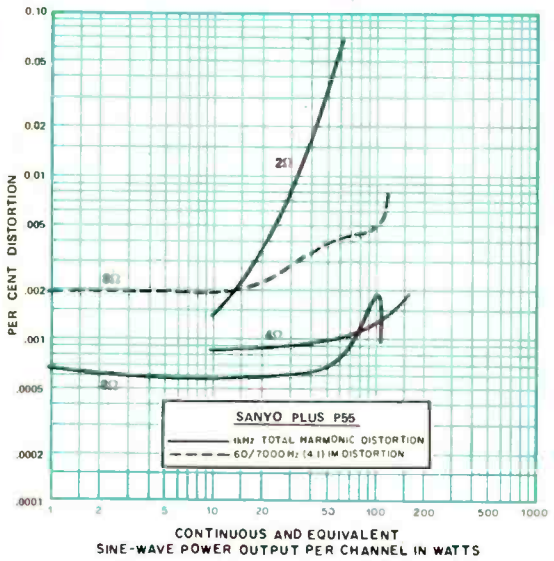
3½"H (440 × 320 × 88 mm) and weighing 26.4 lb (12 kg). Mounting handles are supplied for installing the unit in a standard EIA equipment rack. Suggested retail price is $399.95.

General Description. Each channel of the Sanyo PLUS P55 consists of three voltage amplifier stages, followed by an output stage using four MOSFET devices, connected as source followers in push-pull/parallel. Every stage in the amplifier (except the output driver) is a differential configuration with fully balanced input and output connections.

An integrated pair of FETS, connected in cascode with a pair of bipolar transistors, is used for the input stage (which is protected from r-f interference and ultrasonic noise by a low-pass filter with a 600-kHz cutoff). Cascode and current-mirror circuitry is used in the next two stages.

The headphone jack on the front panel is driven from the amplifier outputs through 560-ohm limiting resistors. In addition to the pushbutton switches for power on/off and display sensitivity, a knob connects either, both, or neither of two pairs of speakers to the amplifier. The two channels of the PLUS P55 have separate power supplies and transformers, both protected by circuit breakers.

An unusual feature of the PLUS P55 is its fluid-convection cooling system. The output transistors are mounted on heavy metal blocks that are fastened in turn to a hollow tube forming an elongated loop fitted with cooling fins. The sealed loop contains liquid Freon that vaporizes under the heat from the output transistors. Freon vapor travels by convection to the upper cooler part of the tube losing heat and condensing. Refrigerant then runs back to the lower part of the loop to complete the cycle. According to Sanyo, this system weighs only about 20% as much as a conventional heat sink, and, unlike a fan, is silent.



THD with 1 kHz, both channels driven, left measured, and IM distortion into 8-ohm load. With 2-ohm load, protective circuit operates at approximately 70 watts.

The advantages of MOSFETs as power amplifiers are well-known, and include thermal stability without complicated biasing and protective circuits, very high switching speed, and a square-law characteristic that limits even their minuscule distortion to even-order components.

The power output display of the PLUS P55 consists of two rows of LEDs sloping upward to the left and right at 45-degree angles. The lights are calibrated in terms of power delivered to 8-ohm loads (in watts and decibels of the 100-watt rated power). The LEDs for 100, 200, and 500 watts are red, while the others are green. In normal operation, the LEDs above 100 watts never light, but a pushbutton increases the readout sensitivity by ten times, so that it spans the range from 25 milliwatts to 50 watts, the later corresponding to the LED for 500 watts.

Laboratory Measurements. The top of the Sanyo PLUS P55, over the heat-radiating fins, became quite hot during the one-hour preconditioning at one-third rated power. In the latter part of that hour, the amplifier cycled on and off with a duty cycle of about 50 percent.

Output (1,000 Hz) into 8-ohm loads at clipping was 118 watts per channel (1HF clipping headroom = 0.72 dB). Into 4 ohms, the outputs clipped at 163 watts, for a clipping headroom of 2.12 dB. Excellent power-supply regulation was demonstrated by the fact that the 8-ohm dynamic power and clipping power were identical.

With lower impedances, dynamic power was only slightly greater than the steady-state clipping output. Into 4 ohms, dynamic headroom was 2.81 dB (191 watts). With 2-ohm loads, for which the amplifier is not rated, clipping power was 72 watts (at which point the protective circuits cut off the amplifier) and the dynamic output was 85 watts.

An input of 100 millivolts drove the amplifier to a reference output of 1 watt; A-weighted noise level was less than −90 dB re 1-watt output.

Frequency response at 1 watt was flat from dc to about 30 kHz, dropping off to −1.5 dB at 100 kHz and −10 dB at 500 kHz. Rise time was 1.5 microseconds. The protective circuits, apparently sensing a small dc component in the output of our square-wave generator, shut down the amplifier and prevented measurement of slew rate, but IHF slew factor measured 7, with a 1-volt sine wave becoming slightly triangular at 140 kilohertz.

For all practical purposes the PLUS P55 is a distortionless amplifier at any level short of clipping. With 4- and 8-ohm loads the amplifier never approached its 0.009% distortion rating until the output was well beyond 100 watts. The 2-ohm load increased distortion to 0.032% at 70, where the amplifier shut down due to excessive current. Worst-case distortion read 0.008% at 120 watts.

We also checked the accuracy of the power display LEDs. The PLUS P55 was pleasantly exceptional in that all the lights came on within 10% of the correct power levels. The display shows elegantly that high power is sometimes needed even at very moderate listening levels.

User Comment. Though we can find no basis for saying that an amplifier with distortion well under 0.001% sounds any better than one with 10 or 100 times as much distortion, it is difficult not to be impressed by this essentially distortionless amplifier. The most brutal treatment we could give it (such as repeatedly driving it into clipping with 2-ohm loads, even under the fully heated conditions of our tests) never distressed it in the least. Its protective systems are effective, yet unobtrusive in that they do not require shutting off the amplifier in order to reset the protective circuit. A few seconds after the fault condition has been corrected, the amplifier comes on automatically.

The PLUS P55 strikes us as one of the better power amplifiers we have used. Sonically, it is the equal of any we know (within its ample power limits), and it has the additional virtues of ruggedness and compactness. Its designers have chosen a sensible combination of design parameters and features. We applaud the end result.

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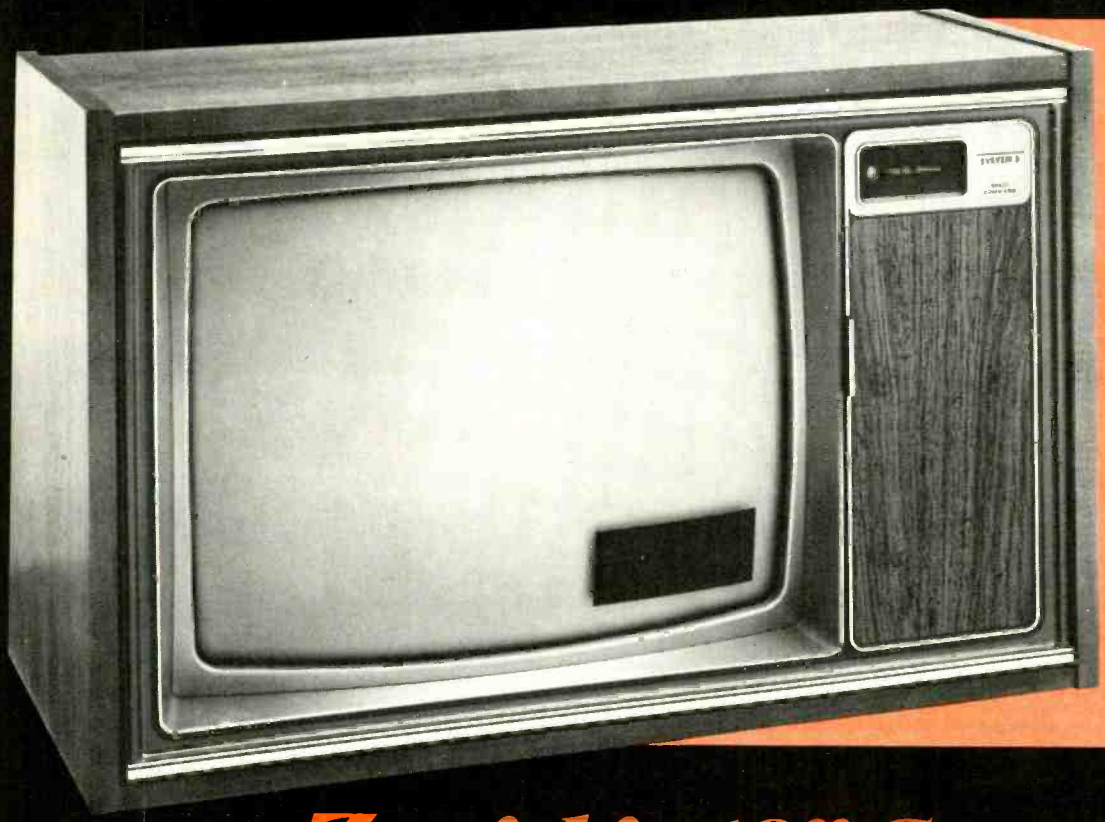

Controls for the Zenith 19" table model are behind panel at right. Patch at lower right of screen is where time and channel are displayed.

Zenith's 19" System III Color TV

TOP-OF-THE-LINE Zenith color-TV receivers are always interesting and usually offer a number of special features. The 19" models for 1980/1981 conform to the annual pattern. Always deluxe, with prices to match, these new System III receivers in the M line are fully modular, making them readily serviceable. Similar in construction to the receivers in the 1979 line, they feature a transformerless pulse-width-modulator power supply, remote control, and microprocessor-controlled tuner and prescaler.

For this report, we examined the table model SM1971P, which is housed in a handsome wood cabinet. Among its many features are a 105-channel tuning capability (to provide complete vhf/uhf and cable-TV reception), an improved phase-locked-loop (PLL) tuning filter, and nonvolatile (passive) memory that permits the tuner to return to the lowest previously programmed channel whenever power is interrupted. Better luminance/chroma separation is provided by a comb filter, while a single LSI device accomplishes all chroma processing and demodulation. A special automatic frequency control switch is provided for use with CATV and video games, and an improved countdown IC accommodates video cassettes, video games, and nonstandard CATV signals. Tuning in the up/down scan mode can be conveniently programmed to skip or stop on any selected channel, and only stored channels (in addition to digital time in hours and minutes) appear on-screen.

Audio features have not been neglected either. Transformer-isolated outputs have been provided for an earphone and to feed a hi-fi system. Plugging in the earphone silences the internal speaker.

Tuner Operation. Separate front-panel slide switches control CATV/NORM and AFC SPEC/NORM functions, which are used in their standard NORM (normal) positions for vhf channels 2 through 13 and uhf channels 14 through 83. In the CATV position, midband channels A through I and superband channels J through W appear at positions 14 through 36 on the uhf dial. Channel selections above 36 in the CATV mode are ignored by the microprocessor.

In AFC NORM the PLL system selects a precise frequency for the tuner vhf/uhf oscillator(s) 45.75 MHz above that of the incoming video carrier. In AFC SPEC, signals that deviate as much as 3.25 MHz from standard channel frequencies, such as CATV or MATV picture carrier offsets to prevent certain interference or nonstandard video games, can be locked in place. (Continued on page 38)

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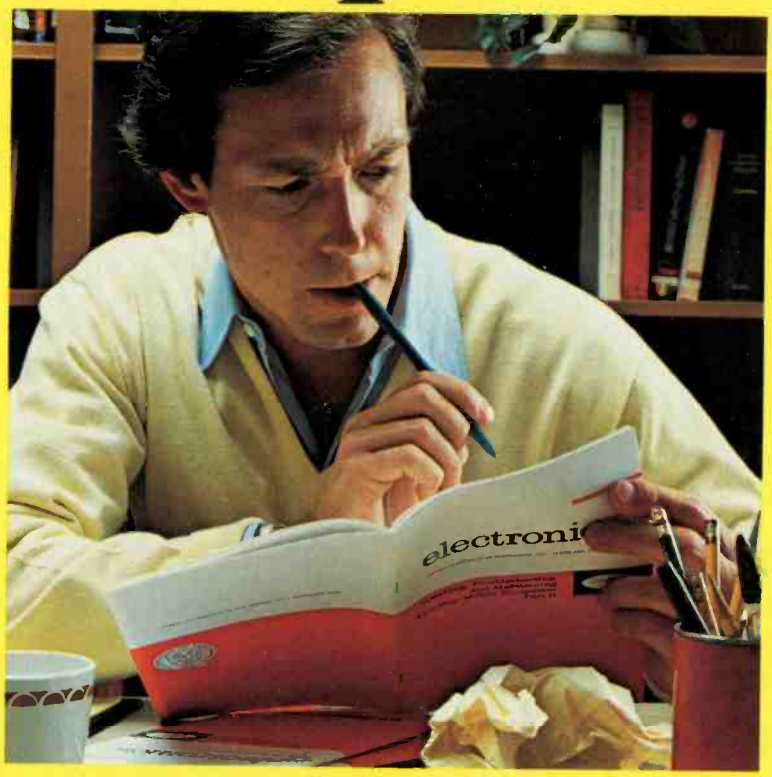

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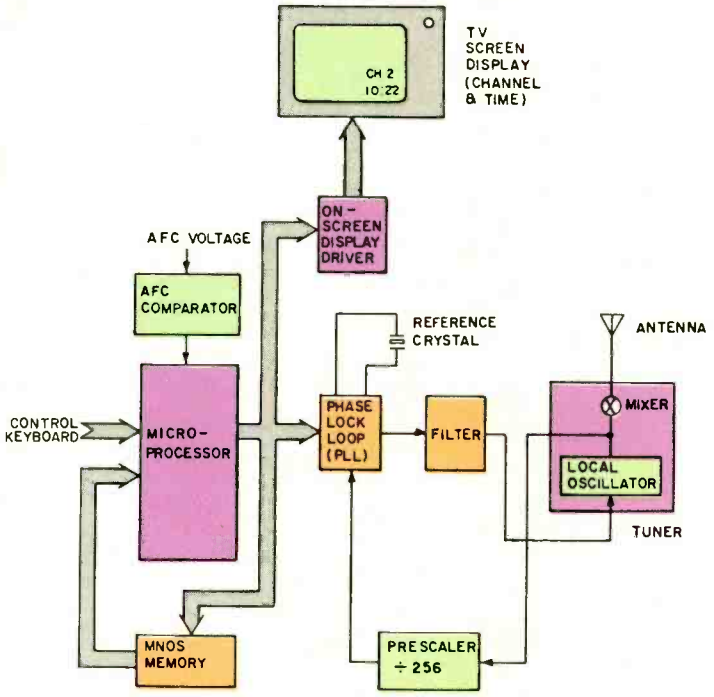

Fig. 1. Block diagram of the M line direct access and scan tuning systems.

(Continued from page 32)

Complete tuning operation depends on a new microprocessor that controls: keyboard scanning, channel information, PLL, remote entry, tuner voltages, bandswitching, and LED or CRT screen numerical display. It also monitors afc through a comparator. For up/down channel functions, the microprocessor has an additional built-in counter where 36.7- and 43-kHz special frequencies decode. There are also the normal eight entry ports for keyboard, MNOS memory, and channel selection.

Zenith's direct address and scan tuning systems for the M line are illustrated in Fig. 1. The control keyboard has 20 buttons (plus AFC/NORM and CATV/NORM switches) that set the time display, adjust volume, change channels in either direction, turn power on and off, and enter channel numbers 0 through 99. An ENTER/RECALL button allows single-digit channel numbers (2,4,6,etc.) A channel SKIP button deletes channels not programmed into memory from the up/down scan mode.

The keyboard programs the microprocessor, which delivers output to drivers for on-screen channel numbers and time while controlling PLL operation and the nonvolatile (MNOS) memory. TV tuner mixers then supply a divide-by-256 redesigned prescaler that has better input sensitivity and greater heat dissipation than in previous models. The various uhf/vhf and CATV channel frequencies are then applied to this prescaler for the PLL, which compares them with a crystal reference. The difference frequency is filtered and routed to the tuner's local oscillators as correction voltages. Channel and time information remains in white and black on the TV screen for approximately 4.5 seconds. The channel ENTER/RECALL button also recalls both channel and time for on-screen display on demand, with no channel change unless specifically programmed.

> ***". . . reproduction of all colors combined together with gray scale is just superb."***

Every five milliseconds the keyboard is scanned by the microprocessor to update the time. Programmed channels are stored in both the RAM and MNOS memory. In the AFC SPEC mode, the microprocessor monitors the afc voltage to determine whether or not it is within a specific "window" of 1 to 5 volts, thereby checking tuning. Also, there is a test to determine the presence or absence of vertical-sync pulses. (Zenith does not recommend field servicing for tuning-system modules.)

A Walking I-F. This year, Zenith is not only using wider and deeper adjacent-channel 39.75-MHz video and 47.25-MHz sound traps, but its "enchanced" surface wave i-f filter adds preshoots to the waveform for a crisper transition from light to dark in the picture. Coupled with these changes, there is also a modification to the i-f IC for a more stable agc crossover point, reducing the need for i-f module adjustment or alignment after field replacement.

An amplifier inside the IC drives an external Q-reducing transistor that, under weak signal conditions, is inoperative because of low forward bias on its base, moving the video carrier toward peak on the response curve. Under strong signal conditions, the transistor turns on hard, loading the i-f block and expanding the circuit's bandwidth. By reactance trap action, the emitter output of the Q-reducing transistor keeps the sound-carrier level constant during all agc excursions, reducing audio noise with weak signals. This "walking" i-f action is shown in Fig. 2, where trace 1 illustrates normal-, trace 2 medium-, and trace 3 high-gain levels of this i-f integrated circuit at tuner inputs of −50, −40, and −25 dBm. Preshoots are evident just before the beginning of the 0.75-MHz oscillation on the staircase.

This deluxe receiver also features a "true" synchronous, full-wave detector with limiter input, tuned and PLL-controlled 45.75-MHz voltage-controlled oscillator (vco), tuned phase shifter for afc multiplier, sync detector, and noise inverter. Objectives are to improve differential gain and color phase and reduce intercarrier audio buzz and traditional envelope detector "tweets," while offering extra afc gain and linear video detection.

Comb Filter. Like Magnavox and RCA, Zenith is now introducing into

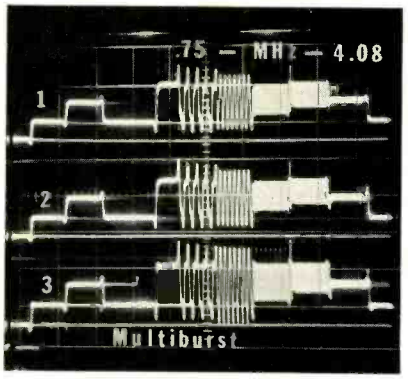

Fig. 2. Scope traces show "walking i-f: (1) is normal-, (2) is medium-, and (3) is high-gain level of the i-f integrated circuit at tuner inputs of −50, −40, and −25 dBm.

More recorders ask for Fuji by name than any other brand.

Recorders are very outspoken in their preference of tapes.

Take video recorders.

They insist on Fuji VHS and Beta videocassettes. Put in anything less and they may give you snow. Washed-out or shifted colors. Or all kinds of distortion.

Unhappy audio recorders without Fuji audiocassettes stubbornly give you less music in return. Plus distortion on loud music. Noise during soft passages. And limited frequency response. Problems our premium FX-I, FX-II and our low-noise FL help you overcome.

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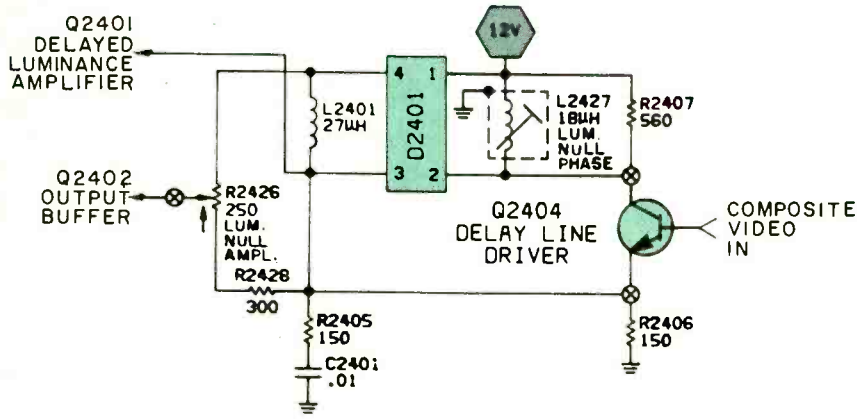

Fig. 3. Zenith's 1981 glass delay-line comb filter used to separate chroma and luminance. Also shown are phase and null adjustments.

its top-of-the-line sets a delay line/comb filter combination that is said to improve luminance resolution and reduce luminance-chroma crosstalk. Zenith chose the glass delay line rather than one of the more intricate charge-coupled devices. In Fig.3, the usual chroma/luminance phase and null adjustments and *D2401* glass delay line are shown.

Paraphase amplifier/delay-line driver *Q2404* receives composite video from the synchronous detector. Since on alternate horizontal scan lines, chroma is out-of-phase and luminance in-phase, a delay equal to a single horizontal interval (63.5 μs) permits out-of-phase chroma to appear across *R2426* along with direct video from the emitter of *Q2404*. Out-of-phase chroma then adds and doubles in value, while in-phase luminance is cancelled. Pure chroma now passes through the emitter of *Q2402* to the color processing circuits. Some of the chroma is also divided across potentiometer *R2401* and ac-coupled and phase adjusted for the base of *Q2401*.

Here, chroma in the composite video at the delayed luminance adder/emitter cancels across the base-emitter junction, leaving only luminance output at the collector of *Q2401*.

Second luminance adder *Q2405* and its emitter and collector networks equalize preshoot and overshoot tendencies, and luminance buffer *Q2403* directly drives the following delay line through *R2227*. An indication of how good this combing is can be seen in Fig. 4. Frequencies all the way out to 4.08 MHz are visible at the output of the video detector, but the 3.56-MHz multiburst is effectively combed out since it is a direct multiple of the 3.579545-MHz burst that is restrained from passing through the luminance channels to the cathode-ray tube. (The lowered 4.08-MHz response can and will probably be at least doubled in production-type Fall designs.) The 3.58-MHz *LC* trap normally used in color receivers is omitted when comb filters are used.

The Zenith chroma chip is quite complex. The circuit built around it contains phase detector (apc), voltage and crystal-controlled oscillator, automatic chroma control (acc), crosstalk adjust, dc color level potentiometer, and matrixed R − Y, B − Y and G − Y (red, blue, and green, less luminance) demodulators. All active circuitry is contained on the chip itself.

Following the crosstalk control, chroma is LC-coupled to a 12-dB limiter, acc amplifier, and the NORMAL/SETUP switch for the 3.58-MHz subcarrier oscillator adjustment. From there it goes through an automatic chroma limiter (acl) and the apc/acc phase detectors, which are ac grounded in the SETUP position. The second chroma amplifier is driven by the ACL limiter, which limits chroma in excess of 200 mV when there is color saturation, especially in the automatic color mode. With no incoming chroma, the color killer biases off the second chroma amplifier following a −26-dB input. This input is ordinarily *LC* coupled to another chroma circuit and then back to the R − Y, B − Y and G − Y demodulators for color detection.

Double-balanced apc and acc phase detectors, with 90° phase-shifted inputs, have single-ended outputs that are sensitive to burst phase and amplitude, respectively, to correct the vco frequency and the acc amplifier output. A dc TINT further changes the phase of this oscillator when operator adjusted.

There is also a dynamic tint correction circuit called AUTO COLOR (lower right) that senses colors in the yellow-to-magenta region and drops the gain of the B − Y demodulator, reducing blue and pulling these colors toward R − Y and fleshtones. This circuit does *not* affect the green vector nor the voltage-controlled oscillator.

To view reaction of this unusual single-chip chroma processor/demodulator, we photographed a specially inverted 10-color-bar generator's rainbow through the receiver and color circuits to observe petal symmetry without removing luminance from the R−Y/G−Y/B−Y display. Then, in double exposure (Fig. 5), the auto color circuit was engaged to illustrate bunching of yellow, orange, and red for broader fleshtone spreads among the first three petals of the vector. The *final* angle of demodulation revealed that the third and sixth petals (R−Y and B−Y) were almost precisely a desirable 90° apart.

Pulse-Width Modulator. An IC is used in the power supply for pulse-width dc-voltage regulation. The horizontal drivers and output stage, supply drive to the TX3352 sweep transformer. This originates high voltage, boost voltage, focus, and a number of tapped outputs that are half-wave rectified and regulated, becoming the 18-,25-, 62-, and 250-volt operating

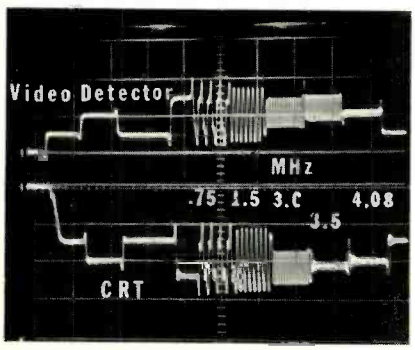

Fig. 4. Multiband responses at output of synchronous detector and input to CRT. Frequencies out to 4.08 MHz are shown with 3.56 and 3.58 removed by comb filter.

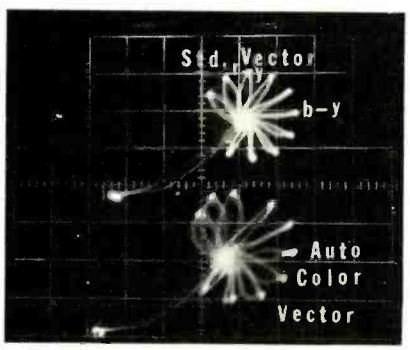

Fig. 5. Symmetrical regular and automatic color vectors. Note the bunching of yellow, orange, and red colors for greater area of flesh tones in the auto position.

PHONE WIZARD

This incredible phone dialer lets you regulate outgoing phone calls using a secret lock command.

DICTOGRAPH® the producer of communication systems for the White House and Pentagon, introduces a space age computer phone. An amazing futuristic instrument capable of 25 functions and memory bank storage of 30 numbers — convenient compact size — all at a price that will make you smile!

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It's an automatic dialer.

Think of the number of people you frequently call. The Phone Wizard stores up to 30 often used phone numbers (up to sixteen digits each) in its Memory Bank. Simply pencil in the name on the handy index pads, just press the appropriate key — one time!

Dial "Hands Free"

When dialing don't pick up the phone, just push the right button and listen. The built in loud speaker lets you hear the other person answer or the busy signal.

You actually see the number dialed.

Glance at the big bright LED display. You'll immediately know the right number is being dialed — no matter whether you're using the automatic dialer or are dialing manually.

More Outstanding Features

- Pressure sensitive keys, solid face (no buttons).
- Beep tones tell you that each digit is being dialed or stored correctly.
- Back-Space Erase lets you 'erase' a wrong number. Easy as pie.
- Want to confirm a stored number? Just press the storage button twice. Instantly you'll see a big read-out so you can verify.
- Automatically rings your number up to six times, then stops when your party isn't home.
- A three-position pulse switch allows the Phone Wizard to be connected to virtually any phone system in the world. Rotary dial or Touch tone.

Busy Number Buster and Emergency Dialer

Suppose the number you're calling is busy, just touch the Re-Dial Key, to recall. Still busy? Just program the Phone Wizard to redial later on (up to 15 times, one per minute). A special sign on the display will indicate that the number is being redialed.

Emergency! Here's the quickest and easiest mechanism for dialing the Police or Fire Dept. This feature alone is worth the price of this amazing Dialer. Program the machine before you leave. Then the babysitter or Grandma just presses the Re-Dial Key. Instantly the call is put through.

Conference Speaker For Group Conversations

Activate the Conference Speaker by depressing a button. Everyone on your end can listen in and have his say-so — with the voice coming through loud and clear. Meet by phone, you'll save time, effort, and not to mention those high gas bills!

Digital Clock, Stop Watch and Timer

Time of day displayed in hours, minutes and seconds.

Stop Watch Feature times all calls automatically — great for gauging long-distance calls, keeping records, cutting down on expenses by limiting calls, etc.

You can even time a particular PART of a call. That's how exact this special feature is.

Want to recheck the time of the last call? You can — easily. Press the Clear Key and the Time Key. A big read-out will appear instantly.

How To Place A Call On Hold

Simply touch the hold button, the word 'hold' will flash on the screen. To resume your conversation touch the button again, and you're ready to continue your conversation.

Prevents Unauthorized Use

An ingenious combination electronic lock allows you to prevent unauthorized long distance out going calls while allowing you local calls. Simply press in the secret code. This locks the dialer unit and the phone itself. No out-going calls can be made, but all in-coming calls will be received. To reactivate, simply press the secret opening code and a beep tone tells you the phone and dialer are ready for making calls. Only you know the codes for this amazing dialer. An instruction kit is included and explains all the secret codes.

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supplies. The 25-V and 18-V sources then emerge as operating voltages for the 12-V dual transistor standard loop-feedback regulator that acts as the principal supply.

Comments. From our technical description, it's evident this is a very sophisticated color-TV receiver. All ICs are Zenith-designed and most are proprietary. This and all other Zenith System III receivers are the only sets we've recently reviewed that are 100% home serviceable—everything can be plugged in!

In looking over our test results, we might wish for slightly greater luminance response beyond 3.58 MHz, which would give maximum resolution. Even so, color purity, sweep linearity, interlace, and gray scale are very good or better, and reproduction of all colors combined together with the gray scale is just superb. This makes for a picture that is delightfully well-balanced and undistorted. Moreover, in appearance and utility, this System III 19 incher is indeed outstanding—and its remote-control system is one of the very best.—*Stan Prentiss*

CIRCLE NO. 105 ON FREE INFORMATION CARD

MODEL SM1971P RECEIVER
LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (min. signal for snow-free picture):	vhf (Ch. 3): −57 dBm uhf (Ch. 40): −55 dBm
Voltage regulation (line varied from 105 to 130 V):	Low voltage: 25V supply (96%) 12V supply (99.9%) High voltage: 27 kV (97%)
Luminance bandpass at CRT:	3.5 MHz
S/N at CRT:	40.1 dB
Horizontal overscan:	5%
Chassis power requirements (signal applied):	110 W (incl. remote)
Direct coupling (or dc restoration):	>85%
Audio bandpass (input to speakers):	40 Hz to 10 kHz +0/−3 dB
Auxiliary audio Output impedance: Nominal output:	 100Ω 4.6 V rms

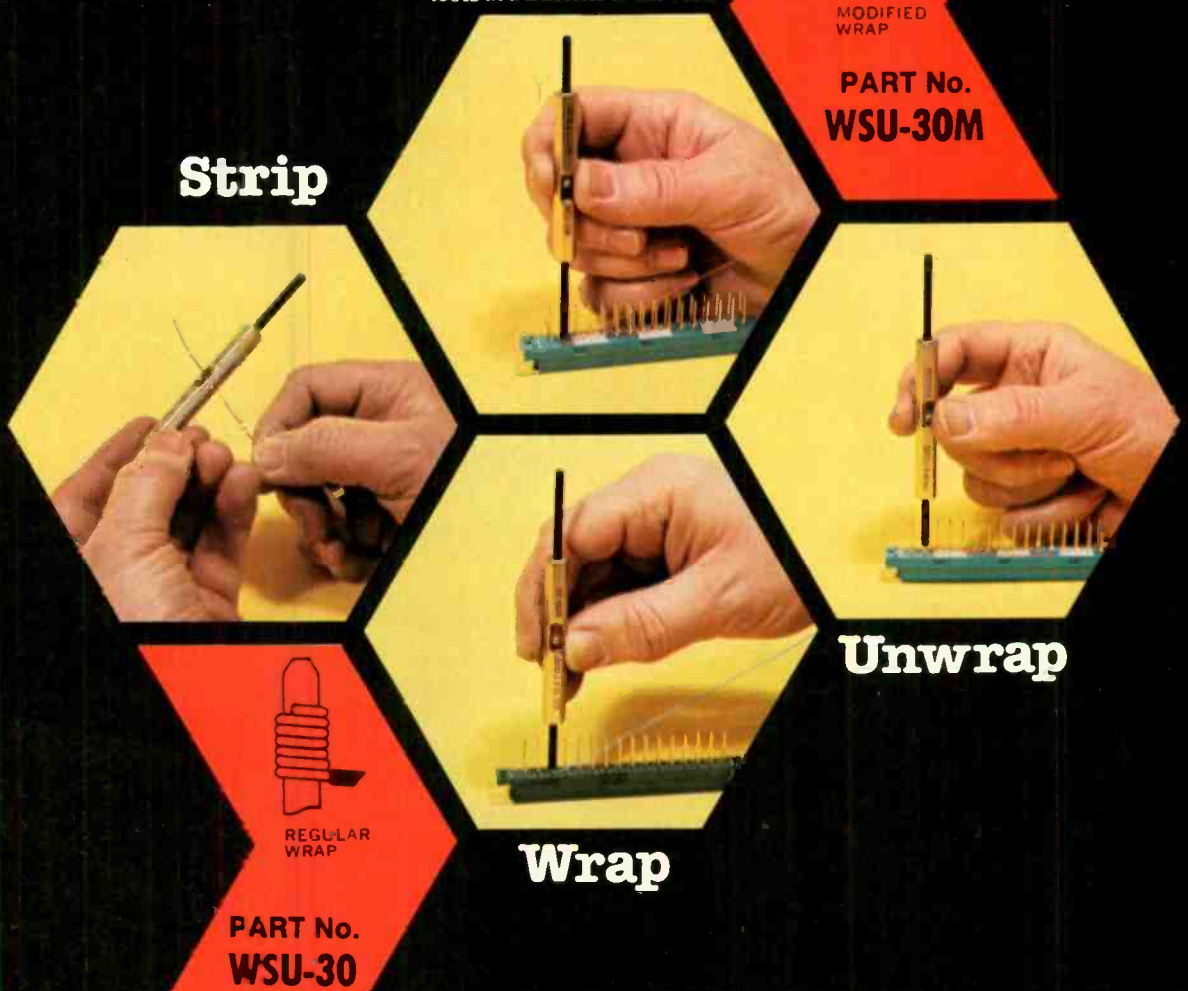
ok

$7.95* WSU-30M

NEW WIRE-WRAPPING TOOL DOES ALL

The new WSU-30M "Hobby Wrap" tool performs the complete wire-wrapping function. First, the tool wraps 30 AWG(0,25mm) wire onto standard .025 inch (0.6mm) square DIP Socket Posts. In addition, the tool also unwraps and, finally, it strips 30 AWG wire nick-free.

WSU-30M makes a "modified" style of wrap, in which approximately 1½ turns of insulated wire are wrapped in addition to the bare wire for purposes of added mechanical stability. Designed for the serious amateur, the WSU-30M features compact, all metal construction for years of dependable service. This unique tool is remarkable value performing the work of three separate tools at a fraction of the cost.



WSU-30 $6.95*

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The compact, inexpensive WSU-30 "Hobby Wrap" Tool does the job of three tools at a fraction of their comparable prices. The tool wraps, unwraps, and even strips wire thanks to a unique built-in stripping blade. Designed for use with 30 AWG(0,25mm) wire on standard .025 inch(0,6mm) DIP Socket Posts. Takes minutes to learn to use; makes perfect connections in seconds without solder.

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The Microsoft Z-80 SoftCard. Leading a Whole New Lineup for Your Apple II.

Plug the new Microsoft Z-80 SoftCard into your Apple II™ and start using all of the system and application software written for Z-80 based computers. Software that you could never use before on your Apple II.

The SoftCard actually contains a Z-80 processor and lets you switch between the Apple's 6502 and the Z-80 with simple commands, so you can use software written for either processor.

Starting with Two Software Standards. Versatile CP/M,* the most widely used microcomputer operating system ever, is included on diskette in the SoftCard package, ready to run on your Apple II.

You get Microsoft's 5.0 BASIC too, the most powerful version to date of our famous BASIC interpreter.

PRINT USING, 16-digit precision, CALL, and CHAIN and COMMON are just some of the major BASIC features you'll add. Applesoft's graphics extensions are still included.

More Power Down the Line. You can get even more programming power and versatility by adding Microsoft's FORTRAN, COBOL, BASIC Compiler and Assembly Language Development System. All are available separately to run with the SoftCard system.

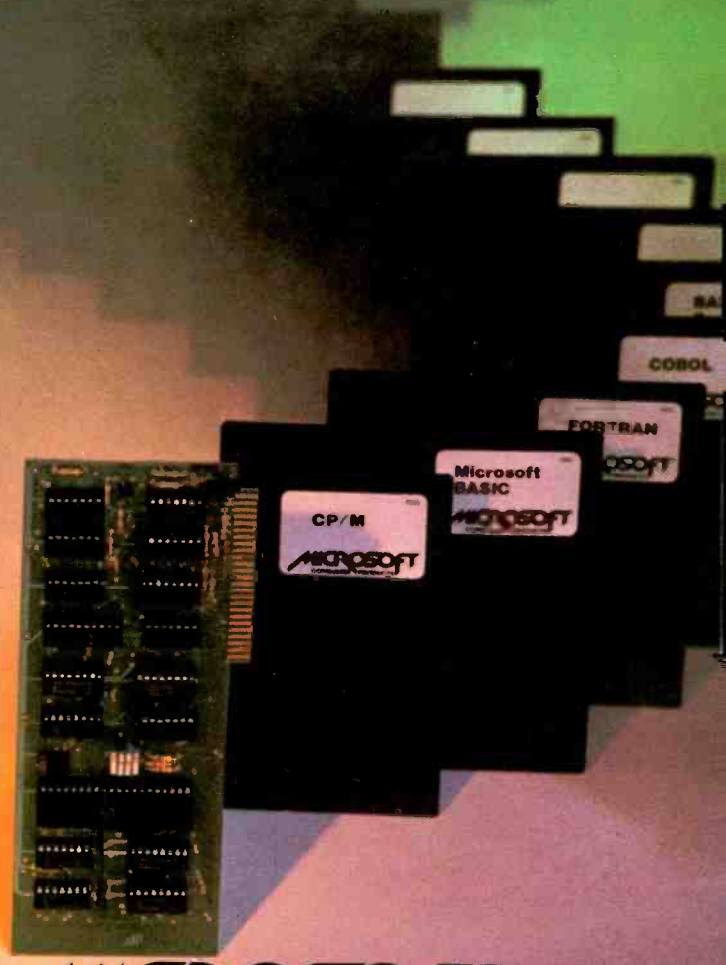
And the whole host of CP/M-based business, scientific and educational applications can be easily transferred to your Apple with SoftCard.

The Microsoft Z-80 SoftCard is compatible with most every Apple product from the Apple II to the Apple II Plus, Language Card and peripherals. Independent peripherals for the Apple are supported as well. The SoftCard package requires a system with 48K and a disk drive.

Line up a SoftCard demonstration at your Microsoft Consumer Products dealer today. They'll be glad to show you how the Z-80 SoftCard and your Apple computer combine to form a system that can't be beat for either practicality or pure pleasure by any personal computer available today. Or give us a call, 206/454-1315, for more information.

But act quickly. At the low price of $349 for SoftCard, CP/M, Microsoft BASIC and complete documentation, you may have to stand in line to get one!

™Apple II is a trademark of Apple Computer, Inc.
*CP/M is a registered trademark of Digital Research.



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Computer Bits

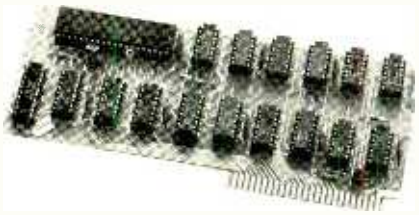
By Carl Warren

Getting Started Can Be Fun and Painless

The fifth annual West Coast Computer Faire was held in San Francisco last March 14 to 16. This show, which has become a tradition among microcomputer hobbyists, demonstrated that the hobby world is well and thriving. This year's show was the largest to date with 19,630 attendees and 384 exhibits representing 276 exhibitors. According to the show's owner, Jim Warren (no relation), the show was bigger than projected and the old excitement that was so characterized of previous shows was readily evident to attendees.

Although most of the exhibits demonstrated items that you have seen advertised and written about, there was one really new device. This was the Z-80 Softcard® for Apple owners, from Microsoft Consumer Products.

What made this hardware entrant important was that, first, it is from a software house, and second, it permits users of the Apple microcomputer to have the same functions that Z-80 based machines have. The plug-in card is designed to fit in an open slot on the Apple motherboard and doesn't require any hardware or software modifications. The card's Z-80 microcomputer operates at 2 MHz and doesn't affect the operation of the main 6502 microcomputer when it is not in operation.



Microsoft's Softcard permits Apple II users to have Z-80 functions.

The Softcard comes with Microsoft BASIC and Digital Research's CP/M® operating system, all for $349.00. According to Vern Raburn, Microsoft Consumer Products' president, the user will have all the full graphics features of the popular Apple, plus the ability to use the thousands of programs that have been written for the Z-80 microcomputer and CP/M. So if you haven't yet decided on a system, you might consider the Apple II. Then add the Softcard, to obtain the best of both worlds.

Training Aids. Since many of you who read PE are just thinking about buying a microcomputer either to play games, handle your business or just to learn, you might give some thought to obtaining an evaluation board or trainer, to become familiar with microcomputers. These dandy little units offer various features which include:

- ☐ For the most part, the evaluation boards and trainer systems have prices as low as $200, depending on capabilities.
- ☐ Units that have been designed as or have been incorporated into training packages usually offer excellent documentation written in a tutorial-type style to assist you in the learning process.
- ☐ A number of the systems have built-in cassette interfaces to permit the loading and storage of programs.
- ☐ The units are almost always upward expandable. Thus, you can use them as a base for building a full-blown system.

Among these systems that you might want to look at is the new unit from Motorola. This evaluation board, called a D4, is built around the MC6809 microcomputer. It is a step up from the company's popular 6800-based D2 unit and has a number of useful features that make it an excellent first system.

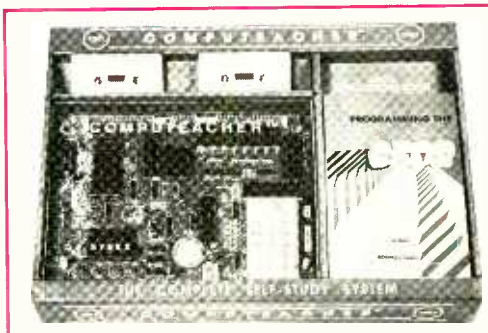
Among these features is a 300/1200 baud cassette interface that permits punch, load and verification of data. The software features permit single stepping through a program, modify, fill or search memory; enter ASCII characters and set breakpoints. The company also offers an Editor, Assembler, and BASIC either on cassette or in a ROM package.

The unit which is part of the manufacturer's MOKEP (Motorola Kit Expansion Product) series is shipped with 512 bytes of user RAM (expandable to 1K), 1K of user RAM and 2K or 4K of ROM. Provisions have been made for the addition of up to 4K of user RAM and 8K of ROM.

The D4 can be used on a mother board or stand-alone with a terminal, or can be used with the optional MEK68KPD, priced at $250. This module includes a 25-key keypad, eight 7-segment LED displays, and an on-board +5V power supply. Also included is a wire-wrapping area.

Currently, only the documentation that comes with the unit is available. But by the time you read this article, my book, the MC6809 handbook, should be available from TAB Books. It will assist you in understanding the 6809 microprocessor.

Another unit that is really quite exciting is based around the 6502 microprocessor. This system is called the

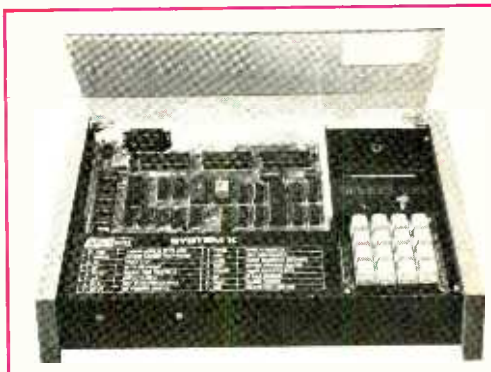


Sybex's Comuteacher has a 6502 trainer with instruction books.

Computeacher® and is priced at $299. What you get is a microcomputer board (Synertek VIM), that has a keyboard, LED displays and cassette I/O), and two books: *Programming the* 6502 and *6502 Applications*, both of which enable you to program the unit and also become familiar with its operation.

The Computeacher® is an educational package from Sybex and, consequently, is designed as a teaching aid, a strong feature of Sybex books.

Yet another unit that is worth considering is the ASCI μ68 System X®. This system is built around the Motorola 6800 microprocessor and is designed specifically as a training aid.



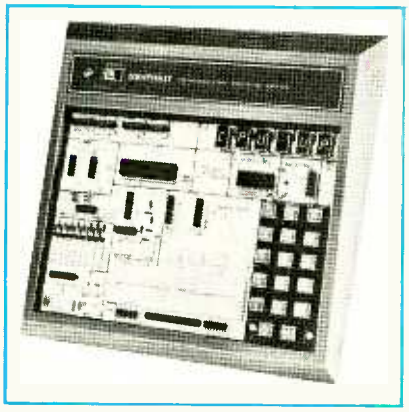
The ASCI System X, using a 6800 can be expanded to 32K of RAM.

The System X®, which is priced at $775, is a complete self-contained microcomputer for the technician or engineer. The basic unit is equipped

with three peripheral interface adapters (PIAs) to permit interfacing the unit to parallel devices. One asynchronous interface adapter (ACIA), for interfacing to serial devices, 1K of RAM which is expandable to 32K using the company's memory expansion boards, and a 16-key keypad and 7-segment LED display for program entry and testing.

Since the System X® is designed specifically as a teaching aid, the company supplies very complete manuals and reference cards to assist in the understanding and use of the system. To increase the flexibility and use of the system, BASIC and an editor/assembler, along with various expansion products, are available from the company.

Quite possibly the best-known microcomputer training system available is the Heathkit ET-3400. This unit, which is priced at $199.95 (kit), is built around the Motorola 6800 microprocessor and is designed to teach



Heathkit's ET-3400 is ideal for beginners to learn about the 6800.

engineers, technicians, and hobbyists the basics of microcomputers. The ET-3400 is laid out on a plug board module, which permits you to try various experiments that are presented in the company's microcomputer course (ED-3401) for $99.95.

The ED-3401 microcomputer course incorporates the best of programmed instruction (PI), by using visual aids in the form of a flip chart and the course notebooks, and cassette tapes that guide you through the history and functions of microcomputers. Also included in this course are number systems, the 6800 instruction set, and numerous experiments that teach you how to add different devices to a microcomputer and why they work.

The Heath unit is not something that should be thought of as a kit that you buy and use once, though. Rather, it's a tool for developing a knowledge of various functions of the microprocessor, as will as support devices such as analog-to-digital converters.

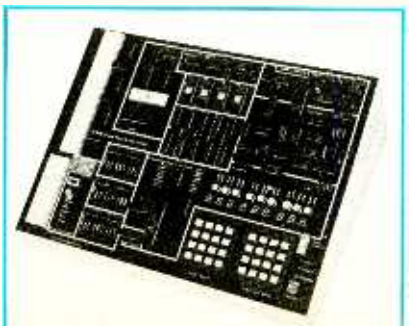
Due to the basic flexibility of design, the ET-3400 can be used for 'breadboarding' designs for later incorporation into another system. Also the unit can be used with the company's ETA-3400 trainer accessory expansion unit at $150 (kit) and tied into a terminal to extend your knowledge of a microcomputer system.

Those of you who are seriously considering developing a strong background in microcomputer technology will not only consider the Heath system, but will be interested in two other introductory courses that can be used in conjunction with the ET-3400 or the Heath H-8 or H-89 microcomputer systems. These are the BASIC language course (EC-1100) at $39.95, and the Assembly language course (EC-1108) at $49.95. Both of these courses are designed with the beginner in mind and cover all the various functions of the language and how to make it function. For example, the BASIC course begins with simple statements in the language and explains how they work with demonstration programs. Then as you become more involved, you are led through the development of a game program ("Black Jack") that demonstrates just about all the features of the language. The assembly language course is designed in the same manner. This course is written to teach you how to program an 8080 microprocesser (it can be used in conjunction with any 8080 or Z-80 based machine), and starts with the very basics. The course carries you through the methods of handling I/O to developing specific system programs.

Should your interest be in learning more about the Intel 8080 microprocessor, then you might consider the MMD-2 mini-micro design trainer. This unit from E&L Instruments Inc., features: an 8080A microprocessor; fully buffered address, data, and control busses; I/O addressing that is fully Z-80 compatible; 4K bytes of RAM; one 8-bit parallel input port; three 8-bit parallel output ports; RS-232 baud-rate-selectable, serial ports, and a 300-baud audio cassette interface system.

The unit also has 9 seven-segment LED displays and a 16-key keypad to facilitate data entry and display. Also

The MMD-2 from E&L, 8080A based, can be used for design and test.



incorporated in the system is an onboard EPROM programmer. The programmer will accommodate either 2708 or 2716 EPROMs. This unit which sells for $1250, also has breadboarding facilities which provide all critical system bus and control lines.

There are additional evaluation and trainer boards in addition to those that I have highlighted here. Among these are: The Rockwell AIM-65 based on the 6502 microprocessor, Mostek's Eval-70 built around the company's MK3850 microprocessor, RCA's Cosmac VIP that incorporates the CDP 1802 microprocessor, and Texas Instruments TM990/189M that uses the TI 9900. All of these units are useful low-cost training units, and can be obtained either directly from the companies or from most computer and electronic stores.

Disk of the Future. A new disk sub-system is available for microcomputer systems. The disk, called a, μ-Winchester, is a 5.25-inch rigid disk utilizing flying head Winchester technology. This drive was introduced in March of this year and demonstrated at NCC in Anaheim. The drive features 6.38 M bytes of storage (unformatted) in a package that fits the same form factor as a standard 5.25-inch floppy.

The μ-Winchester is from Shugart Technology, (no connection with Shugart Associates), Scotts Valley, CA. The drive is being offered by Lobo Drives Int'l and is priced at approximately 20% less than 8-in. Winchesters. Due to the newness of the drive, and fluctuations in pricing schedules, Lobo has requested that all pricing requests be directed to them. The unit, as offered from Lobo, will be compatible to various systems, including the TRS-80, Apple and Heath H-89, and will require little or no software modifications for use with them.

Notes on the MC 6809. One of the most interesting microprocessors to become available in the past 12 months has been the Motorola 6809. This chip is more than an upgraded 6800. It's designed to act as an interim processor from the 6800 to the 68000—a 16-bit machine. The chip, although not a pin-for-pin replacement for the 6800, is software compatible and, at the same time, offers some very unique features that make it a powerful CPU. Among these features are:

- ☐ The 6809 incorporates an internal 16-bit bus structure that enhances its processing power over the 6800.
- ☐ A fast interrupt request line (FIRQ) that is used when the interrupting routine will be using the registers existing contents. When the FIRQ is invoked, only the program coun-

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For just $129.95 (plus the cost of a power supply, keyboard/terminal and RF modulator, if you don't have them already), Explorer/85 lets you begin *computing* on a significant level...*applying* the principles discussed in leading computer magazines...*developing* "state of the art" computer solutions for both the industrial and leisure environment.

Level "A" Specifications

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM-I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, *plus* generous prototyping space.

(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)

Level "A" at $129.95 is a complete operating system, perfect for beginners, hobbiests, or industrial controller use.

PC Board: glass epoxy, plated through holes with solder mask • **I/O:** provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/display...cassette tape recorder input...cassette tape recorder output...cassette tape control output...speaker output.... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • **Crystal Frequency:** 6.144 MHz • **Control Switches:** reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • **Counter/Timer:** programmable, 14-bit binary • **System RAM:** 256 bytes located at F8ØØ, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at FØØØ leaving ØØØØ free for user RAM/ROM. Features include tape load with labeling...tape dump with labeling...examine/change contents of memory ...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address... move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory ...automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all registers...single step with register display at each break point ...go to execution address. Level "A" in the *Hex Version* makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.

Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks...address decoding for onboard 8k EPROM expansion selectable in 8k blocks...address and data bus drivers for onboard expansion...wait state generator (jumper selectable), to allow the use of slower memories...two separate 5 volt regulators.

Explorer/85 with Level "C" card cage.

Level "C" Specifications

Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from ØØØØ to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

Order A Coordinated Explorer/85 Applications Pak!

Experimenter's Pak (SAVE $12.50)—Buy Level "A" and Hex Keypad/Display for **$199.90** and get FREE Intel 8085 user's manual plus FREE postage & handling!

Student Pak (SAVE $24.45)—Buy Level "A," ASCII Keyboard/Computer Terminal, and Power Supply for **$319.85** and get FREE RF Modulator plus FREE Intel 8085 user's manual plus FREE postage & handling!

Engineering Pak (SAVE $41.00)—Buy Levels "A," "B," "C," "D," and "E" with Power Supply, ASCII Keyboard/Computer Terminal, and six S-100 Bus Connectors for **$514.75** and get 10 FREE computer grade cassette tapes plus FREE 8085 user's manual plus FREE postage & handling!

Business Pak (SAVE $89.95)—Buy Explorer/85 Levels "A," "B," and "C" (with cabinet), Power Supply, ASCII Keyboard/Computer Terminal (with cabinet), 16k RAM, 12" Video Monitor, North Star 5-1/4" Disk Drive (includes North Star BASIC) with power supply and cabinet, all for just **$1599.40** and get 10 FREE 5-1/4" minidiskettes ($49.95 value) plus FREE 8085 user's manual plus FREE postage & handling!

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- ☐ **Explorer/85 Level "A" Kit** (ASCII Version), **$129.95** plus $3 p&h.
- ☐ **Explorer/85 Level "A" Kit** (Hex Version), **$129.95** plus $3 p&h.
- ☐ **8k Microsoft BASIC** on cassette tape, **$64.95** postpaid.
- ☐ **8k Microsoft BASIC in ROM Kit** (requires Levels "B," "D," and "E"), **$99.95** plus $2 p&h.
- ☐ **Level "B" (S-100) Kit, $49.95** plus $2 p&h.
- ☐ **Level "C" (S-100 6-card expander) Kit, $39.95** plus $2 p&h.
- ☐ **Level "D" (4k RAM) Kit, $69.95** plus $2 p&h.
- ☐ **Level "E" (EPROM/ROM) Kit, $5.95** plus 50¢ p&h.
- ☐ **Deluxe Steel Cabinet** for Explorer/85, **$49.95** plus $3 p&h.
- ☐ **ASCII Keyboard/Computer Terminal Kit** (features a full 128 character set, upper & lower case, full cursor control, 75 ohm video output convertible to baudot output, selectable baud rate, RS232-C or 20 ma. I/O, 32 or 64 character by 16 line formats, and can be used with either a CRT monitor or a TV set (if you have an RF modulator), **$149.95** plus $2.50 p&h.
- ☐ **Hex Keypad/Display Kit, $69.95** plus $2 p&h.
- ☐ **Deluxe Steel Cabinet** for ASCII Keyboard/Terminal, **$19.95** plus $2.50 p&h.
- ☐ **Power Supply Kit** (±8V @ 5 amps) in deluxe steel cabinet, **$39.95** plus $2 p&h.
- ☐ **Gold Plated S-100 Bus Connectors, $4.85** each, postpaid.
- ☐ **RF Modulator Kit** (allows you to use your TV set as a monitor), **$8.95** postpaid.
- ☐ **16k RAM Kit** (S-100 Board expands to 64k), **$199.95** plus $2 p&h.
- ☐ **32k RAM Kit, $329.95** plus $2 p&h.
- ☐ **48K RAM Kit, $459.95** plus $2 p&h.
- ☐ **64k RAM Kit, $589.95** plus $2 p&h.
- ☐ **16k RAM Expansion Kit** (to expand any of the above up to 64k), **$139.95** plus $2 p&h each.
- ☐ **Intel 8085 cpu User's Manual, $7.50** postpaid.
- ☐ **Special Computer Grade Cassette Tapes, $1.90** each or **3 for $5**, postpaid.
- ☐ **12" Video Monitor** (10 MHz bandwidth), **$139.95** plus $5 p&h.
- ☐ **North Star Double Density Floppy Disk Kit** (One Drive) for Explorer/85 (includes 3 drive S-100 controller, DOS, and extended BASIC with personalized disk operating system—just plug it in and you're up and running!), **$699.95** plus $5 p&h.
- ☐ **Power Supply Kit** for North Star Disk Drive, **$39.95** plus $2 p&h.
- ☐ **Deluxe Case** for North Star Disk Drive, **$39.95** plus $2 p&h.
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By Netronics

ASCII/BAUDOT, STAND ALONE

Computer Terminal

COMPLETE FOR ONLY . . . $149.95

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

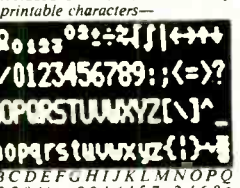
The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ' 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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- ☐ **Netronics Stand Alone ASCII Keyboard/Computer Terminal Kit, $149.95** plus $3.00 postage & handling.
- ☐ **Deluxe Steel Cabinet** for Netronics Keyboard/Terminal In Blue/Black Finish, **$19.95** plus $2.50 postage and handling.
- ☐ **Video Display Board Kit** alone (less keyboard), **$89.95** plus $3 postage & handling.
- ☐ **12" Video Monitor** (10 MHz bandwidth) fully assembled and tested, **$139.95** plus $5 postage and handling.
- ☐ **RF Modulator Kit** (to use your TV set for a monitor), **$8.95** postpaid.
- ☐ **5 amp Power Supply Kit** In Deluxe Steel Cabinet (±8VDC @ 5 amps, plus 6-8 VAC), **$39.95** plus $2 postage & handling.

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ter (PC) and condition-code register is saved on the stack, with control being passed to the interrupt routine via a vector address.

☐ A fast memory ready pin (MR) that stretches the duration of phase 2 of the clock up to 10 ms.

☐ Two 16-bit index registers (X and Y), a 16-bit D accumulator, and two stack pointers (U and S).

The 6809 microprocessor is a CPU that is designed with software development in mind. Consequently, it permits efficient handling of high-level languages, including PASCAL. This microprocessor is as easy to or, in most cases easier, to program than the 6800.

Because the 6809 is upward compatible with 6800 software, the device can be put in operation immediately using existing software with minor modifications. The important point to remember is that, whatever the routine is (in most cases) that uses the 6800 instruction set, it can be rewritten to be more efficient in the 6809 instructions.

Programming the 6809 and instructions on how to use it on the Heath ET-3400 trainer will be the subject of a future column. ◇

MORE INFORMATION

For additional information about products mentioned contact the companies directly.

ASCI Marketing Group
27439 Holiday Lane, Suite 101
Perrysburg, OH 43551
419-874-1991

E&L Instruments Inc.
61 First Street
Derby, CN 06418
203-735-8774

Heath Company
Benton Harbor, MI 49022
616-982-3519

Lobo Drives International
935 Camino Del Sur
Goleta, CA 93017
805-685-4546

Microsoft Consumer Products
10800 NE 8th, Suite 507
Bellevue, WA 98004
204-454-1315

Mostek
1215 W. Crosby Road
Carrollton, TX 75006
214-323-6000

Motorola Inc.
3501 Ed Bluestein Blvd.
Austin, TX 78721
512-928-6000

RCA
Route 202
Somerville, NJ 08876
201-685-6423

Rockwell International Microelectronics Devices
POB 3669
Anaheim, CA 92803
714-632-3729

Shugart Technology
340 El Pueblo Road, Suite C
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TAB Books
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(Attn: TM 990/189), Houston, TX 77001
713-776-6511

Five new Scanners! New 800 MHz!

Communications Electronics,™ the world's largest distributor of radio scanners, welcomes the addition of Fanon to our product line. Fanon introduces *two* new high performance hand-held scanners. More importantly, Fanon has a complete selection of useful accessories to compliment their *Slimline* models.

Electra Company, manufacturers of *Bearcat* brand scanners introduces *three* new scanners *including* a model that can monitor the exciting 800 MHz. band. The new *Bearcat* models will be available Fall, 1980, so reserve your scanner now!

A new product made by Electra, the *Freedom Phone*® is now available from CE. This is the ultimate *cordless* extention phone that can make and take your calls.

Bearcat®† 300

The Ultimate Synthesized Scanner!

Allow 90-120 days for delivery after receipt of order due to the high demand for this product.

List price $519.95/**CE price $339.00**

4-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The new *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

Bearcat® 250

List price $419.95/**CE price $279.00**

50 Channels • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • 3-Band • Count Feature.

Frequency range 32-50, 146-174, 420-512 MHz

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring.

Bearcat® 220

List price $419.95/**CE price $279.00**

Aircraft and public service monitor. *Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.*

The *Bearcat* 220 is one scanner which can monitor all public service bands plus the exciting AM aircraft band channels. Up to twenty frequencies may be scanned at the same time.

Bearcat® 211

List price $349.95/**CE price $229.00**

Frequency range: 32-50, 146-174, 420-512 MHz.

The *Bearcat* 211. It's an evolutionary explosion of features and function. 18-channel monitoring. With no-crystal three-band coverage. Dual scan speeds. Color-coded keyboard. Even a digital clock. All at a modest price. More scanning excitement than you bargained for.

NEW! Bearcat® 210XL

This is a new model. Shipments will begin in Fall, 1980.

List price $319.95/**CE price $219.00**

18 Channels • 3 Bands • Crystalless

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second-generation of the world's best selling crystalless programmable scanner–the *Bearcat* 210. It has almost twice the scanning capacity with 18 channels plus dual scanning speeds and a bright green fluorescent display.

NEW! 50-Channel Bearcat 300

Bearcat® 210

List price $319.95/**CE price $209.00**

10 Channels • 3 Bands • Crystalless

Frequency range: 32-50, 146-174, 420-512 MHz

Use the simple keyboard to select the 10 channels to be scanned. Automatic search finds new frequencies. The 210 features patented selectable scan delay, push button lockout, single antenna, patented track tuning, AC/DC operation. With no crystals to buy. Ever!

NEW! Bearcat® 160

This is a new model. Shipments will begin in Fall, 1980.

List price $279.95/**CE price $199.00**

16 Channels • 3 Bands • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-40, 144-174, 440-512 MHz.

The *Bearcat* 160 presents a new dimension in scanning form and function. The keyboard is smooth. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations, including On/Off, Volume and Squelch. Green easy to read fluorescent display. Requires (2) 9 Volt batteries to retain memory when disconnected from AC Power.

Bearcat® 12

List price $179.95/**CE price $119.00**

10 Crystal Channels • 3 Bands • AC or DC

Frequency range: 33-48, 146-174, 450-512 MHz.

More features, more channels, more action. The *Bearcat* 12 has automatic squelch, individual lockout and more.

NEW! Bearcat® 5/800 MHz

The world's first 800 MHz. scanner!

This is a new model. Shipments will begin in Fall, 1980.

List price $179.95/**CE price $129.00**

8 Crystal Channels • 4 Bands • AC only

Frequency range: 33-50, 144-174, 440-512, 806-870 MHz.

The *Bearcat* 5/800 MHz is the only scanner on the market today that offers coverage of the 800 MHz. public service band and the other public service bands. Individual channel lockout. Scan Delay. Manual Scan.

Bearcat® 5

List price $129.95/**CE price $94.00**

8 Crystal Channels • 3 Bands • AC only

Frequency range: 33-50, 146-174, 450-508 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches.

Bearcat® Four-Six ThinScan™

List price $179.95/**CE price $119.00**

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, new *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This three band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6½ x 1." Includes rubber ducky antenna.

NEW! Fanon Slimline 6-HLU

List price $169.95/**CE price $109.00**

World's smallest 6-channel, 3-band scanner!

The new *Fanon* Slimline 6-HLU gives you six channels of crystal controlled excitement. Unique Automatic Peak Tuning Circuit adjusts the receiver front end for maximum sensitivity across the entire UHF band. Individual channel lockout switches. Frequency range 30-50, 146-175 and 450-512 MHz. Size 2¾ x6¼ x 1." Includes rubber ducky antenna.

NEW! Fanon Slimline 6-HL

List price $149.95/**CE price $99.00**

6-Channel performance at 4-channel cost!

Frequency range: 30-50, 146-175 MHz.

If you *don't* need the UHF band, get this model and save money. Same high performance and features as the model HLU without the UHF band. Order crystal certificates for each channel.

FANON SCANNER ACCESSORIES

CHB-6 AC Adapter/Battery Charger	$15.00
CAT-6 Carrying case for Fanon w/Belt Clip	$15.00
AUC-3 Auto lighter adaptor/Battery Charger	$15.00

OTHER SCANNER ACCESSORIES

SP50 AC Adapter	$12.00
SP51 Battery Charger	$12.00
SP58 Carrying Case for *Bearcat* 4-6 ThinScan™	$15.00
FB-E Frequency Directory for Eastern U.S.A.	$15.00
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CIRCLE NO. 1 ON FREE INFORMATION CARD

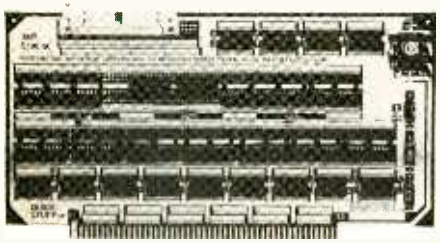
Computer Sources

By Leslie Solomon
Technical Director

Hardware

Prototyping Board. Up until now, building a peripheral for a computer has meant either creating or buying a suitable bus plug-in board, then using soldering or Wire-Wrap to interconnect the components. Some prototype boards come with solderless sockets where both IC's and passive components can be plugged in and interconnected with bits of wire. Although this is an excellent approach that makes for easy circuit modification, the solderless breadboard can get very crowded, very soon.

Recently, we had an opportunity to try out a new approach, the Quick Stuff S100/50 prototyping board for the S-100 bus that combines the best features of Wire-Wrap and solderless sockets. Actual connections are made via insulation displacement contacts (IDC's). These knife-like edge connectors accept 30-gauge kynar (as used in Wire-Wrap) wire that automatically pierces the insulation to form a gas-tight electrical connection. Not only is wire-stripping eliminated, but each IDC contact can support two leads (equal to four wrap levels).



Wires are removed simply by lifting them out of the connector.

The board can accommodate up to 64-pin DIP packages in any arrangement. Contact is made to each package pin through an associated IDC connector. Heavy ground and power traces minimize noise.

Once you have decided on your circuit, the appropriate sockets and their associated IDC contact strips are soldered to the board. The circuit is created simply by following the schematic and pressing each wire end (with insulation still on) into the required IDC contacts, then routing the wire to the other connection and doing the same thing. If an error is made, or if you decide to change the circuit, simply remove the wire and redo. There is more than enough room on the board to create a complex peripheral. Once a design has been debugged, if desired, the circuit can be transferred to a permanent plug-in board. The wires can then be removed from the S100/50 board, making it ready for another prototyping session.

The S100/50 comes with an assortment of low-profile DIP sockets, 5-volt regulator with heat sink, bypass capacitors, a number of IDC contact strips, and a wiring tool required to make clean contacts. The S100 edge connectors are gold flashed. Price is $127. Address: Information Machinery Corp., 110 Middlesex St., Chelmsford, MA 01863 (Tel: 617–251–3270).

Printer. The Vector Graphic MP, a 5 × 7 dot matrix printer, is software driven and can print a large array of graphics characters at 150 cps. Extra soundproofing makes the printer very quiet. Although designed for Vector Graphic systems, it can be used with other computers. Price is under $1000. Address: Vector Graphic Inc., 31364 Via Colinas, Westlake Village, CA 91361 (Tel: 213–991–2302).

Robot Arm. The MiniMover 5, a table-top robot "arm" attaches as a manipulative device to a personal computer. A complete hardware/software package is presently available for the TRS-80 and consists of the arm, power unit, ribbon cable and software. The ARMBASIC software package allows control via BASIC-like commands. The arm is a five-jointed type, controlled by stepping motors, and has a lifting capacity of 8 oz when fully extended. Resolution is 0.013 inch and its parallel-jaw arrangement can grasp objects up to 3 inches wide. Top speed is 6 inches per second. Address: Microbot, 1259 El Camino Real, Suite 200, Menlo Park, CA 94025 (Tel: 415–326–6997).

New System. The QUAY 500 and 520 systems combine a single-board computer with 5¼-inch floppy disk drives. Both are Z80 based and include 32K of RAM (expandable to 64K), DMA-based disk access, CP/M operating system with PROM-resident boot, RS-232/20-mA serial port, and a Centronics-compatible line printer. Additional serial ports are available. The disk provides a formatted capacity in excess of 400K and has a single unit price of $2,500. The 520 system has a formatted disk capacity of 800K and a single unit price of $3,200. Address: Quay Corporation, Box 386, Freehold, NJ 07728 (Tel: 201–681–8700).

Music System. The MUSIC BOX is a hardware/software device that plugs into a TRS-80 and can play up to four notes at a time with a seven-octave range. It can also create various sound effects for games. The device has a built-in volume control, a 400-mW amplifier, and a phono jack

for interconnecting to an external audio amplifier. Software is on a Level II cassette, and it requires a 32K or larger system. $250. Address: Newtech Computer Systems, Inc., 230 Clinton St., Brooklyn, NY 11201 (Tel: 212–625–6220).

6502 Peripherals. A catalog covering a large number of peripherals for the PET, CBM, AIM and KIM machines is now available from Micro Technology Unlimited, 841 Galaxy Way, PO Box 4596, Manchester, NH 03108 (Tel: 603–627–1464).

TRS-80 Interface. The IF-100 Interface Box plugs into the TRS-80 bus to provide "real world" applications as implemented by the BASIC Level II software. The Box provides buffered I/O for control, monitoring, or testing of external devices and development and testing of I/O circuits. It consists of a power supply, logic probe, device and memory decoder, bus buffer and control section with signal buffering. An on-board solderless breadboard permits easy assembly of circuits. Available for either 115- or 230-volt operation. Kit is $150, assembled is $215, and the interconnect cable is $25. Address: E & L Instruments Inc., 61 First St., Derby, CT 06418.

Memory Tester. The MP100 is an S-100 bus device that maintains a continuous check on the computer memory during program execution. It will halt the program if it detects a single bit of erroneous data is fetched by the CPU, thus averting possible destruction of other data. The board contains a parity generator, and whenever a byte of data is written into memory, it is evaluated by the parity generation circuit and a single parity bit is produced. When the data is retrieved, parity is again generated and compared with the previously saved parity bit. Nothing happens if the parity is correct, but a different parity halts the program. An on-board hex display option shows failed memory

locations. Other features include two port-failed locations, bus interface, and board disable and force error for function verification. The 4K RAM blocks can be enabled anywhere in the 64K space. Address: IPDI, 1708 Stierlin Rd., Mountain View, CA 94043 (Tel: 415–969–6086).

Software

TRS-80 COBOL. Cobol-80 is an ANSI-74 implementation of COBOL featuring complete interactive screen handling capability using ACCEPT and DISPLAY, indexed and relative tiles, and an optional packed decimal format that significantly reduces mass storage requirements. It also supports advanced manipulation verbs such as COMPUTE, INSPECT, STRING, UNSTRING, and SEARCH, plus three-dimensional arrays and full COPY facility. $750. Address: Microsoft, 10800 NE 8th, Suite 819, Bellevue, WA 98004 (Tel: 206-455-8080).

SWTP Business Programs. Written in SWTP Disk BASIC 3.0, these programs are for small business use and can be easily changed to suit special requirements. Two to four disc systems are accommodated. Payroll is $25. Deposit is $25 and General Ledger is $45. The payroll and deposit programs write transactions to the General Ledger, which precludes redundant data entry. The General Ledger includes automatic amortization/depreciation and checkbook reconciliation programs. All three are $80 with 86 pages of documentation. Address: Applevalley Day School-Software, c/o R. C. Cagle, 11103 Sagepark Lane, Houston, TX 77089.

8086 Cross Assembler. The XMACRO-86 Cross Assembler can assemble 8086 code on any 8080 or Z80 development system and is compatible with CP/M, ISIS-II, and TEKDOS. It can assemble over 1000 lines per minute. The assembler supports the complete 8080 standard macro facility. An expanded set of conditional pseudo operations include testing of assembly pass, symbol definition, and parameters to macros. It supports LINK-80 Linking Loader and CREF-80 cross-reference facility. $300. Address: Microsoft, 10800 NE Eighth, Suite 819, Bellevue, WA 98004.

Data Manager. The IDM-M2 is an interactive data manager for the TRS-80. Basic components include data base initialization, manipulation, report writer, and writer generator. The data initialization subsystem lets you specify file parameters such as name, type, field size, number of records, etc. Data manipulation allows adding, displaying, printing, deleting or updating a record. The report writer allows specifying page heading, selection of fields and filter criteria. Field calculations include totals, averages, multiplication, division, etc. Up to 10 formatted reports can be saved. The system is menu driven so no commands or syntax must be remembered. Written in BASIC, it requires 64K of RAM and a printer. $199. Address: Micro Architect, 96 Dothan St., Arlington, MA 02174.

High-Speed Sort. VSORT, a high-speed sort-merge system, can be used as a stand-alone utility or as an assembly-language subroutine to CBASIC. It will sort fixed-length records up to 255 bytes long using up to five fixed- or variable-length fields. Requiring CP/M and 32K of RAM for CBASIC, VSORT is also available for specially modified versions of CP/M for the TRS-80 Model I, Heath H-8, and Zenith H-89 systems. $175. Address: Lifeboat Associates, 2248 Broadway, New York, NY 10024 (Tel: 212-580-0082).

CP/M File Management. The MAGS AM IV combines the features of the MAGS AM III with the speed and performance of an 8080 assembler. It allows users to create programs that access data records by user-defined keys. Secondary indexing with any number of keys allows access to data by any and all desired data elements. Real-time record and key deletion with automatic reclamation of free space conserves disc space. Record retrieval includes random by key, sequential by key, generic by key (wild card search), sequential in physical order, and random by record number. Records may be created randomly and sequentially by key, and updated. Key and record deletes are also performed by key. It interfaces directly with CBASIC. The package includes the file manager, a tutorial program, a file dump utility, user guide, reference guide, and one-year update service. $295. Address: Micro Applications Group, 7300 Caldus Ave., Van Nuys, CA 91406 (Tel: 213-881-8076).

ELF Games. Nine programs written in Tiny BASIC for the 1802 include Hi-Lo, Acey-Ducey, Bagles, Russian Roulette, Ugly, Bomber, Weekday, Buzzword and Hamurabi. These will run on a terminal version of Tiny BASIC or 1802 machines that use the video chip and software character generator. Most will run in 4½K when used with the terminal and the remainder at 8½K. ELF standard cassette is $10. Address: Michael J. Di Julio, 97 Woodside Rd., Maplewood, NJ 07040. ◇

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CIRCLE NO. 27 ON FREE INFORMATION CARD

AM STEREO WINS FCC APPROVAL

The Magnavox amplitude/phase-modulation system, selected as the U.S. AM stereo transmission standard, is described

BY STAN PRENTISS

STEREOPHONIC transmission on the standard AM broadcast band, under test and evaluation by the Federal Communications Commission, Electronic Industries Association's Stereophonic Radio Committee and other organizations since September 1978, has finally been approved by the FCC. The nod of acceptance was given to the system proposed by Magnavox Consumer Electronics Company.

In competition with other systems offered by Motorola, Belar, Harris, and Kahn, the Magnavox system that combines amplitude and phase modulation was selected by a vote of five commissioners to two. Broadcast transmitters can be fitted for it fairly simply, with the greatest cost expected to be in studio equipment. Consoles and playback equipment will have to be converted to stereo, and directional antennas will have to be very carefully phased. Signal losses compared with monophonic are not expected to exceed 3 or 4 dB in daytime operation.

The Broadcast Bureau Report and Order, following the Magnavox selection by some 60 days, was published in the Federal Register. However, a formal final vote has not been taken at this writing and rival stereo developers are challenging the decision in an effort to have the Federal Communications Commission modify or reconsider its preliminary ruling.

Meanwhile, the EIA and Institute of High Fidelity (IHF) have recommended that the FCC authorize a nine-month delay in service startup from the time that the final reports and orders are made so that AM-radio inventories can be cleared from dealer shelves and AM stations can install equipment to begin broadcasting. At this writing, Magna-

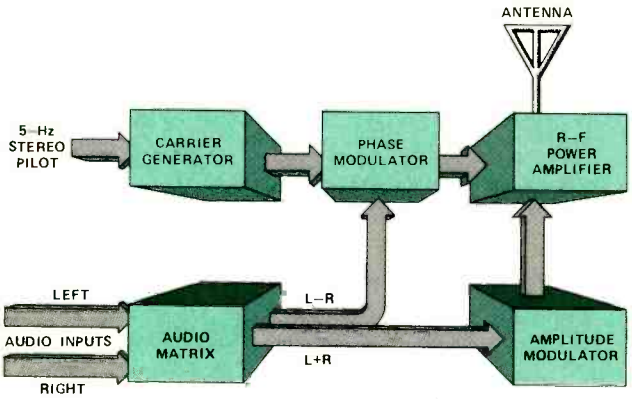

Fig. 1. Block diagram of the stereo transmitter. A 5-Hz stereo identification tone frequency modulates the carrier generator. The L + R signal amplitude modulates the carrier while, the L − R signal phase modulates it.

vox has announced that it will not assert its patent rights against broadcasters or broadcast-equipment manufacturers, but it is willing to enter into licensing agreements with manufacturers of receiving equipment.

How the System Works. Amplitude modulation and phase modulation are the equivalents of FM stereo's baseband main and subcarrier modulation. Left plus right (L + R) channel information is transmitted as standard AM, while the carrier phase is modulated with L − R information so that 100% modulation corresponds to a peak deviation of 1 radian (57°). Negative amplitude modulation is limited to 95%, leaving the phase of the remaining 5% detectable at all times. There is also a 5-Hz signal transmitted to alert the receiver that AM-stereo intelligence is being broadcast. Although this signal could conceivably be used to transmit low-speed digital data such as time, weather, etc., in addition to station identification, there are no plans for such use at this time.

A block diagram of the stereo transmitter is shown in Fig. 1. The 5-Hz stereo identification tone frequency modulates the carrier generator (nominally 20-Hz deviation), with the resultant phase modulation being a 4-radian deviation. (Phase deviation = $\Delta f/f_{mod}$ = 20 Hz/5 Hz = 4 radians, where Δf is nominal carrier deviation and f_{mod} is ID-tone modulation frequency.) This signal then combines in the phase modulator with L − R from the audio matrix as the stereo portion and continues into the final r-f amplifier. Similarly, L + R information is developed through the audio matrix and feeds the amplitude modulator. Finally the carrier, angle-modulated with an ID tone and L − R information and amplitude-modulated with L + R, is fed to the transmitting antenna. Since the L + R and L − R signals may undergo unequal delays in the above process, delay lines are used to reestablish correct time relations.

A simplified block diagram of the receiver Magnavox actually used in all field tests prior to FCC system approval is shown in Fig. 2. The receiver has a conventional r-f/i-f front end, followed by an envelope detector for amplitude modulation. Thereafter, however, circuits become less familiar, since phase variations representing the stereo ID tone and the L − R information must be demodulated and processed.

As a first step, envelope variations are stripped by a limiter. Then a phase-locked loop (PLL) system—consisting of a loop filter/amplifier, voltage-controlled oscillator (VCO), and phase detector—simultaneously recovers phase and stereo indicator signals. L + R and L − R signals are then added and subtracted in the matrix to form the 2L and 2R (left and right, respective) signals. The succeeding stereo—mono switch is activated by the 5-Hz detected impulses, and separated left/right audio flows to respective speakers. (A 10-kHz filter eliminates annoying whistles.)

The PLL detects signal phase and supplies some filtering between the stereo component and 5-Hz identification signal. A low-pass filter then passes the 5-Hz information to its detector and from there on to the control logic. Following the phase detector, L − R information is gain-equalized and passed through a between-channel muting switch. From there, it goes to the L − R/L + R matrix. Muting is controlled by the output of the high-pass noise detector that continually monitors the loop filter/amplifier for the excessive high-frequency noise that is generated when

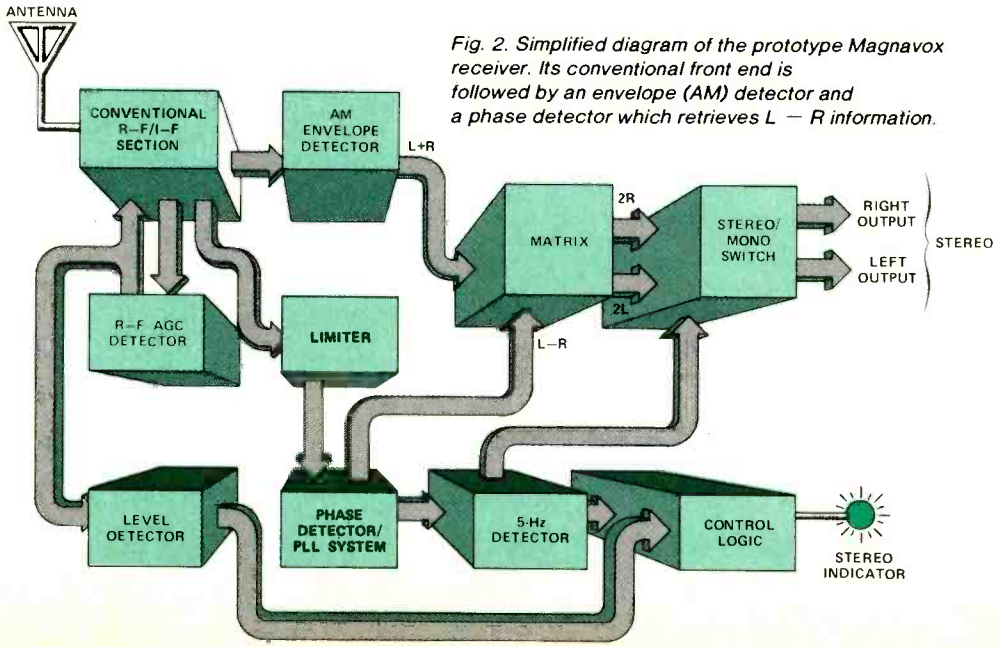

Fig. 2. Simplified diagram of the prototype Magnavox receiver. Its conventional front end is followed by an envelope (AM) detector and a phase detector which retrieves L − R information.

the receiver is not tuned to a specific broadcast. The output of the L + R full-wave detector is delayed 16 μs. Then L + R and L − R are matrixed into 2L and 2R outputs for amplifiers driving the left and right speakers.

Other Proposed Systems. Among the other AM-stereo systems considered and rejected by the FCC was Motorola's C-Quam (Compatible Quadrature Amplitude Modulation). In this system two separate carriers of the same frequency in phase-quadrature are modulated with separate left and right signals, and the outputs of the transmitters are combined and applied to a common antenna load. The two carriers and their intelligence are demodulated in the receiver by two synchronous detectors that derive the stereo information directly.

Belar Electronics proposed an AM/FM system, with some differences, originally tested by RCA as early as 1959. Matrixed right and left audio signals in the Belar system generate L + R and L − R signals, and the L − R portion is preemphasized and frequency modulates the r-f transmitter. The L + R signal is handled in routine fashion. Envelope detection (L + R) and frequency discrimination (L − R) is applied to recover these signals, which are then processed in an audio matrix to produce left and right outputs. Harris's system advocated carrier phase modulation, and Kahn's proposed a method employing independent sidebands.

In Closing. Does all this mean that electronic companies will immediately jump on the AM-stereo manufacturing bandwagon? It's a little early to tell, but at this writing there is some indication they will. For example, Pioneer has demonstrated at the NAB conference both home and auto AM-stereo sets using the Magnavox AM/PM system. Semiconductor manufacturers, too, are ready with products—Motorola with an integrated decoder design already breadboarded, Sprague/Signetics will reportedly announce an IC version in the Fall, and National Semiconductor with an announced decoder product available about now. Japanese manufacturers are eagerly awaiting the day when they too can introduce AM-stereo products to the U.S. market.

Industry sources tell us that Harris, Collins, and RCA are almost certain to offer broadcast transmitters in the near future. Furthermore, once studio links and other gear have been installed, the L-R exciter can be connected into the rest of the system in one evening.

Our sources also say that General Motors, Ford, and Chrysler are laying plans to offer AM-stereo options in their new vehicle models. ◇

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For over a year now, in magazines and newspapers the world over, there have been enthusiastic write-ups on a remarkable new device that can cut your electric bill while helping the U.S. save huge quantities of fuel.

"The NASA/Nola power saver," wrote a **Popular Science** senior editor, "was developed by Frank Nola at NASA's Flight Center in a program to reduce power consumption in spacecraft motors. Nola calls it a PFC — power-factor controller. I prefer to call it a power saver, however, because that's what it does."

NASA TESTED IT

According to NASA documents, "The device has been tested at Marshall Center on over 40 types of motors, with power savings ranging up to 60%, depending on the loading. The motors tested were both single-phase and three-phase, ranging from ½ H.P. to 5 H.P. Most motors will show up to 40 — 50% savings when running lightly loaded or unloaded, and some will show 5-to-7% savings at rated load."

NASA's Technical Support Package showed that "The Power Factor Controller applies to induction type electric motors — the most commonly used type in all major home appliances and the most commonly used by industry."

HOW IT SAVES POWER

Popular Electronics explained it this way: "AC induction motors characteristically run at a nearly constant speed that's fixed by power-line frequency and independent of load and supply voltage. When heavily loaded, the motor draws line current that is nearly in phase with the applied voltage...Under light load conditions, the motor develops less torque by allowing more lag between the voltage and the current. This reduces the power factor while leaving the current essentially the same in magnitude.

"To minimize this waste, Nola's device monitors the motor's power factor and when it detects light load conditions, it reduces the supply voltage..... The current, now more nearly in phase with the voltage, therefore does as much useful work as before, but it and the voltage are smaller, resulting in a net savings of electric power."

THE SAVINGS CAN ADD UP

The cost of electric power keeps going up. In 1980-81 and beyond you'll pay more and more for the privilege of running your electric appliances.

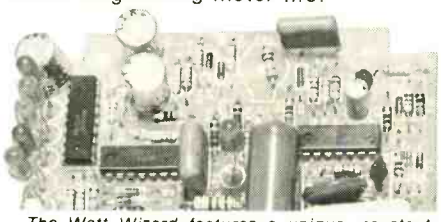
Right now, the typical consumer pays about $8 per month to operate a 16.5 cu. ft. frost-free freezer...$10 to run a 17.5 cu ft. frost-free refrigerator...and about $60 for an air conditioner used during summer months. That's what you're paying to run just **one** of these appliances per year.

Nola's power saver can soon pay for itself, then start reducing your electric bills. Until now, the device has not been **available** — except for industrial models priced at $80 or more.

INTRODUCING THE WATT WIZARD

Cynex, an American manufacturer of electrical and electronic products and a prime contractor for the U.S. Army, has been licensed by NASA to manufacture Frank Nola's power saver. Cynex calls it the Watt Wizard.

The "Watt Wizard" says Ray Beauchea, the firm's **Marketing Director**, regulates the voltage fed into an induction motor making the motors run more efficiently and quieter, while lengthening motor life.



The Watt Wizard features a unique, constant power saving readout. So you can constantly monitor you're energy savings.

SIMPLE TO USE

Cynex makes several models of the Watt Wizard (all with solid state design), including the 110 v. AC plug-in model we're offering. It's for single phase fractional H.P. motors (less than 1 H.P.) used in most freezers, refrigerators, fans, swimming pool pumps, vacuum cleaners, sewing machines, etc.

Simply plug the Watt Wizard into any electrical outlet, then plug the appliance into the Watt Wizard. There's no wiring required. Unlike some competitor's models (if and when available), the appliance does **not** have to be turned on before being plugged into the power saver. You can leave the appliance — whether on or off — plugged into the Watt Wizard all the time. Or you can move the Watt Wizard to various locations.

OTHER MODELS AVAILABLE

Air conditioners, washers and dryers require wire-in model. If you lack mechanical skill, you probably need an electrician to install it. We also offer it in 220 VAC single or three-phase.

CIRCLE NO. 42 ON FREE INFORMATION CARD

EXCLUSIVE ADVANCE FEATURES

The Watt Wizard also includes two more unique features which no **competitor** has. It's fused so if you accidently overload the device, it won't burn out. Just change the fuse, which is available at any auto supply store.

And Watt Wizard features a unique LED readout, so you can actually tell, at any moment, exactly how much power you're saving — 10%, 20%, 30%, 40% or 50%. This feature is **available only on the Watt Wizard.**

There's a **"power-on"** light, too. And the Watt Wizard comes with the manufacturers 1 year limited warranty.

LOW COST — AND A TAX CREDIT

We're offering the Watt Wizard for only **$39.95**, with **immediate delivery.** Want two? Then its just **$37.95** each. Or splurge and get three at **$34.95** each. Wire-in models for heavy duty motors are **$6** more for each unit. Add just **$2.50** postage/handling for each **order** (not each unit).

And next year, when you fill out your tax return, you can deduct a full 15% energy tax credit - for additional savings.

30-DAY MONEY-BACK GUARANTEE

Try the Watt Wizard for up to 30 days. If not completely satisfied, return it (insured) for a full refund.

The sooner you send for the Watt Wizard, the more you can save on your electric bills. To order, send your check or money order to the address below. Or charge it to your Visa, MasterCharge, American Express, or Carte Blanche credit card. If using your charge card, you can also order via our toll-free phone number:

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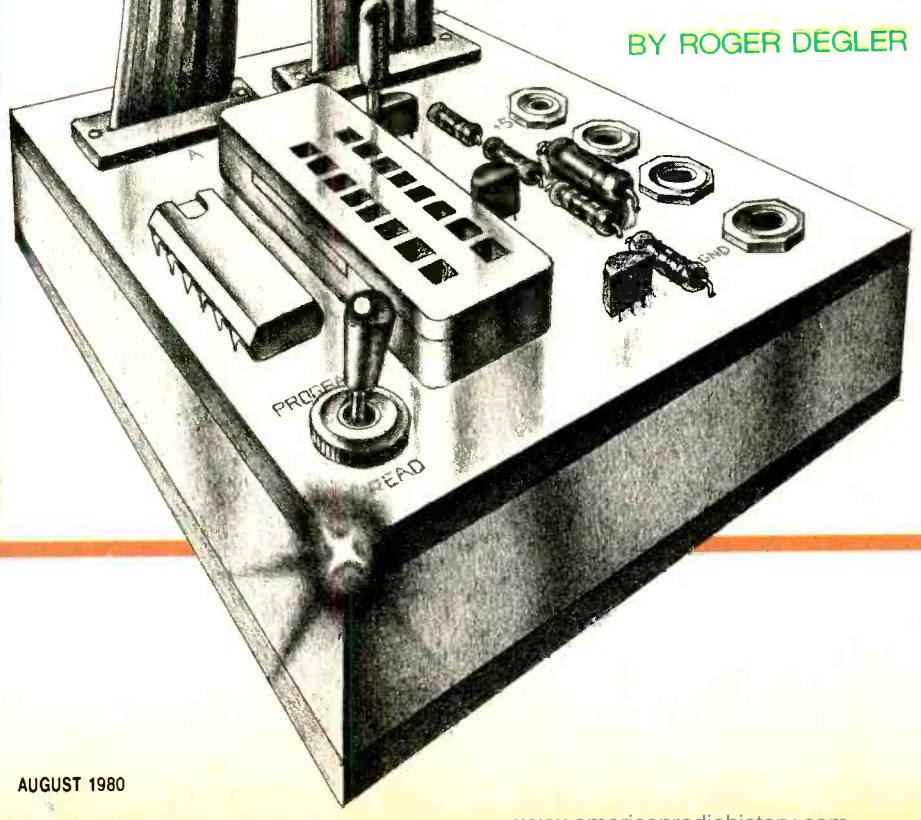
an EPROM programmer for 6800 computers

Low-cost device programs the 1K-by-8-bit 2708 EPROM using specially provided software

BY ROGER DEGLER



ONE of the handiest devices available to the small-computer user is the EPROM (Erasable Programmable Read Only Memory). The basic ROM's advantage over RAM (Random Access Memory) is that its contents are retained when operating power is removed. This means that often-used programs such as bootstraps, monitors, operating systems, high-level languages, etc., can be permanently stored, thus eliminating time-consuming data retrieval from cassette or paper tape.

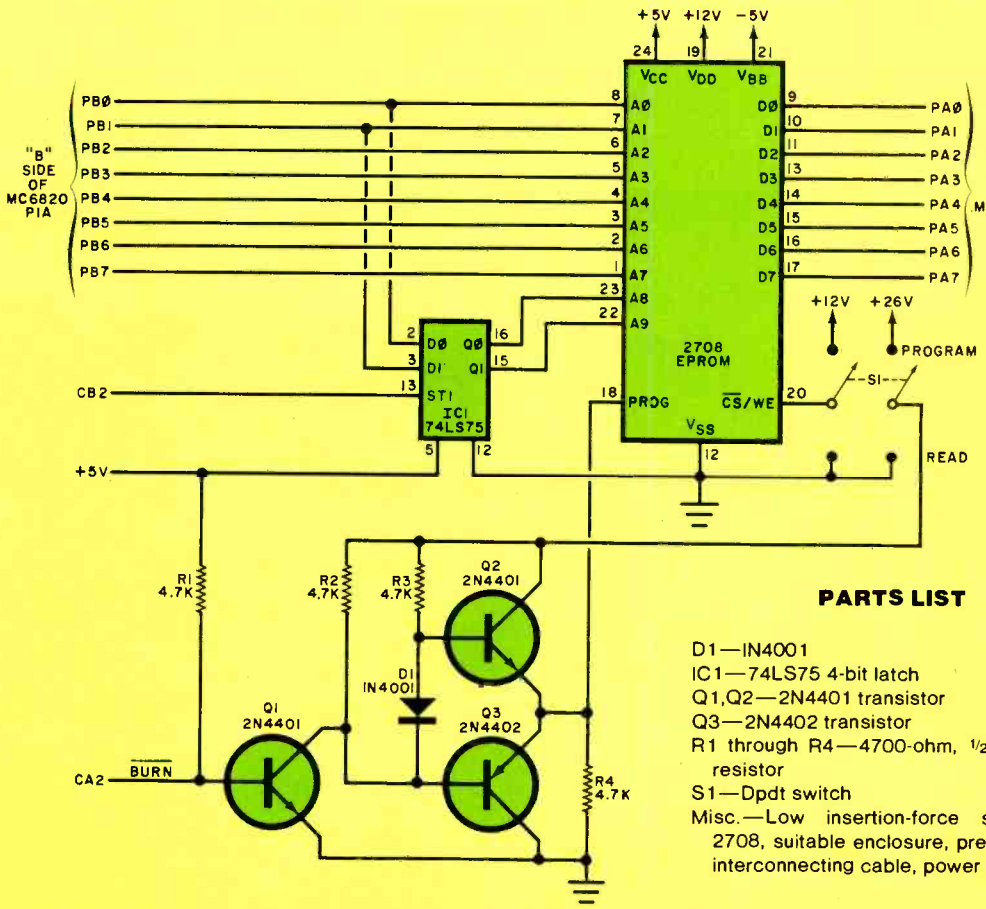
An EPROM is a special type of ROM that can be erased, and re-programmed as desired. Consequently, it makes an ideal storage medium for semipermanent data for experimental programs, or for software prototyping where changes may be made as work progresses.

The EPROM Programmer described here is an inexpensive device that can program the popular 1K by 8-bit, low-cost 2708 EPROM when used with a 6800-based computer having an MC6820 PIA (Peripheral Interface Adapter). The simple schematic on the next page illustrates this.

The computer, controlled by software to be described, supplies the EPROM Programmer with correct addresses, data, and properly timed programming pulses. In addition, the software ensures that the EPROM is blank prior to programming and verifies that the data the EPROM contains after programming is correct. The software also transfers the entire contents, or any portion of it, into RAM (where it can be altered) and writes it into blank EPROM or returns it to the same one. The software package is position-independent and occupies less than 256 bytes.

Circuit Operation. As shown in the schematic, lines PBØ through PB7 of the B side of the PIA supply the necessary addresses to the EPROM. Quad latch *IC1*, strobed by control line CB2, latches the two most significant address lines (A8 and A9) to the EPROM to form the required 10-bit address ($2^{10} = 1024$).

When switch *S1* is placed in the READ position, pin 20 (Chip Select) of the EPROM is grounded and power is removed from the transistor circuit driving the PROG input (pin 18). The computer can now examine the contents of the EPROM. In this mode, lines PAØ through PA7 of the A side of the PIA



PARTS LIST

D1—IN4001
IC1—74LS75 4-bit latch
Q1,Q2—2N4401 transistor
Q3—2N4402 transistor
R1 through R4—4700-ohm, ½-watt, 10% resistor
S1—Dpdt switch
Misc.—Low insertion-force socket for 2708, suitable enclosure, press-on type, interconnecting cable, power source.

The lines from the B side of the PIA supply the necessary addresses to the EPROM. With S1 on READ, the computer can examine the contents of the EPROM through the A side of the PIA.

allow the EPROM data to reach the computer.

In the PROGRAM setting of *S1* pin 20 (Write Enable) of the EPROM is connected to +12 volts to place the EPROM in its programming mode. Lines PAØ through PA7 now allow the computer to supply data to the EPROM. The other section of *S1* connects +26 volts to the three-transistor circuit that generates the programming pulse for pin 18. Transistors *Q2* and *Q3* form a complementary pair that actively pulls the programming input high or low as recommended by the 2708 data sheets. The when-to-burn signal comes in via CA2.

Software. This consists of four major sections; VBLNK, READ, BURN, VRFY and several subroutines. Although the order of these routines may appear strange, they are carefully arranged so that all internal branching may be in the relative mode. This allows the code to be executed at any address in the system memory without change.

Subroutine INIT initializes the PIA so that the A-lines are inputs, the B-lines are outputs with CA2 high and CB2 low. This subroutine also disables the IRQ level interrupts so that nothing will disturb the timing of the programming pulses, and because memory locations $AØØØ and $AØØ1—used to store the IRQ interrupt vector by JBUG and MIKBUG—are used here to store PRMAD (starting EPROM address set by user). This routine is also called at the beginning of each of the four other major sections of the software.

Subroutine ADROUT is used to output the 10-bit address for the EPROM. The most significant two bits are output on the PIA B-side followed by raising and lowering CB2 to latch these two bits into *IC1*. The least-significant bits are then output, which together with the first two bits, make up the required 10-bit address. The EPROM address (PRMAT) is then incremented in the computer's RAM.

Subroutine INPUT calls subroutine ADROUT to output the current address to the EPROM and then loads accumulator-A with the contents of this location of the EPROM.

Subroutine VERI calls subroutine INPUT to get a byte of information from the EPROM. It then compares this byte with the contents of accumulator-B. If they are the same, it returns to the caller. If an error is detected, the index register is decremented so that it will point to the failing EPROM address. A software interrupt is then executed to return to the monitor. Accumulator-A will contain the bad data, and accumulator-B the expected data.

Subroutine WRITE is used to gener-

PROGRAM AVAILABILITY

The lengthy EPROM programmer instruction listing will be supplied on request. Send a stamped (15¢ in U.S.), self-addressed envelope to POPULAR ELECTRONICS, Dept. EPROM-1, One Park Ave., New York, NY 10016.

ate the correct width programming pulses for pin 18 of the EPROM. See the description of the BURN routine below for details of this pulse.

Program section VBLNK makes sure that the EPROM is erased before attempting to program it. Each byte in the EPROM is compared with FF(hex), which is the erased state. It is not necessary to start verifying with EPROM address ØØØØ. If a section of the EPROM already contains data, and it is desired to verify that the rest of the EPROM is blank so that additional data can be inserted, then the desired start of verification address is placed in memory locations PRMAD and PRMAD+1. Otherwise these two locations should be set equal to zero prior to starting execution at locations VBLNK.

The READ section is used to transfer the contents of the EPROM into the computer's RAM. Anything from 1 byte to the entire 1024 bytes may be transferred by setting up PRMAD, BEGAD and ENDAD prior to execution. Keep in mind that PRMAD is the location within the EPROM and has nothing to do with the memory address at which the EPROM will be located when installed in the system. PRMAD equal to zero implies the first location within the EPROM. Data is transferred from the EPROM starting at location PRMAD into RAM addresses BEGAD through ENDAD inclusive.

Section VRFY compares the data contained in RAM addresses BEGAD through ENDAD with the data stored in the EPROM starting at location PRMAD. If any discrepencies are found, a software interrupt (SWI) is issued to return to the monitor. With most 6800 monitors such as JBUG and MIKBUG, this will cause a display of the CPU registers. At this time, the index register will contain the location within the EPROM that contains the failing data, Accumulator-A will contain the failing data, and Accumulator-B will contain what the data should have been.

A BURN routine "burns" the data into the EPROM. Once the EPROM has been put in the PROGRAM mode via *S1*, the address and the data to be programmed into that address are applied to the EPROM. Then a +26-volt program pulse is applied to pin 18. Duration of this pulse must be at least 100 μs and not more than 1 ms. The next address and corresponding data are applied and another programming pulse is issued. This continues until all the addresses have been programmed. The entire process is repeated 256 times. This is done because the total program time applied to each address must be greater than, or equal to, 100 ms. As it is forbidden to apply more than one pulse at a time to any address, programming of the sequential addresses must be repeated many times.

The system that this is currently being used on is an MEK6800D2, a Motorola two-board microcomputer kit, that runs at a clock rate of 614.4 kHz. The number 36 (25 hex) loaded into the INDEX register in the WRITE subroutine is used to establish the width of the program pulse. If a clock rate of 1 MHz is used, this number should be changed to 61 (3D hex). This is based on eight machine cycles in the two-instruction loop at label WRT1, and an additional eight machine cycles outside this loop. If the duration of the program pulse is maintained at 500 μs and the program loop is repeated 256 times, this allows a total program time of 128 ms/location.

Data sheets for the 2708 specify that all 1024 locations should be programmed in each loop, but making the loop as small as 128 bytes has proved successful. Making the loop too small may be detrimental to the EPROM. Length of the program loop is established as ENDAD−BEGAD+1. Note that, at 614.4 kHz, the time required to program all 1024 bytes is only about two and a half minutes.

Construction. Since the circuit is not critical, the Programmer can be built using perf board with Wire-Wrap techniques, or a small pc board can be designed. To avoid pin damage, the use of a low-insertion force socket for the EPROM is suggested. Sockets for *IC1* and the three transistors are optional.

Suitable connectors must be made to contact the A and B parts of the MC6820 PIA and the CA2 and CB2 lines. Sources of +5, −5, +12 and +26 volts are also needed.

Any type of enclosure can be used as long as it will hold the power supplies with EPROM socket and *S1* on top.

Use. Switch *S1* should be in the READ position whenever an EPROM is inserted in or removed from the socket. In its unprogrammed state, the EPROM contains logic 1's at all storage locations. These 1's may be changed to 0's by programming—but 0's may be changed to 1's only by erasing the entire EPROM with exposure to 2537-Angstrom ultraviolet light.

Programming can, in certain cases, alter the contents of a previously programmed EPROM. For example, 27 (ØØ1Ø ØØ111) can be changed to 23 (ØØ1Ø ØØ11), but not vice versa. This is accomplished by using the READ routine to transfer the contents of the EPROM into RAM, locating the 27 in the RAM, changing it to 23, then using BURN to program this data back into the same EPROM.

To program in a small section of new data, for example only four bytes, use VBLNK to make sure that the four locations are in the unprogrammed state. Then with the EPROM removed from the socket, use READ to initialize a section of RAM to all 1's. This can be done because data read back from an empty socket is FF(hex).

Place the four data bytes in the RAM buffer, replace the EPROM and use *S1* at PROGRAM and BURN to program the data into the EPROM. Keep this section at least 128 bytes long. Since trying to program a 1 into the EPROM has no effect, only the four bytes of new data will make a change in the EPROM contents. After using BURN, set *S1* to READ and use VRFY subroutine to make sure that the EPROM was correctly programmed.

Once you gain some proficiency in programming, you can create "personality modules" for any function you desire, from instant bootstrap at turn-on, to full BASIC at the touch of a key. ◇

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  Receives shortwave, medium-wave, and long-wave bands.
- **30 bands, each 1 MHz wide**
  Easy-to-use band switch with large knob.
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  Accurate digital display with 1-kHz resolution and illuminated analog dial with precise gear dial mechanism.
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  Precise 12-hour clock with AM and PM indicators. Timer turns on radio for scheduled listening, and even controls a recorder through remote terminal.
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  Provide exceptional performance and easy operation without the need for bandspread, preselector, or antenna tuning. Excellent sensitivity, selectivity, and stability.
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  12-kHz and 6-kHz (adaptable to 6-kHz and 2.7-kHz) filters for AM wide and narrow, and 2.7-kHz filter for high-quality SSB (USB and LSB) and CW reception.
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  Eliminates ignition and other pulse-type noise. Superior to noise limiter.
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NOTE: *Price, specifications subject to change without notice and obligation.*

MATCHING ACCESSORIES

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- HS-4 headphones
- DCK-1 easy-to-install modification kit for 12-VDC operation

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- **Two 24-hour displays with quartz time base**
  Right display: local (or UTC) hour, minute, second, day. Left display: month, date, world time in various cities, memory time (QSO starting time), and time difference (in hours from UTC)
- **Time in 10 cities around the world**
  Plus two additional programmable time zones.
- **"TOMORROW" and "YESTERDAY" indicators**
- **Memorizes present time**
  And recalls later, for logging purposes.
- **High accuracy**
  ±10 seconds/month

CIRCLE NO. 58 ON FREE INFORMATION CARD

1. High-Tech Gear for Hams & SWLs
2. World Administrative Radio Conference of 1979
3. Sunspots in Action

FOCUS EDITOR: JOHN McVEIGH *Technical Editor*

FOCUS ON Communications

High-Tech Gear for Hams & SWLs

by Karl T. Thurber, W8FX

The latest equipment reflects technology improvements that provide greatly enhanced performance

TODAY's advanced SWL and ham gear is loaded with the latest that our continually evolving electronics technologies can provide. Contemporary amateur and SWL equipment incorporates features and offers levels of performance that would have been extremely difficult, prohibitively expensive, or outright impossible in products of fairly recent vintage.

For example, sophisticated transceivers today can be programmed to store, recall and scan frequencies at will. Advanced slow-scan television (SSTV) converters permit the display of received images on conventional television receivers. All-electronic radioteletype (RTTY) and Morse transmission and reception systems allow information to be exchanged at fast rates with scarcely any effort. And newly developed narrow-band voice modulation (NBVM) and related equipment enables amateurs to pack more signals into a given segment of the spectrum than ever before. Any way you cut it, new IC technology and the application of microprocessor capabilities to radio communications is changing the face of amateur radio permanently—and for the better!

In this article, we will examine this latest breed of communications equipment, with special emphasis on the latest designs for serious shortwave listeners and advanced amateurs.

Transceivers That Think. Perhaps this heading is an exaggeration of their capabilities, but it's not far off the mark. A number of microprocessor-based amateur transceivers add new dimensions in operating flexibility. Among them are the Kenwood TS-180S hf radio, the TR7600/7625 vhf-FM rigs, and the TR-2400 synthesized 2-meter handheld; the Yaesu CPU-2500RK 2-meter digital transceiver, and FT-207R handheld; the Icom vhf IC-211 and hf IC-701 twins; the Drake TR-7 hf radio; and the Collins KWM-380 Pro-mark hf transceiver. The Swan Astro 150 hf and Heath VF-7401 scanning vhf transceivers also fall in this class.

Perhaps the most interesting of the new rigs is Kenwood's TS-180S. The 200-watt, solid-state hf SSB transceiver includes four user-programmable channel memories and digital up/down tuning. The four memories can be used in either transceive or split modes, and they can be tuned in 20-Hz steps, up or down, slow or fast, with recall of the original stored frequency. The microprocessor-controlled digital display can

FOCUS ON Communications

show actual frequency or the difference between vfo and memory frequencies. Other features include provision for accommodating the three new amateur bands approved at Geneva, passband i-f tuning, a tunable noise blanker, up to 30 dB of r-f speech compression; and display blinking that indicates potential out-of-band operation.

The same manufacturer's twin vhf-FM transceivers, the 10-watt TR-7600 and the 25-watt TR-7625, when coupled with the RM-76 microprocessor control unit, make powerful and flexible 2-meter PLL-synthesized mobile systems. Basic features are fairly standard. However, the accessory control unit that resembles a large calculator adds some interesting possibilities for remote control of frequency, scanning, and memory. These include a total of six memories; automatic "memory scan"; automatic band scanning in 5-kHz steps with selectable upper and lower frequency limits; manual up or down scanning in slow or fast 5-kHz steps; and flexible repeater offsets.

The Icom IC-701 hf transceiver sports some unique features in its own right. Incorporating dual vfos, the transceiver accepts incremental or digit-by-digit programming data from an external source such as the RM-2 remote microprocessor-controller. This device also provides remote band selection, automatic increment or single-step tuning, and other functions. The two vfos are independently selectable, digitally synthesized (not analog) units that are controlled by a single knob. In regular operation, the bandspread—100 Hz per increment, 5 kHz per rotation of the knob—is instantly displayed on the fluorescent readout.

The IC-211 is a 2-meter multimode rig with comparable capabilities and features. It, like its hf cousin, employs the same LSI chip that contains the command registers, counters, phase detector and memory system. The RM-2 controller can also be used with the IC-211, the older IC-245 vhf-FM transceiver, and the new IC-551 all-mode, 6-meter transceiver.

The other transceivers mentioned have differing, but comparable capabilities that make operating them a pleasure. These include memory and scanning functions, LED or in some cases LCD digital frequency readout; and remote-control capabilities. For example, the Yaesu CPU-2500RK 2-meter FM mobile transceiver is designed to mate with the YM-2500 microphone, which also serves as a Touch-Tone pad and remote controller. The "CPU" in the model number describes a built-in, 4-bit central processing unit.

SSTV — Voice Bandwidth Video. This is a transmission mode in which a 128-line still picture is transmitted over a period of 8 seconds. The extended frame-transmission time and relatively small number of scanning lines make for a signal compatible with SSB or FM voice bandwidth. As a result, SSTV can be transmitted on any of the hf bands except 160 meters using standard SSB equipment. In classic SSTV systems, received images are displayed on a CRT with a long-persistence phosphor to allow reproduction of the full picture. This cumbersome viewing scheme has long inhibited the full development of SSTV.

Recently, a process known as digital scan conversion has been perfected by Robot Research to convert the slow-scan image into a conventional TV picture. Robot's Model 400 converter integrates the digital/analog scan conversion process in a single unit and performs practically all of the operations required for two-way video communications. On receive, the Robot unit takes an SSTV signal from any variety of sources (an hf receiver, an audio tape recorder, SSTV camera, etc.) and displays the "snatched" picture on a standard TV receiver or video monitor. The 400 has a memory feature so that received images can be reconstructed using digital information stored in its semiconductor RAM memory. The image can be displayed on a standard video monitor by means of internal conversion of the SSTV signal to standard TV format to produce an array of 128-by-128 discrete picture elements (pixels). Each element is coded into one of sixteen gray shades. The result is a motionless, flicker-free picture that is slowly replaced by the newly arriving SSTV picture frame from the top down. There is no separation between old and new pictures—the replacement occurs in the digital memory without noticeable discontinuity.

On transmit, the device accepts standard video from a CCTV camera or video tape recorder. No special SSTV-format video equipment is needed. The unit grabs and freeze-frames video fields to produce an output which is in the accepted SSTV modulation format—1200-to-2300-Hz FM (blacks are at 1500 Hz and whites at 2300 Hz). This signal is used to modulate a conventional amateur AM, FM, or SSB transceiver within acceptable bandwidths.

As in nearly every other phase of amateur radio, microprocessors have made an impact on SSTV. Many amateurs have successfully experimented with microcomputer-generated SSTV pictures as well as with computer image processing and enhancement techniques. Experimental work is continuing in this area, and the results will undoubtedly see their way into commercial equipment in the near future.

What's happening today on SSTV? Check 14.230 MHz, the unofficial slow-scan calling frequency to "see."

Advances in ATV and MSTV. Hand-in-hand with new developments in SSTV, ATV—conventional FSTV communication by amateurs—has enjoyed a modest upswing in interest. Especially active in this field are some Technicians, who are able to experiment with ATV because all work is conducted on the uhf bands.

Advances in video technology that have popularized the medium for the consumer have had a positive impact on ATV by generating useful equipment and accessories. These include high-quality, low-cost cameras, video tape recorders, and various accessories. This has brought ATV within the reach of many less technically sophisticated hams by reducing the traditional high cost, complexity, and bulkiness of video equipment. Almost all ATV work is on the 420-MHz (70-cm) band, where the 5-MHz bandwidth required for high-resolution video can be employed. Basic equipment required includes a video camera or other video source, a 420-MHz exciter or transmitter, and a receiving converter for down-conversion to a standard vhf TV channel). Audio can either be transmitted via a 2-meter FM link or by FM subcarrier. The latter technique allows reception of transmitted audio simultaneously with video on a standard TV receiver.

A few manufacturers offer ready-to-go ATV equipment. A wide range of modules are offered by P.C. Electronics of Arcadia, CA, for example. Recently, the company packaged its modules into a single transceiver for "one stop" convenience in getting on the air. Its TC-1 fast-scan ATV transceiver/converter contains a sensitive tunable channel 2 or 3 converter covering 420 to 450 MHz, a 10-watt, 70-cm transmitter, and a 4.5-MHz FM subcarrier generator. With the unit, no modifications to the TV receiver are required. The transmitter section has extra-wide modulator bandwidth (8 MHz) to allow computer alphanumerics, graphics, and even color to be transmitted. A separate talk-back link can also be set up on 2 meters using conventional FM transceivers.

Along with the recent growth of interest in simplex (direct) ATV work, there

has been considerable growth in television repeater installations. There will probably be 30 or more in use by the end of 1980, with almost all of them in metropolitan areas. Aptron Laboratories of Bloomington, IN, has developed an "in-band" repeater, usually set up with 439.25-MHz input and 425.25-MHz output. It is said to solve the technical problems caused by the narrow input-output frequency separation and extreme bandwith of the signals.

In spite of uhf propagation limitations, the relatively low signal powers used (usually less than 50 watts ERP), and relatively low repeater and base station antenna heights, it is not unusual to hear reports of two-way ATV contact with usable signal levels over distances of 70 miles (110 km) or more.

Radioteletype. Historically, RTTY has been in its own special world of noisy, clanking teleprinter machines, tape readers and reperforators. However, the new generation of teleprinter equipment does away with the mechanical printer and associated hardware. The transmitted message is being displayed on a "dedicated" video terminal or TV receiver teamed up with ancillary equipment. An electronic keyboard replaces the mechanical one, and in some cases can also be used to generate Morse. The system that results is sometimes called a "glass Teletype."

Most amateur RTTY work is at speeds of 100 WPM or less using Baudot code and frequency-shift-keying (FSK) transmitter modulation with carrier shifts of 850 Hz or less. Recently, the FCC authorized the use of eight-level ASCII code as an alternative to the five-level Baudot on the ham bands. This will allow use of a more versatile code (128 symbols are readily available) and make possible many home-computer-interface applications.

Whereas the distribution of surplus Western Union teleprinter equipment used to be the source of most amateur RTTY gear, a number of high-technology manufacturers have begun to provide solid-state sending and receiving equipment. Among these are HAL Communications Corp., Info-Tech Incorporated, DGM Electronics, Flesher, and Microlog Corp. Microprocessor-based systems dedicated to RTTY transmission and reception are available, and some also have Morse capabilities.

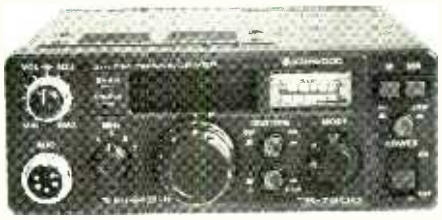
A look at HAL's DS3100 automatic send-receive (ASR) terminal shows what the new RTTY technology is all about. This microprocessor-controlled unit works in either Baudot or ASCII mode at all popular amateur transmission speeds. Containing both a video display and keyboard in one unit, the DS3100 ASR provides such features as full buffering of received and transmitted text (which allows the composition and editing of text to be sent during receive), composition and storage of up to 10 programmable ("canned") messages, an internal real-time clock, on-screen display of terminal status, automatic message reception and acknowledgement/reply capability, full keyboard control of the terminal, and keyboard-operated transmit/receive transceiver switching. An RTTY demodulator is required for use with the ASR unit to properly decode received signals. HAL's ST-6000 takes care of this function and includes a miniature oscilloscope for precise signal tuning. It also includes an audio-frequency-shift (AFSK) keyer unit to modulate the SSB transmitter with which the system is used. The same AFSK keyer can be used to modulate a vhf-FM transceiver (RTTY is popular on 2 meters, and a number of repeaters have been dedicated to this mode).

A hybrid computer/RTTY technology has developed of late, pioneered by a small West Coast company, Macrotronics, Inc. It has produced a line of computer interface hardware and software to enable popular computers such as the Radio Shack TRS-80, Apple, PET, and Exidy Sorcerer to function as sophisticated RTTY send/receive systems.

The accessories allow the computers to receive and transmit RTTY in the same fashion as dedicated systems. Such custom features as split-screen display, instant on-the-air replay of received messages, picture-graphics capability, automatic station ID, a number of programmable messages, keyboard-actuated transmitter control, and automatic printer housekeeping functions have made RTTY "come alive" for a growing number of hams who are also computer enthusiasts. Employing this software ties up the computer while it is being used to work RTTY, naturally. In contrast, dedicated equipment overcomes this problem, but requires a substantial outlay for gear that cannot readily be used for computer purposes or for other ham radio applications like contest logging, OSCAR satellite tracking, or circuit design.

Modernizing Morse. Another microprocessor "spin-off" has affected an amateur transmission mode that is as old as the spark mode that *it* replaced—Morse CW. Most of the dedicated RTTY systems as well as the Macrotronics computer interface are also compatible with Morse code. They are properly described as tri-mode Baudot, ASCII, and Morse systems. For example, the HAL DS3100 ASR will receive, automatically track, and display Morse at rates ranging from 1 to 199 WPM, and

HAL DS3100 automatic send-receive terminal.



Kenwood TR-7600 synthesized 2-m transceiver.

A-Tronix 64-character key board sends timed code over range of 5 to 50 WPM

Kantronics Morse-code radioteletype reader.

Panasonic RF-4900 portable SW receiver.

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can transmit it from the keyboard over the same speed range in 1-WPM increments. The Macrotronics packages will typically "work" CW at speeds from 1 to 399 WPM, and allow a number of user-programmed messages to be set up. The units can also be used for local code practice. Several companies including Info-Tech, DGM, and Xitex, specialize in Morse or tri-mode encode/decode systems.

The heart of microprocessor-assisted Morse systems is the keyboard keyer. Representative of these new-breed keyboards is the AJR Electronics Skipjack 48B keyer kit. Using CMOS and MOS ICs, the AJR kit features standard alphanumeric characters plus special ham characters such as $\overline{AR}$, $\overline{AS}$, $\overline{BT}$, $\overline{KN}$, and $\overline{SK}$; adjustable speed from 1 WPM; 64-character buffer memory; LED display of memory in use at a given moment; choice of grid-block or direct relay transmitter keying; electronically "debounced" keyboard; built-in sidetone monitor; and adjustable character weighting. The unit is sold as a "basic kit," with pc boards and construction details provided, but with parts acquisition and metalwork left to the builder.

Xitex Corp. has even developed what it bills as a "universal code converter," the ABM-100. This impressive device contains all the circuitry required to translate between Morse and ASCII (or Baudot), or between ASCII and Baudot. It can also be used as a RTTY speed converter. Xitex also sells a unit that converts any ASCII or Baudot teletype terminal to Morse capability.

The new advances in Morse technology have spawned a number of interesting Morse "gadgets." Two of these are particularly interesting, AEA's Morsematic and Datong's Morse Tutor. The Morsematic, manufactured by Advanced Electronic Applications, Inc., of Lynnwood, WA, is a multifunction Morse keyer with a number of fascinating capabilities. It can be used as a keyer with a 500-character Morse memory; as a code trainer providing programmable speed-up of code rate and selectable five-character code groups or random group lengths; as a Morse beacon to key a transmitter within a programmed window for test projects in moonbounce or tropospheric scatter DX work; or even as a Morse serial number generator, with automatic number sequencing for "sweepstakes" ham contests. The unit, which contains two custom microprocessor chips, can be used with all popular paddle assemblies, and it allows for independently selectable dot/dash weighting.

The British-made Datong Morse Tutor is a compact yet sophisticated device that produces an "unlimited supply" of precision Morse at the turn of a switch. It also contains an audio oscillator for code-sending practice. The CMOS unit can send a continuous stream of Morse in five-character groups which never repeat over the range 6.5 to 37 WPM. Letters only, numbers only, or mixed-character groups can be sent, and intercharacter delays can be adjusted from the "correct" value (3 dot periods) to a maximum of more than 3 seconds. This feature is particularly useful in conducting Morse training sessions because each letter and number can be learned with the dots and dashes within a letter fast enough to form a complete sound pattern, but with a long delay between each letter. As recognition improves, delay between letters can be decreased.

NBVM and "Super Sideband". An experimental SSB technique is narrowband voice modulation, a new and unique system for reducing communications bandwidth and improving adjacent-channel rejection and signal-to-noise ratio. The new system works on a principle of dual amplitude and frequency compression of speech on transmit, along with complementary expansion of the transmitted speech on receive. The system processes the speech waveform generated by the microphone. The compressor extracts the "essential parts" of speech and electronically down-converts the processed information prior to transmission to provide a substantial reduction in bandwidth. The reverse process is performed at the receiver.

VBC Corp. has the only commercially available amateur NBVM unit, Model 3000, which is distributed by Henry Radio Co., Los Angeles, CA. It's a transceive baseband unit. That is, it contains the circuits required to both generate and demodulate the processed NBVM audio signal. Based on hybrid IC technology, the unit contains a built-in audio amplifier and employs five active filters having a total of 52 poles. The resultant signal must be demodulated by a compatible NBVM unit, but no special FCC permit is required. It can be used on any amateur band on which SSB transmission can be used. Some users have also found that, in the narrow (1.6-kHz) mode, amplitude compandoring improves weak-signal CW reception.

Still experimental, the system is under evaluation by the government and others—in addition to amateurs—because of its potential to improve spectrum utilization, reduce adjacent-channel interference, and improve SNRs. In recent tests, strong interfering signals only 2 kHz off-frequency could be almost completely eliminated. However, some users have found that the processed speech has an unnatural sound. Development is continuing.

Closely related to NBVM is a parallel technology dubbed "super sideband." This is an effort to minimize classic SSB reception problems by transmitting a small pilot carrier along with the speech information that could provide a reference for easier demodulation. Such a system would help turn SSB into more of a consumer-acceptable transmission mode. Applications include incorporation into Citizens' Band transceivers, public safety systems, and, of course, amateur equipment. The presence of a steady pilot or reference signal could, for example, allow carrier-operated keying of vhf repeaters, something difficult if not impossible to achieve with SSB. Without a doubt, you'll hear more about "super sideband" and NBVM in the coming decade.

OSCAR: Reaching for the Sky. Amateurs launched their first satellite in 1961. Since then, several more American and foreign-made satellites have been placed in orbit, and a new generation of sophisticated ones is being planned for the 80s by the Radio Amateur Satellite Corporation (AMSAT), a nonprofit group formed to sponsor and coordinate the launch and use of amateur radio-equipped space vehicles.

Truly exciting amateur space communications possibilities are afforded through the use of these satellities. They work in much the same way as terrestrial earth-bound repeaters, but are able to relay signals over much greater distances. Amateur satellite DX is intercontinental in scope, with long-haul work possible on frequencies that are unable to support ionospheric propagation on a consistent basis.

Equipment needed to work through the satellites is not complex. The key is the ability to generate a SSB or CW signal on 2-meter or 70-cm bands or both. You must, of course, be able to receive on the 2- and 10-meter satellite downlinks. Power levels required to access the satellites are low—just a few watts. For good results, however, circularly polarized antennas that can "track" the path of the satellite should be used. Crossed-polarized Yagis that are rotatable in both azimuth and elevation are popular, as are helical antennas. A satellite locating aid is also required. This can range from simple map overlays and tabular azimuth and elevation information to sophisticated computer-generated track-

ing data—sometimes directly controlling the antenna's rotator.

Most amateur satellite equipment takes the form of special-purpose accessories that mate with existing equipment, rather than all-in-one "satellite transceivers." Nevertheless, about three years ago, KLM Electronics introduced the Multi-2700, a combination 2-meter multimode transceiver and 10-meter receiver in one package that was designed to work the OSCARs. The same company's Echo II 70-cm transceiver has also proved to represent a simple means of accessing Mode B satellites. Most hams, however, use *separate* transmitters and receivers to enable them to transmit and receive simultaneously. This lets them monitor their own satellite-retransmitted signals.

Hamtronics, Inc., Hilton, NY, offers what is perhaps the most comprehensive line of OSCAR accessories. These include low-noise-figure preamplifiers, FET receiving converters, linear transmitting converters, and a line of vhf and uhf power amplifiers. In addition, Advanced Receiver Research of Burlington, CT, and Janel Laboratories of Corvallis, OR, both manufacture vhf and uhf converters and preamps that can also be used in EME ("moonbounce"), scatter, tropo, ATV, repeater, and radio-telescope applications. Cushcraft and Hy-Gain both sell the specially polarized antennas for satellite use.

New Horizons in Shortwave Gear. Recent advances in communications technology are much more visible in amateur radio equipment, owing to a wider range of application. Nevertheless, much of the new shortwave gear incorporates significant advances. Foremost are technical improvements and convenience features in receiver design that allow pin-point tuning accuracy and dial resettability. Among these are digital readout, programmable frequency storage and recall, band-scanning provisions, very low drift, transmitter coupling capabilities for transceive operation, improved sensitivity, selectivity and image rejection.

Also, a number of sophisticated accessories have been developed to make shortwave listening more enjoyable. These include electronic RTTY and Morse readers, flexible active audio filters, frequency converters, and physically small but high-performance antenna systems.

Many strides have been made in solid-state receiver technology, so that even low-priced receivers are much more likely to be satisfactory products in terms of sensitivity, stability and selectivity than at any time in the past. Up-converted, crystal-controlled or PLL-synthesized-injection front ends, precision digital frequency readouts, and high-dynamic range amplifier and mixer stages have ushered in a new age for the serious radio hobbyist. These improvements have largely eliminated nonlinearities, dial error, backlash, and frequency drift.

Popular-priced receivers such as the Yaesu FRG-7 and FRG-7000, the Kenwood R-820 and R-1000, the Realistic DX-300 and DX-302 offer performance levels comparable or superior to expensive, top-rated receivers of years past. Even portable shortwave radios offer greatly improved performance. Such digital-display receivers as the Panasonic P-4900, the Sony ICF-6700W, and the Grundig programmable S-3400 typify the new breed of sophisticated, high-performance portable receivers.

Higher-priced, all-wave receivers like the National HRO-600, McKay-Dymek DR22C and DR33C, and the Japan Radio Company (JRC) NRD series are able to run circles around the best tube receivers of an earlier era—at *any* price.

Scanners, too, are becoming much more technically sophisticated. This partly explains why scanning the vhf and uhf public service and aircraft bands has become a much-pursued hobby unto itself. Microprocessor-controlled, programmable synthesized scanners such as the Bearcat 250 and 300 enable the hobbyist to perform almost any conceivable scanning function. Equipped with such a unit, he can search out, locate, and program into memory new and previously unknown frequencies and instantly recall them.

Accessories for Better Listening. New technological advances are highly visible in accessories for the SWL. One particularly interesting and useful accessory is the active audio filter. A number of companies have introduced these high-performance, variable-selectivity filters, including MFJ, Autek Research, Electronic Research Corp. of Virginia, and Kantronics.

One of the more sophisticated units is a British import by Datong Electronics, the FL-1. It employs unusual circuitry to almost surgically extract the desired signal—AM, SSB, CW, or RTTY—from background interference. The filter is therefore of great interest to both the sophisticated SWL and the advanced amateur. It provides a continuously variable center frequency from 280 to 3,000 Hz and an adjustable bandwidth of 25 to 1,000 Hz for close matching of received passband to actual conditions. In addition to selectable bandpass or band-reject response, the filter offers fast-acting *automatic* suppression of interfering heterodynes by means of an unusual tracking filter. The tracking notch can be left in the signal

(Courtesy P.C. Electronics)

Off-the-air ATV picture as transmitted by amateur Tom O'Hara, W6ORG. Note superimposed clock and CQ ATV. Highly directional beams and two-meter talkback circuits are usually used.

Typical SSTV picture stored in memory of a Robot Research 400 scan converter and displayed on a standard TV set. Picture is 128 x 128 discrete elements.

McKay-Dymek DA100 allwave receiving antenna.

Bearcat 300 automatic scanning receiver.

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path with no audible effect until an interfering whistle appears. The whistle will then be sensed by the circuit and attenuated within about one second. This capability provides an effective countermeasure for the majority of heterodynes that plague reception on the crowded lf, mf, and hf bands.

Another Datong product of interest to amateurs who would like to add general-coverage receiving capabilities to their ham-bands-only stations is the UC-1 up-converter. This interesting device allows general-coverage reception by either 10-meter or 2-meter receivers or transceivers. The UC-1 literally up-converts signals from 90 kHz to 30 MHz in thirty switched bands to a 28-to-29-MHz or 144-to-145-MHz i-f or to both simultaneously. It is an especially attractive accessory for the ham who does not own a high-quality, general-coverage communications receiver. A side benefit is that the UC-1 can also be used as a 2-meter converter with any receiver covering 28 to 30 MHz. A competitive up-converter is offered by Clegg Electronics, an American company.

Spin-offs of the marriage of computer technology with communications gear are the new, sophisticated RTTY/Morse encode and decode devices, discussed earlier. These devices have great appeal to the SWL who does not know Morse or have RTTY gear because it allows him to "read" traffic that would otherwise remain a series of mysterious bleeps. Microcraft has introduced separate RTTY and Morse decoders that display received alphanumeric characters on LED readouts. (Both were originally presented to the readers of POPULAR ELECTRONICS in March, April, November, and December, 1979, as construction projects.) The RTTY reader, for example, allows one to monitor news dispatches, weather bulletins, ship traffic, and amateur radio contacts, among other things. It automatically converts RTTY signals from the receiver's loudspeaker or headphone jack to alphanumeric symbols presented on a moving eight-character readout. The CW reader, dubbed the "Morse-A-Word," is similar. It automatically decodes and displays Morse letters, numerals, punctuation marks, and special characters over a 5-to-35-WPM speed range.

A dual-function reader by Kantronics is the "Field Day" Morse/teletype reader. It decodes and displays *either* type of signal across a 10-digit LED panel. The unit employs a microcomputer to sample the incoming signal, determine its transmission speed, and display the speed when called up by the user. It's said to be capable of handling even "sloppy copy" up to 80 WPM because the code sent by uneven "fists" is edited prior to display.

Other accessories that have contributed to making SWLing more enjoyable include add-on digital frequency displays; precision, gated crystal-controlled receiver calibrators; multi-programmable digital clock/controllers for set-and-forget activation of receiver, tape recorder, and other listening-post equipment; and the antenna noise bridge, for precision resonance and SWR adjustment of receiving antennas without the need for the application of r-f from a transmitter to the antenna.

Antennas. For many SWLs, the antenna presents a real stumbling block, particularly for those living in congested, noisy areas, or in apartment or condominium complexes. Several new and innovative antenna designs offer hope for such cases.

One is the McKay-Dymek DA-100, the heart of which is a small (4½-foot) whip designed for outdoor use. The whip is directly coupled to a base-mounted preamplifier. This "no space" antenna is designed for high performance over the range of 50 kHz to 30 MHz. It is fed with 50-ohm coaxial cable to a control module at the operating position.

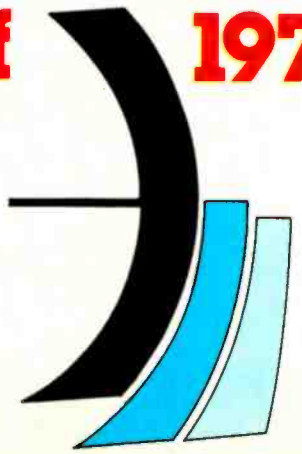
Another antenna of special interest to SWLs troubled by noise and interfering signals is the Palomar Engineers LA-1 amplified loop antenna. This directional antenna is small enough for use at the receiving position, and usually works well in wood-frame buildings. An internal FET amplifier adds up to 20 dB of signal gain. This small, 7¼" x 6" x 2¼" (184 x 153 x 57 mm) amplifier assembly is powered by a standard 9-volt transistor radio battery. Five plug-in, high-Q loop antennas made from Litz-wire wound on ferrite rods are available to cover the frequency range of 10 kHz to 5 MHz. Because the antenna can be used on the vlf and lf band, it is also popular with low-frequency radio enthusiasts ("lowfers").

In sum, technological advances have resulted in the availability of ham and SWL equipment offering previously unattainable levels of performance. And it wasn't accompanied by a dramatic increase in price either. So today more people than ever before can afford top-notch communications gear. ◇

World Administrative Radio Conference of 1979

by Theodore J. Cohen, N4XX

A review of the accomplishments, as well as shortcomings, of the recent worldwide meeting on radio communications



THE radio spectrum is a finite natural resource. Since the possibility of mutual interference exists, a rational and orderly system of radio-frequency allocation which all users agree to observe is essential. It was with this premise in mind that 2,000 delegates from 150 nations met in Geneva late last year

for the World Administrative Radio Conference, or WARC 1979.

At this Conference, the delegates wrestled with frequency-management questions of national and global import. The decisions reached, known as the Final Acts, will exert a strong influence on the evolution of telecommunications until the beginning of the next century. In this article, we will summarize some of the conclusions reached.

The ITU. WARC 1979 was sponsored by the International Telecommunication Union (ITU), an agency of the United Nations with headquarters in Geneva. The ITU has its roots in an organization founded by Napoleon III in 1865 to establish procedures for the efficient handling of telegraph traffic on an international scale.

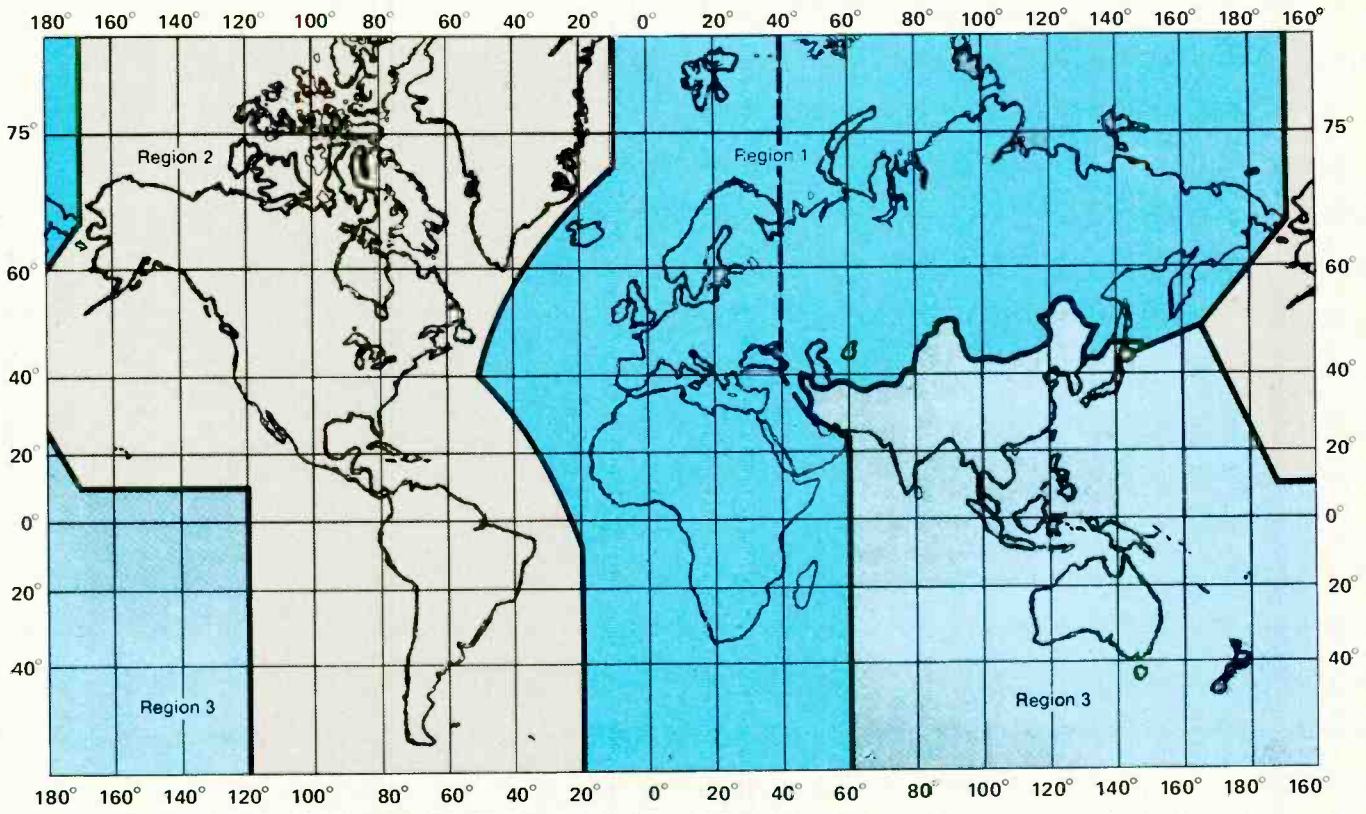
Until the recent past, the modern body was dominated by the relatively small group of industrialized nations. Since the last worldwide allocations conference was held in Atlantic City, NJ in 1959, however, the makeup of the ITU has profoundly changed. Its membership has almost doubled, and nearly all the newcomers are nations that have achieved independence from European colonial powers within the last 25 years.

Voting at ITU conferences is based on a one-nation, one-vote system like that employed in the General Assembly of the United Nations. Accordingly, the newly admitted members, although they are in general less technically developed than the older members, have the largest block of votes. Thus, they hold the balance of decision-making power.

Some observers were predicting an extremely acrimonious confrontation at Geneva, based on the perception that many of the newer member states felt that past WARCs had been guided by political and economic motivations that were adverse to their development. The fear was that this bloc would attempt to redress what it interpreted as a system of frequency allocations that furthered the interests of the developed nations at its expense. As shall be seen, the Conference went much more smoothly than some had predicted.

It is important to note that the deliberations and decisions of the ITU do not infringe on the national sovereignty of any member state. No nation can be forced to accept the Final Acts of an ITU conference—it can agree to do so or reject them. (Ideally, of course, all members will agree to an ITU decision for the sake of courtesy and consistency in the use of the spectrum on an international basis.) Thus, despite the fact that the delegation from the United States initialed the Final Acts of WARC 1979 on December 6, 1979, these Acts must still be ratified by a two-thirds vote of the United States Senate. Once this occurs, the Final Acts will become treaty-binding upon the United States.

The Final Acts of WARC 1979 comprise a set of international Radio Regulations and a Table of Frequency Allocations which become effective on January 1, 1982. Full implementation of the new Table of Frequency Allocations, however, will take as much as 15 years.



The International Telecommunication Union (ITU) divides the world into regions for allocation of frequencies. The regions are: (I) Europe, the Soviet Union, and Africa; (II) the Americas; and (III) Asia, Australia, and the Western Pacific.

The Conference. WARC 1979 was convened on September 24, 1979. An initial controversy over selection of a Conference chairman ended in compromise. Thereafter, WARC soon "settled down" into a marathon eleven-week working session. In the end, the pursuit of technical solutions largely won out over political considerations, thereby ensuring that a significant degree of order in the use of the radio spectrum would be preserved over the next 20 years. In addition, a major U.S. objective—support of the concept that the ITU is *the* international agency capable of providing a useful forum for the discussion of global telecommunications problems and needs—was achieved.

The Final Acts of WARC 1979 occu-

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py more than 1100 pages, and they will, in one way or another, affect all our lives in the years ahead. Although they resolve many issues, they do not settle a number of problems. More than 80 *reservations* in the form of footnotes were taken by member states at the Geneva meeting. (A reservation is a statement by a nation that it does not consider itself bound by a decision reached at the Conference.) The United States alone took five reservations. From an international point of view, such reservations are unfortunate because they undermine the very rationale for convening the WARCs—to produce a single frequency-allocation plan to which all ITU members subscribe, thereby minimizing mutual interference among different telecommunication services.

Unresolved Issues. There were two principal areas in which the Conference was unable to produce acceptable solutions: geosynchronous communications satellites and international (shortwave) broadcasting. Instead, the delegates agreed to deal with these two contentious issues at two limited-agenda meetings to be held in a few years.

In the area of geosynchronous satellites, the dispute revolved around *a priori* planning of operating frequencies and orbital positions of geosynchronous satellites for the fixed service and direct broadcasting. As you might already know, if a satellite is placed in a precise orbit at approximately 22,300 miles (35,888 km) above the equator, its orbital velocity matches the rotational velocity of the earth. The satellite thus appears to hang motionless in the sky above a particular position and has a line-of-sight view of approximately one-half of the earth's surface. A system of three such satellites spaced appropriately offers coverage of the entire planet.

These satellites receive signals from one earth station and rebroadcast them to (usually) many other earth stations. Because the satellites appear motionless, the earth station antennas can be aimed at one of them and left in a fixed position. Today, there are 80 operating satellites in geosynchronous orbits. The bulk of them (64) handle domestic, international, and military traffic; the rest perform scientific, meteorological or experimental functions. They use microwave frequencies above 3 GHz.

TABLE I—AMATEUR AND AMATEUR-

(Note: For more than one service listed in a given

Band	Region I	Region II	Region III
160 meters	1.800-1.810 MHz Radiolocation 1.810-1.850 MHz Amateur 1.850-2.000 MHz Mobile except aeronautical mobile	1.800-1.850 MHz Amateur 1.850-2.000 MHz Amateur; Fixed; Mobile except aeronautical mobile; Radiolocation; Radionavigation	1.800-2.00 MHz Amateur; Fixed; Mobile except aeronautical mobile; Radionavigation; Radiolocation
80 meters	3.500-3.800 MHz Amateur; Fixed; Mobile except aeronautical mobile; 3.800-3.900 MHz Fixed; Aeronautical mobile or land mobile 3.900-3.950 MHz Aeronautical mobile 3.950-4.000 MHz Fixed; Broadcasting	3.500-3.750 MHz Amateur 3.750-4.000 MHz Amateur; Fixed; Mobile except aeronautical mobile	3.500-3.900 MHz Amateur; Fixed; Mobile 3.900-3.950 MHz Aeronautical mobile; Broadcasting 3.950-4.000 MHz Fixed; Broadcasting
40 meters	7.000-7.100 MHz Amateur; Amateur-Satellite 7.100-7.300 MHz Broadcasting	7.000-7.100 MHz Amateur; Amateur-Satellite 7.100-7.300 MHz Amateur	7.000-7.100 MHz Amateur; Amateur-Satellite 7.100-7.300 MHz Broadcasting
30 meters	10.100-10.150 MHz Fixed; Amateur	10.100-10.150 MHz Fixed; Amateur	10.100-10.150 MHz Fixed; Amateur
20 meters	14.000-14.250 MHz Amateur; Amateur-Satellite 14.250-14.350 MHz Amateur	14.000-14.250 MHz Amateur; Amateur-Satellite 14.250-14.350 MHz Amateur	14.000-14.250 MHz Amateur; Amateur-Satellite 14.250-14.350 MHz Amateur
16 meters	18.068-18.168 MHz Amateur; Amateur-Satellite	18.068-18.168 MHz Amateur; Amateur-Satellite	18.068-18.168 MHz Amateur; Amateur-Satellite
15 meters	21.000-21.450 MHz Amateur; Amateur-Satellite	21.000-21.450 MHz Amateur; Amateur-Satellite	21.000-21.450 MHz Amateur; Amateur-Satellite
12 meters	24.890-24.990 MHz Amateur; Amateur-Satellite	24.890-24.990 MHz Amateur; Amateur-Satellite	24.890-24.990 MHz Amateur; Amateur-Satellite
10 meters	28.0-29.7 MHz Amateur; Amateur-Satellite	28.0-29.7 MHz Amateur; Amateur-Satellite	28.0-29.7 MHz Amateur; Amateur-Satellite
6 meters		50-54 MHz Amateur	50-54 MHz Amateur
2 meters	144-146 MHz Amateur; Amateur-Satellite	144-146 MHz Amateur; Amateur-Satellite 146-148 MHz Amateur	144-146 MHz Amateur; Amateur-Satellite 146-148 MHz Amateur; Fixed; Mobile
1¼ meters		220-225 MHz Amateur; Fixed; Mobile; Radiolocation	
70 centimeters	420-430 MHz Fixed; Mobile except mobile radiolocation 430-440 MHz Amateur; Radiolocation 440-450 MHz Fixed; Mobile except aeronautical mobile radiolocation	420-430 MHz Fixed; Mobile except mobile radiolocation 430-440 MHz Radiolocation; Amateur 440-450 MHz Fixed; Mobile except aeronautical mobile radiolocation	420-430MHz Fixed; Mobile except mobile radiolocation 430-440 MHz Radiolocation; Amateur 440-450 MHz Fixed; Mobile except aeronautical mobile radiolocation
	(Note: Many reservations were taken with respect to this band. For example, the U.S., Philippines, Jamaica and Australia permit amateur operations from 420 to 450 MHz.)		
50 centimeters			610-620 MHz Amateur (New Zealand)
33 centimeters		902-928 MHz Fixed; Amateur; Mobile except aeronautical mobile radiolocation	

SATELLITE ALLOCATIONS

allocation, the services share it.)

25 centimeters	1215-1240 MHz Radiolocation; Radionavigation-Satellite 1240-1260 MHz Radiolocation; Radionavigation-Satellite; Amateur 1260-1300 MHz Radiolocation; Amateur	1215 -1240 MHz Radiolocation; Radionavigation-Satellite 1240-1260 MHz Radiolocation; Radionavigation-Satellite; Amateur 1260-1300 MHz Radiolocation; Amateur	1215-1240 MHz Radiolocation; Radionavigation-Satellite 1240-1260 MHz Radiolocation; Radionavigation-Satellite; Amateur 1260-1300 MHz Radiolocation; Amateur
13 centimeters	2300-2450 MHz Fixed; Amateur; Mobile; Radiolocation	2300-2450 MHz Fixed; Mobile; Radiolocation; Amateur	2300-2450 MHz Fixed; Mobile; Radiolocation; Amateur
9 centimeters	3300-3400 MHz Radiolocation 3400-3600 MHz Fixed; Fixed-Satellite; Mobile; Radiolocation	3300-3400 MHz Radiolocation; Amateur; Fixed; Mobile 3400-3500 MHz Fixed; Fixed-Satellite; Amateur; Mobile; Radiolocation	3300-3400 MHz Radiolocation; Amateur 3400-3500 MHz Fixed; Fixed-Satellite; Amateur; Mobile; Radiolocation
5.25 centimeters	5650-5725 MHz Radiolocation; Amateur; Space Research 5725-5850 MHz Fixed-Satellite; Radiolocation; Amateur 5850-5925 MHz Fixed; Fixed-Satellite; Mobile	5650-5725 MHz Radiolocation; Amateur; Space Research 5725-5850 MHz Radiolocation; Amateur 5850-5925 MHz Fixed; Fixed-Satellite; Mobile; Amateur; Radiolocation	5650-5725 MHz Radiolocation; Amateur; Space Research 5725-5850 MHz Radiolocation; Amateur 5850-5925 MHz Fixed; Fixed-Satellite; Mobile; Radiolocation
3 centimeters	10-10.45 GHz Fixed; Mobile; Radiolocation; Amateur 10.45-10.5 GHz Radiolocation; Amateur; Amateur-Satellite	10-10.45 GHz Radiolocation; Amateur 10.45-10.5 GHz Radiolocation; Amateur; Amateur-Satellite	10-10.45 GHz Fixed; Mobile; Radiolocation; Amateur 10.45-10.5 GHz Radiolocation; Amateur; Amateur-Satellite
1.25 centimeters	24-24.05 GHz Amateur; Amateur-Satellite 24.05-24.25 GHz Radiolocation; Amateur; Earth-Exploration-Satellite	24-24.05 GHz Amateur; Amateur-Satellite 24.05-24.25 GHz Radiolocation; Amateur; Earth-Exploration-Satellite	24-24.05 GHz Amateur; Amateur-Satellite 24.05-24.25 GHz Radiolocation; Amateur; Earth-Exploration-Satellite
6.4 millimeters	47-47.2 GHz Amateur; Amateur-Satellite	47-47.2 GHz Amateur; Amateur-Satellite	47-47.2 GHz Amateur; Amateur-Satellite
3.8 millimeters	75.5-76 GHz Amateur; Amateur-Satellite 76-81 GHz Radiolocation; Amateur; Amateur-Satellite	75.5-76 GHz Amateur; Amateur-Satellite 76-81 GHz Radiolocation; Amateur; Amateur-Satellite	75.5-76 GHz Amateur; Amateur-Satellite 76-81 GHz Radiolocation; Amateur; Amateur-Satellite
2.5 millimeters	119.98-120.02 GHz Earth-Exploration-Satellite; Fixed; Inter-Satellite; Mobile; Space Research; Amateur	119.98-120.02 GHz Earth-Exploration-Satellite; Fixed; Inter-Satellite; Mobile; Space Research; Amateur	119.98-120.02 GHz Earth-Exploration-Satellite; Fixed; Inter-Satellite; Mobile; Space Research; Amateur
2 millimeters	142-144 GHz Amateur; Amateur-Satellite 144-149 GHz Radiolocation; Amateur; Amateur-Satellite	142-144 GHz Amateur; Amateur-Satellite 144-149 GHz Radiolocation; Amateur; Amateur-Satellite	142-144 GHz Amateur; Amateur-Satellite 144-149 GHz Radiolocation; Amateur; Amateur-Satellite
1.25 millimeters	241-248 GHz Radiolocation; Amateur; Amateur-Satellite 248-250 GHz Amateur; Amateur-Satellite	241-248 GHz Radiolocation; Amateur; Amateur-Satellite 248-250 GHz Amateur; Amateur-Satellite	241-248 GHz Radiolocation; Amateur; Amateur-Satellite 248-250 GHz Amateur; Amateur-Satellite

A study recently conducted for NASA concludes that there will be a tenfold increase in the demand for geosynchronous satellite communications circuits between the years 1982 and 2000. So a serious overcrowding problem is expected to develop. Presently, in the arc between the longitudes 4° W and 150° W, there are 44 satellites. Within five years, it is estimated that more than 50 additional satellites will be placed into that region of space. Although the satellites will be many miles apart, potential interference problems arise. Satellites using the same frequencies must be at least 3° to 4° (210 to 280 miles or 338 to 450 km) apart if their signals are not to interfere with each other.

There are two ways to minimize interference problems. The first is to use directional antennas on the satellites to confine their radiation into one or more beams. The other method is to increase the spacing between satellite frequency channels. Obviously, satellites already in orbit cannot be retrofitted with either modification, so these methods will have to be applied to future generations of satellites. There are problems associated with both solutions. Restricting satellite radiating beamwidths will mean that certain areas will not receive enough signal to make an earth station feasible there. And increasing channel spacing consumes valuable spectrum space.

To complicate matters, many developing nations began to demand that some of the desirable remaining slots above the equator be reserved for them. These positions would be held open until they are able to put communications satellites of their own into orbit. In contrast, the industrialized nations wanted to maintain the present assignment system of first-come, first-served.

Delegates to WARC were unable to come up with an acceptable compromise. They therefore decided to convene a two-stage geosynchronous satellite planning conference, which is tentatively scheduled for 1984 and 1986. The purpose of the first meeting is to "decide which space services and frequency bands should be planned . . . (and then) establish the principles, technical parameters, and criteria for the planning." Actual assignments are to be made at the second meeting.

Another area in which the WARC delegates deadlocked was allocation of shortwave frequencies to international broadcasting. Although there were some increases in allocations between 9 and 22 MHz (more on this later), no additional frequencies were allocated in the 49- and 41-meter portions of the spectrum. Increased allocations for shortwave broadcasting was a top priority of the United States, which had proposed

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an increase of 46% in frequencies assigned to this service. Owing to failure of the Conference to allocate considerably more frequencies to shortwave broadcasting than it did, 20 nations took exception by way of reservations.

To prevent this controversy from bogging down the proceedings, the WARC delegates decided to hold another two-part limited-agenda meeting. The first session will probably be held in 1983, with a second about 18 months later.

The United States delegation stated that this country would not abide by the WARC shortwave-broadcasting allocations if the upcoming conference does not expand the 49- and 41-meter bands. What's more, the United States might set up broadcasting operations on the frequencies in question anyway. Among the ITU members that have taken the same position are Canada, Israel, Italy, the United Kingdom and Vatican City.

Having examined those questions which WARC did not resolve, let's now look at the decisions that were reached and how they affect those services with which we are most familiar—broadcasting, amateur, and CB radio.

Amateur and Amateur-Satellite Services. Although in this and other countries we speak of the "amateur service," the ITU recognizes and allocates bands of frequencies to two amateur services—the amateur service and the amateur-satellite service. Given this formal distinction, we will consider separately the more important WARC-79 decisions affecting these two services.

In its pre-Conference planning, the amateur (terrestrial) service had as its goals: the preservations of its existing frequency allocations; the allocation of three new hf bands near 10, 18, and 25 MHz; and exclusive allocations in some bands presently shared with other services. Judged against these goals, amateur efforts at WARC were highly successful! Working through the International Amateur Radio Union (IARU), a multinational team of amateurs made the following gains.

All of the current amateur bands were retained. However, a portion of the 1200-MHz band was withdrawn to protect a new satellite radionavigation system, and additional sharing with other services was introduced in some bands above 220 MHz.

Three new hf bands were allocated:
10.1 to 10.15 MHz;
18.068 to 18.168 MHz;
24.89 to 24.99 MHz.

The 10-MHz band is to be shared worldwide with the fixed ("point-to-point") service. The 18- and 25-MHz bands are allocated worldwide on an exclusive basis to the amateur and amateur-satellite services. Although these bands are smaller than those the amateur community was seeking, and an exclusive allocation was sought at 10 MHz, the assignments are considered important to the growth of amateur radio. Table I summarizes the allocations to Region II amateurs (see ITU map).

Exclusive amateur allocations in the 1.8- and 3.5-MHz bands were created for amateurs residing in ITU Region II. For the first time, amateurs in Region I were granted an allocation within the 1.8-MHz band. Region II amateurs gained an allocation from 902 to 928 MHz, which they will share with the fixed, mobile (except aeronautical mobile) and radiolocation services.

The amateur-satellite service also triumphed. Although this service's primary goal was to acquire new bands between 1 and 10 GHz, it also sought new bands above 40 GHz for its own use and use by the amateur service as well. Here, again, the goals were met.

The amateur-satellite service gained a number of new bands including:
1260 to 1270 MHz (uplink only);
2400 to 2450 MHz;
3400 to 3410 MHz;
5650 to 5670 MHz (downlink only);
5830 to 5850 MHz (uplink only);
10.45 to 10.5 GHz.

In addition, both amateur services gained 4700 MHz of new, exclusive bands and 17,040 MHz of new, shared bands above 40 GHz. As a result, amateur radio is well positioned to explore the frontiers of the radio spectrum!

One nonallocation issue involving the amateur service, and one which produced a great deal of controversy, was the U.S. proposal to delete the Morse-proficiency requirement of the amateur service. This proposal was strongly opposed by all but one ITU member—only Japan supported the U.S. Thus, the proposal failed. However, a proposal to lower the frequency limit above which no-code amateur licenses could be issued was approved. Specifically, the frequency limit was lowered from 144 MHz to 30 MHz. Therefore, no-code licenses in the amateur service are still not permitted below 30 MHz.

Amateurs everywhere can be proud of the fine work performed by the IARU team at WARC, and can look forward through the remainder of this century to a time of growth and unparalleled exploration in amateur communications.

Broadcasting. As mentioned earlier, a dispute over frequency allocations for shortwave broadcasting arose at the Conference and could not be resolved. Agreement could not be reached on the possible expansion of the 49- and 41-meter bands. The upcoming limited-agenda conference will hopefully resolve this situation.

In spite of this, the delegates were able to agree on the expansion of other shortwave broadcasting bands. A total of 850 kHz of additional frequencies were given to the international broadcasting bands between 9 and 22 MHz. However, the 11-meter band was trimmed by 70 kHz. Table II summarizes the changes in allocations for shortwave broadcasting.

A major goal of the United States was to increase the size of the mediumwave broadcasting band. The U.S. proposed to raise the top end of the band from the present 1605 kHz to 1860 kHz. Part of this increase was to be devoted exclusively to broadcasting and part to be shared with other services. The Final Acts of WARC provide for some increase in the width of the mediumwave band, but not as much as the U.S. delegation sought. Frequencies up to 1625 kHz will be used exclusively for broadcasting, with those from 1625 to 1705 kHz being shared with other services. In this shared subband, broadcasting will be the primary user.

This increase in the mediumwave

TABLE II—SHORTWAVE FREQUENCIES ALLOCATED TO INTERNATIONAL BROADCASTING

Band	Present Band (MHz)	Future Band (MHz)	Change (MHz)
49 meters	5.950-6.200	5.950-6.200	0
41 meters	7.100-7.300	7.100-7.300	0
31 meters	9.500-9.775	9.500-9.900	+0.125
25 meters	11.700-11.975	11.650-12.050	+0.125
22 meters	—	13.600-13.800	+0.200
19 meters	15.100-15.450	15.100-15.600	+0.150
16 meters	17.700-17.900	17.550-17.900	+0.150
13 meters	21.450-21.750	21.450-21.850	+0.100
11 meters	25.600-26.100	25.670-26.100	−0.070

band does not mean that all of the existing MW receivers are now obsolete. Broadcasting operations on the newly allocated frequencies will not be possible before the end of this decade—at the earliest. A regional conference to set up new mediumwave channels and thus implement the expansion approved at WARC will not take place before 1988.

Another broadcasting-related issue over which concern was expressed at Geneva is *jamming*. This intentional, harmful interference with the reception of broadcast transmissions is a violation of the Torremolinos International Telecommunication Convention. Furthermore, it has been the position of the Ford and Carter Administrations that jamming is contrary to the letter and spirit of the Helsinki Final Act, the Accords adopted at the close of the European Security Conference which guarantee, among other things, the free flow of information between peoples whose governments have pledged to observe that document.

In spite of this, the broadcasts of many nations, including those of the United States, are still the targets of jamming by governments who want to limit their citizens' access to information. Accordingly, the U.S. delegation took the opportunity at WARC to make a closing protocol statement on the subject of jamming. It called attention to the jamming problem and to the fact that much of this deliberate interference is produced by nations which are themselves signatories to the Final Acts of the World Administrative Radio Conference. The U.S. also reserved the right to take necessary and appropriate steps to protect its broadcasting operations so long as this jamming continues.

Citizens Band (CB) Radio. Since Citizens Band is not an ITU-recognized radio service, as such, it has not been, nor is it now, mentioned anywhere in the international Radio Regulations. In the U.S., for example, CB is treated as part of the mobile service (from a regulatory point of view).

This is not to say that CB-related matters were not addressed at WARC. Italy proposed an allocation from 26.96 to 27.28 MHz for a "Non-Professional Personal Service." The proposal failed to gain acceptance. The Federal Republic of Germany, on the other hand, favored the use of the band from 928 to 930 MHz for short-range, low-power mobile communications. This idea also failed to gather support. Thus, no *explicit* provisions for a personal radio service were included in the Final Acts of WARC-79.

The new Table of Frequency Allocations, however, contains numerous allocations to the mobile service. The possibility exists, therefore, that the U.S. will someday assign a mobile allocation to a new personal radio service. In fact, a band near 900 MHz is currently being considered for just such a purpose. There are many factors that suggest that 900 MHz would be an ideal spot for a new, point-to-point personal communications band.

At such frequencies, a large number of channels could be made available to the public. Radio-frequency interference (RFI) to electronic home-entertainment equipment would be unlikely. There would be little temptation for operators to use (illegal) high-power amplifiers because the nature of radio propagation in this portion of the spectrum limits coverage essentially to line-of-sight distances—no matter how high the transmitter's output power. The use of FM would virtually eliminate the problems associated with heterodynes and ignition noise that currently plague CB users. In addition, a new service at 900 MHz could provide the public with selective signaling, telephone interconnections, and expanded coverage through the use of repeaters.

Whether a frequency band at 900 MHz is assigned to a new personal radio service will depend on the outcome of regulatory proceedings being conducted by the Federal Communications Commission. Before a new service is created, however, the need for it must be substantiated by the public which is to benefit from it.

In Conclusion. These, then, are a few of the ways in which the Final Acts of WARC 1979 will affect users of the radio spectrum. In the years to come, the growth of the various radio services will depend on the foresight of the delegates who attended the Conference. It will also depend on the international community's willingness to share that vital, natural resource, the radio frequency spectrum. ◇

Sunspots in Action

by Stanley Leinwoll

Solar Cycle 21 is expected to continue for several more months, providing continued high-level action in shortwave comunications.

FOR everyone interested in shortwave communication, whether they are radio amateurs, shortwave listeners, or CBers, the big news over the past few years has been the dramatic improvement in radio conditions, particularly on the higher frequencies. "Skip" or CB-DX has been a relatively frequent occurrence, especially in rural and suburban areas. The 10-, 15-, and 20-meter amateur bands have been open to most parts of the world for long periods of time. Also, reception of shortwave signals on the 19-, 16-, 13-, and 11-meter broadcasting bands has been better than at any time in the past 20 years!

The significant improvement in shortwave conditions, especially on frequencies above 14 MHz, has been due to near-record levels of sunspot activity. In this article, we will review the basic relationship between solar activity and high-frequency radio propagation, follow the course of Solar Cycle 21 as it has unfolded to date, and hazard a few predictions about radio propagation for the next few years. Armed with this information, as well as the daily reports of sunspot activity broadcast by NBS station WWV, you will be able to plan your use of radio frequencies and time for maximum communications efficiency.

Sunspots and Propagation. The relationship between radio conditions and sunspots can be explained by the fact that radiation from sunspots influences the condition of the ionosphere, the electrified region in the earth's upper atmosphere. The ionosphere is capable of refracting radio waves in the shortwave portion of the spectrum and causing them to return to earth at great distances. If it were not for the ionosphere, long-distance, high-frequency radio communication would be impossible.

The intensity of solar radiation reaching the upper atmosphere is subject to considerable variation. It is obvious that such variations occur from day to night,

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from one season to the next, and one geographical location to the next. As a result, the range of frequencies the ionosphere can reflect varies diurnally, seasonally, and geographically.

In addition, there is another profoundly important variation—the *sunspot cycle*. Because sunspots are a primary source of ultraviolet radiation, the ionosphere's condition will also depend to a great extent upon the number of sunspots visible on the solar disc at any one time.

No completely satisfactory explanation of the mechanism that generates sunspots and controls their dynamics exists. We know, however, from regular observation dating back to the Seventeenth Century that the number of spots on the solar surface varies in a cyclical fashion—from minimum to maximum, and back to minimum again, in a period of approximately 11 years. In general, it takes about four years to go from minimum to maximum, and seven years from maximum back to minimum.

Solar Observations. Although sunspots have been observed with the naked eye for thousands of years, it was not until the discovery of the telescope by Galileo in 1610 that regular recordkeeping of sunspot activity began.

The Federal Observatory in Zurich, Switzerland, began publishing sunspot numbers on a daily basis in 1849. Shortly thereafter, Hendrick Schwabe discovered the periodicity of sunspot numbers and a uniform method of recording sunspot activity was developed.

Rudolph Wolf, working in Zurich, recognized the importance of recording sunspots in accordance with a common standard. He was aware that observatories around the world used telescopes of different sizes, and that viewing conditions varied with geographical location. The *Wolf sunspot number* was based on the following equation: $R = k\ (10g + f)$, where R is the relative sunspot number; k is a factor which takes into account a telescope's size and power, as well as location and viewing conditions; g is the number of sunspot groups observed, and f is the total number of sunspots, including those appearing in groups. Wolf reasoned that groups of sunspots were of more importance as an index of solar activity than individual spots, and therefore weighted them accordingly by multiplying the number of groups by 10. Relative sunspot number R, therefore, is an index of solar activity rather than an actual sunspot count.

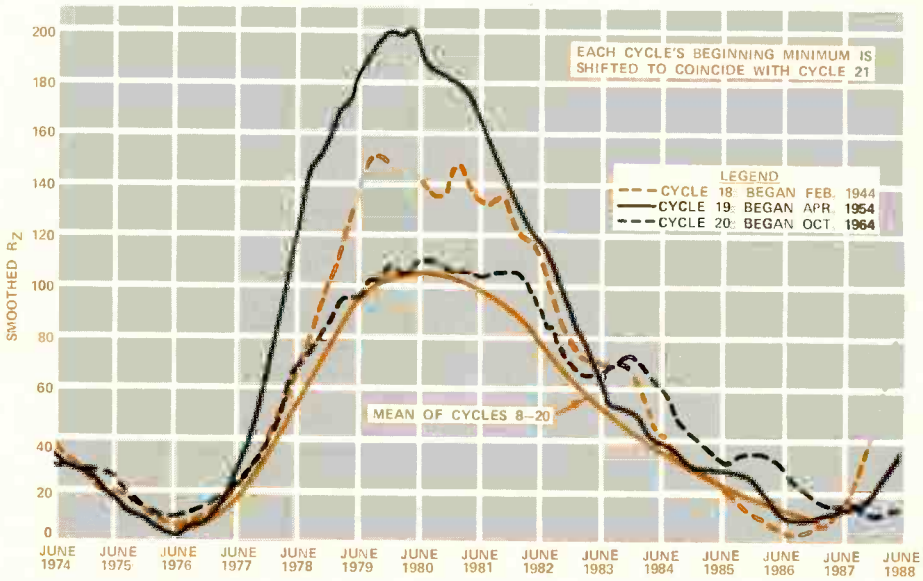

Fig. 1. Sunspot Cycles 18, 19, and 20 compared with a composite average of Cycles 8-20. Cycle 19 was the highest recorded; Cycle 20 the longest.

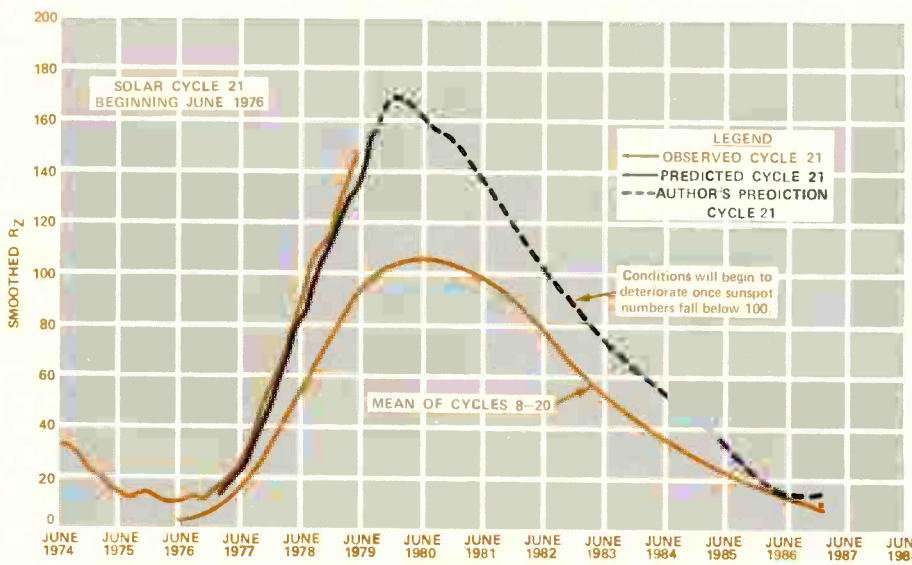

Fig. 2. Observed and predicted smoothed sunspot numbers for Sunspot Cycle 21. Peak of Cycle 21 occurred toward the end of 1979, expected to reach a minimum in 1986.

Figs. 1 and 2 courtesy National Geophysical and Solar Terrestrial Data Center, Boulder, CO.

Since the relative sunspot number varies considerably from day to day, scientists have found that by *smoothing* sunspot numbers, a more accurate assessment of trends can be observed. Sunspot numbers are smoothed by first averaging all the daily R numbers over a one-month period. This yields a mean relative sunspot number R_M.

It is of interest to note that, after nearly a century and a half of publishing relative sunspot numbers, the Swiss Federal Observatory in Zurich recently announced that this service will be discontinued at the end of 1980.

Sunspot Effects. Although scientists do not know precisely what causes sunspots, it is currently believed that they are generated by powerful magnetic fields originating deep within the sun. However, scientists do not know why the postulated magnetic fields near the sun's core vary in a cyclical fashion. Magnetic fields associated with sunspots tend to hold the surrounding particles and gases in relatively stable circular motion, in contrast to the turbulent movement of gases on other parts of the sun's surface. As a result, the temperature within a

sunspot is lower than the surrounding solar areas, making it appear dark relative to the rest of the sun. This darkened area is the sunspot.

Sunspots generally appear in groups, and range in size from several hundred miles in diameter to as much as 80,000 miles across—large enough to contain 10 planets the size of the earth laid end to end. The sunspots move from east to west with the rotation of the solar disc. Because the period of the sun's rotation is approximately 27 days, a spot which is visible coming around the eastern rim of the sun remains visible approximately 13 days before it disappears around the western limb of the sun. Sunspots and sunspot groups can be short-lived, lasting only a day or so, or they can continue in existence for many months, remaining visible on numerous successive solar rotations. It is for this reason that radio storms associated with a particular sunspot group sometimes recur at 27-day intervals, coinciding with the rotation of the sun.

Ultraviolet radiation from the sun influences the condition of the ionosphere. Since sunspots are a primary source of ultraviolet radiation, it stands to reason that during years of high sunspot activity the ionosphere will behave differently than during years of very low activity. This is demonstrated primarily by the ability of the ionosphere to return higher frequencies to earth during years of sunspot maxima than during minimum years. As a result, during periods of high solar activity, frequencies above 14 MHz are reflected for longer periods of time. This is why, over the past several years, signal propagation has dramatically improved in the 10-meter amateur band, 11-meter Citizens Band, and 19-, 16-, 13-, and 11-meter shortwave broadcasting bands.

The number of spots on the sun has reached near-record levels recently. Consequently, radio conditions have been unusually good at the higher frequencies. Those who communicate using the shortwave portion of the spectrum have been particularly interested in projecting the levels of solar activity for the next several years to determine how long these conditions will last. Based on a statistical study of past sunspot cycles, we can predict with reasonable accuracy the number of sunspots that can be expected for the remainder of this cycle. Before doing so, however, it is desirable to review briefly the course of previous sunspot cycles, with particular emphasis on the last three.

Sunspot Cycle Behavior. We are currently in the 21st recorded sunspot cycle. Based on the average of the first 20 cycles, the following is a summary of observed sunspot cycle behavior:

- The average period of a sunspot cycle, from minimum to maximum and back to minimum again, is 10.8 years;
- The average period from the beginning of a cycle (minimum) to maximum is a little more than four years;
- The average period from the maximum of a cycle to the minimum is approximately 6.7 years.

Figure 1 is a composite drawing showing the average of Cycles 8 through 20 (*total* period over which accurate records have been kept.) Superimposed on this are Cycles 18, 19, and 20.

Cycle 19 is of special interest because it was by far the most intense ever observed. This cycle started in April 1954 with a smoothed sunspot number of 3.3. Within 30 months, the smoothed number already exceeded the maximum of Cycle 3, which had reached a peak of 159 in 1778, and which had been the highest recorded to date. By March 1958, the smoothed number was 201.3, easily the highest maximum on record. Conditions during the maximum of Cycle 19 have become legendary. Worldwide F-layer ionospheric (sky-wave) propagation existed in the 6-meter amateur band, and the 20-meter band was open around the clock to most parts of the world. During the period 1957-59, TV DX was commonplace via F-layer sky-wave propagation on lower vhf channels 2, 3, and 4.

Cycle 20 was more "normal," reaching a maximum of 111 in November 1968. However, once the smoothed

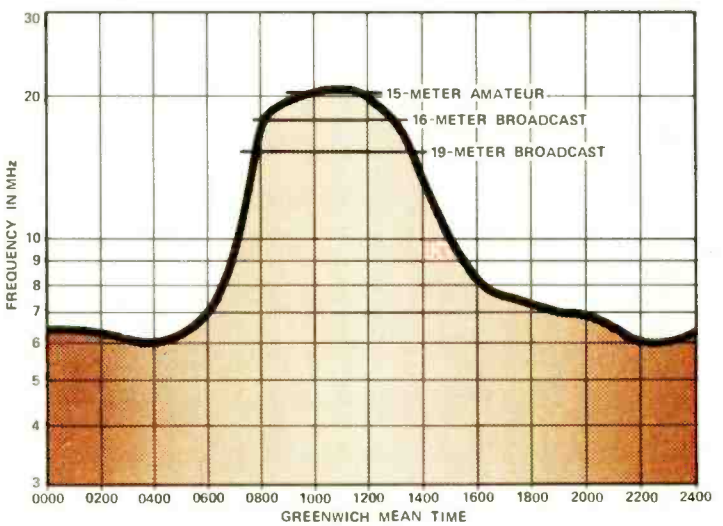

Fig. 3. Frequencies that are most useful between East Coast of USA and western Europe in December during sunspot minimum (10) conditions.

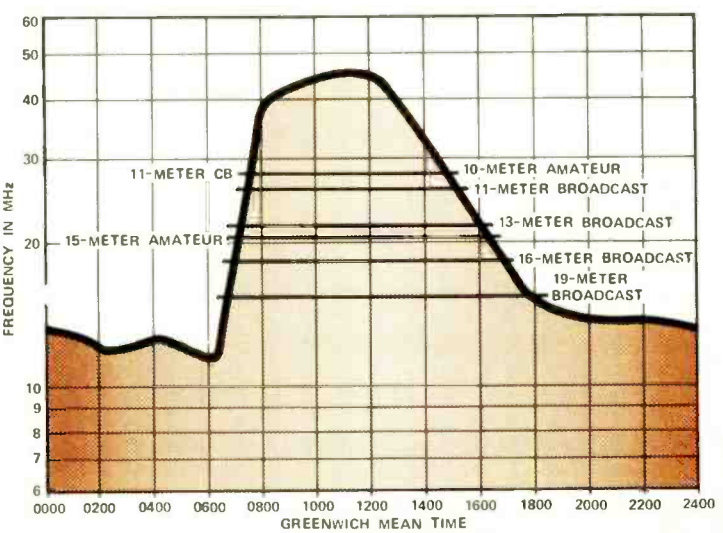

Fig. 4. Frequencies most useful between East Coast of USA and western Europe in December during sunspot maximum (165) conditions.

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numbers began to decline, Cycle 20 displayed some unusual characteristics. The count remained confined to the vicinity of 106 for 17 months, from March 1969 to July 1970. To Cycle 20 belongs the distinction of the longest plateau at maximum ever observed. Cycle 20 was longer (11.5 years) than the average cycle, and took more time (7.4 years) to go from maximum to minimum than the average sunspot cycle.

The Current Cycle. Cycle 21 began in June 1976 with a smoothed sunspot number of 12.2. Many scientists and other observers were fooled by this cycle, expecting it to be similar in intensity to Cycle 20. Some pundits even predicted a maximum smoothed number below 100. However, within 27 months of its start, the smoothed number had already risen above 100; and by October of 1979 it had already become the second highest cycle on record.

In Closing. If we consider that the sun is four billion years old, and that we have been observing sunspots for approximately 230 years, it becomes evident that we know very little about sunspot cycles. We can, at best, offer an educated guess as to where Cycle 21 is going based on our very limited experience (see Fig. 2).

It now appears that Cycle 21 peaked sometime in late 1979 or early 1980. As we have indicated, finding a smoothed number centered on a particular month requires relative numbers for the six months before and six months after, as well as the month on which the number is centered. As of February 1980, the best guess is that the maximum smoothed number for Cycle 21 was approximately 165 and that it occurred in November 1979. It can further be expected that smoothed sunspot numbers in excess of 100 will continue for at least another 18 months.

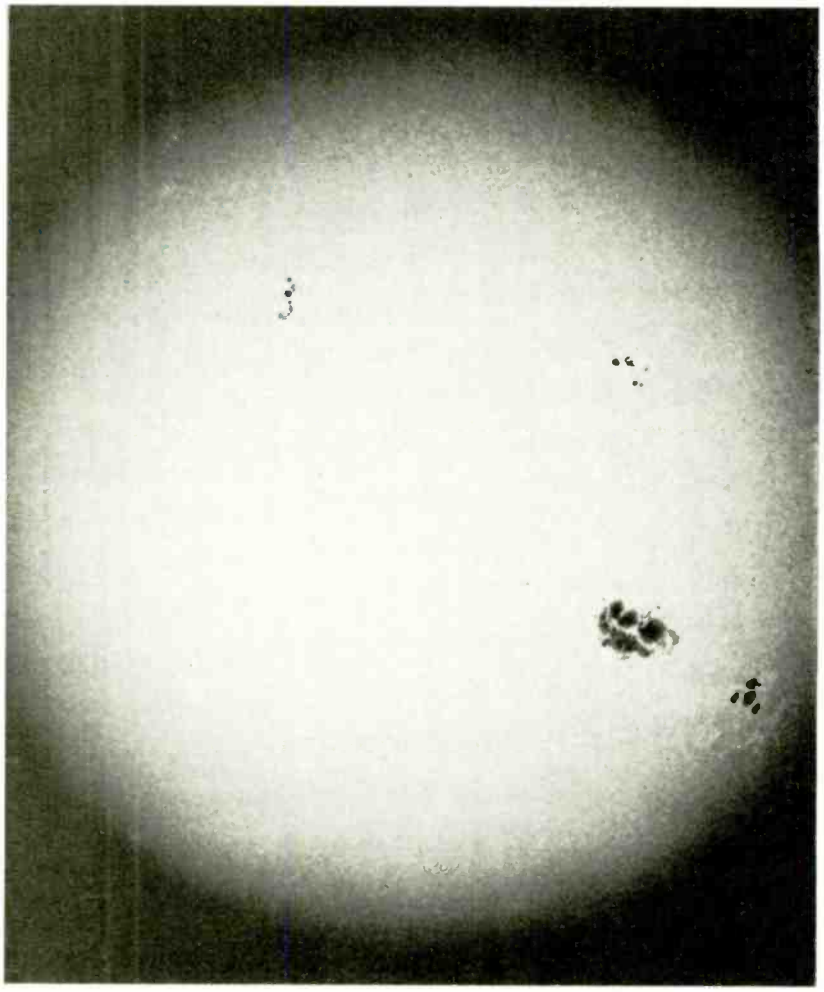
As a result, it is expected that the 10-meter amateur band will be open during daylight hours to many parts of the world and that the 20-meter band will be open around the clock from May to mid-August in 1980, 1981, and possibly into 1982. Sky-wave propagation on the Citizens Band will continue during the same periods, as well as during the daylight hours of the winter months. Because of high interference levels in urban areas, it will be most apparent in rural and suburban areas.

The international shortwave broadcasting bands will also provide SWLs with excellent listening opportunities. The 11-meter (26-MHz) band will be open at the same times as the Citizens Band. The 19-, 16-, and 13-meter bands (15, 17, and 21 MHz) will be open for relatively long periods, with 15 MHz open around the clock during the summer months. Thereafter, there will be a steady decline in band openings on the higher frequencies.

The impact of solar activity on the range of usable frequencies is dramatically illustrated in Figs. 3 and 4. These show predictions of maximum usable frequencies for a circuit between the east coast of the USA and western Europe during the month of December for sunspot minimum (smoothed sunspot number 10), and sunspot maximum (smoothed sunspot number 165).

It can be seen that during periods of maximum solar activity, the 10-meter amateur band and the 11-meter 26-MHz broadcast band are open to and from Europe during a substantial portion of the day, and 15 meters is open even longer. This compares to no openings above 15 meters during sunspot minimum conditions, with 15 meters open for only a very short time. There is no CB-DX during minimum conditions, either from Europe or over circuits of comparable distance, such as between the east and west coasts of the US.

Beyond 1982, therefore, we can expect a slow but steady deterioration of the usefulness of the frequencies above 14 MHz. This will apply to shortwave listening, amateur radio, and the Citizens Band. These poorer conditions will continue into 1986, when the minimum of Cycle 21 is expected, and for at least another year or two into Cycle 22. ◇



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Photograph of sun during sunspot maximum conditions. Four sunspot groups, one of them massive, can be seen.

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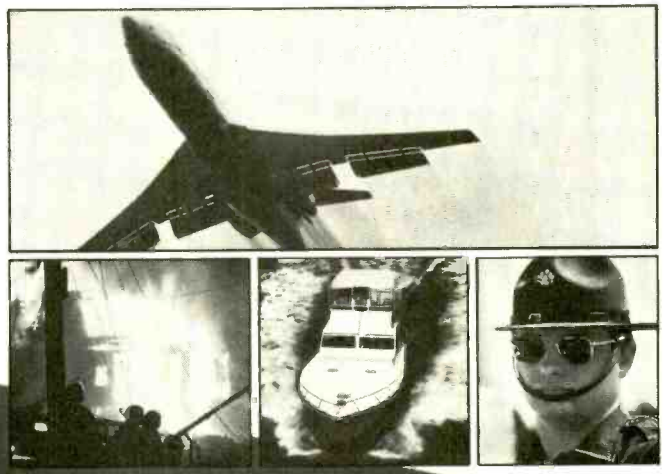

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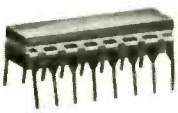

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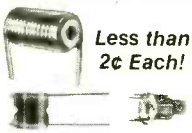

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A Low-cost A/D Converter

BY SAMI A. SHAKIR

This simple, useful circuit employs "current mirrors" instead of conventional op amps

MORE and more digital techniques are finding applications in formerly exclusive domains of analog electronics—tests and measurements, communications, and the recording and reproduction of speech and music, to name a few. One necessary stage in any digital system that processes information originating in analog form is the analog-to-digital or A/D converter. In this article, we will present a low-cost A/D converter that you can build using readily available parts. The circuit can be used to experiment with the conversion of voltages, currents, and transduced physical quantities from analog into digital form.

About the Circuit. The A/D converter circuit, as shown in the schematic, employs a 12-bit CMOS counter and an LM3900 quad operational amplifier. Each of the op amps in an LM3900 IC employs the concept of a "current mirror" to amplify differential signals. They are known as Norton current-differencing amplifiers (CDAs) and are shown schematically as containing current sources to distinguish them from conventional operational amplifiers. Among the advantages of Norton CDAs are circuit simplicity, low cost, and the requirement of only a single-ended power supply from which each amplifier sinks a constant current independent of the supply voltage.

Stage *IC1A* generates a train of pulses whose duration is determined by the values of *R5* and *C1*. The frequency of the pulse train can be varied by adjusting potentiometer *R1*. Pulses generated by *IC1A* are applied to the noninverting input of *IC1B*. This Norton CDA is employed as an integrator which generates a staircase waveform. The staircase increases in amplitude as pulses are received from *IC1A*. It is applied to the inverting input of comparator *IC1C*.

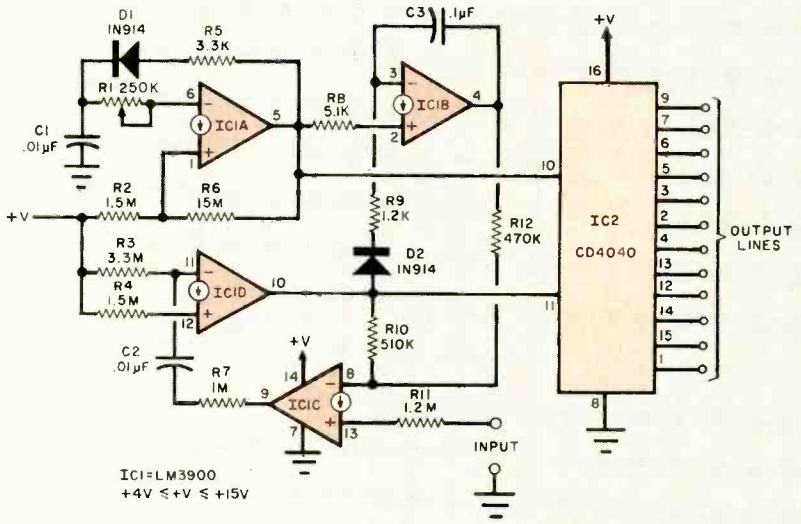
The analog input signal is applied to the noninverting input of this comparator. As long as the staircase amplitude is less than that of the input signal, the output of comparator *IC1C* remains at +V, the positive supply voltage. The staircase continues to increase in amplitude until it just exceeds the input signal's amplitude, at which point the differential input current at *IC1C* becomes negative. This causes the output of the comparator to go to ground potential, and the resulting negative transition is capacitively coupled to the inverting input of comparator *IC1D*.

The negative pulse momentarily toggles the output of *IC1D* from its normal (ground) state to the positive supply voltage. The resulting positive pulse resets both integrator *IC1B* and counter *IC2*, causing the output lines of the counter and the output of the integrator (that is, the staircase waveform) to go to ground potential. The process begins all over again as new pulses are generated by *IC1A* and applied to the integrator and counter.

In operation, the amplitude of the staircase waveform is continuously compared to the analog input signal. If the input is a constant dc level, the staircase increases to a certain amplitude during each cycle until integrator *IC1B* is reset by *IC1D*. Similarly, *IC2* will count up to a certain binary number and then be reset. If the input waveform changes with time, the amplitude attained by the staircase and the magnitude of the binary count generated by *IC2* just before the reset pulse is applied will vary. Accordingly, the larger the input signal, the greater the amplitude of the staircase and the count at the output lines of *IC2* at the instant before the reset pulse causes the outputs of *IC1B* and *IC2* to go to ground. The smaller the input signal, the lower the amplitude of the staircase and count of *IC2* at the instant before the reset command takes effect. The highest count attained by *IC2* be-

fore the output lines are reset to zero describes the amplitude of the analog input signal at the instant that comparator *IC1C* changes states.

Because Norton CDAs are employed, only a single-ended power supply is needed. National Semiconductor, the manufacturer of the LM3900, states in its data sheet that a supply delivering from +4 to +36 volts can be used to power the chip. The power supply rating of the CD4040 CMOS counter is +1 to +15 volts. Accordingly, a supply furnishing a voltage greater than or equal to +4 volts and less than or equal to +15 volts can be used to power the entire circuit. Current demand is modest, so either a battery or small, well-filtered, line-powered supply is suitable.



Schematic of the converter. The Norton CDAs are shown as containing current sources to distinguish them from standard op amps.

PARTS LIST

C1,C2—0.01-μF disc ceramic, silver mica or polystyrene capacitor
C3—0.1-μF disc ceramic, silver mica or polystyrene capacitor
D1,D2—1N914 diode
IC1—LM3900 quad Norton CDA
IC2—CD4040 counter
R1—250,000-ohm, linear-taper trimmer potentiometer
The following are ⅛-watt, 5% tolerance, carbon-composition resistors.
R2,R4—1.5 megohms
R3—3.3 megohms
R5—3300 ohms
R6—15 megohms
R7—1 megohm
R8—5100 ohms
R9—1200 ohms
R10—510,000 ohms
R11—1.2 megohms
R12—470,000 ohms
Misc.—Printed circuit or perforated board, IC sockets, suitable power supply and enclosure, hookup wire, hardware, etc.

Construction. Printed-circuit, point-to-point wiring, or wrapped-wire assembly techniques can be used to reproduce the analog-to-digital converter circuit. The use of IC sockets is recommended, and the standard precautions for the handling of CMOS devices should be employed with respect to *IC2*. Be sure to observe the polarities and pin basings of the semiconductors employed in this project. Also, use the minimum amount of heat and solder consistent with the formation of good connections. Before applying any supply voltages, double check your wiring for errors that might cause damage to the ICs.

To calibrate the circuit, connect its input to the positive supply voltage. Then monitor the output lines of *IC2* and adjust *R1* for the desired weighting factor. This factor n will equal N_C divided by $+V$ where $+V$ is the positive supply voltage, N_C is the highest count attained by *IC2* before it is reset, and n is the number of counts per volt.

This low-cost A/D converter can be used to gain hands-on experience with one type of A/D conversion. It can also form the nucleus of some useful projects. For instance, a latch, decoder, driver and display network can be added to provide a seven-segment readout of the digital numbers generated by *IC2*. One interesting application would be a digital current meter that can be made by adding such a display network and by eliminating *R11*. This can then in turn be converted into a high-impedance (as much as 10 megohms) digital voltmeter. ◇

2. A Low-Cost Analog Audio Delay Line CONCLUDED

BY JOHN ROBERTS

LAST month, we introduced the function and use of audio delay lines—analog and digital—in general. We then described the circuit for a low-cost analog delay line. We continue, now, with the power supply circuits that can be used with that device and construction information.

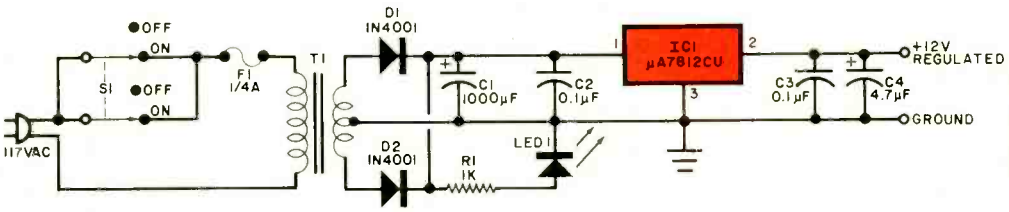


Fig. 3. This full-wave line-powered supply furnishes +12 volts regulated for the audio delay circuit.

The analog delay line project requires very little electrical power—12 volts (single-ended) at 20 mA. This modest amount of power can be provided by the ac supply shown schematically in Fig. 3. It employs a center-tapped stepdown transformer, a full-wave rectifier, a few capacitors, and a 12-volt regulator IC. In mobile and many portable applications, however, a source of 117-volt sinusoidal ac is not readily available. In such situations, the project can be

PARTS LIST
DC POWER SUPPLY

C1, C5—0.1-µF, 50-V disc ceramic capacitor
C2—100-µF, 16-V radial-lead electrolytic
C3—4.7-µF, 16-V radial-lead electrolytic
C4—100-pF, 50-V disc ceramic capacitor
D1, D2—1N914 diode
D3—6.2-volt, 1-watt zener (1N4735 or equivalent)
F1—¼-ampere fast-blow fuse
IC1—LM301AN operational amplifier
LED1—Light-emitting diode
Q1—2N3906 pnp silicon transistor
The following are ¼-watt, 5%, fixed carbon-composition resistors.
R1, R7—510 ohms
R2, R5—30,000 ohms
R3, R4—10 ohms
R6—33,000 ohms
R8—1500 ohms
S1—Dpdt pc-mount push-on/push-off switch or spst toggle switch
Misc.—Printed circuit board, fuse clips, strain relief, circuit board standoffs, hookup wire, solder, hardware, etc.

PARTS LIST
AC POWER SUPPLY

C1—1000-µF, 25-V radial-lead electrolytic
C2, C3—0.1-µF, 50-V disc ceramic capacitor
C4—4.7-µF, 16-V radial-lead electrolytic
D1, D2—1N4001 diode
F1—¼-ampere fast-blow fuse
IC1—µA7812UC 12-volt regulator
LED1—Light-emitting diode
R1—1000-ohm, ¼-watt, 5% fixed carbon-composition resistor
S1—Dpdt pc-mount push-on/push-off switch or spst toggle switch
T1—20-volt, 250-mA center-tapped stepdown transformer (Signal Transformer Co. No. ST-4-20 or equivalent)
Misc.—Printed circuit board, fuse clips, line cord, strain relief, circuit board standoffs, hookup wire, solder, etc.

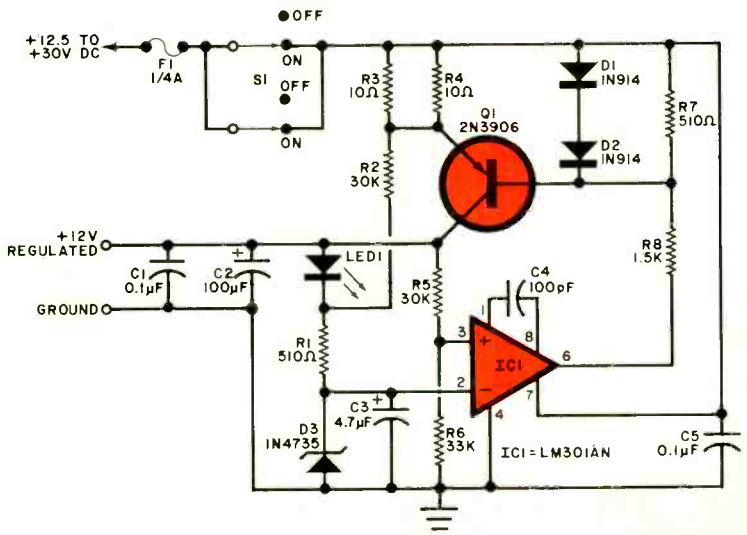


Fig. 4. This supply should be used for remote or mobile applications when ac-line power is not available.

powered by the dc-powered regulated supply shown schematically in Fig. 4. This supply employs a zener diode as a voltage reference for an LM301 op amp which in turn governs the operation of a pass transistor. This transistor acts as a regulated source for the delay circuit. The dc supply can be used with an unregulated source delivering from +12.5 to +30 volts dc.

Construction. The use of printed-circuit construction techniques is strongly recommended. Full-size etching and drilling guides of suitable pc boards for the main delay circuit, the ac supply, and the dc supply appear in Figs. 5, 6, and 7, respectively. Component placement guides for these boards appear in Figs. 8, 9, and 10. The main circuit board has been laid out to keep power and ground bus runs as short and direct as possible, and to prevent objectionable leakage of ultrasonic clock energy into the audio-frequency signal path.

Sockets or Molex Soldercons should be used when mounting ICs on the main circuit board, especially for *IC3*—any device costing that much deserves special handling. When mounting semiconductors and electrolytic capacitors, be sure to observe polarity and pin basing. Use the minimum amount of heat and solder consistent with the formation of good solder joints. Those components mounted off the board can be connected to it by means of suitable lengths of stranded, insulated hookup wire.

When assembly of the circuit boards is

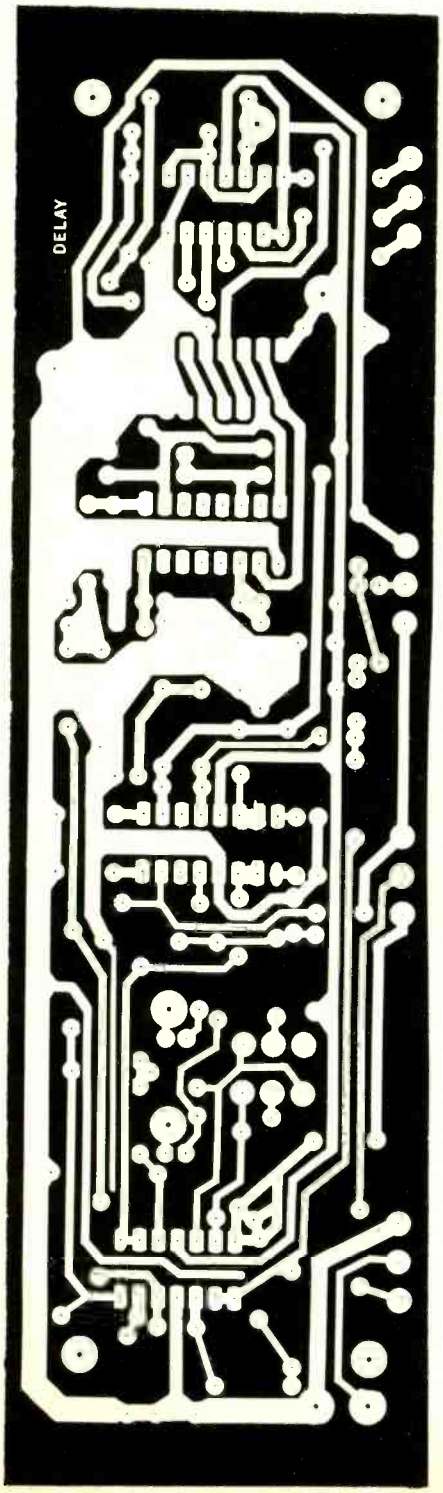


Fig. 5. Full-size etching and drilling guide for the main printed-circuit board.

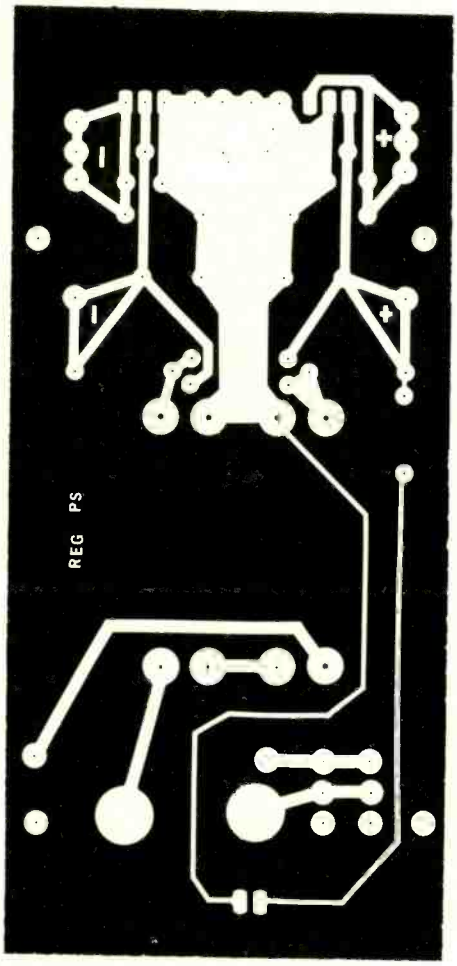


Fig. 6. Etching and drilling guide for the ac power-supply printed-circuit board.

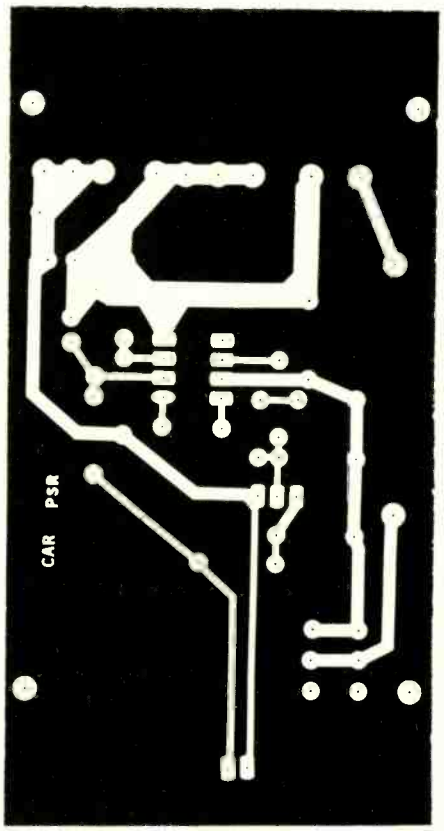


Fig. 7. Etching and drilling guide for the dc power-supply printed-circuit board.

complete, carefully inspect them for cold solder joints, solder bridges between adjacent foils, reversed polarities, etc. Then interconnect the main board with the power supply board that has been assembled, using short lengths of stranded, insulated hookup wire. Finally, mount the boards and other components in a suitable enclosure, with spacers to insulate the boards from the metallic surfaces of the cabinet.

Adding It to Your System. Use shielded audio patch cords of appropriate lengths to interconnect the project with your existing audio system. The main stereo channels should be tapped at some point at which the signals are at line level. If the signals are tapped at the output of the preamplifier, the project's output level potentiometer can be used as a front-to-back balance control. If the signals are tapped before the preamplifier's volume control, the project's output level potentiometer will have to be readjusted every time the level of the front channels is changed.

A single channel of delayed audio information calls for a monophonic power amplifier and one speaker system. However, the author's prototype includes two output jacks wired in parallel so that both channels of a stereo amplifier can be driven by the same signal if desired. The rear-channel amplifier can have a power rating as low as one fourth of that of the front-channel amplifier. Excellent performance has been obtained with as little as 20 watts of

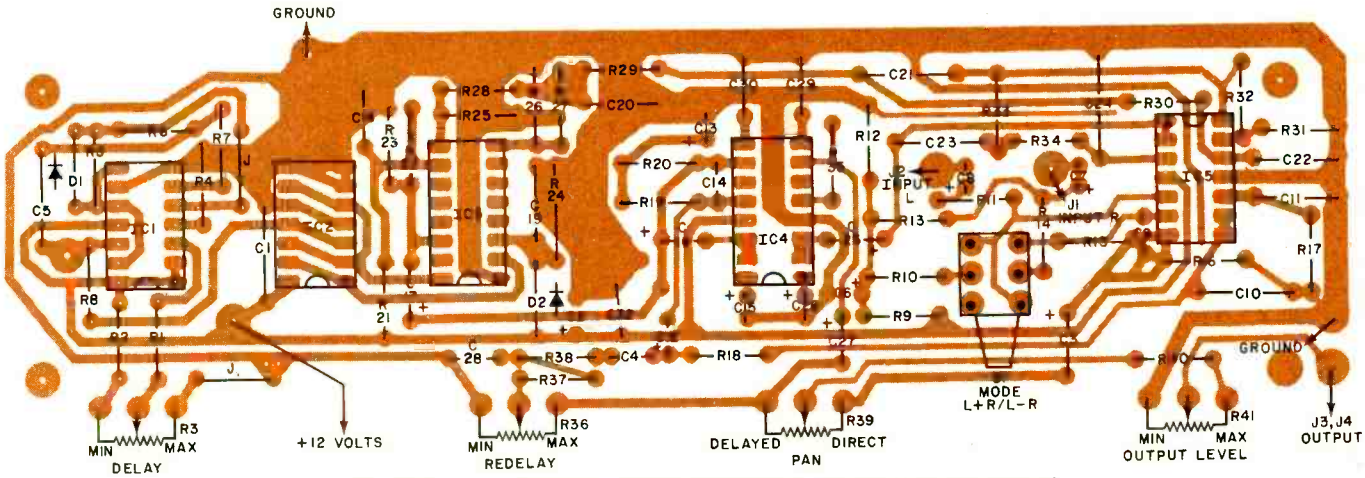


Fig. 8. Component placement guide for the audio delay line's main pc board.

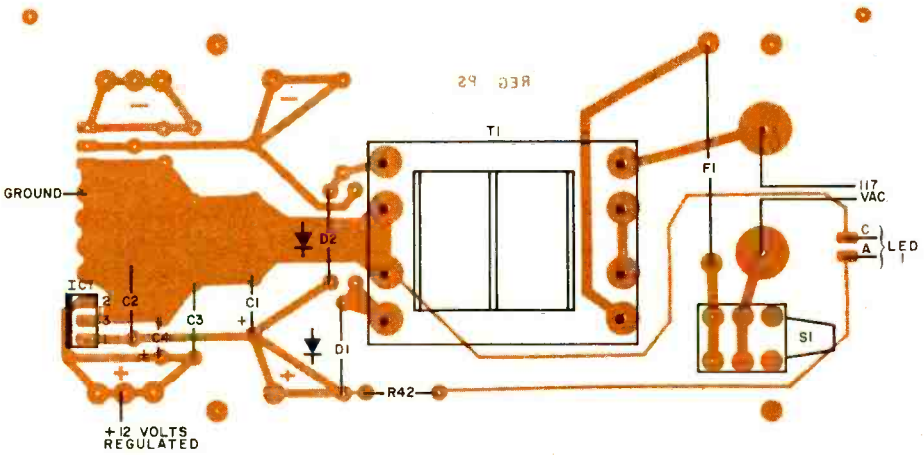


Fig. 9. Component placement guide for the ac power-supply of the project.

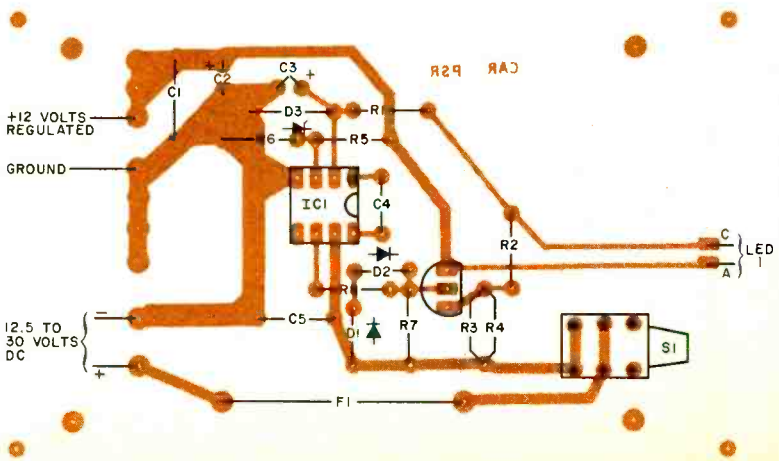


Fig. 10. Component placement guide for the dc-powered regulated supply for the audio delay line.

rated amplifier power for the rear channel.

Similarly, the speaker system associated with the rear channel need not be as sophisticated as those used in the main (front) stereo channels. Deep bass response and an extended high end are simply not needed. A speaker system with clean mid-range response and a power-handling capacity compatible with the rear-channel amplifier output power will suffice.

There are no "correct" delay-unit control settings. These adjustments should be guided by the type of music being reproduced and the personal taste of the listener. Also, the amount of reverberation that will have to be introduced to achieve a desired effect will depend on the individual recording of a given piece of music.

Two discrete delay channels can share a common enclosure and power supply. Such a configuration is available in kit form and can be connected to the main stereo channels in such a way that monaural addition or subtraction will not take place. If desired, one clock can be used to drive both stereo delay lines so that the delay times track each other. A richer sound may result if each channel has an independent, adjustable clock.

In Conclusion. Psychoacoustics is still as much an art as a science, and remains a fertile field for experimentation. The analog delay line that has been presented here is designed with the adventurous, inquisitive audiophile in mind. It is therefore well suited for those readers who want to experiment with time-delay techniques. ◇

KIT AND PARTS AVAILABILITY

The following are available from Phoenix Systems, 375 Springhill Road, Monroe, CT 06468: complete kit of parts including enclosure for a single-channel, dc-powered delay line, No. P-25-DLC, for $145; complete kit of parts including enclosure for a single-channel, ac-powered delay line, No. P-25-DL, for $150; complete kit of parts including enclosure for a two-channel, ac- or dc-powered (specify) delay line, No. P-25-SDL, for $250. The following are also available separately: SAD-4096 bucket-brigade analog shift register IC, No. P-SAD-4096, for $50.00; etched and drilled main printed circuit board, No. P-25-DB, for $8.00; NE570N compander IC, No. P-NE570N, for $7.50; Signal Transformer Co. No. ST-4-20 step-down transformer, No. P-94-T, for $6.50; etched and drilled ac power supply circuit board, No. P-25-PSB, for $4.00; etched and drilled dc power supply circuit board, No. P-25-PSBC, for $4.00; TL074CN high-performance quad BiFET operational amplifier, No. P-TL074CN, for $2.50; μA7812UC 12-volt regulator IC, No. P-7812UC, for $1.50; 100,000-ohm, linear-taper, pc-mount potentiometer, No. P-100KB, for $1.00; 10,000-ohm, linear-taper, pc-mount potentiometer, No. P-10KB, for $1.00; dpdt push-on/push-off pc-mount switch, No. P-2PDT, for $1.00. Add $1 handling charge for orders less than $10. All items postpaid within the continental U.S. COD orders subject to $2 surcharge. Connecticut residents, add state sales tax.

Exterior and internal views of the author's prototype.

Build An AUTOMOBILE WINDSHIELD-WIPER CONTROLLER

Novel circuit provides variable on and off time for windshield wipers

BY WILLIAM KRAENGEL

AUTO-WIPER, an add-on intermittent windshield-wiper controller, evolved as a solution to the shortcomings of conventional controllers. Built around the ubiquitous 555 timer and a handful of discrete components, it offers some unusual features not found in most commercial systems.

Conventional SCR controllers use the wiper motor internal cam switch to commute (turn off) the SCR as the wiper motor cam rotates out of its detent. The electrical power to complete the wipe cycle flows through the cam park switch and the wiper switch until the cam once more rotates into detent interrupting the power flow to the motor. After a pause, the SCR is again pulsed "on" to repeat its single cycle. This approach to control is called open-loop (no feedback), single-cycle operation.

In most SCR wiper controllers, the system continues to operate as long as the wiper switch is turned on and power is applied to the circuit. And, although most can be slowed down (for a very light rain), many cannot be made to automatically perform one "pass" and then "pause" for any appreciable amount of time. To create such a pause requires operation of the wiper switch. This may mean that the wipers stop at any place along the wiper arc and at the park position (where they do not hinder the drivers vision) only fortuitously.

Most modern wiper systems use dynamic braking to stop the wipers at the park position. To interface to these sys-

tems, the SCR controllers usually require additional relay switching, or the dismantling of the dynamic braking feature, both undesirable alternatives.

Auto-Wiper is designed to work with a modern wiper system through a simple interface. Bipolar power transistors eliminate the SCR and its need for external commutation, while providing the dynamic braking essential for proper wiper action. As shown in Fig. 1, by means of a pulse generated by the cam switch once each cycle, synchronization between Auto-Wiper and the windshield wipers is maintained. Furthermore, these feedback pulses allow varying the number of wipes between pauses to one, two, three, or more without resetting the PAUSE control.

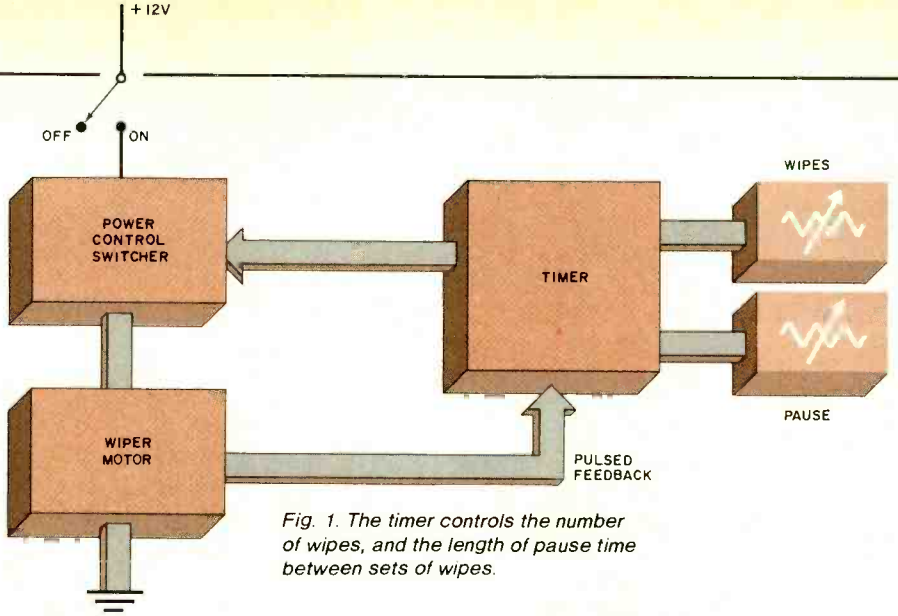


Fig. 1. The timer controls the number of wipes, and the length of pause time between sets of wipes.

How It Works. As shown in Fig. 2, the 555 timer, *IC1*, configured as a gated astable multivibrator with independently adjustable "on" and "off" times, derives its feedback from the voltage across the wiper motor. This voltage, governed by the park switch, pulses in synchronization with the wiper blades. Hence, the timer is controlled by the wipers themselves in addition to its "on" (WIPES, *R1*) and "off" (PAUSE, *R3*) time constants.

When *S1* (part of *R1*) is first closed, low voltage on pin 2 of *IC1* triggers the timer into its "on" state. Darlington power transistor *Q2* is cut-off but *Q1* is

PARTS LIST

C1—8.2-μF, 50-V, 10% solid tantalum capacitor (Sprague Q-Line #QDT1-61)
C2—0.01-μF, 50-V disc ceramic capacitor
C3,C5,C7—0.1-μF, 50-V disc ceramic capacitor
C4,C6,C8,C9—10-μF, 35-V upright (radial lead) electrolytic
D1,D2,D3—1N914 or similar diode
D4—1N4001 or similar diode
IC1—SE555 or MC1455 timer
Q1—2N6384 or MJ1000 transistor
Q2—2N6649 or MJ900 transistor
R1—1-megohm linear-taper potentiometer with push-pull switch (Mallory PP16L or similar)
R2—33,000-ohm, 1/4-W, 10% resistor
R3—10-megohm linear-taper potentiometer
R4—1000-ohm, 1/4-W, 10% resistor
R5,R6—120-ohm, 1/4-W, 10% resistor
Misc.—Heat sink (2) (RCA SK-KH3423 or similar), plastic case (Radio Shack 270-233 or similar), 1-inch diam. knob (2), pc board, IC socket or socket pins (optional), 6-ampere in-line fuse (see text).

Note: The following is available from CM Circuits, 22 Maple Ave., Lackawanna, NY 14218: etched and drilled glass-epoxy pc board for $4.25 plus $.50 postage and handling. Residents of New York state, add sales tax.

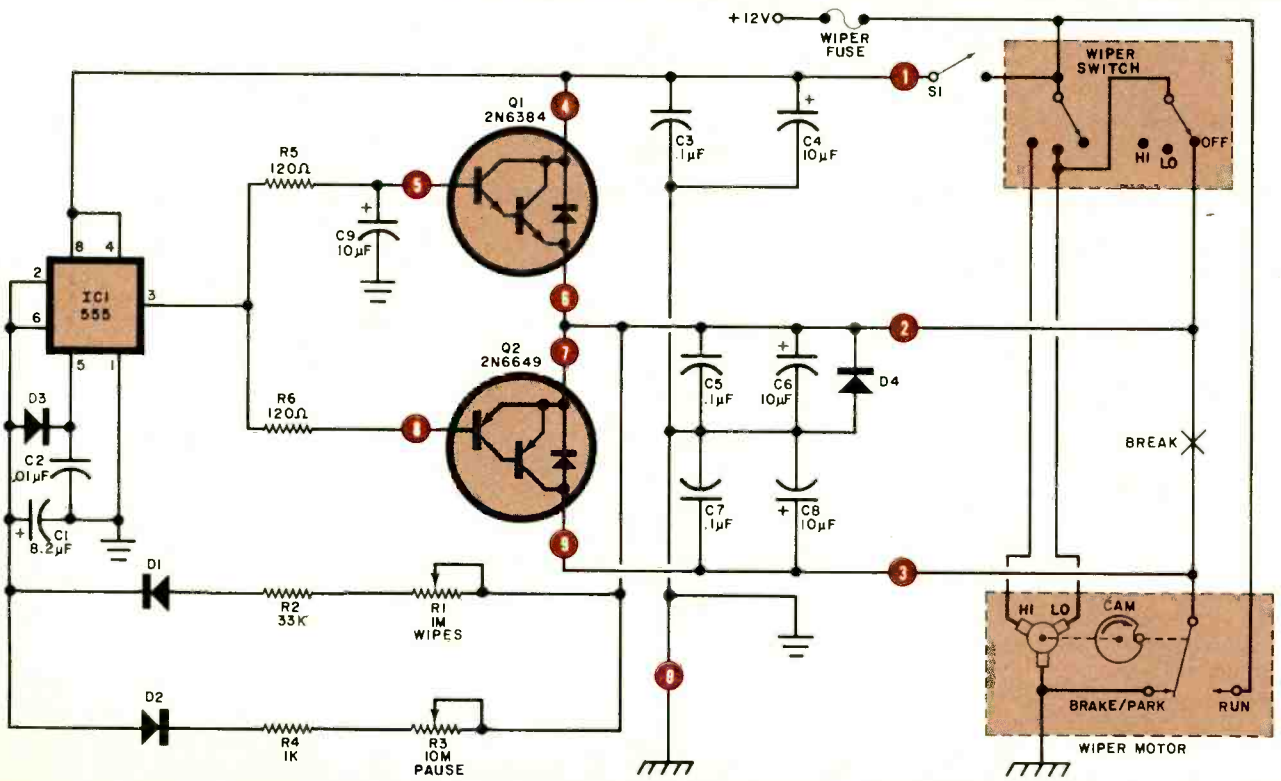


Fig. 2. The Auto-Wiper connects between the wiper switch and wiper motor after one lead is broken.

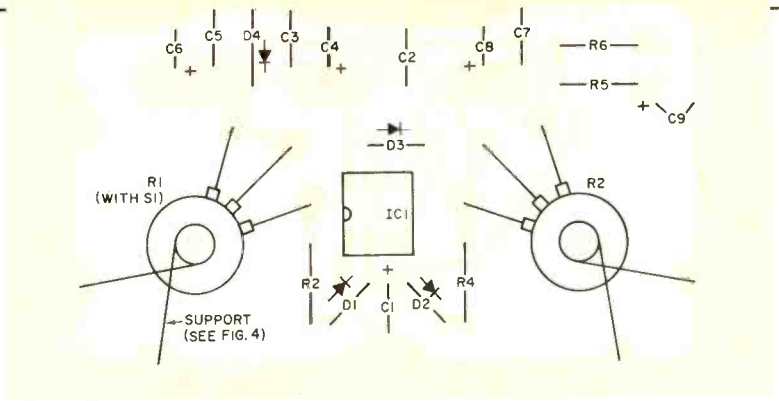
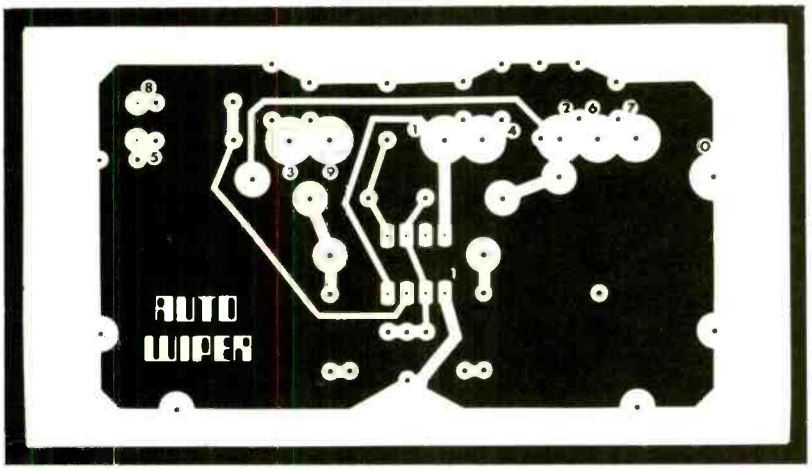


Fig. 3. The two transistors are mounted off the pc board with interconnections via the numbered pads.



turned on, allowing power to flow to the wiper motor. Power is also supplied to the motor through the internal diode of *Q2* as the park switch cam rotates out of detent. The feedback voltage across the motor charges *C1* through WIPES control *R1* until the voltage across *C1* is clamped by *D3* just above the upper threshold of *IC1*.

As the voltage on *C1* rises above the upper threshold of *IC1*, the timer turns "off", turning *Q2* on while cutting off *Q1*. The wiper motor, still powered through the internal diode of *Q2*, continues to operate until the park switch cam once more rotates into detent. The result is that the feedback voltage remains "high", thus preventing the discharge of *C1* until the cam rotates into detent. When this occurs, *C1* is freed to discharge through PAUSE control *R3* toward the zero feedback voltage across the wiper motor. The voltage on *C1* falls until it crosses the lower threshold of *IC1*, triggering it "on" to start the cycle over again. Also, as the cam rotates into detent, the wiper motor's windings are shorted to ground through the WIPER switch and *Q2*. The resulting dynamic braking halts the wiper blades in their proper park position.

During the interval in which *C1* is charging through *R1*, the park switch cam is free to make more than one revolution. Thus, time constant *R1C1* can be varied to allow 1, 2, 3 or more revolutions of the cam before the voltage on *C1* reaches the upper threshold of *IC1*. Similarly, as *C1* is discharged through PAUSE control *R3* toward the lower threshold of *IC1*, time constant *R3C1* varies the discharge time from zero to 60 seconds.

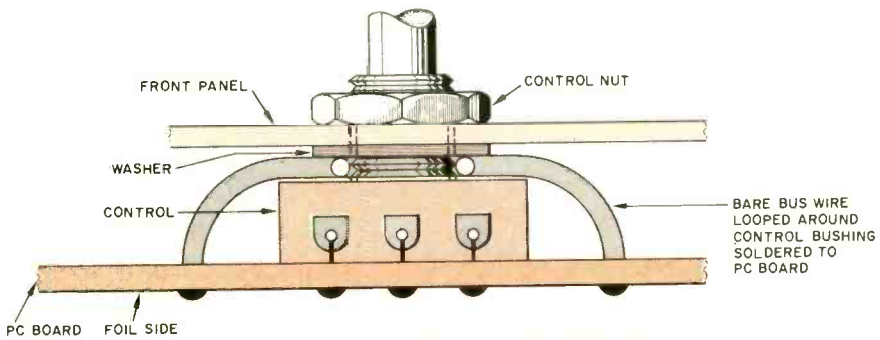


Fig. 4. How potentiometers are wired to board to provide support when mounted in case.

Construction. While there is nothing critical about the layout, construction is greatly facilitated if the pc board shown in Fig. 3 is used. The pc board is held in place by controls *R1* and *R3* which are fastened to the front panel of a small plastic case. If *S1* is attached to *R1*, it mounts through a suitable hole in the pc board. The controls are mounted to the board with short wire extensions from the terminals to the pertinent pc pads and with the bus wire straps shown in Fig. 4. The part specified for *R1* has a push-pull switch. Using this type of switch allows turning the Auto-Wiper on and off without changing the setting of *R1*.

It is suggested that a premium 18-volt 555 timer, such as an SE555 or MC1455 (RCA SK3564 or equal) be used rather than an ordinary 16-volt version since automobile primary voltages commonly exceed 15 volts. Transistors *Q1* and *Q2* are mounted on the rear of the case on individual heat sinks. If the heat sinks cannot be insulated from each other and/or ground, each transistor must be insulated from its heat sink.

Use 16-gauge or heavier wire from pc pads 0-4, 6,7 and 9 to the transistor collectors and emitters and to the wiper connections and automobile frame. If there is no separate fuse or circuit breaker for the wiper circuit, add a 6-ampere in-line fuse and holder to the *S1* input circuit.

Operation. To start a wipe cycle, it is only necessary to pulse *Q1* long enough for the park switch cam to rotate out of detent. Therefore, it is only necessary to advance the WIPES control clockwise until the desired number of wipes are reliably swept. Erratic operation may occur if the control is turned beyond this optimum point. When decreasing the number of wipes, always retard the WIPES control to less than the number of wipes you want, then advance it as above. Any desired pause, up to 60 seconds, is simply set by the PAUSE control.

When first turned on, the initial wipe duration will be somewhat longer than set by the WIPES control. This is caused by *C1* charging from zero volts rather than from the lower threshold voltage of *IC1* as in subsequent cycles. A useful purpose is served, however, in that the windshield is sure to be wiped clean at the start. The original wiper switch is normally not used, but can at any time override Auto-Wiper. ◇

Hobby Scene

By John McVeigh, Technical Editor

Attaching Leads to Solar Cells

Q. I recently responded to an advertisement in your magazine and purchased some solar discs. What did I get? Solar discs! Period! They have no leads connected to them and were accompanied by no instructions as to how connections should be made to them. Can you tell me how to attach leads to these solar cells?—Jim Brown, Katonah, N.Y.

A. Columnist and avid photovoltaic-cell experimenter Forrest Mims has on several occasions discussed how to work with these silicon marvels. I will quote from his March 1979 Experimenter's Corner entitled *Eavesdropping on Light*. "For very low light levels, I've found that a large-area silicon solar cell works best. However, this type of cell is easily broken, so you will need to attach the cell you select to a rigid substrate of plastic, metal or wood. A few drops of cement will secure it in place. . . .

"Most inexpensive, large-area silicon solar cells available on the surplus market are *not* supplied with connection leads. It is very important to use care when soldering connection leads to these cells because improper soldering procedures will cause the fragile electrodes to peel away from the cell.

"The thin upper electrode is more difficult to solder than the large electrode that covers the entire bottom of the cell. For best results, heat a portion of the upper electrode near the corner of the cell if it is rectangular or near the perimeter of the cell if it is circular. Apply heat for only a few seconds with a low-power iron and then apply a small amount of solder. Next, remove 1/8" (3.2 mm) of insulation from one end of a length of Wire-Wrap wire and place the exposed conductor along the electrode adjacent to the solder. Reheat the solder for a moment. It will suddenly flow over and around the wire to provide a perfect solder connection. Use this same procedure to solder a wire to the cell's bottom electrode.

"You will have to provide a means for protecting the wire leads after the cell is mounted on a card or in a tube. I prefer to attach a shielded phono cable to the card or tube and then solder the cell's leads to the cable. This prevents the leads attached to the cell from being broken by a sudden jerk. The shielded cable reduces unwanted noise from nearby ac power lines and other sources."

Forrest was concerned about noise because he was using the cells to transduce an amplitude-modulated light wave into a time-varying voltage that could be amplified and converted to audible sound waves. If you intend to use your cells simply for power generation, shielded cable is not needed. You should, however, solder the leads to lamp cord or similar two-conductor parallel cable and secure this cable to the mounting structure to avoid subjecting the leads and cell electrodes to physical stress.

Mysterious Tone Sequence

Q. I have been picking up a strange signal on approximately 172 MHz, and I would like to know exactly what it is. The demodulated signal consists of a sequence of several (usually three) tones that is repeated for approximately five minutes. I usually receive the signal at 30 to 35 minutes past the hour. It is frequency modulated and its strength is fair to good. I thought it might be coming from a satellite, but have checked with NASA, which says that it doesn't have any satellites operating on this frequency. Any information that you could provide would be helpful.—Gary Edwards, Bryson City, N.C.

A. I have had a similar experience that might shed some light on this. At home I have a vhf-FM amateur transceiver that is periodically overloaded by one of two recurrent signals. One is modulated by a "bleep-bleep" sequence of two tones and the other a raucous buzz. With the help of a fellow amateur who lives a few blocks away and who owns a synthesized scanner, I was able to determine that these signals are transmitted on 152.2 and 152.8 MHz. Their strengths are such that the transmitters must be either fairly close or high-powered. It seems that these signals are used for paging (a nearby hospital makes this likely), for telemetry, remote appliance actuation, or some similar application. I suggest that the signals you are receiving are of a similar nature. Tone-encoded paging, control and telemetry systems are commonly found in the vhf region.

Have a problem or question in 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.

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Experimenter's Corner

By Forrest M. Mims

The Digital Phase-Locked Loop (Part 2)

IN LAST month's column, we introduced one of the most versatile MSI (medium-scale-integration) CMOS chips available, the 4046 micropower phase-locked loop (PLL). We also experimented with several application circuits, all of which used only the vco (voltage controlled oscillator) section of the 4046.

In this final installment on the 4046, we'll experiment with several applications that use the 4046 in its closed-loop or PLL mode. To refresh your memory about how the 4046 works, you might want to scan Part 1 before reading on since we'll be using several terms which apply exclusively to phase-locked loops.

The first circuit to be described, a PLL lock indicator, has no use on its own. Be sure to study it, though, since it serves a very important function when connected to a 4046. You can assemble it on a corner of a breadboard, and it will then be available should you want to connect it to the 4046 circuit with which you are experimenting.

PLL Lock Indicator. It's often difficult to determine whether or not a PLL is out of lock, particularly if a scope is not available. RCA application note ICAN-6101 recommends a simple NOR gate lock-detection circuit, a slightly modified version of which is shown in Fig. 1.

The lock indicator monitors the *phase pulses* output (pin 1) of phase comparator I and the output (pin 2) of phase comparator II. The output of the second NOR gate goes high and extinguishes the red LED when the loop is locked. When the loop is out of lock, the red LED flashes or appears to glow continuously. The optional NOR gate causes the green LED to glow when the loop is locked and go dark when the loop is out of lock.

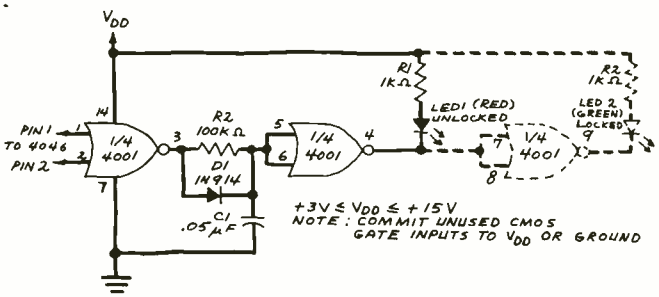

Fig. 1. A simple NOR-gate lock-detection circuit using a 4046 micropower PLL.

This simple circuit is a handy addition to any PLL since it provides an instant indication of a possible malfunction. It can also be used as an active part of a frequency detector or FSK demodulator. In the latter application, a binary signal is converted into a dual-frequency audio tone for remote transmission or storage on magnetic tape. A familiar example of FSK among computer hobbyists, the Kansas City Cassette Tape Standard, assigns a frequency of 1200 Hz to logic 0 and 2400 Hz to logic 1.

The PLL lock indicator can detect the presence of a 0 or 1 if the vco is adjusted so its minimum and maximum frequencies (see Part 1) encompass one of the two frequencies. The lock indicator will then go high for one tone and low for the second tone.

FSK Detector. A 4046 circuit designed specifically for Kansas City FSK detection is shown in Fig. 2. The vco is tuned by selecting *R1* and *R2* to give a capture bandpass from 2100 to 2700 Hz with a peak response of 2400 Hz. Frequencies outside the capture window are not detected; hence the lock detector goes high for a 2400-Hz input signal and low for a 1200-Hz input signal. These logic states can be reversed by adding a third gate in the 4001 to the output of the detector.

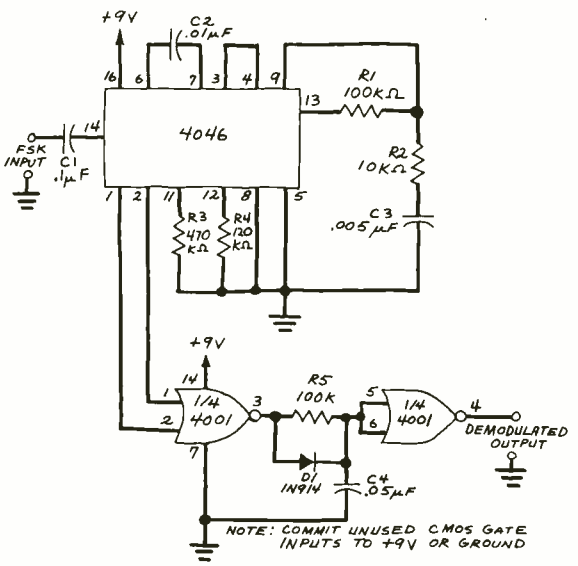

Fig. 2. A frequency-shift-keying (FSK) detector circuit.

Tone Detector. The circuit in Fig. 2 can be used to detect a wide range of input frequencies. For example, when *R4* is 1 kΩ and *R3* is 33 kΩ, the circuit responds to an incoming frequency of 48.775 kHz. The capture window with these values is *very* narrow (48.76-48.80 kHz). This demonstrates the possibility of using the 4046 as a precision tone detector. This application is normally reserved for the 567, a bipolar chip that uses considerably more power than the 4046.

It's easy to alter the response of the loop by substituting potentiometers for *R1* and *R2*. Or you can calculate the resistances required to define a specified frequency window (or loop capture range) by using the equations given in Part 1 or in the 4046 data sheet.

A commercial function generator or a simple dual-gate astable can be used to provide a variable-frequency input signal. A digital frequency meter to measure the peak detection frequency and the capture range is very helpful, but you can design a working circuit without one.

Analog Frequency Meter. In Part 1 we experimented with the 4046 vco as a voltage-to-frequency (V/F) converter.

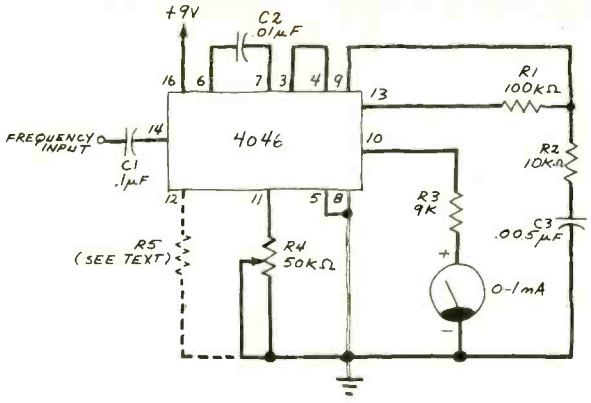

Fig. 3. Frequency-to-voltage converter as an analog meter.

Thanks to the filtered error voltage available from the source follower (pin 10), the 4046 can also be used as a micropower frequency-to-voltage (F/V) converter. Figure 3 shows one of many possible 4046 F/V application circuits: an analog frequency meter. The input frequency is read out on a 0-1-mA meter connected in series with pin 10 and a 9 kΩ load resistor (which doubles as a current limiter).

With the values shown, the frequency meter has a full-scale response of 100 to 8000 Hz. Below 100 Hz, the meter's needle will oscillate or indicate an erroneous reading.

The circuit is calibrated by applying a 5-kHz input signal and adjusting *R4* to produce a meter indication of 0.5 mA. Since the circuit does not have a perfectly linear response, you will need to make a new meter scale or conversion table if you want to use it as a practical frequency counter.

Resistor *R5* is used only to add an offset to the lower end of the frequency measurement scale. For example, when *R5* is 100 kΩ and R4 is adjusted to give an output of 0.5 mA at an input frequency of 5 kHz, the frequency measurement range is 2.3 to 7.0 kHz.

The lock indicator shown in Fig. 1 is a particularly handy addition to this circuit since it provides immediate warning when the circuit is out of range. This prevents erroneous frequency measurements.

Frequency Synthesis. Figure 4 shows how to synthesize exact multiples of a specified input frequency by inserting a

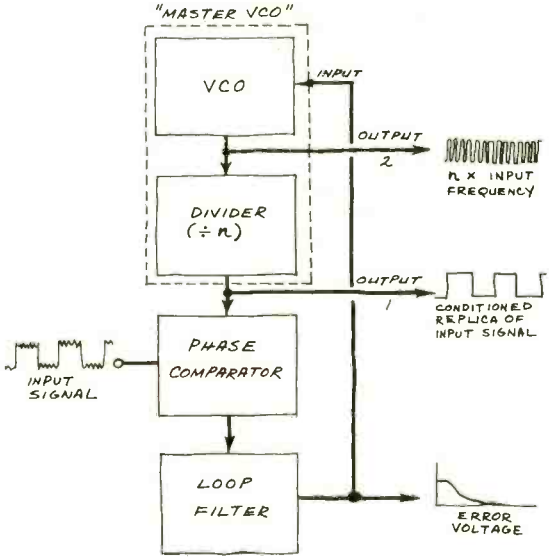

Fig. 4. A phase-locked-loop circuit with a divider.

divide-by-*n* counter between the vco and phase comparator of a PLL. You can understand how this arrangement works by thinking of the vco and divider as a single functional block or *master vco* instead of two separate circuits. The input (error voltage) and output (conditioned replica of the input signal)

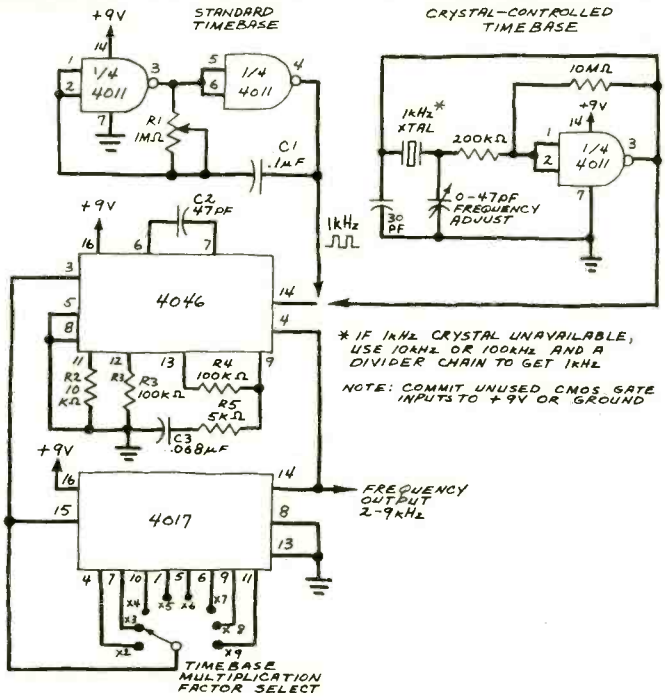

Fig. 5. Basic 2-to-9-kHz frequency synthesizer circuit.

of this master vco are indistinguishable from those of a loop without the divider. The only difference is a second output connected directly to the internal vco having a frequency of *n* times the input frequency.

PLLs with dividers are used in many kinds of frequency synthesizers and function generators. They are particularly important in CB radios and other multiple-channel telecommunications equipment since they provide a wide range of precise output frequencies from a single crystal-controlled reference oscillator.

Basic Frequency Synthesizer. One way to make practical use of a PLL with a divider inserted in the feedback loop is shown in Fig. 5. In this circuit, a 4017 counter is connected as a programmable divide-by-*n* counter where *n* is 2 to 9.

In operation, the NAND gate oscillator serves as a time-base which supplies a reference frequency of 1 kHz to the 4046 input. An 8-position selector switch connects the 4017 reset input to one of the eight count outputs. When the selected count is reached, the 4017 is reset and a new count cycle begins. This provides eight frequency steps ranging from two to nine times the time-base frequency. Each is a precise multiple of the time-base frequency.

For best results, especially in precision applications, use the crystal-controlled time base (also shown in Fig. 5). For non-precision applications or preliminary tests while you are

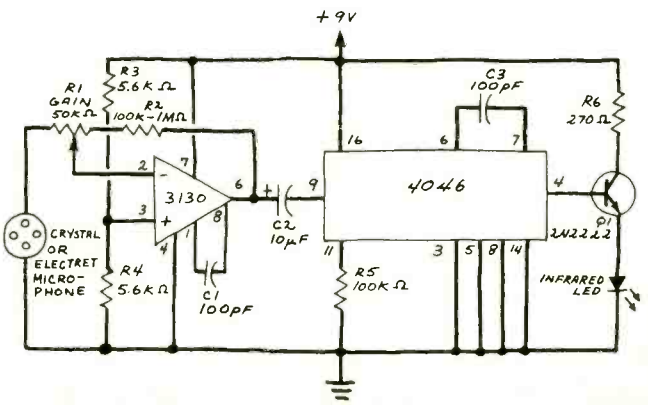

Fig. 6. Pulse-frequency-modulated lightwave voice transmitter.

awaiting arrival of the crystal, use the version without crystal control.

By using a string of divide-by-ten counters in place of the 4017 you can assemble a wide-range 10-Hz to 1-MHz synthesizer. You can achieve the same result by using programmable counters (*e.g.* 4522, 4018, etc.).

Pulse Frequency Modulator. The vco section of the 4046 can be used to make a simple pulse-frequency modulator which can be adjusted to provide a carrier frequency of 1 MHz or more. A simple pulse-frequency-modulated (pfm) lightwave voice transmitter, complete with a microphone preamp designed around a 3130 BiMOS op amp, is illustrated in Fig. 6. This circuit will also work with a 741 or other standard op amp. (Omit *C1* if you substitute op amp for the 3130 that has an internal compensation capacitor.)

With the values shown for *C3* and *R5*, the vco oscillates at a carrier frequency of about 100 kHz. This, and the circuit's modulation bandwidth, ensures reasonably good transmission of audio-frequency signals. The frequency-modulated signal drives an LED through *Q1* with *R6* limiting LED current.

The easiest way to test this circuit in conjunction with the receiver described next is to disconnect the microphone from *R1* and connect the output of a transistor radio to *R1* through a 0.1-μF capacitor.

Pulse Frequency Demodulator. Figure 7 shows a receiver system suitable for detecting and demodulating the pfm signal from the transmitter of Fig. 6. In operation, the infrared signal from the transmitter LED is detected by a phototransistor and coupled into a 3130 BiMOS op amp. This is the same op amp used in the transmitter and it, too, may be replaced with a 741 or other standard op amp. (Don't forget to omit *C2* if you use a 741.)

The amplified signal from the 3130 is ac-coupled via *C3* to the phase comparator input (pin 14) of a 4046. The vco is adjusted by *R5* and *C4* to create a center frequency identical to that of the transmitter (about 100 kHz). Components *C5* and *R7* form the loop filter that determines capture range. In this case, the resistor normally placed in series with the loop filter capacitor (see Part 1) has been omitted. This greatly simplifies the formula for determining the loop capture range:

$$f_c = \pm(1/2\pi)\sqrt{2\pi f_L/R7\ C5}$$

where f_c is the capture range and f_L is half the frequency lock range or, in this case, the vco center frequency. Substituting the values of *R7* and *C5* shown in Fig. 7 gives a capture range or bandwidth of ± 12.6 kHz.

For best results you should connect a lock detector like the one shown in Fig. 1 to the receiver's demodulator. You can use a single red LED to indicate loss of the signal or a single green LED to indicate acquisition of the signal. I prefer to use both the red and green LEDs for a clear go/no-go signal.

For preliminary tests, disconnect the transmitter's microphone from *R1* and connect a radio to *R1* as previously described. When the transmitter's LED is pointed at the receiver's phototransistor, the 4046 in the receiver should quickly lock onto the signal. You should then be able to hear the demodulated signal by means of an audio amplifier connected to the receiver's output.

If the receiver fails to capture the signal, tune its vco by adjusting *R5* until lock is established. If this fails, check the wiring of both the transmitter and receiver. If you've made no wiring errors, experiment with the radio's volume setting until lock is established.

When the receiver's demodulator has captured the input signal, block the beam and note that the signal is *sharply* cut off. This full-on/full-off reception is characteristic of FM transmission systems. It means that the signal from the receiver's demodulator has constant amplitude as long as the received signal has enough amplitude to be captured by the phase-locked loop.

You may notice that the receiver sometimes faithfully reproduces sound sent by the transmitter even when the receiver's 4046 is out of lock. This usually occurs when the signal level is weak. In such cases, the PLL is so close to establishing lock that the sound quality is unaffected.

Though the transmission range of these circuits is only several inches, external lenses or an optical fiber can substantially improve the range. For best results with free-space links, use GaAs:Si LEDs emitting at 940 nm. Suitable LEDs include the TIL-32 (Texas Instruments), OP-195 (Optron), 1N6266 (General Electric), etc.

Going Further. The 4046 is such a dynamic chip it was easy to come up with more than enough circuits to fill this two-part series. Review some of the books that include information about the 4046 if you intend to make full use of this important chip. For example, every 4046 user should obtain copies of the RCA (CD4046B) and Motorola (MC14046B) data sheets for this chip. RCA's ICAN-6101 CD4046B application note is equally valuable. Both the data sheets and the application note include very useful design equations.

Books that describe the 4046 include Don Lancaster's *CMOS Cookbook* (my best source of 4046 information), *Understanding CMOS Integrated Circuits* by Roger Melen and Harry Garland, and *Design of Phase-Locked Loop Circuits* and *Guide to CMOS Basics, Circuits, & Experiments*, the latter two written by Howard Berlin. All are published by Howard W. Sams & Co. In addition, I've included a few pages on the 4046 in *Engineer's Notebook*, a new book published by Radio Shack. ◇

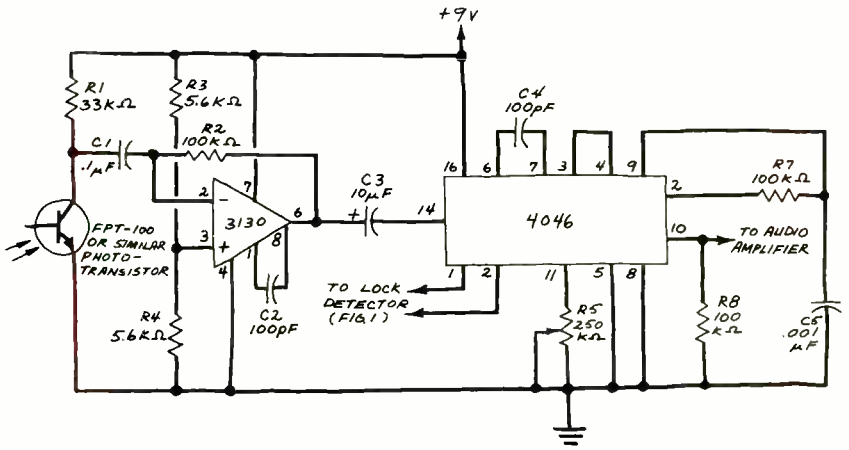

Fig. 7. A receiver system to be used for detecting and demodulating the pulse-frequency-modulated signal from Fig. 6.

WORDS, MUSIC. SIGHT AND SOUND. APPLAUSE, APPLAUSE.

AUDIO ENGINEER RON ESTES MAKES THEM ALL COME TOGETHER.

Watch Ron Estes at the controls of an audio console and you realize the behind-the-scenes artistry that goes into today's television programming.

Ron is an audio engineer for NBC-TV in Burbank, California. His job: to mix the various sound tracks heard during a telecast. In 1978, he received an Emmy nomination for his work on *Our Town*.

Ron's been interested in audio electronics for as long as he can remember. "I built a mixing console when I was 12," he says. "Took a lot of math and science courses. Studied radio and television at San Diego City College and San Diego State University."

In 1964, Ron became a POPULAR ELECTRONICS reader. "It's been an immense help," he says, adding that he looks to it when shopping for components such as his JBL Studio Monitor speakers, Marantz pre-amplifier/amplifier/tuner, reel-to-reel tape recorder and B.I.C. turntable.

According to Ron, "Of all publications in the field, POPULAR ELECTRONICS is first with information on new developments and directions."

Since POPULAR ELECTRONICS' breakthrough article on Mits Altair, one new direction in Ron's life has been microcomputers. "I now have an Ann Arbor CRT, Syner-Data printer, Tarbell tape interface, and plan to buy a dual floppy disc system," he says.

POPULAR ELECTRONICS: every month, 409,000* electronics activists like Ron Estes rely on it to keep themselves informed and involved in the science of electronics.

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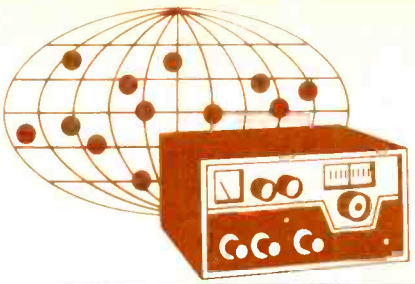

DX Listening

By Glenn Hauser

Recommended Programs

OUR listing of selected shortwave programs in the February issue proved to be very popular. However, besides frequency shifts, there have been a great many changes in programming over the past six months. So we thought this would be a good time to bring you a revised guide to shortwave (and a few widely heard mediumwave) programs we feel are most worthwhile.

Frequencies shown are the best known at press time, but not necessarily the only ones. Listen for announcements of other frequencies which may work better for you. Times shown take into account daylight savings. Certain stations shift their programming one hour later during standard time (US and Canadian Mediumwave, CBC NS, AFRTS, France, and Hungary). New Zealand, now on standard time, broadcasts one hour earlier from November to February. Times *and days* are strictly GMT. For example a listing for Saturday 0030 is 8:30 p.m. EDT Friday in North America. Subtract 3 hours for ADT, 4 hours for EDT, 5 hours for CDT, 6 hours for MDT, 7 hours for PDT, etc. (All information is subject to change, naturally!)

AFRTS makes extensive preemptions in its schedule in order to carry live play-by-play sports broadcasts. Such plans are announced in advance on "Program Notes," Mon.-Fri., 1735 GMT, and Tues.-Sat. 0535 GMT.

Especially recommended programs are shown in capitals. Enjoy!

SATURDAY

0000-0023 RN: "Espacio Diexista" 15315, 6020
0110-0123 RA: "Pick of the Week" 21740, 17795
0137-0145 Prague: "Arts in Czechoslovakia" 11990, 7345
0140-0155 RA: "Week in Science" 21740, 17795
0145-0159 BBC: "SOUTH ASIA SURVEY" 9410, 15360 only
0200-0215 HCJB: "A L'Ecoute du Monde" 15155
0200-0223 RN: "Espacio Diexista" 15315, 6165
0215-0235 RAI: Pagine Pianistiche" 11800, 9579
0230-0245 UN: "UN-Africa" 15240, 6035
0230-0259 BBC: "Classic Serial" 9410, 7325, 6175, 15070
0300-0312 Budapest: "Calling DXers" 17710, 11910
0313-0328 Portugal: "DX" (3 weekly) 11925, 15125
0335-0359 BBC: "This Week & Africa" 11860, 7109
0337-0345 Prague: "Arts in Czechoslovakia" 7345, 11990
0339-0355 RA: "This Australia" 17795
0353-0358 V. of Yerevan: 17870, 15405, 15180
0400-0423 RN: "Espacio Diexista" 9590, 6165
0430-0444 BBC: "THE BACH FAMILY" 9410, 6175, 5975
0435-0459 Sofia: "DX Program and feature" 11750
0435-0459 AFRTS: "World of Religion" 17765, 15430, 15330, 9755, 6030
0440-0455 RA: "Book Serial" 17795
0513-0528 Portugal: "DX" (3-weekly) 11925, 9575
0515-0540 BBC: "This Week & Africa" 15400, 11860
0530-0600 RNZ: "Pacific Newsletter" 17860, 15345
0540-0555 RA: "Profile" 17890, 17870, 15240
0612-0625 RA: "Pick of the Week" 21525, 17795
0630-0659 BBC: "These Musical Islands" 15070, 11955
0630-0700 RA: "Jazz Australia" 17870, 15145
0715-0729 BBC: "FROM THE WEEKLIES" 15070, 6175, 9510
0740-0755 RA: "Week in Science" 15145, 11740, 9570
-0824 RN: "Backtrack" 9770, 9715
0809-0830 HCJB: "DX Party Line" 11835, 15200
0815-0829 BBC: "Talks" 15070, 11955, 9510
0830-0859 BBC: "TCHAIKOVSKY & HIS WORLD" 15070, 9510
0900-0930 HCJB: "DX Party Line" 11900, 9745, 6130
0909-0924 RN: "Backtrack" 9715
0935-0959 AFRTS: "World of Religion" 11805, 9700, 9590, 9575, 6030
0945-1014 BBC: "Science in Action" 17790, 15070
1035-1059 AFRTS: "Portfolio" 11805, 9700, 9590, 9575, 6030
1110-1123 RA: "Pick of the Week" 9580
1115-1123 BBC: "New Ideas" 25650, 21710, 11775, 9510, 6195
1115-1300 Perth: "Sentimental Journey" 9610
1124-1129 BBC: "Week in Wales" 25650, 21710, 11775, 9510, 6195
1130-1159 BBC: "DOCUMENTARIES" 25650, 21710, 11775, 9510, 6195
1140-1155 RA: "Profile" 9580
1215-1244 BBC: "Jazz for the Asking" 25650, 9510, 11779
1230-1300 VOA: "New York, New York" 11715, 9565
1236- Peking: "Music In China" 15520
1240-1255 RA: "AUSTRALIAN INVENTOR" 9580
1245-1259 BBC: "Pedagogical Pop" 21695
1300- Perth: "Orchestral Concert" 9610 (irreg.)
1315-1329 BBC: "Talks" 25650, 21710, 9510, 11775
1321-1343 SRI: "Talkback" alt. "Merrygoround" 21570, 21520
1341-1348 AFRTS: "Spectrum" 15430, 15330, 11805, 9700
1345-1349 BBC: "Operatic Cameos" 25650, 21710
1349-1359 AFRTS: "TAKE TEN" 15430, 15330, 11805, 9700
1400-1428 Sweden: "SATUDAY SHOW" 21615
1459-1529 BBC: "This Week & Africa" 17885, 17695
1535-1559 AFRTS: "Portfolio" 15430, 15330, 11805, 9700
1536-1556 SRI: "Talkback" alt. "Merrygoround" 21570
1605-1659 CBCNS: "QUIRKS AND QUARKS" 11720, 9625
1611-1630 VOA: "Africa in Print" 15410, 15445
1617-1628 AFRTS: "Paul Harvey" 15430, 15330, 17765, 11805
1630-1700 VOA: "New York, New York" 15410
1642-1649 AFRTS: "Spectrum" 17765, 15430, 15330, 11805
1649-1659 AFRTS: "TAKE TEN" 17765, 15430, 15330, 11805
1735-1759 AFRTS: "Special Assignment" 17765, 15430, 15330, 11805
1830-1900 VOA: "New York, New York" 15140
1904-1919 RN: "Backtrack" 17605, 15220
1911-1930 VOA: "Voices of Africa" 15410
1917-1928 AFRTS: "Paul Harvey" 21570, 17765, 15430, 15345, 15330 (usually preempted for sports)
1935-1959 AFRTS: "Town Meeting" 21570, 17765, 15430, 15345, 15330
2010-2030 Israel: "This Week" 17815, 21675, 11610
2045-2114 BBC: "Command Performance" 15260, 15070
2100-2159 AFRTS: "ALL THINGS CONSIDERED" 21570, 17765, 15430, 15345, 15330
2104-2119 RN: "Backtrack" 21640, 17695, 17605, 15220
2130-2200 HCJB: "DX Party Line" 26020, 21480
2135-2156 RCI: "Bonsoir Africa" 17875, 17820, 15325, 15150, 11945
2137-2146 RSA: "DX Corner" 11900, 9585
2145-2159 BBC: "OUR OWN CORRESPONDENT" 15420, 15260, 15070
2145-2159 BBC: "Pedagogical Pop" 15385, 11820
2215-2230 Turkey: "DX Corner" 15360, 9515
2215-2300 DW: "Musik Horer Wunschen" 15410, 17795, 9735, 6079
2217-2227 AFRTS: "Washington Week" 21570, 17765, 15430, 15345, 15330
2230-2238 BBC: "New Ideas" 15420, 15260, 15070, 9590
2235-2259 AFRTS: "Special Assignment" 21570, 17765, 15430, 15345, 15330
2240-2300 Israel: "This Week" 21710, 21675, 15582, 11637, 9815
2300-2328 Sweden: "SATURDAY SHDW" 15380, 11705
2315-2329 BBC: "LETTERBOX" 15070, 9590, 9410, 7325, 6175, 11910
2320-2335 Moscow: "DX Program" 12030
2330-2359 BBC: "Jazz for the Asking" 15070, 9410, 7325, 11910
2335-2354 AFRTS: "Rather/Safer/Wallace" 21570, 17765, 15430, 15345, 15330
2350-2400 DW: "DX Program" (2nd Sat.) 15410, 9735, 6075, 17795

SUNDAY

0004-0034 Japan: "HELLO AMERICA" 17825, 15270
0010-0030 Israel: "This Week" 15582, 11637, 21710
0013-0030 Moscow: "Mailbag" 12030
0030-0130 BBC: "Play of the Week" 15070, 11835,
or -0200 7325, 6175, 5975
0030-0054 WCCO: "Newsmark" (last Sat.) 830
0035-0059 WBBM: "Newsmark" (last Sat.) 780
0035-0059 AFRTS: "Town Meeting" 21570, 17765, 15430, 15345, 15330
0035-0055 Peking: "Music In China" 17680, 15120
0104-0115 RAE: "DXismo Argentino" (alt.) 9690
0105-0159 CBC: "Transcontinental" 1550, 940, 740
0110-0130 Budapest: "Weekend" 17710, 11910
0111-0120 AFRTS: "Safer & Wallace" 21570
0120-0135 Moscow: "DX Program" 9600, 600, 12030
0125-0155 Peking: "Music in China" 17680, 15520
0134-0140 DW: "GERMANY THIS WEEK" 6145, 6085, 6040
0135-0139 AFRTS: "DATELINE AMERICA #1" 21570, 17765, 15430, 15345, 15330
0135-0155 Prague: "Sat Nite Jukebox" 11990, 7345
0140-0155 RA: "MAILBAG #1" 21740, 17795
0145-0200 REE: "Programa Diexismo" 11775, 9360
0149-0219 Japan: "HELLO AMERICA" 21640, 17825
0151-0213 SRI: "Talkback/Merrygoround" 15305, 11715, 9725, 6135
0205-0259 CBC: "ANTHOLOGY" 1550, 940, 740, 1070, 860
0212-0220 RA: "LETTERS TO THE EDITOR" 21740, 17795
0210-0230 Budapest: "Weekend" 17710, 11910
0213-0230 Moscow: "Mailbag" 9600, 600, 12030
0215-0300 DW: "Musik Horer Wunschen" 9735, 6145, 6085
0217-0227 AFRTS: "Washington Week" 21570, 17765, 15430, 9755, 6030
0225-0255 Peking: "Music in China" 17680
0230-0258 Sweden: "SATURDAY SHOW" 11705, 15290
0230-0259 AFRTS: "Communique" 21570, 17765, 15430, 9755, 6030
0230-0300 HCJB: "DX Party Line" 11910, 9745, 15155
0235-0255 RA: "Australia Fair" alt. "Matters of Faith" 21740, 17795
0237-0246 RSA: "DX Corner" 11900, 9610, 9585, 5980
0300-0400 WLW: "Sunday Funnies" 700
0309-0324 RN: "Backtrack" 9590, 6165
0312-0325 RA: "REPORT FROM ASIA" 21740, 17795
0315-0329 BBC: "OWN CORRESPONDENT" 9410, 7325, 6175, 15070
0320-0335 Moscow: "DX Program" 9600, 600, 12030
0325-0355 Peking: "Music in China" 17680
0330-0359 AFRTS: "Roundtable" 21570, 17765, 15430, 9755, 6030
0330-0359 BBC: "TCHAIKOVSKY WORLD" 9410, 6175, 5975
0335-0355 Prague: "Sat Nite Jukebox" 11990, 7345
0340-0355 RA: "AUSTRALIAN INVENTOR" 17795
0347-0400 REE: "Programa Diexismo" 11775, 9630, 9360
0350-0400 DW: "DX Program" (2nd Sat.) 9735, 6145, 6085
0353-0358 V. of Yerevan: 17870, 15405, 15180
0405-0459 CBC: "Best of Radio Noon" 740

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DX LISTENING *(continued)*

0420-0435 Moscow: "DX Program" 15455, 15180
0425-0455 Peking: "Music in China" 17680, 15120
0430-0444 BBC: "PROFILE" 9410, 6175, 5975
0436-0457 SRI: "Talkback/Merrygoround" 15305, 11715
0435-0459 AFRTS: "Reporters' Roundup" 17765, 15430, 15330, 9755, 6030
0445-0453 BBC: "New Ideas" 9510, 9410, 6175, 5975
0513-0530 Moscow: "Mailbag" 15455, 15180
0515-0529 BBC: "LETTERBOX" 9510, 9410, 6175, 15070
0520-0530 Moscow: "DX Program" 12060
0530-0559 AFRTS: "The Source Report" 17765, 15430, 15530, 9755, 6030
0540-0546 DW: "GERMANY THIS WEEK" 5960, 9545
0540-0555 RA: "The Body Program" 17890, 17870, 15240
0545-0559 BBC: "LETTER FROM AMERICA" 15070, 9410, 6175
0609-0624 RN: "Backtrack" 9715, 6165
0611-0629 AFRTS: "Rather/Safer/Wallace" 17765, 15430, 15330, 9755, 6030
0620-0635 Moscow: "DX Program" 15455, 15180
0635-0638 AFRTS: "Dateline America #1" 17765, 15430, 15330, 9755, 6030
0700- WBZ: "Oldtime Radio" 1030 (irregular)
0715-0729 BBC: "OWN CORRESPONDENT" 15070, 9510, 6175
0730-0744 BBC: "High Wind in Jamaica" 15070, 9510
0737-0755 RA: "MAILBAG #2" 15145, 11740, 9570
0745-0759 BBC: "WORLD RADIO CLUB" 15070, 11955, 9510
0810-0825 RA: "REPORT FROM ASIA" 15145, 11740, 9570
0815-0859 BBC: "The Pleasure's Yours" 15070, 9510
0830-0854 WCKY: "World of Religion" 1530
0835-0855 RA: "Australia Fair " alt. "Matters of Faith" 15145, 11740, 9570
0930-0944 BBC: "FROM THE WEEKLIES" 17790, 15070
0935-0959 AFRTS: "Reporters Roundup" 11805, 9700, 9590, 9575, 6030
1030-1059 AFRTS: "The Source Report" 11805, 9700, 9590, 9575, 6030
1100-1130 SLBC: "Radio Monitors International" 11835
1115-1129 BBC: "LETTER FROM AMERICA" 25650, 11775, 9510
1115-1130 VOA: "New Horizons" 11715, 9565
1120-1130 Moscow: "DX Program" 9600
1130-1157 Perth: "MY MUSIC" 9610
1130-1230 BBC: "Play of the Week" 25650, 21710, 9510, or 1300 11775
1135-1159 AFRTS: "World News This Week" 15430, 15330, 11805, 9700, 6030
1140-1155 RA: "THE BODY PROGRAM" 9580
1210-1225 RA: "REPORT FROM ASIA" 9580
1210-1220 CBCNS: "Voice of the Pioneer" 9625, 6065
1230-1259 CBCNS: "The Food Show" 9625, 6065
1235-1250 ORF: "AUSTRIAN SHORTWAVE PANORAMA" 15290
1235-1259 AFRTS: "Listen Closely" 15430, 15330, 11805, 9700
1240-1255 RA: "MAILBAG #1" 9580
1305-1559 CBC: "SUNDAY MORNING" 17880 or 17710, 11720, 9625, 9580
1307-1328 VOA: "New Products/Critics Choice" 9565, 11715
1315-1329 BBC: "OWN CORRESPONDENT" 25650, 21710, 9510, 11775
1320-1345 SRI: "Documentaries/Jazz" 21570, 21520
1323-1330 Finland: "Air Mail" 15400
1330-1400 VOA: "Studio One" 9565, 11715
1335-1359 AFRTS: "Speaking of Everything" 15430, 11805, 15330, 9700
1400-1415 Finland: "On The Town" 15400
1400-1428 Sweden: "MAILBAG" 21615
1400-1430 Norway: "This Week" 17840
1430-1459 BBC: "Comedy Series" 25650, 21710, 21470
1430-1500 Finland: Various Features 21475, 15400
1435-1459 AFRTS: "PERSPECTIVE #1" 15430, 11805, 9700
1459-1529 BBC: "AFRICAN PERSPECTIVE" 17885, 17695
1515-1559 BBC: "Concert Hall" 25650, 17830, 15260
1535-1559 SRI: "Documentaries/Jazz" 21570
1535-1559 AFRTS: "PERSPECTIVE #2" 15430, 15330, 18805, 9700
1600-1615 Korea: "Week in Review" 11830, 9720
1611-1630 VOA: "Voices of Africa" 15430, 15410
1611-1630 Moscow: "Culture and the Arts" 15150, 11840
1615-1630 RFI: "PO BOX 9516" 25820, 21620, 21515, 17860, 25900
1615-1644 BBC: "Science in Action" 21710, 17830, 15260
1630-1700 VOA: "Studio One" 15410
1635-1659 AFRTS: "World News This Week" 17765, 15430, 15330, 11805
1645-1659 BBC: "LETTER FROM AMERICA" 21710, 17830, 15260
1715-1740 BBC: "African Perspective" 21550, 17880, 17695
1715-1742 BBC: "My Music" 21710, 17830, 15260, 15070
1720-1730 Moscow: "DX Program" 15150, 11840
1730-1859 CBCNS: "The Entertainers" 11720, 9625
1730-1800 VOA: "Studio One" 15205
1735-1759 AFRTS: "Listen Closely" 17765, 15330, 15430, 11805
1800-1830 Norway: "This Week" 25730, 15175
1807-1821 RCI: "DX DIGEST" 17820, 15260
1830-1900 VOA: "MUSIC TIME IN AFRICA" 15410, 21485, 26040
1835-1859 AFRTS: "Speaking of Everything" 17765, 15430, 15345, 15330, 21575
1907-1927 RCI: "Bonsoir Africa" 17820, 15260
1907-1927 RCI: "MAILBAG/DX DIGEST #1" 17875, 15325
1913-1928 VOA: "New Horizons" 15410
1935-1959 AFRTS: "PERSPECTIVE #1" 17765, 15430, 15345, 21570, 15330
2005-2059 CBCNS: "Soundstage" 11720, 9625
2007-2027 RCI: "MAILBAG/DX DIGEST #2" 17875, 15325
2010-2030 Israel: "Calling Listeners/DX" 17815, 21675, 11610
2015-2029 BBC: "LETTERBOX' 15260, 15070
2030-2120 RN: "Happy Station" 21640, 17695, 17605, 15220
2035-2059 AFRTS: "PERSPECTIVE #2" 21570, 17765, 15430, 15345, 15330
2100-2114 BBC: "WORLD RADIO CLUB" 15260, 15070
2100-2159 AFRTS: "ALL THINGS CONSIDERED" 21570, 17765, 15430, 15345, 15330
2108-2128 VOA: "New Products/Critics Choice" 15410
2130-2200 VOA: "Studio One" 15410
2135-2156 RCI: "Accent" 17875, 17820, 15325, 15150, 11945
2200-2230 Norway: "This Week" 15175, 17795
2209-2238 BBC: "SCIENCE IN ACTION" 15420, 15260, 15070, 9590
2209-2244 BBC: "Calling Falklands" 12040, 9915
2211-2230 Moscow: "Culture and the Arts" 15460
2217-2227 AFRTS: "World This Week" 21570, 17765, 15430, 15345, 15330
2230-2258 Turkey: "Strolling Thru Anatolia" 15360, 9515
2230-2259 AFRTS: "NBC Documentaries" 21570, 17765, 15430, 15345, 15330
2240-2300 Israel: "CALLING LISTENERS/DX " 15582, 11637, 9815, 21710, 21675
2255-2325 RAI: "Symphonic Music" 11800, 9579
2300-2328 Sweden: "MAIL BAG" 15380, 11705
2306-2330 WCKY: "Newsmark" (after last Sat.) 1530
2310-2400 DW: "Prizequiz" 5-weekly 15410, 9735, 6079
2315-2325 Cairo: "Egypt A to Z" 9805
2315-2329 BBC: "LETTER FROM AMERICA" 9590, 7325, 6175, 11910, 15070
2320-2330 Moscow: "DX Program" 15460
2345-2354 AFRTS: "Mike Wallace" 21570, 17765, 15430, 15345, 15330
2350-2425 RAI: "Music Programs" 11800, 9579

MONDAY

0005-0029 RCI: "DX DIGEST" 5960, 9755
0010-0030 Israel: "Calling Listeners/DX" 15582, 11637, 21710
0013-0030 Moscow: "Mailbag" 9600, 600, 12030
0015-0035 Japan: "PROGRAM PREVIEWS/OX" 17825, 15270
0030-0059 BBC: "Religious Service" 9410, 7325, 6175, 11835
0035-0059 AFRTS: "Face The Nation" 21570, 17765, 15430, 15345, 15330
0045-0100 Belgium: "DX Corner" 15385, 15175
0048-0102 SFR: "CQ, CQ" 11880, 9630
0100-0144 BBC: "Concert Hall" 9410, 7325, 6175, 11835
0105-0159 CBC: "Celebration" 940, 740, 1550
0107-0127 RCI: "MAILBAG" 17820, 9755, 5960
0109-0129 VOA: "New Products & Horizons" 9640, 6130
0110-0125 Israel: "CALLING LISTENERS/OX" 15582, 11637, 21710
0130-0155 ORF: "PROFILE/POST BOX" 9770, 5945
0130-0200 WHO: "Voice of Southeast Asians" 1040
0130-0200 VOA: "Studio One" 17730, 11740, 6130
0130-0200 WGN: "Oldtime Radio" 720

0135-0145 AFRTS: "Dateline America #2 & Collingwood" 21570, 17765, 15430, 15345, 15330
0145-0200 SFR: "CQ, CQ" 11880, 9630
0150-0200 Japan: "Music Time" 21640, 17825
0200-0220 Japan: "PROGRAM PREVIEWS/DX" 21640, 17825
0200-0230 Norway: "This Week" 11870, 11860, 9610
0205-0213 Cairo: "Egyptian Proverbs" 12050, 9475
0207-0227 RCI: "MAILBAG" 11940, 9655, 5960
0210-0228 Budapest: Various Features 17710, 11910
0210-0225 Israel: "CALLING LISTENERS/DX" 15582, 9815, 11637
0213-0230 Moscow: "Mailbag" 9600, 600, 12030
0217-0227 AFRTS: "World This Week" 21570, 17765, 15430, 9755, 6030
0230-0258 Sweden: "MAILBAG" 11705, 15290
0230-0300 Belize: "African Theater" 834, 3285
0230-0325 RN: "Happy Station" 9590, 6165
0230-0400 WBAP: "OLDTIME RADIO" 820
0235-0250 RAI: "Film Music" 11800, 9575
0235-0259 AFRTS: "Meet The Press" 21570, 6030, 17765, 15430, 9755
0300-0330 ORF: "Folk Music" 5945, 9770
0300-0330 Budapest: "Hungarian History" 17710, 11910
0307-0327 RCI: "MAILBAG" 11940, 11845, 9655, 9535, 5960
0310-0400 DW: "Prizequiz" 5-weekly 9735, 6145
0330-0355 ORF: "AUSTRIAN TRIP" 9770, 5945
0330-0400 HCJB: "DX Party Line" 11910, 9745, 15155
0330-0359 AFRTS: "NBC Documentaries" 21570, 17765, 15430, 9755, 6030
0345-0414 Belize: "Clitheroe Kid" 834, 3285
0400- Mexico: "Hora De Mexico" 540, 730, 900, 1050, 15430
0400-0500 WOR: "Hooked on Books" 710 (irreg.)
0407-0429 RCI: "DX DIGEST" 11845, 9655, 9535, 5960
0411-0426 Moscow: "Culture and the Arts" 12060
0430-0444 BBC: "Coming up for Air" 9410, 6175
0430-0455 ORF: "PROFILE/POST BOX" 12015
0435-0459 AFRTS: "Issues & Answers" 6030, 15430, 15330, 17765, 9755
0440-0455 RHC: "Philately in Cuba" 11760
0445-0450 BBC: "NOTES FROM AN OBSERVER" 9510, 9410, 6175
0500-0900 WOR: "Night Talk" 710
0511-0530 Moscow: "Roundabout the Soviet Union" 12060
0513-0530 Moscow: "Mailbag" 15455, 15180
0530-0544 BBC: "ANCIENT MUSIC" 9510, 9410, 6175
0530-0555 ORF: "Homeland Melodies" 12015
0530-0600 "New Zealand Calling" (2 weekly) 17860, 15345
0530-0625 RN: "Happy Station" 9715, 6165
0535-0559 AFRTS: "Face the Nation" 17765, 15430, 15330, 9755, 6030
0545-0559 BBC: "Talks" 15070, 9510, 9410, 6175
0600-0630 Norway: "This Week" 21655
0621-0629 AFRTS: "Mike Wallace" 17765, 15430, 15330, 9755, 6030
0635-0644 AFRTS:: "Dateline America #2 & Collingwood" 17765, 15430, 15330, 9755, 6030
0800-0830 HCJB: "DX Party Line" 11835, 15200
0815-0829 BBC: "Operatic Cameos" 15070, 11955, 9510
0845-0915 "New Zealand Calling" (2 weekly) 11945
0915-0920 BBC: "NOTES FROM AND OBSERVER" 17790, 15070
0935-0959 AFRTS: "Issues and Answers" 11805, 9700, 9590, 9575, 6030
0945-0959 BBC: "The Bach Family" 17790, 15070
1000-1029 BBC: "DOCUMENTARIES" 17790, 15070
1111-1126 Moscow: "Roundabout the Soviet Union" 9600
1115-1129 BBC: "WORLD RADIO CLUB" 25650, 9510, 6195
1130-1159 VOA: "FORUM" 9565, 11715
1130-1159 BBC: "Classic Serial" 25650, 9510, 15070, 11775, 6195
1230-1255 ORF: "PROFILE/POST BOX 700" 15290
1310-1330 Finland: "Voices of Finland" 15400
1440-1429 BBC: "Alistair Cooke's 1940s" 25650, 21470
1405-1430 CBCNS: "Sounds of Shortwave" 11720, 9625 (irreg.)
1415-1430 VOA: "Making a Nation" 9565, 11715
1440-1459 Finland: "Voices of Finland" 21475, 15400
1449-1524 RN: "Monday Programme" 21480, 11735
1615-1630 Korea: "Listeners Corner" 11830, 9720
1711-1730 Moscow: "Roundabout the Soviet Union" 15150, 11840

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DX LISTENING *(continued)*

1730-1800 VOA: "FORUM" 15195
1812-1827 VOA: "Making a Nation" 15410
1930-2000 VOA: "FORUM" 15410
2010-2030 Israel: "Mosaic & Spectrum" 21675, 17815, 11610
2115-2130 India: "Faithfully Yours" 15110, 11620
2130-2159 BBC: "DOCUMENTARIES" 15420, 15260, 15070
2130-2200 HCJB: "DX Party Line" 26020, 21480
2215-2230 Turkey: "Myths" 15360, 9515
2240-2300 Israel: "Mosaic & Spectrum" 15582, 11637, 9815, 21710, 21675
2311-2330 Moscow: "Roundabout the Soviet Union" 15460
2315-2329 BBC: "High Wind in Jamaica" 9590, 9410, 6175, 11910
2330-2359 BBC: "These Musical Islands" 15420, 15260, 15070, 11910, 9590, 7325, 6175
2340-2400 DW: "Dance Music" 15410, 9735, 6075

TUESDAY

0010-0030 Israel: "Mosaic & Spectrum" 15583, 11638, 21710
0015-0030 VOA: "Making a Nation" 6130, 11740, 9650
0020-0035 Japan: "One in a Hundred Million" 17825, 15270
0030-0100 Cayman: "Forum" 1555
0030-0114 BBC: "DOCUMENTARIES" 9410, 7325, 6175, 5975, 15260, 11835, 15070
0110-0125 Israel: "Mosaic" 15582, 11637, 21710
0115-0130 DW: "New LPs" 15410, 9735, 6075
0130-0200 VOA: "FORUM" 6130, 9640, 11740, 15205, 17730
0205-0220 Japan: "One in a Hundred Million" 21640, 17825
0210-0225 Israel: "Mosaic" 15582, 11637, 9815
0215-0229 HCJB: "A L'Ecoute du Monde" 15155
0230-0259 BBC: "DOCUMENTARIES" 9410, 7325, 6175, 5975
0230-0259 HCJB: "DX Party Line" 11910, 9745, 15155
0235-0300 Cairo: "POETRY IN EGYPT/CAIRO AT NITE" 12050, 9475
0249-0324 RN: "MONDAY PROGRAMME" 9590, 6165
0300-0330 ORF: "Thru Austria in Music" 9770, 5945
0330-0400 Belize: "Men from the Ministry" 834, 3285
0340-0400 DW: "Dance Music" 9735, 6145, 6085
0340-0400 Finland: "Air Mail & Notebook" 15400
0505-0530 ORF: "Music For Winds" 12015
0515-0530 OW: "New LPs" 9735, 6145, 6085
0730-0744 BBC: "THE BACH FAMILY" 15070, 11955, 9510
1115-1124 BBC: "LETTER FROM LONDON" 25650, 9510, 6195, 21710, 11775
1124-1129 BBC: "Scotland This Week" 25650, 9510, 6195, 21710, 11775
1130-1157 BBC: "BRAIN OF BRITAIN" 25650, 21710, 9510, 11775, 6195
1235-1255 Peking: "Music In China" 15520
1310-1330 Finland: "AIR MAIL/NOTEBOOK" 15400
1414-1426 Sweden: "CALLING DXERS" 21615
1440-1500 Finland: "AIR MAIL/NOTEBOOK" 21475, 15400
1615-1629 BBC: "High Wind In Jamaica" 17830, 15260
1709-1714 BBC: "Scotland This Week" 15070, 21470
1715-1744 BBC: "Detective" 15070, 21470 (August: Double Bill)
2030-2114 BBC: "DOCUMENTARIES" 15260, 15070
2115-2159 BBC: "The Pleasure's Yours" 15420, 15260, 15070
2224-2229 BBC: "Scotland This Week" 15420, 15070, 15260
2255-2320 RAI: "Instrumental Voices" 11800, 9575
2315-2329 BBC: "Talks" 9590, 9410, 7325, 6175, 11910, 15260, 15070
2314-2327 Sweden: "CALLING DXERS" 11705, 15380
2330-2359 BBC: "Detective" 9590, 9410, 7325, 6175, 11910, 15260, 15070 (Aug: Double Bill)
2340-2400 DW: "From Concerts & Opera" 15410, 9735

WEDNESDAY

0030-0100 DW: "Music" 15410, 9735, 6075
0030-0100 Budapest: "Hungarian History" 17710, 11910
0040-0100 Belgium: "MAILBAG" 15385, 15175
0110-0125 Israel: "Spectrum" 21710, 15582, 11637, 9815
0110-0130 Budapest: "Documentaries" 17710, 11910
0115-0130 DW: "Folk Music" 15410, 9735, 6075
0130-0150 RA: "INDIAN FILM MUSIC" 21740, 17795
0135-0155 Peking: "Music From China" 17680, 15120
0145-0159 BBC: "Coming up for Air" 7325, 6175, 5975, 11835, 15070
0210-0225 Israel: Spectrum" 15582½, 11637½, 9815
0210-0230 Budapest: "Documentaries" 17710, 11910
0215-0229 BBC: "ANCIENT MUSIC" 7325, 6175, 5975, 15070 .
0235-0255 Peking: "Music From China" 17680
0240-0250 Cairo: "Egyptian Woman's Mag." 12050, 9475
0244-0257 Sweden: "CALLING DXERS" 11705, 15290
0300-0312 Budapest: "Calling DXers" 17710, 11910
0305-0315 Cairo: "Tourism in Egypt" 12050, 9475
0340-0400 DW: "From Concerts & Opera" 9735, 6145, 6085
0353-0358 V. of Yerevan: 17870, 15405, 15180
0430-0444 AFRTS: "SCIENCE EDITOR" 6030, 9755, 15330, 15430, 17765
0430-0459 DW: "Music" 9735, 6145, 6085
0515-0530 DW: "Folk Music" 9735, 6145, 6085
0540-0554 RNZ: "Letter from America" 17860, 15345
0630-0659 BBC: "Jazz for the Asking" 15070, 11955, 9510
0745-0759 BBC: "Report on Religion" 15070, 11955, 9510
0830-0859 BBC: "BRAIN OF BRITAIN" 15070, 11955, 9510
0930-0944 AFRTS: "SCIENCE EDITOR" 11805, 9700, 6030, 9590, 9575
1015-1029 BBC: "Coming up for Air" 17790, 15070
1130-1159 BBC: "Nature Notebook & Farming World" 25650, 21710, 11775, 9510, 6195
1130-1157 Perth: "ROUND THE HORNE" 9610
1215-1244 BBC: "Detective" 25650, 15070, 11775, 9510, (August: Double Bill)
1220-1228 Tashkent: "Life in the Village" 15460
1230-1259 Kuwait: "Music" 21685
1330-1414 BBC: "DOCUMENTARIES" 25650, 21710, 15070, 21470
1412-1427 VOA: "Space and Man" 9565, 11715
1415-1429 BBC: "Report on Religion" 25650, 15070, 21470
1530-1550 RA: "Indian Film Music" 11865
1615-1644 BBC: "DOCUMENTARIES" 17830, 15260
1812-1827 VOA: "Space & Man" 15410
2140-2157 RCI: "DX DIGEST" 17820, 15150, 11945
2145-2157 Bagdad: "Cultural Programme" 9745
2215-2245 Turkey: "Letterbox" 9515, 15360
2315-2329 BBC: "WORLD RADIO CLUB" 9590, 7325, 6175, 15070, 11910
2325-2440 RAI: Three Music Programs 11800, 9575

THURSDAY

0013-0030 Moscow: "Mailbag" 9600, 12030
0015-0030 VOA: "Space & Man" 6130, 9640, 11740, 17730
0030-0114 BBC: "Radio Theatre" 9410, 7325, 6175, 15070, 11835
0110-0130 Budapest: "INSIDE HUNGARY" 17710, 11910
0130-0141 RAE: "DXismo Argentino" 9690 (2-weekly)
0145-0159 BBC: "Report on Religion" 7325, 6175, 5975, 15070, 11835
0210-0230 Budapest: "INSIDE HUNGARY" 17710, 11910
0213-0230 Moscow: "Mailbag" 9600, 600, 12030
0230-0259 BBC: "DISCOVERY" 9410, 7325, 6175, 5975, 15070
0230-0259 HCJB: "DX Party Line" 11910, 9745, 15155
0240-0305 RAI: "Instrumental Voices" 11800
0310-0330 Portugal: "Culture" 11925, 15125
0330-0359 BBC: "MY MUSIC" 9410, 6175, 5975, 15070
0353-0358 V. of Yerevan: 17870, 15405, 15180
0420-0500 Belize: "Their Voices Live On" 834, 3285
0430-0441 RAE: "DXismo Argentino" 9690 (2-weekly)
0435-0459 AFRTS: "Capitol Cloakroom" 17765, 15430, 15330, 9755, 6030
0510-0530 Portugal: "Culture" 11925, 9575
0513-0530 Moscow: "Mailbag" 15455, 15180
0630-0659 BBC: "Nature Notebook & Farming World" 15070, 11955, 9510, 6175
0713-0730 Moscow: "Mailbag" 15455, 15180
0749-0824 RN: "DX JUKEBOX" 9770, 9715
0800-0829 HCJB: "DX Party Line" 11835, 15200
0806-0820 WCKY: "SCIENCE EDITOR" 1530
0830-0859 BBC: "Farming World" 15070, 9510, 11955
0849-0924 RN: "DX JUKEBOX" 9715
0900-0929 HCJB: "DX Party Line" 11900, 9745, 6130
0935-0959 AFRTS: "Capitol Cloakroom" 11805, 9700, 9590, 9575, 6030
0945-0959 BBC: "High Wind in Jamaica" 17790, 15070
1000-1029 BBC: "Discovery" 17790, 15070
1030-1057 BBC: "MY MUSIC" 17790, 15070
1225-1255 Peking: "Culture in China" 15520
1345-1429 BBC: "The Pleasure's Yours" 25650, 21470
1415-1430 VOA: "Making A Nation" 9565, 11715
1449-1524 RN: "DX Jukebox" 21480, 11735
1615-1644 BBC: "Classic Serial" 17830, 15260
1715-1744 BBC: "Discovery" 21710, 15070
1815-1830 VOA: "Making A Nation" 15410

1849-1919 RN: "DX JUKEBOX" 17605, 15220
2010-2025 Israel: "STUDIO THREE" 21675, 17815, 11610
2049-2119 RN: "DX JUKEBOX" 21640, 17695, 17605, 15220
2115-2119 BBC: "Ulster Newsletter" 15420, 15260, 15070
2120-2129 BBC: "IN THE MEANTIME" 15420, 15260, 15070
2130-2159 HCJB: "DX Party Line" 26020, 21480
2242-2255 Israel: "STUDIO THREE" 15582, 11637, 9815, 21675, 21710
2311-2330 Moscow: "Science and Engineering" 15460
2320-2325 Cairo: "Science in Egypt" 9805
2340-2400 DW: "Musical Themes" 15410, 9735, 6075

FRIDAY

0010-0025 Israel: "STUDIO THREE" 21710, 15582, 11637
0015-0030 Moscow: "SCIENCE & ENGINEERING" 9600, 12030
0015-0030 VOA: "Making A Nation" 6130, 9640, 11740
0030-0058 Budapest: "Hungarian History" 17710, 11910
0030-0059 BBC: Comedy Series 9410, 7325, 6175, 15070, 15260, 11835
0040-0100 Belgium: "MAILBAG" 15385, 15175
0100-0115 Vatican: "Culture and Religion" 11845, 6015
0110-0125 Israel: "STUDIO THREE" 21710, 15582, 11637
0115-0130 DW: "Folk Music" 15410, 9735, 6075
0145-0149 BBC: "Ulster Newsletter" 7325, 6175, 15260, 15070, 11835
0150-0159 BBC: "IN THE MEANTIME" 7325, 6175, 15260, 15070, 11835
0210-0225 Israel: "STUDIO THREE" 15582, 11637, 9815
0215-0229 BBC: "PROFILE" 7325, 6175, 5975, 15260, 15070, 11835
0215-0230 Moscow: "SCIENCE & ENGINEERING" 9600, 600, 12030
0222-0226 Brazil: "Television" 15290
0230-0259 BBC: "Alistair Cooke's 1940's" 9410, 7325, 6175, 15070
0230-0300 Belize: "Polar Pak Calling" 834, 3285
0249-0324 RN: "DX JUKEBOX" 9590, 6165
0300-0330 RA: "Calling Antarctica" 15260
0300-0330 ORF: "Operetta Concert" 9770, 5945
0322-0326 Brazil: "Television" 15290
0330-0344 HCJB: "MUSICA DEL ECUADOR" 11910, 9745, 15155
0340-0400 DW: "Musical Themes" 9735, 6145, 6085
0340-0400 Finland: "Documentaries" 15400
0430-0439 BBC: "LETTER FROM LONDON" 9410, 6175, 5975
0430-0444 AFRTS: "Meet Author/Newsmaker" 6030, 9755, 15330, 15430, 17765
0500-0515 HCJB: "MUSICA DEL ECUADOR" 11910, 9745, 6095
0511-0530 Moscow: "Science & Engineering" 12060
0515-0530 DW: "Folk Music" 9735, 6145, 6085
0549-0624 RN: "DX JUKEBOX" 9715, 6165
0715-0730 Moscow: "SCIENCE & ENGINEERING" 15455, 15180
0730-0744 BBC: "Profile" 15070, 9510
0930-0944 AFRTS: "Meet Author/Newsmaker" 11805, 9700, 9590, 9575, 6030
1030-1059 BBC: "Comedy Series" 17790, 15070
1111-1130 Moscow: "Science And Engineering" 9600
1115-1124 BBC: "IN THE MEANTIME" 25650, 11775, 9510, 21710, 6195
1124-1129 BBC: "Ulster Newsletter" 25650, 9510, 6195, 11775, 21710
1215-1244 BBC: "These Musical Islands" 25650, 9510, 11775, 21710
1240-1255 RA: "LETTERS TO THE EDITOR" 9580 (irreg.)
1310-1330 Finland: "Documentaries" 15400
1415-1429 BBC: "LETTERBOX" 25650, 21470
1430-1459 BBC: "TCHAIKOVSKY WORLD" 25650, 21470
1440-1500 Finland: "Documentaries" 21475, 15400
1635-1644 BBC: "New Ideas" 17830, 15260
1711-1730 Moscow: "Science & Engineering" 15150, 11840
1900-1930 KSAC: "Ralph Radio Program" 580 (Kansas)
2030-2059 BBC: "Alistair Cooke's 1940s" 15260, 15070
2050-2100 RFE: "COMMENTARY" 15420, 17835, 11825
2135-2159 Sofia: "DX Program and feature" 15135, 11750
2145-2154 BBC: "LETTER FROM LONDON" 15420, 15260, 15070
2200-2230 Riyadh: "MUSIC" 21625, 15060
2215-2230 Turkey: "Last Week in Ankara" 15360, 9515

(Continued on page 102)

DX LISTENING *(continued)*

2225-2229 BBC: "The Week in Wales" 15420, 15260, 15070, 9590
2245-2300 UN Radio: "Caribbean Magazine" 15225, 11920
2300-2324 RN: "Espacio Diexista" 11730, 6020
2311-2330 Moscow: "Science and Engineering" 15460
2315-2325 Cairo: "Land of Minarets" 9805
2315-2329 BBC: "FROM THE WEEKLIES" 9590, 7325, 6175, 15070, 11910
2330-2357 BBC: "BRAIN OF BRITAIN" 15260, 15070, 11910, 9590, 9410, 7325, 6175, 6120

MULTI-DAY

0005-0030 SFR: "Spanish Kaleidoscope" 11880, 9630
0015-0029 BBC: "Radio Newsreel" 9590, 7325, 9410, 6175, 15070, 11910
0030-0058 Moscow: "Kaleidoscope" 9600, 600, 12030
0030-0100 VOA: "Magazine Show" 6130, 11740, 9650, 15205, 17730 (Tues.-Sat.)
0105-0130 SFR: "Spanish Kaleidoscope" 11880, 9630
0115-0144 BBC: "Outlook" 9410, 7325, 6120, 5975, 15070, 11835 (Tues.-Sat.)
0145-0159 BBC: "World Today" 15380, 9410 (Tues.-Fri.)
0145-0214 SRI: "Dateline" 15305, 11715, 9725, 6135 (Tues.-Sat.)
0209-0215 BBC: "British Press Review" 9410, 7325, 6120, 15070, 11835
0215-0229 BBC: "Radio Newsreel" 15380, 9410 (Tues.-Fri,)
0215-0230 DW: "Music from Germany" 9735, 6145, 6085 (Tues.-Sat.)
0220-0235 CBC: "Booktime" (EOT Zone) 1550, 940, 740
0230-0258 Moscow: "Kaleidoscope" 9600, 600, 12030
0235-0259 AFRTS: "Cronkite/Reasoner/Bell/Clark/Chancellor/Brinkley" 21570, 17765, 15430, 9755, 6030 (Tues.-Sat.)
0235-0359 CBC: "Mostly Music" (EOT Zone) 1550, 940, 740 (Tues.-Sat.)
0309-0315 BBC: "News About Britain" 9410, 7325, 5975
0310-0359 KNX: "Mutual Radio Theater" 1070 (Tues.-Sat.)
0315-0329 BBC; "World Today" 9410, 7325, 5975 (Tues.-Sat.)
0315-0345 Cuba: "Classical Music" 640 (Tues.-Sat.)
0320-0335 CBC: "Booktime" (CDT Zone) 990 (Tues.-Sat.)
0334-0900 WJR: "Nightflight" 760
0335-0359 AFRTS: "Business Reports" 21570, 17765, 15430, 9755, 6030 (Tues.-Sat.)
0335-0459 CBC: "Mostly Music" (CDT Zone) 990 (Tues.-Sat.)
0403-0500 RNZ; "Appt. With John Gordon" 17860, 15345 (Mon.-Fri.)
0406-0700 WSB: "Larry King Show" 750 (Tues.-Sat.)
0407-0457 KFBK: "Mutual Radio Theater" 1530 (Tues.-Sat.)
0407-0459 CBC: "ECLECTIC CIRCUS" (EDT Zone) 740, 940 (Tues.-Sat.)
0430-0459 SRI: "Dateline" 11715, 9725 (Tues., Sat.)
0445-0454 BBC: "Financial News" 9510, 9410, 6175 (Tues.-Sat.)
0454-0459 BBC: "Reflections" 15070, 9510, 9410, 6175
0507-0559 CBC: "ECLECTIC CIRCUS" (CDT Zone) 990 Tues.-Sat.)
0515-0540 SFR: "Spanish Kaleidoscope" 11880, 9630
0535- AFRTS: "PROGRAM NOTES" 17765, 15430, 15330, 9755, 6030 (Tues.-Sat.)
0545-0559 BBC: "World Today" 9510, 15070, 9410, 6175 (Tues.-Sat.)
0645-0700 SRI: "Swiss Country Music" 9535, 6165, 3985
0809-0814 BBC: "Reflections" 15070, 9510
1000-1059 AFRTS: "Morning Edition" 11805, 9700, 9590, 9575, 6030
1015-1029 Japan: Various Features 9505
1105-1159 AFRTS: "Morning Edition" 15430, 15330, 11805, 9700, 6030
1130-1140 RA: "Australian News" 9580
1210-1219 RA: "International Report" 9580 (Mon.-Fri.)
1215-1300 VOA: "Music USA—Jazz" 9565, 11715 (Mon.-Sat.)
1235-1259 AFRTS: "ABC & CBS News" 15430, 15330, 11805, 9700
1309-1329 BBC: "24 Hours" 25650, 21710, 9510, 11775, (Mon.-Fri.)
1315-1344 SRI: "Dateline" 21570, 21520 (Mon.-Fri.)
1342-1359 AFRTS: "SPECTRUM/FIRST LINE REPORT/NEWSBREAK" 15430, 15330, 11805, 9700 (Mon.-Fri.)
1415-1430 Japan: Various Features 9505
1430-1444 AFRTS: "The World This Morning" 15430, 15330, 11805, 9700 (Mon.-Fri.)
1500-1515 BBC: "Radio Newsreel" 25650, 21710, 21470
1530-1559 SRI: "Dateline" 21570 (Mon.-Fri.)

1609-1615 BBC: "Commentary" 17830, 15260
1617-1628 AFRTS: "Paul Harvey" 17765, 15430, 15330, 11805 (Mon.-Fri.)
1642-1659 AFRTS: "SPECTRUM/FIRST LINE REPORT/ NEWSBREAK" 17765, 15430, 15330, 11805 (Mon.-Fri.)
1645-1659 BBC: "WORLD TODAY" 21470, 15070, 17830, 15260
1735- AFRTS: "PROGRAM NOTES" 17765, 15430, 15330, 11805 (Mon.-Fri.)
1804-1829 CBCNS: Various Features 11720, 9625
1815-1844 SRI: "Dateline" 21585 (Mon.-Fri.)
1917-1928 AFRTS: "Paul Harvey" 21570, 17765, 15430, 15345, 15330 (Mon.-Fri.)
2009-2129 BBC: "24 Hours" 15260, 15070
2015-2100 VOA: "Music USA—Jazz" 15140 (Mon.-Fri.)
2035-2059 AFRTS: "Cronkite/Reasoner/Clark/Bell/ Chancellor/Brinkley" 21570, 17765, 15430, 15345, 15330 (Mon.-Fri.)
2100-2229 AFRTS: "ALL THINGS CONSIDERED" 21570, 17765, 15430, 15345, 15330 (Mon.-Fri.)
2130-2259 RCI: "AS IT HAPPENS" 17875, 15325 (Mon.-Fri.)
2209-2224 BBC: "World Today" 15420, 15260, 15070, 9590
2215-2280 DW: "Music From Germany" 15410, 9735, 6075 (Mon.-Fri.)
2230-2236 Grenada: "Obituaries" 15045 (Mon.-Sat.)
2230-2239 BBC: "Financial News" 15420, 15260, 15070, 9590 (Mon.-Fri.)
2230-2244 AFRTS: "The World Tonight" 21570, 17765, 15430, 15345, 15330 (Mon.-Fri.)
2230-2359 RCI: "AS IT HAPPENS" 9755, 5960 (Mon.-Fri.)
2240-2244 BBC: "Reflections" 15420, 15260, 15070, 9590
2309-2315 BBC: "Commentary" 9590, 9410, 7325, 6175, 5975, 15070, 11910
2315-2330 Japan: "Various Features" 17755
2317-2322 AFRTS: "The Rest of the Story" 21570, 17765, 15430, 15345, 15330 (Mon.-Fri.)
2330-2400 Grenada: "Tonight" 15045 (Mon.-Sat.)
2335-2359 AFRTS: "Business Reports" 21570, 17765, 15430, 15345, 15330 (Mon.-Fri.) ◇

PROJECT OF THE MONTH

General-Purpose Utility Amplifier

BY FORREST M. MIMS

A GENERAL-PURPOSE utility amplifier can be as useful to the experimenter as a VOM or an oscilloscope. Typical applications include signal tracing, listening to weak audio-frequency signals detected by an appropriate transducer, and monitoring subtle amplitude and frequency changes in an audio-frequency circuit undergoing test or adjustment.

Figure 1 is the schematic diagram of such an amplifier that you can assemble from readily available parts. In operation, the 741C serves as a high-gain preamplifier. Potentiometer *R1* controls the gain of the preamplifier and *C1* is the input coupling capacitor. The LM386 is a power amplifier which drives a small speaker or an earphone. Potentiometer *R2* serves as a level control. Capacitor *C2* sets the gain of the LM386 at 200. It can be reduced to 20 by omitting *C2*.

Signal Tracing. To use the amplifier as a signal tracer, connect a clip lead to the grounded side of the input and a probe or small alligator clip to *C1*. Use shielded cable if the probe lead is more than a few inches long. You can then follow a signal through an audio amplifier or the audio portion of a radio receiver by clipping the ground clip to the chassis or ground of the circuit under test and using the probe to follow a signal through the circuit. Be sure to reduce the gain of the amplifier when tracing a signal which has been subjected to a few stages of amplification. *Caution! Never* use this circuit to trace a line-powered ac/dc radio, phonograph or amplifier! Also, remember that touching the "hot" side of the ac power line or the terminals of a charged power-supply filter capacitor can be *fatal*.

Sound Detection. Connect a crystal, dynamic or electret microphone to the amplifier's input terminals by means of a shielded cable. For long-range, directional sound detection, mount the microphone at the focus of a plastic or metal parabolic reflector. Suitable reflectors include "saucer sleds" and certain plastic food containers, and hubcaps. For short-range, directional use, install the mike at one end of a hollow pipe or tube.

Induction Receiver. Connect a telephone pickup coil to the amplifier's input and you can detect electromagnetic signals from motors, switches, power lines and some electronic watches. This principle is used in some museums to broadcast taped messages to visitors equipped with a receiver comprising an audio amplifier, transducer, and pickup coil. The signal is received when the visitor walks near a large coil antenna driven by an endless loop tape player.

Omni-Frequency Radio Receiver. The addition of a simple tuned circuit and detector will enable the utility amplifier to receive AM radio signals. A suitable germanium diode connected to a simple loop antenna (Fig. 2) allows the reception of signals up to several gigahertz. Transmitters broadcasting in this region include direction finders, radars, earth-space telemetry, radiosondes, and various broadcast, amateur and other telecommunications.

The antenna can be a commercial uhf television loop (the type that attaches directly to the antenna terminals of a TV set) or a homemade version. For best results, experiment with different diodes and antenna configurations. You will find that the orientation of the antenna and its location with respect to large metal objects and electrical equipment greatly affect the receiver's performance.

Going Further. You can spend many entertaining hours experimenting with various other transducers connected to the input of the amplifier. A silicon solar cell will let you "hear" the modulated light emitted by a flickering candle, an automobile headlight (when the engine is running or the vehicle is on a bumpy road), fluorescent lights or a calculator's LED display. An old phonograph cartridge will convert the surface roughness of various objects into sound.

For additional application ideas, see *Listen to Radio Energy, Light and Sound* by Calvin R. Graf (Howard W. Sams, 1978). This excellent book contains detailed instructions on how to detect virtually all kinds of low-frequency, radio-frequency, uhf and light waves using a general-purpose utility amplifier. ◇

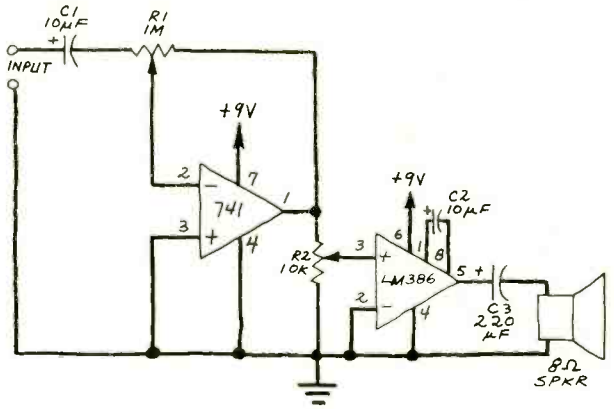

Fig. 1. A simple general-purpose utility amplifier.

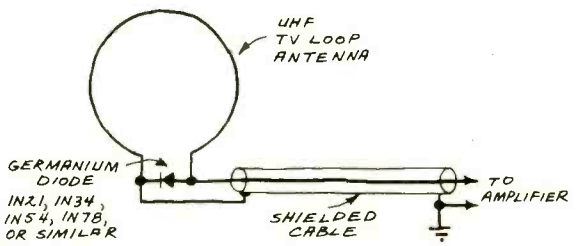

Fig. 2 A broadband pickup.

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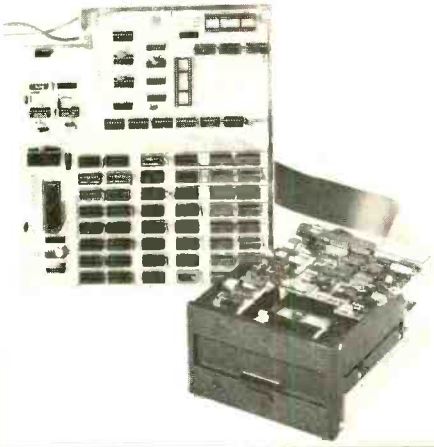

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SAMS manual C4P	$ 16
OS-65D V3.2 Disk Operating System with 9-digit extended BASIC, random access from sequential files	$ 49
C4P computer 8K RAM expandable to 32K RAM	$ 750
C4P MF computer Mini-floppy, 24K RAM	$1795
C8P computer 8K RAM expandable to 32K and dual 8-inch floppies	$ 950
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RIGHT OUT OF ELECTRONIC COUNTERINTELLIGENCE...

THE HIERONYMUS MACHINE™

Voice Stress Computer

The Hieronymus Machine Voice Stress Computer, U.S. Patent No. 4142067. It can help you tell the difference between truth and falsehood in more ways than one.

It's almost beyond belief. This tiny solid-state instrument measures 2½" x 4⅞" x ⅞". Fits in your shirt pocket. Yet it contains a responsive omni-directional microphone, an on/off sensitivity switch, and red and green light-emitting diodes. Inside, there are several transistors and an incredible microprocessor that has been programmed to detect the presence or absence of micro-tremors in the human voice.

Once you learn (in about 30 minutes how to use the Hieronymus Machine, you will be able to discover whether a person is calm and relaxed or experiencing stress - merely by monitoring his or her voice.

DEFINITELY NOT A "LIE DETECTOR"

The Hieronymus Machine is not a lie detector. Nor is it a "truth" device. It might make some aspects of life simpler if such a device actually existed. But it doesn't. Even the famed polygraph machine is not a lie detector, plain and simple. The polygraph can be used to monitor a person's heart rate, breathing, and galvanic skin response, bodily functions that are affected by stress.

And in the hands of a skilled operator, the polygraph can be used to gain valuable insights about a person's stress levels when talking about certain topics. But a very real part of the polygraph's usefulness is the "Hieronymus Effect," which we'll get to in a moment.

SPIES AND COUNTERSPIES

During wartime, counterintelligence people began to wonder if science could come up with some way of helping to ferret out whether captured or suspected spies were telling the truth. The military wanted -- ideally -- a portable device that didn't have all the wires and tubes of polygraph, so that it wouldn't have to be connected to the subject's body. So researchers became attracted to the theory that human voices emit "micro-tremors," low-frequency vibrations that are generally inaudible or masked by other voice components.

An article in **Popular Electronics** (April 1980, pages 66-71) describes the theory in greater detail. But the short story is that after spending millions of dollars, researchers came up with a Voice Stress Computer. And one company, Omnitronics, headed by inventor John Walsh (see **Fortune**, Feb. 25, 1980, for his exploits which Sensormatics), holds U.S. Patent No. 4142067 on it.

WHAT IT DOES, HOW YOU USE IT

The Hieronymus Machine is a personal Voice Stress Computer. Compact, battery operated (you put two 9-volt cells in), it electronically measures changes in voice micro-tremor activity. The read-out is simple: a green light means low or no stress on the part of the speaker. And the red light indicates stress that could range from mild annoyance to severe anxiety.

You, as the operator, could use the Hieronymus Machine like a thermometer, approximating the "fever level" of stress. And as you gain skill, your judgmental abilities will improve, enabling you to pursue or avoid a line of questioning or discussion that produces stressful responses.

MANY APPLICATIONS AT HOME AND WORK

You can use the Hieronymus Machine at home to have a lot of fun with your family. You can discover how it responds to different people's voices, what effect laughter and singing have on it, and see how it helps you evaluate such things as politicians' speeches over TV or radio. Yes, it works quite well on transmitted voices, as well as over the telephone or with tape-recordings; you do have to adjust the dial to compensate for the "noise" and other signals that come over wires or air waves.

Next, try it on friends. See how well someone's favorite fish story holds up when you point out that the Hieronymus Machine doesn't believe a word of it. And watch that poker face disappear as the red diode steadily insists you're not getting the whole story.

BIOFEEDBACK FOR YOU

If you're required to talk in front of groups or need to speak convincingly to one person at a time, you can use the Hieronymus Machine to monitor your voice and learn a more relaxed, self-assured, persuasive style of delivery. If you wanted to learn hypnotism, a relaxed voice would be a real asset -- and the Machine could help you achieve it.

At work, there are numerous situations in which the Hieronymus Machine can work wonders. Here's how:

Hieronymus Bosch was a 15th-Century Flemish painter known for his startling originality. He was also something of a medical practitioner, and he believed that patients could be cured by passing stones over their bodies -- much as Franz Mesmer later developed animal magnetism as a "cure" for numerous maladies in his day. In both instances, Bosch and Mesmer achieved success because their patients believed that a cure was being worked.

Nearer our own time, a couple of science-fiction writers concocted a device they called a Hieronymus machine; it produced varying sensations in the user depending where a dial was set, from zero to 100. The amazing thing was that this machine worked even when it wasn't plugged in!

CIRCLE NO. 44 ON FREE INFORMATION CARD

Now we have a true Hieronymus Machine -- the Voice Stress Computer. It actually works, and among other things is capable of producing the Hieronymus Effect. In its presence, people in a business meeting suddenly become more forthright. And employees being asked about office theft became very cooperative in answering questions truthfully. Naturally, you'll want to use the Machine in plain sight and tell people what it does, this actually gets more cooperation from them.

30-DAY TRIAL, MONEY BACK GUARANTEE

The potential uses of the Hieronymus Machine are limited only by your imagination. Try it at no risk for 30 days. We'll send you one or more with complete instructional literature. You'll be able to try it, experiment, even conduct your own "investigation."

Government and police departments and huge corporations are using large (briefcase-sized) versions of this kind of machine, and they have to pay $3,000 or so for theirs. But you can have a personal Hieronymus Machine for only $159.95. If you're not satisfied, send it back (insured) at the end of 30 days for a full refund, no questions asked. If you want two, the cost is $149.95 each. And if you wish to purchase three or more for business use, ask about our special price. You're also protected by a 1-year parts and labor guarantee.

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MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
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MAN 72	Common Anode-red	.300	.75	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1.50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	3.25	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	1.25	CA3401N	.59
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7-seg. LED driver	1.50
MM5309	4.95

CLOCK CHIPS

MM5309	4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998a	4.95
CT 7001	6.95

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MC1408L7	4.95
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MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
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ASST. 1	5 ea.	10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	50 PCS	$1.75
		27 OHM	33 OHM	39 OHM	47 OHM	56 OHM		
ASST. 2	5 ea.	68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	50 PCS	1.75
		180 OHM	220 OHM	270 OHM	330 OHM	390 OHM		
ASST. 3	5 ea.	470 OHM	560 OHM	680 OHM	820 OHM	1K	50 PCS	1.75
		1.2K	1.5K	1.8K	2.2K	2.7K		
ASST. 4	5 ea.	3.3K	3.9K	4.7K	5.6K	6.8K	50 PCS	1.75
		8.2K	10K	12K	15K	18K		
ASST. 5	5 ea.	22K	27K	33K	39K	47K	50 PCS	1.75
		56K	68K	82K	100K	120K		
ASST. 6	5 ea.	150K	180K	220K	270K	330K	50 PCS	1.75
		390K	470K	560K	680K	820K		
ASST. 7	5 ea.	1M	1.2M	1.5M	1.8M	2.2M	50 PCS	1.75
		2.7M	3.3M	3.9M	4.7M	5.6M		

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) $9.95 ea.

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ICM7045	CMOS Precision Timer	24.95
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TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
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DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.95
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set
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Photo Transistor Opto-Isolator
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49¢ each

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Generates Complex Sounds
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XR320	1.55			XR2567	2.99
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XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	1.45
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4002	100 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4003	200 PIV	1 AMP	12/1.00
1N752	5.6	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N753	6.2	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N757	9.0	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N759	12.0	400m	4/1.00	1N3600	50	200m	6/1.00
1N959	8.2	400m	4/1.00	1N4148	75	10m	15/1.00
1N965	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	28	1N4733	5.1	1w	28
1N5234	6.2	500m	28	1N4734	5.6	1w	28
1N5235	6.8	500m	28	1N4735	6.2	1w	28
1N5236	7.5	500m	28	1N4736	6.8	1w	28
1N5242	12	500m	28	1N4738	8.2	1w	28
1N5245	15	500m	28	1N4742	12	1w	28
1N456	25	40m	6/1.00	1N4744	15	1w	28
1N458	150	7m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N485A	180	10m	5/1.00	1N1184	100 PIV	35 AMP	1.70
1N4001	50 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
				1N1186	200 PIV	35 AMP	1.80
				1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
		2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

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

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	.39	.31	.25	1.5/35V	.41	.33	.26
.15/35V	.39	.31	.25	2.2/35V	.51	.41	.33
.22/35V	.39	.31	.25	3.3/25V	.53	.43	.34
.33/35V	.39	.31	.25	4.7/25V	.63	.51	.41
.47/35V	.39	.31	.25	6.8/25V	.79	.63	.50
.68/35V	.39	.31	.25	15/25V	1.39	1.12	.89
1.0/35V	.39	.31	.25	22/6V	.79	.63	.50

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	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

ULTRAVIOLET INTENSITY METER

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TWO MODELS: LONG WAVE AND SHORT WAVE

Meter consists of a sensor cell attached to a compact (3" x 3¼" x 3") metering unit. Can be hand-held or placed directly on surface for measuring. Can be used remotely, while connected to a meter housing by a 4-foot extension cord. Two models available — one for long wave and one for short wave ultraviolet. Readings are in microwatts per square centimeter. Weight: 1 lb.

Completely assembled (includes sensor cell, reduction screen, extension cord, contrast filter and certification report.)

J-221 LONG WAVE (300nm-400nm) **$242.00**

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16-PIN CLIP	PC-16	$ 4.75
24-PIN CLIP	PC-24	$10.00
40-PIN CLIP	PC-40	$16.00

Proto Boards

PB-6	$17.95
PB-100	19.95
PB-101	22.95
PB-102	26.95
PB-103	44.95
PB-104	56.95
PB-203	99.95
PB-203A	155.00
PB-203A-Kit	131.00

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 ..... **$29.95**

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 ..... **$14.95**

ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 ..... **$12.95**

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$13.95
Z80A(780-1)	CPU	15.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	5.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49

UART'S

A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS

M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S

2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S

1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	7.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516	16K*	EPROM	24.95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

Function Generator Kit

Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

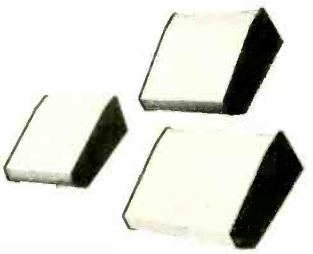
JE2206B **$19.95**

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 ..... **$39.95**

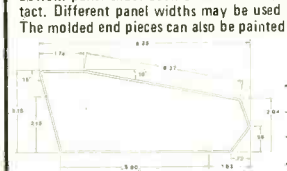
DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top / bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:

The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	$29.95
DTE-11	10.65"	$32.95
DTE-14	14.00"	$34.95

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7-80

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Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark
Receive Sensitivity	-45 dbm acoustically coupled
Transmit Level	-15 dbm nominal. Adjustable from -6 dbm to -20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
* 8 each UPD416-1 (16K Dynamic Rams) 250NS
* Documentation for conversion

TRS-16K **$59.95**

JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and —12V @ 10mA for operation. Features: 60 keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 (Case not included) **$79.95**

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 14½"W x 8¾"D.

DTE-AK $49.95

SPECIAL: JE610/DTE-AK PURCHASED TOGETHER (Value $129.90) $124.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.

JE600 (Case not included) **$59.95**

Desk-Top Enclosure for JE600 Hexadecimal Keyboard Kit

Compact desk-top exclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 8¾"W x 8¾"D.

DTE-HK $44.95

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50-MINI POTS, pc style, single turn, assorted values, (#3345)	2.99
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- Redundant contact points
- YOUR CHOICE — TIN OR GOLD*
  (* Minimum of 50 microinches gold inlay on gold sockets)
- TEXAS INSTRUMENTS QUALITY

TIN INLAY SOLDER TAIL
Series C-85 Min. 200 Microinches Tin

Part No.	Description	1	10	100
C8508	8 pin solder tab, tin	.10	.88	8.00
C8514	14 pin solder tab, tin	.17	1.53	14.00
C8516	16 pin solder tab, tin	.20	1.76	16.00
C8518	18 pin solder tab, tin	.22	1.98	18.00
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Series C-95 Min. 50 Microinches Gold Inlay

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- Standard profile
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  (* Minimum .50 microinch gold inlay on gold sockets)
- TEXAS INSTRUMENTS QUALITY

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Series C-81 Min. 200 Microinches Tin

Part No.	Description	1	10	100
C8108	8 pin wire wrap, tin	.33	2.93	26.00
C8114	14 pin wire wrap, tin	.38	3.70	36.00
C8116	16 pin wire wrap, tin	.42	4.10	40.00
C8118	18 pin wire wrap, tin	.55	4.95	44.00
C8120	20 pin wire wrap, tin	.78	6.98	62.00
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C8124	24 pin wire wrap, tin	.83	7.43	66.00
C8128	28 pin wire wrap, tin	1.05	9.45	84.00
C8140	40 pin wire wrap, tin	1.58	14.18	126.00

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Series C-91 Min. 50 Microinches Gold Inlay

Part No.	Description	1	10	100
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C9116	16 pin wire wrap, gold	.91	8.20	77.15
C9118	18 pin wire wrap, gold	.99	8.95	84.40
C9120	20 pin wire wrap, gold	1.30	11.25	111.00
C9122	22 pin wire wrap, gold	1.33	11.95	113.05
C9124	24 pin wire wrap, gold	1.36	12.25	115.40
C9128	28 pin wire wrap, gold	1.81	16.35	154.10
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- Copper-nickel-tin CA 725 alloy.
- Bifurcated contact points.
- Preloaded, cantilever spring design.
- Contacts are user removable.

* NOTE — Dimensions below are the pin center to center measurement followed by the distance separating the two pin rows.

H4 SERIES .100"x.200" EDGEBOARD CONNECTORS

Positions/Contacts	Part No. Wire Wrap	1	10	100	Part No. Solder Tail	1	10	100
10/20	C6-10	2.22	20.40	167.00	C5-10	2.10	19.30	158.00
15/30	C6-15	2.55	23.40	191.00	C5-15	2.37	21.70	178.00
17/34	C6-17	2.73	25.00	205.00	C5-17	2.52	23.10	189.00
18/36	C6-18	2.88	26.40	216.00	C5-18	2.61	23.90	196.00
20/40	C6-20	3.09	28.30	232.00	C5-20	2.76	25.30	207.00
22/44	C6-22	3.36	30.80	252.00	C5-22	2.97	27.20	223.00
25/50	C6-25	3.75	34.40	281.00	C5-25	3.27	30.00	245.00
28/56	C6-28	3.99	36.60	299.00	C5-28	3.54	32.50	266.00
30/60	C6-30	4.14	38.00	311.00	C5-30	3.75	34.40	281.00
31/62	C6-31	4.32	39.60	324.00	C5-31	3.84	35.20	288.00
35/70	C6-35	4.89	44.80	367.00	C5-35	4.20	38.50	315.00
36/72	C6-36	4.95	45.40	371.00	C5-36	4.32	39.60	324.00
40/80	C6-40	5.49	50.30	412.00	C5-40	4.71	43.20	353.00
43/86	C6-43	5.91	54.20	443.00	C5-43	4.98	45.70	374.00
49/98	C6-49	6.72	61.60	504.00	C5-49	5.58	51.20	419.00
50/100	C6-50	6.81	62.40	511.00	C5-50	5.64	51.70	423.00

for polarizing keys order P/N CR1164-2 .10/ea. 7.50/100

H4 SERIES .125"x.250" EDGEBOARD CONNECTORS

Positions/Contacts	Part No. Wire Wrap	1	10	100	Part No. Solder Tail	1	10	100
10/20	C4-10	2.37	21.70	178.00	C3-10	2.13	19.50	160.00
15/30	C4-15	2.73	25.00	205.00	C3-15	2.46	22.60	185.00
18/36	C4-18	2.97	27.20	223.00	C3-18	2.67	24.50	200.00
20/40	C4-20	3.24	29.70	243.00	C3-20	2.85	26.10	214.00
22/44	C4-22	3.48	31.90	261.00	C3-22	3.00	27.50	225.00
25/50	C4-25	3.90	35.80	293.00	C3-25	3.39	31.10	254.00
28/56	C4-28	4.11	37.70	308.00	C3-28	3.69	33.80	277.00
30/60	C4-30	4.29	39.30	322.00	C3-30	3.81	34.90	286.00
31/62	C4-31	4.44	40.70	333.00	C3-31	4.05	37.10	304.00
35/70	C4-35	5.01	45.90	376.00	C3-35	4.50	41.30	338.00
36/72	C4-36	5.10	46.80	383.00	C3-36	4.56	41.80	342.00
40/80	C4-40	5.64	51.70	423.00	C3-40	5.04	46.20	378.00
44/88	C4-44	6.09	55.80	457.00	C3-44	5.49	50.30	412.00
50/100	C4-50	6.90	63.30	518.00	C3-50	6.18	56.70	464.00

for polarizing keys order P/N CR1164-2 .10/ea. 7.50/100

H4 SERIES .156"x.200" EDGEBOARD CONNECTORS

Positions/Contacts	Part No. Solder Tail	1	10	100	Part No. Solder Eye	1	10	100
10/20	C1-10	2.49	22.80	187.00	C2-10	4.08	37.40	306.00
12/24	C1-12	2.64	24.20	198.00	C2-12	4.32	39.60	324.00
15/30	C1-15	2.94	27.00	221.00	C2-15	4.72	43.20	353.00
18/36	C1-18	3.18	29.20	239.00	C2-18	4.98	45.70	374.00
22/44	C1-22	3.54	32.50	266.00	C2-22	5.49	50.30	412.00
25/50	C1-25	3.84	35.20	288.00	C2-25	5.91	54.20	443.00
28/56	C1-28	4.29	39.30	322.00	C2-28	6.36	58.30	477.00

for polarizing keys order P/N CR1164-1 .10/ea. 7.50/100

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

RS125 Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 meghom (365 total pcs.) **$9.90**

RS225 Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.) **$9.90**

½ WATT RESISTORS ASSORTMENTS

RS150 Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 meghom (365 total pcs.) **$9.90**

RS250 Set of 5 each of the 72 standard 5% ½ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.) **$9.90**

TIME-TEMPERATURE PROGRAMMABLE MODULE

USER PROGRAMMABLE FOR:
- 12 or 24 Hour Display
- °F and/or °C, as well as virtually any number of temperature sensors
- Fixed or flashing colon format
- 50/60 Hz line frequency operation

MA 1026 by National Semiconductor

FEATURES
- Giant 0.7 inch 4 digit LED display with red lens
- PM, colon degree and alarm "ON" LED indicators
- 6 display modes - temperature, time, seconds, alarm, sleep and lamp test
- Exclusive Digi-Key switching panel available to simplify hook-up
- Leading zero blanking
- Time is normal display mode, with temperature display at push of switch, provides for measurement and display of temperatures in range of -40°C to 90°C
- multiple temperature sensors may be used
- power fail condition indicated by flashing
- addition of simple circuit will allow switching of small to medium AC loads
- optional switching panel to simplify hook-up

Catalog No.	Description	COST
MA1026M	MA1026 Clock Module (Assembled and Tested with data sheet)	$ 19.95
MA1026P	Digi-Key Switching Panel Kit for MA1026M (includes P.C. Board, 12 low profile switches, wraposts, standoffs, hardware, components, two LM334 temperature senors, two KOA32 trimpots and instructions)	11.95
MA1026T	Special transformer for MA1026M suitable for most applications	3.95
MA1026B	Alarm buzzer for MA1026M	3.00
MA1026K	Includes MA1026M, P, T, and B	34.95
MA1026C	Conventional Switch Set for applications where MA1026P is not used. Includes one 501PB and ten 502PB switches and special wiring instructions	$ 3.95
MA1026R	Includes MA1026M clock module, MA1026C conventional switch set, MA1026T special transformer, two LM334 temperature sensors, and two KOA32 trimpots	29.95

For each additional sensor unit, the following are suggested:

LM334	Temperature transducer for MA1026M module	$ 1.30
KOA32	300 ohm trimpot for LM334 transducer	.39
502PB	Normally open switch	.45

THE "PROGRAMMABLE" CLOCK MODULES

USER PROGRAMMABLE FOR:
- 12 or 24 hour display
- fixed or flashing colon
- 50/60 Hz line frequency operation

NEW! Two Giant Sizes — 0.7" and 0.84"

FEATURES:
- display brightness can be controlled by introduction of potentiometer
- will adapt for continuous time keeping with introduction of 5M potentiometer and 9V battery
- alarm involves audiing buzzer — no intervening circuitry
- Your Choice — 0.7" or 0.84" red LED display
- low power consumption
- leading zero blanking
- optional switching panel to simplify hook-up

MA1023 — 0.7" HIGH DIGITS

Catalog No.	Description	COST
MA1023M	MA1023 Clock Module Only (Assembled and tested)	19.95
MA1023P	Digi-Key Switching Panel Kit for MA1023 (Includes P.C. Board, Switches, Wraposts Standoffs, Hardware, Components)	6.95
MA1023T	Special transformer For MA1023	2.95
MA1023B	Alarm Buzzer For MA1023	3.00
MA1023K	Includes MA1023M, P, T, & B	19.95
MA1023C	Conventional switch set for applications where MA1023P is not used, includes one 501PB and six 502PB	2.50
MA1023R	Clock Module, Conventional Switches, Transformer	$14.95

MA1020 — 0.84" HIGH DIGITS

Catalog No.	Description	COST
MA1020M	MA1020 Clock Module (Assembled and tested)	$13.95
MA1020P	Digi-Key Switching Panel Kit for MA1020 (includes P.C. Board, Switches, Wraposts Standoffs, Hardware, Components)	7.95
MA1020T	Special Transformer For MA1020M	3.25
MA1020B	Alarm Buzzer For MA1020M	3.00
MA1020K	Includes MA1020M, P, T, and B	26.95
MA1020C	Conventional switch set for applications where MA1020P is not used; includes one 501PB and six 502PB and a 3M ohm resistor, trimmer, battery snaps	$3.50
MA1020R	Includes MA1020M clock module, MA1020C conventional switch set and MA1020T transformer	19.95

DIGI-CLOCK KIT

- 12 VDC — Ideal for Car, Van or Boat!
- Trouble-free Module!
- 270° Swivel Mount
- Inlaid Walnut Chrome Trim Bezel
- Ideal for Car, Van or Boat!
- 3-5/8"x2-3/16" Tall x 1-1/8" Deep
- Quick and Easy to Install!

Part No. 5001K **ONLY $24.95**

CALL OR WRITE FOR YOUR FREE DIGI-KEY CATALOG TODAY

FREE CATALOG Digi-Key Stocks The Entire AP Products Line

STRANDED HOOK UP WIRE
20 ga PVC 2.50/100' 10.00/500'
22 ga PVC 2.80/100' 11.25/500'
24 ga PVC 2.80/100' 11.25/500'

HARDWARE

2-56 1/4 SCREW	1.39/C
2-56 1/2 SCREW	1.39/C
4-40 1/4 SCREW	.99/C
4-40 1/2 SCREW	.99/C
6-32 1/4 SCREW	.89/C
6-32 1/2 SCREW	.99/C
8-32 3/8 SCREW	1.19/C
8-32 5/8 SCREW	1.49/C
2-56 HEX NUT	.75/C
4-40 HEX NUT	.75/C
6-32 HEX NUT	.75/C
8-32 HEX NUT	.75/C
NO. 2 LOCKWASHER	1.55/C
NO. 4 LOCKWASHER	1.40/C
NO. 6 LOCKWASHER	1.40/C
NO. 8 LOCKWASHER	1.40/C

INTEGRATED CIRCUITS

7400 TTL		74LS00 LS TTL		4000 CMOS		LINEAR I.C.S	
7400N	.32	74LS00N	.36	4000	.40	LF347N	2.57
7401N	.32	74LS01N	.36	4001	.31	LF351N	.78
7402N	.32	74LS02N	.36	4002	.35	LF353N	1.40
7403N	.32	74LS03N	.36	4006	1.36	LF356N	1.48
7404N	.35	74LS04N	.39	4007	.49	LF357N	1.48
7405N	.35	74LS05N	.38	4008	1.12	LF13741N	.76
7406N	.41	74LS08N	.36	4009	.56	LM301AN	.58
7407N	.41	74LS09N	.38	4010	.56	LM307N	.68
7408N	.35	74LS10N	.36	4011	.33	LM308N	1.00
7409N	.37	74LS11N	.38	4012	.35	LM311N	.90
7410N	.32	74LS12N	.36	4013	.62	LM317K	5.25
7411N	.35	74LS13N	.59	4014	1.08	LM317MP	2.06
7413N	.48	74LS14N	1.25	4015	1.08	LM317T	3.00
7414N	.85	74LS15N	.38	4016	.55	LM318N	2.58
7416N	.41	74LS20N	.36	4017	1.08	LM320MP-5	1.74
7417N	.41	74LS21N	.38	4018	1.08	LM320MP-6	1.74
7420N	.32	74LS22N	.36	4019	.56	LM320MP-8	1.74
7423N	.40	74LS26N	.37	4020	1.30	LM320MP-9	1.74
7425N	.37	74LS27N	.36	4021	1.14	LM320MP-12	1.74
7426N	.37	74LS30N	.36	4022	1.08	LM320MP-15	1.74
7427N	.37	74LS32N	.41	4023	.35	LM320MP-18	1.74
7430N	.32	74LS37N	.37	4024	.94	LM320MP-24	1.74
7432N	.37	74LS38N	.37	4025	.38	LM323K	8.95
7437N	.41	74LS40N	.38	4027	.74	LM324N	.92
7438N	.41	74LS42N	.85	4028	.99	LM325N	3.44
7440N	.32	74LS47N	1.08	4029	1.19	LM326N	3.44
7442N	.73	74LS48N	1.08	4030	.46	LM327N	3.44
7445N	.93	74LS49N	1.18	4034	2.75	LM334Z	1.52
7446N	1.06	74LS51N	.36	4035	1.42	LM336Z	2.27
7447N	1.06	74LS54N	.36	4040	1.24	LM337K	6.98
7448N	1.06	74LS55N	.36	4041	1.07	LM337T	2.47
7450N	.32	74LS73N	.49	4042	1.08	LM339N	1.15
7451N	.32	74LS74N	.46	4043	1.08	LM340KC-5	2.10
7453N	.32	74LS75N	.59	4044	1.08	LM340T-5	1.32
7454N	.32	74LS76N	.54	4046	1.79	LM340T-6	1.32
7460N	.35	74LS78N	.49	4047	1.45	LM340T-8	1.32
7470N	.49	74LS83N	1.08	4048	.80	LM340T-10	1.32
7472N	.49	74LS85N	1.28	4049	.58	LM340T-12	1.32
7473N	.46	74LS86N	.50	4050	.58	LM340T-15	1.32
7474N	.46	74LS90N	.73	4051	1.19	LM340T-18	1.32
7475N	.62	74LS93N	.73	4052	1.19	LM340T-24	1.32
7476N	.46	74LS107N	.46	4053	1.19	LM341P-5	1.04
7483N	.85	74LS109N	.46	4060	1.58	LM341P-6	1.04
7485N	.95	74LS112N	.52	4066	.79	LM341P-8	1.04
7486N	.46	74LS113N	[illegible]			LM341P-10	1.04
7489N	1.75	74LS114N	[illegible]			LM341P-12	1.04
7490N	.53	74LS122N	.75	4071	.35	LM341P-15	1.04
7491N	.89	74LS123N	1.03	4073	.35	LM341P-18	1.04
7492N	.60	74LS125N	.64	4075	.35	LM341P-24	1.04
7493N	.57	74LS126N	.64			LM348N	1.62
7495N	.71	74LS132N	.93	4081	.37	LM349N	1.82
7496N	.79	74LS136N	.49	4089	2.75	LM350K	7.85
74107N	.46	74LS138N	.84	4093	.76	LM358N	1.10
74109N	.46	74LS139N	.84	4099	2.10	LM377N	2.40
74121N	.55	74LS151N	.77	4503	.90	LM378N	3.15
74123N	.71	74LS153N	.84	4510	1.17	LM379S	5.60
74125N	.64	74LS154N	1.44	4511	1.28	LM380N-8	1.30
74126N	.64	74LS155N	.91	4512	1.39	LM381N	2.25
74132N	.82	74LS156N	.91	4514	2.80	LM382N	1.75
74141N	1.19	74LS157N	.77	4515	2.80	LM383AT	3.64
74145N	.93	74LS158N	.86	4516	1.23	LM386N-1	1.10
74147N	1.73	74LS160N	1.07	4518	1.17	LM387N	1.45
74148N	1.33	74LS161N	1.07	4519	.63	LM1310N	1.90
74150N	1.12	74LS162N	1.07	4520	1.17	LM1458N	.80
74151N	.73	74LS163N	1.07	4522	1.75	LM1496N	.94
74153N	.73	74LS164N	1.18	4526	1.75	LM1800N	1.75
74154N	1.21	74LS168N	1.51	4527	1.68	LM1801N	2.75
74155N	.79	74LS169N	1.51	4528	1.61	LM1812N	6.21
74156N	.79	74LS170N	1.84	4723	1.53	LM1830N	1.75
74157N	.73	74LS173N	1.34	4724	1.53	LM1889N	2.58
74160N	.93	74LS174N	1.22	40106	.90	LM2111N	1.57
74161N	1.02	74LS175N	.90	40160	1.19	LM2907N	2.57
74162N	.93	74LS190N	1.30	40161	1.19	LM2917N	2.5[illegible]
74163N	.93	74LS191N	1.30	40162	1.19	LM3046N	.8[illegible]
74164N	.98	74LS192N	1.17	40163	1.19	LM3086N	.69
74165N	1.1[illegible]	74LS193N	1.17	40174	1.16	LM3089N	2.00
74166N	1.26	74LS196N	1.34	40175	1.16	LM3302N	.92
74170N	1.87	74LS197N	1.34	40192	1.30	LM3900N	1.0[illegible]
74173N	1.35	74LS221N	1.37	40193	1.30	LM3905N	1.83
74174N	.90	74LS247N	1.19	40195	1.19	LM3909N	.83
74175N	.84	74LS248N	1.19	**74C00 MOS**		LM3911N	1.95
74176N	.96	74LS249N	1.19	74C00N	.35	LM3914N	3.75
74177N	.96	74LS253N	1.02	74C02N	.35	NE555CN	.70
74180N	1.00	74LS257N	.89	74C04N	.35	NE556CN	1.07
74181N	2.00	74LS258N	.97	74C08N	.35	NE560N	3.24
74182N	1.10	74LS266N	.50	74C10N	.35	NE565CN	1.33
74184N	2.36	74LS279N	.75	74C14N	.90	NE566CN	1.58
74185N	2.36	74LS283N	1.03	74C20N	.35	NE567CN	1.33
74S189N	2.49	74LS290N	1.12	74C30N	.35	UA709CN	.82
74190N	1.01	74LS293N	1.12	74C32N	.35	UA723CN	.69
74191N	1.01	74LS352N	1.30	74C42N	1.03	UA733CN	.94
74192N	1.03	74LS353N	1.44	74C48N	1.28	UA741CN	.53
74193N	.95	74LS365N	.70	74C73N	.72	UA747CN	.82
74194N	.93	74LS366N	.70	74C74N	.48	UA748CN	.70
74195N	.88	74LS367N	.70	74C76N	.72	UA7805CK	2.10
74196N	.91	74LS368N	.70	74C83N	1.51	UA7805CT	1.32
74197N	.91	74LS386N	.55	74C85N	1.51	UA7806CT	1.32
74198N	1.49	74LS670N	2.59	74C86N	.46	UA7808CT	1.32
74199N	1.49	81LS95N	1.76	74C90N	1.14	UA7810CT	1.32
74251N	1.12	81LS96N	1.76	74C93N	1.14	UA7812CT	1.32
74284N	3.50	81LS97N	1.76	74C95N	1.39	U7815CT	1.32
74285N	3.50	81LS98N	1.76	74C107N	.70	UA7818CT	1.32
74365N	.80			74C150N	3.66	UA7824CT	1.32
74366N	.80			74C151N	2.41	UA78L05ACZ	.45
74367N	.80			74C154N	3.66	UA78L06ACZ	.45
74368N	.80			74C157N	2.41	UA78L08ACZ	.45
A/D & D/A CONVERTERS & MISC.				74C160N	1.19	UA78L10ACZ	.45
				74C161N	1.19	UA78L12ACZ	.45
ADC0800PCN			13.21	74C162N	1.19	UA78L15ACZ	.45
ACD0816CCN			29.95	74C163N	1.19	UA78L24ACZ	.45
ADC3511CCN			12.02	74C164N	1.16	UA7905CT	1.70
ADC3711CCN			13.52	74C165N	1.19	UA7906CT	1.70
ADD3501CCN			11.98	74C173N	1.30	UA7909CT	1.70
ADD3701CCN			13.52	74C174N	1.16	UA7912CT	1.70
DAC0800LCN			3.87	74C175N	1.16	UA7915CT	1.70
DAC0808LCN			3.37	74C192N	1.38	UA7924CT	1.70
MM5314N			3.98	74C193N	1.38	**INTERFACE I.C.S**	
MM5369N			2.80	74C195N	1.19	8093N	.64
MM5837N			2.30	74C221N	1.90	8094N	.64
MEMORY				74C901N	.48	8095N	.80
1702A			10.49	74C902N	.48	8096N	.80
2114N			8.33	74C908N	1.22	8097N	.80
21L02-1			2.24	74C909N	2.26	8098N	.80
2708			16.74	74C914N	1.50	75450N	.92
74S188N			2.10	74C922N	5.70	75451N	.65
74S189N			2.49	74C923N	5.90	75452N	.65
74S287N			2.75	74C925N	7.80	75453N	.65
74S288N			2.12	74C926N	7.80	75454N	.65
74S387N			2.75	74C927N	7.80	75491N	.84
74S570N			5.74	74C928N	7.80	75492N	.84
74S571N			5.74	80C95N	.69	75493N	1.07
9334N			1.90	80C96N	.69	75494N	1.07
93410PC			3.24	80C97N	.69	MC1488N	1.39
MM5257N			8.99	80C98N	.69	MC1489N	1.39
MM5280N-055			4.84				

MICROPROCESSORS

8228N	6.23	8080N	18.58
8238N	6.11	8080AN	9.97
8251N	8.73	8212N	3.25
8304N	6.75	8216N	3.25
ISP-8F/352	32.75	8224N	3.25

DIGI-KEY CORPORATION — BOOKSELLER
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SILICON TRANSISTORS

	1	10	100	1000
2N3055	1.80	16.50	150.00	1200.00
2N3904	.20	1.79	16.25	146.25
2N3906	.20	1.79	16.25	146.25
2N4124	.21	1.93	17.50	157.50
2N4126	.22	2.01	18.25	164.25
2N4401	.21	1.93	17.50	157.50
2N4403	.21	1.93	17.50	157.50
2N4410	.30	2.70	24.38	219.38
2N5087	.24	2.20	20.00	180.00
2N5089	.24	2.20	20.00	180.00
2N5210	.27	2.48	22.50	202.50
2N5457	.54	4.86	43.88	394.88
92PU01A	.38	3.42	30.88	277.88
92PU10	.38	3.42	30.88	277.88
92PU45A	.41	3.69	33.32	299.82
92PU51A	.38	3.42	30.88	277.88
MJ2955	1.47	13.48	122.50	1102.25
MJE172	.74	6.66	60.13	541.13
MJE182	.72	6.48	58.50	526.50
MJE3439	.56	4.80	40.00	360.00
MJE344	.68	6.12	55.25	497.25
MJE370	.89	8.01	72.32	650.82
MJE371	1.10	9.90	89.38	804.38
MJE520	.86	7.74	69.88	628.88
MJE521	.86	7.74	69.88	628.88
MJE703	1.13	10.17	91.82	826.31
MJE712	.74	6.66	60.13	541.13
MJE722	.74	6.66	60.13	541.13
MJE803	1.01	9.09	82.07	738.57
MPF102	.54	4.95	45.00	405.00
MPS2222A	.21	1.93	17.50	157.50
MPS2369A	.24	2.20	20.00	180.00
MPS2907A	.24	2.20	20.00	180.00
MPS3392	.23	2.07	18.75	169.00
MPS3393	.21	1.93	17.50	157.50
MPS3394	.24	2.20	20.00	180.00
MPS3395	.24	2.20	20.00	180.00
MPS3563	.21	1.93	17.50	157.50
MPS3565	.21	1.93	17.50	157.50
MPS3638A	.21	1.93	17.50	157.50
MPS3641	.21	1.93	17.50	157.50
MPS3643	.21	1.93	17.50	157.50
MPS918	.22	1.98	17.88	160.88
MPS930	.21	1.93	17.50	157.50
MPSA13	.27	2.48	22.50	202.50
TIP112	.98	8.40	70.00	630.00
TIP117	1.12	10.08	91.00	819.00
TIP120	1.17	10.73	97.50	877.50
TIP122	1.54	13.20	110.00	990.00
TIP127	1.54	13.20	110.00	990.00
TIP132	2.32	20.88	188.50	1696.50
TIP135	2.32	20.88	188.50	1696.50
TIP29C	.81	6.90	57.50	517.50
TIP30C	.81	6.90	57.50	517.50
TIP31C	.98	8.40	70.00	630.00
TIP32C	1.02	8.70	72.50	652.50
TIP61C	.81	6.90	57.50	517.50
TIP62C	.81	6.90	57.50	517.50

WIRE-WRAPPING WIRE PRE CUT — PRE STRIPPED

Wire for Wire Wrapping, AWG-30 (0.25 MM) KYNAR® Wire, 100 Wires per package Stripped 1" Both Ends

B3	30-AWG Blue Wire, 3" Overall Length	$2.25
Y3	30-AWG Yellow Wire, 3" Overall Length	2.25
W3	30-AWG White Wire, 3" Overall Length	2.25
R3	30-AWG Red Wire, 3" Overall Length	2.25
B4	30-AWG Blue Wire, 4" Overall Length	2.40
Y4	30-AWG Yellow Wire, 4" Overall Length	2.40
W4	30-AWG White Wire, 4" Overall Length	2.40
R4	30-AWG Red Wire, 4" Overall Length	2.40
B5	30-AWG Blue Wire, 5" Overall Length	2.65
Y5	30-AWG Yellow Wire, 5" Overall Length	2.65
W5	30-AWG White Wire, 5" Overall Length	2.65
R5	30-AWG Red Wire, 5" Overall Length	2.65
B6	30-AWG Blue Wire, 6" Overall Length	2.90
Y6	30-AWG Yellow Wire, 6" Overall Length	2.90
W6	30-AWG White Wire, 6" Overall Length	2.90
R6	30-AWG Red Wire, 6" Overall Length	2.90
B7	30-AWG Blue Wire, 7" Overall Length	3.50
Y7	30-AWG Yellow Wire, 7" Overall Length	3.50
W7	30-AWG White Wire, 7" Overall Length	3.50
R7	30-AWG Red Wire, 7" Overall Length	3.50
B8	30-AWG Blue Wire, 8" Overall Length	3.75
Y8	30-AWG Yellow Wire, 8" Overall Length	3.75
W8	30-AWG White Wire, 8" Overall Length	3.75
R8	30-AWG Red Wire, 8" Overall Length	3.75

Digi-Key Means Quality Products, Toll Free Watts, Postage Paid Envelopes!
MASTERCHARGE • VISA • CHECKS • MONEY ORDERS

Panasonic Trimmer Potentiometers

With Thumbwheel Adjustment

Tolerance: ±20% Working Voltage: 350V Max Power Rating: 0.25W/50°C

Part No. Lay Down	Part No. Stand Up	Resistance (Ohms)	Prices 1	Pak of 10	Pak of 100	Pak of 1000
Q1A22	Q0A22	200	.40	3.20	26.00	200.00
Q1A52	Q0A52	500	.40	3.20	26.00	200.00
Q1A13	Q0A13	1K	.40	3.20	26.00	200.00
Q1A23	Q0A23	2K	.40	3.20	26.00	200.00
Q1A53	Q0A53	5K	.40	3.20	26.00	200.00
Q1A14	Q0A14	10K	.40	3.20	26.00	200.00
Q1A24	Q0A24	20K	.40	3.20	26.00	200.00
Q1A54	Q0A54	50K	.40	3.20	26.00	200.00
Q1A15	Q0A15	100K	.40	3.20	26.00	200.00
Q1A25	Q0A25	200K	.40	3.20	26.00	200.00
Q1A55	Q0A55	500K	.40	3.20	26.00	200.00
Q1A16	Q0A16	1M	.40	3.20	26.00	200.00
Q1A26	Q0A26	2M	[illegible]	[illegible]	[illegible]	[illegible]

PANASONIC TRIMMER POTENTIOMETERS

5/16" (8 mm) DIA. PRESET VARIABLE RESISTORS

Part No. Lay Down	Part No. Stand Up	Resist.	Prices 1	Pak of 10	Pak of 100	Pak of 1000
K4A32	K0A32	300	.32	2.40	21.00	160.00
K4A52	K0A52	500	.32	2.40	21.00	160.00
K4A13	K0A13	1K	.32	2.40	21.00	160.00
K4A23	K0A23	2K	.32	2.40	21.00	160.00
K4A53	K0A53	5K	.32	2.40	21.00	160.00
K4A14	K0A14	10K	.32	2.40	21.00	160.00
K4A24	K0A24	20K	.32	2.40	21.00	160.00
K4A54	K0A54	50K	.32	2.40	21.00	160.00
K4A15	K0A15	100K	.32	2.40	21.00	160.00
K4A25	K0A25	200K	.32	2.40	21.00	160.00
K4A55	K0A55	500K	.32	2.40	21.00	160.00
K4A16	K0A16	1M	.32	2.40	21.00	160.00
K4A26	K0A26	2M	.32	2.40	21.00	160.00

PLESSEY MINIBOX METALLIZED POLYESTER CAPACITORS

3002P	.001/1000V	.26	2.19	3016P	.033/250V	.28	2.28
3004P	.0022/1000V	.26	2.19	3019P	.047/250V	.28	2.28
3006P	[illegible]/1000V	.21	1.80	3021P	.068/250V	.28	2.40
3008P	.0047/630V	.18	1.50	3023P	.1/100V	.30	2.52
3010P	.0068/630V	.21	1.80	3027P	.22/100V	.40	3.39
3012P	.01/630V	.28	2.40	3029P	.33/100V	.49	4.20
3014P	.022/400V	[illegible]	[illegible]	[illegible]	.47/100V	.63	[illegible]

½ WATT ZENER DIODES

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5240B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

SILICON DIODES

1N4001	.80	7.00
1N4002	.80	7.00
1N4003	.80	7.50
1N4004	.80	7.90
1N4005	1.00	9.00
1N4006	1.00	9.00
1N4007	1.00	9.00
1N4148	.60	5.00

SLIDE SWITCHES

SPDT	.22	2.00/10	18.00/C
DPDT	.23	2.00/10	19.00/C

PANASONIC ELECTROLYTIC CAPACITORS

VALUE	Radial Leads 1	10	100	Axial Leads 1	10	100
.47/50V	.13	1.08	8.94	.18	1.54	12.83
1/50V	.13	1.08	8.94	.18	1.54	12.83
2.2/50V	.13	1.08	8.94	.18	1.54	12.83
3.3/50V	.14	1.15	9.52	.18	1.54	12.83
4.7/35V	.14	1.18	9.78	.18	1.54	12.83
4.7/50V	.14	1.18	9.78	.21	1.78	14.76
10/16V	.13	1.08	8.94	.18	1.54	12.83
10/25V	.14	1.15	9.52	.18	1.54	12.83
10/35V	.14	1.19	9.90	.21	1.78	14.78
10/50V	.16	1.35	11.20	.24	2.00	16.65
22/16V	.14	1.15	9.52	.21	1.74	14.48
22/25V	.15	1.22	10.17	.22	1.83	15.21
22/35V	.19	1.60	13.30	.24	2.00	16.65
22/50V	.22	1.83	15.19	.28	2.35	19.53
33/16V	.14	1.19	9.90	.21	1.78	14.76
33/25V	.17	1.38	11.50	.24	2.00	16.65
33/35V	.21	1.76	14.80	.28	2.35	19.53
33/50V	.23	1.90	15.77	.32	2.70	22.43
47/10V	.14	1.19	9.90	.21	1.78	14.78
47/16V	.16	1.36	11.32	.24	2.00	16.65
47/25V	.21	1.73	14.42	.28	2.35	19.53
47/35V	.23	1.90	15.77	.33	2.78	23.15
47/50V	.24	2.05	17.03	.36	3.04	25.33
100/10V	.17	1.39	11.58	.24	2.00	16.65
100/16V	.21	1.78	14.80	.28	2.35	19.53
100/25V	.23	1.90	15.77	.33	2.78	23.15
100/35V	.24	2.06	17.10	.43	3.65	30.40
100/50V	.36	3.07	25.62	.45	3.79	31.54
220/10V	.23	1.92	15.95	.29	2.46	20.48
220/16V	.23	1.92	15.95	.33	2.78	23.15
220/25V	.23	1.92	15.95	.44	3.75	31.24
220/35V	.40	3.42	28.45	.51	4.34	36.16
220/50V	.52	4.45	37.08	.61	5.18	43.15
330/6V	.23	1.92	15.95	.29	2.46	20.48
330/10V	.24	2.06	17.10	.33	2.78	23.15
330/16V	.35	2.97	24.69	.44	3.72	30.96
330/25V	.40	3.42	28.45	.50	4.26	35.46
330/35V	.52	4.45	37.08	.57	4.85	40.40
330/50V	.83	7.06	58.78	.92	7.87	65.55
470/6V	.23	1.97	16.34	.33	2.78	23.15
470/10V	.35	2.93	24.69	.44	3.72	30.96
470/16V	.38	3.19	26.58	.50	4.22	35.14
470/25V	.50	4.21	35.08	.58	4.95	41.24
470/35V	.64	5.42	45.13	.65	5.51	45.89
470/50V	.92	7.84	65.33	.92	7.87	65.55
1000/6V	.36	3.08	25.62	.49	4.20	35.00
1000/10V	.40	3.42	28.45	.54	4.64	38.61
1000/16V	.50	4.21	35.08	.59	5.10	42.45
1000/25V	.83	7.06	58.78	.84	7.19	59.84
1000/35V	.92	7.84	65.32	.98	8.38	69.80
2200/6V	.54	4.55	37.95	.60	5.13	42.75
2200/10V	.70	5.93	49.42	.77	6.64	55.28
2200/16V	.87	7.46	62.10	.92	7.85	65.39
2200/25V	1.17	10.01	83.47	1.16	9.92	82.62
3300/6V	.75	6.38	53.10	.81	6.94	57.83
3300/10V	.90	7.71	64.22	.99	8.45	70.38
3300/16V	1.17	10.01	83.47	1.16	9.92	82.62
3300/25V	1.66	14.17	118.03	1.61	13.78	114.76
4700/6V	.92	7.95	66.20	1.04	8.89	74.07
4700/10V	1.13	9.68	80.62	1.28	10.95	91.18
4700/16V	1.57	13.43	111.87	1.56	13.41	111.68
6800/6V	1.13	9.68	80.62	1.27	10.87	90.58
6800/10V	1.54	13.13	109.40	1.55	13.27	110.51
6800/16V	—	—	—	1.98	17.00	141.63
10,000/6V	1.54	13.13	109.40	1.54	13.18	109.76
10,000/10V	—	—	—	1.98	17.00	141.63

PANASONIC POLYESTER CAPACITORS

100 VDC plus minus 10% TOLERANCE

PART NO.	CAP (UFD)	PRICES 1	PAK OF 10	PAK OF 100	PAK OF 1000
M1102	.001	.14	1.17	8.34	75.04
M1122	.0012	.14	1.17	8.34	75.04
M1152	.0015	.14	1.17	8.34	75.04
M1182	.0018	.14	1.17	8.34	75.04
M1222	.0022	.14	1.17	8.34	75.04
M1272	.0027	.14	1.17	8.34	75.04
M1332	.0033	.14	1.17	8.34	75.04
M1392	.0039	.14	1.17	8.34	75.04
M1472	.0047	.14	1.17	8.34	75.04
M1562	.0056	.14	1.17	8.34	75.04
M1682	.0068	.14	1.17	8.34	75.04
M1822	.0082	.14	1.17	8.34	75.04
M1103	.01	.14	1.17	8.34	75.04
M1123	.012	.14	1.22	8.65	77.85
M1153	.015	.14	1.22	8.65	77.85
M1183	.018	.15	1.24	8.80	79.20
M1223	.022	.15	1.26	8.94	80.44
M1273	.027	.15	1.26	8.94	80.44
M1333	.033	.15	1.28	9.10	81.80
M1393	.039	.16	1.32	9.40	84.60
M1473	.047	.16	1.35	9.60	86.18
M1563	.056	.17	1.46	10.38	93.38
M1683	.068	.18	1.51	10.74	96.64
M1823	.082	.18	1.55	11.07	99.57
M1104	.1	.19	1.58	12.28	101.48
M1124	.12	.21	1.80	12.85	115.65
M1154	.15	.23	2.01	14.30	128.70
M1184	.18	.26	2.26	16.09	144.79
M1224	.22	.28	2.38	16.98	152.78
M1274	.27	.32	2.72	19.40	174.60
M1334	.33	.34	2.96	21.12	190.02
M1394	.39	.39	3.35	23.88	214.88
M1474	.47	.41	3.58	25.57	[illegible]

PANASONIC METALLIZED POLYESTER CAPACITORS

250 VDC plus minus 10% TOLERANCE

PART NO.	CAP (UFD)	1	10	100	1000
E2103	.01	.19	1.64	13.68	123.08
E2123	.012	.19	1.64	13.68	123.08
E2153	.015	.19	1.64	13.68	123.08
E2183	.018	.19	1.64	13.68	123.08
E2223	.022	.19	1.64	13.68	123.08
E2273	.027	.19	1.64	13.68	123.08
E2333	.033	.19	1.64	13.68	123.08
E2393	.039	.19	1.64	13.68	123.08
E2473	.047	.19	1.64	13.68	123.08
E2563	.056	.22	1.85	15.43	138.83
E2683	.068	.22	1.85	15.43	138.83
E2823	.082	.22	1.85	15.43	138.83
E2104	.10	.23	1.94	16.13	145.13
E2124	.12	.25	2.12	17.63	158.63
E2154	.15	.27	2.28	18.95	170.55
E2184	.18	.29	2.49	20.73	186.53
E2224	.22	.32	2.68	22.28	200.48
E2274	.27	.34	2.91	24.25	218.25
E2334	.33	.37	3.18	26.47	238.17
E2394	.39	.41	3.44	28.65	257.85
E2474	.47	.43	3.68	30.65	275.85
E2564	.56	.47	4.02	33.45	301.05
E2684	.68	.52	4.43	36.93	332.33
E2824	.82	.58	4.94	41.13	370.15
E2105	1.0	.63	5.35	44.52	400.62
E2125	1.2	.68	5.82	48.50	436.50
E2155	1.5	.86	7.32	60.97	548.67
E2185	1.8	1.01	8.64	72.00	648.00
E2225	2.2	[illegible]	[illegible]	[illegible]	[illegible]

PANASONIC RESIN DIPPED TANTALUM CAPACITORS

Part No.	Voltage Cap (uF)	Prices (V. DC)	1	Pak of 10	Pak of 100	1000
F35ER1	0.1	35	.38	3.21	26.70	240.30
F35ER15	0.15	35	.38	3.21	26.70	240.30
F35ER22	0.22	35	.38	3.21	26.70	240.30
F35ER33	0.33	35	.38	3.21	26.70	240.30
F35ER47	0.47	35	.38	3.21	26.70	240.30
F35ER68	0.68	35	.38	3.21	26.70	240.30
F25E1	1.0	25	.43	3.64	30.33	272.93
F16E1R5	1.5	16	.38	3.21	26.70	240.30
F16E2R2	2.2	16	.42	3.56	29.63	266.63
F16E3R3	3.3	16	.47	4.02	33.43	300.83
F16E4R7	4.7	16	.55	4.65	38.70	348.30
F16E6R8	6.8	16	.65	5.54	46.14	415.24
F16E10	10.	16	.81	6.91	57.53	517.73
F16E15	15.	16	1.06	9.06	75.50	679.50
F16E22	22.	16	1.41	12.05	100.36	903.26

PANASONIC DISC CAPACITORS

(Tolerance: A — plus/minus 5%, B — plus/minus 10%, C-plus 80%/minus 20%)

Part Number	Capacitance	Tolerance	Voltage	10	100	1000
DH100	10PF	A	500V	.74	5.46	45.50
DH150	15PF	B	500V	.52	3.60	30.00
DH220	22PF	B	500V	.52	3.60	30.00
DH330	33PF	B	500V	.52	3.60	30.00
DH470	47PF	B	500V	.61	4.30	35.75
DH680	68PF	B	500V	.61	4.30	35.75
DH101	100PF	B	500V	.64	4.56	38.00
DH151	150PF	B	500V	.74	5.46	45.50
DH221	220PF	B	500V	.74	5.46	45.50
DH331	330PF	B	500V	.74	5.46	45.50
DH471	470PF	B	500V	.74	5.46	45.50
DH681	680PF	B	500V	.74	5.46	45.50
DH102	.001UFD	C	50V	.60	4.20	35.00
DH152	.0015UFD	C	50V	.60	4.20	35.00
DH222	.0022UFD	C	50V	.60	4.20	35.00
DH332	.0033UFD	C	50V	.60	4.20	35.00
DH472	.0047UFD	C	50V	.60	4.20	35.00
DH682	.0068UFD	C	50V	.61	4.29	35.75
DE103	.01UFD	C	25V	.84	6.30	50.00
DE223	.022UFD	C	25V	.84	6.30	52.50
DE333	.033UFD	C	25V	1.14	7.98	66.50
DE473	.047UFD	C	25V	1.09	8.40	70.00
DE104	.1UFD	C	25V	1.40	11.10	92.50

DOUBLE DIGIT DISCOUNTS SAVE YOU EVEN MORE!

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Operation Assist

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

Heathkit model AJ-30 AM/FM mpx tuner. Need schematic and tuning meters. **Heathkit** model AA-100 stereo amplifier. Need 54-89 power transformer and 4-7591 output tubes. John Bissell, Rt. 3, Box 400, Poplar Bluff, MO 63901.

Concord Electronics Corp., F-107 cassette deck. Need service manual or address of company. Ted McLeod, Novelectronics, 200 Wharncliffe Rd. S., London, Ont., Can. N6J 2L1.

B&K model 960 transistor radio analyst. Need operation manual and any available information. Joe Cote, 704 So. Filbert St., Stockton, CA 95205.

Elco model 221 VOM. Need schematic. Mark Greenwald, 2125 Garnet Ct., Merritt Island, FL 32952.

Kuba model RM D56 WI console. Need schematic and parts. Jose Varas, 515 4th St., Apt. 2A, Union City, NJ 07087.

Knight model 83Y102 5-band Star Roamer. Need schematic, assembly and alignment data. Herbert Naugle, 1792 Finch Ct., Hayward, CA 94545.

U.S. Gov't Surplus OS-121/USM-140 oscilloscope. Need schematic and operating manual. M.B. Walton, 1401 S.W. Cloverdale St., Seattle, WA 98106.

Hallicrafters model SX 110. Need antenna coil (band 1 and 2). Rosario Nasca, Via E. Poggi 6, Firenze, Italy.

U.S. Air Force AN/APR-4 and R-444/APR-4Y radio receivers. Need manuals. G. Sargent, 60 Sherman St., Portland, ME 04101.

Hexem model 110A E-I-R meter, **Douglas** P/NFT5898730 pulse generator and **U.S. Government Surplus** PP-22A/MPN-1 regulated power supply. Need schematics. William Flanigan, Rt. 3, Streator, IL 61364.

Heathkit model IM 32 VTVM. Schematic and service manual needed. Lawrence Young, 54 Samuel Ave., Pawtucket, RI 02860.

Hewlett-Packard 741 scope. Need H.V. transformer. Dick Ely, 8 Mechanic St., Wakefield, RI 02879.

Stewart-Warner model R-1301-A receiver. Need schematic. Scot Kretchmar, Box 712, Monticello, IN 47960.

Pioneer model SA-500 (serial No. QE26141) stereo amplifier. Need any available information on pc board #WI5-055A. Charles R. Dowdell, 125 Blueridge Rd., Penfield, NY 14526.

ITT "Formatic" magnetic drum telephone dialer. Manual and schematic needed. Jim Wilkins, 10212 Capitol View Ave., Silver Spring, MD 20910.

Hammarlund model HQ-110-C. Need schematic and/or service information. Tom Roddy, 2121 University, Bakersfield, CA 93305.

Superior Instruments model TV 50 signal generator. Need manual and schematic. Jack Ozminkowski, North 58 West 18330 Juniper Lane, Menomonee Falls, WI 53051.

Webster Chicago model 180-1 wire recorder. Need schematic, operating manual and all available information. Darrel J. Silda, RR 3, Box 3576-50, Juneau, AK 99801.

Advent model 200 cassette deck. Need schematic. Daniel Hegg, Jupiterstrasse 21, 3015 Bern, Switzerland.

RCA model B-52 ac type radio. Operating instructions, schematic and parts list needed. Bruce Davis, RR 1, Gregory, SD 57533.

Regitone chassis No. ARG-99AF (table model) record player, AM and SW receiver. Need schematic. Clyde A. Layton, R1, Box 15-A, Salina, OK 74365.

TI-Data, Inc., model 3600/2 tape editor/word processor. Need service manual and schematic. S. Meadow, 26 Concord Rd., Danbury, CT 06810.

Popular Electronics

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Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested. **Questdata**, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00**, on ROM **$38.00**, original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

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This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50.** A **50 pin connector** set with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

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20	29	40	57

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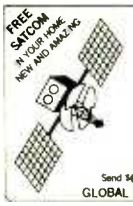

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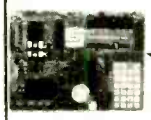

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Personal Electronics News

VIDEO DISCS EXPAND. For example, RCA bought licenses for six recent feature films from Paramount Pictures for its capacitive-pickup "SelectaVision" system: "Star Trek—The Motion Picture," "Escape From Alcatraz," "Starting Over," "American Gigolo," "Nijinsky," and "North Dallas Forty." And Sony has established a video-disc manufacturing plant in Japan for mastering and replicating discs for the optical-disc system developed by Philips.

A FLAT-PANEL COLOR-TV DISPLAY CONCEPT (50 inches diagonal) has been disclosed by RCA in two papers presented at a recent Society of Information Display (SID-80) Conference. The 4" thick display consists of 40 1" X 30" panels fastened together to make a color-TV display that measures 40" wide by 30" high. RCA-developed beam guides in each module control the three electron beams that excite the red, green, and blue phosphors on the modules' faceplates to provide a color picture. According to RCA, the new concept provides brighter and higher quality pictures and occupies much less space than projection-TV equipment for a similar-size picture. The bad news is that it may take a decade before the display can be mass produced at a reasonable price for home use.

COMPUTER SPEECH RECOGNITION PROGRESS is reported by the IBM Research Center. Scientists there have drawn spoken sentences from a 1000-word vocabulary, read at a normal speaking pace, and been able to transcribe them into printed form with 91-percent accuracy. The current work at IBM is said to be on a level higher than that which uses a built-in-microprocessor to respond to a very small vocabulary enunciated in a very careful way. At IBM, they're working on recognition of continuous speech, without the aid of artificial pauses between words or a limited vocabulary. Part of the experimentation involves the use of speech spectrograms such as that shown here, which represents the sentence "John saw one example of speech from several thousand runs."

AN ELECTRONIC VOICE CALLS OUT TIME at 1-, 15-, 30-, and 60-minute intervals in Panasonic's new clock radio, Model RC-6800. The "voice" call can be operated manually for current or alarm time check, while the voice alarm announces the time every minute until turned off. A "Sure-Time" battery system stores current and alarm times, in the event of ac power failure.

3-D TV PROGRAMMING could begin in the U.S. within a year if viewers are willing to buy needed equipment for proper reception and the industry adopts one of the several possible systems. Having thrived abroad (3-D cartoons have been on TV in Japan for three years, with viewers wearing special polarized glasses), three-dimensional TV has recently generated interest here. In fact, a group of experts is trying to decide which system to adopt. If one is endorsed by the group, it will be proposed to the International Telecommunications Union, which is considering adopting a global standard for 3-D TV. When and if it does arrive, 3-D TV programming will most likely come to us over cable-TV service at first.

A STATIONARY-HEAD DIGITAL AUDIO RECORDING FORMAT has been agreed upon by Sony Corp. of Japan and Willi Studer of Switzerland. At a joint press conference held at the Audio Engineering Society Convention in May, the hope was expressed that their common format will be widely accepted in the industry as an international specification in stationary-head digital audio recording.

PERSONAL COMPUTING'S FIRST $1-MILLION PROGRAM SELLER is Personal Software's "Microchess" program on cassette. By the time this appears in print, according to company president Daniel H. Fylstra, the company's "Visicalc" cassette program may have "gone gold."

XEROX PLANS DIGITAL COMMUNICATIONS SERVICE. If its request to the FCC is approved, satellites will be integrated with custom radio links to transmit and receive digital information, including high-quality graphics. Called XTEN (Xerox Telecommunications Network), the information service could be initiated in selected U.S. cities late in 1981.

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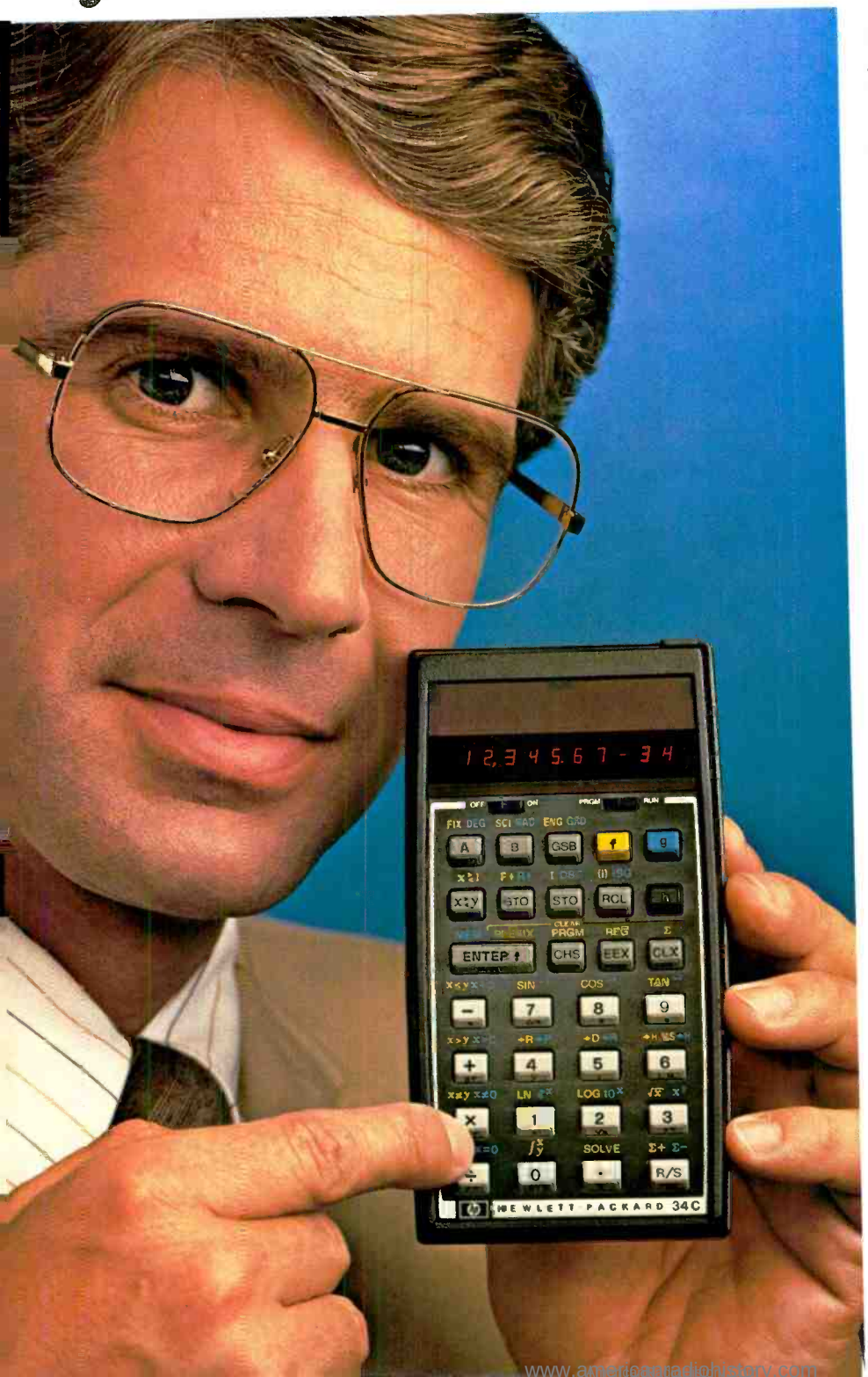

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