$1.00 ■ NOV. 1977

Radio-Electronics

34140 IND

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Forest Belt tells...

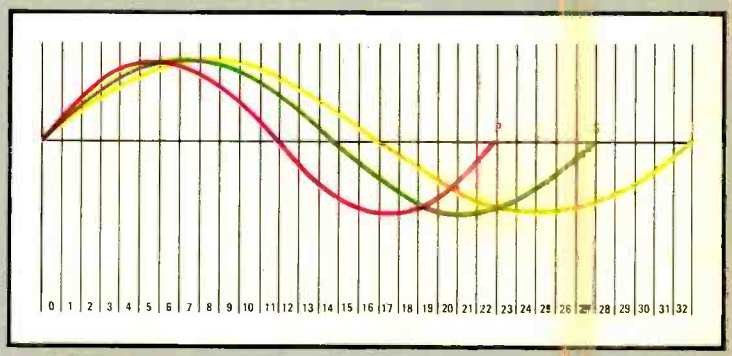
What You Need To Know About CB TEST GEAR

THE VERSATILE Z-80

STARTING A MULTI-PART COMPUTER CORNER THAT TELLS YOU EVERYTHING YOU EVER WANTED TO KNOW ABOUT THE Z-80

BIORHYTHM CLOCK

BUILD FOR LESS THAN $30



SPECIAL DISPLAY ALLOWANCE PLAN

GHOST-FREE TV

CIRCULAR POLARIZATION SOLVES THIS COMMON PROBLEM

CAR CLOCK KITS

ADD DIGITAL TIME TO YOUR CAR

PLUS:

- ★ HOBBY CORNER
- ★ JACK DARR'S SERVICE CLINIC
- ★ BUILD REMOTE RINGER FOR YOUR TELEPHONE
- ★ HI-FI—HOW IHF SENSITIVITY IS MEASURED

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A GERNSBACK PUBLICATION

From blisters to boxes to bags.

Mallory's got the winning team for your solderless terminal needs.

Mallory solderless terminals are available now — packaged to suit your needs. These crimp-type terminals and connectors fit virtually all popular applications and come in a complete range of sizes from 26 through 4/0 AWG.

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CIRCLE 33 ON FREE INFORMATION CARD

Pocket CB

New integrated circuit technology and a major electronic breakthrough brings you the world's smallest citizens band transceiver.

The PocketCom measures approximately ¾" x 1½" x 5½" and easily fits into your shirt pocket. The unit can be used as a personal communications link for business or pleasure.

Scientists have produced a personal communications system so small that it can easily fit in your pocket. It's called the PocketCom and it replaces larger units that cost considerably more.

MANY PERSONAL USES

An executive can now talk with anybody in his office, his factory or job site. The housewife can find her children at a busy shopping center. The motorist can signal for help in an emergency. The salesman, the construction foreman, the traveler, the sportsman, the hobbyist—everybody can use the PocketCom.

LONG RANGE COMMUNICATIONS

The PocketCom's range is limited only by its 100 milliwatt power and the number of metal objects between units or from a few blocks in the city to several miles on a lake. Its receiver is so sensitive, that signals several miles away can be picked up from stronger citizens band base or mobile stations.

VERY SIMPLE OPERATION

To use the PocketCom simply turn it on, extend the antenna, press a button to transmit, and release it to listen. And no FCC license is required to operate it. The PocketCom has two Channels—channel 14 and an optional second channel. To use the second channel, plug in one of the 22 other citizens band crystals and slide the channel selector to the second position. Crystals for the second channel cost $7.95 and can only be ordered after receipt of your unit.

The PocketCom components are equivalent to 112 transistors whereas most comparable units contain only twelve.

A MAJOR BREAKTHROUGH

The PocketCom's small size results from a breakthrough in the solid state device that made the pocket calculator a reality. Scientists took 112 transistors, integrated them on a micro silicon wafer and produced the world's first transceiver linear integrated circuit. This major breakthrough not only reduced the size of radio components but improved their dependability and performance.

BEEP-TONE PAGING SYSTEM

You can page another PocketCom user, within close range, by simply pressing the PocketCom's call button which produces a beep tone on the other unit if it has been left in the standby mode. In the standby mode the unit is silent and can be kept on for weeks without draining the batteries.

SUPERIOR FEATURES

Just check the advanced PocketCom features now possible through this new circuit breakthrough: 1) Incoming signals are amplified several million times compared to only 100,000 times on comparable conventional systems. 2) Even with a 60 decibel difference in signal strength, the unit's automatic gain control will bring up each incoming signal to a maximum uniform level. 3) A high squelch sensitivity (0.7 microvolts) permits noiseless operation without squelching weak signals.

EXTRA LONG BATTERY LIFE

The PocketCom has a light-emitting diode low-battery indicator that tells you when your 'N' cell batteries require replacement. The integrated circuit requires such low power that the two batteries, with average use, will last weeks without running down.

The PocketCom can be used as a pager, an intercom, a telephone or even a security device.

MULTIPLEX INTERCOM

Many businesses can use the PocketCom as a multiplex intercom. Each employee carries a unit tuned to a different channel. A citizens band base station with 23 channels is used to page each PocketCom. The results: an inexpensive and flexible multiplex intercom system for large construction sites, factories, offices, or farms.

NATIONAL SERVICE

The PocketCom is manufactured exclusively for JS&A and is the unit currently used on the hit TV show, Charlie's Angels. JS&A is America's largest supplier of space-age products—further assurance that your modest investment is well protected. The PocketCom should give you years of trouble-free service, however, should service ever be required, simply slip your 5 ounce PocketCom into its handy mailer and send it to our prompt national service-by-mail center.

GIVE IT A REAL WORKOUT

Remember the first time you saw a pocket calculator? It probably seemed unbelieveable. The PocketCom may also seem unbelieveable so we give you the opportunity to personally examine one without obligation. Order only two units on a trial basis. Then really test them. Test the range, the sensitivity, the convenience. Test them under your everyday conditions and compare the PocketCom with larger units.

After you are absolutely convinced that the PocketCom is indeed that advanced product breakthrough, order your additional units, crystals or accessories on a priority basis as one of our established customers. If, however, the PocketCom does not suit your particular requirements perfectly, then return your units within ten days after receipt for a prompt and courteous refund. You cannot lose. Here is your opportunity to test an advanced space-age product at absolutely no risk.

A COMPLETE PACKAGE

Each PocketCom comes complete with mercury batteries, high performance Channel 14 crystals for one channel, complete instructions, and a 90 day parts and labor warranty. To order by mail, simply mail your check for $19.95 per unit (or $39.95 for two) plus $2.50 per order for postage, insurance and handling to the address shown below. (Illinois residents add 5% sales tax). But don't delay.

Personal communications is the future of communications. Join the revolution. Order your PocketComs at no obligation today.

NEW LOW PRICE!

Credit Card Buyers Call Toll-Free

$19.95 per unit

*Sold originally for $40 per unit

JS&A NATIONAL SALES GROUP®

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

CALL TOLL-FREE.... 800-323-6400
In Illinois call ..... (312) 498-6900

GTE Sylvania, Electronic Components Group, 100 First Ave., Waltham, MA. 02154.

We've got the longest running feature on TV.

Our Color Bright 85* picture tube warranty is the longest in the industry. We can offer it because we're confident that a Color Bright 85 picture tube will probably last longer than five years.

The warranty is a great selling tool that builds customer confidence in your quality work. Plus, it lets you form a long-term customer relationship with each picture tube you replace.

*Limited warranty, naturally. It does not cover labor for replacing a tube.

The Color Bright 85 picture tube offers economy with the high quality standards you expect from Sylvania. Couple that with the new 5-year warranty* and you'll find the Color Bright 85 is an easy sale.

And it can be better for you in the long run.

GTE SYLVANIA

Radio-Electronics®

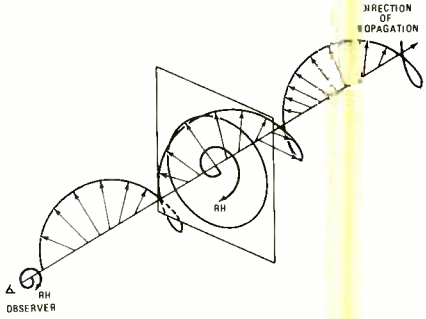
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

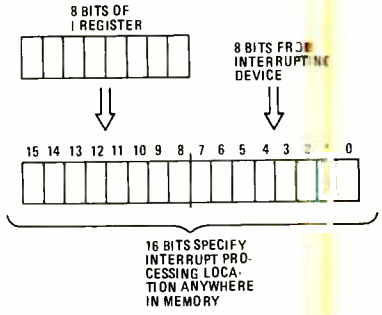
NOVEMBER 1977 Vol. 48 No. 11

ON THE COVER

Biorhythm clock keeps you up to date on good versus bad days. Three-color digital read-out tells at a glance where you are in your Physical, Intellectual and Sensitivity cycles. For full details on how to build your own turn to page 33.



RIGHT-HAND POLARIZED TV signal can bring better TV reception in US. For the whole story turn to page 38 now.



INTERRUPT PAGE MONITOR is one aspect of the Z-80 microprocessor. For more data on the Z-80 see Computer Corner on page 78

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looking ahead

VTR price break: Even before the start of multi-brand mass marketing of home videocassette recorders, pricing attrition has begun. From the time of the introduction of Sony's Betamax until this fall, most standard home VTR's had been list-priced at around $1,300. The only exception had been Quasar's Great Time Machine, a non-compatible but completely acceptable economy unit with a list price of $995. The Sony Betamax has been discounted as low as $995, the Quasar occasionally at $895.

The big price break came with the introduction of the first of the VHS-format units to provide four-hour playing time per cassette—RCA's SelectaVision videocassette recorder. This model is a deluxe unit in every way, and includes a built-in LED timer as well as the standard built-in tuners, etc. RCA astounded some of its competitors when it announced a suggested list price of $1,000. In the couple of weeks preceding RCA's introduction, Zenith had introduced its own Sony-built Beta-format model with two hours' recording time per cassette, and Toshiba showed its similar unit—both listing at $1,300, including timer.

RCA's price level was expected to lead to a general repricing by competitive brands. Indirectly, the result is certain to be a far higher level of sales and quicker growth in popularity of the home videocassette recorder. RCA said it expected to have 5,000 dealers handling its VTR by late October. The cassettes are priced at $17.95 for a two-hour unit, $24.95 for four hours. (The same cassettes are available at $15.95 and $19.95 under the JVC brand label—they're labeled one-hour and two-hour—but in the RCA unit they can be recorded at half speed, doubling their capacity.)

More home cameras: Two new home TV color cameras have been introduced as videocassette recorder accessories, both priced relatively high for consumer products but quite low compared with any other color cameras. In September we reported on JVC's $1,500 camera (we erroneously described it as a one-tube camera; it has two ⅔-inch vidicon tubes). Now Toshiba has introduced a low-light camera capable of taking pictures in standard room lighting as low as five foot-candles. It uses a single one-inch vidicon pickup with stripe filter, has an optical viewfinder and weighs just about the same as the JVC's six pounds. It's priced at $1,700. Another version of this Toshiba camera is being offered under its own brandname by GBC Closed-Circuit of New York for $1,600.

When it comes to home color cameras, that's about it—but every brand is offering home black-and-white cameras, generally in the $300-$400 price range. In the RCA, Quasar and some other units, the camera hooks up to the remote pause-control connection, so the VTR may be turned on and off from the camera. All VTR cameras contain their own built-in microphones for simultaneous sound recording.

And the videodisc: As RCA increasingly concentrates on home video recording, it very obviously feels far less urgency to get its home videodisc system to market. Top company officials, in fact, concede that the expected declining price trend in videocassette recorders probably will dictate that the videodisc player be a relatively low-cost product and that the increasing playing time in VTR's means that the disc must be an ultra-LP record. As a result, RCA has discontinued pre-production development of its SelectaVision videodisc and has sharply reoriented the product. As a matter of fact, it has virtually developed a completely new version of its capacitance videodisc system.

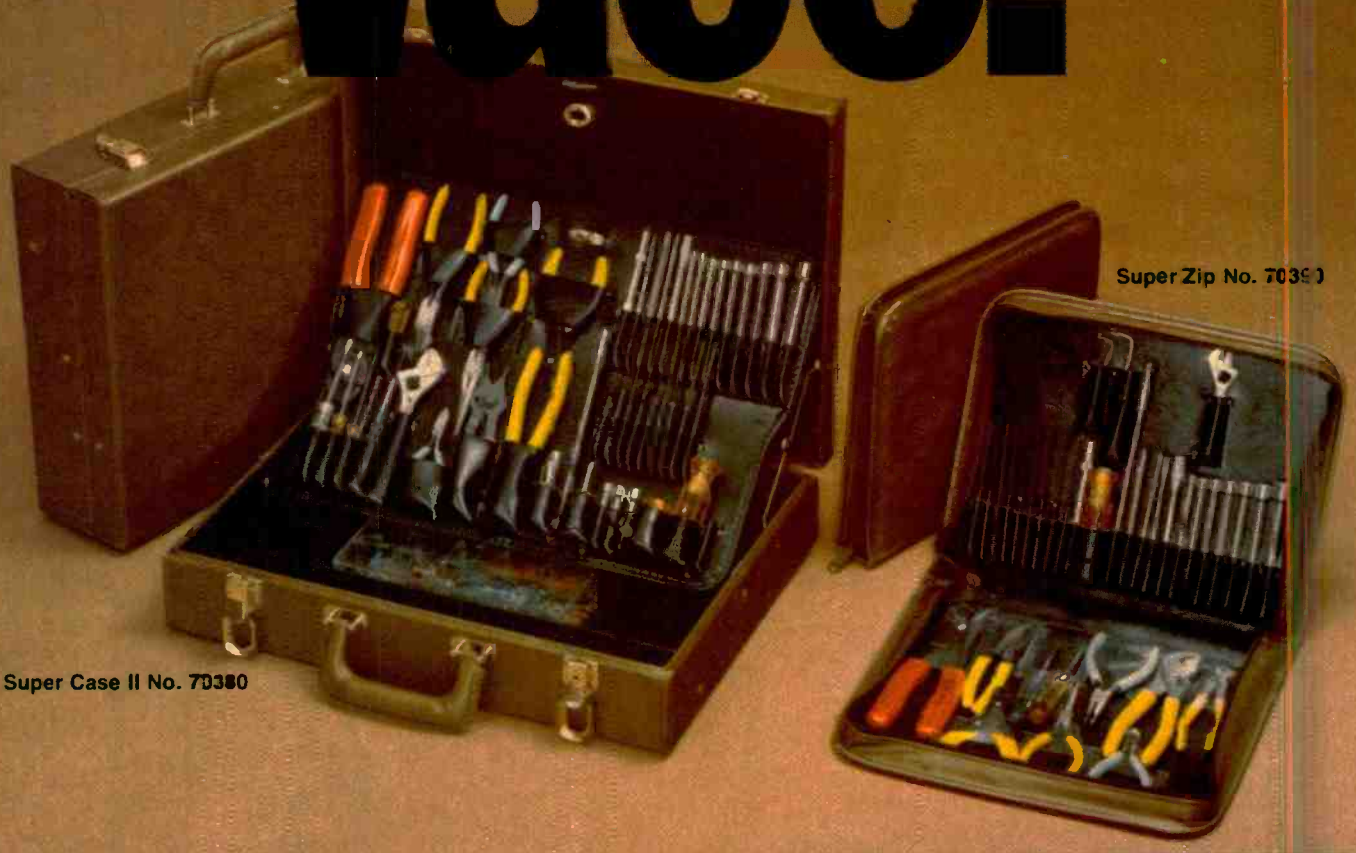
RCA's new system uses a disc which will play for two hours—one hour per side—and therefore a single record can contain a complete motion picture. A major change is in the method of manufacturing the disc, which now is made of an uncoated plastic material, eliminating the expensive and exacting production step of coating the disc with a metallic material. RCA claims this new technique makes production of the videodisc as simple a process as pressing an audio record. Masters for the new RCA disc are cut mechanically, instead of the former electron-beam recording process, again substituting a simple process for a difficult one. The disc is no longer placed on the turntable manually, but fed into a slot in the player in its own rigid plastic jacket or "caddy."

I viewed a demonstration of RCA's new videodisc format and found excellent picture quality, natural colors and virtually no picture dropouts. RCA says it will continue to develop this lower-cost system and will build about 100 players and press developmental discs. But at the present time, it has no plans to go into production. On the other hand, North American Philips and MCA seem to be undiminished in their enthusiasm for the optical disc system. At press time, "test marketing" in one or two areas, probably at a price of $500 per player, was still planned for the end of 1977. Philips' subsidiary Magnavox will produce and market the players in what is expected to be a relatively small-scale test. MCA Disco-Vision will make and market the discs. In the meantime, Magnavox will also sell a home VTR manufactured by Matsushita Electric, which will be compatible with the RCA unit.

Stereo TV sound: Those who are dissatisfied with TV sound quality (and doesn't this include almost everybody?) are now getting their licks in with the Federal Communications Commission (FCC). The Commission has reopened a long-dormant issue: Should TV have stereophonic sound? In an inquiry, it's asking whether the public, broadcasters or manufacturers have any interest in the subject. The FCC last looked into the issue in 1964 at the request of two television set manufacturers, but dropped the subject in 1967 on the basis of lack of interest. One of the prime proponents of TV stereo at this time is the Public Broadcasting System, which would like far better sound for the musical programs it carries. Two companion inquiries being conducted by the FCC look toward AM stereo (adoption likely) and discrete quadriphonic FM (near-future adoption prospects nil).

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Vaco.



Super Zip No. 70390

Super Case II No. 70380

Meet the Super Family!

Our original Super Case was such a success that you asked for more. So here they are!

Super Case II includes 45 professional problem-solving tools from screwdrivers and nutdrivers to hex keys, testers, wire cutters, wrenches and pliers . . . plus a super-handy solderless connector kit complete with crimping tool. *Super Zip* is a compact zipper case assortment of 36 of our most popular tools and components. All professional quality. And all with a full lifetime warranty.

For a full color brochure on all three SUPER CASES, just write:

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Introductory Feature with Super Case II

As a special introductory bonus, we're including the super-size No. 4900-63 metal box solderless terminal kit (complete with crimping tool) in place of the standard service kit. Super!

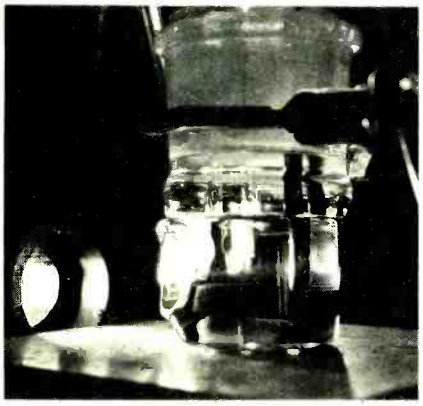
CIRCLE 9 ON FREE INFORMATION CARD

new & timely

Bell Labs liquid-junction solar cells

Since 1954, when Bell Laboratories announced the first solar cell, many studies and experiments have been made in the field of semiconductor/liquid solar devices both in the U.S. and abroad.

Now, Bell has taken the process one step forward by devising a liquid-junction polycrystalline solar cell that promises to be more efficient and, Bell technicians stress, more economical to operate than its brother, the single-crystal cell. Using polycrystalline material reduces the cost of making a cell since liquids conform easily to solids and junctions are easier to make than with all-solid devices.



LIGHT STRIKING BELL LABS SOLAR CELL causes it to produce electricity. Liquid/solid cell is immersed in chemical solution, which may prolong cell life up to three to four years.

The operating principle behind a solar cell is that electricity is formed by light striking the junction of two materials. The Bell device contains two electrodes immersed in a chemical solution; one electrode is made of a semiconducting material, the other of carbon or other metal. When the light strikes the semiconductor, the current starts flowing from one electrode to another via the liquid—just like in a wet-cell battery. Since the chemicals in the water are not affected by this process, it is projected that the cell could last three or four years.

PCM sound-channel system for telephone and data transmission

Time-division multiplex (TDM) telephone and data transmission systems are now being used in some national communications networks. In view of this, Siemens has developed a PCM sound-channel system that offers up to five channels with a 15-kHz bandwidth, or up to 10 channels with a 7-kHz bandwidth in a 2,048,000-bit-per-second channel. Sound programs, telephone calls and data can also be combined for transmission.

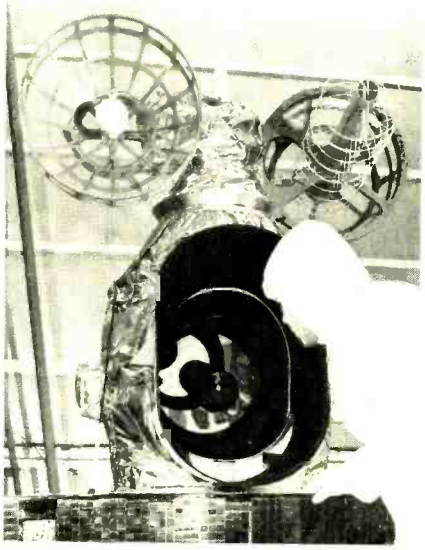
Mono and stereo signals can be transmitted by sound channels that have a 15-kHz bandwidth; these programs can also be sent to and from stations and to VHF transmitters; TV sound can also be transmitted. A 7-kHz bandwidth can be used for outside broadcasts and to transmit radio programs to shortwave, mediumwave and longwave transmitters.

The PCM system encodes signals that are then combined into a digital signal with a 2,048,000-bit-per-second rate. This signal is then sent via the standard 2,048,000-bit-per-second interface to line equipment similar to that used in the PCM30 basic telephone system and the PCM30D data transmission system. This interface allows entry into a higher PCM level and into a PSK radio-relay system. If sound programs are transmitted together with telephone calls via a 2,048,000-bit-per-second channel, six voice channels can be substituted for a 15-kHz bandwidth and three voice channels for a 7-kHz bandwidth sound channel.

Weather satellite tracks Pacific weather patterns

This past July, a new weather satellite, developed by Hughes Aircraft for the Japanese government, was launched by NASA. The GMS (*G*eostationary *M*eteorological *S*atellite) will keep track of typhoons, hurricanes and other dangerous weather patterns prevalent over a large area of the western Pacific.

The heart of the GMS is the VISSR (*V*isible and *I*nfrared *S*pin-*S*can *R*adiometer), which produces visible-light pictures by day and infrared images by night every 30 minutes, 24 hours a day. The satellite also contains a Space Environment Monitor to measure high-velocity ionized gas particles.



THE MAIN SCIENTIFIC INSTRUMENT on the GMS (Geostationary Meteorological Satellite) is the VISSR, or *V*isible and *I*nfrared *S*pin-*S*can *R*adiometer. Shown here is the VISSR scan mirror.

The GMS joins two earlier U.S. environmental satellites launched in 1974 and 1975, as a part of an eventual World Weather Watch program to become fully operational this year. The U.S., Japan, the European Space Agency, the Soviet Union, the U.N., the World Meteorological Organization, the International Council of Scientific Unions, aerospace industries and almost 145 countries will participate.

Semiconductor doping technique speeds manufacture 1,000 times

A new approach to doping semiconductors, *thermomigration*, reduces the time required to fabricate a semiconductor by as much as a thousandfold, while working at lower temperatures and securing better yields than older techniques.

THE INVENTORS AND SOME WAFERS treated by the new thousand-times-faster technology. At left is Dr. Cline, at right Dr. Anthony.

In manufacturing a semiconductor device, the silicon crystal is sliced into thin wafers. These are exposed to precise amounts of a dopant impurity at high temperatures. The time required may be nearly a week.

In the new process, invented by Drs. Thomas R. Anthony and Harvey E. Cline of the General Electric Research Center at Schenectady, NY, only one side of the wafer is heated. The opposite side is cooled. The temperature difference forces the dopant—in the form of a liquid—to migrate through the wafer, from the cool to the hot side. The time required is measured in minutes.

continued on page 12

LCD Watch Breakthrough...

MICRO-ALARM

a 6-digit 6 function LCD Alarm Watch for only $69.95!

At last, a constant readout (no buttons to push) precision quartz electronic watch with a built-in 24 hour alarm system.

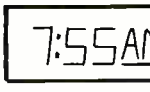
A quiet revolution has been taking place in the electronic watch industry during the last few years. Push-button LED's are being replaced with continuous-display LCD watches; 4-digit displays are being replaced by 6-digit readouts. This year there will be many such LCD watches available.

However, Winthrop-Rogers prides itself on offering not only the most technologically-perfect products available but also on introducing the most technologically-advanced products on the electronic market before they are readily available. Therefore, we are pleased to announce the most remarkable achievement in electronic watch technology to-date.

By combining the quartz-accuracy precision of the LCD watch with miniaturized alarm technology, we proudly introduce the first CONTINUOUS DISPLAY ALARM WATCH. A watch that may not be available from other sources for years can now be yours at a price hundreds of dollars less than you would imagine.

And now consider the incredible convenience of a portable alarm clock handsomely adorning your wrist at all times ! ! !

- *Never again missing an appointment because you lost track of time.*
- *Never again missing a plane or a train because you didn't relize how late it had become.*
- *Never again forgetting to make that all-important phone call.*
- *Never having to worry about forgetting to take important medication on time.*
- *Never worrying about waking up from that catnap, or at a hotel if your wake-up call isn't on time.*
- *Always being aware of when you should be coming or going or doing all that your hectic schedule demands – without devoting your valuable time to trying to remember it all.*



SET TO RING AT 7:55 A.M.

THE ALARM

The MICRO-ALARM has a 24 hour Alarm System, allowing you to set your watch to signal at any minute of the day or night (1,440 settings per day are possible). Once set, you need not be concerned about your next appointment or train, plane or phone call. The MICRO-ALARM will remember for you and remind you when you need to be reminded.

SNOOZE/REMIND CONTROL

For your convenience the MICRO-ALARM will give one short beep prior to its full alarm cycle, allowing you to turn it off without disturbing others. If not deactivated after the first short beep, the alarm will then beep for 15 continuous seconds. Push the deactivate button twice and the alarm is off. However, should you want a further reminder, then push the deactivate button only once and the alarm will go through its cycle again in exactly 5 minutes, allowing you to continue your current activity whether it be a snooze or phone call without fear of forgetting your next commitment

Order now for the holidays!

12:34 AND 56 SECONDS

6-DIGIT LCD DISPLAY

The MICRO-ALARM has a 6-digit readout showing hours, minutes and seconds at a glance. Since the readout is by Liquid Crystal Display (LCD) and not by Light Emitting Diode (LED), no button has to be pushed, the time is continuously displayed! A built in night-light functions at the push of a button for reading in darkness.

AUGUST 15th FRIDAY

CALENDAR DISPLAY

Just one push of the control button converts the display into a 3-function calendar; displaying the month, date of the month, and day of the week. The remarkable memory built into the module knows each month and the number of days in that month and resets automatically on the first day of the new month.

QUARTZ ACCURACY

The MICRO-ALARM is extraordinarily accurate. Its module is manufactured by Hughes Aircraft Company, one of the world's foremost manufacturers of microelectronics, and is guaranteed accurate to within 3 minutes a year (averaging less than 15 seconds per month). You can depend on the accuracy year after year. There are no moving parts, so there is nothing to wear out or even require servicing. The result of this accuracy is that you can set your watch to the second.

THINK ABOUT IT!

Even if you have no consistant need for a watch with a built-in electronic alarm, the MICRO-ALARM is a valuable investment for its watch features alone:

1. It is the most up-to-date fully-functioning electronic watch available today.
2. It is accurate to +/- 15 seconds per month, and never has to be wound – put it on, and the time and date are correct even if it has been in a drawer for a month!
3. Its elegant styling will compliment any attire – and elicit compliments from your associates and friends.
4. At this price you can not find a better buy.
5. One day you will have a critical need to be reminded of a vital appointment – and then, having used the alarm function once, you will never again return to any other reminder system.
6. Why buy an ordinary watch when you can own a MICRO-ALARM?

ELEGANT MESH BRACELET

Each MICRO-ALARM comes with a 1 year limited warranty. You may order in your choice of goldtone or silvertone case. Each for only $69.95 plus $1.99 for shipping and handling. Each MICRO-ALARM comes with a matching, elegant thin mesh bracelet, more handsome and much more practical than those "pull over-snap" type bracelets. This band adjusts comfortably and easily, eliminating cumbersome link adjustments.

15 DAY TRIAL

Wear the MICRO-ALARM for 15 days to assure yourself that this is no ordinary watch. If at the end of that time you are dissatisfied for any reason you may return it for a prompt refund, no questions asked.

To order by credit card please phone our 24-hour toll-free number:

800-325-6400 ask for Oper. 36

In Missouri 800-342-6600 ask for Oper. 36

or mail the attached coupon with your payment and the MICRO-ALARM will be on its way to you.

Allow 3-4 Weeks For Delivery

Winthrop-Rogers Ltd. V6011

Box A69, 1135 Greenridge Rd., Buffalo Grove, Il 60090

Please send ___ MICRO-ALARMS @ $69.95 each plus $1.99 for shipping and handling.

___ Silvertone MICRO-ALARM

___ Goldtone MICRO-ALARM

If I am not completely satisfied I may return for a full refund. Total amount enclosed $___ check or money order. (Illinois residents please add 5% sales tax.) No C.O.D.s please.

Charge: ☐ Amer. Exp. ☐ Bank Amer ☐ Visa ☐ Master Charge MCBK#___

Card # _____ Exp. ___

Signature _____

Name _____

Address _____ Apt ___

City _____ State ___ Zip ___

To expediate shipping by UPS, please provide street address rather than P.O. Box number

CIRCLE 37 ON FREE INFORMATION CARD

Only NRI 25" DIAGONAL designed-

Color TV Quadraphonic

Two home training schools give you a hobby-kit Color TV to assemble. Two others give you a commercial set right off the shelf. Neither was designed to teach you how to repair Color TV's. Only NRI invested the time and money to design equipment with learning in mind!

No other home training school gives you both a solid state Color TV and SQ™ Quadraphonic Receiver complete with four speakers . . . all in one course. In fact, to even match this kind of thorough training at another school, you'd have to take an extra course costing hundreds of dollars more. And only NRI courses in Color TV/Audio servicing let you learn on equipment designed specifically for training.

It's the only way you can (1) get the feel of typical commercial circuitry, (2) learn bench techniques while building complete units from the "ground" up, (3) perform over 35 "in-set" experiments during construction, and (4) end up with a 25" diagonal solid state Color TV with cabinet and a 4-channel Audio Center.

NRI passes the savings on to you

NRI engineering eliminates the cost of buying from an outside source. We pay no salesman's commission. Students are enrolled by mail only. The savings are passed on to you in the form of low tuition fees, extras like the TV's console cabinet and the Quadraphonic System; professional test instruments like a 5" triggered sweep oscilloscope, CMOS digital frequency counter, and integrated circuit Color TV pattern generator. You can pay hundreds of dollars more for similar courses and not

™ Trademark of CBS, Inc.

gives you this for-learning ..plus complete Audio Center.

get a nickel's worth more in training and equipment.

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It all boils down to the quality of training you get for your money. In our 62-year history, more than a million students have come to NRI and we're fully approved for career training under the G.I. Bill. We know the right way to make home training pay dividends for you.

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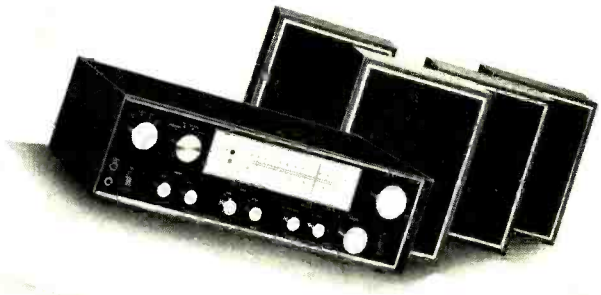

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new & timely

continued from page 6

Not only does the new technique speed up processing, but reduces wafer breakage and increases device reliability. By manipulating wafer alignment and temperature, the size, shape and concentration of doped regions may be controlled, thus increasing design flexibility. This may even lead to "whole new classes of semiconductor devices that never existed before," according to one GE spokesman.

Hands-on microprocessor courses to continue this Fall and Winter

Wintek closed its spring series of "Microprocessor Courses with Free Take-Home Computer" at Rochelle Park, NJ, June 21, 22 and 23. Earlier courses had been given in Indiana, Ohio and New York, beginning in May.

The 24 students who attended the New Rochelle course were largely communications and control engineers with little computer experience. Students were split into groups of two, each with a microcomputer, CRT terminal, and *Fantom-II*, a monitor/debug program that allows single-step execution of programs, insertion and deletion of breakpoints.

After lectures on basics, students set up and corrected programs, worked with memory stacks, designed delay loops and made other experiments, ending with writing, debugging and executing a program involving I/O and interrupts. The course ended with a graduation ceremony during which each student was given his microcomputer and graduation certificate to take home along with his course book and other instructional materials.

Wintek's Fall schedule, which includes a new two-day Hands On Interfacing Workshop in addition to their standard three-day course, is as follows:
Oct. 31, Nov. 1, 2, 3, 4, San Diego, CA; Nov. 14, 15, 16, 17, 18, Indianapolis, IN; Nov. 28, 29, 30, Dec. 1, 2, Boston, MA; Dec. 6, 7, 8, Detroit, MI; Dec. 12, 13, 14, 15, 16, Chicago, IL; and Jan. 3, 4, 5, 1978, at Mayaguez, Puerto Rico.

For further information call Jerilyn Williams at (317) 742-6802 or write to WINTEK Corp. at 902 N. 9th Street, Lafayette, IN 47904.

VICA Skills Olympics test vocational ability

The Vocational Industrial Clubs of America (VICA) recently sponsored a U.S. Skill Olympics competition in Cincinnati, OH Many young men and women participated in the national competition, designed to test their ability to complete projects and perform tasks related to real-life, on-the-job situations in many different technical fields.

Radio and TV repair contestants were given eight malfunction problems, four of which were related to color TV. Working under a time limit, they were also required to diagnose and repair a radio malfunction; assemble a circuit and make the required measurement; mount components and assemble circuit boards; and, last and very important, complete a written safety test concerning proper safety procedures in servicing electronics equipment.

A VICA technical committee chose the panel of judges from among qualified teachers and administrators in the Cincinnati area.

VICA WINNERS IN RADIO & TV REPAIR, pose with their prizes. From left to right: Terry Williams (third place), Richard Lomax (first place) and Joel Barrow (second place).

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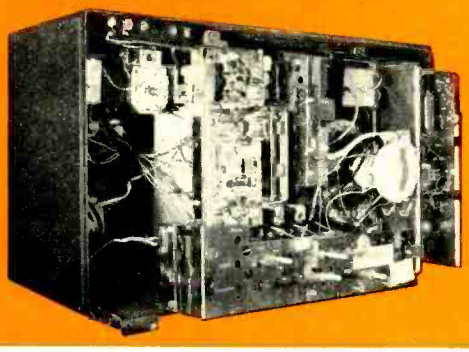

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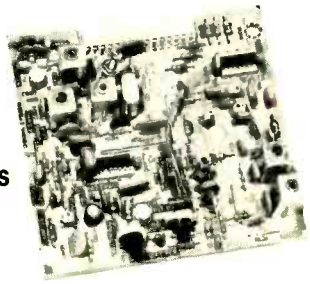

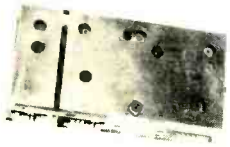

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CIRCLE 10 ON FREE INFORMATION CARD

SWTPC announces first dual minifloppy kit under $1,000

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

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

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

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

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

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

Enclosed is:

_____ $1,990 for the full system shown above (MF-68 Minifloppy, CT-64 Terminal with CT-VM Monitor).
_____ $995 for the Dual Minifloppy
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_____ $395 for the 4K 6800 Computer
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letters

JULY 77 R-E

Have just finished reading your July 1977 issue. The article on digital voltmeters (**Radio-Electronics,** July 1977, p. 53) was fairly complete. I do however question how you came up with the idea that liquid-crystal displays (field-effect type) have relatively short lifetimes compared with LED's. I own an LCD DVM, and was told no one really knows how long the display will last; but judging from my first-generation LCD, field-effect type, digital watch that has been "on" for over three years, I came to the conclusion that they (the LCD's) would last forever—like LED's.

Your article failed to mention one area where I find digital voltmeters may not work satisfactorily, and that is in measuring voltages in pulse circuits, such as the drive on the horizontal output tube that, in many cases around –70 volts, gives oddball readings, and one has to resort to the analog meter.

Your series, *All About Analog Voltmeters,* is very good indeed. One thing you failed to mention is *why* do manufacturers continue to use nonlinear ohm scales in analog meters? Surely manufacturers can come up with an inexpensive constant current source (whatever became of the constant current diode?) to eliminate this. An article on linear-scale analog meters ohms scale would be nice.

Your article on page 58 about sync circuits is timely. I have a set on the bench that has a bad case of vertical jitters, and I have not found the problem yet. Perhaps I will get it with your article in mind.

We also had a color set in with a case of slow jitters that drove everyone nuts who worked on it. We put in a lot of hours on that one and finally found it by accident—the vertical-hold control itself changed value and while its ohms value was being measured, it constantly changed value! You didn't mention, or stress very much, that a can of coolant spray works wonders on vertical problems. Just spray the foil side (not the component side!) and watch the trouble come to light.

Keep up the good work in your Service Clinic. I find it full of useful information.

STUART SJALUND
Ontario, Canada

IC BREADBOARD SYSTEM

I finally did it! I finished my own version of Breadboard System that appeared in the February 1975 issue.

It contains a single split power-supply variable from 0 to ± 120 volts at 1A and a 5-volt TTL supply. I use an 8038 for a signal generator that provides squarewaves, triangular waves, ramp and sinewaves from .01 Hz to 60 kHz. I also have a frequency counter that can be used to monitor the internal signal generator or an external signal (I came up with a very good squaring circuit, with an input impedance of about 2.5 megohms good up to over 1 MHz). Finally, it has a single-pulse generator and 15 Darlington-driven LED's for TTL use.

Building this thing took a long, long time, but it was well worth it.

KENNETH D. LYON
Chelsea, MA

DIGITAL CLOCK IC

In the August 1977 issue, you have a very good article on a "10 Function Digital Clock."

continued to page 16

LETTERS

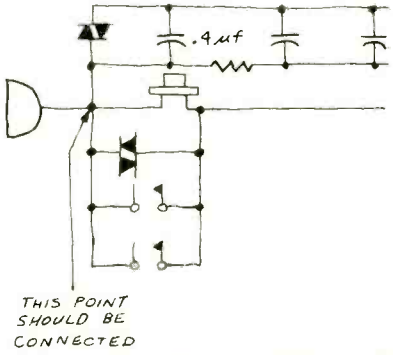
continued from page 15

In the article, the clock chip is called out as a CT7081. This is an old Caltex part number. Caltex was purchased by Exetron, and Exetron was purchased by Fairchild Semiconductor. The part is presently available as an FCM7001 or FTK0401 in the Fairchild Technology Kits™ program, as well as surplus CT7001's.

DAVID M. TULLY
Redmond, WA

ERROR IN DIAGRAM

There is an error in Fig. 1 of the article entitled "Turn-On Appliances Via Long Distance," in the April 1977 issue of **Radio-Electronics.**



The error is shown in the diagram. The indicated point should be connected.

GAINES M. CROOK, P.E.
Chatsworth, CA

DIGITAL-CLOCK CORRECTIONS

A number of errors crept into my article on the 10 Function Digital Clock (**Radio-Electronics,** September, 1977). In the text of Part I, reference is made to a "master driver," which is identified as Q1. Actually, this referred to IC4. In the schematic of Fig. 1, several connection points were missed: IC11 pin 12 to IC3 pin 10 and R29; cathodes of D7 and D8 to IN3; and emitter of Q5 to VDD'. Also, on IC3 pin 9 should connect to pin 4, and pin 2 should connect to IC11 pin 11.

In Fig. 2, all switches that are shown as a three-position type are actually DPDT center-off. Resistor R33 in this figure is really R35. In Part II of the article, Fig. 8, all transistor outlines are shown reversed for TO-92 case. IC9 and IC10 should be labeled 75491, and IC12 is an MM5369.

JEFF MAZUR
Canoga Park, CA

COMPUTER CLUB

Your readers might be interested to know about the Charlotte (NC) Computer Society, formed just a year ago, to further the personal use and understanding of the peaceful uses of computers and computer technology.

Meetings are held the third Wednesday of every month in Room 200, Denny Hall, University of North Carolina at Charlotte. For further information, write Charlotte Computer Society, 7225 Brynhurst Drive, Charlotte, NC 28210.

REX EAGLE
Charlotte, NC

COMPUTER CLUB

Some of your readers may be interested to know about our computer club, the Blackhawk Bit 'Burners.

We welcome all area hobbyists to join us in sharing their questions, experiences and frustrations.

The club meets on the second Wednesday of every month. For further information, write Blackhawk 'Bit Burners Computer Club, Box 5411, Rockford, IL 61101.

BILL MCKENZIE
Rockford, IL

1802 BOOKLET

Very little software for the RCA CDP1802 is currently in the public domain. To remedy this situation, I plan to publish a 10-page booklet listing available software. If you desire to sell or even give away your software, please send me a listing for review. My booklet will provide a complete description and cost information, with a reference number corresponding to a number on an order coupon.

There will be a charge of $1 for the booklet. This amount will also cover the costs of processing the coupon. Using the coupon will reduce the costs to the person ordering from more than one source.

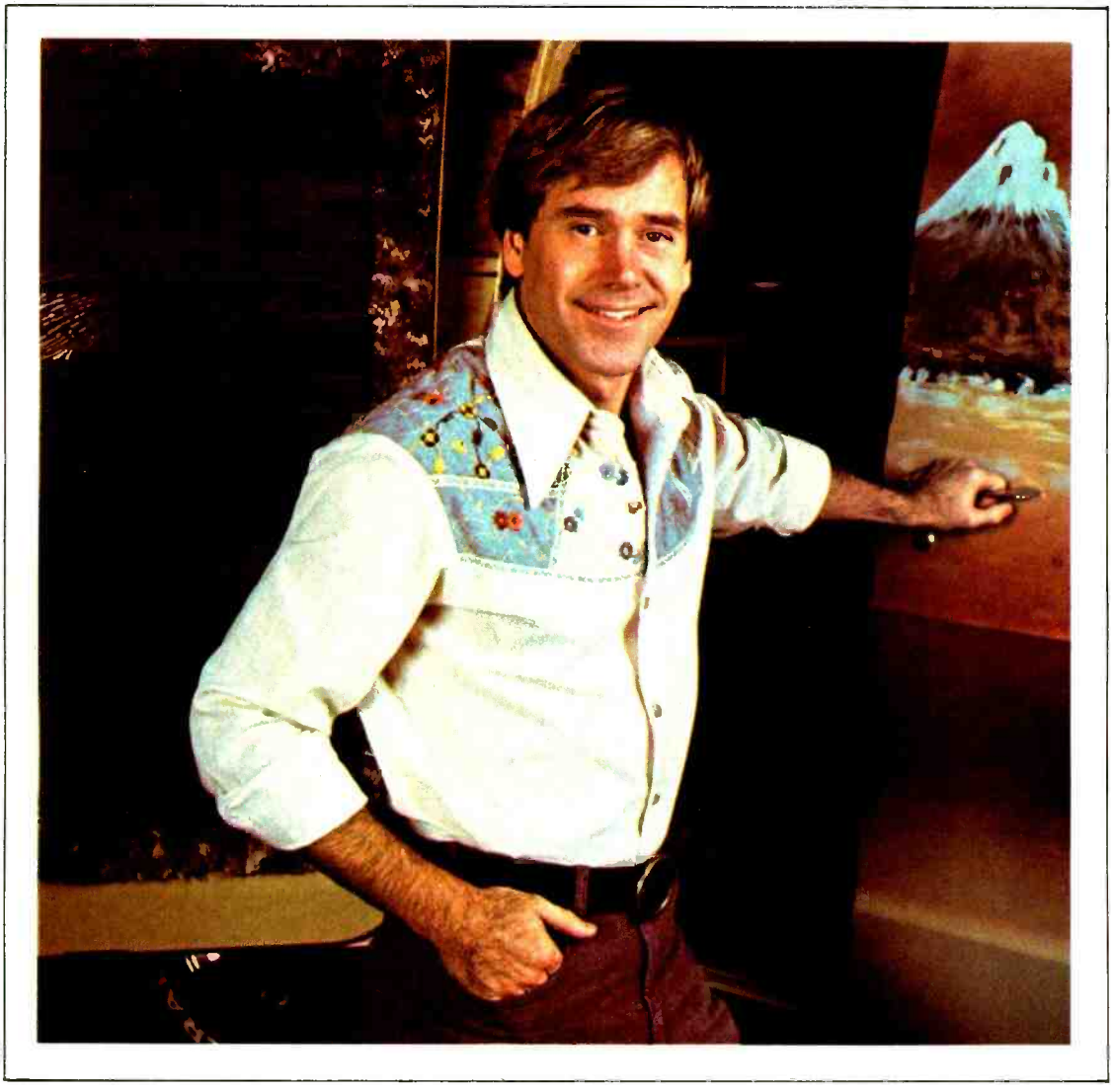
The publication date is set for early December. Advance orders may be taken ($1 a copy). Send all orders, software listings and other correspondence to Ross Wirth, 1636 S. 108 E. Ave., Tulsa, OK 74148.

ROSS WIRTH
Tulsa, OK

R-E

CIRCLE 4 ON FREE INFORMATION CARD

You gotta shop around.



When you do, you'll probably pick CIE. You can't afford to settle for less when it comes to something like electronics training that could affect your whole life.

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* * *

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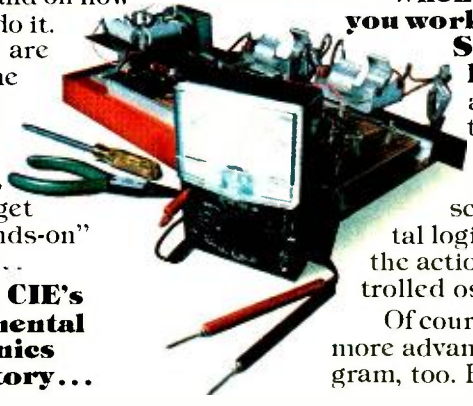

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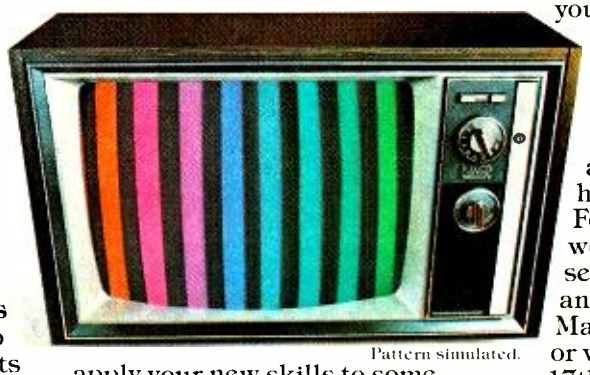
When you get your Zenith 19-inch Diagonal Solid-State Color TV you apply your new skills to some real on-the-job-type troubleshooting! You learn to trace signal flow... locate malfunctions... restore perfect operating standards—just as with any sophisticated electronics equipment!



Pattern simulated.

When you work with a completely Solid-State Color Bar Generator—actually a TV signal transmitter—you study up to ten different patterns on your TV screen... explore digital logic circuits... observe the action of a crystal-controlled oscillator!

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Ungar Model 5001 Versa Torch

CIRCLE 87 ON FREE INFORMATION CARD

THIS POCKET-SIZED TOOL IS BOTH A TORCH and a handy portable soldering iron. The tool fills in seconds from standard propane or MAPP (high temperature) gas cylinders and provides up to 30 minutes of continuous heating per refill. The torch weighs a mere 11 ounces and easily fits into a pocket or tool kit.

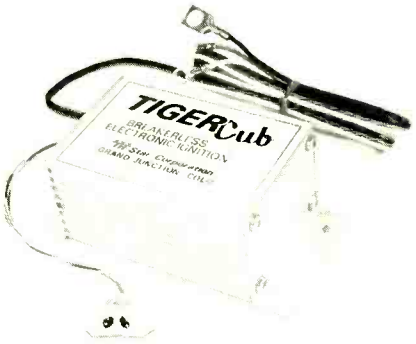
A special adapter allows the *Versa Torch* to be fitted with any Ungar ¼-inch thread-on soldering tip making it a unique soldering iron. It heats quickly to soldering temperature and is ideal for the repair of electrical and electronic systems in the field, in plants, in the home, on boats, in the car or truck or in an aircraft. It is perfect for installing mobile communications gear.

The torch kit comes complete with detachable stand, pinpoint flame tip, soldering tip adapter, three ¼-inch soldering tips, spark lighter and owner's manual.

After thoroughly reading the instructions I tried it myself. Filling the torch with gas was a cinch once I located a full propane container and finished throwing away the three empty ones I was saving (for what I don't know). Then on to an outdoor soldering experiment. Turn on the gas, light the flame, wait a minute for warm up and then to work. It was fine. The flame is completely confined within the soldering tip and I don't think you could find an electric iron with equivalent wattage. Best of all, the *Versa Torch* was as easy to use as an electric iron. And it didn't have a dangling cord. If I had to do outdoors soldering in the winter, this would be my choice.

One word of caution. Make sure the tip is cool before putting the torch away, unless you want to find melted tool handles when you next open your case. **R-E**

Tiger Cub Breakerless Ignition



CIRCLE 88 ON FREE INFORMATION CARD

THE TIGER CUB, MANUFACTURED BY TRI-STAR Corporation, is an electronic replacement for conventional automotive breaker points that eliminates the need for both replacement and adjustment. Teamed up with the Tiger 500 or the Tiger Max Capacitive Discharge system, it

continued on page 24

3 things that TV servicemen want most in a Color Bar Generator

PORTABILITY • PERFORMANCE • PRICE

THE NEW Simpson® MODEL 431 HAS THEM ALL

- Fits in the hand. Weighs 13 oz.
- 28 Patterns. 13 Tests.
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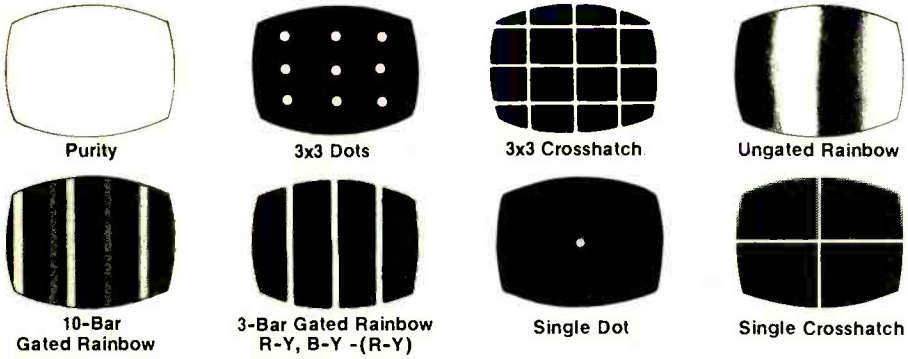

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EQUIPMENT REPORTS

continued from page 22

provides the additional advantages of extended spark-plug life and quicker starts. The Tiger Cub consists of a $3^{1}/_{4} \times 2^{3}/_{8} \times 1^{3}/_{4}$-inch electronics package containing the bulk of the components and the distributor-mounted sensor assembly. The electronics package is mounted in a relatively cool spot in the engine compartment. All the necessary interconnect wiring is supplied.

The sensor device is a combination infrared LED diode and phototransistor mounted in a semicircular plastic holder. Both the light source and the detector have built-in lenses that are aimed through slots in the flat portion of the sensor housing. An acute angle is formed between the axes of the two sensor components, so that the presence of a cam surface, parallel to the flat part of the sensor and at the proper distance from it, completes a light path from one to the other to turn on the phototransistor. Because of the nature of the infrared source, the triggering surface does not have to reflect visible light, and practically any surface, including wood, works well. Therefore, the cam does not have to be particularly shiny.

The electronics package is an AC-coupled pulse amplifier with a power transistor output stage. The output transistor is normally biased on, and sensor input pulses switch it off for 2 ms. This dwell-time is independent of the engine speed. Positive feedback from the driver-transistor collector back to the LED light source results in a regenerative switching action.

The Tiger Cub is available preassembled or as a kit. The *Simpli-Kit* can be assembled quickly and easily. A novice should be able to handle it with the help of some general kit-building reference material. The time-worn advice of reading the instructions through before proceeding is a good idea, so that you won't mount the power transistor on the component side of the printed circuit board like I did. As it turns out, it is the only part that must be mounted on the conductor side of the printed circuit board.

Start by wiring the single printed-circuit board. There are six transistors, twelve resistors, three capacitors and two diodes. The diodes look similar, but one is a rectifier and the other is a Zener, and, of course, must not be interchanged. Unless your vision is better than perfect, use a magnifying glass to read the diode part numbers.

Next, solder the ignition-coil cable and sensor wires to the PC board, and slide the board into the extruded aluminum heat-sink case. The only tricky step is installing the spring clip that secures the power transistor tightly between the PC board and the aluminum case. The clip does a good job of insuring that heat is conducted from the transistor to the heat sink.

After the end plates are screwed on, the unit is ready to be installed in the car. Mount the case in a relatively cool spot such as on the fire wall or the inside fender. The exact position depends on the location of the distributor and the reach of the $2^{1}/_{2}$-foot ignition-coil cable and 2-foot sensor cable. The three-wire color-coded flat cable has lugs on the end of each lead. Install the black ground wire under an engine bolt and the white lead (the power supply to the Tiger Cub) to the ignition-coil positive terminal that comes from the car's

continued on page 26

V-15 Type III . . . critics called the Type III the finest cartridge ever when it was introduced. The ultimate test, however, has been time. The V-15's engineering innovations, the uniform quality, and superb performance remain unsurpassed by any other cartridge on the market today. 3/4 to 1-1/4 gram tracking force.

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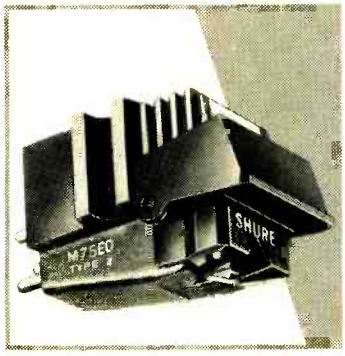
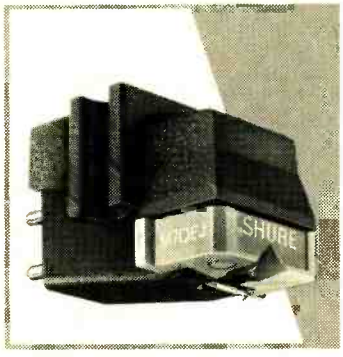
M95ED . . . second only to the V-15 Type III in stereo reproduction. A thinner, uninterrupted pole piece minimizes magnetic losses. Its 20 to 20,000 Hz response remains essentially flat across the entire frequency range for excellent sound quality. 3/4 to 1-1/2 gram tracking force.



M75ED Type 2 . . . excellent trackability at a lesser price. The M75ED Type 2 features a built-in snap-down stylus guard and a smooth 20 to 20,000 Hz frequency response. 3/4 to 1-1/2 gram tracking force.



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ballast resistor and ignition switch. And attach the green wire (the output lead) to the negative switched side of the coil into which the points went previously. Simultaneous or later installation of a CD ignition unit is a little more complicated and requires an additional junction point. Clear pictorials for both hookups are supplied with the kit.

The sensor leads have a convenient connector so that the pickup device can be installed without anything dangling from the end of the wires. Remove the conventional points and capacitor from the distributor and determine the direction of the distributor cam rotation. Clean the cam of any residual lubricant that might interfere with the reflected light or cause false triggering. Mount the sensor with the proper spacing from the cam using the 3/32-inch feeler gauge. An adhesive strip on the bottom of the sensor holds it in place. A second adhesive strip is thoughtfully included if you make any mistake at this point.

For additional security, a hold-down clamp screws into either an available hole in the distributor plate or into one the installer drills.

Now adjust the timing according to the manufacturer's original specifications. Because the system is AC-coupled in the pulse amplifier, the timing must be adjusted with the engine running.

The Tiger Cub sells for $21.95 as a kit; $34.95, assembled. For more information, write to Tri-Star Corporation, Box 1727, Grand Junction, CO 81501. **R-E**

Leader LBO-515 Delayed-Sweep Dual Trace Oscilloscope

CIRCLE 86 ON FREE INFORMATION CARD

IN CAME A NICE NEW OSCILLOSCOPE FOR TESTing. So I plugged it in, turned it on, and five minutes later, having failed to get a trace on the screen, I read the instruction book! After that it was easy.

The *model LBO-515* delayed sweep dual-trace scope, produced by Leader Electronics Corporation, 151 Dupont Street, Plainview, NY 11803, is quite a complex instrument, but simple to use if you read the book first. This standard dual-trace scope has a bandwidth to 25 MHz, a very bright trace for scanning rapid waveforms, and an accelerating voltage of 6 kV on a special flat-face cathode-ray tube (CRT), which has an internal, variably illuminated graticule.

The probes are small, with a spring-loaded hook terminal. Simply twist the probe barrel to set the probes for either direct (×1) or ×10 attenuation. An arrow indicates which is being used.

The vertical controls for each channel are identical. The VOLTS/DIV switch uses the one-two-five sequence in 10 steps. A dual knob has a central continuously variable control for fine height adjustments. When this is in use, a pilot lamp marked UNCAL lights up. Turn the control fully clockwise until it clicks and the light goes out; the switch is then calibrated. The deflection sensitivity is 5 mV-per-division (8 mm) and it rises to 5 volts-per-division on direct input.

The TIME/DIV (horizontal sweep speed) switch goes from 0.5 seconds-per-division up to 0.2 μs-per-division, and this can be increased to 20 ns-per-division by pushing the magnifier or ×10 pushbutton. The TIME/DIV switch is a triple switch: The large knob is the TIME/DIV selector, the middle is the delay adjustment and the small knob is a variable control, also with its own UNCAL light.

There are pilot lights in several places. One lights up when the magnifier switch is in the ×10 position; another, when the Channel 2 switch is in the invert position; and another on the DLEAY TIME control shows whether it is calibrated or not. One light indicates when the sweep is triggered and another signals READY when the single-sweep function is used. And, of course, one also shows when the power is on!

The CRT is a single-gun type. The dual traces can be displayed in any of several

continued on page 82

FREQ.OUT.

CSC's done it again.

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

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

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

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

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

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

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

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

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

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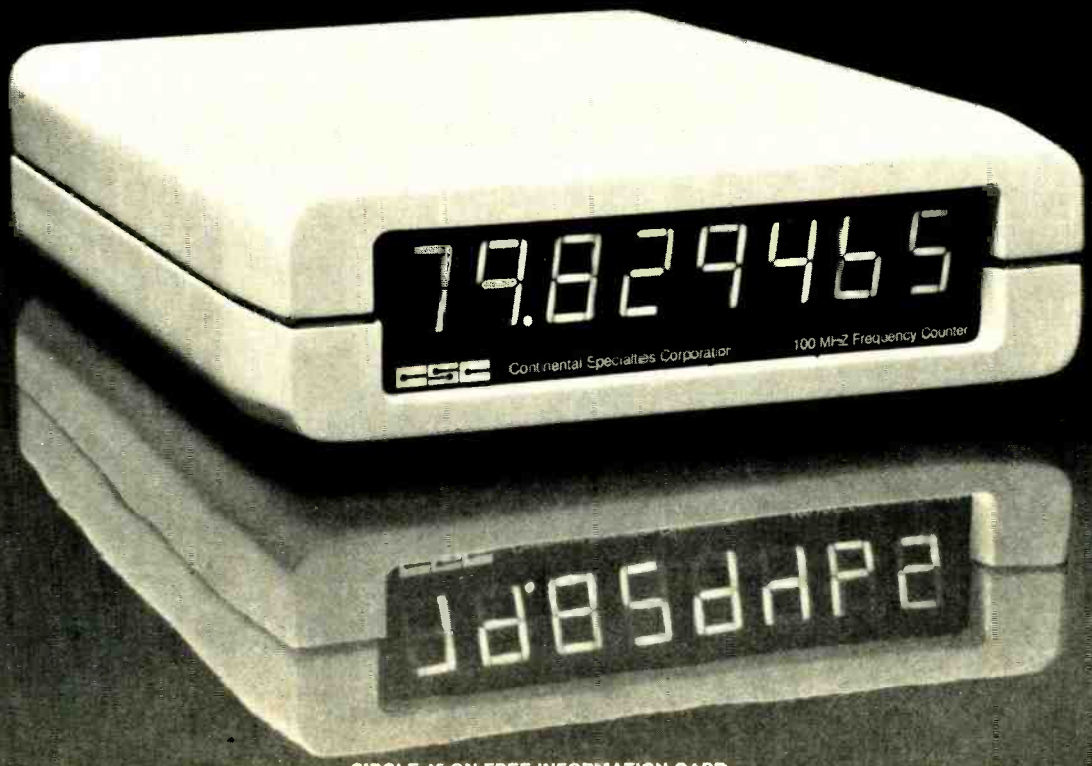

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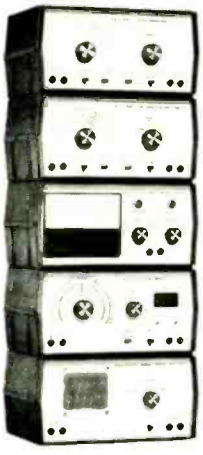
New GD-1110 Pinball Game

The incredible Bally Fireball® pinball game you've been hearing about now in low-cost easy-to-build kit form. One to four players can play this exciting game that's so challenging its impossible to grow tired of. Solid-state electronics and computer technology replace much of the failure-prone electromechanical devices found in other games. The GD-1110 is not a toy but a sophisticated pinball game that will give you years of fun and action.
Only $599.95

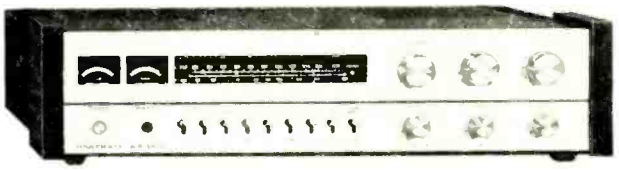


New 5280 Series Test Instruments

Here are five new starter instruments intended for (but not limited to) the beginner. You'll be surprised at the features and performance these new instruments have. There's the IG-5280 RF Oscillator with 1000 Hz audio output, the IM-5284 high performance multimeter that reads volts, ohms and DC current, the IT-5283 Signal Tracer for RF, AF and logic tracing, the IB-5281 RCL Bridge for design and experimentation and the IG-5282 Audio Oscillator with a 10 Hz to 100 kHz frequency range. And to power the 5280 series, you can build the IPA-5280-1 power supply. Only $37.95 each

New CS-1048 Cruise Control

You'll appreciate the CS-1048 every time you take a long trip in your car. Just preset your cruise speed and the CS-1048 does the rest electronically. Maintains your car's speed and improves mileage too.
Only $79.95



New AR-1429 Stereo Hi-Fi Receiver

This year give symphonies, cool jazz, and the driving beat of rock with this stereo performer from Heath. 35 watts, minimum RMS, per channel into 8 ohms with less than 0.1% total harmonic distortion from 20-20,000 Hz. The AR-1429 is perfect for the budget conscious stereo buff who requires a high quality system. It has all the features of a high-priced receiver and the performance too. Phono hum and noise are −65 dB. FM sensitivity is 1.8 μV. Provision for optional Dolby® FM module. Like all Heathkit products, assembly is quick and easy.
Only $319.95

New GD-1186 Digital Electronic Scale

Unique and functional truly describe the new Digi-Scale electronic "weighing machine". Big, bright LED's show your weight with more precision than normal scales and there are no springs or weights to compromise performance. The digital readout may be mounted on the wall or just about anywhere.
Only $99.95

New TO-1860 Heath/Thomas Organ

Microprocessor-based organ has nine preassembled and tested circuit boards for really easy assembly! Color-coded keys and coordinated music make learning to play a breeze. Single-finger chords, automatic rhythms and 17 different instrument voices add real versatility.
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New GC-1107 Digital Alarm Clock

A perfect kit for the first time kitbuilder. This super-accurate timepiece has an attractive blue four-digit display that dims automatically according to ambient light. It also has the features you need in a clock; 24-hour "smart" alarm, snooze switch, alarm-on indicator and power failure indicator.
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Our EE-3401 Microprocessor Operation and Programming Course ($89.95) is your key to the power of microprocessor operation and programming. Features Heath's famous individualized learning techniques to provide you with a thorough background in microprocessor operation, interfacing and programming. Accompanying software and hardware experiments provide "hands-on" experience with the companion ET-3400 6800 Microprocessor-based trainer ($189.95).

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2. H11 LSI-11 16-Bit Digital Computer Kit
3. H9 Video Terminal Kit
4. H10 Paper Tape Reader/Punch Kit
5. LA36 DEC Writer II (Assembled)

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Prices and specifications subject to change without notice.

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Bearcat® 210 $289.

The Bearcat® 210 is a sophisticated scanning instrument with the ease of operation and frequency versatility you've dreamed of. Imagine, selecting from any of the public service bands and from all local frequencies by simply pushing a few buttons. No longer are you limited by crystals to a given band and set of frequencies. It's all made possible by *Bearcat* spaceage solid state circuitry. You can forget crystals forever.

Pick the 10 frequencies you want to scan and punch them in on the keyboard. It's incredibly easy. The large decimal display reads out each frequency you've selected. When you want to change frequencies, just enter the new ones.

Automatic search lets you scan any given range of frequencies of your choice within a band. Push-button lockout permits you to selectively skip frequencies not of current interest. The decimal display with its exclusive "rolling zeros" tells you which channels you're monitoring. When the *Bearcat* 210 locks in on an active frequency the decimal display shows the channel and frequency being monitored.

With the patented track-tuning system, the Bearcat 210 automatically aligns itself so that circuits are always "peaked" for any broadcast. Most competitive models peak only at the center of each band, missing the frequencies at the extreme ends of the band.

The Bearcat 210's electronically switched antenna eliminates the need for the long low band antenna. And a quartz crystal filter rejects adjacent stations as well as noise interference.

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Add $5.00 for U.S. shipping or $9.00 for air UPS to west coast. Charge cards or money orders only please. International orders invited. Michigan residents add tax. Please write for quantity pricing.

Bearcat® 210 Features

- **Crystal-less**—Without ever buying a crystal you can select from all local frequencies by simply pushing a few buttons.
- **Decimal Display**—See frequency and channel number—no guessing who's on the air.
- **5-Band Coverage**—Includes Low, High, UHF and UHF "T" public service bands, the 2-meter amateur (Ham) band, plus other UHF frequencies.
- **Deluxe Keyboard**—Makes frequency selection as easy as using a push-button phone. Lets you enter and change frequencies easily . . . try everything there is to hear.
- **Patented Track Tuning**—Receive frequencies across the full band without adjustment. Circuitry is automatically aligned to each frequency monitored.
- **Automatic Search**—Seek and find new, exciting frequencies.
- **Selective Scan Delay**—Adds a two second delay to prevent missing transmissions when "calls" and "answers" are on the same frequency.
- **Automatic Lock-Out**—Locks out channels and "skips" frequencies not of current interest.
- **Simple Programming**—Simply punch in on the keyboard the frequency you wish to monitor.
- **Space Age Circuitry**—Custom integrated circuits . . . a *Bearcat* tradition.
- **UL Listed/FCC Certified**—Assures quality design and manufacture.
- **Rolling Zeros**—This *Bearcat* exclusive tells you which channels your scanner is monitoring.
- **Tone By-Pass**—Scanning is not interrupted by mobile telephone tone signal.
- **Manual Scan Control**—Scan all 10 channels at your own pace.
- **3-Inch Speaker**—Front mounted speaker for more sound with less distortion.
- **Squelch**—Allows user to effectively block out unwanted noise.
- **AC/DC**—Operates at home or in the car.

Bearcat® 210 Specifications

Frequency Reception Range

Low Band	32—50 MHz
"Ham" Band	146—148 MHz
High Band	148—174 MHz
UHF Band	450—470 MHz
"T" Band	470—512 MHz

*Also receives UHF from 416—450 MHz

Size
10⅝" W x 3" H x 7⅝" D

Weight
4 lbs. 8 oz.

Power Requirements
117V ac, 11W; 13.8 Vdc, 6W

Audio Output
2W rms

Antenna
Telescoping (supplied)

Sensitivity
0.6μv for 12 dB SINAD on L & H bands
U bands slightly less

Selectivity
Better than −60 dB @ ± 25 KHz

Scan Rate
20 channels per second

Connectors
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BUILD

Biorhythm Clock

Predict your good and bad days

Unique digital clock keeps track of your biorhythm curves and determines your physical, intellectual and sensitivity peaks

FRED BLECHMAN, K6UGT

MANY BOOKS AND ARTICLES HAVE BEEN published describing "biorhythms"—life cycles—and their effects on accidents, illness and interpersonal relationships. Various devices for computing biorhythm cycles are available, from electronic calculators to complex gear-driven circular slide rules. Some people pay considerable sums for computer printouts describing and analyzing their biorhythm cycles. These printouts require constant updating, or are difficult to interpret, or both!

The Biorhythm Clock described here can be built for under $30. Set the clock just once and it will continuously display your physical, emotional and intellectual biorhythm curves in digital form without any further attention from you. No calculations, tabular listings, slide rules, templates or computer printouts are needed! All that is necessary is about 7 watts of 117-volt 60-Hz AC power, or as much as a small nightlight.

What are biorhythms?

Biorhythm researchers claim to have statistically determined that, starting from birth, humans have built-in biological "clocks" that vary their physical, emotional and intellectual capacities during regular repeated cycles. Figure 1 shows these cycles. They are conventionally represented as sinewaves of varying lengths—a 23-day physical cycle(P), a 28-day emotional or sensitivity cycle(S) and a 33-day intellectual cycle(I). These cycle lengths apparently have been verified by independent researchers at different times and locations, and with different human subjects. The actual cycle amplitudes (or heights) have no significance; the curves are intended only to represent the day-to-day variation. Above-the-line days are said to be "high" or "discharge" days, below-the-line days are "low" or "recharge" days, and the line-crossing days are termed "critical."

These curves can be interpreted briefly as follows:

Physical—Energy, vitality and endurance during the first 11½ days; fatigue, less reserve power and less energy during the last 11½ days.

Sensitivity (or Emotional)—Optimism, cheerfulness and cooperation during the first 14 days; overly sensitive, moody, irritable and negative the last 14 days.

Intellectual—Clear thinking, good memory, alert, analytical, creative and ambitious for the first 16½ days; difficulty in making decisions, poor concentration, illogical, forgetful and mentally lazy during last 16½ days.

Critical Days—These are the unsettled "switching" days. On these days you should be on guard against accidents, especially when the physical and sensitivity cycles are both critical on the same day.

Although the foregoing is an oversimplification, our intent is only to summarize the biorhythm concept for those unacquainted with it so that the purpose of the Biorhythm Clock can be better understood.

How it works

Figure 2 shows the relative electronic simplicity of the Biorhythm Clock. Three sets of conventional TTL 7490 decade counters together with 7447 decoder drivers and segment resistors are used to light the red, green and yellow seven-segment digital LED displays. Each set of digits is wired so that the displays are reset to 00 at the proper point in their cycle count. An MM5316 clock IC counts down from the 60-Hz line input to

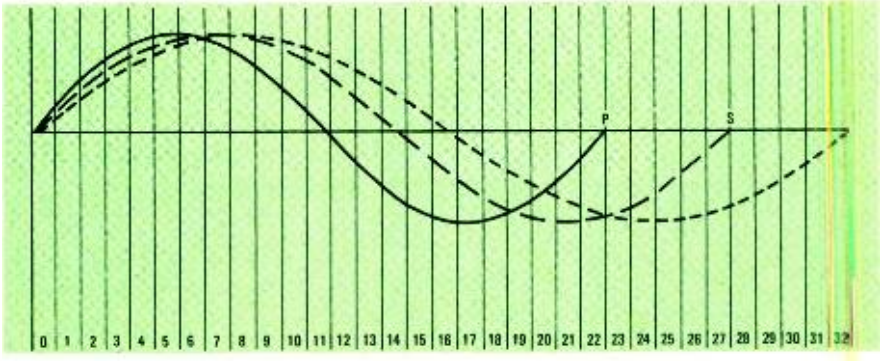


FIG. 1—BIORHYTHM CURVES combined on single graph. The colored version on the front cover should be attached to the clock for easy reference.

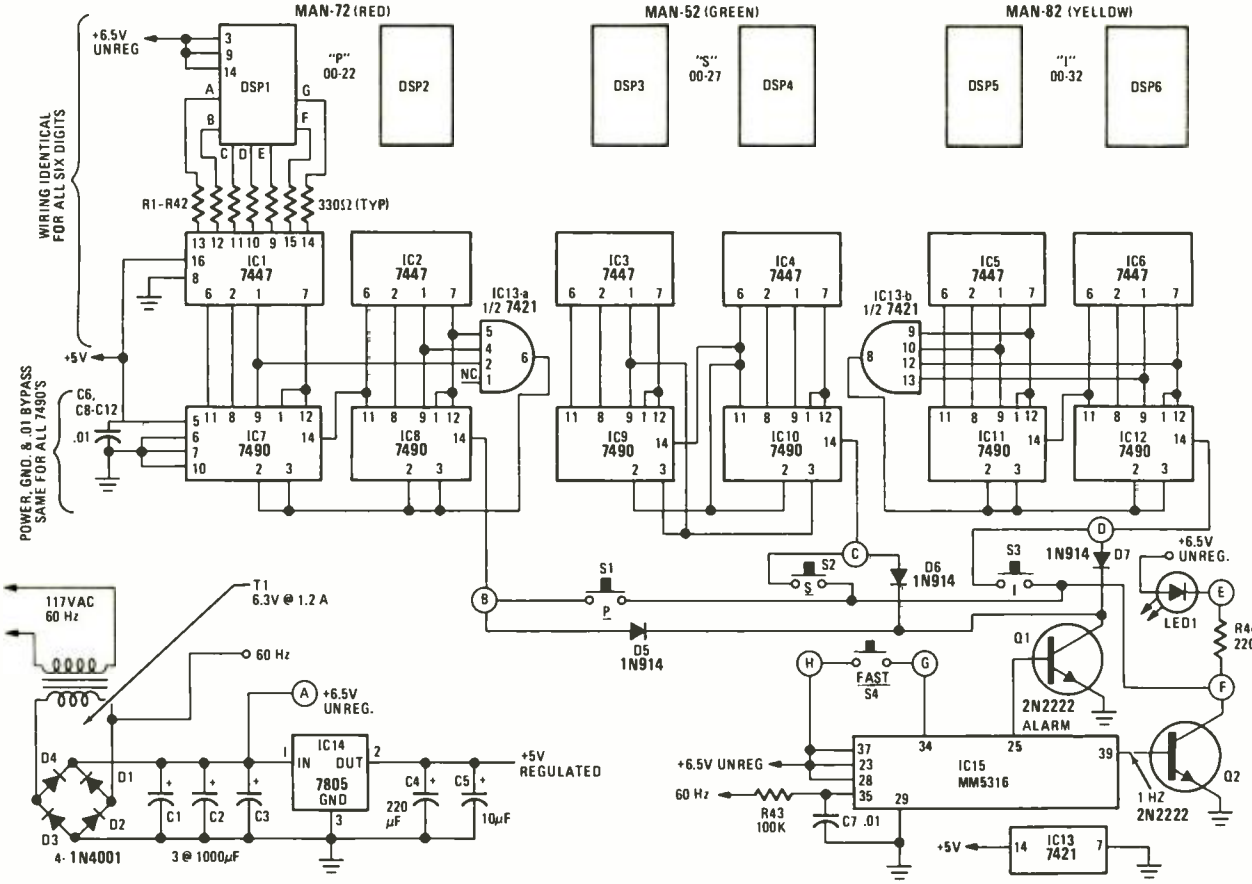


FIG. 2—BIORHYTHM CLOCK displays your cycle-count for the three biorhythm curves.

PARTS LIST

All resistors are ¼-watt, 10%
R1–R42—330 ohms
R43—100,000 ohms
R44—220 ohms
C1–C3—1000 μF, 16 volt, electrolytic
C4—220 μF, 10 volt, electrolytic
C5—10 μF, 10 volt, tantalum
C6–C12—.01-μF disc
D1–D4—1N4001 1A, 50 volt, silicon rectifier
D5–D7—1N914 diode
LED 1—red, jumbo light-emitting diode
Q1, Q2—2N2222 NPN switching transistor
IC1–IC6—7447 BCD-to-seven-segment decoder/driver
IC7–IC12—7490 decade counter
IC13—7421 dual 4-input AND gate
IC14—7805 5-volt regulator
IC15—MM5316 digital alarm clock (National)
T1—6.3-volt 1.2A-amp transformer; 117 VAC 60-Hz primary
DSP1, DSP2—red .3-inch common anode LED display (MAN-72 or equiv.)
DSP3, DSP4—green .3-inch common anode LED display (MAN-52 or equiv.)
DSP5, DSP6—yellow .3-inch common anode LED display (MAN-82 or equiv.)
S1–S4—normally open pushbutton switch
Misc.—Hookup wire for the switches and jumpers, line cord, heat sink for IC14.

The following items are available from Optoelectronics, Inc., Box 219, Hollywood, FL 33022:

Kit BC-P: Complete parts kit, $29.95.

Kit BC-PCB: Printed-circuit boards, drilled, etched, solder-plated and silk-screened with component locations, with three-color metal-foil self-adhesive biorhythm curve decal, $9.95.

Kit BC-S: All IC and display sockets, MM5316 40-pin socket; complete set, $4.95.

Kit BC-C: Custom-made cabinet, with predrilled holes includes hardware. Smoke-gray base, with clear, white or black cover (please specify cover color), $9.95.

Kit BC-A: Completely assembled and tested Personal Biorhythm Digital Clock, with 90-day warranty, $64.95.

Add $2 per order for shipping and handling. Florida residents add state and local sales tax as applicable.

a 1-Hz digit-setting output at pin 39 and a once-a-day all-digit-advance output (alarm) at pin 25. Since the biorhythm count changes only once a day, the MM5316 eliminates the need for a whole string of digital dividers to count the 5,184,000 cycles entering the unit from the power line in one day.

The 7490 counters advance only on a negative-going pulse, and transistors Q1 and Q2 invert the positive-going outputs at pins 25 and 39 to provide an almost direct path to ground for the 7490 pin 14 inputs. Also, because the MM5316 outputs provide insufficient current, transistors Q1 and Q2 are necessary to reliably drive the counters directly.

The normally open pushbutton switches are used initially to enter the digits of your personal biorhythm count on the day you set the clock. When a pushbutton is pressed, the 7490 to which it is connected advances one count per second. At the same time, the red discrete LED lights. This serves as a blinking activity indicator and also, as you will see further on, as a simple, visual switch debouncing device and alarm-setting timer.

Diodes D5, D6 and D7 isolate the digit-pair setting circuits from each other. Once a day, transistor Q1 is driven into saturation by a positive output from pin 39 of the MM5316, grounding pin 14 of the units digit of each digit pair and advancing each pair by one count. The FAST switch, directly connected to pin 34 of the clock IC, allows you to advance the clock IC so that the output from pin 25 occurs at the correct time each day.

Power from the AC line is isolated by step-down transformer T1, so no high voltages appear at any of the circuit points and there is no shock hazard. The low AC voltage is fullwave bridge-rectified, then regulated and filtered by a conventional 7805 IC and electrolytic capacitors C1, C2 and C3. Transient

suppression is accomplished with .01-μF disc capacitors at the power inputs of all the 7490's, and with electrolytic capacitor C4 and tantalum capacitor C5 bypassing the regulated DC supply line. A 60-Hz signal directly off the transformer secondary is conditioned for pin 35 of the MM5316 by resistor R43 and capacitor C7. Unregulated DC power is tapped off ahead of the regulator to drive the displays, the clock IC and the discrete LED; regulated power is used only for the TTL IC's. Although the MM5316 requires a minimum of 8 volts, since only a limited number of functions are used (only 8 pins out of 40 are used), it works well even below the unregulated 6.5 volts used here.

The digit-pair reset circuits are unique and need some explanation. Conventionally, the 7490 IC's, wired as shown, each count from 0 to 9 and then reset to 0 on the next count. They count in BCD (*B*inary-*C*oded *D*ecimal). The "carry" from pin 11 of the least-significant (unit) digit in each pair triggers input pin 14 of the tens digit with a negative-going pulse when the unit digit resets to 0. Left alone in this manner, the digits would count to 99 and then reset to 00 on the next count.

However, for biorhythm counting, it is necessary to "break" the count at different points. The two red digits (physical curve) use a total count of 23; the green digits (sensitivity curve) use a count of 28; and the yellow digits (intellectual curve) need a total count of 33. For circuit simplicity, a count sequence was used that starts at 00 instead of the conventional 01 used in biorhythm counting. Therefore, the physical-curve count (the red digits) runs from 00 to 22 and resets to 00 on the 23rd count. Similarly, the green sensitivity digits and the yellow intellectual digits count from 00 to 27 and 00 to 32, respectively.

A single inexpensive 7421 dual four-input AND gate accomplishes this count sequence by combining the proper BCD outputs of the counters and resetting the counters at the correct count. (See Fig. 2.) For instance, when the physical-curve count is reset, BCD outputs representing the decimal number 23 ("2" from the tens digit, together with "2" and "1" from the units digit) are fed to IC13-a. The output of IC13-a goes high on the 23rd count; this instantly resets both 7490's to 00 through pins 2 and 3. Similarly, the intellectual-curve count is reset to 00 on the 33rd count by a "2" and "1" from each digit, combined in IC13-b to provide a positive pulse to pins 2 and 3 of IC11 and IC12. Reset is simplified for the sensitivity-curve digits; each 7490 has a built-in AND circuit requiring *both* pins 2 and 3 to be high for reset. Therefore, the "2" BCD output of the tens digit triggers one reset pin high on each 7490, and the "8" BCD output of the units digit triggers the other reset pin high, thus driving the count back to 00 on the 28th count.

The blinking LED

The blinking LED is not only an activity indicator, pulsing once per second, but it serves other important purposes. When the LED is on, the collector of transistor Q2 is essentially grounded. This also means that if any of the pushbutton setting switches are operated at this time, contact bounce advances the digits erratically, since each bounce resembles a negative-going pulse to the counters. Of course, debouncing circuits could be used for each switch. However, it's far less complicated to open or close the setting switches when the blinking LED is off, since during that period the transistor collector is high and unable to ground the counter inputs.

The blinking LED can also be used for visually counting the seconds when you set the daily changeover time of the Biorhythm Clock. This is covered in the setting instructions.

Incidentally, don't be alarmed at finding no base, biasing or pull-up resistors used with switching transistors Q1 and Q2. Since pins 25 and 39 of the MM5316 are current-limited internally by their MOS nature, there is no danger of overdriving the transistors.

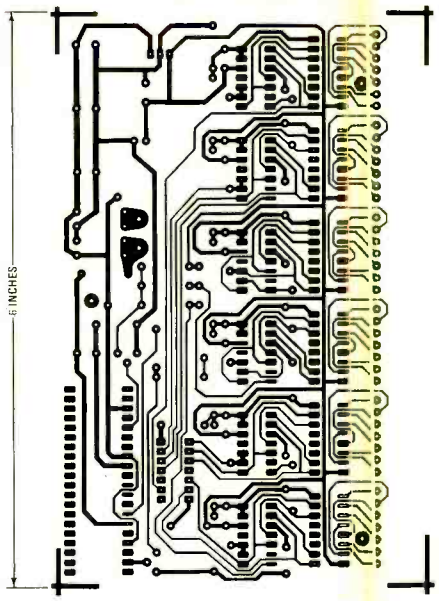


FIG. 3—FOIL PATTERN of main PC board shown half size.

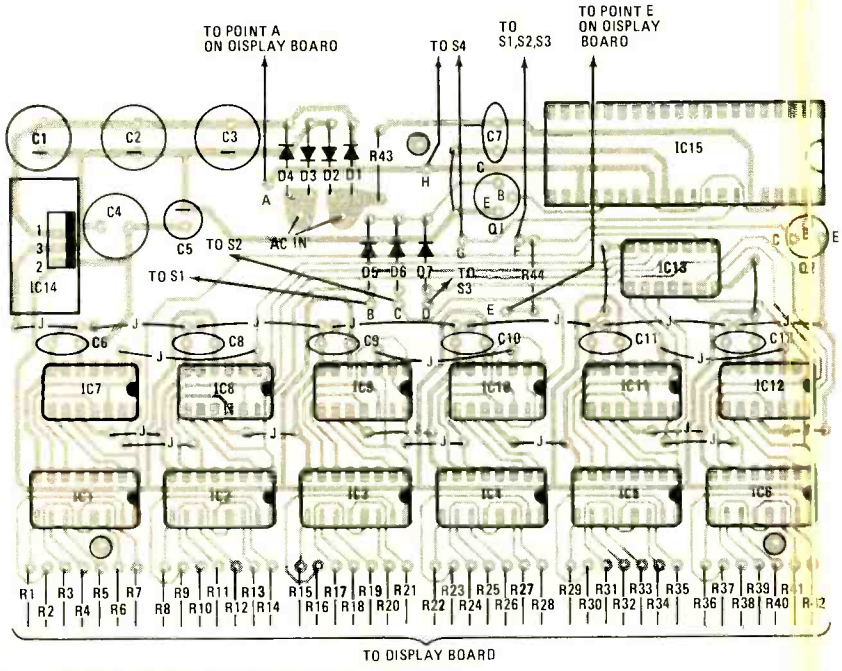


FIG. 4—MAIN BOARD, component placement diagram.

Construction

Two single-sided circuit boards are used. The main board contains all parts except the displays, switches and transformer. The display board, which is placed almost vertical to the main board, contains three pairs of different-colored seven-segment readouts. Of course, if you prefer, you can use readouts of the same color, but much of the effect and the correlation with biorhythm curves used to interpret the digits, will be lost. For simplicity, each board is "stuffed" with parts and soldered independently, then they are joined using the 42 resistors projecting from the main board for physical and electrical mating.

Assemble the main board first. The foil pattern for the main board is shown in Fig. 3 and the component placement diagram is shown in Fig. 4. There is nothing critical about the assembly sequence, but it is wise to mount and solder the smallest parts first, then build up to the larger ones.

If you start with the 42 330-ohm resistors, you'll be able to use the clipped leads later as jumper wires. Bend one lead of a resistor at a 90-degree angle very close to the resistor body, and insert

this lead into the main PC board at location R1. Position the resistor body so the unbent lead sticks straight out from the edge of the PC board. Do the same with the other 41 resistors in locations R2 through R42. Solder each bent lead to the foil side of the board, then cut off and save the excess leads. All the resistor leads extending from the PC board edge should be approximately parallel and equally spaced to mate with the display board.

Install the excess clipped resistor leads in the 22 jumper positions shown on the main PC board. Using pliers, bend the wire to fit between the holes, insert in the board, solder and clip off the excess with a wire cutter. Insert and solder the other resistors, then power diodes D1–D4 and signal diodes D5–D7. Make sure that the cathode (band end) of each diode is oriented as shown.

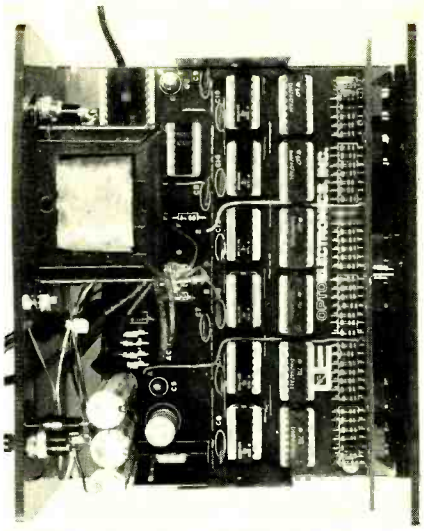
Next, install the sockets; note that there are three sizes. Insert them in the proper hole pattern and bend over diagonally opposite leads to hold the socket in place while soldering. Use a magnifying glass during assembly if possible. If not, examine with a magnifying glass to check that there are no solder bridges between pins or circuit paths, and that the pins are properly soldered to the circuit. If you do not use sockets, solder in all the IC's except the MM5316. The notch, indent or dot marked on an IC designates the pin 1 end.

Solder the small capacitors into the main board, observing polarity for capacitors C4 and C5. Insert and solder the two transistors, being very careful that each lead is in the proper hole. Next, install voltage regulator IC14 and attach the heat sink by pushing it down over the regulator until it snaps into position. Solder electrolytic capacitors C1, C2 and C3 to the PC board, making sure the polarity is as indicated. Set the main board aside for a while.

Assemble the display board next. The foil pattern of the display board is shown in Fig. 5 and the parts layout is shown in Fig. 6. Solder the sockets into the display board, again being extra careful to avoid solder bridges or bad solder joints. If you don't use sockets anywhere else in this project, you should use them here, since unsoldering an inverted digit, or one with a dim or dead segment, can be a real chore. Using sockets also lets you interchange colors and test digits. Finally, be sure to insert the discrete red jumbo LED with the "flat" (cathode) in the hole to the right.

Mating the main board with the display board can try your patience and dexterity unless you use a simple trick. Looking down on the main board, trim the projecting resistor leads so that their length tapers from one end of the main board to the other. You can then insert the longest resistor lead into the first display-board hole (make sure the foil side of the display board faces the main board), then the next shortest lead into the next display-board hole, and so on. When all 42 resistor leads are inserted into the display board, gently rock the display board toward the main board until the two boards almost touch along their common edge. Solder the resistor leads to the foil side of the display board, and clip the excess leads from the front of the display board. Run insulated wire leads from points A and E on the main board to points A and E on the display board, snaking the wires between parts.

The display board is now approximately at a right angle to the main board and ready for mounting in an appropriate case. A plastic pre-drilled case is available from the parts supplier listed in the parts list. Because the front panel of this case slopes back slightly at a 79-degree angle, you'll have to flex the display board back slightly to match the slope of the case. Be gentle, since it is possible to crack one of the segment carbon-resistor bodies if you overdo it.



TOP VIEW of clock mounted in plastic housing.

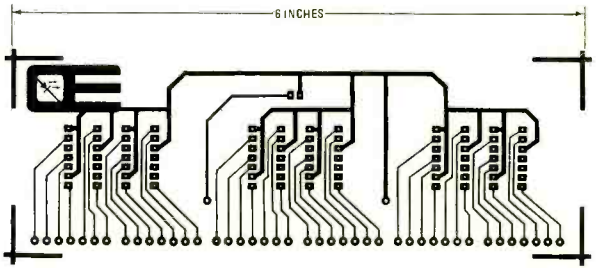


FIG. 5—FOIL PATTERN of display board shown half size.

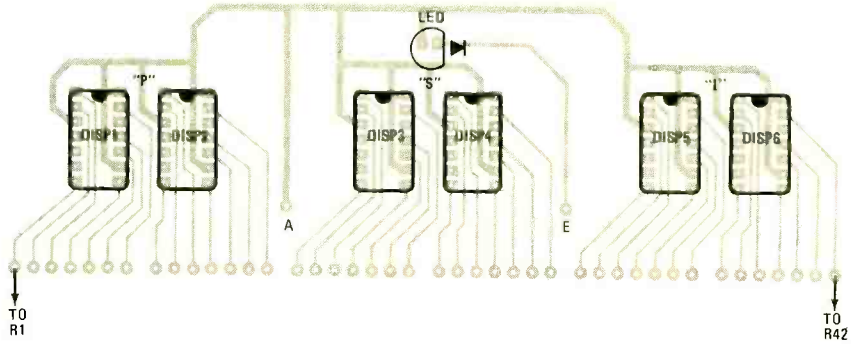


FIG. 6—DISPLAY BOARD, component placement.

The switches are wired to points B, C, D, F, G and H on the main PC board (see Fig. 4). Mount the switches on the cabinet back, with the P switch behind the left side of the PC boards (directly behind the large capacitors), the S switch in the center of the back, and the I switch on the right side. The FAST switch mounts above the P switch.

Feed the line cord through the cabinet back, and knot it near the end to act as a strain relief. Mount the transformer on the cabinet back, then wire the transformer primary (black wires) directly to the line cord. Solder and tape to prevent a shock hazard. The connections for the transformer secondary (green wires) are soldered in the main PC board at the AC In location.

If you used sockets, insert all IC's and displays, observing the proper orientation of pin 1 of each IC. The red digits go on the left, the green in the center and the yellow on the right. The decimal point, visible even on an unlighted display, should be at the bottom. If you did not use a socket for the MM5316, you can solder it directly to the PC board now. It is not necessary to solder the pins to pads that do not have a trace going to them, since most of the MM5316 pins are not used in this application. Make sure that pin 1 is at the right rear corner of the PC board. This is a MOS (*M*etal *O*xide *S*emiconductor) device and easily damaged by a static charge. Leave the unit in its conductive foam carrier until you're ready to use it. For completely safe handling, use a grounded (or battery-operated) soldering iron and a ground strap through a 1-megohm resistor attached to your wrist. The final assembly step is to install the PC boards

into the cabinet base.

"Smoke test" the Biorhythm Clock by plugging it into the 117 VAC line. All the displays should light, but some segments may not operate until the switches are used. The numbers displayed will be random. The red front-panel discrete LED should blink once each second. Operate the pushbutton switches one at a time. When the P switch is depressed, the left-hand pair of digits should count up once per second to 22, then to 00 and then count up again. The S switch should make the center digits count from 00 to 27 and repeat; the I switch advances the right-hand digits from 00 to 32 and repeats. If the numbers seem to jump ahead when you close or open the switch, this is normal. To prevent this, open or close the switch when the blinking LED is *off*. Now close the FAST switch; it may take as long as 23 seconds, but within that time *all* the digit pairs should advance by one count. This operation should repeat every 24 seconds as long as this switch is closed. If the P, S or I switches do not advance their respective digits, close the FAST switch for two or three seconds and try again.

Setting and using

The graph on the front cover of **Radio-Electronics** shows all three biorhythm curves combined on a single 0-to-32-day layout. Each space between the lines represents a day, and each line indicates midnight, with the left-hand line at each space representing the beginning of each day. Day 0, for example, starts at midnight and ends at the beginning of day 1. The last day of each cycle is followed by the 0-day of the same curve, since these curves are said to be exactly repetitive throughout one's lifetime. Your *time* of birth can even be approximated, and your curves would shift to the right by that part of a day; if you were born at noon, your curves would start in the center of space 0.

After the Biorhythm Clock has been set, you will then be able to glance at the digits displayed at any time and simply refer to the curves to see where you are that day on each curve! Each curve in the graph on the front cover is represented in a different color. Simply cut out the graph and paste it on top of the cabinet for quick, easy reference.

To determine the initial settings for the digits, you have to determine the number of days from your birth to the present and divide by 23, 28 and 33 to obtain your personal "P," "S" and "I" curve position for that day. Once this information is entered in the Biorhythm Clock, one count is automatically added each day that is even correct on leap years all the way to the year 2000 and beyond.

To count the total number of full days you've been alive, start with the *full* years since your birth date and multiply by 365. Add the number of leap year days during those years; every year divisible by 4 (such as 1976) is a leap year, except for years divisible by 100, such as 1800 and 1900. However, years divisible by 400, such as 2000, *are* leap years. This compensates for the difference between the length of the common and astronomical years. Now add the days of each *full* month, being careful to get the right number of days in each month. Add to this the number of days in the parts of a month. You now have a *total days* figure, excluding the setting day, which will be added in the setting procedure.

Divide by 23; the result will be a full number and a remainder. The full number represents the completed cycles you've already experienced; the remainder is *yesterday* in your present cycle. Enter this remainder on the "P" (red) digits. Do the same for the "S" (green) curve by dividing by 28, and divide by 33 to obtain the "I" (yellow) count entry.

For example, suppose today is July 2, 1977, and you were born July 23, 1927. Start by calculating the number of days in the full years: 1928–1976, inclusive = 49 years × 365 = 17,885 days. Next come the leap year days: 49 divided by 4 equals 12 days (eliminate the remainder.) Now calculate the number of days in the full months between the day you were born and January 1, 1927 (the beginning of the first full year): 153 days (August through December.) Don't forget to add the number of days in the full months between the last full year and today's date: 181 days (January through June.) Lastly, calculate the number of days in the partial months between the day you were born and the last full month: 9 days (July 23, 1927 and July 31, 1927.) Don't forget the number of days between the last full month and today's date: 1 (July 1, 1977.) Add all the days and you will discover that you have been alive 18,241 days.

Note that the total number of days is *one less* than the actual number of days of your life, since the day of setting was not included. This is the number you must use, since you will add one day when you set the clock.

Now, divide 18,241 by 23, 28 and 33. Since 18,241 divided by 23 is 793 with a remainder of 2, the "P" initial setting is 2. (Note: If you use a calculator, the answer is 793.08695. Multiply the decimal portion by the divisor—in this case, 23—which gives .08695 × 23 = 1.99985, or 2 days.) Similarly, dividing 18,241 by 28 gives an "S" setting of 13, and dividing by 33 yields an "I" setting of 25.

Set these "P," "S" and "I" numbers into the Biorhythm Clock, remembering to press and release the setting switch *only* when the blinking LED is off, or the digits will jump ahead. If this happens, just repeat the operation. Each pair of digits are set separately, and do not interact with any other pair. If the digits do not advance when the pushbuttons are pressed and the LED stays on, this means the clock IC alarm pin is active, grounding the 7490 unit counters through transistor Q1. Just hold down the FAST pushbutton for two or three seconds to clear this condition.

Now you must decide the time you want your digits to advance each day—midnight, noon, 8 AM? The choice is up to you, but around midnight is the most usual time. The time you choose determines the next and final steps in setting clock. Hold the FAST pushbutton down until all three digit pairs advance simultaneously. This could take as long as 23 seconds, depending on the random turn-on clock IC alarm and real-time settings. (Since these settings cannot be read, no control is provided.) Activating the FAST switch causes the clock IC real time to advance one hour per second, until it coincides with the alarm time. At this point, the alarm positive output turns on transistor Q1, the three units digits advance one count and your biorhythm count is displayed for the start of "today."

Releasing the FAST switch causes the clock IC to count in real time; the alarm output at pin 25 of the MM5316 will remain active for an hour, then turn off and repeat 24 hours later, advancing the digits one count. However, you can advance the clock time one hour per second by holding down the FAST switch, moving ahead through "today" for as many hours as you desire. For example, if you set the clock at 4 PM and you want it to change at midnight each day, because 4 PM is 16 hours past midnight, you have advanced 16 hours into "today." Therefore, when the digits have advanced once, which brings them up to "today's" count, just continue to hold the FAST switch down for 16 more seconds, using the blinking LED to count the seconds. When you release the switch, the clock IC will count at normal speed and, in around eight hours (in this example, around midnight) all digit pairs will advance by one, and you'll be into "tomorrow"! **R-E**

EIA urges standardized CB call signals

A simple standardized selective call signal system has been urged by the Communications Division of the Electronics Industries Association. The system could be built into new radios or added to existing sets.

Used for many years in land mobile radios, selective calling is a system in which a receiver remains silent during channel monitoring and is then triggered by a preset tone or tones to respond to a specific call intended for that receiver alone.

When CB was young, selective calling systems were a standard feature. Lately, however, interest has been revived, due to recent solid-state innovations and other technological advances, plus the ever-present problem of CB channel overcrowding.

Circular Polarization Minimizes TV Ghosts

An old technique, now applicable to TV broadcast and reception, promises vastly improved reception for many viewers

ROBERT F. SCOTT
TECHNICAL EDITOR

ALMOST FROM THE VERY BEGINNING OF TV BROADCASTING, SOME television viewers have been plagued with a number of reception problems. The most common are

- Ghosts caused by multipath reception
- Co-channel interference
- Adjacent-channel interference
- Critical antenna orientation
- Fading and weak-signal areas

An announcement, last April 6, that the FCC had amended its rules to permit the use of right-hand circular or elliptical polarization for TV broadcast transmissions almost stood the TV broadcast industry on its ears. The reason for the excitement is that circular polarization—used for about 10 years in FM broadcasting—appears to be the solution to the problems listed above.

In its rulemaking notice, the FCC noted that horizontal polarization, the standard for TV broadcasting since 1941, "was inappropriate for minimizing such problems as reflections (ghosts), spotty coverage (canyon effects) and multipath interference. Also, horizontal polarization requires critical antenna orientation for maximum signal reception and minimum distortion."

Before looking into circular polarization (CP) and how it makes possible the many promised advantages, let's take a look at horizontal polarization (HP) as used in the U.S. and vertical polarization (VP) as used in England and parts of Europe.

Polarization

Radio waves are composed of *electric* (electrostatic) and *magnetic* fields that are at right angles to each other and perpendicular to the direction of wave travel (Fig. 1). The polarization of a given antenna corresponds to the direction of the *electric* field. Thus, an antenna radiator oriented horizontally radiates horizontally polarized waves. When the electric field is vertical the radiator is vertically polarized. It is for this reason that antennas are referred to as being horizontally polarized or vertically polarized. Figure 2 shows how a hypothetical observer might see approaching vertical and horizontally polarized radio waves.

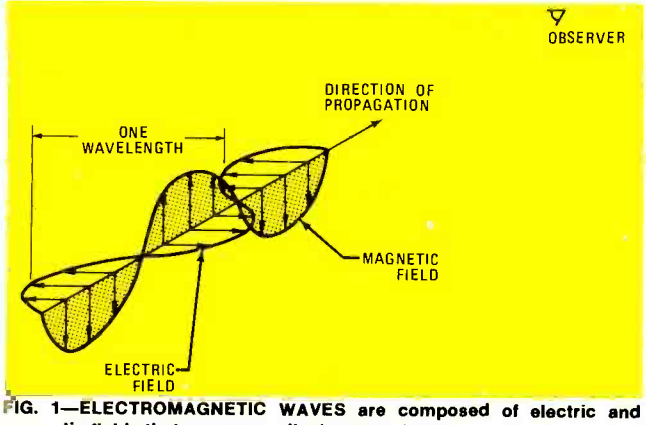


FIG. 1—ELECTROMAGNETIC WAVES are composed of electric and magnetic fields that are perpendicular to each other.

Note that the amplitude of the electric field goes through zero once every half-wavelength. A receiving antenna oriented horizontally in the plane of the electric field, extracts energy from that field. However, that same receiving antenna is incapable of extracting energy from the same electric field when it is oriented at right angles to it. Thus, the strength of the signal generated in the receiving dipole depends on the dipole's orientation. For the best reception of a horizontally polarized signal, we need an antenna that is horizontal and perpendicular to the direction of propagation. The more the antenna deviates from the horizontal, the greater the signal loss. The signal at the antenna terminals drops to zero when the antenna is vertical.

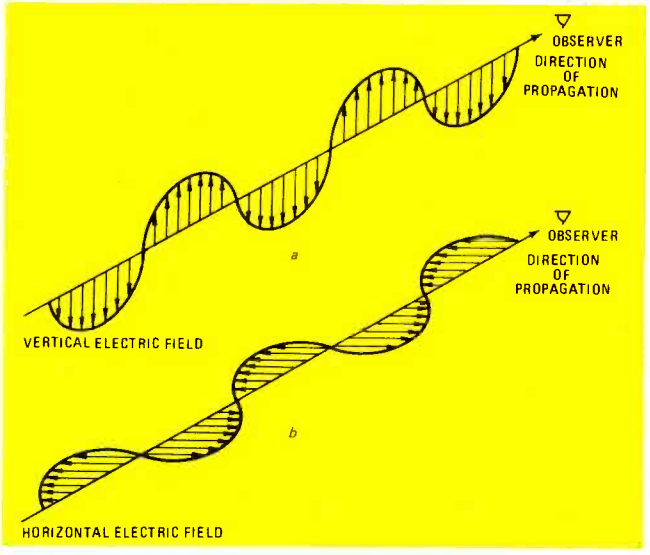


FIG. 2—POLARIZED ELECTROMAGNETIC WAVES. Vertically polarized wave is shown in *a*. Horizontally polarized wave is shown in *b*.

Circular polarization results when two radiators—one horizontally polarized and the other vertically polarized—are fed with the same RF signal. When the signals driving the two radiators are 90-degrees apart, the generated field has constant magnitude and rotates clockwise or counterclockwise, depending on whether the horizontally polarized wave leads or lags the vertically polarized wave. A counterclockwise rotating field is said to be *left-hand polarized*. Conversely, a right-hand polarized signal rotates clockwise (as viewed toward the direction of propagation. See Fig. 3.)

Advantages of circular polarization

1—A dipole antenna in a circularly polarized field intercepts a constant level of signal regardless of its orientation—be it

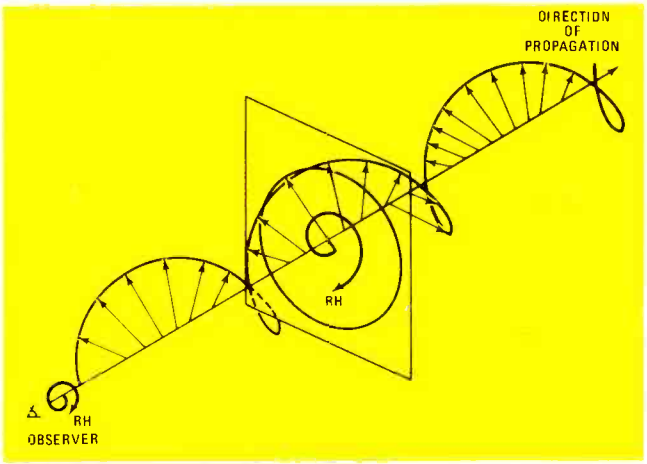


FIG. 3—RIGHT-HAND POLARIZED WAVE appears to rotate clockwise as viewed toward the direction of propagation.

vertical, horizontal or at any angle between 0 and 90 degrees. Thus, circular polarization is compatible with the horizontally polarized outdoor antenna, the collapsible whip built into many portable and table model sets and the "rabbit ears" that may be oriented at almost any desirable angle. Figure 4 shows how the three common types of TV receiving antennas are equally receptive to components of a circularly polarized signal.

2—A circularly polarized receiving antenna is almost totally immune to reflected multipath signals and to co-channel signals arriving from the rear of the antenna. A right-hand circularly polarized antenna responds only to right-hand circularly polarized radiation and is practically immune to the pickup of left-hand polarization. This characteristic of circular polarization offers a great reduction in ghosting from multipath reflections—theoretically as much as 25 dB when both receiving and transmitting antennas are circularly polarized.

The reason for this is that *reflections from a flat surface cause a reversal in the direction of rotation of the electric field.* As Fig. 5 illustrates, a circularly polarized signal with right-hand rotation, when bounced off a flat surface, produces a reflected wave with left-hand rotation. The horizontally polarized receiving antenna will be energized by both the direct and reflected waves and cause a ghost in the picture. On the other hand, the right-hand CP receiving antenna responds only to the direct wave and rejects the reflected wave, so ghosting is eliminated. The photos in Fig. 6 are examples of the ghost-reducing capabilities of circular polarization. The photo on the left was taken when using horizontally polarized transmitting and receiving antennas. The right-hand photo was made at the same location a few seconds later using CP transmitting and receiving antennas. Note the improvement made possible by circular polarization.

Figure 7 shows why a circularly polarized receiving antenna

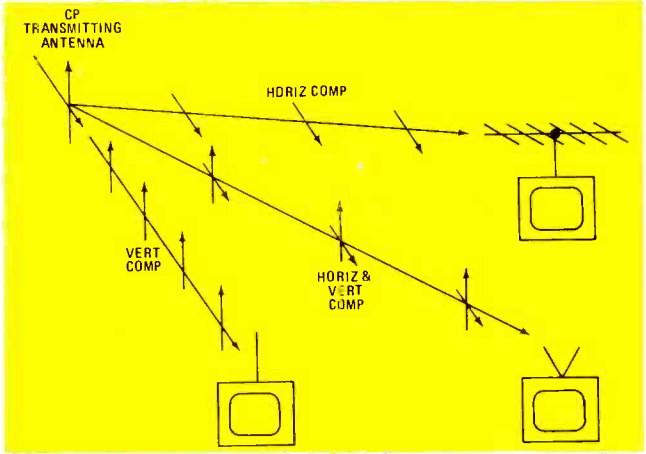


FIG. 4—CIRCULARLY POLARIZED WAVES can be received by three common types of TV antennas.

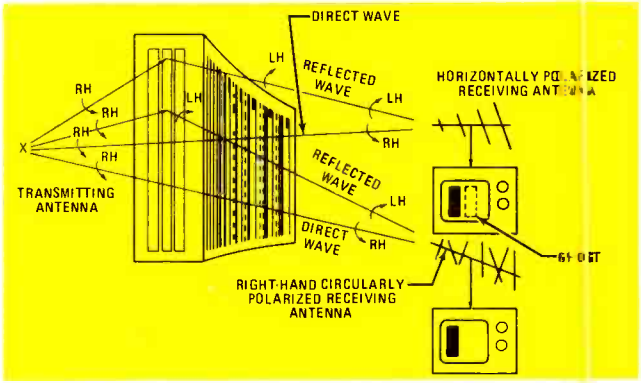


FIG. 5—CIRCULARLY POLARIZED ANTENNA reduces ghosts.

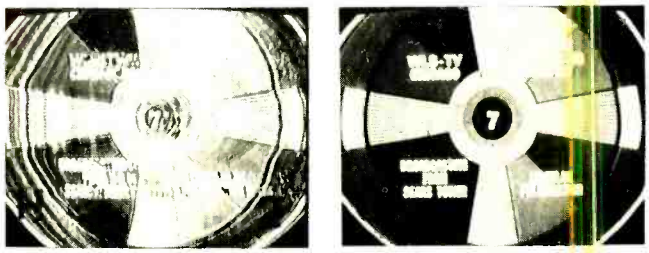


FIG. 6—GHOST REDUCING CAPABILITY is evident. The photo at left was taken while using HP receiving and transmitting antennas. At right, taken moments later, shows CP transmission and reception.

does not respond to signals from the rear. An antenna designed to receive a right-hand circularly polarized wave coming from the front will view a similarly polarized wave coming from the rear as having left-hand polarization. When the antenna in Easton is oriented to receive the Middletown station, its back will see the co-channel Centerport signal as having left-hand polarization and will reject it. Typically, a Yagi or log-periodic receiving antenna has a front-to-back ratio of 15 to 20 dB. A CP antenna can have a front-to-back ratio as great as 40 dB.

Axial ratio

In practice, a CP antenna with perfect circular polarization does not exist. Instead, the rotating electric field is an ellipse that can be represented as two counter-rotating circular polarized signals as in Fig. 8. The ability of a CP antenna to reduce ghosts caused by reflections is determined by a factor called the *axial ratio.* This is defined as the ratio of the major axis (E1) of the polarization ellipse to the minor axis (E2).

Figure 8-a shows the development of a circularly polarized

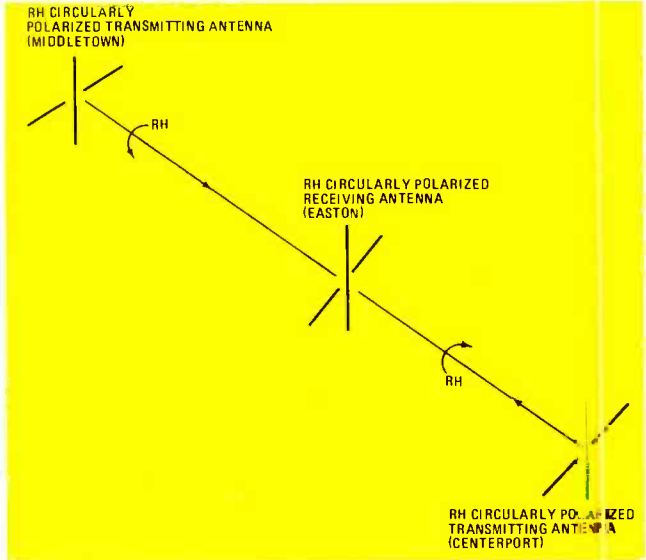


FIG. 7—FRONT-TO-BACK RATIO of circularly polarized receiving antenna can be 20-dB greater than a horizontally polarized receiving antenna.

wave consisting of a large right-hand component and a very small left-hand component. The axial ratio increases toward infinity as the right-hand polarization component decreases and the left-hand component increases. In Fig. 8-c, the left- and right-hand components are of equal amplitude and the axial ratio is infinity. (In these examples, the *polarization ratio* E_V/E_H is unity; where E_V is the vertical component and E_H is the horizontal component.) Figure 9 shows the relationship between the axial ratio and ghost reduction.

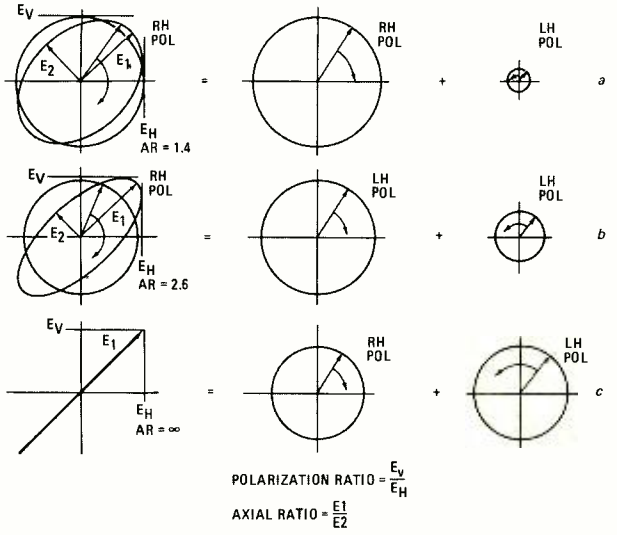


FIG. 8—ELLIPTICAL POLARIZATION is a combination of two circularly polarized signals.

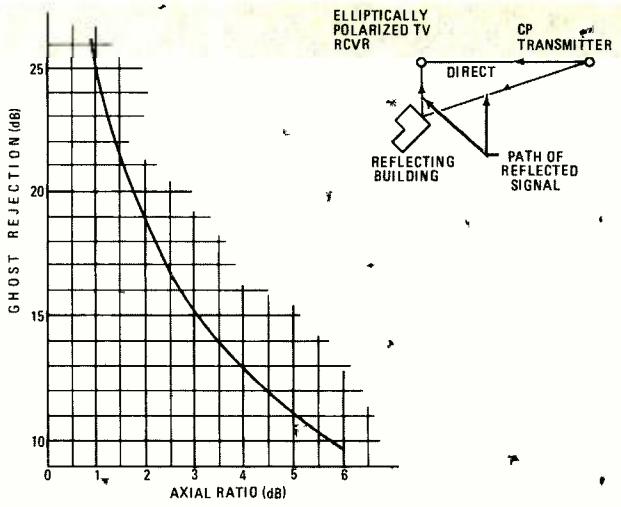


FIG. 9—AXIAL RATIO versus ghost reduction.

Fringe-area performance

When circular and horizontally polarized receiving antennas of the same relative efficiency and gain are compared, the CP model will develop about twice the received power at its terminals. This additional terminal voltage can mean a reduction in snow in fringe areas or an increase in coverage—particularly to sets employing built-in antennas or rabbit ears.

The broadcaster and CP

The maximum ERP (*E*ffective *R*adiated *P*ower) of a TV station is controlled by the FCC. The reference antenna is a horizontally polarized linear dipole. Since half the power in a circularly polarized transmission is horizontally polarized and half vertically polarized, a TV broadcaster must double the transmitter power or install antennas having twice the gain of the original horizontally polarized antenna. This insures that when a station converts to CP, the same signal strength will be developed in a properly oriented receiving antenna.

Thus, stations converting to CP must put the total authorized ERP into both vertical and horizontal polarization. This is done by increasing antenna gain or transmitter power output, or a combination of increased power and antenna gain.

CP and the viewer

What can you, as a TV viewer, expect when local stations convert to circular polarization?

1. Greatly improved reception in areas where rabbit ears and monopole VHF antennas and loop and bow-tie UHF antennas are common. Received signals will be 3.8 dB stronger.
2. Viewers that have good roof-top antennas may not notice a change in the reception. However, there will be an average 3.25-dB increase in received signal strength. If ghosting is a problem, the interference will still exist when the station converts to CP. Note well that when ghosting exists, it will be reduced 10 to 20 dB with CP transmitting and receiving antennas.
3. On many superior HP receiving antennas—those on towers or high buildings, in the clear and away from obstructions and reflective surfaces—there may be no measurable difference in the signal voltage developed on CP and HP receiving antennas.
4. If you are bothered by automobile ignition interference, the change to CP transmission, reception, or both may not help. Ignition interference has a semi-random polarization with a dominant vertical component. When the receiving antenna is close to the ground—as in many mobile and portable TV installations—the increase in signal strength due to the vertical component of the CP transmission *may* result in a substantial improvement in the signal-to-interference ratio.

CP in your area?

When you can expect CP in your area is a difficult question. The TV broadcaster who converts to circular polarization will be serving essentially the same audience as before the conversion. His major advantage will be improved coverage in areas where portable antennas are most common. The estimated average cost of converting to circular polarization is around $500,000. For this reason many broadcasters will not make the change until forced to do so by competition or until such time as the cost can be incorporated in an engineering upgrade of transmitter or antenna. Most likely many of the early conversions will be made by educational and non-commercial TV stations.

Who is using circular polarization?

WLS-TV (7) Chicago, IL—Has been using circular polarization under temporary authorization for nearly two years. WLS-TV is likely to be the first to be licensed for CP transmissions of TV signals.

KLOC (19) Modesto, CA—On the air.

WPBT (2) Miami, FL—Non-commercial educational station. Early fall; September target date.

KYBU-TV (11) Provo, UT—Non-commercial educational station. Early fall. September target date.

WRAL-TV (5) Raleigh, NC—Will begin CB transmissions within a year.

WTTV (4) Indianapolis, IN—Will begin using CP in late 1977.

XETV (5) Tijuana, Mexico—Within a year.

Receiving antenna types

The basic CP receiving antenna is crossed vertical and horizontal dipoles fed in quadrature. Another simple type consists of two V-shaped dipoles fed 90 degrees out of phase. Gain-type CP may consist of crossed Yagis or crossed log-periodics such as the JFD XCP-80. Several types of CP transmitting antennas are being made by RCA, Jampro and Harris. Most manufacturers of TV receiving antennas are developing circular polarized models and it is quite possible that several will be in production before this article appears. **R-E**

ROUNDUP

Part II

Digital Clock Kits For Your Car

FRED BLECHMAN, K6UGT

LAST MONTH WE DISCUSSED MOBILE ELECTRONIC DIGITAL clocks in general—their features and characteristics. A Comparison Chart presented specific information about the various clocks, which are available in either kit or ready-to-install form. This month we'll comment, in alphabetical order, on all the clocks built or studied for this report. Refer to the chart in last month's article for the manufacturer or distributor's suggested prices:

Alpha

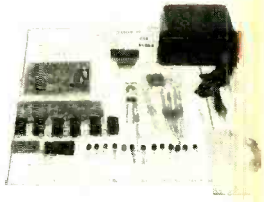
This is the smallest six-digit car clock in a case offered in kit form, and is very simple to build. Most of the parts are on one small PC board, and a preassembled display connects directly to it with 13 short bare jumper wires that mate the board and display physically and electrically. The attractive natural-aluminum case can be painted to match your vehicle interior, and the small size makes it easy to locate under the dashboard.

The small calculator LED digits are enlarged by a red plastic magnifier included with the case. Because of the small LED's, the MM5314 is used to drive the segments directly, eliminating at least seven resistors and transistors. Also, the digit driver transistors are run without any resistors, saving more parts. The crystal timebase uses two IC's to count down to 60 Hz from a 6.5536-MHz crystal. Voltage reversal and transient protection is provided by several diodes and capacitors. A HOLD switch can be added from clock IC pin 13 to ground if you want to set this clock to the second. Alpha Electronics, Box 64726, Dallas, TX 75206.

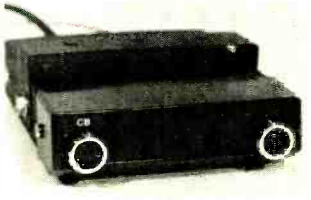
Applied Marketing

The *model LC-100*-series clocks are the only liquid crystal display units found in researching this article. The *model LC-*

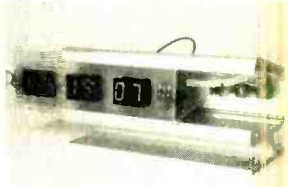
MA-1003's XTAL OSCILLATOR is calibrated at the factory.



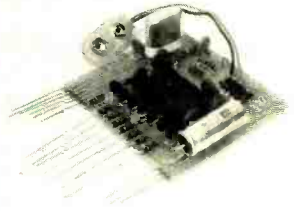
NEXUS PARTS, INSTRUCTIONS.



TONITRON TC-74 CB CONVERTER/CLOCK.

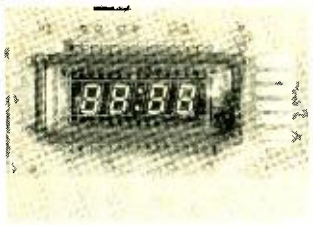


RAMSEY DC-7 UNIT AND CASE.

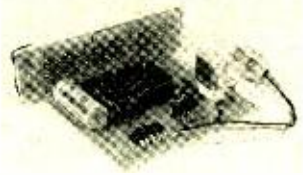


OPTOELECTRONICS 2001 BOARD. Leads mate with display board.

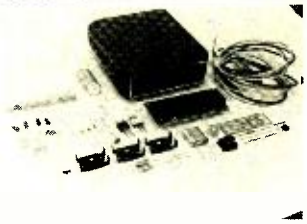
S.D. SALES CLOCK BOARD.



THE NATIONAL MA-1003 "KIT," assembled except for switches.



OPTOELECTRONICS CLOCK ready to drop into its case.



QUEST CLOCK, PARTS LAYOUT.

XANTECH 1611.00 CLOCK uses a lens-magnifjed display.

101 is really a large-display five-function digital watch with constant readout. It can be attached directly to a dashboard with hook-and-loop Velcro (supplied), and removed for portable use, since there are absolutely no wiring connections to the vehicle. Two internal watch batteries last more than a year. The brighter the surrounding light, the clearer the display—even in direct sunlight! You can set and program the timekeeping and calendar functions to display hours, minutes, seconds, month and date in various formats. The *model LC-101* slips into a very stylish, transparent formed plastic holder (*DS-99*, $2) for desk top use. This holder is ingeniously designed to flex when the top is pressed, operating the clock's second/date command button.

Model LC-104 is a portable in-dash model of the *model LC-101*. *Models LC-102* and *LC-103* are the on-dash and in-dash wired models. They connect to the vehicle positive 12 volts and panel-light fuse-block points (using unique snap-on fuse clips) and also to ground. When the vehicle lights are turned on, a light built into the clock makes the display visible.

Model DC-201 is the smallest mobile clock found in this survey—2.35 cubic inches. It is available with red or green 0.3-inch-high LED digits for the same price. An external "regulator" (actually, a series voltage-dropping resistor) is used with the *model DC-201*, but is contained in the case of the slightly larger in-dash *model DC-202*.

The *model VC-501* uses a bright fluorescent display, with a choice of red, green or blue filters, and can be connected to dim when the panel lights are turned on. No provision is made to display or "zero" seconds. The *model VC-502* is the same unit with a case designed for in-dash mounting.

All Applied Marketing clocks use time-setting switches accessible only through tiny holes in the front of the cabinet, to prevent tampering. A toothpick or other nonmetallic object is used to press the "hidden" switches. The brown or black cabinets have a leather-look and chrome-colored rim for an elegant appearance.

The plastic display stand, complete with DC converter, is included *free* to retailers with the order of a demonstration model from Applied Marketing!

Models LC-101 or *LC-102* can be ordered postpaid for $44.95 from Scotty Sless, Electronic City, Inc., 4001 W. Burbank Blvd., Burbank, CA 91505. (California residents add sales tax.) Applied Marketing Corp., 808 Phoenix Dr., Ann Arbor, MI 48104.

Audiovox

This clock is unique in several respects. It is considerably smaller than most of the other cased clocks covered in this survey (5.6 cubic inches as compared to 8.4 cubic inches for the next smallest Alpha clock). It is provided with a mounting bracket, screws and self-stick pads for above- or below-dash mounting, as well as a black plastic housing frame for in-dash mounting, making it the most versatile for installation. Everything is packaged in formed styrofoam that slides into a beautiful windowed black, red and white carton—an especially attractive gift!

This "Made in Japan" unit has extremely high parts density, very bright red digits and tiny time-setting switches on the front panel. A single decimal point between the hours and minutes is used in place of a two-dot colon. It blinks on for one second, then off for one second. Setting the minutes zeros the seconds count, so it can be set right to the second. The gold-colored front frame gives the clock a very rich look, but might contrast with the silver trim used in most car interiors. It is not offered in kit form. A recent Fingerhut Corporation mail-order catalog (11 McLeland Road, St. Cloud, MN 56395) offered this clock for $39.95 plus postage and handling. Audiovox Corp., 150 Marcus Blvd., Hauppauge, NY 11787.

Bullet

The *model MK-03* kit offers both real time and elapsed time in a 24-hour format with six digits—hours, minutes and seconds. By using two clock IC's, real time is retained while elapsed time is displayed, and vice versa. The two clock IC's are presoldered one on top of the other, except for eight pins on the top IC. No switches are supplied, but by using six pushbutton switches and four slide or toggle switches, you can: Select and display either the real- or elapsed-time mode; advance either mode by increments of 1 minute, 10 minutes or 1 hour; display, set and enable an alarm time in either mode (including a 10-minute automatic repeat); reset to zero, or hold and start or restart in the elapsed-time mode. With a photocell and resistor, you can add automatic dimming. The alarm circuit requires a speaker, resistor and common transistor, not included. All other parts, including a timebase that uses a ceramic resonator instead of the more common quartz crystal, are supplied, and assemble onto three PC boards—timebase, display and clock. Packaging is left up to the builder, since so many options are available. Everything could fit nicely in a 1½ × 2½ × 4-inch enclosure, and does fit very well in the Radio Shack No. 270-285 $3.95 case, with plenty of room for switches.

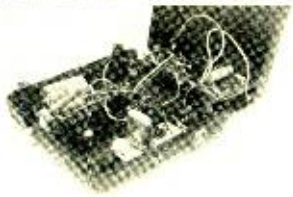
The PC board assembly is straightforward, but interwiring between boards and switches shouldn't be attempted until the options are selected and the switches and assembled boards mounted. The instructions are very complete and clearly show the numerous options. Although intended for aircraft use on 14 volts, it is perfectly usable at 12 volts. For 28-volt aircraft use, a simple voltage regulator is shown in the instructions.

This is an outstanding buy in a combined real-time/elapsed-time clock, and the only one covered capable of displaying 24-hour elapsed time in six digits without destroying the real time.

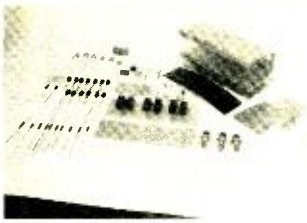
The *model MK-05* is the least expensive case-included kit in this report, as well as being one of the smallest. If you want it without the two-piece aluminum case (the chassis is white, the cover is black-wrinkle, and felt feet are included), the price is $3 less. The case has ample room for the alarm speaker and switches.

The assembled PC board and display are easily packaged in an even smaller enclosure if you desire. The nine-digit magnified calculator display is preassembled, and is connected to the main board with 17 wire jumpers that also provide physical mating. Unused digits 1, 4, and 7 result in spacing between the hours, minutes and seconds digits. The main board is not really crowded, even though it contains a Zener diode and hand-wound toroidal inductor for voltage spike and reversal protection, the clock IC, the crystal oscillator, six digit-driving transistors, and a few resistors and capacitors. Even the two resistors and transistor used with the alarm output are included—all you need to add is the small speaker and two switches.

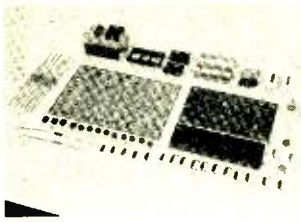
Only two wires are used to connect this clock to the vehicle. Since the whole clock, with the display on, draws less than 50 mA from the battery, it's left on all the time. By pressing both



THREE QUEST MODULES: Power supply, clock, timebase.



RAMSEY DC-7 PARTS LAYOUT.



S.D. SALES, PARTS LAYOUT for the jumbo LED car clock.

OPTOELECTRONICS DISPLAY.

the fast and slow setting buttons at the same time, the display resets to 12 00 00, so this could be used as a six-digit elapsed timer, although real time is lost. Setting minutes zeros the seconds count.

This small, easily assembled mobile alarm clock is an outstanding kit. Bullet Electronics, Box 19442R, Dallas, TX 75219.

CC & SS, INC.

For the style-conscious clock fan, this unit comes with a Stewart-Warner instrument gauge case and custom green lens. The PC board and display are deeply recessed into the case to prevent outside light from washing out the display. A photocell mounted inside the front of the case prevents nighttime glare, and a unique ball-socket pedestal provides for mounting above or below the dashboard at almost any angle.

This clock is "programmed" with an internal switch to the month, date, hour, minute and second, and can even command the display to switch between hours-minutes and month-date every two seconds. This is called "Mode II." Using the external switch, you can display seconds. Or, if set in "Mode I," the display shows hours and minutes, with the external switch controlling month-date or seconds display. All this is done with a digital watch IC packaged in a 40-pin DIP package and powered by an AAA alkaline 1.5-volt cell that draws less than 5 μA in its timekeeping function, so the battery has almost shelf life!

Assembly is relatively simple for a clock with so many functions. All the parts except the external switch and the photocell are mounted on a single-sided PC board that is precisely cut and grooved to fit in the gauge case. This compact design requires careful soldering and patience in installing the multi-pin fluorescent display.

Only two wires are needed for installation in the vehicle (switched 12 volts and ground), since vehicle power is used only to light the display; the internal battery counts continuously, just like a digital watch. CC & SS, Inc., 2309 Santa Monica Blvd., Santa Monica, CA 90404.

Concept

The *model AC-05* LED clock is available with either a 12- or a 24-hour display (*model AC-05-1* is the 24-hour version). Without a case ($2 less), it is called *model AC-03* (12 hours) and *model AC-04* (24 hours), and has a 2-inch diameter for in-dash mounting. Shielded cable is provided to minimize RFI. Another version, with a recessed green fluorescent display in a stylish rectangular on-dash case, is the 12-hour *model AC-06* or the 24-hour *model AC-06-01* for $34.95.

Time-setting is accomplished by merely placing your finger tip between metal tips that project from the clock faceplate; the body capacitance advances the hours or minutes, depending on which contacts you touch. No provision is made to display or to synchronize seconds. Concept Enterprises, Inc., 1308 Wilshire Blvd., Los Angeles, CA 90017.

Fairchild

One of the new *Solid State Technology Kits* available from various distributors, this auto clock has its faults. The physical shape is hard to package in any standard cabinet; it appears to have been designed for in-dash mounting, even though no bezel, faceplate or housing of any sort is available from or recommended by Fairchild.

The kit built for this report was housed in a 4-inch-long, 2-inch inside-diameter plastic tube with a rectangular piece of plastic for a faceplate. The displays and switching transistors are operated at relatively high temperatures to achieve high brightness, which is bound to shorten component life. The crystal oscillator in the tested unit was touchy, and refused to start up at the optimum crystal trimmer timekeeping setting.

But perhaps most important to the kit builder are the instructions. While at first glance these appear to be very good and are printed beautifully, they contain errors and omissions. For example, the instructions did not orient the top of the display digits (which can easily be installed inverted); the polarity of the colon LED's was not shown, except schematically; the displays were labeled incorrectly and the phototransistor inverted on the assembly drawing; the schematic was incorrect, as well as having omitted all IC functions and display pin designations; there was no circuit explanation; and only one side of the two-sided PC boards was shown, making trouble-shooting very tricky.

On the plus side: With only two front-panel switches the user can set the clock and calendar and display the month and date, or seconds, as well as hours and minutes. This is done by using a digital watch IC in a 28-pin DIP package. Because it is multiplexed with relatively heavy current flowing when the display is on, the RFI is particularly high.

If the phototransistor doesn't seem to change the display brightness when covered to block light, remove it from the PC board, cut off the center lead (base), and install it upside down from the way it's shown in the instructions on the assembly drawing. When operating properly, the display will be either bright or dim, depending on the light falling on the phototransistor; this circuit does not give *variable* contrast, like the other automatic brightness circuits checked for this article.

If your display is blank with power on and the toggle switch is to the left, try touching the crystal with your finger tip to start the oscillator. This should cause the digits to flash on sequentially as the oscillator starts up.

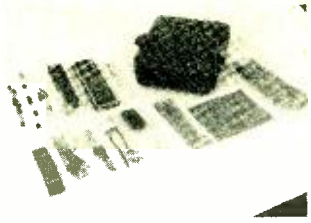
Apparently this clock is subject to false triggering, since an addendum to the instructions describes an external circuit with approximate resistor and capacitor values "which may be increased if the condition persists."

Presumably by the time you read this, Fairchild will have overhauled this design and its instructions. Fairchild Camera and Instrument Corp., Optoelectronics Div., 4001 Miranda Ave., Palo Alto, CA 94303.

Heath

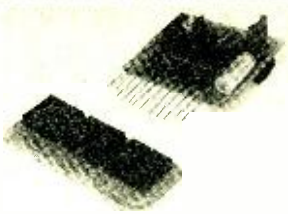
Like all Heath products, the *model GC-1093* has been designed up to a level of performance, not down to a price. The circuitry is complex, but the kit can be assembled with ease because of the excellent instructions and straightforward construction. The display board is preassembled, with the four-digit display mounted and soldered to the PC board. The two PC boards (clock and display) are both masked between solder points to help eliminate solder bridges. This was one of the few clocks built for this project that worked perfectly when power was first applied!

The steel case and bezel are extremely rugged, and the display is outstandingly readable due to digit size, color and brightness. This also is one of the few clocks that displays



OPTOELECTRONICS 2001 PARTS are packaged in poly strips.

S.D. SALES STICK AND BOARD.



NEXUS DISPLAY AND BOARD mate direct, for easy assembly.

TONITRON TC-73 FM CONVERTER/CLOCK.

elapsed time (up to 20 hours, with minutes and seconds for the first 20 minutes) without destroying the real time.

Unfortunately, you can't set the real time to the second, since there is no way to hold the count or zero the seconds. Also, no provision is made to adjust the crystal timebase, but the model built by the author ran very accurately. Heath claims a typical accuracy of 1 minute per month. The complex photocell dimming control circuit worked beautifully, varying the brightness over a broad range and yielding excellent contrast under all lighting conditions except direct sunlight.

Although the *model 0I-1154* was not yet available when this survey was made (May, 1977), the very complete instruction manual provided a lot of information about this unique instrument. Intended for 14- and 28-volt aircraft systems, it is particularly and carefully designed to meet aircraft specifications, including the case for a standard 3⅛-inch instrument panel, and a free after-assembly factory certification and calibration service to conform to FAA regulations.

The construction appears to be no more difficult than many other clock kits. There are just more parts. There are actually *three* clock IC's plus other IC's for counting, control, display and sequencing functions. One clock IC is for "Zulu" Time (Greenwich Mean Time, or GMT). Another is for local time, and the third clock IC is for trip elapsed time, 24 minutes or 24 hours. Seconds are displayed only in the 24-minute trip-time mode. Local time and GMT are retained when trip time is displayed, and vice versa. You can set an alarm to flash the entire display on and off at a preset trip time. ZERO, RESET and HOLD pushbuttons and a five-position function switch make this instrument very versatile. Heath Company, Benton Harbor, MI 49022.

James

The *Quartz Digital* is simple to build, looks great and can be installed above or below the dashboard. Since it has a diode bridge input, you don't have to worry about battery polarity, and you can even power this unit with a small 12-VAC transformer for home use. The backup 9-volt battery will keep time for several days when the clock is wired for DC operation and moved from house to car or for any portable use, and a pushbutton can be added to turn on the display in the portable mode.

The clock has a HOLD button to allow exact time-setting, and a RESET button that zeros the entire display for use as an elapsed timer. Note, however, when you do this, the real time is totally deleted. Reset is accomplished by removing power from pin 2 of the MM5314; when power is restored most of the recently manufactured MM5314's will power up at 00 00 00. Some older ones powered up at 10 00 00, or some number slightly advanced from zero. Therefore, if you try this with an older MM5314 clock, it might not work. James uses selected MM5314's for this purpose.

The *Auto Warble Alarm* is a newer clock design. A preassembled module, containing the large four-digit display, the IC and all the necessary parts for AC operation, is connected to a PC board with components that modify its operation for vehicle use and add an alarm. The standard MM5369 crystal oscillator is used for timing, and a 555 IC and speaker provide the alarm tone. Indicators appear on the display to indicate PM and "alarm on."

Two circuit innovations are particularly worth noting. The 1-Hz pulse output of the module is used to change the alarm tone every second, giving a "tweedle" sound. Figure 2 shows the other unique feature—a headlight alarm. When both the headlights and ignition are on, the transistor is fully on and there is essentially no voltage at the collector. Pin 4 of the 555 IC is held "low" by the 1K resistor, inhibiting oscillation. But when the ignition is turned off and the headlights are still on, the transistor stops conducting and 12 volts are fed through the 5.1K resistor and the diode to pin 4 of the 555 alarm oscillator, raising it above 1 volt, and therefore turning it on.

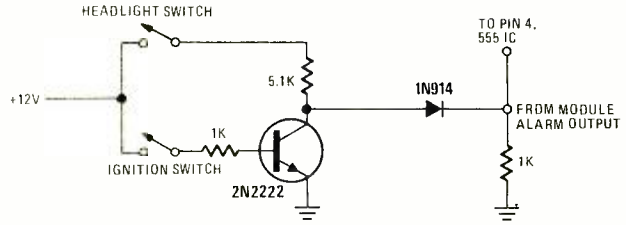


FIG. 2—JAMES HEADLIGHT ALARM warns you if you leave your car with the ignition off and the headlights on.

The switches allow zero-setting seconds, hold count, fast and slow time-setting, alarm set, snooze, alarm on-off and reset to 12 AM for elapsed-time counting by the second for 24 hours, deleting real time. James Electronics, 1201-A Howard Ave., San Carlos, CA 94070.

JBS:

These four .062 fiber glass drilled, etched and plated high-quality PC boards are "stuffed" with your own parts and then packaged in any fashion you desire. There's a display board, a clock board, a power supply board and a timebase board. Each board is exactly 4 wide × 1½-inches high. They are designed to form a perfect four-decker "club sandwich," with the displays on top; or you might prefer a three-decker, with remote displays. All jumpers between boards are straight across, making it very simple to interwire them. This clock operates on 12 VAC or DC, and uses a crystal and six CMOS IC's in a divider chain for the basetime. The timebase can be omitted for AC operation.

The MM5314 clock IC is used with three time-setting switches (FAST, SLOW and HOLD) that allow easy setting of this six-digit clock to the second. Since you supply your own parts, it would be easy for you to use different colored digits for hours, seconds and minutes. For example, James sells the red DL707, the green MAN 52 and the yellow MAN 82 for 99¢ each; they are all common-anode, with physical dimensions and electrical pinouts to mate with the JBS display board.

The entire assembly fits perfectly in the JBS LC-2100A $6.95 extruded aluminum case (4½ wide × 1¾ high × 3¼-inches deep). The case includes transparent red and smoke front and back plates (you can use either as a faceplate), and slots for mounting the PC boards vertically one behind the other.

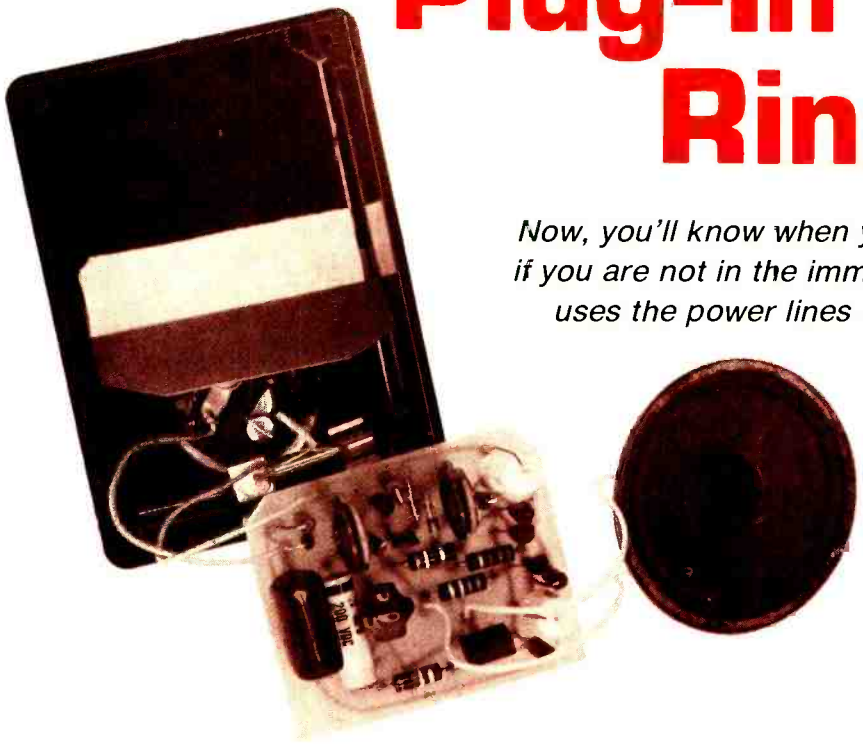
The three-sheet instructions consist of a parts list, actual-size parts layout and a schematic—no text at all. This isn't a beginner's project, but presents no problems at all for a builder with some experience. JBS Electronics, 3050 Valmont, Boulder, CO 80301.

To be continued.

Plug-In Remote Ringer

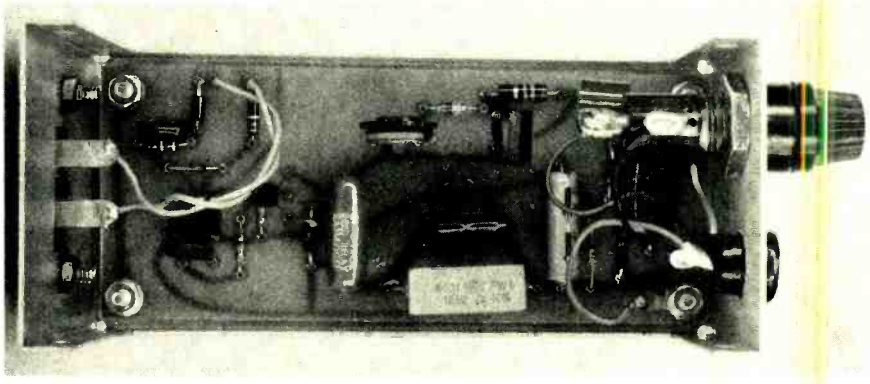
Now, you'll know when your telephone is ringing even if you are not in the immediate vicinity. Wired-wireless uses the power lines to trigger the remote ringer

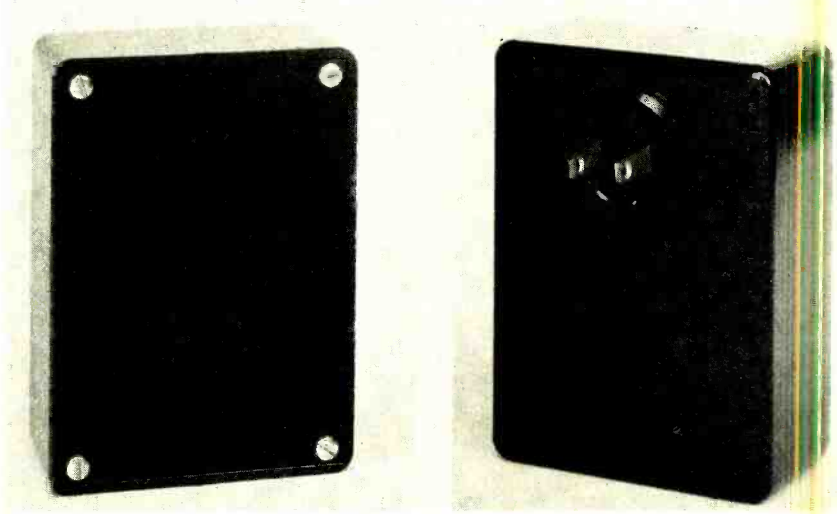
R.K. ATWOOD



HAVE YOU EVER FELT TIED DOWN TO YOUR telephone waiting for an important call but afraid to miss it if you left the immediate area? This remote telephone ringer will prevent a lost call, yet allow you to work in the garage, lounge by the pool or even visit a neighbor for coffee.

The device consists of a ring detector connected to the telephone line. When the telephone rings, the ring detector impresses high-frequency pulses on the AC power line. A receiver placed anywhere on the same power line detects these pulses and emits an audible tone in synchronization with the telephone signal.





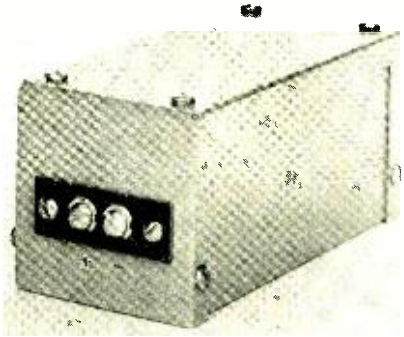
How it works

Figure 1 shows the schematic diagram of the ring detector. Power for the ring detector is derived from the 117-volt AC line by C1, D1, D2 and C2. Diode D3 prevents the supply voltage from exceeding the voltage limits of IC1, a low input-current optic isolator. The ringing signal from the telephone line forward-biases the isolator LED, and the internal Darlington-pair provides the bias to turn on Q1. Integrating capacitor C4 slows the isolator response. The collector current of Q1 operates relay RY1.

Setting R7 controls the turn-on bias of Q2, which is a sensitive-gate SCR (*Si*licon-Controlled *R*ectifier). The C5–R5 network allows Q2 to turn on and off rapidly at about a 2-kHz rate, providing

a series of pulses near the positive peak of the 60-Hz line voltage. The amplitude of the higher harmonics of these pulses applied to the power line is limited by L1.

The line receiver shown in Fig. 2 has a DC voltage at point A of about 100. Under nonringing conditions, the voltage at point B is held to about 10 by the voltage divider consisting of R3 and R4. Base bias to Q3 is provided by R7, holding its collector saturated and preventing gate turn-on bias from being applied to SCR Q6.



THE RING DETECTOR. Terminal strip is for connections to phone line. AC line cord and fuse post are on other end.

The incoming 2-kHz pulses on the power line are applied across L1 and R2 via C2. Resistor R2 varies the pulse amplitude. It is the amplitude of these pulses that turns on Q1. The collector pulses of Q1 are rectified by D2 and D3, resulting in a staircase DC voltage appearing across C4. Eventually this potential reaches a value sufficient to forward-bias Q2, which then saturates and removes the turn-on bias from Q3.

Resistor R8 then provides gate drive to Q6, which turns on at a 60-Hz rate. The speaker sees a series of narrow 60-Hz high-harmonic pulses. The voltage at the junction of R9–R10 holds Q4 in saturation. When a signal voltage appears at the collector of Q1, the base-emitter voltage of Q4 is lowered. At the same time, C4 charges in a staircase fashion, and C5 integrates the turn-on voltage.

The slow charge rate of C4 provides high immunity to power-line transients. In several months of operation, no false triggering has occurred, even with the deliberate introduction of high line-noise levels with SCR dimmers, drill motors, etc.

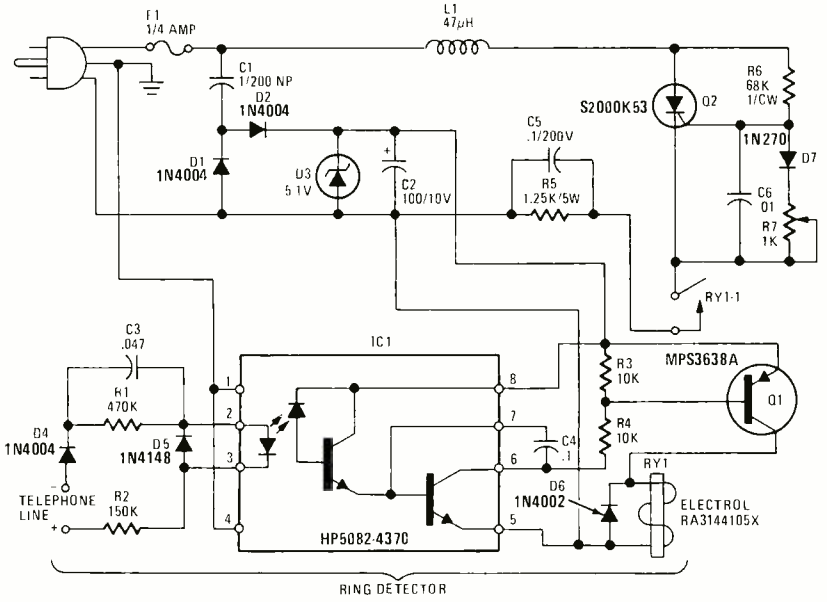


FIG. 1—RING DETECTOR uses an optical isolator to isolate the telephone line.

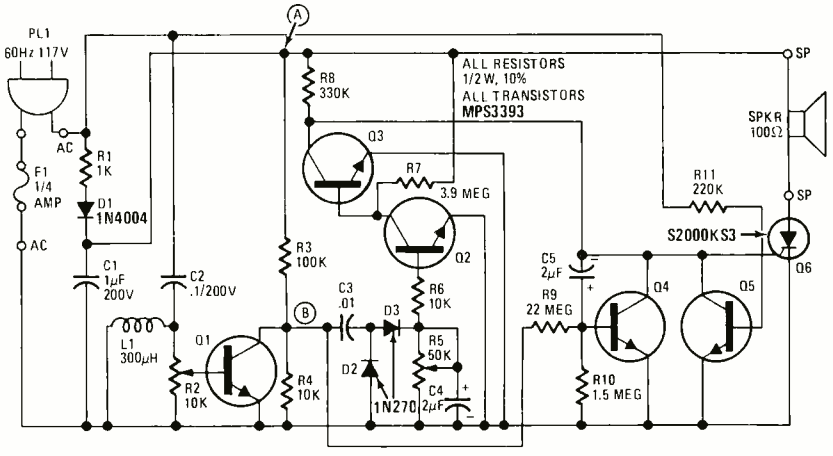


FIG. 2—LINE RECEIVER emits an audible tone when the ring detector is activated.

All resistors are ½-watt, 10%, unless noted.

Line receiver:
R1—1000 ohms
R2—10,000 ohms, ¼-watt trimmer (CTS X201R103B or equiv.)
R3—100,000 ohms
R4–R6—10,000 ohms
R5—50,000 ohms, ¼-watt trimmer (CTS X201R503B or equiv.)
R7—3.9 megohms
R8—330,000 ohms
R9—22 megohms
R10—1.5 megohms
R11—220,000 ohms
C1—1 μF, 200 volts, Mylar
C2—0.1 μF, 200 volts, Mylar
C3—0.01 μF, 50 volts, Mylar
C4, C105—2 μF, 50 volts, electrolytic
L1—300 μH RF choke
Q1–Q5—MPS3393 (Motorola)
Q6—S2000KS3 (ECC-Teccor) sensitive gate SCR
F1—AGC, ¼ amp
PL1—chassis mount male AC connector (Amphenol 61P or equiv.)
Speaker—Miniature, 100 ohms
Case—1⁹⁄₁₆ × 2⅞ × 4-inches (Keystone No. B703PK or equiv.)

Ring detector:
R1—470,000 ohms, ¼ watt
R2—150,000 ohms, ¼ watt
R3, R4—10,000 ohms, ¼ watt
R5—1250 ohms, 5 watts, WW
R6—68,000 ohms
R7—1000-ohm ¼-watt trimmer (CTS X201R102B or equiv.)
C1—1 μF, 200 volts, Mylar
C2—100 μF, 10 volts, electrolytic
C3—0.047 μF, 50 volts, Mylar
C4—0.1 μF, 50 volts, Mylar
C5—0.1 μF, 200 volts, Mylar
C6—.01 μF, 50 volts, Mylar
D1, D2, D4—1N4004
D3—5.1 volts, 400-mW Zener
D5—1N4148
D6—1N4002
D7—1N270
Q1—MPS3638A (Motorola)
Q2—S2000KS3 (ECC-Teccor)
IC1—5082-4370 (Hewlett-Packard)
F1—AGC, ¼ amp
L1—47 μH, RF choke
RY1—reed relay (Electrol RA3144105X or equiv.)
Case—2¼ × 2¼ × 5-inches aluminum (Bud CU2104A or equiv.)
Misc.—fuseholder, 3-wire line cord, terminal strip, ¼-inch No. 6 spacers.

The following parts are available from R.K. Atwood, 11010 159th E, Redmond, WA 98502:

Line receiver kit, order No. LR, consisting of PC board, $5.00

Ring detector Q6, order No. LT, consisting of PC board, IC1, Q2 and RY1, $10.30.

Washington residents add 5.2% tax.

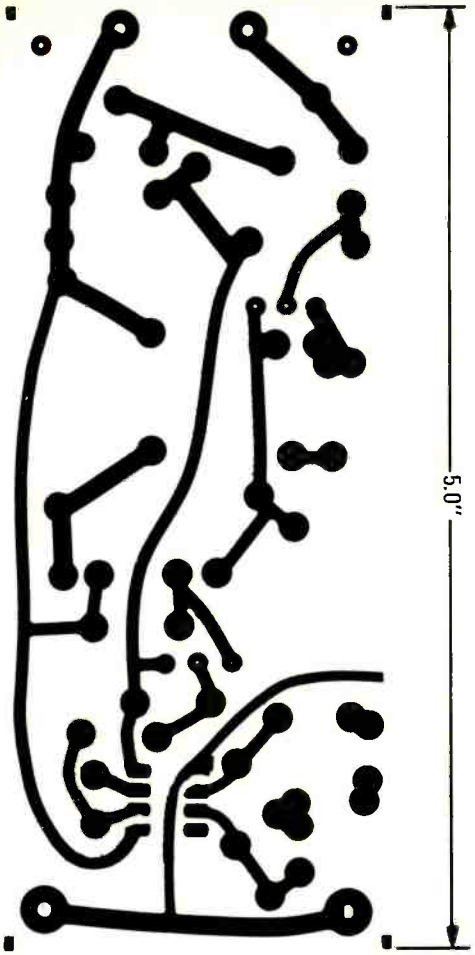


FIG. 3—FOIL PATTERN of the ring detector PC board shown full size.

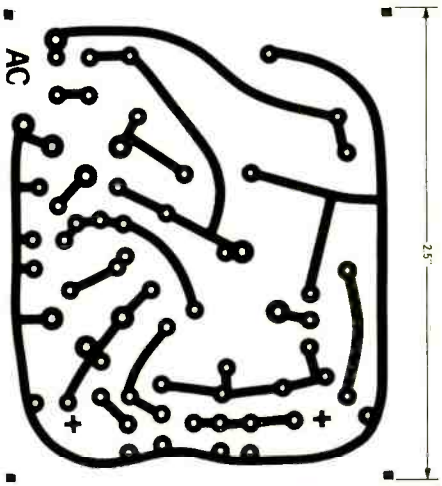


FIG. 5—FOIL PATTERN of the line receiver PC board shown full size.

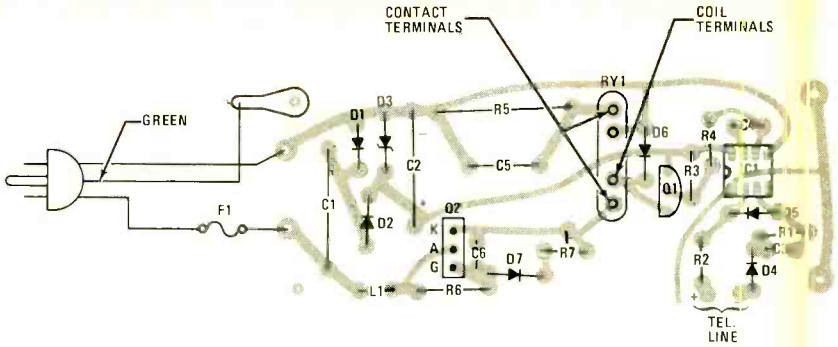


FIG. 4—COMPONENT PLACEMENT diagram for the ring detector PC board.

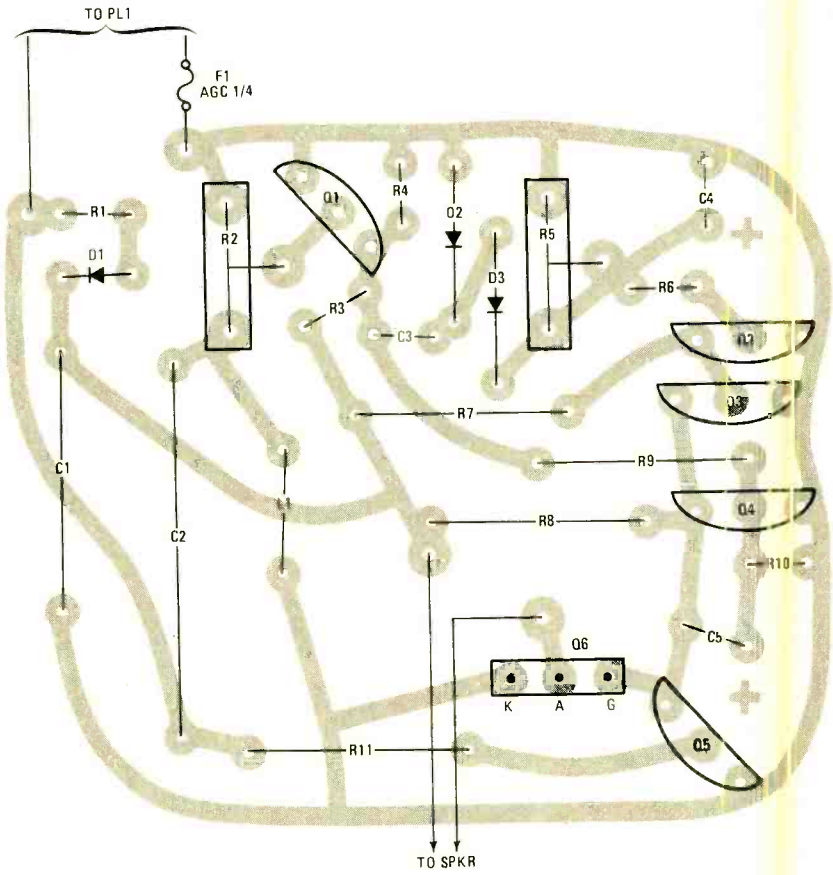


FIG. 6—COMPONENT PLACEMENT diagram for the line receiver PC board.

Construction

The foil pattern for the ring detector PC board is shown in Fig. 3. Use this board to locate the mounting holes in a 2¼ × 2¼ × 5-inch aluminum chassis. Mount all parts on the board, using the component placement diagram of Fig. 4, being especially careful of the orientation of Q2, as well as the other polarity-sensitive components. Use a three-wire power cord and connect the green ground wire via a solder lug to one of the mounting screws at the C1 end of the board. This provides a ground for faulty power wiring and also grounds pins 1 and 4 of IC1, placing an earth ground between the power-line and telephone-line connections.

The line receiver case measures 1⁹⁄₁₆ × 2⅞ × 4-inches and accommodates the circuit board and speaker. Be sure to drill the power plug hole as high as possible, allowing room for its attachment ring. The circuit board will fit crosswise at the other end of the case. Attach wires about 6-inches long for power-line connections and about 3-inches long for the speaker connections to allow the board to extend outside the case for setting R2 and R5. The wires should be of different colors for easy identification. The foil pattern for the line receiver PC board is shown in Fig. 5, and the parts placement diagram is shown in Fig. 6.

Calibration

Adjusting the ring detector is simple but because a direct power-line connection is involved, take proper precautions. Connect an oscilloscope with a ground-isolating adapter on its power cord to the ring detector circuit board. Connect the scope ground to C2's negative lead and the vertical input to the junction of F1–C1. Set the scope controls to display a 60-Hz 200-volt P-P signal. Connect an insulated jumper between R5 and R7 to place a short across the relay contacts. Make no connection at this time to the telephone line.

Set R7 to midrange and apply power to the circuit. Adjust the scope controls to show the positive peak of the line input. A series of pulses of about 15- to 40-volts P-P will appear on this positive AC as R7 is adjusted. Set R7 carefully until 10 to 13 pulses are present. Remove one end of

the jumper between R5 and R7 and reconnect it while observing the pulse pattern. If the pulse pattern does not reappear, adjust R7 slightly, in the direction that lowers the number of pulses, until the pulses appear every time the connection is made. When R7 is set, remove the power from the circuit and disconnect the oscilloscope.

Referring to Fig. 6, on the line receiver set R2 near maximum and R5 at about three-fourths of maximum. Connect the scope ground to the power-line side that

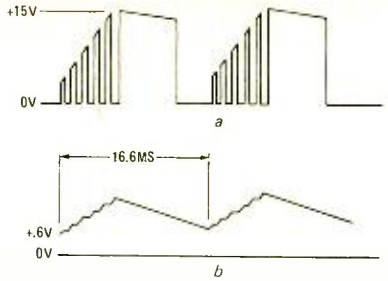


FIG. 7—THESE WAVEFORMS should be obtained during the calibration procedure. See text.

receiver in the farthest possible outlet to insure a satisfactory setting of R5. The power-line pulse level may be temporarily reduced by connecting a 1-μF, 600-volt paper capacitor across the line while adjusting R5.

Put the receiver in its case after R5 is set. Place a piece of insulating paper across F1 and the power plug, then position the circuit board in the lower part of the case. The speaker should be placed over a small piece of foam rubber so that it is pressed securely against the case

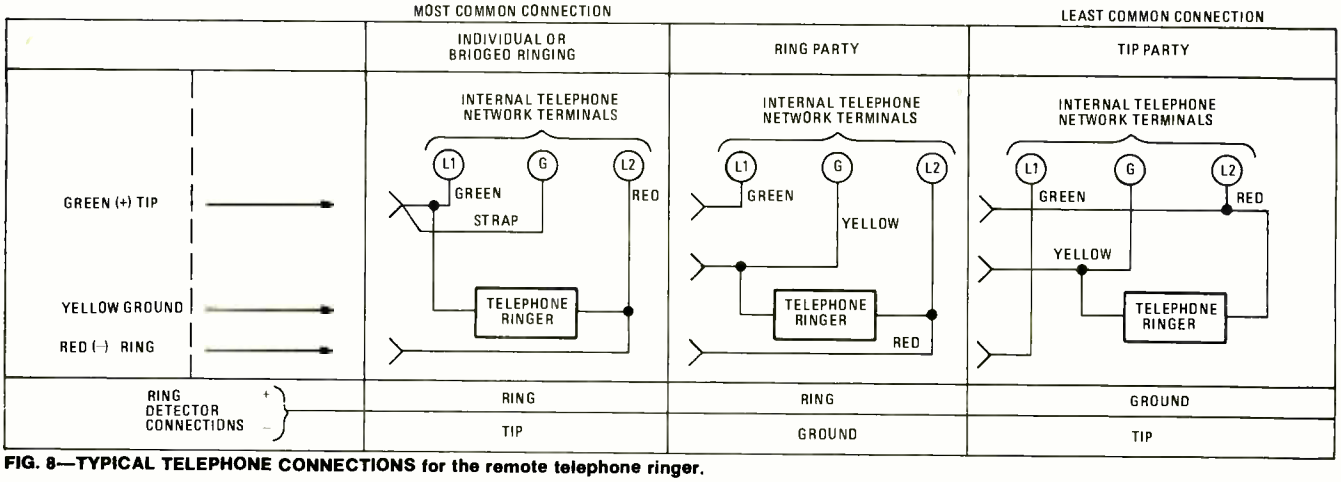


FIG. 8—TYPICAL TELEPHONE CONNECTIONS for the remote telephone ringer.

is common to all transistor emitters and the vertical input to point B. Set the vertical-input controls for a 20-volt P-P signal with DC ground at the bottom of the display. Connect power to the receiver and ring detector circuits.

Reconnect the jumper between R5 and R7 on the ring detector. Adjust R22 until the display shown in Fig. 7-a appears. Now connect the scope input across C4, and adjust the scope to display a 2-volt P-P signal. Disconnect the jumper between R5–R7. The scope pattern shown in Fig. 7-b should appear. After C4 charges up past the base-emitter voltage of Q2, the speaker will sound off. It may be advisable to wrap a piece of foam rubber around the speaker to lower the noise during testing. Adjust R5 until the speaker sounds off reliably when the R5–R7 connection is made. Resistor R5 serves as a sensitivity control, with R2 rarely needing more than initial adjustment.

Telephone connections

The ring detector is now ready to be connected to the telephone line. With a VOM set to the 50-volts DC or higher scale, measure the telephone-line polarity. Then connect the line to the circuit input so that D4 is reverse-biased. If D4 is not reverse-biased, the normal on-hook line voltage will probably keep the ring detector on continuouly. Figure 8 shows the correct tip-to-ground or ring-to-ground connections.

It should not be too difficult to place this unit into operation. As many line receivers as needed can be used but only across the same power line. Thus, the ringer would work when connected to one neighbor's house, but not to another on a different transformer secondary. Test the cover when the unit is being used. For safe operation, do not mount the speaker or circuit board with any metallic protrusions through the case.

The speaker holes should be centered above the speaker. The prototype has 18 holes, $^3/_{32}$-inch diameter, drilled in a grid pattern and covered with a thin cloth glued to the bottom surface of the panel. Since the power rating of most small 100-ohm speakers is limited, wrap foam rubber around the speaker to provide acoustic loading during testing. Do *not* enlarge the number or size of the holes.

The system could be used in alarm setups. However, any relay contacts that turn on the ring detector must be fully isolated, since full power-line voltage will appear across them. If a 2N5060 or a type C106 SCR is substituted for Q2, capacitor C5 should be changed to a 0.33-μF, 200-volt unit. **R-E**

Communications group petitions FCC to test new system

The Harris Corporation, manufacturers of communications equipment, and three mobile radio firms in the Baltimore-Washington area, have asked the FCC for permission to test and build a new radio telephone and paging system that would allow wider public use, improve consumer service and also protect message privacy.

The proposed system calls for a single powerful transmitter to provide service over a 30- to 50-mile radius (as opposed to the cellular system which uses many base-station transmitters within a single cell). Inexpensive mobile units would be used. Message privacy would be guaranteed by using new digital-transmission techniques. Another feature is the lightweight and less costly phone units and pocket pagers.

A wide range of subscriber services is envisioned, and, although doubtless the majority of users would opt for the voice mode, the system could also handle subscriber data processing.

The four-phase program will involve: 1. Modulation, propagation and timing control tests; 2. Evaluation of remote receiving techniques, voting selection and mobile equipment; 3. Switching tests, interconnecting and the start of service tests; and, 4. Checking inter-city mobile transmission capabilities and the first user tests. Target date for completion: 1979. The estimated cost of construction has been put at $1,107,000.

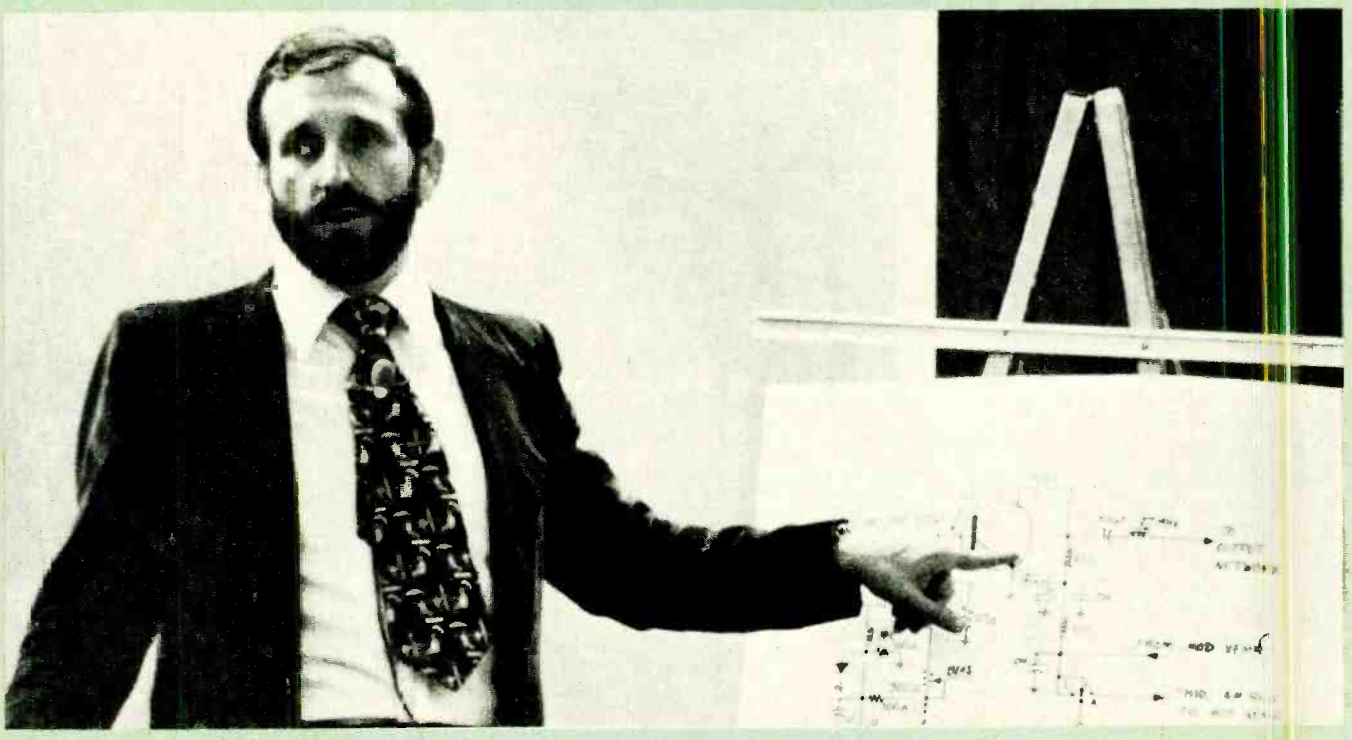
Teledyne Acoustic Research "has computer, will travel"

A new "Mini" computer, devised by Teledyne Acoustic Research, is the star of a unique AR "Science of Sound" traveling show aimed at demonstrating some of AR's capabilities in the high-fidelity field.

The "Mini" is a sophisticated digital unit that has been preprogrammed by AR's in-house computer. On-the-spot calculations and data drawn from storage banks use room-dimension and speaker-placement information to provide the ideal listening conditions desired. The computer does all its mathematical tricks before your very eyes. Additionally, performance data of various AR models and their use in specific installations can be shown on the readout.

Forest Belt tells...

What You Need To Know About CB TEST GEAR



Whether you are new to radio communications or an old hand, you will find guidance among these pages. This section concentrates on recent-model test instruments used for CB servicing; on what they do and how to use them to solve CB troubleshooting problems. Not every instrument or technique appears—not enough room, even in a section this large. Rest assured, though: There's enough information contained in this section to turn you into a better technician.

TEST INSTRUMENTS For CB Servicing

CB servicing requires instruments not used on the TV service bench. Here's what they are and what they do.

AT THE SERVICE BENCH, THERE ARE THREE regular uses for test instruments: measuring performance quality, tracing the cause of poor operation and correcting misadjustments.

To accommodate these tasks, seven basic instruments are needed. Other equipment are used for peripheral servicing. But for diagnosing and curing the main faults in CB receivers and transmitters, these basic items are mandatory: (1) a DC power supply to operate mobile radios; (2) a signal generator that supplies RF and IF frequencies; (3) a frequency counter; (4) a digital or analog electronic multimeter; (5) a wide-band oscilloscope; (6) an RF wattmeter; and (7) a 52-ohm dummy load.

The nature of CB diagnosis and measurement places certain fundamental requirements on the test equipment. These requirements should be understood before you set out to buy. This knowledge is especially needed when working with the equipment at your bench. Instruments that lack certain fundamental qualities can delay—even thwart—diagnosis.

Almost every CB servicing instrument offered today entails compromise. Price, quality, features, convenience, appearance, accuracy, dependability—all should be considered. Choose carefully and buy wisely.

Power Supplies

A basic DC power supply for bench-testing CB radios plugs into the 117 volt AC line and provides 13.8 volts DC. This particular value happens to be the EIA standard test voltage for radios and tape players that are operated in autos.

The most useful DC supplies are adjustable. The typical range is 11 to 15 volts DC; some models offer a slightly wider range.

More important than voltage range is voltage *regulation*. An unregulated voltage source cannot maintain a constant output value under varying loads. That is, when a unit draws more current, as a transceiver does when switched to its transmit mode, the output voltage from the power supply could be reduced. That cannot be allowed to happen, so DC supplies for CB bench work are heavily regulated. The output should change no more than 0.1 volt from no-load to a full-rated load.

A DC power source for CB transceivers must supply as much as 3 amps (3,000 mA) without overloading or upsetting voltage regulation. When a solid-state CB radio is idling (no signal) in the receive mode, it draws about 100 mA. A few large sets draw as much as 200 mA

RECHARGEABLE BATTERIES inside the Sencore model PS43 power supply let you carry the instrument away from power lines. You can operate mobile transceivers or portable test instruments in the field.

Manufacturer	Model	Output Voltage (volts)	Output Current amps	Ripple (mV RMS)	Overload Current (amps)	Reset	Output Meter
B&K/Precision 6460 West Cortland Ave. Chicago, IL 60635	1640	11➔15	3.0	<8.0	5.0	Manual	1 V/A
Hickok 10514 Dupont Ave. Cleveland, OH 44108	244	10.5➔14.5	3.0	<10.0	4.0	Automatic	1 V/A
Sencore 3200 Sencore Dr. Sioux Falls, SD 57107	PS43	0.6➔14.4	1.5 or 5.0[1]	<50.0[2]	5.0	(Fuse)	0

Notes:
1—Depends on NiCad cell used.
2—0.0 with AC line disconnected.

when idling. With a strong incoming signal and the volume turned up, the DC input current may rise to 1,000 mA (1 amp) in some receivers. Press the mike button for transmit and whistle into the mike. You may see the input current rise to as high as 1,800 to 2,500 mA. A supply that cannot handle that demand without changing the output voltage is inadequate for CB bench work.

A meter should be included on the front of the power supply. Some models sport two—one for voltage, one for current. One meter is enough, with a volts/amps switch. Once you've set the voltage, it should remain constant. The meter can be left to monitor input current drawn by the CB radio.

Expanded-scale voltmeters are common. Most have a mark on the scale at 13.8 volts. Always verify that mark with your voltmeter. Inexpensive expanded-scale panel meters are notoriously inaccurate. You must know where the pointer rests when the DC output is *exactly* 13.8 volts. Make your own mark if necessary. *Do not* alter the zero-setting screw of the meter; this spoils the current calibrations if they're on the same meter.

Another kind of DC power supply is valuable, not for operating the CB radio, but for biasing CB transceiver circuits from an external source. It is used to substitute bias on transistors or switching diodes to check their operation. You can clamp DC lines to troubleshoot AGC, squelch or a phase-locked-loop.

This bias or clamping supply must be thoroughly regulated. There should be no fluctuations in the DC voltage it provides. Metering is a desirable extra. Markings on the voltage adjustment dial of some models are reasonably accurate. Otherwise, the DC output voltage must be monitored with a multimeter.

Sencore manufactures a DC power supply, the *model CB43*, that operates from the 117-volt AC line. However, it also contains rechargeable NiCad batteries that act as high-capacitance filters. When they are fully charged, they also act as a regulator, supplying current needs beyond the 200-mA capability of the AC portion of the supply. They recharge between heavy loads. The batteries inside make the *model CB43* completely portable.

Even more unusual and useful, however, is the adjustable output-voltage feature. Voltage is brought to two separate output jacks. Each output has its own voltage-adjustment knob, supplying between 0.6 volts and 14.4 volts. One output can power a transceiver while the other is used for biasing, clamping, or any other function.

RF Generators

Naturally, the foremost specification for a CB RF generator is that it must cover the 40 CB channels, from 26.965 to 27.405 MHz. Its stability, after a half-hour warmup, should be very tight—virtually no drift. Modern PLL and synthesis techniques have almost abolished frequency drift. However, not all RF generators incorporate this advanced technology. Changing the output-level should not affect the frequency.

Next, the generator should provide intermediate-frequency signals for injection troubleshooting and for aligning IF stages. Low IF in modern CB receivers is 455 kHz, high IF in double-conversion sets can range from 4 to 12 MHz. A 2- to 20-MHz generator lends itself to other possibilities, such as injection testing at certain mixers. If you buy a CB RF generator that does not include these IF signals, you'll need an additional generator for them.

You should also be aware of one thoroughly overlooked test frequency. Very few RF generators designed especially for CB servicing reach the 21- to 25-MHz range. Many CB receivers include, as part of the noise-blanker stage, coupling transformers that are tuned to 21, 23.5 or 25 MHz. These preselectors exclude CB signals but couple impulse noise (like auto ignition energy) right through to the blanker processing stages. Hence, when you select a generator to accommodate IF sections, be sure it reaches those frequencies too.

Stability becomes somewhat less crucial in IF generators. Yet, an inexpensive generator may not permit satisfactory alignment of single-sideband sets, which are a bit more critical than AM receivers.

Some expensive combination units generate RF signals from 100 kHz through 1,000 MHz. The desired frequency is simply dialled up on digital thumbwheel switches.

MOTOROLA NOISE SIMULATOR generates bursts of pulses that resemble actual ignition interference.

Examine the generator specifications to make sure that it furnishes the signals needed. If you buy two generators, make sure that between them you also have all the special features necessary for CB servicing.

Output-level attenuators

To be of any practical use for communications servicing, the output level of an RF generator must be under complete control—not as easy as it sounds.

In the more economical models, *leakage* proves a serious problem. At VHF (and UHF) frequencies, even minor stray capacitances tend to couple the signal *around* the elements of an attenuator. Trouble arises when measuring sensitivity in a really good receiver. If a microvolt or so of signal leaks past the attenuator, the output level can not be turned *down*

TEST PACKAGE from LogiMetrics (model 981) includes RF generator so accurate you can compare transmitter frequencies to it for frequency checks. RF attenuator is highly shielded for low leakage. Contains RF power and modulation meter.

RF SIGNAL GENERATORS

Manufacturer	Model	Fixed CB Channel	Output Level (RMS)	Freq. Generating System	SSB Offset	OTHER RF: Low IF (kHz)	OTHER RF: High IF (MHz)
B&K/Precision 6460 West Cortland Ave. Chicago, IL 60635	2040	1→40	0.3 μV 100 mV	PLL	Variable	455	No
Cushman 830 Stewart Dr. Sunnyvale, CA 94086	CE-6A	Digital[1]	0.1 μV→ 100 mV	Synthesizer	Digital[2]	10 →	1000[4]
Hewlett-Packard 1501 Page Mill Rd. Palo Alto, CA 94304	606B	—	0.1 μV→ 3 volts	Oscillator/ Amplifier	Variable	50 →	65
Hickok 10514 Dupont Ave. Cleveland, OH 44108	266	1→40[5]	0.3 μV→ 100 mV	PLL	1 kHz pushbutton	455	1→20 ext crystals
ifr, Inc. 4053 G Navajo La. Wichita, KS 67210	FM/AM 1000A	—[1]	0.5 μV 5 mV	Synthesizer	Digital[2]	0.1 →	1000[4]
Lampkin Labs. Box 9048 Bradenton, FL 33506	107C	—[1]	0.1 μV→ 1 mV	Synthesizer	Digital[2]	1.0	1000[4]
Logi Metrics, Inc. 121-03 Dupont St. Plainview, NY 11803	980	1→40	0.1 μV→ 10 mV	Synthesizer	No	—	—
Sencore 3200 Sencore Dr. Sioux Falls, SD 57107	CB42	1→40	0.1 μV→ 100 mV	PLL	1 kHz switched	315→1500	1.5→12
Singer Instrumentation 5340 Allo Rd. Los Angeles, CA 90066	FM-10C	—[1]	N/A	Synthesizer	Digital[2]	50 →	512[7]
Time & Frequency Technology, Inc. 3000 Olcott St. Santa Clara, CA 95051	767	1→40	0.1 μV→ 300 mV	Synthesizer	Digital[2]	100 →	12

Notes:
1—Not by channel, but by digital frequency (See "Other RF" for ranges)
2—Offset main digital dial by 1000 Hz
3—FM modulation percentage given in kHz of ± deviation
4—Digital, in 0.1 kHz steps
5—Calculation-type digital entry
6—Digital, in 0.1 Hz steps
7—Digital, in 0.1 Hz steps plus variable resolution to 1 Hz; signal generation requires special module
8—Separate modules for AM and FM

far enough to be of any use. Some CB receivers offer a sensitivity of 0.5 μV or better. A 1-μV "stray" signal voids any hope for a sensitivity measurement.

Shielding and costly attenuator design both help; but that's what you must have. If you cannot turn down the RF output level to less than 0.3 μV, the generator is useless for making sensitivity measurements.

Moreover, the output RF level should be accurate. If the attenuator indicates the output RF level is 0.5 μV, that's what it must be. Otherwise, your sensitivity conclusions are worthless, and you can't determine whether a CB receiver performs to its specifications or not.

How can you judge a generator? The fastest way is with a top quality transceiver, preferably one with a sensitivity of 0.5 μV or better. Connect the generator, and set it to the same channel as the transceiver. Turn the output-level control all the way down, but with a modulated signal. You should hear no signal at all in the CB receiver. If you can, the generator is leaking the signal past its attenuator.

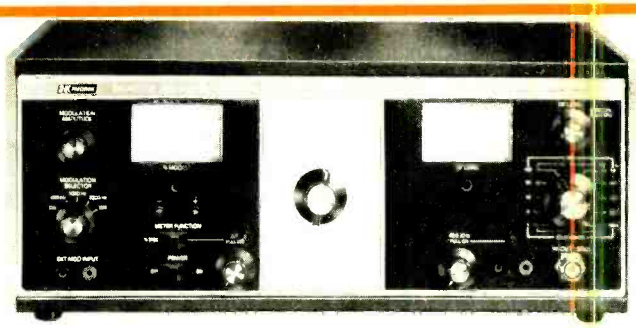
Incidentally, the output impedance of an RF generator for communications must be 52 ohms (sometimes just 50 ohms). Beware of generators designed with a 75-ohm output impedance. Higher impedances are all right for IF injection and alignment, but an RF generator must match the 52-ohm input impedance of the CB or communications receiver.

One danger to a generator arises when you connect it to a transceiver. Pressing the mike button sends 4 or more watts of RF signal into the generator's attenuator. Some generators can handle this abuse; others cannot. You must check the manufacturer's specifications. If the output attenuator cannot withstand a large dose of RF, you must provide fuses for the generator cable. High-priced generators usually have fuseholders and fuses that are intended specifically to supply this kind of protection.

Modulation

A generator should be capable of amplitude modulation, with an internal 1,000-MHz audio tone. Many units built especially for CB also include a 400-Hz tone, which was more-or-less standard in older generators. However, communications measurements always call for a 1,000-Hz audio signal. Gain, audio power and distortion measurements are

Freq. (Hz)	Modulation		Noise Gen.
	Type	Percent	
400 1000 2500	AM	0→100	Yes
20 20 kHz	AM FM[3]	0→80 0→25	No
400 1000	AM	0→95	No
1000	AM	0→100	Yes
10→5000[6]	AM FM[3]	0→90 0→15	No
5→6000	AM FM[3]	0→55 0→15	No
1000 or 500/2500	AM	0→95	No
400 1000 500/2400	AM	30 and 100	No
—[8]	AM FM	— —	No
500 1000 2400 500/2400	AM	0→80	Yes



PHASE-LOCKED-LOOP controls B&K/Precision model 2040 CB signal generator very precisely. Has built-in noise generator, frequency offset knob for SSB testing, and very well shielded and accurate RF attenuator.

all referenced to 1,000 Hz. Likewise, receiver sensitivity measurements call for an RF signal modulated 30 percent with a 1000-Hz audio tone.

To test the ability of a CB receiver to demodulate single-sideband (SSB) transmissions takes a uncommon feature known as *carrier offset*, or *delta frequency*. The most useful format alters the generator frequency exactly 1 kHz (1,000 Hz) from the channel frequency. For example, suppose you're testing CB Channel 40, which has an assigned carrier frequency of 27.405. A low-side offset of 1 kHz (1,000 Hz or 0.001 MHz) places the generator frequency at 27.404. This signal is demodulated by the lower-sideband mode of a receiver and sends a 1,000-Hz audio tone to the speaker. An equivalent offset upward, to 27.406 MHz, demodulates in the upper-sideband mode as a 1,000-Hz tone.

Noise generator

All CB receivers have an automatic noise limiter (ANL) stage that is most useful in reducing impulse-type noise. It follows the AM detector. The ANL stage clips off noise pulses that accompany any demodulated audio. The DC voltage developed in the detector determines the ANL operating point. And the DC voltage, in turn, depends on the strength of the incoming carrier signal.

When there's no carrier, as with an SSB signal, the ANL stage can't work. Hence, SSB receivers—and now many AM sets—incorporate a noise-blanker section. The noise blanker operates up front, sampling noise right at the RF input, turns the noise pulses into blanking pulses and feeds them back into the signal path just after the first mixer. The result: Noise pulses are blanked out and never reach the demodulator, be it SSB or AM.

To test how well a CB receiver cuts out impulse noise, you need a noise-pulse source. You can buy a noise simulator and feed its output right into the RF jack of the transceiver. Flip the ANL and noise-blanker switches on, and note whether the stages reduce speaker noise. If not, or if not enough, you have to troubleshoot the limiter or blanker.

A number of CB RF generators incorporate a standard noise generator. The EIA standard noise pulse for testing communications receivers is 1 μs wide, has a risetime of 10 ns or less and has a repetition rate of 100 pulses-per-second (PPS).

Frequency Counters

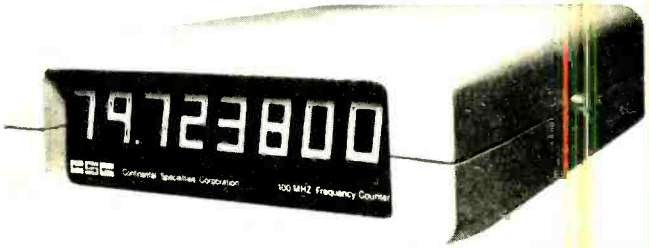
Besides accuracy, two other frequency-counter are important considerations.

First, its frequency range should extend to 50 MHz because in the average modern CB transceiver, whether its tuning system is a synthesizer or phase-locked-loop, many stages operate well above 27 MHz. Some mixers and oscillators generate outputs exceeding 40 MHz.

Second, you must consider frequency-counter sensitivity. Some oscillators inside a transceiver generate signals no greater than 30 mV P-P, that's barely above 10 mV RMS, and it takes a fairly sensitive counter to lock onto that weak a signal.

Typical CB frequency counters (not the most inexpensive ones) have input sensitivity ratings of about 30 to 50 mV RMS. Check the specifications when you're shopping. Manufacturer may claim one sensitivity as "guaranteed" and another, better rating as "typical." If you want to make sure, take along a transceiver you're familiar with when you go for a demonstration. Know ahead of time the output of some weak oscillator in the set. Then take home whichever unit will lock on that weak a signal.

You pay more for greater sensitivity and for a wider frequency range. Given a strong enough signal, many counters exceed their frequency specifications. But sensitivity drops off near the upper reaches of frequency capability. If the sensitivity claimed by the manufacturer is



LARGE-SIZE LED's make Continental Specialties model MAX-100 easy to read, despite small case size. Only a few counters have eight digits like this, which resolves CB frequencies right down to the last hertz.

FREQUENCY COUNTERS

Manufacturer	Model	Digits: Size (in.)	Digits: No. of Digits	Rated Max. Frequency (MHz)	Min. Signal (mV RMS)	Auto Range	Resolution (Hz)	Accuracy (± 1 LSD[1])	Shunt Input Capacitance (pF)[2]
B&K/Precision 6460 West Cortland Ave. Chicago, IL 60635	1801	0.35	6	40	30	Yes	1	.001	25
Communications Power, Inc.	FT70	—	7	40	N/A	—	10	.0003	N/A
Continental Specialties Box 1942 New Haven, CT 06509	MAX-100	0.6	8	100	30	—	1	.0003	56
Data Precision Audubon Rd. Wakefield, MA 01880	5740	0.43	7	100	25[3]	Yes	0.1[4]	.0004	25
Fluke Box 43210 Mountlake Terrace, WA 98043	1900A	—	6	80	25	Yes	0.1[4]	.0005	<30
Heath Benton Harbor, MI 49022	IB-1103	—	8½	180	50	—	0.01[4]	N/A	N/A
Hewlett-Packard 1501 Page Mill Rd. Palo Alto, CA 94304	5300A/5302A	—	6	50	25	Yes	1	N/A	<30
Hickok 10514 Dupont Ave. Cleveland, OH 44108	380X	0.3	7	80	35[3]	Yes	10	.001	25
Non-Linear Systems Box N Del Mar, CA 92014	FM-7	—	7	60	100[3]	—	10	.002	50
Sencore 3200 Sencore Dr. Sioux Falls, SD 57107	FC45	0.5	8	230	25	—	1	.0001	50 ohms[2]
Simpson 853G Dundee Elgin, IL 60120	710	0.35	6	60	50	—	1	.001	30
Wawasee Box 36 Syracuse, IN 46567	JBC-1004FC	0.5	6	50	50[3]	—	10	N/A	N/A

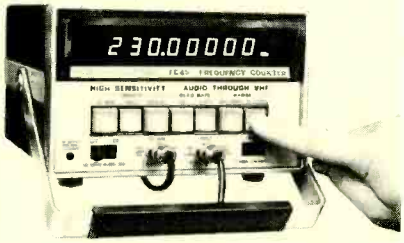
Notes:
1—± percent of reading; all add ± 1LSD
2—all inputs 1 megohm except 50 ohm as shown
3—approx. at CB frequencies
4—on manual—sets gate time

accurate, it embraces all the frequencies listed. The counter can reach higher, but at reduced sensitivity.

A frequency counter is the most valuable troubleshooting tool for frequency synthesizers and phase-locked-loops. Only this instrument can test oscillators, mixers, and loop drivers and phase-locked-loop phase detectors. The instrument must have a high-impedance input for this purpose, a few counters have only a 50-ohm input. Your counter should have a 1-megohm input jack, so that you can connect a high-frequency probe similar to that used with a 30-MHz scope. Ordinary probes won't do.

It's not uncommon for a counter to have both low- and high-impedance inputs. If so, a front-panel switch is mandatory to avoid exchanging connections to use the instrument in either mode.

Expensive counters, like the Hewlett-Packard *series 5300*, may have two channels. Usually both use standard high-impedance inputs: 1-megohm shunted by less than 30 pF. You can buy an impedance-matching pad. A 50-ohm to high-Z pad lets you use one channel for measuring transmitter or generator output frequencies. A high-Z probe connected to the other channel is for instant troubleshooting.



EXTENDED FREQUENCY RANGE characterizes the Sencore model FC45 frequency counter. Includes internal oscillator that lets you check fundamental frequency of any crystal.

You will probably prefer a counter that also has a 1-second mode to let you look at frequency counts to a 1-Hz resolution. With autoranging and observing 27-MHz signals, anything less than an eight-digit readout must suppress the least-significant digits. With six-digit readouts, tens and units do not show; with seven digits only the units (Hz) are missing. A readout "update" of once a second forces the instrument to display digits all the way to units, or hertz.

This does not mean a counter has *accuracy* that tight, only resolution. Accuracy of good frequency counters can be as close as 0.0001 percent (of indicated frequency) or better, which far exceeds the 0.005 percent (of assigned frequency) the FCC requires for CB transmitters. Top-grade instruments extend the accuracy to 0.00005 percent or better, or closer than ±15 Hz at CB frequencies. Modern frequency counters bring measurement accuracy far inside any FCC regulations, and with a large margin for safety.

If you like large LED displays, consider a model that offers that option. Heights of 0.35- and 0.43-inch are typical; 0.6-inch LED's are also available. Some LED's are easier to read than others.

If you prefer small-sized instruments, Data Instruments and Continental Specialties have small but sensitive counters. In searching out special characteristics, do not overlook your basic frequency and sensitivity requirements. They are what make the instrument useful.

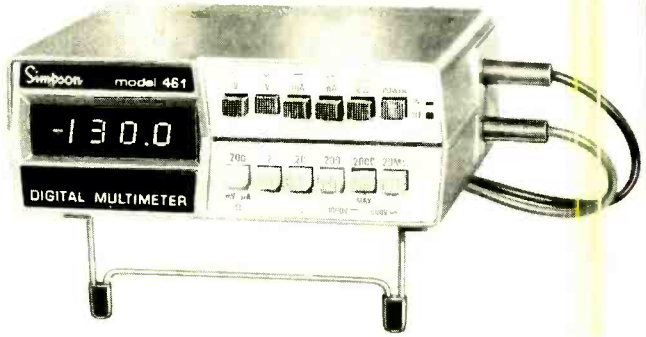
Digital Multimeters

By far the most popular digital multimeters (DMM) are the 3½-digit variety. The half-digit term means that the leftmost of the four digits—usually LED's—displays nothing higher than the numeral 1. The same leftmost digit also shows a minus sign for negative voltages or currents. Usually, the display also flashes some distinctive pattern for overrange—when the applied voltage or current exceeds the 1999 display.

For CB troubleshooting, the 3½-digit display allows accuracy and resolution sufficient for all ordinary purposes. For example, on the 10-volt range, a 3½-digit display can show voltages as low as 00.01 (without autoranging) and as high as 19.99 (some models label this the 20-volt range).

This resolution to hundredths of a volt seems necessary in solid-state radios. Its value can be appreciated when you consider that, in at least one phase-locked-loop system, the VCO control voltage varies only between 2.31 and 2.61 volts for the entire 40-channel band.

As with counters, resolution must not be confused with accuracy. Precision in the range-switch networks as well as the A/D converter accuracy determines the overall accuracy. Accuracy specifications are listed as a certain percentage of the displayed reading, and add the phrase "plus or minus one digit"—always the least-significant or rightmost digit. Consider a meter with an accuracy of 0.1 percent (±1 digit). A 13.8-volt source might cause a reading of 13.78 to 13.82 and remain within the specification limits. (Take 1 percent of 13.8, which is 0.0138; add and subtract it from 13.8; then allow one digit more than the higher reading, and one digit less than the lower.)



PUSHBUTTON RANGE SELECTION is notable feature of Simpson model 461 digital multimeter. This company has always been known for excellent VOM's.

Is a 4½-digit meter worth the extra price? Resolution obviously is greater, and, generally, accuracy is better too—but that's not because of the extra digit. One precision meter in this category stipulates a voltage accuracy of "±0.02 percent of reading, ±0.01 percent of full-scale, ±1 LSD." For a 13.8-volt measurement (20-volt scale), that could amount to as much as 0.00276 volt plus 0.002 volt plus 0.001 volt, for a total possible error of 0.00576 volt in either direction. The reading could be from 13.794 to 13.806 volts and still lie within the accuracy limits specified. Only in laboratory work is such a tight standard useful.

Autoranging

Some models offer *autoranging* as a convenience. When the voltage or current you're measuring happens to be far less than expected, an auto-ranging meter sets itself to a lower range—moving the decimal point on the display to the correct position. Typically, for automatic range-switching to occur, the voltage or current must be less than one-tenth of the full-scale range that has been selected by the range switch. Voltages *higher* than the range chosen merely cause the *over-range* indication on the display.

For example, you set the range switch for 20 volts, expecting to measure 9.65 volts. But there's only 1.235 volts at the point you touch the probe. Instead of the 3½-digit display showing 01.23 volts autoranging moves everything to the 2-volt range. You see the whole 1.235-volt reading, increasing both the resolution *and* the accuracy of the reading.

On the CB service bench, at least while troubleshooting mobile transceivers, the voltmeter is typically set for 20 volts full-scale. (That is sometimes called the *10-volt* range; but 100 percent overranging extends it to 19.99 volts on models with

B&K/PRECISION MODEL 283 digital multimeter takes standard double-banana plug. Comes with direct 100K isolation probe.

DIGITAL MULTIMETERS

Manufacturer	Model[1]	Full Scale DC Voltage Ranges[3] Highest	Lowest	Full Scale DC Milliamp Ranges Highest	Lowest	High/Low Ohms	Frequency Limit[2] AC Volts	DC Accuracy
B&K Precision 6460 West Cortland Ave. Chicago, IL 60635	283	1000	1.0	1000	1.0	Yes	400 Hz	1%
Data Precision Audubon Rd. Wakefield MA 01880	175	1000	0.1	1000	0.1	Yes	5 kHz	1%
Fluke Box 43210 Mountainlake Terrace, WA 98043	8020A	1000	0.2	2000	2.0	Yes	2 kHz	1.5%
Hewlett-Packard 1501 Page Mill Rd. Palo Alto, CA 94304	3435A	1200	0.2	2000	0.2	No	20 kHz	0.3%
Hickok 10514 Dupont Ave. Cleveland, OH 44108	334	1200	0.2	2000	0.2	No	250 Hz	0.3%
Non-Linear Systems Box N Del Mar, CA 92014	LM 3.5-A	1000	1.0	1000	1.0	No	400 Hz	1%
Sencore 3200 Sencore Dr. Sioux Falls, SD 57107	DVM38	2000	0.2	2000	0.2	Yes	5 kHz	0.1%
Simpson 853G Dundee Elgin, IL 60120	460-3	1000	0.2	10 amps	0.2	Yes	20 kHz	0.1%
Triplett 286 Harmon Rd. Bluffton, OH 45817	8000A	1000	0.1	1000	0.01	No	20 kHz	0.1%

Notes:
1—List includes only one popular 3½ digit model from each manufacturer, most offer many other models
2—For 1% accuracy or better
3—With ranges not using integer "2", add 100% overrange except on highest range

that extra half-digit on the display.) Autoranging then allows you to look accurately at any voltage in the transceiver without a range switch.

Ordinarily, you don't have to worry about ranges when you're shopping. But don't forget them altogether. Modern multimeters are designed with solid-state servicing in mind. A "bottom" full-scale range would be 1 volt (or 2 volts). This gives readings from 0.001 (1 mV) to 1.999 volts, which is sensitive enough for CB work. Some meters extend their voltage ranges one decimal step farther down, to 200 mV full-scale. At this range, readings begin at .0001 volt (0.1 mV or 100 μV) and extend to .1999 volt (199.9 mV).

HANDHELD DIGITAL MULTIMETER, Fluke model 8020A features liquid-crystal display, common in watches but not in test gear. Cuts battery drain. Range switches are along one side.

Low-high ohms ranges

The ohmmeter portion of a digital multimeter may not be easy to read, until you're accustomed to it.

For example, set the range switch to 10K. The display reads: 470; this means .470 times 10K, or 4,700 ohms. Or, set the switch to 1K; the display shows 1.245, and you know the resistance is 1,245 ohms. This is simple enough.

However, it sometimes gets confusing on instruments with ranges labeled for the full overrange value. For example, set the switch for 200 ohms. The display reads 180. No problem; that's 180 ohms. Set the switch for 20K; the display shows .725 on the LED's. As long as you remember that the 20K is merely full overrange for 10K, you do all right. The .725 reading therefore means 7,250 ohms. A reading of 1.789 on the same range translates into 17,890 ohms. With a little familiarity and practice, it is easy to make the transition from analog to digital ohmmeters.

Some DMM's have two sets of ohms ranges—or, rather, two ohms settings on the function switch—usually labeled LO and HI. These range settings refer to the voltages inside the ohmmeter that cause the current to flow through the resistance being measured. Some manufacturers refer to low-power and high-power ohmmeter ranges; but the difference actually lies in the applied voltage.

It is impossible to measure resistors that are shunted by a diode or transistor junction if the junction conducts. You can reverse the test leads, but that's extra time wasted. At reduced voltage, the junction does not conduct. Therefore, the measurement shows true resistance in the circuit, and ignores the junction. This is the purpose of the LO ohms setting.

On the other hand, a fast way to test transistors and diodes is by measuring the forward and reverse junction-resistance. *But*, it takes a certain amount of voltage to start a junction conducting;

hence the HI ohms function. Enough voltage is applied to bias the diode or transistor junction into conducting in the forward direction. A few ohms are displayed. In reverse, of course, expect the over-range indication; any ohms reading implies leakage. (Watch out for shunting resistors; the backward reading should be no less than their resistance.) Thus, you can use the HI ohms settings to test transistors and diodes without removing them from their circuits. This low/high feature is desirable on any analog multimeter you buy for backup.

You might give some consideration to the test-lead jack on the front (or side) of the DMM you buy. As you make forward/backward ohmmeter tests, a double-banana setup has a distinct advantage. You can reverse the polarity of voltage applied to the junction merely by turning the plug over at the meter. This saves making and remaking hard-to-reach connections on the circuit board.

Portability

Digital and analog multimeters require internal power for all ranges and functions because they contain internal amplifiers. Batteries make them portable; but ordinary batteries run down too fast and LED's consume quite a bit of current.

Rechargeable NiCad batteries solve this problem. The most useful DMM's or electronic multimeters have built-in automatic charging circuits. That is—when plugged into the 117 volt AC line during bench operation, the batteries are also recharged simultaneously. In the field, a set of batteries, with care, can last all day.

Oscilloscopes

Foremost among the criteria for a CB-servicing oscilloscope stands the vertical-amplifier bandwidth—anything less than 30 MHz limits its usefulness.

A 15-MHz scope is adequate for examining CB-transmitter output. You can thus examine character, amount, and quality of modulation—and the bare RF signal. But since sensitivity falls off so rapidly beyond 15 MHz, this scope helps little when you want to trace trouble in the transmitter or receiver stages. You can measure the output of an oscillator provided the scope offers sensitivity of 5 mV-per-cm or thereabouts and the oscillator doesn't exceed 15 MHz in frequency. But scope bandwidth can't help much in VCO stages nor in many mixers.

You'll pay a price for the extra bandwidth of a good oscilloscope. In the Tektronix and Hewlett-Packard class, with 35-50 MHz bandwidth, you're looking at upwards of $2000-$2500. Only recently could you find a wideband scope for under $1500.

But there's good news if you're budget-strapped. B&K/Precision not long ago introduced the *model 1474P*, a dual-trace 30-MHz oscilloscope priced under $1000. Hickok unveiled a 30-MHz scope at a recent industry show, but has not released details about it yet.

Spend those additional dollars. If there's one instrument you should not skimp on, it's your oscilloscope. The ability to see—really see—waveforms with fast risetimes justifies the expenditure. Besides, you gain the greater sensitivity of a truly wideband scope. Without a top-quality scope, you operate half blindfolded.

Of course, any service scope in this class features a triggered-sweep. If you're accustomed to recurrent-sweep scopes, as used for TV troubleshooting, you may be in for a surprise. Today's triggered scopes are actually easier to operate than the "recurrent" kind. Thousands of technicians have switched over, even for TV servicing. With the increased use of digital and pulse circuitry in all sorts of electronic equipment, the technician who can't operate a triggered scope is 'way behind.

Don't let learning how worry you. One solid day of training and practice and you will master the triggered scope.

Dual-channel scopes are in. The extra channel costs comparatively little since you're into the higher price of triggering and wide bandwidth anyway.

A dual-channel scope makes sense for CB service. You can leave one channel connected across the dummy load to monitor RF output and modulation any time you key a transmitter. A probe connected to the other channel stands always ready for troubleshooting. Saves hours of diagnosis time every week.

Don't confuse *dual-trace* with *dual-beam* oscilloscopes. The latter are very costly. Separate beams come from the electron gun of the CRT. They are swept separately and fed from separate vertical-input channels. *Dual-trace* scopes use a one-beam CRT. Special switching moves the trace baseline up and down. This happens so quickly that it appears as two steady traces, one above the other. Signals applied to Channel A ride on one trace; signals applied to Channel B show up on the other.

Insist on a demonstration of any scope you plan to buy for communications use. Among other things, check trace illumination when you display extremely narrow pulses—such as the 1-μs 100-PPS pulse waveform commonly used for noise-blanker analysis and troubleshooting. When the duty cycle is so tiny (only .0001 in this instance), some CRT's intensity and/or persistence isn't great enough to show a visible display. You don't want to work in the dark just so you can see the scope display. In bright shops, you may need a hood to shade the scope face anyway.

Check into probes and accessories.

FIRST DUAL-TRACE 30-MHz oscilloscope for under $1000, this *B&K/Precision* instrument is for CB servicing. Be sure you order model 1474P, not just 1474, so you get the special high-frequency probes required for CB work.

Countless ways to save time can be found with a good oscilloscope when you have its accessories and know how to put them to work. A busy technician can, in three months or less, save enough time—and therefore money—to afford the nicest scope you can find.

WIDEBAND OSCILLOSCOPES (TRIGGERED DUAL TRACE)

Manufacturer	Model	Rated Bandwidth (MHz)	Sensitivity (mV/cm)	Calibrated Sweeps (/cm)	Risetime (nanoseconds)	Phosphor
B&K/Precision 6460 West Cortland Ave. Chicago, IL 60635	1474	30	5	0.2 μs→ 0.5 sec	11.7	P31
Hewlett-Packard 1501 Page Mill Rd. Palo Alto, CA 94304	180/ 1820C/ 1807A	50	10	.05 μs→ 1 sec	<10	P11 or P31
Hickok 10514 Dupont Ave. Cleveland, OH 44108	532	30	10	.05 μs→ 2 sec	11.7	P31

RF Wattmeters And Dummy Loads

Last but not least of the basic servicing instruments needed for CB is the RF wattmeter. The in-line type is most popular. Simply connect the transceiver coaxial cable to one side and a dummy load or outside antenna cable to the other.

Output power receives a lot of attention from CB owners. That's because no CB transmitter can legally deliver a carrier with more than 4 watts of RF power.

An accurate RF wattmeter is needed for two reasons. First, as the licensed technician responsible for your work on CB transmitters, you must not let a transmitter go that puts out more than 4 watts. Both you and your customer can be cited and fined—and you could lose your Second or First Class License.

Second, since output power is limited, your customer wants every bit he's entitled to. Often, built-in power meters or inexpensive add-on devices mislead the CB'er. You must be able to verify accurately that a transmitter set is or is not up to par.

When measuring the output power of an ordinary AM transmitter, just hook up the wattmeter and a good dummy load. Do not measure power with a transmitter connected to the antenna. Slight mismatches introduce error into power readings. Always feed the signal into a known dummy load. Be certain that the transmitter is connected to an exact 117 volts AC (base) or 13.8 volts DC (mobile). These are the standard supply voltages for tests. Press the mike button, but do not modulate the carrier. Read power in watts on the meter.

One characteristic of an in-line wattmeter is its ability to sense reflected power from the antenna feedline due to a mismatch. This is known as the *reverse* or *reflected* reading. A high ratio of reflected power to forward power indicates a high voltage standing-wave ratio (VSWR) on the feedline. An improperly tuned antenna can cause this condition. So can a broken or damaged coaxial cable. Likewise a defective dummy load.

Therefore, before accepting the wattage reading, also check the VSWR or reverse reading. If it's high, don't trust the wattmeter reading. Change to a good dummy load.

Probably the best known RF wattmeter in the communications business is the Bird *model 43*. With plug-in elements for various power and frequency ranges, the *model 43* stands proven as one of the most accurate units available. It's not expensive, either, as precision instruments go. Under $200 buys the instrument and several plug-in elements. For CB, you need only a 10-watt element in the 25-60 MHz range.

Output power from single-sideband transmitters is measured differently. In the first place, there's no carrier to measure. So you can't measure power unless the transmitter is modulated. Only then is any RF generated. Because of the nature of SSB signals, FCC Rules say a CB transmitter can put out 12 watts of peak envelope power (PEP) in the single-sideband operating mode.

For measuring, the SSB transmitter is modulated with two tones simultaneously. Typical frequencies are 500 Hz and 2400 Hz. These tones should not be harmonically related. They produce a complex single-sideband RF output signal.

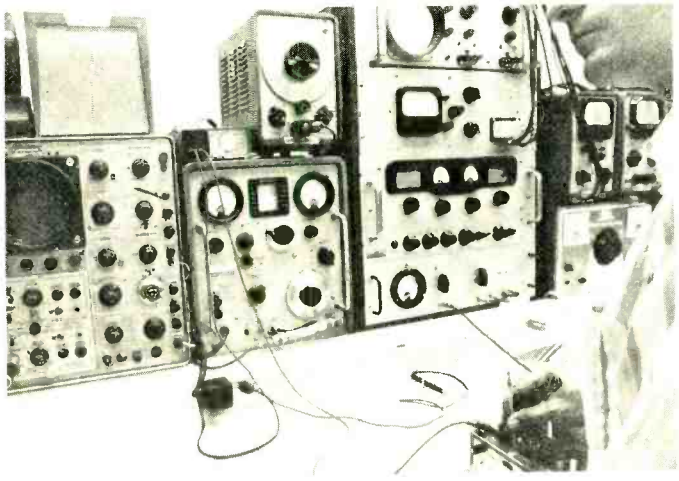
You can't measure SSB power accurately with an ordinary wattmeter, either.

BIRD MODEL 43 wattmeter has long been a standard in communications servicing. Newer model 4314 is peak-reading version for SSB.

Measuring peak envelope power takes a peak-sensing wattmeter. Bird manufactures one, their *model 4314*. You'll also find peak *and* average power-measuring circuits in the *model 1020 Servicemaster* unit from B&K/Precision, and in the *model WM1000* combination meter made by Communications Power, Inc.

One last thing about RF wattmeters. If you carefully check their calibration regularly, you can do okay with low-cost carry around units. **Do not** test accuracy by connecting wattmeters in series. Instead, measure any transmitter output using an accurate meter and a dummy load. **R-E**

TEST SYSTEMS For CB Servicing



Profitable servicing means selecting test instruments that can be used together with a minimum of interconnections. There are five systems

YOU WILL SPEND CONSIDERABLE MONEY to equip your service shop for CB radio testing and repairs. Therefore, you want the best value for your dollar.

But, important as price is, that's not the major decision facing you. First consideration should go to how convenient the equipment is to use. A bench full of equipment that does not fit your work habits can slow you down noticeably.

This does not mean you can't adapt to one group of equipment or another because you can. And, if your present testing and troubleshooting procedures are haphazard—you should. However, your best—and most profitable—bet is to buy a group of instruments that suits your own service philosophy and ideas about setting up a service bench.

CB test equipment today offers five distinct systems, all competing for your attention—and your dollars. The costs of setting up these systems range widely: You will find very expensive and not-so-expensive outfits. While most groups incorporate similar features, each has unique points.

Sometimes special features contribute to the higher price. Sometimes it's the quality of the equipment. Other times, you pay extra for versatility. Comparing systems isn't easy. However, distributors can often arrange demonstrations. You might even borrow your favorite system for a week or two, and see for yourself how compatible it is. The more you find out beforehand, the more confident you'll be that your test-equipment money has been well spent.

Discrete instruments

The most basic present-day bench setup for CB servicing is a *discrete* system that comprises many individual instruments. To put together a discrete system, you choose separate instruments, each on its own merits.

For example, you might select a particular oscilloscope model because it offers certain qualities and features that you think are better than in other scopes. Or perhaps you choose it for its versatility, or because it simplifies tests that others do not.

Then, you might buy an RF generator made by another company. Again, your choice derives from features that allow you to troubleshoot CB receivers the way that suits you best. Also, the instrument might have extras that save buying additional gadgetry.

And so on for other instruments you need to service CB radios: a frequency counter, a digital or electronic multimeter, RF wattmeter, dummy load, or 12-volt DC bench supply. In each instance, for a discrete bench setup, seek out and purchase the one make and model you prefer, without worrying whether it matches others in appearance, price or compatibility.

Yet you must consider interconnection when opting for a discrete system. As a practical matter, some tests require linking certain instruments together. Will you have to build or buy special cables? How many connector variants will you be concerned with? The most common variants are BNC, N and UHF types, but there are others. Even this small selection entails some inconvenience until you construct adapter cables or a patch board.

Some instrument faces may not look well together. Case sizes may be so disparate that instruments don't fit close enough together for handy use.

Yet none of these difficulties are insurmountable. In fact, advantages in particular instruments may far outweigh minor inconveniences.

Eventually, you'll probably build an interconnect panel for your discrete system. The object of such a panel is to connect a CB transceiver quickly for *all* testing, measuring and troubleshooting, without having to change the cables around. Ideally, you should make a power connection, an RF cable connection and a speaker connection; three cables, that's all. A switch (or switches) on the interconnect panel allows various measurements to be made. No fumbling with instruments or moving them around. Connectors and cables last longer, and you spend much less time on each repair diagnosis. That pumps up profits rapidly.

Figure 1 shows how to connect a practical interconnect panel. The panel combines the instruments in ways that facilitate fast testing and measurements. Here's how it works:

Slip the RF connector onto a transceiver antenna jack and connect the DC supply. Plug the audio wattmeter cord into the external speaker jack on the transceiver. The FUNCTION SELECTOR in position 4 allows you to measure the receiver performance and troubleshoot the receiver circuits. Activating the noise generator injects impulse signals for testing noise limiters and blankers.

In some instances, RF signals are needed that are not provided by most RF generators designed just for CB. Position 5 of the FUNCTION SELECTOR couples in a

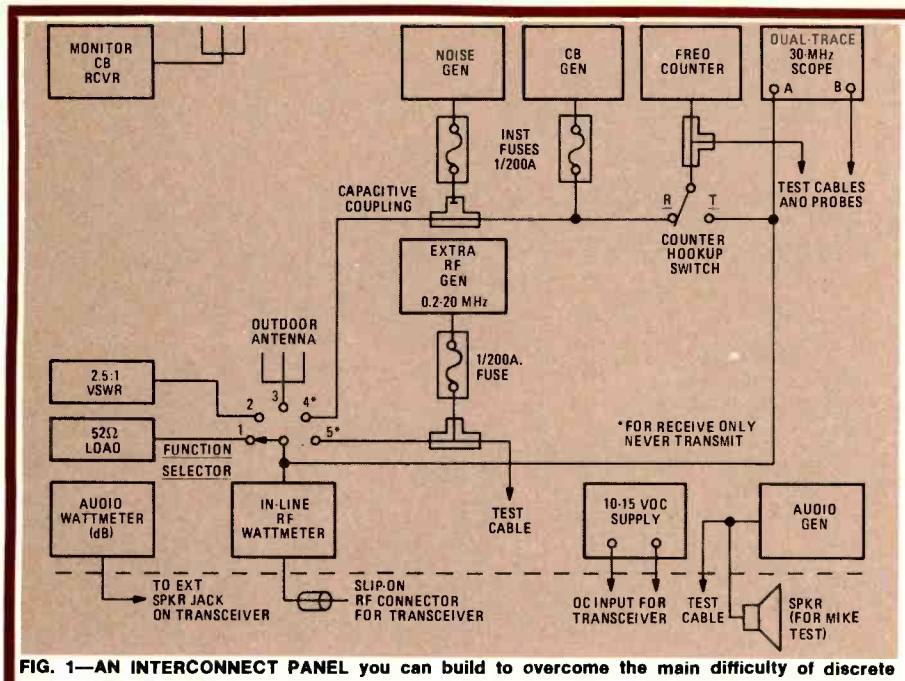


FIG. 1—AN INTERCONNECT PANEL you can build to overcome the main difficulty of discrete systems. Coaxial wiring behind the panel connects instruments together so only one cable connection is needed to test and troubleshoot a transceiver.

generator that does provide these extra signals. Note that the output of this RF generator has been carried also to an external test cable, for injecting signals inside a transceiver.

For transmitting, place the FUNCTION SELECTOR in either of its three positions. (*Never* press the mike button with the switch in positions 4 or 5. However, fuses protect the generators in case you forget.) A 52-ohm dummy load at position 1 is needed for most transmitter testing and tuning. The frequency-counter switch should be placed in the T (transmit) position.

Pressing the mike button permits measurement of the RF output on the in-line wattmeter. A connection to one channel of the 30-MHz oscilloscope reveals the quality of the RF output. The counter shows the carrier frequency without modulation. With the audio generator feeding the tiny speaker, hold the mike near that sound source and observe—on the scope—the quality and percentage of modulation.

The test cables, with probes, that are connected to the audio generator, the frequency counter and the 30-MHz oscilloscope are for direct testing inside the CB transceiver.

A discrete test-equipment system often "just grows." You buy top-priced instruments one at a time as you can afford them. This doesn't mean you can't assemble a discrete system with less-costly gear (many technicians do), but it's usually a haphazard and ultimately unsatisfactory method. Wherever price is a major factor, a different kind of system generally proves better.

Discrete-plus-interface

The B&K/Precision Division of Dynascan Corporation has designed a system of individual instruments especially for CB servicing. (See Fig. 2.)

FIG. 2—TEST INSTRUMENTS from B&K/Precision have their own interconnect panel—a special instrument that automatically switches over from receive to transmit.

What makes the B&K/Precision system unique is the interconnecting device, called the *model 1040* Servicemaster. This device connects the other equipment together in much the same way as with a panel you might build yourself.

Other features of the *model 1040* increase its usefulness well beyond the basic advantage of instrument interconnection and one-cable hookup to a transceiver: A built-in audio wattmeter reads in decibels (handy for AM receiver sensitivity measurements). There's a distortion-measuring setup; single- and two-tone sound sources for AM and SSB-transmitter modulation tests; and an RF wattmeter to measure AM or SSB power. In short, this interface instrument supplies a panel of gadgetry that combines the basic instruments into a rather complete CB testing and measuring facility.

Three basic instruments work with this interface device—a CB-frequency RF generator, a frequency counter and an oscilloscope. (A special note about the scope: It's a 5-MHz unit, the *model 1403A*.) The Servicemaster includes a beat oscillator that heterodynes the 27-MHz output of a CB transmitter down to 1 kHz. Of course, the signal retains whatever modulation the transmitter has induced. So, an ordinary scope can see the transmitter output. A 5-MHz scope costs much less than a 27-MHz scope.

You can buy matching gear to fill out your basic test bench: a 30-MHz scope, a digital or analog multimeter, a bench DC supply, and even a transistor tester. All these medium-priced instruments match in appearance. As a system, they let you test, measure, tune up and diagnose throughout any CB transceiver.

Discrete-in-a-rack

A third system concentrates on discrete instruments, but links them together in a dressy equipment rack. The Hickok *Comm-Line* series best illustrates this approach. (See Fig. 3.)

This system contains a CB RF generator; a frequency counter that also displays—on a six-digit LED readout—RF power, VSWR and modulation percentage; a digital multimeter; a 13.8-volt (adjustable) DC power supply; and a transistor tester. A manual switch that is part of the rack-mounting kit lets you switch the transceiver coax cable back and forth between the generator and frequency counter. Moreover, the RF generator has a high-level output that is unaffected by the attenuator. It feeds the frequency counter, so that you can monitor the generator frequency.

In essence, the Hickok system is an aggregate of individual instruments. There's no oscilloscope. You can buy a 30-MHz model separately from Hickok, but it doesn't fit into the rack. To some extent, the instruments are hooked together, but not in the degree found in an *interfaced* system.

An interesting sidelight on this rack is that it impresses CB customers. If you

FIG. 3—ATTRACTIVE DESIGN adds to usefulness of the Hickok *Comm-Line* rack of CB test equipment. Appearance impresses customers when rack is within view. New instruments can also be added as they are introduced.

have a lot of walk-in trade, place a rack of instruments at the check-in counter. It lets you (or your counterperson, with a little practice) make on-the-spot basic performance measurements. You can also use it to demonstrate how well a set works after you've fixed it.

All in one cabinet

Here's a major departure from other methods of gathering CB test instruments. Consider this lineup: A CB RF generator; a seven-digit frequency counter; two-tone audio source; dummy load; RF wattmeter; amplitude-modulation meter with digital readout; audio wattmeter and distortion tester; crystal tester that reads natural frequency of any crystal; and a beat oscillator to measure RF output and modulation on a relatively narrowband scope. What is unusual is that *all* these instruments are housed in one instrument case—the unit is Sencore's *model CB42* Analyzer shown in Fig. 4.

FIG. 4—SENCORE MODEL CB42 contains several instruments that are needed to service CB gear, plus extra features some systems do not have. With this setup, few other instruments are needed on the bench.

There's more to this Sencore instrument than a list of its components reveals. For example, when used to test transmitter-channel frequency, the *CB42* can measure the *percentage* off-frequency on its digital LED's. An automatic feature measures receiver sensitivity in two simple steps and displays the result digitally. The digital modulation meter tests either the positive or negative side of the envelope to verify modulation balance.

Although there is no oscilloscope, the internal beat oscillator allows you to use just about any scope.

Sencore makes numerous digital voltmeters and multimeters, and a separate frequency counter. A DC power supply is available for bench use or to power CB radios and the *CB42* away from AC power lines. The instrument faces match up for a professional appearance on your service bench.

A similar all-in-one instrument is the *model 767* CB Analyzer made by Time and Frequency Technology. The analyzer contains: a highly accurate RF generator covering 100-kHz CB frequencies; an impulse noise generator to test and troubleshoot automatic noise-limiter and noise-blanker stages; two-tone and single-tone sound sources for modulation checking; audio metering for receiver sensitivity tests and distortion analysis; a seven-digit frequency counter; measurement of either AM or SSB power modulation; and VSWR—all shown on a panel meter. It works on 12.4 volts DC as well as 117 volts AC.

A unique feature in the *model 767* measures transmitter frequency a different way. An internal mixer and amplifier produces an audible beat signal between the internal synthesized frequency and transmitter output. Simply zero-beat the transmitter as you listen. You can also adjust the transmitter closely with the frequency counter.

These elaborate test sets have two major advantages. One, you can carry the test instrument to the customer, to troubleshoot mobile or base radios right on the spot. Second, the all-in-one concept makes these instruments excellent at-the-counter devices to verify reported symptoms as the customer watches.

Combination AM/FM units

Finally, we come to a class of instruments used by communications technicians before the advent of CB radio. These are quite costly compared to CB-only test gear. Originally, they were aimed at FM two-way radio. As CB popularity has grown, updated instruments include CB frequencies and facilities for handling AM radios.

Typical among these units are two made by Lampkin Laboratories, *model 107C* (shown in Fig. 5) and *model 109*, both designed essentially to measure frequency. But well-planned add-ons extend their usefulness. They can monitor AM or FM signals, measure modulation and act as extremely accurate frequency generators. The *model 109* includes a digital frequency counter. This instrument does not reach all the frequencies the *model 107C* does, but you can add modules to include most communications bands: CB, low VHF, high VHF and UHF to 512 MHz.

FIG. 5—LAMPKIN LABORATORIES has been manufacturing frequency meters since the early days of communications. The *model 107C* is highly accurate for AM and FM servicing.

Cushman's *model CE-5* and *model CE-6A* (Fig. 6) both cover CB frequencies as well as those for FM two-way radio. For either one, you choose a plug-in module for either AM or FM. You can buy both modules; they're easily interchanged.

FIG. 6—MULTIPLE FUNCTIONS characterize Cushman instruments for AM and FM communications testing and repair. Modules plug in to adapt unit for mode of testing required.

A company called ifr, Inc., also makes an instrument for both AM and FM servicing. The *model FM/AM-1000S* is a frequency meter, wattmeter and signal generator (AM or FM)—all highly accurate. One outstanding feature: the *S* version contains a spectrum analyzer. You can use it to check transmitters for spurious outputs.

Instruments in this category are versatile, precise to a high degree and relatively expensive. As signal generators, they exhibit accuracy and stability not found in less-costly generators. For measuring frequency, they seem no easier to use than a counter—although they are more accurate than some counters.

Your choice

It boils down to this: You have five different systems to choose from when you go test-equipment shopping for your CB bench. Pick whatever kind fits your work habits or preferences.

But also consider your budget. The first and last of these five categories generally entail expenditures of between $5,000 and $10,000. They are worth the extra money because you buy added dependability, accuracy and versatility.

In a medium-price category, however, you can find plenty of adequate equipment for CB radio servicing. You can be well set up for under $4,000.

Not included in this roundup of CB test systems are a number of low-cost test sets. They fall into the under-$1,000 category (for the test set and comparable associated instruments). A few are very inexpensive.

Some technicians get along well with no more investment than this. Low-cost instruments have not been omitted through any feeling that they don't do a job. By all means try them out at your distributor's. Borrow them if you can for a tryout. If they suit you, buy them. Realize, however, that they will not do the same jobs that expensive gear will do, nor with anything like the accuracy.

What you buy and what you spend are up to you. **R-E**

IHF Sensitivity—What It Really Means

IHF sensitivity combines both noise and distortion into one specification. Now, a new specification—called NDCR—is being used to provide a more meaningful measure of amplifier performance

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WAY BACK IN 1958, THE IHF (*I*NSTITUTE OF *H*igh *F*idelity) proposed a new "usable sensitivity" specification to describe the performance of an FM tuner. The specification, known as IHF Sensitivity, concerned *two* important forms of disturbance that detract from FM listening pleasure: noise *and* distortion. It required the listing of the minimum number of microvolts (late changed to dBf) needed to produce an audio output signal 30 dB (or around 33 times) *greater* than the residual noise-plus-distortion. This did not mean the signal required to lower distortion to the 3% point, nor the signal needed to reduce noise or hiss to 3% of the total signal. But it specified the signal necessary to reduce *both* disturbances until, together, they represented no more than 3% of what is heard.

Audio amplifiers

Contrast this approach with the way the performance of an amplifier or an integrated amplifier is specified. Usually, a manufacturer will state the maximum harmonic distortion at the *full* rated output. The Federal Trade Commission has broadened the required "power output" statement so that it now includes the load impedance, the frequency range over which that power can be delivered, and (implicitly, according to the rule) that no greater distortion will be produced at lower-than-maximum power output levels all the way down to an arbitrary 0.25-watt output.

A diagram of distortion-versus-power output for a typical amplifier would show why the FTC was concerned with distortion at the *lower* power levels. For all power levels between 10 watts and 100 watts, the amplifier's harmonic distortion level might well be under 0.5%. However, at a 0.25-watt level (the low end of the power scale which must be taken into account to conform to the FTC rule), THD could rise to a disturbing 1.5%, and at 0.1-watt output, THD is 2.0%.

Many early solid-state designs suffered from "notch" or "crossover" distortion.

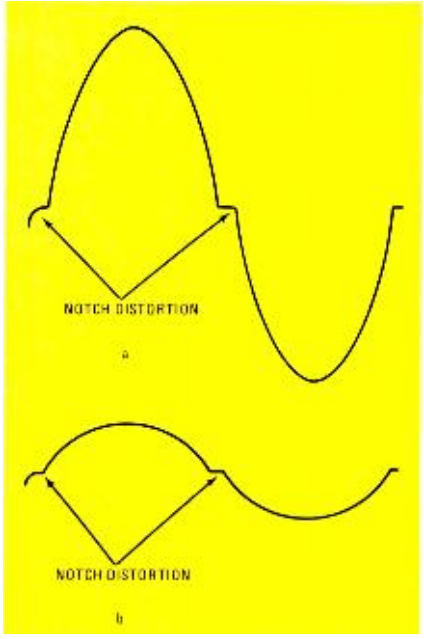


FIG. 1—NOTCH DISTORTION is relatively insignificant in a large-amplitude signal as shown in *a*. As signal amplitude is decreased, distortion becomes significant as shown in *b*.

Figure 1 shows the problem. In Fig. 1-a a high-amplitude waveform contains a slight discontinuity each time it crosses the "zero axis." This condition arises most commonly in a Class-B push-pull stage when one transistor of the output pair begins to shut off before its companion has fully turned on. While the discontinuity is very small in terms of the total output-signal amplitude (and therefore represents a low percentage of total harmonic distortion), as the signal level is decreased (Fig. 1-b), the discontinuity represents a *greater* percentage of the total; that is why distortion tends to rise markedly in Fig. 2.

Referring again to Fig. 2, if we specified the power range over which this amplifier can deliver 1.0% THD or less, we would have to limit that range to between 0.8 watt and 100 watts. On the other hand, if a 2.0% rated distortion were acceptable, then the amplifier could be useful from 0.1 watt to 100 watts—a more than 9.0-dB increase in dynamic range. Even at that, the total useful dynamic range (over which THD is less than 2.0%) would be only 60 dB (the difference between 0.1 watt and 100 watts).

Noise

So far, we have only dealt with distortion. But, as everyone knows, an amplifier also has a residual noise level. Figure 3 indicates the amount of noise at the output of the 100-watt amplifier, expressed as a percentage of any output level, or in the number of dB below that output level. When the amplifier delivers its full rated output of 100 watts, residual

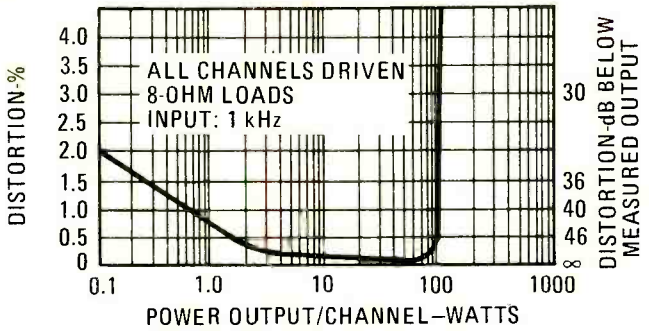


FIG. 2—HARMONIC DISTORTION of a typical amplifier increases at low-power extreme.

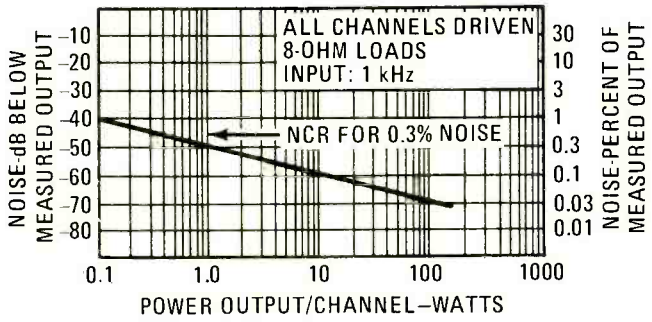


FIG. 3—RELATIVE NOISE LEVEL of a typical amplifier decreases as output power is increased.

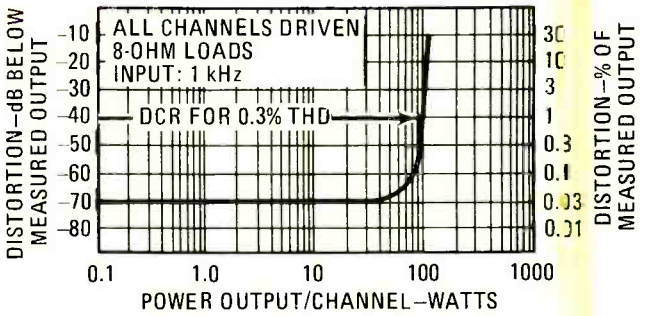


FIG. 4—ELIMINATION OF NOTCH DISTORTION results in a harmonic distortion characteristic that doesn't rise at the low-power extreme.

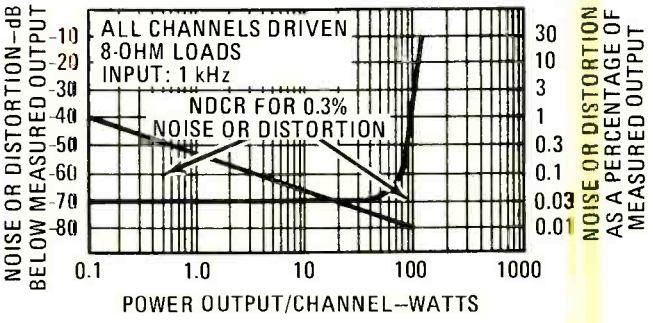


FIG. 5—NOISE AND HARMONIC DISTORTION characteristics combined on a single graph.

noise is 70 dB below that level (0.03% or 0.01 microwatts). Since the residual noise is constant (assuming you don't touch any of the amplifier controls), if a musical signal of less amplitude is applied to the amplifier—say, one that causes the amplifier to deliver only 1.0 watt of power—the noise level will be only 50 dB below 1.0 watt, or 0.3% of the total output.

Modern amplifiers are designed with virtually *no* crossover or notch distortion and, therefore, have a wide "distortion clearance range." In Fig. 4, the distortion clearance range for 1.0% THD extends from zero all the way up to the maximum rated output. If we *combined* the noise clearance range shown in Fig. 3 with the distortion clearance range of Fig. 4, we would come up with the "noise-plus-distortion clearance range" diagram shown in Fig. 5. Now, if we wanted to specify that this amplifier will operate at no more than 0.3% *noise plus distortion*, we would have to assign a noise-plus-distortion clearance range to it that extends from 0.5 watt to 90 watts. If we accepted a combined noise and distortion at some point in its dynamic range of 1.0%, the noise-plus-distortion clearance range would be extended to 0.1 watt at the low-power end and to 100 watts at the high-powered end.

The new NDCR specification

The Yamaha Company of Japan has added exactly that kind of specification to all of their new high-fidelity component products this year. The company uses the abbreviation NDCR (*N*oise *D*istortion *C*learance *R*ange) to describe this specification.

In the lab we took an integrated amplifier and applied a variety of signal levels to it while observing its output on a scope along with the distortion products (available from a separate output jack on our distortion analyzer). Figure 6 shows the 1-kHz output as the upper trace, and about 0.3% distortion as the lower trace. This is what we observed when the amplifier delivered its rated power output of 25 watts per channel. We then lowered the signal level to around a 0.1-watt output (adjusting the vertical gain of the scope so that the upper trace would appear as in Fig. 6). Our distortion analyzer again read 0.3% distortion, but, as is clearly evident from the lower trace of Fig. 7, what the analyzer was really reading was not harmonic distortion but the amplifier's "noise floor"—some 50 dB below a 0.1-watt output level. Perhaps the lower trace of Fig. 7 (and the 0.1-watt output of the amplifier) *does* contain some harmonic distortion; but, at that low level, the overriding noise completely obscures it—and becomes the limiting factor of the amplifier.

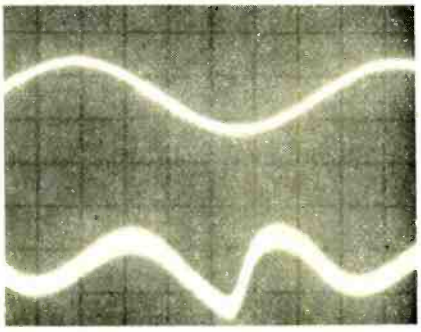


FIG. 6—TEST SIGNAL is shown in upper trace. Same test signal with 0.3% distortion is shown in lower trace.

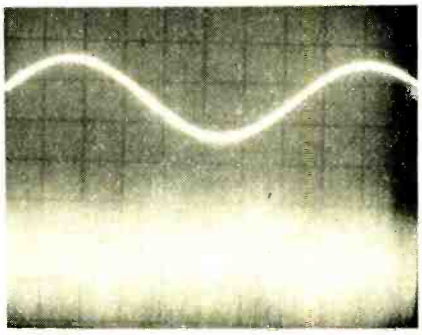


FIG. 7—DISTORTION is overridden with noise when output of amplifier is reduced to 0.1 watt, as shown in lower trace.

To further investigate the amplifier's dynamic range, we used our spectrum analyzer to record the various output signal components at different power levels. Results are shown in the scope photos of Figs. 8, 9 and 10. In Fig. 8, a tall spike at around the 1-kHz frequency mark represents the desired output signal. To the right are additional spikes, the tallest being the third-harmonic distortion component, having a 30-dB-lower amplitude than the desired fundamental 1-kHz signal. (Each vertical division represents a 10-dB amplitude difference.) This photo was taken with the amplifier driven just into clipping—the high-powered NDCR extreme.

When the output is reduced by 10 dB (see Fig. 9), the harmonic distortion (the spikes to the right of the 1-kHz fundamental) is no longer the predominating disturbance factor in the output signal. Hum components (and their harmonics

at 120 Hz, 180 Hz, etc.) are now seen to the left of the desired 1-kHz signal spike. Finally, in Fig. 10, after the output level has been lowered another 10 dB to 40-dB below the clipping level, random wideband noise becomes the dominant disturbance in the amplifier output signal. Major hum components at 60 Hz and 180 Hz are now only 30 dB or so below the desired output signal level (or 70 dB below full output).

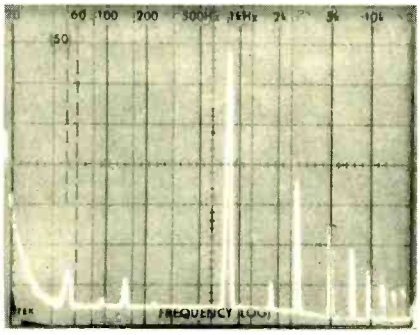


FIG. 8—OUTPUT SIGNAL SPECTRUM when amplifier is fed with a 1 kHz tone and driven just into clipping.

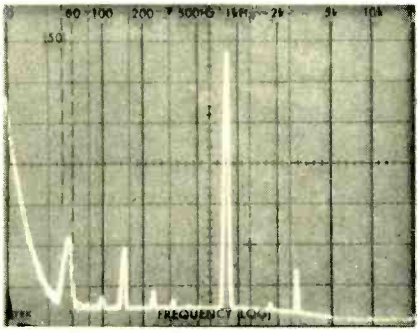


FIG. 9—OUTPUT SIGNAL SPECTRUM when amplifier output is 10-dB below maximum rated output.

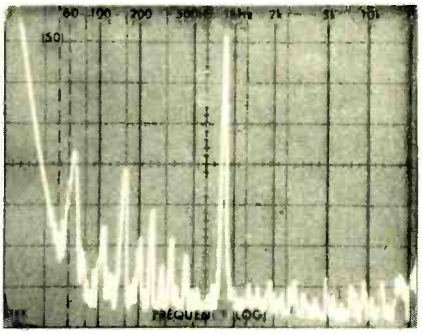


FIG. 10—OUTPUT SIGNAL SPECTRUM when amplifier output is 40-dB below maximum rated output.

How Yamaha quotes NDCR

Yamaha takes NDCR an important step beyond what we have already discussed. As they point out, most separate distortion and noise specifications are usually given for products with their volume controls set at maximum; and distortion is almost always quoted when a signal is applied to the *high-level* (AUX, or TUNER) amplifier inputs or when an input is applied directly to the power amplifier section. Actually, the volume control is hardly ever operated at maximum settings and, depending upon where the volume control appears in the circuitry, its setting can have an important bearing on overall amplifier noise and distortion levels. So, in stating the NDCR for a given product, the volume control setting or settings must be included in the specification.

Yamaha also quotes the NDCR from the phono input all the way to the speaker outputs. If the signal-to-noise ratio of the phono preamplifier is only 60 dB (referred to a 2.0-mV input), no matter how good the signal-to-noise ratio of the power amplifier section may be, the over all signal-to-noise ratio will never be better than 60 dB.

A typical Yamaha NDCR specification

The following NDCR specification is applied to Yamaha's newest receiver, *model CR-2020:*

"Noise-Distortion Clearance Range (NDCR) for 0.1% into 8 ohms at 20 Hz to 20,000 Hz: from 100 milliwatts to 100 watts, with volume control at −20 dB (from maximum), phono input to speaker output."

This means if you are listening to phono records with the volume control set 20 dB below maximum, no more than 0.1% noise or distortion (or a combination of both) can be expected at any program signal level from 100 milliwatts to 100 watts. By including the phono-preamp section in the statement, Yamaha is also guaranteeing that the noise and distortion levels generated by that low-level section of the receiver and all succeeding circuits) will also remain within the overall NDCR specification.

Purists can argue that the subjective annoyance factors of noise and distortion are not the same, and that 1% distortion (−40 dB) may be less bothersome to listeners than a 40-dB signal-to-noise ratio. Nevertheless, we think that Yamaha's NDCR specification succeeds in combining several important performance specifications into a meaningful single number or statement for comparison with those of other products. Now the trick will be for Yamaha (or the rest of us) to persuade others that this new specification is one that all manufacturers should publish. **R-E**

Advantages to servicers in Rhode Island warranty bill

The Electronic Technicians Guild of Rhode Island announces that a warranty bill (755,251) offering several features of benefit to the service industry, has been passed in that State:

Under the new law the manufacturer must:

1. Have service in Rhode Island.
2. Furnish parts within 30 days.
3. Pay the same price as a Rhode Island consumer, both for labor and parts.
4. Have parts and service information available from distributors in Rhode Island.
5. Have parts available for at least four years after the last sale of any model.

The servicer must:

1. Handle warranty repairs and out-of-warranty repairs equally.
2. Complete repair within 30 days, or within 10 days after receiving ordered parts.
3. Charge a manufacturer the same price that he would a Rhode Island consumer, both for labor and parts.
4. Order any needed parts within two days of receiving the unit for repair, and notify customer, unless customer agrees otherwise.

The Rhode Island law, the Guild believes, plus the similar Minnesota law and the Song-Beverly Act in California, may bring about the beginning of the end of the warranty inequities servicers have been enduring for years.

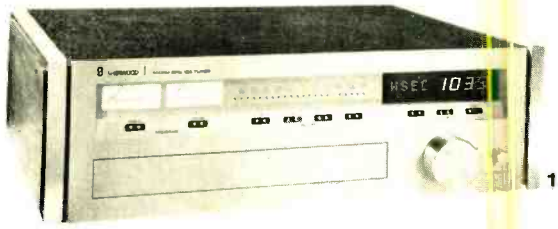
New advantages to users of phones in the 1980's

Telephones that will take the number of a call to a busy line, wait until the line is clear, then dial both numbers and connect the two lines are among the features of the future predicted by a panel of Bell engineers, speaking to the International Conference on Communications in Chicago last summer. Other phone services of the 1980's would include preselection of telephone numbers from which collect calls could be accepted without operator assistance and identification of calls from a preselected "priority" list by a distinctive ringing tone. Eventually, it was stated, the caller's telephone number might be displayed visually on the called party's phone.

These features—and several others—will be made possible through the evolution of a technique already in existence and in use in some telephone offices—stored-program control, or SPC. The control memory can handle different calls in different ways according to the instructions it has received. In the case of the busy-line call, it can forward the caller's number to the program of the called phone, which would then be contacted as soon as the line is available.

A second innovation, Common Channel Interoffice Signalling (CCIS), will also increase the efficiency of future phone services. CCIS operates over pathways separate from the voice circuits to set up and terminate calls, thus reducing the load on the voice circuits. It will also select best transmission routes automatically. Thus, for example, a north-south call made during a busy hour in one time zone might be routed westward to the less-occupied time zone next to it, then back to the called phone, bypassing the busy area directly between them.

Radio-Electronics Tests Sherwood Micro CPU-100 FM Tuner



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CIRCLE 99 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THERE IS SO MUCH TO REPORT ON SHERWOOD'S new *Micro CPU-100* tuner that all aspects of its performance, circuitry and features cannot be covered in one brief test report. Two years in the design labs, the tuner (shown in Fig. 1) has, for the first time, combined the power of a microprocessor with a state-of-the-art frequency-synthesizing FM tuner. The resulting FM reception and convenience of operation would be difficult to surpass. This report will simply describe the tuner's features and analyze its performance.

The front panel seems devoid of knobs, controls and switches. A well-illuminated dial area at the top is flanked by two meters at the left and an alphanumeric display area at the right. That's correct—alphanumeric—because the *Micro CPU-100* not only reads out frequency in megahertz, but can also read out corresponding FM station call letters.

Fig. 2 shows a closeup of the readout, in which the **Radio-Electronics** initials are displayed instead of an actual station designation. What appears to be a linear-frequency scale at the center of the dial area is really a series of LED's, each corresponding to 1.0 MHz. This "scale" was added as a human-engineering aspect of the design, since most FM listeners are accustomed to "seeing" where they are on the FM dial. The LED that is lit up corresponds to the nearest MHz to which the tuner is actually tuned.

The left-hand meters are a signal-strength meter and a multipath meter. A center-of-channel meter is obviously not required, since, in this frequency synthesized tuner, center-tuning is accurate to within 0.0024%. The multipath meter fluctuates in varying degrees depending upon the severity of the signal reflection problem; the idea is to orient your outdoor antenna until such fluctuation stops or is decreased to a minimum for a given received signal. The signal-strength meter, unlike most such meters, is arranged to give meaningful readings instead of whipping up to full scale with just a few microvolts of input signal. Specifically, we measured 5 μV for a reading of "1," 100 μV for "2," 1,000 μV for "3," 2,000 μV for "4" and around 30,000 μV for a reading of "6."

A series of "touch" switches below the dial area operate electronically. To actuate any of them, just brush a finger gently across the two metal tips associated with each switch. The three right-hand switches under the readout area take care of upward (in frequency) and downward automatic scanning. Touch the center switch of this group, and, when scanning in either direction, tuning will come to a stop only when stereo signals are intercepted. Otherwise, scanning will stop every time a usable mono or stereo signal is received. Usability is determined by the settings of a variable-mute threshold control. Manual tuning, as well as alpha programming, is accomplished by means of the large, flywheel-coupled tuning knob below the touch switches. An interesting sidelight is that this tuning knob is coupled only to a flywheel—and to nothing else. The computer circuitry is "told" what to do when the tuning knob is spun because a serrated disc connected to its shaft allows beams of light to pass and impinge upon photoelectric elements that constitute one facet of the interface between user and microcomputer.

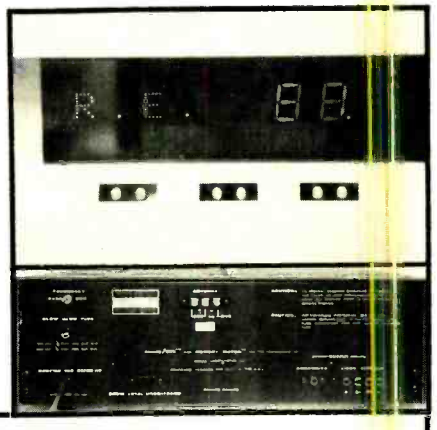
"Programming" your stations

The four switches directly below the "dial scale" are labelled MEMORY A, B, C and D. To store a favorite station in one of these memories, the station is tuned manually, after which the STORE switch is lightly touched, followed by a touch of the desired MEMORY switch. Thereafter, touching the MEMORY switch again will recall the desired frequency instantly. When the manual or scan modes are used, if a station that has been stored in one of the memories is encountered, a red glow appears behind that MEMORY switch as a reminder.

To "program in" station call letters, touch the ALPHA switch at the left of the panel. The tuning knob changes into a letter-selecting knob that displays the alphabet as it is rotated. Once the first call letter has been reached (usually "W" or "K" in the United States), brush a finger across the STORE switch and dial in the next letter. After all four station letters have been dialled in, touching the STORE once more completes the programming and automatically restores the frequency-tuning function to the tuning knob. Up to 48 sets of call letters can be assigned to as many frequencies. In case you listen to *more* than 48 stations and you try to program in a forty-ninth set of call letters, the alpha-readout area will spell out "F-U-L-L," at which point you must cancel one or more of the less-preferred call-letter assignments.

The only other front-panel control visible in Fig. 1 is the POWER on-off pushbutton. Even when the power is shut off all the programmed information is retained indefinitely (including four-station memory and all 48-station alpha designations) as long as the line cord is connected. If the power cord is disconnected from a wall outlet, information can be stored for about a year.

In the lower right section of the panel, a pivoting "trap door" opens to disclose the following controls: An output level control, the muting level control, a muting switch (which



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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

IHF Usable Sensitivity: normal: 1.7 μV (9.84 dBf); wide: 1.7 μV (9.84 dBf). **50-dB Quieting:** mono: normal: 2.1 μV (11.7 dBf); wide: 2.6 μV (13.5 dBf). **50-dB Quieting:** stereo: normal: 25 μV (33.2 dBf); wide: 30 μV (34.7 dBf). **THD:** mono: normal: 0.1% at 100 & 1 kHz; 0.15% at 6 kHz; wide: 0.07% at 100 & 1 kHz; 0.1% at 6 kHz. **THD:** stereo, normal: 0.2% at 100 & 1 kHz; 0.25 at 6 kHz; wide: 0.15% at 100 & 1 kHz; 0.15% at 6 kHz. **S/N Ratio:** mono: 75 dB; stereo: 72 dB. **Capture Ratio:** normal: 1.0 dB; wide: 0.5 dB. **Selectivity:** normal: 80 dB; wide: 18 dB. **Spurious and Image Rejections:** 130 dB. **IF Rejection:** 120 dB. **Muting Threshold:** 3.0 μV to 1000 μV. **Stereo Threshold:** 4.0 μV. **Noise Filter Threshold:** 15 μV. **Frequency Response:** mono and stereo: 20 Hz to 15 kHz, ±0.5 dB. **19-kHz and 38-kHz Rejection:** 80 dB. **Stereo Separation:** normal: 40 dB at 100 Hz, 45 dB at 1 kHz, 35 dB at 15 kHz; wide: 45 dB at 100 Hz, 50 dB at 1 kHz, 40 dB at 10 kHz. **Output Voltage:** fixed: 1.0 V; variable: 0 to 1.5 V. **Power Requirements:** 120 VAC, 50 to 60 Hz, 30-watts. **Dimensions:** 20 W × 6⅜ H × 14¹⁵⁄₁₆ inches D. **Net Weight:** 34 lbs. **Suggested Retail Price:** $2000.

defeats the muting-threshold circuit), and a selectivity switch. The latter uses two separate IF systems to provide "normal" selectivity in crowded FM signal areas, and a wide bandwidth for exceptional stereo fidelity and ultra-low distortion during favorable reception conditions. An automatic stereo filter switch reduces noise during weak-signal stereo reception at the expense of some stereo separation, but it is automatically *removed* from the signal path when signals exceed around 12 μV. Also provided are a stereo/mono mode switch and a de-emphasis switch, which alters de-emphasis to 25 μs when decoding Dolby broadcasts with an external adapter or decoder.

The rear panel shown in Fig. 3 has fixed- and variable-output pairs of jacks, 300- and 75-ohm external antenna terminals, a composite (multiplex or detector) output jack, a single convenience AC outlet, a line fuseholder and a tiny toggle switch with positions for ODD or EVEN frequency tuning. This switch permits the tuner to be used in other countries where stations broadcast at even-decimal portions of a megahertz (for example, 100.2 instead of 100.1). When in the odd-decimal position, tuning progresses in 200-kHz increments from 87.5 MHz to 108.5 MHz; while in the even setting, tuning jumps in similar increments, from 88.6 MHz to 108.6 MHz. The even setting may be useful if the tuner is hooked up to certain cable-FM services in the U.S. which also use "even" frequency increments.

Performance measurements

Our laboratory performance measurements, summarized in Table I, clearly show that the tuner is so far above average in FM performance as to place it in a category all by itself. In most cases of critical measurement, we suspect that our own test equipment imposed limitations on readings. Consider, for example, a signal-to-noise ratio of 83 dB in both mono and stereo (in the wideband IF position). We have never measured such a number, and, for all we know, what noise there was was induced by the random internal modulation of our FM generator. The 21.0-μV (31.6 dBf) signal required for 50-dB quieting in stereo is the lowest we have ever read on any tuner or receiver, as is the 0.5-dB capture ratio in the wideband position. The 0.055% distortion figure obtained with 1-kHz 100% modulation in mono and the comparable 0.06% obtained in stereo are incredible. Sherwood designers attribute these capabilities in part to a new digital FM detector circuit.

Frequency-response curves of the audio output (including the effect of 25-μs and 75-μs de-emphasis) are plotted in Fig. 4. The carefully designed 19-kHz filter, although effective in reducing pilot-carrier and 38-kHz products at the output, permits response out to 15 kHz (the limit of FM broadcasting), which is within 0.1 dB of the prescribed curves both in mono and stereo! As can be seen from the curves of Fig. 5, separation at mid-frequencies measured 56 dB and remained high across the entire audio band (50 dB at 100 Hz and nearly 40 dB at 100 kHz).

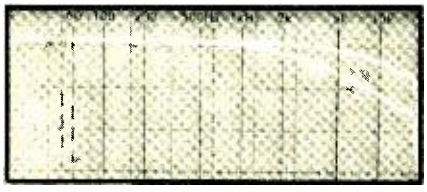

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TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sherwood Laboratories** Model: **Micro CPU-100**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement Normal/Wideband	R-E Evaluation
IHF sensitivity, mono: (μV) (dBf)	1.7(9.8)/1.6(9.3)	Excellent
Sensitivity, stereo (μV) (dBf)	4.0(17.2)/3.5(16.1)	Excellent
50-dB quieting signal, mono (μV) (dBf)	2.3(12.4)/2.1(11.6)	Superb
50-dB quieting signal, stereo (μV) (dBf)	24(32.8)/21(31.6)	Superb
Maximum S/N ratio, mono (dB)	81/83	Superb
Maximum S/N ratio, stereo (dB)	72/83	Superb
Capture ratio (dB)	1.0/0.5	Excellent
AM suppression (dB)	70	Superb
Image rejection (dB)	More than 100	Superb
IF rejection (dB)	More than 100	Superb
Spurious rejection (dB)	More than 100	Superb
Alternate channel selectivity (dB)	82/20	Excellent
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	0.1	Superb
Harmonic distortion, 1 kHz, mono (%)	0.1/0.055	Superb
Harmonic distortion, 1 kHz, stereo (%)	0.1/0.06	Superb
Harmonic distortion, 100 Hz, mono (%)	0.1/0.07	Superb
Harmonic distortion, 100 Hz, stereo (%)	0.15/0.09	Excellent
Harmonic distortion, 6 kHz, mono (%)	0.1/0.1	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.2/0.15	Superb
Distortion at 50-dB quieting, mono (%)	1.2/2.3	Good
Distortion at 50-dB quieting, stereo (%)	0.6/0.6	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV(dBf)	3.0 (14.7)	Excellent
Separation, 1 kHz (dB)	52/56	Superb
Separation, 100 Hz (dB)	49/50	Excellent
Separation, 10 kHz (dB)	31/38	Excellent
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	3.5(16.1) adjustable	Superb
Dial calibration accuracy (±kHz at MHz)	"Perfect"	Superb
OVERALL FM PERFORMANCE RATING		Superb

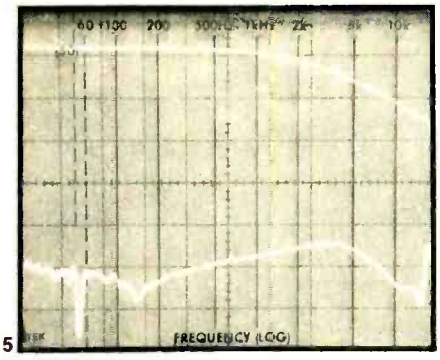
TABLE II

OVERALL PRODUCT ANALYSIS

Retail Price	**$2000**
Price Category	**High**
Price/Performance Ratio	**Superb**
Styling and Appearance	**Excellent**
Sound Quality	**Superb**
Mechanical Performance	**Superb**

Comments: The Sherwood *Micro CPU-100* FM tuner is, without a doubt, the finest, most brilliantly engineered FM tuner that we have measured to date. Those familiar with frequency-synthesized FM tuners (and Sherwood's is not the first) have long maintained that in order to use this precision form of digital tuning, certain sacrifices in front-end performance must be made. The designers of the *Micro CPU-100* have finally disproved this myth. Even if one were to "strip away" all that programmability—the station-letter call-outs, the innovative front-panel touch-switches, the station memories and all the other functions which the microprocessor circuits make possible—the tuner would still rank extremely high because of its superlative performance. In just about every operating parameter, the tuner approaches theoretical limits of performance.

This tuner, when subjected to listening tests, actually *sounds* better, too. Of course, it takes a pretty good broadcast signal to show up audible differences between the *Micro CPU-100* and competitive instruments, and therein lies the problem. This tuner is capable of delivering signals that are actually better than most U.S. FM stations are capable of broadcasting. Doubtless the product will find its way into many broadcast stations' monitoring equipment. Perhaps it may even inspire some broadcasters to upgrade their signals once they realize what kind of FM and stereo FM reception is possible.



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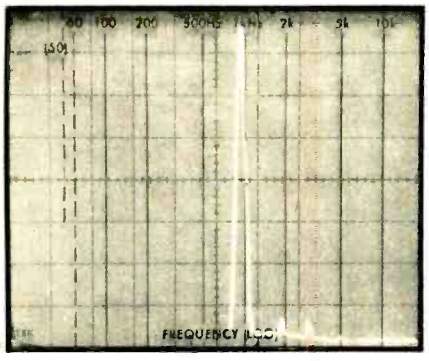

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To confirm the unbelievably low distortion figures obtained as single readings with our distortion analyzer, we used a spectrum analyzer. Figure 6 shows the results, using a 1-kHz signal at 100% modulation. The second harmonic contribution is "down" some 72 dB below the 1-kHz fundamental, which corresponds to a 0.025% distortion and the third harmonic contribution is a dB or so lower than that.

Summary

We feel this product is so outstanding it can only be fully appreciated by hands-on experience and extended listening. We continue to discover new things about it.

For instance, while other digital or frequency-synthesis tuners have up-and-down frequency-scanning capability, this one does it a bit more intelligently. For example, if you were in a weak signal area (or had no antenna connected) and started to scan upwards from 98.1 MHz encountering no "usable" signals up to 108.1 MHz, the tuner would begin downward scanning—not from 108.1 MHz but from the starting point, 98.1 MHz. Then, if no good signals were encountered all the way down the frequency scan, instead of endless scanning up and down, the sequence would come to rest once more at the starting point.

Our overall product analysis will be found in Table II, together with a few comments about the tuner's reception capabilities. To some, $2000 may seem like a very high price for a top-performing FM tuner. We suggest that even if you don't want to spend such a large amount, do yourself a favor and "test drive" the *Micro CPU-100* if you can find a dealer with a model display. **R-E**

Spectro-Acoustics 101B Preamp

HERE'S A PREAMP-CONTROL UNIT MADE BY Spectro-Acoustics, a company we believe you'll be hearing more about. The firm was first brought to our attention when we examined a graphic equalizer that was their initial entry into the high-fidelity market. The *model 101B* preamp-equalizer tested for this report incorporates some of the earlier design philosophy, but offers a complete control center.

From the looks of this unit (see Fig. 1), outer design emphasis was not placed on styling or pleasing nomenclature. The stark white letters on an all-black background are more useful than glamorous. Nevertheless, the controls themselves are logically arranged for easy comprehension and use. The left section of the panel contains five slide controls making up the equalizer section of the *model 101B*. To the right of these controls are two more slide controls that adjust left- and right-channel gain. These gain controls are sufficiently close together to permit their simultaneous adjustment with one finger, thus eliminating the need for a separate balance control.

Farther to the right are ten identical looking pushbuttons that handle mono/stereo selection, equalizer defeat or application of equalization to the tape-out jacks, tape monitoring of either of two tape circuits, dubbing or copying from either tape deck to the other and signal source selection (PHONO, TUNER or AUX). A similarly shaped pushbutton at the lower right of the panel turns on power to the unit; an LED indicator lights when power is applied. A phone jack below and to the far left of the ten pushbuttons drives high-impedance phones directly from the preamp output.


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There's no problem identifying the maker or the model number when the *model 101B* is viewed from the rear (see Fig. 2). However, in addition to the banner lettering, there are input and output jacks, two switched and one unswitched AC receptacles plus a chassis ground terminal near the phono input jack pair.

Circuit highlights

A high-gain/low-noise monolithic operational amplifier is used for phono preamplification and provides isolation between the RIAA feedback loop components and critical cartridge-loading components. To insure silent thump-free turn-on and turn-off, special FET circuitry common to both channels is respon-

MANUFACTURER'S SPECIFICATIONS:

Rated Output: 2.0 volts. **Output at Clipping:** 9.0 volts into 10,000-ohm load; 5 volts into 600-ohm load. **THD at Rated Output:** less than 0.05% at any frequency from 20 Hz to 20 kHz. **IM Distortion:** less than 0.01% at any level up to clipping. **Gain:** phono to main output, 50 dB at 1 kHz; high-level inputs, 10 dB. **S/N Ratio:** phono, 74 dB below 10-mV input reference; high level; 90 dB below 1.0-volt input reference. **Frequency Response:** phono, RIAA ±0.5 dB; high level, within 0.1 dB, 20 Hz to 20 kHz; within 3 dB, 5 Hz to 100 kHz. **Phono Overload:** 100 mV at 1 kHz. **Equalizer Gain and Range:** ±15 dB at each center frequency indicated (20 Hz, 80 Hz, 320 Hz, 1250 Hz, 5 kHz, 20 kHz); within 0.1 dB of unity gain with controls set to midposition (flat). **Input Impedance:** phono, 47,000 ohms shunted by 220 pF (internally adjustable); high level, 50,000 ohms shunted by 10 pF. **Output Impedance:** main and tapes, less than 600 ohms, resistive, direct-coupled.

GENERAL SPECIFICATIONS:
Power Requirements: 110-125 VAC, 50-60 Hz, 14 watts. **Dimensions** (less optional wood cabinet): 15 W × 6 H × 5½-inches D. **Shipping Weight:** 10 lbs. **Suggested Retail Price:** $335.

sible for the warm-up period; music appears slowly as circuits stabilize. All selector and function switching, except for the EQUALIZER LINE and EQUALIZER TAPE switches, are totally click-free.

Cross-talk from unused signal sources along with hum-and-noise are reduced by using "guard traces" between signal lines on the main PC board. Input jacks are all automatically shorted when nothing is connected to them. Internal grounding is a five-branch single-point system with separate ground paths for input, power supply, output, control and chassis grounds. Three IC's are used in the unit (Type-4136P quad op-amps).

The equalizer controls identified as LOW BASS and MID-BASS use so-called gyrator synthesized inductors that are nonmagnetic and and do not pose the saturation problems of coils. For mid- and upper-equalizer sections, where good performance can be obtained with coils, the *model 101B* uses miniature toroidal inductors. The lowest- and highest-frequency controls are "shelved" and therefore act like normal tone controls with their turnover points at 75 Hz and 8 kHz. The required supply voltages are developed by a bridge rectifier, whose output is regulated by a Zener diode.

Lab measurements

Table I shows that the harmonic distortion is well below the published figure of 0.05% at all audio frequencies with the 2.0-volt rated output delivered by the preamp. We would have preferred a bit more gain in the high-level amplifying section of the unit, since some power amplifiers do have rather high input sensitivities approaching 2.0 volts and, if the unit is used with such amplifiers, high-level input signals from program sources would have to approach one-half volt to drive the system to rated output. Cartridges would have to provide nearly 5 mV for the same drive condition. For amplifiers having a 1.0-volt input sensitivity (most common), all these drive requirements are divided in half. In any event, if you can ignore the psychological disadvantage of having to operate those master-gain slide controls near the top of their range, there should be no problem getting adequate drive in most systems. Note, in particular, the incredibly low IM distortion produced by this preamp/control unit: 0.0037 at 2.0-volts rated output.

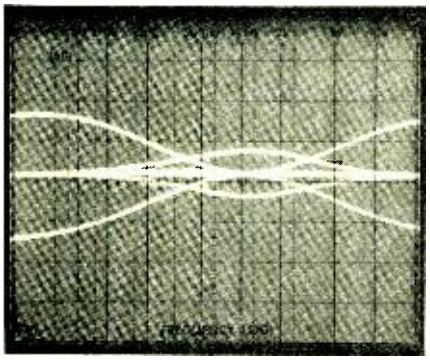

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Figure 3 shows the superiority of a five-band equalizer over conventional tone controls. Shown are the superimposed control ranges of each of the five slide controls, first at maximum boost, then at maximum cut and, finally, in their center or flat positions. Even though no physical detent is provided on these controls (you have to eyeball the "0" settings), we were able to obtain the wide response (10 Hz to 60 kHz within 0.2 dB) shown in Table I with the equalizer section in circuit. **R-E**

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Spectro-Acoustics** Model: **101B**

PREAMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
VOLTAGE OUTPUT RATINGS		
Rated output (V)	2.0	
Maximum output, high impedance (V)	10.5	**Excellent**
Maximum output, 600 ohms (V)	6.0	**Excellent**
DISTORTION MEASUREMENTS		
THD at rated output, 1 kHz (%)	0.01	**Excellent**
THD at rated output, 20 Hz (%)	0.035	**Very good**
THD at rated output, 20 kHz (%)	0.039	**Very good**
IMD at rated output (%)	0.0037	**Excellent**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± dB)	0.5	**Good**
Maximum input before overload (mV)	100	**Very good**
Hum/noise referred to full output (dB) (at rated input sensitivity)	73	**Very good**
HIGH-LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± dB)	10-60, 0.2	**Superb**
Hum/noise referred to full output (dB)	88	**Very good**
Residual hum/noise (minimum volume) (dB)	88	**Good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls		**N/A**
Action of secondary tone controls		**Excellent**
Action of low-frequency filter(s)		**N/A**
Action of high-frequency filter(s)		**N/A**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	4.6	
Input sensitivity, auxiliary input(s) (mV)	460	
Input sensitivity, tape input(s) (mV)	460	
Output level, tape output(s) (mV)	460	
Output level, headphone jack(s) (V or mW)	2.0 V (600 ohms)	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Very good**
Adequacy of input facilities		**Good**
Arrangement of controls (panel layout)		**Excellent**
Action of controls and switches		**Very good**
Design and construction		**Excellent**
Ease of servicing		**Excellent**
OVERALL PREAMPLIFIER PERFORMANCE RATING		**Very good**

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Spectro-Acoustics** Model: **101B**

OVERALL PRODUCT ANALYSIS

Retail price	**$335**
Price category	**Medium**
Price/performance ratio	**Very good**
Styling and appearance	**Fair**
Sound quality	**Excellent**
Mechanical performance	**Good**

Comments: The chief virtue of the *model 101B* is that it incorporates a five-band graphic equalizer. While dividing the audio spectrum into five segments hardly affords the same degree of tonal response tailoring that an octave-by-octave equalizer provides, it beats any combination of conventional bass, treble and mid-range tone controls normally found on preamplifiers, integrated amplifiers and receivers. Hardly a showpiece, visually or aesthetically (the makers tell us they are going to change the cosmetics of the unit soon), it will appeal to those audiophiles who prefer performance to outward appearance. While the unit lacks some of the features we have come to expect from "separate" preamps (a second set of phono inputs, for example), those basic facilities over and above the five-band equalizer that are provided do work well. The headphone output jack works with 600-ohm or other high-impedance phones, but it should not be used to connect 8-ohm stereo headsets since there is no separate amplifier section to drive the phone jack, which is simply wired-in parallel with the main output jacks.

Were it not for the equalizer, this would be one of those bare bones preamps that dedicated audiophiles talk about—the kind that offer accurate amplification of phono and other high-level signals with little or no sound coloration. To many, that is more important than a fancy gold front panel, flashing lights and program-source switching that is not likely to be needed in most hi-fi component installations. If your thinking runs along these lines, think about this for a moment: A multiband equalizer can cost a couple of hundred dollars. A good basic preamp-control unit can cost more than that. The *model 101B* combines both at a most appealing price.

WE GOOFED!

In our September issue, we mixed two halves of two different hobby corners. The result was mass confusion. To resolve the problem this has caused we are reprinting here, the correct installment.

hobby corner

Part II. *Homebrew breadboard that's inexpensive, easy to build and versatile. The basic design can be easily modified.*

EARL R. SAVAGE, *K4SDS.*

IN LAST MONTH'S COLUMN, WE PROVIDED schematics for several of circuits of the breadboard system. This month, the column concludes with the rest of the schematics and the construction details.

Pulser switch

The trouble with the logic switches previously described is that they tend to "bounce" when making or breaking a connection. In fact, all mechanical switches have contact bounce. It usually doesn't matter because you don't care if something is turned on and off five or ten times very rapidly every time you throw the switch. In some circuits this bouncing can cause serious problems.

Suppose you are working with counters, for example, and you use one of the logic switches for a trigger. You throw the switch from LO to HI and the counter shows that you did it *eight times.* Surely that is no way to test a counter circuit!

The pulser switch (See Fig. 6) is "bounceless." The mechanical switch S1 is not connected to the output. Instead, it causes the two gates (7400) to change the state of the output. The gates don't bounce.

The two LED's, one red and one green, indicate the state of the output (LO or HI). Switch S1 is an SPDT type that was not used in the prototype. The prototype used two normally open momentary SPST pushbutton switches instead. Either arrangement is satisfactory.

Pulse generator

After the power supply, without which none of these circuits would operate, the pulse generator (See Fig. 7) is the most useful device in the breadboard. A pulse generator is often called a clock because its output "clocks" back and forth between a LO and HI level.

The generator is a 555 timer IC with an approximate squarewave output. The frequency is changed by selecting various capacitors with switch S1. The four values shown produce pulses at rates of about 0.1, 1, 10 and 100 pulses-per-second. These have been found adequate to meet all needs to date. Of course, you may change the values or increase or decrease the number of frequencies available.

The LED is included in order that the operation and state of the output of the clock can be monitored directly. This is an advantage when working with some types of circuits. Note, too, that the stated frequencies are only approximations because resistors R1 and R2, and the timing capacitors are not precision units. All you need is to be in the right ballpark—the expense of precision is unjustifiable.

Construction

Construction is greatly simplified by using a plastic parts box (6 × 11 × 2-inches) instead of a conventional metal cabinet. Mounting holes and even rectangular openings for the slide switches are easily made and there is no worry about insulating parts from the chassis. There are, however, disadvantages.

The box is clear plastic and it would be confusing at best to look through the panel. This was solved by painting the *inside* of the box *after* making all the holes but *before* mounting the parts. In fact, I made the various sections different colors—red, yellow, black, white, blue, silver.

continued on page 96

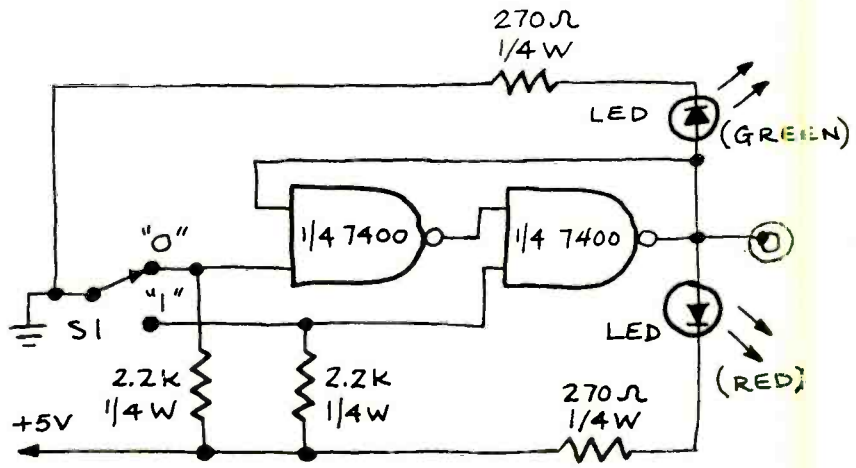

FIG. 6—PULSE SWITCH provides bounceless switching.

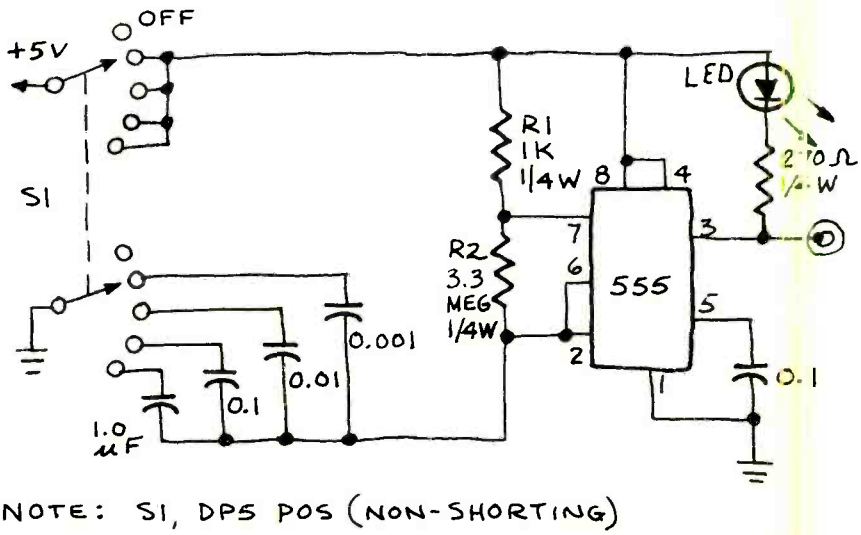

FIG. 7—PULSE GENERATOR produces squarewaves at frequencies of 0.1, 1, 10 and 100 hertz.

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NiCad batteries. *An early death can be reversed if you follow this simple procedure.*

JACK DARR, SERVICE EDITOR

WE HEAR A LOT ABOUT "MEMORIES" IN electronics today: RAM's, ROM's and PROM's, and even the one I use, the SAM (*S*eldom *A*ccessed *M*emory; not electronic!) Here is something similar that might be called BWM for "*B*attery *W*ith *M*emory." However, this doesn't mean memory in the regular sense; it refers to a problem found in some NiCad (nickel-cadmium) batteries that showed up first during satellite test programs.

Under certain conditions these batteries would show a reduction in capacity, causing a much shorter life than normal. They simply seemed to "forget how to take a charge!" This problem caused a whole lot of research to be started. G-E and others worked on it and, luckily, found a very simple way of detecting and curing it.

After a normal charge time, the "memory" battery would drop to about 1.0 volt after 25% of the rated life. With a symptom like this, the first thing to suspect is a bad battery. This *will* be true in some cases, of course. The key clue here would be a check of each individual cell in the battery, to make sure that none has reversed in polarity, a sure sign of battery trouble. If all cells check about the same, this could be a memory problem.

First, a quick review of definitions: A "cell" is one unit; a "battery" is always a *group* of cells. In NiCads these cells are practically always in series. The normal voltage for one cell is 1.25. Right after charging, it may read up to 1.4 volts, but will very quickly drop to 1.25 volts. When the cell voltage under load drops to 1.1, the battery is considered discharged and should be recharged. (See upper curve in Fig. 1.)

A good NiCad battery will hold the voltage up to 1.25 per cell over at least 85% of full-rated life. Cells with a memory problem will drop to about 1.0 volt after only about 25% of life. Note that this is below the 1.1-volt level of normal discharged cells. (See lower curve in Fig. 1.)

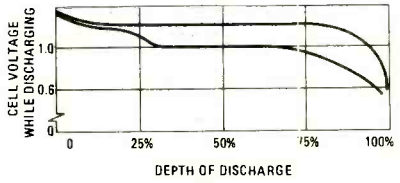


FIG. 1

There are two major types of NiCad batteries: the sintered-plate type that includes all the more common small batteries used in consumer electronics, and the "pocket-plate" type used only for larger units. The latter ones are the same as lead-acid car batteries, and use a liquid electrolyte.

The sintered-plate type of NiCads are made almost exactly the same way as the familiar Leclanche zinc-carbon dry cell. The cylindrical types use the "jelly-roll" construction, with foil electrodes separated by an insulator, rolled up into a cylinder. An electrolyte is used just as in the dry cells. The positive plate (uncharged) is made of nickelous hydroxide, which is converted to nickelic hydroxide when fully charged. The negative plate is made of cadmium hydroxide that becomes metallic cadmium when charged. The electrolyte is a potassium hydroxide solution.

The material of both plates is "sintered," meaning it is ground to a very fine powder and then formed. This produces a crystalline structure with a greater surface area, similar to an etched-plate electrolytic capacitor.

This crystalline plate structure turned out to be the cause of the memory problem. It took a scanning electron microscope to find it, though! The capacity of the battery depends on the *type* of crystalline structure. In the normal cell, the crystals were still very fine. In cells with memory problems, the crystals had become a great deal larger.

Because this change takes place every time the cell is discharged and recharged, the researchers were able to find a simple solution. When a battery shows memory problems, the remedy is to run it down to a "deep discharge" which means 0.6-per-cell voltage instead of the normal 1.1-volt cutoff. The battery is then recharged using only one-half the normal charging current. If this fails to clear up the problem, the procedure is repeated. A maximum of three cycles seems to clear up even the worst cases.

To do this in the shop, discharge the battery through a suitable resistor so that the maximum current isn't exceeded. You can find the maximum current by checking the battery specifications. Each battery will be rated at a certain number of mAH (*M*illi*A*mpere-*H*ours). Most are rated for 10 hours; a battery with a 500-mAH rating delivers a 50-mA current for 10 hours, etc. Be sure to check the voltage of each cell under load to make sure that none is reversed in polarity, which would indicate the cell is no good. If they all check out pretty close, go ahead. While discharging, monitor the voltage of one cell until it reaches 0.6 volt, or deep discharge; then stop.

Next, recharge at the 20-hour rate, or one-half the normal charge rate. Monitor this current. To recharge a NiCad battery, it is necessary to put back 140% of the energy taken out. In other words, charge for 14 hours at the 10-hour discharge rate, or 28 hours at one-half the 10-hour rate.

Then, recheck the battery for normal life. You can use automotive incandescent lamps for test loads; there are types that draw the necessary current and give a visible indication at the same time. Discharge current should be monitored and the time noted. For example, if the battery is fully recovered, it will deliver a full output voltage for at least 80% to 85% of normal life. Watch for a sudden drop to about 1.0 volt after only 25% of life; this means that the memory problem hasn't been cleared up yet. However, if the battery runs to 50% of normal life before dropping, this is a good sign. Repeat the deep-discharge/charge cycle until it clears up.

The Eveready *Battery Application Engineering Handbook* does *not* recommend trickle-charging or constant charging for NiCad cells. A fairly deep discharge, followed by a full recharge is preferred. If you must trickle-charge, keep the current to a bare minimum, the

continued on page 76

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

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

continued from page 75

30- or 50-hour rate is recommended. If you have NiCad cells that have been unused for, let's say, six months, do *not* put them in the charger before use! Discharge them fully, then recharge them at one-half the normal rate, or C/20. However, this would only be necessary for small button-type cells, not for the larger types.

Full details of the memory experiments can be found in an article by Saverio F. Pensabene and James W. Gould II in the September 1976 issue of IEEE *Spectrum*. Another useful book is the *Nickel-Cadmium Battery Applications Handbook*, General Electric, P.O. Box 861, Gainesville FL 32602. **R-E**

service questions

COLOR BUT NO BLACK-AND-WHITE PICTURE

Here's the problem: I have no black-and-white picture on this Sylvania D02-1, but I have a color picture. It is odd-looking. When I turn the color control off, all I have is a gray raster. Sound is OK. Can you help?—J.F., Forest Hills, NY.

You've already found the answer. You are losing the black-and-white ("video") signal. A color picture is actually two separate pictures, one black-and-white and one color. You obviously have good signal at the video detector and at the 1st video amplifier. This tube acts as a common-cathode amplifier for video and as a cathode follower for the color signals. So, this one is apt to be working.

Trace the video signal from the plate of the 1st video amplifier tube on through the delay line and to the video output (6JT8). You will probably find something like an open delay line that is stopping the black-and-white signal between these two points. There are a couple of peaking chokes in this line and one of these could be open.

HUM-BARS, LOW DC VOLTAGE

There is an odd problem in this Motorola TS-914. I have a hum-bar in the picture and the B+ voltage is not up to what it ought to be. I also see a lot more ripple on the DC output of the power supply than I should have. Bridging filter capacitors won't remove it, either. Whattheheck?—E.R., El Paso, TX.

This could be puzzling. This chassis uses a voltage doubler DC power supply and any ripple out of that should be 120 Hz and give you two hum-bars. Check the voltage across *both* of the doubler capacitors in the power supply. This should be very close to the same. If you get an unbalance, one of the doubler capacitors is probably open.

(Feedback: "Woops! One of the doubler capacitors *was* completely open.") Note: this *may* have accounted for the single hum-bar symptom, since it might have been developing excess ripple with a 60-Hz component.

ODD SCOPE SYMPTOMS

I have a Dumont 304A lab scope which I've been using with D/A converters and my Altair 8800. I accidentally left it on for several days. Now I have a weird pattern! For about an inch in the center of the CRT, dots are displayed normally. If you move a dot, even manually, outside of this area, it becomes a dash pointing radially out!

I've never seen or heard of anything like this! I can't get any ideas from anyone. Any help would be appreciated.—J.R., San Francisco, CA.

This is a new one to me, also. I thought I'd seen all of the oddball patterns possible on a scope, but apparently I haven't! The crystal ball says that a most likely suspect would be something that affects both horizontal and vertical deflection circuits at the same time. This would be in the DC power supply. Scope the filter capacitors as well as the deflection plates and see if you find an unusual amount of ripple from an open filter capacitor.

(Feedback: "You're 100% correct! There was a very high ripple on both of the deflection plates. An 80-μF electrolytic capacitor in the B+ was completely open. New one cleared up the problem. You, sir, are a genius!")

No, I'm not! (I have written proof of that!) I just tell *everyone* to check filter capacitors!

TWO BRIGHT HUM-BARS

There are two very sharp, bright hum-bars on the screen of this RCA CTC-68. I don't seem to have too much ripple on the +245-volt supply. What can cause this?—J.G., Mena, AR.

From "official sources" (my friend who fixes RCA's!) I find that if C105-c—a 500 μF capacitor connected to the +36-volt source—is open, you'll get this kind of a symptom. This line feeds the MAL001B video-amplifier module.

NO RASTER

The high voltage is very low in this G-E N-2 chassis. I get only +320 volts on the boost and the cathode current of the 21LG6 is 400 mA. Plenty of drive signal to 21LG6 grid. The only thing I can do that makes any difference is disconnect the horizontal deflection yoke. Then the 21LG6 current drops to 100 mA, boost goes to more than normal and the high voltage comes up to almost 10 kV. The yoke winding seems to check OK with an ohmmeter. Any ideas?—F.R., San Angelo, TX.

The first idea I get from the crystal ball is that horizontal yoke winding *is* bad! The only other thing that would give you such a reaction in the boost voltage is an open boost capacitor, but this would not make the horizontal output tube current go to 400 mA. A shorted horizontal winding in the yoke will. Try a new yoke.

TOUCHY TUBE PLATE

I had a problem in this RCA CTC-25. Fixed it by changing the 3rd video IF tube, 6JC6. Tried to check the DC voltage on the plate with a VTVM but the screen goes dark when I touch the meter probe to it. Scope probe does the same thing. This isn't normal, is it?—A.J., Cleveland, OH.

Yes, it is. When you touch even a very low-capacitance meter probe or scope probe to the plate of *this* tube you detune it, and also cause the stage to oscillate, in some cases. It is very touchy. Practically all IF stages show the same reaction.

If you want to read the plate voltage, check it on the screen grid of this tube. There is nothing between this point and the plate but the high impedance (low resistance) of the plate coil. If this coil has continuity, you do have plate voltage.

CB POWER TRANSISTOR

I need a replacement transistor for a Tenna CB radio. It's the RF power output in the transmitter. The original is a 2SC517. Do you know where I can get a replacement?? I've looked everywhere without luck.—J.D., Howard Beach, NY.

This one is easy. (Thank goodness; I've been looking for an easy question all day!) RCA SK-3049. Motorola HEP-243; G-E GE-20; Sylvania ECG-224. Any of these will do the job.

SIX DARK BARS IN RASTER

There are 6 dark vertical bars in the raster of this Craig 6305 black-and-white TV. I've tried everything I can think of with no luck.—D.M., Middle Village, NY.

This sounds like the jail-bar symptom found in several color TV sets. I see that this one uses a horizontal blanking diode. Check this to see if it's shorted. If so, the whole horizontal waveform gets into the blanking. Normally, the diode clips off the ringing along the scan portion. If this gets through, it can cause bars like the ones you see.

AGC PROBLEM

The only way I can get a picture or sound on this Sears 562.10423 TV is to turn it off and on rapidly! Each time it's turned off, the picture comes on for a second or two! The collector voltage on the AGC keying transistor is off. I read

continued on page 79

computer corner

Z-80 *An in-depth look at the Z-80 and how it differs from the 8080.* WILLIAM BARDEN, JR.

THE Z-80 MICROPROCESSOR IS THE LATEST in the line of MOS LSI (*M*etal-*O*xide-*S*emiconductor *L*arge *S*cale *I*ntegration) microprocessors that evolved from the Intel 8008. Designed and produced by Zilog, Inc., the Z-80 is "downwards compatible" with the Intel 8080 instruction set, just as the Intel 8080 instruction set included the Intel 8008 instruction set. Not only can the Z-80 execute programs based on the 8080 instruction set, but it includes 80 additional instructions that supplement the 78 instructions of the 8080.

Accompanying the new instruction set is a new architecture, which, in general, encompasses the architecture of the Intel 8080. Whereas the 8080 has seven general-purpose registers, a stack pointer and a program counter available to the programmer, in addition to internal registers not accessible to the user, the Z-80 has another *set* of the seven general-purpose registers and two *index* registers. All of the nine new registers are available to the programmer. In addition, two other registers provide interrupt control and memory refresh control.

The third difference between the Z-80 and the 8080 is the pin-out, the signals associated with the 40 pins of the Z-80. As in the 8080, a 16-bit address bus enables a direct address of 65,536 bytes of memory. Likewise, an eight-bit data bus allows transfers of eight bits or one byte of data between the Z-80 CPU and memory or I/O devices. However, the Z-80 requires only one +5-volt power supply and only a single-phase clock, and adds an external NMI (*N*on-*M*askable *I*nterrupt) line. In comparison, the 8080 requires three supply voltages (+5, −5 and +12 volts) and a two-phase clock, and has only a single interrupt line.

The final major difference between the Z-80 and the 8080 is in the clock speed. Some microcomputer manufacturers hand-select Z-80's that will run at clock speeds of 4 MHz, twice as fast as the standard 8080 version. The standard version of the Z-80, however, operates at 2.5 MHz, which is 25% faster than the 8080's 2.0-MHz clock speed.

All in all, the above features make the Z-80 an attractive replacement for the 8080, and at least seven manufacturers are producing either microcomputers based on the Z-80 or microcomputer boards that are compatible with the MITS (S-100) bus. Many commercial users are seriously considering using or are already using the Z-80 microprocessor in new designs. This first of a series of columns will discuss the Z-80 in terms of the architecture, pin-out description, address modes and instruction set and use.

Architecture

Figure 1 shows the basic architecture of the Z-80 microprocessor. The program counter holds the address of the current instruction that is being fetched from external memory. Since it is a 16-bit register, up to 65,536 (64K) bytes of external memory can be addressed to fetch an instruction. The stack pointer is also a 16-bit register and addresses a memory stack area anywhere within external memory. As in other microprocessors, this stack area is used for temporary storage of variables in the program, storage of the PC during subroutine calls and storage of registers during interrupt processing.

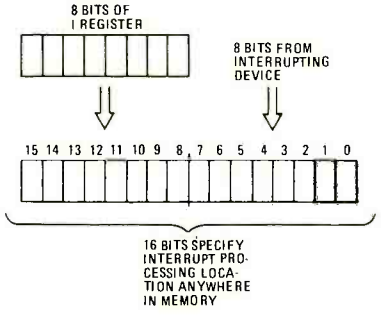


FIG. 2

Memory-refresh register R is a seven-bit counter that continually counts every instruction fetch. The contents of the R register (0 to 127) are sent out on the seven least significant bits of the address bus while the current instruction is being decoded. External memory logic uses the count to refresh dynamic RAM memories. The I register, or Interrupt Page Register, is loaded by the program and provides the eight most significant bits of an interrupt vector address (Fig. 2), while the lower eight bits are supplied by the interrupting device. An interrupt processing routine can therefore be located anywhere in the 64K of memory.

Two 16-bit index registers, IX and IY, perform an indexed type instruction useful in accessing tables in memory. This addressing mode will be discussed in a later column in this series.

The general-purpose registers are divided into two groups, each consisting of

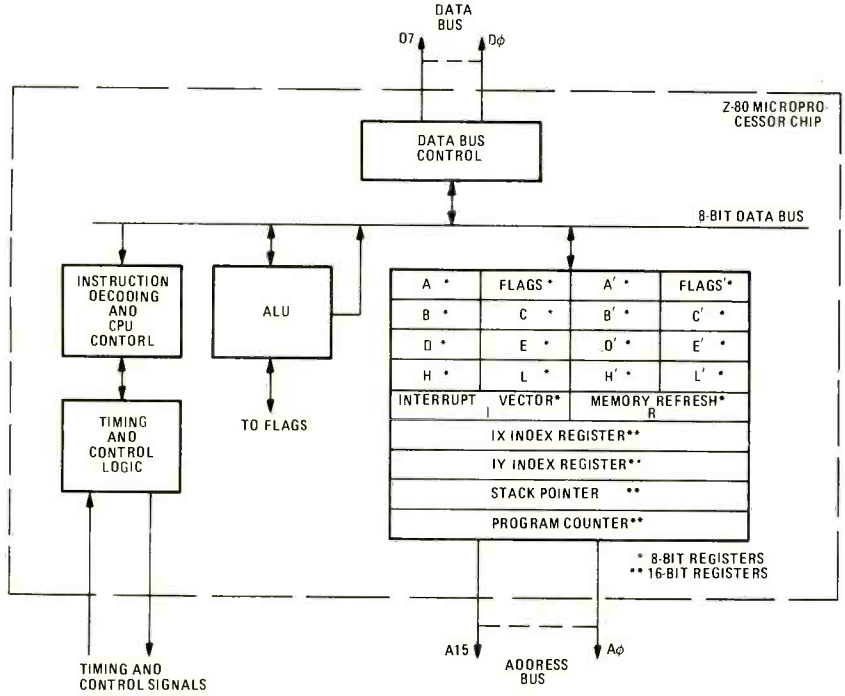


FIG. 1

seven general-purpose registers, designated A, B, C, D, E, H, and L. As in the 8080, six of these registers operate together as register *pairs*: B and C, D and E, and H and L. Taken together, a register pair is 16 bits, although either register of the pair can be used as an eight-bit register by itself.

Accumulator register A is the primary register used in arithmetic and logical operations in the Z-80. At any time, the CPU can switch from one group of seven registers to the other group of seven registers by a single instruction. The other group has the same designations except that they are primed—A′, B′, C′, D′, E′, H′, and L′. There are many advantages in having the additional storage of the second group of registers as, for example, in rapid interrupt processing and increased processing speeds when temporary results can be held in the second set of CPU registers rather than in memory.

Two sets of flags, F and F′, are associated with the register groups. The flags are set as a result of arithmetic and logical operations performed by the ALU (*A*rithmetic and *L*ogical *U*nit). The flags record whether the results of the last operation produced carries, a zero result, a negative result, parity, and/or overflow, and can be tested to cause conditional branches in the program (Fig. 3).

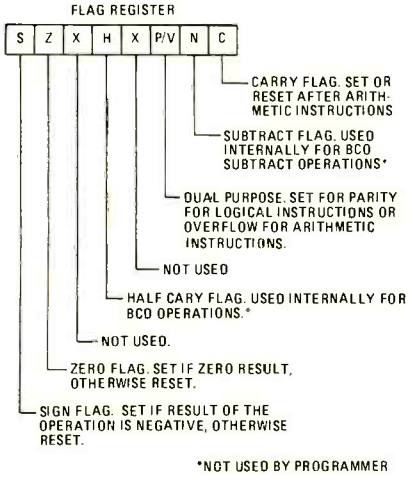


FIG. 3

The ALU is an eight-bit arithmetic or logical unit that can add, subtract, shift, AND, OR, exclusive OR, and perform other operations on two binary operands. It also performs addition or subtraction of two BCD (*B*inary *C*oded *D*ecimal) operands. The current set of flags is set on the results of the arithmetic or logical operation.

Next month, the column will continue with a discussion on the pin-out of the Z-80 IC and the Z-80's timing.

In the column that will follow, the discussion of the Z-80 will include: interrupts, interfacing techniques, the different types of instructions and the various addressing modes. **R-E**

SERVICE QUESTIONS

continued from page 77

—0.3 volts and it ought to be —4.8 volts. Transistor and diode replaced. Where is it?—G.M., Washburn ME.

In the AGC from what you have found so far. Try clamping the IF AGC at about +1.5 volts and see if this gives you a picture. If so, leave the clamp voltage there and check your AGC keyer to make sure that you do have the keying pulse *and* the video signal on the base. You need both of these to get any AGC action. I suspect that one of them didn't show up for work this morning!

HORIZONTAL PROBLEMS

There are all kinds of screwball problems in this Curtis-Mathes CMC-1C. The horizontal hold is very unstable, color acts up and so on. The waveforms on the AFC diodes are very odd. I found a burnt resistor which seems to be R115, on the flyback. I'm confused!—J.G., Hatfield.

To start with, replace that resistor. R115 is a pulse-coupling resistor from the flyback to the AFC. While you are there, check the capacitive voltage-divider network C520/C521. If one of these is open, the pulse will be off. Also, from

continued on page 83

state of solid state

A new processor from National that can function as a programmable calculator or as a number cruncher for your microcomputer. **KARL SAVON,** *SEMICONDUCTOR EDITOR*

IF YOU HAVE EVER TRIED TO PROGRAM A microcomputer to do an elementary decimal arithmetic calculation, you know how complicated simple things can get. The National MM57109 MOS/LSI Number-Oriented Microprocessor is designed to make life considerably easier. Its language is calculator-oriented, and the circuit can be used with or without a separate controlling microprocessor. In control applications such as measurement and navigation systems, the device functions with the aid of an external program counter and program source. Where number handling is only one part of the overall picture, the number cruncher becomes the peripheral to a more conventional microprocessor.

The number cruncher

Microcomputer instruction sets are limited to binary addition with the occasional luxury of subtraction. A couple of machines have BCD adjustment instructions or can do BCD arithmetic, but this is only of limited help.

To develop a software math package that can handle scientific or more generally floating-point calculations is an education in itself. Decimal inputs must be converted to binary and normalized for the best use of the available memory space. The calculations must be done and the results rounded off and converted back to decimal. In addition to the magnitude of this task, even if such a package were already available, the math routines eat up memory and, of course, must be loaded from a storage medium or programmed into ROM or PROM.

The MM57109 performs conventional scientific calculations, does program branches based on flag and register tests, and inputs and outputs data with coordinating handshake signals. It combines the arithmetic functions of a scientific calculator with the control instructions used in stand-alone microcomputer systems.

This device is actually a mask-programmed version of the MM5799 part of the COP (*C*alculator *O*riented *P*rocessor) family; these processors have CPU, ROM, RAM, and I/O circuitry on the same IC.

Figure 1 is the block diagram of the MM57109. There are eight internal registers, each with 12 digits of storage. Registers X, Y, Z, T and M are accessible through programming. It is possible to expand the internal register files with an external 256 × 4 RAM. Lines DA1 through DA4 and the external instruction storage are used to address these 16 registers.

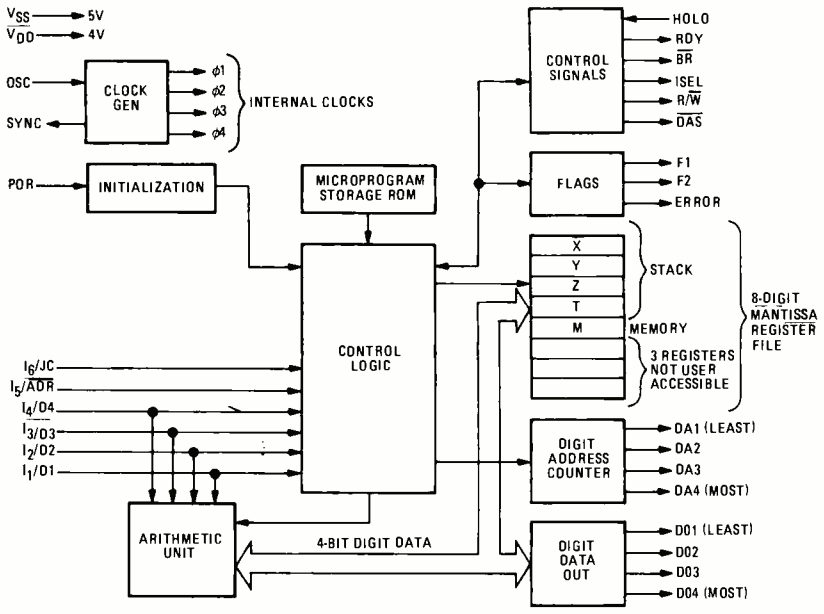


FIG. 1—NUMBER CRUNCHER. National's MM57109 is a dedicated processor that can be used as a stand-alone programmable scientific calculator or as a peripheral for your microcomputer.

The clock generator runs from an external noncritical single-phase 400-kHz oscillator. The clock circuitry generates a SYNC output pulse every four oscillator cycles to form a 10-μs "microcycle." Each instruction requires the execution of many microcycles.

The initialization block provides automatic power-on resetting when 5 volts is first applied to the POR terminal and then switched to −4 volts. Three pulses on the RDY line signal that the MM57109 is ready for its first instruction.

The instruction format includes a 6-bit operation code. Pins I1 through I6 are the instruction input pins driven by the external program source. They also function as the data lines when the ISEL line is set to logic 0.

When the device is ready for an instruction, the RDY line goes high and remains there for as long as the HOLD line is held high. The HOLD line is switched to ground when the instruction from the program source has been accessed. If the system timing is such that the instructions are always ready within 9 microcyles of when the RDY line goes high, the HOLD line can be permanently wired to ground. When the MM57109 is used in a stand-alone system, the RDY line becomes the clock for the external program counter. The parallel outputs of the program counter address the program memory, which holds the sequential instructions.

The $\overline{BR}$ control output provides the results of test instructions. The output is a 4-bit, microcycle low pulse when the performed test proves true.

Numbers have BCD-encoded 8-digit mantissas and 2-digit exponents, and are manipulated in a four-register stack and memory register in Reverse-Polish style. The device can be considered as a programmed scientific calculator with a different type of I/O interface and separate program counter and instruction source.

Each of the four stack registers and the logic-1 memory register store the bits of the 8-digit mantissa and 2-digit exponent

as well as sign bits and decimal-point position indicator.

Numbers are transferred in and out of the MM57109 through data pins D1 through D4. Single decimal digits are received serially as 4-bit BCD words. Either the floating point or scientific notation mode is selected with the TOGM (*TOG*gle *M*ode) instruction. On initialization, the mode is set to floating point, which does not use exponents. The SMDC (*S*et *M*antissa *D*igit *C*ount) instruction sets the number of digits between 1 and 8, and is initially set to 8. As digits are fed in or out serially, the state of lines DA1 through DA4 identifies the digit.

There are three flag outputs: F1, F2 and Error. Flags F1 and F2 are set by instructions SF1 and SF2 or pulsed by instructions PF1 and PF2. The Error output is set high when calculation errors occur, such as taking the logarithm or natural log of a number less or equal to 0, a result exceeding the 10^{-99}-to-10^{99} range, and taking the square root of a negative number.

Input JC shares the I6 line and is tested with a TJC instruction.

The MM57109 instruction set has a total of 70 digit-entry, move, math, clear, branch, I/O and mode control instructions. Instructions have a 6-bit op code, and another two bits available for extended hardware such as device selection using the AIN instructions. Two-word instructions use a second 8-bit word that holds a branch address or the mantissa digit count.

The digit entry group of instructions are: 0–9, decimal point, enter exponent, change sign, π, enter, no operation, and halt.

If the instruction preceding an entered digit is enter, register X is cleared and the digit is put into X. When a number is entered, the stack is pushed; the contents of Z move into T, Y into Z, X into Y, and X is cleared to 0. This "initiation of number entry" occurs only once for each series of digits corresponding to a single number. Digits following the eighth mantissa digit are ignored. As in calculators, the number-entry mode is terminated by any non-entry instruction. The IC then normalizes the number by shifting the decimal point until it is to the right of the first mantissa digit and adjusts the exponent accordingly.

The move instructions include the stack operations, register exchange, memory store and recall, and left and right shifts of the mantissa.

The math group does the conventional four functions, plus trigonometric and logarithmic functions.

Two clear instructions clear and initialize the system.

The branch group is divided into two subclasses: The test class that checks the JC, Error and register X conditions. The count class increments or decrements memory, and branches if memory is not zero.

Input/output instructions are the multidigit IN and OUT and the single-digit asynchronous AIN entry.

Flag instructions control flag 1, flag 2, and R/$\overline{W}$ outputs.

The TOGM, SMDC and INV instructions set the operating mode; the INV instruction sets the inverse mode for trigonometric or memory instructions.

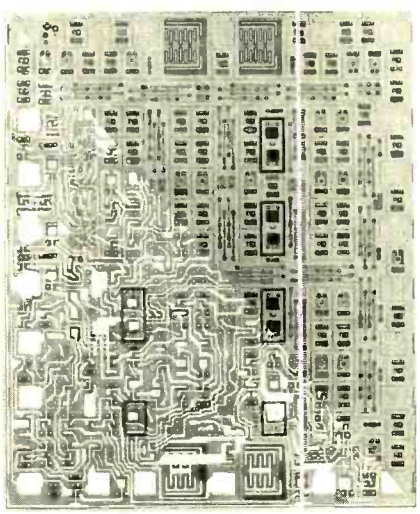
The number of microcycles varies from the hundreds for number entry to tens of thousands for trigonometric functions. For example, the sine function averages 56,200 microcycles and has a worst case of 95,900.

The MM57109 uses a 9-volt power supply that can be split into +5 volts and −4 volts for partial TTL compatibility. The technology is PMOS metal-gate low threshold, and the typical current drain is only 12 mA. For more details, write National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051.

NMOS and MOS/bipolar monochips

Interdesign's digital n-channel MOS silicon-gate monochip is the result of a joint project with Fairchild Semiconductor. The 138 × 138-mil IC has the equivalent of 262 gates.

Interdesign claims that this IC is more area-efficient than I^2L, the logic design is more conventional than I^2L, and is also directly TTL- and CMOS-compatible. This is the first of a series of closely stepped sizes which will allow optimum choice of size.



LARGEST LINEAR CHIP on the market. Interdesign's semicustom *Monochip F* contains 460 components.

Monochip E is 70 × 70-mils, has 200 components and 18 bond pads. Monochip F is 90 × 110-mils, has 460 components, including 10 MOSFET's and four high-current NPN's, and 24 bond pads. For information, write Interdesign, Inc., 1255 Reamwood Avenue, Sunnyvale, CA 94086. **R-E**

continued from page 26

modes: ALTernate, which means that you scan first one channel and then the other; CHOP, in which both channels are chopped at the 250-kHz frequency and displayed in sections; and ADD, in which Channel 1 is added to Channel 2 and the result displayed. Channel 1 or Channel 2 can be displayed at the same time or singly. The Channel 2 waveform can be inverted for comparison purposes. The signal from either channel can be selected for the triggering on internal trigger. All these functions are controlled by a vertical row of pushbuttons located to the right of the selector switches. Either channel input may be switched to AC-, DC-coupling or ground. Vertical positioning controls for each are located above and below the pushbuttons.

Three pushbuttons take care of synchronization and triggering. The first button is labeled AC for (standard) coupling; the next, HF REJ that inserts a filter that cuts off at 10 kHz to make it easier to display noise-filled signals. The TV pushbutton is a sync separator that works on vertical sync pulses when the sweep speed is 0.1 ms or slower, and on horizontal sync pulses when the sweep is faster than 0.1ms. A push/push switch selects either the positive or negative slope of the waveform for the triggering.

With my uncanny skill at coming up with a job that requires just such an instrument as the *model LBO-515*, we had a sync problem that required a very steady scope. The scopes TV pushbutton provided two solid traces on the input and output of the sync-separator that helped considerably in correcting the problem. (Incidentally, by locking the sweep to the vertical sync pulse on the 0.1-ms range and then pushing the magnifier ×10 button, both lines of the VITS signal were visible simultaneously, one on each trace.)

Delayed triggering of the sweep is controlled by the middle section of the TIME/DIV selector, and can be adjusted independently of the main control. The pointer indicates the time by which the sweep is delayed on the regular scales. The delay and/or the holdoff can be adjusted separately. The instruction manual describes other functions and applications in more detail and includes directions for checking and recalibrating all circuits.

The *model LBO-515* can measure the phase angle between two signals, the time difference between two signals, pulse risetime (the actual risetime of the *model LBO-515* is only 0.014 μs, so that it can be subtracted from the reading to yield a highly accurate value), and modulation percentages of AM or single-sideband signals. You can switch to X–Y, and do vectorscope anlaysis from the front: Channel 1 is the X-axis and Channel 2 of the Y-axis.

A set of three switches controls triggering: NORMal, SINGLE and RESET. Pressing only the NORMal pushbutton does not show a trace until an input signal is connected. With both NORMal and SINGLE pushbuttons out, the scope is in auto-run or free wheeling; both traces are visible on the screen even without a signal input. In both positions, the trigger level is set by the LEVEL control just below it, and when it is triggered, the TRIG'D pilot light goes on.

This is quite a versatile instrument, and it performed well both in actual work and in experimental "tricks." **R-E**

SERVICE QUESTIONS

continued from page 79

experience, I'd try a new AFC diode unit—use an RCA SK-3119.

HIGH-VOLTAGE ADJUST PROBLEM

After fixing vertical problems in this RCA CTC-49XA, I can't get the high voltage below 25 kV (normal 21.5). The high-voltage adjust has no effect at all.—S.G., Tucson, AZ

I told him to "check CR3, CR2 and the +77-volt source, etc., etc." He did; no help. He checked all suspicious parts, and then—

"I replaced the high-voltage regulator transformer, T2. That did it! I don't know why, since the resistance seemed to check out OK."

Thanks very much to Sam Garbushian, Expert TV Service, Tucson, AZ, for the feedback.

TV REPAIR BOOK

I've just finished a TV repair course and, frankly, I'm still in the dark about repairing TV! Can you recommend a good TV repair troubleshooting book that will indicate the symptom and then pin it down to the right circuit and, hopefully, to the specific part?—F.P., Canton, OH

No. (If there were a book like this, *I'd* buy one!)

HORIZONTAL RADIATION

This Emerson 9300 color TV set has some unusual problems. Its horizontal hold isn't at all good, and this even affects the vertical sync. Also, when it's turned on, other sets nearby have sync problems and a fuzzy vertical line moving across the screen! I need enlightenment!—H.G., St Croix, Virgin Islands.

Don't we all? The chances are that this is some kind of horizontal AFC problem in the Emerson—bad AFC diodes, loss of horizontal sync to AFC circuit, etc. This is making the horizontal circuit unstable. In turn, the displacement of the horizontal gating pulse is upsetting other circuits in the set.

Also, it is obviously *radiating* far too great a "signal" from the horizontal sweep stages. Suggestion; take the scope probe and wave it around the back of the Emerson. Look for a place that shows a very large stray pickup. Try this on a set working normally and you'll see what this pulse should look like. This one will probably be very "hashy". Shields missing, etc. **R-E**

Service Questions and solutions appear in every issue of Radio-Electronics. Don't miss any—subscribe now.

new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card follows page 106.

WATCH BATTERY DISPLAY, *W1084,* displays four types of *Eveready* batteries, 24 batteries to each peg. A cross-reference chart is affixed to back of eye-catching header sign. Other dis-

player units also available.—**Union Carbide Corp.,** Battery Products Div., 270 Park Ave., New York, NY 10017.

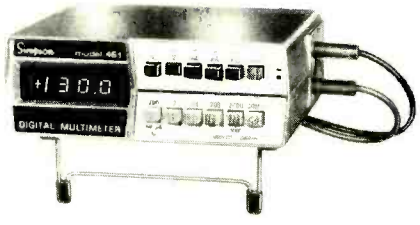
CIRCLE 98 ON FREE INFORMATION CARD

CB COAXIAL CABLE, *RG 8X*™, features 95% braid shielding and a 19-strand center conductor. Citizens band users of this miniaturized, low-loss

cable will find a gain of 2 dB over other 58/U antenna cables because of its 1.35-dB attenuation at CB frequencies. Suggested retail price, 16¢ per foot.—**Berk-Tek Inc.,** Box 60, Reading, PA 19607.

CIRCLE 99 ON FREE INFORMATION CARD

DIGITAL MULTIMETER, *model 461,* comes ready for use with 4 nickel-cadmium cells, an AC charg-



er/adapter, plus test leads and instruction manual. The *461* has a 0.5% accuracy on the DC voltage scales, automatic polarity and zeroing, LSI reliability with a single IC containing all the A/D conversion components. The 3½ digit (1999 count) display has high-readability 0.3-inch LED's. Pushbuttons select all functions and 26 overload-protected ranges. The unit measures voltages from 100 mV to 1000 VDC (600 VAC), resistance from 0.1 ohm to 20 megohms, AC or DC current from 10 nA to 2A. Accessories include Simpson's Amp-Clamp adapter for AC measurements up to 200 amps, a new 40 kV high-voltage probe, an RF probe and a carrying case. Measures 2 × 5.6 × 4.6 inches and weighs 1½ pounds. Priced at $130.00.—**Simpson Electric Co.,** 853 Dundee Ave., Elgin, IL 60120

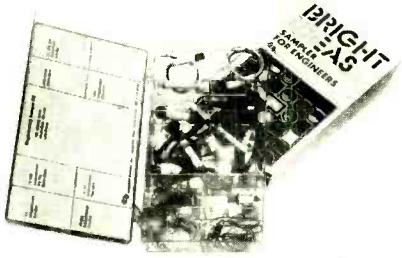
CIRCLE 101 ON FREE INFORMATION CARD

INTERFERENCE FILTER for stereo speakers. CB transmissions often enter stereo, hi-fi or cassette systems causing audio IM and distortion. Installing this compact filter in each speaker lead will

help reduce or eliminate unwanted transmissions. Price: $9.95 a pair.—**Electronic Specialists, Inc.,** Box 122, Natick, MA 01760.

CIRCLE 102 ON FREE INFORMATION CARD

INDICATOR LIGHT KIT contains working samples of 24 different indicator and pilot lights for use in breadboarding or building prototypes. There are 16 styles, including incandescent, neon

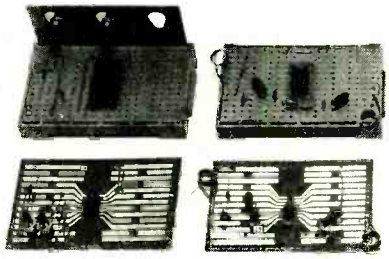


and solid-state LED, with five voltages from 6 to 250 volts; units fit five different mounting-hole sizes. This bargain kit comes in a compartmented plastic box and sells for $10, postpaid.—**Industrial Devices, Inc.,** Edgewater, NJ 07020.

CIRCLE 110 ON FREE INFORMATION CARD

BREADBOARDING SYSTEM consists of plug-in prototyping boards and printed-circuit boards. Called New Concept Masterboard, the plug-in prototyping board enables the user to experiment and easily modify circuits until they operate correctly. Once the circuit is operating, the circuit can be transferred to the printed circuit boards, called New Concept Breadboards.

Several versions of the New Concept Masterboard are available. The basic one consists of an array of 13 × 16 holes, each hole identified by a letter and number. Carriers are available for inserting IC's. Other Masterboards are available



with either one or two built-in IC sockets. All Masterboards are capable of being snapped together for expansion. Prices range from $5.49 to $19.95 each.

The foil patterns of the New Concept Breadboards match the bus structure of the prototyping boards. These boards are nondrilled and have letter and number designations that correspond to the prototyping boards. Circuits are transferred one lead at a time from the prototyping board to the corresponding point identified by letter and number on the New Concept Breadboard. Components are mounted on the foil side of the board. Various boards are available to match the various prototyping boards. Prices for the New Concept Breadboards range from $1.03 to $7.59 each.—**Saxton Products, Inc.,** 215 No. Route 303, Congers, NY

CIRCLE 111 ON FREE INFORMATION CARD

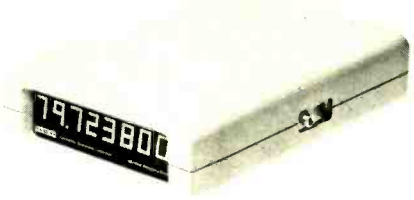
RADAR DETECTOR, *CON-55KXS Secret Scout,*

detects both X- and K-band radar. A wide-detection aerospace parabolic antenna is contained in

a fog light housing to prevent theft. "Beep-flash" varying-frequency rate indicates presence of radar. Retail price, $199.95.—**Convoy Products,** P.O. Box 2018, Witchita, KS 67201.

CIRCLE 103 ON FREE INFORMATION CARD

FREQUENCY COUNTER, *model MAX-100,* provides 20-Hz to 100-MHz direct frequency readings on 8-digit LED display. Crystal-controlled timebase offers 3-ppm accuracy and high temperature stability. A wide range of optional accessories is available: A 3-watt rated low-loss tap-off (*model 100-LLC*); mobile charger/eliminator that can be used to recharge NiCads from 12-volt car battery (*model 100-CLA*); 110- and 220-VAC charger/eliminators (*models 100-CA1* and *100-CA2*); and a mini-whip antenna (*model 100-MA*). An input cable with leads and an owner's manual are included with the unit. The *model MAX-100* measures 1¾ × 7⅜ × 5⅝-inches, and weighs less than 1.5 lb. Suggested retail price: $139.95.—**Continental Specialties Corp.,** 44 Kendall St., New Haven, CT 06509.



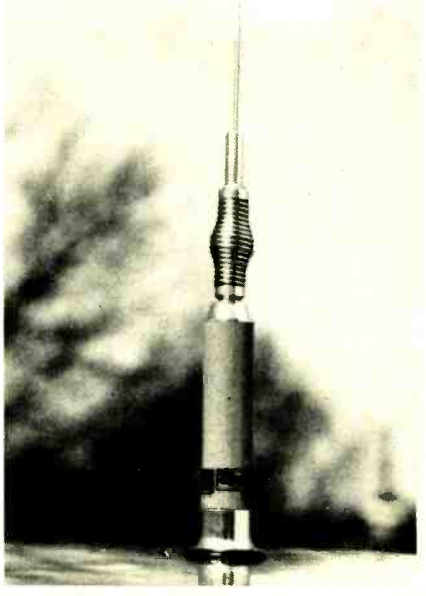
CIRCLE 104 ON FREE INFORMATION CARD

DIGITAL CLOCK KIT is a compact, 2-inch-diameter LED unit designed for in-car installation. It features automatic night dimming, plus date and seconds controls. All circuit boards and components are included; only three connections are needed for attachment to the vehicle. The kit is the first of a series of Solid State Technology Kits™ anticipated for regional distribution.—

Fairchild Optoelectronics Div., 4001 Miranda Ave., Palo Alto, CA 94303.

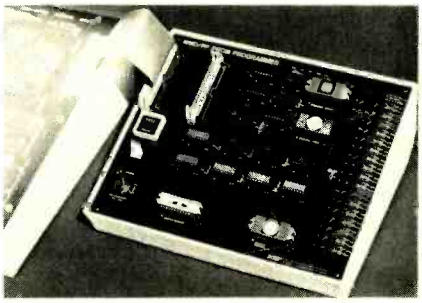
CIRCLE 105 ON FREE INFORMATION CARD

ROOF/DECK MOUNT ANTENNA, *model MR 125,* features a waterproof mount to prevent car wash damage. The 17-7 stainless steel whip has a shock spring for maximum protection. Also included is a 17-foot coax cable with attached radio connector. Suggested list price, $22.95.—**The Antenna Specialists Co.,** 12435 Euclid Ave., Cleveland, OH 44106.



CIRCLE 106 ON FREE INFORMATION CARD

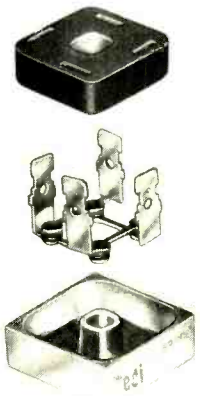
EPROM PROGRAMMER, *model MMD-PP,* is designed as an accessory for the MMD-1 Mini-Micro Designer training and development computer. A 256-word by 8-bit EPROM inserted in an *MMD-PP* socket accepts data from any RAM or ROM memory as well as PROM. Data transfer between microcomputer and programmer takes



place over a 40-pin connector and ribbon cable assembly. Controls and memory sockets on top panel. Power is supplied from a 115/230-volt, 50- to 60-Hz line. Unit includes PROM, interconnect cable, integrated circuits and manual. The *MMD-PP* measures 9 × 7.6 × 3.5-inches and weighs 7 lb. Prices: assembled, $220; kit, $166.—**E&L Instruments, Inc.,** 61 First St., Derby, CT 06418.

CIRCLE 107 ON FREE INFORMATION CARD

SILICON BRIDGE RECTIFIERS, *Series PB,* are rated at 25 amps, have a 300-amp surge and peak-reverse voltages from 50 to 1000. Units measure 1.125 × .438-inch, and have a dielectric



strength of 1500 volts RMS, Underwriters-Lab approved components and 0.250 quick-connect terminals. Available in 1000-lot quantities at $1.90.—**Electronic Devices, Inc.,** 21 Gray Oaks Ave., Yonkers, NY 10710.

CIRCLE 108 ON FREE INFORMATION CARD

40-CHANNEL REMOTE CB TRANSCEIVER, *model 2716 (Thumbs Up™),* is an advanced phase-locked-loop system that combines computer IC technology with pushbutton keyboard versatility. Computer features include two separate memory units, providing instant return to previous channels without readjustment; "on-stand-by" memory that retains settings from prior communications; and a one-channel memory that stores the last transmission channel number when transferring to other channels.

Keyboard command module also contains LED digital clock, Channel 9 emergency key, noise

blanker, squelch and noise keys, PA ON/OFF keys, ANL, AGC, built-in mike preamp, TVI filter, FM/AM audio muting jack, external speaker and PA jacks, and detachable cord.

Command module can be stored on-dash for easy detachment; transceiver can be installed under the seat, in-trunk or other protected area. Suggested retail price: $249.95.—**Hy-Gain Electronics Corp.,** 8601 Northeast Highway 6, Lincoln, NE 68505.

CIRCLE 109 ON FREE INFORMATION CARD

continued on page 92

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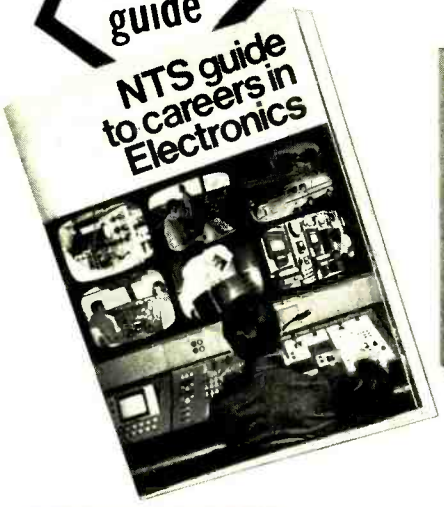
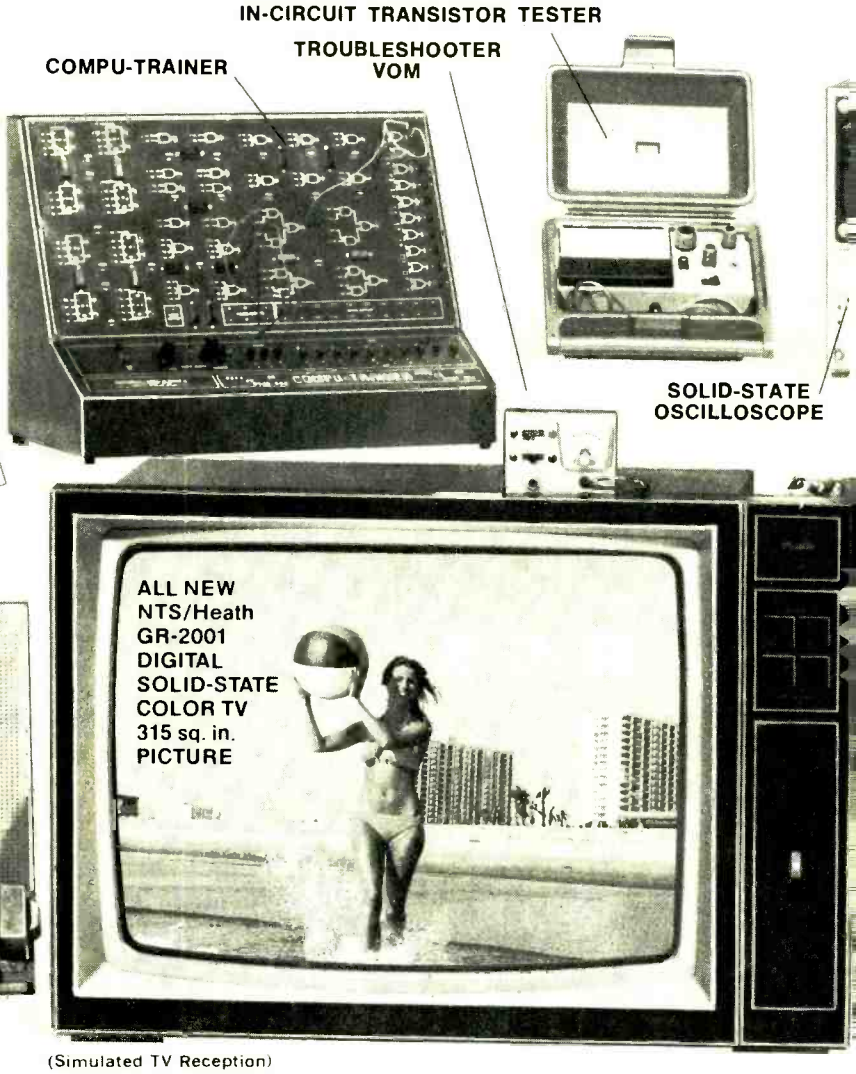
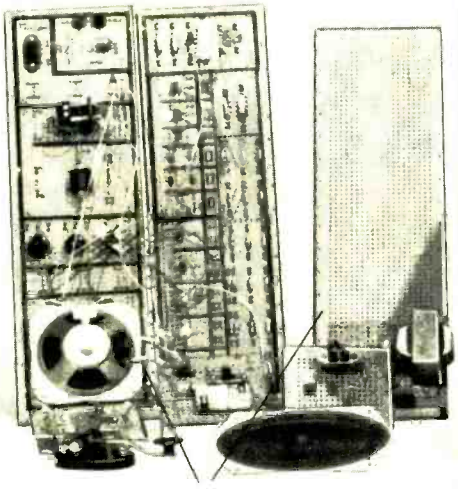




(Simulated TV Reception)



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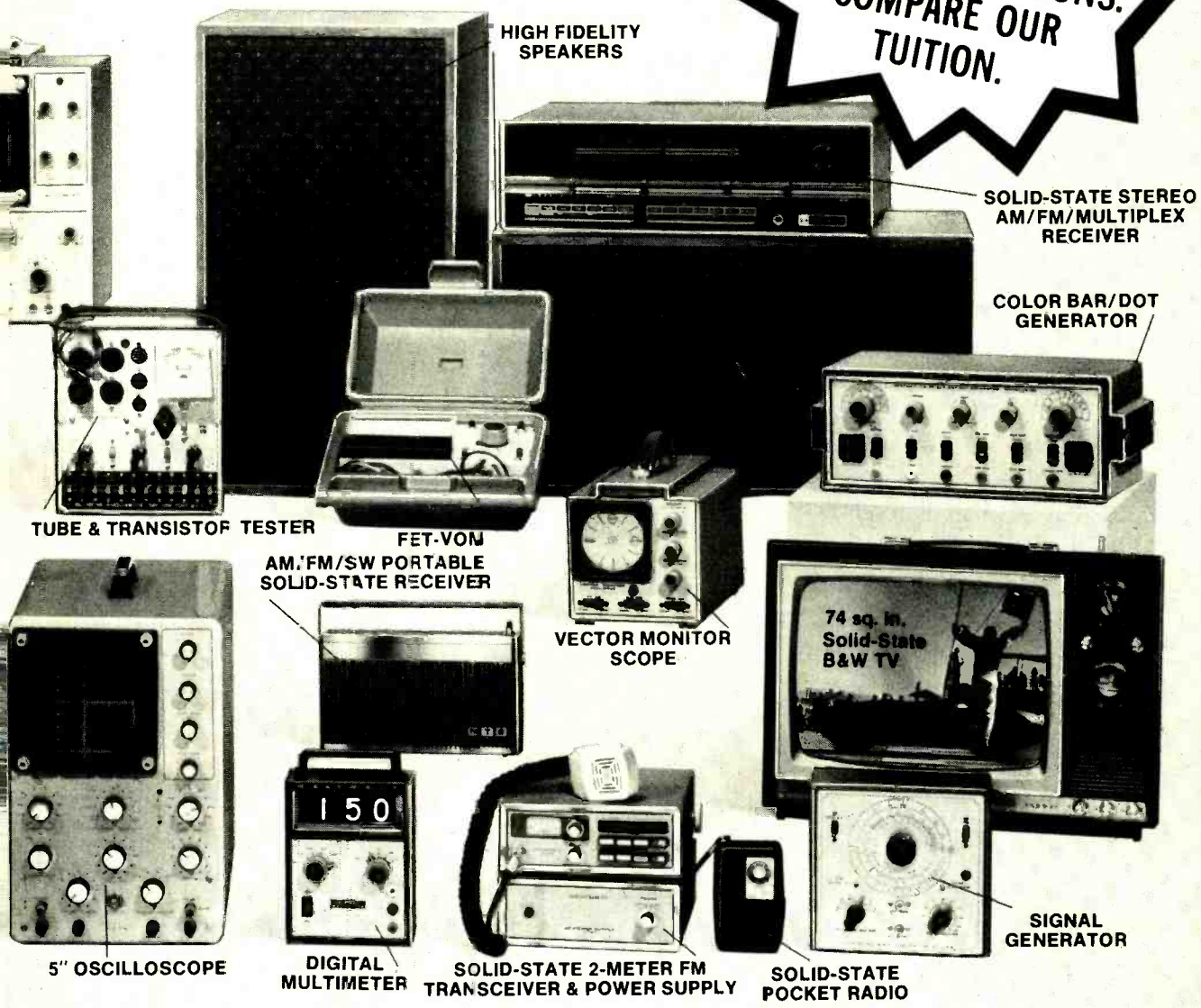

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NEW PRODUCTS

continued from page 87

SPEED-WRAP TOOL, *model G200/R3278,* is designed to produce solderless wire-wrapped connections by merely squeezing the trigger. The hardened steel working parts ensure long life and

trouble-free service. Enclosed in Lexan housing enabling the tool to be light in weight.—**O.K. Machine and Tool Corp.,** 3455 Conner St., Bronx, NY 10475

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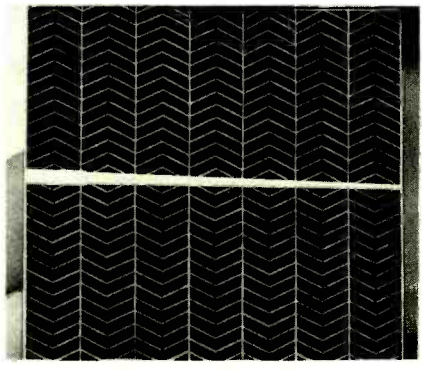
HIGH-EFFICIENCY SOLAR CELL, *stock No. 42,514,* the largest, most powerful ever made for terrestrial use, is ideal for building solar panels where maximum power-per-unit-area is required.

A significant feature of this ultra-high-efficiency solar cell is that it can be used to build panels



with outputs up to 12 watts per square foot.

Each cell can produce 0.8 A at 0.45 V, and has a 0.38 watt output. It weighs only 2 ounces and is 2 × 2 inches square. Initial tests indicate that the new square cell offers more use flexibility than the circular kind. Priced at $39.95.—**Edmund Scientific Co.,** 555 Edscorp Bldg., 101 E. Gloucester Pike, Barrington, NJ 08007

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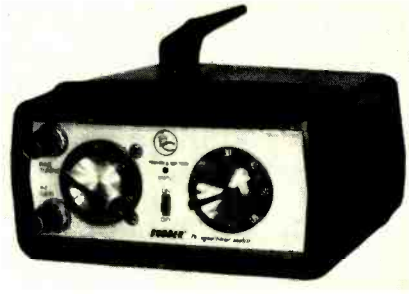
BATTERY-POWERED UHF-VHF TV TUNER AND IF SIGNAL ANALYST, *Subber, Mark IV-CUVB,* tunes all VHF and UHF channels. Its smooth, exact tuning ensures precise setting for care in



testing TV tuners. It also has dual 40-MHz IF output jacks.—**Castle Electronics,** 5233 Old Highway 37 South, Bloomington, IN 47401

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next month

DECEMBER 1977

■ **Optical Synthesizer**

Add a new twist to your oscilloscope with this easy to build add-on. With you at the controls, an enormous variety of intriguing 3-dimensional traces can be displayed.

■ **CB Switcher**

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■ **Computer Cryptography**

How to use your microcomputer to decipher secret messages.

■ **AM Stereo**

A look at the different systems being considered by the FCC to add stereo to AM radio.

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Hi-Fi Test Reports

More Digital Car Clocks

Service Clinic

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new lit

More information on new lit is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 106.

PERSONAL CALCULATOR DIGEST, a 32-page digest that describes the design and operation of the manufacturer's pocket and personal calculators along with a complete catalog of calculator models and accessories. Two separate sections providing in-depth background on such subjects as thermal printing, testing, servicing, C-MOS, P-MOS, and N-MOS circuits and RPN language. Includes Letters to the Editor, Questions and Answers section and a collection of unusual case histories.—**Hewlett Packard**, 1000 N.E. Circle Blvd., Corvallis, OR 97330

CIRCLE 93 ON FREE INFORMATION CARD

CB ANTENNAS FACTS AND FABLES is a 16-page booklet that clears the air on what CB antennas will and will not do. It discusses the various types of antennas, what to do when you don't have a ground plane, how to interpret gain, co-phasing and much more. A must for every

CB'er.—**Antenna Specialists Co.,** 12435 Euclid Ave., Cleveland, OH 44106

CIRCLE 94 ON FREE INFORMATION CARD

DIGITAL INSTRUMENTATION CATALOG, a 12-page brochure that shows the manufacturer's complete line of instruments. It lists all specifications for digital voltmeters, frequency counters and accessories.—**Data Precision Corp.,** Audubon Rd., Wakefield, MA 01880.

CIRCLE 95 ON FREE INFORMATION CARD

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NC FLASHER CATALOG, an 80-page collection of unusual tools for the technician and hobbyist. Tools described include: nippers and grabbers, solvents and lubricants, testers and pullers, vises and blowers, pick-ups and punches; more than 2,000 hard-to-get (and familiar) tools and supplies.—**National Camera,** Dept. QRR, 2000 West Union Ave., Englewood, CO 80110.

CIRCLE 97 ON FREE INFORMATION CARD

CB CATALOG, 40 pages, full-color, contains manufacturer's entire new line of 40-channel AM and SSB CB transceivers, hand-helds, marine communications equipment, and their full line of antennas and accessories. Featured items include one base and five mobile CB's with solid-state modular chassis construction; a new 40-channel in-dash unit with an AM/FM stereo radio and LED channel readout; and a new line of antennas and accessories. Catalog priced at $2.00.—**Royce Electronics Corp.,** 1746 Levee Road, North Kansas City, MO 64116. **R-E**

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HOBBY CORNER
continued from page 69

The greatest disadvantage of this box is that the plastic will crack and even break. Take care not to over-tighten the mounting bolts (I cracked it in two places). Though the breadboard has been in use almost a year, someday I may drop it and regret that the box is not metal. Perhaps not; I am normally careful not to drop any of my equipment—metal box or whatever!

The front panel layout can be seen in Fig. 1 (see August column). Note that the panel is the *bottom* of the box. Placement is not critical and controls can be shifted to suit the builder.

Looking at the front panel, you will note the round transistor sockets which serve as terminals for the circuits in the box. Jumper wires can be run to and from them and the breadboard strips. The voltage regulators and their homebrew heat sinks are located on the top side. The *Sonalert* is mounted in the right side. The upper pair of binding posts are connected to the output of the external (heavier duty) power supply. The lower pair are free; they are used to bring outside power to the panel.

The LED's are "mounted" by pushing them up through holes drilled slightly undersize so the fit will be snug. If you get a hole too big, don't worry—the

wiring will hold the LED up there or you can apply a drop of cement to hold it. All of the LED's used were included in assortments of six diodes from Radio Shack (catalog number 276-090).

Figure 8 shows the placement of parts inside the box. Quite obviously, point-to-point wiring was used—a rat's nest but effective since there is no interaction between the various circuits. You can see that there is plenty of space for another

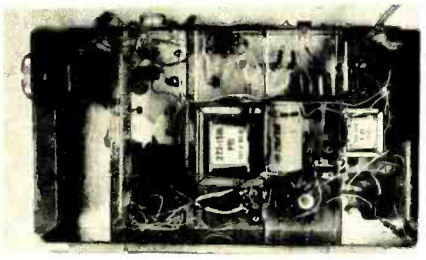

FIG. 8—TERMINAL STRIPS and large components are bolted to the fixed partitions.

power supply or two, even with everything spread out as it is.

The clock circuit is on a piece of perforated circuit board in the upper left corner. The board in the right partition holds the pulse/state checker and the pulser switch circuits. It can be seen again in Figure 9.

I recommend that you check each circuit for proper operation as it is built. When you hay-wire something like this, it is easy to make an error. Check and correct as you go along.

While you may make your breadboard just like mine, there is plenty of opportunity to tailor it to your specific needs. Some suggestions have already been made. There is one addition that I shall make when I get around to it. I

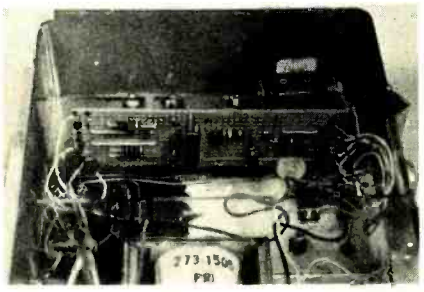

FIG. 9—PULSE CHECKER AND PULSE SWITCH are mounted on perf board.

intend to add a miniature milliammeter (lower right panel) so that I can keep an eye on the current being drawn by my experimental circuits. Right now, I am too busy using the thing to make any changes!

When you get your breadboard in full operation, you will wonder how you ever did without it. Like me, you will use it for more things than you can now imagine and it will save you much time and money. **R-E**

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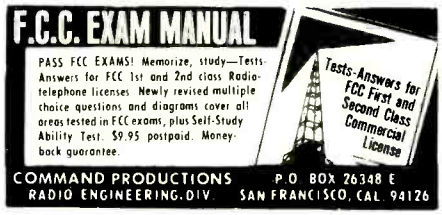

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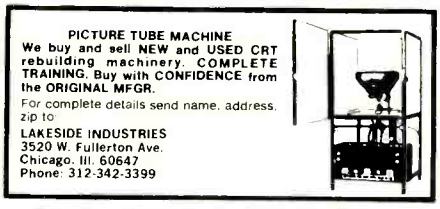

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74C74	276-2310	$1.29	89¢
74C76	276-2312	$1.59	89¢
74C90	276-2315	$2.29	1.49
74C192	276-2321	$2.49	1.69
74C193	276-2322	$2.49	1.69
4001	276-2401	$ .69	49¢
4011	276-2411	$ .69	49¢
4013	276-2413	$1.29	89¢
4017	276-2417	$2.49	1.49
4020	276-2420	$2.49	1.49
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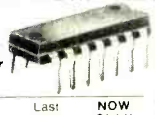
4049	276-2449	$ .99	69¢
4050	276-2450	$ .99	69¢
4511	276-2447	$2.69	1.69
4518	276-2490	$2.49	1.49

Linear ICs

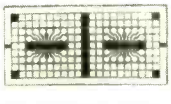
First Quality Devices by National Semiconductor and Motorola



Type	Cat No	Last Year	NOW ONLY
301AH	276-017	$ .69	49¢
324N	276-1711	$1.99	1.49
339N	276-1712	$1.99	1.49
386CN	276-1731	$1.99	99¢
555CN	276-1723	$1.49	79¢
556CN	276-1728	$2.79	1.39
566CN	276-1724	$2.99	1.69
567CN	276-1721	$2.99	1.99
723CN	276-1740	$ .99	69¢
741CN	276-007	$ .69	49¢
741H	276-010	$ .69	49¢
3900N	276-1713	$1.39	99¢
3909N	276-1705	$1.29	99¢
3911N	276-1706	$2.19	1.99
4558CN	276-038	$ .99	79¢
75491	276-1701	$1.49	99¢
75492	276-1702	$1.49	99¢
7805	276-1770	$1.59	1.29
7812	276-1771	$1.59	1.29
7815	276-1772	$1.59	1.29

Experimenter's PC Board

Simplifies IC Projects



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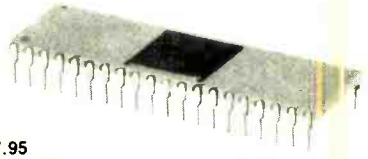
276-151 ..... **2.99**

Microcomputer Chip



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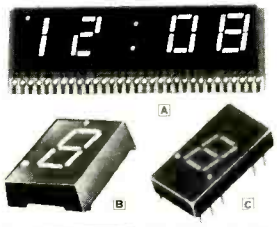
Item	Cat No	Reg	Now Only
A Solar Cell	276-115		1.59
B Silicon Solar Cell	276-128		1.99
C Photocell	276-116		99¢
D FPT 100	276-130		79¢
D Lg Red LED	276-041	2/69¢	2/49¢
E Lg Clr LED	276-047	2/69¢	2/49¢
E Med Red LED	276-026	2/69¢	2/49¢
E Med Clr LED	276-040	2/69¢	2/49¢
E Sm Red LED	276-042	2/69¢	2/49¢

Digital Displays



Digits	Size	Drive	Cat No	Last Year	NOW ONLY
A 4	0.5"	Anod.	276-1201	$9.95	6.95
A 4	0.5"	Cath.	276-1202	$9.95	6.95

Digits	Size	Drive	Cat No	Last Year	NOW ONLY
B 1	0.6"	Anod.	276-056	$3.99	2.99
B 1	0.6"	Cath.	276-066	$3.99	2.99
C 1	0.3"	Anod	276-053	$2.95	1.99
C 1	0.3"	Cath	276-062	$2.99	1.99
C 1	0.3"	Anod	276-1210	4/$8.97	4/6.99
C 1	0.3"	Cath.	276-1211	4/$8.97	4/6.99

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C **2-Voltage Source Edge-Card Board.** .1368 mounting holes. **276-154** **2.99**

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D **22-Pin Edge-Card Board Connector.** 44-terminals. **276-1551** **2.99**

D **100-Pin Edge-Card Board Connector.** For standard S-100 hobby computer bus.
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276-1980 ..... **1.29**

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270-251 ..... **2.59**

G **Metal Cabinet.** 4x2¾x6"
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1N5402	276-1142	2/89¢	2/79¢
1N5403	276-1143	2/99¢	2/89¢
1N5404	276-1144	2/$1.19	2/99¢
PTC205	276-1114		3/1.39¢

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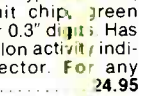

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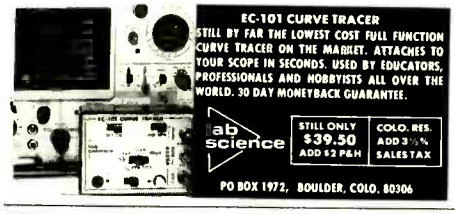

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7422N	1.39	74LS113N	.38	LM733N	1.00	CD4020	1.11	74C107	.85	CT7001	5.80
7430N	.20	74LS132N	.78	LM741CH	.35	CD4021	1.11	74C154	3.00	CT7002	6.25
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7450N	.17	74LS162N	1.00	LM1304	1.10	CD4026	1.60	74C906	1.50	7205	16.50
7474N	.29	74LS163N	1.00	LM1305	.27	CD4027	.39	74C911	1.95	DS0026CN	3.75
7475N	.49	74LS174N	1.03	LM1307	2.00	CD4028	.85	74C925	10.50	DS0056CN	3.75
7485N	.68	74LS190N	1.15	LM1310	2.75	CD4029	1.11	74C926	10.50	MM5314	2.50
7489N	2.00	74LS221N	1.95	LM1458	.59	CD4030	1.11	74C927	10.50		
7490N	.43	74LS259N	.73	LM1800	.75	CD4035	1.11				
7492N	.43	**LINEAR**		LM1812	7.50	CD4042	.77	**INTERFACE**			
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7495N	.69	CA3046	.95	LM2111	1.75	CD4044	.68	8096	.65		
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74107N	.29	CA3081	1.60	LM3900N	.55	CD4049	.39	8098	.65		
74121N	.34	CA3082	1.90	LM3905	1.75	CD4050	.39	8110	2.50		
74123N	.59	CA3089	2.95	LM3909N	.69	CD4051	1.22	8113	3.00		
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74145N	.69	LM301AN AH	.35	NE540L	2.00	CD4053	1.54	8123	3.10		
74150N	.95	LM305H	.87	NE550N	.65	CD4056	.78	8124	3.50		
74151N	.69	LM307N	.35	NE555V	.43	CD4068	.35	8125	3.20		
74154N	1.00	LM308N	.80	NE556A	.80	CD4069	.40	8126	1.69		
74157N	.69	LM309H	1.15	NE565A	1.00	CD4070	.40	8127	2.75		
74161N	.87	LM309K	.95	NE566V	1.22	CD4071	.22	8128	2.75		
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74163N	.87	LM317T	2.95	78L05	.90	CD4073	.22	8136	2.75		
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74175N	.90	LM320K-5	1.35	79L05	1.00	CD4076	.75	8216	1.69		
74190N	1.15	LM323K-5	6.95	78M05	.75	CD4078	.42	8224	4.50		
74192N	.87	LM320K-12	1.35	75108	1.75	CD4081	.22	8228	8.50		
74193N	.85	LM320K-15	1.35	75491CN	.50	CD4082	.22	8255	11.55		
74221N	1.55	LM320T-5	1.60	75492CN	.55	CD4116	1.30	8267	19.95		
74298N	1.65	LM320T-12	1.60	75494CN	.89	CD4490	5.50	8275	25.00		
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74LS04N	.28	LM340K-12	1.60			CD4520	1.10	N8259	3.75		
74LS05N	.28	LM340K-15	1.60	**CMOS**		CD4527	1.60	N8263	3.75		
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74LS10N	.28	LM340T-5	1.20	CD4000	.18	CD4553	5.75	N8275	3.75		
74LS13N	.46	LM340T-8	1.20	CD4001	.22	CD4566	2.25	N8279	3.75		
74LS14N	1.00	LM340T-12	1.20	CD4002	.22	CD4583	1.50	N8291	3.75		
74LS20N	.28	LM340T-15	1.20	CD4006	1.19	CD4585	1.15	N8293	3.75		
74LS27N	.28	LM340T-18	1.20	CD4007	.22	CD40192	3.00	N8295	3.75		
74LS28N	.41	LM340T-24	1.20	CD4008	.75	74C00	.28	N8297	3.75		
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Video Interface board kit 149.95
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16K Static RAM board kit 185.00
North Star Floppy Disc Kit $685.00
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Model 100A 180.00
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Encoder HD0165-5 6.95
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MAN72	CA	300	1.03
MAN74	CC	300	1.50
DL704	CC	300	1.25
DL707 DL707R	CC	300	1.50
DL722-1	CC	300	1.00
DL727	CA	500	1.90
DL728	CC	500	1.90
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FND510	CA	500	.90
FND800	CC	800	2.20
FND807	CA	800	2.20
DGB Fluorescent			1.75
DGTG Fluorescent			1.75
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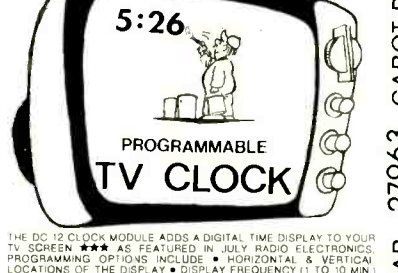

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74LS09	.28	74LS158	.71
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74LS11	.21	74LS161	.85
74LS13	.45	74LS162	.88
74LS14	.99	74LS163	.85
74LS15	.26	74LS168	.85
74LS20	.24	74LS169	.85
74LS21	.28	74LS170	1.69
74LS22	.28	74LS173	1.10
74LS26	.32	74LS174	1.00
74LS27	.32	74LS175	.81
74LS30	.26	74LS190	.95
74LS32	.32	74LS191	.95
74LS37	.32	74LS192	.95
74LS38	.32	74LS193	.95
74LS40	.26	74LS194	.95
74LS42	.65	74LS195	.85
74LS51	.26	74LS196	.85
74LS54	.26	74LS197	.85
74LS55	.26	74LS251	.85
74LS3	.35	74LS253	.81
74LS74	.35	74LS257	.71
74LS76	.49	74LS258	.71
74LS86	.36	74LS260	.26
74LS90	.55	74LS266	.26
74LS92	.55	74LS279	.55
74LS93	.55	74LS290	.75
74LS109	.38	74LS293	.61
74LS112	.38	74LS295	.95
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7406	.16	7493	.43
		7494	.67
7408	.19	7495	.67
7409	.19	7496	.67
7410	.13	74100	.28
7411	.18	74107	.28
7413	.37	74121	.29
7420	.13	74123	.48
7421	.13	74125	.37
7423	.25	74141	.75
7425	.29	74145	.85
7426	.24	74151	.61
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7438	.23	74157	.63
7440	.13	74161	.86
7442	.47	74163	.85
7443	.59	74164	.85
7444	.59	74174	.91
7447	.68	74175	.85
7448	.71	74180	.67
7450	.13	74181	1.89
7451	.13	74191	.98
7453	.13	74193	.81
7454	.13	74194	.81
7460	.19	74195	.69
7470	.27	74H00	.25
7472	.25	74H05	.25
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CD4019	.45	CD4520	1.10
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CD4022	.97	74C04	.32
CD4023	.19	74C107	.79
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CD4025	.19		
CD4027	.45		
CD4028	.89		
CD4029	.99		
CD4030	.35		
CD4035	.99		
CD4040	1.00		
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$4.95

Use with Digital Clocks for 12VDC or Portable Operation

KIT INCLUDES:
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3.5795 MHZ XTAL & All Other Parts
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FEATURES: Reads minutes, seconds, & 100ths of seconds
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ULN2224	ULN2298	ULN2311
ULN2228	ULN2125	ULN2312

Darlington Arrays - Any 2 for $.99

ULN2001	ULN2011	ULN2032
ULN2002	ULN2012	ULN2046
ULN2003	ULN2013	ULN2054
ULN2004	ULN2014	ULN2081

Radio - 3 for $.99

ULN2111A — ULN2136 — ULN2126 — ULN2231

Audio - 3 for $.99

ULN2274 — ULN2278 — ULN2280 — ULN2281

BIG-BRIGHT - .5" LED ALARM CLOCK
6 DIGIT AC or DC or ELAPSED TIMER KIT
$19.95 Complete

- PC Board Drilled & Silk Screened (Includes Xtal Time Base Circuitry)
- 5375 Nat. Clock Chip & Fairchild Displays
- Includes EVERY part required for clock and all options except Cabinet and Crystal Time Base components. If desired see below
- Brightness Control
- 24 Hr. Alarm w/ snooze
- Freeze feat. on every mode
- 0-60 Min. Elapsed Timer
- Field Tested over 1 Yr.
- 12 Hr., 60 Hz. type

Most Important — Complete Instructions, schematics, Pictorials, layouts — everything for trouble free assembly.

OPTIONS —
XTAL Time Base Components - $2.95 when purchased w/clock
Wood Clock Cabinet - $4.00 when purchased w/clock

12/24 Hr. Version of Above — $17.95
except no Alarm or Elapsed Timer

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INTEGRATED CIRCUITS

TTL

7400	.21	74198	1.49	74LS261	2.00	LF357N	1.20
7401	.21	74199	1.49	74LS266	.39	LF13741	.716
7402	.21	74221	.86	74LS273	1.28	LM301AN	.44
7403	.21	74251	1.09	74LS279	.62	LM307N	.64
7404	.21	74279	.55	74LS283	.79	LM308N	1.00
7405	.21	74298	.94	74LS283	.65	LM309k	1.80
7406	.25	74365	.67	74LS293	.65	LM311N	.90
7407	.25	74366	.67	74LS295	1.12	LM317T	3.00
7408	.21	74367	.67	74LS298	1.30	LM317MP	1.90
7409	.21	74368	.67	74LS365	.67	LM318N	2.70
7410	.21	**74LS00**		74LS366	.67	LM320MP-5	1.30
7411	.21	74LS00	.28	74LS367	.67	LM320MP-6	1.30
7412	.21	74LS02	.28	74LS368	.67	LM320MP-8	1.30
7413	.25	74LS03	.28	74LS377	1.50	LM320MP-9	1.30
7414	.89	74LS04	.29	74LS386	.39	LM320MP-12	1.30
7416	.25	74LS05	.29	74LS395	1.74	LM320MP-15	1.30
7417	.25	74LS08	.29	74LS670	2.34	LM320MP-18	1.30
7420	.21	74LS09	.29	81LS95	.77	LM320MP-24	1.30
7421	.25	74LS10	.28	81LS96	.77	LM323K	7.50
7423	.35	74LS11	.28	81LS97	.77	LM324N	.72
7425	.35	74LS12	.28	81LS98	.77	LM325N	2.70
7426	.25	74LS13	.47	**INTERFACE**		LM326N	2.70
7427	.33	74LS14	1.02	8093	.40	LM327N	2.70
7428	.28	74LS15	.28	8094	.40	LM339N	1.15
7430	.21	74LS20	.28	8095	.67	LM340T-5	1.25
7432	.25	74LS21	.28	8096	.67	LM340T-8	1.25
7433	.30	74LS22	.28	8097	.67	LM340T-12	1.25
7437	.25	74LS26	.33	8098	.67	LM340T-10	1.25
7438	.25	74LS27	.33	75450	.88	LM340T-12	1.25
7439	.50	74LS28	.33	75451	.61	LM240T-15	1.25
7440	.21	74LS30	.28	75452	.61	LM340T-18	1.25
7442	.53	74LS32	.33	75453	.61	LM340T-24	1.25
7445	.70	74LS33	.33	75454	.61	LM341P-5	.98
7446	.70	74LS37	.33	75491	.81	LM341P-6	.98
7447	.70	74LS38	.33	75492	.84	LM341P-8	.98
7448	.70	74LS40	.28	75493	1.09	LM341P-10	.98
7450	.21	74LS42	.67	75494	1.19	LM341P-12	.98
7451	.21	74LS47	.79	MC1488N	.90	LM341P-15	.98
7453	.21	74LS48	.77	MC1489N	.90	LM341P-18	.98
7454	.21	74LS51	.28	**4000 CMOS**		LM341P-24	.98
7460	.21	74LS54	.28	4000	.23	LM348N	1.60
7470	.30	74LS55	.28	4001	.23	LM349N	1.60
7472	.30	74LS73	.39	4002	.23	LM358N	.72
7473	.30	74LS74	.39	4006	1.23	LM1310N	.84
7474	.30	74LS76	.39	4007	.23	LM1800N	9.60
7475	.42	74LS78	.39	4008	.79	LM1801N	1.70
7476	.32	74LS83	.79	4009	.44	LM1812N	4.80
7480	.70	74LS85	.49	4010	.44	LM1830N	1.30
7483	.70	74LS86	.79	4011	.23	LM1889N	2.00
7485	.89	74LS90	.57	4012	.23	LM2111N	1.25
7486	.28	74LS92	.57	4013	.79	LM2907N	1.50
7489	2.19	74LS93	.57	4014	.96	LM2917N	1.50
7490	.44	74LS95	.88	4015	.96	LM3089N	1.30
7491	.70	74LS96	.57	4016	.40	LM3900N	.88
7492	.44	74LS107	.39	4017	1.05	LM3900N	.88
7493	.44	74LS109	.39	4018	1.05	LM3905N	1.40
7494	.70	74LS112	.39	4019	.23	LM3909N	.69
7495	.70	74LS113	.39	4020	1.14	LM3911N	1.50
7496	.70	74LS114	.39	4021	1.14	MC1456V	1.00
74100	1.28	74LS123	.79	4022	.96	MC1458V	.53
74107	.30	74LS125	.49	4023	.23	MC1496N	.70
74109	.33	74LS126	.49	4024	.84	MC3302P	1.15
74110	1.26	74LS132	.81	4025	.23	NE536T	2.50
74121	.35	74LS136	.39	4026	1.68	NE540L	2.04
74122	.44	74LS138	.73	4027	.40	NE555V	.48
74123	.61	74LS139	.73	4028	.89	NE556A	.88
74125	.40	74LS145	.73	4029	1.14	NE558N	2.40
74126	.40	74LS151	.73	4030	.23	NE559N	2.40
74128	.48	74LS153	.75	4033	1.51	NE560B	2.50
74132	.70	74LS154	1.10	4034	3.50	NE561B	2.50
74141	.88	74LS155	.75	4035	1.14	NE562B	2.50
74145	.70	74LS156	.75	4040	1.14	NE565A	1.25
74147	1.63	74LS157	.75	4041	.79	NE566V	1.28
74148	1.30	74LS158	.75	4042	.79	NE567V	1.36
74150	1.16	74LS160	1.02	4043	.70	UA709CV	.44
74151	.70	74LS161	1.02	4044	.70	UA710CA	.44
74153	.65	74LS163	1.02	4046	1.86	UA711CA	.53
74154	1.03	74LS164	1.02	4049	.40	UA723CA	.60
74155	.70	74LS168	1.14	4050	.40	UA741CV	.44
74156	.70	74LS169	1.14	4051	1.26	UA747CA	.70
74157	.70	74LS170	1.73	4052	1.26	UA748CV	.49
74160	.88	74LS173	1.34	4053	1.26	UA7805CU	1.25
74161	.88	74LS174	1.06	4060	1.58	UA7806CU	1.25
74162	.88	74LS175	.84	4066	.79	UA7808CU	1.25
74163	.88	74LS181	2.50	4071	.23	UA7812CU	1.25
74164	.96	74LS190	1.18	4072	.23	UA7812CU	1.25
74165	1.15	74LS191	1.18	4073	.23	UA7815CU	1.25
74166	1.15	74LS192	.98	4075	.23	UA7818CU	1.25
74170	2.64	74LS193	.53	4081	.23	UA7824CU	1.25
74174	.98	74LS194	.88	4082	.23	UA78L05ACZ	.40
74175	.93	74LS195	.86	4502	.79	UA78L06ACZ	.40
74176	.79	74LS196	.86	4510	1.14	UA78L08ACZ	.40
74177	.79	74LS197	.86	4511	1.05	UA78L10ACZ	.40
74180	.70	74LS197	.86	4514	2.80	UA78L12ACZ	.40
74181	2.20	74LS221	1.06	4515	2.80	UA78L15ACZ	.40
74181	2.15	74LS240	1.90	4516	1.23	UA78L18ACZ	.40
74182	.79	74LS241	1.90	4518	1.14	UA78L24ACZ	.40
74184	2.15	74LS242	1.70	4520	1.14	UA7905CU	1.70
74185	2.19	74LS243	1.70	4527	1.68	UA7906CU	1.70
74189	3.50	74LS244	1.70	4528	.88	UA7908CU	1.70
74190	1.23	74LS247	.79	4585	1.23	UA7909CU	1.70
74191	1.23	74LS248	.79	**74C00**	.23	UA7912CU	1.70
74192	.88	74LS249	.79	**LINEAR**		UA791SCU	1.70
74193	.88	74LS251	.84	CA3046	.75	UA791BCU	1.70
74194	.88	74LS253	.84	CA3086	.50	UA7924CU	1.70
74196	.88	74LS257	.75	LF351N	.76	**MISC IC**	
74197	.88	74LS258	.75	LF356N	1.20	MM5314N	3.75

I.C. SOCKETS

8 PIN SOLDER	.17	1.60/10	14.50/C
14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.25/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.00/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

SLIDE SWITCHES

SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

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	2.10/100	8.50/500
26 ga PVC	2.10/100	8.50/500

50 VOLT DISCS

100 PF	.40/10	3.50/C
220 PF	.40/10	3.50/C
470 PF	.40/10	3.50/C
001 UF	.40/10	3.50/C
0022 UF	.40/10	3.50/C
0047 UF	.40/10	3.50/C
01 UF	.45/10	3.65/C
022 UF	.50/10	4.00/C
047 UF	.70/10	5.60/C
1 UF	1.35/10	11.50/C

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8228	SYSTEM CONTROLLER	$ 6.95
8251	COMMUNICATIONS INTERFACE	$12.95
8255	PERIPHERAL INTERFACE	$11.95
1702A	2K EPROM (256x8)	$ 6.95
2708	8K EPROM (1Kx8)	$29.50
2102-1	1K RAM 500 NS	$ 1.79
SC/MP	5 VOLT SC/MP CPU	$ 9.95
2650	MICROPROCESSOR 1.25 MH-2 CLOCK 40 DIL	$24.95

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1000 pcs/value **1.2¢** ea.

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METALIZED POLYESTER CAPACITORS

.001	.14	1.15/10	9.00/C	.033	.15	1.25/10	10.00/C
.0022	.14	1.15/10	9.00/C	.047	.15	1.25/10	10.00/C
.0033	.14	1.15/10	9.00/C	.068	.15	1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17	1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30	2.50/10	20.00/C
.022	.15	1.25/10	10.00/C	.47	.36	3.00/10	24.00/C

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS			AXIAL LEADS		
.47/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
1.50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.08	.67/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.12	1.00/10	8.48/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.13	1.05/10	9.65/C	.17	1.34/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.13/10	10.41/C	.19	1.53/10	12.89/C
45/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.30/C
220/25V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.41/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.21	1.66/10	14.14/C	.31	2.45/10	22.70/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	28.38/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/16V	.15	1.21/10	11.16/C	.20	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.22	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/100	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
1000/50V	.76	6.86/10	26.41/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

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400 BEZEL WITH RED FILTER 4.95
420 MOUNTING ADAPTER FOR MA1001 & MA1002 69
421 MOUNTING ADAPTER FOR MA1010 69

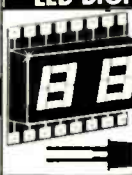
CLOCK MODULES

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

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

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

LED DIGITS AND LAMPS



FND357	.375" Single Digit CC Red		$1.35
FND500	.5" Single Digit CC Red		1.35
FND507	.5" Single Digit CC Red		1.35
FND800	.8" Single Digit CC Red		2.50
FND807	.8" Single Digit CA Red		2.50
MSA373	.3" Dual Digits CA Red		2.20
MSA374	.3" Dual Digits CA Red		2.20
MSA583	.5" Dual Digits CC Red		2.60
MSA584	.5" Dual Digits CA Red		3.00
MSA783	.7" Dual Digits CC Red		3.00
MSA784	.7" Dual Digits CA Red		3.00
MSL5053	Dif. Red T-1¾ Lamp		
	= Mfg. Holes	81.80/10	16.00/100
NSL5056	Dif. Narrow Angle Red T-1¾ Lamp		
	= Mfg. Holes	81.80/10	16.00/100

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

RS125	1 set of 5 each of the 73 standard 5% ¼ watt carbon film resistors (365 pcs)	$9.90
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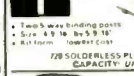

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MPS3563	.16	1.55/10	13.00/C
MPS3565	.16	1.55/10	13.00/C
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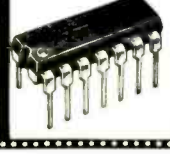

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CMOS	Pin-out & Description of 4000 Series ICS	**$2.95**
Linear	Pin-out & Functional Description	**$2.95**
	ALL THREE HANDBOOKS $6.95	

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

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

TRANSISTORS

MPS A05	5/$1.00	PN3567	3/$1.00	PN4249	4/$1.00
MPS A06	5/$1.00	PN3568	4/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3569	4/$1.00	PN4400	4/$1.00
2N2221	4/$1.00	PN3704	5/$1.00	PN4401	4/$1.00
2N2222A	5/$1.00	PN3705	5/$1.00	PN4402	4/$1.00
2N2369	5/$1.00	PN3706	5/$1.00	PN4403	4/$1.00
2N2369A	4/$1.00	2N3707	5/$1.00	PN4409	5/$1.00
2N2484	4/$1.00	2N3711	5/$1.00	PN5086	4/$1.00
2N2906A	4/$1.00	2N3724	$.65	PN5087	4/$1.00
2N2907A	5/$1.00	2N3725	$1.00	PN5088	4/$1.00
2N2925	5/$1.00	2N3903	5/$1.00	PN5089	4/$1.00
2N3053	2/$1.00	2N3904	4/$1.00	2N5129	5/$1.00
2N3055	$.89	2N3905	4/$1.00	2N5138	5/$1.00
MJE3055	$1.00	2N3906	4/$1.00	2N5139	5/$1.00
MJE2955	$1.75	2N4013	3/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N4014	3/$1.00	2N5951	5/$1.00
2N3398	5/$1.00	2N4123	10/$1.00	C106B1 SCR	2/$1.00
				2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100
10 pf	05	04	03
22 pf	05	04	03
47 pf	05	04	03
100 pf	05	04	03
220 pf	05	04	03
470 pf	05	04	.035
.001μf	12	10	07
.0022	12	10	07
.0047mf	12	10	07
.01mf	12	10	07
1/35V	28	23	.17
15/35V	28	23	.17
22/35V	28	23	.17
.33/35V	28	23	.17
47/35V	28	23	.17
68/35V	28	23	.17
1 0/35V	28	23	.17

	1-9	10-49	50-100
.001μF	05	04	.035
.0047μF	05	04	.035
.01μF	05	04	.035
.022μF	06	05	04
.047μF	06	05	04
1μF	12	09	.075

100 VOLT MYLAR FILM CAPACITORS

.022mf	13	.11	08
.047mf	21	17	13
.1mf	27	23	.17
.22mf	33	27	22

+20% DIPPED TANTALUMS ($DLID) CAPACITORS

1 5/35V	30	26	.21
2 2/35V	31	27	.22
3 3/25V	31	27	.22
4 7/25V	32	28	.23
6 8/25V	36	.31	25
10/25V	40	35	.29
15/25V	63	50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead		
47/50V	15	13	10	47/25V	15	13	10
1.0/50V	16	14	.11	47/50V	16	14	.11
3 3/50V	15	13	.10	1 0/16V	15	.13	.10
4 7/25V	16	14	12	1 0/25V	16	14	11
10/25V	15	13	10	1 0/50V	16	14	11
10/50V	16	14	12	4 7/16V	15	.13	.10
22/25V	17	15	12	4 7/25V	15	13	.10
22/50V	24	20	18	4 7/50V	16	.14	11
47/25V	19	17	15	10/16V	14	12	09
47/50V	25	21	19	10/25V	15	13	10
100/25V	24	20	18	10/50V	16	14	.12
100/50V	35	30	28	47/50V	24	.21	.19
220/25V	32	28	25	100/16V	19	15	.14
220/50V	45	41	38	100/25V	24	.20	.18
470/25V	33	29	27	100/50V	35	30	28
1000/16V	55	50	45	220/16V	23	17	16
2200/16V	70	65	55	470/25V	31	28	26

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY2.01	2.010 MHz	HC33/U	$1.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

EXAR

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

WAVEFORM GENERATORS

XR-205	$8.40
XR-2206CP	4.49
XR-2207CP	3.85

STEREO DECODERS

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

MISCELLANEOUS

XR-2211CP	$6.70
XR-4136	.99
XR-1468	3.85
XR-1488	5.80
XR-1489	4.80
XR-2208	5.20

TIMERS

XR-555CP	$ .49
XR-320P	1.55
XR-556CP	1.85
XR-2556CP	3.20
XR-2240CP	3.25

PHASE LOCKED LOOPS

XR-210	5.20
XR-215	6.60
XR-567CP	1.95
XR-567CT	1.70

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out

Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100	PINS (Wire Wrap)	$6.95
50/100A (.100 Spacing)	PINS (Wire Wrap)	$6.95

25 PIN-D SUBMINATURE

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95

HEAT SINKS

205-CB — 680-.75A

205-CB	Beryllium Copper w-black finish for TO-5	$ .25
291-.36H	Aluminum for TO-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum for TO-3	$1.60
401-A	Black Anodized Aluminum — predrilled mounting holes for TO-3 — 4¾ x 1¼ x 2"	$1.75

DIP SWITCHES SPST Slide Action

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

Etching Kits

(cannot be shipped via air)

32 X A-1	P.C. Etch Materials Kit enough for 5 circuit boards	$29.95 ea.
27 X A-1	Etched Circuit Kit Complete kit — only add water	$ 9.95 ea.

Plugboards

3662	6.5 X 4.5 X 1.16 Epoxy glass P-Pattern-44 P.C. Tabs-spaced .156	$ 6.95 ea.
22/44	Mating connector for plugboard — 22 pin double readout	$ 2.95 ea.
8800V	Universal Microcomputer/Processor plugboard — Epoxy Glass — complete with heatsink and mounting hardware 5.313 X 10 X 1/16 copper clad	$19.95 ea.

Vector

1/16 VECTOR BOARD

	0.1 Hole Spacing Part No	P-Pattern L	P-Pattern W	Price 1	Price 2-Up
PHENOLIC	64P44-062XXXP	4.50	6.50	1.72	1.54
	169P44-062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44-062	4.50	6.50	2.07	1.86
	84P44-062	4.50	8.50	2.56	2.31
	169P44-062	4.50	17.00	5.04	4.53
	169P84-062	8.50	17.00	9.73	8.76
EPOXY GLASS COPPER CLAD	169P44-062C1	4.50	17.00	6.80	6.12

Vector

SLIT-N-WRAP WIRE WRAP TOOL

- Slits and opens insulation exposing bare wire
- No pre-cutting or pre-stripping
- Comes complete with two - 100 ft spools #28 AWG wire

Model P180 $24.50

HEXADECIMAL ENCODER 19-KEY PAD

- 1 - 0
- ABCDEF
- Return Key
- Optional Key (Period)
- — Key

$10.95 each

63 KEY KEYBOARD

$24.95

This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER CHIP **$7.95**

TOOLS

A97MS	— Diagonal Cutter - 4" semi-flush cut	$8.50 ea.
A11DMS	— Chain Nose Pliers - 4¾" long	7.50 ea.
T-6	— Wire Stripper - #16 to #26 gauge	3.75 ea.
55B	— Wire Stripper - #10 to #20 gauge	2.50 ea.
CS-8	— Cutter-Crimper Tool - 8¼" long	8.50 ea.
Nibbling Tool	— Cuts, Trims or Notches Metal up to #18 gauge	6.95 ea.
Nibbling Tool Replacement Punch		3.75 ea.

PERMACEL® P-29 PLUS Electrical Tape - All Weather
• ¾" wide x 66 ft. • Black vinyl
1-9 Rolls **$.79 each** 10-up Rolls **$6.95/10 roll package**

MICROPROCESSOR COMPONENTS

8080A	CPU	$16.00	8228	System Controller - Bus Driver	$10.95
8212	8 Bit Input/Output	4.95	MC6800	8 Bit MPU	22.50
8214	Priority Interrupt Control	15.95	MC6820	Periph. Interface Adapter	10.00
8216	Bi-Directional Bus Driver	6.95	MC6810AP1	128 x 8 Static RAM	7.95
8224	Clock Generator/Driver	10.95	MC6830L8	1024 x 8 Bit ROM	15.00
CDP1802		19.95	Z80	CPU	39.95

CPU'S

8080	Super 8008	24.95
8080A	Super 8008	16.00
2650	8 BIT MPU	26.50
P8085	CPU	29.95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	3.00
2519	Hex 40 BIT	3.00
2524	512 Dynamic	2.49
2525	1024 Dynamic	3.00
2527	Dual 256 BIT	3.95
2529	Dual 512 BIT	4.00
2532	Quad 80 BIT	3.95
2533	1024 Static	5.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95

UART'S

AY-5-1013	30k Baud	$5.95

ROM'S

2513(2140)	Char. Gen. upper case	$ 9.95
2513(30211)	Char. Gen. lower case	9.95
2516	Char. Gen.	10.95

RAM'S

1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107 5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
2112	256 x 4	Static	3.49
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	1.49
5101	1024 x 1	Static	2.25
5200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	2 for 1.00

PROMS

1702A	2048	Famos	$ 9.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tri-state	5.00
74S287	1024	Static	7.95
3601	256 x 4	Fast	3.95
2708	8K	Eprom	19.95
2716	16K	Eprom	34.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95

SPECIAL REQUESTED ITEMS

FCM3817	$ 5.00	4N33	$ 3.95	5841	$ 9.95	9368	$ 3.95
AY-3-8500-1	8.95	8T20	7.50	MK50240	17.50	MC1408L7	9.95
MC3061P	3.50	8T97	2.00	11C90	19.95	LD110/LD111	25.00/set
MC4016P (74416)	7.50	9374	1.95	DS0026CH	3.75	AY-5-9100	17.50 ea.
MCM6571	17.50	82S145	25.00	TIL308	10.50	95H90	11.95
MCM6574	17.50	MCM6575	17.50	ICM7208	22.00	ICM7209	7.50
AY-5-2376	14.95	ICM7045	24.95	ICM7207	7.50	HD0165	7.95

CLOCK CHIPS

MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
CT7001	5.95

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PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit

MODEL 100A
$229.00/Kit

- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation
- Some applications are:
  - Troubleshooting microprocessor address, instruction, and data flow
  - Examine contents of ROMS
  - Tracing operation of control logic
  - Checking counter and shift register operation
  - Monitoring I/O sequences
  - Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit) **Model 10 — $229.00**
Baseplate — $6.95

BUGBOOK

Continuing Education Series

BUGBOOK I & II - Basic concepts of TTL logic — over 90 experiments **$17.00/set**
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555 TIMER APPLICATIONS SOURCEBOOK WITH EXPERIMENTS — over 100 design techniques **$6.95/book**
CMOS-M-DESIGNERS PRIMER AND HANDBOOK — a complete CMOS instruction manual **$6.00/book**
OP AMP MANUAL — over 25 experiments on all phases of OP AMPS **$9.00/book**
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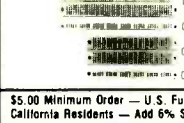
CONTINENTAL SPECIALTIES

PROTO BOARD 6

SPECIAL **$15.95**
(6" long X 4" wide)



Other CS Proto Boards	
PB100 - 4.5" x 6"	$ 17.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	129.95

PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50

DESIGN MATES

DM1 - Circuit Designer $69.95
DM2 - Function Generator $74.95
DM3 - RC Bridge $74.95

MAX-100 FREQUENCY COUNTER 20 MHz-100 MHz — 8 digit — .6" LED **$134.95**

Logic Monitor $84.95
for DTL, HTL, TTL or CMOS Devices

QT PROTO STRIPS

QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00
Experimentor 300		$ 9.95
Experimentor 600		$10.95

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Digital Alarm Clocks

C-500 - Ivory Case
C-500B - Ebony Case
$16.95

C-511
White Satin Case
$19.95

- 24-hour alarm
- Doze Button
- 100% Solid State
- Large Red Led Display (.8" high)
- AM/PM indicator
- Seconds display at touch of button
- Power failure indicator
- One year factory warranty

Timeband by FAIRCHILD — LAMP CLOCK

- 24 hour alarm
- Doze button
- Alarm-on indicator
- .8" high Red LED Display
- AM/PM Indicator
- High intensity lamp
- Lamp shuts off when collapsed

Model C-590 (Ivory) $29.95

EAC AM/FM 8-Track Stereo Receiver With BSR Changer

- PLL System
- BSR Record Changer
- Slide Controls
- Automatic A.F.C. Control
- 4 Speaker Output
- Walnut finish vinyl covered wood veneer with smoke dust cover

Size: 20"W x 9¾" x 15¼"D
Model 8365 $149.95

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One
  Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

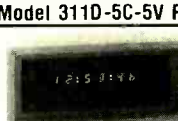
Stop Watch Chip Only (7205) **$19.95**

iMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model 311D-5C-5V Power Kit $17.50

JE700 CLOCK



The JE700 is a complete digital clock, but is a very high quality unit. The unit features a simulated wood grain case with dimensions of 6" x 2" x 1". It utilizes a MAN72 high brightness readout and the MM5314 clock chip.

12 or 24 Hour

115 VAC — KIT ONLY **$17.95**

Rejected ATARI GAME BOARDS

Over 60 Reusable IC's, misc. transistors, resistors, diodes, caps, crystals, switch, etc. (8½" x 16"). Limited Quantity.

$4.95 ea.

INSTRUMENT/CLOCK CASE

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

$3.95 ea.

JE803 PROBE

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

$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

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

$9.95 Per Kit

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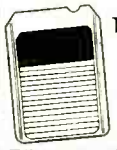


TA-907 **49¢**

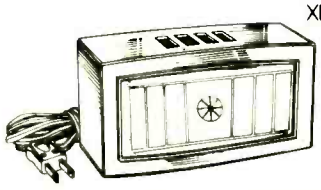
- Designed for Music Reproduction
- Erased Never Used

BATTERY NI-CAD RECHARGEABLE "AA" PEN-LITE CELL

BA-341 **$1 EACH**

- 1.2 Volt
- Made By 3 Famous Manufacturers

SMOKE & GAS ALARM



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- Loud Horn Warning

CASSETTES

Pkg. of 3 TA-879

REG. ~~1.49~~ **79¢**

- 60-Minute Blank

NICKEL CADMIUM BATTERY PACKS

LOW AS **2.75**

- Standard Penlight Size
- Rechargeable Over & Over

2-"AA" Batt. Pack. 2.4 Volts
BA-359. . . . . Ea. 2.00

3-"AA" Batt. Pack. 3.6 Volts
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4-"AA" Batt. Pack. 4.8 Volts
BA-361. . . . . Ea. 4.00

VHF-AM PORTABLE 3-CHANNEL RECEIVER

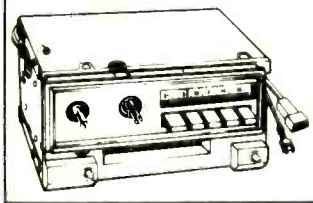
RA-422 **22.99**

Was ~~39~~ in 677 Cat.

- Hear (Hi-VHF 150-175 mHz) Police, Weather, Fire, More!
- Hurry! Quantities Limited
- Just Install Crystals Needed
- 9V Battery Included

XM-677. Crystals . . . Ea. 1.29

AUTO RADIO PUSHBUTTON AM

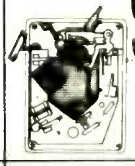


AU-580 **10.99**

- Mounts In or Under-Dash
- Has Volume, Tone and Manual Tuning Controls
- 12 VDC Negative Ground

EXPERIMENTER'S WIDGET CAMERA SHUTTER ASSEMBLY

XM-637 **99¢**



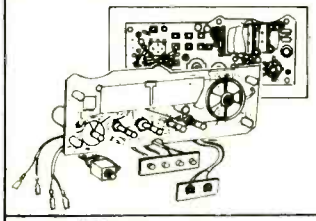
- Photo Cell, Resistors, Capacitor
- Electronic Shutter for Camera

CB MONITOR CONVERTER CHANNELS 1 THRU 23

4.99 CB-417

- Converts AM Auto Radio to CB Monitor
- For Traffic & Road Condition Reports

MONO FM-AM RECEIVER CHASSIS



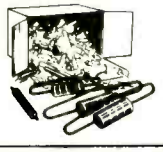
RA-573 **7.99**

- Mono Phono Input
- AM-FM Antennas
- Tape Output • Head Phone Jack
- For 11-12 VDC Operation

Stereo Version of Above
RA-574. . . . . 9.99

RESISTORS ONLY

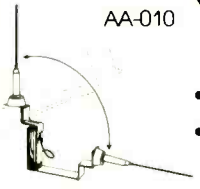
100 PIECE ASSORTED KIT **79¢**



RR-077

- Less Than 1¢ Each
- ¼-½, 1 Watt Resistors

6.99 DISAPPEARING "FLIP-FLOP" ANTENNA TRUNK MOUNT



AA-010

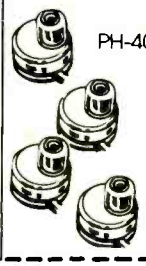
- Conceal Your Antenna
- Installs in Minutes Without Special Tools

2" PM SPEAKER 79¢

2/1.50 SS-295

- Replacement for Radios, Recorders, Etc.
- 8 to 10 Ohms Impedance

8 OHM EARPHONES



PH-405 **49¢**

Was ~~1.19~~ in 677 Cat.

- Pkg. of 4
- Earphones Without Plugs

VOLUME CONTROLS

Pkg. of 12 ONLY

VC-274 **59¢**

- Various Diameters & Lengths
- Some Have Switches

40 TERMINAL STRIPS

XM-501 **69¢** REG. ~~1.30~~

- Ass't Lengths and Various Number of Terminal Solder Lugs

Olson® electronics

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NAME _____
ADDRESS _____
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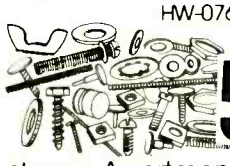
QTY	STK #	DESCRIPTION	PRICE EA	TOTAL

HARDWARE KIT 1 POUND

Reg. ~~79¢~~ EA.

HW-076



50¢

- Large Assortment of Screws, Washers, Nuts, Bolts, Etc.

Big 5 lb. Version. Wt. 5 lbs
HW-181. Reg. ~~2~~ **1.00**

50-PC. LOW VOLTAGE CAPACITOR KIT

CD-407

2.50 REG. ~~5.00~~

- Axial and Radial Lead Types
- Low Voltage, High Capacity Types

NOVEMBER 1977

CIRCLE 49 ON FREE INFORMATION CARD

FIND BREAK IN HEATING WIRE

I've got a tough job. I need to find the break in a radiant heating wire embedded in the ceiling of a kitchen. If I can do this, I can get into it from above and splice it. How can this be located.—G.H. Rossville, GA.

There's one way. Disconnect the heating wire completely and connect the output of an audio signal-generator to one end. Rig up some kind of pickup device. I've done this with an old G-E magnetic phono cartridge! Connect this to a power audio-amplifier using shielded wire.

Now run the pickup over the ceiling and you should be able to hear the audio signal when you get close to it. When you get to the break, the signal will drop off. Mark this point. For a double-check, hook the signal generator to the other end of the wire, and then trace it out. I found a thermostat wire like this. I built it into my office and then forgot where it was!

BREAKER TRIPPING

The customer complained about intermittent circuit-breaker tripping on this RCA CTC-46H chassis. At his home we found the breaker tripped and SCR 101 shorted. We took the chassis to the shop, replaced this, and hooked it up to our test jig.

We got a loud squeal, with a full horizontal sweep, but a big foldover taking up about two-thirds of the screen. We have been through the power supply and so far have come up dry. Reducing the line voltage doesn't help now, although it did for a while. I'm enclosing a list of the things we checked. Hope you can make more sense out of it!—K.J., Maurertown, VA

After all of the things you've checked, there's not much left! A crystal-ball diagnosis: You seem to have plenty of *output*, but the output also seems to have no *control*! Here's something you can try from another technician with a similar problem. He ran a lot of tests, including one on the regulator transformer, T2. He found it seemed to be good and *replaced* it. This fixed the thing. Since the regulator transformer does most of the work in "control" functions try it and see. I hope it works!

POWER TRANSFORMER

I need a power transformer for my Jackson TVG-2 signal generator. Where can I get one?—A.H., Diamond, MO.

We're in luck. I have a schematic of the Jackson TVG-2, but no voltage readings. I also have a service manual that gives them! This is a stock power transformer—310-volts RMS each side the center tap of at about 50-75 mA; 6.3-volt heater winding at 2.0 amps. Try a Triad R105B or Stancor P-6358.

GOOD NEWS
BARGAINS OF THE MONTH

TRAVELS FAST!

POLY PAKS® IS THE WORLD'S LARGEST ELECTRONIC DISCOUNT SUPERMARKET
NOV.77 RADIO ELECTRONICS SPECIALS

RCA High quality "POCKET" VOM
- 1000 ohms per volt

Model WV-539A. Features 1% precision, movements diode protected against burnout. Measures DC volts 0-15-150-1000; AC volts 0-15-150-1000; DC current 0-150ma; resistance X1000. Sensitivity 1000 ohms/volt AC-DC. Uses penlite cell, not included. Size 2⅜ x 3½ x 1¾". Wt. 5 ozs.
$8.88 ☐
Cat. No. 11R3921

3½ DIGIT OPEN FACE DPM
- Dual Range!
- 0-2V, 0-200mV

DIGITAL PANEL METER Kit

LOWEST PRICE ANYWHERE . . . others have 'em at $19.95. Displays DC voltage in 3½ digits, at 0.05% accuracy! Minus sign automatically displays negative input. High input impedance, 100 megohms. Uses the latest MOS-LSI circuitry, (7107), assembles in minutes. Automatic zeroing. Voltage range selectable by changing two components (both sets supplied). Complete kit with PC board, readouts, IC, & all other components. Less case. Requires ±5VDC. Size 3¼" x 2".

0.4" LED Digits!
$29.95

☐ Cat. No.	11R4041	DPM Kit Wt. 14 ozs.	$29.95
☐ Cat. No.	11R4042	DPM Wired	39.95
☐ Cat. No.	11R4038	7107 Chip	15.95

ECC INDUSTRIAL SPEED CONTROL
3 FOR $5.95
$16. ☐

A 880 Watt. Rated at 1200 watts. A very elaborate circuit for controlling many electrical and electronic devices. Easily controls speeds of electric drills, brush type motors, etc. Built with heavy duty aluminum framing. Complete with external pot, for variable speed control. Heavy duty colored wires for 115VAC 60 cycles, and item to be controlled. 10/32 mounting stud. Outperforms our previous sell-out. With hookup diagram. Use as temperature controller too. Wt. 2 lbs.
Cat. No. 11R3292

$5.50 TV GAME & HI-FI JOY STICK
- Includes four 100K pots

For TV & computer games, and quadrophonic balancing! 1½ x 1½ x 1". With 1" handle. Wt. 6 ozs.
Cat. No.11R3808

Attention 2 meter FM HAMS! Phone from your mobile or portable rig. Kit Includes: Chinmerics touch tone pad, Motorola MC-14410 chip, & all components necessary, with PC board. 1 mHz crystal. Wt. 8 ozs. Cat. No. 9R3385

TOUCH-TONE ENCODER KIT $22.50
Buy 'em separately

☐ 11R3382	Touch Tone IC MC14410P	$6.95
☐ 11R3149	12-Key "feather touch Keyboard	6.88
☐ 11R3635	1.00 MHz Crystal	5.95
☐ 11R3383	Autopatch PC Board	2.95

POLY PAKS "CHIPS" AWAY IC PRICES!
Order Cat. No. 11R4048 and Type No.

Type		Sale
☐ ICM7205	Stopwatch	$14.95
☐ AY3-8500-1	Six TV Games	9.95
☐ MM5330	4½ Digit DVM	4.95
☐ 8038C	Volt Control Osc	4.95
☐ KR2376	Encoder ROM BCD	6.95
☐ 9SH90DC	350 MHz Prescaler	6.88
☐ MC14410	Touch Tone Encoder	9.95
☐ MK2002P	Char. Gen. (2513 equal)	3.95
☐ 7207A/7208	Frequency Counter, pair	29.95
☐ ICM7107	3½ Digit DPM	12.50
☐ MM5316	Alarm Clock	2.95
☐ 8080A	Microprocessor	14.95
☐ 1702A	Erasable PROM	4.95
☐ 2708	8K EPROM	22.88
☐ 2102-1	1K RAM	1.39

- 115 VAC fan-cooled motor
- Slides easily into modular cabinet.

J. C. PENNEY'S
8-Track TAPE TRANSPORT
$12.95 ☐
- Shielded preamp

Excellent replacement or design your own quality tape system! Automatic or manual track selection with program indicator lights. Player shuts off automatically when tape is removed. Built-in low-distortion preamp and wow free motor. With input & output cables. Requires external power supply. With instructions. Size 9 x 6 x 3¼". Wt. 4 lbs. Cat. No.11R3010

DIP Switches
Reg. $1.69 ea.
Your Choice $1.00

Cat. No.	Switches
☐ 11R3668	2
☐ 11R3669	3
☐ 11R3021	4
☐ 11R3670	5
☐ 11R3671	6
☐ 11R2677	7

We've sold 'em as high as $2.98 each. You can mix them when you buy. All SPST, fits 14-pin DIP socket. Wt. 1-oz.

69¢ EACH 6 for $2.50
SPECTROL "SKINNY-TRIMS"

¾" square. Screwdriver shaft, 20% tolerance, ½ watt. Cermet construction. PC leads. Order by Cat. No. and Value. *Available in all types **Available in Cat. No. 9A3883 only.

OHMS			
☐ 10	**	☐ 50	**
☐ 20	**	☐ 100	*
☐ 50	*	☐ 200	*
☐ 500	*		
☐ 1K	*		
☐ 2K	*		
☐ 5K	*		
☐ 10K	*		
☐ 20K	*		
☐ 50K	**		
☐ 100K	**		
☐ 200K	**		
☐ 500K	**		
☐ 1 Meg	**		

☐ 11R3863 25 Turn upright, type 64
☐ 11R3864 25 Turn flat, type 64
☐ 11R3866 Single turn flat, type 63

Upright / Flat

"CB" POWER SUPPLY
☐ 3 AMPS $16.88
☐ 4 AMPS $19.95

- Completely wired
- 12 VDC @ 3 Amps output
- Regulated, continuous duty

Ideal for CB's, Ham rigs, tape decks & more! Modern cabinet, 5 x 4½ x 2¼". With on/off switch, LED lamp, built-in circuit breaker. 115 VAC 60 Hz. Wt. 5 lbs. Cat. No.11R3452

ECC INDUSTRIAL 5 GIGAHERTZ MICROWAVE POWER TRANSISTOR
☐ Cat. No. 11R4011 $5.95

HAMS take note! High frequency, high power NPN, stud mount TO-128 case. Perfect for UHF and microwave communications gear. ⅝" dia. epoxy case, ½" gold plated leads and 1-32 stud for heat sinking. Rated 30W, 1Hz 26-260, Ic max 500 mils, power dissipation 5 watts. Two emitter leads. Type SD1043. 2 ozs.

- Great for Light Shows, Strobes, Light Displays, Slide Projector!
- Works many times our asking price.
- Wide angle focusing lens!

5 IN 1 PROJECT-ALL SLIDE PROJECTORS 12.50 ☐

U.S. maker. Originally designed as a slide projector. Some may be modified for projecting a bar of light quality 3 lens condensing system. Requires standard 100 watt projection bulb. 35mm slides can be inserted and removed manually. Heavy duty bakelite case, grey hammertone finish. Design your own low cost light show. Use a Xenon flash tube and make a strobe light. Many other uses too numerous to mention. Size 11 x 5½ x 4½". Wt. 5 lbs. Cat. No. 11R3870

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TEST 'EM YOURSELF 'N SAVE!
EXCLUSIVE GUARANTEED 50% YIELD ON UNTESTED.....

Buy 10 BARREL KITS AND CHOOSE THE 11TH KIT Free

BARREL KIT #203 CALCULATOR KEYBOARDS
10 for $1.98
It's true! 20-key, 4 function keyboards at ridiculous give-away. Wt. 12 ozs.
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100's of AC power used Heavy-duty, 6-ft. long, 18 gage. White vinyl insulation & molded plug. Wt. 8 ozs. Cat. No. 11R3843

BARREL KIT #200 6 DIGIT READOUT MODULES
5 for $1.98
Barrels and barrels and no time to test. Calculator and driver chips beneath epoxy on back. Wt. 6 ozs.11R3515

BARREL KIT #244 HOBBY 1702A ROMS
3 for $1.98
Hobby fallouts of the famous eraseable programmable ROM. 2048 bit.
Cat. No. 11R3729

BARREL KIT #264 PRE-CUT'N'TINNED HOOKUP WIRE
200 lengths* $1.98
Breadboarders note. #22 wire, precut into 4" to 8" lengths. Asst. color plastic jackets. Wt. 12 ozs. *200 pc. approx.
No. 11R3989

BARREL KIT #230 SHIELDED CABLE
40-ft. $1.98
For mikes, stereos: 1-cond. plus shield, 22 ga. vinyl jacket. Wt. 1 lb.
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BRIDGES! KIT #170
20 for $1.98
We bot 2 tons of 4, 10 and 25 amp full wave bridges. How many we don't know. Untested hobby. Wt. 9 ozs. No. 11R4022

BARREL KIT #225 SOUND TRIGGERS
3 for $1.98
"Hand clap" sensitized crystal mike amplifier, triggers SCR. Use for alarms, etc! Wt. 6 ozs. No. 11R3625

BARREL KIT #221 IC SOCKETS
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Mfr unloadal Four 14-pin, four 18-pin. Solder tail, lo-profile. No. 11R3621

BARREL KIT #205 MINI BLOCK CAPACITORS
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Unbelievable! Worth $50 high precision submini caps for all applications. Wt. 3 ozs. No. 11R3528

BARREL KIT #201 6V INDICATORS w/leads
15 for $1.98
Test lamp manufacturer dumps inventory! Worth 69¢ ea. Like grain-o-wheat. Cat. No. 11R3526 hobby

BARREL KIT #194 10 AMP INLINE BRIDGES
20 for $1.98
Factory dumped in barrels. We can't test 'em, but for the price you can't go wrong. Hobby. Wt. 8 ozs.
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BARREL KIT #192 NYLON GEARS
40 for $1.98
Wide variety of sizes 1" to 3". Ream for the mechanical gear train hobbyists. Wt. 10 ozs. No. 11R3427

BARREL KIT #218 400 PARTS
$1.98
Includes resistors, caps, diodes, IC's, for hobby work, some on PC boards. Dumped into barrels by factories. 100% material. Wt. 12 ozs.
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BARREL KIT #184 ¼-WATT METAL FILM
150 for $1.98
100% metal film resistors. Long leads. 11R3413

BARREL KIT #162 JUMBO RED LEDS
15 for $1.98
100% material, user cancellation from factory dumps, 3V 10 mils. For 100's of projects, red lens.
Cat. No.11R3369

BARREL KIT #163 MINI TRIM POTS
30 for 1 oz. $1.98
Asst. values 100 to 1 meg What a buy. Single turn. ¼ W. Wt. 6 oz. 11R3345

BARREL KIT #160 HOBBY VOLTAGE REGULATORS
10 for $1.98
LM-309K TO-3 barreled, but by the pound, but who wants to check 'em? Your gain. Wt. 20 ozs.11R3330

BARREL KIT #138 PANEL SWITCHES
30 for $1.98 9 ozs.
Did you hear of OAK? Another eqpt maker barrelled all types of rotaries, electric, slides, etc. 11R3268

BARREL KIT #128 MINI-DIP IC'S
100 for $1.98
741's, LM380, 703, 567, 555, who knows? Factory mixed, you test. Untested and hobby. Wt. 1 lb.
Cat. No. 11R3245

BARREL KIT #127 AXIAL ELECTROS
40 for $1.98
Asst. capacities and voltages. Cat. No. 11R3227

BARREL KIT #126 UPRIGHT ELECTROS
40 for $1.98
1mf to 300mf in mixture of voltages. 100% marked 'n good. 11R3226

BARREL KIT #115 MOLEX SOCKETS
100% good
150 for $1.98 Cat.No.11R3144
Calculator maker dump! We got a zillion of 'em.

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Wide asst. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat.No.11R3136

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10 for $1.98
Cat.No.11R3057

BARREL KIT #101 RESISTOR SPECIAL
200 for $1.98
Includes: ⅛, ¼, ½, 1, 2-watters, carbon, 5% oz. 100% good.11R3054

BARREL KIT #99 PHOTO ELECTRIC CELLS
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Asst. GE types, CDS types. Mixed by factory. Big job for us to separate. 100% good. Cat.No.11R3052

BARREL KIT #98 HALF WATTERS
200 for $1.98
Resistor factory hired to tout us by mixing 100% color-coded resistors in barrel. But value is there. 4 oz.11R1046 Untested

BARREL KIT #87 NAT. IC BONANZA
100 for $1.98
Hobby and untested, factory mixed in barrels. Linears, 7400's, ROMS, DTL'S, registers, clock and calculator chips and more. Wt. 12 ozs.
Cat. No. 11R2860

BARREL KIT #86 HOBBY LEDS
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WOW! Top U.S.A. maker dumps discretes in barrels. Hobby and untested. Usable yield 50% or better! Wt. 4 ozs. Cat. No.11R2859

BARREL KIT #83 LM-340T VOLTAGE REGULATORS
15 for $1.98
Factory rejects, hobby, cosmetic rejects. May include 5, 6, 12, 15, 18 or 24 volts, TO-220 power tab. Wt. 4 ozs. Cat.11R2635

BARREL KIT #71 CAPACITOR SPECIAL
100 pcs. $1.98
micas, moldeds, plastics, ceramics, discs, etc. Nifty 100% good Cat.No.11R2738

BARREL KIT #68 2 WATTERS
100 for $1.98 100% good.
Suppliers throw 'em in the barrel. It's a lil' gold mine. All marked Cat.No.11R2735

BARREL KIT #61 POLYSTYRENE CAPS
100 for $1.98
Finest caps made. An gambler we bought 10 barrels from factory, mixed values: all good. Cat.No.11R2729

BARREL KIT #58 SLIDE SWITCHES
30 for $1.98
All shapes, sizes, spdt, momentaries, etc. Tremendous shop pak for 100's of switching projects. Cat.No.11R2726 100% good

BARREL KIT #39 HOBBY NPN POWER TRANSISTORS
15 for $1.98
Factory fallouts and "off spec" TO-3 powers. 100% hobby, no opens, no shorts. Wt. 1 lb. Cat. No.11R2617

BARREL KIT #31 METALLIC RESISTORS
100 for $1.98
Made mostly by Corning, the finest resistor made. Mostly ½ watters. 1% to 5% tol. & a barrel of values. Cat. No. 11R2609

BARREL KIT #30 PREFORMED RESISTORS
200 for $1.98
We got barrels of ¼ and ½ watters for PC use. 100, ¼, 100 ½ watters. No.11R2608 100% good

BARREL KIT #27 PREFORMED DISCS
150 for $1.98
Hi-Fi mfr's shelf inventory but he dumped 'em in barrels. Preformed, for PC use. Mixed values too! 11R2605

BARREL KIT #26 PLASTIC TRANSISTORS
100 for $1.98
Untested and hobby translators. TO-92 (TO-18), asst. 2N numbers, asst. manufacturers. Wt. 8 ozs.11R2604

BARREL KIT #20 LONG LEAD DISCS
100 for $1.98
auction sale! Primemarked only. Long leads Cat. 11R2598 100% good

BARREL KIT #19 DIPPED MYLARS
60 for $1.98
Finest capacitors made, shiny finish. Imagine factory dumping 'em in barrels. Cat.No.11R2597 100% good

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200 for $1.98
Marked and unmarked ¼, ½, 2 watts. No 11R2428

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30 for $1.98 100% good
Singles, duals, variety of values, styles, big ones — small ones. Cat. 11R2421

BARREL KIT #3 1N4148/914 SWITCHING DIODES
100 for $1.98
Immense famous switching diodes at these prices! Cat.No.11R2418 Untested

BARREL KIT #1 SN7400 DIP IC'S
75 for $1.98
Marked 14 and 16 pin dips, may include gates, flip-flops, registers, counters, who knows? Untested, hobby. Wt. 14 ozs. 11R2415

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And Equinox 100™ 4K memory kits ($109). Assembled 8K memory boards ($188). EQU/ATE™ editor/assembler and BASIC-EQ™ software on cassettes.

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32-2102.1 fully buffered, 16 address lines, on board decoding for any 4 of 64 pages, standard 44 pin buss.

EXPANDABLE F8 CPU BOARD KIT
$99.00

featuring Fairbug PSU.1K-of static ram, RS 232 interface, documentation, 64 BYTE register

4K BASIC FOR FAIRBUG F8
on paper tape $25.00

C/MOS (DIODE CLAMPED)

74C10	.22	4012	.22	4023	.22	4042	.78
74C193	1.50	4013	.40	4024	.75	4046	2.25
4001	.22	4015	.95	4025	.22	4049	.40
4002	.22	4016	.40	4027	.40	4050	.40
4006	1.20	4017	1.05	4028	.88	4055	1.50
4007	.22	4018	1.00	4029	1.10	4066	.80
4009	.42	4019	.25	4030	.22	4071	.27
4010	.42	4020	1.05	4033	1.50	4076	1.05
4011	.22	4022	.95	4035	1.10		

WSU-30 Hand wire wrap tool used to wrap, unwrap & strip # 30 wire $5.30

#24, EIGHT CONDUCTOR SPECTRA FLAT CABLE 10'/$1.50 100'/$13.50

DIP SOCKETS

8 PIN .22 24 PIN .40
14 PIN .25 28 PIN .50
16 PIN .28 40 PIN .60
18 PIN .30

#30 WIRE WRAP WIRE SINGLE STRAND 100'/$1.40

2708 8K EPROM	$20.95
2522 STATIC SHIFT REG	$ 1.95
2513 CHARACTER GEN	$ 9.95
2518 HEX 32 BIT SR	$ 2.50
2102.1 1024 BT RAM	$ .99
2107B	$ 3.50
MK4008P	$ 1.95
5280 4K DYNAMIC RAM	$ 4.75
1101A-256 BIT RAM	$ .75
MM5203 UV PROM	$ 6.95
1702A UV PROM	$ 4.95
5204 4K PROM	$10.95
82S23	$ 1.95
AY-5-1013 UART	$ 6.95
LIGHT ACTIVATED SCR's TO 18 200V 1A	$ 1.10
IN 4148 (IN914)	15 $1.00
MCA 81 OPTICAL LIMIT SWITCH	$1.50

LED READOUTS

FND 359 C.C. .4"	$ .50	DL-704-.3" C.C.	$ .95
FND 70 C.C. .4"	$ .55	MAN-7 .3" C.A.	$ .95
FND 503 C.C. .5"	$ .85	NS 33-3 dig. array	$ .75
FND 510 C.A. .5"	$ .85	DL 747 C.A. .6"	$1.95

PRINTED CIRCUIT BOARD

4.1 2"x6.1 2" SINGLE SIDED EPOXY BOARD 1.16" thick, unetched $.60 ea. 5/$2.60

7 WATT LD-65 LASER DIODE IR $8.95

2N 3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646	$ .45
ER 900 TRIGGER DIODES	4 $1.00
2N 6028 PROG UJT	$ .65

MINIATURE MULTI TURN TRIM POTS 100, 500, 1K,2K,5K,10K,25K,50K,100K, 200K,500K 1 Meg. $.75 each. 3/$2.00

CCD202-100X 100 charge coupled device image sensor $145.00

VERIPAX PC BOARD

This board is a 1/16" single sided paper epoxy board. 4" x6 1/2" DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16, or LSI DIP IC's with busses for power supply connector. $4.00

MV 5691 YELLOW-GREEN BIPOLAR LED	$ .90
FP 100 PHOTO TRANS	$ .50
RED, YELLOW, GREEN or AMBER LARGE LED's	6/$1.00
1L-5 (MCT-2)	$ .75
MOLEX PINS	100/$1.00
	1000/$8.00
10 WATT ZENERS 3.9, 4.7, 5.6, 8.2, 12,15,18,22,100,150 or 200V ea.	$ .60
1 WATT ZENERS 4.7, 5.6,10, 12, 15 18 or 22V ea.	$ .25
MC6860 MODEM CHIP	$9.95

Silicon Power Rectifiers

PRV	1A	3A	12A	50A	125A
100	.06	.14	.30	.80	3.70
200	.07	.20	.35	1.15	4.25
400	.09	.25	.50	1.40	6.50
600	.11	.30	.70	1.80	8.50
800	.15	.35	.90	2.30	10.50
1000	.20	.45	1.10	2.75	12.50

SILICON SOLAR CELLS

2¼" diameter .4V at 500 ma. $4.00

REGULATORS

309K	$ .95	340K-5,12,15	
723	$ .50	or 24V	$ .85
LM 376	$ .60	340T-5, 6, 8, 12	
320K-5 or 15V	$1.40	15,18 or 24V	$1.10
320T-5, 15		78 MG	$1.35
or 24V	$ .85	79 MG	$1.35

RS232		DB 25P male	$2.95
CONNECTORS		DB 25S female	$3.50

TRANSISTOR SPECIALS

2N3585 NPN Si TO-66	$ .95
2N3772 NPN Si TO-3	$ 1.60
2N1546 PNP GE TO-3	$ .75
2N4908 PNP Si TO-3	$ 1.00
2N6056 NPN Si TO-3 Darlington	$ 1.70
2N5086 PNP Si TO-92	4/$ 1.00
2N4898 PNP TO-66	$ .60
2N404 PNP GE TO-5	5/$ 1.00
2N3919 NPN Si TO-3 RF	$ 1.50
MPSA 13 NPN Si TO-92	3/$ 1.00
2N3767 NPN Si TO-66	$ .70
2N2222 NPN Si TO-18	5/$ 1.00
2N3055 NPN Si TO-3	$ .70
2N3904 NPN Si TO-92	5/$ 1.00
2N3906 PNP Si TO-92	5/$ 1.00
2N5296 NPN Si TO-220	$ .50
2N6109 PNP Si TO-220	$ .55
2N3638 PNP Si TO-5	5/$ 1.00
2N651 / NPN TO-92 Si	3/$ 1.00

TTL IC SERIES

7400	.14	7445	.55	74151	.60
7401	.14	7446	.65	74153	.60
7402	.14	7447	.65	74154	.95
7403	.14	7448	.65	74155	.70
7404	.18	7450	.15	74157	.58
7405	.18	7472	.29	74161	.85
7406	.25	7473	.29	74163	.80
7407	.25	7474	.29	74164	.95
7408	.18	7475	.45	74165	.95
7409	.17	7476	.30	74173	1.20
7410	.14	7480	.35	74174	.95
7411	.20	7483	.62	74175	.82
7412	.20	7485	.87	74176	.75
7413	.39	7486	.30	74177	.75
7414	.63	7489	1.85	74180	.65
7416	.25	7490	.42	74181	1.90
7417	.25	7491	.58	74190	1.00
7420	.14	7492	.43	74191	1.00
7425	.25	7493	.45	74192	.83
7426	.22	7494	.70	74193	.83
7427	.25	7495	.65	74194	.85
7430	.14	7496	.65	74195	.52
7432	.25	74107	.28	74196	.86
7437	.21	74121	.33	74257	1.25
7438	.21	74123	.65	74279	.87
7440	.14	74125	.40	75324	1.75
7441	.70	74126	.40	75491	.50
7442	.40	74150	.90	75492	.50

M7001 ALARM CLOCK CHIP $5.75

MINIATURE DIP SWITCHES
CTS-206-4 Four SPST switches in one mini dip package $1.75
CTS-206-8 Eight SPST switches in a 16 pin dip package $2.20

5.8V SPST Miniature reed, relay normally open, 330 Ohm coil resistance $.75, 3 $2.00

ALCO MINIATURE TOGGLE SWITCHES
MTA 106 SPDT $1.20
MTA 206 DPDT $1.70

Full Wave Bridges

PRV	2A	6A	25A
100			1.30
200	.75	1.25	2.00
400	.95	1.50	3.00
600	1.20	1.75	4.00

SANKEN AUDIO POWER AMPS

Si 1010 G 10 WATTS	$ 7.95
Si 1020 G 20 WATTS	$15.95
Si 1050 G 50 WATTS	$27.95

TANTULUM CAPACITORS

22UF 35V	5/$1.00	10UF 10V	$ .25
47UF 35V	5/$1.00	22UF 25V	$ .40
68UF 35V	5/$1.00	15UF 35V	3/$1.00
1UF 35V	5/$1.00	30UF 6V	5/$1.00
2.2 UF 20V	5/$1.00	33 UF 15V	$ .40
3.3UF 35V	4/$1.00	47UF 20V	$ .35
4.7UF 15V	5/$1.00	68 UF 15V	$ .50
6.8UF 35V	4/$1.00		

74LS SERIES		74LS SERIES		LINEAR CIRCUITS	
74LS00	.26	74LS126	.65	LM 101	.75
74LS02	.26	74LS132	.80	LM 301 748	.31
74LS03	.26	74LS136	.39	LM307	.30
74LS04	.28	74LS138	.72	LM 308	.95
74LS05	.28	74LS139	.72	LM 311	.95
74LS08	.28	74LS151	.98	LM 318	1.35
74LS09	.28	74LS153	.93	LM 319	.95
74LS10	.26	74LS155	2.00	LM 324	1.05
74LS11	.26	74LS156	.95	LM 339	1.10
74LS13	.50	74LS157	.98	LM 358	1.40
74LS15	.28	74LS160	1.02	LM 370	1.15
74LS20	.26	74LS161	1.02	LM 377	2.50
74LS21	.26	74LS162	1.02	LM 380	.95
74LS22	.26	74LS163	1.02	LM 381	1.25
74LS26	.33	74LS168	1.10	LM 382	1.25
74LS27	.33	74LS169	1.10	LM 537	2.50
74LS30	.26	74LS170	1.72	LM 553	2.50
74LS32	.33	74LS173	1.39	LM 555	.44
74LS37	.37	74LS174	1.05	LM556	.85
74LS38	.37	74LS175	1.22	NE540L	2.75
74LS40	.27	74LS190	1.50	560	2.00
74LS42	.88	74LS191	1.50	565	1.10
74LS47	.79	74LS192	1.75	566	1.50
74LS51	.26	74LS193	1.75	567	1.50
74LS54	.26	74LS195	1.25	703	.90
74LS90	.95	74LS196	.99	709	.25
74LS73	.40	74LS197	.99	710	.35
74LS74	.40	74LS221	1.25	741C or V	.31
74LS76	.40	74LS257	1.35	747	.65
74LS90	.89	74LS258	1.38	LM 1310	2.50
74LS92	.85	74LS279	.75	1456	.95
74LS93	.85	74LS365	.66	1458	.60
74LS109	.43	74LS366	.66	CA3046	.75
74LS112	.43	74LS367	.66	3900	.49
74LS113	.43	74LS368	.66	8038CC	3.90
74LS114	.43	74LS390	2.20	UA791P5	1.95

TRIACS

PRV	1A	10A	25A
100	.40	.70	1.30
200	.70	1.10	1.75
400	1.10	1.60	2.60
600	1.70	2.30	3.60

SCR'S

	1.5A	6A	35A
	.40	.50	1.20
	.60	.70	1.60
	1.00	1.20	2.20
		1.50	3.00

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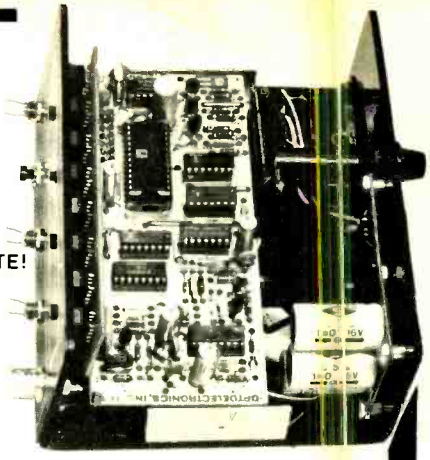
TAKE ADVANTAGE OF THIS NEW STATE-OF-THE-ART COUNTER FEATURING THE MANY BENEFITS OF CUSTOM LSI CIRCUITRY. THIS NEW TECHNOLOGY APPROACH TO INSTRUMENTATION YIELDS ENHANCED PERFORMANCE, SMALLER PHYSICAL SIZE, DRASTICALLY REDUCED POWER CONSUMPTION [PORTABLE BATTERY OPERATION IS NOW PRACTICAL], DEPENDABILITY, EASY ASSEMBLY AND REVOLUTIONARY LOWER PRICING!

KIT #FC-50C ..... 60 MHZ COUNTER WITH CABINET & P.S. ..... $119.95 COMPLETE!
KIT #PSL-650 ..... 650 MHZ PRESCALER [NOT SHOWN] 29.95
MODEL #FC-50WT ..... 60 MHZ COUNTER WIRED, TESTED & CAL. 165.95
MODEL #FC-50/600WT .. 600 MHZ COUNTER WIRED, TESTED & CAL. 199.95



SIZE:
3" High
6" Wide
5½" Deep

FEATURES AND SPECIFICATIONS:

DISPLAY: 8 RED LED DIGITS .4" CHARACTER HEIGHT
GATE TIMES: 1 SECOND AND 1/10 SECOND
PRESCALER WILL FIT INSIDE COUNTER CABINET
RESOLUTION: 1 HZ AT 1 SECOND, 10 HZ AT 1/10 SECOND.
FREQUENCY RANGE: 10 HZ TO 60 MHZ. [65 MHZ TYPICAL].
SENSITIVITY: 10 MV RMS TO 50 MHZ, 20 MV RMS TO 60 MHZ TYP.
INPUT IMPEDANCE: 1 MEGOHM AND 20 PF.
[DIODE PROTECTED INPUT FOR OVER VOLTAGE PROTECTION.]
ACCURACY: ± 1 PPM [± .0001%] AFTER CALIBRATION TYPICAL.
STABILITY: WITHIN 1 PPM PER HOUR AFTER WARM UP [.001% XTAL]
IC PACKAGE COUNT: 8 [ALL SOCKETED]
INTERNAL POWER SUPPLY: 5 V DC REGULATED.
INPUT POWER REQUIRED: 8-12 VDC OR 115 VAC AT 50/60 HZ.
POWER CONSUMPTION: 4 WATTS

KIT #FC-50C IS COMPLETE WITH PREDRILLED CHASSIS ALL HARDWARE AND STEP-BY-STEP INSTRUCTIONS. WIRED & TESTED UNITS ARE CALIBRATED AND GUARANTEED.

PLEXIGLAS CABINETS

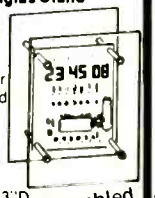
Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I 3"H,6¼"W,5½"D
CABINET II 2½"H,5"W,4"D
Black, White or Clear Cover $6.50 ea

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS 3"x6"x1/8" 95¢ ea. 4/$3

SEE THE WORKS Clock Kit Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr. time
- 3 set switches
- Plug transformer
- all parts included



Plexiglas is Pre-cut & drilled
Kit #850-4CP
Size: 6"H,4½"W,3"D
Assembled $23.50 ea. 2/$45. $29.95

60 HZ. XTAL TIME BASE

Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC. 1"x2" PC Board Power Req. 5-15V (2.5 MA. TYP.) Easy 3 wire hookup Accuracy: ± 2PPM
#TB-1 (Adjustable)
Complete Kit $4.95
Wir & Cal $9.95

SPECIAL PRICING!

PRIME - HIGH SPEED RAM
21L02-3 400 NS
LOW POWER - FACTORY FRESH

1-24	$1.75 ea.	100-199	$1.45 ea.
25-99	1.60 ea.	200-999	1.39 ea.
1000 AND OVER			$1.29 ea.

6-DIGIT LED CLOCK CALENDAR KIT

DATE-TIME-SNOOZE ALARM & MORE... KIT 7001

FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM, SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

KIT - 7001B WITH 6 - .5" DIGITS $39.95
KIT - 7001C WITH 4 - .6" DIGITS & 2 - .3" DIGITS FOR SECONDS $42.95
KIT - 7001X WITH 6 - .6" DIGITS $45.95

KITS ARE COMPLETE (LESS CABINET)
ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

JUMBO DIGIT CLOCK

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC 12/24 Hr. time, PC Boards, Transformer, Line Cord, Switches and all Parts. Ideal Fit in Cabinet II

Kit #5314-5 $19.95 2/$38.

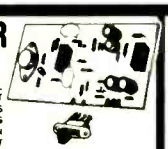
JUMBO DIGIT CONVERSTION KIT $9.95 ea.

Convert small digit LED clock to large .5" displays. Kit includes 6 - LEDs, Multiplex PC Board & Hook up info.
Kit #JD-1CC For Common Cathode
Kit #JD-1CA For Common Anode

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout.

Specify for 7001 **B, C or X - $7.95**

AUTO BURGLAR ALARM KIT



AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND. KEYLESS ALARM HAS PROVISION FOR POS & GROUNDING SWITCHES OR SENSORS. WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN. KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH. REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED. CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED

KIT #ALR-1 $9.95
#ALR-1WT WIRED & TESTED $19.95

VARIABLE REGULATED 1 AMP POWER SUPPLY KIT

- VARIABLE FROM 4 to 14V
- SHORT CIRCUIT PROOF
- 723 IC REGULATOR
- 2N3055 PASS TRANSISTOR
- CURRENT LIMITING AT 1 Amp

KIT IS COMPLETE INCLUDING DRILLED & SOLDER PLATED FIBERGLASS PC BOARD AND ALL PARTS (Less TRANSFORMER) KIT #PS-01 $8.95

TRANSFORMER 24V CT will provide 300MA at 12V and 1 Amp at 5V. $3.50

MOBILE LED CLOCK

12/24 HR .4" DIGITS!

MODEL #2001 — 12 VOLT AC or DC POWERED

- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY [Use When Key Off in Car, Etc.]
- TOP QUALITY PC BOARDS & COMPONENTS - INSTRUCTIONS.
- MOUNTING BRACKET INCLUDED

KIT #2001 COMPLETE KIT $27.95 EA. 3 OR MORE $25.95 ea. 115 VAC Power Pack #AC-1 $2.50 Ea.

ASSEMBLED UNITS WIRED & TESTED ORDER #2001 WT [LESS 9V. BATTERY] Wired for 12-Hr. Op. if not otherwise specified. $37.95 EA. 3 OR MORE $35.95 ea.

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8K RAM BOARD

FULLY ASSEMBLED & TESTED, JUST PLUG IT IN - 64 21L02's (in sockets) ALTAIR & IMSAI 8080 COMPATIBLE, ON BOARD REGULATORS, FULLY BUFFERED

$189.95

WHO NEEDS A KIT? BUY IT, PLUG, & GO

IC SOCKETS

SOLDER TAIL TIN			
pins	ea.	10	100
8	25¢	22	18
14	25	22	18
16	27	23	20
24	50	45	36
28	80	75	68
40	99	94	89

WIRE WRAP TIN (3)			
pins	ea.	10	100
14	45	40	32
16	48	43	35
24	75	70	60

molex

500	$4.75	5K	$38
1K	8.50	10K	70
2K	16	50K	325

CARBON FILM RESISTORS

High quality .25W 5% All STANDARD VALUES FROM 2.7Ω to 2.2m STOCKED IN DEPTH

each	ten	hundred	thousand	100 minimum
10¢	40¢	$1.60	$14-	per value

no mix of values

RESISTOR ASSORTMENTS

LEADS TRIMMED FOR PRINTED CIRCUIT BOARD

200 ¼W 5% $2-

200 ½ 5% $2-

COUNTER DISPLAY KIT

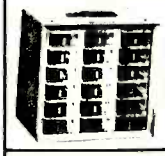
Ideal module for home built counter projects. Includes 7490 decade counter 7475 latch, 7447 driver, and RCA .6" NUMITRON display. PCB with plated thru hole and instructions supplied..... KITS SUPPLIED FROM ONE TO TEN DIGITS PER BOARD (all interconnects plated)..

$5.89 per digit

-SUPER SPECIALS-

74S206	DIP 256x1 45NS RAM	$ .90
93410	" " " "	.90
LM308AH	OP-AMP µpwr.	.90
µA776	" " PROGRAMMABLE	.90
78L05	TO92 .1A + REGULATOR	.30
78L12	" " "	.30
78L2.6	2.6V .1A positive	.30
MM5369	CRYSTAL OSC. TIME BASE	1.75
MM5058	1024 BIT STATIC S.R. MINI.	2.00
LM300	ADJUSTABLE REGULATOR	.60
LM723	" "	.50
747	DUAL OP-AMP	.50
ZENER	16V 1W on tape	.10
DIAC	27 VOLT TRIGGER DIODE	.20
CERAMIC FILTER	10.7 Mhz.	1.25
7812	TO-3 1amp REGULATOR	.69
78M05	TO220 .5A "	.69

RESISTOR ASSORTMENT with metal cabinet



100ea 1/4W 5%

3.9	6.8	12	18	27	39	
56	82	120	180	270	390	
560	820	1.2K	1.8K	2.7K	3.9K	
5.6K	8.2K	12K	18K	27K	39K	
56K	68K	100K	120K	180K	270K	
390K	560K	820K	1.2M	1.8M	2.7M	

$44.95

TV REPAIR INTEGRATED CIRCUITS

221-34	221-46	612007-1	$2.25 ea.
221-42	221-48	LM3089	10/ $20
221-45	221-62	LM2111	

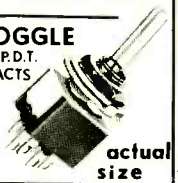
-SWITCHES-

RED PUSH BUTTON N.O. MOMENTARY CONTACT

30¢	each
8	$ 2
100	22
1000	195

actual size

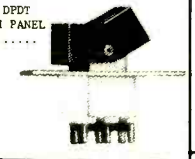
MINI MINI TOGGLE
EXTRA SMALL D.P.D.T.
3A 125VAC CONTACTS



each $1.50
8 — 10.
100 — 95.

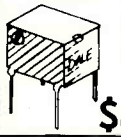
actual size

JBT MR1-223 5 AMP DPDT ROCKER SWITCH WITH PANEL MOUNTING HARDWARE.....



79¢ ea.
ten $6
$49/c

DIP TRIMMER



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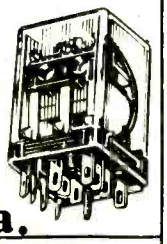

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150 Mhz Prescaler

Use your low frequency counter to measure VHF or UHF frequencies. This kit will divide the input signal by ten (10 or 100 with 650MHz option) Kit contains drilled circuit board, 2 MC10131 IC's, all parts needed and instructions.

150/170MHz KIT $12.95

650MHz option W/11C90 IC.....$29.95

-requires 5v at app. .2A. power supply and case are not part of kit---

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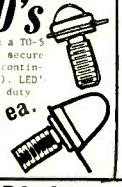
This family of LED's are mounted on a TO-5 header with a 6/32 threaded stud to secure to a heat sink.. TWO AMPERES max. continuous current rating (with heat sink). LED's can be pulsed at up to 25A with low duty cycle. Data supplied w/order.



ME2 Infra Red w/low lens
ME5 Infra Red w/high lens
MV4 Visible Red with low lens
MV4H Visible Red with high lens

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7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74177	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

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74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

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

HIGH SPEED

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

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4000A	.26	4018A	1.19	4066A	.89
4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
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4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
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4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		

74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
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CT5002	12 digit, 4 function fixed decimal battery operation — 40 pin	1.95
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MM5725	8 digit, 4 function, floating decimal 18 pin	1.98
MM5736	6 digit, 4 function, 9V battery operation — 18 pin	2.95
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation — 24 pin	3.95
MM5739	9 digit, 4 function, 9V battery operation — 22 pin	3.95

6 Digit Clock Kit

MM5314 with 6 NS71 .27" displays 2 P.C. boards — Display board may be remote. Internal or wall transformer can be used. 50-60 Hz, 12-24 hour. Includes all necessary transistors, resistors, capacitors, diodes, 3 switches and complete assembly instructions.

CK6-3 ..... **$14.95**

MM 5330 4½ DIGIT DVM LOGIC **$6.95**

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MM 5616 QUAD BI-LATERAL SWITCH **$1.25**

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Solder Tail - low profile

8 pin	$ .17	24 pin	.42
14 pin	.20	28 pin	.59
16 pin	.22	40 pin	.69
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372	AF-IF Strip Detector DIP	2.93
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1496	Balanced Modulator-Demodulator	.99
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ULN2208	FM Gain Block 34db (typ) mDIP	1.18
ULN2209	FM Gain Block 48db (typ) mDIP	1.35
2513	Character Generator 64x8x5 DIP-24	10.20
3046	Transistor Array DIP-14	.73

LINEAR CIRCUITS

300	$ .71	373	2.42	723	.62
301	.29	376	.68	733	.89
302	.53	380	1.30	739	1.07
304	.80	380-8	1.25	741	.32
305	.71	381	1.75	747	.71
307	.26	382	1.75	748	.35
308	.89	531	2.95	1458	.62
309k	1.35	540	2.95	1800	2.48
310	1.07	550	.79	3900	.49
311	.95	555	.45	7524	.71
319	1.13	556A	1.19	7525	.90
320T	1.39	560	3.39	8038	4.25
320k	1.39	562	3.39	8864	2.25
322	1.70	565	1.18	75150	1.75
324	1.52	566	1.95	75451	.35
339	1.58	567	1.95	75452	.35
340k	1.69	709	.26	75453	.35
340T	1.49	710	.35	75491	.71
372	2.93	711	.26	75492	.80

DISCRETE LED's

			EACH
ME4	INFRARED CLEAR DOME	.170"	.29
MV10B	CLEAR DOME	.170"	.25
MV50	CLEAR — AXIAL	.09"	.12
MV50	RED — AXIAL	.09"	.12
NSL100	RED	.19"	.12
RL209	RED DIFF. SUBMINIATURE	.12"	.12
RLT-T1-03	WHITE DIFF. SUBMINIATURE NO FLANGE	.124"	.15
RLC-200	RED DIFF. CURRENT REG. CONST. BRIGHTNESS 4.5-12.5V	.190"	.25
RLC-201	RED DIFF. CURRENT REG. CONST. BRIGHTNESS 4.5-	.190"	.25
RL-4403	RED DIFF. FULL FLOOD	.190"	.15
GREEN	SPOT	.190"	.18
CLEAR	POINT	.190"	.15

LEDs

			EA.
DL10A	RED CA	.27" LHD	$1.89
DL 707	RED CA	.30" RHD	1.49
DL 507	RED CA	.50" RHD	1.49
FND 359	RED CC	.375" RHD	.89
DL 702	RED CC	.30" LHD	1.39
NSN 74R	RED CC	.30" RHD	1.49
DL 500	RED CC	.50" RHD	1.49
MAN5	GREEN CA	.27" LHD	1.39
MAN8	YELLOW CA	.27" LHD	1.39
MAN82	YELLOW CA	.3" LHD	1.89
MAN66	RED CA	.6" LHD	2.19
DL747	RED CA	.6" LHD	2.39

DIGITAL

7416	.29
7427	.24
7437	.19
7454	.12
7493	.39
7495	.69
74145	.89
9602	.59
74C154	2.49

SPECIALS

MEMORIES

1101	$.69
1103	.69
1702A	5.95
5262	.99
74S200	3.25
82S23	2.75
93410	1.39

LED DISPLAYS

DLIOA	$1.49
NSN 74R	.99
FND 359	.59
MAN 72	.99
DL702	.99

MVIOB 6/$1.00
MV50 16/$1.00
556 .99
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2102 1024X1 STATIC RAM 16 PIN **$1.29**

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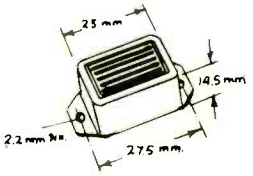

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EB-106	6V	15mA	4-9 VDC	$1.99
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			EACH
2502	1024 bit MULT DYN	16 pin	$2.95
2504	1024 bit MULT DYN	8 pin	2.95
2511	Tri-State Dual 50-100-200 bit STATIC	14 pin	2.95
2518	Hex 32-bit STATIC	16 pin	2.95
2519	Hex 40-bit STATIC	16 pin	2.95
2527	Dual 256 bit STATIC	8 pin	2.95
2532	Quad 80 bit STATIC	16 pin	3.95
5013	1024 bit accum. Dynamic	8 pin	1.75
5016	500/512 bit Dynamic	8 pin	1.59

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MCD2	Opto isolator diode	$1.19
MCT2	Opto isolator transistor	.79

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AY51013A **$6.95**

SP-425-09 9 digit .25" neon direct interface with MOS/LSI. 180 VDC, 7 seg. 1.79

MEMORIES

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1702A	2048 bit PROM-STATIC Elect. Programmable, UV Erasable 24 pin	9.95
2102	1024 bit Ram Static 16 pin	1.49
5203	2048 bit PROM-STATIC Elect. Programmable, UV Erasable 24 pin	9.95
5261	1024 bit RAM MOS Dynamic 16 pin	.99
5262	1024 bit RAM MOS Dynamic 22 pin	1.29

MM5369 Divider mDIP 2.49
Crystal 3.58 MHZ color TV 1.75
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4 Digit Clock Kit

MM5312 and 4 NS71 .27" displays 12-24 hours, 50-60 Hz. One P.C. board accommodates clock, displays, and all necessary transistors, resistors, capacitors, diodes, 2 switches, complete instructions and schematics for assembly.

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2.2 mfd	20V	.25	15 mfd	20V	.45
2.2 mfd	35V	.30	22 mfd	16V	.45
3.3 mfd	35V	.30	33 mfd	10V	.40
4.7 mfd	16V	.30	47 mfd	6V	.40
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Why you should buy a digital multimeter from the leader in digital multimeters.

If you're shopping for your first multimeter, or moving up to digital from analog, there are a few things you should know.

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Second, quality pays. Fluke is recognized as the leading maker of multimeters (among other things) with a 30-year heritage of quality, excellence and value that pays off for you in the 8020A.

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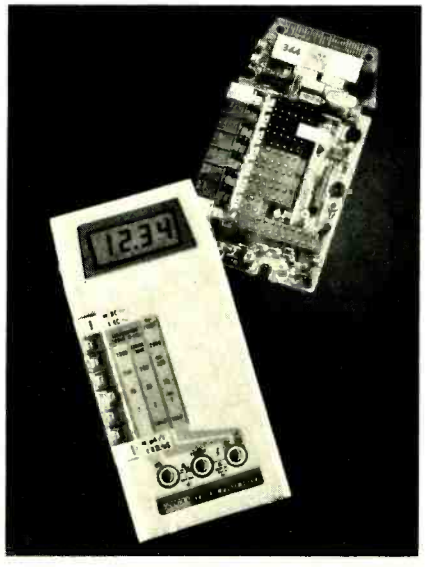

Why not analog? Because the 8020A has 0.25% dc accuracy, and that's *ten times better* than most analog meters.

Also, the 8020A's digital performance means things like 26 ranges and seven functions. And the tougher your home projects get, the more you need the 8020A's full-range versatility and accuracy. The 8020A has it; analog meters don't.

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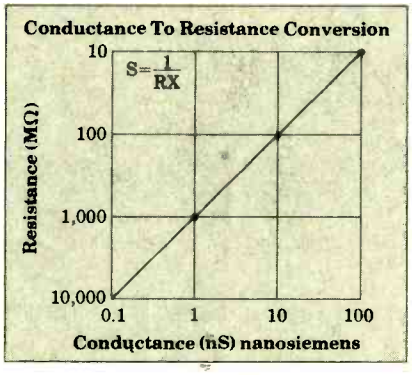
You already know Fluke. And you probably own a benchtop-model multimeter.

Now consider the 8020A: smaller in size, but just as big in capability. Like 2000-count resolution and high-low power ohms. Autozero and autopolarity. And the 8020A is MOV-protected to 6000V against hidden transients, and has overload protection to 300V ac.

Nanosiemens?



Beginner or pro, you'll find the meter you now have can't measure nanosiemens. So what? With the 8020A *conductance* function, you can measure the equivalent of 10,000 megohms in nanosiemens. Like capacitor, circuit board and insulation leakage. And, you can check transistor gain with a simple, homemade adapter. Only with the 8020A, a 13-oz. heavyweight that goes where you go, with confidence.

What price to pay.

$169.*

Of course, you can pay more. Or less. In fact, you could pay almost as much for equally compact but more simplistic meters, and get far less versatility. And, the 8020A gives you the 'plus' of custom CMOS LSI chip design, and a minimum number of parts (47 in all). All parts and service available at more than 100 Fluke service centers, worldwide. Guaranteed, for a full year.

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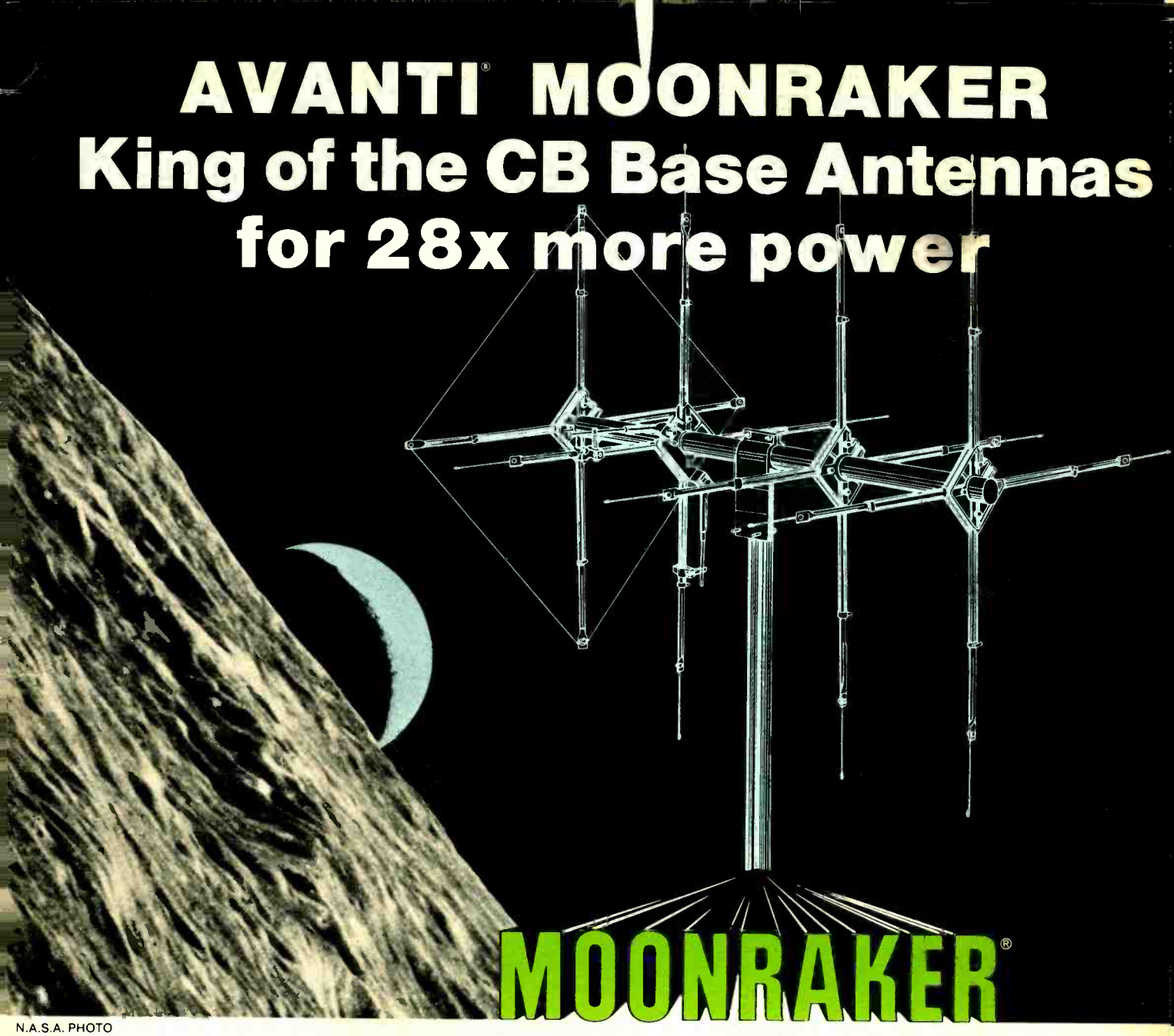


N.A.S.A. PHOTO

The AVANTI CO-INDUCTIVE™ principle makes the the Moonraker the ultimate in CB antennas.

The MOONRAKER Dual Polarity design follows that of the original Moonbounce antennas used to rebound signals off the moon.

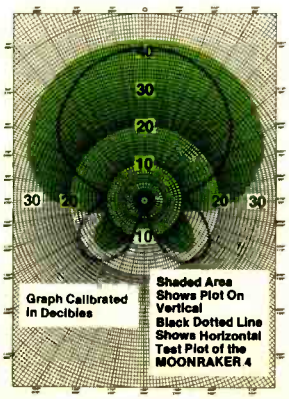
The close spacing of the elements increases coupling and signal excitation while the AVANTI P.D.L. reflector is the best available. AVANTI's co-inductive matches provide correct feeding impedance, improve power handling ability and eliminate coils which can detune or burn out.

The mechanical construction is typical of AVANTI's aerospace craftsmanship, using cast aluminum hubs, extrusions, and aircraft quality aluminum throughout.

A fine point: The ends of each dipole element are extended by the use of stainless steel wire, which decreases wind loading profile.

Each antenna comes with the new AVANTI switchbox which allows instant switching between vertical and horizontal modes.

AVANTI's switchbox makes contact before it breaks, therefore eliminating RF arcing and subsequent burnout or loss of efficiency.



WHY DUAL POLARITY? With the crowded channels these days, a vertical is needed to work mobiles and other verticals, but those in the know go to horizontal when they wish to quiet things down. The horizontal is especially valuable when you realize that most hash from automobiles, etc., is vertically polarized and can be quieted by about 25 db when operating horizontal.

SPECIFICATIONS FOR MOONRAKER — Model AV-140

Gain — 14.5 db over isotropic
Front to back separation — 38 db
VSWR — 1.2:1
Impedance — 50-52 ohms
Vertical to horizontal separation 25 db
Weight — 24 lbs.
Length — 16.5 ft.
Rotor required — medium to heavy duty
Power multiplication — 28x
Bandwidth — full 40 channel
Wind load (sq. ft.) of beams — 5 sq. ft.

Avanti makes a complete line of base and mobile CB antennas from $11.95 to $404.00.

avanti

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AVANTI RESEARCH AND DEVELOPMENT, INC., 340 Stewart Avenue, Addison, IL 60101

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