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Measuring just 11" wide x 11" deep x 5" high, and weighing a mere 7 pounds, the Altair™ 680b is a complete, general-purpose computer.

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The Altair 680b can be programmed from front panel switches, or it can be interfaced to a video display terminal, or teletype-writer. Three additional circuit boards can be plugged inside the Altair 680b for further memory and interface expansion. The first of these boards now under development is an 8K RAM memory board.

Software already developed includes a resident two pass assembler and 8K BASIC. The Altair 680b is also compatible with Motorola 6800 software.

The Altair 680b is ideal for hobbyists who want a powerful computer system at an economic price. Altair 680b owners qualify for membership in the Altair Users Group, and like other Altair owners, they receive a complimentary subscription to Computer Notes and complete factory support.

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SMALL ENOUGH FOR YOUR POCKET
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 anywhere 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—as a pager, an intercom, a telephone or even a security device.

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.

A MAJOR BREAKTHROUGH
The PocketCom's small size results from a breakthrough in the solid state device that made the pocket calculator a reality. Mega scientists took 112 transistors, integrated them on a single silicon wafer, and produced the world's first two-transistor integrated circuit. This major breakthrough not only reduced the size of radio components but improved their dependability and performance. A large and expensive walkie talkie costing several hundred dollars might have only 12 transistors compared to 112 in the PocketCom.

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, the unit will sound 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. 4) Harmonic distortion is so low that it far exceeds EIA (Electronic Industries Association) standards whereas most comparable systems don't even meet EIA specification. 5) The receiver has better than one microvolt sensitivity.

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.

MULTIPLEX INTERCOM
Many businesses can use the PocketCom as a multiplex intercom. Each employee carries a unit tuned to a different channel. A stronger 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 by JS&A by Mega Corporation. JS&A is America's largest supplier of space-age products and Mega Corporation is a leader in manufacture of two-transistor integrated circuit technology. The PocketCom is manufactured in factories in the United States.

The PocketCom measures approximately 3/4" x 1 1/2" x 5/8" and easily fits into your shirt pocket. The unit can be used as a personal communications link for business or pleasure.

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 Mega's prompt national service-by-mail center. It is just that easy.

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ON THE COVER
Mindpower: Alpha is no ordinary brainwave monitor. It displays the presence of alpha waves on a TV screen in either of two possible modes. Use it to train yourself to relax. To get started on this project turn to page 36.

WHAT! NO CLOCKS
Last month we reported that this issue would feature two construction projects—a countdown timer and a digital clock. We are sorry to report that both these projects experienced difficulty and we had to delay publication. The countdown timer will run in the August, 1976, issue and the digital clock will run in a near future issue.

As a service to readers, Radio-Electronics publishes available plans or information relating to newsworthy products, techniques and scientific and technological developments. Because of possible variances in the quality and condition of materials and workmanship used by readers, Radio-Electronics disclaims any responsibility for the sale and proper functioning of reader-built projects based upon or from plans or information published in this magazine.
New CB licenses

The FCC is now issuing temporary CB licenses to all transmitter purchasers, enabling them to go on the air immediately—and legally—right after the purchase. The temporary permit is supplied by the dealer at the time of purchase, and is good for 60 days from the date a permanent-license application is mailed to the FCC. The applicant derives his own temporary call sign, consisting of the letter K followed by the initials of his first and last names and his ZIP code.

By mid-April, the FCC was receiving an average of 500-000 CB license applications a month. The backlog of unopened mail at its Gettysburg, PA, license-processing center was about 2½ weeks and it was taking seven weeks from the time the application was mailed to Gettysburg to receipt of a permanent license.

30-inch color tube

The largest picture tube ever produced in quantity is the new giant Sony Trinitron direct-view color tube that measures 30-inches diagonally. The measurements of the picture are 21.1 x 27.2 inches or approximately 375 square inches in area, 82.5% larger than the 25-inch color tube (315 square-inches). The tube will be offered in Japan this fall in a television console at about $5,000 and in a monitor at approximately $3,000. Both units are designed for use with Sony's U-Matic and Betamax videocassette recorders. The tube may be offered in U.S.-market TV receivers later.

Old-timers will recall another 30-inch television set that hit the market a long time ago. This was the DuMont Royal Sovereign, introduced in 1951, sporting a giant 30-inch round black-and-white tube with a picture measuring around 550 square inches. Between 500 and 1,000 of these sets were sold before they were obsoleted by the 27-inch rectangular tube that briefly reigned as the largest "industry-standard" black-and-white picture tube.

VIR TV

A line of television receivers whose chroma and tint are adjusted by the TV station has been introduced by General Electric. The sets have a special circuit that makes automatic adjustments based on the standard color burst and chrominance elements of the vertical interval reference (VIR) signal which is rapidly becoming a standard feature of broadcast transmission.

The VIR signal has been approved by the FCC for insertion in line 19 of the blanking period between television frames. The signal contains references for luminance amplitude, black-level amplitude and sync amplitude as well as chrominance amplitude and color-burst amplitude and phase. At any point of origination—from videotape recorder to transmitter—the color, brightness and contrast of the picture is adjusted, and it's hoped that eventually all stations will make use of it. Adjustment at the station is usually manual, although automatic adjustment equipment is available from Tektronix.

The new G-E sets automatically track the color portions of the reference signal by means of a 5-in. x 5-in. circuit-board containing five specially developed IC's. A pilot light indicates when the VIR signal is present. The automatic correction may be overridden by a defeat switch. The special VIR feature is included in one 19-inch set designed to sell for about $550 and four 25-inch consoles in the $775- to $800 price range. The automatic circuitry adds an estimated $30 to $50 to the retail price. Although the VIR signal could also be used to automatically adjust the contrast-brightness ratio, G-E has decided that these settings should be left to the viewer's own preference.

Another new feature in G-E's 1977 line is the first 25-inch color-picture tube with in-line gun. The new tube has a standard dot-type mask (as opposed to the slot mask in most in-line tubes) with a new electron gun designed to provide a finer spot size, overcoming the major problem of in-line guns in large-size picture tubes.

CB expansion

The eagerly awaited expansion of the 27-MHz Class-D Citizens band has been postponed again, as reported here last month. The FCC says it could come by January 1—although some veteran FCC-watchers caution against expecting anything before next April. The hold-up in expansion is an investigation of interference problems—particularly intermodulation (IM). The FCC stressed that expansion in the current 27-MHz band is only an interim step to relieve the immediate problem of congestion, and that it is studying "long-term needs of the public for personal radio communications." It's generally believed that the ultimate home for personal radio will be further upstream in the spectrum, possibly around 600 MHz.

The Commission has already started on the first of 250 or so initial video programs. RCA President Anthony Conrad estimates that marketing of player and discs will start on a regional basis some time between mid and late 1977.

Philips and its subsidiary Magnavox are quieter about their plans, but they seem to be headed for a 1977 introduction date as well. RCA DiscVision is now in the process of mastering the forerunners of an anticipated 1,000 initial programs on 30-minute optical discs for the Philips player.

David Lachenerbruch
Contribution Editor
**FEATURES**

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**IF YOU WANT TO BRANCH OUT INTO THE TV TUNER REPAIR BUSINESS, WRITE TO THE BLOOMINGTON HEADQUARTERS ABOUT A FRANCHISE.**

Circle 2 on reader service card
Two Bell scientists honored for semiconductor research

William G. Pfann and Henry C. Theurer have been named by the American Physical Society as the winners of the Society's International Prize for New Materials. The prize is awarded for outstanding achievement in research and carries a $2,500 award for each recipient. The two Bell scientists were cited "for their outstanding work on the development of methods for purifying semiconductors and growing epitaxial crystals from the vapor phase. This effort has been of vital importance in the growth of semiconductor technology."

Mr. Pfann invented the zone refining method (Radio-Electronics, December 1972, page 36) to make the ultra-pure germanium that made the first transistors possible. Mr. Theurer invented the floating zone refining method that improved ordinary zone refining and eliminated the need for a crucible. It was used to make ultra-pure silicon, the basic material for field-effect transistors and for most of the transistors used today. Theurer also invented a process for preparing ultra-pure silicon tetrachloride, which Bell Labs used to make the first successful epitaxial crystals for transistors. These developments were all quickly adopted by the semiconductor industry and since then have been extended to other fields.

Vertical interval test signal for automatic color correction

With the anchoring of VIRS (Vertical Interval (Color) Reference Signal) on line 19 by the FCC, a completely automatic color television receiver becomes possible. Although some manufacturers insist they can regulate chroma, color sync and luminance signals in their receivers without recourse to outside signals, others are enthusiastic about the proposed new approach.

Bill Quinn, manager at General Electric, Portsmouth, VA, says “Broadcasting VIRS offers an excellent tool for the receiver manufacturers, networks and local broadcast stations to ensure that the customer receives and maintains a picture of the quality seen by the studio camera.”

According to Quinn, to make VIRS work in TV receivers, the circuitry must locate and identify line 19; gate out the black-reference and white-reference levels, chroma and burst; correlate the amplitude of the 3.58-MHz chroma in the luminance part of the signal and luminance reference to insure the proper relationship between luminance and chroma; establish the black level for the picture-tube cutoff; and correct differentially the phase errors between the chrominance reference and the corresponding frequency in the receiver-regenerated subcarrier.

One drawback is that the FCC has not yet made it mandatory to broadcast the VIRS, though manufacturers tend to believe it will become a federal regulation.

Footstep detector patented

Two Honeywell engineers have invented a seismic human footstep detector to be used in intruder alarms. Vibration and sound detectors have been used in intrusion alarms in the past, but have had the weakness that they would respond to many other signals than human footsteps.

According to Patent 3,992,663, issued to Roger A. Lubke and Charles P. Varecka and assigned to Honeywell, Inc., the human footstep does not normally exceed 250 milliseconds in duration and successive footsteps occur within a period of less than 1.6 seconds. With this basic data, the device is able to determine whether the vibrations—picked up by a geophone—are human footsteps or not. If they fit the specifications, an alarm is sounded.

Newest transatlantic cable carries 4,000 conversations

Second step in the laying of the world's largest capacity transatlantic cable began early last spring when the Bell System's cable ship Long Lines began to lay the deep-sea portion of the cable. The work began last August when the French cabinet of the French cable ship Vercors, that has plowed under—in a trench about two feet deep—the parts of the transatlantic cable that lie in shallow water on the continental shelves off the U.S.A. and France.

Cable ship Vercors plowed under the shallow-water portions, burying 111 nautical miles of cable between the Rhode Island shore and the edge of the continental shelf. It then laid a similar section off the French coast. The cable was buried about two feet deep with the special plow, designed by Bell Laboratories, that forms part of the equipment of the Vercors. This prevents damage from fishing vessels or anchoring ships.

The entire cable system, called TAT-6, will extend 3,379 nautical miles (3,891 land miles) from Green Hill, Rhode Island, to the French coastal towns of St. Hilaire. It will be able to carry 4,000 telephone conversations simultaneously—more than twice the capacity of any transatlantic cable now in service—and will also carry data, telex and other forms of communications.

Repeaters, each weighing more than 600 pounds, spaced every 5.1 nautical miles (roughly every 6 miles) along the cable will amplify the signals so that they will arrive at their destination with approximately the same strength they started with.

The system was developed as a joint engineering project by groups from the British Post Office, the French Ministry for Posts and Telecommunications and AT&T.

Cable-TV companies in struggle against pirate program tappers

Hundreds of thousands of homes in the United States are connected illegally to local cable-TV distribution systems, says the president of a national cable-TV company. These free riders are enjoying their programs at the expense of the viewers who do pay, and endangering the very existence of some of the companies by denying them revenues they would receive if the free-riders paid for the services they are receiving.

The recent expansion of Pay-TV has aggravated the situation by increasing the incentive to rob the cable. The companies costs have also increased by the fees they have to pay to transmit the programs, and these costs must be paid back in customer rental fees if the companies are to survive.

Some cable companies use special security forces to track down illegal connections. In Manhattan, for example, Teleprompter Corp. employs a force of 30 persons to trap thieves who tap into apartment building connection boxes. The security system is paying for itself—Teleprompter reports that 25 percent of the persons disconnected decide to pay for the service.

On another front, prosecutions are being initiated against concerns that sell the converters that change the shortwave transmissions from the cable companies to an unused local VHF channel. State
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laws are also coming into play against cable pirates. More than a dozen states have passed theft-of-service laws—some of which provide jail sentences as well as fines. In Wilmington, DE, several members of the local police force were found enjoying cable-TV without pay. A number of converters stolen from the local cable company had been recovered by one of the officers, who turned in a number and gave the rest to his friends. He was indicted on 10 criminal charges.

Most severe sentence reported so far was a 45-day jail sentence imposed on an illion, NY, man who connected his girlfriend's TV set to the local cable.

In spite of the partial successes against the pirates, there are still a number of difficulties including the uncertainty of the legality of making and selling converters that can be used for illegal purposes only, and the fact that perfectly legal equipment can in some cases be used to receive such signals. The struggle is crucial according to the cable companies, and on its success may depend the future expansion of cable TV—particularly pay-TV, the viewers of which tripled in number last year from 160,000 to more than a million.

Maritime satellite provides instant ship-shore radio ties

MARISAT, the world's first commercial telecommunications satellite was launched into synchronous orbit over the equator at 15 degrees West longitude. Its twin was launched into orbit over the Pacific at 176 degrees East longitude. The satellites will provide "a new clear voice for ships." Ship captains have in the past waited as long as 8 to 20 hours for messages by ordinary shortwave radio, troubled as it is by severe fading, interference, atmospherics and propagation difficulties.

The new satellite technique assures instant communication by voice, telex, facsimile and data communications, both for the international merchant marine and the U.S. Navy. Three channels are provided, one in the UHF range for the Navy and two in the gigahertz region—L-band for merchant vessels and C-band between shore stations and the satellite.

Lighter weight, lower costs in new Zenith picture tube

Zenith has demonstrated to TV manufacturers a new 19-inch color tube expected to reduce cost as well as weight. The tube has a unique slot-type shadow-mask assembly two pounds lighter than previous masks. It is made by multi-stage mask forming dies to achieve a self-supporting mask that eliminates the conventional mask frame and can be inserted with automatic equipment.

Another weight-reducing concept is a "skirtless" faceplate panel that eliminates the heavy molded glass flanges of current tubes. The new faceplate panel, with an unground seal edge, can be joined easily with a newly designed funnel shaped for maximum strength.

The new tube has a deflection angle of 100 degrees, a small neck in-line high resolution gun and a smaller spot. It is 2.5 inches shorter than older 19-inch Zenith picture tubes.

Two CB stations silenced

Val G. Hodges of York, PA, was fined $200 and received a suspended 60-day sentence, and James R. Laden of Anchorage, AK, lost his license for violation of FCC regulations.

Hodges was operating a mobile without a license. He was tracked down by direction-finding equipment, which made the final positive identification of his operation from a vehicle in violation of a previous cease and desist order. Six pieces of radio transmitting equipment, including two illegal linear amplifiers, were seized.

Laden (KHO-4585) was found guilty of transmitting communications to another station on a frequency reserved for in-transit communication, for failing to identify his station, and of refusing to permit an inspection of his station by FCC personnel. His conduct, the judge stated, was further aggravated by "misrepresentation" and lack of the truthfulness and candor required to qualify to be or remain an FCC licensee.
NEW 3½ Digit Multimeter from B&K-PRECISION

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Circle 4 on reader service card
letters

ASCII TO BAUDOT

I would like to call attention to two important corrections that were omitted from the "ASCII To Baudot" article (R-E, March 1976).

First: In Table 1, word 31, Bell should be removed and replace with a Null, and no bits should be shown programmed. The code as shown is the same as letter "S".

Second: On the schematic diagram (Fig. 1), pin 3 of IC2-a should be shown connected to pin 15 (not 11) of IC7. We must detect a change in bit 6 instead of bit 7 or else a CR or LF will shift us to LETTERS with no way to output FIGURES.

Printed-circuit boards from Southwest Technical Products are correct. It should also be pointed out that the kit of all parts includes the PC board.

ROGER L. SMITH

TI CALCULATORS

Many of your readers probably have the SR-52 or SR-51 calculators which are manufactured by Texas Instruments, Inc. Both of these calculators have fully addressable memories which are accessible from the keyboard that are not mentioned in the respective owner's manuals.

For the SR-51, memories 1, 2, 3, 4, 5, 6, 7, 8, and 9 are available. Care should be exercised in using memories 4-9 since they are used during various calculations, chiefly for linear regression.

On the SR-52, memories 60-69 are the operational registers and are directly accessible from the keyboard. With care, some of these registers can be used for data storage—depending on the number of pending operations required. Registers 70-79 are used for program storage. Each of the registers 70-97 corresponds to 8 programming steps, i.e. register 70 corresponds to program steps 000-007. If all programming steps are not required, registers 70-97 are available for data storage.

Care must be exercised in using registers 70-97 for data storage since these registers can be written over when loading a program from magnetic cards. Registers 98 and 99 are also available on the SR-52. These registers are not destroyed by loading magnetic cards, internal operations, etc. Registers 60-69 are cleared by pressing the CLR key. Registers 70-99 can be cleared by storing 0 in them or overwriting them with new data.

Access to the memories on the SR-51 is provided by following STO or RCL by the numbers 1-9. Memories on the SR-52 are accessed by STO or RCL followed by the appropriate two digit number. It should be noted that register arithmetic can be done in any of the registers mentioned for the SR-52.

It should be re-emphasized that extreme care must be taken to avoid losing data stored in these memory registers. With proper precautions the capabilities of both of these calculators is greatly enhanced.

I read your magazine every month and find it very interesting. Keep up the good work!

THOMAS S. COX
Greenville, SC

MICROCOMPUTER/TV INTERFACE

I can't understand it!! There are so many computer hobbyists without any I/O. And yet we can find no circuit that will take our 8 bit output and put it on our TV screen.

There are many TV typewriters, TV games and TV graphics (most in the range of $160-$300). Where is the circuit (inexpensive) that will accept 8-bits of x, y, brightness (whatever the TV will need) and convert it to video for my portable TV?

My 6800 is waiting as are many others! This circuit would be more versatile than a dedicated TV typewriter or game.

Let the computer owner build it to fit into his system to accommodate his needs. Let him decide on where the memory shall reside.

There is a need!!!! See what you can do!!!!

PAUL HYDE JR.
Milwaukee, WI

We agree. There is a definite need for an inexpensive project of this kind. If any of our readers have any ideas, circuits, etc., please forward them. We are interested.—Editor

LOW-FREQUENCY METER

Ever since the calculator on a chip came out a few years ago, I've been waiting for someone to come out with a kit for a high-accuracy low-frequency meter. Using a crystal-controlled time-base, it would count the number of crystal oscillations between input pulses. The calculator chip would then divide this number into an appropriate constant to obtain the display output. For example, with a 1-MHz time-base and a 60-Hz input, the counter would count to 16,666. This could be entered into the calculator as 16,666 ms. Then dividing 16,666 into 1,000 (the constant for hertz output), the meter (digital display of course) would display 60.00. With a .01% crystal, this reading is approximately ± .01 Hz. To obtain RPM, the constant would be 60,000 and the display would read 3600 RPM.

The uses for low-frequency meters are quite extensive: tachometers, tuning meters,

(continued on page 16)
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LETTERS
(continued from page 14)

Another instrument, measuring a heart beat or even setting a mechanical tape by measuring the time between ticks. In the case of heart beat or ticks of a clock, the meter might be arranged to take an average over four or five or more input pulses. The meter would still be faster and more accurate than meters that use long pulse counting periods or pulse insertion methods.

Now the processor on a chip is available at quite reasonable prices, and it seems this device would make simper the implementation of the meter.

If such a kit already exists, I would appreciate knowing about it. If not, it might be a good idea for a construction project for your magazine.

DOUGLAS GORGEN
Apt. 202-A
548 W. Johnson St.
Madison, WI 53703

IC BREADBOARD
Enclosed you will find a photograph of my finished IC Breadboard Prototyping system (R-E, February 1975 issue). After 5 months of construction and wiring and all, I finally finished it. I changed several things from the suggested layout but I tried to stick with the general format of your article.

Some innovations I put in were: a built-in 3" speaker on the bottom of the cabinet and a pair of terminals (banana jacks) on rear panel for a scope—these jacks are interconnected to pin jacks to left of breadboarding socket through a rotary switch to make testing circuit conditions much easier. I added an external position to the voltmeter in the meter section and I included an AM/FM modulation type generator using two XR205's enabling me to have 2 separate signals if I choose. There are +5 and +12 volt pin outs too.

I priced the nearest thing to what I had constructed and it cost well over $1400 and it fell way short of the capabilities of my system. I think this system is worth close to $2000 and it only cost me about $180. That's a bargain. Keep up the fine projects.

DONALD MAHARAS
Everett, WA

CALCULATOR/STOPWATCH
Regarding the article on Build a Calculator/Stopwatch (R-E, November, 1975 and February, 1976) I had a National Semiconductor model 600 calculator which had the right components to attempt the conversion, so I decided to attempt it.

The parts were procured for the added circuit and put together. When wiring the circuit I found that the driver IC was wired entirely different than the one shown in the article. After figuring out the correct combination of which driver went to which digit (new pin numbers are shown in circles on diagram), I wired in the Stopwatch unit and it worked fine. I adjusted it to within .33 seconds in 2 minutes.

Fine, but when I went to use the calculator I found that when entering 8 from the keyboard, a zero was automatically displayed and also stored in the register. This caused some head scratching since all other functions of the calculator performed normally. Through some consultation with local engineers, it was decided to try breaking the foil from pin 1 of the 5736 IC to the keyboard and connect the keyboard side to pin 14 of the driver IC. After accomplishing this, the calculator worked properly (including the 8) and the stopwatch ran fine.

Maybe other readers have run into this same problem and have wondered what to do. Also, since I could not find a source for the MC14571, I used a N4061 which seems to be an exact replacement. (MC14571 was a Motorola developmental type number. The production type number is MC14081. The RCA equivalent is CD4081.—Editor)

I enjoy your magazine very much—keep up the good work.

BILL WAINES
Regulation of cable-TV rates now being checked by FCC

The Federal Communications Commission has ordered an inquiry into the process by which cable-TV subscription rates are regulated. At present, most of these rates are set by the municipalities in which the cable systems are located.

The FCC reported that the inquiry does not indicate any immediate intended change in the present system of largely local regulation. One of the reasons suggested for the investigation was concern by some cable companies over what they considered "unreasonable delays" in considering requests for rate increases.

Circularty polarized antennas improve TV pictures

Results of an extensive FCC-authorized test of circularly polarized TV antennas were reported to the recent NAB convention in Chicago by Peter K. Onnigian of Jampro Antenna Co.

The test results, Mr. Onnigian reported, indicate that TV pictures on home receivers are "significantly improved" when the signal is transmitted with a circularly polarized antenna. Ghosts are eliminated while snow and signal fading are reduced.

The tests were carried out at TV Station KLOC-UHF in Modesto, California. Test results have been submitted to the FCC for analysis. Jampro has had long experience in designing and manufacturing circularly polarized FM broadcast antennas.

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R-E

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And even though you need an oscilloscope to perform their experiments, they don't provide it. You have to buy your own. And their course does not even include a Digital Computer-Trainer. The closest thing to our program they offer costs over $200 more than ours. Another school's course in Electronics Technology offers even fewer lessons, and kits to build only a VOM. That's all. Think it over, and check it out, course by course, program by program. There's no comparison.

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DAVID LARSEN, PETER RONY,
and JOHN TITUS

This month we will discuss the 8080 microprocessor. Will cover the 8080's hardware architecture and in a future column we will discuss its instruction set and programming characteristics. This should provide us with enough information to begin discussing various programming techniques illustrated with examples using the 8080.

Background
The 8080 microprocessor was introduced by Intel Corporation in late 1973. It is a direct descendant of the Intel 8008

and it was developed to provide additional features and corrections to limitations imposed on the 8008 by process and packaging constraints. The 8080 is an 8-bit parallel microcomputer central processing unit, manufactured on a single integrated circuit using an n-channel MOS process. It has a basic machine cycle time of 500 ns, with instruction execution times ranging from 4 to 18 machine cycles (2 $\mu$s to 9 $\mu$s). The 8080 requires an external two-phase clock and power supplies of +5, +12, and -12, all referenced to ground.

The 8080 must be supported by various peripheral circuits if it is to be made into a useful system. This interface is accomplished using an 8-bit data bus, a 16-bit address bus, and ten timing and control signals (six outputs and four inputs). The bus structure and control signals allow the 8080 to be interfaced to a wide variety of memory and I/O devices. All outputs and inputs (except for the clocks) are capable of directly interfacing one TTL load. In addition, the address and data busses are both three-state. This provides for bi-directional data transfers using the normal high or low states. The third is a high impedance "floating" state that permits multiple devices to be wired in parallel to the bus.

Architecture
A block diagram of the 8080's basic architecture is shown in Fig. 1. With the
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Circle 100 on reader service card
except for its internal register file and separate address and data buses, the architecture is fairly conventional. From a user standpoint, the areas that are of most interest to us are the registers, memory addressing modes, instruction set and basic timing and control sequences. These are the features that have the most effect on how we will be able to use the processor in practical systems.

**Registers**

The 8080 provides an interesting internal register structure. The user accessible registers are organized into three 16-bit general-purpose registers (BC, DE, and HL), a 16-bit stack pointer (SP), a 16-bit program counter (PC), and an eight-bit accumulator. There are also five processor flags that are treated together as a register by certain instructions.

The three 16-bit general-purpose registers are designed so that they can also be used as six independent 8-bit registers for a number of operations. The internal organization of the 8080 makes this feature significant. The 8080 uses an 8-bit word (byte) as its basic memory data elements. However, it addresses memory with a 16-bit memory address. To do this, the 8080 is effectively divided internally into an eight-bit “data side” and a 16-bit “address side”. Now, one of the most important measure of any computer's flexibility is (continued on page 87)

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JULY 1976

Circle 8 on reader service card
A novel battery-monitoring circuit from Intersil plus new releases from RCA and Motorola

KARL SAVON
SEMI CONDUCTOR EDITOR

EVERY TIME IN A WHILE I SEE A CIRCUIT so free of nuances that its simplicity is a joy to behold. Intersil’s ICM7201 is nothing much more than a Schmitt trigger that is adaptable to the majority of rechargeable battery powered equipment. It is a four-terminal circuit mounted in a TO-72 can.

The circuit in Fig. 1 will sense the charge-level of a 3-cell series-connected nickel-cadmium battery pack. The battery voltage is applied directly across pins 1 and 4. When the battery voltage falls below a preset threshold, pin 3 is switched to ground by turn-on of Q4. Design center trigger points of the circuit are 2.9 and 3.1 volts. The 0.2-volt hysteresis between the two voltages is the noise margin that prevents the output indicator from flashing intermittently, or being only partially energized as the voltage reaches one of the trigger points. The collector of Q4 can be connected to trigger an audible alarm with extra parts, but the simplest hookup is to an LED that will light at the lowered voltage as the batteries become depleted.

The fully charged voltage of a single cell Ni-Cad is 1.3 adding up to 3.9 volts for the three. When the rated ampere-hour capacity has been drained from the cell its voltage drops to 1.1 volts at the 10-hour discharge rate. A voltage of 2.9 for three cells, or .967 volt for one, is the cutoff voltage at some higher discharge rate. There is no easy way to determine the ampere-hour capacity between the fully-charged and cutoff points. The voltage discharge characteristic is nearly flat until it nears full discharge.

Connecting the batteries to the 7201 first turns on transistors Q3 and Q4 as pin 1 quickly rises and passes through 2V+, (about 1.2 volts). The conduction path is through R4, the base-to-emitter of Q3, R7, and the base-to-emitter of Q4. Q2 is still off and does not divert any current. Above this point pin 2 sees the 0.6-volt Q4 junction through R6 and ground through R5. Voltage divider R1, R2, R3, drops V+ by a ratio less than one: A = R3/(R1 + R2 + R3). When A times V+ minus the Vce of Q2 exceeds BVA where B = R5/(R5 + R6), Q2 turns on. This is set up to be the 3.1-volt point, which is still below the voltage of a partially charged 3-cell battery pack. Q2 now conducts current and its collector begins to fall below V+, reducing the current in Q3. Q3 had been supplying a portion of the current in R5. As it turns off, Q2 must pick up the extra current, further dropping its collector voltage. The action continues in regenerative fashion until Q3 is turned off. Q4 goes off at the same time and the circuit is in the "charged battery" state. Q2 and Q3 are the conventional Schmitt trigger circuit. Both devices are in a non-inverting DC loop. Q2 operates as a grounded-base DC amplifier and Q3 as an emitter follower. The loss of the contributing emitter current of Q3 accounts for the circuit hysteresis, voltage lag before the circuit will switch back when the battery voltage drops 0.2 volt.

What has happened is the emitter of Q2 previously saw a voltage higher than ground, B+, through the Thevenin equivalent parallel resistance of R5 and R6. Now with Q2 on and Q3 off, the emitter of Q2 sees a lower voltage, namely ground, through R5 alone. AV+, the base voltage of Q2, must now drop below one Vce before Q2 starts turning off and the loop becomes regenerative in the reversed sense.

Putting it into numbers, at 3.1 volts: VcesA = Vce = VceB or B = 4.17 A.

(continued on page 28)
Logic Probe 1 is a compact, enormously versatile design, test and troubleshooting tool for all types of digital applications. By simply connecting the clip leads to the circuit's power supply, setting a switch to the proper logic family and touching the probe tip to the node under test, you get an instant picture of circuit conditions.

LP-1's unique circuitry—which combines the functions of level detector, pulse detector, pulse stretcher and memory—makes one-shot, low-rep-rate, narrow pulses—nearly impossible to see, even with a fast scope—easily detectable and visible. HI LED indicates logic "1", LO LED, logic "0", and all pulse transitions—positive and negative as narrow as 50 nanoseconds—are stretched to ½ second and displayed on the PULSE LED.

By setting the PULSE/MEMORY switch to MEMORY, single-shot events as well as low-rep-rate events can be stored indefinitely.

While high-frequency (5-10MHz) signals cause the "pulse" LED to blink at a 3Hz rate, there is an additional indication with unsymmetrical pulses: with duty cycles of less than 30%, the LO LED will light, while duty cycles over 70% will light the HI LED.

In all modes, high input impedance (100k) virtually eliminates loading problems, and impedance is constant for all states. LP-1 also features over-voltage and reverse-polarity protection. Housed in a rugged, high-impact plastic case with strain-relieved power cables, it's built to provide reliable day-in, day-out service for years to come.

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CONTINENTAL SPECIALTIES CORPORATION
FORUM 758
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Circle 9 on reader service card
STATE OF SOLID STATE
(continued from page 26)

From the 2.9 volt point: A = 2.9 = 0.6,
A = 0.207 and B = 4.17 x 0.207 = 0.862,
giving a feel for what these resistor ratios
have to be. A more complete analysis
would include the effects of base currents
and the exact points at which the loop
gain is high enough to be regenerative.
Pin 2 is a test point that is pulled down
through diode-connected Q1 to simulate
a reduced battery voltage on the Q2 base
divider. If the sensing circuit is working
properly it will switch and turn on Q4,
activating the low-battery alarm.

RCA's gold chip
RCA has announced a tri-metal pro-
cecess, similar to Bell Telephone Labs
beam-lead construction. Changes have
been made so the RCA method is simpler
and more cost-effective for plastic DIP's.

Tri-metal is short for Silicon Nitride
Passivated Tri-metal. Conventional inte-
grated circuits use a layer of aluminum,
evaporated on the chip surface, to inter-
connect all the devices, thereby wiring the
circuit. Moisture may leak in where the
leads penetrate the plastic package or it
can seep through the plastic material it-
self. Insulating layers of aluminum oxides
and hydroxides form, creating open cir-
cuits, which cause malfunction. There are
other failure mechanisms besides this

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2305 Basstationen
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In the USA this means: "The new Handic
2305 Base Station is a spectacular performer!"

- Built-in "Priority Channel" can be switched on so that a pre-
selected channel (i.e. Emergency CH-9) will override any other
channel being used.
- Full 23-CH operation on 110VAC or
12VDC.
- Selectivity — 90dB at ±10kHz.
- Sensitivity — 0.5µV
at 10dB S/N.
- Built-in PA Facility.
- Automatic Gain Control.
- Automatic Noise Limiter Switch.
- Selective Call Facility.
- Built-in SWR Bridge and Illuminated S/F Meter.
- Complete with "Mic", AC cable, crystals for 23-Chan.'s, jacks for Selective
Call, external speaker, PA speaker and hand-held telephone.

Send for FREE Catalog!

Two new IC's, CA741CG and CA741G,
electrolytic corrosion. "Purple plague" is
a compound that forms at high tempera-
tures between the dissimilar gold bond
wire and aluminum metallization. The
junction becomes brittle and may eventu-
ally break open. Electromigration is the
physical movement of metal at high tem-
perature and current densities above
10A/cm². The surface of an IC is a series
of hills and valleys over which the alumi-
um is evaporated. Poor step coverage is
a common problem that will produce
creaks where the metal is thin, high con-
tact resistance, and high current density
areas.

Figure 2 shows the IC surface after
fabrication by the Gold Chip process. Up
to the final silicon nitride and metalliza-
tion steps, circuit production is the same
as the aluminum metallization process.
The similar procedure makes cost differ-
ences minimal and the circuits will be sold
at the same price as the standard versions.
After completing device diffusions end-
ing with an SiO₂ layer, a silicon nitride
layer hermetically seals all device junc-
tions (continued on page 89)
Crown Overlay Glass 19" CRT
EIA recommended to protect against dangerous X-radiation

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J-6
The Quad combines the best of the Quad & Yagi designs giving one of the best performing lightweight lightweight antennas on the market. Uses a Quad Reflector and Yagi driven element.

ANGLE OF RADIATION

The Quad Reflector assures the angle of radiation even at low heights for real long-distance performance.

FRONT TO BACK

The Quad Reflector gives an excellent front to back ratio of 25-30 dB along with a forward gain of 10-5 dB.

DUAL POLARITY

This feature gives considerable improvement in the following types of communications:

A. Maximum transmission to either base or mobile stations.
B. Mobiles indoors are invariably vertically polarized antennas. Switching to the vertical mode of the Y-Quad allows effective common situations with these mobiles.
C. Base to base transmissions are more effective using horizontal polarization.

Gain 5.5 dB
Front to back ratio 25-30 dB
Gain length radials

Mobile types of communications' combines one and gives eliminates the four full antennas on the market.

ALPHA V58

5/8 Wave Ground Plane

The Alpha V58 is a full 5/8 wave ground plane with four full size radials, using a loop for loading which eliminates the need for a coil that could easily burn out. The use of DC ground reduces the static noise and gives a cleaner received signal.

Gain 5.14 dB
4 full length radials
Loop loading
1.1 to 1 SWR
No need to tune out
Will handle 250 watts
Weight 21 lbs.
New radial feed design

ALPHA V1

5/8 Wave Ground Plane

Without Radials

Our V1 a 5/8 wave vertical ground plane without radials

It's the perfect antenna, compact and small to 1414 to have in portable equipment. It's built & finished for your lifetime enjoyment. It comes in as many as 5 minutes after arrival of your camping gear.

Gain 5.9 dB
Horizontal
Load feeding
1.25 to 1.5 SWR
Has ability to tune out
With weights 3.5 lbs.
Weight 23 lbs.

WILSON ELECTRONICS' SUPER LASER 500

THE MOST POWERFUL AND DIRECTIVE CB ANTENNA IN THE WORLD

40 FT. BOOM - WORLD'S LONGEST

500 WATTS EFFECTIVE MULTIPLIED POWER

The Super Laser's tremendous Gain and Directivity, with the first direction of unwired signal, will enable you to hear as far as distances that lackies would no longer be visible in the direction of transmission. Your standard CB rig will develop an effective power of 500 watts, and the proposed signal will pass in head and ears.

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"They'll have to... You've got no choice!"

You've seen advertisements telling of the magic of antennas. Now, hear the Real Story of CB Antenna

1. World's largest boom - 4300 watts
2. World's most powerful - 800 watts of Effective Multiplied Power
3. World's most directive- unbreakable
4. World's best 5/8 Wave & Side Reception - Initial 50 dB
5. World's most rugged construction - special aircraft aluminum

And the list continues on...

Ask one of the WB at Wilson Electronics what he

ELECTRICAL

Gain 18 dB
Full Band 
600 MHz to 50 MHz
Side Band
up to 50 MHz
Semi
1.3 to 1.2 in the ratio
Horiz or Vertical Power
2 KW

Shed of the Super Laser, and its screen will be "FAN TASTIC!" That's what we describe this antenna.

The unique method of gain and directivity of the Super Laser will take CB transmission a new level. Despite the highest gain and lowest SWR of any antenna, the Super Laser has the best SWR and Side Reception. Its special design makes it possible to achieve the highest performance and to provide an EVALUATED 500Watts of Multiplied Power.

The Super Laser is available in 1600 watts, 2000 watts, and 2500 watts. It is available in a variety of colors and styles to suit your individual needs. The Super Laser is available in a variety of colors and styles to suit your individual needs.

MECHANICAL

Boom 40 ft. 3" OD aluminum Elements, 5/8" od aircraft tubing Antenna Weight 70 lbs. Quad Reflector for improved Gain & F/B New Fiberglass Spreaders

Wilson Electronics Corp.

SHOOTING STAR

With dual antenna you can reach to socials and search the bowels of loud stations and still be able to talk to the lowest and fastest stations in传来 and eliminate interference back as 25 dB.

Gain 14.5 dB
SWR 1.3 to 1. Two Impedance 50 52 Ohms
Power Handling Capabilities 2000 watts
Front to Back Ratio 30 dB
Vertical Horizontal Separation 29 dB
Weight 79 lbs.
Boom 20 ft.
Recommended Rotor CD44 or Harn II
Fiberglass Spreaders

With dual antenna you can reach to socials and search the bowels of loud stations and still be able to talk to the lowest and fastest stations in传来 and eliminate interference back as 25 dB.

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With dual antenna you can reach to socials and search the bowels of loud stations and still be able to talk to the lowest and fastest stations in传来 and eliminate interference back as 25 dB.
Wilson Electronics Corp.

NEW LONG BOOM
12 ELEMENT LASER BEAM

31 FT. BOOM
400 WATTS EFFECTIVE POWER

The new 12 Element Laser has been expanded to achieve the maximum forward gain and flight to back ratio covering a wide range of installations. This is achieved by the unique use of a Quad Parasitic and Yagi Parasitic elements. These are six elements horizontal and six elements vertical, scientifically spaced, on a new 31 ft. boom. The 12 Element Laser has been wired and proven. It is second only to the Super Laser 300. The same top quality aircraft aluminum that has made Wilson Electronics famous, is used in the new 12 Element Laser.

MECHANICAL SPECIFICATIONS
- Boom Length: 31 ft.
- Longest Element: 17 ft.
- Element Material: Aircraft type aluminum
- Element Spacing: 14 gauge copper stranded
- Weight: 40 lbs.
- Recommended Remote: Type III

ELECTRICAL SPECIFICATIONS
- Gain: 19 db
- Front to back ratio: 15-20 db
- Side Radiation: up to 35 db
- Maximum Vertical Radiation: 3000 watts
- Maximum Horizontal Radiation: 2000 watts
- Gain, 10.5 db
- SWR: 1.3:1 or 30 MHz
- Fr. polarisation, SWR: 1.3:1 or 30 MHz
- Rejection: 40 dB or 5-watt power transfer
- Full Compression: 2.0 kw
- Vertical polarization: 53 db or 450 watts
- Horizontal polarization: 25 db or 300 watts
- Medium: 1.0 kw
- Quality: 2.5 kw
- Heavy: 3.0 kw

MECHANICAL VQ2
- MECHANICAL SPECIFICATIONS
  - Boom Length: 31 ft.
  - Longest Element: 17 ft.
  - Element Material: Aircraft type aluminum
  - Element Spacing: 14 gauge copper stranded
  - Weight: 40 lbs.
  - Recommended Remote: Type III

ELECTRICAL SPECIFICATIONS
- Gain: 19 db
- Front to back ratio: 15-20 db
- Side Radiation: up to 35 db
- Maximum Vertical Radiation: 3000 watts
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- Gain, 10.5 db
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- Medium: 1.0 kw
- Quality: 2.5 kw
- Heavy: 3.0 kw

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Circle 11 on reader service card
Selecting Station

Selecting the best possible is a difficult choice, and specifications that

Getting maximum range from CB equipment is a never-ending quest for many operators. With maximum legal power output limited to 4 watts, the only way a CB'er can be assured of maximum communications range is to use the most efficient base antenna installation he can afford.

This means selecting the antenna that is best for typical operating conditions and then installing it within the limits set by the FCC. The factors to be considered are antenna polarization, vertical radiation angle, directivity and gain.

Perhaps one of the first things that anyone should consider in connection with 2-way communications antennas is based on the principal of reciprocity. In effect, this states that polarization, gain, directivity, radiation angle and all other characteristics are the same whether the antenna is transmitting or receiving.

Polarization

When power is fed to a transmitting antenna, it radiates magnetic and electric fields that are at right angles to each other. The electric (or electrostatic) field components are always—at least as far as CB antennas are concerned—in the same plane as the radiator. Thus, a vertical antenna such as a mobile whip or vertically oriented Yagi will radiate a vertically polarized signal. Similarly, an antenna with elements parallel to the earth radiates a horizontally polarized signal. (As an example, TV and FM antennas in the U.S. are horizontally polarized. However, recent announcements indicate that the U.S. TV standard may be changed to circular polarization to minimize aircraft-flutter, ignition interference and other problems.)

For the most reliable contacts between two CB stations using ground-wave communications—as intended by the FCC—both should use antennas with the same polarization. An antenna with one type of polarization will still pick up signals of the opposite polarization but with much lower efficiency. Usually, cross-polarization results in a signal loss of around 20 dB—3 to 4 "S" units on your receiver. Generally, base antennas are vertically polarized to provide the best communications to and from mobile units that use vertical whips.

Vertical Radiators

The basic vertically polarized CB antenna is the quarter-wavelength ground-plane type. It consists of a one-quarter wavelength radiator cut from aluminum or copper tubing (one-quarter wavelength is approximately 108 inches at 27 MHz) and a ground plane composed of three or four quarter-wavelength radials mounted horizontally at the base of the radiator. The radiator and ground plane are insulated from each other and used as the connecting points for the coaxial feed line as shown in Fig. 1.

The feed-point impedance is generally between 25 and 35 ohms. Most CB transceivers are designed to match 50- to 52-ohm antenna systems so some means must be provided to raise the feed-point impedance to 50 ohms to match the coaxial transmission line.

Fig. 2—Drooping Radials raise antenna feed-point impedance to 50 ohms to match the coaxial transmission line.

In free-space where proximity to earth does not affect feed-point impedance—the pattern resembles a doughnut as in Fig. 3. In practical applications, a quarter cross-section of a ground-plane radiation pattern is shown in Fig. 5-a. The

FIG. 1—DIAGRAM OF A TYPICAL GROUND-PLANE. Some have three radials.
antenna to fit your needs
Here's a rundown of the factors should be considered

The quarter-wavelength ground-plane antenna is generally inexpensive and has a relatively high angle of radiation—an appreciable amount of power is radiated at an angle of about 50 degrees above the horizon. It is the standard or basis for comparing the performance of all other vertically polarized antennas. Its gain is unity or 0 dB.

Gain vertical antennas
An antenna is not an amplifier so it cannot radiate more power than is fed to it by the transmitter. Thus, a CB antenna cannot legally radiate more than 4 watts. However, a gain-type antenna can provide nearly 4 dB gain (2.5 times the power) over a quarter-wave type by concentrating the radiated energy at a lower and more useful angle. This is accomplished by lengthening the radiator. Figures 5-b and 5-c compare the vertical radiation patterns of half-wave and five-eighths wavelength radiators to the quarter-wave ground-plane. Figure 6 shows these patterns superimposed on a representation of the earth’s surface to show the effective gain and coverage of each type.

The five-eighths wavelength antenna provides the greatest gain. As length is increased beyond five-eighths wavelength, the energy in the low-angle lobe drops drastically and much of the power is radiated at around 80 degrees.

The basic half-wave vertical has a gain of approximately 1.8 dB over a ground-plane. It does not require radials in most installations but some designs use short radials as a part of the impedance-matching system and to decouple the coax shield from the field of the antenna. (Coax shielding that absorbs energy from the antenna is a common cause of TVI and RF feedback in the CB shack.)

Figure 7 shows two common methods of connecting the low-impedance coax feedline to a half-wave base-fed radiator. Fig. 7-a shows the coax tapped onto the 50-ohm point on a 27-MHz tuned coil at the base of the radiator. Fig. 7-b shows the version of the resonant circuit used by Cush-Craft. The parallel-resonant circuit is horizontal like a ground plane. The single-turn coil is tapped at the 50-ohm point to match the transmission line.

Figure 8 shows the basic construction of the Cush-Craft gamma loop matching network used in the new CX-1000 antenna. The variable capacitor consists of a piece of dielectric sleeving between two telescoping sections of vertical tubing.

The five-eighths wavelength vertical provides a gain of nearly 4 dB over a ground plane and also eliminates the need for radials. Some manufacturers vary the...
basic configuration by using short stubby radials at about half-way up the radiator (as in the Hustler Trumpet model 27-T, see photo) and/or small loops or radials at the tip to further lower the radiation angle and thus provide greater gain. The Hy-Gain CLR series of five-eighths wavelength verticals has a matching coil and three one-quarter wavelength radials at the base and a "top hat" consisting of three short radials to lower the radiation angle and provide a gain of approximately 3.4 dB. Another approach to the design is Mosley's Devant Special with its gamma match and "top hat" radials. The tapped matching coil and the gamma impedance-matching section permit the whole antenna to operate at DC ground potential, thus providing lightning protection and a reduction in atmospheric and precipitation static:

![FIG. 6—RADIATION PATTERNS of antennas in Fig. 5 superimposed on representation of earth's surface to show how quarter-wave ground-plane wastes energy in high-angle radiation while longer verticals have increased communications range through their lower angles of radiation.](image)

![FIG. 7—TWO COMMON METHODS OF FEEDING HALF-WAVE VERTICALS. The method at (a) uses a tapped coil in a resonant circuit at the antenna base. The second method (b) uses a tuned circuit with a single-turn helical coil mounted horizontally.](image)

![FIG. 8—BASIC CONSTRUCTION of the Gamma-loop matching system used in Cushcraft verticals such as the new CX-1000.](image)

FIG. 6—RADIATION PATTERNS from three popular types of CB antennas. The five-eighths wavelength vertical (c) provides highest gain through its lower angle of radiation.

**Rotatable vertical beams**

The most common uni-directional beam antennas consist of three to five vertical elements in a Yagi configuration so it looks like a "real wild" TV antenna standing on end. In these beam or directive antennas, gain is realized by the ability to concentrate all the energy in a narrow signal beam that can be directed to a specific area or point. This type of antenna consists of a half-wave radiator or driven element, a slightly longer reflector and one or more shorter elements called directors. The directors point in the direction of maximum radiation. The beam antenna must be rotated when 360° coverage is desired. Two identical Yagis can be mounted on a cross boom to provide a very narrow horizontal beam with a gain of 3 dB over a single Yagi of the same type.

Beam antennas can provide nearly 13 dB of gain, depending on the number of elements and their configuration. Figure 9 shows how stacking two simple Yagis horizontally can sharpen the horizontal radiation pattern and increase gain by 3 dB.
For this reason, several manufacturers have developed dual-polarity CB antennas consisting of two Yagis on the same boom. The elements of one are horizontal; the other's are vertical. Typical antennas of this type are the Avanti Moonraker, Cush-Craft Superfire (see photo) and Mosley's Sacker. The Hy-Gain approach to dual polarization is the two-element model Eliminator II quad. Antenna polarization is selectable through switching from the operating position.

Another advantage of selectable polarization is the ability to avoid interference from distant CB stations whose signals arrive at your antenna after being bounced between the ionosphere and earth. These "long-hop" or "skip" signals often undergo polarity reversals as they are reflected off the earth or ionosphere. Thus, when "skip" comes in, you can polarize your antenna system for minimum interference.

Large rotatable beam antennas like those just discussed have several disadvantages. Among them are high installation cost—you need a tower and heavy-duty rotator, TV-grade components won't do—and you need a large cleared area to accommodate the beam's turning radius with sufficient clearance from trees, power lines and your neighbor's property.

**Fixed steerable arrays**

This type of beam antenna—called a phased-array—has the advantages of a rotary beam while eliminating the need for a sturdy tower and rotator. It consists of vertical radiators spaced either one-quarter or one-half wavelength apart and fed through phasing harnesses to provide the desired directivity pattern. For example, two ground-plane antennas one-half wavelength apart and fed through equal-length transmission lines will radiate two narrow beams at right angles to the plane of the antennas as in Fig. 11-a. When the antennas are excited (fed) in-phase, radiation is broadside to the plane of the antennas with a gain of about 3.85 dB over a single ground-plane. Half-power beam width is about 60°.

If the phasing harness adds one half-power point (continued on page 75)
MIND POWER: ALPHA

Build this biofeedback device that displays the presence of alpha waves on a TV screen. You can use it to learn how to control your alpha waves and gain from the benefit of the relaxation that comes with it.

NOTE

Mindpower: Alpha is an intriguing device for entertainment and experimentation in video biofeedback. It is not a therapeutic instrument, neither is it suggested as a cure for individuals suffering from psychological or physiological disorders.

DEvised BY SCIENTISTS, RATHER THAN YOGIS, ALPHA-WAVE biofeedback is a technique of mental training, through which the brain and the body are made to link-up more closely, so that the physiologic sources of stress come under the control of the mind.

If that seems a bit too much to grasp on the first pass, consider this: Since birth, your mind has gradually "learned" to control many of your body's important functions. Most have come naturally, like learning to stand erect, to walk, to throw a ball, ride a bicycle, to speak, to type, and countless others. Yet, there are several functions in which the body apparently acts independently of the mind. The heartbeat, respiration, digestion and certain glandular functions are representative of these autonomous functions. So, too, are the reactions of small muscle masses surrounding the tiny blood vessels of the body. When these tense under stress, blood pressure goes up.

What has this to do with alpha wave biofeedback? Well, research over the past two decades has suggested that if we can get the brain to downshift from its usual high-gear state, to the "idling" state, in which a recording of brain wave activity shows a predominance of alpha waves, a host of beneficial physiologic changes take place. A feeling of well-being and general comfort spreads throughout the body as muscles slacken, heart-rate and respiration slow down, body temperature eases and the body enters into a longed-for state of relaxation. The body is essentially responding to a mental state of relaxation. Obviously, therefore, a feedback link does exist between the brain and "involuntary" body functions. To strengthen that link, an outside training instrument is needed. Using it, the mind can be made aware of its success in achieving the alpha state, and, the accompanying beneficial physiologic responses serve as a "reward" to the mind, thus inspiring the continuation of the alpha state.

Such an instrument is Mindpower: Alpha. It is a true alpha-wave biofeedback instrument that incorporates an electroencephalographic "front-end," designed to amplify and selectively process the tiny potential indicative of the brain's "idling" state, as picked up by headband electrodes. It also includes the circuitry for converting these potentials into signals, that exert control over both auditory and visual stimulus devices. In the auditory sense, Mindpower: Alpha provides an audible tone indication when the user's mind is generating alpha waves. However, Mindpower: Alpha also includes the circuitry to convert alpha waves into signals that control a video display on a television screen.

Why? Well, if it is possible to train the mind to generate the waves of relaxation in quiet meditation, with eyes closed, does it not make sense that the mind can be trained to exceed the extent that the waves of relaxation can be generated with eyes open? After all, the things that cause stress and anxiety to arise in our minds are largely visual in nature. We see emotion-charged situations that cause our bodies to tense-up. We read words that produce anxiety. We respond to television news programs, in which the visual input sometimes elicits responses from us which can only be classed as preparation for fight or flight.

And so, it is only natural that the brain should "communicate" with and train itself, through our powerful visual sensors: the eyes. But, to do so, an external instrument is needed to "close the loop." That instrument is the combination of Mindpower: Alpha and your television set.

The Mindpower: Alpha biofeedback loop

The brain is totally dependent upon its sensors for information. The eyes, ears, nose, mouth, skin, and the proprioceptors within the body's muscles supply the basic data inputs through which the brain is informed, educated, and on which it bases its executive functions. But, our sensors are mostly directed to the external world, rather than to our internal environment. We have no built-in means to see or hear what is happening within our bodies. Without a mirror, we cannot even look into our own eyes!

Yes, once information about what is going on inside the body or mind can be brought outside ourselves, where our sensors can detect it, a main-line path is opened to the information-hungry brain. With that link established, the executive power of the mind can begin to go to work on itself.

Mindpower: Alpha is designed to detect and amplify the tiny bioelectric signals produced by your brain's activity. From the full spectrum of the brain waves, it filters-out everything but the alpha waves (slow 8 to 13-Hz variations) and converts these into signals that control an audio "beeper" and a video display created by a symbol generator. (The symbol is a white rectangle on a black field.) The beeper sounds each time a significant amount of alpha appears in your brain-wave spectrum, thus feeding back to your brain via the ears.
Part of the price we pay for the comfort and convenience of living in an advanced, industrialized society is the acceptance of a high degree of anxiety and stress. Sociologists, psychiatrists, and medical investigators agree that the forces of our complex, technologic, and ever-changing society hammer away incessantly on the individual. Shock waves of change and new crisis wash over us so rapidly that, scarcely have we prepared ourselves to deal with a problem, when suddenly, it mutates or disappears, leaving us confronted by a new threat. In rapid succession, we find ourselves buffeted by an Energy Crisis, Inflation, Recession, Shortages, Lay-offs, Corruption in High Government, and the countless smaller forces in our daily lives which keep us constantly "on edge" and defensively anxious.

This anxiety and the stress of being always ready to ward off the blow of some new crises can have fearfully great effects upon our health and our ability to lead a "normal" life. Extreme, prolonged stress is believed to be linked to high blood pressure, increased incidence of heart attacks and strokes, and serious deterioration of important organs of the body. What's more, constant stress and anxiety exert a debilitating effect on the mind as well as the body. That "always tired" feeling—the inability to hold a problem in focus and think through a solution—both may have the same malevolent origin: constant stress!

Small wonder that Transcendental Meditation (TM) has found so many new converts in our overwrought society. Combining the mysticism of the East with varied exercises in meditation, TM seems to have proven helpful to many people in the relief of stress. Unfortunately, the technique is long in learning for many people and requires a daily regimen of meditation which some busy people find as hard to swallow as their dentist's demand for thrice-daily brushing!

However, there is another approach to stress—relief, relaxation, and the rejection of anxiety. This article will show you how to build an Alpha-Wave trainer to help you learn how to control these stresses with your own MINDPOWER.

Meanwhile, the alpha has a direct visual impact on the video display. In Mode 1, where the rectangle is normally stationary, when alpha occurs, the rectangle shrinks. Steady alpha will reduce it to a small dot at the screen center. When alpha stops, the rectangle grows again, until it fills the screen, or until reappearance of alpha reverses the process.

In Mode 2, the rectangle is always moving, originating as a dot at the screen center and automatically growing outward until it passes beyond the extreme edges of the screen, only to reappear at the screen center and start travelling outward again. In this mode, the occurrence of alpha slows or stops the rectangle's inexorable travel. Prolonged alpha will even beck it down to a dot and hold it there!

The implications of this instrument are apparent. By feeding back success at alpha generation to the brain which is producing it, more and stronger alpha should be produced. With time and practice, it should be possible to extend the periods of alpha and, it may ultimately be possible for the user to generate the waves of relaxation at will! In effect, here is the prospect for developing a new retaliatory response to everyday stress, and to increasing the power of the mind to overcome anxiety.

Understanding your brain waves

More properly called the EEG (electroencephalogram), brain waves are neither incomprehensibly medical nor mystical. However, to properly understand the workings of Mindpower: Alpha, you must have a fair grasp of these simple facts.

The adult human brain contains some 12 billion neurons—specialized nerve cells that are densely packed to form an organ that weighs scarcely more than three pounds and fits easily into the limited space within the human skull. All of the brain's neurons exhibit bioelectrical activity: the production of small varying potentials associated with their functioning. Such a dense population of active neurons might be compared to a crowd of noisy spectators in a football
stadium, and the shouts of individual spectators likened to the changing potentials of individual neurons. Just as it would be hard to single-out a conversation within the noisy environment of the crowd, it is also practically impossible to single-out the electrical activity of just a few neurons in their "noisy" environment.

But just as the overall noise of the crowd is audible outside the stadium, so also are the gross changes of the bioelectric potentials detectable outside the brain, on the surface of the forehead and scalp. And, just as you, standing outside, might easily detect rhythmic chants of the crowd in the stadium without knowing specifically what is being said, so also can we detect rhythmic variations in the gross bioelectric activity of large neural masses of the brain by strategically placing electrodes on the forehead and scalp.

Early in this century, medical researchers discovered that the brain generates a broad spectrum of rhythmically varying electrical waves. Though very low in amplitude (on the order of 10 microvolts in averaging amplitude), these potentials are detectable at the skin surface of the forehead and scalp. At first, the waves appeared to be completely random—rather like the noise of the football stadium crowd. But, through patient research, investigators were able to separate the dominant bands of brain-wave rhythms into these four: delta (δ): 1 - 3 Hz theta (θ): 4 - 7 Hz alpha (α): 8 - 13 Hz beta (β): 13 - 30 Hz

Further research has shown that psychological and physiological states affect the frequency content of the brain waves. Thus, when we are in deep sleep, the brain generates delta waves. Day-dreaming and problem solving brings up the theta waves. Fear, anger and intense concentration increase the beta waves. But a state of relaxation and tranquility bring up the alpha waves. A graphic recording of the brain waves produces a chart that is called an electroencephalogram. (EEG, for short).

The waves are recorded by placing electrodes on the forehead and scalp, and by measuring the instantaneous potential difference between selected pairs of electrodes. Thus, for example, the potential detected at the right frontal lobe of the brain may be differentially measured with respect to the potential present at the rear of the skull, opposite the left occipital lobe of the brain. The two electrodes, connected to a carefully designed high-gain differential amplifier that rejects common-mode voltages (60-Hz pickup, im-
All resistors 1/4-watt 10% unless noted
R1, R11, R14, R20, R28, R32, R45, R46, R64—10,000 ohms
R3, R4, R41, R42, R47, R68, R72, R73—
10,000 ohms, 5%
R5, R31—3700 ohms
R6—27,000 ohms
R7, R8, R49—30,000 ohms, 5%
R9, R10, R12—3 meghms, 5%
R11—20000 ohms
R15, R53, R65, R74, R75, R77, R78, R79, R80, R88—4700 ohms
R17—820,000 ohms
R18—22 ohms
R19, R36, R52—56,000 ohms
R21, R39, R44, R59, R76, R91—15,000
ohms
R22, R34, R51—100,000 ohms
R23, R24, R25, R26, R33, R61, R82, R83, R84, R86—22,000 ohms
R24—47,000 ohms
R27—3300 ohms
R29—10 meghms
R30—1.5 meghms
R35—75,000 ohms
R37—20,000 ohms, 5%
R38—4700 ohms, 5%
R40, R89—1000 ohms
R43—15,000 ohms, 5%
R49—120,000 ohms
R50—39,000 ohms
R53, R57, R58, R60, R61—5600 ohms
R55, R62—33,000 ohms
R56—220,000 ohms, 5%
R66, R71—13,000 ohms, 5%
R67—220,000 ohms
R69—12,000 ohms, 5%
R70—7500 ohms, 5%
R85—12,000 ohms
R87—240 ohms
R90—200 ohms
R92—10,000 ohms, linear potentiometer
All capacitors 25V or more unless noted
C1, C2—0.47 µF, 100V, 10%
C3, C4, C5, C6—0.0033 µF, disc, 10%
C7, C8, C20—5 µF, electrolytic
C9, C15, C29, C30—10 µF, 25V, electrolytic
C10, C12, C14, C19—1 µF, 100V, 20%
C11, C23—0.1 µF, 100V, 10%
C13, C26, C27—0.01 µF, disc
C16—(see text)
C17, C18—2000 µF, 50V, electrolytic
c21—0.001 F, disc, 10%
c22—0.033 F, 100V, 10%
c24—0.0015 µF, disc, 10%
c25—0.0068 µF, disc, 10%
c26—150 pF, disc
c29, C30—10 µF, 25V, electrolytic
*C31, C32—10 µF, 25V, electrolytic
*If required (see text)

Transistors*
Q1, Q2, Q3, Q4, Q5, Q7, Q8, Q9,
Q10, Q11, Q12, Q13—2N4001
Q6—2N4043
Q14—2N5524
Q15—SE4021

Diodes*
D1 through D19—1N3004
D20—1N5240, 10V, 10% Zener

Integrated Circuits*
IC1—CD4046AE (CMOS)
IC2, IC3—CD4001AE (CMOS)
IC4—CD4011AE (CMOS)
IC5, IC6, IC7, IC8, IC9, IC10, IC11, IC12—
LM311N (voltage comparator)
IC13—LM318N (op amp)
IC14, IC15, IC16, IC17, IC18, IC19, IC25,
IC26—LM307N (op amp)
IC20, IC22—NE555 (programable timer)
IC21—CD4040AE (CMOS)
IC23—MC7815 (+15V regulator)
IC24—MC7915 (–15V regulator)
IC27—MCT-2 photocoupler

Miscellaneous
Printed circuit board (2 sided, plated through holes)
Plastic case
Miniature speaker, 8-ohms
Headband assembly
Battery clips
Battery connectors
BATT1, BATT2—9-volt alkaline batteries
Transformer
S1—3-pole, double throw slide
S2—N.O. single pole pushbutton (or slide)
S3—dpst slide
S4—spst slide
IC sockets
Misc hardware

*Do not substitute

The following items are available from
National Mentor Corp., Box 53, Wykagyl
Station, New Rochelle, NY 10804

Circuit board, 2-sided, plated through holes. Order part number NM-P108: $34.50
Transformer. Order part number NM-T6: $17.50
Headband. Order part number NM-H439: $9.50
Case, punched and drilled. Order part
number NM-CS6: $14.75
Set of all semiconductors including 27
IC’s and 35 transistors and diodes. Order part
number NM—Sems 1: $99.50
Complete set of all parts needed to build
Brainwave: Alpha: $265.00.
All prices include postage and insurance
in the continental United States.

Ping noise voltages, etc.) produce a signal that shows
the predominant make-up of the brain waves across
the greatest mass of the brain, traversing the frontal, temporal,
parietal, and occipital lobes. In effect, such a signal describes
the principal state of the brain’s major, distinguishable lobes,
thus providing a useful index of brain-wide mental state.

How it works

A simplified functional block diagram of Mindpower:
Alpha is shown in Figure 1. There are five principal sec-
tions, enclosed by dashed lines. These are: the horizontal
and vertical sweep generators, the display logic and video
driver, the isolated EEG amplifier, the display beep control
section, and the power supply.

Because Mindpower: Alpha creates a video display that is
then acted upon by control signals developed from an
alpha wave input, the most logical starting point is the hori-
zontal and vertical sweep generators section.

To establish a field for producing a display on a TV
screen, it is necessary to sweep the CRT electron beam both
horizontally and vertically on the screen face. The horizontal
sweep must produce 256 left-to-right lines (one-half frame),
moving vertically from top to bottom of the screen with
1/60th of a second. Each line must be written within
65 microseconds. The flyback time between lines must thus
be less than nine microseconds. To develop this basic field,
the horizontal and vertical sweep generators receive a 60-
Hz AC input signal from the AC power supply. This signal
is squared by transistor Q9. This stage provides 60-Hz pulse
outputs to the two sweep generators. Horizontal sweep is
obtained with a X 256 phase-locked loop (IC, IC21), that
multiples the input to an output of 15.36 KHz. This output
is differentiated by Q3, and is applied to the horizontal
ramp generator, IC13. This stage produces a ramp voltage
rising from 0 to 10 volts in 65 microseconds. Its output is
applied to the horizontal comparators and gates of the dis-
play logic and video driver section.

Since the vertical sweep rate is synchronous with the line
frequency, the pulse output of Q9 is simply differentiated
to produce pulses which control the vertical ramp generator,
IC16. The output of this stage is a ramp voltage rising from
0 to 10 volts in 1/60th of a second (16.7 milliseconds),
and is applied to the vertical comparators and gates of the dis-
play logic and video driver section. Sync pulses to determine
field timing are provided by sync driver Q1, Q2 to video
driver Q12.

The two ramp voltages provided from these earlier stages
are used to produce a rectangular display by comparing
their instantaneous voltage levels against reference voltage
levels in horizontal comparators IC5 through IC8 and ver-
tical comparators IC9 through IC12. These develop beam
control signals which determine the point on each line
where the CRT electron beam will be turned-on and shut-off.
However, since it is desired to produce a rectangle display
rather than a cross-hatch, we must use logic to eliminate
those line segments which lie outside the rectangle’s confines.
This function is performed by gates IC2, 3, and 4. The
result is a white rectangle on a dark field, sized (in Mode 1)
to fill about 75% of the screen’s usable area. This video
signal is applied to the television set by video driver Q12.

Having established the basic display, all we now need is
a way to vary the size of the display. This is done by the dis-
play/beep control section. Vertical control amplifier IC17
(continued on page 91)
THE FIRST WORLD ALTAIR COMPUTER CONVENTION WAS HELD March 26-28 at the Airport Marina Hotel in Albuquerque, NM. Successful? Was it ever! Over 700 participants from 46 states and 7 foreign countries gathered to talk computers, exchange information, ask questions, participate in seminars, match their system against other systems in a demonstration contest and see many different systems in operation.

MITS sponsored the convention and they plan to make it an annual event. Seminars were presented by MITS' engineers and software developers.

Saturday night's event was a discussion led by a group of guest speakers. The theme of the discussion was the future of computers in general and its effect upon hobbyists in particular. The group of speakers included Ted Nelson (author of Computer Lib), David Ahl (Creative Computing), Carl Helmers (Byte Magazine), Larry Steckler (Radio-Electronics) and Les Solomon (Popular Electronics) among others.

The highlight of the convention was the awards banquet held Sunday where the winners of the demonstration contest were announced. The grand prize, a complete Altair floppy-disc system, was awarded to Don Alexander of Columbus,
PAUL ALLEN, director of software at MITS, announces the winners of the software contest at the Awards Banquet.

OH, for his computer-controlled amateur radio station. The system consisted of an Altair 8800 with 8K of memory, an ASCII keyboard, a video display, Baudot Teletype and standard transmitter and receiver. The system was designed to transmit and receive messages in a radio Teletype contest. The Altair was used for ASCII to BAUDOT translation, cross-checking calls for duplication, transmitting the time and message number of a transmission and generating a hard-copy printout of all exchanges. Mr. Alexander developed his own software and wrote the assembler and editor in addition to building the hardware.

The competition resulted in a tie for second place. Randy Miller of Tempe, AZ, with a computer chess demonstration and Wirt and Valerie Atmar of Las Cruces, NM, with a speech synthesizer, were the second place winners. Both winners received an Altair 8800B.

Third place was awarded to Danny Kleinman, Steve Grumette and Mike Gilbert of Los Angeles, CA, for their backgammon game. The software was written in Altair Basic and displayed by a Cromemco TV Dazzler. An Altair 16K static-memory card was the prize.

The winners of the MITS' yearly software contest were also announced at the banquet. James Gerow of Houston, TX, took first place for the Best Program and Lee M. Eastburn of Langdon, MD, won the top prize in the subroutine category.

This was the first computer convention of its kind and you had to be there to experience the enthusiasm. Computer hobbyists brought just about everything with them to the convention—from Teletypes to floppy discs. Have you ever walked through the halls of a hotel in the early hours of the morning and heard Teletypes clanking away? The era of the home computer system is definitely upon us and we would like to add our support to MITS and hope their plans for an annual convention develops into a reality in time for next year's convention. BRAVO MITS!
State of SOLID STATE

A new semiconductor transistor-like device from G-E that operates beyond 3 GHz, new memory devices and power Schottky diodes are featured this month

KARL SAVON
SEMICONDUCTOR EDITOR

GENERAL ELECTRIC HAS A NEW SOLID-STATE device designed for operation beyond the present 3-gigahertz limitation of present transistors. Seven times higher frequency range will be possible with the new triode. The CATT (Controlled Avalanche Transit Time) triode combines transistor and IMPATT diode features.

Radar and communications equipment design should be simplified by the G-E development. The CATT could play an important role in increasing activity in the less crowded upper portion of the radio spectrum.

Just like conventional transistors, the low power input signal feeds the emitter-base junction, injecting carriers into the base region. The base-collector depletion region has an IMPATT diode profile with the avalanche zone close to the base.

G-E's TRANSISTOR-LIKE CATT TRIODE, shown mounted for operation in a microstrip circuit, can operate at as much as seven times the frequency of conventional transistors.

Computer simulation was used in the development of the triode. So far devices have been operated between 2 and 3 GHz with 12 watts output, 13 dB gain, and 30% collector efficiency.

General Electric Company, Research and Development Center, P.O. Box 8, Schenectady, NY 12301.

Memories

TI and Signetics have introduced new memory products.

Texas Instruments has the TMS4033, 4044, and 4045 types organized as 1024 1-bit words. Their access times are 450, 650, and 1000 nanoseconds. N-channel silicon gate technology is used and they are fully compatible with the 74 TTL series. The price of the TMS4035NL is $13.36 in 100 quantities.

Signetics’ 82S10 open collector and 82S11 tri-state output in a 1024 x 1 bipolar RAM. It is the fastest 1024 bit bipolar random-access-memory on the market with a 30-ns typical access time. Schottky processing and dual-layer metalization is used. It surpasses other high speed 1024 bit RAM’s, whether ECL or quasi-static N-channel, as well as standard 256-bit TTL RAM’s. Performance is at the same level as 256-bit ECL RAM’s and specially selected TTL RAM’s. Typical input currents are 10 microamps giving a reduction in fan-in. This specification lets a single TTL gate drive many paralleled address and control inputs, well beyond the normal fanout of 10. The 82S10 and 82S11 can be used in high-speed main frame, cache memory, buffer storage and writeable control storage applications.

TRW power Schottky diodes

All the energy converted from the AC power line to DC voltages passes through the power-supply rectifier diodes. Power dissipation in the diodes is often substantial. A 1-volt forward diode drop at 10 amps is 10 watts of unproductive dissipation. Efficiency is poorer at the lower power-supply voltages because a larger proportion of the voltage appears across the diodes. Many logic, computer, and industrial systems use 5 volt supplies at large currents.

Schottky diodes have forward drops that are less than half the comparable normal silicon junction drops, and wasted power drops in the same proportion. Not only does power supply efficiency leap upward, but the entire cost picture improves. The devices shrink in size because of the reduction in thermal resistance requirements. System cooling and heat exchange needs are less demanding.

TRW has added the new SD-41 30-amp device to their already existing SD-51 60-amp device. Early Schottky rectifiers had problems at high temperatures and high reverse-voltages. But the SD-41 has a maximum forward voltage drop of only 0.55 volt at 30-amps and an unprecedented 125°C case temperature. The SD-41 is rated at a maximum reverse-current of 100-mA at 125°C and 35 volts. Non-repetitive 500-amp peak forward-current surges cause it no harm. Reverse recovery time is under 10 nanoseconds.

TRW POWER SEMICONDUCTORS' 30-amp Schottky diode.

Schottky’s have metal-to-silicon junctions instead of conventional PN junctions. TRW credits much of the superior performance of their power Schottky line to a new structure that uses a proprietary metalization technique for the interface in the silicon-to-metal junction.

TRW’s SD-41 comes in a JEDEC DO-4 case and is priced at $5 each in production quantities.

SIGNETICS 82S10 bipolar random-access memory.

TRW POWER SEMICONDUCTORS' 30-amp Schottky diode.
DIGITAL REVERB
FOR TODAY'S
HI-FI SYSTEMS

A new digital time-delay system that brings the spaciousness associated with a concert hall into the living home

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

EVEN AN UNTRAINED LISTENER CAN easily distinguish the differences between music in a spacious concert hall and the same music reproduced over an audio system in a home listening environment. The concert hall has richness and depth because of the blending of the direct sounds coming from the performers on stage with indirect sounds reflected in a variety of complex patterns from the sides and rear of the hall. These reflected sounds arrive fractions of a second later than the direct sounds and, though they may not be perceived as separate sounds by our ears, are responsible for the listener's ability to perceive—even with eyes closed—that the musical event is taking place in a spacious environment.

Earliest recording experiments with 4-channel sound attempted to recreate this feeling of spaciousness or ambience by using the added pair of back channels to record and reproduce random reflections picked up at some point far removed from the sound itself. Less dramatic, perhaps, than later "surround sound" quadraphonic recordings (in which primary musical information reaches the listener from every direction), the "ambience" approach to 4-channel sound soon gave way to more "gimmicky" musical effects. At a recent electronic industry exhibition in Chicago, we were introduced to a newly developed digital time delay system which, to our ears, seemed more able to recreate the spaciousness of a concert hall than any quadrophonic approach we had heard before. Designated the Model One Digital Time-Delay System by its makers, Audio Pulse (a division of Hybrid Systems, Inc.), this unusual device synthesizes the live listening experience by adding multiple continuous time delays to the original content of a stereo recording or broadcast. The delayed reverberant signal is fed to a separate stereo amplifier and heard over a second set of speakers to the sides or rear of the listener's usual seating area. The number, length and combination of time delays can be varied, so that the blend of direct and indirect sound in a listening room can be varied to suit different kinds of music and listening requirements. Fig. 1 shows how the time-delay unit would be hooked into an ordinary stereo component system. Superficially the setup resembles the familiar 4-channel array, but that's where the similarity ends.

Digital design comes to audio

Nor is Audio-Pulse's time delay system a new-fangled version of the old mechanical "reverb" units which employed springs as transducers and were moderately popular in the earlier days of high-fidelity and stereo. Such spring devices were noted for adding a "twangy" coloration to delayed or reverberant signals produced by them; and, in any event, delay effects were at best random, incapable of being varied, and certainly unrelated to what takes place in a large concert hall.

The Audio-Pulse unit can be thought of as a miniature computer containing an electronic model of acoustic space. Using various components to be described, the system converts input audio signals to digital pulses with an analog-to-digital (A/D) converter. Once in digital form, signals can be delayed by selected amounts of time, added or mixed together at selectable amplitudes and finally reconverted by a digital-to-analog (D/A) converter and reinserted into the audio reproduction chain through the extra pair of amplifier and speaker channels.

The idea of electronic digital time delay for audio is not, in and of itself, new. Such devices as the Cooper Time Cube have been in use in professional recording studios for some time. Their drawback, from the home user's point of view, has been their cost, which can mount up to several thousands of dollars because of the complexity of the circuits involved. While the Audio Pulse unit employs the equivalent of 150,000 transistors (most of which are reduced to integrated circuitry), its advanced encoding process and decoding process has made possible the introduc-
tion of this device at a cost of under \$600.00.

This time delay system is a unity-gain device. It contains level-matching input and output circuitry to enable the line-level audio signals to be matched to the dynamic range of the digital encoders for optimum signal-to-noise ratio. Selecting the optimum gain is simplified by a sensitive, frequency-controlled, front panel 3-color, 12-LED display which continuously shows the peak signal levels at the encoder inputs.

Circuit description

A simplified block diagram (Fig. 2) will aid in understanding the operation of the digital time delay system. In each channel, the incoming audio signal is fed to a buffer stage and then to an active filter, which attenuates frequencies above 8 kHz. This deliberate roll-off is introduced because it has been found that in actual concert halls the reverberant-field energy rolls off rapidly at high frequencies. The filtered audio signal then goes on to a pre-emphasis/compression circuit used as a noise reduction encoder, somewhat analogous to Dolby (but with different characteristics specifically matched to the behavior of the encode-decode system which follows.)

The audio signal in each channel is converted to digital pulses by an ana
glo-to-digital (A/D) converter. This particular A/D circuit is a new one employing Delta Modulation With Memory, which will be explained in detail shortly, and which was developed expressly for this instrument. The A/D encoding takes place at regular intervals defined by the "clock". In the long position of the front panel initial delay switch, encoding occurs at a rate of 250,000 pulses per second. In the short position of the switch, the encoding interval is about 2.5 microseconds, yielding 400,000 pulses per second.

At either rate, the two channels of pulses are fed into two serial memories consisting of a total of thirty-seven 1,000-bit shift registers. In either channel, as each clock pulse occurs, a data pulse from the encoder enters the first shift register and all the data pulses in the memory are shifted by one bit. Pulses emerge from the opposite end of the shift register bank after a time delay that is simply the clock interval multiplied by the number of shift register bits. In addition to this full delay, a brief partially delayed signal is obtained by tapping the shift register memory at about one-third its length.

The fully and partially delayed pulse trains then go to the digital-to-analog (D/A) converters to be decoded back into audio waveforms. The decoders also operate on the Delta Modulation with Memory principle and complement the A/D converters precisely.

Fully and partially delayed audio signals are fed to a variable mixer. Here, relative proportions of partial and full delays are controlled by a bank of selectable delay time switches on the front panel. Increasing the proportion of the fully-delayed signals lengthens the reverberant decay time and vice versa.

A dynamic expansion/de-emphasis circuit restores the signal to its original dynamic range and frequency spectrum balance while reducing noise and distortion introduced by the digital encoding and decoding process. An active filter, similar to the one used at the input, smooths out the signal and reduces residual noise beyond 8 kHz while limiting reverberated signals to that bandwidth. The delayed output from each channel is fed back and mixed into the input of the opposite channel, where it is further delayed and then fed back to the input of its original channel, and so on. In addition to these cross-channel recycling loops there are also recycling loops within each channel (not shown in Fig. 2). As each delayed signal is recycled it is mixed into the input at a reduced level, corresponding to the attenuation of a sound wave as it is reflected from the walls of a concert hall. As a result, the composite output signal following an input transient contains dozens of delayed signals, decaying exponentially in amplitude, very much like the actual reverberant decay of sound that takes place in a real concert hall, as illustrated in Fig. 3.

In a real concert hall or any other large acoustic space, reverberant-field energy arriving at a listener's two ears is largely incoherent and random-phase in character, with little or no left-right symmetry. So, the Model One contains active signal processing output circuits following the digital time delay circuitry. These include a phase-shifting
network whose purpose is to insure that the delayed signals will have the spacious, non-localizable character of actual reverberant-field energy in an acoustic space. At the same time, these extra circuits solidify the bass energy in the sound field by minimizing low-frequency cancellations due to the standing waves in listening rooms of typical size.

**Delta modulation with memory**

As mentioned earlier, the most important element in this time delay audio system is a new form of analog-to-digital converter which Audio Pulse calls “Delta Modulation With Memory” (DMM). Unlike conventional pulse code modulation (PCM) encoders, which digitally encode the amplitude of audio waveforms, the DMN encoder is a waveform slope detector, which digitally encodes the moment-to-moment changes in the audio signals applied to it. To understand its operation, refer to Fig. 4, which is a detail of the more generalized central blocks of Fig. 1 (A/D encoder, shift register memory and D/A encoder).

The core of the digital DMM encoder is a comparator IC. The comparator is essentially a high gain open-loop operational amplifier in disguise. It has two inputs (“sig” and “ref”) and one output. This comparator is a binary, or digital device in that it is capable of only two output levels of voltage. If the audio signal voltage is greater than the reference voltage, output of the comparator is equal to the power supply voltage (corresponding to a “1” logic state). When audio signal level is less than reference voltage level, comparator output instantly flips to 0 volts (corresponding to a “0” logic state).

In the DMM circuit developed by Audio Pulse, the reference voltage supplied to the comparator is not a fixed level; rather, it is a rising or falling voltage ramp. The ramp generator is part of a feedback loop that varies the comparator reference voltage in an attempt to track the incoming audio signal voltage. Thus, the comparator’s binary output is essentially an error signal continuously indicating whether the ramp generator’s voltage is above or below the audio waveform voltage. Generation of the reference voltage is the key to the DMM encoder’s operation.

At regular intervals of a few microseconds (as determined by the clock signal), the comparator’s “up” or “down” output state is transferred into a short-term digital memory. This memory contains several storage cells (the exact number remains a proprietary secret with Audio Pulse, for the moment) which retain logic “1”’s and “0”’s generated during an equal number of previous clock intervals. The contents of the memory comprise an n-bit digital code (“n” being the number of cells) which describes recent history of the audio signal waveform. At each clock interval this group of logic pulses is fed to a weighting network whose output controls the ramp generator. The ramp generator produces a rising or falling voltage ramp whose polarity and slope are selected in accordance with the control signal produced by the weighting network.

The weighting network uses the pattern from the digital memory to predict what the audio waveform slope will be during the forthcoming clock interval, and it causes the ramp generator to produce a voltage ramp whose slope approximately leads the predicted audio waveform slope. The comparator then generates an “up” or “down” binary output, depending upon whether ramp voltage rises above or falls below audio waveform voltage during the next clock interval. The serial pulse train that results is then time-delayed by sequential shift through the shift registers. The output pulse train from the delay shift register is identical in every way to the pulse train generated by the encoder section except for its time delay.

When the delayed pulse train reaches the decoder, it is fed into a multiple-bit digital memory which is identical to that used in the encoder section. In each clock interval, pulses in the DMM decoder memory comprise an n-bit digital code identical to that previously found in the encoder. The pulse group is fed to a weighting network (also identical to that in the encoder) whose output controls another ramp generator. The delayed pulse train causes the decoder’s ramp generator to reconstruct audio waveforms, segment by segment. The low-pass filter removes the sharp corners of the reconstructed waveform, resulting in a smooth and undistorted delayed replica of the original audio signal.

While delta modulators have been available for several years and, unlike PCM encoders, cannot be overloaded by low-frequency or mid-frequency signals (unless they exceed the encoder’s power supply voltage), the simpler form of basic delta modulator was subject to severe slew-rate limitations and had a constricted high-frequency dynamic range. The development which made the Audio Pulse Model One practical was the new form of delta modulator with short-term memory which has just been described. The encoder’s slew-rate is effectively quadrupled in this approach, providing ample dynamic range for high-frequency transients.

What is most exciting about this new device is that, in our opinion, it provides a level of sonic realism that serious audiophiles have sought for a long time (and have not been able to find in any available quadrophonic system, as presently offered). While it does call for a second stereo amplifier and pair of speakers, the performance requirements for those extra pieces of equipment do not seem to be as critical as they are for quadrophonic reproduction. Since bandwidth of the reverberant sound signals is deliberately restricted to reproduce the narrower bandwidth of reflected sound, the second pair of speakers need not be of ultrawide range. And since the device requires no special program material (it even does some remarkable “space expanding” when reproducing older, monophonic program sources), it won’t become obsolete or incompatible.

**Evaluative listening test**

We first heard the Audio Pulse Model One in a listening room which was, if anything, smaller than most people’s living rooms. Speakers driven by the Model One and its second stereo amplifier were mounted fairly high on the side walls of the room parallel to our front-to-back listening point. The most amazing thing about what we heard is the fact that one is not conscious of the presence of those...
Build A Gas Sensor

This simple device measures the concentration of various noxious gases

THE GAS SENSOR gives a direct readout of the relative concentrations of noxious gas.

CASS R. LEWART

THE GAS SENSING INSTRUMENT described in this article can detect and measure low concentrations of various noxious gases in your car or boat and can possibly give you a warning before it is too late. The instrument is based on an inexpensive semiconductor device called the Taguchi Gas Sensor (TGS).

Sensor operation

The TGS sensor changes its resistance as a function of minute quantities of a deoxidizing gas that is present. Typical gases detected by this device are carbon monoxide, gasoline or alcohol vapors, propane, methane and hydrogen. The TGS sensor consists of a combination of n-type metal oxides, such as tin, zinc and ferric oxides, that decrease their electrical resistance with an increasing concentration of a deoxidizing gas.

The sensor has an amazing range of sensitivity to gas concentration. Depending on external circuitry, it can detect concentrations of a few parts-per-million, but it can also be used to measure high gas concentrations encountered in the exhaust of an automobile. Due to this wide sensitivity range, the instrument can be used to check the inside of a boat, car or trailer for escaping gasoline vapors, carbon monoxide or exhaust fumes. It can also be used for automobile tune-ups. Because of the wide variety of gases to which the TGS sensor responds, the readings of the instrument can only be interpreted in a qualitative, comparative way.

If you observe the meter needle jumping as the TGS sensor approaches a pipe joint, you will know that gas is escaping. If the inside of your car, boat or trailer gives a higher meter reading than the fresh air, you will know that a problem exists. However, there is no way to translate the meter readings directly into gas concentration because the sensitivity of the TGS sensor is different for various gases.

Circuit description

The circuit consists of a regulated voltage supply for the TGS sensor and a resistance-indicating meter that has its own regulated voltage supply. A higher than normal concentration of a noxious gas lowers the TGS resistance between pins 1, 2 and 3, 4 and causes the meter reading to increase.

The TGS sensor requires approximately 1 volt at 0.4 ampere to operate. This voltage is derived from a 12-volt automobile or boat battery by the voltage regulator consisting of the transistor Q1 and three diodes as shown in Fig. 1. The voltage drop across diodes D1, D2 and D3 (approximately 1.7 volts) minus the voltage drop across the base-emitter junction of Q1 (0.7 volts) provides the required regulated voltage of 1 volt for the TGS sensor. Then Zener diode D4 supplies a constant voltage for the resistance-indicating meter circuit making it independent of battery fluctuations. The initial adjustment consists of connecting points A and B with a jumper wire and rotating R4 to read full scale on the meter. Switch S1 shunts resistor R5 across the metering circuit, thus giving a low and high sensitivity range of gas concentration. A 0.75-ampere fuse is recommended to protect the circuit.

The normal reading on the meter after the initial warm-up of 5–10 minutes is 0.3–0.6 mA on the high sensitivity setting and 0.1–0.3 mA on the low setting. You can test the circuit by putting a drop of gasoline on your finger, bringing it close to the TGS sensor and watching the meter needle deflect. The meter should then register close to its maximum reading. After the sensor detects a high gas concentration, it takes several minutes after the gas removal until the reading goes back to normal.

Construction

Wiring of the circuit is not critical, however, we would recommend the parts layout shown. Mount the meter in a metal cabinet. Depending on the intended use you can mount the TGS sensor on the cabinet or in a separate housing connected with a 3-wire extension cord to the main circuit. The TGS sensor will fit into a 7-pin miniature
Public Broadcasting Service wants captioned video

A petition recently filed with the FCC by Public Broadcasting Service asks that video scanline 21 be permitted to carry captions so that deaf viewers may read the titles and some of the information content of the program they are watching. This, it is estimated, would help 13.7 million hard-of-hearing television viewers. Station WETA, channel 36, near Washington, DC, has been given permission to test the system.

Home decoders for these captions are expected to cost less than $100, and since they have been developed under federal funding, their designs will be available to all manufacturers.

An important by-product of the proposal is a special "ghost excisor" that cancels secondary bounce reflections. Engineers suspect that this excisor could be developed to the point that all video ghosts could be curtailed or eliminated.

Public Broadcasting Service would use satellite relays

The FCC has been asked to approve a plan for linking the Public Broadcasting System (PBS) stations by satellite instead of by leased land-lines as at present. Economy (savings of $1 million per year), better reception and more flexibility in programming are cited as advantages of the proposed system. The plan, approved by the annual conference of PBS members held in Los Angeles last February, would provide three two-way channels. Under the present system, programs are sent out over a single line for live broadcast or taping for later use by the receiving station. The three-channel system would have far more flexibility and capacity (comparable to that of a three lane, two-way highway as opposed to a one-lane, one-way road).

With three channels, PBS could send out two programs at the same time giving its stations a chance to select. Programs could also be originated from various points and individual stations would even be able to exchange programs. While all these types of transmission are technically possible with leased lines, the excessive costs make them practically unattainable.

Quality would be better since signals can deteriorate when sent long distances in 30-mile jumps by microwave, and reception would be more uniform—each station would receive practically the same signal.

Western Union is prepared to offer three two-way channels on its Westar satellite, and Collins Radio has bid for the construction of earth stations at about $100,000 each.

X-ray tomography patent to Maryland doctor

Patent 3,922,582 has been issued to Dr. Robert S. Ledley, of Georgetown University Medical School, for an X-ray machine that scans any organ, or the whole body, and immediately displays a cross-section of the area scanned.

Tomography, a technique that has attracted the attention of several scientific journals recently, is performed by what one reviewer called the "barbecue" method. However, instead of rotating the body being scanned, the X-ray tube is rotated around the body. On the opposite side, a group of X-ray detectors—with sensitivity far surpassing that of any X-ray film—is rotated. The area of interest is in the center of the plane of rotation. Scanning signals are fed continuously into a computer that generates—as soon as the scanning is complete—a cross-section picture of the scanned area on a color television receiver.

The cross-section picture (tomograph) shows the exact location of any object in the plane being scanned. Thus a brain tumor or other object can be located for surgery. Much lower-voltage (softer) X-rays can be used with this technique, reducing the amount of radiation the patient receives. Resolution down to one millimeter is possible (this is good in X-ray photography!). This makes it possible to see such details as a clogged coronary artery that would be difficult or impossible to see in an ordinary X-ray photograph.

Cost is also high—about 20 times that of an ordinary X-ray machine. In spite of that, about four dozen of the machines are already in use.

Smoky ticketed by FCC

The FCC hands out hundreds of fines each week to amateurs and CB'ers. The difference is that this particular fine goes to a police station in Marion, New Jersey. Their police radio station, call sign KFR-661, was in "repeated violation of Section 1.89 of the rules by failing to reply to official communications." The fine was set at fifty dollars.
The first two parts of this article (May and June, 1976) described the Dyna-Micro and presented the construction details.

This third and concluding part of the article discusses the 8080A and describes how the Dyna-Micro works.

The 8080A microprocessor

The 8080A microprocessor is an eight-bit parallel central processing unit (CPU). Unlike the earlier 808 and 8080-1, the 8080A is a more powerful, easy to use device. The 808 was an 18-pin device and many things were multiplexed on the same bus. The 8080A is a 40 pin package that offers many advantages over the earlier devices:

- A simplified bus that has separate address (16 bits) and data (8 bits) buses.
- Three state and TTL compatible buses.
- Simplified control.
- Improved interrupt and stack.
- More instructions.

While the power and clock requirements for the 8080A are more complex than for the 8008, they are easily met.

How the Dyna-Micro works

The Dyna-Micro uses the same basic computer functions found in most other computers, large or small. These are:

- Central processing unit (CPU)
- Memory (R/W and PROM)
- Control Logic
- Input/Output Control
- Clock and power supplies

The 8080A has 24 output lines, 16 of which are used for address information and eight of which are a bi-directional data bus taking data to and from the CPU. The data flow on the data bus is controlled by the DAIN (Data Bus IN) signal from the 8080A chip on pin 17. Two bus buffers, Intel type 8216, are used to boost or buffer the data bus outputs and to protect the 8080A's inputs. The DAIN signal switches the 8216 IC's for either input or output of data on the bus.

The system's operation is controlled by signals from the 8080A at various times as synchronized by the clock frequency. An Intel 8224 clock chip with a 6.75-MHz crystal is used to provide the 750-kHz MOS clock levels to the 8080A. These clocks are slightly out of phase and do not overlap. While the 8080A chip can operate at frequencies up to 2 MHz, the Dyna-Micro's clock has been set to 750 kHz so that it will work with the relatively slow 1702A type PROM's. You can increase the speed of the Dyna-Micro by using a higher-frequency crystal. The 8224 chip divides the crystal's frequency by nine, so an 18 MHz crystal will give the 2 MHz output needed for the highest operating speed.

The clock chip also synchronizes the ready input to the clock so that system can slow down for slow memories and I/O devices. The reset input from the r key is also input to the 8224 IC where it, too, is synchronized to the clock and output to reset the 8080A.*

The 8080A's data bus will also contain some status information that is used by the control logic section to synchronize its control operations. The status information is output and is available when the SYNC signal is output from the 8080A. The 8224 clock IC gates the sync pulse from the 8080A with the main system clock to provide a very short STSB (Status Strobe) signal that 'catches' the status information in the SN74174 latch. The status information indicates data output, data input, halt condition, memory read, memory write and a special condition that signals the start of the next instruction. M1. Four of these status signals are gated with other system signals to provide the IN, OUT, MR and MW signals used throughout the Dyna-Micro. These signals are used as indicated below:

- IN and OUT—used to synchronize data flow to (IN) and from (OUT) the 8080A CPU. They are used with external devices for data transfer.
- MR and MW—used to indicate to the memory that the computer is executing a Memory Read or a Memory Write.
- INTA—indicates that the computer has acknowledged an interrupt.
- HALT and ML—latched and provided for the user. These are not used in the Dyna-Micro, but are described in the experiment modules and are available for your use.

When the 8080A addresses memory, one and only one address must be specified on the 16-bit address lines. Since the 1702A and the 8111-2 memories only have eight lines to address their 256 locations, the remaining eight lines must be used to select one and only one of the memory blocks. We can select from two blocks of PROM, two blocks of R/W or possibly no blocks on the Dyna-Micro if we have expanded the memory off the PC board.

Address lines A0 through A7 are applied directly to the memory IC's on the Dyna-Micro card. Address lines A10 through A15 are gated in a six input NOR gate IC13. When this gate's output is a logic 1, it indicates that we are selecting one memory location within the first 1024 locations. Address lines A10—A15 are equal to logic 0. This would be one of the locations in either R/W or PROM, since these are located within the first 1024 locations. If the NOR gate produces a logic 0, at least one of the address inputs (A10—A15) must be at a logic 1, indicating that we are now addressing memory outside the blocks on the Dyna-Micro. Address bits A8 and A9 and the memory read signal (MR) are gated together in an SN74LS155 decoder to select the proper block of the four possible on the Dyna-Micro card. The 8111-2 memories input the memory read and memory write signals to control the flow of data from and to the CPU. The 1702A PROM has only a chip-select input, so the memory read synchronizing signal is used in the SN74LS155 to gate data from the 1702A onto the bus at the correct time.

Table V shows the memory selection.

<table>
<thead>
<tr>
<th>TABLE V—MEMORY SELECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOR</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

*MR and MW applied independently to the 8111-2 chips.

Data flows to and from the memory on the bidirectional data bus and the 16-bit address bus specifies each location. This address bus is also used to help control the flow of data to and from external devices. The eight least significant or LOC address bits can specify one of 256 possible peripheral devices. The address bits are decoded in (continued on page 85)
Radio-Electronics

Tests Tandberg 10XD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

TANDBERG STATES QUITE SIMPLY THAT their new model 10XD is the best tape deck they have ever produced. That's quite a statement for a highly respected company that has been designing and manufacturing tape recorders and tape decks almost as long as that type of product has been available for home and professional studio use. By the time we were finished with our tests and evaluations we were ready to agree and to go even a bit further. The Tandberg 10XD may well be among the few best tape decks ever produced by any home tape deck manufacturer!

It is a credit to the industrial designers of this flexible unit that its front panel seems to be remarkably simple in layout and ideally organized as to its control functions. The complete unit is shown in Fig. 1 while a closeup of the lower control-section is shown in Fig. 2. We'll deal with the transport, tape paths and tape guidance system presently. For the moment, let's examine those tastefully designed controls. A rocker switch below the left tape reel turns-on power, indicated by a green lamp just above it. Next is a speed selector knob for the three available speeds, followed by a re-size selector button and an EDIT/CUE button. When this button is depressed, the user can hear sounds recorded on the tape even when the transport is in either of its fast wind modes or when tape is moved by hand for precise editing. Below the right take-up reel is a 4-digit tape counter.

Transport mode selection buttons are located beneath the digit counter and there are no restrictions on the sequence of buttons depressed. The RECORD button also sets tape in motion, thereby acting in lieu of a pause control which this machine does not possess as such. Since recording can only take place if one or both of the RECORD SELECT buttons (elsewhere on the panel) is activated, a measure of safety (against inadvertant recording or erasure) is also provided. Tiny lights beneath each of the transport keys become illuminated indicating the mode of transport motion that is in progress, while the RECORD key is totally illuminated in red whenever it is depressed.

The lower section of the front panel contains a pair of record level meters that also read during playback. The meters are peak-reading and are inserted in the circuit chain beyond the record equalization circuits. Furthermore, a 0-dB reading on these meters corresponds to a +0.6 VU record level in terms of NAB standards, so that in reality the machine has a good deal more headroom than one might at first suppose. To the left of the meters are individual slide controls for each channel's microphone and line inputs. Microphone input jacks (that are balanced and have a self-adjusting sensitivity feature that is dependent upon the impedance of the microphone used) and the record select buttons are located below the two meters. The lower right section of the panel contains HEADPHONE jack, SOURCE/TAPE switches, OUTPUT LEVEL slide controls, a three position SOUND-ON-SOUND switch and a DOLBY selector switch with positions for NORMAL Dolby encoding or decoding, FILTER, and DOLBY FM (used for recording a Dolbyized FM program). Lights located above the two last switches turn on when either sound-on-sound or Dolby operation is selected. A photo of the rear panel is shown in Fig. 3. It contains the usual LINE IN and LINE OUT jacks, a DIN connector (that Tandberg prefers to label RADIO), and a REMOTE CONTROL socket for connection of an available accessory that permits complete remote operation of the transport system in any mode.

Internal features

While the visible features and controls of the Tandberg 10XD are certainly impressive enough, a real appreciation of the engineering that went into this unit can only be gained by exploring the not-so-obvious built-in features. Covering them all is beyond the scope of this report, but a few of the more important ones will be touched upon briefly. Consider, for example, the photo in Fig. 4. It is a closeup view of the head area with tape-head covers removed. What is unusual is the pair of heads that traverse the tape path from either side. These are the record and bias head, positioned on opposite sides of the tape. The technique is called cross-field recording and with it, Tandberg maintains that the tape can accept much stronger signals then with conventional techniques in which bias and recording signals are applied via a single recording head.

A simplified block diagram of the 10XD is shown in Fig. 5. The operation of the tape transport is controlled ele-

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

- Tape speeds: 15, 7½, 3¼ IPS. Speed Tolerance: ±0.3%. Wow-And-Flutter: (WRMS): (15 IPS) 0.04%; (7½ IPS) 0.06%; (3¼ IPS) 0.11%. Frequency Response: (15 IPS) 30-25 KHz; (7½ IPS) 30-22 KHz; (3¼ IPS) 40-18 KHz. S/N: (unweighted) 76; (unweighted, with Dolby) 66 dB. Crosstalk: (mono) 60 dB; (stereo) 50 dB. Harmonic Distortion: (0 dB Record Level) 0.2%. Mic Input Sensitivity: automatically adjusted for mic impedance; balanced mic inputs. From 1 mV to 130 mV. Line Input Sensitivity: Automatically adjusted from 100 mV to 5 V. Line Output Level: 1.5 V at 100-ohms load. Dimensions: 17¾" (45.1 cm) high by 17¾" (45.5 cm) wide by 7¾" (18.4 cm) deep. Weight: 56 lbs. (16.3 Kg). Suggested Retail Price: $1299.00.
tronically. Of the three motors used in this model, the two reel-motors are connected directly to the reel hubs while the third motor drives the tape capstan. The capstan motor is a servo-controlled brushless DC motor.

The 10XD is equipped with photoelectric stop. The tape passes between a lamp and a photo-transistor. At the end of the tape (or if a transparent leader passes through the tape path) the tape drive stops automatically and the pinch roller is retracted from the tape. The operation of the transport logic control is such that regardless of the order that the mode buttons are depressed, the electronic control and tape tension-adjusting system ensures that tape travel is always correct and the tape is never stretched or in any way damaged. Controlled braking is also accomplished electronically. A light-emitting diode and a photo-transistor sense whether the right reel-motor is rotating or not and sends the information to the logic control. At the instant when that reel motor stops, the logic control dictates that information and permits the tape recorder to go into playback with practically no delay.

In the 10XD, power from the capstan motor is transferred by a belt to the flywheel. This keeps the capstan motor far away from the tape heads to avoid interference pickup and provides a simple and stable power transfer system.

Additional features of the 10XD include automatic adjustment of the tape tension as the tape is transferred from one reel to another. What Tandberg calls “flying start” electronic editing permits the user to go directly from the play mode to the record mode while the tape is running, thereby permitting precision editing or recording revisions. As far as we know, the 10XD is probably the only high-speed (15 IPS) machine that has as flexible a Dolby system. For example, the 10XD

![Image of a diagram with various circuit components and labeled parts such as MIC, L, PRE, AMP, DOLBY ENCODER, REC, SELECT L, REC, SELECT R, EQUAL, REC AMP, DOLBY DECODER, OM, AMP, SOURCE/TAPE, REEL, STOP, WIND, REWIND, PLAY, RECORD, LOGIC UNIT, FUNCTION, DOLBY, WINDING MOTOR, BRAKE SOLENOID, CAPSTAN, AC/D C CONVERTER, COMPARATOR, DC REFERENCE, LINE OUT, RADIO OUT, HEADPHONES OUT, AUX OUT, SOURCE/TAPE OUT, AMP OUT, PRE AMP OUT, MIC AMP OUT, R, G, B.]

### TABLE I

**RADIO-ELECTRONICS PRODUCT TEST REPORT**

**Model: 10XD**

**Manufacturer: Tandberg**

<table>
<thead>
<tr>
<th>OPEN-REEL TAPE DECK MEASUREMENTS</th>
<th>R-E Measurements</th>
<th>R-E Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FREQUENCY RESPONSE MEASUREMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STANDARD TAPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency response @ 15 IPS (Hz-kHz ± dB)</td>
<td>29-27, 2-dB</td>
<td>Excellent</td>
</tr>
<tr>
<td>Frequency response @ 7½ IPS (Hz-kHz ± dB)</td>
<td>32-22.5, 2-dB</td>
<td>Excellent</td>
</tr>
<tr>
<td>Frequency response @ 3¼ IPS (Hz-kHz ± dB)</td>
<td>35-15, 2-dB</td>
<td>Superb</td>
</tr>
<tr>
<td>CRO1 TAPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency response @ 15 IPS (Hz-kHz ± dB)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Frequency response @ 7½ IPS (Hz-kHz ± dB)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Frequency response @ 3¼ IPS (Hz-kHz ± dB)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>DISTORTION MEASUREMENTS (RECORD/PLAY)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmonic distortion @ 10 VU (highest speed) (%)</td>
<td>0.9%</td>
<td>Very good</td>
</tr>
<tr>
<td>Harmonic distortion @ 3 VU (highest speed) (%)</td>
<td>0.7%</td>
<td>Very good</td>
</tr>
<tr>
<td>Harmonic distortion @ 0 VU (highest speed) (%)</td>
<td>0.5%</td>
<td>Very good</td>
</tr>
<tr>
<td>Harmonic distortion @ 3 VU (highest speed) (%)</td>
<td>0.7%</td>
<td>Very good</td>
</tr>
<tr>
<td>Recording level for 3% THD (dB VU/µV-meter)</td>
<td>+8/+2</td>
<td>Very good</td>
</tr>
<tr>
<td><strong>SIGNAL-TO-NOISE RATIO MEASUREMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best S/N ratio, standard tape (dB)</td>
<td>61 dB weighted</td>
<td>Very good</td>
</tr>
<tr>
<td>Best S/N ratio, CROi tape (dB)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>MECHANICAL PERFORMANCE MEASUREMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wow-and-flutter @ 15 IPS (% WRMS)</td>
<td>0.017</td>
<td>Superb</td>
</tr>
<tr>
<td>Wow-and-flutter @ 7½ IPS (% WRMS)</td>
<td>0.025</td>
<td>Superb</td>
</tr>
<tr>
<td>Wow-and-flutter @ 3¼ IPS (% WRMS)</td>
<td>0.07</td>
<td>Superb</td>
</tr>
<tr>
<td>Rewind time, 1800' tape (seconds)</td>
<td>90 sec.</td>
<td>Average</td>
</tr>
<tr>
<td><strong>COMPONENT MATCHING CHARACTERISTICS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microphone input sensitivity (mV)</td>
<td>0.5mV/600 ohm (see text)</td>
<td></td>
</tr>
<tr>
<td>Line input sensitivity (mV)</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Line output level (mV)</td>
<td>1800</td>
<td></td>
</tr>
<tr>
<td>Phone output level (mV or mW)</td>
<td>5 mW/8 ohm (see text)</td>
<td></td>
</tr>
<tr>
<td>Bias frequency (kHz)</td>
<td>Approx. 125</td>
<td></td>
</tr>
<tr>
<td><strong>TRANSPORT MECHANISM EVALUATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action of transport controls</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Tape guidance system</td>
<td>Excellent</td>
<td>Very good</td>
</tr>
<tr>
<td>Absence of mechanical noise</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Tape head accessibility</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Construction and internal layout</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Evaluation of extra features, if any</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>OVERALL TAPE DECK PERFORMANCE RATING</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

50
can be used with any tuner or receiver equipped with 25 microsecond de-emphasis to decode FM Dolby broadcasts even if you do not wish to record them.

Laboratory measurements

Some of the most important performance measurements taken for the 10XD in our laboratory are listed in Table I and these may be compared with published claims of the manufacturer. Note that we have used a 2.0 dB roll-off point in specifying frequency response simply because that is what Tandberg did. Were we to specify the 3 dB roll-off points (as most other tape deck manufacturers do), high-end response would extend even further than the impressive figures shown. Figure 6 is a plot of frequency response taken the three transport speeds. Maxell UD tape was used in all of these measurements. It should also be noted that 0 dB on the Tandberg's own meters really corresponds to +6 VU based upon NAB standards. This demonstrates the outstanding characteristics of the cross-field recording technique insofar as recording level capabilities without tape saturation are concerned.

As for wow-and-flutter, the readings shown are the lowest we have ever observed for a consumer-intended tape deck. Distortion at all levels observed was far below that conservatively listed by Tandberg, rising to 3% at +6 VU (+2 VU on Tandberg's meters).

A word of clarification is needed with regard to the single signal-to-noise measurement of 61 dB (weighted) that we show for this unit. First, the measurement was made without Dolby. With Dolby, the S/N would increase to around 66 or 67 dB as a single meter reading. If one were to use IEC A weighting in making the S/N measurement, the reading would be further increased to around 65 dB without Dolby and more than 72 dB with Dolby! Tandberg gives all these S/N numbers in their data sheet and our observations came out a bit better than the numbers they quote in every instance using our tape sample (Maxell UD).

Using the Tandberg 10XD

In its advertising literature, Tandberg suggests that the quality of the recorder can best be judged subjectively by switching from “source” to “tape” while making a recording. (This can be done without interrupting the tape recording process) and that is just one of the things they tried while using the machine for more than a week. The point of this test is to try to determine any difference between the source material (which should be of highest fidelity to begin with) and the recorded version of it. Suffice it to say, we could tell no difference even at the slowest speed of 3 IPS!

Tandberg has a winner here—and the serious recordist has a new machine to consider—one that sells for but a fraction of the total cost of those studio or professional tape recorders that it comes close to equaling.

R-E

PIONEER MODEL SX-1250

PIONEER BILLS THEIR NEWEST TOP-OF-THE-LINE Receiver as the most powerful in the world—and that it certainly is. But it is also a superior piece of equipment from several other viewpoints, and one that will appeal to the audio enthusiast who requires high power but hasn't the room or the funds to purchase a two-piece or even a three-piece high-fidelity configuration.

The front panel of the SX-1250 (shown in Fig. 1) is styled very much like that of Pioneer's separate tuners (and the front panels of many other new products made in Japan), in that it has abandoned the black-out dial approach that had become almost standard for most receivers in the last decade. Now, the linearly calibrated FM dial and AM dial speeds are highly visible even when the unit is turned off. Both tuning and signal-strength meters are centrally positioned above the dial scales and these meters are flanked with a series of colored rectangles containing legends that illuminate to denote the speaker system (or systems) in use, program source selected and reception of a stereo FM signal. The dial pointer itself is smoothly guided along the bottom edge of the sloped (for easy viewing) dial scales by means of a massive flywheel-tuning knob arrangement that is about the smoothest we have ever twisted.

A series of pushbuttons just below the dial area select one or two out of three possible pairs of speaker systems. Actuate low- and high-cut filters, turn FM muting

TABLE II

<table>
<thead>
<tr>
<th>Manufacturer: Tandberg</th>
<th>Model: 10XD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OVERALL PRODUCT ANALYSIS</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Retail price</strong></td>
<td>$1299.00</td>
</tr>
<tr>
<td><strong>Price category</strong></td>
<td>High</td>
</tr>
<tr>
<td><strong>Price/performance ratio</strong></td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Styling and appearance</strong></td>
<td>Superb</td>
</tr>
<tr>
<td><strong>Sound quality</strong></td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Mechanical performance</strong></td>
<td>Superb</td>
</tr>
</tbody>
</table>

Comments: It is difficult to come up with the proper superlatives with which to summarize this report. The Tandberg 10XD is certainly that company's best effort to date. We have never measured a machine with lower wow-and-flutter, or lower distortion at high recording levels. As we recall, Tandberg was the first company to prove to the world that high-fidelity recording results could be obtained even at low 3% IPS speeds and it is altogether fitting that they should have included that non-professional speed in this thoroughly professional deck. No doubt Tandberg's cross-field biasing technique has much to do with the amazing frequency response achieved at that slow speed, and the transport mechanism together with its governing electronic and logic control is as much a masterpiece of design as are the purely electronic elements that govern recording quality. The Dolby noise reduction system incorporated in this machine almost seems unnecessary—especially when the machine is used at its highest 15 IPS speed, but of course it provides the usual improvement in signal-to-noise and if users intend to make dubblings or re-recordings from master tapes originally recorded on the 10XD, those extra dB's of signal-to-noise capability really make a difference as each successive dubbing adds its own noise contribution. The Tandberg 10XD is adjusted to be used with low-noise, high-output tape and, since there are no selectable bias or EQ positions (other than those that are automatically adjusted as speeds are changed), the user would be well advised to use only that type of tape if best results are desired. Action of the logic-controlled transport is just about as perfect as anyone would desire and we have not seen a faster "start up" on any consumer machine. Pauses between fast and push modes are just long enough to prevent tape damage, but not so long as to negate the advantages of this fully-automated tool-proof automated transport system. All in all, we shall be most reluctant to part with this magnificent example of open-reel tape deck technology.

R-E
on and off, permit audible observations of multipath interference and select the various program inputs. The usual phone jack (at the left) and a pair of left- and right-channel microphone input jacks are also in line with these buttons. The lower section of the panel contains six rotary-controls and nine toggle-switches. Pioneer’s novel twin-bass and twin-treble control arrangement has been carried over from earlier receivers and affords a degree of tone control not possible with simple, single bass and treble control arrangements. The toggle switch between these pairs of controls defeats the tone control action entirely when desired. Other rotary controls are the usual balance control and a step-type master volume control calibrated in dB down to –70. Two tape monitor switches are augmented by a TAPE DUPLICATE switch (enabling tape dubbing from either tape deck connected to the other) and a fourth toggle switch labelled ADAPTOR that is in reality a third circuit interruption point suitable for connection of a four-channel or a third tape deck or other accessory. LOUDNESS, stereo/mono mode and audio MUTING switches plus a main POWER on/off switch complete this most carefully thought out from panel layout.

The rear panel, shown in Fig. 2, has three sets of spring-loaded SPEAKER terminals for connection of as many speaker pairs (only two of which may be heard at any one time), the usual PHONO inputs (two phono pairs of jacks), high-level AUX inputs, TAPE and ADAPTOR inputs and outputs and a pair of jumpers that interconnect the preamplifier output and amplifier input circuits. Antenna connection facilities include 300-ohm and 75-ohm coaxial for FM, plus external AM and ground terminals. A pivotable AM ferrite bar antenna is included, as are three convenience AC outlets (one switched) and an FM detector output jack for possible use with future FM 4-channel adaptors.

There is also a slide switch that selects 75-µs or 25-µs FM deemphasis (the latter required for Dolby FM listening if you have an accessory Dolby decoder). A DIN socket parallels the 32C input and output jacks.

Construction and circuit description

A view of the SX-1250 chassis with cabinet cover removed is shown in Fig. 3. Visible is a massive toroidal-core power transformer with separate windings for powering the left and right channels and flanking this transformer are dual pairs of 22,000 µF filter capacitors for each voltage polarity of each separate channel. Not visible, because of extensive use of shield covers, are the circuitry of the FM and AM sections of the receiver. Five-gang tuning is used in the FM front-end while three gangs are employed in the AM section. Dual gate MOSFETs are used for two RF amplifiers and mixer and the local oscillator is equipped with a buffer stage to increase oscillator stability. Four-phase

(Continued on page 60)
microphones in pro sound systems

Microphones are an important part of the professional sound system. Here's the ins and outs of selecting the right one.

JOE BLACK

IT IS VITAL TO EVERY SOUND SYSTEM that the proper microphone be used. For no matter how good the amplifier, no matter how well laid out the speakers, no matter how beautiful the auditorium or restaurant or meeting room or nightclub, the wrong microphone will destroy all the previous planning.

Yet, selecting a microphone can be easy if it is approached in a logical, step-by-step fashion. The procedure is simple and breaks down into four basic areas: (1) pick-up patterns (2) frequency response (3) the type of microphone and (4), last but not least, price.

Pick-up patterns

There are three basic types of microphone sensitivity patterns. Unidirectional, omnidirectional, bidirectional. The unidirectional picks up sound mainly from the front and at the same time suppresses sound and noise coming from the back. The most generally useful unidirectional pick-up pattern is the cardioid, meaning heart-shaped. This pattern successfully suppresses rear sounds by at least seventy percent, while picking up sound from the front over a broad area. Sounds 120° to 180° off-axis are almost entirely suppressed, but you must be sure to check the pattern of the particular microphone you plan to use to determine the exact cut-off angle. A typical pattern of a unidirectional cardioid microphone is shown in Figure 1.

The cardioid microphone is most commonly used to solve feedback problems. Because of its reception pattern (the rear of the microphone rejecting sound) it can be easily positioned so that sound projecting from the speakers of the system cannot re-enter the microphone and produce feedback. As a result, performers can work much further away from unidirectional microphones than they can with omnidirectional microphones, because amplifier gain can be set to a higher level without encountering feedback.

The use of the unidirectional microphone also reduces the affects of audience noises; coughing, shuffling feet, etc. Because of the wide reception area, it is also convenient to use for a fixed installation in front of an individual performer or even a small group. To cover a large group, multiple unidirectional microphones are necessary.

Omnidirectional microphones pick up sounds from all directions and with almost equal sensitivity. A typical omnidirectional pattern is shown in Figure 2. For all practical affects these microphones are non-directional. They can be hand held, stand mounted or worn around the performer's neck. These are perhaps the most commonly used microphones, and probably account for the largest number of microphones in use.

Omnidirectional microphones are great in applications where feedback or audience noise is no great problem. Since these microphones are extremely

*We wish to thank Shure Brothers Inc., Evanston, Ill. for providing the materials used to develop this article.
versatile, and many of them are thin, long, probe type units, they are perfect for walk-around and interview situations.

The bidirectional microphone (its pattern is shown in Figure 3 picks up sound from both front and back, but

**BIDIRECTIONAL MICROPHONE** has a typical pick-up pattern as shown.

suppresses the reception of audio signals from the side, the top and the bottom. This category of microphones is perfect when two performers or groups are positioned on opposite sides of the same microphone. It permits that same freedom of movement that you get when you use unidirectional microphones, yet helps solve feedback problems caused by rooms that have hard, reflective ceilings, or in set-ups where the loudspeakers are mounted directly over or to one side of the microphone.

**Frequency response**

Once you have decided on the kind of pick-up pattern your application demands, it's time to decide on the frequency response required. Because the fidelity of reproduction is not always the prime requirement. The frequency response of a microphone should be tailored to the application. For example: if you are going to do recording, broadcasting, or need a PA system that can handle quality music, you've got to look for a wide-range frequency response, and here your microphone must deliver a minimum of 50 to 15000 Hz. And the response has got to be both flat and smooth over that range. The best types of microphones for such an application are ribbon and dynamic types. On the other hand, if all we need is a quality public address system for voice and music, but total frequency response is not needed, we can get by with a microphone that only covers 70 to 10,000 Hz. It, like the wide range microphone, should have a flat response. It could be slightly rising, but definitely must have no prominent peaks. There are three types of microphones that can be used in this type of application. They are: ribbon, dynamic, and some of the better crystal or ceramic units.

If all we are concerned with is indoor paging systems and public address systems for voice only, a frequency response from 200 to 5000 Hz is more than enough. Again, it is desirable to have a response curve that is slightly rising and it must have no prominent peaks. For this kind of application, again, we can use ribbon, dynamic, and some the better crystal or ceramic microphones, but we can also use some controlled-magnetic mikes.

The final application area is for outdoor paging systems or systems that are installed in noisy locations, such as in a factory or warehouse. These systems are normally used only for voice, and the requirement here is maximum intelligibility of what is being said. Ideally, the response requirements should be limited, and the range of 300 to 3500 Hz is ideal. The response curve should be rising and should show a peak in the 2000 to 3500-Hz region. This peak is not mandatory, as in some situations it is not necessary, but it is helpful in improving intelligibility under the circumstances outlined. These microphones are available in controlled magnetic, dynamic, carbon, and some ceramic units.

In general, the more extended the frequency response of the microphone,
the more faithful the reproduction. Therefore, the more important reproduction quality is, the better and wider and flatter the frequency response you should look for.

A true high-fidelity microphone will deliver a response that is very smooth. When you look at its response curve, you should see no obvious abrupt peaks or valleys of output at any frequency. A mike that does this results in a smooth frequency curve and good high-fidelity type quality reproduction.

A flat frequency response curve, as we all know, is one that shows no change in the output signal over the frequency range. This means that the microphone responds equally well at any frequency, and as we so well know, this is an absolute must for hi-fi reproduction.

While we know that microphones that have the widest frequency range, coupled with the smoothest and flattest frequency response curves, will give the best fidelity, they are not necessarily best for every application.

For example, we often deliberately use a microphone that has a shaped response plus peaks in some area of the frequency curve so that we can add presence and improve intelligibility in systems used for paging and communications use.

**Types of microphones**

We will not attempt to present here a course on microphones, but instead will briefly summarize the five major types of microphones used in pro sound systems. These are ceramic, ribbon, controlled magnetic, dynamic, and crystal types.

**Ceramic microphones** are quite similar to crystal microphones in design. The difference is that the ceramic microphone uses a man-made ceramic element. These microphones are economical, and are better than crystal types for outdoor use since they are not affected by high temperature extremes and humidity changes. These mikes have a high output impedance too. Overall, whenever price becomes an important factor, ceramic microphones should be used. They are available in both omnidirectional and unidirectional units. All tend to be economical and rugged.

**The ribbon microphone** offers the great advantage of virtually uniform frequency response. It is definitely among the very best microphones available. It is extremely rugged for normal use indoors, offers adjustable impedance and is great for use wherever the quality of frequency response is the first consideration, such as in broadcasting, professional recording or PA systems intended to carry good music. They can be found in both omnidirectional and bidirectional versions. They are excellent for music, but are not recommended for outdoor use, however, they can be used outdoors if protected against wind and environmental conditions.

**The controlled-magnetic microphone** uses a balanced armature, and as a result, is rugged, stable and delivers high signal-output. This type of microphone was originally developed for the military to combine the advantages of carbon and dynamic microphones with none of the disadvantages. It has the ability to directly supply any needed impedance without using a transformer, and controlled magnetic microphones tend to be modestly priced and deliver dependable performance over a long life time.

These microphones can be used indoors or outdoors; in fact, wherever rugged performance must be coupled with a reasonable price and frequency response. They are ideal for paging, language labs, portable PA systems, and are normally available only in omnidirectional types.

**The dynamic or moving-coil microphone** is available in a wide range of types, styles, and prices. The better dynamic units are among the very best microphones for frequency response, flat response up to 20,000 Hz is not unusual.

These dependable units should be used where unusual performance coupled with ruggedness and reliability are required. These encompass broadcasting and better-quality public address systems. The dynamic microphone tends to be superior in frequency response to ceramic, crystal, carbon, and controlled magnetic units are available in both directional and omnidirectional versions.

**The crystal microphone** offers good quality at a low price. Response is normally somewhat limited, usually to somewhere around 10,000 Hz at the top. Sealed crystals used in some microphones makes it possible to use the crystal microphone in applications where high humidity could otherwise cause a problem. However, high temperature, such as indirect sunlight, over a prolonged period will normally require the use of another type of microphone. Crystal microphones provide high impedance and are primarily used where price is a limiting factor.

**Price is always a consideration**

Microphones vary from the very inexpensive to the very expensive, but compared to the total cost of a sound system, the microphone is often the lowest priced single item in the system. Despite this, the function of the microphone is critical. Actually, no sound system can be any better than the microphone that does the original conversion from sound into electrical impulses. If you want to make comparisons, the omnidirectional carbon microphones tend to be the most expensive, however, there are first rate omnidirectional and bidirectional microphones that can cost just as much as the unidirectional. If economy is the major factor, you've got to look at crystal, ceramic or controlled magnetic units. Where quality is the most important factor, a ribbon or dynamic microphone becomes a must.
The first part of this article (June 1976) presented the schematic and began the discussion of how the circuit works.

This second part of the article concludes the discussion of the main circuit board and presents the foil patterns.

Generating the ball

In a manner somewhat similar to that used to produce the paddles, we generate the ball. Two comparators are used to determine the vertical and horizontal coordinates of the ball. The actual position of the ball is set by the voltages appearing on the collectors of transistors Q3 and Q4. Q3 determines the vertical position and Q4 the horizontal position. When the horizontal ramp voltage reaches the voltage of Q3, pin 14 of IC6-d goes low, producing a negative pulse at pin 11 of IC5-d. These two pulses are passed by IC5-d to produce a positive pulse at the output pin 13 of IC5-d. This signal is the ball signal that is displayed on the screen via IC13.

Since the ball is always in motion, it is apparent that the voltages on Q3 and Q4 are constantly changing. The direction (positive or negative) of that change is determined by the state of two flip-flops, IC9-a and IC10-a. The signal at pin 5 of IC9-a determines the balls vertical direction. The signal at pin 9 of IC10-a determines its horizontal direction. The rate of change (ball speed) is determined by the rate at which the two capacitors C5 (vertical) and C14 (horizontal) are charging or discharging.

Let us assume for the purpose of this description that the ball on the screen is moving diagonally from the upper left to the lower right corner. When this is happening, the voltages on the collectors of Q3 and Q4 are both increasing in the direction of the incident flip-flops IC9-a and IC10-a are both in the set state.

Now the ball reaches the bottom boundary, and must rebound back into the playing field. The ball is made to rebound simply by changing its vertical direction, since IC9-a controls ball vertical direction, all that is required is to reset IC9-a. This resetting is done by the signal from pin 8 of IC7-c. The inputs of this gate are the signals from pin 9 of IC7-c and pin 10 of IC7-c. The ball signal is on pin 9 of IC7-c and the bottom boundaries on pin 10 of IC7-c.

If the ball and bottom boundary both occur at the same time (the ball has reached the boundary), both of these inputs will be high, causing their ANDed output to go low. This output signal goes to the direct clear input of IC9-a causing the flip-flop to reset, which in turn reverses the direction of the charge on C5 and Q3, thereby reversing the vertical direction of the ball.

The top boundary rebound functions in a similar manner. The ball is ANDed with the top boundary signal at pin 3 of IC7-b. When a coincidence occurs at the top boundary, IC9-a is set, causing the ball to reverse direction downwards. Diode D2 connected to pin 14 of IC4-d and pin 1 of IC7-b is part of the video circuit allowing the score to be displayed in the top boundary area and has no function in the rebound circuit.

Horizontal direction of the ball is controlled by IC10-a and Q4/C14 in a similar manner. Horizontal direction is reversed only in an instance where the ball strikes a paddle (or the bumper). Horizontal direction is reversed by resetting IC10-a. This is controlled by the output at pin 6 of IC7-a and pin 6 of IC8-a, which are ANDed outputs of the ball and right paddle and left paddle, respectively.

They are used to direct set or direct clear IC10-a in the same manner as IC9-a is controlled for vertical direction. Additionally, the output from pin 8 of IC8-b is the ORed signal from either paddle which indicates a paddle hit. The signal is used for the audio as well as in the ball angle randomizer circuit.

When the ball is hit

When the ball rebounds from a paddle, several other things take place. The ball may or may not change speed or angle. Whether or not it does is determined in the ball-hit randomizer circuit. This circuit is a pseudo-random pattern generator that gives ten different combinations to determine the ball's speed and angle. The ten combinations are provided for IC20, a counter, that is clocked at the horizontal sync rate (15, 750 Hz). Thus, the four outputs (A, B, C, D) are changing at rates of 7875, 3937, 1968 and 984 times per second.

When a paddle-hit occurs, the four sections of IC21 are enabled by the paddle-hit signal, and at that instant the pattern contained in IC20 is applied to the clock inputs of four flip-flops IC9 (a and b) and IC22 (a and b).

If the respective output of the pattern happens to be low at the time of the hit, the corresponding flip-flops will toggle. As a result pin 5 of IC9-a, which controls vertical direction, may reverse if the signal at pin 12 of IC20 happened to be low at the time of the hit, and so on for pin 5 of IC22-a and pin 9 of IC22-b.

The signal from pin 5 of IC22-a controls vertical speed. The signal from pin 9 of IC22-b is used to allow a newly horizontal shot. When set, it causes the signal at pin 11 of IC8-d to continuously toggle IC9 at a 7875 Hz rate. Thus the ball will travel nearly horizontally because the signal at pin 5 of IC9-a will be rapidly setting and resetting during the ball's travels across the screen, preventing capacitor C14 from either charging or discharging and the ball from changing its vertical direction.
The following items are available from Visulect, P.O. Box 4204, Mountain View, CA 94040. Also available from Technology Trends, P.O. Box 722, Manhasset, NY 11030

Main circuit board, with pre-aligned horizontal and vertical sync oscillators soldered in place. Includes circuitry (but not components) for paddle, paddle and boundary display, sound effects, computer-control module, paddle size selector, ball speed/angle randomizer, game action electronics for bumper and power filters. Order Kit MB-3: $29.50

Component kit for main board. Contains all additional ICs, IC sockets, transistors, resistors, diodes, trimpots and 5V regulator. Order Kit MBK-3: $48.50

Assembled and tested main board. Order MBA-3: $105.00

On screen scoring circuit board, including LSI character display generator IC. Order kit SB-3: $18.75

Component kit for scoring board contains all additional ICs, IC sockets, resistors, capacitors, diodes and trimpots. Order kit SBK-3: $20.50

Assembled and tested scoring board. Order SBA-3: $55.00

Accessory kit contains parts for external game control. Includes paddle potentiometers for horizontal and vertical motion, 6-wire cables for remote use of paddle motion potentiometers, paddle size potentiometer, switches for computer control and game selection, score reset push button, speaker and hook-up wire, knobs. Order kit AK-3: $25.75

Power supply, 12 volts DC. Powers the entire game including scoring module. Order kit PS-3: $8.70

Cases. Including main cabinet plus remote player control boxes. Order kit CC-3: $22.50


Ball speed

Should the ball encounter either the top or bottom boundary in this mode, the signal at pin 9 of IC22-b will be cleared through diodes D17 or D18 and the ball will rebound off the boundary. The two diodes, D15 and D16 that connect to pin 3 of IC2-a and pin 11 of IC8-a are simply an or gate to allow either gate to clock pin 3 of IC9-a.

Ball speed is controlled in both the vertical and horizontal directions. As was previously mentioned, the signal from pin 9 of IC9-b controls the horizontal speed while the signal at pin 5 of IC2-a controls the vertical speed. The element that determines the speed is IC12, a bilateral switch.

You will recall from the previous discussion that ball speed is a function of the charge rates of capacitors C5 and C14. These rates are determined by resistors R11 and R50. The values of these components were selected to produce the slower ball speeds. When the faster ball speed has been selected, an additional resistance R49 (or R51) is switched across the appropriate resistor by IC12 under the control of the signal from pin 5 of IC9 or pin 5 of IC22. This additional resistance effectively lowers the value of R11 (or R50) thereby increasing the ball's speed.

The computer-controlled paddles, a special feature of this machine and not to our knowledge seen elsewhere operates via IC1-b. By means of the external switch switches, the vertical paddle position voltage on pin 4 of IC4 and pin 6 of IC4 can be determined by either the player potentiometer or the computer control circuitry.

Recall the previous discussion of how the vertical position of the ball is determined by the voltage appearing on the collector of Q3. If this same voltage were applied to the paddle vertical position input, then the paddle should have the same vertical position as the ball. This is exactly the case. Instead of the player potentiometer determining the vertical position of the paddle, then a paddle is slaved to the ball. Thus, the paddle tracks the ball motion and always has the same vertical position as the ball.

Since there are two paddles, it is necessary to select which one is to be slaved to the ball. This selection is done via the remaining two sections of IC12 and is controlled by IC10. When the ball is travelling toward the left side, the left hand paddle is slaved to the ball. When IC10 caused the ball to reverse direction, the other paddle becomes selected at that time.

Registering a point

A miss is detected by two end boundaries which are generated by IC15 and IC16, although not displayed on the screen. The left-hand boundary is generated by stretching the width of the horizontal sync pulse to about 8 microseconds through pins 11 and 8 of IC15; and then by sending with the ball signal from pin 13 of IC5, the left-hand signal from pin 9 of IC10, and the inverted ball horizontal position signal from Q4 (also pin 11 of IC6) via pin 3 of IC15.

Coincidence of all four input signals on IC16 (ball presence, ball on left, ball going left, very near edge of screen) constitutes
MAIN CIRCUIT BOARD FOIL PATTERN shown from component side of double-sided board.

a miss. The output pin 8 of IC16 goes low, through IC15 which is used as an OR gate and sets pin 5 of IC17, which indicates a miss. Similarly, a right hand miss is detected by pin 6 of IC16, which detects ball off the screen to the right at the beginning of the next scan line.

With pin 5 of IC17 set, pin 5 is high, which allows capacitor C17 to start charging. When C17 reaches the required level, IC11, the re-serve timer generates a re-serve signal. The signal resets pin 5 of IC17 and also clocks pin 9 of IC10 causing the ball to reverse direction horizontally.

In addition, with the occurrence of a miss signal pin 5 of IC9 is cleared from pin 6 of IC17, which causes the ball to return to the top of the screen. You will note that the ball always re-serves from either the upper right or upper left corner.

In the August issue we will present the description of the second game “Bumper” and the remaining construction information, which will include the parts location diagram. This article has required more space than we originally expected, but we want to present all the information we have.

"Rampart, this is three. I have a mahogany patient, about four years old, picture weak, stand by for vital signs."
DC power supplies—how they work and how to troubleshoot and repair them

WHAT! DO A WHOLE TROUBLE-SHOOTING article on the DC power supply? Yes, SIR! This is a vital part of all electronics equipment. It is also the first thing that should be checked in any halfway logical approach to troubleshooting. If you have no DC power supply, none of the other stages can work at all. Besides, the DC power supply gives us a large percentage of the service jobs we run into.

Most of the circuits used are simple, and “stock”. But a large part of the mail we get shows that this circuitry isn't all that clear to too many of us. In addition to the regular problems, it can give us some real headaches, with the cause too often unsuspected. Let’s look over these circuits.

How do they work?

The stock AC-to-DC power supply is very simple. We feed an AC voltage to rectifier, which converts it to pulsating DC. The pulsations (ripple) are filtered out and we wind up with a nice smooth DC voltage. The DC voltage output is determined by the AC input voltage.

The simplest circuit is the half-wave rectifier of Fig. 1. The AC line voltage is fed directly to the rectifier diode. We come out with a series of pulses at 60 Hz; the polarity of these pulses is determined by the polarity of the diode. In tube sets, polarity is always positive; in transistor sets it can be either + or –.

Let's pause for a moment here and go over something that puzzles a lot of novices. Our AC input voltage here is 117 volts AC RMS. The DC output voltage is +140 volts. Are we getting something for nothing? No! The apparent gain of voltage is simply due to the way we read these voltages! Our AC voltmeter is calibrated in RMS, which is roughly 70% of the peak voltage. When the AC is rectified, we come out with a series of pulses, but these go to the peak value of the AC. Fig. 2 shows this relationship. These pulses are fed into the input filter capacitor and charge it up to peak voltage, and we could see a DC output voltage of about 160 volts, if there were no load at all on it. When we load the power supply, we are actually drawing out the charge that we put into the input filter capacitor. So, the voltage goes down somewhat. This capacitor is sometimes called a “reservoir” capacitor, for it acts like one.

The next most common type of supply is the full-wave rectifier. Fig. 3 shows a typical circuit. This type is generally used with a power transformer, with a center-tap in the high-voltage winding. The cathodes of the diodes are tied together for the + DC voltage, and the center-tap of the transformer secondary is the minus terminal, usually grounded. (If you put a resistor in series with this CT lead, you can develop a negative voltage across it. Lots of older sets used this circuit.)

The voltage output here has the same ratio as the first circuit. The DC voltage output is higher than the AC RMS input. Just as before, we can get a negative voltage by reversing the diodes (and the filter capacitors)! In tube type TV sets, the DC voltage will run from about 300 to 400 volts, always positive to ground. In solid-state TV sets, you may see voltages or either or both polarities. Voltages will be lower.

The “bridge” rectifier

If we use four diodes hooked up as a “full-wave bridge” (Fig. 4) we can save some money. The secondary doesn't need to be center-tapped, and it doesn’t have to be twice the DC voltage. It can be the same (well, approximately). For a +300-volt DC output, a full-wave rectifier transformer would have to be 270-0-270 volts AC, or +270 volts each side of center tap”. Using a full-wave bridge rectifier, we need only a 270-volt winding. The common-cathode connection of the bridge is the ' + ' terminal and the common-anode connection the –. We can get DC voltage of any polarity we need by grounding the appropriate terminal of the bridge.

Voltage doublers

A popular circuit for line-operated DC power supplies is the half-wave voltage doubler of Fig. 5. A polarized electrolytic capacitor is connected directly to the AC line input. (This confuses people, but wait. This capacitor does not have ac on it.) Two diodes are used; they are called the series diode and the shunt diode. A filter capacitor is connected across the output.

Here’s how it works: During the first negative-going half-cycle of the AC input voltage, input capacitor C1 charges up to the peak voltage, because diode D2 is conducting. During the positive-going half-cycle, D2 is cut off, but D1 (series diode) is conducting. So, the charge on the capaci-
tor C1 is fed through D1, in addition to the charge developed by the positive-going half-cycle. This action charges C2 (filter capacitor) to double the applied AC line voltage. C3 then discharges into the load, to give us a DC output voltage of about 260. Because of the presence and hookup of the diodes, C1 never actually has AC applied to it, though it does look like it! For reference, remember how a diode conducts: Fig. 6.

The full-wave voltage doubler

Another form of this circuit is shown in Fig. 7. It is called a full-wave voltage doubler. You'll find this circuit in sets with power transformers, because the AC input must be isolated. The basic action is the same as in the half-wave type. The only difference is that each diode charges one of the doubler capacitors while it is conducing; one on each half-cycle, so that we use them both. In effect, the doubler capacitors are charged in parallel, then discharged in series. So, we get double the input voltage again.

The "identifier" for this circuit is the low side of the ac line. Note that it goes to the junction of the two doubler capacitors and nowhere else! C3 is the filter capacitor.

Table I is a fault-chart giving the typical reactions to various faults in each of the rectifier circuits. Each one has its own peculiarities. These are valuable clues to the actual part causing the trouble.

The filter circuit

The "DC output" of each of these rectifier circuits still consists of pulses of current or voltage. This has too much ripple in it; we've got to get rid of it before we can use the DC. So, we "filter" it out. The stock filter circuit is called a "pi-filter" because the AC circuit is in and nowhere else. Though it does look like a transformer, it isn't one in the usual sense. The only AC circuit is in the primary, and nowhere else. One common mistake is to put in a larger fuse. This can allow serious damage to happen to the set, unless the circuit trouble that blew the original fuse is cleared!

Testing and test equipment

The DC power supply can be tested with only a few pieces of test equipment. A good AC/DC voltmeter is essential. A DC milliammeter can be very helpful. For some tests, a wattmeter is a time-saver, for reading the input power. Finally, the scope. We'll go into the uses of each in a minute.

Power supply testing can be very simple; just turn the set on and read the DC voltage under normal load. If it is up to the value shown on the schematic, fine. This is also a pretty good indicator of conditions in the whole set. If the DC voltage is normal, most of the trouble is OK. If it's below normal, you may have an overload somewhere. Its above normal, you have an open circuit somewhere.

There are only two types of faults in DC power supplies. One is "weak supply"; the thing won't supply enough current for normal operation, so down goes the DC voltage. The other one is overload; some stage or part is drawing too much current. This too pulls the DC voltage down. However, in the last one, something will usually get hot.

There is one easy way to tell which of these faults you have. Read the input wattage with a wattmeter. For example: the set has a normal input of 150 watts. You can get this figure from the service data, or by looking at the rating-plate on the chassis. You have low DC voltage. Plug the television receiver into the wattmeter and turn it on.

A reading of say about 75 watts means that you have something weak, or open. A reading of 250 watts means that something is leaky; about 400 watts means that you've got a big fat short somewhere! This should be the first step in the actual diagnosis. More on this useful instrument later.

<table>
<thead>
<tr>
<th>Circuit</th>
<th>DC Voltage Low</th>
<th>No DC Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half-Wave</td>
<td>Open input filter capacitor</td>
<td>Open diode, open surge resistor, shorted input capacitor</td>
</tr>
<tr>
<td>Full-Wave</td>
<td>Open input filter capacitor</td>
<td>Open diodes, or shorted input filter</td>
</tr>
<tr>
<td>Full-Wave Bridge</td>
<td>Open input filter capacitor (NOTE: one diode in bridge open will not reduce DC voltage by very much, but will increase ripple)</td>
<td>Shorted filter capacitor</td>
</tr>
<tr>
<td>Half-Wave Doubler</td>
<td>Open input filter capacitor</td>
<td>Open input doubler capacitor, diode or surge resistor</td>
</tr>
<tr>
<td>Full-Wave Doubler</td>
<td>Open input filter, one diode open, one doubler capacitor open</td>
<td>Shorted filter capacitor</td>
</tr>
</tbody>
</table>
Weak supply problems

Let's take the easy one first, the weak supply. In half-wave and full-wave circuits, a low-emission rectifier tube or selenium rectifier can cause it. For a quick check, just shunt a silicon diode across the original rectifier. If the DC voltage comes up, replace the old one. The same symptom can be caused by a low-capacitance or open input-filter capacitor. Since it acts as a reservoir to hold the charge, the DC voltage drops when it loses capacitance. Here again, just shunt another capacitor across the suspected one. If the DC voltage comes up, that was it.

In both half-wave and full-wave voltage doubblers, low or open capacitors will reduce the DC voltage. In the half-wave circuit, the input doubler (not the filter, the doubler capacitor) can reduce the DC output to almost nothing if it opens. Clue: there will be very little AC voltage on the rectifier side of this capacitor. In the full-wave doublers, if either one of the doubler capacitors opens, down goes the voltage. Clue: half normal output DC voltage across one of the capacitors, very little across the other. It is a good idea to replace both of them. It must be matched.

NOTE: do not bridge large electrolytic capacitors across others in transistor power supplies, with power on. This causes a large transient, and can damage transistors. Turn the power off first.

In a full-wave bridge rectifier circuit, an open input-filter capacitor will drop the voltage; same reason. If one of the diodes in the bridge should open, the DC voltage will not drop by very much, but the ripple will go up quite a lot.

Overloads and shorts

An overload is just that. Something is trying to draw far too much current from the DC power supply. Typical symptoms are low DC voltage and something getting very hot (like the power transformer). The input power reading will be well above normal, and fuses or circuit breakers will open up.

This can be caused by a shorted part in the DC power supply itself. Silicon diodes should be checked; you can do that with an ohmmeter. All good silicon diodes should show a high resistance one way and a much lower one with the ohmmeter prods reversed. A shorted one will usually read almost zero both ways.

Electrolytic filter capacitors can short. These too can be checked with the ohmmeter. Hint: electrolytic capacitors will show a low resistance if the ohmmeter polarity is reversed; always reverse the ohmmeter prods. In a full-wave bridge rectifier circuit, you will probably get a low ohms reading both ways! One of the diodes will always be forward biased and conducting. For a definite check, lift the DC output lead of the bridge, and repeat the resistance check.

Electrolytic capacitors can develop high leakage, causing an overload. The clue to this is a "hot can" in the can types. Normally, electrolytes should not be warm, unless there is a hot tube nearby. If the can is hot, leakage is too high.

Breaker tripping

Circuit-breaker tripping is often the sign of an overload. Note that I didn't say "always." The breaker may be tripping on too little current. To check, let it trip; then clip a duplicate breaker across its terminals, and turn the set on again. If this one trips, then you do have an overload. There are several other tests, as usual. You can connect an AC ammeter across the terminals of the breaker and read the actual AC current being drawn.

Power transformer shorted?

In quite a few cases, we have trouble finding out whether the short is in the load circuits or in the power transformer itself. It's not too hard to tell. One good check is to disconnect all loads from the secondaries, plug it in and let it sit for about 15 minutes. If it isn't shorts, the case will still be at room temperature. If there is an internal short, the case will be pretty hot. The wattmeter can be used here; a good transformer, with no load, will show a very small reading, about 5 watts or less, with a wattmeter in its primary. This is the "iron loss" of the transformer. Note: the wattmeter used for this test must be the "true wattmeter" or dynamometer type with a current coil and voltage coil. You can identify one by the fact that the meter has four terminals.

You can make an "emergency wattmeter" by connecting a 1-ohm resistor in series with the AC circuit, and then hooking an AC voltmeter across the

(continued on page 108)

TABLE II—TROUBLESHOOTING CHART

<table>
<thead>
<tr>
<th>SYMPTOM: NO DC VOLTAGE</th>
<th>SYMPTOM: LOW DC VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATTAGE HIGH</td>
<td>CHECK AC INPUT VOLTAGE</td>
</tr>
<tr>
<td>WATTAGE LOW</td>
<td>TUBE RECTIFIER WEAK</td>
</tr>
<tr>
<td>FULL-WAVE BRIDGE: SHORTE DiODES, LEAKY FILTER CAP</td>
<td></td>
</tr>
<tr>
<td>HALF-WAVE, FULL-WAVE: SHORTE DiODES, LEAKY FILTER CAP</td>
<td></td>
</tr>
<tr>
<td>HALF-WAVE DUBLER: SHORTE DiODES, LEAKY INPUT DUBLER OR FILTER CAP</td>
<td></td>
</tr>
<tr>
<td>FULL-WAVE DUBLER: SHORTE DiODES, LEAKY INPUT DUBLER OR FILTER CAP</td>
<td></td>
</tr>
<tr>
<td>HALF-WAVE DUBLER: SHORTE DiODES, LEAKY INPUT DUBLER OR FILTER CAP</td>
<td></td>
</tr>
<tr>
<td>FULL-WAVE BRIDGE: OPEN INPUT FILTER CAP</td>
<td></td>
</tr>
<tr>
<td>note: THIS CHART COVERS ONLY TROUBLES IN THE DC POWER SUPPLY ITSELF, NOT SHORTS OR LEAKAGE IN ANY OF THE LOAD CIRCUITS</td>
<td></td>
</tr>
</tbody>
</table>

FIG. 9—COMPLETE DC POWER SUPPLY.
WITH THE RECENT INCREASE OF CB radios, we're beginning to get the kind of complaints that we got on ham transmitters. These complaints are in regards to interference with other services—radio, TV, stereo, hi-fi and musical instrument amplifiers, as well as PA systems.

The problems in TV are beats and lines on the screen and garbled voice signals in the sound. In audio amplifier systems, it's different. The interference is usually loud and clear. Speaking of loud, one reader says that it almost broke windows in his home—he had a 500-watt amplifier!

The cause is usually unmistakable. When your stereo suddenly booms out "Big Bad Bertha to Poodle! Pete. Is Smokey in sight?", there isn't much doubt! However, before I get run over by a 16-wheeler, let me say this in self-defense. Hardly any legally operated CB radio will cause this severe interference. Not in a properly designed radio, stereo, TV or PA system.

Causes

People say, "But this is an RF signal. How can it get into my audio amplifier?" Easy. The input of a modern audio amplifier is pretty sensitive. When there is a strong RF signal at the input, it can be demodulated by the first preamplifier stage. After this, it's audio and goes sailing right on through. Transistor stages are especially prone to this. Any of the junctions can act as a diode detector. A tube stage will do the same thing in a slightly different way.

In fact, this is a well-known servicing trick. I have used it for many years in testing audio amplifiers, particularly PA systems. I just connect a TV antenna to the input (see Fig. 1). Any antenna with continuity will do, an open-end type like a simple dipole will make it hum very badly. If the amplifier is working, it will sit there and "radio" all day. This works in any place with a fairly strong local radio station.

That's what happens in audio amplifiers, we'll get to the TV later. Now, how can we stop this? The cure is fairly simple; just kill the RF signal at the input of the amplifier. All we need to do is add a simple filter to eliminate the RF. This should have no effect on the audio signals. The simplest way of doing this is to connect a small bypass capacitor, say 250 pF, from the base of the first preamp stage to ground. This will look like a dead short to the RF and a very high resistance to the audio signals. The 250-pF capacitor has 650,000-ohms reactance at only 1.0 kHz, but only 200 ohms at 27 MHz. Be sure to use the shortest possible leads and connect it directly from the base of the transistor to ground, as shown in Fig. 2.

If this helps but doesn't cure the problem, add a small RF choke in series with the lead from the audio input to the base of the transistor. Figure 3 shows the addition of the RF choke. Here we're taking advantage of
the opposite characteristics of a coil to a capacitor. A 1.0 millihenry choke has only 31.4-ohms reactance at 5,000 Hz, but almost 200,000 ohms at 27 MHz. If you still need more attenuation, you can convert this into the familiar pi-type filter by adding another capacitor to ground at the input jack (see Fig. 4.)

If you want to do a little extra work, you might even try tuning this filter to 27 MHz! Or, rig up a parallel-resonant circuit and put this in series with the input lead. Ordinarily, this isn't needed.

Shielding
Oddly enough, this kind of interference will be found even though all leads are shielded. I don't really understand this, but it happens. The RF signal may be coming into the chassis on the AC lines. This could be cured by the same basic method. Bypass the AC line to chassis right at the point where it enters. It might be that the shielding braid on audio cables, though adequate for audio, isn't "tight" enough for RF. In difficult cases, you might try adding a "bottom plate" to the amplifier chassis. A piece of aluminum foil held by the mounting bolts will do nicely.

**CB in the TV**

Now we come to a more difficult type of CB interference—in TV sets. The typical symptom will be beats in the picture, sometimes these will be in the form of a typical 120-Hz hum-bar. There will be two bands of wiggles across the picture, sometimes affecting the color, sync, etc. In most cases, you'll be able to hear garbled voice signals along with the TV sound.

Here we have several possibilities. One, the 27-MHz RF signal may be getting into the tuner. The signal can beat with the TV station signal or the local oscillator, or simply develop its own harmonic beats in the mixer. TV RF stages are not noted for sharp selectivity. If they were, they wouldn't work. If there is a 2nd harmonic developed in the mixer, it would produce some dandy beats, sidebands, etc., right in the middle of the TV's bandpass!

A less common but possible place for RF pickup might be in the IF input. The 2nd harmonic would be developed in the 1st IF stage. This is one place...
where we might get better results by shielding. The coupling from the tuner to chassis is through an RF coaxial cable. If the IF stage is properly shielded, as is customary, pickup in this area should be very rare.

In the large combination sets with TV and a stereo amplifier, we could get pickup directly on the audio system input. If this happens, the cures mentioned can be used.

**Tuned traps**

In cases where you're almost certain that the problem is caused by RF pickup on the lead-in, you should be able to minimize it with tuned traps. A high-pass filter can be connected between the lead-in and TV input terminals. If this is efficient enough, it should be able to reduce all RF signals below about 40 MHz. You can get these already made, but get a good one. I have tried some of the cheaper ones. I couldn't even tell they were in there!

**The FCC**

In most cases, complaining to the FCC won't do a great deal of good. At least not immediately. The FCC is overloaded right now. You should exhaust all local alternatives first. For one reason, (I repeat) it is possible for a perfectly legal CB transmitter to cause some interference to a radio, TV or audio amplifier that isn't properly designed to reduce RF pickup at its input. The better amplifiers do have this protection built-in. For consumers, the first step should be to check with your radio-TV technician. He can probably help the situation with some of the things mentioned.

A good CB transmitter doesn't radiate enough 2nd harmonic signal to give any trouble. FCC type-acceptance specifications require that the 2nd harmonic emission be held to a very low level—60 dB down or more. It is possible for 2nd harmonics to be bothersome, but in most cases these are generated inside your own set!

Another good way to get help is to contact the head of the local CB or amateur radio club. These groups are interested in clean interference-free operation and reception.

Listen carefully to any interfering transmissions. Make notes of any handles used, or even a call-sign. See if you can get any idea of the location of the station. When you get some information, ask the CB'ers to check it out. When you have something to go on, then write or call the nearest FCC Field Office, giving dates, places, type of interference and so on.

Speaking to the electronics technicians, check up on cases of CB interference in your area. Eliminating this is often quite simple and can provide a good source of extra business. Follow the suggestions given and you may be able to help clear up the problem. Technicians, listeners and CB clubs working together can help clean up this particular kind of noise pollution. R-E

---

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**reader questions**

**INSTRUMENTATION PROBLEM**

I'm having difficulty in trying to fix a black-and-white Zenith. After tube changes, the raster came back. Now I have some very unusual readings! The grid of the horizontal-output tube ought to be −39 volts, and I read a +100 volts. The horizontal oscillator grid ought to be −70 volts, and I get +125 volts. Others are also off. The only voltages I get that are normal are the boost at +680 volts and B+ of 260 volts. I've changed some capacitors and resistors, but I still can't get any change in these readings. What else can I try?—G.S., Baton Rouge, LA.

We have a couple of contradictory statements here! If you do have a raster, a picture, and a boost voltage of +680 volts (normal), this set is work-
ing! It couldn’t possibly work with the grid voltages you read. So, I think the first thing to try would be another voltmeter. For a crystal-ball guess, your voltmeter is giving you incorrect readings because of the presence of high pulse voltages. I’ve had this happen to me. You need a bypass capacitor across something to prevent this.

AUDIO POWER MODULES
I’ve just gotten hold of some RCA HC2500 100-watt power amplifier modules. What would be the best way to get a 200-watt power output from these? Could I use one of these as a booster for another?—D.K., Commack, NY.

You can’t increase the power output of these above the rating. However, you could easily get a 200-watt total output by using two modules, each driving its own speaker system, and feeding the inputs in parallel. The power supply would have to be beefed up to handle the extra current drain, of course.

ODDBALL SYMPTOMS
This set came in with no high voltage. I found a short between the horizontal and vertical windings of the deflection yoke. Replacing this, I put my DC milliammeter in the cathode circuit of the horizontal output tube. Now I get some very odd reactions! There’s a chirping in the flyback and it loses horizontal sync, then there is a frying in the flyback. Current through the output stage decreases and the high-voltage goes down.

I checked several things, including the filter capacitor—no help. I accidentally grabbed the leads to the meter and the high-voltage came back! I found that I could twist these and it came back to almost normal. Taking the meter out, it works fine. What’s going on here?—R.O., Daly City, CA.

You’re getting some kind of screwball feedback due to pulse voltage across your milliammeter! When you grabbed the leads, you added some shunt capacitance. Add a 0.5 \( \mu F \) capacitor right across the meter and you won’t have this trouble any more.

RCA TRANSISTOR NUMBERS
I’m not having any luck crossing the IF transistors from an RCA CTC-38 against the substitution guides! Especially the 3536, AGC; 3535, 1st IF, and 3576 3d video IF. Any ideas?—G.R., Clymer, PA.

Try using the stock numbers. In the RCA SPG-202R Transistor Manual, the ones you’re looking for are on page 110. AGC transistor, 124573 = SK-3122. The 1st and 2d IF, 124757 = SK-3117. The 3d IF 124754 = SK-3132. The secret is to keep looking until you have found all of the numbers that start with “124.”—R.E.

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Circle 17 on reader service card
linear ceramic filters, two IC's and an LSI circuit are employed in the FM-IF section.

The multiplexer decoder section uses the now-popular phase-locked-loop IC circuit plus low-pass output filtering for extra subcarrier suppression. FM muting employs a reed relay for positive action at the threshold signal level. The AM circuit uses an IC to replace most discrete components. The phono equalizer-preamp section uses a three-stage direct-coupled circuit powered by relatively high (±49 volts) supply voltages for high overload characteristics. A dual-polarity supply is used to power the tone control stages, too.

A two-stage class-A differential amplifier is used as the input stage of the power amplifier section that is entirely DC-coupled and the output section (drivers and outputs) consists of a three-stage Darlington direct-coupled circuit with power transistors arranged in a parallel push-pull circuit. The electronic protection circuitry of the SX-1250 uses a power relay which also delays turn on until the supply voltage has been stabilized. A block diagram of the entire receiver (one amplifying-channel only) is shown in Fig. 4, while Fig. 5 shows the variety of auxiliary equipment that may be connected to the unit.

**FM performance measurements**

A summary of FM performance measurements made in our lab is listed in Table II. We feel that Pioneer "pushed" sensitivity specs just a bit too far in their published literature. While a given number of receivers may well meet the 1.5 µV (8.7 dBf) usable sensitivity figure claimed, that is so difficult to maintain consistently in production that the company would have been well advised to settle for a 1.7 µV (10 dBf) claim—which is what we measured for our sample—rather than risk failing to meet what is at best an unimportant spec.

We have also advised Pioneer that their interpretation of the new dBf notations in their literature is *not* correct. In our list of Manufacturer's Published Specs shown

![Image](image-url)

**TABLE II**

<table>
<thead>
<tr>
<th>SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE</th>
<th>R-E Measurement</th>
<th>R-E Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF sensitivity, mono (µV) (dBf)</td>
<td>1.7 (10.0)</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sensitivity, stereo (µV) (dBf)</td>
<td>3.0 (14.9)</td>
<td>Excellent</td>
</tr>
<tr>
<td>50 db quieting signal, mono (µV) (dBf)</td>
<td>2.4 (13.0)</td>
<td>Good</td>
</tr>
<tr>
<td>50 db quieting signal, stereo (µV) (dBf)</td>
<td>50.0 (39.3)</td>
<td>Very good</td>
</tr>
<tr>
<td>Maximum S/N ratio, mono (dB)</td>
<td>81</td>
<td>Excellent</td>
</tr>
<tr>
<td>Maximum S/N ratio, stereo (dB)</td>
<td>73</td>
<td>Excellent</td>
</tr>
<tr>
<td>Capture ratio (dB)</td>
<td>1.0 dB</td>
<td>Excellent</td>
</tr>
<tr>
<td>AM suppression (dB)</td>
<td>58 dB</td>
<td>Excellent</td>
</tr>
<tr>
<td>Image rejection (dB)</td>
<td>Greater than 100</td>
<td>Excellent</td>
</tr>
<tr>
<td>IF rejection (dB)</td>
<td>Greater than 100</td>
<td>Excellent</td>
</tr>
<tr>
<td>Spurious rejection (dB)</td>
<td>81 dB</td>
<td>Very good</td>
</tr>
</tbody>
</table>

**FIDELITY AND DISTORTION MEASUREMENTS**

- Frequency response, 50 Hz to 15 kHz (dBf): +0, -1.0
- Harmonic distortion, 1 kHz, mono (%) : 0.14
- Harmonic distortion, 1 kHz, stereo (%)     : 0.20
- Harmonic distortion, 100 Hz, mono (%)      : 0.12
- Harmonic distortion, 100 Hz, stereo (%)    : 0.20
- Harmonic distortion, 6 kHz, mono (%)       : 0.14
- Harmonic distortion, 6 kHz, stereo (%)     : 0.24
- Distortion at 50 kHz quieting, mono (%)    : 0.6
- Distortion at 50 kHz quieting, stereo (%)  : 0.25

**STEREO PERFORMANCE MEASUREMENTS**

- Stereo threshold (µV) (dBf): 4.0 (17.4)
- Separation, 1 kHz (dB): 48
- Separation, 6 kHz (dB): 42
- Separation, 10 kHz (dB): 36

**MISCELLANEOUS MEASUREMENTS**

- Muting threshold (µV) (dBf): 2.0 (11.4)
- Dial calibration accuracy (±kHz @ MHz): -300 kHz

**EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION**

<table>
<thead>
<tr>
<th>Control layout</th>
<th>Ease of tuning</th>
<th>Accuracy of meters or other tuning aids</th>
<th>Usefulness of other controls</th>
<th>Construction and internal layout</th>
<th>Ease of servicing</th>
<th>Evaluation of extra features, if any</th>
<th>Excellent</th>
<th>Superb</th>
<th>Very good</th>
<th>Excellent</th>
<th>Good</th>
<th>Very good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
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<td>Superb</td>
<td>Very good</td>
<td>Excellent</td>
<td>Good</td>
<td>Very good</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
separately, we have correctly specified the dBF versus microvolt readings. Pioneer, for example, interpreted 8.9 dBF correctly but paraphrastically called that reading equivalent to 3.0 µV across a 300 ohm input impedance when, in fact, it corresponds to 1.5 µV across that impedance. All other microvolt readings (listed alongside the dBF figures in Pioneer's literature) are equally in error by two- to-one, or 6 dB. We give Pioneer an "A" for effort in hastening to try to conform to the newly accepted measurements and notations but suggest that they re-read the standards very carefully. If you happen to pick up a spec sheet for any new 1976 Pioneer receiver or tuner, simply divide the "µV" notations that you will find listed near the dBF notations by two to get the right microvolt equivalent!

Nearly all of the measured results regarding FM performance were either very good or excellent, with the exception of 50 dB quieting in stereo which, on our sample, required a signal input of 39.3 dBF (50.0 µV/300 ohms). The various rejection ratios (image, IF and spurious) were, in fact, so superior that we could not measure them accurately with our lab equipment that had a 100-dB limit. Distortion readings in both mono and stereo were very good to excellent and we were particularly impressed with the low THD reading (0.24%) at the high-frequency test point in stereo where THD usually tends to get out of hand because of beat frequencies. Separation was also excellent both at mid frequencies and at the audio frequency extremes. Dial calibration was off by a consistent 300 kHz across the dial which simply means that the dial pointer needed to be shifted slightly (and is not indicative of mis-alignment of the RF section).

Amplifier and preamplifier measurements

The power amplifier was subjected to the usual one-hour preconditioning tests with no resulting heat problems or thermal cutout. The SX-1250 is one of very few receivers that boasts a 4-ohm power rating these days, since at 4-ohms considerably more current is delivered by the output circuits than is true under 8-ohm loads and not many receivers can pass the stringent FTC burn-in requirements when so loaded. Maximum power-output ratings were exceeded moderately under 8-ohm conditions before reaching the low 0.1% rated THD figure, and by a wider margin under 4-ohm load conditions. These and other results are listed in Table III. The IM distortion at rated power was almost as low as the THD, measuring only 0.095%. At the one-watt level, where many amplifiers tend to show higher or rising distortion, both THD and IM were still low.

Hum and noise for both phono and high-level inputs was very low, as would be expected from a receiver of this quality. But even more surprising was the incredible overload capability of both phono inputs which measured 540 millivolts.

continuing on page 82
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new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

ELECTRONICS TOOL SET. The model 250K is a 12-piece starter tool set for electronic technicians and kit builders in a compact plastic carry case with storage tray. Included are the Weller® UL listed 25-watt iron with two 750°F. tips, soldering aid tool and 10 oz. of resin core solder. From Xcelite®, 4" long-nose pliers, diagonal cutters and wire strippers, all with Poly-Cushion grips, a ¼" nutdriver, and both slotted and Phillips head screwdrivers with chrome vanadium steel blades and plastic handles.—Weller-Xcelite Electronics Div., The Cooper Group, Apex, NC 27502.

Circle 31 on reader service card

MINIATURE NEEDLE-TIP TEST PROBE with a miniature banana plug 48 inches long. Model 4071-48 includes a sharp, replaceable needle tip that easily pierces varnish or plat- ing to give a good electrical reading. Tough thermoplastic is molded directly onto the probe tip and wire lead, providing a strong, reliable integral unit. The pin tip plug is .080 inches in diameter, made of gold-plated brass. The stack-up is of beryllium copper spring, gold-plated, and accepts .080 inches diameter pin. Operating temperatures are from -25°C to +105°C. $2.50.—ITT Pomona Electronics, 1500 E. 9th St., Pomona, CA 91766.

Circle 32 on reader service card

25-WATT POWER AMPLIFIER, model F62500, is a compact monitor power amplifier for recording and broadcast studios and for commercial-sound and sound-reinforcement applications. It fills the need for an amplifier with higher power output than the company's 10-watt model 610 (shown), but with lower power than the company's 70-watt model 870 monitor amplifier. One important application of the new amplifier is for use by disc jockeys who want more headroom sound than can be provided by lower-power units while monitoring a record.

The unit is completely self-contained with a built-in 110 to 120 volt AC, 50 to 60 Hz power supply. Operating from a standard 600-ohm audio line, the amplifier readily drives an 8- or 16-ohm monitor loudspeaker. The model F62500 is housed in a compact chassis with brushed-aluminum front panel. Up to five of these amplifiers can be mounted in the company's 602 PM 5¼ by 19 in. rack-mounting frame.

Some important specifications of the amplifier are: power output (8-ohm load), 25 watts continuous; power output (16-ohm load), 15 watts continuous; harmonic distortion at full power, 0.4 percent; frequency response, ±1 dB from 20 to 20,000 Hz; hum and noise, 85 dB below rated output; and input voltage for full output, 0.4 volt.—Robins Industries, 75 Austin Blvd., Commack, NY 11725.

Circle 33 on reader service card

TOOLS FOR CABLE INSTALLATION. The D'versaBit combines a long flexible spring-steel shaft with high-quality drill bits in a tool system that reduces the time required for in-wall cable installations. The tools can be used for rapid installation of coaxial and electrical cable within all type of building walls. A standard quarter-inch drill is used to drive the tools.

The various items making up the system include: a ½-inch auger bit with a 54-in. flexible shaft for easy starting and a clean entrance hole; a ½-inch carbide-tipped masonry bit with a 54-in. flexible shaft for drilling cement blocks and plaster; and a ½-inch combination bit with a 54-in, flexible shaft for greater durability and general-purpose use. Also available is a special alignment tool to guide and hold steady the D'versaBit flexible shafts; a line-recovery pulling-grip attachment for drawing RG-59 and RG-6 coax cable through the drilled holes; and a 54-in. extension attachment.

Installers of burglar and fire alarms, TV cables, telephone lines and electrical power lines will find the new tool system indispensable for quick and easy installations.—Blonder-Tongue Labs, 4 Lake Brown Rd., Old Bridge, NJ 08857.

Circle 34 on reader service card

AM/FM STEREO RECEIVER, model 331. Tuner section uses circuit-board module construction, has frequency-linear variable capacitor, a low-noise MOSFET to improve sensitivity, and heavy sintered alloy flywheel
for smooth tuning. There is also a sensitive
tuning meter and a blackout dial face. Two
ceramic filters and IC's deliver first rate per-
formance. The model 331 is rated at 12
watts-per-channel, minimum RMS power
with both channels driven into 8 ohm speak-
ers over a bandwidth of 40 Hz to 20,000 Hz
with no more than 1.0% THD. Power band-
width is 40 Hz to 20,000 Hz at or below rated
minimum RMS power output and total har-
monic distortion. Frequency response at 1-
watt output is 25 Hz to 30,000 Hz, +2 dB,
-3 dB. IHF sensitivity is 2.5 microvolts,
signal-to-noise ratio is better than 65 dB,
selectivity is better than 60 dB, capture ratio
less than 1.5 dB. $200.00—Sansui Elec-
tronics Corp., 55-11 Queens Blvd., Woodside, NY
11377.

Circle 35 on reader service card

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Kriket KC-45 is built for external mounting
on boats, sports vehicles, tractors, or any
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the AFPC test point.
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Circle 22 on reader service card

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'feel' the difference in performance
between my conventional
ignition and the
Mark Ten..."

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eliminates fouling and cleans dirty plugs.

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into new life.

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Mark Ten B, available assembled or in
kit form; and the Mark Ten C,
assembled only.

Circle 23 on reader service card
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  8" x 6" 3 for $3.99
  6" x 11/2" 11¢ ea., 3 for $3.29

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  Listing includes axial & radial chip capacitors, transistors, and diodes.

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Circle 37 on reader service card

Circle 38 on reader service card

CAR FM SIGNAL BOOSTER, the Stereo One, is designed to help eliminate signal fade and flutter associated with weak-signal FM reception. The Stereo One can be used with any auto AM/FM radio without adverse affect on normal AM/FM operation. The circuit more than triples the received signal in the "on" mode to provide clear, crisp FM reception in fringe signal areas. The booster does not overload in strong-signal metropolitan areas.

The base incorporates the FONS anti-feedback phase cancellation suspension system. The unit comes with a walnut baffle and hinged, smoked, piezoglass dust cover. Approximately $300.00. The turntable is manufactured in Scotland by Ferguson- Fons and distributed by -Audio Dimensions, 4 Riverstone Drive, Weston Ontario M5P 2R6 Canada.

The Stereo One is a 2-piece unit consisting of the amplifier that mounts close to the auto radio and the ON-OFF control switch that mounts on the dash in any convenient location. The control switch includes an LED "on" indicator - The Finney Co., 34 W. Interstate St., Bedford, OH 44146. R-E

Circle 34 on reader service card

Circle 36 on reader service card

and keep operating during all weather conditions, the Kriet KC-45 is carefully crafted with an impact-resistant, Duralex cover for rugged dependability.

Kriet KC-45 outdoor speaker specifications: power handling, 5 watts, 9 watts program, 13 watts peak. Frequency response: 150Hz - 10,000 Hz. Impedance: 8 ohms. Shipping weight: 2 lb. 6 oz. -Acoustic Fiber Sound Systems, Inc., P.O. Box 18228, Indianapolis, IN 46218.
wavelength to the feed line to one of the verticals, the array provides an end-fire bi-directional pattern along the plane of the antennas as in Fig. 11-b. End-fire gain is 2.3 dB and beamwidth is about 80°. Note that broadside operation provides more gain while end-fire operation provides wider lobes.

When two identical vertical antennas are spaced one-quarter wavelength apart and fed 90° out-of-phase (by adding one-quarter wavelength to the feed line to one antenna) the radiation pattern is uni-directional in the shape of a cardioid with 120° beamwidth, 30 dB attenuation to the rear and 20 dB attenuation to the sides. Radiation is in the direction of the out-of-phase antenna (Fig. 11-c).

When three identical ground-plane verticals are spaced one-quarter wavelength apart and excited directly, 90° out-of-phase, the cardioid radiation pattern has a half-power beamwidth of 60°. This pattern can be switched in either direction. Inserting a one-quarter wavelength section in the feed line to one vertical causes the array to “fire” in the direction of that particular element. By using three radiators one-quarter wavelength (9 feet) apart in the form of a triangle, it is possible to steer the 60° cardioid pattern around the horizon in six steps while providing 4.5 dB over a single vertical radiator.

![Diagram](image1)

**FIG. 12—THIS THREE-ELEMENT PHASED ARRAY—Antenna Specialists’ Super Scanner MS119—provides 360° directionality by selecting one vertical dipole as the radiator and using the other two as reflectors.**

The switching system—usually controlled from the operating desk—selects the two radiators to be directly excited and the other that is to be fed with a 90° phase shift. This permits the beam to be switched to any one of six positions. A letter to the engineering department of most antenna makers will bring application notes and engineering reports that will make it easy for you to design your own steerable vertical array.

---

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**MODEL 3157**—15,000 volts DC.
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**MODEL 4312**—15,000 volts DC.
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**MODEL 3200**—10,000 volts AC.

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Circle 25 on reader service card
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Chicago, Illinois 60646

Electrically steerable antenna systems based on the phased array are the Super Scanner model MS119 by Antenna Specialists and the Turner Ultra Kicker. The Super Scanner (Fig. 12) consists of three elements mounted 120° apart on a bracket that mounts on a mast. Predetermined lengths of coaxial cable connect each element to a set of switching relays. The relays switch the cables so one element becomes the radiator while the other two are electrically lengthened to act as reflectors. All points of the compass can be covered by switching the 120° cardiod through three positions. The control switch has a OMNI/MONITOR position that provides an omnidirectional pattern for use when on stand-by or monitoring. When a call comes in, the operator turns the selector switch for the strongest signal.

Selecting your base antenna

Carefully consider your requirements before you select an antenna for your base. (If you have received your license and are anxious to get on the air, then obtain an inexpensive ground plane while you analyze your needs. A coffee break or jamboree is a good place to get an inexpensive antenna. Be wary if offered a phased-array beam at a bargain price. The relay switching box is generally jammed with coax coils that make up the half-wave or quarter-wave phasing sections. Many a CB'er and a few hams have been known to lop off the "extra" coax for use in a mobile installation or other application. If any of the phasing lines are shortened or removed, the system won't work right and you'll have to purchase new phasing networks—if you are smart enough to figure out why the antenna array won't work.)

Factors to be considered are desired range, terrain, elevation above mean ground level, weather conditions (if your winters are severe with heavy icing, you'll need a rugged system) and cost. A simple ground-plane will do for local contacts in fairly open terrain and residential areas. A half-wave antenna provides a little more range and is relatively free from precipitation static and man-made interference.

FIG. 13—HOW HEIGHT AND ANTENNA-TYPE affect the communications range. The curves are based on developing a 2-mV signal in a 108-inch mobile whip.

Use a beam if you need extended range or the ability to "punch" a signal into "dead spots" where signals are attenuated by terrain or tall buildings. Figure 13 (prepared from material developed by International Crystals Corp.) interference on their TV or radio. You may be innocent but you'll have a heck of a time proving it to him. Many neighbors antenna height above mean terrain level

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MODEL 100 AUDIO RESPONSE PLOTTING SYSTEM and general purpose sweep/square/triangle function generators, pulse generator, frequency counter and peak amplitude measurement sections. It is primarily intended to generate a frequency response plot on an X-Y recorder or scope.

Time base generator offers symmetrical or independent control of the positive and negative sides of the ramp providing a duty cycle of .7% to 99.3%. Frequency range is .0005Hz to 100kHz. Amplitude is 15Vpp into 500 ohms with ±5VDC offset. The time base output drives the X axis of an X-Y recorder.

Audio sweep generator provides manual frequency adjustment or log/linear sweep of 20Hz to 20kHz. Blanking mode produces zero reference line on X-Y recorder or tone burst. Amplitude is 15Vpp into 500 ohms or 10Vpp into an 8 ohm speaker.

Pulse generator frequency range is .0005Hz to 525kHz. Pulse widths is adjusted independent of frequency from 4 seconds to 40 nanoseconds. Outputs are complementory TTL. Peak amplitude measurement section measures internal or external signals from mike to power amp level. Amplitude output drives Y axis of X-Y recorder.

Frequency counter is 6 digit, line triggered, and reads either internal or external. Sensitivity is 50 mV peak at 20kHz.

Dimensions: 8 x 14 x 3. Warranty: 1 year. $525, stock to 30 days.

Circle 26 on reader service card

Circle 27 on reader service card

Circle 28 on reader service card
and the horizontal scale shows how far away each antenna will put a 2-mV signal into a 108-inch mobile whip.

Remember, if you use a beam and intend to do a lot of monitoring, you may miss an incoming call if the antenna is not aimed in the right direction. Too, before considering one of the really big rotary beams, give a thought to your neighbors. Many, seeing your big antenna, will immediately blame you for all the interference on their TV or radio. You may be innocent but you'll have a heck of a time proving it to him. Many neighbors will suspect anything unusual sprouting from your roof but won't give a second thought to a couple of verticals in your back yard. Don't ask for trouble.

NO RADIALS ARE USED on this Hy-Gain 488 antenna. It consists of a 70.5-inch fiberglass mast topped by a 52-inch stainless steel whip. Ratchet-type base permits mounting on flat or sloping surface.

WILSON ELECTRONICS' SUPER LASER 500 is a 16-element dual-polarized array on a 40-foot boom. It features 18-db gain.

If you need more information on antennas, there are lots of good books in your local library and on the shelves of a good book store. A glance through them will enable you to select one on your level. For a good, easy-to-understand treatment on antennas, take a look at The ARRL Antenna Book published by The American Radio Relay League. Another one of interest is The Truth About CB Antennas by Orr and Cowan.

Another good way to separate truth from scuttle-but is to arrange for your CB club to have a speaker from the engineering staff of one of the leading antenna makers. Some distributors have knowledgeable field agents that will be happy to speak on antennas at your next club meeting. Beware of a lot that you'll hear about antennas over the air. The best antenna in the world won't be satisfactory if it is not properly installed or if the owner expects too much from it.
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electronics
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teresting and useful part of your train-
ing.

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reer advancement.

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☐ Computers       ☐ Cable TV
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Address
City        State        ZIP
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Age
Employed by

Type of Present Work
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Our detailed VDM-1 Owner's Manual is available for $4, refundable with purchase of the VDM-1 Kit Price: (ext. 7/1/76). $199
(premium grade, low profile IC sockets included).

Write Us, about our other plug-in modules, compatible with the 8800 system.

HI-FI TEST REPORTS
continued from page 67

volts, the highest we have ever recorded for an all-in-one receiver we tested.

The complete range of tone control action, in discrete 2 step increments, is shown in Figs. 6 and 7. There are several nice things worth mentioning about the tone control system. For one thing, the rotary controls have distinct "stops" so that any of the curves shown in Figs. 6 and 7 (or combinations of both) can be reliably duplicated exactly. In addition, the sub-bass and sub-treble controls permit adjustment of the frequency extremes without affecting mid-range tones. Single or combined use of main and/or sub controls affords an unusually great choice of pre-
continued on page 84

TABLE III

RADIO-ELECTRONICS PRODUCT TEST REPORT
Manufacturer: U.S. Pioneer Electronics
Model: SX-1250

AMPLIFIER PERFORMANCE MEASUREMENTS

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER OUTPUT CAPABILITY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMS power/channel, 8-ohms, 1 kHz (watts)</td>
<td>169.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>RMS power/channel, 8-ohms, 20 Hz (watts)</td>
<td>166.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>RMS power/channel, 8-ohms, 20 kHz (watts)</td>
<td>167.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>RMS power/channel, 4-ohms, 1 kHz (watts)</td>
<td>235.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>RMS power/channel, 4-ohms, 20 Hz (watts)</td>
<td>232.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>RMS power/channel, 4-ohms, 20 kHz (watts)</td>
<td>200.00</td>
<td>Good</td>
</tr>
<tr>
<td>Frequency limits for rated output (Hz-kHz)</td>
<td>15-20</td>
<td>Very good</td>
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DISTORTION MEASUREMENTS

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonic distortion at rated output, 1 kHz (%)</td>
<td>0.077</td>
<td>Excellent</td>
</tr>
<tr>
<td>Intermodulation distortion, rated output (%)</td>
<td>0.095</td>
<td>Excellent</td>
</tr>
<tr>
<td>Harmonic distortion at 1 watt output, 1 kHz (%)</td>
<td>0.018</td>
<td>Excellent</td>
</tr>
<tr>
<td>Intermodulation distortion at 1 watt output (%)</td>
<td>0.002</td>
<td>Excellent</td>
</tr>
<tr>
<td>DAMPING FACTOR, AT 8 OHMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hum/noise referred to full output (dB) (at rated input sensitivity)</td>
<td>75 (weighted)</td>
<td>Good</td>
</tr>
</tbody>
</table>

PHONO PREAMPLIFIER MEASUREMENTS

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency response (RIAA = 0 dB)</td>
<td>0.2</td>
<td>Excellent</td>
</tr>
<tr>
<td>Maximum input before overload (mV)</td>
<td>540</td>
<td>Excellent</td>
</tr>
<tr>
<td>Hum/noise referred to full output (dB)</td>
<td>75 (weighted)</td>
<td>Good</td>
</tr>
</tbody>
</table>

HIGH LEVEL INPUT MEASUREMENTS

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency response (Hz-kHz, = -10 dB)</td>
<td>11.54</td>
<td>Excellent</td>
</tr>
<tr>
<td>Hum/noise referred to full output (dB)</td>
<td>85 (weighted)</td>
<td>Very good</td>
</tr>
<tr>
<td>Residual hum/noise (min. volume) (dB)</td>
<td>96 (weighted)</td>
<td>Very good</td>
</tr>
</tbody>
</table>

TONAL COMPENSATION MEASUREMENTS

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action of bass and treble controls</td>
<td>See Fig. 6</td>
<td>Excellent</td>
</tr>
<tr>
<td>Action of secondary tone controls</td>
<td>See Fig. 7</td>
<td>Excellent</td>
</tr>
<tr>
<td>Action of low frequency filter(s)</td>
<td>See Fig. 8</td>
<td>Very good</td>
</tr>
<tr>
<td>Action of high frequency filter(s)</td>
<td>See Fig. 8</td>
<td>Very good</td>
</tr>
</tbody>
</table>

COMPONENT MATCHING MEASUREMENTS

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input sensitivity, phono 1/phono 2 (mV)</td>
<td>2.2/2.2</td>
<td>Excellent</td>
</tr>
<tr>
<td>Input sensitivity, auxiliary input(s) (mV)</td>
<td>150</td>
<td>Excellent</td>
</tr>
<tr>
<td>Input sensitivity, tape input(s) (mV)</td>
<td>150</td>
<td>Excellent</td>
</tr>
<tr>
<td>Output level, tape output(s) (mV)</td>
<td>N/A</td>
<td>Very good</td>
</tr>
<tr>
<td>Output level, headphone jack(s) (V or mV)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequacy of program source and monitor switching</td>
<td></td>
<td>Very good</td>
</tr>
<tr>
<td>Adequacy of input facilities</td>
<td></td>
<td>Very good</td>
</tr>
<tr>
<td>Arrangement of controls (panel layout)</td>
<td></td>
<td>Very good</td>
</tr>
<tr>
<td>Action of controls and switches</td>
<td></td>
<td>Excellent</td>
</tr>
<tr>
<td>Design and construction</td>
<td></td>
<td>Very good</td>
</tr>
<tr>
<td>Ease of servicing</td>
<td></td>
<td>Good</td>
</tr>
</tbody>
</table>

OVERALL AMPLIFIER PERFORMANCE RATING

<table>
<thead>
<tr>
<th>Measurement</th>
<th>R-E</th>
<th>R-E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Very good</td>
</tr>
</tbody>
</table>
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Wat-50 V

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90° COLOR TV for most popular WCOLOR-TV SPEC Agency.
Hi-Fi Test Reports
continued from page 82

Cise tone control settings. Filter responses are combined (low cut and high cut) in Fig. 8 and cut-off points (−3 dB) were precisely at the frequencies specified, with slopes in both instances at 12 dB per octave as claimed.

A summary of our reactions to the SX-1250 will be found in Table I. We were especially pleased with the price and with all the controls on the panel of the receiver and particularly so with that master volume control. Those multiple, well-defined steps of attenuation are extremely practical to use and give the receiver a professional feel besides. The tape monitoring facilities, coupled with the tape duplicate feature will appeal to anyone owning more than one tape deck, regardless of the tape format, and the extra Adaptor jacks make it easy to add a Dolby decoder without having to give up one of the other tape monitor circuits for this purpose.

FM reception was excellent and that audible multipath indicator really works (as we proved by deliberately rotating our outdoor antenna to a less-than-optimum position). This multipath-minimizing scheme is actually easier to use than some of the visual indicators (meters or scopes) that have been used for this purpose.

AM reception was better than average, with considerably less variation of output level with change in signal strengths than we are accustomed to hearing on AM sections of all-in-one hi-fi receivers.

But by far the most impressive thing about the SX-1250 is its unbelievably high power-output capability. We were fortunate in having a brand new pair of full-range electrostatic speakers in the lab at the time we were testing this receiver. These speakers, while extremely smooth and well balanced in response, are notoriously inefficient and require lots of power to produce reasonable sound levels in a large listening room. They posed no problem whatever for this high powered Pioneer receiver. With conventional dynamic speaker systems of varying efficiencies, there were times when we felt that the bass reproduction could have been a bit tighter, but this is largely a matter of personal taste. $900.00 may seem like quite a lot of money to spend for an all-in-one receiver, but if you try to assemble this much power and equivalent performance using "separates" you will quickly conclude that the new Pioneer SX-1250 is a bargain at that!

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BUILD A COMPUTER
(continued from page 48)
the Dyna-Micro to select one of four possible onboard devices. These are the three groups of LED's and the keyboard. Address bits A3-A7 are all gated together in IC17, an OR gate made from a series of open-collector inverters in an SN74LS05 chip. If the 8-bit LO address specifies a value greater than seven, the OR gate’s output becomes a logic 1. Address bits A0-A2 are used in IC18, an SN74L22 decoder chip to provide a one-out-of-eight code for devices 0 to 7. The OR gate’s output is used to enable the decoder for the device coded 0-7, but to disable it for other codes. The decoding scheme is shown in Table VI.
You will notice that device-code 0 selects both the LED PORT 0 and INPUT PORT 0 (the keyboard). How can the computer output and input data at the same time. It can’t, and some means must be used to distinguish between them. The Control Logic section outputs two control signals, IN and OUT that indicate whether data will be input to the CPU or output to an external device. Both signals are exclusive, never taking place at the same time. The pulses are generated by the 8080A and the Control Logic section under control of the software. Only when we execute an I/O type instruction will either of these signals be generated. The device codes for the SN7457 latches are gated with the OUT signal in IC19, and the IN signal is gated with the keyboard device code in the DM8095 buffer chip associated with the keyboard, IC31. Data is input or output only when we have a valid device code and the presence of either the IN or OUT signals.

<table>
<thead>
<tr>
<th>TABLE VI—ON BOARD I/O DEVICE DECODER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OR</strong></td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
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<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

When we designed our cartridge holder, it wasn’t uncommon for an enthusiast to have several cartridges. Perhaps one for stereo, one for four-channel, and maybe an old favorite for special records. But with our new UNIVERSAL cartridges, this handy little idea may well be doomed. Because one UNIVERSAL cartridge is just fine, thank you, for both stereo and four-channel. New records and old. If you’re from the old school, ask one of our dealers to show you our holder. It can protect as many as three cartridges in their shells, while you play a fourth. But then ask to hear one of our UNIVERSAL models. There are four to choose from. And any one of them may be all you’ll need to own for every record in your library.

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KOMPUTER KORNER
(continued from page 24)

the ease with which it can manipulate addresses as data and convert data into addresses. Were it not for the 8080's ability to use the register file on either the "data" or "address" side, its ability in this area would be severely limited. As it is, we have the option of using the registers either way, with conversion between the two being readily accomplished using the instruction set. This makes this register structure much more versatile than its simple appearance would first indicate. It also makes this organization much more useful than having either three 16-bit registers or six 8-bit registers.

The stack pointer (SP) is a special type of memory address register. It maintains the address of a special region in read/write memory called, appropriately, the stack. The stack operates as a LIFO (last in, first out) memory buffer. Certain 8080 instructions cause the contents of the internal registers to be transferred into or out of the stack. When this happens, the stack pointer is automatically incremented or decremented so that it always contains the address of the top (last in) element in the stack. This makes it easy to save and restore the registers during program operation. All you have to remember is to take the data out of the stack in the opposite order that it was placed into it. This ease of saving the register contents and status makes the stack architecture very powerful, particularly for interrupt and subroutine programming. Ways to take advantage of a stack will be mentioned in later columns.

The program counter (PC) is used to determine the address in memory where the next instruction or data is to be found. In normal, sequential instruction execution, the program counter is incremented by one every time an instruction- or data-byte is fetched from memory. Certain instructions, however, can cause the contents of the program counter to be modified in various ways. When this is done, program execution jumps to the instruction specified by the new contents of the program counter. This is known as a program branch or jump. Program branches can be either unconditional or conditional. An unconditional branch is always executed, no matter what the state of the processor is when the instruction is executed. A conditional branch, on the other hand, will only execute if the state of the processor matches some specified condition. (For example, branch if the carry flag is set.) If the condition is not met, the processor ignores the branch instruction and continues executing where it is. Conditional branching is the way that any computer is able to make decisions based on the results of operations.

The eight-bit accumulator (A) is used in a variety of ways. For all 8-bit operations with ALU, the accumulator holds one of the operands and receives the result of the operation. For I/O operations, the accumulator serves as the I/O register with all data transferred to or from the various I/O devices passing through it. It serves as the primary memory data regis-
Memory addressing modes

With its 16-bit address bus fully decoded, the 8080 is capable of directly addressing 65,536 bytes of memory. To access all this memory, the 8080 provides three basic modes of memory addressing—direct, register indirect, and immediate. Direct addressing instructions contain the address of the memory location that contains data to be used in an operation in the second and third bytes of the instruction. Register indirect addressing instructions use the contents of one of the 16-bit registers (BC, DE, HL, or SP) to specify the memory location that contains the data to be used in the operation. Immediate addressing instructions contain the actual data to be used in the operation in the second and, if necessary, third bytes of the instruction.

Of the three address modes, the register indirect mode is the most versatile. It allows us to use the various instructions that manipulate the registers to form addresses for memory references.

Timing and control

The timing and control section of the 8080 decodes instructions, senses the state of the control inputs, and generates a sequence of control signals for both the processor and the external devices attached to the control output lines. The 8080 instructions are one-, two-, or three-bytes long, depending on the function performed. The first byte is always decoded to provide the operation to be executed. For two-byte instructions, the second byte provides either immediate data or an I/O address. For three-byte instructions, bytes two and three provide either double-length immediate data or a memory address.

To decode and execute these multiple byte instructions, the 8080 uses one to five machine cycles (M1...M5). Each machine cycle consists of from three to five states (T1...T5). All instructions require a four- or five-state first machine cycle, M1. Additional cycles, if required, are all three-states long. A general timing waveform is shown in Fig. 2.
The end of this time, the 8080 issues the WAIT signal high (indicating it is not executing) and enters the WAIT state (an extension of T1). The processor remains in the WAIT state until the READY line is again high, at which time it resets the WAIT signal low and enters state T0. Thus by controlling the READY line, peripherals and memories of varying speeds can be synchronized with the 8080. Once in state T0, the 8080 loads the contents of the data bus into the instruction register. The instruction is then decoded and executed during states T0 and, if necessary, T1. If the instruction executed was a 1-byte instruction, the processor then enters state T1 and the instruction executed was a 2-byte instruction, the processor then enters state T2, and, if necessary, T3.

For instructions requiring more than one machine cycle, cycles M1-M3 provide additional times for the 8080 to transfer data or addresses between the various internal registers and memory or I/O devices. Cycles M1-M3 are all three states long and all operate according to the same general sequence. During state T3, the processor issues the sync signal, places the processor status word onto the data bus, places some address information onto the address bus and enters state T1. The address information placed onto the address bus will depend upon the instruction being executed. It can be a memory address (specified by the contents of register BC, DE, HL, PC, or SP) or the address of an I/O device specified by an IN or OUT instruction. In the case of 1/I/O addresses, the same 8-bit I/O address appears on both A1 and A0. Once in state T3, the processor waits for the READY line to indicate that the memory I/O device is prepared for the data transfer. State T1 is then entered and the required data transfer is performed. The own and wa signals are used to indicate to peripherals and memory whether the 8080 is accepting input data or writing output data. If execution of the current instruction is complete, the processor enters cycle M3 of the next instruction. Otherwise it continues executing with the next cycle of the current instruction.

**8080 MANUFACTURERS**

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>City, State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Micro Devices</td>
<td>901 Thompson Road</td>
<td>Sunnyvale, CA</td>
</tr>
<tr>
<td>Intel Corporation</td>
<td>3065 Bowers Ave.</td>
<td>Santa Clara, CA</td>
</tr>
<tr>
<td>NEC Microcomputers, Inc.</td>
<td>5 Militia Drive</td>
<td>Lexington, MA</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>P.O. Box 1443</td>
<td>Houston, TX</td>
</tr>
</tbody>
</table>

**Conclusion**

The hardware architecture of the 8080 is obviously too complex to be treated thoroughly in this short space. Hopefully this brief overview will give you enough information to follow and understand references made to the various registers and other structures that will occur in later columns.
tions. At this point the chip has been protected from the hostile environment. What remains are the steps to metatize the wafer and bond to the package terminals so that this environmental screen is maintained.

Contact windows in the silicon dioxide are next opened up with conventional photomask operations. The wafer is sputtered with platinum and sintered in, forming platinum silicide low-resistance contacts. Titanium and platinum layers are sputtered on next. The platinum is etched with the metallization interconnect pattern and a gold layer electrolytically plated onto the platinum. So the three layers of the tri-metal process are titanium, platinum, and gold. The titanium layer has very good adherence to the silicon nitride contact areas. Platinum, the middle layer, is a diffusion barrier between the titanium and gold. Gold has very low resistivity, does not corrode and is perfect as a bonding surface for the connecting wires. The last wafer step is silicon dioxide passivation to protect against damage during handling in the wafer testing, pellet separation, and packaging steps.

RCA says that the product passed 5,000 hours of a standard 15-volt reverse bias test at 85 degrees C and 85% humidity life test with no failures. One percent failure of standard product with aluminum metallization occurs within 1,500 hours; a strong contrast.

The price schedule for the 741CG and 747G op-amps is $5.50 and $1.50 respectively at the 100 to 999 level. Other prices in the same quantity are: CA324G Quad Op-Amp, $2.50; CA372G4 High-Current NPN Transistor Array, $1.50; and the CA339G Quad Voltage Comparator, $2.25.

Let's hope that your next TV set with its probable complement of a half-dozen IC's will be easier to repair than this communications satellite in the sky with its unserviceable electronics package.

New Motorola releases

Motorola's CMOS MSI logic line has two new additions. They are the MC14560 NBCD Adder and the MC14561 9's Complementer.

The MC14560 is a 4-bit binary full-adder. It adds two 4-bit Natural Binary Coded-Decimal words (NBCD). This term refers to the normal 8-4-2-1 weighting convention.

An NBCD word at the data input of the MC14561 is transferred to its output terminals either complemented or uncompplemented as instructed by the complement control input. Putting the two IC's together gives a 4-Bit NBCD Adder/Subtractor.

The circuits are mounted in either ceramic or plastic DIPs and are grouped into two operating temperature ranges. The MC14560CP is a plastic –40 to +85°C unit which sells for $4.71 in small quantities. In the same lowest cost package and temperature range, the MC14561 goes for $1.45.

Motorola is also moving ahead with LSI MOS. Their new MCM6590L is a 2048 by 8 bit read only memory useful as a look-up table, for program storage, and in display terminals. The 16K ROM is mask programmable. Six conversion codes are factory programmed into the MCM6591L version. They are ASCII to and from Selectric (IBM), EBCDIC, and a modified 8 bit Hollerith. The same chip also has 128 USACII characters in mixed character fonts of 5 x 7 and 7 x 7 dot matrixes. They cost $23.95 each in 24 pin ceramic DIP packages in 100 quantities.

In the linear market, Motorola has the new MPC900 Negative Voltage Regulator. It covers a range of -4 to -30 volts at load currents up to 10 amps. These ratings do not lean on any external transistors since the MPC900 power dissipation rating is 100 watts. The regulator's TO-3 style package plugs into a roval tube socket. Price is $20.66 each in small quantities.

For more information on any of these new products, write to: Technical Information Center, Motorola Inc., Semiconductor Products Division, P.O. Box 20294, Phoenix, AZ 85036.

New microprocessor

MOS Technology has announced an 8-bit microprocessor, the MCS6501, first of a family. It is plug-compatible with the Motorola M6800. The new device uses N-channel, silicon gate, ion implanted, depletion load technology. It operates from a single 5-volt supply.

MOS Technology says the MCS6501 combines the compatibility of the M6800 bus system, the ready and indirect memory access of the 8080 and the on-chip clock of the 850.

True address indexing, two types of indirect addressing and two index registers are powerful features. It is designed for cost effectiveness with a price of under $20 in quantity.

Software plans include an efficient Cross Assembler and a Fortran-like software emulator.

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AUGUST 1976

CB Transceiver Roundup
What's new and available in CB gear. We look at the equipment and the features. We've included the new products our editors have seen at both the Personal Communications show in Las Vegas and the NEWCOM show in New Orleans.

Digital Clock Kits—1976
A special survey of the 35 different digital clock kits you can buy today. We examine how they work, list their specifications and tell you where you can get them.

New Digital Clock Module
Just announced by National Semiconductor, here's a preview of a new digital clock module that requires only the addition of a power supply and switches (and a case) to make a complete electronic digital clock.

Mindpower: Alpha
Unique brainwave monitor that has visual feedback. This month we get into the circuitry and take a look at the circuit boards.

Darkroom Countdown Timer
A digital darkroom timer that you set by using a calculator-type keyboard. It counts down and you can add an audio tone to the seconds.

PLUS
State-Of-Solid-State
Jack Darr's Service Clinic
Komputer Korner
Hi-Fi Lab Test Reports
Looking Ahead
Equipment Reports
and horizontal control amplifier IC14, IC15, provide control voltages to the horizontal and vertical comparators that can vary the "detect" points of the stages with respect to the horizontal and vertical ramp inputs. Since this determines the coordinates at which the electron beam will turn-on and shut-off, the apparent size of the rectangle is determined by the respective levels of the display control signals.

As we have now established the method for producing and sizing the on-screen display, let us now examine the method by which the minute alpha wave potentials produced by the brain achieve control of the display.

The Mindpower: Alpha user wears an elastic headband that places three electrodes against the skin of the forehead and scalp. Two of these lie opposite the brain's right frontal lobe and left occipital lobe, thus establishing differential signal-measuring points that traverse most of the brain's neural mass. These two electrodes provide the differential input to an FET differential amplifier, comprising Q15 and Q16. The third electrode connects to the isolated ground of the EEG amplifier, establishing a neutral reference on the skin that aids in the elimination of stray signal pickup. The FET-input stage provides extremely high common-mode rejection and a high input impedance, thus making it the most efficient processor of the very low-level brain wave signals obtainable at the cranial skin surface and picked up by the head-band electrodes.

All front-end stages of the unit are operated from a dual 9-volt battery power supply for user safety, and the amplified output of the EEG amplifier is safely isolated from the remaining stages by means of a photo-isolator (IC27). This ensures complete user safety.

The amplified neurological potentials of the FET input stage are applied to cascaded operational amplifier stages IC25 and IC26, that are optimized for response to signals in the 8- to 13-Hz alpha wave frequency range. Overall gain of the amplifier is approximately 100,000 and output appears across threshold control R92. This control can be set so that amplified alpha waves of increasing level are required to achieve audible or visual response. The selected alpha voltage is applied to isolator driver Q14. It drives the light-emitting diode section of optical isolator IC27. Hence, as alpha wave bursts are detected and amplified, IC27 converts these to light pulses which are transmitted across a space to a phototransistor. This, in turn, provides the alpha pulse to pulse shaper/differentiator Q8, Q7, in the display/beep control section (that is transformer-powered from the AC line).

The output signal of the isolated EEG amplifier section, for a given signal input, is a train of about-equal amplitude pulses, which are differentiated and applied to both 1-KHz beep oscillator IC20, and display motion generator IC18, IC19, Q5. The differentiated pulses key IC20 on and off so that an audible indication of alpha occurrence is provided to the user by the speaker. (This can be silenced by opening a switch.) The pulses also control the display motion generator's response in either of two ways, depending upon the units selected mode.

In Mode 1 (fixed display), incoming alpha pulses subtract from a fixed reference voltage, so that the display motion generator produces an output causing the display rectangle to shrink in size in proportion to the alpha produced. Return to normal size is automatic, if alpha is not sustained. In Mode 2 (moving display), the generator produces a rising ramp voltage which can be reduced by the arrival of an alpha wavetrain. This makes it possible for the user to hold the display "in check" on screen, or to move it down to smaller size by sustained alpha. Failure to sustain alpha causes the display to grow in size.

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Circle 79 on reader service card

July 1976
VERTICAL JITTERS

This Magnavox IT5502 has a bad vertical jitter and intermittent roll. I've checked tubes and changed the 171ZB twice. Scope seems to show everything OK around the vertical circuits. It's not the 20-µF capacitor in the AGC; I changed that! Where to go from here?—E.D., Tappan, NY.

Go to the DC power supply. Scope all of the DC supply lines feeding the sync separator. You may find some vertical-frequency pulses floating around. If so, one of the electrolytic filter capacitors isn't doing its job.

(Field Feedback: Right! A 200-µF electrolytic that reads less than 80-µF isn't too good. That did it.)

SAME PROBLEM, TWO TV SETS

I've got an Admiral PG910 and an RCA 172-4049 with the same problem. No high voltage. All of the DC voltages in both of them check out, including the boost. What have I done wrong?—M.B., Jackson, MS.

If your boost voltage is up to normal, you must have the right amount of driving pulse to the flyback. So, this will almost have to be something in the high-voltage rectifier tubes, sockets or the heater wiring to them. For a quick check, try replacing the tube with one of the solid-state rectifiers such as RCA SK-3067 or SK-3068. If this gives you high voltage, OK.

FLOATING COLOR BARS

I asked for help on finding the cause of two floating bars of color in the picture, on an Admiral. You suggested several things, but your post-script was the right one. The autodeguss coil was bad. Glad you had that last-minute thought!—L.B., Wallkill, NY.

So am I!  R-E

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Kit Includes: Woodlike Color Plastic Case, 4 Digit 1.2" Bright Yellow Color Display with AM/PM. TMS 3834 Alarm Chip, 2 pcs. double sided PC Boards, 16 transistors, all other components. Transformer and speaker.

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Japanese transistors. All transistors original factory made. Free catalog. WEST PACIFIC ELECTRONICS, P.O. Box 25837, W. Los Angeles, CA 90025

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$1 $2 $3 $4 $5 $6 $7 $8 $9 $10

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144 53 42 31 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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- NPN Transistor
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**SOLDIERS AND CIRCUIT BREAKERS FOR YOUR USE.**

**SUPER UNEQUIVOCAL ONLY $225.00**

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**PRINTED CIRCUIT BOARD**

<table>
<thead>
<tr>
<th>BOARD NAME</th>
<th>DIMENSIONS</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 x 200 mm</td>
<td>$1.50</td>
<td></td>
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<tr>
<td>100 x 100 mm</td>
<td>$5.00</td>
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**TANTALUM CAPACITORS**

<table>
<thead>
<tr>
<th>CAPACITORS</th>
<th>TYPICAL SPECIFICATIONS</th>
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<tbody>
<tr>
<td>2200µF/5V</td>
<td>50µF/15V</td>
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<tr>
<td>10µF/35V</td>
<td>1µF/50V</td>
</tr>
<tr>
<td>0.1µF/450V</td>
<td>0.01µF/100V</td>
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**C/MOS (DIODE CLAMPED)**

<table>
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<tr>
<th>TYPE</th>
<th>DESCRIPTION</th>
<th>PRICE</th>
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<tr>
<td>7403</td>
<td>3-input NAND gate</td>
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<td>7404</td>
<td>4-input NAND gate</td>
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</tr>
<tr>
<td>7405</td>
<td>5-input NAND gate</td>
<td>$2.00</td>
</tr>
</tbody>
</table>

---

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---

### Table: Barrel Kits and Transistors Prices

<table>
<thead>
<tr>
<th>Kit</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BARREL KIT 27</td>
<td>40 for $1.98</td>
<td>VOLUME CONTROL, KB-95A/40</td>
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<tr>
<td>BARREL KIT 73</td>
<td>50 for $1.98</td>
<td>Linear &amp; 7400 DIPS</td>
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<tr>
<td>BARREL KIT 13</td>
<td>100 for $1.98</td>
<td>Linear/OP-amps, 100% good</td>
</tr>
<tr>
<td>BARREL KIT 19</td>
<td>60 for $1.98</td>
<td>FUCA, 100% good</td>
</tr>
<tr>
<td>BARREL KIT 26</td>
<td>300 for $1.98</td>
<td>Resistors, 100% good</td>
</tr>
<tr>
<td>BARREL KIT 31</td>
<td>150 for $1.98</td>
<td>Resistors, 100% good</td>
</tr>
</tbody>
</table>

---

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<table>
<thead>
<tr>
<th>Part No.</th>
<th>Value</th>
<th>CRM5</th>
<th>CRM4</th>
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<tbody>
<tr>
<td>74L56N</td>
<td>5.0</td>
<td>0.70</td>
<td>0.80</td>
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<td>74L57N</td>
<td>6.8</td>
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## LINEAR IC's

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## MICROPROCESSOR SPECIAL

<table>
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<th>Parts</th>
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<th>CRM5</th>
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<tr>
<td>8089</td>
<td>39.0</td>
<td>42.0</td>
<td>44.0</td>
</tr>
</tbody>
</table>

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**Circle 89 on reader service card**

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E-Z Hooks have been designed and field tested throughout the industry to save time and money in commercial electronic production and servicing. The spring-loaded hook attaches firmly, yet so gently it will not damage component — frees hands while testing. Durably constructed and fully insulated to a single contact point assuring true readings. Meets exacting laboratory and space age computer technology requirements. AVAILABLE IN 10 RETMA COLORS: Red, black, blue, green, orange, yellow, white, violet, brown or gray. The most unique field-serviceable test connectors available. Fast, safe, sure and trouble-free. NOW AVAILABLE FROM ANCRONA . . . the source you can trust for fine quality, industrial-grade electronic components and accessories.

DIGITAL REVERB (continued from page 45)

second speakers. One hears only expanded space as the buttons on the device are successively depressed—from shortest time delay interval to maximum delay. We were able to easily duplicate acoustic space ranging from a “nightclub” environment to a spacious cathedral-like sound.

According to the inventors of the device, this first version of the time delay system is a “high end” product intended for use with relatively high-priced stereo component systems. There was more than a hint, however, that other products are planned—all based upon digital time delay principles. In our own view, a device of this kind (suitably proportioned downward in size, price and features) might make a wonderful addition to a car stereo system, for example. When we offered this suggestion to the people at Audio Pulse, they smiled slyly—as if they knew something and we didn’t—and they very probably do!

STEP-BY-STEP (continued from page 61)

resistor. You’ll read 1.0 volt for each 1.0 ampere flowing. This type will give you an accurate reading on an unloaded power transformer, which is a pure inductive load. You will see a reading of about 35-40 watts on a good transformer. However, this trick is reasonably accurate on a fully loaded power transformer.

“Load-shedding”

Power companies use a trick called “load-shedding” to locate a short. They disconnect all the loads and then put them back one at a time. The one that trips the breaker is the bad one. You can do the same thing, if necessary. Disconnect the high-current loads; in a hybrid or tube TV, these are the horizontal output stage, vertical output stage and audio output stage. The other stages normally take only small currents.

You can make this easier by opening the main DC power supply lead at the filter output and hooking in a DC milliammeter. This is point A in Fig. 9, a typical TV power supply circuit from a Sans Photofact schematic. Note that they show the normal load current; this is found on all Sans schematics, and should be used on all. Note this current; if it’s far too high, disable the high current stages one at a time, and you’ll be able to tell which one is faulty.

In transistor power supply stages, particularly in high-powered audio amplifiers, you’ll see two current readings. One will be the resting or “no-signal” current. The other will be the full-volume current, and will be much greater. This is typical of class-B output stages.

“Visible symptoms”

In TV sets, there will often be visible symptoms of power-supply trouble. One of these is the small raster; it will be pulled in on both sides, top and bottom. This shows that neither the horizontal or vertical sweeps have full output. The cause is something common to both, meaning the DC power supply. Another visible symptom is “hum-bars” in the raster. Fig. 10 shows how these look. In sets with full-wave rectifier circuits, the hum (ripple) has a frequen-

FIG. 10—OPEN FILTER CAPACITOR is the commonest reason for these hum bars.

cy of 120 Hz; so you see two hum-bars on the raster. In sets with half-wave power supplies, the ripple is at 60 Hz, so
THE KIT INCLUDES:
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2 Hewlett Packard .30 in. common cathode readouts.
15 NPN Driver Transistors
2 Switches for time set
2 Slide Switches for alarm set and enable
1 Filter Cap
4 IN4002 Rectifiers
1 IN914 Diode
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15 Resistors
1 Speaker for alarm
1 LED lamp for PM indicator.

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B. Directly interfaces with all MOS clock chips.
C. Super low power consumption (1.5 Ma typ.).
D. Uses latest MOS 17 stage divider IC.
E. Eliminates forever the problem of AC line glitches.
F. Perfect for cars, boats, campers, or even for portable clocks at ham field days.
G. Small size, can be used in existing enclosures.

Kit includes crystal, divider IC, P.C. Board plus all other necessary parts and specs.

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MC757P-89c MC780P-89c MC9706P-69c

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Read a roll of the dice in a digital display. 1 thru 12 on each die. The other 12 allows you to select the number of dice you want to play for a single number.
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**CB145**

- **08212** 8 Bit CMOS
- **08200** 8051
- **08230** 8051
- **08240** 8051

**COLUMN CHIPS — CALCULATOR CHIPS**

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<td>8 Bit 8031</td>
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<tr>
<td>MM5316</td>
<td>8 Bit 8031</td>
<td>$4.95</td>
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**MISC. NOS**

- MM309: TV Camera Core, Generals
- MM308: 8031 DIP Chip
- MM307: 8031 DIP Chip
- MM306: 8031 DIP Chip
- MM305: 8031 DIP Chip
- MM304: 8031 DIP Chip

**VECTOR TERMINALS**

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- MM5729: TV Camera Core, Generals
- MM5728: TV Camera Core, Generals
- MM5727: TV Camera Core, Generals
- MM5726: TV Camera Core, Generals

**FILAMENT TRANSFORMERS**

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<tr>
<td>CB147</td>
<td>System Controller</td>
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**VECTOR WIRING PENCIL**

- 6x4x36: 6x4x36
- 6x4x3: 6x4x3

**REPLACEMENT WIRE**

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**CLOCK CHIPS**

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<tr>
<td>MM5732</td>
<td>8 Bit 8031</td>
<td>$4.95</td>
</tr>
</tbody>
</table>

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**STOCK NO. R5312**

| 1 AMP DC PANEL METER | $1.75 each, 4/6.00 |

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you'll see only one hum-bar. Same cause; probably an open filter capacitor in the DC power supply. A related symptom is the "floating bar": a horizontal bar about an inch high, which drifts up or down in the picture. It may be light or dark. This is caused by insufficient filtering in the DC power supply. The bar comes from the normal pulse of current drawn by the vertical output stage once each field. It gets back into the DC power supply, if the filters don't have enough capacitance to get rid of it.

Cure: check filter capacitors. If necessary, ADD more capacitance! The original design may have been a little short of capacitance to start with.

**Other troubles**

One problem is actually caused by failure of a part in the DC power supply. However, it fools a lot of us if we forget it! This is the sudden appearance of multiple symptoms; loss of sync or instability; AGC problems, color problems, and so on. What does it is "non-zero impedance to ground" in the filter circuits! One of the electrolytic capacitors has developed high power factor, etc., and isn't doing the job. So, this lets a great many different signals show up on the DC power supply lines, and you have the mother and father of all feedback loops!

Only one tool in the shop will catch this, and that is the scope. In a normally operating DC power supply, you should see absolutely no signals of any kind on the DC supply lines: scope's vertical gain set high. Whenever you run across multiple-symptom problems, always scope the filter capacitors first. If you see any kind of signal, replace them.

**Hint:** If you find a bad section in a run of electronics, always replace the whole thing. Don't hook a replacement across the bad section. Whatever happened inside the can to make that one section go bad will get the rest very soon, and you'll have a call-back.

**To sum up:**

The DC power supply is an ideal subject for logical step-by-step test methods. You start out with the primary voltage supply, then check the DC voltage output, then the current drain. You simply walk it out, one step at a time. Follow the Trouble-Free Chart, and checking will be much easier.
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This is a unit featuring a true "state of the art" design. It is something you will be proud to show your friends.

With a basic knowledge of electronic circuitry, this kit can be assembled and played in just a few hours. If you have trouble, test facilities are available at nominal cost to remedy the problem.

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1. Unique curve button adds extra thrill and skill to game.
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3. 16 different angles of detection for the ball compared to 3 with most competitive designs.
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<tr>
<th>Unit</th>
<th>Description</th>
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<tr>
<td>VK-1</td>
<td>PC board only includes parts list &amp; wiring diagram.</td>
<td>25.00 net</td>
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<tr>
<td>VK-2</td>
<td>PC board with parts includes PC board, 78 IC's (those necessary to stuff the board).</td>
<td>125.00 net</td>
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<tr>
<td>VK-3</td>
<td>Hardware, wire, controls, switches Does not include housing or case.</td>
<td>17.50 net</td>
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<tr>
<td>VK-4</td>
<td>RF Module To convert video signal to TV receiver signal eliminates internal &quot;wire in&quot; on TV set. This unit can be used with other manufactured or kit type video games.</td>
<td>22.50 net</td>
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<tr>
<td>VK-5</td>
<td>Power Supply Kit Hardware, wire, controls, switches Does not include housing or case.</td>
<td>12.50 net</td>
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PREASSurement & Test 75.00 plus components.

C-MOS

LINEAR IC's

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IC Sockets

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DIODES

74HC42 Switching Dihode | 201.00 | 100.00 |

RESISTORS

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<td>10K</td>
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</table>

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Circle 106 on reader service card

July 1981

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2 Tuner Service Corp.  5
11 Wilson Electronics Corp.  30-31
**PACKAGE OF TEN — DEDUCT 15%**

**PACKAGE OF ONE HUNDRED — DEDUCT 25%**

### TTL

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<th>Part Number</th>
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### LEAD FREE SOLDER PASTE

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headband, solid-state circuitry; 5 microvolt sensitivity, more!
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electronics knowledge, you can do it!
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