CB REPORT—KOMPUTER KORNER—NEW IC'S

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Radio-Electronics

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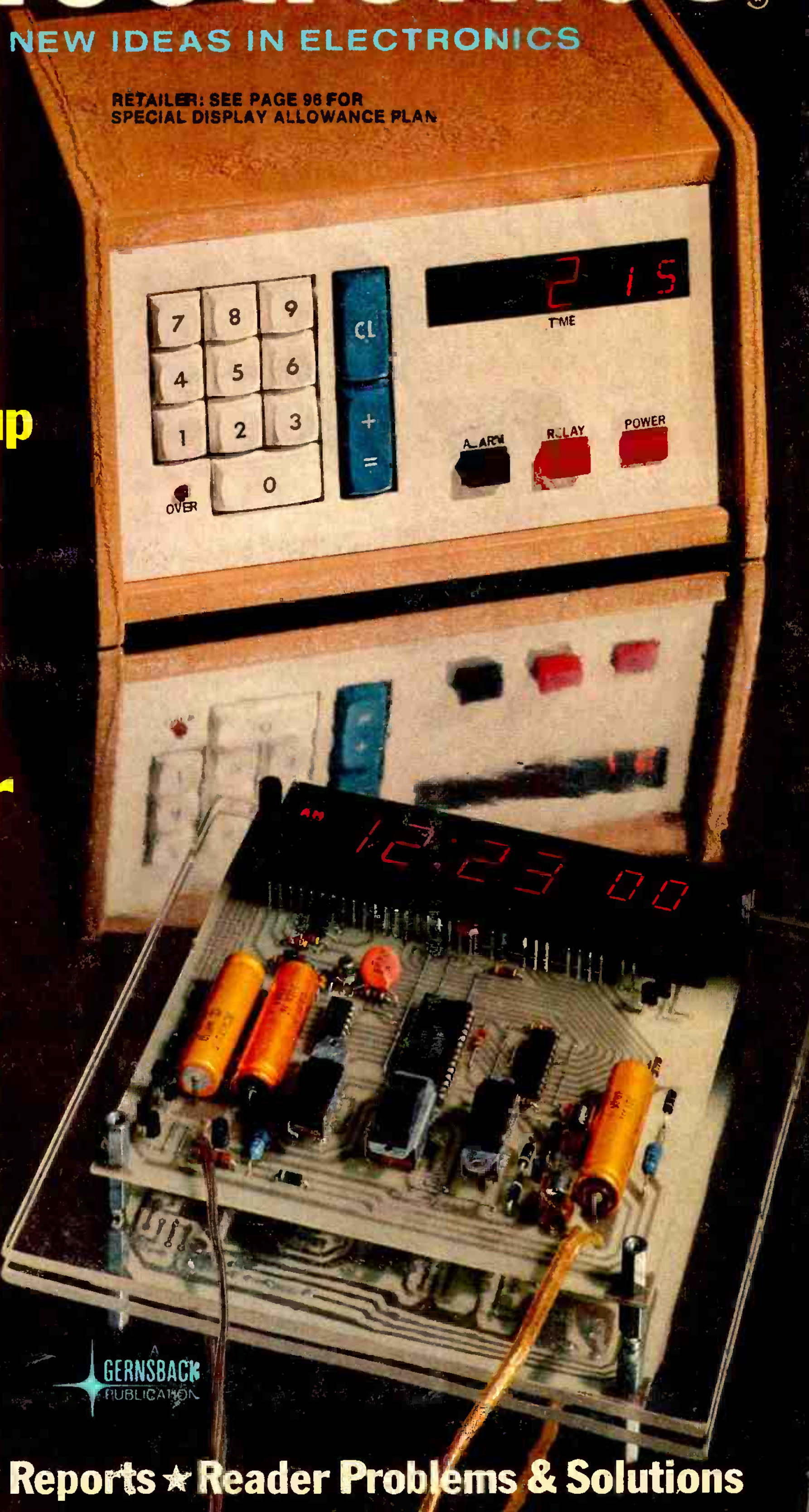
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

DIGITAL CLOCK KITS
R-E Tries Them All

CB TRANSCEIVERS
New Equipment Roundup

Build This Digital Readout Darkroom Timer



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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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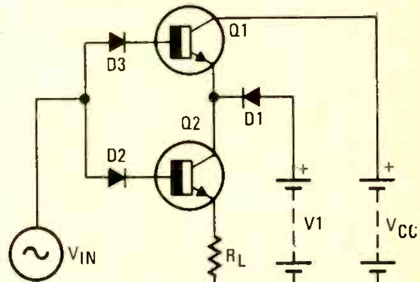
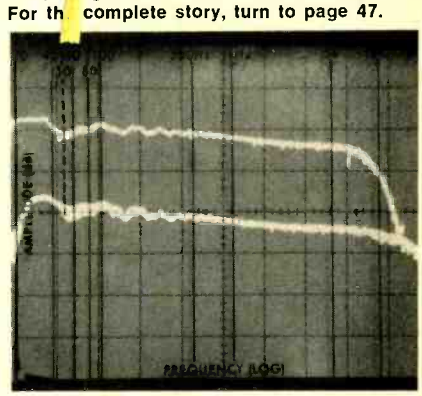
AUGUST 1976 Vol. 47 No. 8

ON THE COVER

A digital countdown timer that can be used to control external devices. The time interval is entered via a keyboard and can be programmed in one-second increments from one second to approx. 11,000 years. To get started on this project, turn to page 43.



CLASS-G HI-FI AMPLIFIER provides increased efficiency that can result in reduced size, weight and cost of future equipment. For the complete story, turn to page 47.



PERFORMANCE OF HITACHI D-3500 with low-noise ferric tape. Get all the performance specs starting on page 53.

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looking ahead

1977 TV preview

Television set changeovers for 1977 promise to be extensive. We've already reported here on G-E's set that adjusts the picture to the vertical interval reference (VIR) signal (**R-E,** July 1976) and Zenith's new picture tube (**R-E,** June 1976). Here are some other major changes:

Sony—The new Trinitron Plus tube is a negative-matrix design, increasing brightness and contrast. A new chassis is designed for greatly improved serviceability and more interchangeability of parts among models. Remote-control sets now have silent 12-channel electronic varactor tuning. A new 21-inch model has the largest screen Sony has ever offered in the United States, to be followed next year by a 25-inch. This will give Sony a full range of sizes consistent with its position as a domestic manufacturer (Sony builds sets 17-inches and larger for the U.S. market in a modern plant near San Diego, CA).

Magnavox—Digital tuning is the thing again. The "Star" models have added on-screen time display, presumably to compete with RCA's ColorTrak remote models that do the same thing. A new lower-priced digitally-tuned set provides the same calculator-keyboard tuning at the set, but unlike Star it must be set to receive 20 selected channels. Remote versions have more conventional tuning. One major innovation in the Magnavox line is optional remote control on 25-inch models with its new digital tuner; the remote unit can be installed by the dealer at the time of purchase or later.

Panasonic—A new 19-inch color chassis, designed for automated production and power consumption as low as 108 watts, was introduced. It's scheduled to be used in all such sets made or marketed by Matsushita affiliates throughout the world, to realize substantial economies through standardization. The same chassis is expected to show up in the JVC and Quasar lines. Panasonic also introduced two models with electronic channel readout that displays the time when it's not being used for tuning.

Zenith—The new color tube is expected to make its appearance in 19-inch sets. Zenith's introductions had not yet been made by presstime, but a sophisticated new tuning system is expected in 25-inch sets.

Although there are no major changes in the RCA and Sylvania lines for 1977, both are extending their "automatic" chassis—ColorTrak for RCA and GT-Matic for Sylvania—virtually throughout their range of models so that "self-adjusting" color will be available at lower prices.

In giant-screen projection TV, a major new entry is Advent's second model—this one designed for home use but still carrying the rather hefty price tag of $2,495 (the original VideoBeam sells for $3,995). The new projector, like VideoBeam, uses a system of three projection tube-and-lens assemblies and a separate reflective screen. The new screen measures six feet diagonally, just a foot less than the VideoBeam's Ektalite screen, and is said to be more resistant to damage. The system will be marketed in Canada under the Electrohome name by that Canadian firm, which is producing the electronic chassis to Advent specs for both the American and Canadian versions.

Interference crackdown

The FCC is getting tougher on all devices capable of emitting RF radiation, partially as a result of mounting complaints of CB interference with TV sets. In what appears to be the start of an all-out attack on these problems, the Commission took these recent actions: 1. Proposed that all CB receivers be subject to certification of their specs to make sure they don't cause interference. Currently, the transmitter portion of a CB transceiver must be approved by the FCC, but there are no receiver requirements. 2. Sponsored a task group of CB manufacturers to determine what can be done about CB-caused interference. 3. Proposed broad new rules requiring certification for such devices as coin-operated electronic games, RF-switched power supplies, wireless intercoms and other short-range "restricted-radiation" devices using RF for communication. It indicated that such widely used products as electronic watches, calculators and tape recorders may be added to the list. 4. Took an apparently harder line on approving home video games, rejecting two applicants, presumably because its tests showed antenna isolation switches didn't sufficiently keep game's RF from leaking into the antenna lead-in.

White House and CB

The fact that Betty Ford is "First Mama" is only coincidental—but Citizens band has become so important that the White House has been taking a close look at its long-term implications at a high level. A special task force has been established to deal with the problems of personal communications and make recommendations to the FCC and Congress. One of the proposals it's considering is to break the current Citizens band into several different bands of frequencies, each earmarked for separate uses—such as highway safety, telephone interface, personal contact, even hotel and motel reservations. The group is even considering re-allocating some frequencies currently reserved for government use to be devoted to the new person-to-person service. The task force is determined to make CB "more than just a hobby service." It's also expected to propose legislation to make licensing simpler.

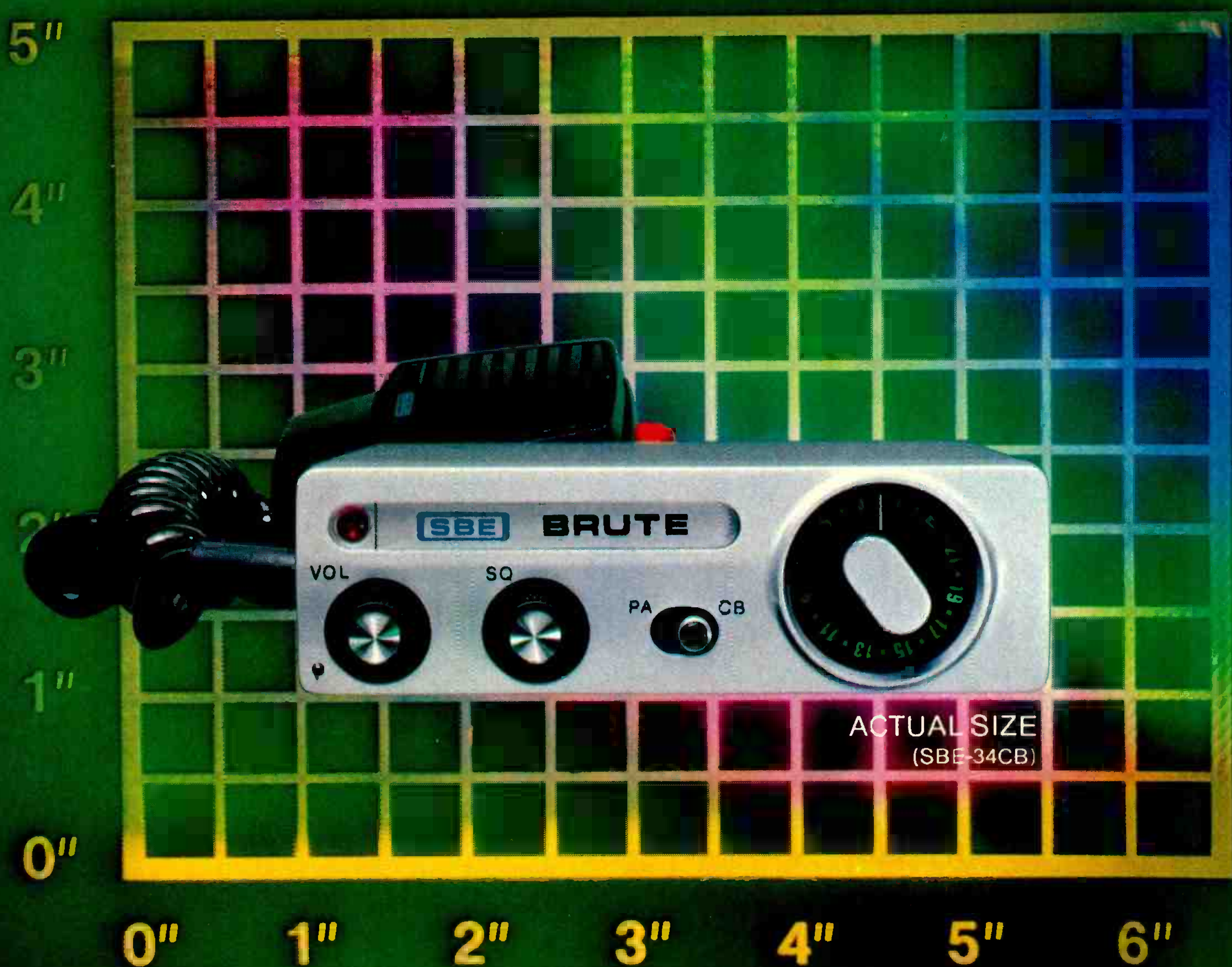
Another home VTR

The second home videocassette recorder to go on the U.S. market will be introduced by Sanyo in October. Designed to compete with Sony's Betamax (**R-E,** June 1976), it will sell for approximately the same price—about $1,300, including tuner and timer. Sanyo has taken aim on what it believes are the vulnerable spots in the Sony system—playing time and flexibility. Where the Sony Betamax will record and play for only one hour on a single $15.95 cassette, Sanyo's V-Cord II can be switched from an hour to two hours on a $19.95 cassette—the two-hour time being accomplished by skipping every other field in the television picture.

The Betamax is designed only to record the television picture for later playback. V-Cord II can do this, but also has the ability to record from an external camera (not included), to dub sound on the picture, to provide stop-motion in playback and to feed the audio output into an external high-fidelity system.

Sony has been worrying about the short playing time of the Betamax cassette. In Japan, it demonstrated a prototype cassette changer that can accommodate up to 10 videocassettes, with a changing time of 10 seconds in either record or playback mode. In addition, Sony is considering an optional slower tape-speed and thinner tape to extend recording and playing time per cassette. This is an important issue because it is felt that many consumers will want to use their home videocassette recorders to record automatically programs that are broadcast while they're away from home—and they should be able to accommodate programs of more than an hour's duration.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR



5"
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(SBE-34CB)
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new & timely

Cable-TV system improvements may be delayed some years

The FCC ruled, just before the annual National Cable Television Association convention last April, that some improvements that were to be required of cable TV systems by 1977 will not have to be met for another ten years, and that others will not have to be met at all.

In 1972, the Commission ruled that cable systems in the 100 largest television markets would be required to furnish communications for non-broadcast use, such as marketing, meter reading and newspaper facsimile transmission. That ruling also required systems to offer 20-channel capacity, technical capacity for two-way communication and a channel each for public, educational, government and leased-access use in each community served. Deadline was March 31, 1977.

The new revised rules delete the requirements for non-broadcast channels and for the special public, educational government and leased-access channels.

The 20-channel and two-way capacity requirements remain in the rules, but apply only to systems with more than 3,500 subscribers and won't have to be met for another ten years. Qualifications, using such terms as "if technically possible," were also added to several rules.

New Schottky rectifiers work up to 150 volts

A new method of fabricating Schottky diodes—an old but not too-much-used type of solid-state rectifier—has resulted in producing power rectifiers that work at more than four-times the voltage of Schottky rectifiers now on the market. The fabrication process is adaptable to mass production.

The Schottky diode has a metal-to-semiconductor contact, somewhat reminiscent of the old point-contact diodes used in radio reception. Because of their lower forward voltage-drop, as compared to that of P-N junction devices, they have from 60% to 80% lower losses than straight semiconductor diodes. But it has been extremely difficult to manufacture quantities of diodes of nearly identical performance.

The G-E developmental diode is made by sputtering platinum onto a silicon base. Platinum silicide is thus formed, in a reliable, reproducible way, with a barrier height of 0.8 electron volts. The barrier height is somewhat lower than that of platinum silicide formed by heating in a furnace after the components are placed in position.

The problem of premature low-voltage breakdown has been solved by using a mesa structure for the new diodes. This permits the devices to be operated at ratings up to 150 volts.

PROTOTYPE SCHOTTKY DIODES made by a new technique. These are 50-volt, 50-ampere units. In the foreground is a disc of the hexagonal silicon substrates used in the rectifiers. At left is a diode without its protective cap, showing how the metal to semiconductor contact is made.

The diodes were developed by Dr. Linus F. Cordes, Ernest A. Taft, and Dr. Marvin Garfinkel of the General Electric Research and Development Center, Schenectady, NY, with guidance as to appropriate goals and specifications formulated by the NASA Lewis Research Center.

Nine video-game makers get FCC violation notices

During the months of February and March, at least nine notices to manufacturers of TV game devices have warned them to cease all home video-game activity, states a report in *Electronic News*. The manufacturers were cited for offering the games for sale without first having them tested and approved by the FCC.

Most of the companies were toy manufacturers, but three were reportedly planning to sell home video kits. The orders in February were against Entex, Mobil Oil (which was offering the Entex game in its gift catalog) and Intech Industries. Names of the companies cited in March were not immediately available.

Several companies are now selling FCC type-approved TV games. These include Magnavox, Atari, First Dimension, Executive Games, Broadmoor Industries and Universal Research. The Magnavox game, *Odyssey*, was described fully and others discussed briefly in **Radio-Electronics**, November, 1975.

Satellites peer into future weather conditions

The climate of North America does not appear to be moving toward harsher winters as some predictions have indicated, according to the National Oceanic and Atmospheric Administration (NOAA). These are the initial findings of a climate study being undertaken with the help of weather satellites, designed and built by the RCA Astro-Electronics Div. in Princeton, NJ. Snow and ice charts based on this satellite-aided study constitute the most complete record of hemisphere snow cover ever made.

The study shows no significant change in North American snow cover during the nine years of the investigation. "Because snow cover is an important, sensitive variable that influences climatic change, the lack of systematic snow increases contradicts evidence that predicts harsher winters could be expected in the Northern Hemisphere," states the NOAA report.

New automatic system detects bombs, explosives in baggage

A new approach to detecting concealed weapons, bombs or explosives in checked airplane baggage is being worked out by Westinghouse Research Laboratories under contract with the Federal Aviation Agency. A similar system for the somewhat easier task of locating weapons in hand-carried baggage has already been demonstrated in prototype form to the FAA.

The model demonstrated is a dual-belt system. A gamma-ray source (barium 133) is mounted in a specially constructed container placed between the two belts. It aims two narrow fan-shaped beams across them. Detectors on the other side of the belts measure the amount of radiation passing through the luggage.

Electronic circuitry scans the detector array each time the conveyor moves ahead one centimeter (about 0.4 inch), producing a vertically scanned density profile that shows how much the radiation is impeded by various objects in the luggage.

When radiation drops below a given point over a minimum area of the scan, an alarm sounds automatically. (The conventional technique displays a visible X-ray image on a screen, which must be

continued on page 12

Where do the pros get their training?

Almost half of the successful TV servicemen have home study training and with them, it's NRI 2 to 1.
It's a fact! Among men actually making their living repairing TV and audio equipment, more have taken training from NRI than any other home study school. More than twice as many!

A national survey*, performed by an independent research organization, showed that the pros named NRI most often as a recommended school and as the first choice by far among those who had taken home study courses from any school. Why? Perhaps NRI's 62-year record with over a million students . . . the solid training and value built into every NRI course . . . and the designed-for-learning equipment originated by NRI provide the answer. But send for your free NRI catalog and decide for yourself.

Two Famous Educators... NRI and McGraw-Hill.

NRI is a part of McGraw-Hill, world's largest publishers of educational material. Together, they give you the kind of training that's geared for success . . . practical know-how aimed at giving you a real shot at a better job or a business of your own. You learn at home at your convenience, with "bite-size" lessons that ease learning and speed comprehension. Kits designed to give you practical bench experience also become first-class professional instruments you'll use in your work.

25" Diagonal Color TV... And 4-channel Quadraphonic Stereo.

As a part of NRI's Master Course in color TV/Audio servicing, you build a 25" diagonal solid state color TV with console cabinet. As you build it, you perform stage-by-stage experiments designed to give you actual bench experience. *And* you get a Quadraphonic system with 4 speakers. NRI's instruments are a cut above the average, including a transistorized volt ohm-meter, triggered sweep 5" oscilloscope, CMOS digital frequency counter and digital integrated circuit color TV pattern generator. They're top professional quality, designed to give you years of reliable service. You can pay hundreds of dollars more for a similar course and not get a nickel's worth extra in training and equipment.

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NRI doesn't stop with just one course in TV/Audio servicing. You can pick from five different courses (including an advanced color course for practicing technicians) so you can fit your training to your needs and your budget. Or, you can go into Computer Technology, learning on a real, digital computer you build yourself. Communications with your own 400 channel digitally-synthesized VHF transceiver. Aircraft or Marine Electronics. CB, Mobile Radio, and more.

Free Catalog... No Salesman Will Call.

Send the postage-paid card for our free color catalog showing details on all NRI electronics courses. Lesson plans, equipment, and career opportunities are fully described. Check card for information on G.I. benefits. No obligation, no salesman will call. Mail today and see for yourself why the pros select NRI two to one!

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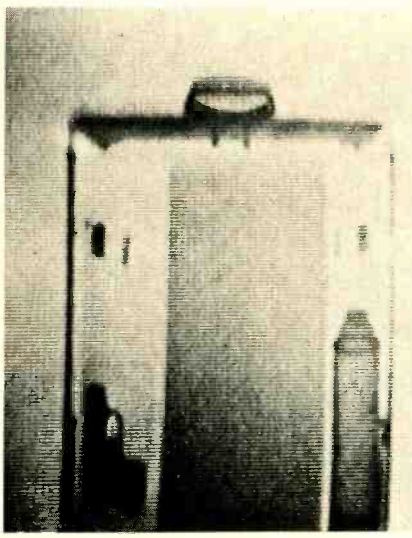
*Summary of survey results upon request.

new & timely

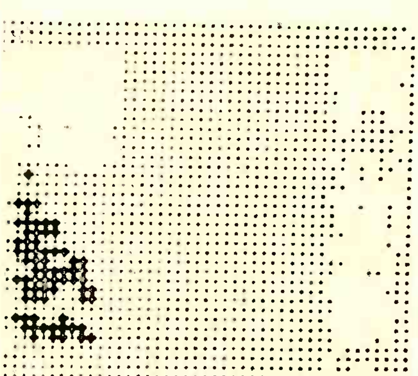
(continued from page 6)

viewed and evaluated by an operator in attendance.) The system is controlled by a minicomputer, removing the hazards of operator distraction or fatigue.

Because of the narrow beam and short exposures, radiation is held to less than 10% of that required by conventional single-pulse X-ray systems. Camera film is not measurably affected and there is no long-term exposure hazard to operating personnel.



SCANNING DETECTOR VS. X-RAY. Conventional X-ray (above) shows—right to left—a spray can, a book and a gun. A reconstructed image of the gamma-ray transmission through the same piece of luggage (below) indicates high attenuation—more than enough to trigger an alarm—in the area occupied by the weapon. The system is controlled by a minicomputer programmed for a predetermined—and adjustable—attenuation and minimum area. Alarm is automatic and there is no need for an operator to watch the screen constantly.



The dual-belt hand luggage system already demonstrated will handle 12 items per minute. The checked baggage system under development will have to be faster and more sophisticated, Westinghouse Lab personnel state. Weapons have a higher concentrated density and are therefore easier to spot than the bombs or explosives normally searched for in checked baggage, and the equipment will have to check a minimum of one piece per second.

World's no. 1 radio announcer, Eddie Startz, dies at 77

World-famous radio announcer and commentator, Edward Startz of the international shortwave "Happy Station" program from the "Peace, Cheer and Joy" station PCJ in Hilversum, Netherlands, died March 17, 1976. His age was 77.

After an education in classical languages, the young Startz spent five years wandering the face of the earth earning his bread at all kinds of jobs from dishwasher to interpreter, and incidentally improving his modern languages. Returning to Holland in 1928, his excellent voice and fluency in seven languages made him the first announcer and commentator on the new Philips experimental shortwave broadcast station PCJ. His microphone manner and rapport with listeners in all countries kept him behind the same microphone (with a break only during an underground period while Holland was occupied by the Germans) for more than 40 years. His last broadcast was on December 31, 1969. **R-E**

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When you install a B-T Booster outside, you get a lot of new boosters inside.

The service technician's job is a tough one. Customers are always grumbling about the high cost of TV service calls. And they complain about poor reception—even when it's almost impossible to get a good signal.

But now and then a TV service technician wins one. And one of the products that can make him a winner, and create customer goodwill, is a Blonder-Tongue outdoor booster.

B-T Boosters can produce a dramatic improvement in picture quality, particularly on color and especially in difficult reception areas. After 25 years of making outdoor boosters, B-T is number one in sales, and enjoys the finest reputation for making products of highest performance and reliability. B-T Boosters do cost a bit more than competition, but they perform and last longer. And that's what makes satisfied customers.

The VAULTER, for example, is the number one outdoor booster today in the B-T line... *and* in the entire industry. This ultra-high performance, all-channel amplifier offers the ideal combination of lowest possible noise figure (4.6dB, VHF; 7.0dB, UHF) and high gain (15dB). While it can't make unusable, snowy pictures perfect, it *can* reduce fading, loss of color, overcome cable loss and reduce lead-in cable noise. It can even feed more than one TV set from the same antenna in fringe reception areas. It has separate U/V inputs and a coax output. Finally, it's specially designed for lightning prone areas.

The B-T line consists of 5 all-channel models (including the popular VOYAGER); 5 VHF models and 4 UHF boosters (the ABLE-U2b is a favorite).

See your B-T distributor for details. And see why you can count on boosters inside, when you install B-T Boosters outside. Blonder-Tongue Laboratories, Inc., One Jake Brown Road, Old Bridge, N.J. 08857.

BLONDER-TONGUE

Circle 2 on reader service card

Imagine a microcomputer

Imagine a microcomputer with all the design savvy, ruggedness, and sophistication of the best minicomputers.

Imagine a microcomputer supported by dozens of interface, memory, and processor option boards. One that can be interfaced to an indefinite number of peripheral devices including dual floppy discs, CRT's, line printers, cassette recorders, video displays, paper tape readers, teleprinters, plotters, and custom devices.

Imagine a microcomputer supported by extensive software including Extended BASIC, Disk BASIC, DOS and a complete library of business, developmental, and industrial programs.

Imagine a microcomputer that will do everything a mini will do, only at a fraction of the cost.

You are imagining the Altair™ 8800b. The Altair 8800b is here today, and it may very well be the mainframe of the 70's.

The Altair 8800b is a second generation design of the most popular microcomputer in the field, the Altair 8800. Built around the 8800A microprocessor, the Altair 8800b is an open ended machine that is compatible with all Altair 8800 hardware and software. It can be configured to match most any system need.

MITS' plug-in compatible boards for the Altair 8800b now include: 4K static memory, 4K dynamic memory, 16K static memory, multi-port serial interface, multi-port parallel interface, audio cassette record interface, vectored interrupt, real time clock, PROM board, multiplexer, A/D convertor, extender card, disc controller, and line printer interface.

MITS' peripherals for the Altair 8800b include the Altair Floppy Disc, Altair Line Printer, teletypewriters, and the soon-to-be-announced Altair CRT terminal.

Introductory prices for the Altair 8800b are $840 for a kit with complete assembly instructions, and $1100 for an assembled unit. Complete documentation, membership into the Altair Users Club, subscription to "Computer Notes," access to the Altair Software Library, and a copy of Charles J. Sippl's Microcomputer Dictionary are included. BankAmericard or Master Charge accepted for mail order sales. Include $8 for postage and handling.

Shouldn't you know more about the Altair 8800b? Send for our free Altair Information Package, or contact one of our many retail Altair Computer Centers.

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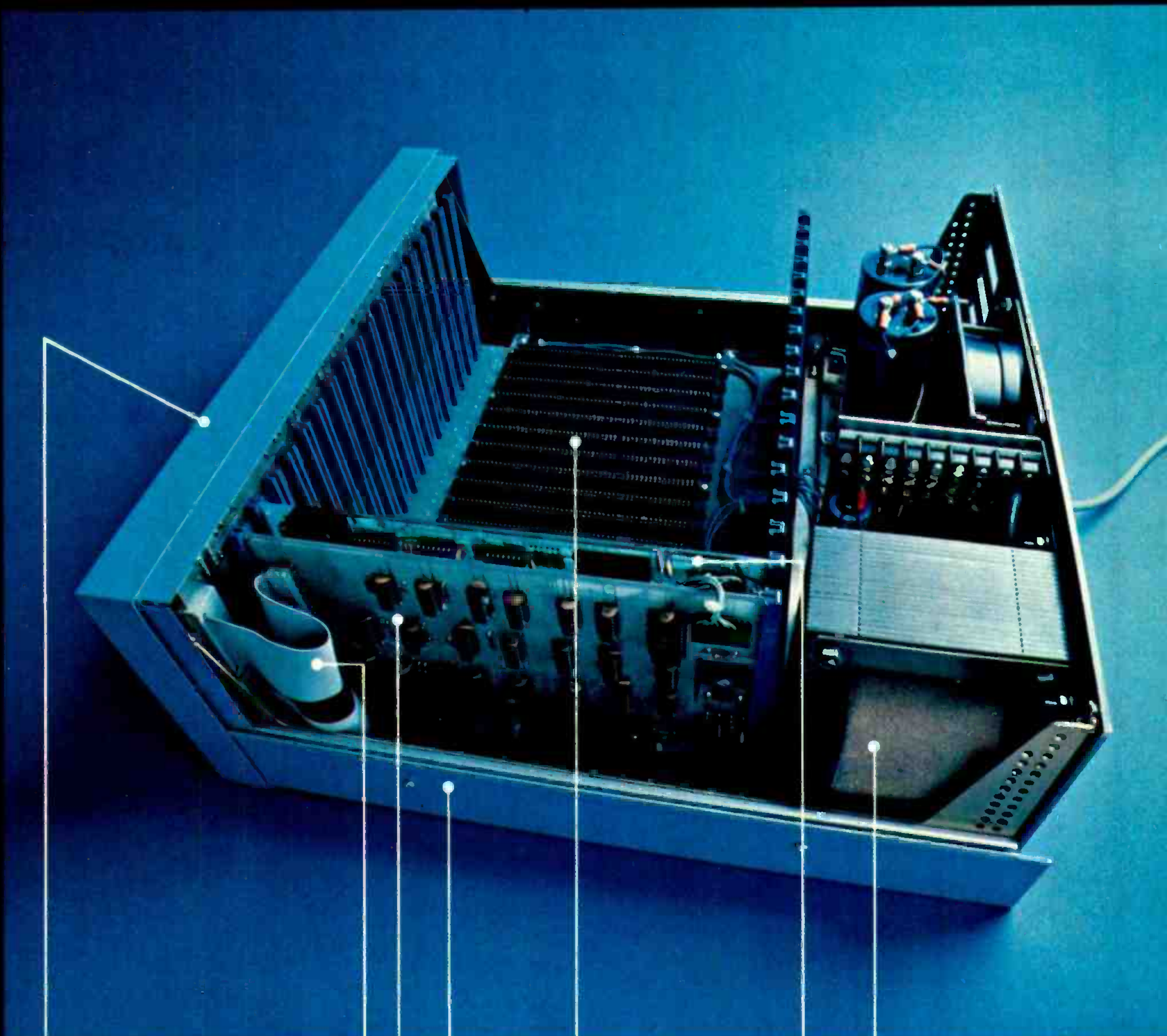

Redesigned front panel. Totally synchronous logic design. Same switch and LED arrangement as original Altair 8800. New back-lit Duralith (laminated plastic and mylar, bonded to aluminum) dress panel with multi-color graphics. New longer, flat toggle switches. Five new functions stored on front panel PROM including: DISPLAY ACCUMULATOR (displays contents of accumulator), LOAD ACCUMULATOR (loads contents of the 8 data switches (A7-A0) into accumulator), OUTPUT ACCUMULATOR (Outputs contents of accumulator to I/O device addressed by the upper 8 address switches), INPUT ACCUMULATOR (inputs to the accumulator from the I/O device), and SLOW (causes program execution at a rate of about 5 cycles per second—for program debugging).

Full 18 slot motherboard.

Rugged, commercial grade Optima cabinet.

New front panel interface board buffers all lines to and from 8800b bus.

Two, 34 conductor ribbon cable assemblies. Connects front panel board to front panel interface board. Eliminates need for complicated front panel/bus wiring.

New, heavy duty power supply: +8 volts at 18 amps, +18 volts at 2 amps, -18 volts at 2 amps. 110 volt or 220 volt operation (50/60 Hz). Primary tapped for either high or low line operation.

New CPU board with 8080A microprocessor and Intel 8224 clock generator and 8216 bus drivers. Clock pulse widths and phasing as well as frequency are crystal controlled. Compatible with all current Altair 8800 software and hardware.

altair 8800-b

mits

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Circle 51 on reader service card

letters

REACT REACTION

In reference to the article "REACT—What's It All About," by Fred Shunaman in the January issue, I must disagree with several key points.

Mr. Shunaman states, in effect, that "the CB'er is *highly mobile*" while the "amateur must *set up his portable equipment*." With the advent of VHF-FM and UHF-FM hand-held radios and repeater systems, a typical local amateur net can cover an area not possible by even a higher powered CB base station.

In addition, the amateur has the flexibility of choosing frequency bands to accommodate transmitting-range needs.

As a CB'er and member of a REACT group, and as a ham associated with RACES and AREC I have compared the two services and find both quite valuable. REACT provides fine local service communications, while RACES and AREC assist in both local *and* distant emergencies.

Let us not forget the licensed radio amateur, whose number is small in proportion to licensed CB's, but does a job comparable to the CB'er and performs distant work that no CB'er can.

DEREK W. YELLY
WB4DAM/KFW-1030
Alexandria, VA.

DIGITAL STOPWATCH

In this column in the April issue, a reader indicated that the newer Novus Mathbox model 650 calculators cannot be used in the digital stopwatch (November 1975 and February 1976 issues). This is not true. I have used both and have achieved equally good results. However, pin connections are different in the two versions. The connections at the edge of the display board are (left-to-right with the display facing you) as follows: 1—B—(ground), 2—B+, 3—D4, 4—D2, 5—D1, 6—D3, 7—K3, 8—D5, 9—D6, 10—K1 and 11—K2.

These are the only pins used. With this information, readers should be able to use either Mathbox they happen to have.

Thanks for the article. It stimulated my interests. Keep up the good work and let's have more articles using digital techniques.

BRUCE COLEMAN
Belton, MO.

TVT-II AND ASCII-TO-BAUDOT CORRECTIONS

I have enjoyed building and studying the TV Typewriter II. I have made all the boards and have learned a lot about digital techniques by going through the theory of the system. At some points, however, the theory wouldn't fit the circuitry. These turned out to be misprints in the articles and some drawing errors.

In case some of your readers are having the same difficulty, I have listed the errors that I have found. The following errors are on the schematic for the main board. (The foil pattern of the PC board is correct.)

> Output of IC13-a pin 8 should also be connected to the input of IC12-a pin 3. There should be no connection between IC12-a pin 3 and IC20-c pin 13.
>
> There should be no connection between $\overline{\text{Bit-4}}$ and $\overline{\text{Bit-6}}$ at input pin 9 of IC32-c. (Only Bit-6 is used.)

In the March issue of **Radio-Electronics**, there also seems to be errors in the schematic for the ASCII to BARDOT converter. (Fig. 1.)

> There should be no connection between IC6 pin 12 and IC6 pin 2. IC6 pin 12 should be connected to IC12 pin 3.
>
> On Fig. 3 (connections to TVT-II), I think pin 8 and pin 9 have been swapped. A should be connected to pin 8, and B to pin 9.
>
> In the modification procedure on page 58, it is stated that the foil on the main PC board should be cut at IC36 pin 3, but this will make only partial storage of Bit-7 possible. I think the foil should be cut at the output of IC11-b pin 8. Am I right?
>
> The new wiring for the memory board seems strange, is the procedure correct?

I hope this information will help other readers. I also have some questions I hope you can answer.

> Are the PROM's in the ASCII to BAUDOT kit programmed for this application?
>
> Is it possible to use other PROM's with the same capacity?
>
> Why must the foil be cut between J8-14 and IC36 pin 5?
>
> Is it necessary to use a Computer Cursor board with the converter application? Otherwise, I can't see any reason for connecting J7-10 to J4-4 since the latter is not used on Manual Cursor board.
>
> What type of board is supposed to be mounted on J1?

I will appreciate any assistance you can offer in answering these questions.

BJORNER DRAGNES
Honefoss, Norway

Regarding the errors you found in the ASCII to BAUDOT converter, I will answer them in the same order that you listed them in your letter:

continued on page 22

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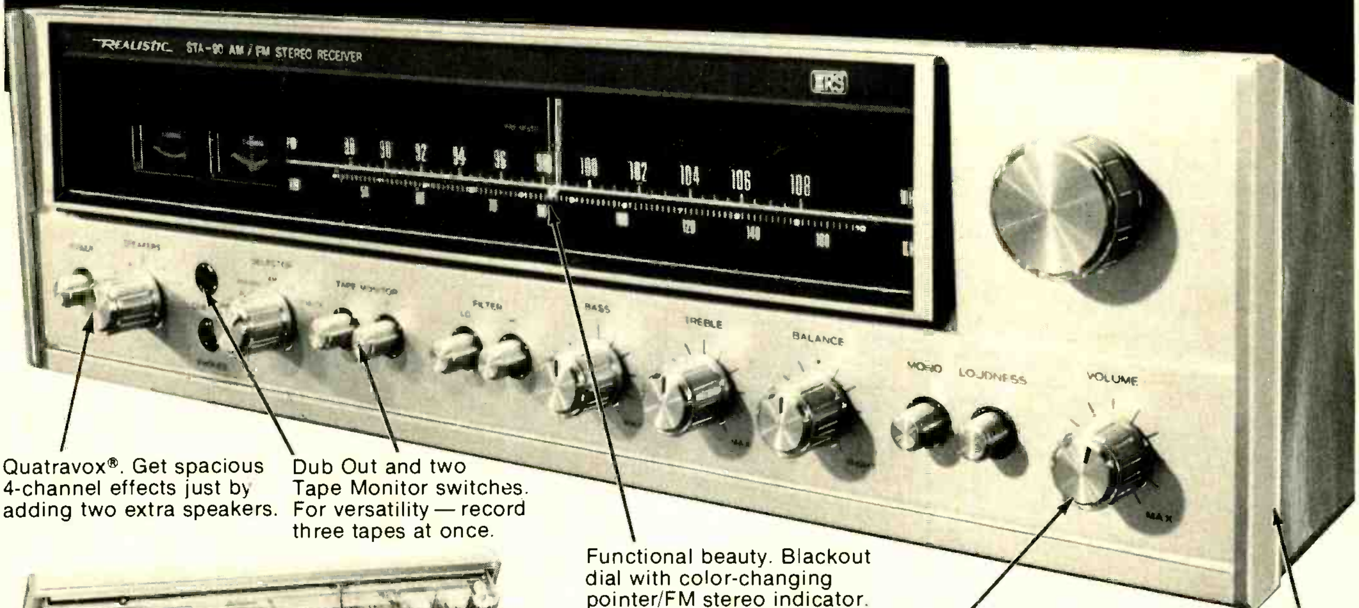

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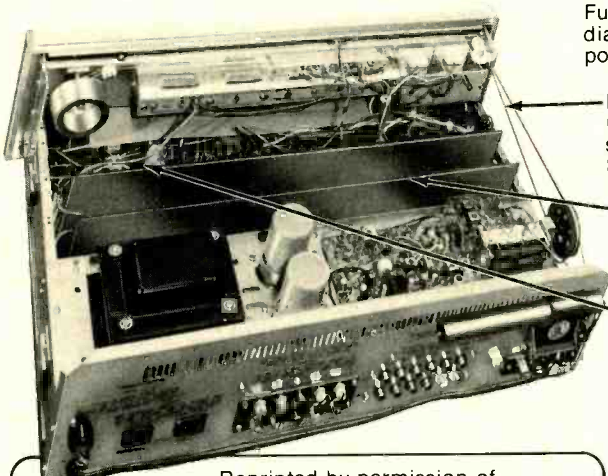

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continued from page 16

Yes, there is an error in the connection of pin 12 of IC6. Pin 12 of IC6 should connect to IC12 pin 4 and IC10 pin 1.

Yes—pins 8 and 9 in Fig. 3 were reversed.

Yes, you are correct. IC9-a must not be cleared or you will clock out the character in IC36 thru IC39 at the next strobe. Cut foil at IC11 pin 8 and insert a STORE *switch there.*

Yes. Bit-7 is at J4 pin 4 which you wire to J7 pin 10, then to pin 11 of the new 2102 IC. J8 pin 14 is the path used to connect output of the 2102, but connection to IC36 pin 5 must be cut.

Here are the answers to the other questions you asked:

No, the PROM's are not programmed. Too many BAUDOT codes exist to match everyone's machines.

Yes, other PROM's could be used (such as 74188A).

See above.

See above.

See April, 1976, issue of **Radio-Electronics** *for BAUDOT to ASCII circuit.*

I hope these answers help.
ROGER L. SMITH

SK-10 EQUAL FOR DYNA-MICRO

The May issue of **Radio-Electronics** featured an 8080 microcomputer construction article. One of the components specified in the parts list was an E & L Instruments SK-10 breadboarding socket.

I feel that it should be brought to the attention of your readers that this is not a proprietory item available only from E & L Instruments. Other companies, including Continental Specialties Corporation, produce a direct replacement for the breadboarding socket.

Continental Specialties Corporation's equivalent of the SK-10 is one QT-59S connected to two QT-59B's.

RONALD J. PORTUGAL
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I'm dropping you this note to point out that the A P Products *Super-Strips* are exact replacements for the solderless breadboard used in the Dyna-Micro construction article.

Super-Strips are available at many dealers and distributors, or may be ordered direct from A P Products, Inc., Box 110-P, 72 Corwin Drive, Painsville, OH 44077. Model SS-2 (order #923252 at $17.00) features nickel/silver terminals. Model SS-1 (order #923748 at $18.90) features gold-plated terminals.

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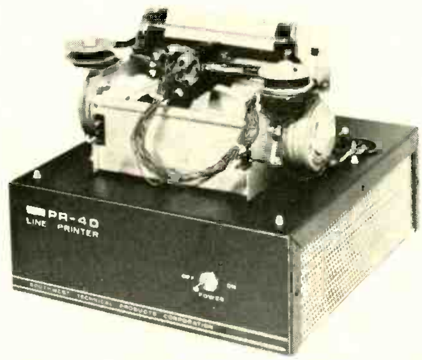

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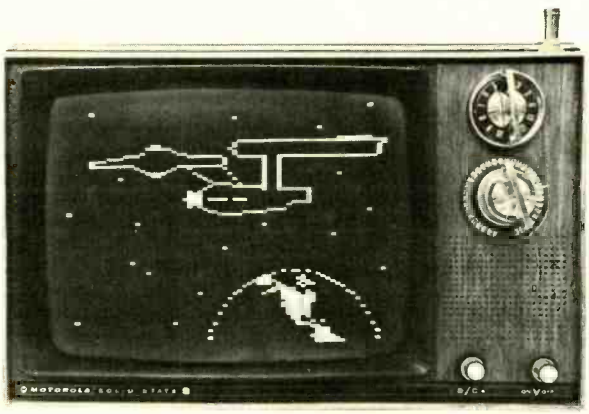

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Circle 62 on reader service card

KOMPUTER KORNER

DAVID LARSEN, PETER RONY, and JOHN TITUS*

THIS MONTH, WE SHALL DISCUSS THE INterfacing of an 8080-based microcomputer to a very versatile laboratory instrument, the Keithley model 160B digital multimeter and model 1602B digital output. We purchased this multimeter one year ago and found it to be an excellent example of what manufacturers can do to facilitate the interfacing of their instruments.

The Keithley model 160B is a general-purpose 3½-digit multimeter than can function as a DC voltmeter, DC ammeter, or ohmmeter. A total of twenty-six different ranges exist for the multimeter in its three modes of operation. The lowest range scales provide maximum readings of 1.999 mV, 19.99 nA, and 1.999 Ω. The 1.999 mV scale has an accuracy of ± 0.1% of reading ± 1 digit. Thus, a display reading of 1.000 mV will have an uncertainty of ± 0.002 mV, or 2 μV. The highest possible readings associated with the three different ranges are 1200 V, 1999 mA and 1999 megohms, with the megohm reading being accurate to only ± 30%.

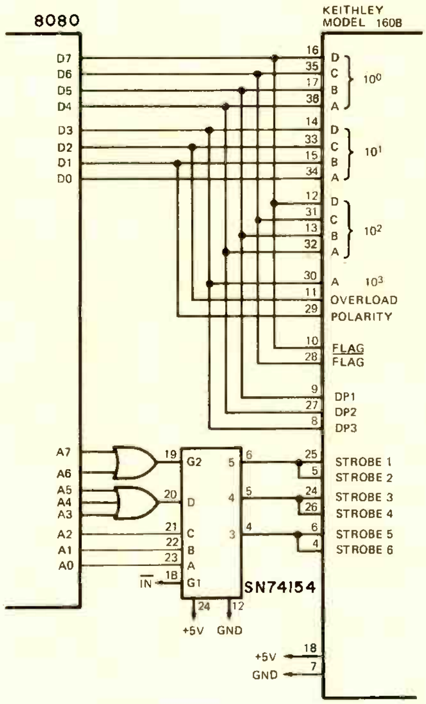

FIG. 1

The model 160B multimeter is basically a sophisticated analog-to-digital converter (ADC) that can handle most laboratory requirements for digital data acquisition provided that the rate is no greater than one measurement per second. Switching between the twenty-six different ranges is performed manually. We would expect that, in the future, such switching will be performed by a built-in microprocessor operating under the control of an external computer.

The interface circuit between the Keithley model 160B and a small 8080-based microcomputer is shown in Fig. 1. The two OR gates and the SN74154 decoder generate three different device-select pulses that are required to input data from the Keithley meter to the 8080 microcomputer. Note the $\overline{IN}$ signal at pin 18 of the SN74154 decoder. This interface circuit takes advantage of the fact that the outputs from the model 1602B digital-output board are open collector and can be bussed together as is shown in Figure 1. Notice how pins 16, 12, and 10 on the model 160B are connected to the same 8080 microcomputer input, D7. These three pins are said to be bussed together. Pins 35, 31, and 28 are bussed together to input D6; pins 17, 13, and 9 are bussed together to input D5; and so on. The eight inputs to the 8080, D0 through D7, comprise an eight-bit data bus over which information passes, one group at a time, from the Keithley multimeter to the 8080 microcomputer.

Only one transfer of information can take place at any one time. In Fig. 1, this transfer is accomplished with the aid of the three sets of strobe inputs. When a logic 0 is applied at strobes 1 and 2, the BCD codes corresponding to the 10^0 and 10^1 digits are transferred to the accumulator of the 8080. Similarly, strobes 3 and 4 and also strobes 5 and 6 permit the acquisition by the microcomputer of the remaining output data from the Keithley multimeter. Therefore, three device-select pulses permit the strobing of 20-bits of data from the multimeter to the microcomputer over a set of eight data bus-lines D0 through D7.

A simple program that accomplishes the data transfer from the multimeter to the microcomputer is provided in Table 1. The entire data acquisition and movement of data to registers C, D, and E occurs in 21μs, a time that is fast when compared to the rate of five conversions-per-second by the multimeter. Clearly, considerable time is still available to the microcomputer to manipulate the acquired data before new data is input into the accumulator.

Not shown in Fig. 1 are eight 4700-ohm resistors that are the required pull-up re-

continued on page 26

*This article is reprinted courtesy American Laboratories. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University. Mr. Titus is president of Tychon, Inc.

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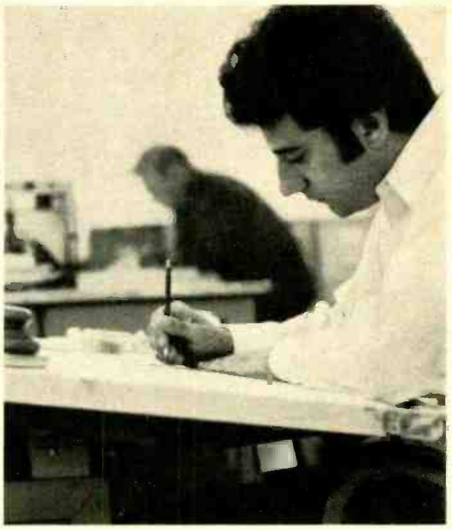

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KOMPUTER KORNER
continued from page 24

sistors for the eight open-collector bus lines. One pull-up resistor is required for each of the eight data bus inputs. One end of the resistor is tied to +5 volts, and the other end to the bus line. These resistors are not shown in the diagram because they can be added to the circuit board within the Keithley multimeter. The 8080 data bus normally employs an alternative bussing technique called three-state bussing. The interface circuit shown in Fig. 1 is actually the combination of two bussing-techniques, open collector and three-state. The 4700-ohm resistors do add a load to the data bus, but this does not prevent other devices from being tied to the bus provided that each bus connection in the other devices can sink, in the logic-0 state, the additional 1 mA current produced by the 4700-ohm pull-up resistor.

At the beginning of this column, we stated that the Keithley multimeter is an example of what manufacturers can do to facilitate the interfacing of their instruments. In this case, what Keithley did was to provide open-collector outputs for all twenty output pins on the model 1602B digital-output board. The added cost was small when c[illegible]d to the added value of the instrument. We expect future instruments to be microcomputer oriented in the sense that data-bus outputs will be provided to permit the direct interfacing of the instruments to microcomputers via simple wire interconnections. We hope that these columns encourage manufacturers to provide minicomputer- and microcomputer-oriented digital outputs, and also to document such outputs as well as Keithley has done with the model 160B. **R-E**

TABLE 1—DATA ACQUISITION PROGRAM

LO memory address	Instruction byte	Mnemonic	Clock cycles	Description
000	333	IN 5	10	Generate device select pulse that strobes the 10^0 and 10^1 digits into the accumulator
001	005	—	—	Device code for strobe inputs 1 and 2
002	117	MOV C,A	4	Move accumulator contents to register C
003	333	IN 4	10	Generates device select pulse that strobes the 10^2 digit, the 10^3 bit, and the overload and polarity outputs into the accumulator
004	004	—	—	Device code for strobe inputs 3 and 4
005	127	MOV D,A	4	Move accumulator contents to register D
006	333	IN 3	10	Generate device *select* pulse that strobes the Flag, DP1, DP2, and DP3 outputs into the accumulator
007	003	—	—	Device code for strobe inputs 5 and 6
010	137	MOV E,A	4	Move accumulator contents to register E
•				
•				
•				
•				
•				
•				

At this point, twenty data-bits are stored in registers C, D, and E. The microcomputer can now take this information and manipulate it in different ways. With the aid of the BCD digits and DP1, DP2, and DP3 (DP = Decimal Point), it can determine the magnitude of the input decimal number. With the aid of the polarity input, the sign of the decimal number can be determined.

"I want it installed in the attic. No need to advertise the fact I have a color TV!"

State of SOLID STATE

An operational amplifier from RCA that combines bipolar and COS/MOS devices on the same chip

KARL SAVON
SEMICONDUCTOR EDITOR

AFTER A COMPLEX SERIES OF OXIDE-GROWing, etching, diffusion metal deposition, wafter-probing, bonding and sealing steps, out pops a bipolar integrated circuit. Doesn't sound so simple? No, it's not! The steps are done at very closely regulated temperatures over carefully controlled time intervals. The entire process is governed by a set of precise microscopic photographic masks that determine the boundaries of the collector isolations, bases, resistors, emitters, and other IC elements. Despite the degree of complexity, RCA doesn't stop here. By adding a few more steps to the process, complementary COS/MOS transistors are fabricated on the same chip as the NPN and PNP bipolar devices. Combining the two gives the IC designer the best of both worlds. He is not hindered by the limitations of either process where the other offers an advantage.

Very high input-impedance, very low input-current, good offset specifications and wide bandwith can be optimized to a level previously impossible. Performance approaches that of amplifiers that are presently being put together with hybrid techniques. RCA says their CA3130 op-amps are the first of a new generation of circuits to take advantage of the new process that is based on their pioneering and accumulated experience in COS/MOS.

RCA CA3130 operational amplifier

The schematic diagram of this new op-amp is much simpler than what you probably had expected to see. In itself, sche-

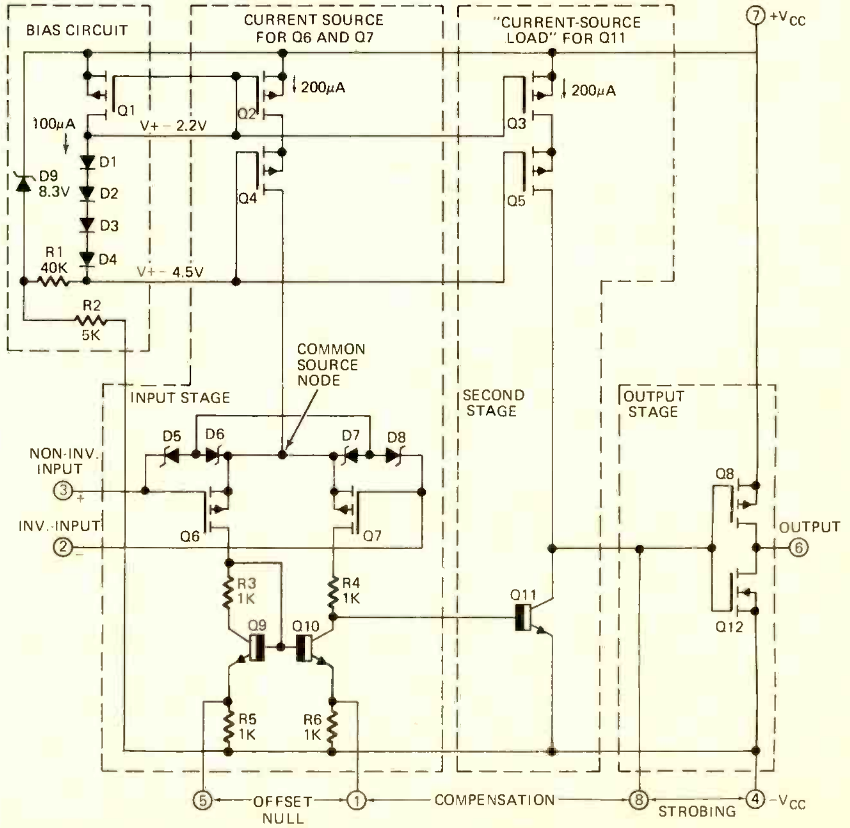


FIG. 1—RCA CA3130 operational amplifier.

continued on page 30

STATE OF SOLID STATE
(continued from page 28)

matic simplicity is not a technical feat. But when added to a list of exceptional circuit traits, it is the icing on the cake. Circuit simplicity is an indicator of how well the pieces go together. PMOS devices become active loads for bipolar transistors. And a COS/MOS inverter is simple; there are no complicated biasing schemes and no load resistors.

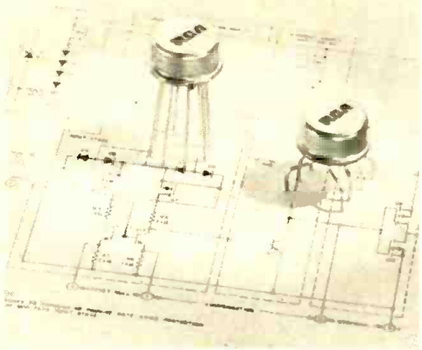
Looking at the schematic for a short while (See Fig. 1), you'll notice there is something glaringly missing! Nowhere on the diagram can you spot a PNP transistor. It is no accident. Talk to an integrated circuit engineer and undoubtedly he'll say, "I wish we had a better PNP." The PNP devices they use simply don't work that well. They are compromise devices lost in a process designed primarily to make good NPN's. Their gain-bandwidth products are poor, they have a generally low beta and high saturation-resistance. Addition of COS/MOS circuitry allows the elimination of PNP's normally used in amplifier and current "mirror" level-shifting stages. There are three easily separable gain stages in the CA3130; a PMOS input differential amplifier, a high-gain common emitter NPN amplifier, and a COS/MOS output inverter. The picture is completed by a diode and PMOS current source and that's it.

Let's look at the circuit in detail. The gates of the differential amplifier PMOS FET's (Q6 and Q7) are connected directly to the input terminals. The two transistors are analagous to the PNP differential amplifier that often appears in this spot. PNP's or PMOS input amplifiers can be biased close to or at ground potential, a big application plus. The CA3130 inputs can swing 0.5 volt below $V_{cc}-$. Gates of MOS devices that contact the outside world must be protected from static charges that can build up excessive voltages. Voltages above 100 volts endangers the oxide layer below the gates. Because of the very high input impedances, it is not hard to store sufficient charge to exceed the 100 volt level. Input resistance of this amplifier is 1.5 teraohms (tera = 10^{12}) and is calculated by dividing half of a 15 volt supply voltage, 7.5 volts, by the 5 picoamp input current. Above the room temperature reference of 25°C, the current doubles for every 10°C increase. Diodes D5 through D8 are the protection system. Voltage stress across the gate oxide is limited to a safe value by conduction of the Zeners when the gate to source voltage of either Q6 or Q7 exceeds the Zener breakdown voltage.

PMOS types are also used as a current source to energize the input amplifier. Q1 and Q2 is a current "mirror" and even though made from PMOS devices, operates in much the same way as the bipolar "mirrors" I've described in previous columns. Because of their common source and gate connections and because of their close thermal and diffusion profiles, the current in Q1 is proportionately reproduced in Q2. The area of Q1 is twice that of Q2 and so Q2 supports twice the current set up in Q1. Q1 conducts a current determined by the voltage developed across Q1. Subtracting the 2.2 volts across Q1 and the 2.3 volt sum of the four diode junctions (D1 through D4) from 8.3 volts yields 3.8 volts. The current in Q1 is 3.8/40K or about 100 microamps, and Q2 becomes a 200 microamp source. When the power supply drops below 8.3 volts, D9 does not regulate and the bias current falls below the nominal value. Q4 is a cascode transistor that raises the impedance of the current source to contribute to the 70 dB minimum common-mode rejection of the CA3130. Common-mode signals raise the input voltage on both transistor gates (Q6 and Q7) by the same amount. The voltage rise is transferred to the common source node. If the current source presents a high impedance, this change in voltage gives a minimal change in the currents through the input transistors with a correspondingly small change in the amplifier output.

The drains of Q6 and Q7 are connected to an NPN current "mirror" Q9 and Q10. This one functions as a balanced to single-ended converter; in effect, a transistorized balun. Compared to a single-ended output, it doubles the input stage gain and increases the common-mode rejection. The first factor is important if you realize that the low transconductance of the FET reduces the voltage gain of the first stage to only about 5 times. Gain in the first stage influences the noise output of the amplifier. Transistor Q10 carries the same current as Q9 because of its common base connections and matched emitter resistors.

IC terminals 1 and 5 can be connected to opposite ends of a grounded-wiper 100K offset-nulling pot. Resistors R3 and R4 are subtler design details. To minimize offset voltages of the input MOS pair, it is desirable to operate both transistors with equal source-to-drain voltages. At balance, when the current is split between Q6 and Q7, each carries half the current source bias or 100 microamps. The drain of Q6 is at the 0.6 volt base-to-emitter voltage of Q10



RCA CA3130 operational amplifier.

plus the 0.1 volt drop across R6. The collector of Q10 is lower; it is fixed at one V_{be} above $-V_{cc}$ because of the base connection of Q11. Even though Q11 conducts 200 microamps, twice that of Q9, doubling current only raises the junction voltage 18 millivolts. The 0.1 volt drop across R4 raises the drain of Q7 to about 0.7 volt, the same as Q6. Resistor R3 drops the voltage on Q9's collector by 0.1 volt, matching the collector to emitter voltages across Q9 and Q10. When the current in Q6 and Q7 are equal, Q7 is supplied completely by Q10 and there is no net current into the base of Q11. As the current in Q7 increases, the currents in Q6, Q9, and Q10 decrease by an equal amount. The net current change into the base of Q11 is twice the current change in Q7. The current drive arrangement requires no gain robbing load resistors at the base of Q11. Input offset for the CA3130, CA3130A, and the CA3130B is 2, 5, and 15 mv.

Transistor Q11 is the second stage and the highest gain contributor of the op-amp. Its voltage gain is about 600. Transistors Q3 and Q5 are a cascoded high-impedance current load for Q11; they are in parallel with Q2 and Q4 and supply the same 200 microamp current. Again there is no load resistor. The high impedance of the current source paralleled with the very high gate input impedance of the output amplifier is an extremely high AC collector load for Q11 giving the high stage gain. Stability compensation is easily applied to this point. A single capacitor, normally 47 pF, connected between IC pins 8 and 1 will provide stable unity-gain operation.

Finally, the output stage (Q8 and Q12) is the COS/MOS part of the circuit. Large complementary PMOS and NMOS transistors are connected with their drains and gates tied together and with their sources connected to opposite supply voltages. When the gate voltage rises, Q8 tends to turn off and Q12 on. At the extremes of the gate swing, one device is turned completely on and the other is off. Attached to an output impedance that is high compared to the channel resistances, the output can swing within 10-mV of either supply rail. The amplifier output can be strobed or disabled by pulling IC pin 8 down to $-V_{cc}$. The COS/MOS output inverter sources and sinks a minimum of 12 mA and typically 20 mA. Many operational amplifiers use extra devices to protect the output stages from excessive currents. Even with such protection they can sometimes be destroyed under transient conditions. The COS/MOS output stage has inherent protection due to its finite channel resistance. In this case, the important spec is the maximum current which is 45 mA. Quiescent current in the stage is 8 mA when the output is at 7.5 volts and the amplifier supply is 15 volts. With a 2000-ohm load tied to IC pin 6, the gain of the third stage is about 30 times. The output will drive standard COS/MOS logic circuitry or 7400 series TTL.

Supply voltage range for the CA3130 series is 5 to 16 volts. Typical unity gain bandwidth with a 47 pF compensation capacitor is 15 MHz. Estimating the total open-loop amplifier gain using the three values mentioned above we get: $5 \times 600 \times 30 = 90,000$. Converting to dB: $20 \log 90,000 = 20 \times 4.996$ or about 100 dB. The more accurate data sheet specification reads 110-dB typical.

The 3130 can be used in digital-to-analog converters, peak detectors, full-wave signal rectifiers, power-supply error amplifiers, multivibrators and long duration timers. **R-E**

STATE-OF-SOLID-STATE

(continued from page 31)

Semiconductor memory continues to nudge traditional cores from their intricately wired boards. The achievement record of IC technology in the last few years makes it difficult to imagine the physical wiring complications of core from competing much longer. Inevitably, this trend will put the minicomputer into the home, probably in the next decade. A TV-display keyboard system will control the entertainment and work machine.

Non-volatility—the ability to store data for long periods of time without power—is essential in some applications. Even here, where cores have a natural upper hand, the economics permits standby battery power supplies to be included in the IC system and yet be cost competitive.

There hardly seems to be an argument when it comes to ROM (Read Only Memory.) The IC ROM is as non-volatile as core—even more so because its mask-programmed ones and zeros cannot be erased or altered even with failure of auxiliary control circuits. Once the memory has been manufactured, it cannot be changed by electrical write signals, there are in fact no write terminals on the device.

Semiconductor ROM's are used in computers, data terminals, anywhere where fixed programs or data tables are commited to permanent storage. It is always less expensive than RAM (Random Access Memory) and becomes the obvious choice where the application calls for ROM.

Peripherals like teletypes and card readers must be able to communicate with the computer. A computer with a blank memory is helpless; communication with anybody or anything is impossible. Bootstrap program loading routines are stored in ROM's. They are transferred to the main memory by pushing a button. More complex programs are then entered from paper tape, magnetic tape, or magnetic disk to allow more efficient transfer of information to and from. Even if the computer main memory is jumbled by some programming "accident", the ROM remains intact. The push of a button restores the system for program correction and another try at execution.

IC ROM's are also finding wide applications as code translators, programmable waveform generators, in display systems, as character generators, and as one we will take a closer look at—electronic look-up tables.

Table look-up ROM's

American Microsystem's S8771 is a 5120-bit high-speed MOS read-only-memory. It can be used as a 4096-bit conventional "4K" ROM by altering its organization with input pin voltages. Not all of the cells are used in this case. Two standard preprogrammed versions, the S8771A and S8771B, use all 5120 bits. The first is a sine/cosine look-up table, and the second an arc-tangent look-up table. The memories are compatible with TTL logic. Outputs are three-state. Besides the active 1 and 0 output states there is the third state, an inactive open condition in which the output leads are left floating. This setup allows the outputs of many chips to be paralleled so they can be combined to form large composite memories. Individual circuits are selected by output enable terminals.

Figure 1 shows the general organization of the device. Address terminals A1 through A9 select the columns and rows of the memory to locate individual words. 512 10-bit words addressed by the inputs are transferred to the B1 through B10

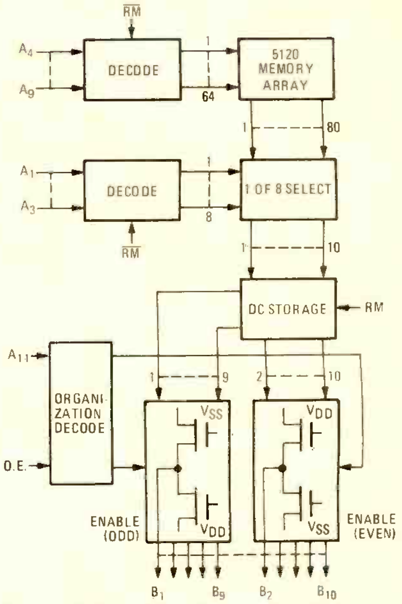


FIG. 1—THE S8771 HIGH-SPEED ROM.

output terminals when the output enable pins are energized. If A11 and O.E. are low, all outputs are disabled. Raising A11 to a high logic level enables the odd outputs B1, B3, B5, B7, B9. Putting a high logic level on O.E. enables the even outputs. The memory looks like a 1024 × 5 or 1024 × 4 arrangement when these pins are used to enable half the outputs at a time.

The terminal arrangement of the A version is shown in Fig. 2. The output enable and A11 inputs are jumpered to enable all outputs simultaneously.

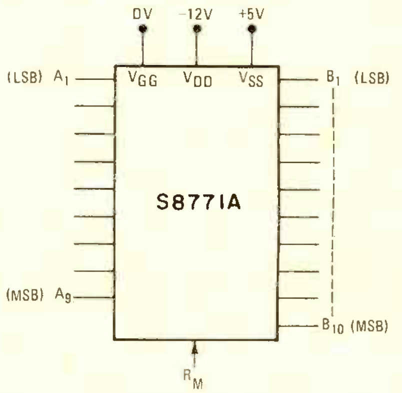


FIG. 2—SINE-COSINE LOOK-UP TABLE.

The S8771A will find the sine of an angle between 0 and 90 degrees. By subtracting multiples of 180 degrees from larger angles and applying the correct sign depending on the quadrant of the angle, the sine of any angle can be found.

(continued on page 74)

DIGITAL CLOCK KIT ROUNDUP

PART I. A comparison between the various digital clock kits that are currently available

FRED BLECHMAN

DIGITAL CONCEPTS model EC-2000K.

ESE model ES-112K.

FORMULA INTERNATIONAL model MM5314.

HEATHKIT model GC-1094.

"TIME FLIES" . . . "TIME IS MONEY" . . . "A STITCH IN TIME SAVES nine" . . . "TIME heals all wounds" . . . "TIME is of the essence." These and countless other familiar phrases abound, since TIME, reputed to be the fourth dimension, is so important in all our lives. The latest evidence of the consuming interest in TIME is the proliferation of watches and clocks with digital readouts. Who hasn't seen the familiar "countdown" numerals displayed on TV during space launches?

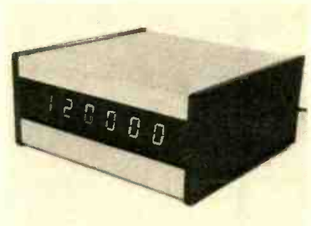
Early-generation digital timepieces contained ingenious mechanical or electro-mechanical movements. These were followed by electronic "modules," solid-state crystal-controlled microcircuits—very expensive, but highly accurate and reliable. With broad acceptance, technological advances and the resultant economies of high production, electronic module price structures have collapsed encouraging even higher sales, more production, and still lower prices. This is most noticeable in the digital wristwatch field. Today you can buy a five-function (hour, minute, second, day and date) digital wristwatch for $39.95, with good likelihood of some models at years-end selling for $19.95. A digital readout watch of the same kind cost over $200 just two years ago!

The digital clock field has been much less dynamic. Electromechanical movements abound, stimulated by the clock-radio and bedside alarm market. Size and life requirements are much less demanding than in wristwatches, allowing the use of cheap mechanical contraptions from "flip-cards" to light-shutter devices. Only recently, with the availability of sophisticated, specially-designed IC's, are electronic digital clocks making an impact in the consumer marketplace. With 1/60th-second accuracy, 6-digit readouts in various colors and sizes, alarm accuracies to the minute and no moving parts, electronic digital clocks are beginning to challenge the "old-timers." With technology advancing by leaps and bounds, formerly hard-to-get parts are becoming readily available at realistic prices, as a survey of the advertisers at the back of this magazine will confirm.

Therefore, it's not surprising that many suppliers and manufacturers are jumping on the electronic clock-kit bandwagon. One supplier reported that they fill orders for 50 clock kits a *day*, at $19.95 each, and another claimed they had sold 25,000 clock kits at $9.95 before discontinuing that design! Until about a year ago, it was hard to find a digital clock kit for under $50, and they were relatively complex units. Today, as a glance at the accompanying comparison chart will show, you can get kits for under $12, and—perhaps the best news of all—several of them are really easy to build!

Many of the terms used in the digital clock field are peculiar in their application to this area, so explanations follow. By referring to these explanations, the comparison chart will be found to contain a great deal of valuable information if you are con-

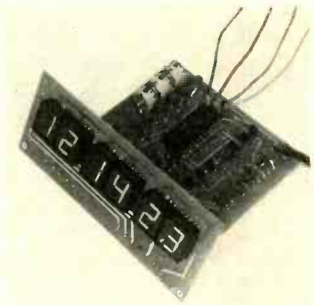
(chart on page 34 & 35)
(text continues on page 36)



ALTAJ—"THE KING."

BABYLON SPACE-AGE CLOCK.

CARINGELLA model DWC-1.



QUEST ELECTRONICS

HEATH COMPANY BENTON HARBOR, MICHIGAN 49022 (CONT)	GC1092D	79.95	6	.5	ORANGE	—	✓	—	(1)	—	—	(19)	MOSTEK 5017BA	BROWN	PLASTIC	2 1/2	8 3/8	4 7/8	EXCELLENT	HARD	BATTERY-POWERED OSCILLATOR FOR POWER-FAILURE OPERATION. CALENDAR DISPLAYS MONTH & DATE.
	GC1093	64.95	4	.5	ORANGE	✓	—	✓	(1)	—	—	—	S1856A	BROWN & BLACK	PLASTIC & METAL	1 7/8	4 5/8	4 3/4	EXCELLENT	HARD	CAR CLOCK, ALSO DISPLAYS ELAPSED TIME. CRYSTAL-CONTROLLED TIME BASE
	GC1094	49.95	6	.5	ORANGE	(18)	✓	—	—	✓	7	✓	MOSTEK MK5017PAA	BLACK & WALNUT	PLASTIC	2 1/2	7	4 3/4	EXCELLENT	HARD	
INTERNATIONAL ELECTRONICS UNLIMITED P.O. BOX 3036 MONTEREY, CA 93940	CLOCK* KIT	11.95	6	.25	RED	—	✓	—	—	—	—	—	NATIONAL MM5314	NOT SUPPLIED					FAIR	EASY	(2) (3) (4) (10) (20) (21)
JAMES ELECTRONICS P.O. BOX 822 BELMONT, CA 94002	JE-700*	19.95	6	.3	RED	—	✓	✓	—	—	—	—	NATIONAL MM5314	WALNUT	WOOD	3 1/8	6 5/8	2 1/2	GOOD	MEDIUM	(4) 29 JUMPER WIRES—OTHERWISE SIMPLE ASSEMBLY. NO SWITCH TO HOLD SECONDS
	WALL CLOCK	34.95	6	.6 & .3	RED	—	✓	✓	—	—	—	—	NATIONAL MM5314	WALNUT	WOOD	4 3/4	7 1/2	2	POOR	MEDIUM	(4)
	3 1/2" DIGIT WALL CLOCK	49.95	4	3.5	RED	—	✓	✓	—	—	—	—	NATIONAL MM5314	WALNUT	WOOD	5 5/8	18 5/8	1 3/4	FAIR	MEDIUM	(4) ASSEMBLED: $59.95 (SPECIFY 12 OR 24 HR)
		69.95	6	3.5	RED	—	✓	✓	—	—	—	—	NATIONAL MM5314	WALNUT	WOOD	5 5/8	27 5/8	1 3/4	FAIR	HARD	(4) ASSEMBLED: $79.95 (SPECIFY 12 OR 24 HR)
MESHNA SURPLUS P.O. BOX 62 E. LYNN, MASS. 01904	#SP-284* CHEAPY CLOCK KIT	14.00	4	.25	GREEN	(25)	✓	(16)	(25)	(25)	(25)	—	NATIONAL MM5316	NOT SUPPLIED					GOOD	EASY	(2) (3) (4) (6) (13) DIRECT DRIVE IC
	#SP-169 CLOCK KIT	21.00	6	.3	RED	—	✓	—	—	—	—	—	NATIONAL MM5314	BLACK	PLASTIC	3 3/4	5 1/2	4 3/4	FAIR	MEDIUM	CASE INCLUDES SPEAKER & VOLUME CONTROL (2)(3)(4)
NEXUS TRADING CO. BOX 3357 SAN LEANDRO, CA 94578	CAR* CLOCK	34.95	6	.3	RED	—	—	—	—	—	—	—	NATIONAL MM5314	BLACK	PLASTIC	1 3/4	3 1/2	3 1/8	GOOD	MEDIUM	$29.95 WITHOUT CASE & SWIVEL MOUNT (3)(4)(21) ASSEMBLED: $45.95 CRYSTAL-CONTROLLED TIME-BASE
	VAN CLOCK	45.95	6	.6	RED	—	—	—	—	—	—	—	NATIONAL MM5314	BLACK	PLASTIC	6	3	1 1/2	GOOD	MEDIUM	ASSEMBLED: $59.95, NO CASE KIT: $39.95 (3)(4) CRYSTAL-CONTROLLED TIME-BASE
NOVUS 1177 KERN AVE. SUNNYVALE, CA 94086	500A-4-P	29.95	4	.5	RED	✓	—	✓	(1)	✓	7	✓	NATIONAL MM5375 OR MA1002	BLACK, WHITE OR BROWN	PLASTIC	2	4	4 1/2	—	—	NOT A KIT! COMPLETELY ASSEMBLED.
QUEST ELECTRONICS P.O. BOX 4430 SANTA CLARA, CA 95054	DIGITAL* CLOCK KIT	17.45	6	.5	RED	—	✓	—	—	—	—	—	NATIONAL MM5314	NOT SUPPLIED					GOOD	MEDIUM	KIT WITHOUT XFMR & PC BOARDS: $12.95 (3)(4)(10)
SABTRONICS INTERNATIONAL P.O. BOX 64683 DALLAS, TEXAS 75206	6-DIGIT* LED CLOCK KIT	18.50	6	.5	RED	—	✓	(24)	—	—	—	—	NATIONAL MM5314	NOT SUPPLIED					GOOD	MEDIUM	(2)(3)(4)(21) .25 DIGITS KIT: $13.50
S.D. SALES CO. P.O. BOX 28810 DALLAS, TEXAS 75228	ALARM* CLOCK KIT	16.50	6	.3	RED	✓	✓	(23)	(11)	✓	10	✓	MOSTEK 50252	NOT SUPPLIED					GOOD	MEDIUM	(2) (3) (4) (21) (22)
SINCLAIR RADIONICS 375 PARK AVE. NEW YORK, NY 10022	BLACK* WATCH KIT	29.95	4	.12	RED	—	—	—	(11)	—	—	—	UNKNOWN	BLACK	PLASTIC	1 7/8	1 1/8	3/8	GOOD	EASY	HOURS, MINUTES, SECONDS & DATE BATTERIES & STRAP INCLUDED (THIS IS A WRISTWATCH, NOT A CLOCK)

NOTES: * BUILT FROM KIT BY AUTHOR

(1) PHOTOCELL SENSOR.
(2) LINE CORD NOT INCLUDED.
(3) WIRE NOT INCLUDED.
(4) SOLDER NOT INCLUDED.
(5) MOLEX PINS NOT INCLUDED.
(6) OPTIONAL SLEEP SWITCH.
(7) TEMPERATURE & CHIME MODULES OPTIONAL.
(8) 24 HR. ON 50 Hz. ONLY.
(9) FLASH IN 10 SEC. CODE
(10) SWITCHES NOT INCLUDED
(11) BRIGHT-DIM SWITCH
(12) PRE-CUT WIRES INCLUDED
(13) SWITCH DISPLAYS SECONDS
(14) OTHER COLORS AVAILABLE
(15) 24 HR. ON REQUEST
(16) BLINK—STEADY OPTIONAL
(17) ORANGE OPTIONAL
(18) TIME OR ALARM SET ONLY
(19) BATTERY-POWERED FOR POWER FAILURES, KEEPS COUNTING.
(20) 12V TRANSFORMER NOT INCLUDED
(21) REMOTE READOUTS OPTIONAL
(22) TIME BASE KIT AVAILABLE
(23) CAN BE ADDED
(24) DECIMAL POINTS USED AS COLONS
(25) INSTRUCTIONS SHOW AS OPTION; PARTS NOT INCLUDED

COMPARISON CHART – ELECTRONIC DIGITAL CLOCK KITS

MANUFACTURER OR DISTRIBUTOR	MODEL	KIT PRICE ($)	DISPLAY: NUMBER OF DIGITS	DISPLAY: DIGIT HEIGHT (IN.)	DISPLAY: COLOR	DISPLAY: AM/PM INDICATOR	DISPLAY: 12/24 HOUR OPTION	DISPLAY: COLONS	DISPLAY: ADJUSTABLE BRIGHTNESS	ALARM	SNOOZE TIME (MINUTES)	POWER FAILURE	CLOCK IC	CASE: COLOR	CASE: MATERIAL	CASE: HEIGHT (IN.)	CASE: WIDTH (IN.)	CASE: DEPTH (IN.)	ASSEMBLY: MANUAL	ASSEMBLY: RATING	NOTES & REMARKS
ALTAJ ELECTRONICS P.O. BOX 38544 DALLAS, TEXAS 75238	4-DIGIT* ALARM CLOCK	21.50	4	.25	RED	✓	—	—	(1)	✓	7	—	MOSTEK 70380	CREAM & WALNUT	METAL & PLASTIC	2 1/2	5 1/4	6 1/4	GOOD	MEDIUM	.5" DIGITS FOR $22.50 (2)(3)(4)(5)(6) NO SWITCH TO ZERO SECONDS.
	THE KING	23.50	6	.3	RED OR YELLOW OR GREEN	✓	(8)	—	(1)	✓	10	✓	MOSTEK 70250	GRAY & BLACK	METAL & PLASTIC	3 1/4	7 1/4	7 1/4	GOOD	HARD	SPECIFY COLOR DISPLAY. .5" OR 6" DIGITS (RED ONLY) FOR $28.50 (2)(3)(4)(5)(7)
BABYLON ELECTRONICS P.O. BOX 41778 SACRAMENTO, CA 95841	SPACE* AGE CLOCK	10.95	4	.25	RED	—	✓	(9)	—	—	—	—	NATIONAL MM5314	BLACK	METAL & PLASTIC	1 7/8	3 1/4	1 1/2	FAIR	EASY	(4) SMALLEST. BUILT-IN TIME-SETTING SWITCHES
BILL GODBOUT ELECT. BOX 2355 OAKLAND AIRPORT, CA 94614	SON-OF* A-CHEAP-CLOCK	14.50	6	.3	RED	—	✓	—	—	—	—	—	NATIONAL MM5314	NOT SUPPLIED					FAIR	MEDIUM	(2)(3)(4)(10) SOCKETS FOR IC & ALL DIGITS. (21)(22)
CARINGELLA ELECTRONICS, INC. P.O. BOX 727 UPLAND, CA 91786	DDC-1*	59.95	6	.6 & .4	WHITE-YELLOW	—	✓	—	(11)	—	—	—	NATIONAL MM5314	SMOKE GRAY & WALNUT	PLASTIC, METAL & WOOD	3 1/4	7 1/2	4 3/4	GOOD	MEDIUM	ASSEMBLED: $84.95 (12)
	DWC-1	159.95	6	3.5 & 2.5	RED	—	✓	—	—	—	—	(19)	NATIONAL MM5314	WALNUT	WOOD	8	21	3	GOOD	HARD	ASSEMBLED: $199.95 (12) CRYSTAL CONTROLLED OSCILLATOR FOR POWER FAILURE IMMUNITY.
	LDC-1	59.95	1	3.5	RED	—	—	—	—	—	—	—	NATIONAL MM5314	WALNUT	WOOD	7 INCH HIGH HEXAGON			GOOD	MEDIUM	ASSEMBLED: $74.95 (12)
	MDC-1	99.95	6	.6 & .4	WHITE-YELLOW	—	✓	—	(11)	—	—	(19)	NATIONAL MM5314	SMOKE GRAY & WALNUT	PLASTIC, METAL & WOOD	3 1/4	7 1/2	4 3/4	GOOD	MEDIUM	ASSEMBLED: $124.95 (12) CRYSTAL CONTROLLED OSCILLATOR FOR POWER FAILURE IMMUNITY.
	SDC-1	39.95	1	.6	WHITE-YELLOW	—	—	—	—	—	—	—	NATIONAL MM5314	SMOKE GRAY & WALNUT	PLASTIC, METAL & WOOD	3	5	4	GOOD	MEDIUM	ASSEMBLED: $49.95 (12)
	SSC-1	59.95	6	.6 & .3	RED	—	✓	—	—	—	—	—	NATIONAL MM5314	WALNUT	WOOD	2 3/4	5 3/4	3 1/4	GOOD	MEDIUM	ASSEMBLED: $84.95 (12)
DIGITAL CONCEPTS CORP 249 ROUTE 46 SADDLE BROOK, NJ 07662	EC-2000K*	29.95	4	.5	BLUE (14)	✓	(15)	(16)	(1)	—	—	✓	ELECTRONIC ARRAYS DCC7301	CLEAR ACRYLIC TUBE 2 7/8 DIA. 3 1/2 X 3 1/2 WOOD END BLOCKS (WALNUT, ROSEWOOD OR ZEBRA WOOD)					EXCEL-LENT	EASY	WITHOUT CASE OR SWITCHES: $24 ALARM/SNOOZE VERSION (13) OPTIONAL AT EXTRA COST.
	CK-131	59.95	6	.55	RED (17)	—	✓	—	—	—	—	✓	MOSTEK MK5017BB	WALNUT	WOOD	4 3/4	6 1/2	4	EXCEL-LENT	MEDIUM	INCLUDES CALENDAR READOUT WITHOUT CASE: $47.95 (CK-100)
ESE 505½ CENTINELA AVE. INGLEWOOD, CA 90302	ES-112K	85.00	6	.6	WHITE-YELLOW	—	(15)	—	—	—	—	—	15 DISCRETE IC'S	GRAY & WALNUT	METAL & PLASTIC	2 1/2	8 1/4	6	GOOD	MEDIUM	ASSEMBLED: $130 DIRECT DRIVE NOT MULTIPLEXED
FORMULA INTERNATIONAL, INC. 12603 CRENSHAW BLVD. HAWTHORNE, CA 90250	MM5314*	19.95	6	.32	GREEN	—	✓	—	—	—	—	—	NATIONAL MM5314	GRAY	PLASTIC	2 1/4	4 1/2	3 3/4	POOR	MEDIUM	(3) (4)
	OC1030	29.50	4	.5	GREEN	✓	✓	✓	—	✓	7	✓	TMS 3834	ORANGE	PLASTIC	3	5 3/4	2 1/2	FAIR	MEDIUM	(3) (4)
	OC1032	35.90	4	1	ORANGE	✓	✓	✓	—	✓	7	✓	TMS 3834	WALNUT	PLASTIC	3 1/2	5 1/4	5	FAIR	HARD	(3) (4) (13) COLON BLINKS
HEATH COMPANY BENTON HARBOR, MICHIGAN 49022	GC1092A	79.95	6	.5	ORANGE	(18)	✓	—	(1)	✓	7	(19)	MOSTEK 5017AA	BROWN	PLASTIC	2 1/2	8 3/8	4 7/8	EXCEL-LENT	HARD	BATTERY-POWERED OSCILLATOR FOR POWER-FAILURE OPERATION

sidering buying a kit, or if you just want to be more familiar with this "branch" of electronics. To help, Fig. 1 is a schematic of the simplest of the units reported on, the *Space Age Clock* from Babylon Electronics, yet it contains all the essential elements of a basic electronic digital clock. Figure 2 shows another schematic. This one is for the Caringella *model DDC-1* desk clock.

Display

This is what you see, the "readout." Most of the kits feature 6 digits, with two for hours, 2 for minutes, and two for seconds. Those with four digits normally display only hours and minutes, and are not very exciting to watch. Some four-digit clocks shift to unit-minutes and second display with a switch. Colors and size cover a broad range. Several years ago, only very large (0.6 inches high) or very small (0.125 inches high) characters were available in kits. Now the smallest digits any respectable kit supplier offers are 0.25 inches high—easily readable from 15 feet with normal eyesight. The largest digits in any of the kits shown are 3½-inches high, and you can read them from at least 200 feet away.

DIGITAL CONCEPTS model EC-2000K, rear view.

FORMULA INTERNATIONAL model OC1030.

The most common displays are red, but the ones listed as white—yellow in the chart can be made to appear almost any color by placing colored plastic or glass in front of them. You can even make each *digit* a different color if you want a really unique display! One manufacturer, Digital Concepts, will color your display to order, with their standard display an outstanding bright blue (*model EC-2000*).

Some displays are fluorescent vacuum tubes, some light-emitting diodes (LED's), some gas-discharge types, and some are incandescent. All the units reported on use seven segments to form the numbers, as shown in Fig. 1. Before long you can expect units with alphanumeric readouts to show the day of the week on calendar clocks.

AM/PM indicators are provided within some displays as actual letters, but a less expensive, and hence more popular method of designating AM or PM is to use a decimal point or separate LED. In some kits, the first digit is mounted inverted so that the decimal point appears at the upper left corner of the display. This AM/PM designator allows 12-hour format alarm clocks to be set for repeating in 24 hours. For the non-alarm clocks, the AM/PM indicator is hardly a necessity, except for submarines, caves or dungeons!

Many of the kits can be wired for either a 12- or a 24-hour display. The 24-hour format is popularly known as "military time," but is used worldwide in time measurement. Midnight is 00:00:00, noon is 12:00:00, 1 PM is 13:00:00, 6 PM is 18:00:00 and one second before midnight is 23:59:59. AM/PM indicators are not needed with 24-hour displays, since any number under 12:00:00 is AM, and any number larger is PM.

Surprisingly, many of the clocks omit colons (:) between pairs of hours, minutes and seconds digits. Six-digit displays without colons are confusing, especially if there isn't wide spacing between the pairs of digits. Some of the 4-digit clocks have blinking colons that go on and off every second, adding some action to an otherwise lifeless display. The most interesting of these blinking colons is in the Babylon *Space Age Clock*, where the upper and lower points of the colon are coded to count seconds from 1 to 0 with a change every second. This is done by having the upper colon point driven by the segment E command to the non-displayed sixth digit, and the lower colon point driven by the segment D command to the same digit. Figure 1 shows when each colon is on during the seconds count. The colon display is different every second, and repeats every 10 seconds. This is useful in precise time-setting of the minute digit.

The purpose of adjustable brightness is to dim the display in low ambient light environments, so the display doesn't overpower its surroundings, and to conserve power. This is done in most clocks with a light-sensing photocell, although some use a bright-dim switch. The Digital Concepts *EC-2000* was outstanding in its photocell control of brightness, from a pleasant blue glow in darkness to a very bright display in highly-lighted areas.

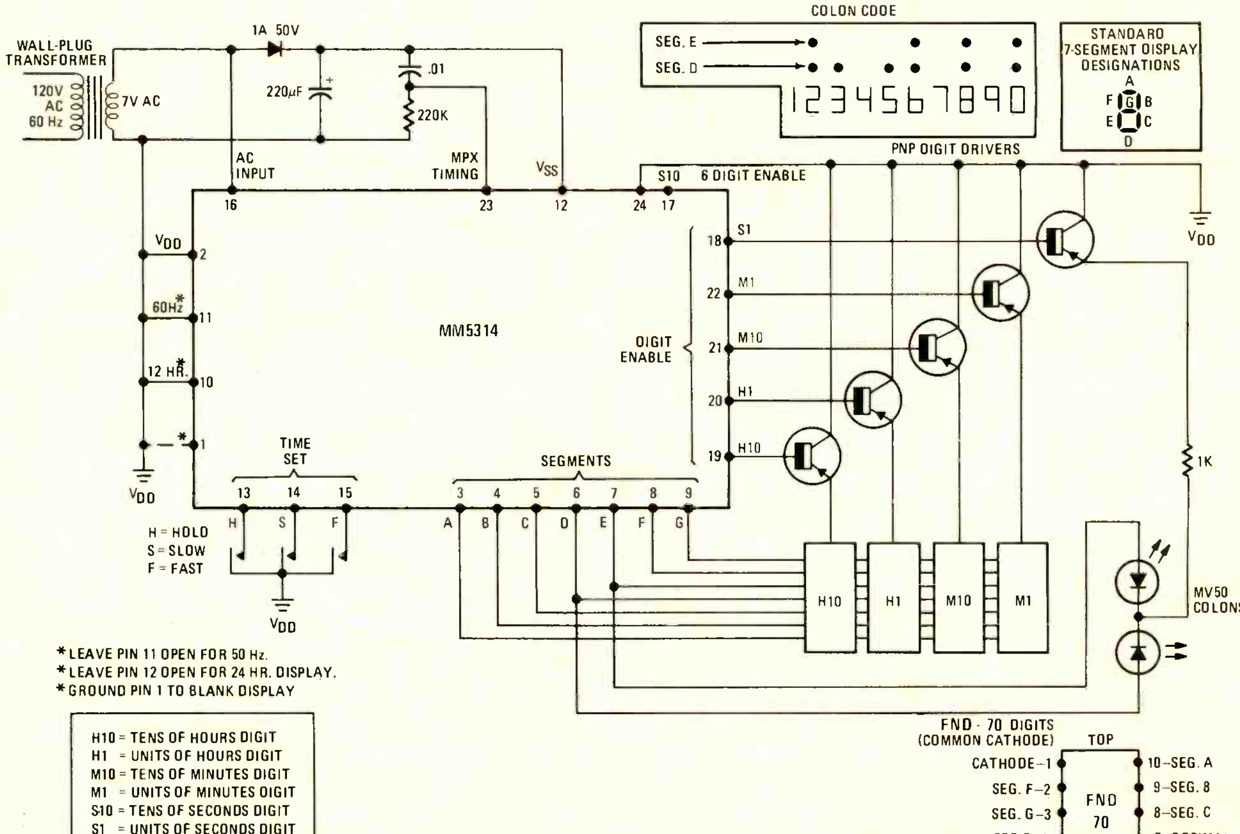


FIG. 1—THE BABYLON SPACE-AGE, a simple digital clock. Also shown are the display segment letters and the colon code for the seconds.

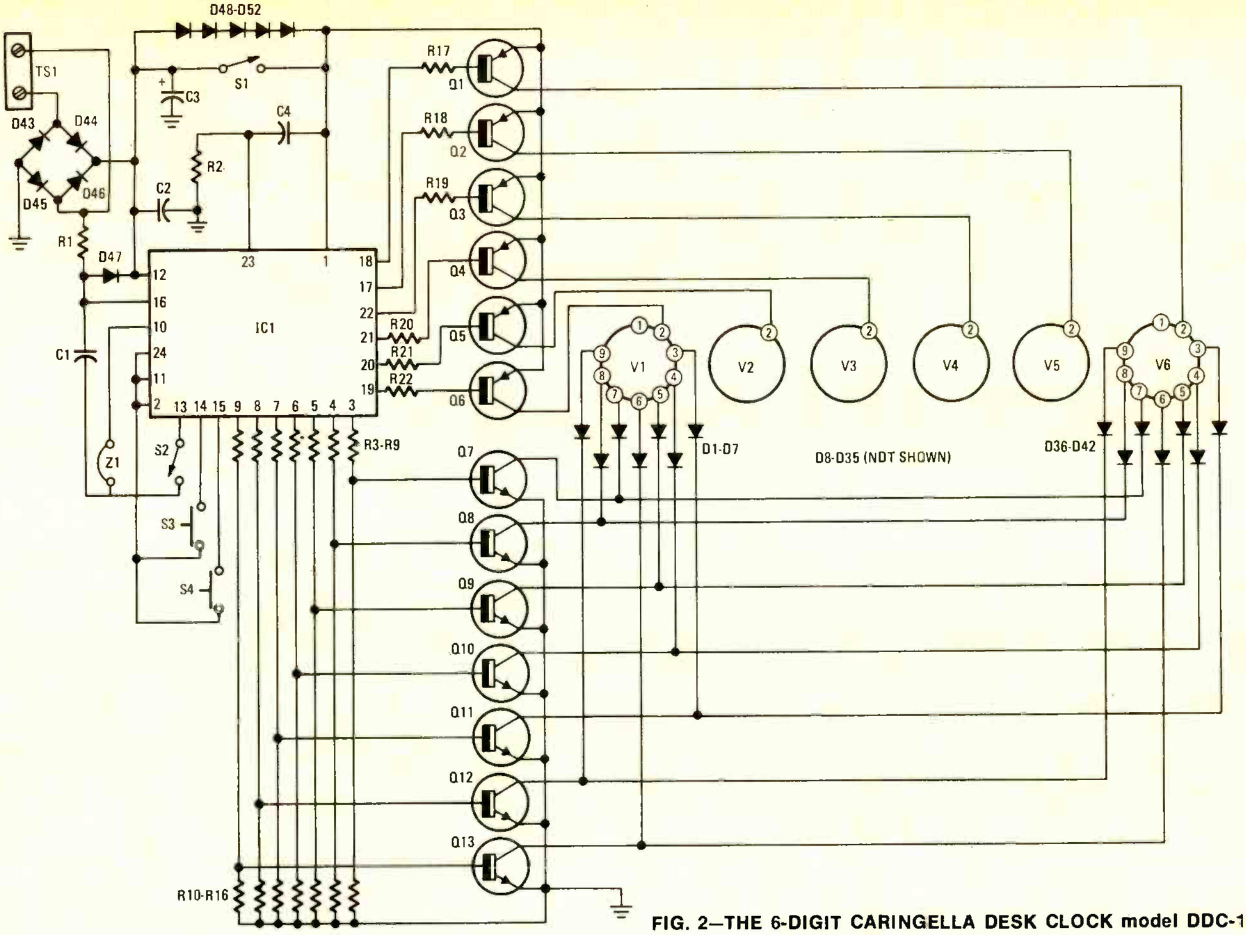


FIG. 2—THE 6-DIGIT CARINGELLA DESK CLOCK model DDC-1.

Alarms

Many of the clock kits available now can be used as bedside alarms. In addition, the Altaj *4-Digit Clock* and the Meshna *SP-284 Clock Kit* can be used to control an external radio to turn on or off (sleep switch). The alarms, instead of a raucous buzzer, are a beeping tone from a built-in speaker. All the alarm clocks have a "snooze" switch that shuts the alarm off for a short period of time (7 or 10 minutes). The big advantage of the alarm on these clocks is that they can be set to the *minute*, and most can literally be set to go off at the desired second (*exactly* on a minute change). Also, all the alarm clocks have 24-hour repeatability, with the use of the AM/PM indicators for alarm-time setting. This means you can shut off the alarm when it sounds, turn it right back on again, and it will repeat 24 hours later! Try that with a regular alarm clock!

Power failure indicator

With most regular electric clocks, if the power is interrupted for a short time, they start automatically when power returns, and are slow by the length of time the power was off. You could be completely unaware of this time inaccuracy. Since power outages often occur in the middle of the night, you could be late for work! Electronic clocks are not that callous! They will respond, depending on their design, one of three ways to an AC power loss when the power returns: 1. the clock starts counting at some random, completely inaccurate time—usually around zero; 2. the display comes back on after going off, and is right on time (battery-driven time-base oscillator keeps counting during the outage) or 3. the display "signals" that the power has been interrupted. This "signal" may be a non-counting display locked on 12:00:00, or 88:88:88, or a blinking AM/PM indicator, or blinking colons, or the sounding of the alarm, or some combination of the above (or none of the above!). The alarm going off is particularly important for those who depend on the alarm to wake them and experience a middle-of-the-night power loss.

Clock IC

All but one of the clocks on the Chart use a main clock "chip" that performs wave-shaping, counting and control functions instead of having an abundance of individual IC's. The IC only needs DC power and a source of 60 (or 50) Hz; it counts down to seconds and signals the proper segments of each digit to display the correct number for that instant. Also, most of the clock IC's shown "multiplex" the digit signals; all segment commands are carried on parallel lines to each digit, and the individual digits are enabled one at a time at a rate too fast for the eye to follow—this eliminates flicker. The scanning rate is controlled by a resistor-capacitor circuit to the clock IC, with typical values yielding a multiplex frequency of 2000 Hz. (See the 0.01 capacitor and 220K resistor in Fig. 11).

Multiplexing reduces the number of leads between a 6-digit display and the clock control from 42 to 13, as well as saving 29 driver-transistors and 35 current-limiting resistors in most applications! Most clock IC's can't handle display current requirements directly, and require driving transistors and current-limiting resistors. However, more "direct drive" clock chips are appearing on the market, eliminating many of the resistors and transistors to drive the displays. Many parts can be eliminated by clever design and component selection. The Babylon *Space Age Clock* (Fig. 1) and the International Electronics Clock drive the segments of the FND-70 low-current displays directly, and depend on the current-limiting of the MM5314 IC to keep the LED display from "avalanching" and burning out—this eliminates seven transistors and seven resistors! Several clock kits use direct-drive IC's that eliminate almost all the transistors and resistors.

Enclosures

Some of the kits do not include a case, and the builder is left to his own ingenuity. It can take more time to "package" the clock than to build it! So, unless you have a custom application, it's recommended that you buy a kit that includes a case. Some of the cases are exotic—Digital Concepts offers a variety of wooden decorator end-blocks for its *EC-2000 Clock* that is enclosed in a clear plastic tubular enclosure. The Altaj clocks have sturdy, modern-design metal and plastic cases, punched to accept switches and mounting hardware for the electronics. Some have wooden cases, with the most unusual in this group being the

(continued on page 93)

CB Transceiver Roundup

With the number of CB tranceivers increasing, it's getting difficult to keep track of what's available. Here's a sampling of the market

ROBERT F. SCOTT
TECHNICAL EDITOR

THERE ARE A GREAT NUMBER OF DIFFERENT MAKES AND models of CB transceivers on the market at this time. Just how many models there are, no one knows precisely, as the number of FCC type-approved sets increase in number day by day.

To get an idea as to the trends in CB tranceiver design, note that for this directory, we asked each manufacturer and importer for a photo and complete specifications on one of his models. Some sent details on their latest models, others included their best-sellers. Most, however, asked us to include the top-of-the-line model.

Quite a few of the models have interesting circuit features that we will describe for you in the coming months. These will include different types of synthesizers, noise-reducing circuits and other features. The most interesting and pertinent items are included in the description of each model in this round-up. We included all manufacturers who responded to our request.

Alaron B-1050
A 23-channel mobile transceiver with all required crystals included. Among its features are a delta-tune switch, PA switch, variable squelch control, full-time automatic noise limiter, self-contained speaker and illuminated channel selector. The plug-in dy-

namic mike has a fastener-type connector and coil-cord. Jacks are provided for external speaker for monitoring or PA use. Four watts maximum RF power output. Requires 12 volts DC, positive or negative ground. Mounting bracket and hardware, mike holder and power cord included. 6¼" × 7½" × 2¼".—**B & B Import-Export, Inc.,** 185 Park St., Troy, MI 48084.

Audiovox MCB-1000
This unit uses frequency synthesis for full crystal-controlled receive and transmit on all 23 channels. The receiver circuitry uses ceramic filters for superior selectivity. Variable squelch and a high-impedance automatic noise limiter reduce annoying noises when the receiver is in the receive and standby modes. Other features include S/RF meter, on-air indicator light, local-dis-

tance switch, PA/CB switch, external speaker jack. Can be used on 12-volt electrical systems having either positive or negative grounds.—**Audiovox Corp.,** 150 Marcus Blvd., Hauppauge, NY 11767.

Automatic CXB-2472
A new in-dash CB transceiver with AM/FM stereo radio. It is a full-feature CB rig with

delta tuning, squelch control, S/RF meter, illuminated channel selector and detachable microphone. The AM/FM multiplex radio has a stereo indicator light, and on-off, volume, tone, balance and fader controls. A unique feature in a unit as comprehensive as this is a "monitor" circuit that lets the user enjoy the AM/FM stereo radio without missing any activity on a selected CB channel. The control shafts are adjustable for secure and convenient installation in most cars.—**Automatic Radio,** 2 Main St., Melrose, MA 02176.

Blaupunkt BCB-5231
A mobile unit for under-dash mounting that uses 14 crystals in a synthesizer to produce 23 crystal-controlled transmit and receive frequencies. The re-

ceiver has adjustable squelch, a series-gate noise limiter and delta tuning with a ±1 kHz adjustable range. Transmitter provides 100% modulation with 4-mV microphone output. Maximum power output is 4 watts. Transmitter power input 6.6 watts at 13.8 VDC. Other features are PA switch, external CB switch for feeding receiver output to external speaker and RF gain control.—**Robert Bosch Corp.,** Car Radio Div., 2800 S. 25th Ave., Broadview, IL 60123.

Bon Sonic CB-23
Compact all-transistor mobile transceiver providing 23 crystal-controlled transmit and receive channels. Receiver is dual-conversion type featuring a ceramic filter and delta tuning with ±2 kHz on each channel, switchable ANL, and

S/RF power meter. An S-9 signal equals 100 μV input at the antenna terminal. The push-to-talk dynamic microphone provides convenient send-receive switching. Operates from 13.8-volt DC source with either positive or negative ground.—**Hanabashiya Ltd.,** 39 W. 28th St., New York, NY 10001.

Browning Golden Eagle
Deluxe base station comprising separate transmitter and receiver for AM and SSB modes. Each is fully independent with its own power supply operating from 117 V, 60-Hz lines. Circuits include 20 vacuum tubes performing 28 functions. Transmitter RF output up to 12 watts PEP on upper or lower sideband and up to 4 watts on AM. AM

modulation capability is limited to 100%. SSB carrier suppression better than 70 dB. Transmitter frequency control is adjustable in ±100, 300, 500 and 700 Hz steps with a "spot" switch for zero-beating with the received signal.

Lighted panel indicators show mode of emission. The receiver features exceptional sensitivity and selectivity with 70 dB minimum adjacent-channel rejection. There are two noise-limiters. Pulse-diode type for SSB and series-gate type for AM. Channel selector provides continuous tuning with separate bandspread control for coverage up to 27.595 MHz. Both units are 6.75" H × 15.50" W ×9.88" D.—**Browning Laboratories,** 1269 Union Avenue, Laconia, NH 03246.

Challenger 550

Compact, lightweight solid-state transceiver delivering 4 watts RF power output. In-

cludes a continuously variable squelch, 10-crystal frequency synthesizer, automatic modulation control, three-position delta-tune, illuminated S/RF output meter, output jacks for PA and auxiliary speakers. Audio power output 3 watts into 8 ohms; PA output 4.3 watts into 8 ohms. Operates from 13.8 VDC negative or positive ground power source. 6½" × 2½" × 7¾".—**TRS International Ltd.,** 4825 N. Scott St., Schiller Park, IL 60176.

Cobra 139

Base-station transceiver featuring console-type styling in walnut-grain finished cabinet. Transmits and receives in the AM and single-sideband

modes. Transmitter delivers the full maximum power of 4 watts on AM and 12 watts PEP on upper and lower sidebands in the SSB mode. Has separate modulation and RF output/signal strength meters. The dual-conversion receiver circuit includes RF gain control, and switchable noise limiting and noise blanking for maximum interference elimination. The Voice-Lock delta tuning system varies the receiver tuning over ±600 Hz. The transmitter carrier is suppressed 40 dB in the SSB mode. The Cobra 139 operates from 13.8 volts DC, positive or negative ground or 117 volts AC. —**Dynascan Corp.,** 6460 W. Cortland, Chicago, IL 60635.

Commando 2310

Mobile unit features synthesized frequency control on AM transmit and receive functions.

Transmitter output into 50-ohm load is 3.8 W, no modulation and 4.8 W with 100% modulation. Receiver is dual-conversion superhet. Operating voltage 13.8 VDC, battery drain on receive; no-signal, 230 mA transmitter drain, no modulation, 690 mA; 100% modulation 1.190 A. 5³⁄₁₆" × 2" × 9".—**Commando Communications,** Chattanooga, TN.

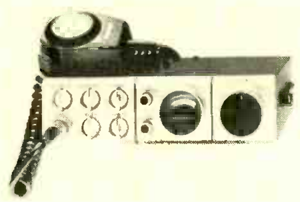
Cornell-Dubilier Mark X

Frequency synthesized base unit with all crystals supplied for full 23-channel operation.

Shown beside the antenna rotor control box, the unit has quite a few notable features. Among them are: dual-conversion superheterodyne receiver with ceramic filter for superior selectivity. variable squelch and high-impedance automatic noise limiter, separate S/Mod, power and SWR meters, headphone jack on the panel, delta tuning, digital channel readout, separate RF and IF gain controls, ANL switch and a dual power supply for 117 VAC or 13.8 VDC operation. —**Cornell-Dubilier Electronics,** 150 Avenue L, Newark, NJ 17101.

Craig 4103

Mobile transceiver that can deliver the full 4 watts RF output authorized by the FCC. High-level modulation is used for full 100% modulation. Built-in microphone preamplifier circuit provides special voice-frequency shaping and dynamic compression to maintain maximum intelligibility through a



high average modulation without the danger of overmodulation. The dual-conversion receiver includes a 455-kHz ceramic filter to reduce adjacent-channel splatter. Standard automatic noise limiting (ANL) is always on to reduce atmospheric noise. A switchable noise blanker blanks the receiver for a microsecond or two during noise impulses, stopping the noise before it reaches the audio circuits. A variable squelch circuit silences noise between transmissions. The RF gain control can be set so you can hear weak distant signals or prevent "blasting" from nearby stations. Other features include delta tuning, a LED modulation indicator lamp, S/RF/SWR meter, 8¼" × 2⅜" × 8⅞".—**Craig Corp.,** 921 W. Artesia Blvd., Compton, CA 90220.

EICO 7723

Compact mobile transceiver with full 23-channel synthe-

sized circuitry, dual-conversion superhet receiver with full-time ANL and AGC. Other features include a variable squelch control, tuned RF stage, PA switch, combination S/RF meter and a facility for either positive or negative ground operation from 14 VDC supply. It is 1¾" × 5" × 8½" in a metal cabinet and comes with mike and power cord.—**EICO Electronic Instrument Co.,** 283 Malta St., Brooklyn, NY 11207.

Fulcomm 15-2301

Mobile transceiver operating on 23 frequency-synthesized channels with 4 watts maximum RF power output. It features delta tuning, ANL, illuminated S/RF power meter, squelch control, modulation indicator, built-in, speaker, ex-

ternal speaker jack and PA capability. Requires 13.8 VDC, positive or negative ground. 6¼" × 2¼" × 7¾".—**Arthur Fulmer Communications,** P.O. Box 177, Memphis, TN 38101.

Gemtronics GTX-23

Powerful and compact, this unit features 3-position delta tune switch, S/RF meter, squelch control, PA/CB selector, noise limiter and modula-

tion indicator lamp. Covers the 23 channels with synthesizer frequency control. Receiver is dual-conversion superhet with 10.595–10.635-MHz first IF and 455 kHz second IF. 6" × 2" × 8⅔".—**Gemtronics,** P.O. Box 1408, Lake City, SC 29560.

General Electric 3-5820

A 23-channel mobile unit with 1-channel priority monitor and LSD digital channel readout. The channel priority feature allows the user-selected priority channel to be received regardless of the setting of the channel selector. (The crystal for the priority channel is available as a user-selected accessory.) The unit features PLL synthesized transmit and receive frequency control. RF

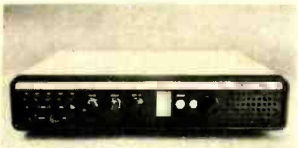
gain and volume controls help balance distant and near-by stations for equal clarity. Adjustable squelch eliminates background noise when the monitored channel is not in use. Can be adjusted for weak or very strong stations. The delta-tune circuit provides 3-position fine tuning. Transmitter has push-to-talk microphone and automatic modulation control circuit. 7¼" ×

2¼" × 8⅜".—**General Electric Co.,** Audio Electronics Products Dept., Syracuse, NY.

Globe 9001
Maximum transmit range is assured by the 4-watt maximum RF power capability and the AMSC (Automatic Modulation Stabilization Circuit). The

sensitive dual-conversion superheterodyne receiver circuit assures a receiving range that matches the capabilities of the transmitter—you can't work 'em if you can't hear them. Twenty three phased-locked loop (PLL) synthesized channels with delta tuning for fine-tuning off-frequency stations. S/RF meter indicates both receiver and transmit signal strengths. Positive- or negative-ground operation in any vehicle with 12-volt DC battery. Receive battery drain 0.25 to 1.6 A. Maximum audio at external speaker jack 3 watts. Transmitter power input 5 W, output 4 W without modulation. Battery drain without modulation 0.9 A.—**Globe Electronics,** Div. of Hydrometals, Inc., Rockford, IL 61101.

Handic 2350
Base-station transceiver designed for 120/240 VAC line or 12 VDC operation. Includes



a sub-receiver that can be crystal controlled on a priority channel. When there is a signal on the priority channel, the priority lamp flashes and the signal is heard in the loud speaker, no matter to which channel the channel selector is set. The squelch for the sub-receiver is set so the main receiver is not interrupted by noise. The 2350 base unit includes a special jack for connection to the S-12 selective call unit. This selective call unit responds only to calls with its own private tone code and so the user need not listen to a lot of other traffic on the monitored channel. Other features include S/SWR/RF meter, automatic noise limiter, built-in PA amplifier, switch and control for calibrating the SWR meter, jacks for external and PA loudspeakers.—**Handic USA,** Kennedy Building, 14560 N. 60th Ave., Miami Lakes, FL 33014.

Hy-Gain Hy-Gain VIII
Base transceiver with both AM and SSB capabilities. It has a crystal matrix frequency-synthesizer for 23 AM channels plus upper and lower sideband. Extra features include adjustable noise limiter for atmospheric noise, a switchable noise blanker to eliminate man-made noise and a crystal filter for superior adjacent-channel rejection. A black-out face conceals the signal/modulation and SWR/RF meters, receive and transmit LED indicators and digital readouts for

time and channel. Controls are provided for volume, channel, squelch, function, fine tuning, tone, RF gain, SWR calibration, modulation adjustment, noise blanker, ANL, PA, SWR bridge and power. Supplied with plug-in microphone. Jacks for optional telephone handset and remote or external speaker. Operates from 120/240 VAC, 50/60 Hz or 13.8 VDC. 4¾" × 11" × 16".—**Hy-Gain Electronics Corp.,** 8601 Northeast Highway Six, Lincoln, NE 68505.

Kris XL-23
Mobile unit featuring variable squelch, PA and ANL and internal-external speaker switches, illuminated S/RF meter, transmit indicator light, external-meter jack, transmit-relay contacts and TVI filter adjustment. The receiver is a sensitive dual-conversion type with mechanical filter that re-

duces interference from adjacent channels. 8.375"D × 6.50"W × 2.25"H.—**Kris Inc.,** N144 W5660 Pioneer Rd., Cedarburg, WI 53012.

Lafayette Telsat SSB-100
A base station that has 69-channel capability—46 upper and lower-sideband channels as well as 23 standard AM channels. Features include two dual-function meters displaying RF output and "S" readings plus SWR and % modulation readings. Both meters have external calibration controls that can be adjusted without external gear. Additional features include a delta tune, circuit, RF gain control, switchable ANL, a special

noise blanker, built-in range-boost circuit, automatic modulation control, variable squelch, PA and tape-recorder output. For 105—120 volt, 50/60 Hz AC operation, the SSB-100 is capable of emergency DC operation when used with the optional power cord and an external 12-volt battery.—**Lafayette Radio Electronics,** 111 Jericho Turnpike, Syosset, NY 11791.

MetroSound MS-357
23-channel mobile unit with pushbutton noise blanker, pushbutton local/DX switch,

variable squelch, special RF gain circuitry, plug-in dynamic mike with push-to-talk switch, dual-conversion receiver, pushbutton ANL switch, pushbutton PA/CB selector, S/PWR meter, receive/modulation lights, external speaker and PA jacks. 6½"W × 2"H × 8½"D. 12 VDC, negative or positive ground.—**MetroSound,** 11144 Weddington St., North Hollywood, CA 91601.

Midland 13-882C
Deluxe full-power 23-channel mobile unit with both switchable ANL and noise blanker. The transmitter provides a maximum of 4 watts RF power output with high-level modulation for maximum talk power. The dual-conversion receiver has a tuned RF stage for good sensitivity and front-end selec-

tivity. The advanced PLL synthesizer uses only three crystals. A warning light shows antenna mismatch or failure. Controls include on-off/volume, variable squelch, PA, delta tune, channel selector, noise blanker, ANL, external CB speaker jack, S/RF meter and dynamic push-to-talk microphone. Power source 13.8 VDC, positive or negative ground. 2¼" × 6⅜" × 7⅞".—**Midland International, Communications Div.,** P.O. Box 19032, Kansas City, MO 64141

Motorola Mocat 2020
Full solid-state mobile transceivers with digital phase-locked-loop synthesizer that holds the receiver and trans-

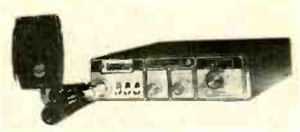
mitter on frequency, a large illuminated S/RF meter, positive or negative ground operation, LED digital channel indicator with dimmer control and a mounting bracket for underdash or overhead installations. The transmitter features TVI filter, burn-out protection to prevent damage to the set if antenna is damaged or set is operated without antenna. Audio compression for maximum talk power and a stronger signal. The receiver has adjustable squelch, ANL with variable threshold, noise blanker and ceramic filters for improved adjacent-channel selectivity. 2.46 in. high, 7.24 in. wide and 9.4 in. deep.—**Motorola Inc.,** Communications Div., 1301 Algonquin Rd., Schamburg, IL 60172.

Nuvox TC-5020
Mobile unit supplied with all crystals for 23-channel opera-

tion. Has lighted S/RF power meter, dual-conversion superhet with ceramic filter for superior selectivity, squelch control, ANL and 3½" speaker. The four-stage transmitter is Class-B modulated and delivers a minimum of 3.8 watts RF output. 7½"D × 4⅜"W × 2"H.—**Nuvox Electronics Corp.,** 150 5th Ave., New York, NY 10011.

Pace CB 166
Mobile transceiver with synthesized 23-channel operation

made possible with only one crystal and an integrated circuit module containing a phase-locked loop (PLL) circuit. The dual-conversion



superhet receiver has tuned IF filters for immunity from adjacent-channel bleed-over. The narrow-band filters are also responsible for the added noise reduction. Features include S/RF meter, ANL control, switchable noise blanker, PA function, adjustable squelch and transmit and receive indicator lamps. Approximately 6⅝" × 1⅞" × 9".—**Pathcom Inc.,** 24-49 Frampton Ave., Harbor City, CA 90710.

Palomar — Digicom 100
23-channel AM/SSB mobile unit with a unique programmable digital frequency synthesizer. There are two channel

selector knobs; one for each digit of the channel number. For example channel 13 would be selected by turning 1 on the left knob and 3 on the right knob. The synthesizer is programmable for any future increase in the number of channels authorized by the FCC. The transmitter is delivered inoperative for channels 24 through 99. Other unique features are a pre-emphasis noise blanker, full automatic RF gain control utilizing a PIN diode attenuator, source-injection JFET mixer to minimize cross-modulation, dual-made 8-pole crystal filter for superior selectivity on both AM and SSB, PIN-diode antenna switching and transmitter automatic level control (ALC). 13.5 VDC operation. 10¼"W × 14½"D × 2½"H.—**Palomar Electronics Corp.,** 665 Opper St., Escondido, CA 92025.

Panasonic — RJ-3200
Receives and transmits on all 23 channels with full 4-watt

output capability. A 3-position delta tune switch shifts the receiver frequency ±1 kHz. Also included are switchable ANL, S/RF power meter, 2-step tone control, "on-the-air" LED indicator, modulation indicator, CB/PA switch and built-in speaker. Modulation percentage is 90% and power output is 4 watts with 6 mV at the mike input jack. Comes with dynamic mike, quick-release bracket, power plug and jacks for external and PA speakers.—**Matsushita Electric Corp. of America,** 50 Meadowlands Parkway, Secaucus, NJ 07094.

Pearce-Simpson — Simba SSB
Base unit for AM and SSB operation providing maximum outputs of 4 watts RF on AM

and 12 watts PEP on either lower or upper sideband. Unique feature is a digital clock that sounds an alarm and turns on the set at a predetermined time. A variable preamp, built into the unit, allows you to set your modulation as you want it. A modulation meter keeps check on your operation. A desk mike is standard equipment. The Slide-O-Tune circuit lets you move the receive and transmit frequencies for best possible SSB communications. Among the other features are RF-type noise blanker, built-in 117 VAC/12 VDC power supply, S/RF/Modulation and SWR meter. 7⅜"H × 12"D × 15"W.—**Pearce-Simpson,** Div. of Gladding Corp., P.O. Box 520800, Biscayne Annex, Miami, FL 33152.

Ray Jefferson — CB-711 Saturn
Designed for the boatsman, this unit operates on all 23 CB

channels and receives VHF/FM Weather I and Weather II. The receiver RF gain control eliminates nearby station override for sharper and clearer reception. The unit is solid-state with maximum permissible power output. Built-in meter measures signal strength and RF power output. Operates from any 12 VDC power source, is 7½"W × 3"H × 9"D and comes with power cord, universal mounting bracket and push-to-talk microphone.—**Ray Jefferson,** Main and Cotton Sts., Philadelphia, PA 19127.

RCA — 14T200
A solid-state mobile transceiver that uses a crystal frequency

synthesizer and comes ready for operation on all 23 channels. The transmitter features full 4 watts RF maximum output and automatic level control for correct modulation. The S/RF meter measures the strength of incoming signals and the relative RF power output level. An external CB speaker jack is provided so a separate speaker can be used in noisy areas such as truck cabs and in power boats. Delta tuning permits clear reception of signals that are slightly off frequency. 6½" × 2¼" × 7¾". Power source 13.8 VDC, positive or negative ground.—**RCA, Distributor and Special Products Div.,** Cherry Hill Offices, Camden, NJ 08101.

Realistic — Navaho TRC-57
Base unit for AM and SSB operation with FET's and IC's used in all key electronic cir-

cuits. The digital PLL circuit is accurate to within 100 Hz. A "Clarifier" (delta tune) is provided for best speech intelligibility on incoming signals. The receiver has a crystal-lattice filter for superior selectivity. The RF gain control permits sensitivity to be reduced to cut background noise in strong-signal areas. The built-in electronic digital clock operates on AC only. There are two meters on the panel, S/RF output and SWR. Operates from 120 VAC or 12 VDC positive or negative ground systems. 3⅞" × 14⅞" × 10½".—**Radio Shack** Stores or catalog.

Robyn — DG-30
23-channel mobile unit that converts quickly to base operation when plugged into the accessory SX-7 module containing a regulated 14-volt DC supply. Receiver is a dual-conversion superhet with switchable ANL and adjustable squelch and tone. Transmitter provides up to 4 watts RF out-

put and 100% modulation. Channel indicator is a two-digit 7-segment LED display. Power consumption 200 mA on standby, 1.5 amps on transmit with 100% modulation. Dimensions $2\frac{9}{32}$"H × $6\frac{9}{64}$"W × $7\frac{17}{32}$"D.—**Robyn International, Inc.,** P.O. Box 478, Rockford, IL 49341.

Regency — CR-240
A mobile transceiver designed with marine use in mind. Its 4-watt RF output and 10-watt hailer/fog horn/alert horn help you get your message across while the receiver and ANL circuits ignore the most

stubborn noise and splatter. PLL controlled on all 23 channels. Includes illuminated S/RF meter, DX switch, delta tuning, high-cut tone control. Complete with mounting bracket, mike hanger and power cord. 12-VDC operation.—**Regency Electronics,** 7707 Redords St., Indianapolis, IN 46226.

Royce — 1-662
Transceiver incorporates the manufacturer's Wireless chassis design. Each circuit module is automatically tuned and tested to strict computer programs. There are no wires con-

necting the modules. Each is mated with the master board by precision assembly techniques. The 1-662 features the Vol-U-Mike circuit which allows the volume to be controlled from the microphone or the front panel. Other features include the LED digital channel indicator with push-button dim/bright switch, PLL 23-channel operation, S/RF meter, dual-conversion receiver with tuned RF stage, variable squelch control, LED transmit light and automatic modulation control. Receiver operation is enhanced by continuous RF gain control and ANL circuits, three ceramic filters and amplified AGC. Power 13.8 VDC, negative or positive ground.—**Royce Electronics Corp.,** 1746 Levee Rd., North Kansas City, MO 64116.

Rystl CBR-1800
Dual-conversion superheterodyne transceiver with frequency synthesis circuit to pro-

vide 23 crystal-controlled send and receive channels. Delta tuning (±2 kHz) improves clarity when receiving stations that are not exactly on frequency. Features switchable ANL, CB/PA switch, S/RF power meter, modulation indicator and a low-threshold full-range squelch. The receiver incorporates a ceramic filter in the 455-kHz IF section for high adjacent-channel rejection and low-noise performance. Comes with push-to-talk dynamic mike, fused DC power cable and mobile mounting bracket.—**Rystl Electronics Corp.,** 328 N.W. 170th St., North Miami Beach, FL 33169.

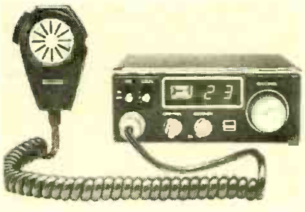
SBE Console II, SBE-16CB
Full 23 channel synthesized transceiver that operates in the full-carrier AM mode as well as fully suppressed carrier, single-sideband mode, upper or

lower sideband. The Console II features proportional output meter, crystal lattice filter and single-conversion receiver for both AM and SSB. The equipment has internal provision for VOX (voice-operated relay) and the SBE-1NB noise blanker. An "ON THE AIR" lighted panel indicates when the transmitter is energized. The 3-function meter displays relative power output, receive "S" units and VSWR. Automatic load control (ALC) on SSB, modulation limiting and AGC are self-adjusting. The 117-volt AC power supply is built in. Set shifts automatically to 12-volt DC external source if AC power fails. Comes with plug-in dynamic mike with coil-cord but can be used with the 100X and 200X desk mikes. Current drain at 13.8 VDC: Squelched receive 300 mA, 2 watts audio output 600 mA. Transmit AM w/o modulation, 1.2 A; SSB, full PEP output, 2.2 A. 5"H × 12" × 10¼"D. The slip-on natural-grain wood cabinet shown in the photo is an extra-cost accessory.—**SBE,** 220 Airport Blvd., Watsonville, CA 95076.

Shakespeare GBS/5000
Solid-state high-performance transceiver operating in the AM and SSB modes for effective 69-channel coverage using frequency synthesizer. Features include squelch control, noise blanker, RF gain switch, S/RF power meter, PA speaker jack and single-conversion superhet on SSB and dual-

conversion superhet circuit on AM. Transmitter modulation employs filter method. Antenna impedance adjustable to 50 or 52 ohms. 9.37"W × 2.7" H × 10.58"D.—**Shakespeare Electronics Group,** P.O. Box 246, Columbia, SC 29202.

Sharp CB-800
The most noticeable feature in this mobile transceiver is LED digital channel indicator that



blinks on and off when set to channel 9. Other main features include a dual-conversion superhet receiver with variable squelch and ANL (series-gate type), PA and delta tuning. Frequency control is crystal synthesized. The delta tuning switch has three positions (+1 kHz, normal and −1 kHz) for pinpoint tuning of incoming signals. The automatic level control prevents over modulation and splatter. 5¾"W × 2¼"H × 7⅞"D.—**Sharp Electronics Corp.,** Paramus, NJ 07652.

Siltronix Cherokee SSB-23A
Fully solid-state transceiver operates on 23 AM channels plus 46 channels in the SSB mode. A sharp IF filter insures exceptional tuning selectivity and rejection of adjacent-channel interference. Other features include delta tuning, PA amplifier, CB/PA selector and PA volume control, voice modulation indicator, adjustable squelch, variable RF gain con-

trol, automatic noise blanker and S meter. The rig is 2.5 inches high, 8 inches wide and 11 inches deep. Operates from 13.8-volt DC source and draws 250 mA to receive and 1.2 amps to transmit.—**Siltronix,** 330 Via El Centro, Oceanside, CA 92054.

Sonar FS-3023
This transceiver is unique in that it is the only one covered that is not all solid-state. It uses frequency-synthesized crystal control (12 crystals) to cover the 23 transmit and receive control frequencies. Features low-noise dual-purpose power supply for 120 VAC and 12 VDC operation, adjustable squelch, switchable gated-series type noise limiter and

built-in low-pass filter for TVI prevention. Draws 96 watts on 120 VAC, 7.0 amps from 12 VDC source. 11¾"W × 5¾"H × 11¾"D.—**Sonar Radio Corp.,** 3918 N 29th Ave., Hollywood, FL 33020.

SparkOmatic CB-2023
Full-featured solid-state transceiver that is designed for mobile installations. Among its operating conveniences are delta tuning, variable squelch

control, variable intensity modulation light, ANL, switchable noise blanker, PA switch, separate output jacks for CB and PA speakers, operates from positive or negative ground supplies. 2⅜"H × 7"W × 7½"D.—**Sparkomatic Corp.,** Milford, PA 18337.

Standard Horizon 29
An all solid-state transistorized transceiver employing PLL controlled synthesizer frequency control. Receiver is dual-conversion type with the first IF at 5.575 MHz and the

second IF at 455 kHz. Convenience features include switchable ANL and noise blanker, variable squelch, delta tune, RF gain control and "hailer" output jack for marine applications. Output to the hailer jack is 10 watts maximum with 15 mV input. Power supply 12 to 16 VDC. 8½"L × 6⅛"W × 2¼"H.—**Standard Communications Corp.,** Los Angeles, CA 90009.

Surveyor 2600
Fully transistorized receiver/transmitter designed for either

mobile or base service. It has a variety of features such as built-in PA amplifier, 3-position delta tune switch, ANL, S/RF power meter, on-air lamp and jacks for external speaker and PA speaker. Powered by 12 VDC negative or positive ground or appropriate AC/DC converter for fixed-station operation.—**Surveyor Manufacturing Corp.,** 29245 Stephenson Highway, Madison Heights, MI 48071.

Teaberry Racer "T"
23-channel mobile transceiver featuring PLL frequency synthesizer and delta tuning. Also includes ANL, PA function,

jack for external speaker, S/RF meter, modulation indicator and slide mounting bracket. 6½"W × 9¼"D × 2$\frac{3}{16}$"H.—**Teaberry Electronics Corp.,** 6330 Castleplace Drive, Indianapolis, IN 46250.

Trans-Comm 2701
Unique design incorporating a 23-channel transceiver, AM/FM/FM stereo radio and 8-track stereo player. Tape cartridge inserts through-the-dial. Three large speakers. All in a leather-tone, crush-resistant carrier. Complete with micro-

Continued on page 92

build a digital countdown timer

A versatile countdown timer with keyboard programming that can control various external devices. The time interval can be programmed in increments of one second from one second to approx. 11,000 years

GEORGE R. BAUMGRAS

TIMERS OF ONE TYPE OR ANOTHER, ranging from the simple mechanically actuated switches to highly sophisticated electronic controls, are an essential part of modern technology. Industrial processes, laboratory experiments, photography, functional testing and similar operations represent only a few of the more serious applications, but we also find them useful in the household as appointment reminders, alarm clocks, kitchen aids and so on. Somewhere within this broad spectrum there are many requirements for a reasonably-priced programmable countdown timer that affords superior accuracy and versatility and is not too difficult to build.

Most of the recent circuits, although they may use the latest in integrated circuits, usually suffer from at least one of several drawbacks—precise intervals cannot be programmed, the time period available is somewhat limited, or calibration is frequently required and uncertain at best. The countdown timer described here eliminates all of these deficiencies, and for that reason is called SPOT (Superior Programmable Optimized Timer). The prime objectives established for its development were: acceptable cost—about $125 for parts, the use of readily available and generally well understood components, long-term accuracy without need for calibration and, of course, a wide range of uses. SPOT can be programmed, in increments of one second, for any period from one second to eight digits worth of hours (about 11,000 years), which is of course, far beyond any possible need but does eliminate one of the drawbacks mentioned. Assuming there will be diligent frequency monitoring by the local electric utility and there are no power failures, the total timing error for any period selected will be .17 seconds plus the pull-in time of the relay, both of which are known factors. On a percentage basis, this represents an error of about .3% for one minute, and correspondingly less for longer periods.

Operation

Using the timer is extremely simple—the desired interval is entered manually via the keyboard in the same manner that a number is entered into a calculator. The ALARM and RELAY switches on the front panel are set for the desired operation and the START pushbutton is depressed—and that's it. In the prototype, the START pushbutton is labeled "+" for convenience. This pushbutton also enters a negative number into the calculator memory. At the end of the programmed time period, the alarm will sound if the ALARM pushbutton was depressed, and the relay will open or close depending on the position of the RELAY pushbutton.

The LED display continuously shows the remaining time in seconds, minutes and the last significant hour as it is being programmed in, and throughout the timing period. Most entries will be for less than 10 hours which is why only 5 digits are displayed. However, if there are 6 or more digits stored in the memory, a small LED lamp will light to indicate that there may have been a keyboard error or that there are hours in the memory.

The digits may be entered into the program in any convenient form, in some cases eliminating the need to convert seconds into minutes or minutes into hours. For example, 90 seconds is equal to 1 minute and 30 seconds. This time period can be entered in either form. An entry of 9 hours, 99 minutes and 99 seconds is therefore exactly the same amount of time as if we had entered 10 hours, 40 minutes and 39 seconds. The display will eventually revert to normal readings. In the latter example, at the end of 40 minutes and 40 seconds it would read 9:59:59 and continue to read in "clock" time from thereon.

The timer described here contains one modification that the original does not. This modification permits the timer to emit an audible "beep" at one-second intervals. This feature can be inhibited by a rear-panel MUTE switch. The countdown timer (see Fig. 1) consists

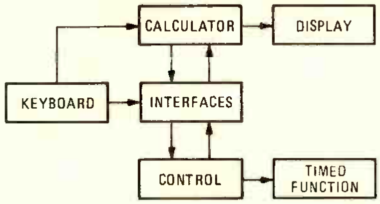


FIG. 1—FUNCTIONAL BLOCKS of the countdown timer are shown.

of a calculator circuit, control circuit, interface IC, keyboard display and timed function. The calculator circuit (see Fig. 2) closely resembles the circuit specified for the CT-5001 calculator IC. The difference being that it is tailored to perform only add and subtract arithmetic, and the ÷, ×, minus sign, overflow decimal point, and 6 of the digit outputs have no function. This particular IC was selected because, in addition to being available at low cost (under $4), it can handle a diode-encoded keyboard system and readily accepts external commands at a suitable rate.

The control circuit (see Fig. 3) has many functions, performing as a time-base, decimal-to-clock converter, electronic keyboard simulator and zero balance detector in addition to manipulating the alarm and relay functions. The 7400 series TTL logic IC's were selected as a practical alternative, again because they are available at low prices and are not particularly difficult to design a circuit around. The interface

PARTS LIST
CALCULATOR AND KEYBOARD

All resistors are ¼-watt, 10%, unless noted.
R1-R14—100,000 ohms
R15—150,000 ohms
R16-R27—4700 ohms
R28-R31—27,000 ohms
R32—5100 ohms
R33—2200 ohms
R34-R46—12,000 ohms
R47—1000 ohms
R48—10,000 ohms
R49—680 ohms
R50, R51—470 ohms
R52-R58—47 ohms
R59—330 ohms
C1—10-μF, 25 volt, electrolytic
C2, C3—470-pF disc
C3, C4—220-pF, 5%, disc
D1-D8—1N4001
D9-D29—1N914 or 1N4148
LED 1—discrete LED, 0.16-inch maximum diameter
Q1-Q26—MPS6563 or equal, TO-92 case
Q27-Q41—2N2222, 2N3904, or equal, TO-92 case
IC1—CT5001 calculator IC
MISC.—Keyboard switches with "0" through "9", "CL" and "+ =" legends (Oak Industries, Inc., Switch Division, Crystal Lake, IL 60014. Switch No. 415), 40-pin socket for DIP.

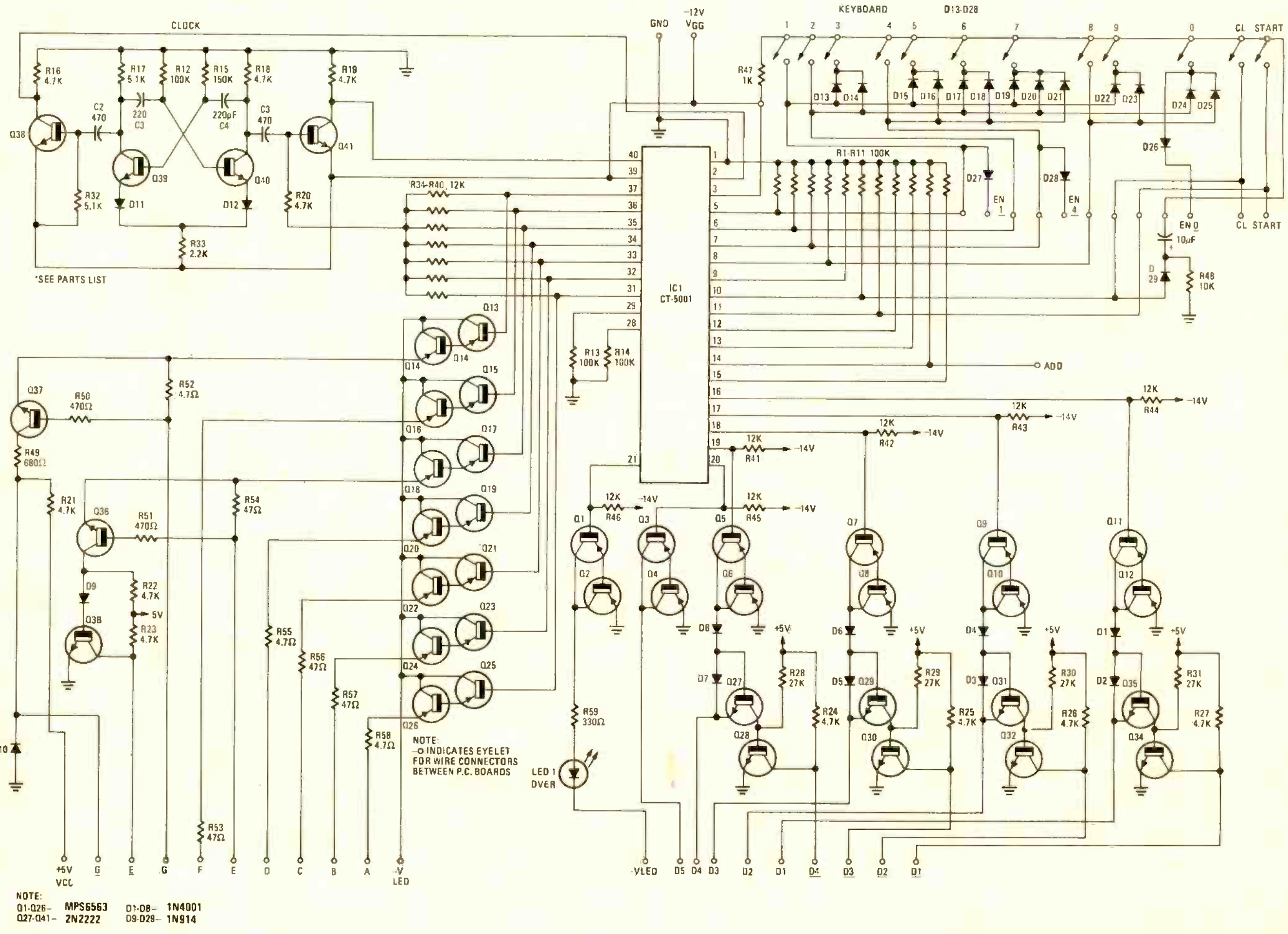


FIG. 2—CALCULATOR AND KEYBOARD circuitry is built around CT-5001 integrated circuit.

PARTS LIST
ALARM CIRCUIT

All resistors are ¼-watt, 5%, unless noted.
R1—10,000 ohm
R2—1 megohm
R3, R5—13,000 ohm
R4—50,000-ohm trimmer
R6—100 ohm
R7—6800 ohm
R8—3300 ohm
R9—4700 ohm
C1—0.47-μF disc
C2—.005-μF disc
C3—20-μF, 25V, electrolytic
D1-D3—1N4000
Q1, Q2—2N2222
S4—SPST switch
IC1, IC2—555 timer
SPKR—3-inch, 4-8 ohm, speaker

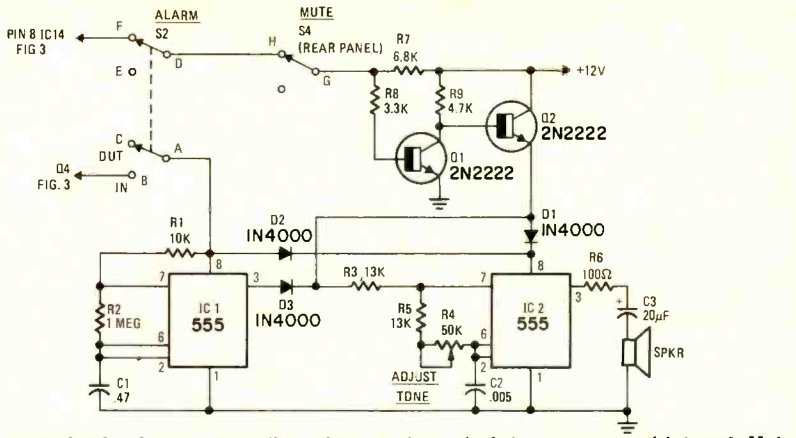


FIG. 5—ALARM CIRCUIT emits an audible alarm at the end of the programmed interval. Mute switch inhibits alarm from emitting an audible "beep" once-every-second during the programmed interval.

PARTS LIST
CONTROL CIRCUIT

All resistors are ¼-watt, 10%, unless noted.
R1-R3—300 ohm
R4—10,000 ohm
R5—33,000 ohm
R6, R7—1000 ohm
R8, R9—12,000 ohm
R10-R19—18,000 ohm
R20-R24—4700 ohm
R25—470 ohm
R26—470 ohm, ½ watt
R27-R29—3300 ohm
R30—2700 ohm
C1—4.7-μF, 20V, electrolytic
C2, C3—10-μF, 20V, electrolytic
C4—2.2-μF, 20V, electrolytic
C5—0.1-μF, 50V, disc
C6—0.47-μF, 50V disc
Q1-Q3, Q5—2N2222, 2N3904, or equal
Q4—2N5296 or equal
Q6-Q13—MPS6563 or equal
D1-D8—1N914 or 1N4148
D9—1N4001
IC1, IC2—7420
IC3, IC4, IC7, IC13, IC15—7400
IC5, IC8, IC9, IC14, IC16—7490
IC6—7442
IC10, IC11—7404
IC12—7410
IC17—7492
S1, S2—DPDT switch, push-push type (Radio Shack)
RY1—DPDT, 12VDC coil, 10A contacts

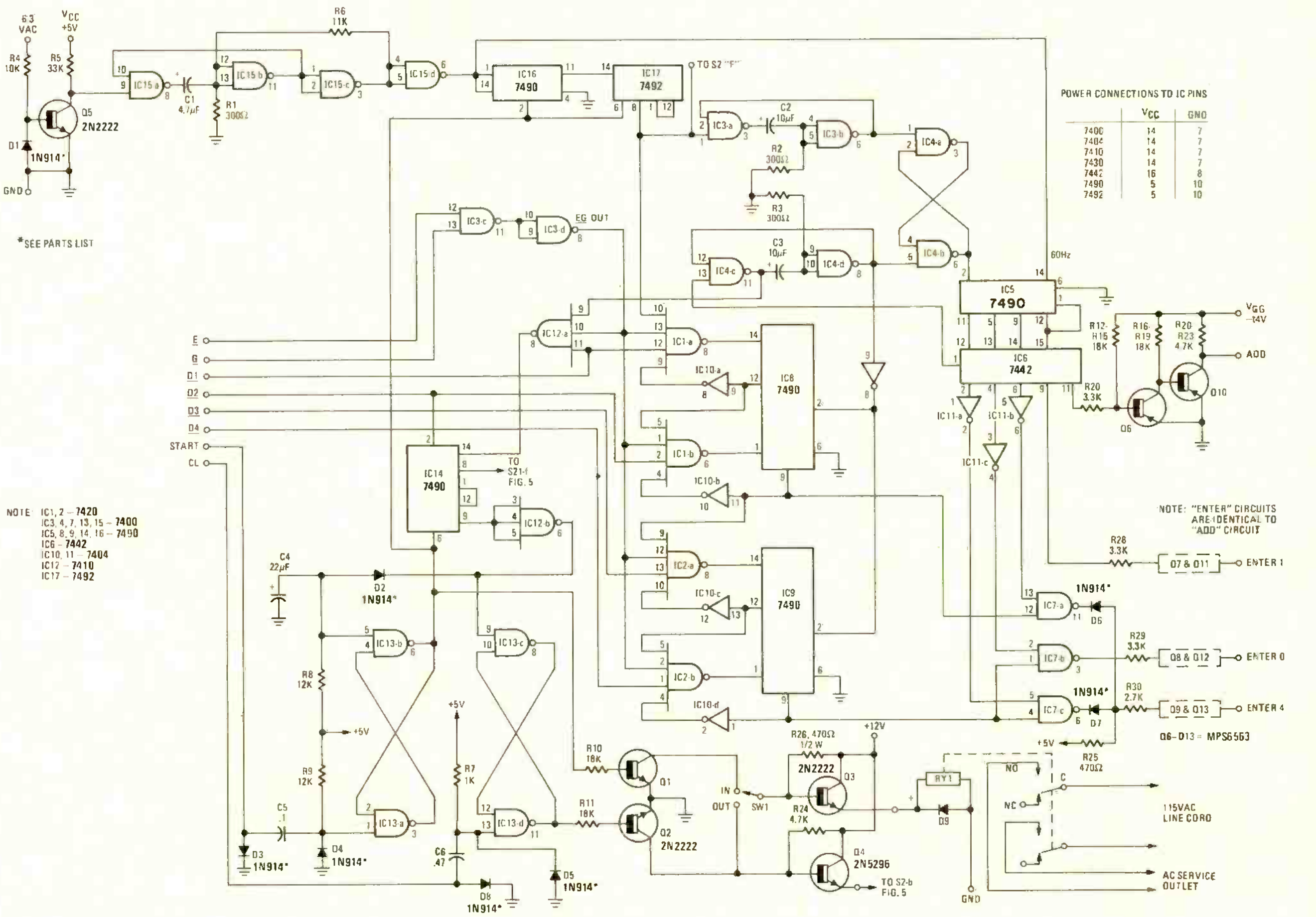


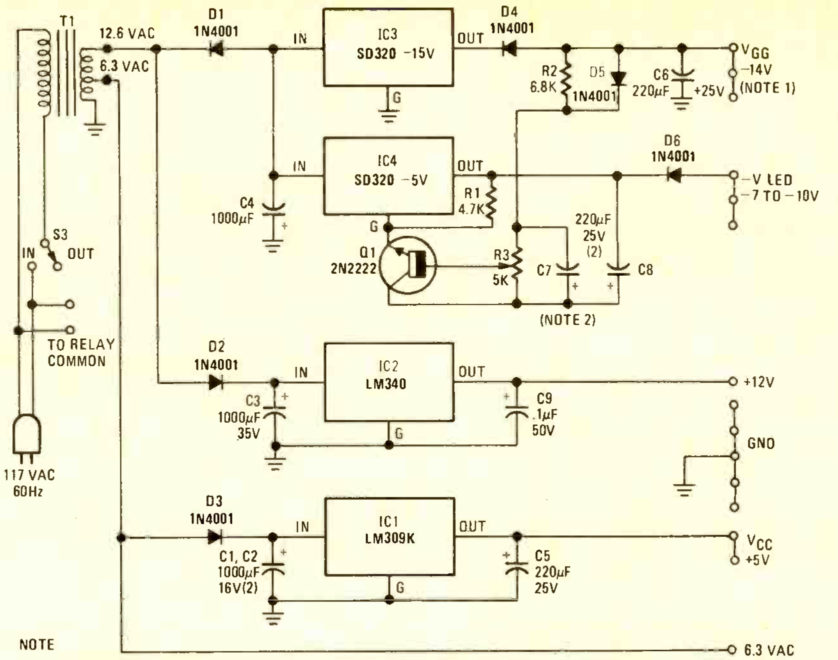
FIG. 3—CONTROL CIRCUITRY contains the timebase, decimal-to-clock converter, electronic keyboard simulator and zero-balance detector.

components are required because of the difference in logic levels and polarity between the two systems. The display circuit is the conventional multiplexed common anode type, plus the addition of the colon. The LED displays must be as specified or very similar because the segment current (20 mA average) is used to trigger the interface circuits.

The power supply circuit shown in Fig. 4 was designed around four IC voltage regulators, all of which operate well under their specified ratings. The LED voltage from IC4 can be varied over a −7 to −10 volt range by means of the voltage divider R1, Q1 and the trimmer R3. Trimmer R3 is used to vary the display brightness over a narrow range and should initially be set at minimum. At some setting of R3, the display will be at or near the specified brightness and the current through the segments will be within the limits required to operate the interfaces.

The alarm circuit shown in Fig. 5 emits a hee-haw sound. An assortment of sounds is possible, ranging from whistles to bird calls, or a commercial unit such as a Sonalert could be used.

Next month, the article continues with the construction details and the circuit board and component layouts.



NOTE

1. THE CT500, IC MAY NOT OPERATE PROPERLY AT LESS THAN -15V, HOWEVER, VGG SHOULD NOT BE MORE THAN -14V. ADD A DIODE IN SERIES WITH D4 IF VGG IS HIGHER THAN -14V AT 40 MA.

2. SET R3 INITIALLY FOR MINIMUM LED VOLTAGE. AFTER ASSEMBLY, INCREASE TO ADEQUATE LED BRIGHTNESS, APPROXIMATELY -.9V. IF -V LED IS TOO HIGH OR TOO LOW, INTERFACE CIRCUITS FOR SEGMENTS E AND G WILL BE ADVERSELY AFFECTED.

FIG. 4—POWER-SUPPLY CIRCUIT uses IC regulators to derive the various voltages.

PARTS LIST DISPLAY BOARD

IN1-IN3—MAN6A, 7-segment, 0.6-inch high
IN4-IN5—MAN 64A, 7-segment, 0.4-inch high
LED1, LED2—discrete LED's, 0.16-inch maximum diameter
R1—120 to 330 ohms, ¼-watt (value required to suit LED's selected)

PARTS LIST POWER SUPPLY

R1—4700 ohm, ¼ W, 10%
R2—6800 ohm, ¼ W, 10%
R3—5000-ohm trimmer
C1, C2—1000-μF, 16V, electrolytic
C3, C4—1000-μF, 35V, electrolytic
C5-C8—220-μF, 25V, electrolytic
C9—0.1-μF, 50V, disc
D1-D6—1N4001 or equal
Q1—2N2222 or equal
IC1—LM309K, +5V regulator
IC2—LM340T, +12V regulator
IC3—SD320, —15V regulator
IC4—SD320, —5V regulator
S3—SPDT switch, push-push type (use DPDT, Radio Shack or equal.)
T1—117V primary, 12.6V @ 1.2A secondary

PURPLE POEM

I think that I shall never see
Anything drive me up my tree
Quite as fast as a balky TV.
This accursed, balky, blind, TV
Is a black-and-white Sears model 528.70623.
The sound is O.K. clear and nice,
The screen has a raster but blank as ice.
From Sams Photofacts 1134,
I dove into the circuit to give it whatfor.
An audio signal at the video detect
Produced bars on the screen as sure as heck.
The volts in the IF I checked just for fun
For the sound from the speaker said they weren't the ones.
I've checked by every known means
All components from IF to picture screen.
I'd appreciate help if you don't mind my rhyme
Before I completely go out of my mind.—D.G., West Chester, PA.

If I were you, the AGC
I'd check as closely as can be.
For this if dead can well suffice
To make the screen as blank as ice.
It kills the picture, as you see,
Tho' sound can often sneak home free!

FLYBACK REPLACEMENT

I can't locate a replacement flyback for this Setchell-Carlson black-and-white TV, and the company is out of business. Do you know where I could find one?—G.P., Governor's Island, NY.

I don't, but my Triad catalogue does! It's listed in there. A Triad D-638 flyback will replace the original TWF-110X.

THIN WHITE LINE

Read your Clinic for years. I laughed a little but I also learned a lot. Now I need help. Magnavox T915 set with everything fine except for a thin white line in the center of the picture (and raster). Tried everything I can think of with no results.—W.P., Columbus, OH.

If my memory serves me (which it usually doesn't), this is due to an open .0082 μF capacitor connected from the hot terminal of the yoke socket to ground on the horizontal yoke connection. Be sure to use one with at least a 1 kV rating, there's a pretty good pulse voltage at this point.

(Field Feedback: Your memory is good! That was it.)

HUM PROBLEM

If you have audio hum in a Truetone GEC4617A-67 color TV, relocate the ground lead from the volume control. It's now connected to the negative terminal of filter capacitor C904. Move this to the grounded terminal of the terminal strip located above and to the left of C904. This is directly to the metal chassis. (Thanks to a Truetone factory service note.)

CLASS G
High Efficiency HI-FI Amplifier

A new high-efficiency audio amplifier circuit that can reduce the size, weight and cost of future hi-fi amplifiers. Here's an inside look at the theory and circuitry

LEN FELDMAN*
CONTRIBUTING HI-FI EDITOR

SOME TIME AGO, THE AUDIO INDUSTRY WAS startled by the announcement that Infinity Systems, Inc. (best known for their loudspeaker systems) had come up with a more efficient way to build audio power amplifiers. They called the technique "Class D" amplification. Briefly, the system involves the use of high-frequency (in excess of 200 kHz) pulses that are first modulated by the audio signal to be amplified and then decoded by an integrating circuit that restores the audio envelope or waveshape. Since the duty cycle of each high-frequency pulse is relatively short, conduction of the output transistors is such that heat dissipation is a fraction of that encountered with more conventional Class-B circuits and overall efficiency (at least when the amplifier delivers close to its maximum power output) is high. Thus far, the product has not reached the consumer market but Infinity claims that all production problems have been licked and that the Class D, or "switching" amplifier will soon be a commercial reality.

In the meanwhile, other companies have been working on improving the efficiency of audio amplifiers. This work is so widespread, in fact, that the Hitachi Company of Japan (whose approach to better amplifier efficiency is the subject of this article) has had to change the name of their invention from Class E (which they had first proposed to use) all the way to Class G, the designation they currently plan to assign to the new and innovative circuitry we will describe here.

Class-B efficiency

When a Class-B audio amplifier delivers its maximum rated power, its efficiency (power delivered to the load divided by power used by the amplifier is quite high —70% or more. Studies show, however, that under music listening conditions, an audio amplifier is called upon to deliver full or nearly full output for only a very small fraction of the time it is operating. Figure 1 represents the results of studies of a variety of musical selections. It shows that while music may reach peaks of +14 dB (referred to a 0-dB average power level), for much of the time, actual power levels are even well below the 0-dB average level. In fact, for nearly 50% of the time (Fig. 1, left vertical scale), power levels are some 30-dB below the 0-dB point, while a + 10-dB level is reached for only 0.7% (Fig. 1, right hand vertical scale) of the time. Even allowing for highly compressed music (in which dynamic range is restricted and music is therefore more uniformly "loud") and assuming only a 10-dB crest-factor (average power is 10% of peak power), we can see from the curve of Fig. 2 (efficiency of a Class-B circuit versus the ratio of actual output to designed maximum output) that for most of the time that an amplifier of this type is reproducing music, it is operating at approximately 20% efficiency.

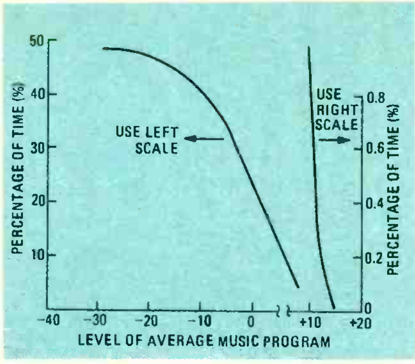


FIG. 1—AVERAGE MUSIC PROGRAM LEVEL expressed in terms of percentage of total time at which that level exists.

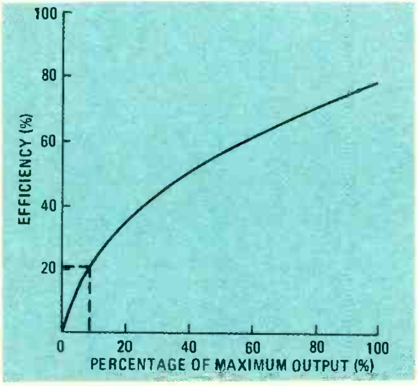


FIG. 2—CLASS-B EFFICIENCY at various percentages of maximum output.

The Class-G idea

Hitachi's invention is designed to enable amplifiers to operate more efficiently over more of their operating range, based upon the way in which they are called upon to actually amplify musical signals. The simple diagram of Fig. 3 illustrates the Class-G idea. The input voltage, V_{in}, is the signal to be amplified and it is ap-

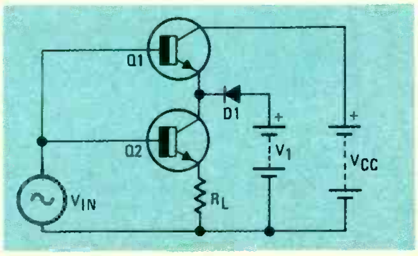


FIG. 3—BASIC CLASS-G amplifier.

plied to the base of transistors Q1 and Q2. A load resistor, R_L, is connected to the emitter of Q1. Supply voltage V_1 is applied through diode D1 to the collector Q1 and the emitter of Q2. The collector of Q2 is connected to a second supply voltage V_{cc} that is higher than supply voltage V1.

Operation of the circuit is as follows: If input signal voltage V_{in} is lower than V1, Q2 is reverse biased between its base and its emitter and is therefore cut off. Current flowing through load R_L is supplied from V_1 through diode D1. Under these conditions, the instantaneous efficiency of the circuit is given as: Efficiency (%) $= V_{in}/V1$. If the signal voltage increases to a value beyond that of V1 (but less than V_{cc}), transistor Q2 becomes forward biased and is turned on. Current flowing through load R_L is now supplied from the second, higher supply-voltage V_{cc} through Q2. If we neglect saturation voltage between collector and emitter of Q2 (assuming it is sufficiently low), the instantaneous efficiency of the circuit is given as: Efficiency (%) $= V_{in}/V_{cc}$.

Figure 4 represents the two efficiency

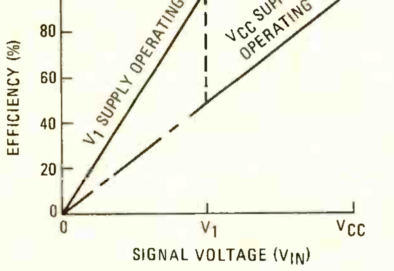


FIG. 4—INCREASED EFFICIENCY results from two-level power-supply system in Class-G amplifier.

levels of the system and the vertical line represents the point at which the supply voltage transition takes place. Thus, in the lower ranges of input signal voltage, the efficiency of this circuit is improved considerably and the amount of heat generated in the output transistor is reduced compared with conventional Class-B amplifiers. Referring once more to Fig. 3, it should be noted that diode D1 also serves to prevent current flowing from the higher supply-voltage source (V_{cc}) from flowing back into the first power source V1.

The thermal efficiency of the system will, of course, depend upon the choice of the two power-supply operating voltages.

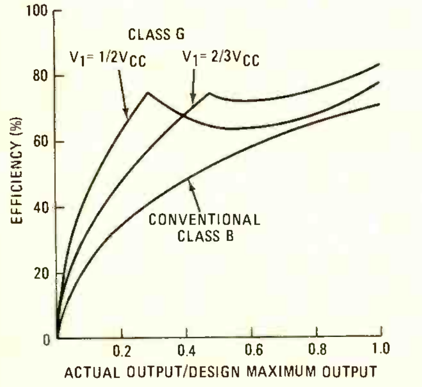


FIG. 5—EFFICIENCY OF CLASS-G amplifier depends upon V_1/V_{cc} ratio.

Figure 5 compares the efficiency level at various outputs (expressed as a fraction of maximum design output) for two different Class-G designs having different $V1/V_{cc}$ ratios as compared with conventional Class-B operation. Regardless of whether V1 is half or two thirds as great as V_{cc}, we see that efficiency is far greater than that of Class-B operation, particularly at lower output levels where, as we have seen earlier, the amplifier is likely to operate most of the time when reproducing actual music programs.

Along with improvement in efficiency comes reduced internal heat dissipation of the output devices used in the Class-G approach. Figure 6 illustrates this point for

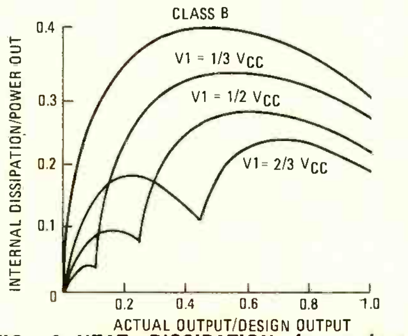


FIG. 6—HEAT DISSIPATION for various V_1/V_{cc} ratios.

various $V1/V_{cc}$ ratios. Internal dissipation is plotted as a fraction of maximum power output on the vertical axis, while the ratio of output power to designed maximum power is shown along the horizontal axis of the graph. As expected, internal dissipation is lower at all operating conditions for Class-G compared with conventional Class-B operation.

Distortion

Closer examination of Fig. 3 points up certain problems that exist in the basic concept of Class G. In the simple form

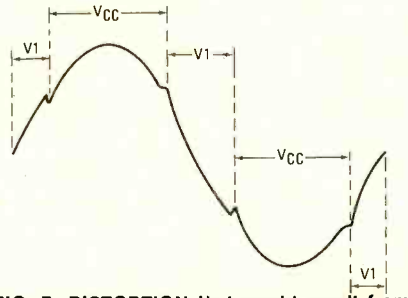


FIG. 7—DISTORTION that would result from simplest form of Class-G circuit.

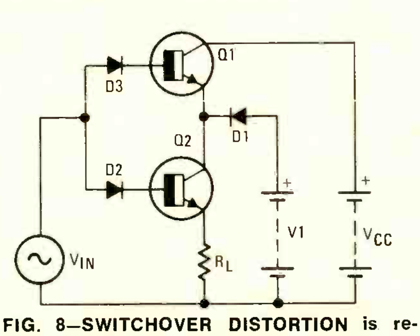


FIG. 8—SWITCHOVER DISTORTION is reduced by the addition of diode D2.

of the circuit shown, Q2 is not turned on until input signal voltage exceeds the collector voltage of Q1 by an amount equal to the base-emitter voltage V_{be} of Q2. Thus, when the value of input signal voltage V_{in} is in the range between V1 and $V1 + V_{be}$, Q1 is already saturated (between collector and emitter) before conduction of Q2 begins. This results in a distorted output waveform signal as shown in Fig. 7.

To prevent this form of distortion during the changeover from one power supply level to the other, the circuit must be modified so that saturation of Q1 does not occur until Q2 is turned on. This is accomplished by adding another diode, D2, as shown in the simplified schematic of Fig. 8. Now, when V1 is less than the input signal, the voltage between the collector and the emitter of Q1 is lower than the saturation level by an amount equal to the threshold value of D2 and thus Q1 remains unsaturated. Diode D2 may be a Zener diode or even a resistor since it is only required to maintain a voltage difference equal to the V_{be} voltage of Q2. Still another diode, D3, is added to the basic circuit as shown in Fig. 7. Since a reverse bias is applied between the base and emitter of Q2 when the signal voltage is lower than supply voltage V_1, the base-emitter junction of Q2 must be able to stand a reverse voltage higher than V1. Since the maximum inverse voltage of the base-emitter circuit of most transistors is generally low, diode D3 is provided to prevent the flow of reverse current through the base-emitter junction of Q2, thus protecting this junction against the reverse voltage.

Push-Pull operation

Figure 9 shows the required configura-

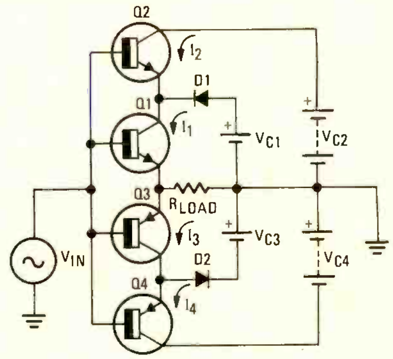


FIG. 9—PUSH-PULL Class-G amplifier.

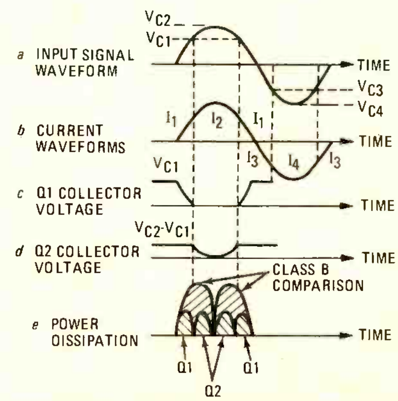


FIG. 10—VOLTAGE AND CURRENT relationships in push-pull Class-G amplifier.

tion for a push-pull output circuit. Diodes D2 and D3 shown in Fig. 8 have been omitted for the sake of clarity. Two values of positive and negative supply voltages are required and transistors Q3 and Q4 operate at opposite polarity voltages compared with Q1 and Q2 to form the familiar complementary configuration (NPN nd PNP pairs are used). Fig. 10-a shows the input signal waveform, together with the voltage levels V_{C1} and V_{C2} (for the first half of the cycle) and V_{C3} and V_{C4} for the opposite half of the signal waveform. Fig. 10-b shows the current waveforms resulting from the four supply-voltages (two voltages for each polarity). Fig. 10-c represents that portion of the output waveform powered by the lower-level supply voltage V_{C1}, while Fig. 10-d shows the contribution of output waveform powered by the higher supply voltage V_{C2}. Finally, Fig. 10-e shows a comparison of power losses (or dissipation) in Q1 and Q2 (for the half cycle shown) as compared with the power loss that would take place in a conventional Class-B configuration.

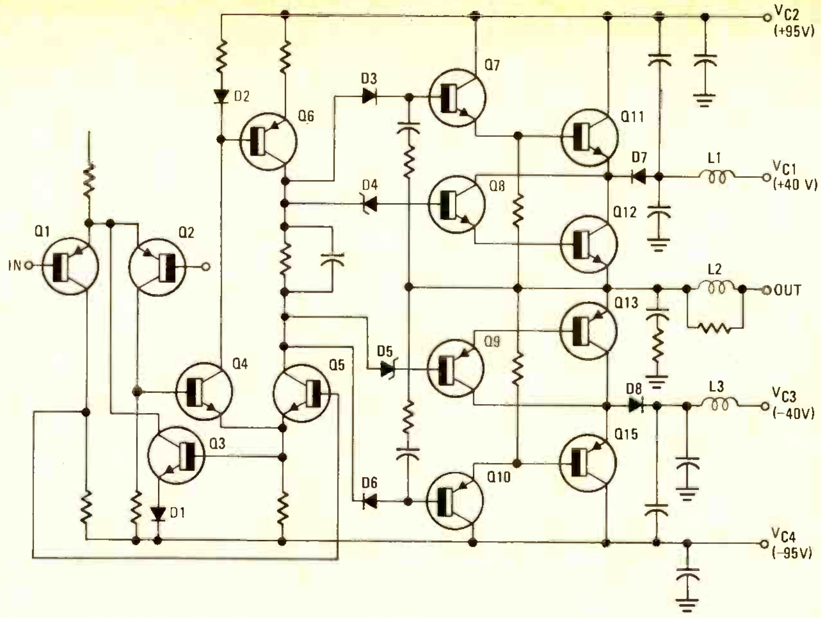


FIG. 13—OUTPUT CIRCUIT of the Hitachi HMA-8300 power amplifier.

Practical Class-G circuit

The first product which Hitachi intends to introduce that will incorporate the Class-G principle is their Model SR-903 AM/FM stereo receiver, pictured in Fig. 11. By way of illustrating the improvement

FIG. 11—HITACHI SR-903 stereo receiver uses Class-G output circuit.

FIG. 12—HITACHI HMA-8300 power amplifier will be introduced in the near future and will contain Class-G output circuitry.

in efficiency attained because of this new output circuit, Dr. Gentaro Miyazaki of Hitachi Consumer Products Research Center was kind enough to supply me with some advance comparisons between this 75 watts-per-channel receiver (from 20-Hz to 20-kHz, 8-ohm loads, 0.3% maximum THD) and a typical Class-B unit having the same FTC power rating. The SR-903 will weigh in at 28.7 lbs as against 40.8 lbs for the Class-B unit. Under "music power" measurement conditions (abandoned by the industry since the advent of the FTC power rule, but nevertheless indicative of the short-term power output capability of an amplifier), the SR-903 will deliver 160 watts-per-channel

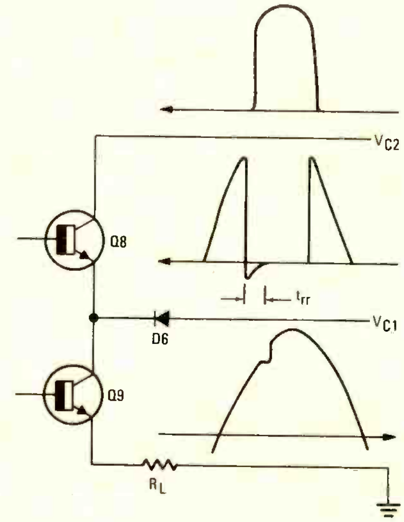


FIG. 14—DISTORTION resulting from storage time delay in Class-G circuit.

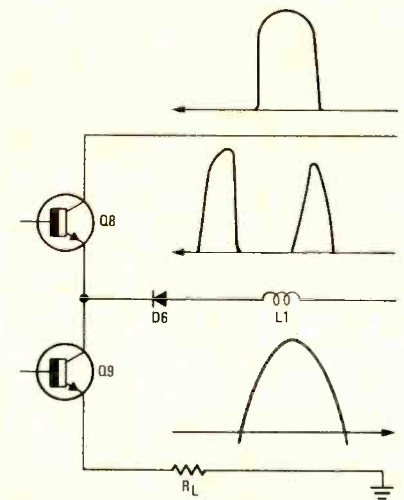


FIG. 15—DISTORTION resulting from storage time delay is reduced by the addition of L1 to circuit.

as opposed to 110 watts-per-channel for the Class-B unit against which it was compared.

Hitachi plans to introduce many more units employing Class-G circuitry. Typical of these will be the stereo power amplifier, model HMA-8300, pictured in Fig. 12. A circuit of the power output stages of this unit is shown in the schematic diagram of Fig. 13. In addition to the circuit elements already described, we see one more refinement that should be mentioned. Note, that in series with supply voltages V_{C1} and V_{C3} are small inductors L1 and L3. Because transistors have finite turn-on and turn-off times, a form of distortion can be introduced to the output waveform as illustrated in the waveforms of Fig. 14. This form of dstortion is due to an effect known as storage time-delay and is quite independent of the base-emitter V_{be} voltage discussed earlier. To counteract this effect (and to further reduce output waveform distortion in Class-G circuits), a coil is added in series with diode D6 shown in the improved circuit of Fig. 15.

The effect of storage delay would be

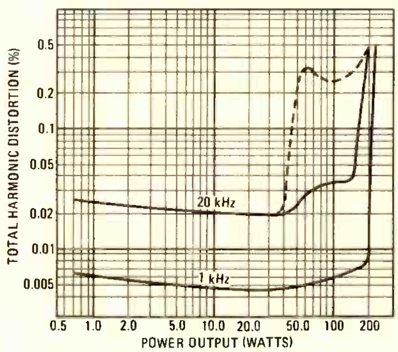


FIG. 16—THD VS. POWER OUTPUT at 20-kHz before and after addition of L1 (Fig. 15) in circuit. Distortion characteristic at 1-kHz is also shown.

particularly noticeable when reproducing high frequencies, since the time required for amplification of a single cycle of a 20 kHz signal is only 50 microseconds. The curves of distortion versus output measured at 1 kHz and 20 kHz for a typical Class-G circuit shows clearly that without

(continued on page 87)

MIND POWER: ALPHA

Part II. 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

THANKS TO MODERN ELECTRONIC TECHnology, the idea that your brainwaves can control a video display on a TV screen is no longer in the realm of science fiction. Mindpower: Alpha makes use of state-of-the-art techniques and components to make that dream of science-fiction writers into concrete *fact!* Whether you build it just to find out if you have the *mindpower* to control the display on your TV set screen, or because you have a serious interest in experimenting with altered states of consciousness and the alluring prospects of achieving more complete control of the brain-body matrix, you'll find Mindpower: Alpha a fascinating instrument unlike any other you've ever seen!

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.

How the circuit works

Figure 1 shows the complete schematic diagram of the Mindpower: Alpha circuit. The sweep voltages required to control the picture tube's electron-beam position are derived from the 60-Hz AC line. The 60-Hz sinusoidal voltage appearing across the secondary of transformer T1 is applied to the base-emitter junction of Q9, driving this stage into saturation on each peak of the sinewave. The square-wave output of Q9 provides the input signal to the CMOS phase-locked loop (IC1) and to Q4.

IC1 consists of a phase comparator and a voltage-controlled oscillator (VCO) connected through a low-pass filter (R49, C19, R50, C20) to form a closed-loop frequency feedback system. The center frequency of the VCO is nominally 15.36 kilohertz and is determined by the value of C21, R47 and R48. The output of the VCO is applied to a CMOS ripple counter/divider (IC21) that divides the VCO center-frequency to 60 Hz. The output of IC21 is connected to one input of the phase comparator; the squared 60 Hz input from Q9 is the other input. So long as the two inputs are exactly the same, the phase comparator output is zero, signifying that the 15.36 kHz oscillator is precisely on-frequency. If the VCO tends to drift, the comparator develops a proportional error voltage output that precisely corrects the VCO frequency. In this way, the horizontal sweep-frequency is maintained in a phase-locked relationship to the 60 Hz line frequency.

The 15.36 kHz output of IC1 is differentiated by C24 and R63, and is applied to Q3 to generate 9-μs horizontal-sync pulses. These pulses are summed by Q1 and Q2, and applied to the video driver Q12. Meanwhile, the output pulses of Q3 are also applied as control pulses to horizontal discharge switch Q10 to determine the flyback interval of the horizontal ramp generator IC13. The ramp generator is a linear integrator whose period is determined by C25 and R66. The output of IC13 rises linearly from 0 to 10 volts in a period of approximately 65 μs. Each horizontal scan line is written on the picture tube during one such period. At the end of this period, the sync pulse input from Q3 turns on Q10 for a period of approximately 9 μs., discharging C25 and instantaneously resetting the integrator to zero. (During this brief period, the spot flies-back to the left of the screen to commence a new line.) The horizontal ramp output of IC13 thus consists of an endless series of linear sawtooth waves of 65 μs duration, separated by 9-μs flyback periods during which the output is 0 volts. These are applied to the inputs of horizontal comparators IC5 and IC8.

The vertical sweep is considerably simpler than the horizontal sweep because the vertical sweep frequency is synonymous with the 60 Hz AC power line frequency. Thus, the squared output of Q9 is simply differentiated by C22, R51 and R52, and is applied to Q4. Transistor Q4 produces a pulse of approximately 1.2 ms duration every 16.7 ms. These vertical sync pulses are summed with the horizontal sync pulses by Q1 and Q2.

The vertical sync pulses also control the period of the vertical ramp generator IC16 by causing Q11 to discharge C23 every 16.7 ms. Operation of IC16 as a linear integrator is identical to that described for IC13. Thus, IC16 produces an endless series of linear sawtooth waves of 1/60th second duration, separated by 1.2 ms periods during which the output is zero volts. Thes are applied to the inputs of horizontal comparators IC9 and IC12.

Display logic and video driver

The function of the display logic is to detect the points on each line written on the picture-tube face where the electron beam is to be turned-on and turned-off, so as to create the white rectangle (beam on), on the dark field (beam off). This requires four detect-points for the horizontal and four detect-points for the vertical. Also, because the size of the rectangle must be controllable, the detect-points of all comparators must be proportionally variable. However, the detect-points must remain in-ratio with one another so as not to distort the rectangle as its size changes.

For simplicity, we will first look at the vertical comparators, IC9 and IC12. These are LM311-types that feature very closely controlled characteristics making them well-suited to this application. The waveforms associated with the comparators is shown in Fig. 2.

The vertical ramp output of IC16 is applied to the inverting inputs of IC9 and IC11, and to the non-inverting inputs of IC10 and IC12. The non-inverting input of IC11 is biased from the positive 15-volt supply through R76, and the non-inverting input of IC9 is biased a constant 0.6 volts less positive, by the forward voltage drop across D9. Also, the inverting input of IC12 is biased from the negative 15-volt supply through R44, and the inverting input of IC10 is biased a constant 0.6 volts less negative by the forward voltage drop across D10.

The comparators receive two vertical display control inputs, consisting of the voltage output of IC18 (which is a fixed voltage in mode 1, under quiescent conditions; or, a 0–5 volt ramp voltage in mode 2), and an inverted form of the IC18 output, obtained from IC17. These two vertical control inputs are respectively applied to the non-inverting input of IC9 and to the inverting input of IC10.

Looking now at the states of the vertical comparators, as the vertical sweep ramp starts to rise from zero, IC9 and IC11 outputs are at a logic 1 level. The output of IC10 and IC12 are at logic 0 level. As the sweep ramp rises (assuming that the circuit is operating in mode 1, where the vertical display control signals

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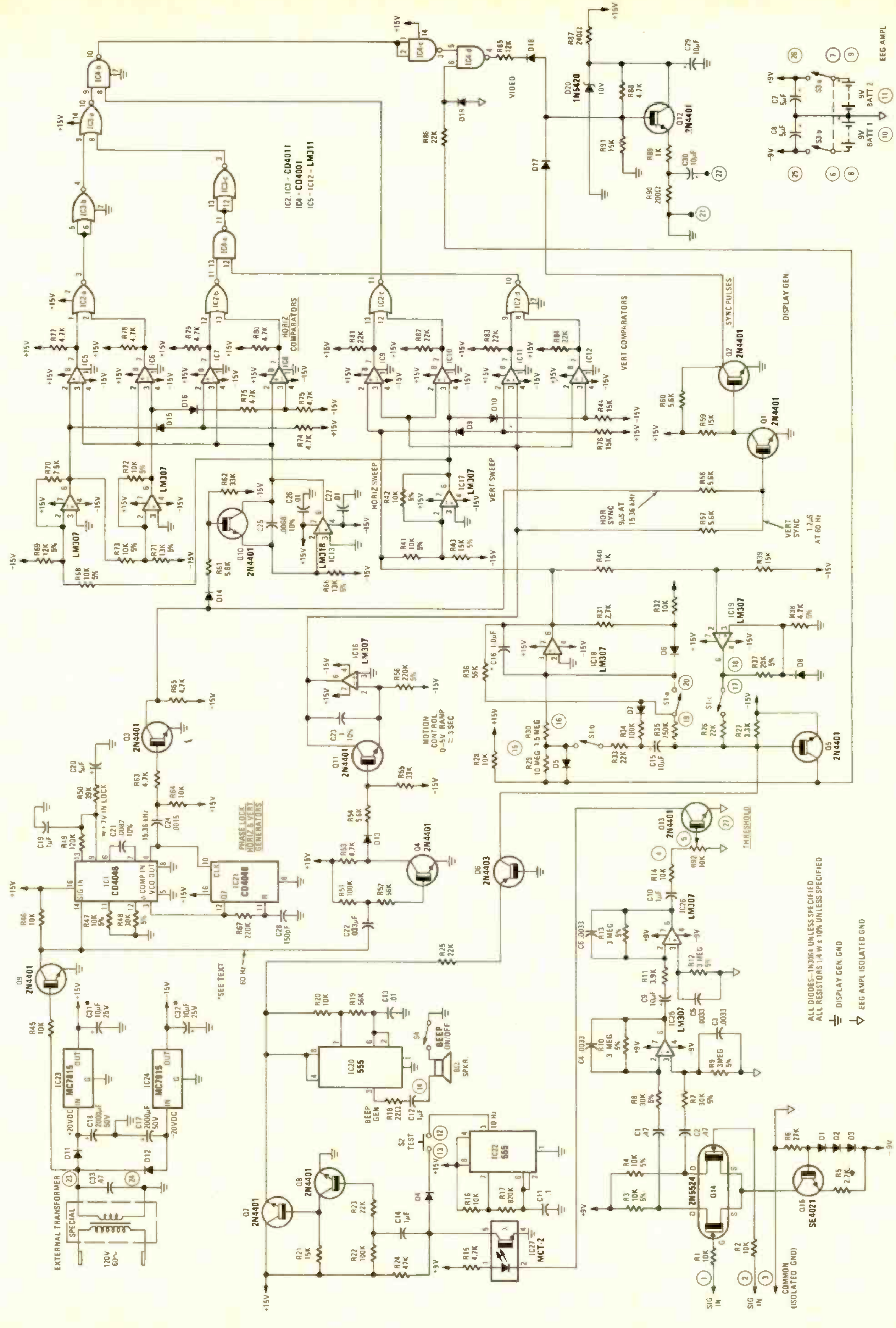

FIG. 1—COMPLETE SCHEMATIC DIAGRAM OF MINDPOWER: ALPHA. The EEG amplifier in the front-end is battery powered and optically isolated. Thus, the user is safely isolated from the AC power line.

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 originate from *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. Here's how to build an Alpha-Wave trainer to help you learn how to control these stresses.

are fixed positive and negative voltages), IC9 reaches its threshold point and its output falls to a logic 0 level. IC11 remains at a logic 1 level because of the 0.6-volt drop across diode D9, until the ramp has reached a higher level corresponding to its threshold point, after which it switches to a logic 0 level. As the ramp rises higher, the outputs of all the vertical comparators are a logic 0 level, until the threshold level of IC12 is reached, causing its output to go to logic 1. A further increase in the ramp voltage accounts for the constant drop across D10, and IC10 switches to a logic 1.

In effect, comparators IC9 through IC12 have now determined the "top" and "bottom" bar segments of the rectangle, and D9 and D10 have set the thickness of these segments. The apparent size of these elements is a function of the display control voltages supplied by IC18 and IC17. Thus, if that voltage is not fixed, but is a ramp, the threshold points along the vertical sweep ramp can be smoothly varied to create the illusion of expanding display

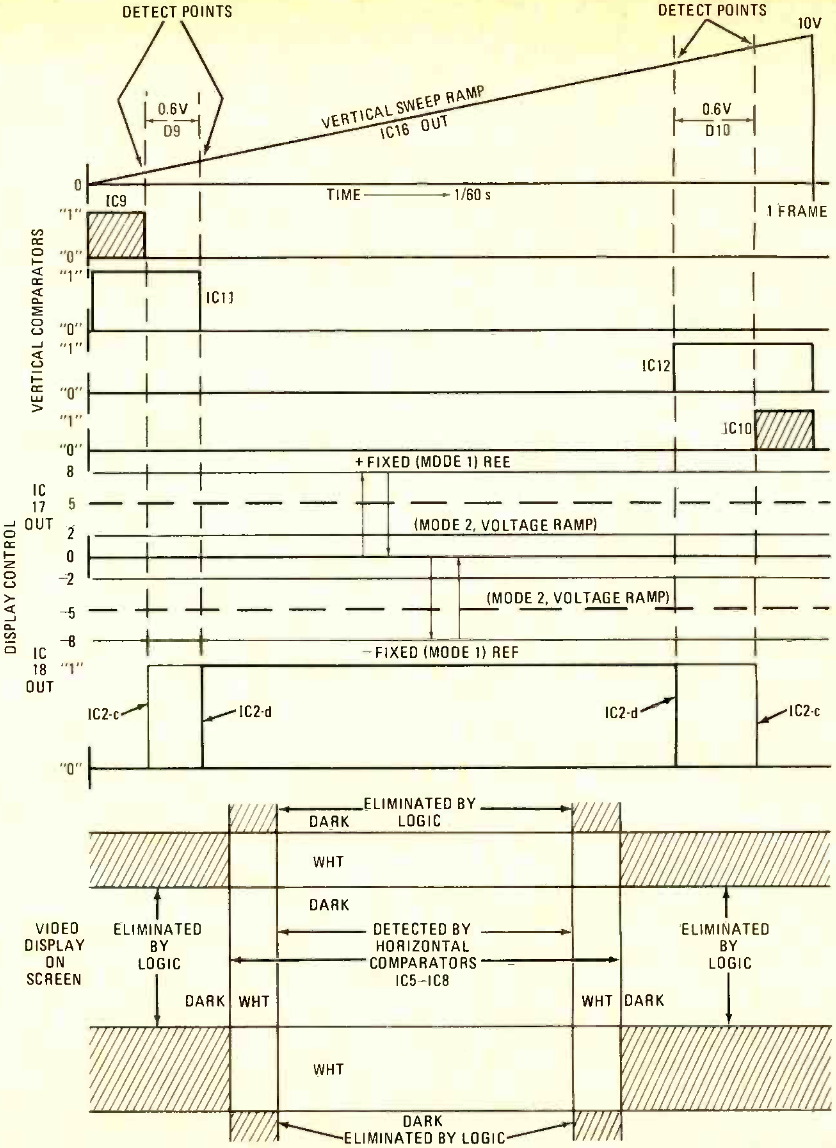

FIG. 2—TIMING WAVEFORMS associated with the comparators in the display logic and video driver section. Generation of the video display on the picture tube is also shown.

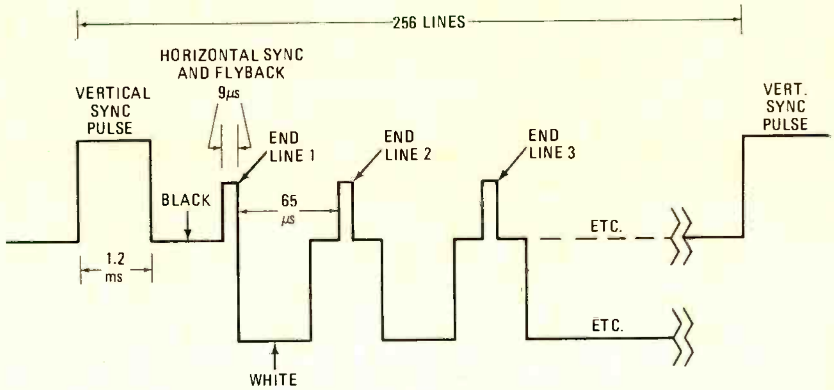

FIG. 3—COMPOSITE VIDEO SIGNAL produced from Mindpower: Alpha.

segments. Also, if the display control voltages are changed sharply, in response to a proportional level of alpha activity, these segments will abruptly "shrink" as the threshold-points are shifted.

The horizontal comparators IC5 through IC8 are identical in function to the vertical comparators, and are controlled from the output of IC17 through IC14 and IC15.

Having now established two pairs of controllable bars, overlying each other horizontally and vertically to form a crosshatch (rather like a tic-tac-toe pattern, we still have to eliminate those bar segments that lie outside the rectangle defined by the intersections of the vertical and horizontal bars. This is achieved by comparing the logic states of the horizontal and vertical comparators, and appropriately gating video output.

In order to gate the video beam on (that is, to write a white segment), the

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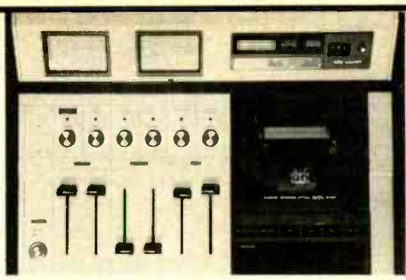
Radio-Electronics



1

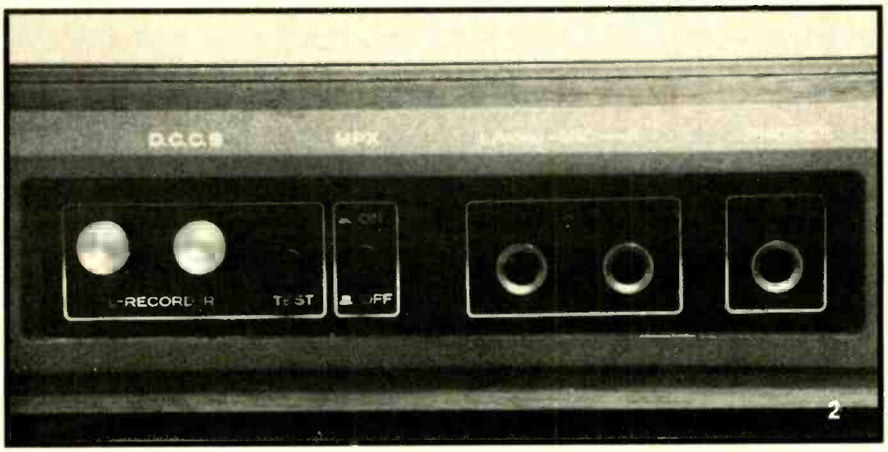
Tests Hitachi D-3500

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

YOU CAN COUNT THE NUMBER OF "THREE-headed" stereo cassette tape decks available to consumers on the fingers of one hand, and most of them cost more than twice as much as this neat little deck from Hitachi. For those who aren't quite sure of the distinction between "two-headed" and "three-headed" decks, let me explain that by far the vast majority of cassette machines use a single record/playback head that performs both functions. The "second" head is usually the erase head that is mounted ahead of the record/play head relative to the direction of tape travel. It is well known that the ideal construction for a record head differs from the ideal required for optimum playback. Thus, all two-headed machines represent a compromise in head design. While it is relatively easy to use separate record and play heads in an open-reel tape deck (and most open-reel machines do use at least three heads) the configuration of the standard cassette (that was never envisioned as a high-fidelity tape medium by its inventors originally) makes the problem difficult indeed. Hitachi has solved the problem by building two heads and gap arrangements into a single housing, so arranged that the tape passes the record gaps before passing the playback gaps. The three-head arrangement, besides offering the optimization possibility for each function, permits tape monitoring (the ability to listen to the recorded results a small fraction of a second after recording has taken place) via the usual tape-output and tape-input jacks commonly provided on hi-fi component amplifiers and receivers.

A top view of the Hitachi D-3500 is shown in Fig. 1. The sloped section of the rear panel contains a pair of fast-acting VU meters at the left. A three-digit tape counter and lights that indicate recording or playback mode are located to the right of the meters. Below the meters, on the flat surface of the panel, are six identical pushbuttons and associated indicator lights to denote their use. The pushbuttons include a METER SELECT switch, a MEMORY rewind switch (used in conjunction with the 3-digit counter), a TAPE SELECT switch (with positions for chrome or regular ferric oxide tape), a DOLBY NR on/off switch, an INPUT SELECT switch (that selects line inputs or line plus mic inputs that can be mixed) and a MONITOR SELECT switch (that determines which signals reach the output jacks of the unit). Six slide-controls below the pushbuttons adjusts the level of the individual line input, mic input and mic output for each of the two stereo channels. Control keys below the cassette compartment area include STOP/EJECT, RECORD, PLAY, REWIND, FAST FORWARD and PAUSE. It is necessary to depress PLAY and RECORD simultaneously to activate the record function, but if the PAUSE key has been previously depressed, tape motion will not start until it is released so that all record levels can be properly set up before the tape starts to move.

The front apron of the D-3500, shown in Fig. 2, has a recessed well that contains a pair of Dolby record-level calibration controls, a 400-Hz test tone switch, a pair of microphone input jacks and a phone jack. Overseas manufacturers have a penchant for "initializing" circuits and functions and it took us a while to figure out that Hitachi's D.C.C.S. nomenclature above the Dolby calibration controls and test tone switch must stand for Dolby Calibration Control System (*Everyone* knows that, right?).



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The rear-panel contains the usual line-input and line-output jacks plus a DIN record/play multiple-pin connector and an output on/off switch (which, if accidentally left in the off position, could lead to needless service calls). Since just about any amplifier that the deck might be used with has provisions for switching off the tape program sources (if headphone listening directly from the deck is desired) we wonder why Hitachi elected to include this sort useless switch.

Circuitry

A block diagram of the D-3500 is shown in Fig. 3. Twenty five transistors, 21 IC's, 26 diodes, a Zener diode and two thermistors comprise the active elements of the circuit and there are a total of five separate printed-circuit boards used. An excellent and complete service manual is available from the company that details both mechanical and electrical construction of the unit and provides a complete guide to all adjustments that might ever be required. A 4-pole synchronous motor coupled to a 4-inch diameter flywheel is used in the drive system and the capstan

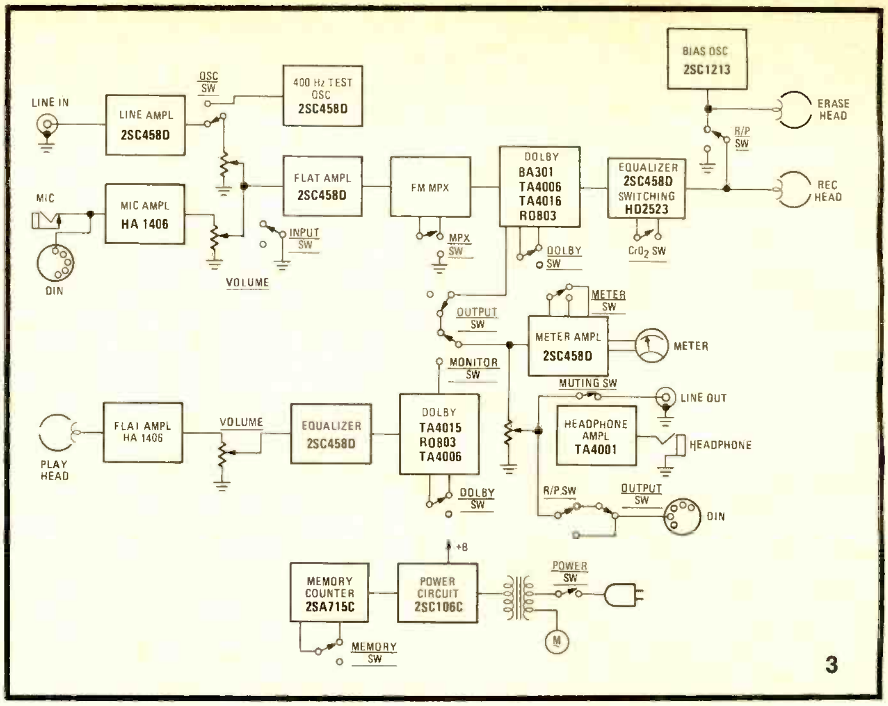
MANUFACTURER'S PUBLISHED SPECIFICATIONS:

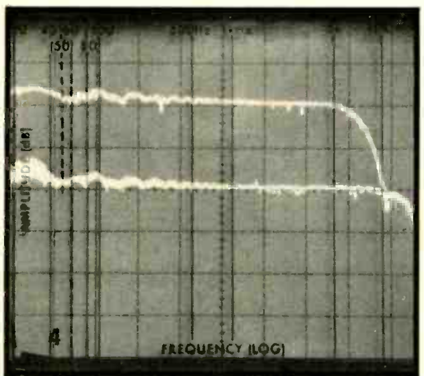
Frequency Response: Chrome: 20 Hz to 20,000 Hz; Normal: 20 Hz to 15,000 Hz. **Wow-and-Flutter:** 0.05% WRMS. **Signal-to-Noise Ratio:** Dolby "off": 55 dB; Dolby "on": 63 dB. **Distortion:** 2.0% (at 0-dB, 1 kHz). **Erase Ratio:** 65 dB. **Crosstalk:** 60 dB. **Input Sensitivity:** Line: 35 mV; Mic: 0.18 mV. **Output Level:** more than 0.5 volts. **Fast Rewind Time:** 90 seconds (C60). **Power Consumption:** 20 watts. **Dimensions:** 16-15/16" wide × 5½" high × 11⅛" deep (43.0 × 14.0 × 28.3 cm). **Weight:** 15.4 lbs. **Suggested Retail Price:** $420.00.

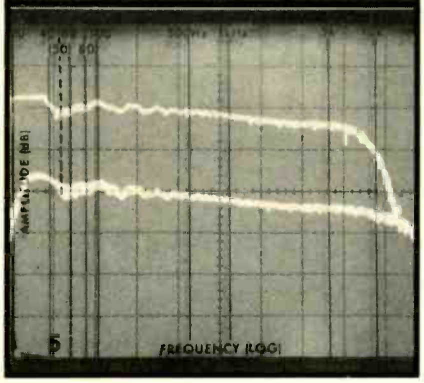
is said to have a roundness accuracy of 0.1 micron. A fully mechanical system of end-of-tape automatic stop is incorporated in the machine that we found to be effective if a bit slow in its response. A multiplex filter switch is also included in the recess of the front apron, useful in eliminating high-frequency content from the stereo FM tuner outputs that might upset the action of the Dolby encoding circuits when recording such broadcasts.

Laboratory measurements

Our performance measurements on the D-3500 are listed in Table 1. While Hitachi fails to assign a "plus and minus" dB tolerance to their stated frequency response specification, they need not have been so cautious. It is extremely good, with response for low-noise ferric tape (we used Maxell UD in our tests) ranging from 22 Hz to 19,500 Hz ±3 dB, as confirmed in the spectrum analyzer photo of Fig. 4 (lower trace taken at a record level of −20 dB) and from 20 Hz to 18,000







Hz ±3 dB using chrome tape (lower curve of Fig. 5).

When chrome tape is used, the deck has an automatic sensing system that flips the circuits over to correct bias and equalization for such tapes that have an extra notch on the cassette housing even if the user forgets to depress the tape selector button. The rather unusual response characteristic observed using chrome tape (gradual roll-off from one frequency extreme to the other) can only be accounted for by the record (and possibly the play) equalization curves built into this machine, since the very same "tilt" was observed both at the high (0 dB) and low (−20 dB) level frequency-sweeps with which we tested this tape.

On the basis of results obtained with this sample we would tend to use better grades of ferric tape with the D-3500 rather than chrome despite the slight

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Hitachi** Model: **D-3500**

CASSETTE TAPE DECK MEASUREMENTS

FREQUENCY RESPONSE MEASUREMENTS	**R-E Measurments**	**R-E Evaluation**
Frequency response, standard tape (Hz-kHz ± dB)	22-19, 5±3, 0	Excellent
Frequency response, CRO_2 Tape (Hz-kHz) ± dB)	20-18, 0±3, 0	Very good
Frequency response, other (see text) (Hz-kHz ± dB)	—	
DISTORTION MEASUREMENTS (RECORD/PLAY)		
	Std./Chrome	
Harmonic distortion @ −10 VU (1 kHz) (%)	3.0/	(Mostly noise)
Harmonic distortion @ − 3 VU (1 kHz) (%)	1.8/	Fair
Harmonic distortion @ 0 VU (1 kHz) (%)	1.8/2.0	Good/Good
Harmonic distortion @ + 3 VU (1 kHz) (%)	2.5/3.0	Very good/Good
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Standard tape. Dolby off (dB)	50	Very good
Standard tape, Dolby on (dB)	55	Very good
CRO_2 tape, Dolby off (dB)	53	Excellent
CRO_2 tape, Dolby on (dB)	61	Excellent
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow and flutter (%, WRMS)	0.06	Excellent
Fast wind and rewind time, C60 (seconds)	75	Good
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)	0.2	
Line input sensitivity (mV)	40	
Line output level (mV)	840	
Phone output level (mV)	34 (8 ohms)	
Bias frequency (kHz)	105	
TRANSPORT MECHANISM EVALUATION		
Action of transport controls		Very good
Absence of mechanical noise		Average
Tape head accessibility		Good
Construction and internal layout		Excellent
Evaluation of extra features, if any		Very good
CONTROL EVALUATION		
Level indicator(s)		Very good
Level control action		Good
Adequacy of controls		Excellent
Evaluation of extra controls		Excellent
OVERALL TAPE DECK PERFORMANCE RATING		Very good

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Hitachi   Model: D-3500

OVERALL PRODUCT ANALYSIS

Retail price	**$400.00**
Price category	**Medium/High**
Price/performance ratio	**Excellent**
Styling and appearance	**Good**
Sound quality	**Excellent**
Mechanical performance	**Very Good**

Comments: While we categorize the price of Hitachi's D-3500 as "medium/high," we must hasten to add that in terms of such three-headed cassette machines as are currently available it is almost "bargain priced." We were intrigued by Hitachi's solution to the problem of "crowding" separate record and play heads into the available space of the exposed openings of the cassette housing and admire their solution to this problem (discussed in the main section of this test report). The slightly "sloped" record/play response of the machine when using Chrome tape is obviously a function of imprecise equalization (we cannot tell whether the error is in record or playback equalization), and that may be common only to the sample we tested. If it is present in all machines bearing this model number, that's rather a pity since this is one of the few machines we have tested recently that actually delivers significantly better S/N ratios when using Chrome tape compared to the S/N achieved with low-noise ferric tape. Even if response using Chrome were "tilted" back to where it belongs, the S/N advantage would still be significant.

In our sample, at least, low-noise ferric tape wins hands down as far as overall response and distortion are concerned and the 50 dB S/N ratio observed using such tape (without Dolby) renders this machine quit usable for serious music recording.

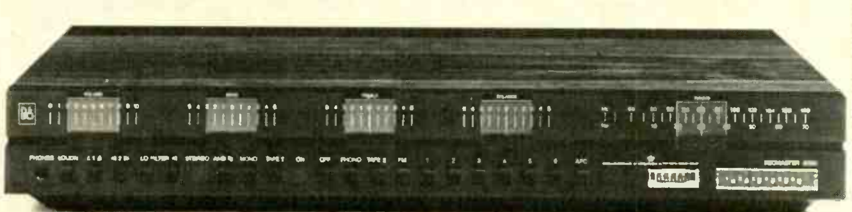
reduction in signal-to-noise capability (which was excellent with either kind of tape but better when chrome tape was employed). All S/N measurements were made with reference to the 3% total harmonic-distortion point for the particular tape used. That point occurred at +3 dB (1 kHz) for chrome tape and at +4.5 dB for the low-noise tape.

Using the Hitachi D-3500

This deck, while not the quietest running machine we have checked, did provide truly excellent wow-and-flutter numbers. Action of the transport keys is a bit "clunky," especially when the automatic end-of-tape stop returns the depressed key to its off position. Level-meter action is good and can be classified as "peak reading," though meters are placed ahead of record equalization so that readings fall-off rapidly with high frequencies applied. We felt that the line-input sensitivity was actually too high (that is, it takes very litle line-input signal to reach 0 dB record levels). Since the tape-output terminals of most receivers or amplifiers generally provide 150 mV or even 200 mV of signal for normal inputs, this means that the user must work the record level controls at their bottom range during most recording work done from amplifier or receiver derived program sources. This reduces the usefulness of the long-range slide controls somewhat. If you care enough about this, an external resistive pad ahead of the line inputs could easily rectify this minor flaw.

Because of the unique two-in-one-but-separate record/play head construction of the D-3500, there was no need for azimuth alignment between record and play heads (a feature considered a must on other three-headed machines) which simplifies operation considerably compared to those few more expensive three-headed cassette units. All in all, if you have been frustrated by your inability to monitor recorded results "as you go" and are not quite prepared to spend upwards of a thousand dollars for a machine having that capability, the Hitachi D-3500 offers a worthwhile alternative—and unusually good recording performance at its price level. **R-E**

B&O 4000 FM Receiver



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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

TUNER SECTION:
IHF Sensitivity: 2.0 μV at 75 ohms (17.4 dBf). **Signal-to-Noise Ratio** (mono): Greater than 65 dB. **Harmonic Distortion:** (mono) 0.4%. **Frequency Response:** 20Hz to 15000Hz ±1.5 dB. **Stereo Separation,** (1 kHz): 35 dB. **19 kHz and 38 kHz Suppression:** 40 dB.

AMPLIFIER SECTION:
Power Output: 60 watts continuous into 4 ohm loads at any frequency from 40 Hz to 20,000 Hz with no more than 0.4% total harmonic distortion. (No rating supplied for 8-ohm operation.) **IM Distortion:** 0.3%. **Damping Factor:** Greater than 20. **Input Sensitivity:** (phono) 3 mV; (tape) 250 mV. **Signal-to-Noise Ratios:** (phono) 62 dB; (tape) 75 dB. **Tape Out Level:** 170 mV. **Bass Control Range:** (at 40 Hz) ±17 dB. **Treble Control Range:** (at 12.5 kHz) ±14 dB.

GENERAL SPECIFICATIONS:
Power Requirements: 117 V, 60 Hz, 20 to 275 watts maximum. **Dimensions:** 22-13/16" W × 3¾" H × 10⅝" deep. (57.94 W × 9.53 H × 26.99 D cm.) **Weight:** 22 lbs. (9.97 Kg.) **Suggested Retail Price:** $595.00.

IF YOU HAVE EVER VISITED THE NEW YORK Museum of Modern Art you may have noticed that there is displayed a high-fidelity turntable system designed and produced by Bang & Olufsen of Denmark. That turntable system is as different in appearance and operation from most other turntable systems as the model 4000 FM receiver is from any other receiver you may have seen in the past. Both the turntable system and the 4000 (shown in Fig. 1) are beautifully styled, with the emphasis on human engineering and aesthetics. Having visited B & O's facilities in Struher, Denmark last year, we can attest to the fact that other products made by this Scandinavian company are equally well styled and functional. (The company is a producer of mass-entertainment products such as TV sets that are sold only in Europe and which bear the same distinctive Scandinavian industrial design approach.) While execution of the exterior of the 4000 and its control arrangement is innovative and appealing, measured performance of this relatively expensive receiver is a bit disappointing, at least when compared with other receivers selling for approximately the same price.

The all-black, slim and long front panel of the 4000 is divided vertically into two sections. The upper portion of the panel has what look like five "slide rule" indicators. Each transparent indicator slides horizontally, controlling such functions as VOLUME, BASS, TREBLE, BALANCE and TUNING. The tuning bar, or indicator, is additionally equipped with two tiny thumbwheels along its bottom to facilitate vernier action of the slider.

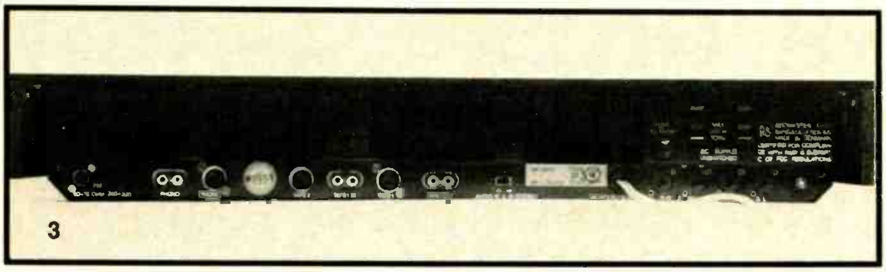
The lower section of the front panel contains a HEADPHONE jack, STEREO and POWER-ON indicator lights, a signal strength meter, twin light indicators for center-of-channel tuning, six tiny thumbwheel controls with which six pre-selected stations can be tuned and nineteen small downward depressable switches. The switches select loudness circuitry, either or both of two pairs of speakers, low and high cut filters, ambience connection of the second pair of speakers (for synthesized 4-channel sound), MONO/STEREO, tape monitoring, power OFF (choosing any program source automatically turns power *on*), PHONO, TAPE 2 (a non-monitorable input) or FM, the six pre-tuned stations and AFC. A closeup view of the tuning slider and pre-tune controls is shown in Fig. 2.

Access to the tape and phono inputs on

2

the rear panel (See Fig. 3.) is either by means of DIN connectors or standard phono-tip jacks. A coaxial connector is provided for 75-ohm transmission line from FM antennas, but if a 300-ohm line is used it is necessary to connect wire ends to a separately provided plug that fits neatly into a mating socket on the rear panel. All speakers are connected by means of polarized plugs (supplied in an accessory bag) that require no soldering and have the advantage of maintaining correct speaker phasing if speakers are ever unplugged for transporting, cleaning, etc. B & O's own speaker systems come equipped with suitable plugs and cables, so that the accessory plugs are only needed if you use other makes of speakers. A pair of convenience outlets are also provided on the rear panel along with a bracket which is intended to hold an optionally available "rabbit ears" antenna made by B & O.

Figure 4 illustrates the type of component equipment that can be used with the 4000. The second pair of speakers may be used stereophonically in a remote location or to complete an "ambience" type 4-channel arrangement in a single listening room. B & O calls this arrangement "ambio system," but it is essentially no different from the out-of-phase or "left minus right" rear speaker arrangement first proposed by Dynaco in this country several years ago and requires no additional channels of audio amplification.



3

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Bang & Olufsen** Model: **4000**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (μV) (dBf)	3.5 (16.3)	Fair
Sensitivity, stereo (μV) (dBf)	4.0 (17.4)	Good
50-db quieting signal, mono (μV) (dBf)	7.0 (22.3)	Good
50-db quieting signal, stereo (μV) (dBf)	38.0 (37.0)	Fair
Maximum S/N ratio, mono (dB)	67	Good
Maximum S/N ratio, stereo (dB)	63	Very good
Capture ratio (dB)	3.2	Fair
AM suppression (dB)	55	Good
Image rejection (dB)	N/A	Not rated
IF rejection (dB)	N/A	Not rated
Spurious rejection (dB)	80	Good
Alternate channel selectivity (dB)	55	Fair
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	0.5	Very good
Harmonic distortion, 1 kHz, mono (%)	0.45	Fair
Harmonic distortion, 1 kHz, stereo (%)	0.26	Good
Harmonic distortion, 100 Hz, mono (%)	0.30	Good
Harmonic distortion, 100 Hz, stereo (%)	0.65	Poor
Harmonic distortion, 6 kHz, mono (%)	1.20	Fair
Harmonic distortion, 6 kHz, stereo (%)	1.3	Good
Distortion at 50 dB quieting, mono (%)	1.8	Fair
Distortion at 50 dB quieting, stereo (%)	0.4	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV)	4.0	Very good
Separation, 1 kHz (dB)	35.0	Good
Separation, 100 Hz (dB)	32.0	Good
Separation, 10 kHz (dB)	20.0	Fair
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV)	N/A	No muting
Dial calibration accuracy (±kHz @ MHz)	−250 @ 108	Poor
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Excellent
Ease of tuning		Very good
Accuracy of meters or other tuning aids		Poor
Usefulness of other controls		Good
Construction and internal layout		Excellent
Ease of servicing		Excellent
Evaluation of extra features, if any		Very good
OVERALL FM PERFORMANCE RATING		Fair

Construction and Circuitry

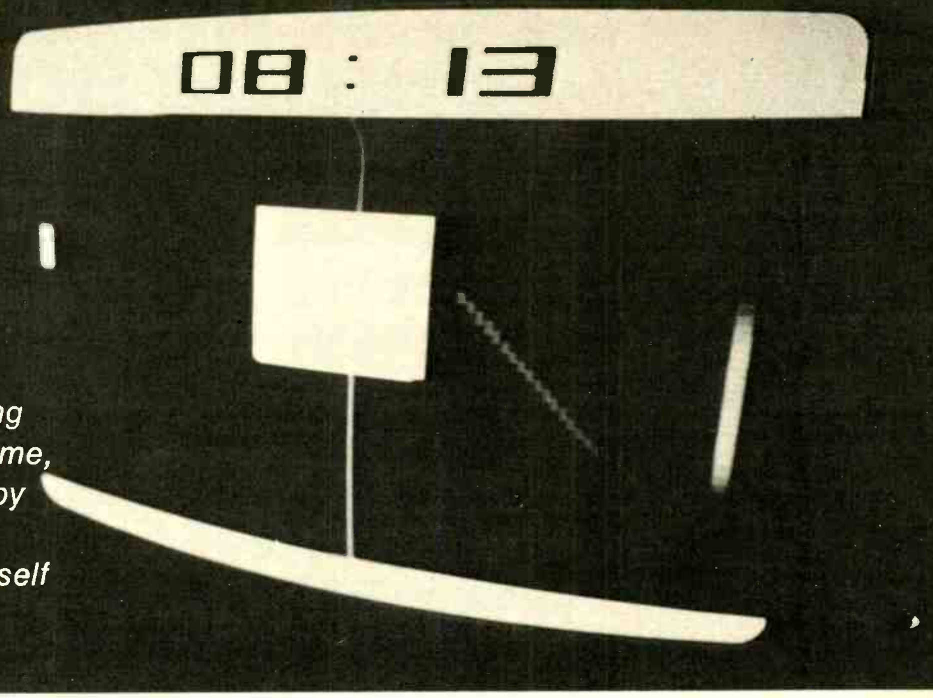
The 4000 is easily disassembled for servicing and/or alignment, and a top view of the chassis with wood cover removed is shown in Fig. 5. Visible at the upper left is a tuning wheel that rotates a precision potentiometer, since the front end of the 4000 is varactor-diode tuned and varying the voltage applied to four tuned circuits of the front end alters the frequency to which the tuner is tuned. It is this arrangement that makes possible the six pre-set station capability, since the controls used to set up favorite stations are nothing more than six tiny potentiometers. The RF amplifier uses a pair of FET's in a cascode arrangement and an FET is used for the mixer stage as well. Fixed solid-state 10.7 MHz filters are used in the FM IF circuitry that is contained on a single board along with a fairly conventional stereo multiplex decoder circuit that uses six adjustable coils and transformers as opposed to more modern phase-locked-loop circuitry.

Preamp input stages are contained on a separate PC board and discrete transis-

(continued on page 88)

Build This Great TV Game

Part III. With on-screen digital scoring and a unique alternate "bumper" game, this ping-pong game can be played by two or four people or it can be set to play a perfect game against you or itself



IN THIS FINAL SECTION WE'LL TAKE A LOOK at the circuitry for Bumper and examine the methods for connecting the game to a TV set. In addition, we will describe a trouble-shooting system to use if you can't get your game to work.

Bumper is generated by four one-shots. Two of them determine the bumper's position. The other two determine its dimensions. The vertical position is set by the signal from pin 12 of IC24 and pin 8 of IC23. The vertical dimension is set by the signals from pins 8 and 12 of IC23. The horizontal position is determined by the signals from pins 8 and 10 of IC24. The horizontal dimension is determined by the signals from pins 2 and 6 of IC24. These one-shots work similarly to the one-shots used to generate the center line and top boundaries (see **Radio-Electronics,** July 1976). The output of the bumper comes from pin 12 of IC25 and it AND's the vertical and horizontal dimensions to produce the rectangle.

A third input is used to enable or disable this game with the GAME SELECT switch. The output is inverted and displayed on the screen. And also AND'ed with the ball signal from pin 13 of IC5. This output is used to clock IC10, the horizontal position flip flop. When the ball enters the bumper, IC10 is clocked. This causes the ball to reverse horizontal direction. However, because of the size and shape of the bumper, and the various entry angles, the ball will not always immediately leave the bumper. Thus, on successive lines, the ball may still be in the bumper. When this happens IC10 will continue to be clocked and the ball will continually reverse direction until it is finally clear of the bumper. Since the length of time the ball remains in the bumper is random, the direction of the emerging ball is unpredictable. The signal from pin 8 of IC 25 is used as an OR gate to combine the hit signals with the signal from the reserve timer.

Audio for both games is generated by IC18, IC19 and IC6. When a ball is hit with a paddle, or when a ball strikes a boundary, a one-shot made of two sections of IC18 is triggered. The diodes D19, D20 and D21 are an OR gate. And the signals from pins 3 and 6 of IC19 comprise a free-running oscillator operating at about 1kHz. Thus, a series of pulses are generated at pin 6 of IC19 for the period of the one-shot. This pulse string is amplified by Q6 and is the "*bink*" heard on a hit or rebound.

The "*brapp*" missound is generated by ANDing the vertical sync pulses with a longer pulse generated by the flip flop, pin 6 of IC17. Capacitor C45 determines the length of the "*brapp*." When IC17 sets, the Q output is inverted via IC23 and differentiated by capacitor C45 and resister R74. On a re-serve, the ball crosses through the top boundary and could cause a false "*brapp*" signal. This is prevented by pin 8 of IC17 which is set on a re-serve and cleared the first time the ball crosses the center line. With pin 8 of IC17 set, pin 3 of IC19 is disabled.

IC13 is used to combine all of the video outputs from the boundaries—paddles, ball, center line, and bumper—into one video signal to be displayed on the TV screen. The scoring video output is OR'ed for the top boundary video through diode D2 to produce black numerals on the white top boundary field. The output goes through a voltage divider R37-R38 which is used to adjust for the correct video level. The resulting video signal is then OR'ed with the combined vertical and horizontal sync from pin 3 of IC8 in IC5. The resulting video signal is buffered by an emitter-follower circuit, transistor Q5, and is available for direct connection to a video display unit via the video detector.

Connecting to the TV set

Connecting external devices delivering an RF signal to the antenna terminals of a television set is prohibited by FCC rules. Therefore, the only acceptable method is to feed the signal from our TV game directly into the set's video detector/amplifier. To do this, there are two preliminary steps that must be taken. **First, you must be sure that the TV set you intend to use has a power transformer and is not an AC/DC set that has one side of the power line connected to the chassis. Sets such as these offer a potentially dangerous shock hazard, and must not be used with the circuits recommended here. Before proceeding further, be sure that the set you plan to modify is safe to use for the game and that the chassis is isolated from the power supply.** Next, you must secure a complete set of schematics of the set, either directly from the manufacturer or from a Howard Sams' Photofact. This schematic is a necessary part of hooking up our game to your TV.

The point for direct connection is shown in Fig. 1. Locate this point in the schematic for your TV set and then find that point physically in the TV set where the input signal first enters the first video amplifier.

If your set is a vacuum tube type, look at Fig. 2. The modification here consists of three simple sections—a self-biasing cathode circuit, an input jack with bypass resister, and a game/video selector switch. The cathode bias circuit provides about 2 volts (positive) on the cathode for game playing. (And the switch re-establishes the typical 0 cathode voltage for TV watching). For both tube and transistor type sets, the sync level runs about 2 volts below the white level. Any existing bias network on the cathode must be increased to bias the black level (vs. white) for game playing.

If the TV set is a transistor type, use any of the circuits shown in Fig. 3. These will provide the necessary white level/

black level biasing through which the diode drops within the transistors (and in a separate diode for case 3). When no video signal appears, the video driver is driven below the black level to about 1.2 volts. When a white signal of 2 volts appears, the video driver is biased to its usual 3+ volts. The ideal direct video connection circuit will provide the same level of white level bias and black level bias for game playing as for TV watching.

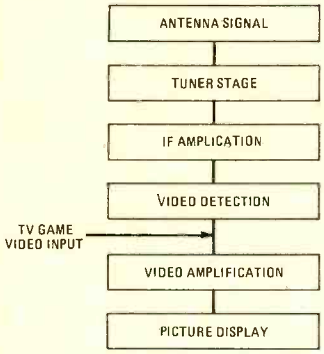


FIG. 1—TV GAME is connected directly to input of video amplifier stage.

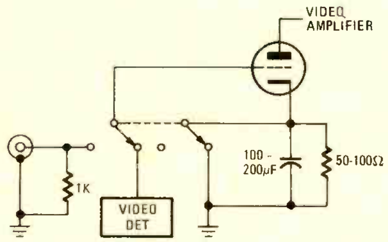


FIG. 2—TUBE-TYPE TV requires minor modification to connect TV Game.

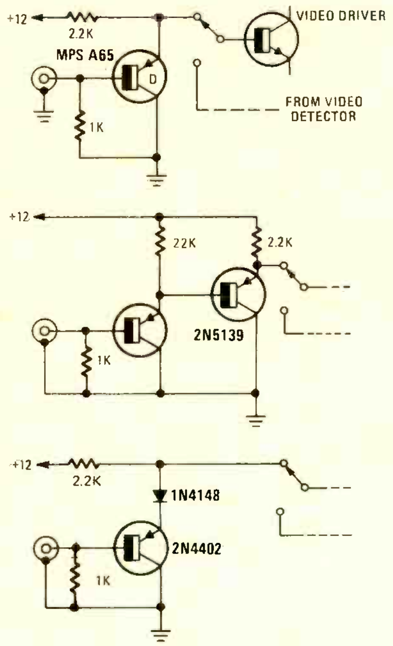
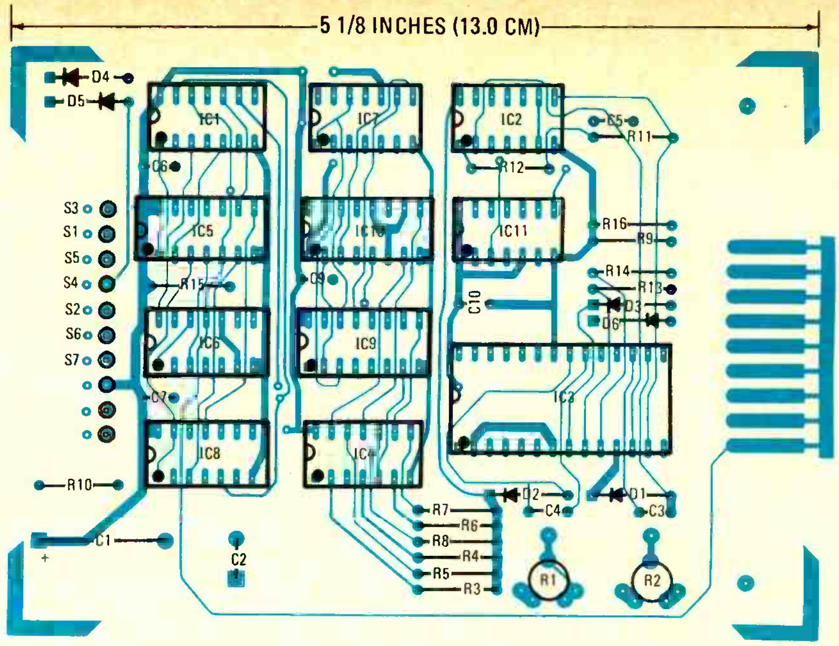
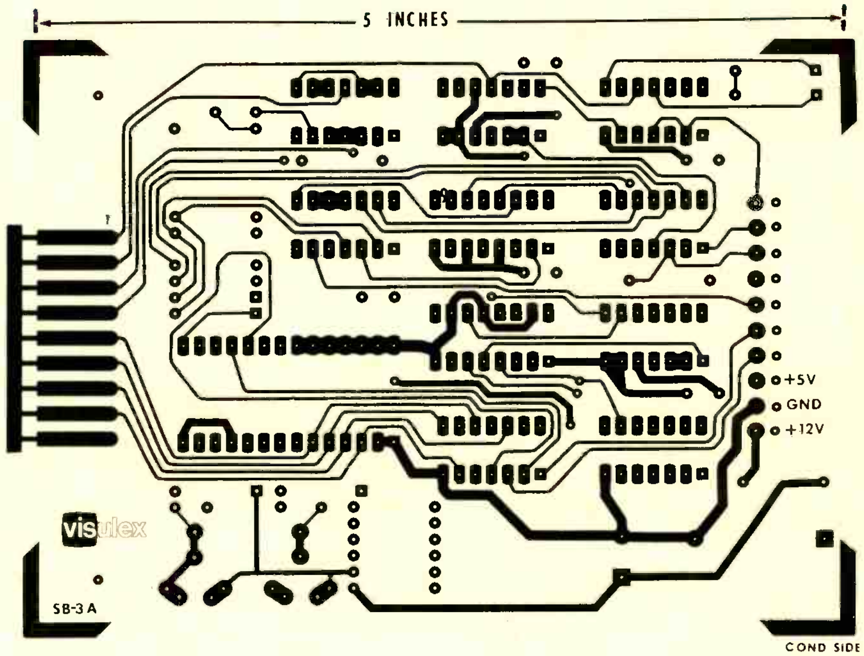
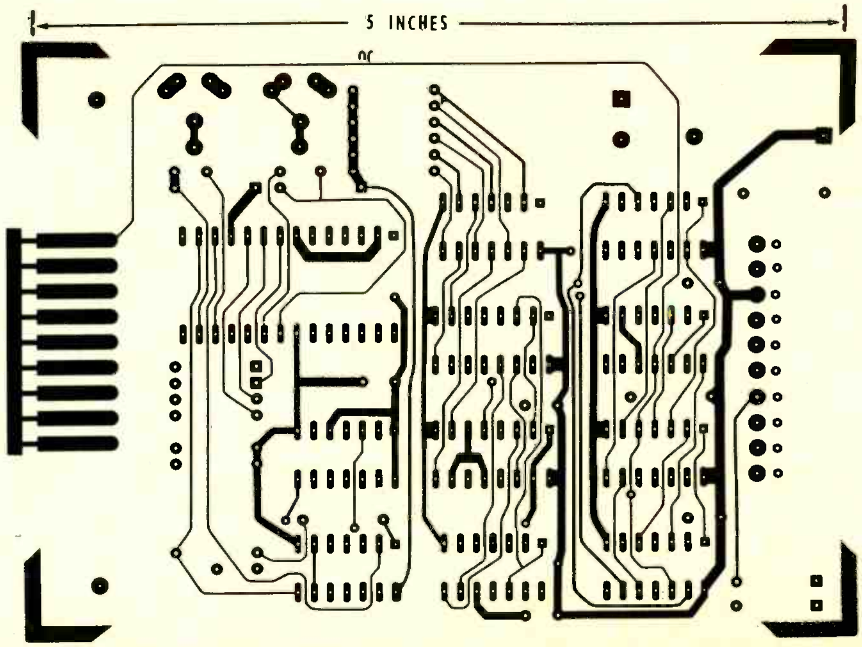


FIG. 3—TYPICAL CONNECTIONS to a transistor-type TV receiver.

The single-pole double-throw switch is designed to isolate the detector and normal bias network when the video input jack is used. Use leads as short as possible and make sure that if any lead run is







DIGITAL SCORING BOARD, component placement diagram (left, top). Foil pattern (left, middle) of component-side of double sided board. Foil pattern (left, bottom) of bottom-side of double sided board. Board measures 5 × 3½ inches.

PARTS LIST SCORING BOARD

All resistors ¼-watt 5% unless noted
R1, R2—50,000 ohms, trimpot
R3, R4, R5, R6, R7, R8, R9, R13, R14, R16—5100 ohms
R10—15 ohms
R11—510 ohms
R12—2000 ohms
R15—47,000 ohms
All capacitors 25 volts or more
C1—50 μF, 25 volts
C2—1000 μF
C3—1000 pF
C4, C6, C7, C8, C9, C10—.05 μF
C5—270 pF
Diodes
D1 to D6—1N4148 or equal
Integrated Circuits
IC1, IC11—7400
IC2—74C00
IC3—5841 display IC provided with circuit board.
IC4—7406
IC5—75C04
IC6, IC7—74C90
IC8—7474
IC9, IC10—74153
Connectors
1 Ten-circuit male (Molex 09-64-1103 or 04)
1 Ten-circuit female (Molex 09-52-3102)

longer than 3 inches, that you use shielded cable for these connections. (For additional information on direct TV connections, we recommend you refer to Don Lancaster's comprehensive article in the October 1975 issue of *Byte* magazine.)

After you have completed the modification to the set, connect the game output, interconnect pads 4 and 4a to the video input jack with 2-wire 24-gauge lamp cord (Since the signal power is relatively low, unshielded wire will usually work. However, where even this potential interference is undesirable, use shielded wire). The lead on pad 4a should connect to the video jack ground terminal. Limit wire length to 15 feet.

When using this direct video connection, replace resistor R55 with a 10-μF capacitor (positive side goes to the emitter of Q6).

Operating instructions

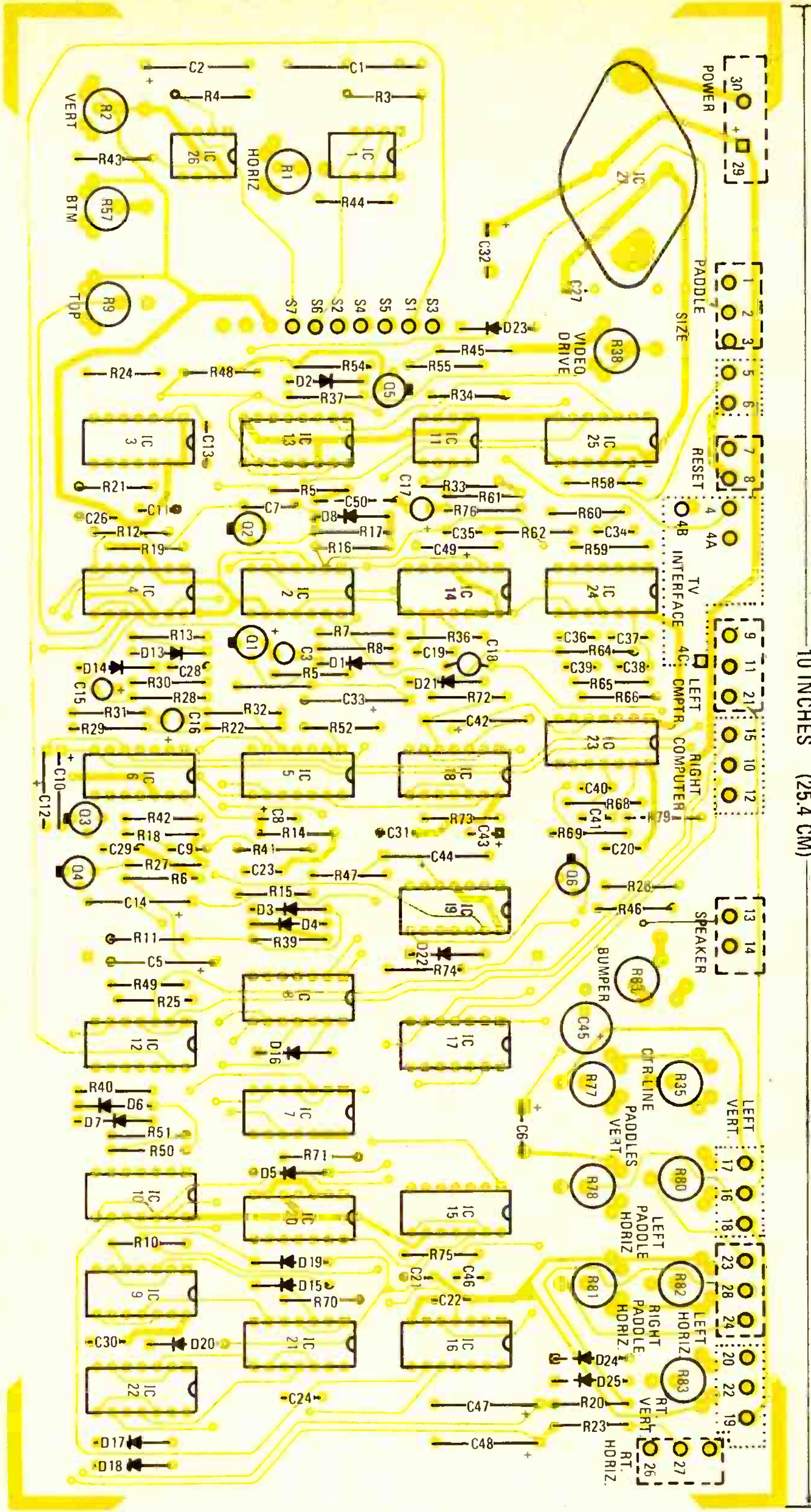
Attach the unit's video output to the video input jack as just described in the previous section. Connect the power supply to 117 volts AC. Adjust the TV set's contrast control to maximum for deepest black. And lower the brightness control until the screen's raster is black. Only the paddles, ball, center line, and boundary should appear white.

Use the RESET button to put the game in the starting position with the score 0-0. If the game is shut down at a score of 18 and no ball can be seen, push the RESET button and release. The ball should re-serve in about 2 seconds. If the ball is in motion, it will be necessary to allow the ball to go off-screen to either the right or left and then to push and release the button before the ball re-serves.

When you want to play "BUMPER", use the GAME SELECT switch to select that game.

When automatic play is desired, flip one of the COMPUTER CONTROL switches to "ON." In this mode, one person can play against the machine. When both switches are on, the machine will play against itself.

In the manual mode, (COMPUTER CONTROL switches off) use the player controller to control the horizontal and vertical position of the paddles. The game ends when the one player scores 18 points.



COMPONENT PLACEMENT DIAGRAM of main circuit board.

Trouble shooting

Most first-time or one-of-a-time projects of this size require some trouble shooting and debugging. The best tools are a scope, comprehensive circuit description, schematic diagram, and a set of scope traces.

continued on page 86

Step-by-step TV Troubleshooters Guide

Servicing private-label receivers can be a real challenge

STAN PRENTISS

AS CHANGES COME FAST AND FURIOUSLY to TV manufacturing around the country, servicing routines appear to be shifting somewhat, too, as more private-label receivers keep popping up at rural and suburban shops. True, wholesale parts prices aren't the rule when dealing with a retailer, but you can still lend a helping hand wherever you can even though service information may present an additional challenge. It's possible this could be remedied shortly and, in the meantime, hang loose and see if a tube, transistor, capacitor, or resistor won't put a few sets back in working order.

Sears chassis

The chassis is a Sears 564.80020. The first three numbers represent the source and the remaining five identify the model and its various changes. A quick check shows this color set has 20 tubes, 14 diodes, and no transistors. Heaters are strictly series-string with a filament transformer for picture tube and shunt regulator, but only a hot chassis for the 280–380-volt power supplies. Source here, I'm told, is 564 for Sanyo, 562 for Toshiba, and 528 for domestic Warwick.

When this one arrived in the shop, these were multiple problems because its owner had allowed it to run down to the point of desperation. There was no picture, peculiar AGC, complaints of poor sync, weak color, indistinct pictures, etc. Of course considerable time was requested for repairs, and parts could be received by mail as needed. So the task was begun, mostly between jobs when rush work was slack and sufficient time became available for careful examination and analysis. Replacing the 1st video amplifier aided our AGC problem somewhat and a 10JY8 in the keyed AGC and 2nd video amplifier cured both AGC and what appeared to be a pressing high-voltage problem, but was nothing more than an erratic output luminance amplifier. However there still remained poor horizontal and vertical sync, so this needed clearing up before continuing.

Tracing inadequate sync

Whenever there is a sync problem, always start with the 1st video amplifier and work through the sync separator and amplifier inmmediately. Then, you'll not confuse AGC signal compression with poor sync separation and can quickly locate the particular circuit that's at fault. As stated repeatedly before, the overall composite video waveform consists of 25% sync tips and 75% video information at 100% modulation. This ratio is, for all of us, inviolate!

What turned up in this set was the usual class-C problem of a typical tube sync separator. The schematic diagram is shown in Fig 1. Here, signal drive comes from the L118 series plate peaking coil of the 1st video amplifier through dropping resistor R143, coupling capacitor C118, grid leak bias C119–R145 and 2.2-megohm grid resistor R146. As you see from the schematic diagram, conduction of V106-a draws grid current, C119 charges negatively and a voltmeter on the grid reads −2.3 volts or more depending on the sync tip amplitude of the incoming signal. So since this tube conducts some 1.4 ms during each 16.664-ms field, and about 10 μs for every 63.5-μs line, it can be called a class-C amplifier because it conducts less than 50% of the overall waveform time. Capacitor C119 discharges mainly through R146, consequently the negative bias is dissipated when the next positive sync pulse comes along to trigger the tube into conduction. Capacitor C119 is then charged positively on the C118 side, and its time constant with R145 passes well-shaped vertical and horizontal pulses. Sync separator V106-a inverts these pulses for stable operation of the vertical and horizontal sweep oscillators.

As you might imagine, capacitor C118 was leaky and letting some video into the sync signal making it unstable. This affected both the vertical and horizontal oscillators. Capacitor C119

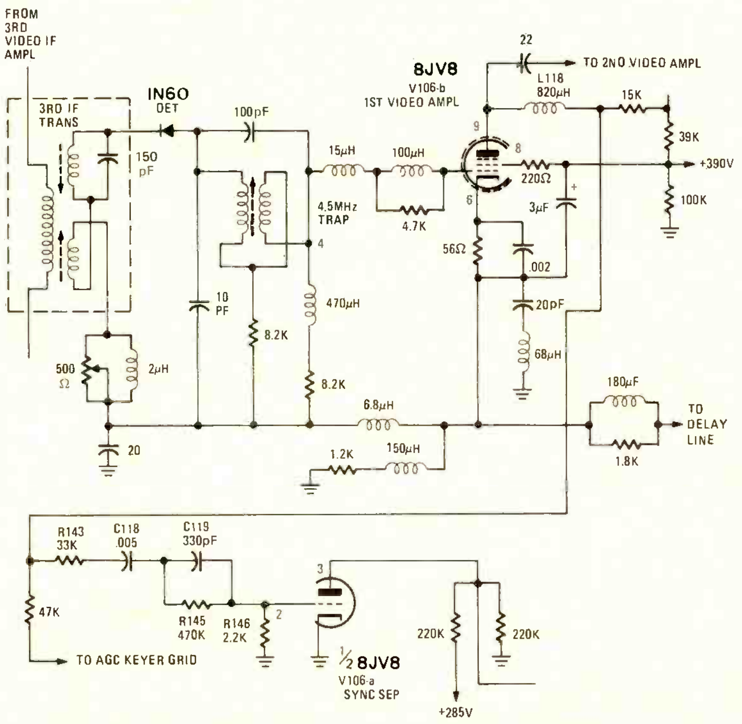


FIG. 1—AGC, SYNC SEPARATOR and 1st video amplifier stages of a Sears 564.80020 chassis.

was also replaced for good measure, but both R145 and R146 checked good. The vertical oscillator now seemed to free-run nicely at 59.94 Hz, but horizontal sync was not that fortunate—it still had significant problems.

The horizontal oscillator

This circuit (see Fig. 2) is similar to RCA's original Synchro-Guide twin-triode oscillator, less perhaps a little feedback but with additional components added for extra stability. The circuit, purely and simply, is a blocking oscillator with feedback from plate to grid through coil terminal 1 and timing capacitor C307, although another winding between terminals 2 and 3 helps produce a sinewave. This sinewave is used to increase the slope of the grid waveform as it recovers from cutoff and to prevent line voltage changes or critical circuit parameters from falsely triggering the oscillator, thus causing loss of horizontal sync. That's why this section of L301 is called a *stabilizer* coil.

Plate voltage from the 380-volt supply is routed across R310, thermistor TH1 (shunting R365), and on through the stabilizer and main coil of the blocking oscillator to V112-b, pin 6. Initial grid bias through R308 forces tube V112-b into conduction and conduction continues depending to a large extent on the L301—C308 tank circuit. To keep grid-plate voltage transients out of the power supply, VDR1 has been added between dividers R307—R308, and R312. Although the cathode of V112-b is at ground, additional positive bias has been added to the cathode of V112-a oscillator control tube. However, instead of the conventional Synchro-Guide capacitor being connected to this cathode, a pair of diodes have been inserted in the grid circuit to compare feedback from the stabilizer coil through R309—C304 and incoming sync via C301.

This type of circuit is called an automatic frequency control circiut. The AFC diodes D3-a and D3-b and related circuitry provide zero voltage to the grid of V112-a if there is no phase difference, and more positive or negative voltages if there is. The plate current through V112-a then develops lesser or greater voltages across R307—R308 to control the grid of the V112-b oscillator, slowing or increasing the repetition rate. A manual bias for this same purposes is furnished by external horizontal hold control between the 380-volt supply and ground. Other circuit components such as R304—C303 form an anti-hunt network to prevent oscillator overcorrections from transient changes, while C306 is a smooth filter.

When V112-b is cut off during line trace, C309 charges toward B+ through R365 and R310 to form the grid drive sawtooth for the horizontal output tube V113. C311 and R313 couple to a resistive amplitude output drive control on the rear control board. C310 then becomes both a V113 output-coupling and grid-leak capacitor, which discharges through R314 since V113 draws grid current when conducting and charges C310 negatively. This charge leaks off through R314 so that the exponential waveform generated by C309 will force the tube to conduct for half of its 52.4-μs rising-curve following cutoff. The other half of the curve, of course, occurs during conduction of the high-voltage damper (not shown). R910 helps prevent grid oscillations.

The ultimate problem

The circuit problem rested entirely in this blocking oscillator. Sears instructions say "short the stabilizer coil" across C308 and adjust the lower core of the transformer for stable picture with the receiver tuned to an active channel. Unfortunately, each time this step was attempted, we picked up a condition that seemed to be a combination of AFC malfunctions, pie crust, squegging and Christmas tree symptoms all rolled into one, even though the horizontal hold was mechanically centered and several 8FQ7 oscillator tubes were replaced in the circuit. Now, as everyone in our business knows (or should), the horizontal oscillator will usually operate independently of AFC diodes and incoming sync, especially with no incoming signal. In other words, the oscillator should be able to work on its own without "help" from the AFC. As a check, simply remove the short from terminals 2 and 3 of L301 and connect your jumper wire between R301—R202 and ground, cancelling the effects of the AFC diodes and feedback from the stabilizer coil. Most oscillators under these circumstances will barely hold sync, or slowly sweep through the sync point—a condition that's perfectly normal.

For voltage measurements, B+ was closer to 400 volts than 380 volts—and that's all to the good—and tube measurements were: pin 1, 24 volts; pin 2, 0 volts; pin 3, 1.7 volts; pin 6, 265 volts; pin 7, −86 volts; and pin 8, 0 (ground). Now you may think three of these variations are significant, but pins 1 and 3 depend on the setting of the horizontal hold control, and the voltage at pin 6 is largely determined by the characteristics of warm-up thermistor TH1 (and R310), a special part that isn't usually available except from the manufacturer. With V112 out of socket, and B+ disconnected at point DD, a quick check of other resistive components showed insufficient reason for any changes. Anti-hunt capacitor C303, timing and coupling capacitors C307, C308 and C310 however, were replaced on the basis of age and for good measure since they could all affect final stability of the circuit.

Regardless of these precision changes, a short across the stabilizer

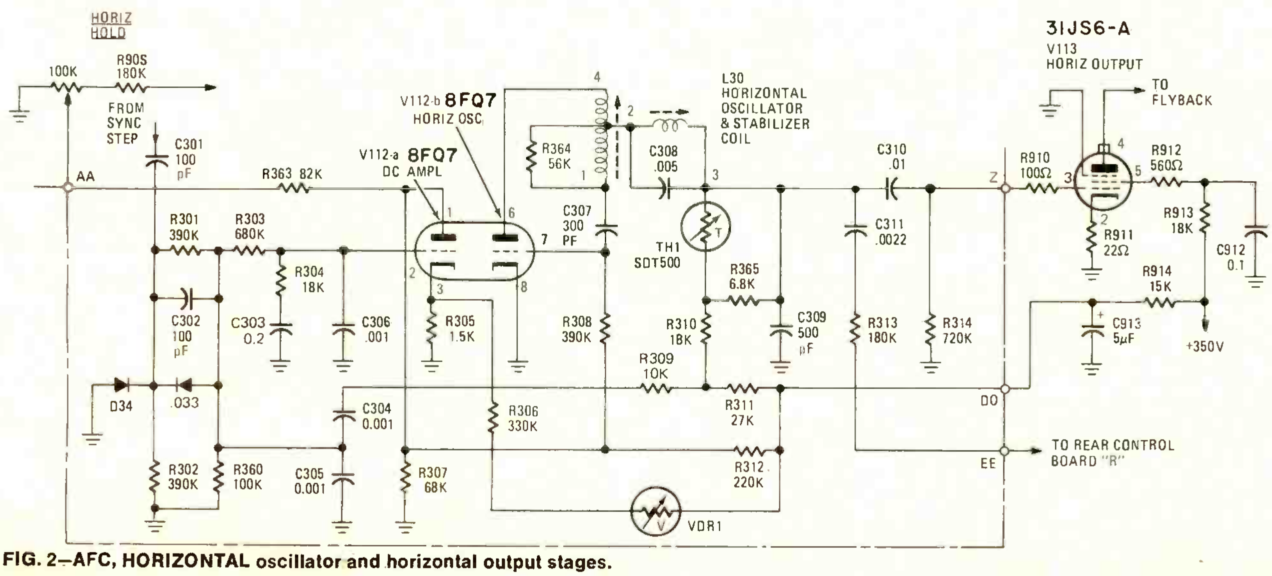
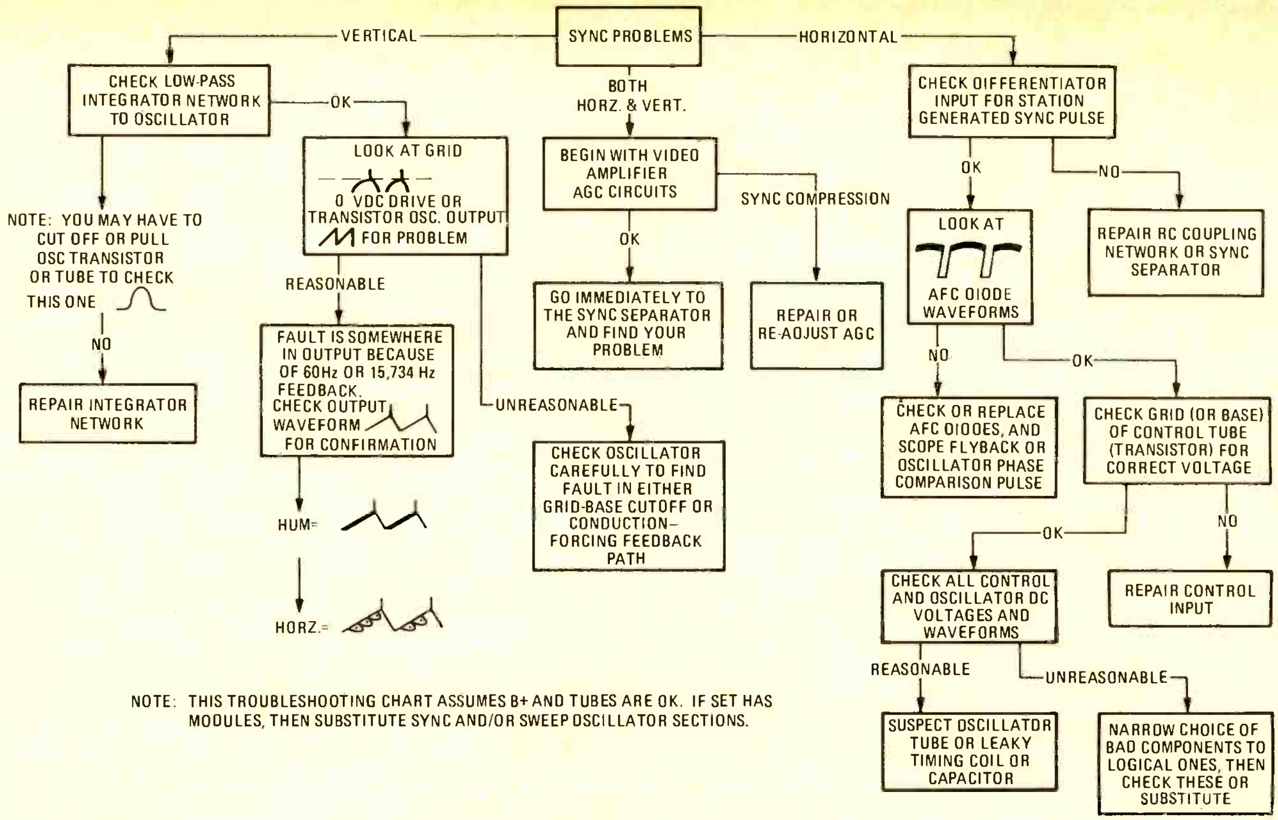


FIG. 2—AFC, HORIZONTAL oscillator and horizontal output stages.



TROUBLESHOOTING CHART—Sync Problems

still wouldn't permit anything like a locked picture by twiddling the oscillator's lower ferrite core. Removing the short, we decided to look at the oscillator plate and grid waveforms with our trusty oscilloscope. The signal at pin 7 (Fig. 3, lower trace.) wasn't

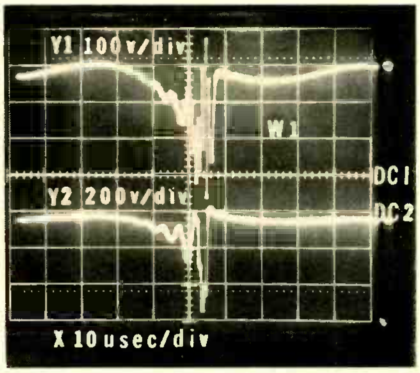


FIG. 3—HORIZONTAL OSCILLATOR grid waveform (lower trace) is good, but plate waveform (upper trace) shows excessive ringing.

bad, and VDR1 cut the transients, but considerable oscillations did show at pin 6 (Fig. 3, upper trace.) between conduction and cutoff. So we decided that L301 had to be the problem, and tried a new one. Unfortunately, same difficulty, same results. We couldn't short the stabilizer coil and tune the oscillator.

Final recourse

At this point, you really have only one basic step left. Try a *different brand* 8FQ7 oscillator tube. There is such a thing as *interelectrode capacitance*, and something else might just match the circuit. Fortunately an RCA 8FQ7 did the trick and the oscillator tuned just fine. There is also an upper core for L301, remember, and this must be tuned so that the second waveform peak is about half that of the first (taller) peak. If you have a *good* scope this can fool you. In Fig. 4, the upper trace is displayed at 5V/div., whereas the lower trace is displayed at 10V/div., with the time base

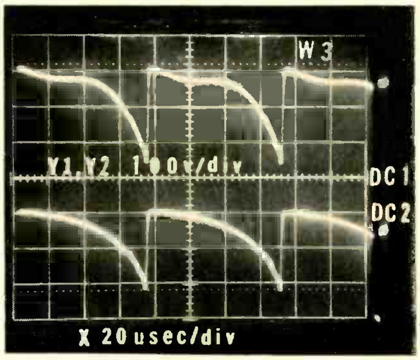


FIG. 4—STABILIZER COIL is adjusted by setting the ratio of the waveform peaks. Be careful, however, as oscilloscope setting can affect the ratio. Upper trace is displayed at 5 V/div and lower trace is displayed at 10 V/div.

set at 50μs. Obviously, the peak amplitudes differ from waveform to waveform. So, adjust the lower peak for a null with the top core of L301, and this will give you maximum *dip* between peaks and the proper ratio setting. Sears now says turn the horizontal hold control fully clockwise and readjust the bottom core of L301 for 10 to 20 bars sloping to the left, then set the hold control for pull in. This is your option, and you can check it out with receiver operation. But if your receiver locks in reasonably well on warm-up and regular reception, leave it alone.

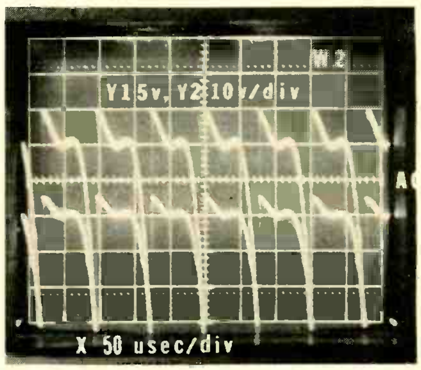


FIG. 5—GOOD WAVEFORMS of transformer pin 2 (upper trace) and the grid of the horizontal output tube (lower trace).

Final waveforms at transformer pin 2, and the grid of horizontal output tube V113 are shown in Fig. 5 upper and lower traces, respectively. The 564.80020 also stood in need of an IF sweep alignment touchup—which is possible on this and most vacuum tube receivers—with just a little negative bias to the Z terminal on the video and sound board and −10 volts to the AGC terminal of the VHF tuner. Connect sweep generator to the mixer test point and twiddle with care. Response can be slightly double humped with chroma at 50% and video at 40% ±5%. **R-E**

R-E's Service Clinic

Output Transistor Failure

How to avoid repeated failures

JACK DARR
SERVICE EDITOR

DO YOU GET TIRED OF REPLACING THE output transistors in small and medium-powered amplifiers over and over again? Especially when they blow in less than two weeks and you're stuck with a warranty replacement? This can be distressing to say the least, especially if you like to make a profit. There are ways of getting around this pitfall.

Most of these amplifiers are import types with the output transistors shockingly underrated and the power output overrated. They're being driven to almost their peak voltage or current with the inevitable result. The "repeater" problem is more apt to come up if you use exact-duplicate replacement transistors. Some of these carry very well-known brand names, too.

There are two ways of avoiding this problem. One is to select a replacement transistor with a much higher voltage and current rating. You'll find full specifications on these in the listings in the replacement guides. I like to derate very heavily (spelled *safety factor*). Read the maximum DC voltage from the power supply and then double it. If you see 35 volts DC, use a replacement with at least a 70-volt collector break-down rating, or more. You can get an idea of the maximum current from the values given in the Sams schematics. More on this in a minute. Be sure that your replacement can handle at least twice the value shown.

The safest way to check one of these is by using a variable-voltage transformer. After installing the replacement, open the collector supply lead and hook in a DC milliammeter. Now plug the amplifier into the variable-voltage transformer and slowly increase the AC line voltage while monitoring the collector current. Now check for excess resting current (no-signal condition.) If this is too high, your full-load current will be completely out of the ball park.

For the typical small amplifier shown in Fig. 1, note that the resting current is 36 mA and the maximum current 500 mA. This is a stereo amplifier, so the 500-mA current is for both channels, 250 mA each channel. This kind of reaction is typical of the *O*utput *T*ransformer*L*ess (OTL) class-B circuits almost universally used.

If the resting current is too high, check the bias on the output transistors. If this is way off, turn the amplifier off and make a careful check for such things as open or shorted bias diodes, burnt bias resistors, and so on. In many of these you'll find thermistors in the base circuits that are usually shunted by resistors. You can check these with an ohmmeter. Not too long ago, we had an epidemic of bad solder joints in this circuit! In this one (and in the ones I had so much trouble with), note that the thermistor reads 45 ohms cold, shunted by a 47-ohm resistor. The combination reads about 22 ohms. If you get 45 ohms, either the resistor or the thermistor is open! Bias diodes can also be checked with the ohmmeter. Oddly enough, in one amplifier, the only thing I could find besides the blown output transistors was an *open* bias diode. Evidently this was the cause, for it worked after I replaced the transistors and the diode. I haven't figured this out yet but I saw it.

turn page

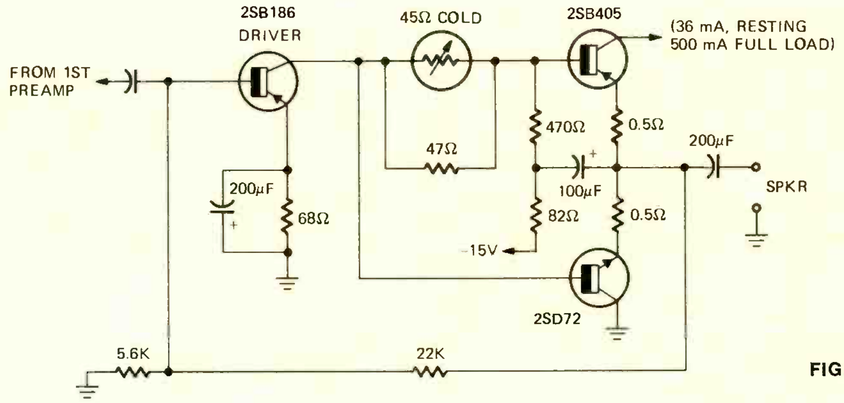
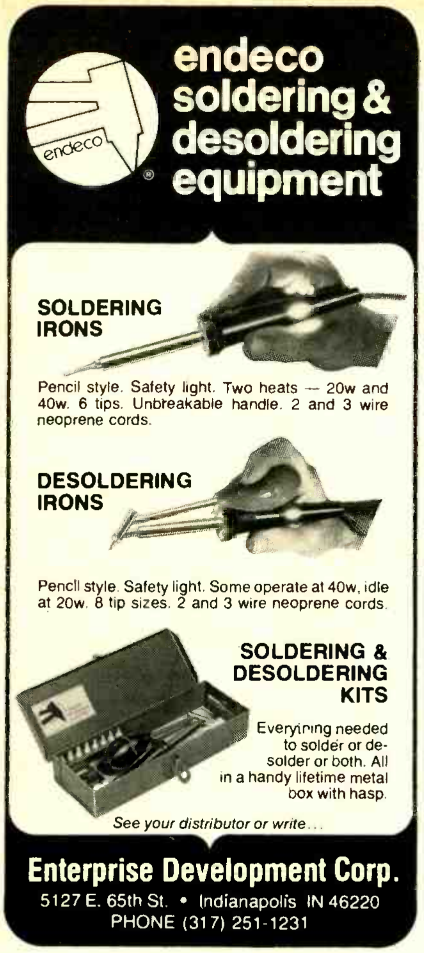


FIG. 1



Circle 17 on reader service card

After checking the bias circuitry, bring the line voltage up to normal and recheck the resting current. If this is in the ball-park, fine. Now feed in a low-level audio test signal and slowly increase the volume while keeping an eye on the collector current. **CAUTION:** Do **NOT**—repeat **NOT**—feed in a high-frequency sinewave audio signal at a high level. You can pop a pair of perfectly good transistors by doing this. It keeps the transistors turned on too long and they dissipate too much power! Use a music signal from a test record or tape, etc. Check the peak current at full volume. If this goes above the maximum rating shown on the schematic, back off *quick*! In some circuits you'll see *peak* swings of a far greater current than the maximum rating. I've seen swings of 600-700 mA in circuits that were supposed to draw 500 mA!

If the unit has a history of blowing output transistors or if you're locked into using exact duplicates (unit still in warranty, etc.), there is a way of getting around this. It's a bit of a Q&D (Quick and Dirty) way, but it does work. Open the collector supply circuit to the output stages *only*, and insert a small current-limiting resistor. The value of this isn't too critical; somewhere around 220-230 ohms 1-watt. Now go back and recheck at full volume and you'll be surprised to see how this holds those high peaks down. Also, this seems to have very little effect on the maximum *loudness*. I first used this on a set that was working on its *fourth* set of output transistors in less than two months. It hasn't been back since. I have used the same trick on several others with good results. I have also heard from readers saying that they had used it.

Heat-sinking is very important. Be sure to put the replacement transistors back snugly into the heat-sinks. A lot of these use the TO-1 transistors such as 2SD405. They use an "ox-bow" shaped heat-sink tightly clamped to the chassis. I made some deliberate "test to destruction" checks with one of these. The originals would last only for a minute or two at full volume when they weren't clamped to the heat sinks. A pair of slightly higher-rated transistors lasted a little longer, but still burned up. Using these higher-rated types in the heat sinks, they held up nicely. Watch out for replacement transistors in this case with the collector electrically tied to the case! If you have these, you'll have to insulate the heat-sinks with thin sheets of mica, liberally daubed with silicon grease.

If the original heat-sinking doesn't look too good, you can add more.

Clamping to the metal chassis is the best. If the transistors aren't getting too hot, you can use the push-on heat-sinks; RCA, G-E, Motorola and many others have quite a few different types, look in the back pages of the replacement guides. If necessary, you can mount the new transistors on the metal chassis and run some longer leads to them.

Be sure to check *everything* in the output circuit. Many of these amplifiers do not use the emitter resistors found in the better designs, for over-current protection (as in Fig. 1.) Check all resistors that could have been damaged when the output transistors blew. Even though they are not discolored, lift one end and read the resistance on an accurate ohmmeter. **R-E**

reader questions

INTERMITTENT WEAKNESS

This Rambler 5BA auto radio almost drove me nuts. It had intermittent low sensitivity. Hammer on it or touch the PC board on the foil side and it came back! I checked a whole lot of things. Finally found that I could touch the board near C18, the emitter bypass on the RF stage. Taking this out, it checked perfectly on a bridge and with no leakage. Apparently, the thing had an intermittent high-impedance condition for RF only!

One more; if you take the PC board out for servicing, as you must, look out for an open *ground* where it circles around the bottom side. This is completed by the metal frame when it's in place. To make it work, you must complete this ground circuit with a jumper, and another from here to the frame!

(Thanks to Richard Niessen of East Dubuque, IL for this tale!)

FIX FOR SYNC PROBLEMS

Thanks for the helpful letters on my problems with a CTC-10 RCA that I am reworking. A friend told me about a fix he remembered for the sync problems. There's a 2.0 μF electrolytic capacitor on the screen grid of the 6AW8 video-output amplifier. This was open. Replacing it brought back the sync, steady as a rock. Don't know why but it works, and thanks!—R.W., Bachmann, Andover, MA.

Yes. Now *I* remember that one! (*Now* you remember it!) Used to be fairly common. Evidently, the open bypass on the screen causes a feedback that cancels out the sync. Glad you got it going!

MINDPOWER: ALPHA

continued from page 52

FRONT PANEL of the assembled Mindpower: Alpha unit.

output of NAND gate IC4-d must be at logic 0. Beam off (black) is obtained with a logic 1. Looking backwards to the vertical comparators, NOR gate IC2-c, and NOR gate IC2-d respectively gate the outputs of the two comparators that define the beginning and end of a bar segment. Thus, if either comparator output is at logic 1, the NOR gates will be at logic 0. If both comparators are at logic 0, the output of the NOR gates will be logic 1. In the horizontal section, NOR gates IC2-a and IC2-b perform the same function.

The output of NOR gate IC2-a is inverted by IC3-b and applied to NOR gate IC3-a. Meanwhile, the output of NOR gate IC2-b is applied to NAND gate, IC4-a, along with the output of NOR gate IC2-d. The output of IC4-a is inverted by IC3-c, supplying the second input to IC3-a. The outputs of IC3-a and IC2-c are then gated by IC4-b. At this point, if *either* input is a logic 0, the output of IC4-b will be a logic 1. If both inputs are at logic 1, the output will be logic 0. This is inverted by IC4-c and supplies the video input to NAND gate IC4-d, which gates it with the output of Q5 in the display motion generator section. In effect, any of the comparator outputs representing bar segments that occur when there are no coincident outputs from the comparators controlling bar segments in the other display axis, will result in a logic 1 output from IC4-d—corresponding to blanking of the electron beam. Where the display logic does detect the required coincidence, the output of IC4-d goes to logic 0, providing a beam-on video signal to write a white-bar segment. The result is a white, open-center rectangle, appearing on a dark field.

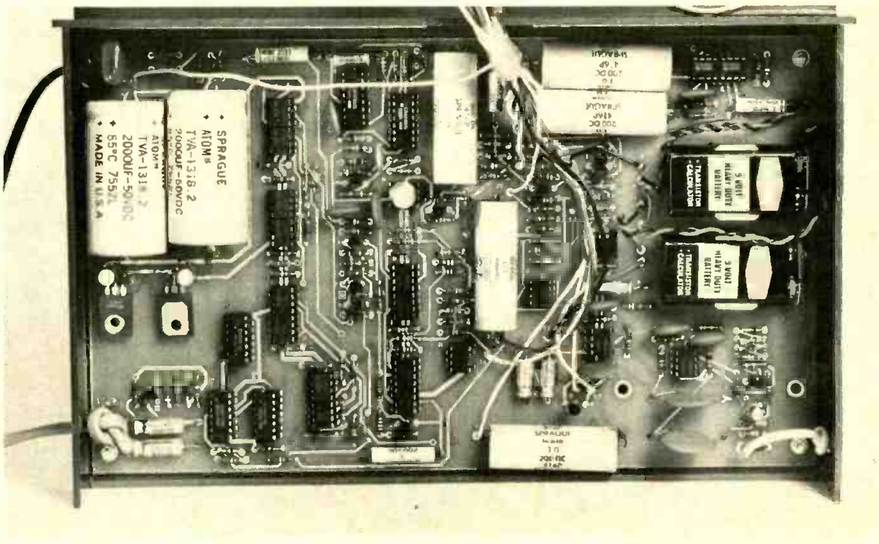
The video signal thus created is applied through diode D18 to video driver Q12, an emitter follower that supplies the signal to the TV set. Horizontal and vertical sync pulses from Q1 and Q2 are supplied to the base of Q12 through diode D17. A representative illustration of the composite video signal appearing at Q12's output is shown in Fig. 3.

Isolated EEG amplifier

The very low amplitude of brainwave signals at the skin surface of the head necessitates use of a differential input amplifier that possesses a high common-mode rejection-ratio (CMRR) and an input impedance that is very high with respect to the equivalent impedance measurable between the electrodes.

The optimum choice for an EEG amplifier subjected to these wide extremes is a matched—FET input amplifier (Q14 in Fig. 1). The 2N5524 FET features very high input impedance, by virtue of the "floating gate" configuration used. Resistors R1 and R2 provide current-limiting in the input circuit to limit the effect of static potentials applied to the electrodes. Gate-source protection is provided by diode junctions within the 2N5524 structure, which prevent the gate potentials from rising to a level that might damage the FET structure. The excellent CMRR of the dual FET input stage is maintained by use of a constant-current source, consisting of bipolar stage Q15. Fixed bias for this stage is obtained by diodes D1, D2, D3. Noise potentials common to both electrodes are applied to the base of Q15 from the common isolated ground electrode. These potentials are inverted by Q15 and thus, cancel the common mode noise potentials appearing at the gates of the dual FET. The gain of the Q14 stage is about 4.

The outputs of Q14 are coupled to the non-inverting and inverting inputs of IC25, a differential amplifier. The values of C1 and C2 limit the low frequency re-



MINDPOWER: ALPHA with front panel removed reveals the printed-circuit board and the components. Speaker is mounted against front panel.

sponse of IC25 to about 8 Hz. Feedback provided by C4, R10, C3 and R9 sets the upper frequency response limit of IC25 to about 13 Hz. Within the bandpass of the amplifier, a gain of approximately 300 is provided. The single-ended output of IC25 thus represents the amplified alpha wave content of brain wave potentials picked up by the active headband electrodes. The alpha signal is further amplified by IC26.

The alpha wave output of IC26 is coupled by C10 and R14 to the THRESHOLD control R92. Here, the amplified alpha signals are picked-off and applied to Q13, which converts the alpha impulses into keying signals for the light-emitting diode (LED) half of optical isolator IC27.

The optical isolator consists of an LED and a photo-transistor, separated by an air gap of about 10 mm. Each time Q13 conducts in response to alpha, the LED is turned-on, illuminating the photo-transistor and causing it to switch from the off-state to the on-state. Thus, the alpha waves are converted to square waves of equal amplitude, whose width depends upon the duration of the alpha input. Importantly, the alpha signal conversion is accompanied by the fact that the signal transmission occurs over an *optically coupled path*. This path offers no electrically conductive pathway between the isolated circuitry driving the LED and the transformer-powered circuitry that receives its signal input from the excited phototransistor.

The isolated EEG amplifier is powered by a dual 9-volt battery supply, B1, B2. Power input is controlled by switch S3-a, S3-b, and decoupling is provided by capacitors C7 and C8.

Audio control section

The optically coupled alpha signal (now uniform squarewave pulses) from IC27 is applied to pulse shaper/differentiator Q8, Q7, that provides a switched keying signal to IC20—a type 555 connected as an audio oscillator. IC20 provides an audio output to the loudspeaker through C12 and R18. The speaker can be silenced by opening switch S4. Assuming, however, that S4 is closed, an alpha-burst keys on Q7 so that IC20 receives power for the duration of the burst, thus issuing a "beep" for that period.

The output of transistor Q7 is applied through Q6 to the display motion generator, Q5, IC18, IC19. Transistor Q6 is connected in a noise-immunizing configuration, so that a definite switching input is required from Q7 before a signal is passed. In this way, noise is prevented from securing control of the video display's size.

Transistor Q5 is connected as a switch, capable of pulling-down the input voltage to IC18 each time an alpha burst occurs. IC18 has two modes (Mode 1 and Mode 2), determined by the position of switch S1. In Mode 1 (S1-a open, S1-b open, S1-c closed), IC18 receives a bias voltage through R28, R29, and R30. (The value of R30 determines the rate of response of the stage to an alpha burst. For a quicker response, values down to 330K can be used.) This causes a fixed voltage to appear at output pin 6, thus providing a fixed reference to the vertical and horizontal

continued on page 72

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MINDPOWER: ALPHA

(continued from page 67)

comparators through IC14, IC15 and IC17. As a result, the video display on the TV set screen is a stationery rectangle in this mode. However, when an alpha burst is applied to Q5, it switches on, instantly pulling-down the bias to IC18 through diode D5. This reduces the output of IC18 and shrinks the size of the rectangle on the screen. To speed up the process, IC19 is regeneratively connected from the output of IC18 to the base of Q5. The added gain of IC19 significantly reduces the on-screen size of the rectangle, overcoming the integrating effect of C16. When the alpha burst ceases, Q5 switches off and IC18 receives normal DC bias. As C16 recharges, the rectangle on the TV screen grows back to its normal, quiescent, size.

Assuming now that switch S1 is in the Mode 2 position (S1-a closed, S1-b closed, S1-c open), IC18 now functions as an active integrator. The input bias to the stage now is applied to C15 through the resistive ladder of R28, R29, and R33. An exponential voltage is applied to the IC18 input, resulting in a ramp output of 0–5 volts. This slowly increases the size of the rectangle display on the TV screen from a small size at screen center to a larger rectangle that disappears at the screen edges, bringing on the next cycle. An alpha burst switches on Q5, partially discharging C15. The output of IC18 falls, thus causing the rectangle to shrink. If the alpha burst has ceased, C15 recharges and the rectangle resumes its growth/reappearance/growth cycle.

Power supply

Other than the isolated EEG amplifier, all stages of Mindpower: Alpha are powered from the AC line through external plug-in transformer T1.

The input from the transformer is rectified by diodes D11 and D12, each of which is filtered by a 2,000 μF capacitor (C18, C17). In order to provide "stiff" supply voltages under load, the filtered outputs are applied to integrated voltage regulators IC23 and IC24. As a result, the +15 and −15-volt DC power supplies that serve the non-isolated circuitry of Mindpower: Alpha are maintained constant under varying load conditions.

Because the power supply is an integral part of the many circuits, it is essential that the supply impedance be as low as possible to minimize the possibility of circuit interaction through the supply impedance. For this reason, the regulator outputs are bypassed by 10 μF decoupling capacitors, soldered to the parts side of the board. Also, to prevent the horizontal or vertical sync stages from responding to noise (transients) coupled through the inter-winding capacitance of transformer T1, a 0.47 μF bypass capacitor is connected across the line input terminals (23 and 24) of the printed-circuit board. **R-E**

PARTS LIST

All resistors ¼-watt 10% unless noted

R1, R2, R14, R16, R20, R28, R32, R45, R46, R64—10,000 ohms
R3, R4, R41, R42, R47, R68, R72, R73—10,000 ohms, 5%
R5, R31—2700 ohms
R6—27,000 ohms
R7, R8, R48—30,000 ohms, 5%
R9, R10, R12, R13—3 megohms, 5%
R11—3900 ohms
R15, R53, R63, 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, R25, R26, R33, R81, R82, R83, R84, R86—22,000 ohms
R24—47,000 ohms
R27—3300 ohms
R29—10 megohms
R30—1.5 megohms
R35—750,000 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
R54, 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, 100 V, 10%
C3, C4, C5, C6—.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—.0082 µF, disc, 10%
C22—.033 µF, 100V, 10%
C24—.0015 µF, disc, 10%
C25—.0068 µF, disc, 10%
C28—150 pF, disc
C29, C30—10 µF, 25V, electrolytic
C31, C32—10 µF, 25V, electrolytic

Transistors*

Q1, Q2, Q3, Q4, Q5, Q7, Q8, Q9, Q10, Q11, Q12, Q13—2N4401
Q6—2N4403
Q14—2N5524
Q15—SE4021

Diodes*

D1 through D19—1N3064
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-HA39: $9.50

Case, punched and drilled. Order part number NM-C56: $14.75

Set of all semiconductors including 27 IC's and 35 transistors and diodes. Order part number NM—Semis 1: $99.50

Complete set of all parts needed to build Mindpower: Alpha: $265.00.

All prices include postage and insurance in the continental United States.

STATE-OF-SOLID-STATE

(continued from page 32)

For cosines, the complement of the angle Ø, 90°-Ø is used as the input. This memory could be used by a scientific calculator to find sine values. Other trigonometric functions can also be determined using manipulations inspired by those trigonomertic identities you struggled with in high school. The general scheme is labeled a Look-Up Table because the system works just like the printed tables in math reference books. Numbers are stored as their binary equivalents.

The best way to show how it works is to go through an example. Let's pick one you probably know the answer to already. How about the sine of 30 degrees? If you recall, the sine of 30° is exactly 0.5.

The S8771 takes the 90-degree input range and breaks it up into 512 discrete segments, one for each of the 10-bit words it retains. There are 511 increments between the 512 values, so each step corresponds to 90/511 = 0.1761 degrees. To find the address of the sine of 30 degrees take (30 × 511)/90 = 170.33 and round it out to the nearest integer 170. Now we must convert this to its binary equivalent for addressing. The largest power of two in 170 is 128 or 2^7. Now we have to account for the remaining 170-128 = 42. The largest power of two in 42 is 32, 2^5 leaving 42-32 = 10. Continuing in this fashion 2^3 = 8 leaving 2, and 2^1 = 2. The binary address for the sine of 30° (actually 170/511 × 90 or 30 × 0.1761 = 29.94°) is formed by putting ones in the 8th, 6th, 4th, and 2nd places: 0010101010. When these corresponding inputs are put on the A9 through A1 input points and R_M is activated, the ten-bit word stored at address $170_{(10)}$ is read out. The actual word in the S8771A at location 0010101010 is 0111111111. To find the sine in base 10 we convert this binary number to decimal by giving the weights 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512, 1/1024 to the corresponding bits. Where there is a one in the binary output word, the weight corresponding to that position is added to the decimal accumulation. Where the binary output contains a zero, nothing is added. Of course in a real application a hardware converter or a software conversion routine does the work. For our demonstration we will work it out the hard way. Adding the last nine weights, since the last nine binary bits are all ones, we get (256+128+64+32+16+8+4+2+1)/1024 = 511/1024 = 0.4990. The error is one part in 500 or 0.2%.

The S8771B arc-tangent look-up table works much the same way except the tangent is fed in and the angle is the otuput.

Direct access through such a table is about the fastest way to get to the answer. The S8771 has a minimum R_M cycle time t_c = 500 ns. It is made up of 200 ns address stable time, 250 ns propagation delay time, and an additional 50 ns. Additional conversion times must be added to this figure. In a complex calculation of which the look-up procedures may only be a small part, the output conversion would only be done once with the intermediate arithmetic done directly in base 2. Incidentally such now commonplace computer-inspired procedures as these is one of the reasons for the new math where other base number systems than decimal are studied.

There are other ways of getting trig functions with less memory. Calculators and computers often use series solutions of trigonometric functions. No tables at all are used in the series method. Only relatively few memory cells are tied up in compact routines to calculate the values. An iterative procedure cycles until the function is calculated to within a small enough error. Various floating-point routines are shared with other functions in the system and the overhead of the trigonometric function is low. Another method uses shorter words and stores the increments only from one step to the next. To get the table value for any input the increments up to that point must be successively summed. Both these alternate procedures are going to take longer to get the answer because of the numerous intermediate steps. The series of arithmetic and comparison steps eat up many machine cycles. If there is sufficient time they offer good alternatives to the straight ROM look-up table. Where speed is of the essence it's hard to beat the larger table.

Another ROM type, the S8773, is a similar but smaller 2560-bit circuit. The chip is divided into 256 10-bit words. It is also available preprogrammed as a sine/cosine look-up table. The outputs are weighed differently than in the S8771. The lines B9 through B0 are weighted from 0.512 or $2^9 \times 0.001$ to 0.001 or $2^0 \times 0.001$. The S8773 is also available as a $64 \times 5 \times 7$ bit ASCII character generator in its B version.

American Microsystems, Inc., 3800 Homestead Road, Santa Clara, Ca. 95051.

National LF op-amp series

An important non-obvious point is brought out in a paper by a National Semiconductor Author, James E. Solomon, "The Monolithic Op-Amp: A Tutorial Study." It points out that one of the best ways to get high slew rate, an often elusive quality, is to use a low transconductance input amplifier. I know I have tried selecting a fairly wideband op-amp for use in some switching or waveform generation circuit and have been sadly disappointed to find very slow response in the output. It just didn't swing at the rate I had expected. Wide bandwidth is simply not enough

Figure 3 is the equivalent circuit of an op-amp. The input differential amplifier stage has high output impedance because the output is the junction of transistor collector terminals. The output current of the input stage feeds the low-impedance input of the following simplified capacitor compensated output stage. The output stage works like an integrator. The amplifier feedback creates a virtual ground at the input to the output amplifier, a point I keep repeating and hope you have picked up. The input is essentially at

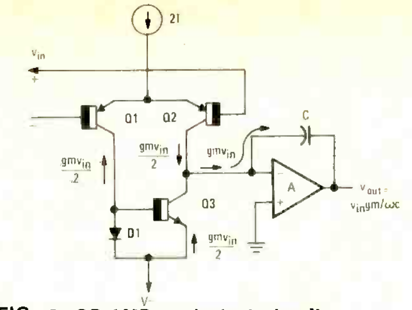


FIG. 3—OP-AMP equivalent circuit.

ground potential and does not shift as the signal current from the differential stage changes. The current can be considered directly entering the capacitor, forcing the output terminal to shift directly as the accumulated charge. This is a fair simplification of the actual situation. Although other distributed poles or RC frequency roll-off points may have an effect on amplifier stability, this equivalent circuit gives a valid representation for basic analysis.

The LF series is divided into three groups depending on current and bandwidth specifications. The fastest in the group is the LF157 with a slew rate of 75 V/μs at a voltage gain of 5. Its gain bandwidth product is 25 MHz at this same gain and reduces to 5 MHz at unity gain.

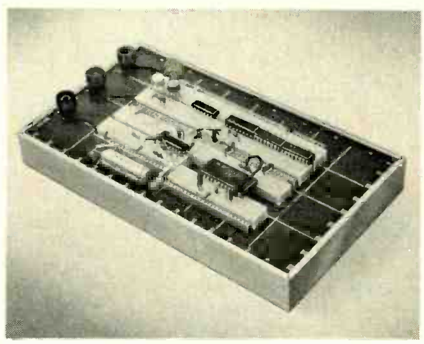
The op amps come in 8 pin-TO-79 cans and are rated for three temperature ranges for military and commercial use. The prices vary from $2.50 to $17.50 in 100 quantities depending on specs. **R-E**

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.

TWO-SIDED DIP BREADBOARD. The *model 51X Klip-Blok* breadboard, mounted on an aluminum chassis, allows components to be attached and interconnections to be made from both sides to increase wiring convenience and reduce clutter. Signal and power bus connections can be made on the bottom, if desired, leaving the top clear for wiring that must be altered. Interconnections can be made with 22-gauge wire. DIP's and most semiconductor units plug in. The board's design concept allows quick, solderless assembly of breadboard circuits. The eight *Klip-Bloks* accommodate a maximum of twelve 14- or 16-pin DIP's, or four 24- or 40-pin devices. *Klip-Bloks* may be quickly repositioned for 0.6 in. spacing of tabs. Additional *Klip-Bloks,* sockets or discrete components may be mounted on the perforated Vectorbord® surrounding the *Klip-Blok* area. The *51X* accommodates packages with 0.6 in. lead spacing as well as devices with conventional 0.3 in. spaced leads. *Klip-Strips* supply convenient signal or power busing.

The glass-epoxy mounting board is 4.5 in. by 8 in., and has a 0.1 in. spaced hole pattern. Printed registration numbers along the edges identify component positions. The *51X* board is unclad; however, a model *51X-GP* may be ordered with an etched ground plane on the bottom side for breadboarding high-frequency circuits. The *51X* is $25.50; the *51X-GP* is $29.95.—**Vector Electronic, Co., Inc.,** 12460 Gladstone Ave., Sylmar, CA 91342.



Circle 80 on reader service card

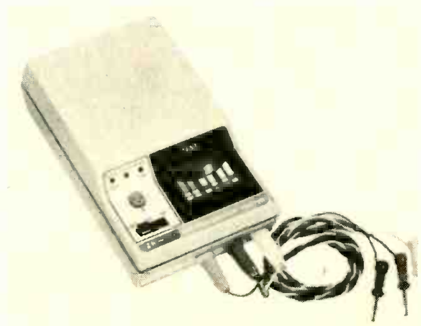
DIGITAL STOPWATCHES designed for industrial timing applications. The *ET200* and *ET202* are decimal minute watches which time to 99.999 minutes. They also have an automatic reset to zero function for timing requirements that exceed 100 minutes. Easy one-hand operation allows use in any of several timing modes: Simple Start/Stop, Time-In/Time-Out, or Split action time for partial readouts. The *ET200* is a standard split-action timer for freezing partial event times while continuing to measure total elapsed time. The *ET202* has Taylor split-action time which provides for a series of individual event times, or total elapsed time (but not both).

Both stopwatches feature a bright LED display with intensity control and specially designed bezel to enhance readability under all ambient light conditions. Rechargeable nickel-cadmium batteries provide 8 hours of continuous operation, fully recharging in 6 hours. These solid-state electronic watches require no calibration or preventive maintenance to assure quartz-crystal controlled accuracy of better than 0.001 minutes per hour (0.002%). These watches are guaranteed (parts and labor) for a period of one year from date of purchase.

The mechanical specifications of the watches are: weight (with batteries, 6 oz (170 gm); dimensions, 4.45 in. × 2.26 in. × 1.45 in. (11.3 cm × 6.2 cm × 3.7 cm); operating temperature, −12°F to +132°F (−25°C to + 55°C); storage temperature −40°F to +158°F (−40°C to +70°C). $79.95 including a leather carrying case, neck strap and AC charger.—**Siliconix Inc.,** P.O. Box 4088, Agnew Station, Santa Clara, CA 95054.

Circle 81 on reader service card

PORTABLE TRANSISTOR TESTER, *model 510,* provides fast go/no-go in-circuit transistor testing. Uses digital high-current, low



duty-cycle pulse-testing technique to test semiconductors even with resistive and capacitive shunt impedance. Gives positive good/bad indication, polarity and identification of all three leads, in-circuit or out-of-circuit. Tests transistors, FET's and SCR's. Identifies transistors as NPN or PNP. Indicates whether FET is N-channel or P-channel. Identifies FET gate lead, identifies all leads of transistors in LO drive, base lead in HI drive. Identifies all leads of SCR's. Weighs 1 lb., measures 3.75" × 6.63" × 1.75". $90.00.—**B & K Precision,** Division of Dynascan, 1801 W. Belle Plaine Ave., Chicago, IL 60613.

Circle 82 on reader service card

NEW CB RADIO, *Realistic TRC-56,* features a telephone-type mike and speaker handset which is said to virtually eiminate background noise.

A speaker/handset switch lets you listen through the handset, built-in speaker or both. When using the handset speaker, replacing the handset in the cradle automatically switches operation to the transceiver's built-in speaker. A push-to-talk switch is built into the handset.

The *TRC-56* comes with all crystals for full 23-channel operation and is rated at 4 watts maximum AM output. Includes automatic modulation gain circuit for constant "talk power" without overmodulating. The sensitive receiver features dual-conversion circuitry plus ceramic filters for top selectivity, and delta tune switch to help pull in

off-frequency stations. A built-in automatic noise limiter and noise blanker switch provide superior noise suppression from auto ignitions and other forms of electrical interference, according to Radio Shack.

An adjustable squelch control silences the receiver between calls. The *TRC-56* also has an S/RF power output meter which indicates the strength of incoming signals while receiving and monitors power output when transmitting. The meter includes a built-in modulation light.

Receiver sensitivity is given as 0.5μV for 10 dB S+N/N; selectivity, ±3 kHz at −6 dB; adjacent channel rejection, −50 dB; audio power output, 3 watts. Size: 5 x 8¾ x 7". For 12 VDC, positive or negative ground. $179.95 with mobile mounting bracket and power cable.—**Radio Shack,** 2617 W. 7th Street, Ft. Worth, TX 76107.

Circle 83 on reader service card

METERLESS TESTERS. Two new testers use LED's to indicate continuity, voltage and polarity. The LED indicators provide fast, easy readings without the confusing scales associated with meters. The testers were designed especially for the do-it-yourselfer for use around the home, car, boat, RV, snowmobile, motorcycle, trailer, etc.

The *Sea, Road & Home Tester,* priced at $22.95, uses five LED's. Four are used on the combination AC and DC voltage tests of 6, 12, 110 and 220 volts, nominal. The fifth LED is used as an indicator for the continuity test. The tester will also show polarity of DC voltages and the "hot" side of AC power lines.

The four voltage test levels were chosen as those most often encountered in normal do-it-yourself repair and installation projects. The 6 and 12 volt tests help in working on cars, RV's, boats, cycles, etc., with the capa-

(continued on page 82)

Circle 70 on reader service card

Circle 42 on reader service card

Learning with CIE is

Circle 12 on reader service card

Circle 76 on reader service card

Circle 74 on reader service card

NEW PRODUCTS

(continued from page 77)

bility of measuring not only DC battery voltages, but also the AC output of alternators. The 110 and 220 volt tests are of most use around the home.

The voltage test figures are nominal values—the LED's will light on voltages somewhat above and below these figures to allow for the RMS differences of AC and DC voltages as well as allowing for variations in devices and those due to temperature.

The *Everyman's Circuit Tester*, priced at $11.95 assembled and $8.95 as a kit, uses a single LED to indicate continuity, voltage presence (any potential from 4 volts to 600 volts, AC or DC), and polarity. A two position switch selects the tests.

Both testers use solid-state circuitry and the *Sea, Road & Home* model also incorporates integrated circuits. Both will test continuity of circuits with voltage present without "blowing"—a feature believed to be unique in continuity testers. The testers have survived rigorous drop-testing and continue to function (don't try that with those delicate meters). An ordinary 9V transistor radio battery (not supplied) give the testers "go-anywhere" portability. The probes will reach test points as far as 50" apart. The red (positive) probe is an integral part of the tester case to make readings even more convenient with the LED readouts being right in your hand at the test point. The cases are hand size, measuring just 8" × 1½" × 1", and weighing just a few ounces.

These new meterless testers are available in the U.S. by mail order from **E/B.A Marketing**, Box 727, St. Joseph, MI 49085.

Circle 84 on reader service card

SINE/SQUARE WAVE GENERATOR. A fast-rising squarewave for testing transient response and low distortion sinewave are among the features of the *LAG-26* generator. It has a sinewave output range of 20 Hz—200 kHz at 0–5 VRMS with ±1 dB flatness and with distortion at less than 0.5% below 20 kHz. Squarewave output is 20 Hz—20 kHz in the 0–10 VP-P voltage range with 0.5 μs risetime. The new product also synchronizes signals from an external source and has a calibration accuracy of ±3%. Output impedance is 600 ohms unbalanced and the frequency range is in four decade bands.

The *LAG-26* offers a 115/230 V; 50/60 Hz; 3 VA approx. power supply. It measures 6"H × 10"W × 5"D and weighs 5.5 lbs. $139.95.—

Leader Instruments Corp., 151 Dupont St., Plainview, NY 11803.

Circle 85 on reader service card

4-CHANNEL RECEIVER, *model SA-7300X.* This 4-channel/2-channel receiver has a built-in CD-4 demodulator. Includes a CD-4 hi-blend switch, automatic separation control, carrier mode switch, and level and volume controls. Also features a one-touch changeable BTL circuitry, 2 tape monitors, an FM/AM linear dial scale, FM muting and loudness switches, 2 headphone jacks, and a speaker switch for 4-channel and 2-chan-

nel. With 4 VU meters and 1 tuning meter. It also includes 2 kinds of matrix circuitry. $529.95.—**Technics by Panasonic,** 200 Park Avenue, New York, NY 10017.

Circle 86 on reader service card

STEREO HEADPHONE. The new *DT 440* will meet the requirements of the most demanding audiophiles who need an open high-velocity headphone, with a high degree of comfort, and an exceptional sound quality. This stereophone brings you full and clean bass response, crystal clarity of the highs, and accuracy in the midrange. With power output of up to 116 dB sound pressure, and extremely low distortion, they are ideally suited for both rock and classical music.

The headphone itself is very light, weighing only 9.6 oz. It is finished in brushed aluminum and mat black, and will match ideally with any high fidelity stereo system. $55.00.—**Beyer Dynamic,** 155 Michael Dr., Syosset, NY 11791.

Circle 87 on reader service card

Circle 23 on reader service card

Circle 68 on reader service card

LARGE HANDLE SCREWDRIVERS, *Bull driver*, a 35% larger handle delivering 50% more power to the job. Line includes 16 models in round and square blade styles.

Genuine Phillips types, stubby and pocket clip models.—**VACO Products Co.,** 510 North Dearborn St., Chicago, IL 60610.

Circle 88 on reader service card

IC TEST CLIP, *Proto-Clip 24*. Mini-troubleshooter offers a narrow throat—perfect for bringing IC leads up from high-density printed-circuit boards, practically eliminating accidental shorts while testing live circuits.

Can also be used to inject signals and wire un-used circuits into other boards. Scope probes and test leads lock onto the gripping contact teeth, freeing hands for other work. $8.50.—**Continental Specialties Corp.,** 44 Kendall St., P.O. Box 1942, New Haven, CT 06509.

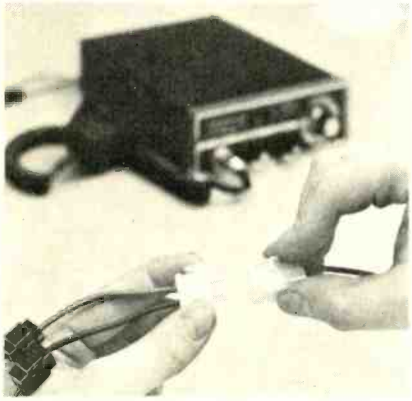
Circle 89 on reader service card

CRYSTAL-LESS SCANNER, *Opti/Scan* model *SBE-12SM*, a ten-channel AC/DC scanner receiver that digitally derives 16,000 different radio frequencies. With a pre-programmed card inserted in the unit, ten channels can be sequentially scanned for continuous automatic monitoring. Scan cards can be programmed by the user for any frequencies within the public service, land mobile, marine or business-industrial FM bands (30-50 MHz, 150-170 MHz, 450-470 MHz, and 490-510 MHz). Frequencies on any of the bands can be mixed on a single card.—**SBE,** Dept. P, Airport Blvd., Watsonville, CA 95076.

Circle 90 on reader service card

QUICK-DISCONNECT CONNECTOR aptly named *Q.D.C.* that connects and disconnects easily for fast installation and quick removal of Citizen band radios and other mobile electronic accessories. It is designed primarily to help the CB radio users remove their expensive CB transceiver quickly from cars, trucks, recreational vehicles, trailers or motorcycles when leaving to keep it from being stolen or to use for base operation. It can also be used on tape decks, speakers, lights, scanners, horns and other auto accessories.

Installing it is equally fast. Compressing the two clasps on either side of the male portion of the sturdy connector frees the CB radio or accessory from the power



source leads. It is also ideal and fast for new CB radio installations. The molded *Q.D.C.* is completely insulated and polarized. Positive lock is assured between male and female sections. Disengagement is by slight finger and thumb pressure on the flexible molded clasps on either side of the connector. To make power source and accessory leads interconnection with *Q.D.C.*, four small quick-splice connectors are used. They easily snap the leads together. Electrical contact is made through metal contacts molded in the splice connectors shearing into the wire leads.

The *Q.D.C.* consists of the polarized quick-disconnect connector with red and black colored connecting leads and four quick-splice connectors. All are packaged attractively on a Breaker Corp. identifying red, white and blue display card. $2.95. Available at Breaker electronic parts distributors.—**Breaker Corp.** 1101 Great Southwest Parkway, Arlington, TX 76011.

Circle 91 on reader service card

METAL DETECTOR KIT, *model UK 780,* is used with simple home-built pickup coil that can be made from a length of copper tubing. Output is applied to any available

earphone. Operated from built-in penlite batteries, draws only 3 mA. Operating frequency is around 300 kHz. $29.50.—**Amtroncraft Kits, Ltd.,** One West 13th St., New York, NY 10011. **R-E**

Circle 92 on reader service card

Circle 20 on reader service card

Circle 56 on reader service card

TV GAMES

(continued from page 59)

As a first step in your trouble shooting approach, we suggest you read through the circuit description that appeared in the first part of this article and become familiar with the various circuits. As you go through the description, refer to the schematic to clarify the logic theory and refer to the scope traces shown here for verification of the circuit functions.

The TV screen is also an important tool in isolating trouble areas. For example, if the screen shows no paddles, you would immediately look at the outputs of IC4 and IC6 to determine if the paddle signals exist. Similarly, if the ball is not seen, look at the collectors of Q3 and Q4 to determine if rising and falling voltages are present. The screen can even be used to retweek the horizontal and vertical sync frequencies controlled by IC1 and IC26.

The best troubleshooting approach uses the circuit description as a roadmap. Follow the write-up and use a scope to confirm that the signals are present and functional. In troubleshooting there is often a tendency to suspect components and overlook some of the more common faults that work their way into construction projects. The most common problems will be traceable to solder shorts, cold-solder joints, misconnections, mislocated components and backward components.

Some problems, especially intermittent ones, can be traced to inadequate decoupling. Because TTL circuitry is noise prone, it is important to provide adequate decoupling between +5 volts and ground. Builders, who provide their own layout, may need to experiment with different decoupling capacitors (other values and types) at different circuit locations. As a general rule, be sure that you have provided a 1000-μF main filter. Provide .01 to .05-μf disc capacitors on a 1 for every 2 IC's basis. Where ceramic discs appear to be ineffective, use dipped tantulums of higher values (0.1 to 2.2 μF). Try a 5 to 40-μF tantalun capacitor at various board locations.

As a systematic approach to trouble shooting, you may want to follow this sequence. Confirm that the individual horizontal and vertical sync signals exist at pins 10 and 3 of IC1 and 10 and 3 of IC26, and the combined signals at 10 and 3 of IC8 and 10 and 1 of IC5. Next, determine that the vertical and horizontal ramps appear at the collectors of Q1 and Q2. Then go to the horizontal and vertical ball signals on pins 1 and 2 of IC4 and pins 1 and 2 of IC6. Make sure that these signals are present and do vary with the movement of the four external paddle controllers. The next step would be to look for ball direction changes by checking for logic level changes on pin 5 of IC9 and pin 9 of IC10. Then check to see that the randomizing counter, IC20, is clocking. Beyond this, a combination of checking out the circuit description, the schematic, and following the logic signals through the circuitry with a scope should uncover any remaining problems. We do hope you've enjoyed this story and will expect to hear that you have had many hours of enjoyable game playing with both Super-Pong and Bumper. **R-E**

(continued from page 49)

the addition of the extra coils (L1 and L3) in the circuit of Fig. 13, harmonic distortion would rise more rapidly for a 20 kHz signal while remaining at a much lower level for lower frequency signals. With the addition of this final refinement, total harmonic distortion is maintained at very low levels for both md- and high-frequencies, as shown by the solid-line 20-kHz curve of Fig. 16.

FTC and Class-G

The Class-G circuit seems to be particularly attractive at this time in light of the pre-conditioning tests now required by the FTC in connection with determining the power output ratings of audio amplifiers. As many readers know, the FTC requires that amplifiers be able to sustain one third of their rated continuous power output for one hour. In Class-B circuits, this power level results in almost the greatest internal heat dissipation for the output devices and, in many cases, this has forced designers to increase heat-sink dimensions (and cost to consumers) without really providing audible benefit to users. On the other hand, Class-G operation can result in very nearly the most efficient operation at this one-third rated point (and at lower levels more often encountered in musical reproduction) with appropriate economies in weight, power-supply demands and, most important of all, retail prices that the consumer has to pay for high-quality audio amplification. **R-E**

*The author is indebted to Dr. Gentaro Miyazaki of Hitachi for allowing us to publish the first definitive description of Hitachi's innovative new amplifier circuit. Several claims of a pending U.S. (as well as foreign) patent have already been allowed by the Patent Office, and it should be noted that the actual inventor of the Class-G circuit is Mr. Tohru Sampei, of Hitachi. At one point in its development, classes of amplifiers seemed to be developing so rapidly that the company had thought to call the new circuit the "S"-system in honor of its inventor, but they settled for Class-G instead, after researching the matter thoroughly here and abroad.

"I'm afraid we'll have to take it in."

(continued from page 56)

tors are used throughout this section as well as on the separate voltage amplifier/tone/driver combination PC board. A single-polarity 70-volt supply energizes the PNP-NPN complementary output pairs which require a 5000 μF coupling capacitor for isolation between output and speaker connection points. A total of 58 transistors are called out on the schematic which is found tucked into an envelope stapled to the underside of the wood cover. (Why frighten consumers with a schematic before servicing is ever needed?). Parts layout above and below chassis is such that access to any part is readily available when and if servicing should ever be required and a total of seven major and minor PC boards are used in constructing the model 4000.

FM Performance

Bang and Olufsen have obviously not had time to translate their tuner specifications to the newly approved standards now being used by other manufacturers. Even based upon older standards, however, the specifications supplied to consumers omit many important tuner performance figures and tend to confuse the reader with others. For example, IHF sensitivity is quoted in microvolts for a 75-ohm input as better than 2.0 μV. The knowledgeable FM fan will at once realize that this is equivalent to a 4.0 microvolt figure if the 300-ohm input is used. This is one of the reasons why the new power (dBf) notations were adopted in the new standards. Regardless of impedance, this spec turns out to be 17.4 dBf.

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Bang & Olufsen** Model: **4000**

OVERALL PRODUCT ANALYSIS

Retail price	**$595.00**
Price category	**Medium/high**
Price/performance ratio	**Poor**
Styling and appearance	**Excellent**
Sound quality	**Good**
Mechanical performance	**Excellent**

Comments: The B & O Model 4000 stereo FM receiver presents a series of curious contradictions. From a human engineering and aesthetic point of view, it is a veritable masterpiece, in the Danish tradition of clean styling and functionalism. Yet, as you examine its performance specifications (aside from its high power rating) it looks not much better than a "compact" receiver that you can buy for much less (and which no spec-minded audiophile would consider seriously). The surprising thing about this "Beomaster" (as they call it) is that when you actually hook it up to a pair of decent speakers it doesn't sound as bad as those less-than-superb measured specs would have you believe. All of which raises the question (again) of how closely do measured specs correlate with what we hear under actual music listening conditions? This comment certainly applies to the amplifier portion, which delivered clean power—and plenty of it—to our relatively low-efficiency speaker systems (the B & O Model M-70 units, used for cable compatibility). Unfortunately, we cannot be as kind when it comes to the tuner. The sophisticated dual-light center-of-channel tuning indicator gave us different results for stereo and mono—neither of which correspond to lowest distortion tuning point. We even tried touch-up alignment but could never get the "equal brightness" point of the two lights to agree with the best tuning of mono and stereo stations for one dial setting. Each required retuning. Clearly, the 60-watt rating per channel at 4 ohms is given as a primary rating because B & O probably expect to sell this unit with their own speakers having that nominal impedance rating, but U.S. consumers have a right to know the 8-ohm power output capability, too, since so many speakers with which the unit will be used have that impedance.

TABLE III

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Bang & Olufsen** Model: **4000**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	48.0	No rating given
RMS power/channel, 8-ohms, 20 Hz (watts)	40.0	No rating given
RMS power/channel, 8-ohms, 20 kHz (watts)	42.0	No rating given
RMS power/channel, 4-ohms, 1 kHz (watts)	69.0	Very good
RMS power/channel, 4-ohms, 20 Hz (watts)	44.0	Fair (see text)
RMS power/channel, 4-ohms, 20 kHz (watts)	60.0	Fair
Frequency limits for rated output (Hz-kHz)	40-20	Poor
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.16	Good
Intermodulation distortion, rated output (%)	2.00	Poor
Harmonic distortion at 1 watt output, 1 kHz (%)	0.065	Very good
Intermodulation distortion at 1 watt output (%)	0.190	Good
DAMPING FACTOR, AT 8 OHMS	24	Good
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± ___ dB)	0.6	Very good
Maximum input before overload (mV)	50.0	Poor
Hum/noise referred to full output (dB) (at rated input sensitivity)	67.0	Excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± ___ dB)	10-57, 1.0	Excellent
Hum/noise referred to full output (dB)	90	Excellent
Residual hum/noise (min. volume) (dB)	95	Very good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 8	Very good
Action of secondary tone controls		---
Action of low frequency filter(s)	See Fig. 9	Very good
Action of high frequency filter(s)	See Fig. 9	Fair
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.87/	
Input sensitivity, auxiliary input(s) (mV)	N/A	
Input sensitivity, tape input(s) (mV)	230	
Output level, tape output(s) (mV)	200	
Output level, headphone jack(s) (V or mW)	0.37V @ 8 ohms	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Fair
Adequacy of input facilities		Good
Arrangement of controls (panel layout)		Excellent
Action of controls and switches		Very good
Design and construction		Superb
Ease of servicing		Very good
OVERALL AMPLIFIER PERFORMANCE RATING		Fair

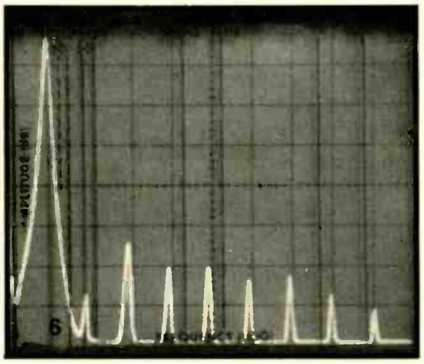
Our sample did better, measuring 3.5 μV (16.3 dBf) for sensitivity in mono and 4.0 μV (17.4 dBf) in stereo (see Table I), but these are hardly "state-of-the-art" sensitivity figures.

The two tuning lights on the front panel are supposed to glow equally when correct center channel tuning has been accomplished. Try as we might, we could never get agreement between these lights when we tuned for minimum distortion of received audio signals during our tests. We tried to align the IF system but if indicator correspondence was achieved for mono it was wrong for stereo and vice versa. Since we are equipped with a distortion analyzer we were able to tune for lowest distortion and to ignore the light indicators, but what would a poor consumer do in this case? Other measured results tabulated in Table I speak for themselves and ranged from poor to very good, taking the price of this receiver into account. For some inexplicable reason, some of the THD readings in stereo actually turned out to be better than in mono. Stereo separation figures were typical of those observed from circuits of this type which have so many critical alignment points, though they were certainly adequate for obtaining a good stereo effect from two-channel FM broadcasts.

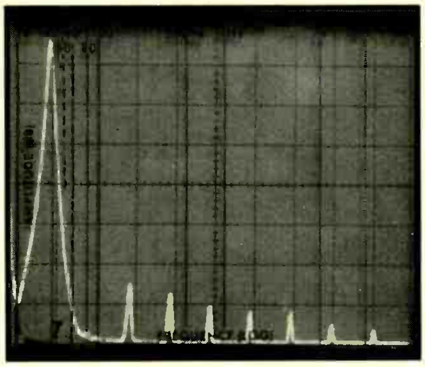
Amplifier measurements

B & O evidently did have time to alter their statement of audio output power so that it more or less conforms with FTC requirements in this country. Quoting power only a 4-ohm output impedance levels seems a bit deceptive, however, even if B & O's own speakers recommended for use with this receiver have that nominal impedance. If we had to rate the power capability of the 4000 operating into 8-ohm loads, based on the limited power band of 40 Hz to 20,000 Hz that they use for their 60 watt/channel 4-ohm specification, the receiver turns out to be a 40 watt/channel unit, as tabulated in Table III. Note, too, that even with 4-ohm loads the 20 Hz capability of the 4000 is only 44 watts for the rated THD of 0.4%. The 2.0% IM distortion that we measured should not be regarded by readers with all that much criticism, for remember that IM measurements are made using 60 Hz and 7000 Hz frequencies. Evidently, the low-frequency power output limitation of this receiver accounts for the inordinately high IM figure. Reducing equivalent output to just a couple of watts below the "rated" 60 watt output level brings the IM figure into line with published claims.

The excellent conformity of the phono preamp section to standard RIAA equalization and its superior signal-to-noise ration (measured unweighted and with reference to the 3.0 mV input sensitivity) is, unfortunately, offset by the rather low overload capability (50 mV) of the phono

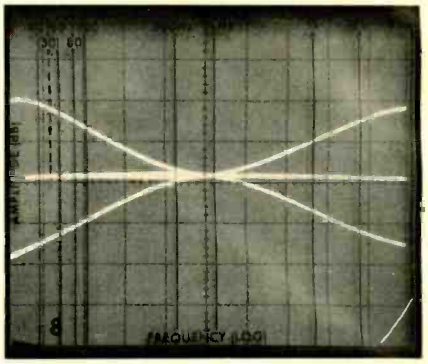


input section. Thus, dynamic range of the phono section is limited not so much at the "quiet" end, as at the "loud" end, since peak velocities recorded on modern records might well drive high-output cartridges into audible levels of distortion. We would have expected at least 6 dB more of overload capability in a receiver costing nearly $600.00.



Referring once more to amplifier performance, Fig. 6 is a spectrum analysis of harmonic distortion components when the amplifier is delivering rated THD for a 1000-Hz signal (this occurs at an output of 69 watts into 4-ohm loads). Sweep in this 'scope presentation and that of Fig. 7 is linear, so that harmonics are evenly spaced. In Fig. 7, output was reduced to nominal rated value (60 watts) and the spectrum analysis shows that second harmonic contribution has all but disappeared while third harmonic content is some 60-dB below the reference 1-kHz fundamental at the left of the display.

Maximum boost and cut range of the bass and treble controls is shown in the multiple sweep frequency scope photo of



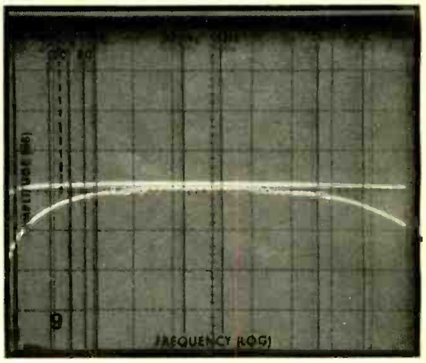
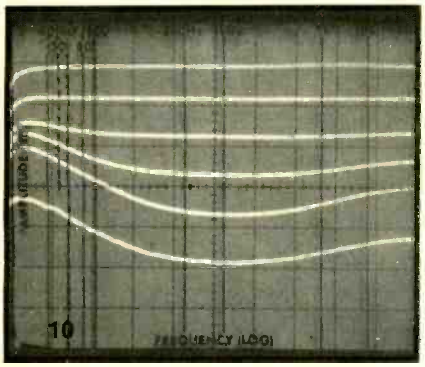


Fig. 8, while action of the high- and low-frequency filters is similarly presented in the scope photo of Fig. 9. Note that in the case of Figs. 8 and 9, sweep is logarithmic in order to present a more conventional display of "frequency response" graphs. Filter action is seen to be minimal, with starting points extending too far into the important mid-range musical portion of the audio spectrum and with slope rates at only 6 dB per octave. The filters, therefore, are not much more effective than the normal tone controls would be in reducing rumble or high-frequency noise.



Loudness control action at various levels is shown in Fig. 10.

Conclusion

Our overall product analysis will be found in Table II, together with comments concerning the use and listenability of the B & O 4000. For sheer beauty and styling, B & O deserves the recognition afforded to them, but we can only hope that future electronic components distributed by them in this country will cater more to the perfectionist who craves top performance as well as top styling in a high-fidelity receiver. **R-E**

Electronic tickets to replace subway tokens and hotel-room keys

Ticket-activated turnstiles are being tested at a New York City subway station under a contract between the New York Transit Authority and Kenilworth Research and Development Corp. A patent for a "static reader" of cards and tickets has just been issued to that company.

Magnetic tickets are already in use in some European subway systems, some of which charge different amounts for different distances and therefore cannot use the same "message" on all tickets.

Kenilworth is also developing a coded-card system for hotels or motels. When a guest checks in, he gets a coded card to use as a room key. When he checks out, the room clerk changes the room lock combination by remote control from his desk. The next guests gets a card to match the new combination, randomly selected from a possible several million.

next month

SEPTEMBER 1976

■ CB Antenna Roundup

Selecting the best possible mobile antenna is vital for obtaining reliable communications in a moving vehicle.

■ 555-Timer Applications

More about this versatile IC and the things you can do with it.

■ MATV Antennas

What you should look for and how to install them properly.

■ Digital Time-Delay System

A look at a prototype instrument used in hi-fi research. The system can create a concert hall of any size or shape in an ordinary listening room.

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CB TRANSCEIVER ROUNDUP

(continued from page 42)

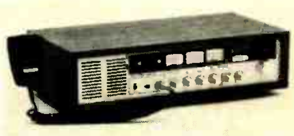
phone, chassis-mount CB antenna, AM/FM telescoping antenna and polarity inverter.

—**Trans-Comm Manufacturing Co.,** 8885 Bond St., Overland Park, KN 66214.

Unimetrics — Porpoise I
Base unit that covers all 23 CB channels plus one VHF/FM crystal-controlled channel for

monitoring NOAA weather. Has volume and squelch controls, delta fine-tuning circuit, 455-kHz filter for adjacent-channel rejection, S/RF meter. Rugged watertight construction and corrosion-resistant materials for possible marine use. 117 VAC only. 8" × 9" × 2½".—**Unimetrics, Inc.,** 123 Jericho Tpk., Syosset, NY 11791.

UTAC — Studio 4000
Base unit with dual power-supply for 117 VAC and 12 VDC operation. It can serve as a 5-watt PA system, has detach-



able mike and power cords, circuit-breaker protection, accessory 117 VAC outlet on rear panel and external speaker jack. Additional features are digital readout channel indicators, on-air/standby indicators, switchable ANL, separate AF, RF and IF gain controls, delta tune, dual-conversion receiver with headphone jack. Wood cabinet 18"W × 7½"H.—**I. A. Sales Co. of California, Inc.,** 766 Lakefield Rd., Suite H, Westlake Village, CA 91361.

Westport — CB9000
State-of-the-art transceiver with features that include a multi-purpose meter that displays incoming signal strength, transmitter power output and SWR when tuning transmitter to antenna, a three-position delta tuning switch and ANL switch to disable the noise limiter when listening to extremely weak signals. 6"W ×

8"D × 2"H.—**Westland International,** 1658 10th St., Santa Monica, CA 90404.

XTAL — XCB-7
Solid-state frequency-synthesized 23-channel transceiver for mobile installations. Has sensitive dual-conversion receiver, S/RF meter, transmit and receive indicator lamps, switchable ANL, delta tuning,

PA function and 5 watts audio output. There is an auxiliary volume control on the microphone for mobile operatiing convenience. 7.5" × 2.4" × 8.5".—**Far Eastern Research Laboratories, Inc.,** 8749 Shirley Ave., Northridge, CA 91324.

Zodiac — M-5026
Mobile, synthesized solid-state transceiver originally designed for use on boats but its rugged construction makes it applicable to all mobile and base installations. It is prepared for

optional plug-in selective call modules (one for receive and one for transmit) and a scanning module for automatically scanning two optional channels. A jack for an 8-ohm external speaker is on the rear panel. The connecting plug can be inserted in two positions. In one of these positions, the internal speaker is automatically disconnected. Power supply 11.4—14.5 VDC, positive or negative ground, and 6 VDC to 24 VDC or 117/220 VAC with appropriate DC voltage converter and AC line adapter.—**Zodiac Communications Corp.,** Chrysler Building, New York, NY 10017. **R-E**

(continued from page 37)

Caringella *LDC-1*, a 7-inch high hexagon with one single large digit displayed! Also unique in appearance is the Babylon *Space Age Clock* whose case is a black-anodized 3¼-inch length of aluminum extrusion with a "far-out" cross-section.

Assembly

Some of the assembly and instruction "manuals" were one sheet of paper with a schematic and a parts list. Others were elaborate (such as the unexcelled Heathkit manuals), with many drawings and specific step-by-step instructions. Only the Heath manuals went to the extent of describing the physical appearance of each part, so a gross beginner in electronics could identify the components; others seemed to assume the builder could identify resistors, capacitors, diodes, etc., and could put the kit together with minimum instruction. This is unfortunate, since many of the kits were really simple enough for a beginner to tackle if they only had more detailed instructions.

Clock kits that should take the average electronic hobbyist less than an hour for electronic assembly (not including case installation and checkout) are rated "Easy"; "Medium" is from 1 to 3 hours, with over 3 hours rated "Hard." Despite the excellent instructions, the Heathkits, with many wires between subassemblies, appear to be the toughest to assemble of this group. The easiest of the group to assemble is, without reservation, the *EC-2000*. It was also the only clock built by the author from a kit that required no trouble-shooting!

Building the kits

Before attempting to build any of these clock kits, be sure you have the right equipment. You'll need a 25 to 50-watt soldering iron with a *small* tip (⅛ inch diameter), fine longnose pliers, 20-gage stranded, insulated wire, wire cutter and stripper (a finger-nail clipper works great for small wire), and some small-diameter solder (if the kit doesn't include it). Digital Concepts include "solder wick" with their kits; it uses capillary action to soak up solder from unwanted points—very handy for some of the close work on these clocks. Patience is required, as well as careful soldering. Most of the problems encountered by the author in constructing these kits were traced to soldering—either bad joints, or "bridges" between circuit paths.

A circuit trick you might want to add to most clocks using the MM5314 clock chip is one used in the Formula International *MM5314 Clock*. It is a characteristic of the display output of this chip that the number "six" is without a top—segment A is not activated. To remedy this, add one 1N4001 or similar rectifier-diode from segment D or E to segment A (marked cathode end to A). This will add the top segment to *all* the sixes as they appear in the display, since they are multiplexed.

You may encounter some difficulty getting the clock to work properly after it's completed. The display, if it's lighted at all, will give you the best clues. Use a magnifying glass or jeweler's loupe to inspect all suspect (and non-suspect) solder joints—it's amazing how a connection that looks perfect to the naked eye is a mess under 7-power magnification! Also look for solder bridges or "jumpers" across printed circuit paths or display or IC pins. If a common segment is "missing" from all the digits, check back through the segment driver circuitry to the IC. If a single digit doesn't light, check the digit-driver circuit back to the IC. If a particular segment of a single digit is dark, check the connection of that digit pin to the circuit—it could be a dead segment in the digit itself, which means a new digit! If the clock doesn't count, operate the time-setting controls—some clocks won't start until then. Be sure the HOLD switch isn't shorted. Also, be sure the AC is getting to the IC (pin 16 in Fig. 1). If the display doesn't light at all, check the power supply section. A voltage check across the power supply filter (220 μF in Fig. 1) will quickly tell you if you have DC voltage.

For a better understanding of digital clocks and watches, including details on circuitry, an excellent book is "Electronic Clocks and Watches," by Michael S. Robbins (Howard W. Sams, Cat. No. 21162. $6.50).

Setting your clock

The time on these clocks is set with pushbutton, slide or toggle switches. Clocks using the MM5314 IC have the simplest time setting: the FAST switch moves the hours ahead once per second,

turn page

the SLOW switch moves the minutes ahead once per second, and the HOLD switch stops all counting. By simply setting the display time ahead of the real time, and then putting the count on HOLD until the real time catches up, you can set your clock to within a fraction of a second of whatever time standard you're using. Other IC's use various control arrangements to set time, some advancing tens of minutes, others changing twice-per-second instead of once, and some use two switches in combination to provide a third function. Calendar and alarm controls are the most confusing at first. Three of the 4-digit clocks that normally display hours and minutes can be switched to show minutes and seconds. Of all the clocks tested, only the Altaj *4-Digit Alarm Clock* had no means of synchronizing to the second.

Some sort of time standard is necessary to set these clocks accurately. The phone company offers the most available and least expensive method—look up the number for "time" in your local directory. A short-wave receiver that can tune in WWV or CHU time broadcasts gives more accurate time information. Caringella Electronics offers a specially-designed *Standard Time Receiver* kit (STR-1 $79.95, assembled $99.95) that receives these broadcasts on three crystal-controlled receiving frequencies.

Going mobile

You may want to use your digital clock in your car, trailer, camper or dune-buggy. Only the Heath *GC1093* and Nexus clocks are specially designed for car use, but at least three of the other kits included in this article could be adapted readily for car use. The Godbout *Son-of-a-Cheap-Clock* instructions specifically describe car operation using their optional *Crystal-Controlled Timebase* kit ($10.50) that provides 60 Hz from 12 volts DC. Actually, all the MM5314 kits, and all the others that don't require boosted display voltages, can operate from DC supplied by a 12-volt car battery if a timebase is added. S.D. Sales offers a timebase kit for $5.95 that uses a 3.58 MHz color-TV crystal and a National Semiconductor MM5369 IC to count down directly to 60 Hz. You might even consider using a timebase in your AC-powered clock. This eliminates power line "glitches" (transient peak voltages) that can literally "knock your clock off" in terms of accuracy. The author has found the MM5314 chip particularly vulnerable to this problem, sometimes advancing hours or minutes for no apparent reason when powered by certain wall-sockets or near other electrical appliances.

Simply power the timebase by connecting it across the clock's power supply filter capacitor, observing polarity, and feed the 60-Hz output of the time base to the 60-Hz input pin of the clock IC (disconnect the existing input). This could increase the accuracy as well, since the power-line frequency can be "uncorrected" as much as 2 seconds in a 24-hour period. Bear in mind, however, that crystal-controlled circuits are temperature-sensitive, and will probably need trimmer adjustment initially to put them "on the money." Claimed accuracy is typically 0.01%, or about 9 seconds per day.

concluded next month

Harry Nyquist, Bell scientist and inventor, dies at 87

Harry Nyquist, former Bell Labs scientist, possibly most widely known to readers of this magazine for the famous Nyquist diagram, died April 4 in Harlingen, Texas. He was 87 years old. Many of his inventions and theories are now widely accepted as fundamental to voice, picture and data transmission. He was awarded 138 patents during his 37 years with the Bell System.

His discovery of the conditions necessary to keep feedback circuits stable, called the Nyquist criterion, is used not only in the study of electronic devices such as amplifiers, but even in the study of human regulating processes.

Through theoretical analysis he determined the minimum band of frequencies required to transmit various kinds of communication signals.

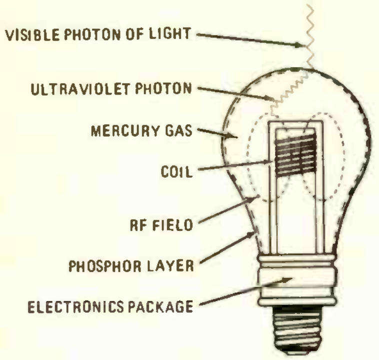
Nyquist was the first to supply a quantitative explanation of thermal noise. He also invented methods of TV transmission and of correcting delay distortion in TV.

Among the many honors he received are the Institute of Radio Engineers Medal of Honor and the Stuart Ballantine Medal of the Franklin Institute (both in 1960), the Mervin J. Kelly Award of the American Institute of Electrical Engineers, 1961, the National Academy Founders Medal, 1969, and the Rufus Oldenburger medal of the American Society of Mechanical Engineers in 1975.

New fluorescent long-life lamp may fit ordinary lamp socket

A fluorescent lamp now under a development contract between the Energy Research and Development Administration (ERDA) and its inventor, Donald D. Hollister of California, will screw into an ordinary electric light socket, use only one-third the energy of present incandescent lamps and may last ten years without burning out.

The principle is the same as that of today's fluorescent lamps. These are usually long tubes with a phosphor coating on the inside surface and containing mercury vapor. The phosphor emits visible light when struck by photons of ultraviolet light, produced by exciting the mercury atoms with an electric discharge. In the household type of light,



comparatively bulky starters and ballasts are needed to initiate and control the discharge—in the larger industrial "cold-cathode" lamps, high voltages are necessary.

The Hollister *Litek* lamp looks much like an ordinary "inside-frosted" bulb. The mercury vapor is excited by radio frequency rather than the 60-Hz house current. Transistor circuitry in the base of the bulb produces the RF current. Part of the circuit is a small coil in the center of the bulb. The RF field set up around this coil excites the mercury vapor atoms producing the ultraviolet rays.

Much of the developmental work will be aimed at bringing down the initial high cost of the lamps (which would now be about $10 each) to a point where they will sell competitively with ordinary lamps.

Second 24-channel satellite launched by RCA

Satcom II—second in a series of high-capacity domestic communications satellites—was launched March 26 from Cape Canaveral. Like Satcom I—launched December 12 (**Radio-Electronics,** April 1976, page 6)—it has 24 channels, twice the number of any previous satellite.

The new satellite, like its older companion, gets its greater capacity by frequency interleaving and polarization diversity—alternate transmission of signals on vertically and horizontally polarized antennas—to get 24 independent 34-MHz channels within the allotted band of 500 MHz.

One of the four reflector antennas of Satcom II has been aimed at a point near Anchorage, Alaska, to concentrate six channels on the country's largest state. Another six-channel reflector antenna is directed to center its beam over Kansas, to provide concentrated coverage of the 48 contiguous states and Puerto Rico. (Satcom I has 12 of its channels beamed on Hawaii.) Satcom II's other 12 channels are for general coverage of the U.S. mainland, Alaska and Hawaii.

FCC to simplify rules covering TV games

The Federal Communications Commission is reviewing the regulations that deal with video games, with the idea of simplifying them, states the chief of the FCC division that oversees approval of these games.

All TV games must be submitted to the FCC for testing and approval before they can be sold. The games are tested for radiation, energy emission and interference, among other characteristics.

TV games are not all alike. A few operate on video frequencies and must be connected into the video circuitry of the receiver or use an independent monitor to display the game board. These are classed by the FCC as low-power devices, under Part-15 of the Regulations, which covers devices that emit radio-frequency radiation.

Most home TV-games have a control panel connected to the antenna of the TV set and operate on an unused channel frequency—often Channel 6 or one of a number of UHF channels. These are considered as "Class-1 TV devices" by the FCC.

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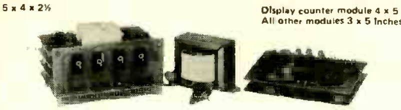

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400	.09	.25	.50	1.40	6.50
600	.11	.30	.70	1.80	8.50
800	.15	.35	.90	2.30	10.50
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7406	.35	7474	.32	74161	.99
7407	.33	7475	.50	74164	1.05
7408	.18	7476	.35	74165	1.05
7409	.18	7480	.42	74173	1.30
7410	.15	7483	.71	74174	1.00
7411	.25	7485	.95	74175	.90
7412	.30	7486	.33	74177	.79
7413	.45	7489	2.00	74180	.72
7414	.80	7490	.47	74181	2.10
7416	.27	7491	.69	74190	1.15
7417	.33	7492	.47	74191	1.10
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7427	.28	7495	.70	74194	.95
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100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
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* Components for Kit No. 2 or Kit No. 3 sleep radio feature, add $.95

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DL727
One of our best readouts .5 in. high, 20mA per segment. Common anode. $3.75

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FND 807 ANODE
FND 800 CATHODE
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.25 in high orange digit. 160v dc. Free socket. $2.50

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Jumbo red	.15
Jumbo green	.20
Jumbo yellow	.25

TI
Fully multiplexed common cathode. Goldplated. Idea for mini 6 digit clock. $1.30

DL33
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PC Board for 4 digit display FND503	$2.00
PC Board for 6 digit display FND503	$3.00
PC Board for 4 digit display DL747	$2.50
PC Board for 6 digit display DL747	$3.00
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All PC display boards are multiplexed for adding additional digits

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THE KING FEATURES:
1) 6 digit, 12 hr. 60 cycle or 24 hr. 50 cycle alarm clock.
2) Time sharing capability for display of additional information
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4) AM-PM and automatic power failure indications.
5) 10 minute snooze
6) Intensity control of LEDs.

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Kit No. 70250-1G (Green readouts)
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All kits include components, PC Boards, Transformer, case, and construction manual.

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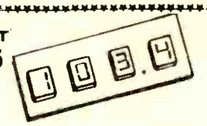
FATIMA 4-DIGIT TEMP. KIT **$19.95**



Features 4-digit temperature display; farenheit or centigrade; complete C-Mos application; uses 7002 4-digit counter.

Kit includes all components, PC Board and instructions for interfacing with THE KING 6-digit alarm clock. **Addition Number 1**

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4.) Ideal for Cars, Boats, & Campers.

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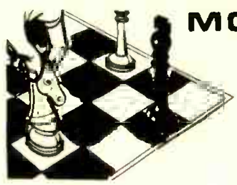

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RPM Counter	Kit 012 + Kit 030 + Kit 020 + Kit 018

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$19.95 KIT 012

One chip 4 digit decade counter kit, with both 7 segment and BCD output.

1. Chip features internal oscillator for scanning speed.
2. Overflow and count extent outputs.
3. Transfer, reset, count, blanking and true compliment control inputs.
4. PC Boards can be cascaded to 8-12-16, etc. digits.
5. Kit includes counter chip, drive circuit for 4 cathode type displays and PC Board. (For readout board see (FND70-FND503)

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Features FET input front end with trigger circuit for measuring complex waveforms. Measures from 0.1Hz to 10MHz when used with Kit 015 or 019. Measures from .01Hz to 35MHz when used with Kit 013 and 014. $24.50

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KIT 020 RPM COUNTER

Counts from 1 to 100,000 RPM. RPM counter kit contains components and PC board. $8.95

KIT 030 POWER SUPPLY

*Input voltage: 25V max. *Output current: 1 amp max. *Load regulation: 50mV. *Output voltage: 5V. *Line regulation: .01%. (requires 8-20V transformer) $4.55

(Contains all parts except transformer)

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1 Mhz crystal chain time base divider. Outputs: 1Mhz-100Khz-10Khz-1Khz-100Hz-10Hz-1Hz-0.1Hz. Accuracy better than .005% with proper adjustment.

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Kit 014 Same as Kit 013, but with TTL $13.75

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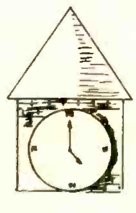
Kit 019 Same as Kit 015, but with TTL and 60Hz only $7.75

Kit 018 60Hz chain time base using line frequence for Kit 020 RPM counter.

*Outputs: .6 sec. = 100th of RPM
6 sec. = 10th of RPM
60 sec. = full revolution



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Circle 61 on reader service card

REPLACEMENT FOR PIX TUBE?

I need a replacement picture tube for a Sears TV. This is a 12DCP22. They quoted me a price of $200.00 on it! Do you know of another tube that will replace this?—A.C., Penns Grove, NJ.

From the replacement picture tube manual, it looks as if either an 11SP22 or 11WP22 might do. Also, a 13JP22, (which will be so close to the same size that it wouldn't make any difference!). The electrical parameters are all close.

VERTICAL PROBLEM

I see two pictures on this Sylvania DO5. One's rolling slowly down and behind it another one upside down! I can twiddle the controls and get one picture, but it's only about an inch high. I've changed the tube; no luck. Any ideas?—A.N., Lake Geneva, WI.

You've got what looks like a tremendous foldover. Check your vertical height and vertical linearity controls; one of them may be open. If they're not, then you have probably got a shorted capacitor in the feedback loop. One that has caused this kind of problem is C318, the .0056 μF from the red wire of the vertical output transformer to the junction of R326 and C320. If this one is OK, check all the rest, especially the .1 μF coupling capacitor C314.

COMPLETE ALARM CLOCK

- 4 Digits 0.5" LED with brightness control
- 12 Hour display with AM/PM indication
- True 24 hour alarm with repeatable snooze
- Power failure indication for power interrupt

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Features: 12/24 Hour Display, 24 Hour Alarm Set, 10 Min Snooze Switch, AM/PM Indicator

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

SPECIAL $35.90

MODEL OC1030

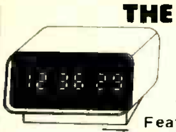
4 DIGIT ALARM CLOCK KIT 0.5" Green Color Readouts

Features: 12/24 Hour Displays, 24 Hour Alarm Set, 10 Min Snooze Switch, AM/PM Display.

Kit Includes: Orange Color Plastic Case, 0.5" LD8132 Green Color Readouts PC boards with transformer, all electronic parts with speaker.

Only $28.50

THE MOST POPULAR MM5314 KIT



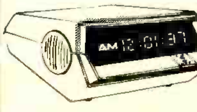
WITH A NEW CASE!!

Features: 12/24 Hour Display 50/60 HZ Input 6 Digits Readout

Kit Includes: Grey Color Plastic Case MM5314 Clock Chip PC Boards and Transformer, 6 Green Color 0.3" Tube Readouts, All other transistor Drivers and other Components.

Special Only $19.95 ea.

MODEL CT7001



Drive 6 Fairchild FND 0.5" Red LED with MONTH & DATE 50/60HZ and ALARM

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Standard Teletype Keyboards with gold plated contact switches. All switches are independent and allow you to connect into any form of output.

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Fully ASCII decoded with electronic parts TTL logic. Used but all in good condition.

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MUX and BCD output			$.4.50 each
MM 5313	28 pin	6 digit	
MUX output			$4.00 each
MM 5314	24 pin	6 digits	
MUX output			$3.50 each
CT 7001	28 pin		
Alarm Time & Date			$.6.50 each
MM 5316 (F3817)	40 pin		
Alarm, Direct Drive Led			$4.50 each

GOLD WIRE WRAP IC SOCKETS

14 pin	.36 each	10 for $3.00
16 pin	.50 each	10 for 4.00
24 pin	1.25 each	10 for 10.00
28 pin	1.25 each	10 for 10.00

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14 pin	.35 each	10 for 2.80
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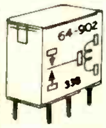
24 pin	1.00 each	10 for 8.00
28 pin	1.10 each	10 for 9.00
40 pin	1.25	10 for 10.00
Standard Xtal Socket		.35 each



12 VDC Relay SPDT 4 amp **$1.25 ea.**

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12V 150MA AC output

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The Crimefighter Auto Alarm is an electronic, self - controlled auto protection system, normally mounted within the glove box of an automobile. Two minutes after turning off the ignition, the alarm automatically turns itself "on." When the auto is re-entered, the horn will sound after a 10-45 second entry delay. The automobile owner, by inserting the ignition key, will activate the alarm. Once activated, the alarm will sound for two minutes before automatically turning off. The alarm then resets and is ready to again protect the vehicle from unwanted entry.

FEATURES: Simple installation: 5 wires, Automatically turns on when auto is parked, Adjustable entry time, Extended exit time to allow for unrushed exit from vehicle. Numerous applications include protection of boats, campers, trailers, motorcycles, trucks. Cannot be deactivated by "hot wiring" an auto. Cannot be turned off without ignition key. Negative ground only.

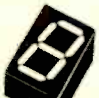
ONLY $10.00 per kit Completed Unit $16.00

LED READOUTS

Fairchild FSC 8000 0.8" Red LED 3½ Digits with AM/PM.

Direct Drive by MM 5316 or Fairchild 3817

$10.50 ea.



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Fairchilc FND 800 0.8" Common Cathode Red Color

ONLY $3.50 ea.

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DL 727	Double Digit	$2.50
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Size 2¾" x 2¼" **Only $3.80 ea.**

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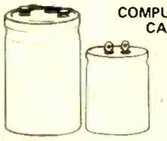
LOOK

2107A 4K RAM in 22 pin DIP

4096 BIT Dynamic Memory, Intel Prime Units

$16.50 each or 4 for $60.00

TTL AND CMOS PRICE LIST WILL BE MAILED OUT ON REQUEST.



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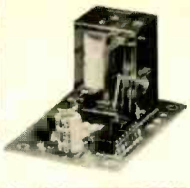
15500 MFD 75 V-DC $4.95 ea.

5600 MFD 60V-DC $1.25 ea.

ELECTRONIC SWITCH KIT



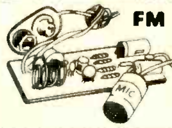
CONDENSER TYPE

Touch on Touch Off

use 7473 I.C. and 6V relay

$5.50 each

FM WIRELESS MIC KIT

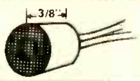


Transmit range up to 500ft.

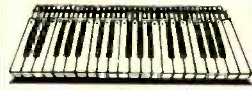
Easy to assemble

$4.50 each

Sub-Mini Size Condenser Microphone **$2.50 each**



ELECTRONIC ORGAN KEYBOARD



3 Octaves Full Size

Limited Quantity

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Part No 1004-692 4XSPST SW

1008-692 8XSPST SW

4 Toggle SPST Switches on a Mini DIP (8 pins) Only $1.50 ea

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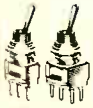

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DPDT On-None-On $1.50 ea.

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8 positions	$1.25 ea.
10 positions	$2.15 ea.
12 positions	$2.50 ea.

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3.58 MHZ Color TV Crystals $1.25 ea.

Use with Nation MM 5369 to make a perfect time base for clock.

NEW !

NATIONAL MM 5369 17-STAGE PROGRAMMABLE OSC/DIVIDER generate A 60 Hz reference Frequency with a 3-58 MHZ Color TV X'TAL in Mini DIP Package

ONLY $2.25 each

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MM 5375 Series by National 24 pin package Multiplex output with brightness control

ONLY $3.50 ea. Data .25 ea.

PROGRAMMABLE OPTIONS		PART #				
FEATURE	OPTION	AA	AB	AC	AD	AE
Input Frequency	60 HZ	X	X		X	X
	50 HZ			X		
Time Display	12 Hour	X	X		X	
	24 Hour			X		X
Duplicate Register	Alarm Counter	X	X			
	Date Counter			X		
	Minute Timer				X	
	Second Timer					X
Alarm Signal	Tone	X	X			X
	DC Level			X	X	
Alarm Output	Modulated @ 2.0Hz	X	X		X	X
	Not Modulated			X		
Alarm at Power Failure	ON	X	X			
	OFF			X	X	X
Segment Output Polarity	Vss for Display		X		X	
	Vdd for Display	X		X		X
AM or PM Indication	Off during time display	X	X			
	Displayed at all times			X	X	X

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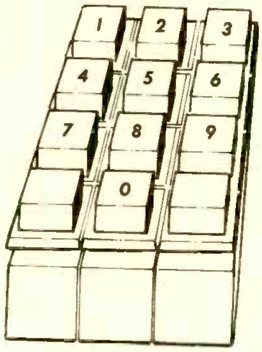
By Controls Research. High quality long life switches with keytops. For encoders, combination locks, etc.



12 switches and tops, including 0 thru 9. Switch contacts are independent, allows hook-up to any matrix. Keytops easily removed.

$2.95 Set
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Thousands of hobbyists have bought and built our original clock kit and were completely satisfied. But we have received many requests for an alarm clock kit with the same value and quality that you have come to expect from S.D. So, here it is!

THE KIT INCLUDES:

- 1 Mostek 50252 Alarm Clock Chip
- 6 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
- 1 .01 Disc Cap
- 15 Resistors
- 1 Speaker for alarm
- 1 LED lamp for PM indicator.

$9.95

PCB - 3.00
XFMR - 1.50

60 Hz. Crystal Time Base

FOR DIGITAL CLOCKS $5.95

S. D. SALES EXCLUSIVE!

KIT FEATURES:

A. 60 Hz output with accuracy comparable to a digital watch.
B. Directly interfaces with all MOS clock chips.
C. Super low power consumption (1.5 Ma 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.

BUY TWO FOR $10.00

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

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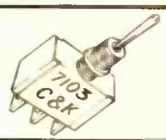

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74S04 – 44c	7438 – 39c	7485 – 95c	74161 – 95c
7404 – 19c	7440 – 19c	7486 – 45c	74164 – 1.10
7406 – 29c	7447 – 85c	7490 – 65c	74165 – 1.10
7408 – 19c	7448 – 85c	7492 – 75c	74174 – 95c
7410 – 19c	7451 – 19c	7495 – 75c	74181 – 2.50
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MC767P-69c	MC788P-49c	MC9704P-89c
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10 for $1
Factory Prime!

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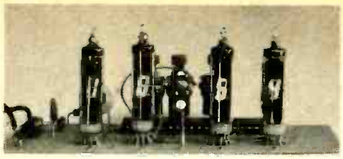

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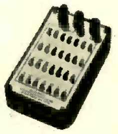

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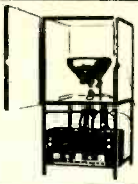

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- PC Board with all Electronic Parts
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Plans and Parts, too.
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RHYTHM UNIT - SYNTHESIZERS

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CARBON film resistors—¼W, 5% 10—4.7 megohms for 3½¢ each. Fifty per value $0.85. Discounts available. Free samples/specifications. Other quality components. $1.00 postage. **COMPONENTS CENTER,** Box 134R, New York, NY 10038

PLANS & KITS

CB'ers—"triple your power" using new 46' all-directional CB antenna!!! Plans $2.—**ASTROBEAM-9,** 704 Edwards, Visalia, CA 93277

AMAZING ELECTRONIC PROJECTS and PRODUCTS:

Lasers Super Powered, Burning, Cutting, Rifle, Pistol, Pocket. See in Dark—Shotgun Directional Mike—Unscramblers—Giant Tesla—Stunwand—TV Disrupter—Energy Producing, Surveillance, Detection, Electrifying, Ultrasonic, CB, Auto and Mech. Devices, Hundreds More—All New Plus INFO UNLTD PARTS SERVICE. Catalog $1. **Information Unlimited, Box 626, Lord Jeffery Court, Amherst, N.H. 03031.**

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FOR discriminating builders: quality parts, bits, pieces, military and industrial. Free catalog. **BRAND X,** Rt. 3, Box 223, Ontario, OR 97914

Circle 45 on reader service card

VIDEO GAME KIT

5IVE GAMES TO PLAY

A CHALLENGE TO BUILD. A CHALLENGE TO PLAY.

This is a unit featuring a true "state of the art" design. It is something you will be proud to show your friends.

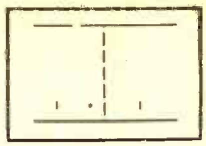
With a basic knowledge of electronic circuitry, this kit can be assembled and playing in just a few hours. If you have trouble, test facilities are available at nominal cost to remedy the problem.

FEATURES

1. Unique curve button adds extra thrill and skill to game.
2. Disappearing score - allows full vision of playing field when ball is in action.
3. 16 different angles of deflection for the ball compared to 3 with most competitive designs.
4. Fast action paddles.
5. Commercial quality design.

PRICES FOR THE UNITS ARE:

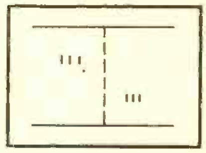
VK-1	PC board only Includes parts list & wiring diagram.	25.00 net
VK-2	PC board with parts Includes PC board, 78 IC's (those necessary are pre-programmed), resistors & capacitors to stuff the board.	125.00 net
VK-3	Hardware, wire, controls, switches Does not include housing or case.	17.50 net
VK-4	RF Module To convert video signal to TV receiver signal eliminates internal "wire in" on TV set. This unit can be used with other manufactured or kit type video games.	22.50 net
VK-5	Power Supply Kit	12.50 net
	Trouble shoot & Test Buyer assembled set	25.00 net
	Preassemble & Test	75.00 plus components



GAME 1

Let's start with a Tennis "**MATCH**". Fun for all, particularly beginners. This is the game that started the craze.

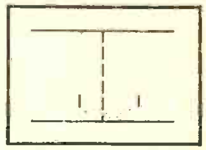
Scores to 12 points



GAME 2

Then go to the "**PRO MATCH**". You'll need 3 paddles to return the ball on this one, almost as fast as a Hockey Puck. A challenge for the 2 players this is designed for.

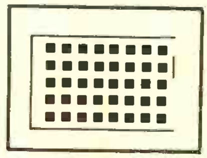
Scores to 12 points.



GAME 3

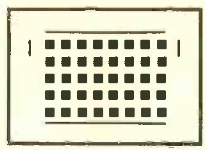
Now to deflate the ego's of the "Pros" put them to a "**GRAVITY MATCH**". A bouncing ball adds more fun and excitement plus it plays havoc with the skill of the 2 players.

Scores to 12 points.



GAME 4

WIPE OUT I
A game for a single player. Test your reflexes and see how many squares you can knock out. As your score increases so does the speed of the ball.
Top Score is 2400 points in 6 trys.



GAME 5

WIPE OUT II
If you can't beat the machine by yourself, get someone to help you. Together you can (that is it is possible to) score 2800 points in 6 trys.

All games have sound.

LINEAR IC's

309K	1.25
323K	6.00
339N	1.00
531H	2.75
739N	1.00
741M	3/1.25
760N	4.25
1303N	2/1.75
3900N	2/1.00
3905N	1.25
3909N	1.25
4136N	2.00

C-MOS

34001 FSC	1.00
4000	4/1.00
4001	4/1.00
4011	4/1.00
4012	4/1.00
4013	3/1.25
4016	3/1.25
4024	1.00
4033	2.00
4081	1.00
4512	1.50
4528	1.50

MICROPROCESSOR COMPONENTS

CPU'S

8008	19.95
8080A	34.00

KITS

F-8	95.00
MEK6800DI	125.00

PROMS

1702A	12.00
1702AL	12.00
8223B	3.00

ROMS

7488	3.50
74186	4.99

SMOKE DETECTOR KIT $29.95

TRANSISTORS

2N718A	3/1.00
2N1302	3/1.00
2N3054	2/1.25
2N3055	2/1.50
2N3563	5/1.00
2N3903	5/1.00
2N3906	5/1.00
2N3772	2.00
2N5400	5/1.00
2N5447	4/1.00
2N5550	3/1.00
2N6027	2/1.00

DIODES

Prices for any one number

1N746A through 1N759A
7/1.00 100/11.00
1N4728A through 1N4764A
5/1.00 100/15.00
1N5221B through 1N5267B
7/1.00 100/11.00
1N4007
10/1.00 100/8.00

IC SOCKETS

8 Pin	LoPro	4/1.00
10 Pin	Trans	10/1.00
14 Pin	LoPro	3/1.00
14 Pin	W.W.	3/1.00
16 Pin	Std.	3/1.00
24 Pin	Std.	3/1.25
28 Pin	Std. & W.W.	3/1.25

CLOCK KIT $12.95

Complete with display except case.

LED'S

FND500	1.50
FND507	1.50
MAN 4	2/1.50
MTC 2	2/1.50

CLOCK CHIPS

MM5311	4.95
MM5312	4.95
MM5313	4.95
MM5314	4.95
MM5316	6.75
CT7001	6.75

P.C. Bd. Edge Connector

22 Pin .156 Center double readout/solder2.25

CALCULATOR CHIPS

MM5725	2.95
MM5736	2.50

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Telephone 213-320-1250

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Circle 47 on reader service card

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$4.95
CY2A	2.000 MHz	HC33/U	$4.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

CLOCK CHIPS — CALCULATOR CHIPS

MM5309	6 Digit, BCD Outputs, Reset PIN.	$5.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5313	6 Digit, BCD Outputs, 1PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit, Alarm, 1PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calander, Alarm, 12 or 24 Hour	6.95

CALCULATOR CHIPS

MM5725	8 Digit, Four Function, Chain Decimal	$2.95
MM5738	8 Digit, 5 Function; +, −, ×, ÷, %	2.95
MM5739	8 Digit, 4 Function, Floating Decimal	2.95
CT5001	12 Digit, 4 Function	3.95
CT5005	12 Digit, 4 Function with Memory	5.95
CT5030	12 Digit, 4 Function and %	7.95

MISC. MOS

MM5320	TV Camera Sync. Generator	$19.95
MM5330	4½ Digit DVM Chip	9.95
MM5369	60 Hz Timebase Circuit From 3.58 MHz	5.00
MM5841	Video Generator For MM5318	18.00
MC1408-L7	7 Bit Digital to Analog Converter	9.95
MK5007	4 Decade Counter with Latches	10.95
LD110/LD111	3½ Digit DVM Chip Set	25.00
95H90	100 MHz ÷ 10 Counter For Prescalers	13.95

FILAMENT TRANSFORMERS

FILAMENT single secondary 50-60 Hz

Type No	Secondary volts	Secondary Amps	Primary Volts	RMS Test Voltage	Case Type	Connections or Lead Holes Used	Case Dimension H	Case Dimension W	Case Dimension D	Mounting Dimension MW	Mounting Dimension MD	Mtg Hole Size	Price
F-7X	5 CT	3	115	1500	K	Leads	1-15/16	3-5/16	2	2-13/16		3/16	5.10
F-13X	6.3	6	115	1500	X	Leads	1-3/8	2-3/8	1-3/8	2		3/16	3.80
F-14X #	6.3 CT	1.2	115	Pri 1500 Sec 2500	K	Leads	1-5/8	2-13/16	1-5/8	2-3/8		3/16	4.15
F-16X	6.3 CT	3	115	Pri 1500 Sec 2500	X	Leads	1-15/16	3-5/16	2	2-13/16		3/16	5.35
F-25X	12.6 CT	1.5	115	1500	X	Leads	1-15/16	3-5/16	2	2-13/16		3/16	5.25
F-40X	26.8 CT	1	115	1500	X	Leads	2	3-1/4	2-1/8	2-13/16		3/16	7.00
F-45X	24.0 CT	1	115	1500	X	Leads	2	3-1/4	2-1/8	2-13/16		3/16	7.50
F-54X	36.0 CT	1.5	115	1500	X	Leads	2-19/32	4	2-1/4	3-9/16		3/16	8.50

Add 50¢ Postage

VECTOR WIRING PENCIL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self-contained replaceable bobbin, onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord®. Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire. **$9.50**

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

W36-3-A-Pkg. 3	250 ft. 36 AWG GREEN	$2.40
W36-3-B-Pkg. 3	250 ft. 36 AWG RED	$2.40
W36-3-C-Pkg. 3	250 ft. 36 AWG CLEAR	$2.40
W36-3-D-Pkg. 3	250 ft. 36 AWG BLUE	$2.40

1/16 VECTOR BOARD

0.1" Hole Spacing — P-Pattern

	Part No.	L	W	Price 1-19	Price 20-49
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 02XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

VECTOR TERMINALS

Series	Part No. Gold	Part No. Tinned	Post Size	25 pcs Gold	25 pcs Tin	50 pcs Gold	50 pcs Tin
T44	T44-1	T44	.025" sq	1.50 lot	1.00 lot	2.75 lot	1.75 lot
T46	T46-1	T46	.028 sq.	1.75 lot	1.25 lot	3.00 lot	2.25 lot
T49	T49A	T49	.025 sq	1.75 lot	1.25 lot	3.10 lot	2.25 lot
T42-1	PKG. 100	Terminals		$3.50 C	$13.00M		

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications. **$1.95**

SCR AND FW BRIDGE RECTIFIERS

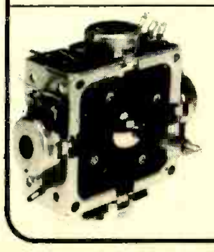
C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	25A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	25A @ 200V	FW BRIDGE REC.	1.95

64 KEY KEYBOARD

This keyboard features 64 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications. **$19.95**

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

$9.95 ea.

MICROPROCESSOR COMPONENTS

8080 SUPPORT DEVICES

8080A $37.95

8212	8 BIT INPUT/OUTPUT PORT FOR 8080	$ 5.95
8224	CLOCK GENERATOR AND DRIVER FOR 8080	12.95
8228	SYSTEM CONTROLLER AND BUS DRIVER FOR 8080	12.95

8080 $24.95

CPU'S			RAM'S			
8008	8 BIT CPU	$19.95	2601	256 x 1	FAST	5.00
8080	Super 8008	24.95	1101	256 x 1	Static	$ 2.25
8080A	Super 8008	37.95	1103	102 x 1	Dynamic	2.95
SR'S			2101	256 x 1	Static	6.95
2504	1024 Dynamic	$ 9.00	2102	1024 x 1	Static	1.95
2518	Hex 32 BIT	7.00	2107	4096 x 1	Dynamic	19.95
2519	Hex 40 BIT	4.00	2111	256 x 4	Static	7.95
2524	512 Dynamic	2.95	7010	1024 x 1	MNOS	29.95
2525	1024 Dynamic	6.00	7489	16 x 4	Static	2.49
2527	Dual 256 BIT	3.95	8101	256 x 4	Static	7.95
2529	Dual 512 BIT	4.00	8111	256 x 4	Static	7.95
2532	Quad 80 BIT	3.95	8599	16 x 4	Static	3.49
2533	1024 Static	7.95	91L02	1024 x 1	Static	2.49
3341	Fifo	6.95	74200	256 x 1	Static	6.95
74LS670	16 x 4 Reg.	3.95	93410	256 x 1	Static	1.75
UART'S			PROMS			
AY-5-1013	30K Baud	$ 6.95	1702A	2048	Famos	$15.95
ROM'S			5203	2048	Famos	14.95
2513	Char. Gen.	$11.00	82S23	32 x B	Open C.	5.00
2516	Char. Gen.	13.00	82S123	32 x 8	Tristate	5.00
74S387	1024-Bit Programmable	1.95	74S287	1024	Static	7.95

2K RAM SPECIAL

MM5262 Fully decoded 2Kx1 dynamic RAM. All inputs except clocks are TTL compatible. Provides a 635 ns minimum access time, and requires, a +5, +8.5, and −15V power supply. Low power provides non volatile memory using battery back up.

$0.99 ea. (0.05 cents per bit)

Special Requested Items

RC4194	Dual Track V Reg	$ 5.95	N8T97	$ 2.00	MK5007	$10.95	MC4044	$ 4.50
RC4195	±15V Track Reg	3.25	4024P	2.25	8263	5.95	LM3909	1.25
F9368	Decoder	3.95	DM8130	3.25	8267	2.75	MM5320	19.95
LD110/111	DVM Chip Set	25.00	9322	1.30	8288	1.15	4072AE	.45
CA3130	Super CMOS Op Amp	1.49	MC14016	.56	8826	3.00	7422	1.50
MC1408L7	D/A	9.95	2525	6.00	8880	.80	7497	4.00
F3341	FIFO	6.95	2527	3.95	4511AE	2.50	74186	5.00
MM5841	Character Gen.	18.00	CD4518	2.50	XR4136	2.00	74279	.90
AY5-9100	Push Button Dialer	17.50	MM5309	5.95	4566AE	3.00	82S90	4.00
							MCT-2E	2.95

WE'LL BE HAPPY TO QUOTE ON YOUR SPECIAL PARTS —

Continental Specialties

PROTO POWER! POWER FOR THE PROFESSIONAL

Made in USA Patents Pending

$75 Proto Board 203

Breadboard Prototesting with 5 Volt, 1 AMP Regulated Power Supply Included!

A total ready-to use power breadboard prototest device with a built-in regulated short-proof power supply. Just plug-in and start building! 2 extra floating 5-way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24-14 pin DIP capacity. Attractive two-tone quality case. All metal construction. 9¾" L x 6½" W x 2¾" H. 5 lbs. Order today!

For the economy-minded experimenter . . .

NEW

Proto Board 100 — 19.95

Here's a low cost, big 10 IC capacity breadboard kit with all the quality of QT Sockets and the best of the Proto-Board series . . . complete down to the last nut, bolt and screw. Includes 2 QT-35S Sockets, 1 QT-35B Bus Strip, 2 5-way binding posts, 4 rubber feet, screws, nuts, bolts and easy assembly instructions.

COMPLETE KIT . . .

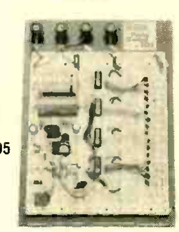
THE MINI-BREADBOARD BUDGET KIT

Proto Board 101, Compact, Inexpensive. 10-14 pin DIP capacity, 5.8" long x 4.5" wide **29.95**

Proto Board 102, Compact 12-14 pin DIP capacity 7" x 4½" **39.95**

Proto Board 103, 2,250 solderless tie points, (4) 5-way binding posts, 24-14 pin DIP capacity, 9" x 6" **59.95**

Proto Board 104, Huge 3,060 solderless tie points, (4) 5-way binding posts, 32-14 pin DIP capacity, 9½" long x 8" wide **79.95**

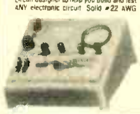


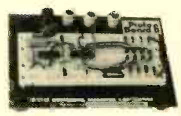
DESIGN MATE 1

CIRCUIT DESIGNER

You asked for it, HERE IT IS! CSC's basic circuit designer to help you build and test ANY electronic circuit. Solid #22 AWG wire interconnects any discreet component without solder. Resistors, Transistors, Linear/Digital ICs in TO-5 DIP packages (from 8-40 pins). And more. Components fit directly into Sockets and Bus strips instantly and easily. Plus, DESIGN MATE ONE's (DM-1) variable regulated power supply gives 5-15VDC up to 600ma (9 watts). Now that's design flexibility for you!

You can even monitor the DM-1's internal power supply or external circuits thanks to the built-in 0-15V voltmeter. If you're into electronics, DM-1 is a must for your laboratory. It comes to you completely wired, tested and ready to use for only $49.95





PROTO BOARD 6

The PB-6 lets the user test and build circuits without soldering or patch cords; all interconnections between components are made with common #22 AWG hook-up wire. This quality breadboarding kit includes 630 component tie points at less than 2.5 cents each. It measures 6" long by 4" wide. Designed specially to Breadboard Microprocessor Circuits. $15.95

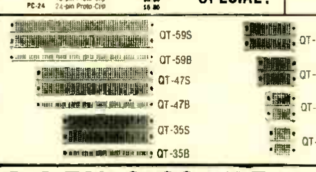
Now trace signals or troubleshoot fast. Inject signals or wire unused circuits into existing boards. Scope probes, test leads lock onto Dynagrip insert. Plastic construction — no springs or pivots. Thousands of operations. Narrow throat for high density PC boards.

PC-14	14-pin Proto-Clip	$3.60 ea
PC-16	16-pin Proto-Clip	$3.80
PC-24	24-pin Proto-Clip	$6.80

SPECIAL!

LOGIC MONITOR

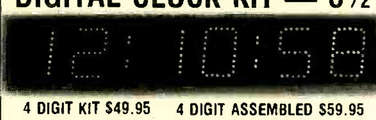
Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size. $84.95.



QT Proto Strips

QT type	#holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

DIGITAL CLOCK KIT — 3½ INCH DIGITS



This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" x 3½" x 1½", and the 4 digit is 18" x 3½" x 1½". Kits come complete with all components, case and transformer. Specify 12 Or 24 Hr. When Ordering

4 DIGIT KIT $49.95	4 DIGIT ASSEMBLED $59.95
6 DIGIT KIT $69.95	6 DIGIT ASSEMBLED $79.95

Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax — Data Sheets 25c each
Send a 13c Stamp (postage) for a FREE 1976 Catalog

JAMES

1021 HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS — (415) 592-8097

AUTOTEL ™

WARNING LIGHTS ARE NOT ENOUGH

AN AUDIBLE ALARM INDICATING POTENTIAL ENGINE DAMAGE

AUTOTEL is an effecient (15 ma current standby) device by which every owner of an automobile, truck or vehicle equipped with indicator lights for temperature and oil pressure can be assured of a reliable warning before an impending failure.

AUTOTEL, by means of an audible signal 70 db pulsing) immediately forewarns the vehicle operator of a malfunction or failure, allowing time to correct and prevent major engine failures. It is programmed so there is no sound during normal operating conditions.

AUTOTEL features CMOS circuitry, packaged in a 2½" sq. x ⅞" case. The kit comes complete with all components, hardware and case to hook directly into your car's warning light system.

$14.95 Assembled $9.95 Per Kit

IMC 3½ DIGIT DVM KIT

This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case	$49.95
B. 5V Power Supply	$14.95

JE700 CLOCK

12 / 24 Hour — 115 VAC

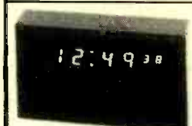
The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

$17.95

Liquid Crystal Temperature Display

Six Digit Light Emitting Diode Display — DL 33 Display

This clock makes an attractive addition to any desk. It has an extruded, black anodized aluminum case. It displays hours, minutes, and seconds with .11 inch displays, and comes complete with a liquid crystal thermometer. It operates off 115 VAC at 50 or 60 Hz. $24.95



This large digit clock (.6" hours & minutes, .3" seconds) features the MM5314 clock chip. It operates from 117 VAC, and will operate in either a 12 or 24 hour mode. The clock is complete with a walnut grain case, and has fast set, slow set, and hold time set features.

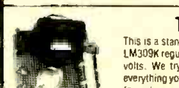
KIT - ALL COMPONENTS & CASE $34.95
WIRED & ASSEMBLED $39.95

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (H) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

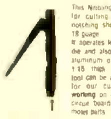
$9.95 Per Kit printed circuit board

T²L 5V 1A Supply



This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **$9.95 Per Kit**

NIBBLING TOOL — DIAGONAL CUTTER



This Nibbling Tool is perfect for cutting, trimming or notching sheet metal up to 18 guage. It operates like a punch and die and also works well on aluminum or plastic up to 1/16" thick. We feel that this tool can be a real time-saver for our customers when working on chassis, printed circuit boards and prototype model parts.

Nibbling Tool	$6.95
Replacement Punch	$3.75 Each

½" Semi-Flush Cut Fine Diagonal

4-in. long. Most popular cutter on assembly line; cuts at extreme tip. Semi-flush cut. For fine wire work only. No. 20 soft copper wire and smaller. Width across joint 13/32", thru joint 7/32", tip length 1/2".

Light Blue Handle A97MS $8.50 ea.

THIS MONTH ONLY!!!

C & K Rocker Switch SPDT	2/$1.00
6PDT Push Button Switch	2/$1.00
MAN 7G Common Anode-Green .3" DISPLAY LED	$1.25
6' Black 3 Conductor Power Supply Cords	.99
LM309KC	.99
2N2222 NPN to 18 Package	8/$1.00
JE100 1¼" x 1½" PC Mount XFMER. Primary: 120 VAC @ 50 Hz-60 Hz. Secondary: 10 VAC @ 50 MA and 50 VAC @ 30 MA	.79

Miniature Aluminum Electrolytic Axial Caps

47 µF/25V	8/$1.00	470 µF/16V	5/$1.00
100 µF/25V	7/$1.00	470 µF/50V	2/$1.00
220 µF/16V	7/$1.00	10,000 µF/10V	2/$1.50

7400N TTL

SN7400N*	.16	SN7453N	.27	SN74150N	1.00
SN7401N	.16	SN7454N	.20	SN74151N	.79
SN7402N	.21	SN7459A	.25	SN74153N	.89
SN7403N	.16	SN7460N	.22	SN74154N*	1.25
SN7404N*	.18	SN7470N	.45	SN74155N	.99
SN7405N	.24	SN7471N*	.69	SN74156N	.99
SN7406N	.20	SN7472N	.39	SN74157N	.99
SN7407N	.29	SN7473N*	.37	SN74160N	1.25
SN7408N	.25	SN7474N*	.32	SN74161N	.99
SN7409N	.25	SN7475N*	.50	SN74163N*	.99
SN7410N*	.18	SN7476N*	.32	SN74164N	1.10
SN7411N	.30	SN7479N*	5.00	SN74165N	1.10
SN7412N	.33	SN7480N	.50	SN74166N	1.25
SN7413N	.45	SN7482N	.98	SN74167N	5.50
SN7414N	.70	SN7483N	.70	SN74170N	2.10
SN7416N	.35	SN7485N	.89	SN74172N	18.00
SN7417N	.35	SN7486N	.39	SN74173N	1.50
SN7420N	.21	SN7488N	3.50	SN74174N	1.25
SN7421N	.33	SN7489N	2.25	SN74175N	.99
SN7422N*	.49	SN7490N*	.45	SN74176N	.90
SN7423N	.37	SN7491N	.75	SN74177N	.90
SN7425N	.29	SN7492N	.49	SN74180N	.99
SN7426N	.29	SN7493N*	.49	SN74181N	2.49
SN7427N	.37	SN7494N	.79	SN74182N	.95
SN7429N	.42	SN7495N	.79	SN74184N	1.95
SN7430N	.26	SN7496N	.89	SN74185N	2.20
SN7432N	.31	SN7497N*	4.00	SN74186N*	5.00
SN7437N	.27	SN74100N*	1.00	SN74187N	6.00
SN7438N	.27	SN74107N	.39	SN74190N	1.19
SN7439N	.25	SN74121N*	.39	SN74191N	1.25
SN7440N	.15	SN74122N	.39	SN74192N*	.89
SN7441N	.89	SN74123N*	.70	SN74193N*	.89
SN7442N	.59	SN74125N	.60	SN74194N	1.25
SN7443N	.75	SN74126N	.60	SN74195N	.75
SN7444N	.75	SN74132N	1.09	SN74196N	1.25
SN7445N	.75	SN74136N	.95	SN74197N	.75
SN7446N	.81	SN74141N	1.15	SN74198N	1.75
SN7447N*	.69	SN74142N*	4.00	SN74199N	1.75
SN7448N	.79	SN74143N*	4.50	SN74200N	5.59
SN7450N	.26	SN74144N*	4.50	SN74279N*	.90
SN74[illegible]N	.27	SN74145N	1.15	SN74251N	1.79
		SN74147N	2.35	SN74284N	6.00
		SN74148N	2.00	SN74285N	6.00

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

CMOS

CD4000	25			74C04N	.75
CD4001	25	CD4035	1 85	74C10N	65
CD4002	25	CD4040	2 45	74C20N	65
CD4006	2 50	CD4042	1 90	74C30N	.65
CD4007	25	CD404[illegible]	1 50	74C42N	2 15
CD4009	59	CD4046	2 51	74C73N	1 50
CD4010	59	CD4047	2 75	74C74	1.15
CD4011	25	CD4049	79	74C90N	3 00
CD4012	25	CD4050	79	74C95N	2 00
CD4013	47	CD4051	2.95	74C107N	1 25
CD4016	.56	CD4053	2.95	74C151	2 90
CD4017	1 35	CD4060	3 25	74C154	3 00
CD4019	.55	CD4066	1 75	74C157	2 15
CD4020	1 49	CD4069	.45	74C160	3.25
CD4022	1.25	CD4071	45	74C161	3.25
CD4023	25	CD4072*	.45	74C163	3 00
CD4024	1 50	CD4081	.45	74C164	3.25
CD4025	25	CD4511	2	74C173	2 60
CD4027	69	CD4518	2	74C193	2.75
CD4028	1 65	74C00N	.39	74C195	2 75
CD4029	2.90	74C02N	.55	MC4044*	4 50
CD4030	65			MC14016*	.56

LINEAR

LM300H	80			LM1351N	1 65
LM301H	35			LM1414N	1.75
LM301CN	35	LM377N	4 00	LM1458C	65
LM302H	75	LM380N	1 39	LM1496N	95
LM304H	1 00	LM380CN	1 05	LM1556V	1.85
LM305H	95	LM381N	1 79	LM2111N	1 95
LM307CN	35	LM382N	1 79	LM2901N	2 95
LM308H	1 00	NE501K	8 00	LM3065N	69
LM308CN	1 00	NE510A	6 00	LM3900N	55
LM309H	1 10	NE531H	3 00	LM3905N	60
LM309K	99	NE536T	6 00	LM3909*	1.25
LM310CN	1 15	NE540L	6.00	LM5556N	1 85
LM311H	90	NE550N	79	MC5558V	1 00
LM311N	90	NE553	2 50	LM7525N	90
LM318CN	1 50	NE555V*	45	LM7535N	1 25
LM319N	1 30	NE560B*	5.00	8038B*	4 95
LM319D	9 00	NE561B*	5.00	LM75450	49
LM320K-5	1 35	NE562B*	5.00	75451CN	39
LM320K-5 2	1 35	NE565H*	.99	75452CN	39
LM320K 12	1 35	NE565N*	1 25	75453CN	39
LM320K 15	1 35	NE566CN*	1 95	75454CN	39
LM320T-5*	1.75	NE567H*	1 25	75491CN	79
LM320T-8*	1.75	NE567V*	1 50	75492CN	89
LM320T-12*	1 7	LM703CN	.45	75494CN	89
LM320T-18*	1.75	LM709H	29	**RCA LINEAR**	
LM323K-5*	9.95	LM709N	29	CA3013	1 70
LM324N	1 80	LM710N	79	CA3023	2 15
LM339N	1 70	LM711N	.39	CA3035	2 25
LM340K 5	1 95	LM723N	55	CA3039	1 35
LM340K-12	1 95	LM723H	.55	CA3046	1 15
LM340K-15	1 95	LM733N	1 00	CA3059	2 46
LM340K-24	1 95	LM739N	1 29	CA3060	2 80
LM340T-5	1 75	LM741CH	.35	CA3080	85
LM340T-6	1 75	LM741CN	.35	CA3081	1.75
LM340T-8*	1 75	LM741 14N	39	CA3082	2.00
LM340T-18*	1 75	LM747H	79	CA3083	1 60
LM340T 12	1 75	LM747N	79	CA3086	59
LM340T-15	1 75	LM748H	.39	CA3089	3.25
LM340T 24	1 75	LM748N	39	CA3091	8 25
LM350N	1 00	LM1303N	.90	CA3123	1 85
LM351CN	65	LM1304N	1.19	CA3130*	1 49
LM370N	1.15	LM1305N	1 40	CA3600	1 75
LM370H	1 15	LM1307N	85	RC4194	5 95
LM373N	3.25	LM1310N	2 95	RC4195	3.25

KITS EXAR ICS

XR-2206KA — **SPECIAL $17.95**
Includes monolithic function generator IC PC board, and assembly instruction manual

XR-2206KB — **SPECIAL $27.95**
Same as XR 2206KA above and includes external components for PC board.

TIMERS		**STEREO DECODERS**	
XR-555CP	$ 69	XR-1310P	$3 20
XR-320P	1 55	XR-1310EP	3.20
XR-556CP	1 85	XR1800P	3 20
XR-2556CP	3.20		
XR-2240CP	3.25	**WAVEFORM GENERATORS**	
		XR-205	8.40
PHASE LOCKED LOOPS		XR-2206CP	4.49
XR-210	5.20	XR-2207CP	3.85
XR-215	6.60	**MISCELLANEOUS**	
XR-567CP	1.95	XR-2211CP	6.70
XR-2567CP	2 99	XR-2261	3.79
		XR4136	2.00

DATA HANDBOOKS

7400	Pin-Out & Description of 5400/7400 ICS	$2.95
CMOS	Pin-out & Description of 4000 Series ICS	$2.95
LINEAR	Pin-out & Functional Description	$2.95

ALL THREE HANDBOOKS $6.95

CONSUMER ELECTRONICS

DIGITAL WATCH

This watch is manufactured by National Semiconductor It provides 5 functions; hours, minutes, seconds, date, A.M. Indicator dot. Accuracy is assured to 5 seconds per month by precision quartz crystal. If something should go wrong with the watch, repair Is assured within 48 hours after it is received. Complete with steel black leather band.

ES4-YS
3 MICRON GOLD PLATE BEZEL
$29.95
NOT A KIT

DIGITAL ALARM CLOCK

This 4 digit Novus Alarm Clock is a very reliable and smartly styled unit. It provides such features as an alarm settable to any minute of the day, a 7 minutes snooze alarm, a power failure indicator, and even an A.M., P.M. Indicator.

NOT A KIT **$19.95**

OPTO ELECTRONICS

XCITON
LITRONIX
MONSANTO

DISCRETE LEDS

R - RED
G - GREEN
Y - YELLOW
O - ORANGE

.125" dia.		.185" dia.		.190" dia.	
XC209R	5/$1	XC526R	5/$1	XC111R	5/$1
XC209G	4/$1	XC526G	4/$1	XC111G	4/$1
XC209Y	4/$1	XC526Y	4/$1	XC111Y	4/$1
XC209O	4/$1	XC526O	4/$1	XC111O	4/$1

.200" dia.		.200" dia.		.085" dia.	
XC22R	5/$1	XC556R	5/$1	MV50	
XC22G	4/$1	XC556G	4/$1	.085" dia. Micro red led	
XC22Y	4/$1	XC556Y	4/$1		6/$1
XC220	4/$1	XC556O	4/$1		

DISPLAY LEDS

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	COMMON ANODE	270	$3.25	MAN 74	COMMON CATHODE	300	$1.50
MAN 2	5 x 7 DOT MATRIX	300	4.95	DL707	COMMON ANODE	300	$1.50
MAN 3	COMMON CATHODE	125	.39	DL747	COMMON ANODE	600	2.25
MAN 4	COMMON CATHODE	187	1.95	DL750	COMMON CATHODE	600	2.49
MAN 7	COMMON ANODE	300	1 50	DL338	COMMON CATHODE	110	1.25
MAN 7G	COMMON ANODE-GREEN	300	1 95	FND70	COMMON CATHODE	250	.50
MAN 7Y	COMMON ANODE-YELLOW	300	1 95	FND503	COMMON CATHODE	500	1.75
MAN 72	COMMON ANODE	300	1 50	FND507	COMMON ANODE	500	1.75

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

14 pin	$.27	.25	.24	28 pin	$ .99	90	.81
16 pin	30	.27	25	36 pin	1,39	1.26	1.15
18 pin	35	.32	.30	40 pin	1 59	1.45	1.30
24 pin	.49	.45	42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$ 30	.27	24	24 pin	$. 70	.63	.57
14 pin	35	.32	.29	28 pin	1.10	1.00	90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1 45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

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

50 PCS. RESISTOR ASSORTMENTS $1.25 PER ASST.

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

ALL OTHER RESISTORS FROM 2 2 OHMS 5 6M AVAILABLE IN MULTIPLES OF 5 ea 5-25 PCS: .05 ea. 30-95 PCS. .04 ea 100-495 PCS: .03 ea. 500-995: .0275 ea.

14 PCS. POTENTIOMETER ASSORTMENTS

ASST. A 2 ea: 10 OHM-20 OHM-50 OHM 100 OHM-200 OHM-250 OHM-500 OHM
ASST. B 2 ea 1K, 2K, 5K, 10K, 20K, 20K, 50K
ASST C 2 ea: 50K, 100K, 200K 250K, 500K, 1M, 2M

$9.95 Per Asst.

Each assortment contains 14 pcs of 10 turn pots. All pots are available in single unit quantities. $.99 ea.

Astrisk Denotes Items On Special For This Month
Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax — Data Sheets 25c each
Send a 13c Stamp (postage) for a FREE 1976 Catalog

JAMES

1021 HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS — (415) 592-8097

74LS00 TTL

74LS00	.39	74LS55	.39	74LS151	1.55
74LS02	.39	74LS73	.65	74LS153	1.89
74LS03	.39	74LS74	.65	74LS157	1.55
74LS04	.45	74LS75	.79	74LS162	2.25
74LS05	.45	74LS76	.65	74LS163	2.25
74LS08	.39	74LS83	2.19	74LS164	2.25
74LS10	.39	74LS86	.65	74LS181	3.69
74LS13	.79	74LS90	1.25	74LS190	2.85
74LS14	2.19	74LS92	1.25	74LS191	2.85
74LS20	.39	74LS93	1.25	74LS192	2.85
74LS26	.49	74LS95	2.19	74LS193	2.85
74LS27	.45	74LS96	1.89	74LS194	2.25
74LS28	.49	74LS107	.65	74LS195	2.25
74LS30	.39	74LS112	.65	74LS257	1.89
74LS32	.45	74LS132	1.55	74LS260	.55
74LS40	.49	74LS136	.65	74LS279	.79
74LS51	.39	74LS138	1.89	74LS670	5.95

THIS MONTH ONLY!!! DL728
The DL728 is a dual 0.5" common cathode red display It is ideal for use with clock chips, as segments are already multiplexed **$1.95**

MINATURE TOGGLE

DPDT				JMT	1	2-9	10-29	30-99
	ON	OFF	ON	221	3.06	2.65	1.97	1.78
	ON	NONE	ON	223	2.85	2.26	1.68	1.51
	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	123	3.05	1.65	1.21	1.10

PUSH BUTTON

SPDT - SERIES PB, PB1
Maintained Action Switch: Push To Make Contact And Push Again To Reverse Action
Momentary Action Switch: Normally Open or Normally Closed (For N C circuit use terminals 2 & 1, for N O 2 & 3; for N C and N O 1, 2 & 3

Model Number	1 Each	Quanity net prices 2-9	10-29	30-99
PB-123	$2.35	$1.95	$1.47	$1.30
PB-126	$2.35	$1.95	$1.47	$1.30

5 AMP RATINGS

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY
SF - Front Mount SR - Rear Mount

Part No.	Description	Price
SF 12	Single Pole 10 Position	$2.50
SR 12	Decimal	3.00
SF 21	10 Position BCD only	2.50
SR 21	" "	3.00

Ordering: Order desired switch or switches and add necessary accessories for your particular application

Part No.	ACCESSORIES Description	Price	Part No.	ACCESSORIES Description	Price
SF EP	End Plate (Pair)	$.50	SR EP	End Plates (pair)	$.50
SF DP	Divider Plate (each)	40	SR DP	Divider Plate (each)	40
SF BB	Blank Body (each)	40	SR BB	Blank Body (each)	40
SF HB	Half Body (each)	40	SR HB	Half Body (each)	40

8 POSITION ROTARY SWITCH — **2 FOR $1.00**
These switches are a 7 position, one position open, rotary switch enclosed in a TO-5 can They have a standard 8 pin configuration and will mount perfectly on printed circuit board

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3 3	400m	4/1.00	1N4005*	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006*	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6 2	400m	4/1 00	1N3600	50	200m	6/1.00
1N754	6 8	400m	4/1.00	1N4148	75	10m	15/1.00
1N965B	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1 80
1N4003	200 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00
1N4004	400 PIV	1 AMP	12/1 00				

TRANSISTORS

MPS A05	5/$1 00			PN4249	4/$1 00
MPS A06	5/$1 00	PN3567	3/$1.00	PN4250	4/$1 00
2N2219A	3/$1 00	PN3568	4/$1 00	2N4400	4/$1 00
2N2221	4/$1 00	PN3569	4/$1 00	2N4401	4/$1.00
2N2222A	5/$1 00	2N3704	5/$1 00	2N4402	4/$1.00
2N2369	5/$1 00	2N3705	5/$1 00	2N4403	4/$1 00
2N2369A	4/$1 00	2N3706	5/$1 00	2N4409	5/$1 00
FN2415	5/$1 00	2N3707	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3711	5/$1 00	2N5087	4/$1.00
2N2906A	4/$1 00	2N3724	$ 65	2N5088	4/$1 00
2N2907A	5/$1.00	2N3725	$1 00	2N5089	4/$1 00
2N2925	5/$1 00	2N3903	5/$1 00	2N5129	5/$1 00
2N3053	2/$1 00	2N3904	4/$1 00	2N5138	5/$1 00
2N3055	$ 89	2N3905	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N3906	4/$1.00	2N5209	5/$1.00
MJE2955	$1,25	2N4013	3/$1.00	2N5951	5/$1 00
2N3392	5/$1.00	2N4014	3/$1 00	C106B1SCR	2/$1 00
2N3398	5/$1.00			2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS	1-9	10-49	50-100		1-9	10-49	50-100
	.05	.04	.03	.001µF	.05	.04	.035
	05	.04	03	0047µF	.05	.04	.035
	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	05	.04
220 pf	.05	04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	12	.10	.07	.047mf	.21	17	.13
.0047mf	12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	22mf	.33	.27	22
20% DIPPED TANTALUMS (SOLID) CAPACITORS							
1 35V	.28	.23	.17	1.5 35V	.30	.26	.21
15 35V	.28	.23	.17	2.2 25V	.31	.27	.22
22 35V	.28	.23	.17	3.3 25V	.31	.27	.22
33 35V	.28	.23	.17	4.7 25V	.32	.28	.23
47 35V	.28	.23	.17	6.8 25V	.36	.31	.25
68 35V	.28	.23	.17	10 25V	.40	.35	.29
1 0 35V	.28	.23	.17	15 25V	63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
47 50V	.15	.13	.10	.47 25V	.15	.13	.10
1.0 50V	.16	.14	.11	.47 50V	.16	.14	.11
3.3 50V	.15	.13	.10	1.0 16V	.15	.13	.10
4.7 25V	.16	.14	.12	1.0 25V	.16	.14	.11
10 25V	.15	.13	.10	1.0 50V	.16	14	.11
10 50V	.16	.14	12	4.7 16V	.15	.13	.10
22 25V	.17	.15	.12	4.7 25V	.15	.13	.10
22 50V	.24	.20	.18	4.7 50V	.16	.14	.11
47 25V	.19	.17	.15	10 16V	.14	.12	.09
47 50V	.25	.21	.19	10 25V	.15	.13	.10
100 25V	.24	.20	.18	10 50V	.16	.14	12
100 50V	.35	.30	.28	47 50V	.24	.21	.19
220 25V	.32	.28	.25	100 16V	19	.15	.14
220 50V	.45	.41	.38	100 25V	.24	.20	.18
470 25V	.33	.29	27	100 50V	.35	.30	.28
1000 16V	.55	.50	.45	220 16V	.23	.17	.16
2200 16V	.70	.62	.55	470 25V	.31	.28	.26

Circle 49 on reader service card

MASSIVE FOLDOVER

When I complained of a massive foldover in an RCA CTC-36 AW chassis last December, you suggested checking the grid circuit of the vertical output tube. There *was* too much positive voltage there, as you said. However, checking coupling capacitors and other things didn't help it. Finally noted an 1800-ohm resistor going off toward the back of the chassis. This was connected to the SERVICE switch to ground the grid in the SERVICE position. Disconnecting this cleared up the trouble. My ohmmeter showed no leakage across the switch but a new one cleared up the problem.

(Make a note of this, fellows. Thanks to John Heineman, Winston-Salem.)

WRONG TUBE IN TUNER?

The IF coil in the tuner of this Zenith 14N22 was burnt up. I've checked for shorts and can't find anything. The 6GJ7 tube is all right, in the tube tester. What did this?—T.C., Ink, AR.

Check the tuner top plate. See if they stamped 6EA8 by that socket! The tube layout is marked 6EA8, 6GJ7/6HB7. The 6HB7 and 6GJ7 are interchangeable; the 6EA8 isn't. It has a different base.

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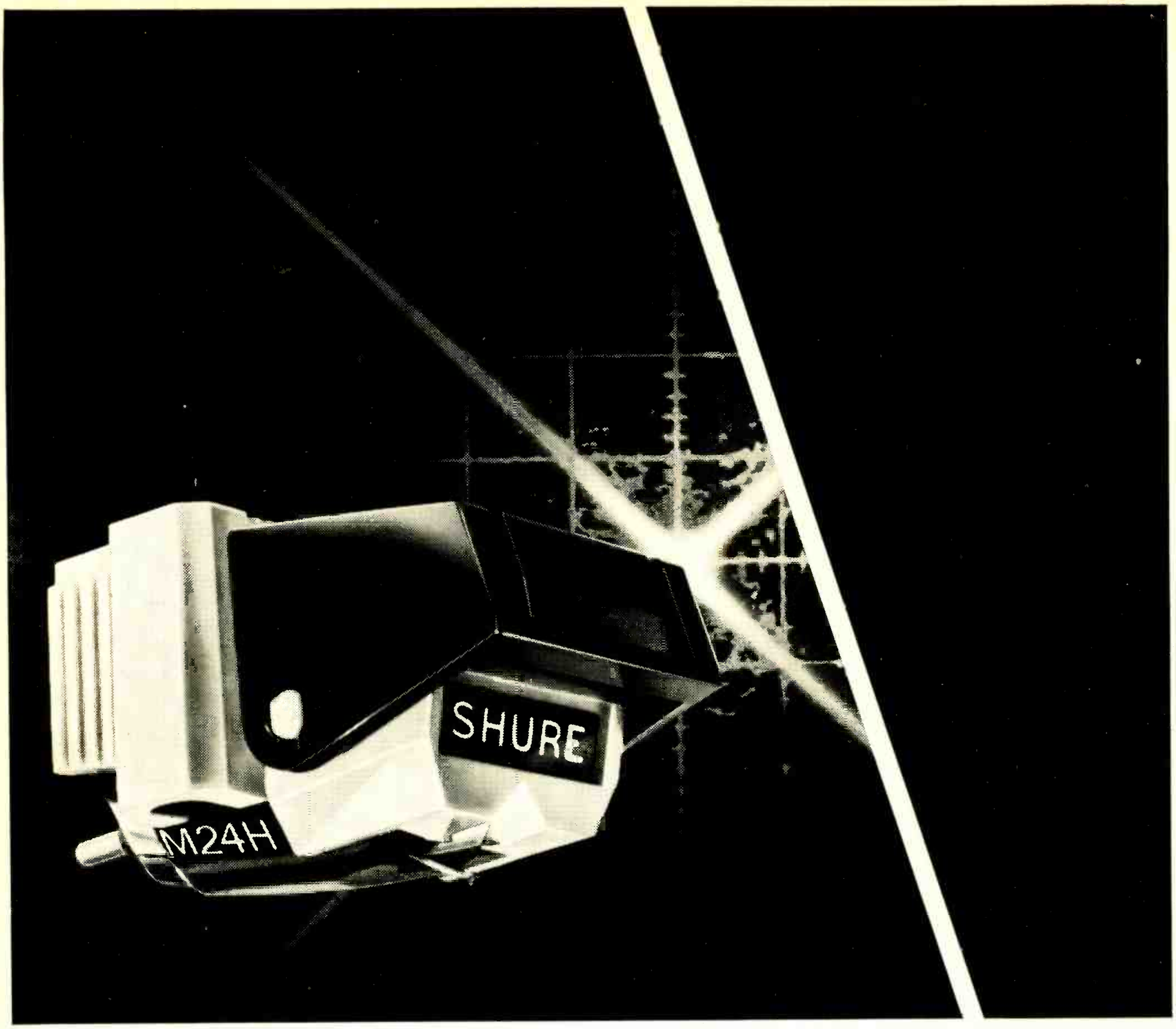
Circle 3 on reader service card



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Talk to Cobra. And you know you're punching through. One glance at the 29's over-sized illuminated meter tells you just how much power you're punching out and pulling in. For voice modulation the DynaMike delivers at 100%. Same way with power: The 29 transmits at maximum power levels.

Sooner or later you'll get a Cobra. And you'll get engineering and craftsmanship second to none. Performance that will make your first CB seem obsolete. Reliability and durability that have set standards for the industry. Above all, you'll get power. The power to punch through loud and clear like nothing else. Because when it comes to CB radio, nothing punches through loud and clear like a Cobra.

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