STEREO SCENE: HI-FI UPGRADING TIPS

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

APRIL 1976/75c

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16-page Bonus!

Special Focus on CB RADIO

including:

- How to Choose CB Base Station Antennas
- It's Easy to Install a CB Mobile Transceiver
- Your CB Bicentennial Highway Buddies
- Five-minute "on" One-minute "off" Timer
- CB Equipment Terms Made Easy for Buyers

A ZIFF-DAVIS PUBLICATION

Experience is the best teacher. You might settle for any CB first time around. Understandably. A lot of people think they're all pretty much alike. But you'll soon discover that, like everything else, there are exceptions.

Ask the pros. America's long distance truckers. These guys talk CB day in and day out. And they demand the best. That's why truckers refer to the Cobra 29 as "The Diesel Mobile."

Listen to Cobra. You'll hear a big difference. Because the Cobra 29 gives you features which assure crystal clear reception. Like switchable noise limiting and blanking, to cut out practically all pulse and ignition interference. Add squelch control and RF gain and you've got exceptional—adjustable—receiver clarity. Even in the heaviest CB traffic. You also get Delta Tuning which makes up for the other guy, because even off-frequency transmitters are pulled in. Perfectly.

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.

Cobra

Punches through loud and clear.

Cobra Communications, Products of Dynascan Corp.
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CIRCLE NO 14 ON FREE INFORMATION CARD

IF YOUR FIRST CB ISN'T A COBRA YOUR SECOND ONE WILL BE.

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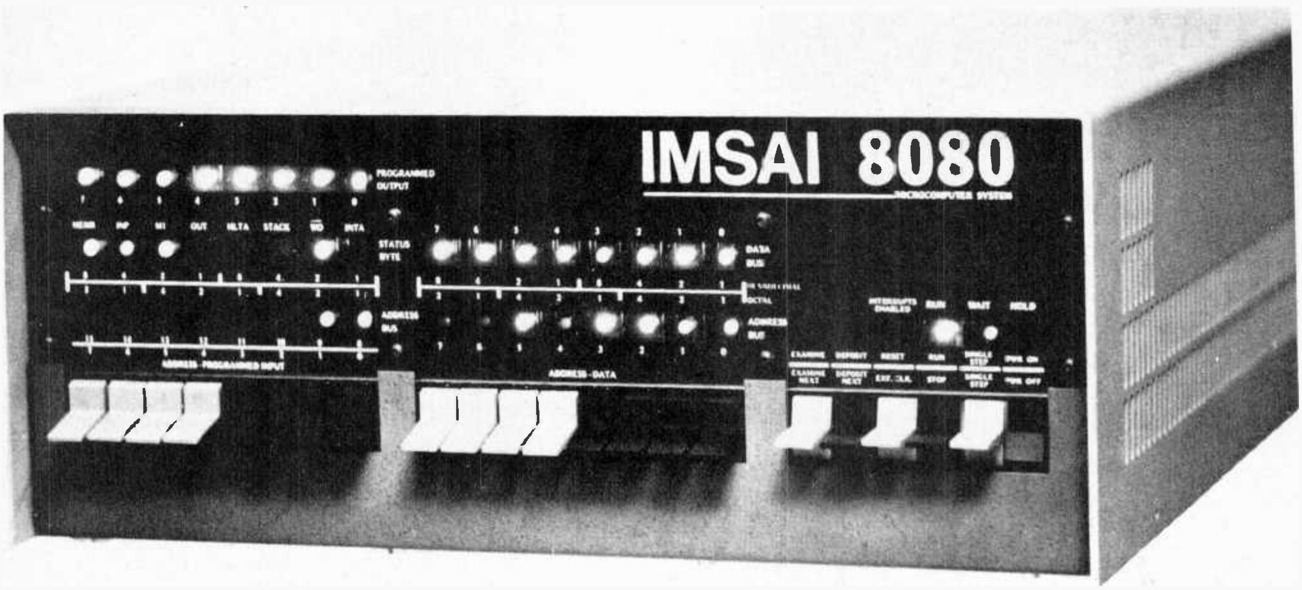

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A commercial grade cabinet, made of heavy gauge aluminum, custom designed for this specific product. Rack mounting is optional.

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If you would like to step-up to the superior quality of an IMSAI 8080, you will be pleased to know that your ALTAIR 8800 boards are "plug-in" usable—without modification—in the IMSAI 8080 cabinet. Furthermore, by acquiring IMSAI's unique Memory Sharing Facility, your ALTAIR MPU Board and IMSAI MPU Board can co-exist in the same cabinet, operate in parallel with each other, and share all memory in common. This is the technology that laid the foundation for IMSAI's powerful HYPERCUBE Computer and Intelligent Disk systems (recently featured in Computerworld, Datamation and Electronics magazines.)

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APRIL 1976 VOLUME 9, NUMBER 4

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COLUMNS

PRODUCT TEST REPORTS

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Editorial

WARC-79 AND COMMUNICATIONS HOBBYISTS

The year 1979 will be a milestone in the world of communications. This is when the World Administrative Radio Conference (WARC) of the International Telecommunications Union (ITU) will be held to reexamine uses of the radio spectrum and institute changes reflecting needs and new technology for the remainder of the century.

For hams and SWL'ers, this conference will likely be the most important "happening" in a long, long time. To a lesser extent, CB'ers will be interested in the outcome of WARC-79 because it is hoped that CB will be recognized as an international service.

The present division of the radio spectrum is based largely on major changes made in 1947. At that time, meetings were dominated by the leading nations in science and technology—the U.S., U.S.S.R., U.K. and France. The same was essentially true at the last meeting in 1959. But the passing of 20 years promises a dramatic change.

Expanded by the entry of new countries, the membership at WARC-79 can be expected to be about one-third higher than at the 1947 conference. Because each country has an equal vote (as in the General Assembly of the United Nations), *any* under-developed country's vote holds as much weight as the U.S.'s. More importantly, decisions are binding in the sense of being international agreements. And clearly, cooperation and agreement are most desirable to maintain orderly radio "traffic."

Many of the new nations to be represented at WARC-79 are indifferent to the radio-advanced nations and couldn't care less about some radio services. The advancement of amateur radio could conceivably suffer because of these attitudes. As an example of what 1979 might harbor, consider the experiences at the Geneva Space Radio Conference (1971). New Zealand proposed that five amateur bands be considered individually for close study of spectrum allocations, with the purpose of getting a small portion of higher frequencies for hams. Statements supporting this view were made by the U.S., U.K., Canada, Italy, Denmark, Israel and the Philippines. Statements against were made by Cuba, Syria and Sweden. New Zealand's proposal lost by a vote of 38 to 26 with 6 abstentions. As a result, amateur use of these higher frequencies was put to a second test on a "should they" or "should they not" proposition. The amateur group lost: 46 against, 18 for, 7 abstentions.

With the radio spectrum expected to expand up to 275 *GHz*, it's important for amateur radio to stake out its claim for the future. Over the years, amateur radio spectrum space has been chipped away in one region or another. Unfortunately, there don't seem to be too many countries today that will give strong support to amateur radio. Furthermore, the "third-world" countries are heavily dependent upon point-to-point communications in the high-frequency bands. Accordingly, there might be an effort to slice away at present international shortwave allocations to favor national interests. And "CB radio" is not beloved in many countries either. So we in the U.S., with only one vote, need all the friends we can marshal at the upcoming WARC-79.

Art Salsberg

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Letters

FROM BARK TO WHIMPER

Frustrated by many fruitless attempts to eliminate the ignition noise in my pickup truck, I decided to put into practice the hints given in the February 1975 CB Scene. The solution was simple but none too pretty. I reduced the bark in my spark to a whimper . . . as a result the noise level went from S7 to S2 . . . can run my rig with squelch wide open and noise blanker off. Now to convince Detroit and/or other motorists to clean up their ignition noise problems.—*W.A. Fuller, Friendswood, Texas*

PARTS AVAILABILITY

The part of the January 1976 Editorial that laments the shortage of walk-in electronics parts retail stores with broad inventories certainly hits home. I have most mail-order catalogs and can attest to the fact that it takes a lot of searching for particular parts (or equivalent substitutes) called for in projects. There is no doubt in my mind that serious hobbyists would welcome at least one broad-range parts supplier to relieve them of hunting down what they need and then having to order from more than one source.—*Benjamin H. Lane, Jr., Oklahoma City, OK*

I didn't like your Editorial on parts availability. POPULAR ELECTRONICS is one of the principal causes of the shortage of suppliers. With PE as much in the business of selling as in publishing articles, the hobbyist is not required to find sources for his projects, which means that he doesn't have to approach the OEM suppliers. Hence, the suppliers are led to believe that hobbyists don't provide much of a market.—*A. D. Acton, Washington, MI.*

POPULAR ELECTRONICS does not sell kits or profit from their sales. We are exclusively in the publishing business. Where possible, we often obtain suppliers of kits for construction projects so that readers can obtain parts that are not available from most other sources. Complete kits from a single source are listed for those who don't want to "hunt around." We decided to perform this service only after sources of supply began to dry up years ago, and devices proliferated.

FOR RADIO ASTRONOMY BUFFS

Readers of "An Introduction to Radio Astronomy" (January 1976) will be interested to know that there is a magazine titled *The Radio Observer* that is devoted entirely to this hobby. The magazine provides a forum where amateurs can share their progress in observing and equipment, and where newcomers can find help to get started in the hobby. Address is *The Radio Observer*, 657 Circle Dr., Santa Barbara, CA 93108.—*Richard H. Peterson, Editor.*

QUIZ WHIZ KID

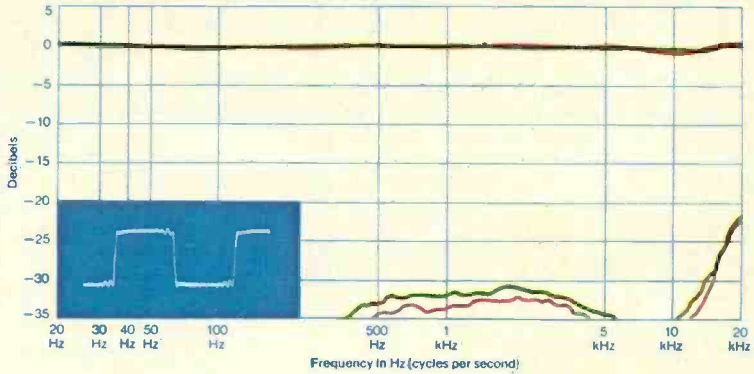
I very much enjoyed the "Black Box Quiz" that appeared in the December 1975 issue, but I must admit that it was a little too easy. I'm hoping for more quizzes like this in the future.—*Don D. Lavanway, Lasalle, Ill.*

Out of Tune

In the March 1976 "CB Scene," the dc power leads of the transceiver should be connected to the de-energized contacts of the upper poles of the relay, not to the energized contacts as shown.

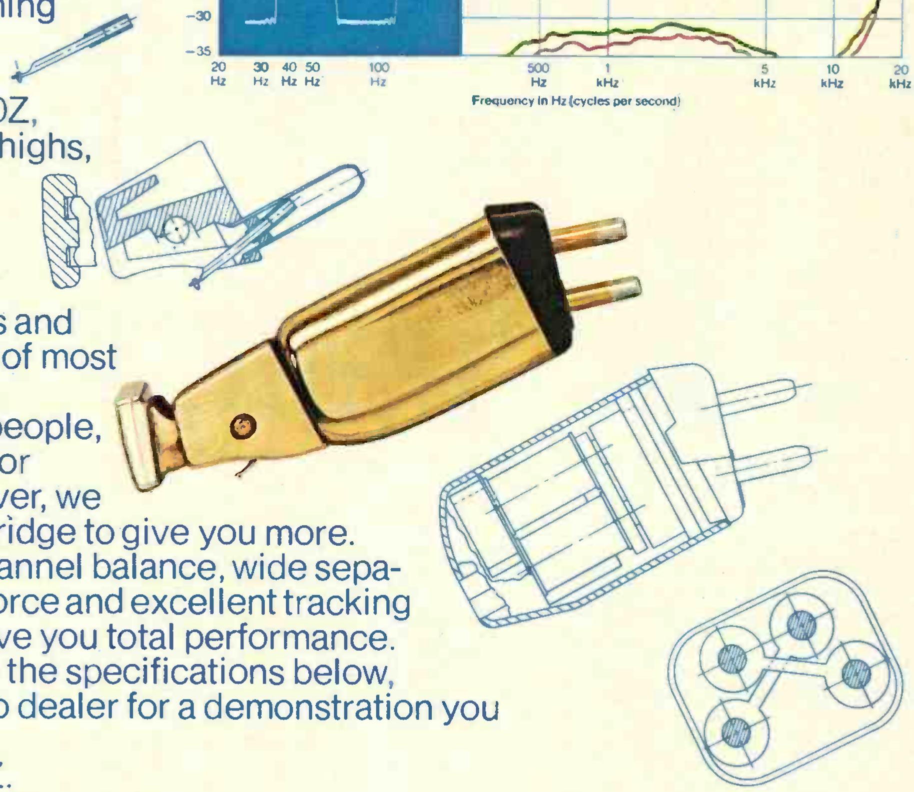
Blueprint for Flat Frequency Response

In the graph below, frequency response was measured using the CBS 100 Test Record, which sweeps from 20-20,000 Hz. The vertical tracking force was set at one gram. Nominal system capacitance was calibrated to be 300 picofarads and the standard 47K ohm resistance was maintained throughout testing. The upper curves represent the frequency response of the right (red) and left (green) channels. The distance between the upper and lower curves represents separation between the channels in decibels. The inset oscilloscope photo exhibits the cartridge's response to a recorded 1000 Hz square wave indicating its resonant and transient response.



Smooth, flat response from 20-20,000 Hz is the most distinct advantage of Empire's new stereo cartridge, the 2000Z.

The extreme accuracy of its reproduction allows you the luxury of fine-tuning your audio system exactly the way you want it. With the 2000Z, you can exaggerate highs, accentuate lows or leave it flat. You can make your own adjustments without being tied to the dips and peaks characteristic of most other cartridges.



For a great many people, this alone is reason for owning the Z. However, we engineered this cartridge to give you more. And it does. Tight channel balance, wide separation, low tracking force and excellent tracking ability combine to give you total performance.

See for yourself in the specifications below, then go to your audio dealer for a demonstration you won't soon forget.

The Empire 2000Z.

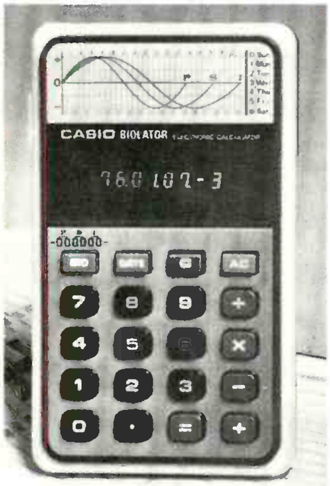
Already your system sounds better.

Frequency Response—20 to 20K Hz ± 1 db using CBS 100 test record.
Recommended Tracking Force—¾ to 1¼ grams (specification given using 1 gram VTF)
Separation—20 db 20 Hz to 500 Hz
30 db 500 Hz to 15K Hz
25 db 15K Hz to 20K Hz
I.M. Distortion—(RCA 12-5-105) less than .08% .2K Hz to 20K Hz @ 3.54 cm/sec
Stylus—0.2 x 0.7 mil diamond
Effective Tip Mass—0.2 mg.
Compliance—lateral 30×10^{-6} cm/dyne
vertical 30×10^{-6} cm/dyne
Tracking Ability—0.9 grams for 38 cm per sec @ 1000 Hz
0.8 grams for 30 cm per sec @ 400 Hz
Channel Balance—within ¾ db @ 1 kHz
Tracking Angle—20°
Recommended Load—47 K Ohms
Nominal Total System Capacitance required 300 pF
Output—3mv @ 3.5 cm per sec using CBS 100 test record
D.C. Resistance—1100 Ohms
Inductance—675 mH
Number and Type of Poles—16 Laminations in a 4 pole configuration
Number of Coils—4 (1 pair/channel—hum cancelling)
Number of Magnets—3 positioned to eliminate microphonics
Type of Cartridge—Fully shielded, moving iron

INTRODUCING
EMPIRE
2000Z
SUPER STEREO CARTRIDGE

news HIGHLIGHTS

Biorhythm Calculator



A new calculator which measures an individual's biorhythm in three significant areas — physical, sensitive (emotional), and intellectual — is being introduced by Casio as the "Biolator." A person's biorhythm is said to fluctuate in cycles of 23 days for physique, 28 days for sensitivity, and 33 days for intellect. A biorhythm graph is provided above the calculator's numerical display. Although the company has expressed no opinion as to the validity of the biorhythm theory, for adherents of the idea, the calculator offers a quick and inexpensive means of determining biorhythm guide numbers. Aside from the machine's biorhythm capabilties, it also performs regular mathematical functions of addition, subtraction, multiplication, and division. Priced at $29.95.

Drops Receiving Tubes & Test Instruments

Faced with a sharp decline in demand for receiving tubes, RCA has announced that it is closing its receiving tube plant in Harrison, NJ. The continuing shift to solid-state devices in consumer, industrial, and defense electronic systems is responsible for the decision. Sales in number of tubes dropped 80% since 1966. RCA is presently the sole source of about 110 tube types and plans to continue to sell tubes. Hopefully, there will be a buyer on the horizon. At the same time, RCA has sold its electronic instrument business to Viz Manufacturing Co., of Philadelphia, which will manufacture and distribute RCA's VOM's, scopes, signal generators, probe assemblies, and battery testers.

"Inching" Toward Metric

Although the metric system of weights and measures has been legal for use in the U.S. since 1866 by an Act of Congress, legislation to place the United States on a course toward voluntary conversion to the metric system was only recently signed into law. Under the new policy, industrial and commercial enterprises will be encouraged to export products made to metric dimensions, thus meeting the needs of foreign purchasers and, hopefully, providing a stimulus to international trade. The National Bureau of Standards, which has had primary responsibility for providing metric information, will hand over its duties to a 17-member United States Metric Board. NBS will continue to make available metric information, including the NBS Metric Kit and "What About Metric," a booklet that explains metric in layman's terms. NBS Metric Information Office, Washington, D.C. 20234 is the place to write.

NBS Measures 148 THz

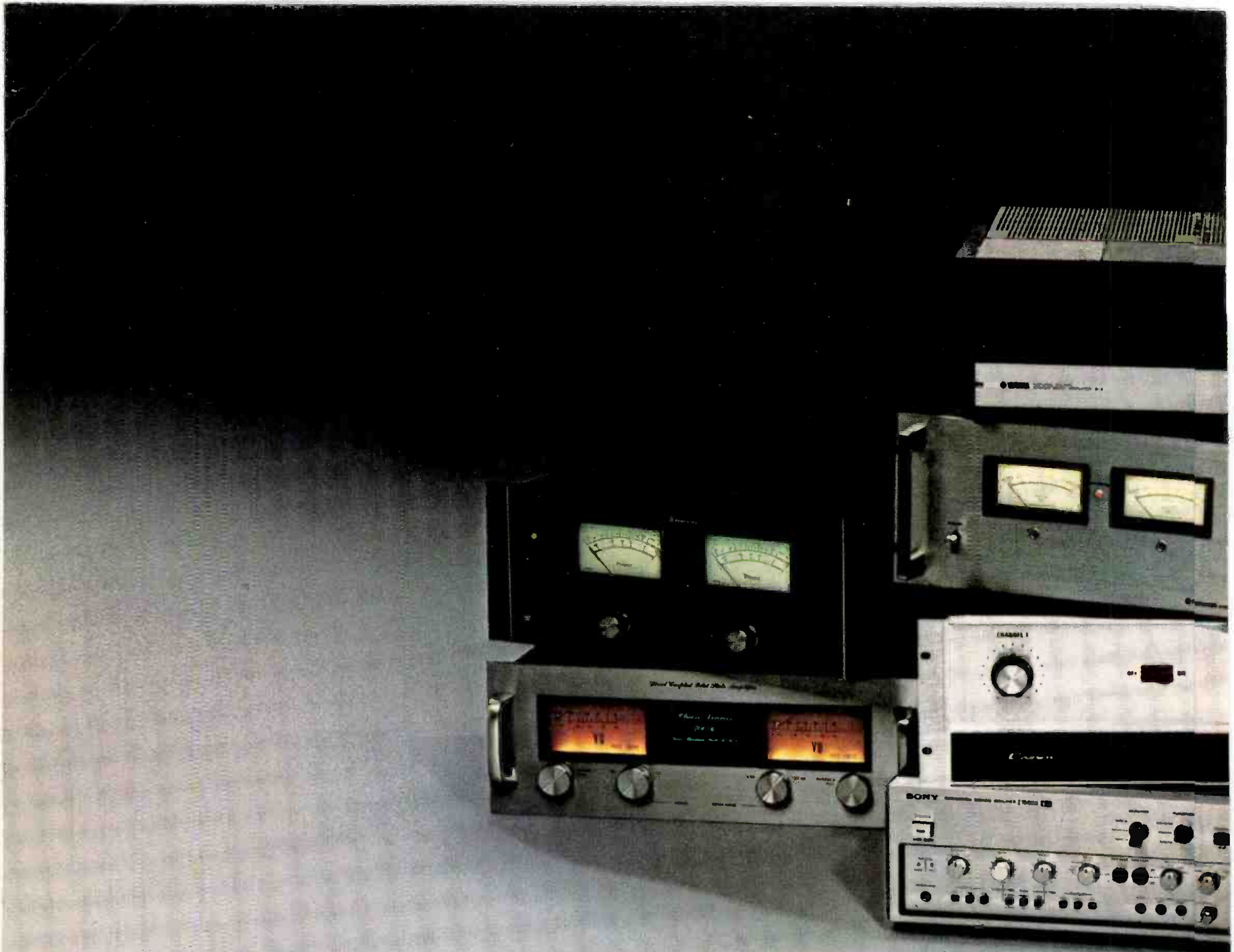
Researchers at the Boulder Laboratories of the National Bureau of Standards have extended the realm of directly measurable frequencies to 147.91585 THz (terahertz, or 10^{12} Hz), with a probable error of one part in ten million. This frequency is only a factor of three below the red end of the visible spectrum, which is the next target of the NBS physicists. Frequency measurement in the near infrared was carried out without the benefit of stabilized lasers. Had they been used, accuracy could have been improved to the level of one part in 10 billion or better. A high, accurately known frequency is synthesized by heterodyning, usually by irradiating a metal-to-metal point-contact diode with laser and klystron oscillators. Then, the known signal is mixed with an unknown on the same diode. If the beat (difference) frequency is not too large, it can be measured with ordinary instruments. Thus, the unknown frequency is the sum of the difference frequency and the known laser/klystron frequency.

Computer-Generated Art Exhibit

"A Total Environment of Computer Art and Design" will be the theme of the 1976 National Computer Conference's computer art exhibit. The exhibit will demonstrate the varied forms of computer-generated art, including wall hangings, computer music, and computer films, plus computer-created objects for space planning, such as furnishings and fabric designs. The Conference will be held at the New York Coliseum from June 7 through 10. According to a Committee member, much of the material on exhibit will be auctioned for the benefit of those who participate. Requests for facsimile entries will go out shortly to individuals, companies, and educational institutions. Further details are available from American Federation of Information Processing Societies, Inc., 210 Summit Ave., Montvale, NJ 07645.

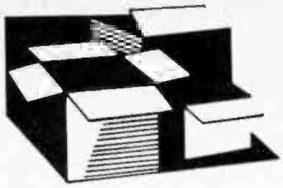
London To Honor Blumlein

The Greater London Council will erect a commemorative plaque on the wall of Alan Dower Blumlein's home in London in recognition of his many achievements in science and technology. Blumlein was the inventor of modern recording techniques, of stereo, the closely coupled inductive ratio-arm bridge, the cathode-follower circuit, and the so-called "Miller" integrator, among others. The BBC adopted Blumlein's specification in the 1930's for the 405-line, 50-frame interlaced TV system still used by the BBC today. During his short working life, Blumlein was awarded an average of one patent each six working weeks. The official unveiling of the plaque will take place on or about June 7, 1977, the anniversary of his death.



IN THE LAST 24 MONTHS 11 COMPANIES HAVE INTRODUCED "SUPER AMPLIFIERS" THAT YOU CAN'T FULLY APPRECIATE UNTIL YOU HEAR THEM THROUGH THESE SPEAKERS.


dynaco
STEREO 400 POWER AMPLIFIER
SAE
HPM-200



New Products

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

POWER-BOOSTER AMPLIFIERS

Two power-booster amplifiers that electronically boost the audio output of a car stereo or radio are being marketed by Boman Industries. The PB-50 increases power to 50 watts "peak" and has input jacks for an electric guitar or public-address microphone. PB-40 boosts power to 40 watts "peak." Both units measure 7¾" D × 5" W × 2" H, and have independent volume controls.

CIRCLE NO. 85 ON FREE INFORMATION CARD

JVC STEREO CASSETTE DECK

The Model CD-1950 stereo cassette deck from JVC America features a front-load configuration and 0.1% wow and flutter rating. In addition, the unit offers pushbutton control mechanisms, independent capstan

and reel disc drive belts, a capstan flywheel, and an automatic noise reduction system. Other features include a 3-digit tape counter, headphone jack, left/right mike jacks, and VU meters. The deck weighs 17 lb (7.5 kg) and measures 16½" W × 11¾" D × 5⅛" H (42 × 30 × 13 cm). It comes with one cassette tape, two head-cleaning sticks, and two connecting cords.

CIRCLE NO. 86 ON FREE INFORMATION CARD

HEADPHONES FOR CB

Three headphones, designed specifically for CB applications, have been introduced by Superex Electronics Corporation. All three models have a built-in gain-limiting circuit which automatically and instantaneously cuts volume when a strong signal is received. CB-10-2 is a base-station unit ($25.00); CB-10-2S is a single-ear mobile unit ($20.00); CB-10-2S-M is a mobile unit phone with 200-ohm boom mike attached, featuring remote-control PTT switch ($40.00). The series comes in black and stainless styling.

CIRCLE NO. 87 ON FREE INFORMATION CARD

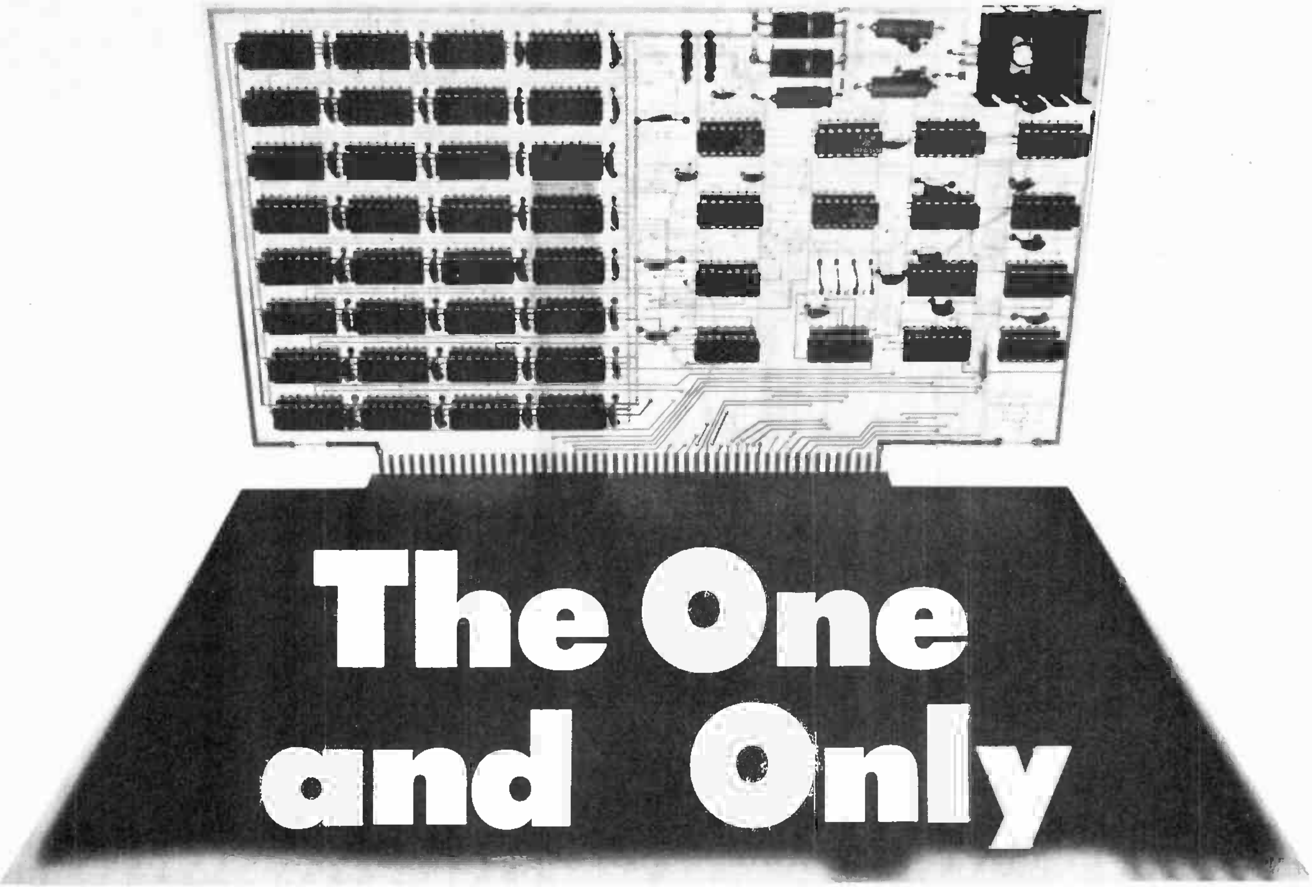
AUDIO EQUALIZER

Ace Audio Co. has announced a new audio equalizer, the AE 2002, which is being offered in kit or wired versions. The equalizer has 5 bands/channel, each covering a range of two octaves. Rated at 2 V output to a 10,000-ohm load, maximum output is 8 V rms; distortion is less than 0.5% IM or harmonic; hum and noise is −80 dB. There are switches for power, tape monitor, and equalizer in-out. An unswitched ac outlet is provided. Uses include adjusting speaker response, room acoustics, program material, and tape recordings. The unit is housed in an aluminum chassis with brushed aluminum faceplate and maple end caps. Measures: 12¼" W × 7" D × 3½" H (32 × 17.5 × 9 cm) and weighs 3 lb (2.7 kg). $84.25 (kit), $133.75 (wired).

CIRCLE NO. 88 ON FREE INFORMATION CARD

HAND-HELD DIGITAL MULTIMETER

Non-Linear Systems has added the LM-3.5 "Volksmeter Plus" to its line of digital multimeters. The instrument has 3 full digits



Altair® 4K Static.

Altair 4K Static from MITS is unquestionably the finest 4K static memory available anywhere. It is also the fastest.

Altair 4K Static uses Intel 2102 A-4 memory chips which have a worst case access of 450 nanoseconds at 70°C. At normal system temperatures the access times are typically less than 300 nanoseconds.

Altair 4K Static is fully isolated from the system bus by Schmitt™ Triggers. Thus, the excessive capacitive loading caused by other 4K static memories is eliminated. Use of these triggers on all Altair 4K static inputs greatly reduces noise. Internal data collection nodes also use Schmitt Triggers, which prevents internal data bus noise from being transmitted to the system data bus.

Altair 4K Static is the only 4K static supported by MITS. Owners of Altair 4K Static are eligible to qualify for discounts on Altair BASIC and other MITS products.

Altair 4K Static is the only 4K static that comes with all the required Altair hardware including edge connectors and card guides.

Altair 4K Static is the answer for Altair owners who need static memory for special applications such as the TV Dazzler from Cromemco.

PRICES:

Altair 4K Static Kit	$159
Altair 4K Static Kit with 2K Memory	$134
Chip set to convert 2K to 4K	$ 45

SPECIAL—Altair Documentation Notebook. Contains catalog, price sheet, Computer Notes newspaper, Software Information Package, technical data on Altair hardware, list of authorized Altair dealers, list of computer clubs, survey of home computing market, and much more. All in top quality three ring binder. Only $5 plus $1 for postage and handling. Offer expires April 30, 1976.

MAIL THIS COUPON TODAY

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BankAmericard # ________ or Master Charge # ________
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Include $3 for postage and handling
☐ Please send me the Altair Documentation Notebook. Enclosed is $5 plus $1 for postage and handling.
☐ Please send free catalog and price sheet.

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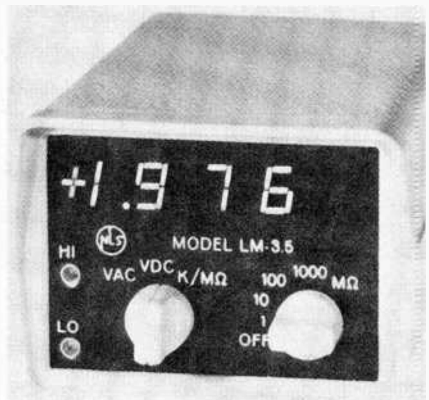
MITS/2450 Alamo SE/Albuquerque, NM 87106/505-262-1951

Prices, delivery and specifications subject to change.

mits
2450 Alamo SE/Albuquerque, NM 87106/505-262-1951

CIRCLE NO. 37 ON FREE INFORMATION CARD

plus 100% overrange and is a multifunction, multi-range meter that fits in the palm of the hand. Self-contained rechargeable NiCd batteries permit portable operation or 117-V ac operation with the charger unit (batteries and charger included). Features include four ranges of dc and ac volts to 1000 V dc or peak ac with 1 mV resolution on the 2-V range, ohms with 1-ohm resolution and five ranges from 2k to 20M full-scale, ac and dc current in 3 ranges using shunts supplied, and automatic polarity. Input impedance is 10M on all voltage ranges to eliminate circuit loading. 4" D × 2.7" W × 1.9" H (10 × 6.5 × 5 cm).

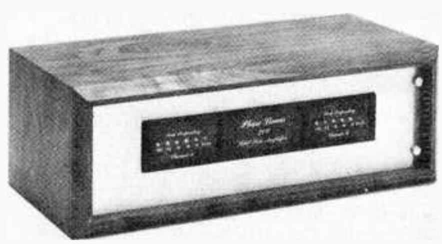


Price $147 including input leads, batteries, charger, and current shunts. Optional accessories include leather case, high-voltage probe, and desk stand.

CIRCLE NO. 89 ON FREE INFORMATION CARD

105W/CH POWER AMPLIFIER

Phase Linear has introduced the Model 200 stereo power amplifier. Power output is 105 W/ch minimum rms at 8 ohms from 20 to 20,000 Hz at 0.25% THD. Hum and noise is rated at least 100 dB below rated power. The amplifier features a peak-responding power-output display using LED's and an



electronic protection circuit which interrupts the amplifier output whenever hazardous input is present. The amplifier also includes a current-feedback-reducing switch. A walnut cabinet is available as an accessory. 19" W × 8¾" D × 5½" H (48 × 22 × 14 cm). Weight 16 lb (7 kg). $389.00.

CIRCLE NO. 91 ON FREE INFORMATION CARD

TRIGGERED-SWEEP SCOPE

The Model 1471 dual-trace 10-MHz triggered-sweep scope from B&K-Precision has 18 calibrated sweep ranges from 1 μs/cm to 0.5 s/cm and sweeps to 200 ns/cm. It will display characters directly from TTL drives. The scope is suitable for logic and digital design applications and for troubleshooting phase-locked loops, DMM's, synthesizers, counters, and calculators. Deflection factor is 0.01 V/cm to 20 V/cm ±5% in eleven ranges. Calibration accuracy is maintained from 105 V to 130 V ac. Rise time is rated at 35 ns. Measures: 16⅛" D × 9⅞" W × 7⅞" H (41 × 25 × 20 cm); and weighs 19.6 lb (8.9 kg). $495.00.

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RECTILINEAR FLOOR SPEAKER SYSTEM

Rectilinear Research Corp. introduces the "Rectilinear 7" floor-standing speaker system, a new top-of-line system in its Contemporary Laboratory Series. A four-way system, it employs six drivers: a 12" woofer, 7" upper-bass midrange, two 1½" upper-midrange tweeters, and two 1" super tweeters. Minimum amplifier power, 30 W rms, maximum power handling, 350 W rms. Uses a filter network rather than conventional crossover, set for uniform energy output; no level controls. Claimed frequency response, 32 to 20,000 Hz ±2 dB. Oiled walnut cabinet made of high-density fibrous material. Measures 35" H × 18" W × 12" D (88.9 × 45.7 × 30.5 cm) and weighs 80 lb (36.28 kg). $399.00.

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24-PIN IC TEST CLIP

A new 24-pin test clip for IC's from Continental Specialties, the Proto-Clip 24, has a narrow throat to bring IC leads up from high-density pc boards. It can be used to inject signals and wire unused circuits to other boards. Scope probes and test leads lock onto the gripping contact teeth, freeing hands for other work. Noncorrosive nickel/silver contacts provide simultaneous wiping action. $8.50.

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CORDLESS SOLDERING IRON

An 11-piece soldering iron kit, Model WC100K which contains a cordless iron and standard outlet power charger, three different tips, screwdriver, solder, soldering aid tool, sponge, instruction booklet, and plastic carrying case with tool tray has

AN INTRODUCTION TO STEREO.

At Yamaha, we feel uniquely qualified to introduce you to the joys of true stereo high fidelity sound.

Since 1887, Yamaha has been making some of the finest musical instruments in the world. Pianos, organs, guitars, woodwinds, and brass.

With our musical instruments, we've defined the standard in the *production* of fine sound. And today, with our line of state-of-the-art stereo components, we're defining the standard of its *reproduction.*

However, at one time, owning a Yamaha stereo system tended to be a rather expensive proposition. Our "ultimate" system, for example, hailed by the critics for such innovations as Vertical-FET circuitry and beryllium dome speakers, carries a suggested retail price of over $7,000.

But now, Yamaha introduces a selection of new stereo components that let your Yamaha audio dealer create a high quality system for a suggested retail price of around $700.

What you're getting is the same performance and design concept of our most expensive system, but without the frills. Also, each component has been specially selected and matched to enhance the performance of the other components.

The Receiver: There's a lot more than power to our new CR-450 stereo receiver.

You'll enjoy brilliant tonality resulting from super low distortion—0.1% intermodulation and total harmonic distortion. (These figures are amazing, considering most other competitive receivers are typically .5% to 1.0%!)

In addition, Yamaha offers a full complement of functional features on the CR-450. Twin meters for precise tuning. High and Low Filters to eliminate noise interference. And two headphone jacks, so you don't have to listen alone. Plus our own exclusive Variable Loudness Control, which gives you full tonal balance—even at low volume levels.

The Turntable: Yamaha's new high-performance YP-450 shares many of the features of our "ultimate" system turntable, the YP-800.

A low mass tonearm, with adjustable height and anti-skating, allows the stylus to track flawlessly at the lightest pressure. And the cue control is viscous-damped in both directions to prevent record damage.

A handsome walnut-grained base and a dust cover are standard.

The Speakers: By the careful refinement of proven acoustic and electronic engineering principles, Yamaha's NS-2 rivals the sound quality of many larger, more expensive speakers.

The NS-2's soft dome tweeter and high compliance, foam surrounded woofer (the same design principles featured in our superlative NS-690 speaker) offer excellent high frequency dispersion as well as clean, accurate bass reproduction.

Underneath the NS-2's removable grille cloth, quality construction is evident in the fully finished front cabinetry.

The Headphones: Yamaha's patented new Orthodynamic design HP-2 combines the smooth highs of the best electrostatic headphones with the full, rich bass of the best dynamic types.

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An Introduction to Stereo. Chances are, when it comes to understanding terms like watts, dB's and signal-to-noise ratios, you're probably a little confused. So we've prepared a booklet that explains the basics of the world of sound.

Appropriately enough, it's titled "An Introduction to Stereo."

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Then, once you know the basics, visit your local Yamaha audio dealer. His knowledgeable salesmen and extensive demonstration facilities can save you a great deal of time and money in helping you select a system. And his first-class service will keep you happy.

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HAM COMPUTER TERMINAL

Computronics' "Morsetyper" computer terminal, Model BDC, can store over six "Quick Fox" sentences or 256 "V" characters in its five registers. It will use this memory capacity in two modes, QSO or QST, at speeds from 5 to 200 w/m. Both modes allow random speed touch-in while the machine outputs uniformly at any set speed. A 56-pad touch keyboard provides 36 alphanumerics, 8 punctuation, 7 prosigns, 5 prowords, and error. Distress messages or bulletins can be endlessly repeated, making the machine a solid-state equivalent of a tape recorder but with the advantage of instant reprogramming. Three status lights and a monitor allow the functions of the Morsetyper to be seen and heard. The unit will operate from 120/240V, 50/60 Hz ac. It measures 13.75" W × 8.5" D × 4" H (35 × 22 × 10 cm); shipping weight is 10 lb (4.5 kg). $495.

CIRCLE NO. 96 ON FREE INFORMATION CARD

CD IGNITION SYSTEM

Delta Products, Inc. now has a new high-energy capacitive discharge ignition system — Mark Ten C. Designed for modern-day engines with or without emission con-

trol devices, the system uses "Vari Spark" circuitry plus improved thermal output energy, new dc-to-dc converter/ transformer, and high output energy to help overcome problems caused by poor manifolding, lean mixtures, and variations in gasoline. Available fully assembled at $69.95.

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BASE-STATION FILTER FOR CB

Cornell-Dubilier has added a susceptibility base-station filter to its line of CB noise filter products, the Model CBBS-1. It is designed to remove interfering power-line signals entering base-station receptacles through the ac power lines. The filter is applied at the base station.

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AUDIO SIGNAL-TO-NOISE SQUELCH

"Sound Off" is a self-compensating signal-to-noise squelch that operates directly on the audio signal. It can be placed anywhere in the audio line and will squelch the signal whenever speech or other information is removed. Applications include vhf communications, SSB communications, telephone circuit systems, and voice-operated tape recorders. It operates from its own ac power supply and automatically compensates for changes in atmospheric noise and is insensitive to false triggering by impulse or other noise. Heart of

the unit is a patented miniature signal analyzer which constantly monitors the content of the channel and determines if information or noise is present. Kahn Communications, Inc., 74 N. Main St., Freeport, N.Y. 11520.

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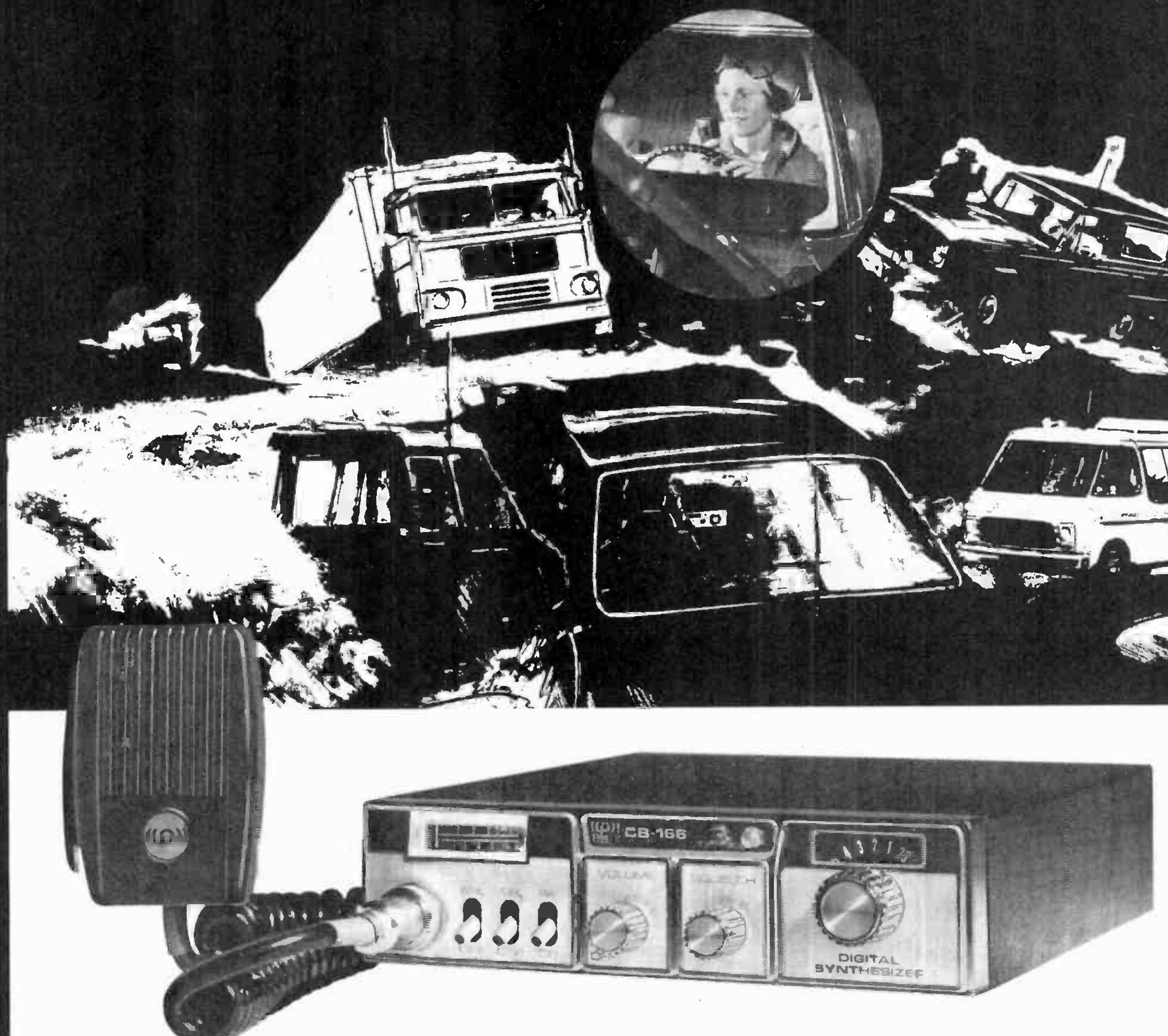

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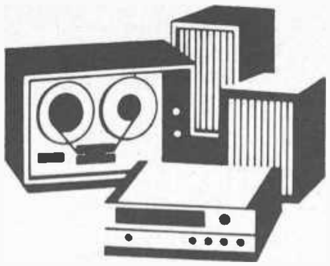

Stereo Scene

By Ralph Hodges

HI-FI UPGRADING TIPS

THIS COLUMN is addressed mainly to those who, having recently acquired their first audio systems and installed them in a mad rush of anticipation, have never gotten around to those last, fussy little details and adjustments necessary to bring performance up to its peak. There are also some notes on routine maintenance, and a couple of items that might be called helpful hints of interest even to old timers.

The War With the Neighbors. You apartment dwellers who risk eviction proceedings every time you turn up the volume control may appreciate this item. It is amazing—even astonishing—to discover how much intra-building noise is transmitted, not through the air, but through the structure of the building itself. A heavy speaker resting on a bare floor will inevitably impose vibration on the underlying supports, and these impulses can travel with very little loss to the strangest and most remote places. The solution is to shock-mount the speaker at the points where it rests on the building structure. Experience shows that the smallest expenditure can yield great improvements. Even the simple rubberized squares intended to be placed under the legs of furniture will, in many cases, completely pacify a disturbed neighbor. Layers of carpet underneath the speaker should do better still. For problem cases you might construct a "sandwich" of plywood sheets with a slab of polyurethane foam in between, making sure that the foam is not compressed so much that it loses its resiliency.

My speakers sit on a wood platform constructed of 2 × 3's and plywood flooring. Every point where the platform contacts wall or floor is buffered with a rubber socket. I think I may have overdone it, because aside from those few privileged guests who have been invited to the inner sanctum to hear the system in all its glory, no one else in the building seems to know it exists.

Incidentally, another prime factor in noise transmission is the ventilating ducts found in apartments with interior bathrooms or kitchens. Usually these can be blocked off with chunks of foam for listening sessions, but even closing strategic doors around the apartment before you turn on the music may do the trick.

Wiring Yourself For Sound. Now it's time to look at that rat's tangle you call your speaker cables. Any conductor that connects speaker to amplifier will enable the speaker to make a noise, but inadequate wiring will waste amplifier power, degrade the damping factor, and subtly but measurably affect frequency response. Rarely will any of this be grossly audible, but why ask for trouble? The nomograph of Fig. 1 (courtesy Crown International) reflects the practices of professional installers. If you're in doubt or too lazy to measure the required cable lengths, number 16 lamp cord is adequate for most home installations where amplifier and speakers share the same room.

Cleanliness Counts. Air circulates in generous amounts through an audio amplifier when it is in use, and the air brings dust with it. When it collects on heat sinks and chassis, the dust tends to contain the heat, which then has a chance to do its dirty work on capacitors and other circuit components. At least once a year it's a good idea to take the cover off your amplifier (and other electronic components) and wipe it down with a rag dampened with a mild cleaning agent. Vacuum tubes, if any, should be removed and thoroughly swabbed, and the fans on the backs of capstan motors in tape recorders deserve a careful going-over. The little finned assemblies often attached to circuit-board transistors are also heat sinks that require the cleaning treatment. There will usually be a greasy substance in the vicinity of driver and power transistors. Novices have been known to react to its presence with horror, but it is merely a silicon compound to improve the efficiency of the heat sinks, and it should be left undisturbed as much as possible.

While the covers are off, you might (if you're equipped with a proper voltmeter) want to check that the power-supply voltage(s) is within tolerance, and that none of the coupling capacitors are "leaking." The presence of appreciable dc levels on the "cold" sides of coupling capacitors is often a sure prophecy of puzzling sonic degradation in the near future. If supply voltages and coupling capacitors are holding up, you can clap the cover back on the unit with reasonable confidence of good performance in the coming year. But before you close things up squirt all controls and switches with a good TV tuner cleaner. And when you reinsert the component into the system, make sure that all connections are tight and that interconnecting cables are not intermittent.

Getting Needled. Surprisingly, a major contributor to bad sound is a dirty phono stylus. I once thought that the enormous pressures involved with tracking a phonograph record would pulverize and then wipe away any contaminants that might build up on the stylus, but authorities tell me otherwise. Anyway, there is certainly no question about the horrendously bad sound that a dirty stylus can produce.

You can pick your own solution to dirty styli. Any grain alcohol will do, although I prefer vodka when I can get it. Simply fold your cocktail napkin to form a sharp point, dip said point quickly into the alcohol and rub it gently around the tip and base of the stylus. In a short time the tiny diamond chip should begin to exhibit a (usually) yellowish highlight, and the job is virtually done. Afterward, the stylus should be kept clean by stroking, with a soft brush, after every record. The experts say you should brush only from back to front, but for many years I have had no problem with brushing every which-way. I do keep the speakers on when I brush, however. (A noise loud enough to harm the stylus is also likely to destroy the speakers, so you

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The AU-7700 integrated amplifier offers a power output of 55 watts per channel, min. RMS, both channels driven into 8 ohms, from 20Hz to 20kHz and no more than 0.1% total harmonic distortion. Features a 7-position tape play/dubbing switch for creative recording versatility; selectable phono input impedance. It is matched with the TU-7700 tuner, featuring a 1.8μV sensitivity for picking up even the weakest signals. Selectivity of better than 80 dB.

Sansui also offers an AU-4400 integrated amplifier and TU-4400 tuner which display the same Sansui high quality performance and many of the same features as the other pairs in this series of separates.

If you should not be as yet a devotee of separate components, any of these pairs is sure to make you one. Stop in soon at your nearest Sansui franchised dealer to select any of the three combinations for musical enjoyment you will value for many years to come.

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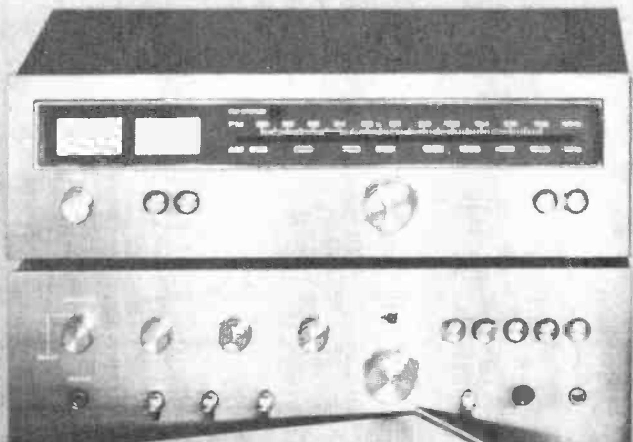
AU4400



TU5500
AU5500

TU7700
AU7700

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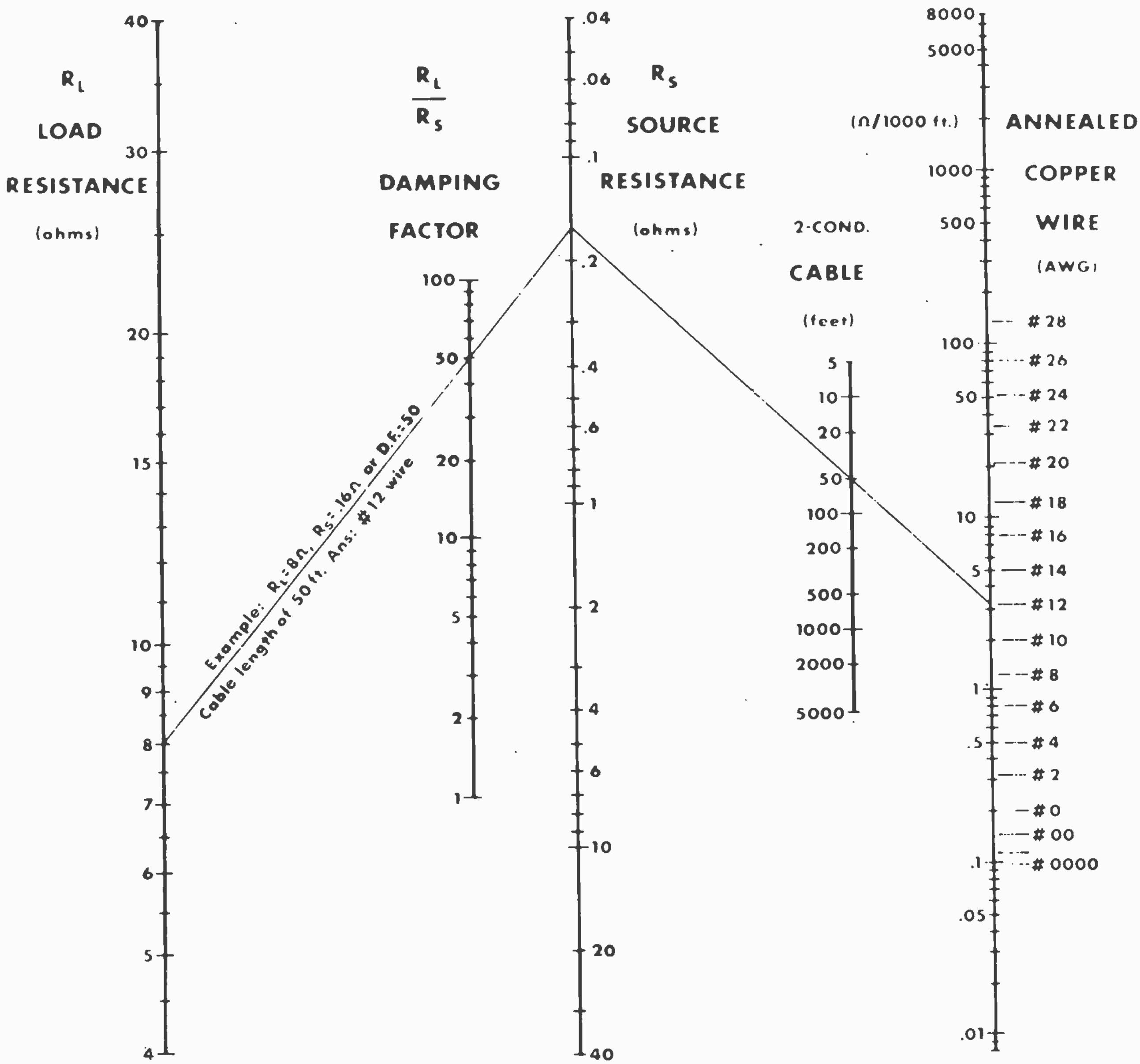

Fig. 1. Nomograph relating cable length, wire size, and damping factor. For a given load resistance and damping factor, wire size and length can be determined.

generally know where you are). And I use *reasonable* care!

When it's time to get your stylus checked for wear (twice a year for heavy users is advisable), go to a place with a good microscope designed for the purpose. However, be aware that many microscopes have insufficient depth of field, improper lighting, or other limitations. Insist on examining the stylus yourself, after the salesman has had his look. This is not to forestall hanky-panky (although it has happened that people have been sold new styli when the old was perfectly adequate), but to familiarize yourself with the appearance of a worn stylus. It is not always easy to judge when a diamond tip has passed the point of usability. Some elliptical styli never acquire the flat spots and chisel edges that are such a risk to records; instead, they grow more rounded, finally becoming virtually conical (or spherical) in profile. In this case, the sound you get from your records remains the best indicator of excessive wear. When the stylus starts snagging the bottom of the record groove (usually indicated by an intolerable increase in noise), it has had it.

I don't want to play down the damage a worn stylus can do to a record; it is a very real and sobering fact.

Alignment Aggravations. A cartridge's stylus assembly must be properly aligned with the record groove or the record won't be traced in the intended way. I have heard numerous testimonials to the effect that cartridge alignment is not critical, but I am still not so sure. Alignment, I feel, can have an effect on the sound you hear, particularly with difficult records. The trouble is that perfect alignment is very difficult to achieve in practice.

The lateral tracking-angle adjustment attempts to assure that the front-to-back axis of the cartridge is precisely parallel to the tangent of the record groove at the point where the stylus contacts it. This tangency is most important at the inner grooves, where the curvature of the grooves is greatest, and where recorded wavelengths are short. The stylus overhang adjustment on many record players can be used to try to achieve this

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CIRCLE NO. 15 ON FREE INFORMATION CARD

(Drawing from Shure owner's manual.)

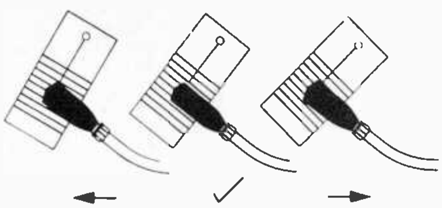


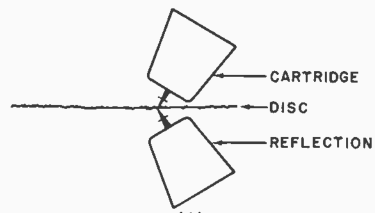
Fig. 2. Center sketch shows correct alignment of cartridge.

tangency, but many turntables are sold without specific instructions on how to make the adjustment. If that is your problem, you can construct the alignment protractor shown in Fig. 2. A 3 × 5 index card should serve your purpose. Drill or cut a hole in one end to fit the turntable spindle snugly. Then draw a straight "radius" line from the center of the hole to the other end of the card. Draw several perpendiculars to this line. Then make a tiny pinhole in the middle of the radius line about 2½ inches away from the spindle hole. If you fit the spindle hole over the turntable spindle and place the phono stylus in the pinhole, the outline of the tonearm's cartridge shell, as viewed from directly above, should be square with the perpendicular lines on the protractor. If it is not, moving the cartridge forward or back in the shell will make it so. And then, assuming that the cartridge is mounted straight within the shell, you have done the best job of lateral alignment that the naked-eye approach permits.

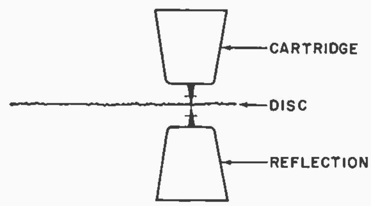
The vertical tracking-angle adjustment is also a line-of-sight operation. The object is to make sure that the cartridge, viewed from the side, is precisely parallel to the record surface. (The reference plane for this adjustment is usually the top of the cartridge, although there is doubt about this in some cases). If the cartridge is not parallel, shimming it with spacers on its mounting screws, or raising or lowering the tonearm base, will get it into shape. Note that this is a compromise adjustment that will not be absolutely correct for every record.

Azimuth adjustment (ensuring that the stylus is vertical to the record surface when viewed from the front) is the easiest adjustment to make. The procedure usually recommended is to place a pocket mirror on the turntable platter, lower the stylus onto it, and adjust until the cartridge and its reflection are aligned (Fig. 3). Unfortunately, most pocket mirrors are silvered on their undersides, so the reflection is some distance away from the cartridge, complicating the adjustment. As a substitute for the mirror, you can use an actual record, which when properly lighted and viewed from the right angle will give an adequate reflection.

How About a New Turntable? The quickest thing to wear out in an inexpensive system is usually the record changer, which may become erratic in its changing mechanism or just generally tired and rumbly. If you're willing to get involved with its innards, even an inexpensive compact system can often be connected to an external



(A)



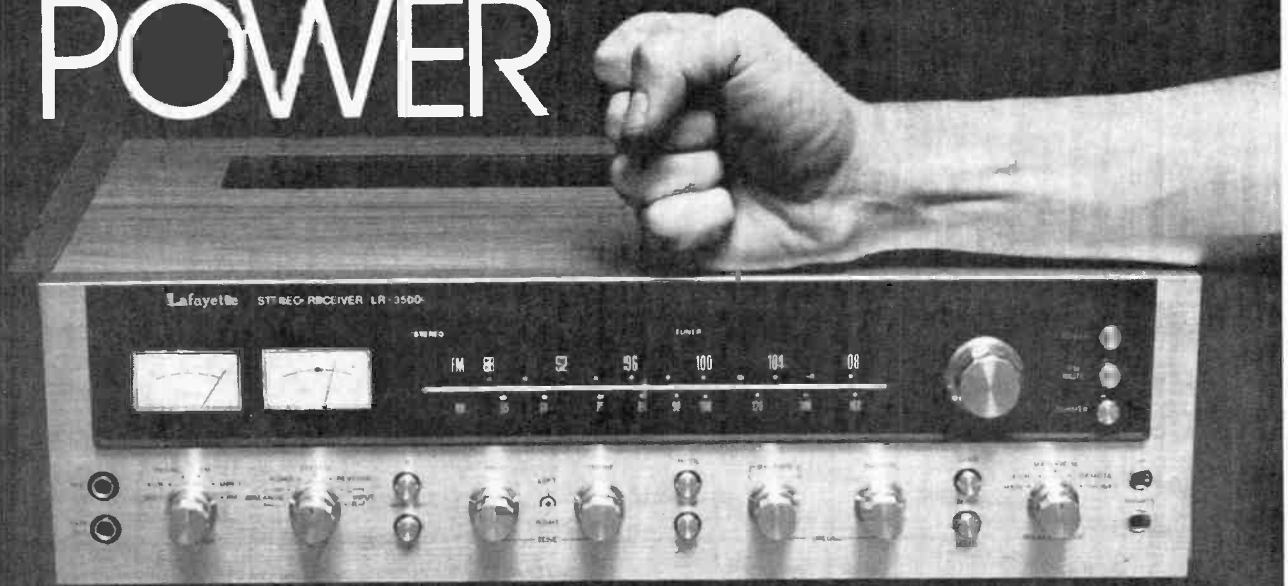
(B)

Fig. 3. Cartridge should line up with its reflection in mirror.

turntable, bypassing the packaged unit. And if it is of reasonably good quality, the outboard turntable will preserve your record collection until you can afford the "ultimate" system.

An obstacle to this plan may arise since most modest record players use ceramic phono cartridges, whereas a good turntable is customarily designed to accept a comparatively light-tracking cartridge of high compliance. As a rule, this means a magnetic cartridge, since there is a severe dearth of high-quality ceramic pickups. However, to meet the requirements of an amplifier designed for ceramic cartridges, the output of a magnetic pickup must be equalized and somewhat amplified. You'll need, therefore, an outboard phono preamplifier to go with the turntable. Such devices are in good supply, ranging from deluxe (and costly) units from Shure and All-Test, among others, to Pickering's and Shure's inexpensive Models PP-1 and M64, respectively. Interfacing these with almost any amplifier should involve no insurmountable problems, although you'll have to pay attention to ground connections. ◈

POWER



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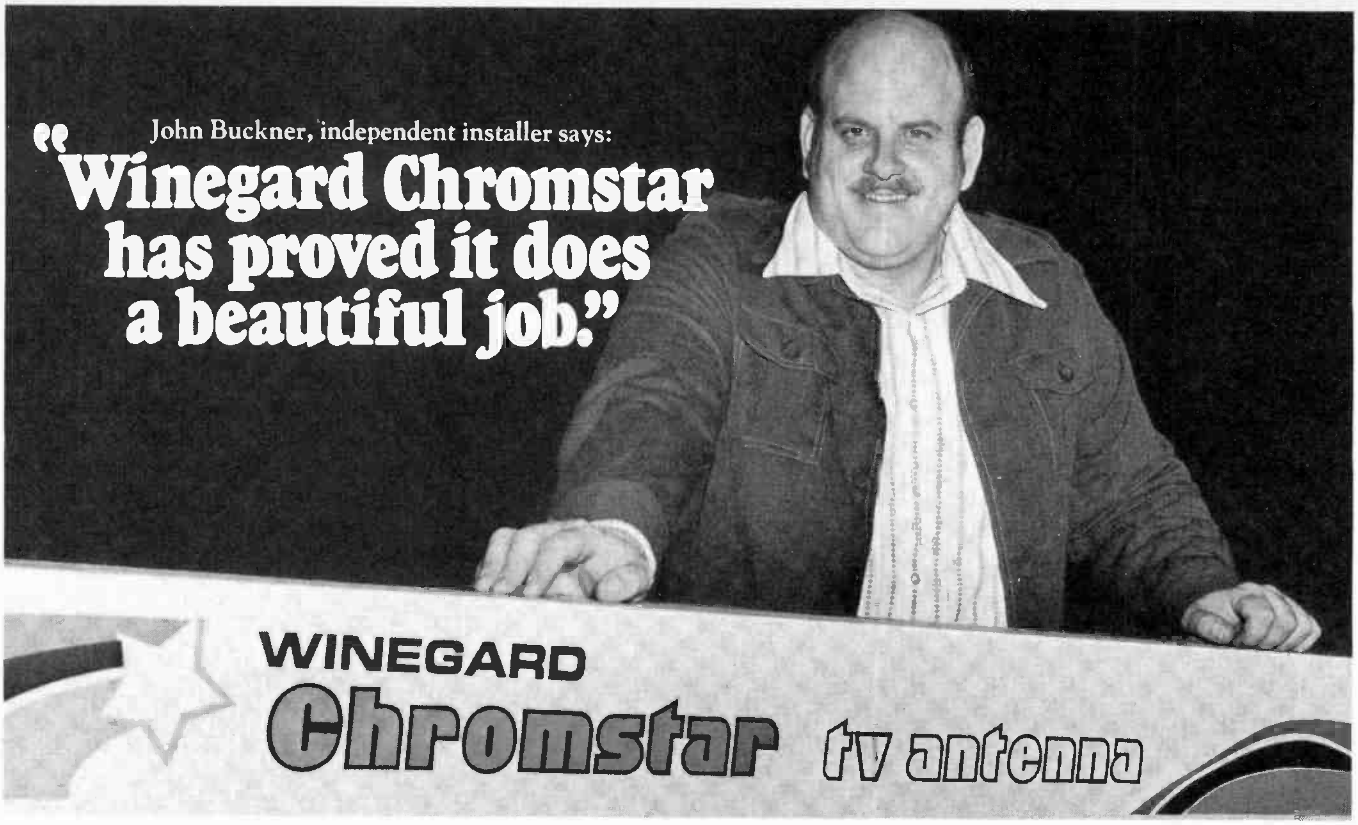

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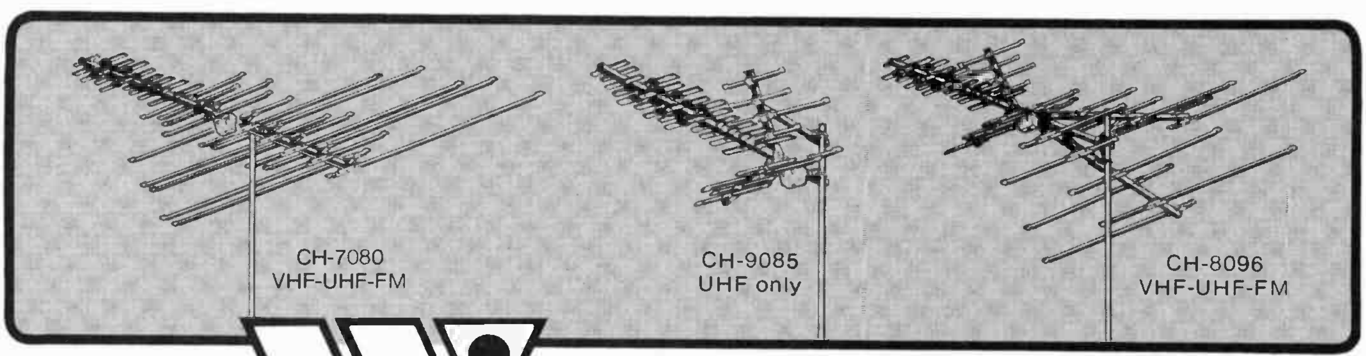

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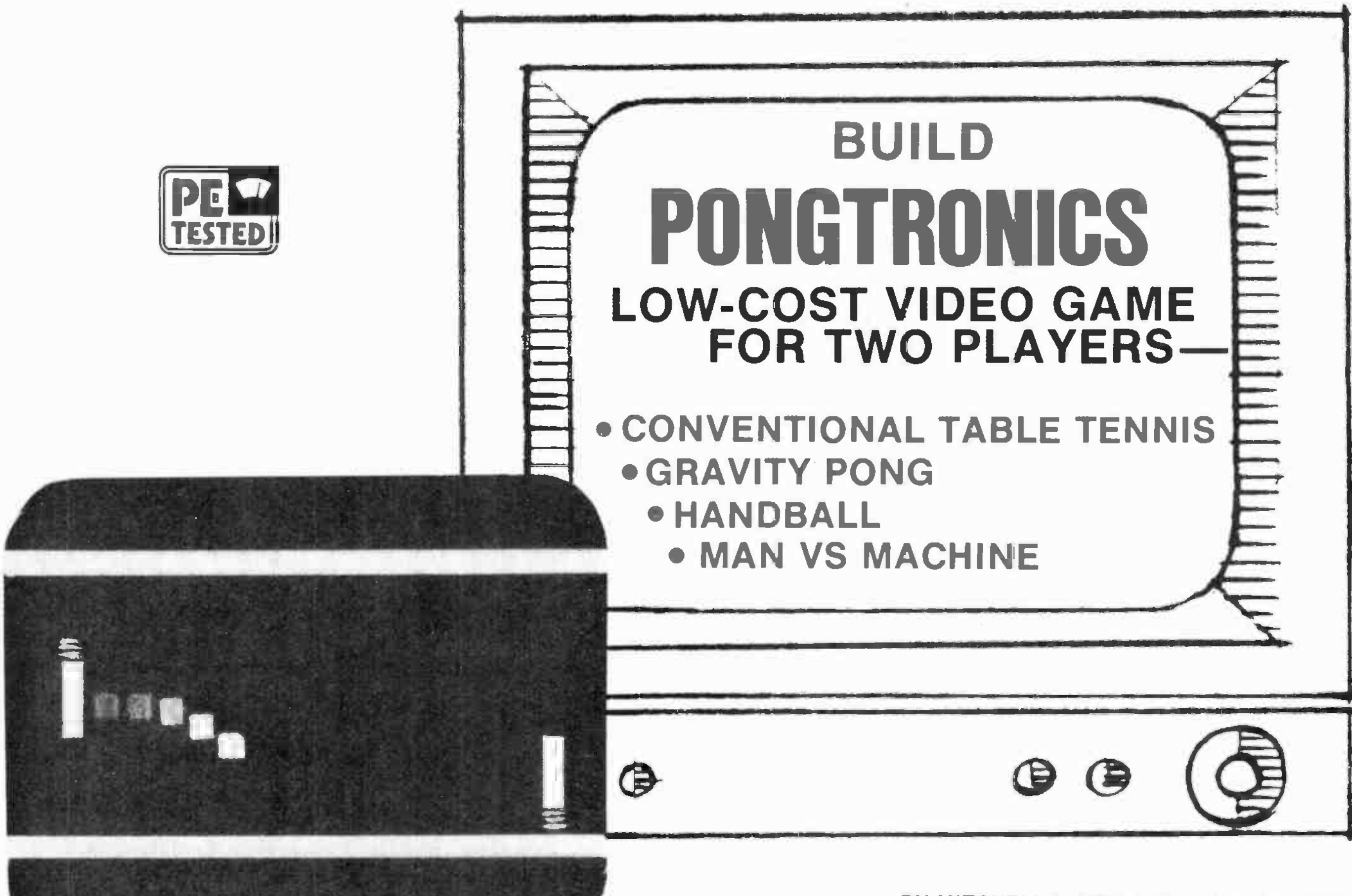


BY MITCHELL WAITE AND LARRY BROWN

EVER since Magnavox introduced its "Odyssey" TV game for home use, the popularity of such items has been increasing. Coin-operated games simulating tennis and hockey now appear in shopping centers, airports, etc., and are challenging conventional electro-mechanical pinball machines in popularity.

Pongtronics, described here, lets you play conventional table tennis on TV, with the ball bouncing back and forth between two paddles and off either the top or bottom walls of the "court." You can also play "gravity pong," where the ball bounces in an arc simulating the influence of gravity, except that in this case it may even reverse gravity. Finally, you can play handball, which converts one paddle into a full court wall on one side.

The Pongtronics is also designed to let one player pit himself against the machine or even have the machine play against itself. In the latter case, you can set the system up so that one paddle has the advantage over the other. The machine-play feature requires the addition of a single switch and a couple of resistors.

Automatic "English" can be put on the ball. How much English depends on which portion of the paddle strikes the ball. If the ball strikes the upper portion of the paddle, it rebounds upward, and vice versa. Hit the ball with the center of the paddle, and it rebounds off in a direction perpendicular to the paddle's plane.

The speed of the ball can be controlled over a relatively wide range from rather slow to quite fast. You can even try to catch your opponent off guard by operating a SLAM pushbutton, to speed up the ball.

In a future issue, we will describe how to add an optional scoring and sound-effects board to the basic Pongtronics game. Provisions are already on the board for this added assembly. (A kit of parts for the addition will be $33.00.)

About the Circuit. The entire schematic diagram of the Pongtronics is shown in Figs. 1 through 4.

Gates *IC1A* and *IC1B* form the horizontal sync generator whose on time is controlled by *C1*, *R2*, and *R3* and off time is controlled by *C1* and *R4* (*D1*

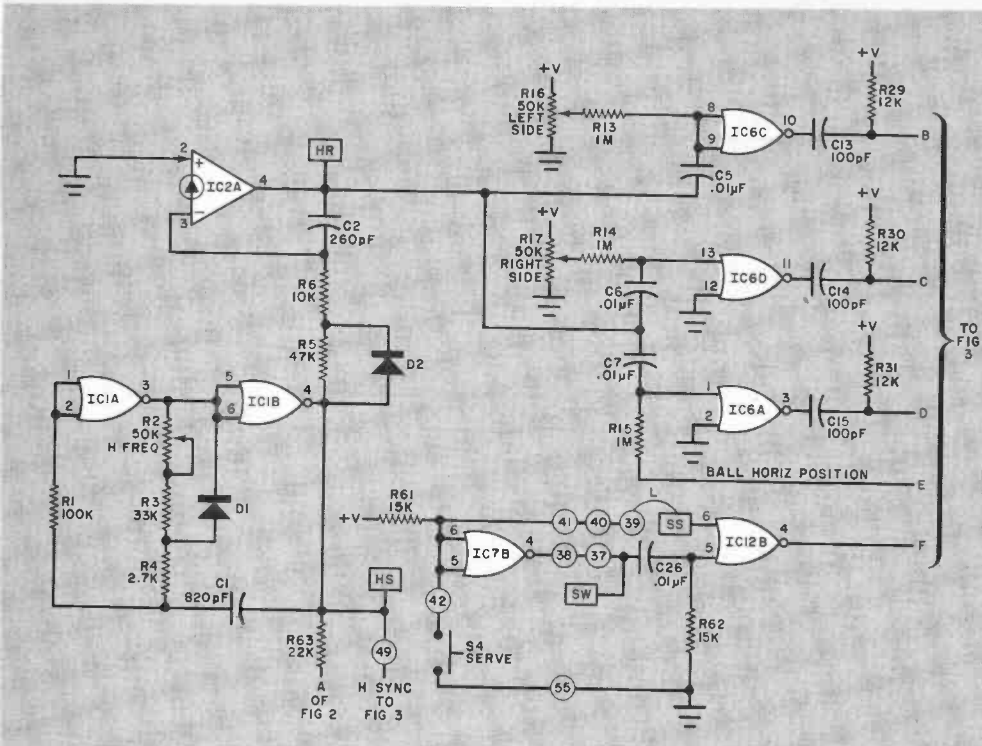


Fig. 1. Horizontal sync and ramp generator and associated comparators.

shorts out *R2* and *R3* during this interval). The output from *IC1B* drives integrator *IC2A*, which ramps up during the on time and resets during the off time. Diode *D2* improves the fall time of the integrator.

The vertical pulse generator, made up of gates *IC1C* and *IC1D* and integrator *IC2D*, operates in exactly the same manner as the horizontal sync generator, except for the repetition rate and the fact that it generates both the vertical sync and vertical ramp.

The horizontal ramp from the output of *IC2A* is coupled through *C5, C6*, and *C7* to left paddle, right paddle, and ball horizontal position comparators *IC6C, IC6D*, and *IC6A*, respectively. By controlling the trip point of the comparators with *R16* and *R17*, the horizontal position of the right and left side of the court (paddles) are set on the TV screen. Differentiators *C13/R29* and *C14/R30* set the horizontal width of the paddles, while differentiator *C15/R31* determines the horizontal width of the ball.

The vertical ramp from *IC2D* couples through *C8* to *C12* to the left and right paddles, top and bottom wall, and vertical ball position comparators. Paddle controls *R24* and *R25* set the trip points of the comparators to position the paddles vertically on the screen. Trimmer control *R26* sets the vertical center reference position of the ball, *R27* the vertical position of the top wall of the court, and *R28* the vertical position of the bottom wall.

Differentiator *R32/C16* at the output of *IC9A* determines the vertical height of the left paddle; *R33/C17* at the output of *IC9B* the vertical height of the right paddle; and *R35/C19* and *R36/C20* at the outputs of *IC9D* and *IC9C* determine the thickness of the top and bottom walls.

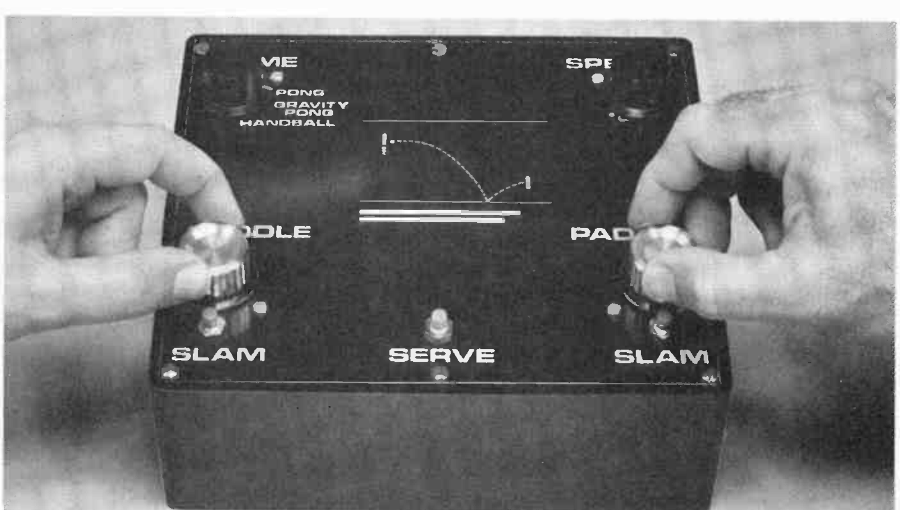
Gates *IC7A, IC7C*, and *IC7D* combine the vertical, and horizontal pulses for the paddles and balls. The top and bottom wall pulses and ball and paddle information are summed in four-input gate *IC8B* to produce the object video signal. The horizontal and vertical sync pulses are summed in *Q1*, while *Q2* accepts the object video signal. Resistors in the *Q2* circuit maintain the black level at about 30%.

The composite video/sync signal is generated across 75-ohm load resistor *R55*. The signal can then be ac coupled into the video amplifier of a TV receiver, or it can be used to modulate an FCC-certified class-1 device for r-f operation into the antenna input of the receiver, on an unused channel.

The left-to-right and right-to-left horizontal movement of the ball is controlled by position integrator *IC2B*, which in turn is driven by horizontal ball control flip-flop *IC4B*. This flip-flop sets and resets each time the ball strikes a paddle. The ball/paddle coincidence signal causes the Q output to change states and *IC2B* to start ramping in the opposite direction. Since the output of *IC2B* connects to ball horizontal position comparator *IC6A*, the horizontal motion of the ball reverses. The horizontal speed of the ball is controlled by *R37, R38*, and *R39*. SLAM pushbuttons *S2* and *S3* can momentarily short out *R38* and *R39* to increase the ball's speed.

The vertical angle and position of the ball are controlled by differential integrator *IC2C*, analog sample-and-hold circuit *IC12A*, the transmission gates in analog switch *IC5*, and bounce flip-flop *IC4A*. The rebound angle can be controlled by varying the rate at which the vertical integrator charges. With the horizontal rate of the ball a constant, any change in the vertical rate will change the angle of the ball.

Operation begins when the circuit produces a pulse at the exact moment



One way to assemble the controls and switches is in single chassis.

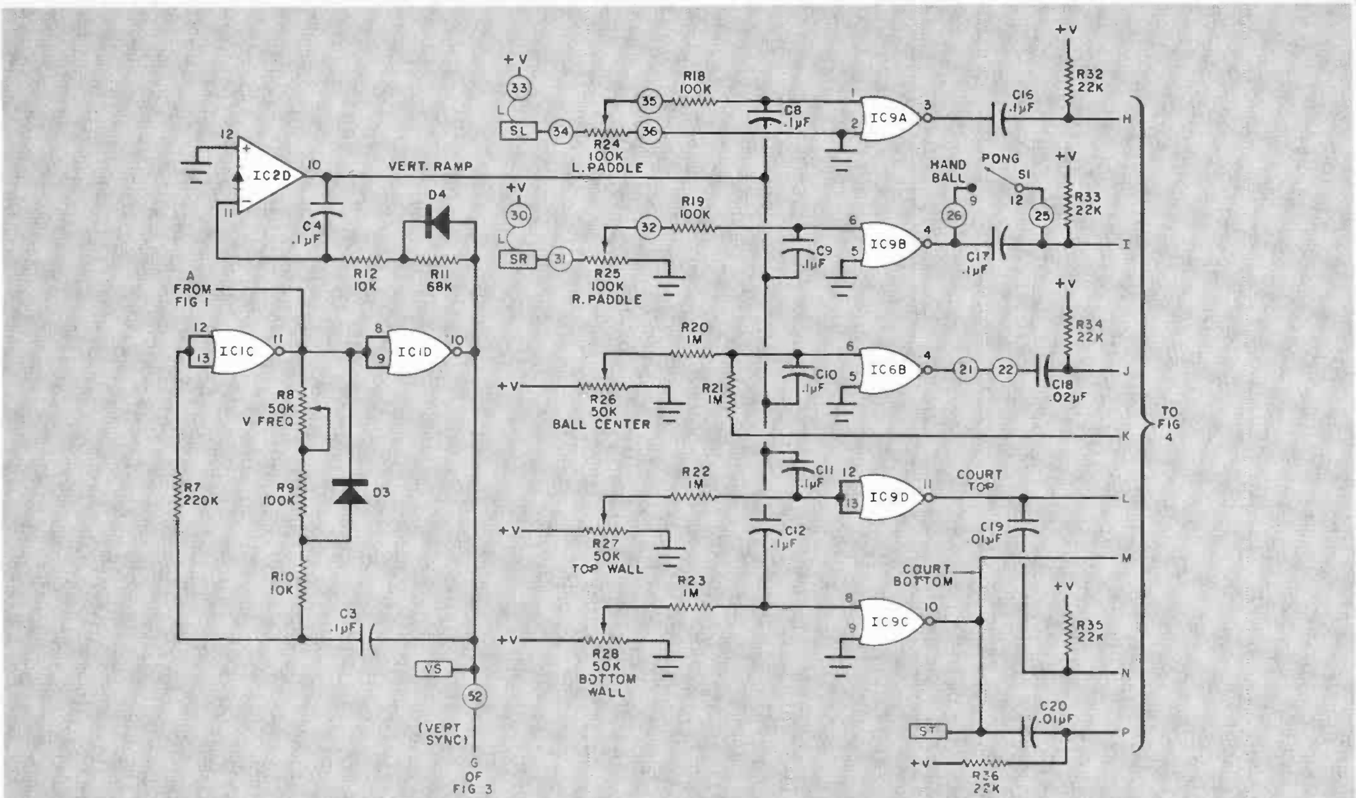


Fig. 2. Vertical sync and ramp generator and related circuits.

the ball hits the paddle (*IC10C*). The hit pulse sets change-angle RS flip-flop *IC12C* and *IC12D*, causing electronic switch *IC5D* to close. At the same instant, *IC5A* is momentarily closed by differentiator *C21/R45* to zero the charge on integrator *IC12A*, which then begins to charge.

When the vertical scan detects the bottom of the paddle, NAND gates *IC11A*, *IC11B*, and *IC11C* reset change-angle flip-flop *IC12C/IC12D* to open the *IC5D* electronic switch. Integrator *IC12A* stops charging and holds its output voltage. (Only a CMOS device could be used as a gate element and sample-and-hold integrator.) The voltage now at the output of the sampling integrator represents where the ball hit vertically on the paddle. This voltage is then used to set the charge rate of vertical ball position integrator *IC2C*.

Differential integrator *IC2C* and analog switches *IC5B* and *IC5C* apply the angle-reference voltage held at the output of *IC12A* to the integrator inputs. The states of *IC5B* and *IC5C* are, in turn, controlled by bounce flip-flop *IC4A*, which keeps track of the ball's direction. Exclusive-OR gate *IC10B* applies the correct information to the *IC4A* D input so that, when a bounce from a wall occurs, the integrator changes its direction of charging in

PARTS LIST

B1—9-volt battery
C1—820-pF, 5% silver mica capacitor
C2—260-pF, 5% silver mica capacitor
C3,C4,C8 through C12,C16,C17,C29 through C35,C37—0.1-µF, 10% Mylar capacitor
C5,C6,C7,C19,C20,C26,C36—0.01-µF, 10% Mylar capacitor
C13,C14,C15—100-pF, 5% silver mica capacitor
C18,C22—0.02-µF, 10% Mylar capacitor
C21—0.002-µF, 10% Mylar capacitor
C23,C38—3.3-µF, tantalum capacitor
C24—1.5-µF tantalum capacitor
C25—0.68-µF tantalum capacitor
C27,C28—100-µF, 16-volt electrolytic capacitor
D1 through D6—1N4148 diode
D7—6.2-volt, 400-mW zener diode
IC1,IC6,IC9—34001 quad two-input NOR gate (Fairchild). Do not substitute.
IC2—LM3900 quad op amp (National)
IC3—4081 quad two-input AND gate
IC4—4013 dual JK flip-flop
IC5—4016 quad bilateral switch
IC7,IC12—4001 quad two-input NOR gate
IC8—4002 dual four-input NOR gate
IC10—4030 quad two-input XOR gate
IC11—4011 quad two-input NAND gate
Q1,Q3—2N4401 transistor
Q2—2N3638A transistor
The following resistors are ¼-watt, 5%:
R1,R9,R18,R19,R38—100,000 ohms
R3—33,000 ohms
R4,R41—2700 ohms
R5,R47—47,000 ohms
R6,R10,R12,R58—10,000 ohms
R7—220,000 ohms
R11—68,000 ohms
R13,R14,R15,R20,R21,R22,R23,R42—1 megohm
R29,R30,R31—12,000 ohms
R32 through R36,R40,R43,R45,R63—22,000 ohms
R37—270,000 ohms
R46—10 megohms
R48,R53,R54,R59,R61,R62—15,000 ohms
R49,R50—470,000 ohms
R51,R52—390,000 ohms
R55—75 ohms
R56—270 ohms
R57—1000 ohms
R60—100 ohms
R64,R65—30,000 ohms
R2, R8, R16, R17, R26, R27, R28, R44—50,000-ohm, ⅛-watt trimmer potentiometer
R24,R25—100,000-ohm linear-taper potentiometer
R39—500,000-ohm potentiometer
S1—Three-pole, three-position rotary switch
S2,S3,S4—Normally open spst pushbutton switch
S5—Dpdt, center-off miniature toggle switch
S6—Spst switch (part of R39)
Misc.—Printed circuit board; IC sockets (12) or Molex Soldercons; control knobs (4); suitable case; coaxial cable; battery holder; machine hardware; hookup wire; solder; etc.
Note: The following items are available from Cal Kit, P.O. Box 877, Sebastopol, CA 95472:
No. TV-1 plated epoxy-type pc board for $12.00
No. TV-3 complete kit of game parts less battery, sound/score option, and case for $55.00
No. TV-6 set of IC's for game for $15.50
No. TV-8 set of sockets for game for $6.00
No. TV-10 FCC type-approved r-f modulator; write for details
No. TV-11 drilled and silk-screened case for $12.50
All items postpaid and insured. Add $2.00 for handling. No COD's. California residents, please add sales tax.

Editor's Note: New 22" video monitor, with audio, available from GBC Closed Circuit TV Corp., 74 Fifth Ave., NY, NY 10011 for $119.50. NY residents, add sales tax.

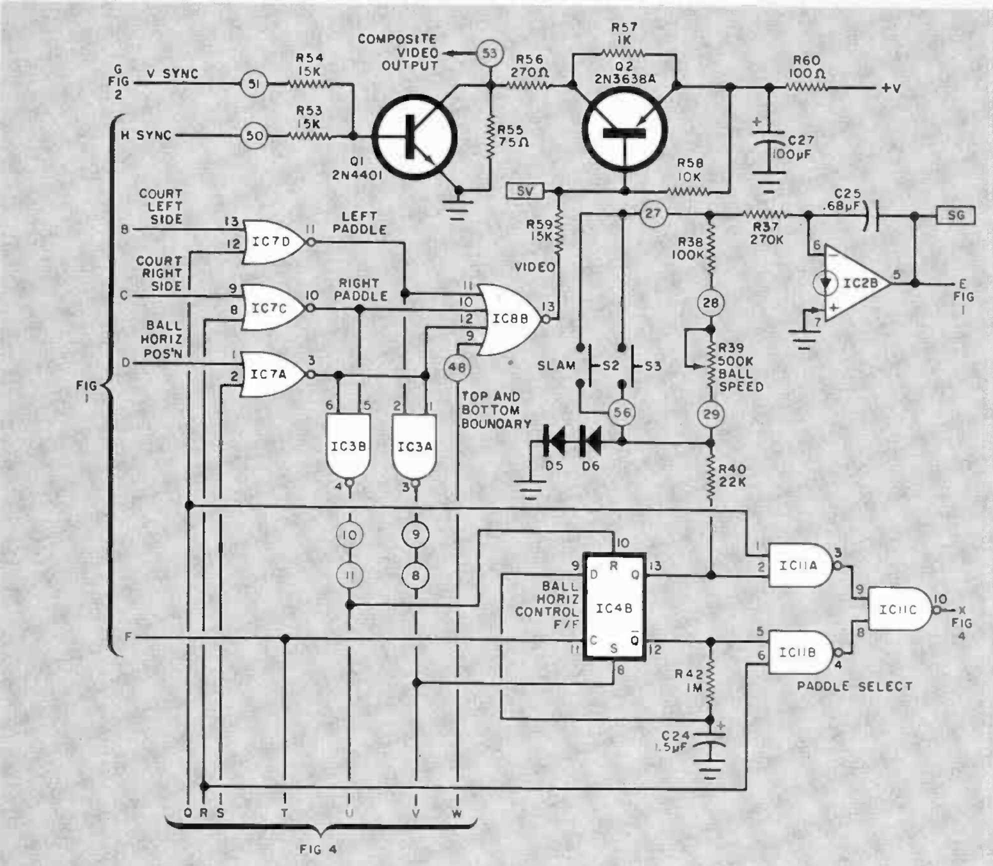


Fig. 3. Six gates operate on ball-paddle contact to reverse motion.

step. The current angle voltage is compared with the instantaneous vertical position voltage by *IC10B*.

Bounce flip-flop *IC4A* is also controlled by the paddle and ball coincidence circuits. A paddle/ball coincidence generates a hit pulse that resets *IC4A*, deflecting the ball upward when it hits the upper half of the paddle and downward when it hits the lower half.

The GRAVITY portion of *S1* applies a small dc voltage to the integrator to cause the angle of the reference voltage to decay as the ball moves across the screen.

Initiating gate *IC10A* is used to get the vertical motion of the ball in sync with the bounce flip-flop. It is also used to invert the ball video and put a vertical line on the screen for purpose of alignment.

Without the scoring and sound circuit, *IC7B* and *IC12B* simply debounce SERVE switch *S4*. When the scoring option is used, the link between the two gates is removed. The scoring circuit then senses when the SERVE switch is operated and uses this information to start a new game. After a brief period, determined by the time constant *C26* and *R62*, it allows the game to start by pulsing *IC12B* and clocking the horizontal flip-flop.

As shown in Fig. 5, power is supplied to the circuit by a single 9-volt battery through a series regulator made up of *Q3* and *D7* and decoupled by *C28*. Capacitors *C29* through *C33* decouple the CMOS IC's connected to the 5.5-volt line.

Also shown in Fig. 5 is CYBERNETIC switch, *S5*, an option that might prove of interest to you. This is the switch that allows you to play against the machine or have the machine play against itself.

GAME switch *S1* allows you to select

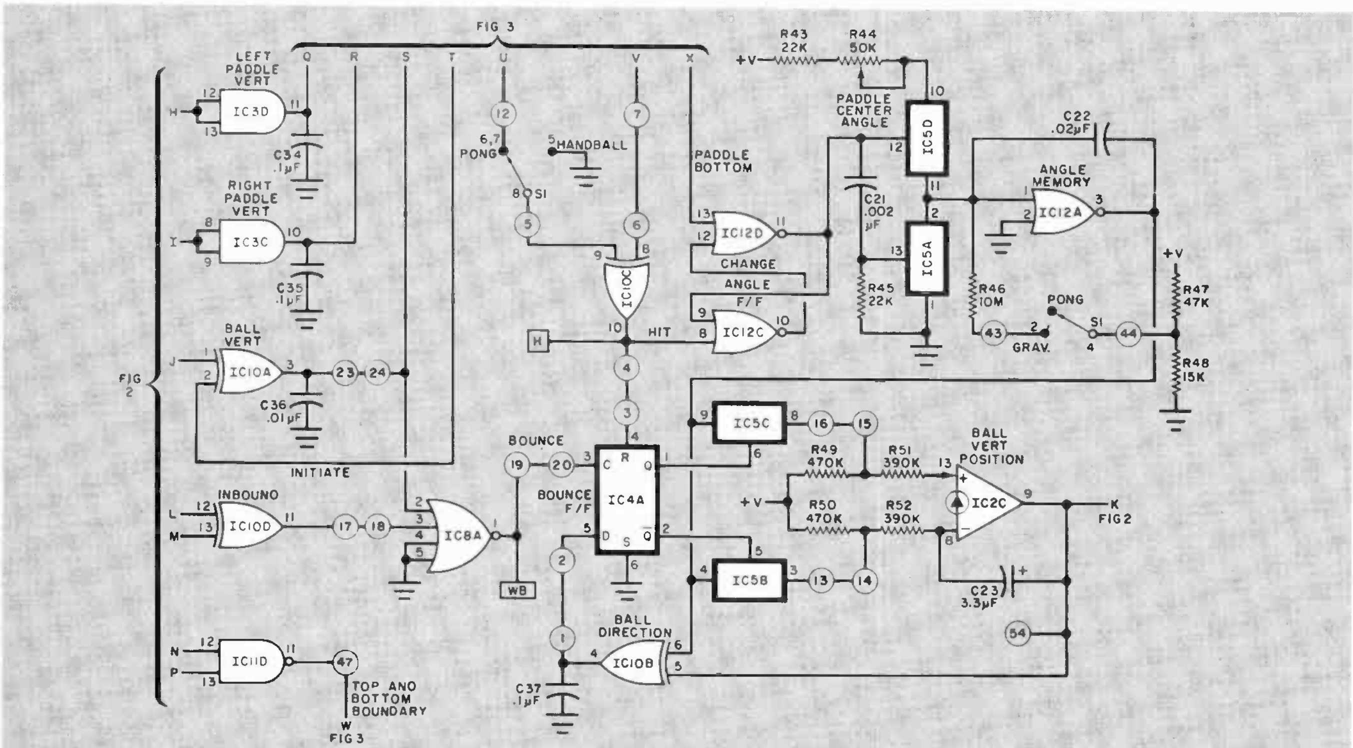


Fig. 4. Circuit to determine "English" and change type of game.

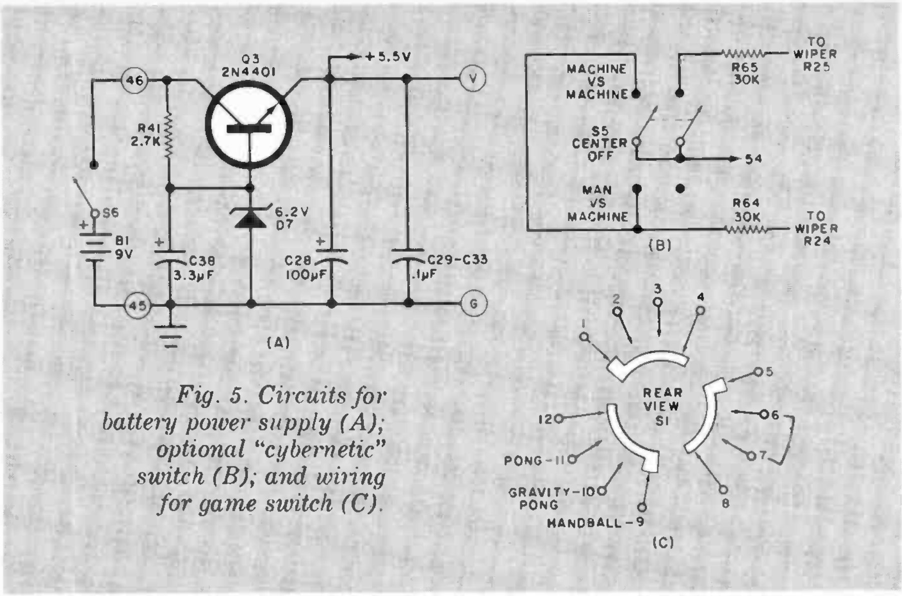
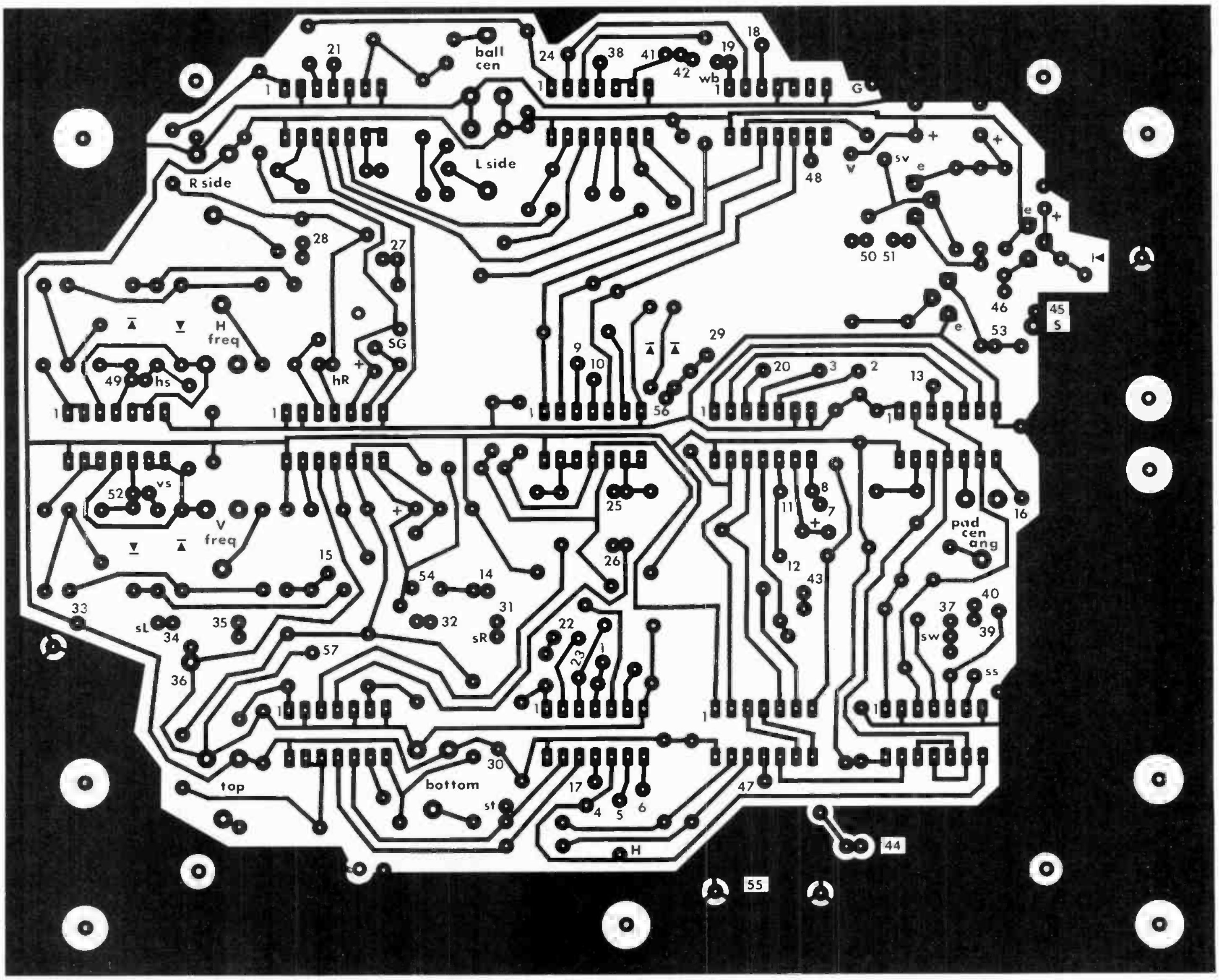


Fig. 5. Circuits for battery power supply (A); optional "cybernetic" switch (B); and wiring for game switch (C).

the game you want to play. In the PONG position, the Pongtronics operates as a conventional TV table tennis game. In the GRAVITY position, *IC12A* is reconfigured, while in the HANDBALL position, *C17* is shorted out to extend the right paddle's vertical height to the top and bottom of the screen. Also, the "hit" information is overridden by grounding one input to *IC10C*. The right paddle becomes a wall that deflects the ball according to where the ball strikes it.

Construction. Because of the number of IC's used and the complexity of the associated wiring, a printed-circuit board is highly recommended for assembling the Pongtronics. If you plan to make your own pc board, you can use the actual-size etching and drilling guide shown in Fig. 6. Once the board is prepared, you can mount the components on it as shown. Note that all components, including PADDLE potentiometers, SERVE pushbuttons, GAME select switch, and BALL SPEED control can be mounted directly on the board. Alternatively, these controls can be mounted separately and

Fig. 6A. Actual-size etching and drilling guide for pc board. Component layout guide is on next page, with wiring table for connections to numbered pads.



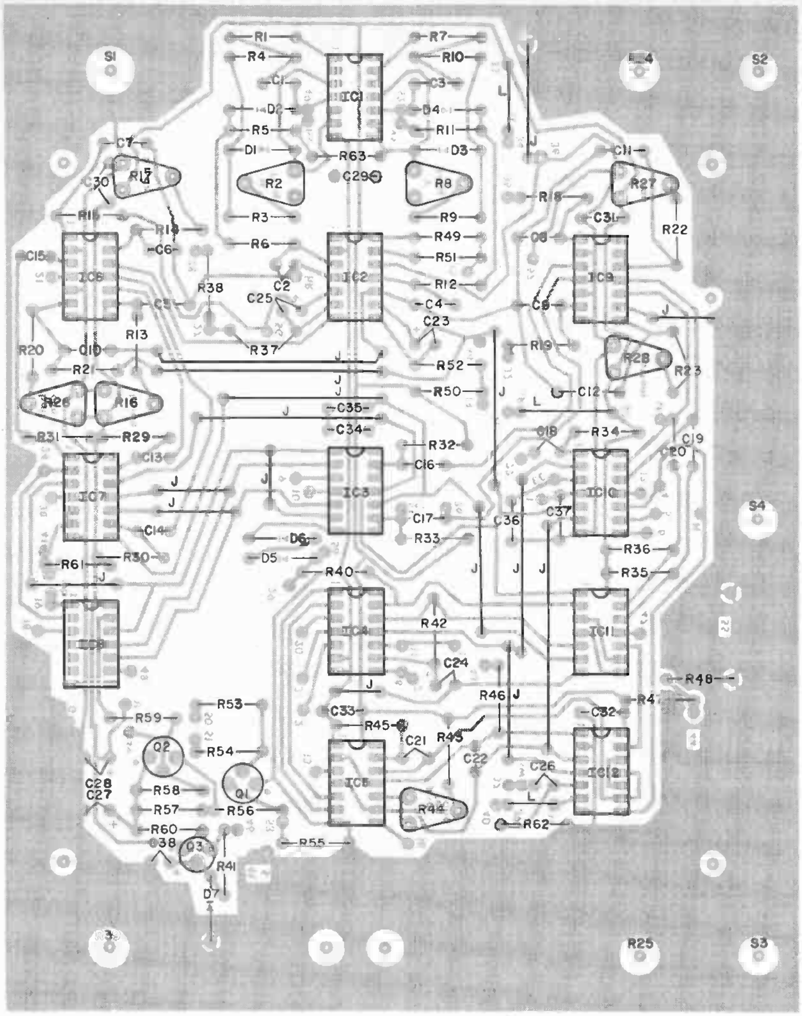


Fig. 6B. Component layout and wiring table.

WIRING TABLE

From	To	From	To
1	2	33	SL (link)
3	4	34	R24, +V side
5	S1 lug 8	35	R24 wiper
6	7	36	R24,R25 GND
8	9	37	38
10	11	39	SS (link)
12	S1 lugs 6,7	40	41
13	14	42	S4 (serve)
15	16	43	S1 lug 2
17	18	44	S1 lug 4
19	20	45	B1-
21	22	46	S6 (on R39)
23	24	47	48
25	S1 lug 12	49	50
26	S1 lug 9	51	52
27	S2 & S3	53	Video output
28	R39	54	S5
29	R39,S2,S3	55	S4 GND
30	SR (link)	56	S2 & S3
31	R25, +V side	57	S1 lug 5
32	R25 wiper		

Note: Pads on the board with letter legends are for optional scoring/sound board.

connected to the board with cables.

Circled numbers in the schematic represent numbered pads on the foil side of the board. Interconnections for these points are detailed in the table that accompanies Fig. 6. (The small squares containing letters in the schematic are the points in the circuit to which the optional scoring and sound-effects board connect.)

To make insertion and removal easier, you can mount the IC's in the circuit with sockets. All controls and switches (except *S5*) can mount directly on the board. You'll have to drill suitable holes to accommodate the controls and mount them from the foil side of the board. Don't forget to mount the jumpers and three "links" (marked L) wires on the board. The three link wires will be removed if and when you install the optional scoring and sound-effects subassembly.

Use the Wiring Table and Fig. 7 to install the various interconnects. Then install the 9-volt battery in a holder secured to the foil side of the printed circuit board.

Adjustments. There are two ways to have the Pongtronics fed to your TV receiver. One is an ac connection to the receiver's video amplifier input, the other is to use an FCC type-approved r-f modulator that permits you to feed the game into the antenna input of your receiver and operate on an unused channel in your area. If you elect video feed, you can install a switch that lets you select between normal TV operation from the receiver's video detector or game operation

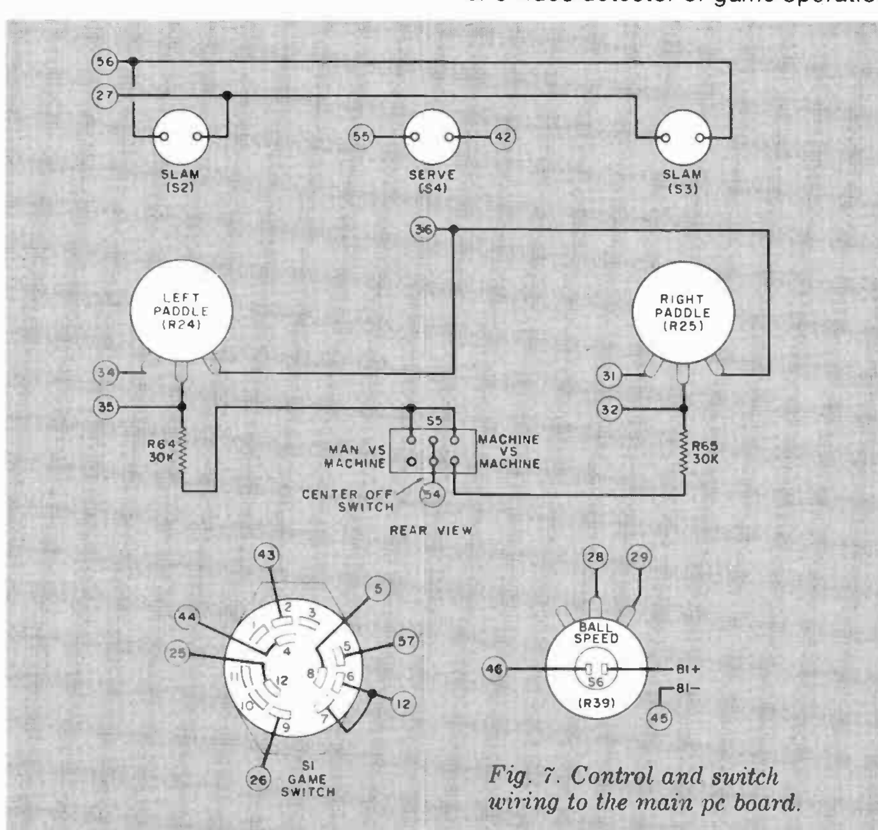


Fig. 7. Control and switch wiring to the main pc board.

through a chassis-mounted connector for the Pongtronics' output.

Assuming your receiver's horizontal and vertical controls have been set for a stable picture, connect the Pongtronics to the receiver through the desired input. Turn on the power to the receiver and Pongtronics, in the latter case rotating the BALL SPEED control clockwise. If you notice that the picture is rolling, adjust trimmer potentiometer *R8* until the frame locks. If you notice horizontal "tearing," adjust *R2* for stable horizontal lock. You can now adjust the receiver's BRIGHTNESS and CONTRAST controls for a sharp picture with a black or dark gray background and white paddles, ball, and court walls.

Adjust trimmer potentiometer *R27* until the upper wall of the court is about 1" (2.54 cm) from the top of the screen. Then adjust *R28* so that the bottom wall is the same distance away from the bottom of the screen. Adjust *R16* to set the left paddle about 1" from the left side of the screen and *R17* to position the right paddle. One or both paddles may initially be off the screen, so you may have to start your paddle adjustments by first getting the paddles onscreen.

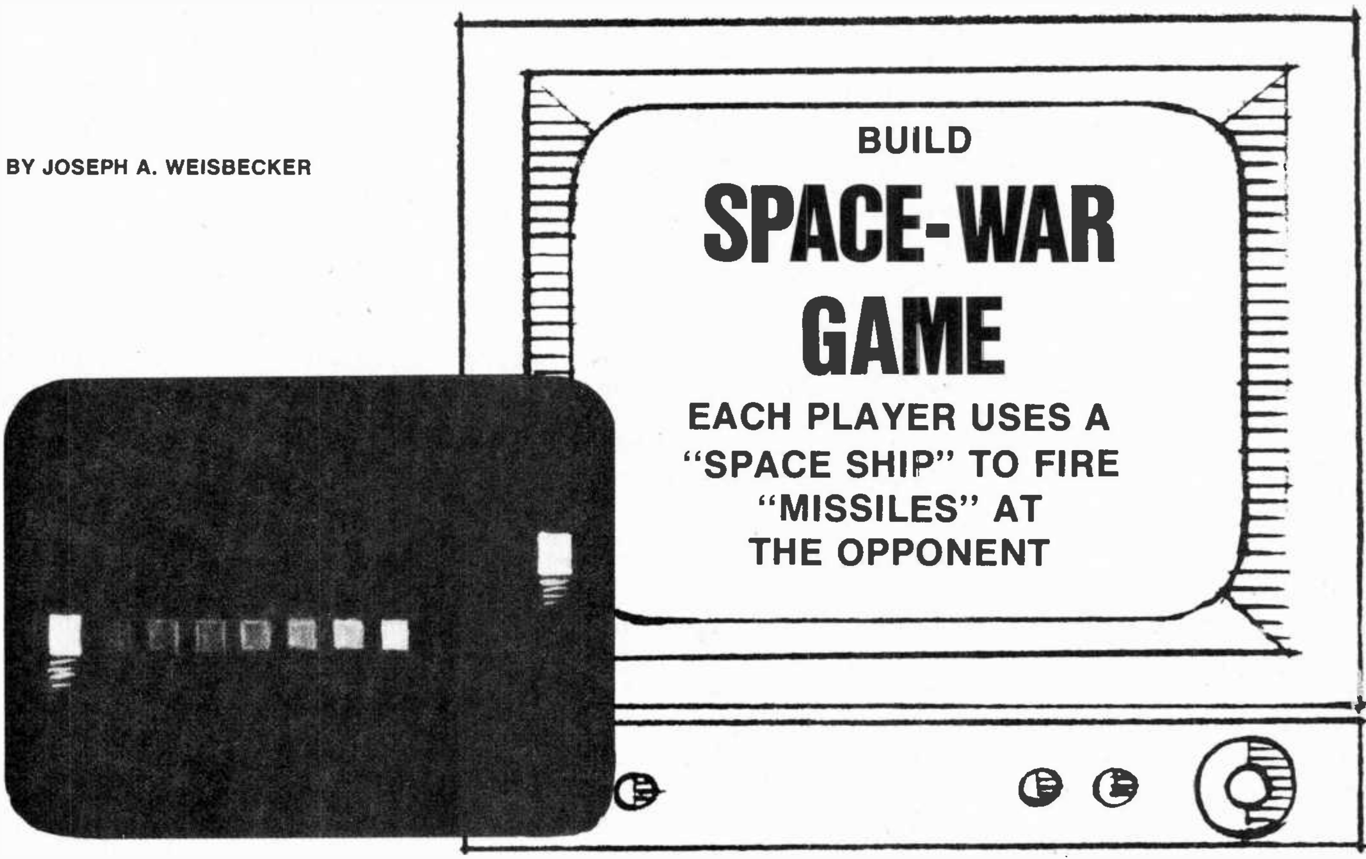
Hold down the SERVE button. A vertical white line with a small "hole" in the middle should appear on the screen. This hole corresponds to the ball. The line will rebound back and forth between the paddles. Adjust *R26* to center the hole on the screen.

The angle of rebound between ball and paddle is controlled by *R44*. Adjust this trimmer potentiometer until the ball rebounds in a straight line across the screen when the ball hits the center of the paddle. A simple way to do this is to temporarily bring the two paddles close together and narrowing the court to form a small rectangle with the paddles. When the ball is trapped inside the rectangle, *R44* is properly adjusted. Return the paddles and walls to their proper positions.

The Pongtronics is now ready to use. Bear in mind that each time you turn on the game it may be necessary to touch up your receiver's horizontal and vertical controls as the agc circuit locks up in the wrong direction. Momentarily changing channels may also break the sync lock. You can also hold down the SERVE button to initiate the game and allow the Pongtronics' flip-flops to get into synchronization.

After operating the SERVE button, you may have to wait for up to five seconds, depending on the setting of the BALL SPEED control, for the ball to appear on the screen. ◈

BY JOSEPH A. WEISBECKER



BUILD SPACE-WAR GAME

EACH PLAYER USES A "SPACE SHIP" TO FIRE "MISSILES" AT THE OPPONENT

Popular among people who use computers is a "war" game in which space ships are positioned on the screen of a computer terminal and simulated missiles or laser beams are fired at them by the opponent. Since most people don't have access to a computer for such games, the simple version described here has been devised to be used with any TV set.

Signals are generated to produce two space ships (small white squares), one on each side of the screen. Each player can move his ship up or down by means of a single control. When one player thinks he is within range, he operates a pushbutton switch to make it appear that a "laser beam" is being fired from his ship to the opponent's. If he scores a hit, the opponent's ship disappears from the screen and the game is over. It can be restarted by the operation of a reset switch.

However, once a player has fired his laser (and it can only be fired in a single burst), it takes several seconds for it to be "recharged." During this period of time, his ship is helpless against the opponent and all he can do

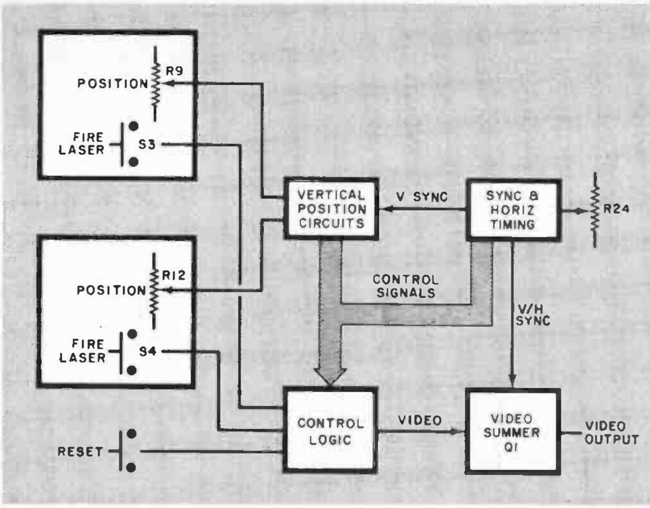


Fig. 1. Logic diagram shows how various stages are connected.

PARTS LIST

B1,B2—9-volt battery
C1—100-pF polystyrene capacitor
C2,C14,C15—0.05-µF disc capacitor
C3,C4—0.01-µF disc capacitor
C5,C6—4.7-µF, 6-V electrolytic capacitor
C7,C8—220-pF polystyrene capacitor
C9,C11—10-µF, 60-V electrolytic capacitor
C10,C16,C17—1-µF, 100-V electrolytic capacitor
C12—1000-µF, 16-V electrolytic capacitor
C13—0.1-µF Mylar capacitor
D1 to D9—1N4148 diode
IC1—4049 CMOS hex inverter
IC2,IC3—4024 CMOS 7-bit counter
IC4—4012CMOS dual 4-input NAND gate
IC5,IC6—555 timer
IC7,IC8—CMOS triple 3-input NAND gate
IC9,IC10—CMOS quad 2-input NOR gate
Q1—2N5129 transistor
The following are 5%, ¼-watt resistors unless otherwise noted:
R1,R7,R10,R14,R16—100,000 ohms
R2—15,000 ohms
R3,R4,R5,R21—47,000 ohms
R6—33,000 ohms
R8,R11—3900 ohms
R9,R12—250,000-ohm potentiometer
R13,R15—39,000 ohms
R17—22,000 ohms
R18—10,000 ohms
R19—47 ohms
R20—100 ohms
R22,R23—10,000-ohm potentiometer
R24—5000-ohm potentiometer
S1—Spst slide switch
S2 to S4—Spst normally open pushbutton switch
Misc.—Suitable chassis, extension cable, remote enclosure, knobs (2), battery holders, mounting hardware, etc.
Note—The following is available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216: complete kit (SW-1) including chassis at $39.50, postpaid. Texas residents, please add sales tax.

is try to keep out of the line of fire. Also, during this period, the ship of the player who fired is flashing on and off. When the flashing stops, his laser is recharged and ready to fire again. This feature discourages continuous firing and encourages the use of caution and strategy.

The block diagram (Fig. 1) shows how the system operates. Note that the output is a composite of sync and video signals. It can be applied directly to the video amplifier of a TV receiver or, through an FCC type-approved r-f device, to the TV receiver's antenna input using a locally unoccupied channel.

Circuit Operation. The sync and horizontal timing circuit is shown in Fig. 2. Basic timing is performed by two inverters in *IC1*, which is wired as an oscillator operating at a nominal 122.88-kHz frequency. Resistor *R1* increases the stability of the circuit, while *C1* and the combination of *R2* and *R24* are used to adjust the frequency. The output is a square wave with a period of 8.14 microseconds.

This signal drives a 14-stage binary counter formed by *IC2* and *IC3*. Diodes *D1*, *D2*, and *D3* decode the 000 output of *IC2* to form an 8.14-µs pulse occuring 16.28 µs after the beginning of each horizontal syhc pulse. This pulse, if applied alone to the receiver, would produce a vertical bar on the left side of the screen. Diodes *D7*, *D8*, and *D9* decode the 110 output to provide an 8.14-µs pulse 48.8 µs after the horizontal sync pulse. This pulse alone would produce a vertical bar on the right side of the screen.

The differentiator formed by *C2* and *R6* provides a negative-going vertical sync pulse 60 times per second. This pulse in about 2 milliseconds with the component values shown.

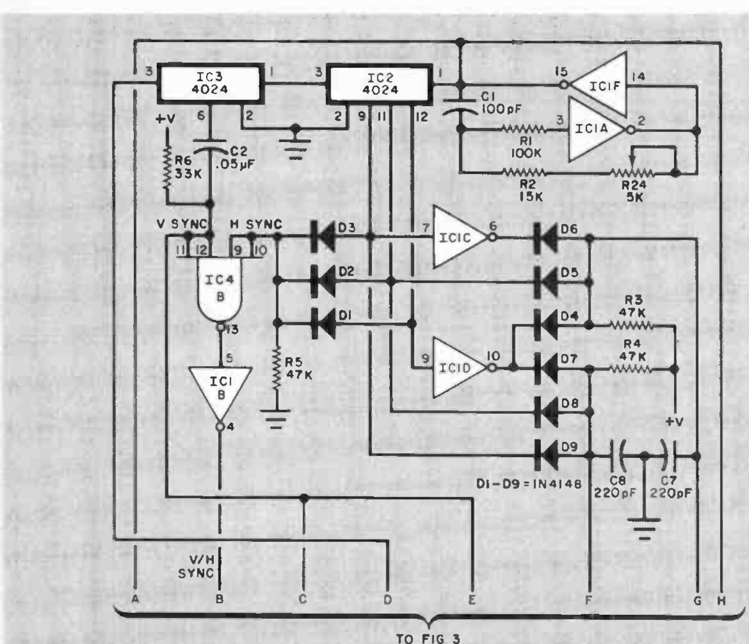


Fig. 2. Sync pulses and timing are generated by this circuit.

The horizontal and vertical sync pulses are combined in one section of *IC4*, a dual 4-input NAND gate. The composite positive-going sync is fed to the r-f circuit.

In this circuit, 256 horizontal sync pulses occur for each vertical sync pulse. However, once the oscillator is adjusted (by *R24*) for a good TV vertical sync lock, the small deviation from conventional TV line rate is easily tolerated by the receiver.

The vertical position circuits (Fig. 3) use two 555 timers in *IC5* and *IC6*. Both are connected as monostable (one-shot) multivibrators and are triggered (pin 2) by the negative-going sync pulse from *IC3*. The duration of the output waveform is determined by the value of the RC network connected to pins 6 and 7. The width of the output pulse is determined by the amount of dc voltage applied to pin 5. For example, the width of the output pulse from pin 3 of *IC5* is determined by the adjustment of *R9*. Since *IC5* is triggered by the vertical sync pulse, the rising edge of the output waveform coincides with the vertical sync pulse. Changing the value of *R9* varies the time at which the trailing edge of the pin-3 waveform occurs relative to the sync pulse. Capacitor *C3* and resistor *R7* provide a negative-going pulse from this trailing edge that can be positioned between the vertical sync pulses by *R9*. This signal alone would produce a horizontal line on the screen, moved up and down by *R9*.

Similarly, *IC6* and its associated components provide a horizontal line that can be moved by *R12*.

Note that each timer control pin (5) is connected to ground through a large capacitance (*C5* and *C6*). The charging and discharging of these capacitors produce a lag in the vertical movement of the displayed signals. The lag is deliberately introduced to improve the playing of the game.

The horizontal and vertical signals for each side of the screen are combined in the circuit shown in Figs. 3 and 4. Figure 3 also includes the laser firing circuit.

The horizontal pulse on line G is applied to pin 1 of *IC7B*. If laser switch *S3* is not depressed, pin 13 of *IC7C* will be low, causing its pin 10 to be high. This forms the signal for pin 8 of *IC7B*. If the reset switch has been operated, the two flip-flops (*IC9A, IC9B, IC10A, IC10B*) are in their reset states, providing a low signal at pin 13 of *IC9D*. The vertical signal from pin 3 of *IC5* is then inverted at pin 11 of *IC9D* and pin 2 of *IC7B*. Thus, the negative-going pulse at pin 9 of *IC7B* represents the intersection of the horizontal and vertical pulses and part of the video output of *IC4A*. The video output produces a small white rectangle on the left side of the screen for one of the space ships. The right-hand space ship is generated in a similar manner using the other gates.

When laser switch *S3* is depressed, a high level is applied to pin 13 of *IC7C*. A positive pulse is also applied to pin 3 of *IC7A*. The duration of this pulse is determined by the values of *C16* and *R14*. The pulse gates the inverted vertical signal at pin 4 of *IC7A* to the video output. The vertical signal would normally form a line across the TV screen at the same position as the left space ship. The line appears dotted because of the 8.14-µs square wave on pin 5 of *IC7A* and it forms the "laser beam" fired by that space ship.

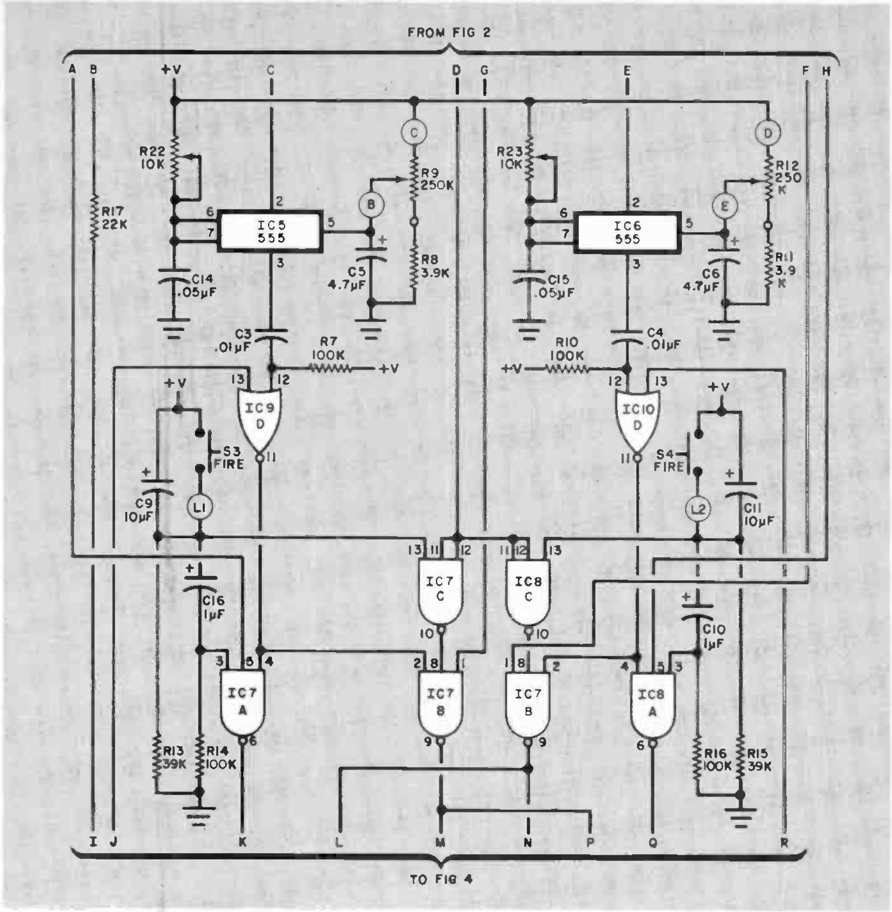


Fig. 3. One 555 timer is used for each spaceship. Though both are synced to the same vertical pulse, each has its own independent vertical position potentiometer. The high capacitance at each pin 5 makes vertical positioning "soft" to keep players on their toes. This circuit also produces "laser" effect and determines "helpless" time.

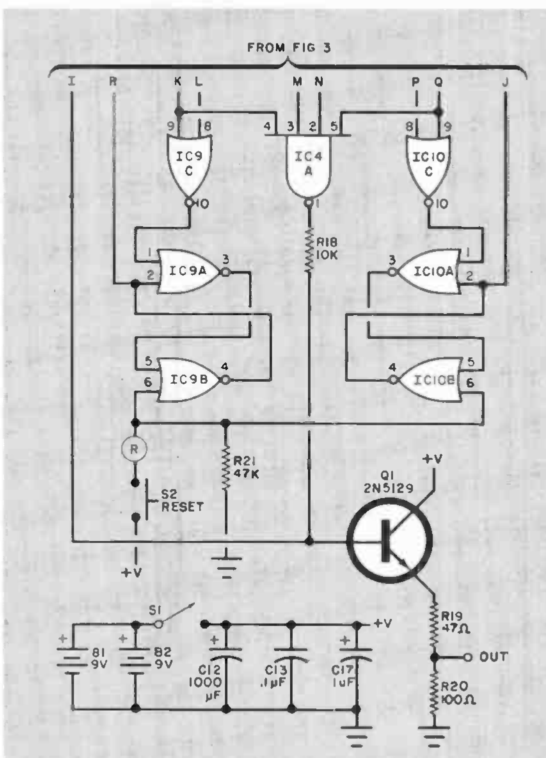


Fig. 4. Each set-reset flip-flop locks out the other space ship when it is "hit" by opposing laser. Power supply circuit is also shown here.

The position of the right space ship is represented by pulses at pin 9 of *IC8B*. A pulse at pin 10 of *IC9C* indicates a coincidence of the left laser beam and the right space ship. This is a "hit" pulse which sets the *IC9A-IC9B* flip-flop to cause pin 13 of *IC10D* to go high. This turns off *IC8A* and *IC8B*, causing the ship to disappear from the screen. If coincidence between pin 6 of *IC7A* and pin 9 of *IC8A* does not occur while the pulse at pin 3 of *IC7A* is present, the left ship did not hit the right one and the game continues.

When laser switch *S3* is depressed, only one laser pulse occurs at pin 3 of *IC7A* due to the action of *C16* and *R14*. However, pin 13 of *IC7C* remains high as long as *S3* is depressed. This causes the signal at pin 9 of *IC7B* to be modulated by the square-wave input and the space ship flashes on and off at about 8 times per second as long as pin 13 of *IC7C* is at a high level.

When *S3* is released, pin 13 of *IC7C* remains high until *C9* discharges through *R13* to about half of the supply voltage. This time constant holds pin 13 of *IC7C* high for several seconds after the laser pushbutton has been released. Pin 13 of *IC7C* must be low before *S3* is operated to provide a sufficient voltage swing to generate a laser pulse at pin 3 of *IC7A*. The time constant of *C9/R13* keeps the space ship flashing for a few seconds and also inhibits firing again for the same period of time. The values of *C9* and *R13* can be changed if desired.

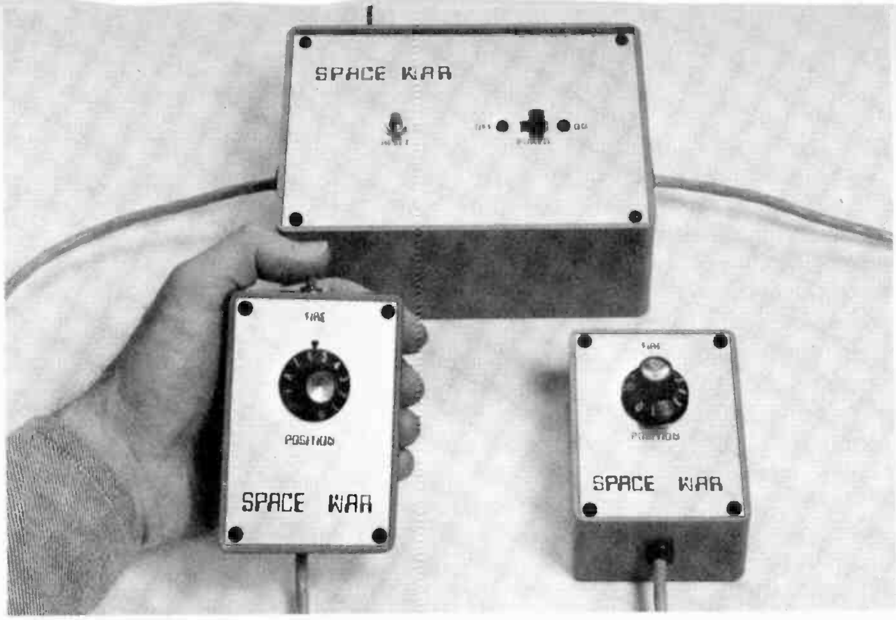


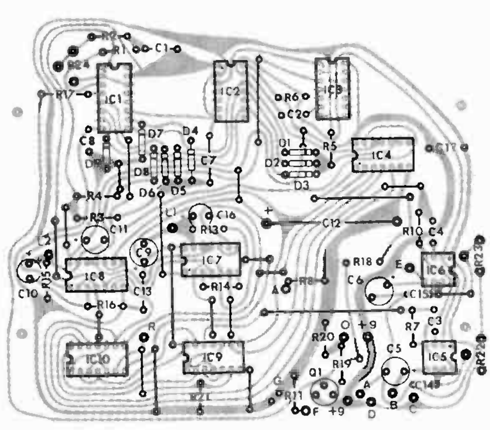
Photo shows main control box with two control stations as arranged for the prototype.

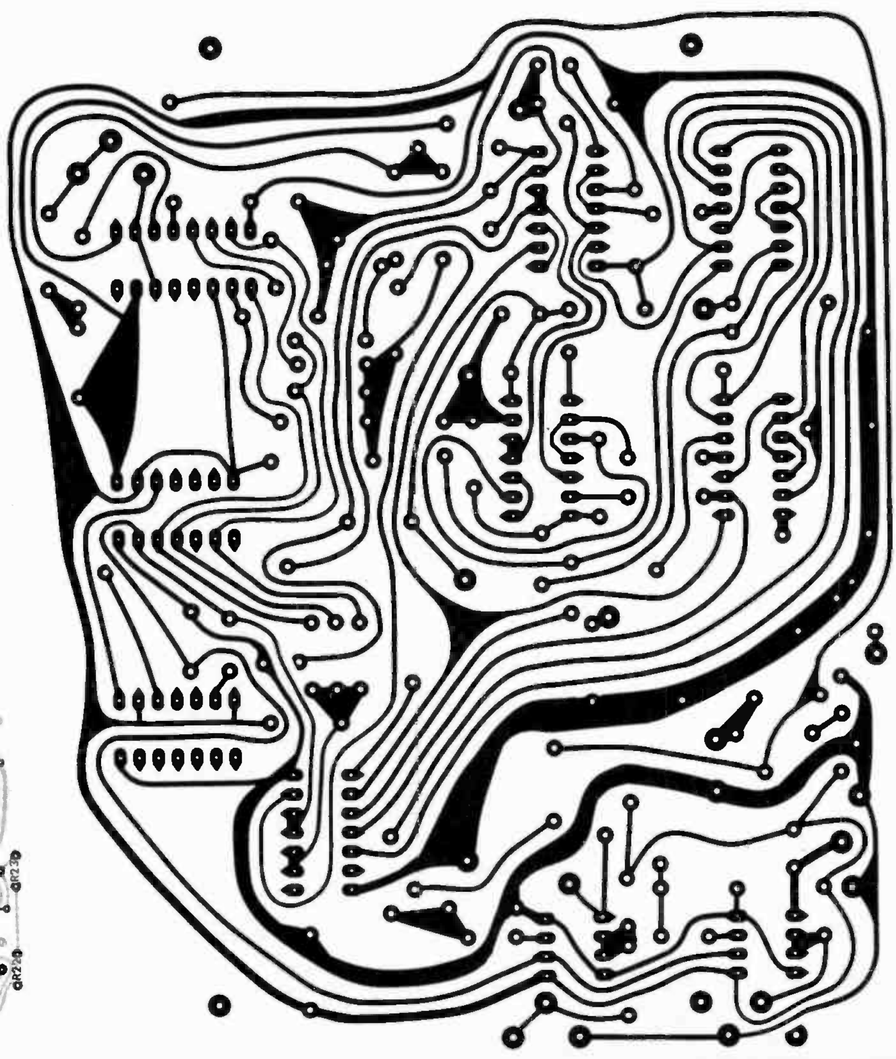
The logic circuit for the other space ship is similar.

The reset circuit and the power supply are shown in Fig. 4. Note the use of filter capacitors to smooth switching transients. Transistor *Q1* sums both the video and sync and presents a low-impedance composite video signal for use by the video amplifier of the TV receiver or an FCC-approved class-1 device.

Construction. The circuit is easily assembled on a pc board such as that

Fig. 5. Actual-size etching and drilling guide is at right. Component layout guide is below.





shown in Fig. 5 (which also shows component installation). Position controls and laser firing switches can be mounted in separate small enclosures with cables connecting them to the main board. The latter (including battery holders) is mounted in its own enclosure. The power switch (*S1*) and reset switch (*S2*) should be on the front panel. The composite video/sync signal should be brought out through a phono connector.

Testing. Check all wiring before turning on the power. Connect the game to the set's video amplifier. Turn on the space game (*S1*) and operate the reset switch (*S2*). Adjust *R24* (Fig. 2) for proper vertical sync. If necessary, trim *R2* for a stable vertical sync.

If the system is working properly, you will see two white squares (the space ships) on the edges of the screen. Turn up the contrast and turn down the brightness until the squares are clear white on a black background.

You should be able to move the space ships up and down using the appropriate controls. The width of the space ships can be altered by changing the values of *C7* and *C8* (Fig. 2). Their heights are determined by *R7* and *R10* (Fig. 3). The larger the spaceship, the easier the game is to play. About 8 to 10 TV lines is a good height.

Adjust both position potentiometers until the spaceships are at the lowest point on the screen. If they are not even, determine which is higher, and adjust the appropriate potentiometer (*R22* or *R23*) to get them even. Then position both at the top of the screen. If they are not even, adjust *R8* or *R11*.

Depress laser switch *S3* to check the firing. A streak of white dots should extend from the left ship to the other side of the screen. If the right ship is hit, it should disappear. Check the other side in a similar manner. If the firing or recover times differ appreciably from one side to the other, adjust *R13* and *R14* or *R15* and *R16*. ◈

Editor's Note—*The Magnavox Company, 1700 Magnavox Way, Fort Wayne, IN 46804, has exclusive worldwide rights to certain patents pertaining to electronic television games such as the ones described in this article. Magnavox has indicated that any making, using or selling of such electronic TV games may come within the purview of these patents and the U.S. patent laws.*

Introduction to COMPUTER CODES

The foundation for programming computers—binary, octal, hexadecimal, and BCD codes.

BY R. T. ROBBINS

COMPUTERS and other digital equipment communicate in "languages" based on 1's and 0's that must be mastered if any meaningful communication between human and machine is to be accomplished. There are four number systems in common use in electronics today. For human-to-human communication, we use the 0 through 9 "decimal," or base-10 (n_{10}), number system. The other three are the digital 1/0-based systems, which include: binary (base-2, or n_2), octal (base-8, or n_8), and hexadecimal (base-16, or n_{16}).

Converting from one to any other numbering system is a relatively simple matter. Let us review how these systems compare with each other and interact.

The Binary System. The binary code is the basic digital machine numbering system. In essence, it is a simple 1/0 representation of the decimal system. Its great disadvantage, and the reason it is rarely used in computers, is that binary equivalents of decimal numbers become increasingly ponderous with each succeeding number

To illustrate how to use the binary numbering system, let us convert 69_{10}, 230_{10}, 1976_{10}, and 52801_{10} to binary. (Note: It is important to use subscripts to identify the numbering system when more than one system appears in your notes. The numbering system subscripts are detailed above.) The four numbers we have selected at random will illustrate the drawback of the binary system.

The binary system is a simple 1/0 format. Going from right to left, as each position is filled by a 1 and another 1 is added to it, the result is 0 and a 1 is carried to the next place to the left. A table of binary equivalents for the decimal numbers 0 through 15 would appear as follows:

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Note the logical progression of the numbers in binary and the increasing number of digits used as you count up. Note also that the points at which you add digits to the left occur at the power-of-two (2^n) points—2,4,8,16,32, etc. And one final note: 0 is always considered a number possibility in all digital machine languages.

Now we can make some step-by-step conversions. The first step is to list across the page the decimal equivalent of each power of two that will be required for making the conversion, as shown in Fig. 1. Each location will

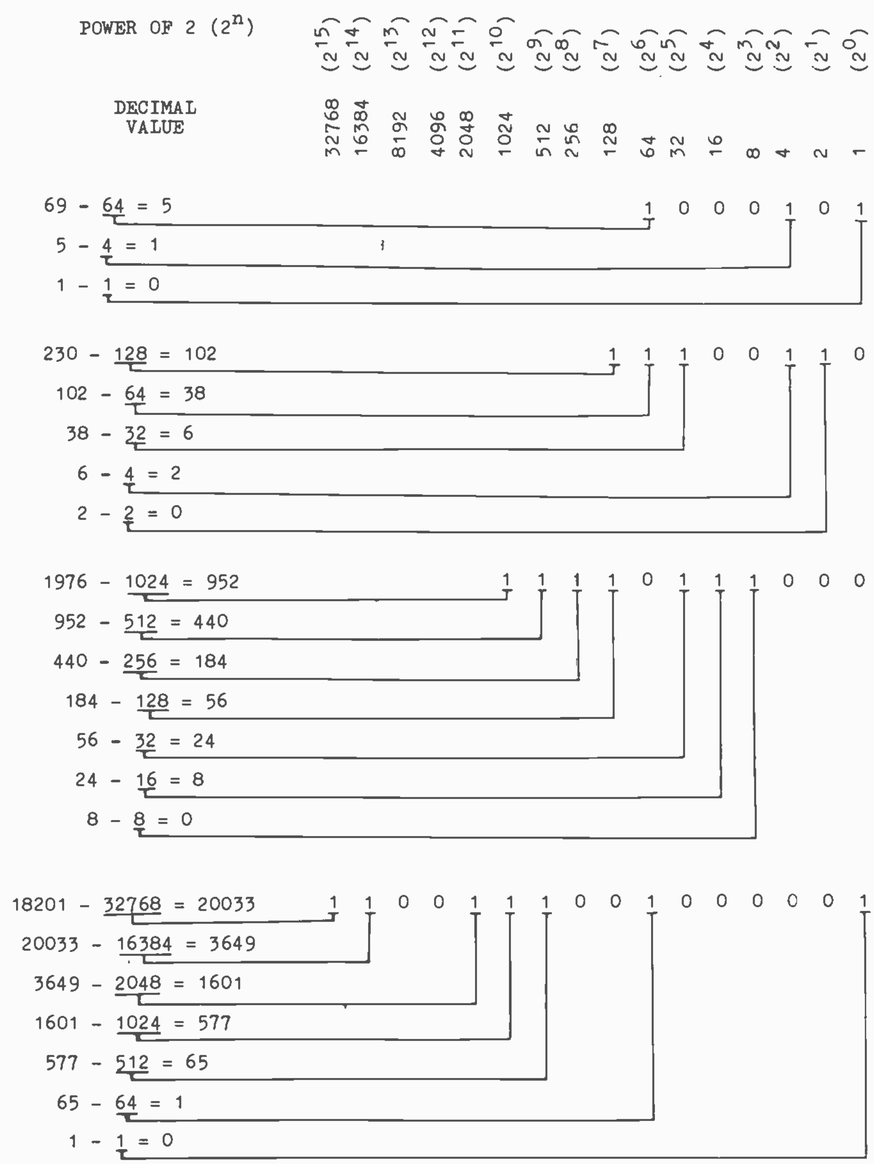


Fig. 1. Converting decimal numbers to equivalents in binary code. The final binary conversions are at the right.

$69_{10} = 1000101_2$

$230_{10} = 11100110_2$

$1976_{10} = 11110111000_2$

$52801_{10} = 1100111001000001_2$

be filled in with a 1 or a 0 (binary "bit"), depending on whether or not its value is used during computations. If the value is used, you enter a 1; otherwise, you enter a 0. (Leading 0's need not be entered.)

Start your conversion by placing a 1 under the largest decimal number that doesn't exceed the number you're converting. Next, subtract the number under which you placed a 1 from the number you're converting to determine which is the next number under which you must place a 1. Always keep in mind that you must never have a negative result. Only positive results or 0 after subtraction are acceptable. If you must skip numbers to enter a 1, fill in the blank spaces with 0's. Continue subtracting numbers until you've filled each column and your final result equals exactly zero. If, after obtaining a 0 result, you still have empty spaces to the right, fill in 0's. To double-check your conversion, simply add all the power-of-2 numbers under which you've entered 1's and check that the result is the decimal number with which you started. (Note: This is the procedure to use when converting *any* binary number back to its decimal equivalent.)

The final conversions to binary for our sample decimal numbers are shown at the bottom of Fig. 1. Note how many more digits must be filled in as the numbers increase in magnitude.

Once you understand the binary code, the octal and hexadecimal codes are much easier to understand and learn.

The Octal Code. Much of the ponderousness of the binary code can be eliminated by switching to the more efficient octal code. An octal number is only one-third as long as its binary equivalent. Once a number has been converted from decimal to binary, separate it into groups of three digits, working from right to left.

In any group of three digits, the minimum will be 000 and the maximum will be 111. Now, to get the equivalent octal number, simply translate the three binary numbers back to decimal, which means the smallest number you will have will be 0 (000) and the largest will be 4+2+1=7 (111). Bearing in mind that 0 is always a number possibility, you now have a base-8 number system:

Decimal	Binary	Octal
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	10
9	1001	11
10	1010	12
11	1011	13
12	1100	14
13	1101	15
14	1110	16
15	1111	17

When converting from binary to octal, you may end up with only one or two digits in the left-end group. To handle this situation, simply assume that the missing digits are 0's.

The octal equivalents of the sample decimal numbers chosen above are shown in Fig. 2.

The Hexadecimal Code. Greatest efficiency is obtained when the hexadecimal code is used to format decimal numbers. Here, the binary number is separated into four-digit slices (right to left). Now, the maximum number capable of representation is 1111_2, or $8+4+2+1=15_{10}$. You still count up from 0 in the usual decimal manner, but only to 9. This still leaves six numbers to fill in to reach the 16 maximum. However, you cannot enter 10 as the next number because that is the first numeral in the second hexadecimal set. So, you continue counting with alphabetic letters from A to F:

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

The conversion to hexadecimal code from decimal requires that you first convert your decimal number to binary. Then break the binary number into groups of four digits. Each four-digit binary group is then assigned a hexadecimal equivalent. The conversions for our sample decimal numbers are derived as shown in Fig. 3.

When converting hexadecimal back to a decimal number, first convert the hex number into binary and then the binary into the decimal number.

Binary Coded Decimal. This coding system, also commonly known by its initials BCD, is the easiest to obtain from a decimal number. Instead of considering the decimal number as a whole, treat each digit in the number as a separate entity when converting

$69_{10} = 001000101_2$

105_8

$230_{10} = 011100110_2$

346_8

$1976_{10} = 011110111000_2$

3670_8

$52801_{10} = 001100111001000001_2$

147101_8

Fig. 2. Octal equivalents of four decimal numbers.

$69_{10} = 01000101_2$

45_{16}

$230_{10} = 11100110_2$

$E6_{16}$

$1976_{10} = 011110111000_2$

$7B8_{16}$

$52801_{10} = 1100111001000001_2$

$CE41_{16}$

Fig. 3. Hexadecimal conversions for sample decimal numbers.

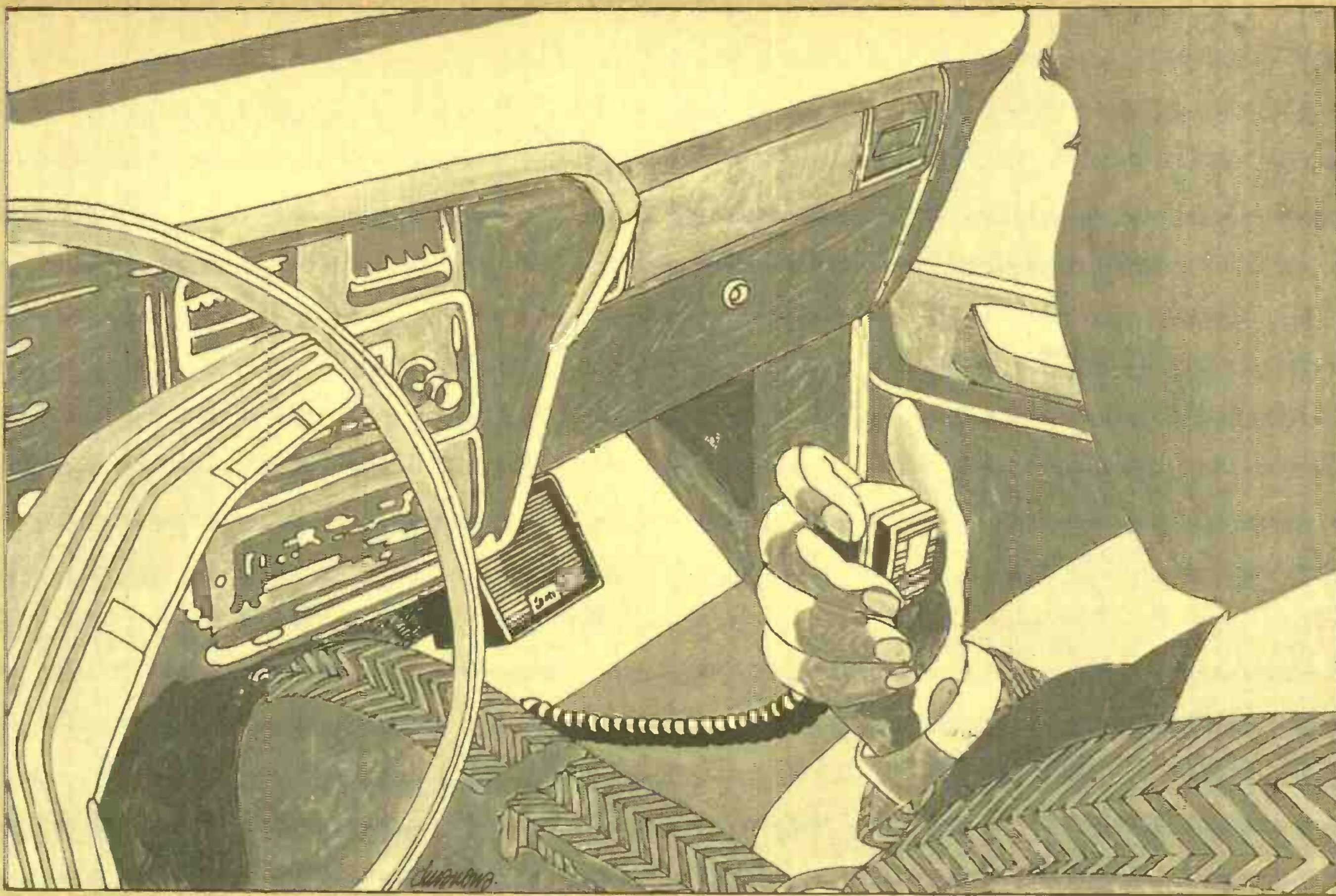
to BCD. Each digit must be assigned a four-bit, strictly binary number. The reason for assigning a four-bit number is that decimal covers a range of 10 numbers (0 through 9). Therefore, the lowest number you can have will be 0000 and the highest 1001, which represent 0 and 9, respectively.

The BCD equivalents for our sample decimal numbers are as follows:

Decimal	BCD
69	0110 1001
230	0010 0011 0000
1976	0001 1001 0111 0110
52801	0101 0010 1000 0000 0001

Note that when a BCD number is written, an obvious space must be left between each four-bit binary slice for identification purposes. BCD is the only numbering system that should have such spaces. Therefore, It doesn't need a subscript, except in the special case where only a single decimal digit is to be converted, in which case you can use a BCD subscript.

Summing Up. We have discussed four basic numbering systems used in digital equipment. Of these, hexadecimal is the most efficient but has the disadvantage of requiring both numeral and alphabet symbols. Slightly less efficient, the octal system has the advantage of employing only easy-to-understand decimal numbers. The least efficient numbering systems are binary and BCD. BCD is by far the least efficient numbering system, requiring five times the number of spaces (including the required blank space) of its equivalent decimal number. ◈



Popular Electronics®

Special Focus on CB RADIO

MORE and more people are turning to Citizens Band Radio to satisfy their two-way radio communication needs. They might be motivated by a desire to have an emergency line in an automobile, check on traffic conditions by listening to trucker's conversations (now mostly on Channel 19 rather than Channel 10), participate in public service activities, develop new friends, enjoy general conversations when alone in the home, contact the business office while driving, and so on.

Coupled with the no-test requirement and relatively low equipment cost, it's not surprising that the growth of CB Radio (Class D) has been astonishingly great. As an example, the last report received from the FCC indicated that almost 300,000 new *CB license applications were received in the month of November 1975! And the FCC projects that there will be about 15-million CB'ers in the U.S.A. by 1979.*

This certainly has been a good year for CB. Operating restrictions were relaxed (including removal of the "hobby" prohibition), license fees were reduced from $20 to $4 for five years, and interstation channels were increased, among other benefits. By relaxing CB rules, however, the FCC expects full compliance with present restrictions, which include use of one's Call Letters, transmission-time limits, no obscene language, etc. It's to every CB'ers advantage to press for compliance with the rules. Remember, what the FCC gives it can take away!

This special 16-page insert examines a variety of CB areas: (1) Base-station CB antennas, which can significantly increase communication range, are given authoritative treatment. (2) A pictorial presentation shows how easy it really is to install a mobile CB system. (3) A CB highway assistance program in Washington, D.C. underlines the important public service performed by many CB'ers. (4) An easy-to-build communication timer simplifies complying with the new FCC ruling on communication time. (5) A glossary of CB equipment terms will enable buyers to understand specification and feature claims in product literature. (6) Finally, a list of CB radio equipment and antenna manufacturers and addresses for reference purposes.

How to Choose CB Base Station Antennas

BY JOHN J. McVEIGH, Associate Editor

A MAJOR concern of many CB'ers is extending their reliable communications range beyond, say, five miles or so. Since there is a 4-watt r-f power output limit imposed by the FCC, the only way to extend the range legally is to do something about the antenna. Due to physical limitations and other factors, not much can be gained by improving a mobile antenna. But it's a different story with base antennas. A dramatic jump in range can often be obtained by using the right antenna and mounting it properly.

Bewildered by so many different antenna shapes and sizes, most CB'ers end up asking, "How can I choose the right base antenna without studying to become an antenna engineer?" To answer, let's take a quick look at some antenna basics and consider the various types available.

Antennas, whether mobile or base station models, are designed to perform two functions: (1) Accept r-f power from the transmitter section and radiate it into space. (2) Capture a portion of signals passing by and convert them into small voltages that are processed by the receiver section. But that's where similarities end!

Antennas can be differentiated according to four basic characteristics: polarization, directivity, radiation angle, and feedpoint impedance.

Polarization concerns the plane in which the electric field is set up by the antenna. (Radio waves have electric and magnetic fields at right angles to each other.) Most often, polarization of signals radiated by the antenna lies in the same plane as its active element(s), as shown in Fig. 1. Therefore, a vertical antenna (such as a mobile whip) radiates vertically polarized signals, whereas an antenna element mounted at right angles to a vertical mast is horizontally polarized.

Does the foregoing make a difference to a base station antenna buyer? Yes! If you anticipate communicating mainly with mobile units, it is best to have a *vertically* polarized base antenna since most mobile signals are vertically polarized. However, if you're primarily interested in a few fixed stations, get together with those operators and install *horizontally* polarized antennas at each location. Choosing a "horizontal" antenna will also bring a degree of noise immunity to the user since most electrical noise is vertically polarized.

It's important to note that an antenna polarized in one plane can still pick up signals in the other. It just won't receive them as efficiently, resulting in poorer reception on weak signals. For example, a ground-wave signal (one travelling along the earth's surface) received by a cross-polarized antenna will generally be attenuated about 20 dB (3.3 "S" units). Considering the low power levels in CB work—4 watts *maximum*—it's to your great advantage to have as efficient an antenna as possible.

Directivitiy. When an antenna performs better in one direction than another, it's said to be directive. One that works equally well in all directions is omnidirectional. Coupled with an antenna's directivity is its *gain*, which shows how much more it favors one direction than another.

Gain is usually expressed in dB, referenced to either an isotropic source (a theoretical antenna radiating equally well in all directions) or a dipole, which is a simple antenna radiating best at right angles to itself. A dipole has a gain of 2.1 dB compared to an isotropic source. When comparing antenna gain, be sure to know what the reference is—the same antenna will have a gain of 8 dB or 10.1 dB, based on a dipole and isotropic antenna, respectively. Sometimes "dBi" will be used to express gain over an isotropic reference antenna.

It's easy to understand these concepts by looking at the *polar diagram* of an antenna. The response of an isotropic antenna is shown in Fig. 2A. The intensity of radiation is represented by the radius of a circle, since it is constant at all points around the antenna at a given distance. (Of course, the radiation gets weaker the farther away from the antenna you measure it.) A dipole has a response like that shown in Fig. 2B. Note that the maximum signal is radiated broadside to the antenna. Thus, it is moderately directive.

A very directional antenna has a response like that in Fig. 2C. It "beams" its power toward one direction in a single major "lobe." Consequently, it can increase the apparent signal strength in the favored direction by as much as 10 dB or more. This is equivalent to radiating 40 watts from your transceiver—legally! (10 dB represents a 10-fold increase in power. See the nomograph of Fig. 3.) The technical term for this apparent power level is *effective radiated power*, or simply *erp*.

Directional antennas are just as useful on receive as transmit. With them, you can reduce interference to a station in the desired area by boosting its strength. At the same time you'll be cutting down the strength of those from other directions.

But you don't get something for nothing. What you gain in signal level in one direction is taken from other directions. This means, in many cases, that, if you want a stronger signal in more than one direction, you must physically rotate the antenna to aim it the right way. Although this can be done with an electric motor (a rotator), it does boost the cost of the antenna system.

Radiation Angle describes how the signal "takes off" from the antenna. If the radiation angle is near zero, most of the signal runs parallel to the earth's surface as a "ground wave." This is most desirable. As the radiation angle increases, more and more of the radiated signal is sent up into the "blue." Although these signals are some-

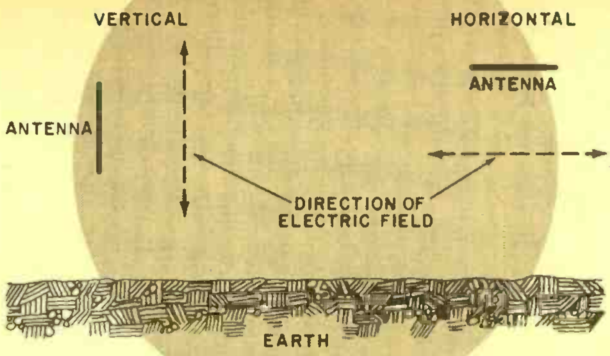


Fig. 1. Vertical polarization (left) and horizontal (right).

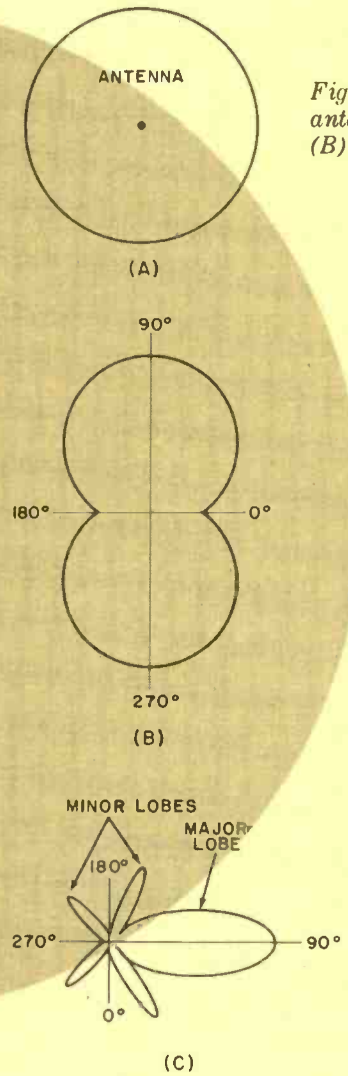


Fig. 2. Polar diagrams for antennas: (A) isotropic; (B) dipole; (C) beam.

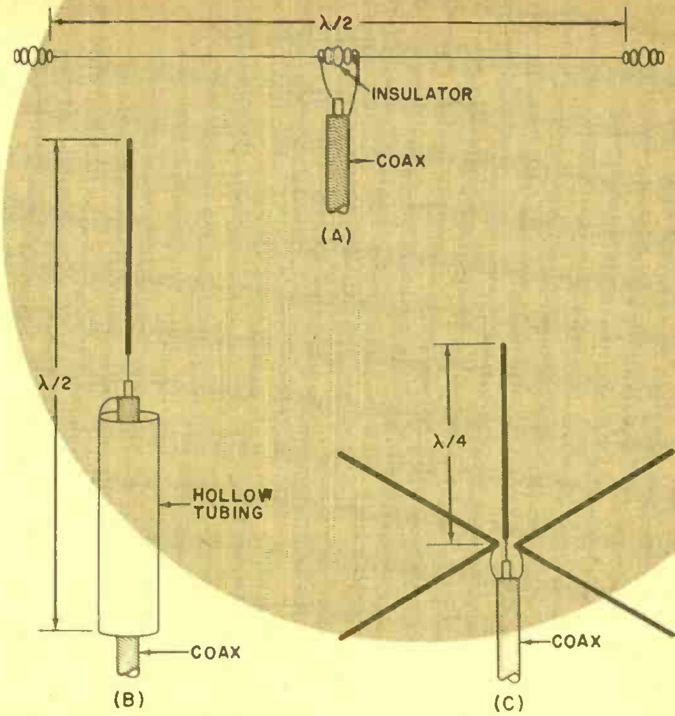


Fig. 4. Three simple antennas: (A) horizontal dipole; (B) vertical (coaxial) dipole; (C) ground plane.

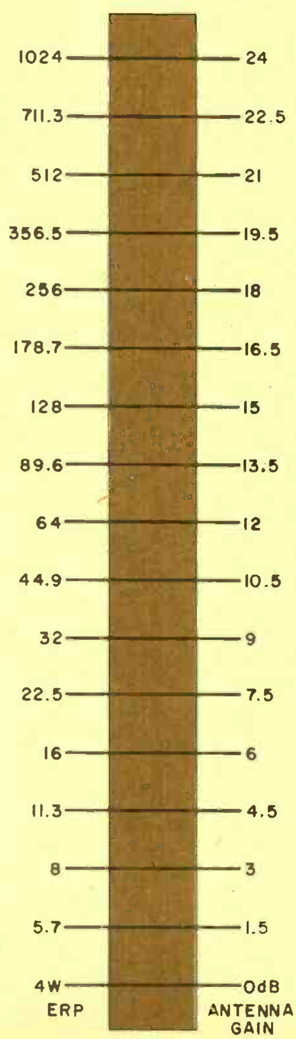


Fig. 3. Nomograph of antenna gain versus effective radiated power. (Feedline loss neglected.)

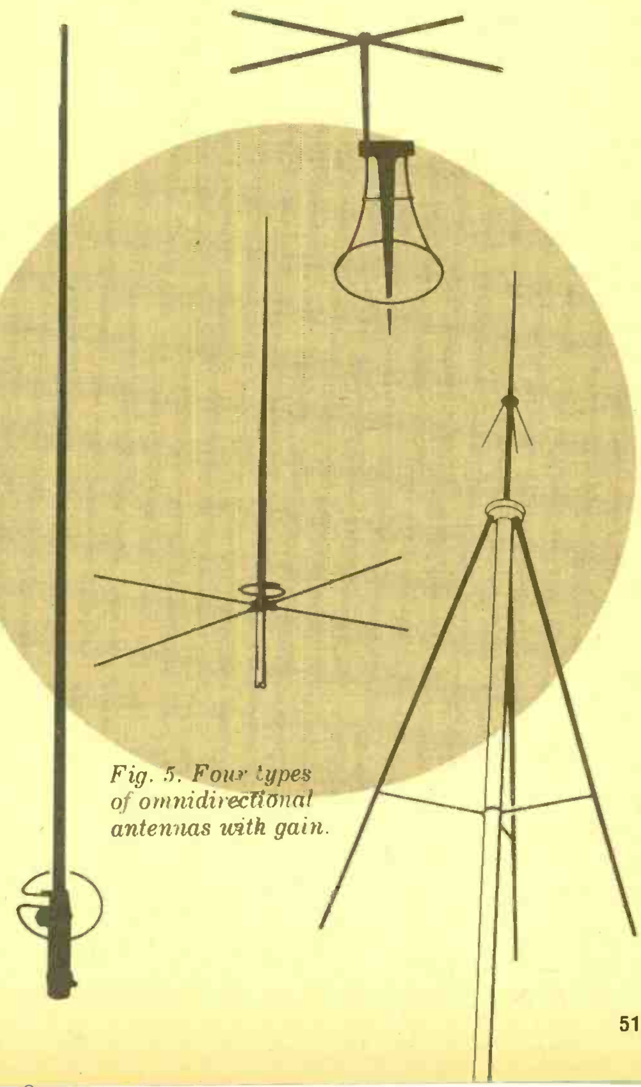


Fig. 5. Four types of omnidirectional antennas with gain.

times reflected back to earth many hundreds or thousands of miles away ("skip" signals), they are not the basis of good CB communications. Apart from legal considerations (the FCC limits CB communication range to 150 miles), "skip" is a transient phenomenon at best. For reliable communications, most of the radiation should be ground wave.

The radiation angle is as much a function of the antenna design as it is of the way the antenna is mounted. Generally, the higher the antenna is placed above actual or artificial ground, the lower the radiation angle becomes. As a rule, vertical antennas tend to have lower radiation angles than horizontal ones mounted at the same height.

Feedpoint Impedance, expressed in ohms, is the amount of opposition the antenna exhibits to the flow of r-f current into it. But don't draw a common-sense conclusion from this that you'll want the minimum opposition possible, or 0 ohms. Without delving into theory, let's just say that all impedances of the communications system—the input impedance to the receiver, the output impedance of the transmitter, the "characteristic" impedance of the coaxial transmission line, and the feedpoint impedance of the antenna—should be équal.

The common feedpoint impedance of CB antennas is 52 ohms, and the same holds for the other impedances mentioned. When one or more of these varies, part of the output of the transmitter is reflected back into it, and "standing waves" are set up. These represent lost signal power. (The same holds true for received signals entering the receiver.)

The standing wave ratio (SWR) is an index of how well the antenna system is matched. When all impedances are equal, the SWR is one or "1:1" ("one to one"). It is obtained by forming the ratio of antenna impedance to feedline impedance, or feedline impedance to transmitter output impedance, etc. So, if a 50-ohm-output transmitter is connected through a 50-ohm transmission line to a 100-ohm antenna, the SWR is 2:1, which is commonly accepted as the maximum tolerable SWR.

Some antennas have matching or loading coils. These are used to convert the "actual" antenna impedance to the desired 52 ohms. Other things being equal, antennas with these coils will not perform as efficiently as those whose "actual" impedance is 52 ohms. Coils, even if they are wound from silver or gold wire, still introduce losses. Some of the r-f power applied to them simply heats the coil, rather than being radiated as useful signal power.

Armed with these concepts, let's examine the common CB base station antenna designs from which you will have to choose.

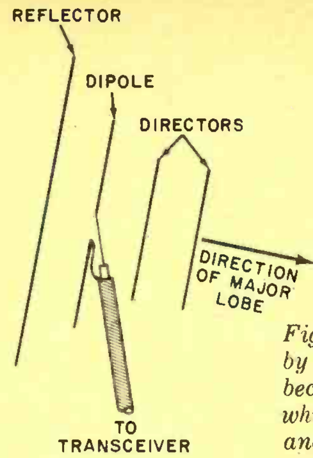


Fig. 6. A dipole surrounded by "parasitic" elements becomes a Yagi beam, which can have high gain and good directivity.

Simple Antennas. The two basic antennas that are used in communications are the *dipole* and *ground plane*. Dipoles are formed by splitting a piece of wire one-half wavelength (the distance a radio wave travels in 180° of one cycle), and feeding it with a transmission line. The antenna can be installed in either the horizontal (A) or vertical (B) plane, as shown in Fig. 4. The *coaxial* dipole is often used because it is vertically polarized. One half of the dipole is a rod or wire connected to the inner conductor of the coaxial feedline. The other half is a piece of tubing tied to the outer conductor or "braid" of the coaxial line. Each element of the dipole is one-quarter wavelength (λ/4) or about 9 feet.

The ground plane (Fig. 4C) is a commonly used CB antenna, consisting of a vertical quarter-wavelength rod, and three or four "radials" of the same length (λ/4). The result is an omnidirectional antenna with a fairly low radiation angle. Often, the radials will droop. This is done to raise the feedpoint impedance to the desired 52 ohms. If the radials were rigid, the impedance would be in the neighborhood of 30 ohms, and a mismatch would result.

The advantages of these antennas include simplicity of construction (you can build your own) and ease of installation. They also tend to last a long time in the face of high winds. However, don't expect high gain or directionality.

Omnidirectional Antennas with Gain. This class of antennas offers some gain over the simple types without sacrificing directivity. No, that's not a contradiction of what was said previously. (You don't get something for nothing.) The increased power is taken from signal components that would be radiated at higher angles. The polar diagrams shown in Fig. 2 are two-dimensional—but antennas radiate in *three* dimensions. So, the radiation pat-

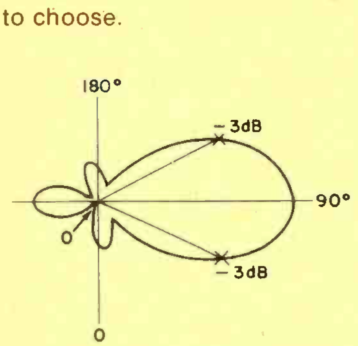


Fig. 7. Half-power (−3-dB) points determine angular bandwidth of a directional antenna.

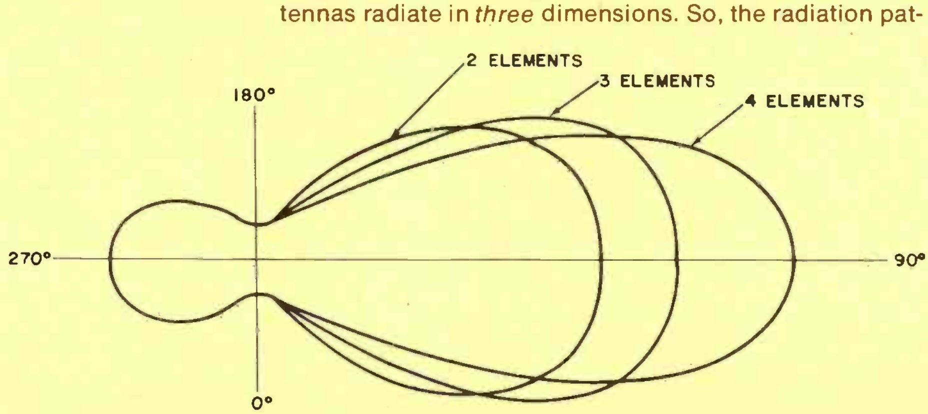


Fig. 8. Adding elements to a Yagi increases directivity.

tern of an isotropic source is really a sphere, a cross section of which was presented earlier. A dipole is surrounded by a doughnut-shaped field, which, in two dimensions, looks like the figure-8 of Fig. 2B.

When speaking of omnidirectionality, we confine ourselves to low radiation angles. Consequently, if we compress the isotropic's "balloon" or the dipole's "doughnut," we end up with greater field strength in the ground wave by adding that portion that would otherwise be wasted as sky-wave signal. This is usually done through capacitive loading (by means of a metallic "hat" or similar structure), extending element length (say, to 5λ/8), or phasing effects between different antenna components. Realizable gain is generally on the order of 3 to 6 dB over an isotropic source. Figure 5 shows typical antenna configurations that are all vertically polarized.

There are a few antennas which can be used as omnidirectionals with a certain amount of gain, or as directionals with more gain. They rely on a control box to set phasing, which in turn governs directivity and gain. However, their patterns can usually be focused in one of three or four directions. Maximum gain is about 8 dBi.

Yagi Beams. This class of antenna has enjoyed great popularity among amateur, CB, and commercial radio operators. It has both directionality and gain due to phasing effects among its elements, which number two or more.

A Yagi beam (Fig. 6) consists of a dipole, called the *driven element*, and one or more rods about the same length mounted on a common "boom" and spaced about λ/10 away. These rods are called *parasitic elements,* since they are parasitically coupled to the driven element by electric fields. If an element is slightly longer than the driven element, it is called a *reflector*. In operation, it absorbs power coming toward it from the driven element and re-radiates it in the opposite direction. In other words, it reflects the signal back toward the driven element. If a parasitic element is slightly shorter than the driven element, it focuses or directs the signal into a narrower beam travelling in the direction from which it came. Such a parasitic element is called a *director*.

A two-element beam generally consists of a driven element and a reflector. It has a gain of about 7.1 dBi in the direction away from the reflector. Adding a director yields an additional 3 dB, and narrows the beam width. The width of the signal "beam" is often referred to in the specifications as the *half-power beam width*, in degrees. It is measured by finding the points on the major lobe where the radiated signal power is exactly one-half (−3 dB) of the value at right angles to the antenna (Fig. 7). Then lines are drawn from these points on the polar diagram to the graph's origin and the angle formed is measured. The smaller this angle is, the more directional the antenna. The lengths of these lines are proportional to signal strengths at those points.

Directionality and gain can be increased by adding more parasitic elements (usually directors). Practical considerations generally limit the total to five elements. Gain increases are shown in the table, and the effects on beamwidth and radiation pattern are shown in Fig. 8.

A typical three-element beam is shown in Fig. 9. When the beam is mounted at right angles to its vertical mast, as in (A), the antenna is horizontally polarized. When it is mounted as in (B), it is vertically polarized.

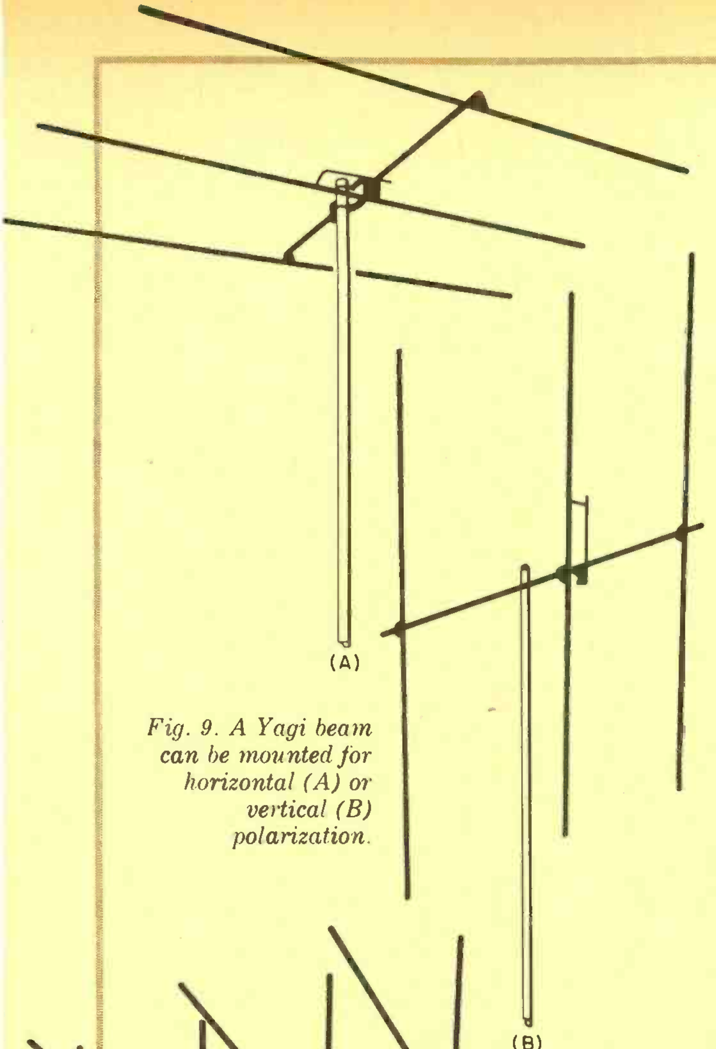


Fig. 9. A Yagi beam can be mounted for horizontal (A) or vertical (B) polarization.

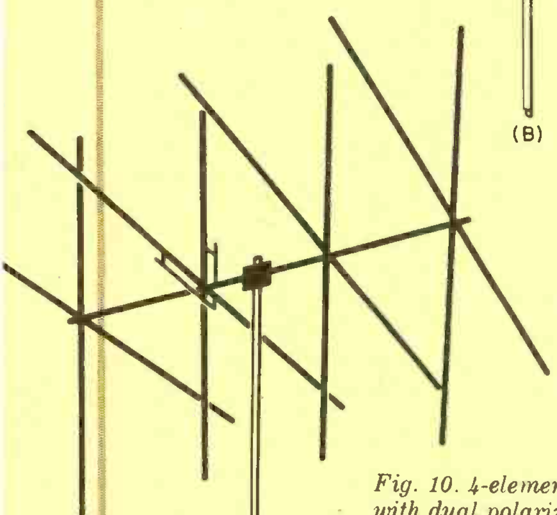


Fig. 10. 4-element Yagi with dual polarization.

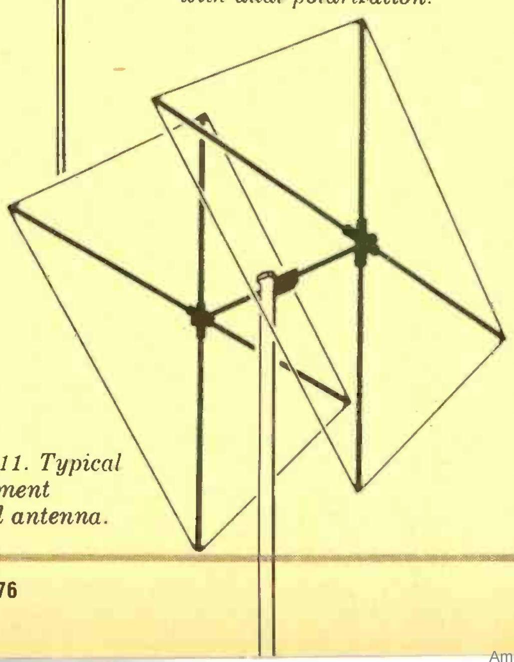


Fig. 11. Typical 2-element Quad antenna.

It is possible to mount two Yagi beams on the same "boom" to provide switchable polarization (Fig. 10). In this case, separate feedlines would have to be run down to the transceiver, with a coaxial switch to select the desired polarization. But it is also possible, through the use of a coaxial phasing harness, to feed both beams simultaneously and radiate signals polarized in the two planes. Each beam accepts half of the total output power, which means that 3 dB of gain is lost in each plane. The advantage of this system is that both horizontally and vertically polarized signals will be received equally well. To calculate the gain for each plane, subtract 3 dB from the gain of the active antenna. Referring to the table, horizontal and vertical gains for the four-element beams is 9.1 dBi.

COMPARISON OF ANTENNA CHARACTERISTICS

Type	Gain Over Dipole (dB)	Gain Over Isotropic (dB)	Radiation Angle	Polarization
Isotropic (theoretical)	−2.1	0	All angles	All planes
Ground plane	−1.8	0.3	Low	V
λ/2 dipole	0	2.1	Vaires inversely with mounting height	Same as mounting plane
5λ/8 vert.	1.2	3.3	Gen. low	V
Yagi Beam:			Varies inversely with mounting height	Same as mounting plane
2-element	5.0	7.1		
3-element	8.0	10.1		
4-element	10.0	12.1		
5-element	12.0	14.1		
Cubical Quad:			Varies inversely with mounting height	Determined by feedpoint (see Fig. 12)
2-element	7.0	9.1		
3-element	10.0	12.1		
4-element	12.0	14.1		

Cubical Quads. This type of antenna made its debut in the late 1940's, and is very popular. It consists of a driven element and one or more parasitic elements, as does a Yagi beam. But the Quad's elements are wire loops, not metal rods. The driven element measures λ/4 on each side, with a total perimeter of one wavelength.

Standing alone, a full-wave loop has a gain of about 2 dB over a half-wave dipole. Placing a slighly larger loop near the driven one will produce reflective action, much like the reflector on a Yagi. Slightly smaller loops placed on the other side of the driven element act as directors. Adding a parasitic element near the driven element will produce about the same amount of gain obtained by adding one to a Yagi. However, since the driven element inherently has the 2-dB advantage of a dipole (the Yagi's driven element), a Quad will have 2 dB more gain than a beam with the same number of elements.

Quads have other advantages over beams. For a given antenna height, a Quad will have a lower angle of radiation

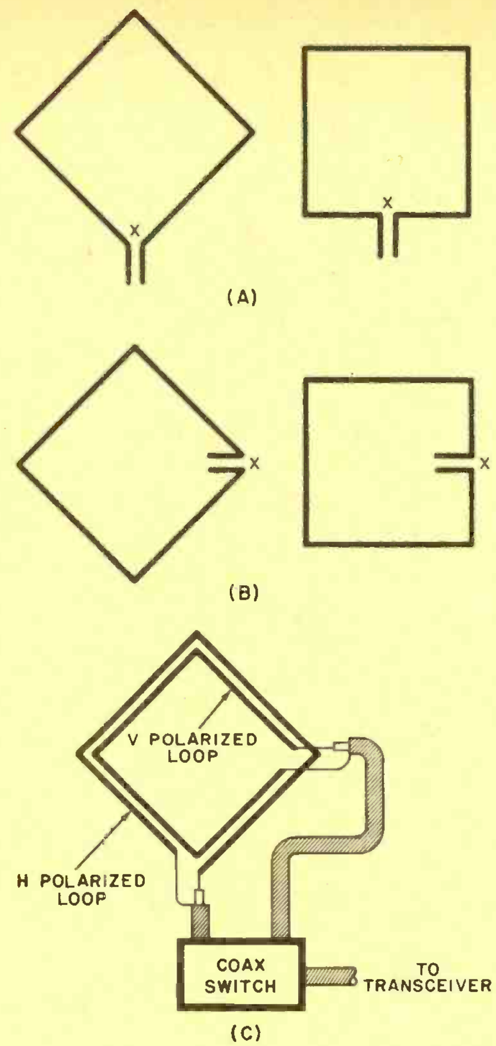


Fig. 12. Polarization of a Quad depends on feedpoint geometry. Diamond and square Quads can be horizontally polarized (A), vertically polarized (B), or both (C).

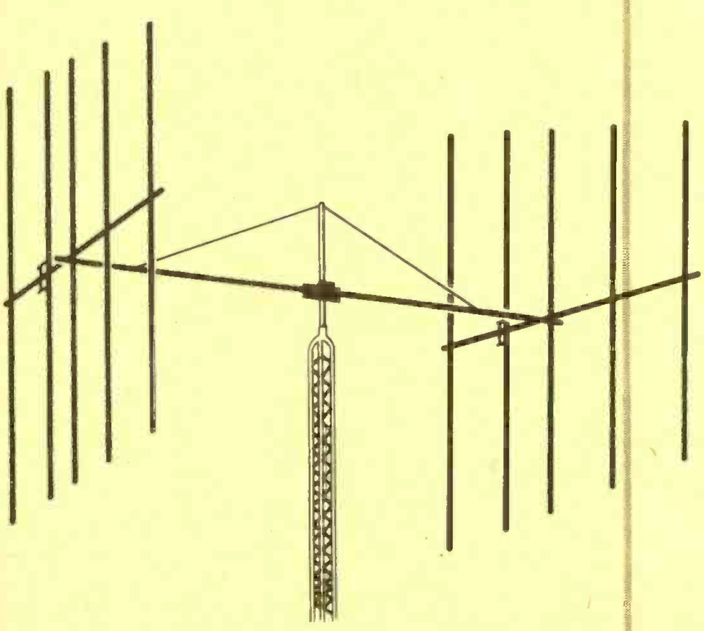


Fig. 13. Stacking two beams in the same plane yields a 3-dB increase in gain.

than a beam. Also, Quads are lighter than Yagis. A typical two-element Quad is shown in Fig. 11. The actual antenna consists merely of the two rectangular loops of wire. The rest of the structure is a supporting framework, made of bamboo, fiberglass, or light-weight metal tubing. (The latter two materials are more durable, and more expensive.) The Quad offers less wind resistance than a beam. This, combined with its lower weight, means that a lighter-duty rotator can be used with the Quad to aim it in the desired direction. For these reasons, many experienced operators prefer Quads to beams.

As shown in Fig. 12, a Quad can be either a square or a diamond in shape. It will perform equally well in either configuration. Its polarization depends only on the feedpoint (where the transmission line is attached to the antenna). By feeding the Quad as shown in Fig. 12A, horizontal polarization is obtained. Attaching the transmission line to the feedpoint (point X) as shown in Fig. 12B will result in vertical polarization. Switchable polarization is accomplished in much the same way as with Yagi's. Figure 12C shows a driven element that is actually composed of two separate loops. One is vertically polarized, the other horizontally. A weatherproof relay mounted near the antenna selects the appropriate loop, and thus the polarization. Also, a special phasing harness can be used to feed both loops simultaneously, so that horizontally and vertically polarized signals are radiated. Gain in each plane is 3 dB lower, as we noted in the similar Yagi case.

Stacking. Effective radiated power can be doubled (an additional 3-dB gain) if directional antennas are "stacked." Figure 13 shows a "king-size" antenna system composed of two stacked 5-element beams. (Note that both beams are vertically polarized.) A total gain of 17.1 dBi is obtained—14.1 dBi (the gain of a single 5-element beam) plus 3 dB (for stacking) equals 17.1 dBi. That means the erp of this system, when driven by 4 watts of r-f (neglecting feedline losses), will be 205 *legal* watts! Such an installation requires a lot of space, as well as tolerant family and neighbors.

Conclusion. As you can see, there are a myriad of base station antenna types from which to choose. They range in price from about $13 to $375, so anyone's pocketbook can be satisfied. Add to this the material costs for a mast, mounting accessories and cable. For a sophisticated installation, you might want to include a rotator, a small tower, etc.

Don't overlook legal restrictions when planning your base antenna system. If you live near an airport, special limitations must be observed (see FCC part 95 Rules and Regulations). Also, an omnidirectional antenna cannot be higher than 60′ above ground level or natural formation. Other regulations: on an existing antenna structure for a licensed transmitter in another service, an omni cannot exceed 60′ above ground nor higher than the structure. Directionals cannot be more than 20′ above ground or a building, or exceed the 20′ point on an existing antenna structure.

Local zoning ordinances should be checked for antenna height restrictions. Sometimes a lease or covenant prohibits outdoor antennas entirely. In the latter case, there are inexpensive, back-of-set, center-loaded antennas and so-called "apartment" ¼-wave antennas. However, using these antennas won't get you the "reach" that's possible with outdoor types. ◈

It's Easy to Install a CB Mobile Transceiver

BY STEPHEN R. DAVIS

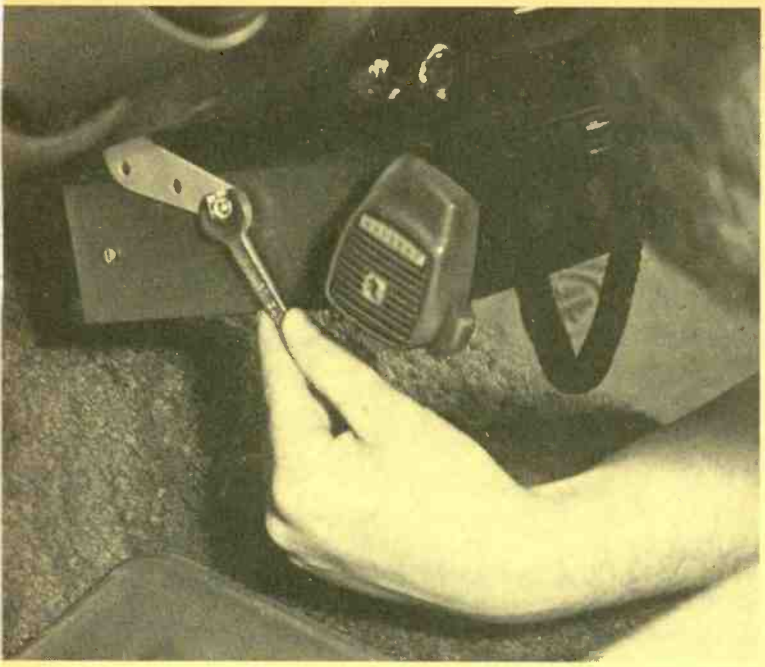
WHILE it is true that many CB retailers do not have installation facilities, this should not deter anyone from enjoying the benefits of a mobile CB communication system. Installation—both from a technical and a cosmetic point of view—is simple. You can do it yourself.

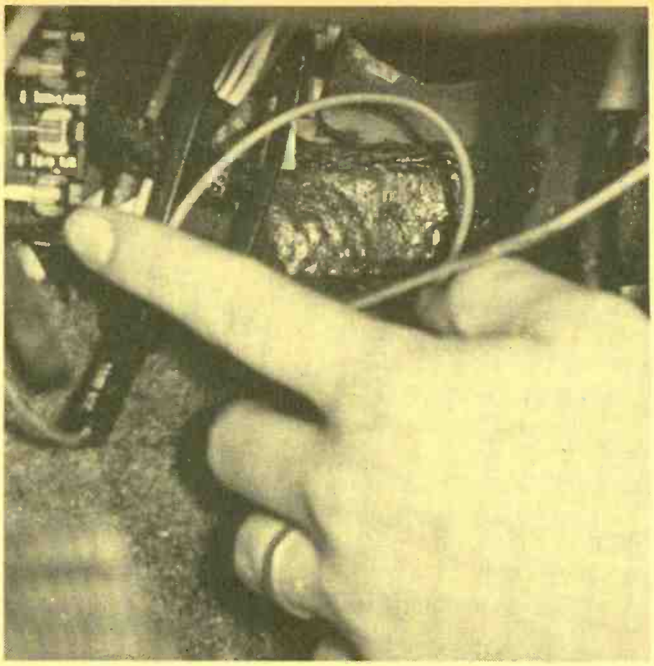
Assembly kits for transceivers, antennas, and external speakers contain easy-to-follow instructions. Only a few standard tools, already owned by most people, are needed. Usually, a screwdriver and a wrench or pliers will suffice. Sometimes a drill is needed, though even this is often not required.

Before You Start. At this point, three notes of caution should be mentioned: (1) Do not attempt to operate your transceiver until the antenna is connected. (2) Don't operate the system until you have checked out the antenna/

Parts and tools for do-it-yourself mobile CB installation.

1





2 Mounting transceiver under dash.

3 Attaching line to unused fuse terminal.

transceiver impedance match with a Standing Wave Ratio (SWR) bridge. An SWR greater than 3:1 can damage the transceiver or greatly reduce output power and usable range. (3) Don't communicate with other operators or test the system on the air until you have received your CB license from the FCC. It is easily obtained, costs only $4, and the required application is packed in the transceiver's shipping carton.

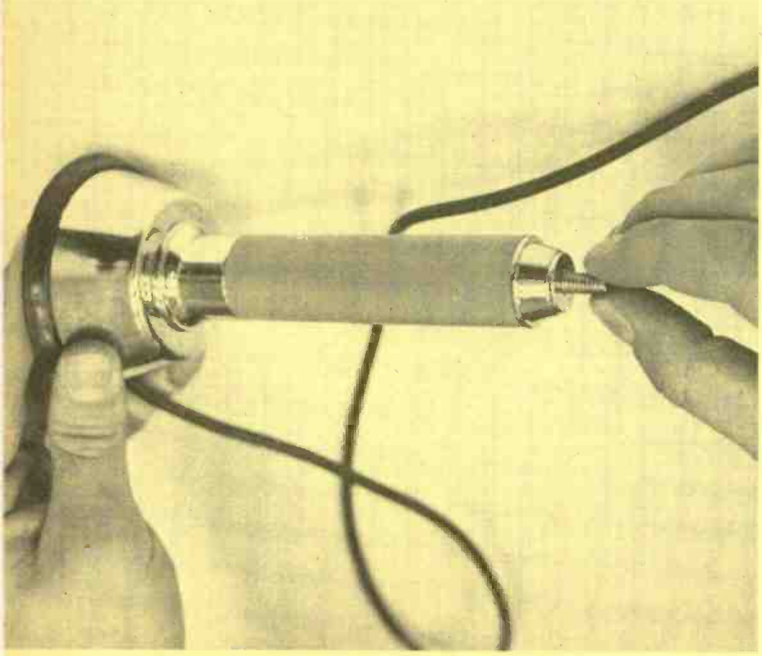
Installation Procedure. Start by laying out all the required tools and hardware, as shown in Fig. 1. Choose the mounting location carefully (usually under the dash). Be sure the transceiver and the external speaker (if used) do not interfere with the safe operation of the vehicle or hamper leg movement.

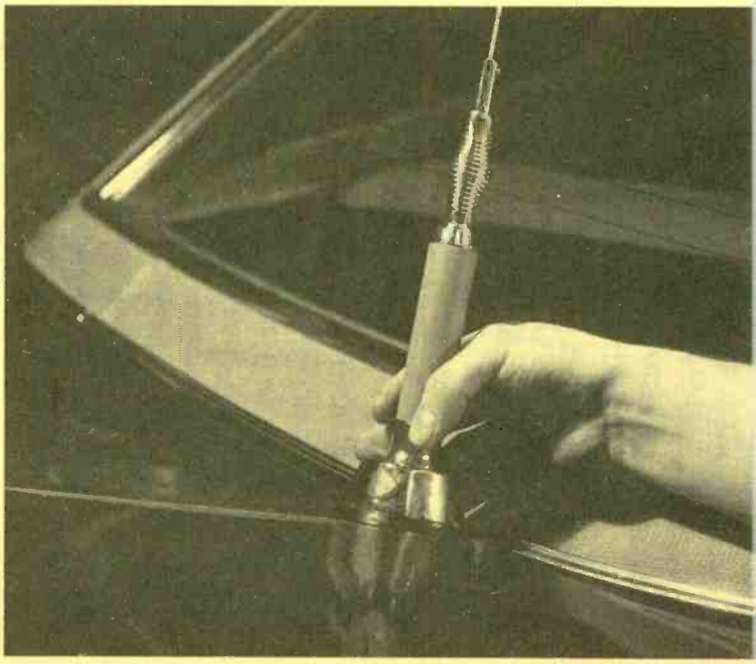
In many vehicles, you'll find mounting screws already in place under the dash. If so, they will accommodate the transceiver's mounting bracket. Obviously, it's easier to use them than to drill into the dash. (It might be necessary to redrill the bracket.) Mount the bracket and, if necessary, secure the microphone retaining clip to the transceiver case. Then, using protective washers, fasten the transceiver to the mounting bracket (Fig. 2).

Now you must connect the power cord to a +12-volt tie point. The transceiver's power lead is only one wire; the antenna feedline serves as the ground. You may decide to

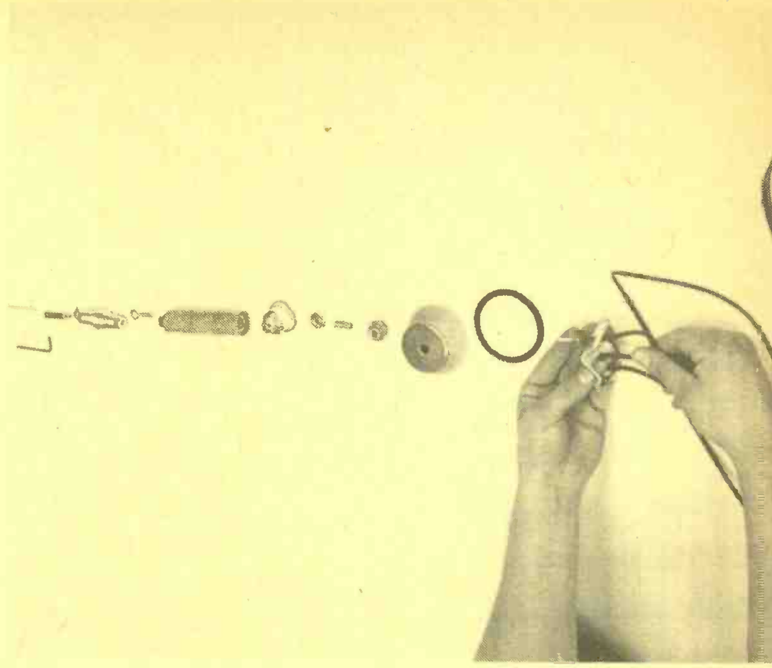
6 Tightening down the antenna coil.

7 Centering antenna on the trunk lid.





4 Transceiver and external speaker in place.



5 Threading coax into antenna mounting bracket.

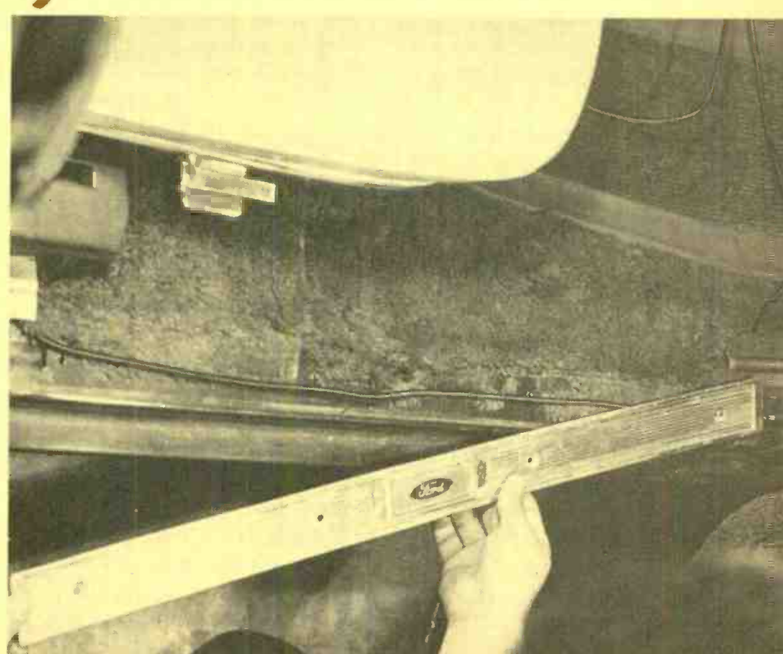
use the auxiliary fuse on your vehicle's fuse block. If so, attach a female spade connector to the power lead and slip it onto the appropriate "hot" point (Fig. 3). You have a choice of wiring the transceiver so that it will be powered with or without having the ignition switch on. Therefore, check the electrical system's schematic for the right tie point. Some transceivers come with a self-stripping tap connector. With it, getting power to the rig requires only sliding the connector onto any hot lead and crimping it with pliers.

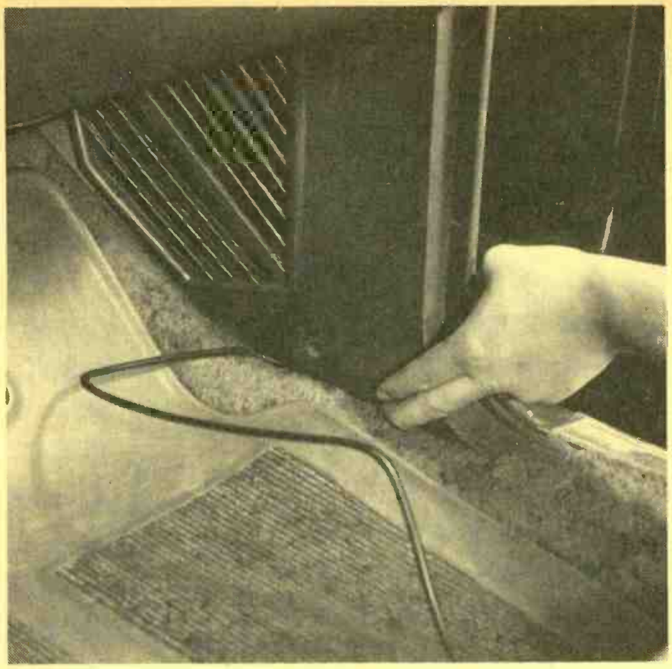
Speaker Installation. Next, mount the external speaker, if one is to be used. Again, you'll probably find usable screws in place under the dash—but be sure not to impair the use of the glove compartment door when positioning the speaker. Mount the bracket, attach the speaker, and connect the speaker wire to the appropriate jack on the transceiver. Although the power lead can be cut to the right length, you should not shorten the speaker lead. You might want to move the speaker at some future time, so simply coil up the excess cable and tape it up under the dash. At this point, the installation should look like Fig. 4.

Antenna Installation. Here's where things get a little more complex. Using a trunk mount, the coaxial cable is

8 Pulling the cable from trunk into car.

9 Working coax under carpet retaining plate.





10 Slipping the coax behind the kick plate.

11 Testing with a standing-wave meter.

fed into the trunk lip bracket and brought up through the cup (Fig. 5). Remove the vinyl outer jacket and foam inner insulator according to the dimensions given in the antenna assembly instructions. Then, slide on and secure the cable clamping assembly, mount the cable adaptor, loading coil, spring, and whip adaptor, tightening each securely (Fig. 6). The antenna whip is secured with a set screw, but its height will probably have to be adjusted slightly to achieve a good impedance match.

Now you're ready to secure the trunk-lip-mounted antenna in place. It should be mounted at the center of the trunk lip (Fig. 7) for best all-round radiation. (Using this location makes running cable trickier than a front cowl position, but increased reception and transmission range make it worthwhile.) Two set screws hold the antenna base to the inside edge of the trunk lip. Tighten them, but be sure to save the allen wrench supplied for this purpose in the event you wish to remove the antenna and stow it in the trunk for security reasons. Apply silicone grease compound for protection against the elements.

How do you get the antenna feedline from the trunk to the transceiver? Well, the easiest way is to simply poke a hole in the insulation behind the rear seat with a screwdriver. Then feed the cable through. Get into the car, shove your hands between the cushion and the back of the seat, locate the cable and pull it through. As shown in Fig. 8, you do *not* have to remove the rear seat to do this.

Next, work the cable down the side of the seat. Remove the carpet retaining plate and run the cable under it (Fig. 9). Replace the plate, taking care to keep the cable away from the retaining screws. Pull out the kick panel and slip the coax behind it, feeding it up and under the dash (Fig. 10). Finally, plug the cable's coaxial connector into the antenna jack on the back of the transceiver. Under no circumstances should you trim the coax. It is "tuned" for the specific length to present a proper impedance.

System Checkout. As noted before, you should not operate the transceiver before the antenna system is tested. This can be done with a directional wattmeter or an impedance bridge. If neither of these is available, a reflectometer or SWR bridge (Fig. 11) can be used. (Some transceivers have built-in SWR meters.)

Key the microphone but don't talk. With the SWR bridge in the forward mode, set the sensitivity control so the meter pointer just reaches the full-scale calibration point. Then switch the bridge to the reflected mode. If the meter indicates an SWR of 2:1 or less, you're in good shape. A reading up to 3:1 is barely tolerable. If the SWR reads on the high side, try adjusting the length of the whip. If neither shortening or lengthening the whip improves matters, check to see if the base of the antenna is properly grounded. If the antenna is properly installed, then perhaps the coax was inadvertently shorted.

Remember that any time you remove the antenna, it must be replaced in exactly the same spot. Otherwise the SWR might rise and/or the antenna's radiation pattern become skewed.

Conclusion. Figure on spending anywhere from 30 minutes to two hours on the installation. If you're not handy or fearful of drilling a hole in your car, head for a skilled installer. It might cost $25, depending on the area and whether or not you purchased the equipment from a retailer who does installations.

However, whether you have an installer nearby or not, this rundown has shown that the installation of a mobile CB unit in your car is really not too difficult. If you can't do it, surely you have a friend who can.

Illustrated in this article is the installation of an E.F. Johnson Messenger 123A CB 23-channel Transceiver, an AFS/Kriket KC35 Voice Communications Speaker, and an Antenna Specialists Model 176 Mobile Antenna. ◈

Your CB Bicentennial Highway Buddies

BY JAMES B. SWEENEY

VISITORS to the Washington, D.C. area will welcome a new, local highway assistance service. Called the "Courtesy Highway Patrol," it consists of CB operators who formed a volunteer body to patrol the main vehicle traffic arteries around the nation's capital in order to assist motorists.

The patrol deploys three pickup trucks, each equipped with CB Class-D transceivers. Trucks are painted bright orange, equipped with flashing lights, and labelled "Courtesy VA. Highway Patrol" in large black letters. Volunteers wear orange uniforms and white hardhats. Truck teams (two CB'er volunteers) carry battery jumper cables, minor repair tools, first-aid kits, selected auto spare parts, extra gasoline and diesel fuel, and even lollipops for restless children. And all service and parts are free!

This CB service concept was originated by John Sullivan, president of the Virginia CB Radio Association. He was motivated by a sudden upsurge in violent crimes committed against helpless motorists stranded along the superhighways in the D.C. area. Although local CB'ers had always done whatever they could to assist such persons, they were rarely able to be of immediate help. Either they weren't in the area or did not have extra fuel, auto parts, etc. Sullivan decided that what was really needed was a number of organized CB patrols covering assigned areas of highway, night and day, on weekends.

Sullivan proposed his highway patrol idea at a meeting of his CB club, the Mt. Vernon 4 Wheelers. It received a hearty endorsement from 97 club members. He then turned to the thousands of CB'ers in the Washington-Virginia-Maryland area of the beltway encircling the capital, seeking volunteers. This was an effective approach, since many of the CB'ers were already organized into clubs, had a record of assistance to the public, and were generally acquainted with one another through CB contact on the air.

He originally started his patrol with his own pickup truck, organizing those who offered their services into two-man teams, each patrolling a fixed area for a specific number of hours. From the moment his truck rolled onto the highway, it was swamped with calls channelled through the CB base station headquarters set up in Sullivan's own house. During the first five weekends of operation, almost 600 people were aided. Highway accidents, empty gas tanks, flat tires, over-heated engines, a heart attack and a woman about to give birth were among the situations encountered.

At first, the public service group anticipated that their highway assistance would largely concern helping families in disabled cars. But the volunteers soon discovered that numerous tractor-trailers were calling for assistance. A breakdown in the early morning hours places a driver in a tough spot. Since so many commercial drivers are into CB, it proved to be a natural way to communicate.

Finances are tight, of course. Sullivan notes that expansion of the association's services is badly needed to cover other than main arteries. A gratifying source of income stems from truckers and motorists who were given assistance. "Once safe on their home turf," Sullivan points out, "many will mail in small amounts of money to offset the cost of fuel and parts we've given them. Checks come in from as far away as California. Each contribution helps put someone's stranded vehicle back in operation.

The Courtesy Highway Patrol assisting a motorist.

NATIONAL CB ORGANIZATIONS.

The main CB emergency service organization on the national level is REACT International, Inc., a non-profit association. Since 1962, REACT teams have handled an estimated 55 million emergency calls including about 12 million highway accident-related messages. Over 200,000 volunteers have provided a total of approximately 100 million man-hours in public services through local REACT team projects. A formal cooperative understanding exists between the American National Red Cross and REACT, and many team members have taken Red Cross first-aid training.

ALERT (Affiliated League of Emergency Radio Teams) is represented in all 50 states by more than 400 emergency teams. Its Washington-based headquarters serves as CB'ers voice before government bodies. It also coordinates organization efforts of local clubs; sponsors junior auxiliaries; distributes a bi-monthly bulletin with news, views, and comments of interest to all CB'ers, as well as reporting on local assistance activities.

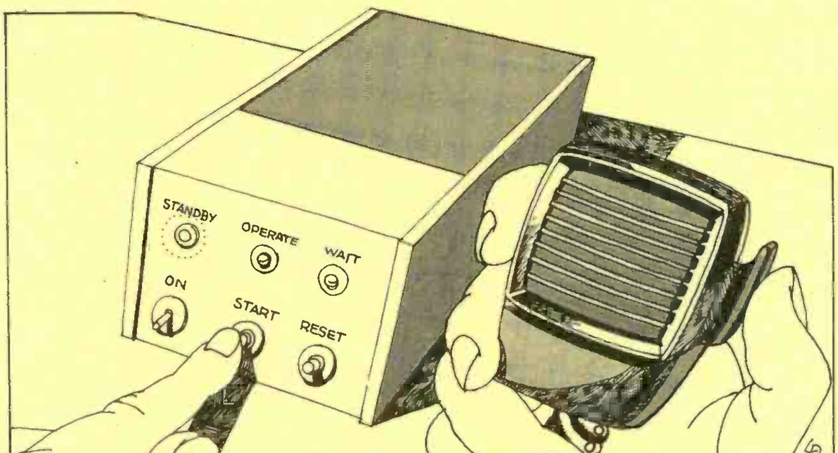
Ten-4 International is a newly-formed association of CB users. Ten-4 will publish a roster of local club affiliates and a periodic newsletter for members featuring FCC news, new products, and technical information.

Addresses:
REACT International, Inc., 111 East Wacker, Chicago, IL 60601.
ALERT National Headquarters, Suite 818A, National Press Building, Washington, D.C. 20004.
Ten-4 International, National Headquarters, 427 Birchwood Avenue, Deerfield, IL 60015.

Sullivan has the satisfaction of seeing his dream of volunteer service in operation. He has further plans for expansion, including a training center for the 5,000 CB volunteers he thinks are required to patrol all the traffic areas around the capital. Satisfying, too, is the knowledge that this group serves as an example for other CB groups around the country, some of which are duplicating the efforts in their communities. ◈

BUILD THE Five-minute "on" One-minute "off" Timer

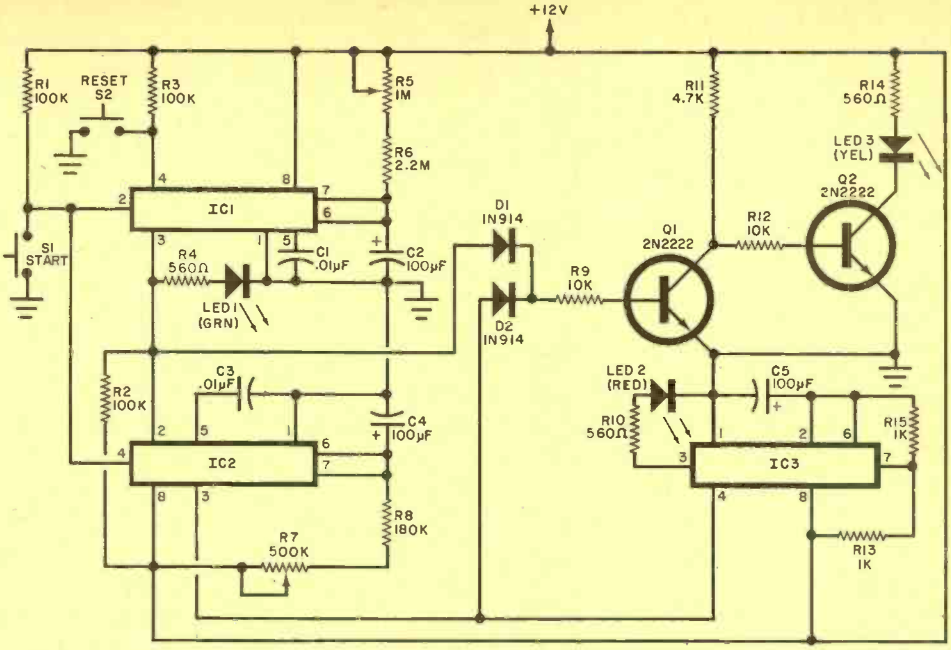
BY JOHN J. McVEIGH, Associate Editor



ONE section of the recently relaxed FCC regulations for the Citizens Radio Service deals with duration of communications. Now, interstation communications are limited to five minutes "on," followed by a one-minute silent period, instead of five minutes "on," and 5 minutes "off." That sounds simple enough—but how can you carry on CB communications without a stopwatch? The Timer described here will do the job. It uses IC's and three LED's to indicate the "status" of your activities—standby (yellow), operate (green), and wait (red).

About the Circuit. Three 555 timing chips form the heart of the circuit (Fig. 1). Two of them (*IC1* and *IC2*) are monostable multivibrators or "one-shots." After they are triggered, their outputs go high for a predetermined time, and then low. The third timer is a free-running square-wave oscillator which is triggered by the second one-shot.

When switch *S1* is depressed, the output of *IC1* (pin 3) is connected to the +12-volt supply, and remains high for 5 minutes. This time is determined by the equation $t=1.1\,(R5+R6)\,C2$. *LED1* glows green for this period, signifying that communications can be conducted. At the end of five minutes, pin 3 goes low, extinguishing *LED1* and triggering the second one-shot, *IC2*. The output of *IC2* (pin 3) goes high for one minute. This period is determined by the equation $t=1.1\,(R6+R7)\,C4$. As long as this output is high,



PARTS LIST

C1,C3—0.01-μF, 50-V disc capacitor
C2,C4,C5—100-μF, 25-volt tantalum capacitor
D1,D2—1N914 switching diode
IC1-IC3—555 timer
LED1-LED3—20-mA light emitting diodes
Q1,Q2—2N2222 npn switching transistor
The following resistors are ½-watt, 10% unless otherwise noted:
R1,R2,R3—100,000-ohm resistor
R4,R10,R14—560-ohm resistor
R5—1-megohm trimmer potentiometer
R6—2.2-megohm, 5% resistor
R7—500,000-ohm trimmer potentiometer
R8—180,000-ohm, 5% resistor
R9,R12—10,000-ohm resistor
R11—4700-ohm resistor
R13,R15—1000-ohm resistor
S1,S2—Normally open momentary pushbutton switch
Misc.—Printed circuit or perforated board, suitable enclosure, hookup wire, rubber grommets, machine hardware, etc.

Fig. 1. 555 timer IC's control status of LED's.

the free-running oscillator *IC3* is allowed to operate. When one minute is up, *IC3* stops oscillating. The operating frequency of this timer is about 5 Hz, and *LED2* will flash on and off at this rate while *IC3* is activated. This signals the operator to end the contact, and to remain off the air as long as *LED2* is blinking.

After the one-minute silent period is up, the Timer goes into a standby mode. Both *LED1* (green) and *LED2* (red) are dark, and *LED3* (yellow) comes on. This LED will only glow when both one-shot ouputs are low. The circuit will remain in this state until *S1* is depressed again.

If your communications do not last for the full five-minute period, depress *S2*. This will disable *IC1*, which in turn will trigger *IC2*. The free running oscillator will be activated for one minute, flashing *LED2*. Then *LED3* will come on and glow until *S1* is depressed again, and the entire sequence will be repeated.

Construction. The simple circuit can be built on pc or perforated board, depending on the builder's preference.

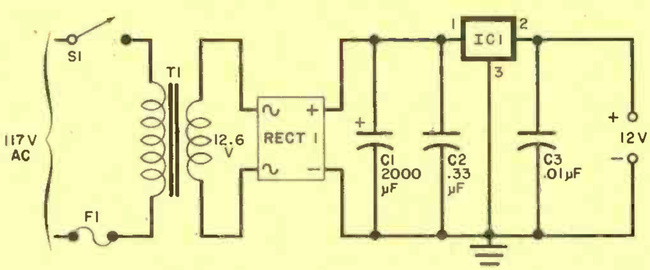


Fig. 2. Circuit for Timer's power supply

PARTS LIST

C1—2000-μF, 50-volt electrolytic capacitor
C2—0.33-μF, 50-volt Mylar capacitor
C3—0.01-μF, 50-volt disc capacitor
F1—¼-ampere fuse
IC1—78L12 voltage regulator IC (Radio Shack 276-801 or equivalent)
RECT1—50-PIV, 2-ampere bridge rectifier
S1—Spst switch
T1—12.6-volt, 300-mA transformer
Misc.—Line cord, fuseholder, hookup wire, solder, terminal strips, suitable enclosure, machine hardware, etc.

General purpose LED's, switching diodes (*D1* and *D2*), and switching transistors (*Q1* and *Q2*) can be used. The only components that require close tolerances are *C2, C4, C5, R6,* and *R8*. The capacitors should be tantalum components. They are usually within 20% of their rated values. Printed circuit board potentiometers (*R5* and *R7*) are used to compensate for these variations. Resistors *R6* and *R8* should be close-tolerance (5% or better) units.

Because a 12-volt dc source is required, the CB Timer can be used in base or mobile environments. At home, a dc supply such as that shown in Fig. 2, will be needed. Of course, if you have access to a +12-volt bus, you can take advantage of it. Maximum current demand is about 50 mA. Both the power supply and the timing circuitry can be mounted in a small utility box.

Adjustment. After you have completed assembly, connect the Timer to a suitable voltage source. The yellow STANDBY LED should glow. Then depress *S1*. The green OPERATE LED should glow, and remain on for somewhere between 3¼ and 7 minutes. When that LED extinguishes, the red WAIT LED will flash for 15 to 90 seconds. Next, the yellow STANDBY LED will glow as soon as the flashing LED goes dark. If the green LED glows for less than 5 minutes, increase the setting of *R5*. If the LED remained on too long, back down on *R5*. With *R5* properly adjusted, the green LED will glow for 300 seconds.

Similarly, the length of time that the red LED flashes can be set to the desired 60 seconds by adjusting *R7*. When the two timers are "on the nose," depress *S1* once again. At some point before 300 seconds have passed, depress *S2*. The green LED will immediately go dark and the red LED will flash for one minute. Then the circuit will revert to the STANDBY mode and the yellow LED will glow.

Using the Timer. As soon as communications begin, depress *S1* momentarily. Continue the contact (if necessary) until the red WAIT LED starts flashing. Immediately terminate the contact and stay off the air until the WAIT LED goes dark and the STANDBY LED comes on. If communications do not last five minutes, depress *S2*, and wait until the red LED goes dark to start again. ◈

CB Equipment Terms Made Easy for Buyers

A-f Output. The power in watts that the transceiver will deliver to a speaker of a given *impedance* at a given level of *distortion*. Typical usage — 2 watts a-f output into 8 ohms at 5% distortion. One watt is usually sufficient, but more power might be needed in noisy locations. Distortion can run as high as 10% without serious loss of intelligibility.

A-f Response. In the receiver section, a measure of the uniformity or flatness of the a-f output over the range of the human voice. In the transmitter, it indicates how uniformly the signal is modulated over the same range. Typical usage — ±X dB or from −X dB to +Y dB from 300 to 3000 Hz. Usual deviation limits are 3 or 6 dB.

AGC. Automatic Gain Control; a means of controlling gain of the receiver section through feedback to suit the strength of the incoming signal. Ideally, the output level at the speaker should remain constant over a wide range of input signals. For low-level inputs, the feedback signal is small and gain is high. For stronger signals, the feedback loop cuts gain to prevent overload.

AM. A method of transmitting information by amplitude modulating or varying the strength of a carrier wave in step with the modulating (voice) signal. The composite AM signal contains a carrier and two sidebands, which are mirror images of each other and contain the transmitted information.

AML. Abbreviation for Automatic Modulation Limiting. A circuit that uses an AGC effect to prevent overmodulation. As a stronger voice signal is applied, this stage reduces the gain of the audio amplifier(s), keeping the modulation level below 100%.

Clarifier. A control on *SSB* transceivers. It is a fine-tuning control that is carefully adjusted so the received signal sounds natural. Its effective range is usually ±600 to ±1500 Hz.

Coax. Popular term for coaxial cable, the transmission line used to couple signals from the transceiver to the antenna, and vice versa. It is made up of a center conductor embedded in plastic or foam insulation (dielectric), around which a copper or aluminum braid is woven. Foam cable is better than plastic, since the dielectric contains much air, which is a very good insulator. Premium coax uses a copper tube in place of a braid, and small glass or foam beads spaced at regular intervals to separate the inner conductor from the tube. All coax causes some signal loss, which is specified in dB per 100 feet. Its characteristic *impedance* in CB work is usually 50 or 52 ohms, and the cable is identified by an RG number. (RG-58-U is low-power 52-ohm coax, RG-8-U can handle higher power levels and has lower loss.)

Crystal. A quartz crystal which exhibits piezoelectric properties. That is, when physically compressed, a voltage develops across it. Crystals also behave as tuned circuits. With external components, they oscillate at a frequency determined by the size and shape of the crystal, the way it is cut, circuit parameters, etc. Crystals are often used to generate signals in oscillators, as well as in filters, microphones and earphones.

dB. An abbreviation for decibel, a measure of signal strength when compared to a specified reference. For voltage, the dB ratio is determined by the formula $dB = 20 \log V_1/V_2$. For power, the relation is $dB = 10 \log P_1/P_2$. When power is doubled, there is a gain of 3 dB. When power is multiplied by ten, the gain is 10 dB. Decibels are often used to express how much a stage will amplify a signal, how much greater a signal is than background noise (*S/N* or signal-to-noise ratio), or how an output varies over a given frequency range.

Delta Tune. A control or switch similar in function to a *clarifier*, found on many *AM* transceivers. It compensates for signals off the center frequency of a CB channel. Although its effective range is about the same as that of a *clarifier*, adjustment is not as critical.

Desensitization. The effect on the receiver section tuned to one channel that is caused by a strong signal on another channel. It is an *AGC*-type effect whereby the desired signal's strength appears to be decreased by the presence of a nearby signal. This effect will influence a receiver's overall *selectivity*.

Distortion. An unwanted modification of a signal's phase and/or amplitude that occurs when an amplifier stage is behaving nonlinearly. All amplifiers display some nonlinearity, but good ones are designed so that the nonlinearities are as small as possible. A nonlinear amplifier will produce a signal that looks distorted when viewed on an oscilloscope, and that contains energy at frequencies other than that of the input signal. *Harmonics* are such products, as are intermodulation distortion, phase distortion, etc. Nonlinearities occur in a-f as well as r-f amplifiers.

Filters. In the broadest sense, filters are networks that favor or attenuate one group of frequencies more than others. A low-pass filter will allow all frequencies below a cutoff frequency to flow unimpeded, but will attenuate any above it. Such a filter is often placed at the output of a CB transceiver to attenuate any *harmonics* that could cause TV interference (TVI). A high-pass filter works in the opposite manner, passing all signals above the cutoff frequency. Bandpass filters allow signals between upper and lower limits to flow at the expense of signals outside the passband. Bandpass filters are used in the i-f sections of receivers to boost *selectivity*. They are usually made in modular form, using *quartz crystal*, mechanical, or ceramic elements. Less critical filters, such as low- and high-pass types, are usually made from discrete coils and capacitors.

Frequency Synthesis. A means of generating several different frequencies without using separate oscillators governed by *crystals* specially ground for each frequency. For example, a synthesizer composed of ten crystals (not all used simultaneously) can generate transmit and receive frequencies for the 23 CB channels. A more recent development, the digital synthesizer, uses only one reference crystal, a phase-locked loop, and a digital counter to generate a large number of stable frequencies. These circuits are used to reduce dependence on individual crystals, which are relatively expensive.

Frequency Tolerance. Indicates how much the actual frequency generated inside the transceiver for a particular channel will vary from the ideal value. This deviation can be caused by slight changes in the oscillating *crystal*, the surrounding circuitry, wide variations in ambient temperature, supply voltage, etc. The maximum legal frequency tolerance is 0.005%, or about 1350 Hz on the CB band.

Harmonics. Undesired signals that appear at multiples (2, 3, etc.) of the desired fundamental frequency. They are produced by nonlinear amplifiers and can cause interference to TV receivers and other services. The second harmonic is the strongest, followed by the third, then the fourth, and so forth. For example, the strong second harmonic (54 MHz) of a 27-MHz CB carrier can cause severe interference to TV channel 2 (54-60 MHz).

Impedance. The opposition a circuit element, transmission line, or antenna displays toward an ac or r-f signal. Although measured in ohms, like a resistance, it is a composite of resistive and reactive effects. The common impedance of CB gear is 50 or 52 ohms, and all equipment should be matched to this value.

Modulation Indicator. A relative indicator (usually a small lamp) that glows brighter and brighter as the modulation level approaches 100%. It gives the operator some idea of how fully he is modulating the carrier.

Noise Blanker. Another circuit for reducing noise interference. It is usually placed in the r-f section, or at the beginning of the i-f section of the receiver, before the high-selectivity circuits. A noise blanker samples the received signal, and actually *squelches* the receiver for a very short period of time (the width of the noise spike). Noise blankers are more effective than noise limiters, but their circuitry is more complex.

Noise Cancelling Mike. A microphone that is built in such a way as to minimize transmission of any background noise at the transmitting site.

Noise Limiter. Sometimes called a series-gate noise limiter, a circuit that shaves off the noise spikes riding on the desired signal. Usually, diodes are used to obtain the clipping action. When the circuit operates at a predetermined threshold without any user activation, it is called an automatic noise limiter or *anl*. These diode noise limiters are usually in the i-f or a-f sections of the receiver.

PEP. Abbreviated form of Peak Envelope Power. The power input or output of an SSB transceiver is measured in watts PEP. Unlike an AM transceiver, an SSB rig only develops output power when modulated, so that terms like "rms carrier power" are meaningless. (There is no carrier to speak of.) The only practical way of measuring SSB output power is by determining the power contained in the signal at the maximum (peak) amplitude. The peak envelope power of a given transmitter is closely related to the amount of distortion that is considered tolerable. It is hard to measure PEP accurately, especially under practical operating conditions. Envelope peaks occur sporadically and are short-lived. Almost all meter movements are too sluggish to catch them, and readings will be averaged over several cycles of the modulating signal. (Note that these remarks are made in the context of voice signals, not "pure" sine waves!) The relationship between average power or rms power and PEP varies widely with individual voice characteristics. When one person modulates a given transceiver, 12 watts PEP of output power (the legal limit) might be developed, while the average power output is only 4 watts. In that case the ratio of PEP to average power is 3:1. When someone else modulates the same transceiver, the PEP output might remain at 12 watts, but the average power is only 3 watts. In this case, the PEP/average ratio is 4:1. Other voices will develop lower values — say, 8 watts PEP and 4 watts average, or 2:1.

Phase-Locked Loop. An electronic network consisting of a voltage controlled oscillator (VCO), a phase comparator, a low-pass filter, and an amplifier. The PLL can be used as an FM detector of extreme linearity, as a tunable filter, and as an extremely stable oscillator. When combined with an external reference oscillator and $\div N$ circuit, it will function as a *frequency synthesizer*, yielding stable outputs at various frequencies.

Pi Network. A tuned circuit at the output stage of a transmitter to match it to the antenna/feedline. Sometimes a transceiver will have screwdriver adjustments which allow the pi network to make the optimum *impedance* match for a given antenna.

PTT. Abbreviation for Push to Talk. Usually a pushbutton on the microphone case that activates the transmitter when depressed.

R-f Gain Control. A manual control that sets the gain of the receiver section. It is included on some transceivers to supplement the *AGC* circuit. Some signals are simply too strong for the *AGC* to handle, and will overload the receiver unless gain can be further reduced by this control.

R-f Power Output. For an AM transmitter, this specification rates the amount of carrier (in watts) that is delivered to the antenna jack. The legal limit for AM is 4 watts, and most transceivers deliver that amount (or close to it). The r-f power output of an *SSB* transceiver is rated in watts *PEP*, as previously described.

"S" Meter. A meter that gives relative indications of the strength of received signals. It is calibrated in "S" units and dB. Nominally, each S unit equals 6 dB. Above S9, most meters are calibrated in 10-dB increments. Sometimes, a manufacturer will specify what input level (usually between 50 and 100 µV) is required for a reading of S9. But this can vary widely even among transceivers of the same model number. Again, S meters are intended to be relative, rather than absolute, indicators. They are useful to an extent in comparing the strength of two stations, or the performance of two antennas at one location.

Selectivity. Basically, this relates to how well a receiver can differentiate between the signal to which the receiver is tuned and an adjacent one. It is also expressed as Adjacent Channel Rejection. The figure (a ratio in dB) shows how much stronger an adjacent channel signal (10 kHz away) must be to interfere with intelligible reception of the desired signal. Sometimes, selectivity is stated as the i-f passband; that is, the "window" the receiver can see through to detect signals of a specified strength. It is stated, "X kHz at Y dB down." For example, at X kHz away from the operating frequency a signal will be reduced in strength by Y dB. In AM transceivers a typical bandwidth is about 3 kHz at 6 dB down, and 30 kHz at −60 dB. For proper AM reception, the window should be no narrower than 2500 Hz (2.5 kHz). SSB requires greater selectivity for best results, and a rating of 2.1 kHz at 6 dB down is not uncommon.

Sensitivity. Another key receiver specification. It describes the minimum signal strength that the receiver can work with to provide an intelligible output at the speaker. The signal strength is measured in microvolts, and the second part of the rating is called the signal-to-noise (*S/N*) ratio (See **S/N**), expressed in dB. A transceiver with an *AM* sensitivity of 1 µV for a 10-dB S+N/N will produce an output that is ten times louder than the background noise. That's a typical figure, although some AM transceivers will produce a 10-dB S+N/N with as little as 0.25 µV of signal applied to the input. *SSB* receivers are generally a little "hotter" than AM units, with ratings of 0.15 µV for 10 dB S+N/N regularly achieved. In general, any rating below 1 µV for a 10 dB S+N/N is adequate.

S/N. Abbreviation for signal-to-noise ratio. Expressed in *dB*, it relates how much louder a signal is than the background noise. It is measured at the speaker, and is used in sensitivity ratings. Often, *S+N/N* is used, as it is easier to measure. It is the ratio of the signal and background noise to the background noise, and will yield an apparently higher sensitivity than straight S/N.

Speech Compression. A means of boosting the average level of voice signals to provide increased "talk power" or higher average modulation levels. The human voice has a low average level with sharp, transient peaks. If the voice signal is not compressed, the carrier will not be modulated more than 20% or so most of the time, but will be fully modulated on voice peaks. Overall efficiency will be low. But if the peaks are clipped and the average level boosted, the average degree of modulation will rise. This form of processing is called speech clipping. Another technique, speech compression, has an *AGC*-type amplifier which cuts down gain on voice peaks while amplifying the average low levels. Clipping or compression can be introduced in the audio or r-f sections of the transceiver. R-f methods are more effective, and clipping produces better results than compression, but requires extensive shielding and filtering within the transceiver.

Spurious Emissions. Undesirable r-f energies appearing at the antenna jack. They often are at frequencies far removed from the operating channel. Harmonics, mixer products and parasitic oscillations are all considered spurious emissions. They should all be at least 50 dB below the desired output signal.

Spurious Response. This describes how the receiver section handles undesired signals, especially ones generated inside the transceiver itself. Spurious response should be at least 25 or 35 dB down.

Squelch. A circuit that silences the receiver in the absence of signals above a certain level of signal strength. This *squelch threshold* is usually adjustable by a front-panel control. When properly adjusted, it will stop background noise from reaching the speaker, but will activate the receiver when an intelligible signal is detected.

SSB. Abbreviation for Single Sideband. A type of amplitude modulation in which one sideband and the carrier are not transmitted. This gives SSB a 6:1 efficiency advantage over *AM*, and thus greater range per watt of output power. SSB occupies ½ of a conventional AM (double sideband) channel. So one can get 46

SSB channels + 23 DSB channels, though SSB can't be used at the same time as DSB, and vice versa. However, transceiver circuitry for SSB is more complex and tuning methods are more critical than for AM. For these reasons, addditional controls like *clarifiers* must be included, making SSB units more expensive than AM transceivers with similar features.

Superheterodyne. A common type of receiver in which the incoming signal is translated in frequency by means of frequency converters or mixers. The signal is translated to an intermediate frequency or i-f. A receiver that has one i-f is called a *single conversion* receiver. One with two i-f's is a *dual conversion* receiver. I-f stages are used to provide selectivity and good spurious signal rejection.

SWR. Abbreviation for Standing Wave Ratio. When *impedances* within a communications system are not equal, reflections are set up, sending power back toward the transceiver away from the antenna. As a result, standing waves of voltage and current are set up on the transmission line. The SWR can be determined mathematically by the formula SWR $= Z_1/Z_2$ with the higher impedance on top. So, if a 50-ohm transmission line feeds a 50-ohm antenna, the SWR is 1:1 or "one to one." Under these conditions all power (neglecting feedline losses) delivered at the transceiver output reaches the antenna. If the antenna impedance is 100 ohms or 25 ohms, the SWR is 2:1. This figure is considered the upper limit that SWR should reach in a good communications system. SWR is usually measured by a reflectometer or SWR bridge. Such devices are available as external accessories, but are included in some CB transceivers.

VOX. Voice-Operated Transmitter. When the operator speaks into the microphone, the VOX circuitry automatically activates the transmitter without depressing the PTT switch. When speech ends, the *VOX Delay* circuit holds the transceiver in the transmit mode for an adjustable period of time. This prevents relay chatter between syllables or words. ◈

CB TRANSCEIVER MANUFACTURERS

Alaron, B&B Import-Export Inc., 185 Park St., Troy, MI 48084
Browning Laboratories Inc., 1269 Union Ave., Laconia, NH 03246
Courier, Fanon/Courier Corp., 990 S. Fair Oaks Ave., Pasadena, CA 91005
Craig Corp., 921 W. Artesia Blvd, Compton, CA 90220
Demco, Command Electronics, Inc., 11830 Shaver Rd., Schoolcraft, MI 49807
Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago, IL 60613
Echo Communications, Inc., Cedarburg, WI 53012
Fanon/Courier Corp., 990 S. Fair Oaks Ave., Pasadena, CA 91005
Fieldmaster Radio Corp., 21212 Vanowen St., Canoga Park, CA 91303
Gemtronics, Gem Marine Products Inc., P.O. Box 1408, Lake City, SC 29560
Hallicrafters, Div. of Breaker Corp., 110 Great Southwest Pkwy., Arlington, TX 76011
Handic of USA, 14340 N. W. 60th., Miami Lakes, FL 33014
Hitachi Sales Corp., 401 W. Artesia Blvd., Compton, CA 90220
J.I.L. Corporation of America, 737 W. Artesia Blvd., Compton, CA 90220
Johnson, E.F., Co., Waseca, MN 56093
Kraco Enterprises Inc., 2411 N. Santa Fe, Compton, CA 90224
Kris, Inc., Cedarburg, WI 53012
Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, NY 11791
Lake Electronics, Inc., 1948-E Lehigh Rd., Glenview, IL 60025
Midland International Corp., P.O. Box 19032, Kansas City, MO 64141
Motorola Communications Div., 1301 Algonquin Rd., Schaumburg, IL 60172
Olson Electronics, 260 S. Forge St., Akron, OH 44327
Pace Communications, Pathcom Inc., 24049 S. Frampton Ave., Harbor City, CA 90710
PAL Electronics Co., 2962 W. Weldon, Phoenix, AZ 85017
Panasonic, Matsushita Electric Corp. of America, One Panasonic Way, Secaucus, NJ 07094
Pearce-Simpson, Div. Gladding Corp., P.O. Box 520800 Biscayne Annex, Miami, FL 33152
Radio Shack, A Tandy Corp. Company, 2617 W. 7th St., Fort Worth, TX 76107
Ray Jefferson, Main & Cotton Sts., Philadelphia, PA 19127
Regency Electronics Inc., 7707 Records St., Indianapolis, IN 46226
Robyn International, Inc., P.O. Box 478, Rockford, MI 49341
SBE, Inc., 220 Airport Blvd., Watsonville, CA 95076
Sharp Electronics Corp., 10 Keystone Place, Paramus, NJ 07652
Siltronix, Div. of Cubic Corp., 269 Airport Rd., Oceanside, CA 92054
Sonar Radio Corp., 73 Wortman Ave., Brooklyn, NY 11207
Sony Corporation of America, 714 Fifth Ave., New York, NY 10019
Standard Communications Corp., 108 W. Victoria St., Carson, CA 90248
Superscope Inc., 8150 Vineland Ave., Sun Valley, CA 91352
Surveyor Manufacturing Corp., 29245 Stephenson Highway, Madison Heights, MI 48071
Teaberry Electronics Corp., 4655 Massachusetts Ave., Indianapolis, IN 46218
Tram/Diamond Corp., Lower Bay Rd., Winnisquam, NH 03289
Unimetrics, Inc., 1534 Old Country Rd., Plainview, NY 11803
Utac, I.A. Sales Co. of California, 766 Lakefield Rd., Suite H, Westlake Village, CA 91361
XTAL, Far Eastern Research Lab, Inc., 9749 Shirley Ave., Northridge, CA 91324
Zodiac Communications Corp., Chrysler Bldg., New York, NY 10017

CB ANTENNA MANUFACTURERS

Alaron, B&B Import-Export Inc., 185 Park St., Troy, MI 48084
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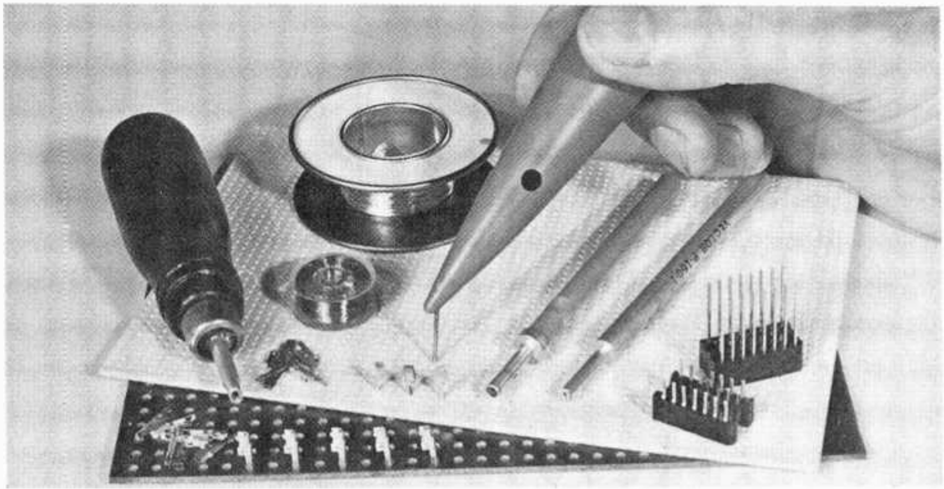
Antenna, Incorporated, 23850 Commerce Park Rd., Cleveland, OH 44106
Antenna Specialists Co., The, Div. of Orion Industries, Inc., 12435 Euclid Ave., Cleveland, OH 44106
Avanti Research & Development, Inc., 340 Stewart Ave., Addison, IL 60101
Blue Streak, CPD Industries, Inc., 200 E. Wilshire Ave., Santa Ana, CA 92705
Breaker Corp., 110 Great Southwest Parkway, Arlington, TX 76011
Cushcraft Corp., 621 Hayward St., Manchester, NH 03103
Francis Industries, 431 W. Broad St., Pataskala, OH 43062
GC Electronics, Div. Hydrometals, Inc., 400 S. Wyman St., Rockford, IL 61101
Gotham, 2051 Northwest 2nd Ave., Miami, FL 33127
Hustler, New-Tronics Corporation, 15800 Commerce Park Dr., Brook Park, OH 44142
Hy-Gain Electronics Corp., R.R. #3, Lincoln, NB 68505
Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, NY 11791
Radio Shack, A Tandy Corp. Company, 2617 W. 7th St., Fort Worth, TX 76107
Robyn International, Inc., P.O. Box 478, Rockford, MI 49341
Shakespeare Industrial Fiberglass Div., P.O. Drawer, Columbia SC 29202
Taylor Radio Company, Inc., 3329 Commerce Dr., North Leg Industrial Park, Augusta, GA 30904
Tenna Corporation, 19201 Cranwood Pkwy, Cleveland, OH 44128
Turner Company, Inc., Div. of Conrac Corp., 909 17th St. N.E., Cedar Rapids, IA 52402
Unarco-Rohn, Box 2000, Peoria, IL 61601
Valor Enterprises, Inc., 185 W. Hamilton St., West Milton, OH 45383
Wilson Electronics Corp., 4288 S. Polaris, Las Vegas, NV 89103

PERF BOARD WIRING TECHNIQUES FOR EXPERIMENTERS

Rapid circuit assembly and alteration methods using perforated board.

BY ADOLPH MANGIERI



Useful tools include (left to right) pin insertion tool, wiring pencil, manual wire wrapping tool and unwrapping tool.

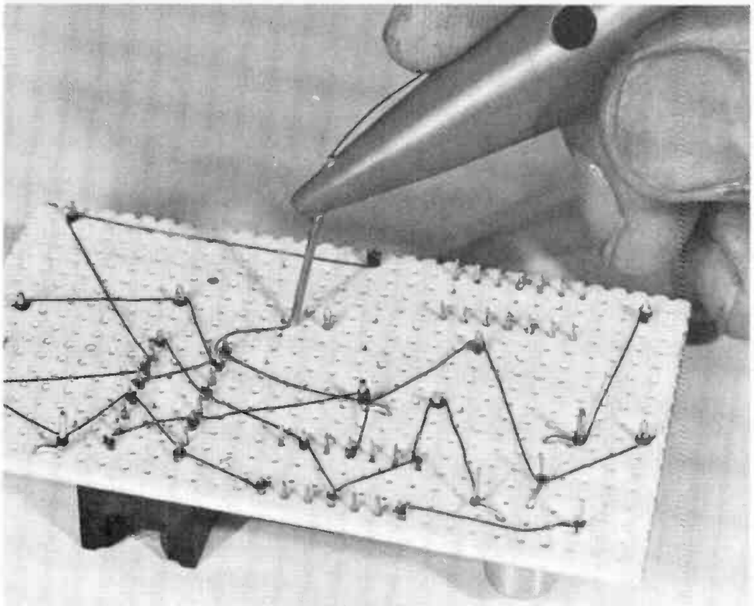
MOST electronic projects are best assembled on either printed circuit or perforated board. Both types have advantages and disadvantages which should be considered before starting a project. The pc board permits compact assemblies but impedes experimentation and circuit alterations. Perf board, on the other hand, permits rapid assembly and easy circuit alterations but tends to take up more room for the same circuit. With few exceptions, any project you can build on a pc board can also be assembled on perf board.

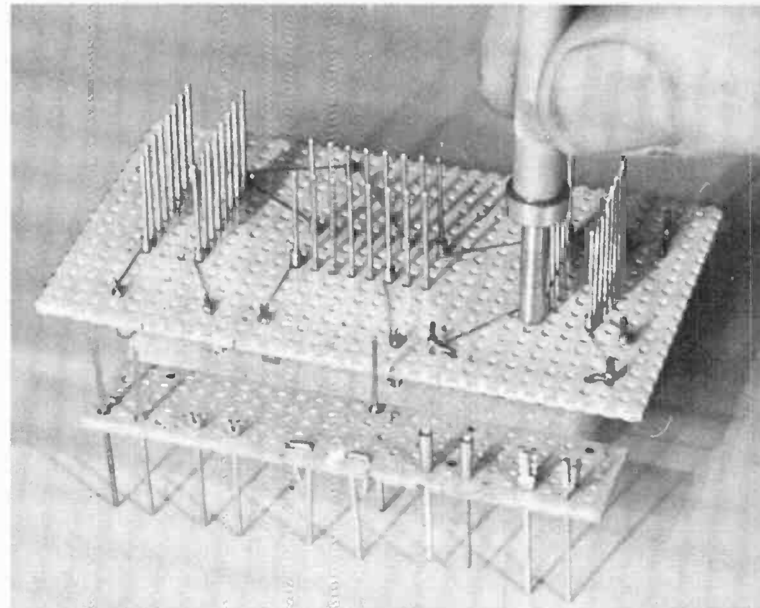
Perf board construction has another important advantage over the pc board. It eliminates the need for using chemicals and drilling holes. This might be an important consideration if you're pressed for time and want to get right to assembly after designing a layout. Needless to say, the perf board technique is a very attractive alternative to project assembly, especially if you do a lot of experimenting.

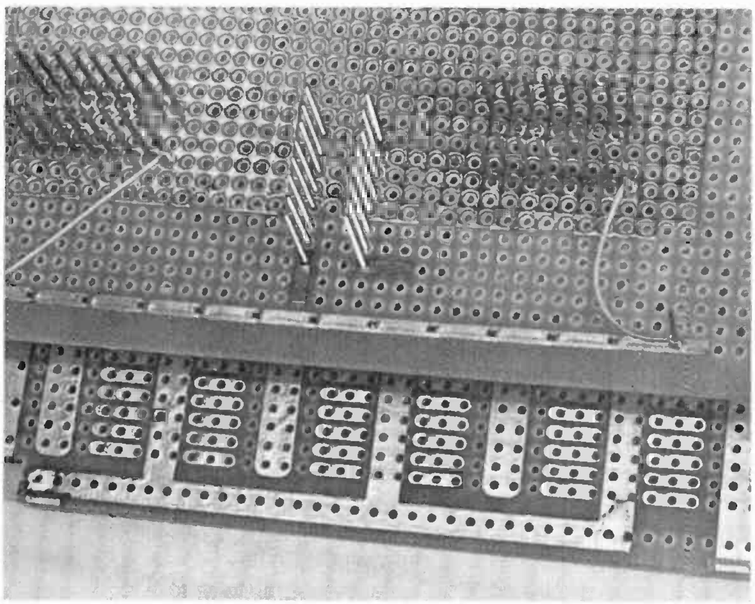
Perf Board Materials. The first step in working with perf boards is to familiarize yourself with the various types of boards, tools, and hardware available. Perf boards are letter-coded according to patterns, sizes, and spacing of holes. Furthermore, you have a choice of XXX phenolic, paper epoxy, and epoxy fiberglass material and unclad (plain) and clad blanks. Add to this list a choice of board thicknesses.

The Table lists the most popular perf board configurations (from two typical sources) according to letter code, the various push-in terminals and insertion tools, and prepunched bus strips to be used with each. It is obvious that you can choose the materials to meet the requirements for your project. For example, use P-pattern board for IC's in dual in-line packages (DIP's) and either P- or G-pattern board for round (TO-5) transistors. A less desirable alternative would be to use F-pattern board and drill extra holes as necessary. For heavy-weight projects, such as power supplies, you can use A-pattern board with extra thickness and the large No. T9.4 push-in terminals. (For general use, 1/16"-thick board is an excellent choice, while 3/32"-thick board is recommended for the majority of the heavier duty jobs.)

Bus strips are flat, prepunched and tinned and made of copper for use as power supply and common buses. They eliminate wiring complexity and







1	2
3	
4	5

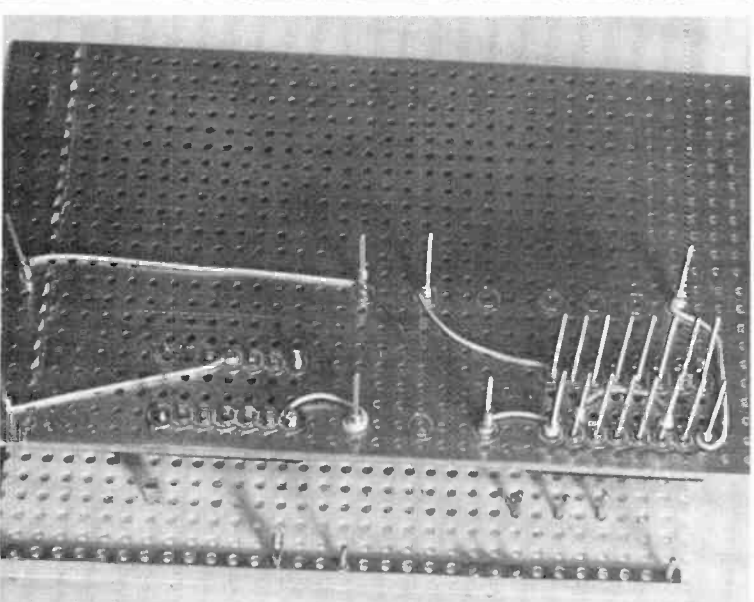
1 *Wiring pencil wraps solder-through insulated wire on leads of resistors, IC's and transistors.*

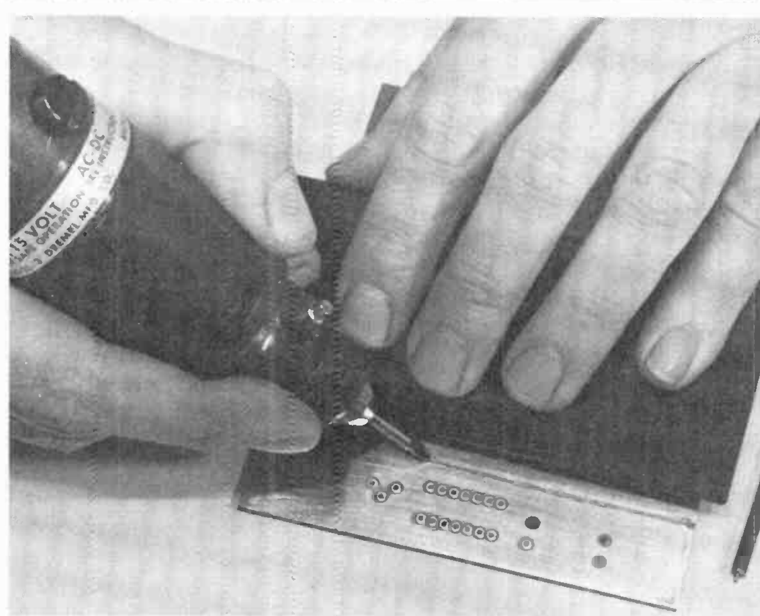
2 *Wrapping tool used on solderless connections. Terminals in foreground facilitate wire wrapping.*

3 *Ground-plane board at top has terminals for ground connections. Below is interdigitated bus board.*

4 *Clad perf board requires cutting of circle pad for isolation of socket and board terminals.*

5 *Clad ground-plane board requires drilling and line and circle pad cutting. Pad cutter at right.*





reduce the chance of ground loops that create circuit instabilities. Low-cost solder pin insertion tools permit you to install pins safely and speedily.

Accommodating most semiconductor devices (including IC's) and accepting an almost endless variety of board pins, the 1/16" thick P-pattern board will prove to be the most versatile for many projects.

Conventional Wiring Method. As is the case when doing pc work, careful layout planning will be rewarded with neater perf board assemblies and error-free wiring. You can design a parts layout and wiring guide for perf board with the aid of the grid paper available for most board patterns or even ordinary graph paper. To a large extent, your parts layout will follow the schematic diagram for your project. Of course, you'll have to trial-fit the components on the board, making allowance for the pattern and spacing of the holes.

Once you know how a board is to be laid out and wired, you can install push-in terminals, transistor and IC sockets, and power and common buses. If you choose to omit bus strips, use 20-gauge (or heavier) solid bare hookup wire in their place.

When making interconnections, 28-gauge solid wire is suggested for easy handling and manipulation with tools. Wherever possible, use bare wire; but if you must make crossover connections, switch to insulated wire. Use 24- or 26-gauge insulated stranded hookup wire between the board assembly and off-the-board components. When your project includes DIP (dual in-line package) IC's, avoid confusion by labelling pin 1 of each. Better yet, use E-Z-Code self-sticking pin number marking strips.

Fitting wire with longnose pliers can prove to be a trying task, particularly when using P-pattern board and DIP sockets. You can save a great deal of time and avoid much frustration by using a manual tool to wrap the wire on a terminal (such as the Vector No. P160-2 or similar). This tool neatly forms a tight wrap on either socket solder tabs, No. T42.1 flea-clip tails, component lead ends, or directly on DIP IC pins. These aren't true Wire Wraps®, which means that every connection must also be soldered to assure good mechanical and electrical bonds.

After wiring a project, it's always good practice to check for errors before applying power. Look for reversed installation of diodes, electrolytic capacitors, LED's, etc.; IC's and transistors plugged in backwards; and transposed connections to battery clips and holders.

"Pencil Wiring." Recently, a new approach to wiring perf board assemblies has been introduced. Vector's new Model P173 wiring pencil promises to become a very popular tool for perf board work. Applied Manufacturing of Texas has a similar tool for making Solder Wraps®.

The wiring pencil eliminates having to cut wires to size and strip away insulation. The pencil dispenses and wraps 36-gauge solder-through insulated solid wire around any size post or terminal. Much faster than point-to-point wiring, pencil wiring permits you to interconnect a number of terminals with an unbroken length of wire. Once the wire is wrapped around a terminal, you apply heat directly to the joint. The insulation immediately vaporizes to allow you to flow solder into the connection. A very important advantage of pencil wiring is that it permits you to omit all sockets and most solder terminals.

As shown in Fig. 1, the wiring pencil feeds the wire from a bobbin containing 250' (76.2 m) of wire through the tool's barrel, out one of two holes, and down through a hollow "needle." Wire feed and tension are controlled by finger pressure on the wire where it comes out of the hole in the body of the tool. (The two holes are provided so that either right or left handed people can use the tool.) At the end of a run, you simply twist the pencil, and the point of the needle quickly and neatly clips the wire.

Sockets and solder clips can be omitted during assembly by using the pencil to wire directly to protruding leads and lugs. To use this technique, however, the components must be staked to the board (leads bent to mechanically secure parts in place) as shown in Fig. 1. You can use longnose pliers for staking, but Vector's No. P174 staking tool makes the job easier. Components can also be cemented to the board with a quick-set adhesive, and eyelets make excellent solderable anchors for problem components.

You can avoid having to stake components by isolating circular pads on copper-clad perf board (discussed later under Ground Plane Methods). Solder upright ends of component leads and socket tabs to the circle pads to anchor the parts in place. Use pre-punched bus strips on the top of the board (unclad side) for the power buses. For feedthroughs, use either No. T42-1 flea clips, double-ended No. K31C round-shank pins inserted with a No. P133-A tool, or the single-ended No. T50 round-shank series shorting pin. Using clad perf board, you can dispense with bus strips altogether by isolating strips of copper (also discussed later).

Here are a few useful hints when working with a wiring pencil. Form your wraps slightly away from the board's surface to avoid marring the board with heat during soldering. Use a soldering pencil that has a tip temperature of at least 650° F (343° C) and "wet" the tip with solder before applying heat to a joint or wrap. To prevent wire breakage, dress the wire close to the board and secure lengthy runs with drops of quick-drying cement. Isolated round-shank pins make good pivot points for routing wires around obstacles. Alternatively, you can use a No. P179WS plastic wire spacer for grouping wires in a bundle. In a pinch, you can use 30-gauge bare solid wire, at least for ground returns.

Wire Wrapping. Wrapping wires around terminals, either with or without solder, offers wiring flexibility to permit rapid circuit changes. The standard wrapped connection consists of six to eight turns of wire applied under tension to square, sharp-edged wrap posts. The modified wrap, or anti-vibration wrap for extreme conditions, includes an additional one or two turns of insulated wire at the start of the wrap.

If you plan to use this technique, you'll need an efficient and easy-to-load manual wrapping tool, such as Vector's No. P160-2. The No. P160-1 is an unwrapping tool for easy removal of wrapped connections. The preferable wire size for wrapping is 28-gauge bare or Kynar insulated (Vector No.'s 2323A-28-3 or 2323A-28-4). Pre-cut and pre-stripped wire (Cambion sells a 30-gauge No. 601-2515 wire kit) will speed assembly but, unless trimmed as you go, will leave a maze of slack wires.

You can assemble an entire project using wrapped wire and the appropriate pins as shown in Fig. 2. From left to right, the pins shown include pairs of Vector No.'s. T46-3 double-ended

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PERFORATED BOARD CONFIGURATIONS

Board Pattern	Hole Size	Hole Spacing	Push-in Terminal Vector	Push-in Terminal Radio Shack	Insertion Tool (Vector)	Bus Strip (Vector)
A	0.093"	0.265"	T9.4	—	P122B	T58
B	0.062"	0.188"	T28	270-1394	P91A	—
F	0.062"	0.20"	T28	270-1394	P91A	T104
G*	0.062"	0.20x.10"	T28	270-1394	P91A	T104
P	0.042"	0.10"	T42.1	270-1392	P191A	T107

*Alternate rows staggered .10".

wrap posts that should be inserted with tool No. P133-A; T44 Miniwrap posts (No. A13 insertion tool); K32 J pins; R32 socket pins; and the versatile T49 Klipwrap post (No. P156 insertion tool). All this hardware is designed to fit P-pattern perf board.

It's difficult to insert a pin perpendicular to a board's surface unless you have an alignment block, such as Vector's No. MB45-20-062. It consists of 10 pieces of 1/16" P-pattern board glued in a stack. If you wish, you can make a small version from scrap board for use in tight places.

Forming perfect wrapped connections is a simple procedure, but it takes some practice to get the knack of handling the tool for positioning and dressing the wire. Use bare wire wherever possible. As with the wiring pencil, you can wrap a number of posts with an unbroken length of wire by passing the wire down through the handle of the wrapping tool.

Practice loading the wire until you can do it instinctively. The wrapping tool has a central hole that fits over the post. The end of the wire fits into a smaller off-center hole or tunnel near an index mark. If you're using 28-gauge insulated wire, strip away ¾" (about 2 cm) of insulation. Hold the tool about horizontal with its index mark up. Catch the end of the wire in the cross slot of the tool's recessed tip near the index mark and insert into the wire tunnel. If the wire bottoms out before accepting the entire stripped end, it's in the wrap post hole. You'll have to withdraw and try again. Once the wire is properly inserted, anchor it in place by withdrawing half way, bend the wire about 30°, and push home before making the final right-angle bend.

Projects requiring numerous wrapping card sockets are best assembled with a cordless power wrapper, such as the Vector No. P160-4, which accepts the No. P160-2 manual wrapper.

Ground Plane Methods. Having a large area of copper at ground potential, the ground plane affords minimum ground circuit impedance and permits the shortest possible connections to ground. This not only eliminates instability in broadband vhf amplifiers, it also minimizes noise and ringing in digital circuits. To achieve these benefits, keep lead lengths as short as possible and inputs and outputs well separated.

Beginning with P-pattern etched ground-plane board (Vector No. 3677-7), the copper surrounding the board holes is pre-etched, leaving circles of insulation around the holes (Fig. 3). Primarily intended for wire wrapping, this board can also be used with any other wiring method. To ground a wrap post to the ground plane, push a self-fastening No. T112-1 bus link onto the post with a No. P133A insertion tool and solder the tab to the plane.

With all ground-plane wiring methods, it is best to run insulated wire right up to the pin to avoid short circuits. Better yet, wrap a turn of insulated wire on the pin nearest the board. This is easily accomplished with the No. P160-2 wrapping tool by pushing a bit of wire insulation into the recessed tip before bending the wire at a right angle. Alternatively, you can bend the wire on the insulation before loading the wrapping tool. (You can also use this tip to form antivibration-wrapped connections.)

Etched padboards that have generous interdigitized ground and supply buses (Vector No. 3677-6) closely approximate the full-ground type plane. Assign ground to buses passing between socket pads. By jumpering common-ground and supply buses, a further reduction in ground and supply bus impedance can be effected. The padboard lends itself well to any wiring scheme. A manual line cutting chisel (Vector No. P139) permits you to safely cut through a bus or pad to isolate it.

Fully clad (one side only) perf board can be used for ground planes (Fig. 4). For P-pattern board, you'll need a circle pad cutter, such as Vector's No. P138C tool. Cut circle pads at all pin locations where the circuit must be isolated from ground. Grounded points should not be isolated. To avoid rapid cutter wear and tearing out pads, use a low drilling speed. (Hint: With high-speed power tools, like those made by Dremel under the "Moto" brand name, use a solid-state speed control set for about 45 volts ac.) You can avoid drilling too deeply into the board by backing the board with a metal plate to serve as a stop for the cutter bit's pilot pin. If the cut is too shallow and doesn't remove enough copper, place an index card between board and plate.

Accidents are bound to occur. So, if you do tear out a pad, install a No. T102 or T103 eyelet with flange on the clad side of the board. Pads not required for use as anchors or supports are best removed wtih an Xacto knife to reduce the chance of solder bridging or wiring shorts to ground. If you capture a pad within the cutter, remove it with a large needle or awl. Before you start wiring a circuit, check all pads with a magnifying glass and redrill any that have copper bridges to ground.

Use No. T107 bus strips on the unclad (top) side of the board, or section off a strip of copper on the bottom of the board using an electric line cutter. A tungsten carbide router bit (Dremel No. 9909 or Vector No. P141A) chucked into a Dremel Moto tool will make short work of line cutting, as shown in Fig. 5.

You can make a line cutting guide by cementing a 4"L×1½"W×1/16"T (10.2×3.8 cm×1.6 mm) piece of insulation board to a block of ¼" (6.4-mm) thick plywood, overlapping it by ¼" along the long dimension. Cement a sheet of nonskid rubber to the bottom of the plywood. To use the block, place the guide along the line to be cut and hold the cutting tool at about a 45° angle to the board's surface and held firmly against the guide edge. Don't try to cut the line in one pass; make several light passes until all copper is removed along the line. A prepackaged line cutting kit containing a Dremel Model 260 drill, router bit, and several accessories is available from Vector as the No. P141B kit. ◈

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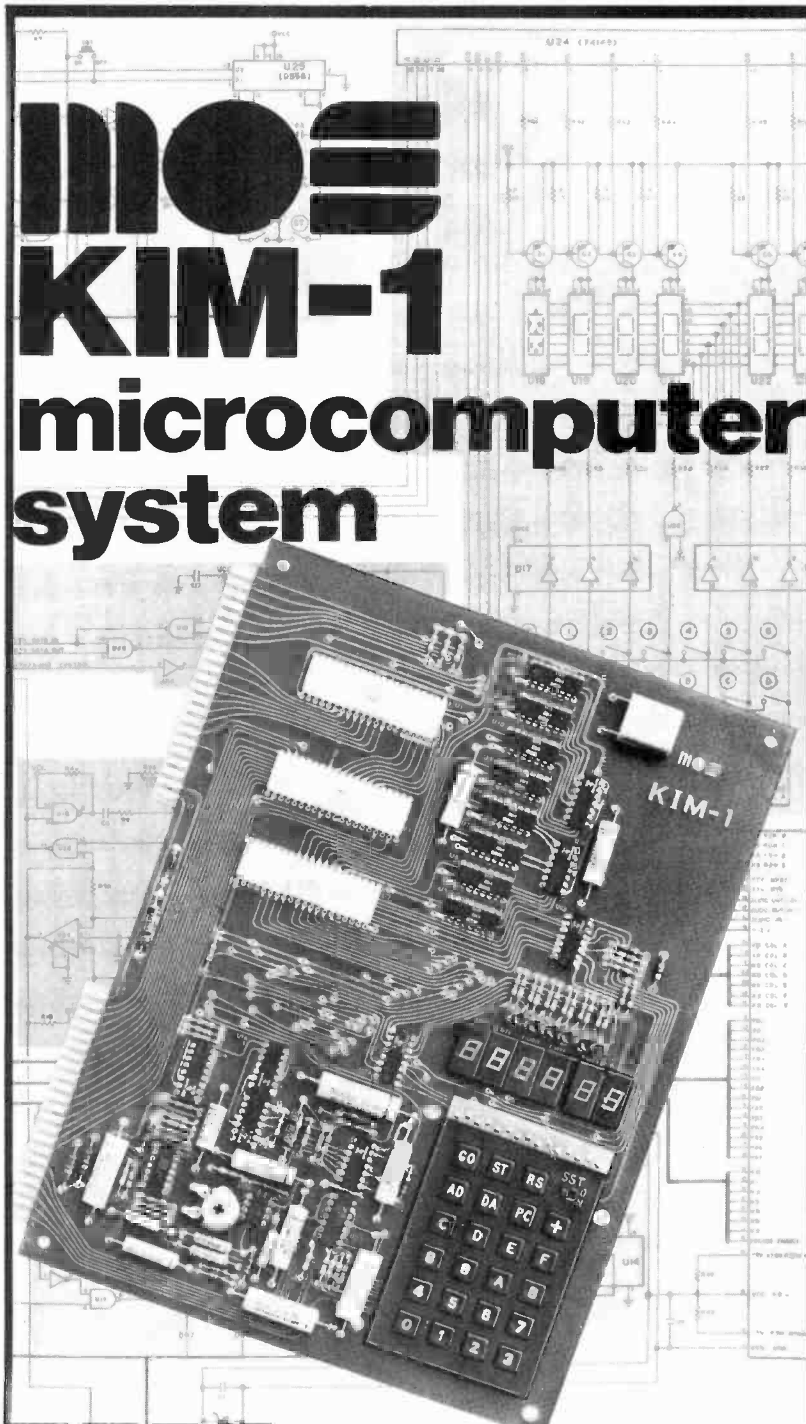

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Product Test Reports

ABOUT THIS MONTH'S HI-FI PRODUCTS

The Luxman T-310 AM/Stereo FM Tuner is one of a growing number of tuners having built-in Dolby decoding circuits. Most metropolitan areas are already served by at least one FM station broadcasting Dolby-encoded programs, and a tuner with a built-in decoder makes listening to them more convenient than to have to include a separate "black box" in the system. Luxman has also made the Dolby circuits in the tuner accessible for use with an external tape recorder that doesn't have decoding circuitry for playing back Dolby-encoded tapes. In addition to its Dolby system, the rich-looking Luxman tuner is a fine performer.

Pioneer's RG-1 Dynamic Processor is a volume expander for use as an accessory to any stereo system. It restores much of the program dynamic range sacrificed during recording or broadcast by the use of limiters or compressors. Up to 14 dB of expansion is possible, considerably enhancing the realism of reproduction, with virtually no undesired side effects. An extra fillip is the 6 dB of noise reduction.

—*Julian D. Hirsch*

LUXMAN MODEL T-310 AM/STEREO FM TUNER

High-quality tuner features Dolby circuits.

HIRSCH-HOUCK LABS REPORT

A line of deluxe audio components now marketed in the U.S. under the Luxman brand name includes a high-performance AM/stereo FM tuner with built-in Dolby circuits. The Model T-310 tuner is designed so that the Dolby circuits can be used to decode the playback of Dolbyized tapes or cassettes from an external recorder as well as process incoming Dolbyized FM signals. In the FM mode, the tuner's internal de-emphasis is automatically switched from the usual 75 µs to the Dolby standard of 25 µs.

The tuner comes with a handsome rose-wood cabinet. It measures 19"W×11"D×6⅝"H (48.3×28×16.8 cm) and weighs 21½ lb (9.7 kg). It retails for $595.

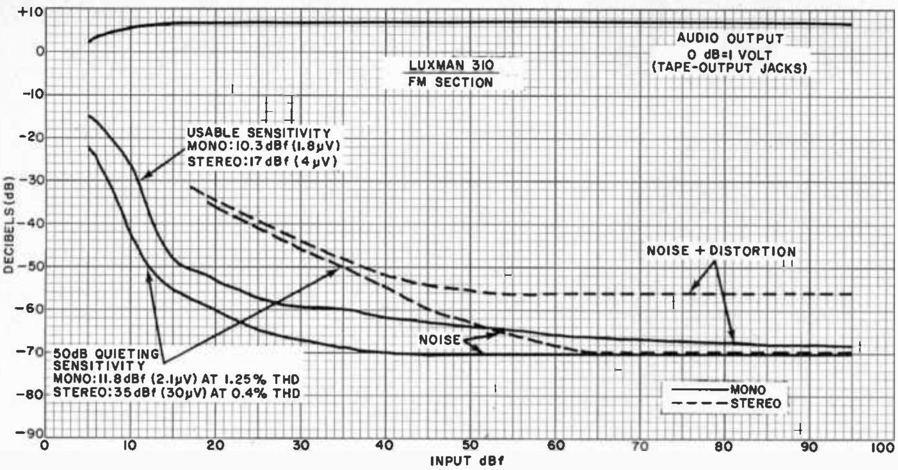
General Description. The FM "front end" of the tuner employs a dual-gate MOSFET r-f amplifier and mixer stages and three tuned circuits for high rejection of image and other spurious signals. The i-f section features a linear-phase five-pole filter preceding each of its two IC amplifier stages. Next come an IC limiter and a Foster-Seeley discriminator. The muting circuit is comparable to the i-f circuit in complexity, and IC's are used for the multiplex decoder and several other circuit functions. The Dolby section, however, is made up of discrete components. The AM tuner has a tuned r-f amplifier, self-oscillating mixer, and two i-f stages. Unlike any other AM tuner we have seen, this one has interstation noise muting.

The right side of the front panel is devoted to a large blackout dial area and the TUNING knob. An indicator lights when a stereo FM broadcast is received, and small red and amber lights indicate the FM and AM reception modes. The pointer's illumination also changes from red to amber when AM is selected.

Within the dial area are the two tuning meters. A zero-center meter indicates correct tuning for FM, while the other meter indicates relative signal strength for both FM and AM. The latter also serves as a Dolby-level indicator when two small pushbuttons on the panel are pressed. This allows the Dolby circuits to be calibrated against the playback from a standard Dolby level tape or cassette. (In the FM mode, the calibration is internal and is factory set.)

The FM dial scale is linearly calibrated at 100-kHz intervals. Both the tuning scales and the meters are lit in white when the tuner is on. The POWER switch is a pushbutton at the lower left of the panel.

To the left of the dial are the small Dolby TAPE CAL buttons mentioned above and a MODE switch for selecting AM, stereo FM (with automatic stereo/mono switching), stereo FM only (the tuner unmutes only when a stereo signal is received), or mono FM operation. Three-position lever switches are provided for controlling the muting, noise filtering, and Dolby operation. The MUTING switch has OFF, NORMAL, and VARIABLE settings. The NORMAL position provides the factory set muting threshold, while VARIABLE transfers control to a knob in the rear of the tuner so that the muting threshold can be adjusted over a wide range. The NOISE FILTER switch, in its FM position, blends the stereo channels at high audio frequencies to reduce hiss without affecting frequency response. In the AM position, it introduces a steep (18-dB/octave) audio low-pass filter. Finally, the DOLBY switch (OFF in its center position) connects the Dolby system to the FM tuner outputs and changes the deemphasis to 25 µs in the FM position, and in the TAPE position its input and output terminals are available in the rear of the tuner (together with left and right channel level adjustments for calibra-



tion). When the front panel TAPE CAL buttons are pressed, a Dolby-level tone is present at the tape recording outputs of the tuner for the purpose of calibration.

On the rear apron of the tuner are two pairs of audio ouputs, a small level control knob, REC OUT and TAPE PLAY jacks for connecting the Dolby system to an external tape recorder, and the Dolby calibration controls. Two small knobs permit setting the AM and FM (variable) muting thresholds.

Output jacks are provided for the vertical and horizontal inputs of an oscilloscope, which can be used as a multipath distortion indicator. There is also an output for a future 4-channel decoder. Slide switches permit changing the illumination intensity of the dial scales, the FM deemphasis (in the FM Dolby mode), and introducing a nominal 12-dB attenuation in the antenna circuit to prevent strong-signal overload. There are terminals for 300- and 75-ohm FM antennas and an AM wire antenna. (A fixed AM ferrite rod antenna is located inside the tuner.) Finally, on the rear apron is a single unswitched ac outlet.

Laboratory Measurements. The IHF Usable Sensitivity on FM was 10.3 dBf (1.8 µV) in mono and 17 dBf (4 µV) in stereo. The latter was determined by the stereo switching threshold. A 50-dB quieting was achieved at 11.8 dBf (2.1 µV) in mono, with 1.25% distortion. In stereo, 50-dB quieting occurred at 35 dBf (30 µV) with 0.4% distortion. At 65 dBf (1000 µV) the total harmonic distortion was a very low 0.047% in mono and 0.16% in stereo, and the unweighted noise level was −70 dB in mono and −69.5 dB in stereo.

The stereo FM frequency response was flat within ±0.5 dB from 30 to 13,000 Hz and down 1.9 dB at 15,000 Hz. Channel separation was between 34 and 37 dB from 30 to 5000 Hz, reducing to 26 dB at 15,000 Hz. The capture ratio at 45 dBf (100 µV) was 1.85 dB, the AM rejection an excellent 70 dB. The effectiveness of the selective r-f circuits of the FM tuner was demonstrated by its outstanding 92-dB image rejection. The alternate-channel selectivity of 79 dB was also well above average. The fixed muting threshold was 5 µV, and the variable threshold could be set between 3 and 13 µV. The 19-kHz pilot carrier in the audio outputs was 70 dB below the 100% modulation level.

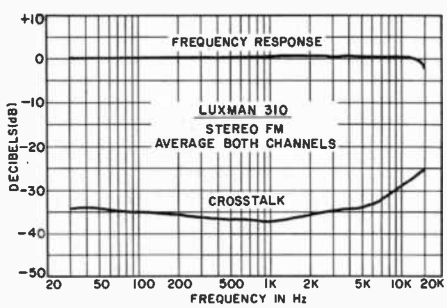
We did not make separate tests of the Dolby system, except to check its internal calibration level against the standard 50% FM modulation level established by Dolby as the standard. The tuner appeared to be calibrated some 3 dB below standard Dolby level. (The specifications indicate that 40% modulation has been set as the internal Dolby level, so that the circuit performance was within 1 dB of the factory rating, if not of the more generally accepted value recommended by Dolby Laboratories.)

The frequency response of the AM tuner was quite flat, although it was not particularly wide. It was down 2 dB at 120 and 3300 Hz and down 6 dB at 100 and 4500 Hz. The steep AM noise filter rolled off the response sharply above 2000 Hz, to −6 dB at 2700 Hz.

User Comment. In general, the measured performance of the tuner met or surpassed the published specifications. The few cases where our sample tuner fell slightly short were more than compensated for by the many cases in which it exceeded its rated performance. Clearly, this is a first-rate tuner, noteworthy for its low distortion (below the measurement capability of the best signal generators in the mono mode), exceptional weak-signal sensitivity, excellent selectivity and spurious-response rejection, and overall operating flexibility.

Some of the most effective FM Dolby reception we have yet heard was obtained with a definite reduction in noise compared to reception without Dolby and with standard 75-µs de-emphasis. This was in spite of the apparent calibration-level discrepancy noted earlier.

The antenna attenuator, which had some 16.5 dB of attenuation, shouldn't be required in most cases, since we never experienced any cross modulation or spurious responses in spite of some *very* strong local signals.



The AM section sounded much like any other AM tuner we have heard, with noticeable restriction in its high-frequency response. Otherwise, it sounded clean, and the AM muting was effective in removing the buzzes and other noises usually heard between stations.

We did observe some minor flaws to contrast with the otherwise high performance of the tuner. The FM muting, although quite good, allowed some transient noise to pass through as the tuner was slowly tuned on or off a station. This situation didn't occur during fast tuning across the dial. Also, the FM calibration, with 100-kHz markings, had significant error at some points. Finally, while tuning is easy and noncritical using the zero-center meter, the signal-strength meter saturated rapidly. It gave the same reading for any signal level exceeding about 100 to 150 µV.

Our test results confirm the excellent performance of this tuner in a

high-quality music system. Not reflected in the results is the high quality of the materials used in the tuner and its rich-looking appearance. One final note: If the $595 price is beyond your budget, and you already have Dolby facilities externally, you can get the exact tuner without Dolby (Model T-300) for $100 less.

CIRCLE NO. 80 ON FREE INFORMATION CARD

PIONEER MODEL RG-1 DYNAMIC PROCESSOR

Restores dynamic range of program material.

HIRSCH-HOUCK LABS REPORT

The Pioneer Model RG-1 Dynamic Processor is designed to restore some of the dynamic range of the original program (stereo or mono) to compressed or limited recordings and radio broadcasts. In general, the correction process is one of expansion, in which high-amplitude signal levels are made even higher by an automatic gain increase, while soft signals are made softer by a gain reduction. The unit also provides some noise reduction.

The Model RG-1 measures 13¾"W ×12⅝"D×5⅜"H (35×32×13.7 cm) and weighs 11 lb, 10 oz (5.3 kg). $175.

General Description. The processor is a single-ended device that can be used with any program source. Its expansion (gain) is controlled by the characteristics of the signal itself. The two basic components of a dynamic expander are a voltage-controlled amplifier, and a circuit that senses the program level and frequency content and creates a control signal from them. The latter is usually the most critical part of the system, since it is easy to create unnatural effects by an incorrect choice of attack and decay time constants.

At the heart of the Model RG-1 is a peak detector (proprietary). Its output is virtually free of ripple and needs little or no filtering. This allows the operating time constants to be optimized without the handicap of the large time constant imposed by the usual detector or rectifier filter. The attack time is 0.5 ms and the decay (release) time is 80 ms.

Entirely separate control and amplifier sections are used for the two stereo channels. However, the outputs of the control circuits are partially blended so that a signal appearing in only one channel will also control the gain of the other (but to a lesser degree than signals in its own input). This is necessary to preserve stereo positioning, which might otherwise wander from side to side as the channel gains are varied.

The gain-controlled amplifiers have a flat frequency response. The rated maximum output of each channel is 6.5 volts, with less than 1% total harmonic distortion (THD). At a nominal 1-volt output level, the THD is less than 0.1%. The "sensor" section has a shaped frequency response broadly peaked at 2500 Hz and sloping off at 6 dB/octave on either side. This is done so that the processor will respond most readily to the frequency range containing a strong musical content (either harmonics or fundamentals) and will be less subject to control by less audible signals at low and high frequencies. The amount of expansion desired can be selected by a front-panel switch, which has positions for 6, 8, 10, 12, and 14 dB. The processor's circuit is fairly complex, containing two IC's, 22 transistors, and 20 diodes.

On the front panel are the DYNAMIC EXPANSION switch, and an INPUT LEVEL control. The latter is used to set the level at which expansion takes place. There's a meter for each channel, too. They constantly display the amount of expansion, or gain boost, provided. Three toggle switches on the front panel control the power, bypass and switch in the expander circuits, and restore the tape monitoring facility of the associated amplifier or receiver. (The processor normally connects to the tape recorder input and output jacks.) The input impedance is 70,000 ohms, while the output impedance is 300 ohms. There is a constant 3-dB insertion loss when the expander is used. The residual noise in the output is specified at less than 65 μV or about 84 dB below a nominal 1-volt output level. On the rear apron are the signal inputs and outputs, tape recorder connection, and a single unswitched ac outlet.

Laboratory Measurements. The input/output transfer characteristic of the processor was measured over an input signal range of 70 dB (from 1 mV to more than 2 V), using the full 14 dB of expansion. The maximum level was limited by the clipping output of the unit, which was about 8 volts. As the instruction manual advises, operation is linear for low signal levels up to about 10 mV (at the maximum INPUT LEVEL setting). From 10 to about 200 mV, a 26-dB range, the gain is increased by the selected amount of expansion, relative to its unexpanded value. From 200 mV to 2 volts, or a 20-dB change, the characteristic is again linear. The meter readings agreed closely with the actual amount of expansion we measured. The test was made on only one channel, and the gain of the unused channel was increased by 3 dB less than the controlled channel, due to the blending of the sensor outputs.

At maximum sensitivity, an input of 0.2 volt at 1000 Hz, or 0.15 volt at 2500 Hz, was sufficient to produce full expansion. The output noise was below our 100 μV measurement capability, or better than 80 dB below 1 volt. The THD in the output, masked by the noise up to about 1 volt output, was 0.062% at that level. It increased smoothly to 0.09% at 3 volts, and 0.225% at the rated 6.5-volt maximum output.

It was not possible for us to measure the actual frequency response of the processor since gain was varied by the frequency-sensitive control circuit as the input frequency was changed. Our tests confirmed that this circuit was broadly peaked at 2500 Hz. The attack

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NUMBER
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DATE AND TIME OF EXPIRATION: MARCH 31, 1980 AT THREE O'CLOCK A.M., EASTERN STANDARD TIME.

SPECIAL ENDORSEMENT:

SHIP RADAR ENDORSEMENT WASHINGTON, D.C. MARCH 31, 1975 Paul J. Harris
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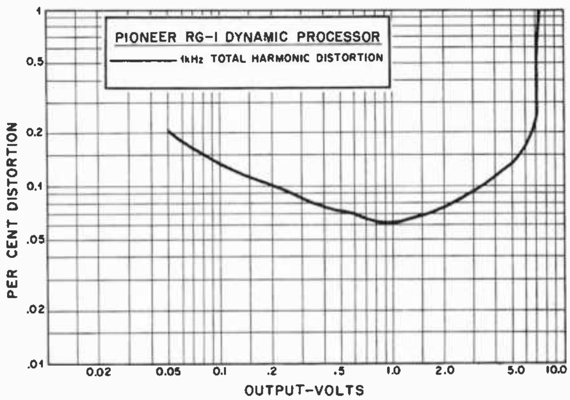

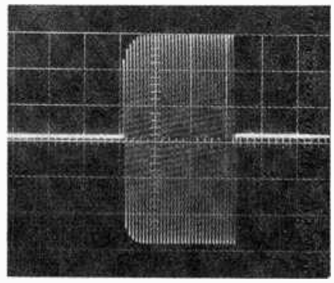

Tone-burst response at 10,000 Hz.

time of the expander was measured with a tone burst of a 10,000-Hz sine wave. An oscilloscope photo showed that the output reached its fully expanded level in 0.5 ms, as rated. When we pulsed the input with a 28-dB level change in a 1000-Hz signal, feeding the output to a chart recorder, the attack and decay times were shorter than the 200-dB/second response of the recorder pen would show. However, the decay trace, after dropping 25 dB almost instantly, required another 1.5 seconds to decay the final 3 dB linearly.

User Comment. Although our laboratory tests confirmed that the processor easily met or surpassed its published specifications, a device such as this can be judged only in actual use. We connected it into several music systems and listened to a variety of program material over a period of weeks. We found its action to be completely natural and under most conditions undetectable. It is easy to become accustomed to hearing programs with an enhanced dynamic range, to the point where "unexpanded" music seems bland and artificial.

The major weakness of most expanders is a tendency to "pump," producing unnatural surges in program level or "swishes" of background noise. We concentrated on trying to trick the Model RG-1 into this sort of misbehavior, with generally unsuccessful results. Occasionally, when using the full expansion on a solo instrument or voice, one gets the impression that the volume is varying more than it should. This is not the fault of the processor. It simply indicates that too much expansion is being used for the program material. By using less expansion with solos and chamber music, as suggested in the instructions, we were always able to clear up the problem.

If a program is fairly noisy (a weak stereo FM signal, non-Dolbyized cassette, or an old record), it is possible under some conditions to hear the modulation of the background noise level by the expander's gain changes. However, to put the matter into perspective, one must really search for such programs and use the full expansion of the processor to create this swishing effect.

Using the processor intelligently and according to instructions, it is as nearly perfect an expander as we have heard. By appropriate settings of the input level and expansion controls, it is possible to use it as an upward expander (making loud passages louder, but leaving soft passages unchanged), a downward expander (high-level signals are not changed, but soft passages and noise are appreciably reduced) or in some combination of these modes. The dynamic range enhancement is equally effective in all modes; and we found the noise reduction to be one of the most useful features of the device. It is compatible with most other noise reduction systems; and, when used in conjunction with these systems, produces spectacular results.

The Pioneer Model RG-1 Dynamic Processor is a most worthwhile addition to any music system. It is certainly reasonably priced for the benefits it offers. To appreciate fully what it can do—restore dynamics compressed by the recording studio and provide about 6 dB of noise reduction (in addition to any other noise reduction in a system)—you've got to listen to the RG-1 at home with program material you're familiar with. Under these conditions, its contribution to making music reproduction more realistic is very evident.

LAFAYETTE COM-PHONE MARK II AM CB BASE STATION

Handset Base Station uses synthesizer.

THE Com-Phone Mark II is the base station version of the Lafayette Radio Electronics Com-Phone mobile transceiver reviewed here in February 1975. Like its mobile counterpart, the Mark II features an all solid-state design and frequency synthesis to provide full 23-channel coverage. It has two special features. One is a telephone-type handset that permits private listening and lessens noise interference from outside sources. The second is a HI/LO button that can be used to reduce the transmitter's output power to 1 watt for nearby communication.

The transceiver has a built-in loudspeaker that can be switched in and out and a nominal 117-volt ac power supply. Among its other features are a full-time noise limiter (anl), variable squelch, "range boost" for automatic modulation control (amc), PA operation, external-speaker and tape recorder jacks, S/r-f meter, and transmitter-on lamp.

The transceiver retails for $229.95.

The Receiver. Double conversion is employed in the receiver section,

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INTERFACE—

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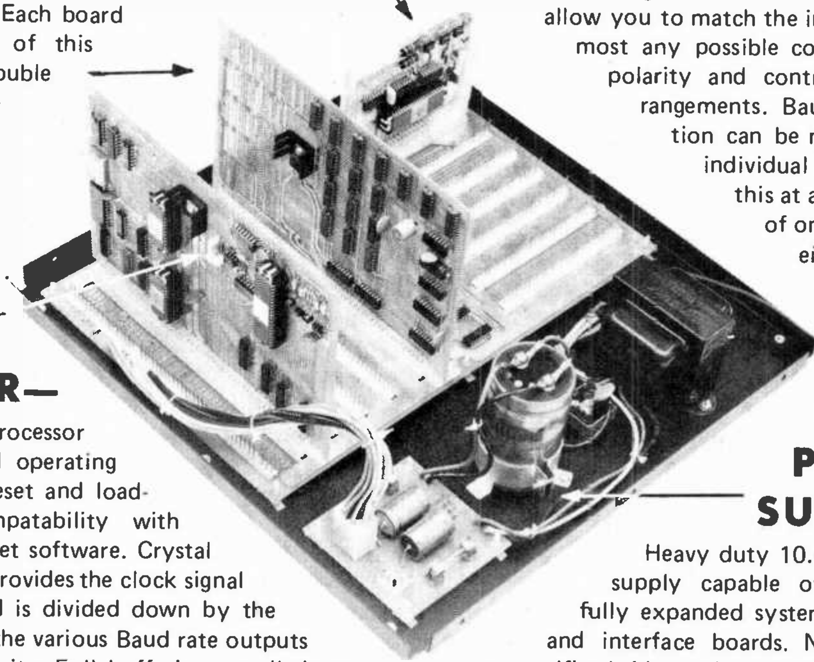

PROCESSOR—

"Motorola" M6800 processor with Mikbug® ROM operating system. Automatic reset and loading, plus full compatability with Motorola evaluation set software. Crystal controlled oscillator provides the clock signal for the processor and is divided down by the MC14411 to provide the various Baud rate outputs for the interface circuits. Full buffering on all data and address busses insures "glitch" free operation with full expansion of memory and interfaces.

POWER SUPPLY—

Heavy duty 10.0 Amp power supply capable of powering a fully expanded system of memory and interface boards. Note 25 Amp rectifier bridge and 91,000 mfd computer grade filter capacitor.

DOCUMENTATION—

Probably the most extensive and complete set of data available for any microprocessor system is supplied with our 6800 computer. This includes the Motorola programming manual, our own very complete assembly instructions, plus a notebook full of information that we have compiled on the system hardware and programming. This includes diagnostic programs, sample programs and even a Tic Tac Toe listing.

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Southwest Technical Products Corp., Box 32040, San Antonio, Texas 78284 g the common frequency-ersion scheme of 10.695 to 10.595 MHz and 455 kHz first and second i-f's. Six synthesizer crystals in the 37.7-MHz and four in the 10.160-MHz ranges are used to derive the i-f's.

High sensitivity and low noise are obtained from a grounded-base r-f amplifier and a crystal-diode second mixer. A 455-kHz ceramic filter provides the selectivity. A three-stage audio system has the usual class-B push-pull speaker amplifier. (This audio section is also used as the transmitter's modulator.)

In our tests, the receiver's sensitivity (rated at 0.7 μV) measured slightly better than 0.5 μV for 10 dB (S+N)/N with 30% modulation and a 1000-Hz test tone. Selectivity or adjacent-channel rejection was an excellent 60 dB minimum, referred to 0.5 μV. Primary-image (CB channel frequency plus two times the first i-f) rejection was 80 dB, while secondary-image (CB frequency plus two times the second i-f) rejection was 35 to 40 dB. First i-f signal rejection measured 38 dB, and other unwanted spurious responses were down a minimum of 40 dB. The agc held the audio output change to within 10 dB from an 80-dB input change at 1 to 10,000 μV. (About 8 dB of the output variation occurred at 1 to 10 μV.) A 150-μV signal level was needed to drive the meter to S9.

The performance of the series-gate anl was good. At the onset of clipping, with a 1000-Hz test tone, the audio output measured 2.5 watts with 11% distortion into 8 ohms and almost 4 watts with 10% THD into 16 ohms.

The Transmitter. A synthesizer mixer and r-f, driver, and power amplifiers make up the usual transmitter configuration employing four synthesizer crystals in the range of 10.625 MHz along with 37.7-MHz crystals. A two-section pi-type network matches the transmitter's 50-ohm output to the antenna system and filters out harmonics. Antenna switching is accomplished electronically, while other circuits are transferred by a relay.

The r-f carrier output measured 4 watts with both our wattmeter and the meter built into the transceiver. The Mark II's meter is calibrated directly in watts for operation into a 50-ohm nonreactive (1:1 SWR) load. A built-in electronic voltage regulator made it possible to maintain this output power over wide variations of the 117-volt ac line potential.

With a 1000-Hz tone, the "range boost" (amc) held the modulation to a sine wave at about 90% modulation with a 20-dB increase in audio input level above that required for 50% modulation. Without amc, this would have occurred with only about a 5-dB input increase. Total harmonic distortion (THD) under the available high degree of compression held to within 10%.

Under dynamic conditions (voice operation), the modulation held to just 100% with adjacent-channel splatter down a nominal 55 dB. The 6-dB audio response was approximately 550 to 7000 Hz, and the maximum r-f frequency deviation for any channel was within 0.002%.

User Comment. The Mark II's styling is different from the usual CB base station. Its cabinet has a sloping top panel, at the rear of which rests the handset in its cradle. A HANDSET/SPEAKER pushbutton on the control panel lets the user choose his type of listening. With the button pushed in, both the speaker and handset earphone are live. With it out, the speaker is live until the handset is removed from its cradle, silencing the speaker and transferring the sound to the handset. During PA operation, only the external speaker is operational and the volume control serves as the microphone gain control.

We obtained typical telephone-type audio quality with the handset. Improved response, with a more natural sound, was obtained from the built-in speaker.

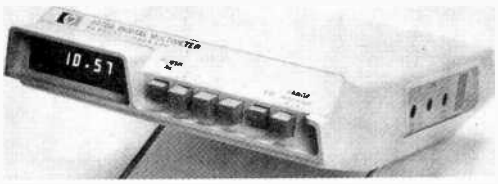
The handset is detachable. If desired, a standard desk-type microphone can be substituted when operating in the speaker listen mode.

The meter is of a good size for easy readability. The receiver is exceptionally quiet when no signals are present, quiet enough in fact so that one might mistake it as being off when no transmission is being received. However, even a weak signal will come in clear, thanks to an excellent sensitivity characteristic. Couple this with the fine selectivity, listening versatility, and exceptional range-boost amc performance for maintaining high modulation without adverse splatter, and the Mark II is a good choice for a CB base station.

CIRCLE NO. 82 ON FREE INFORMATION CARD

HEWLETT-PACKARD MODEL 3476A AUTOMATIC DMM

Luxury-performance, medium-cost instrument.



HEWLETT-PACKARD's new medium-priced Model 3476A digital multimeter offers features and functions normally found in only the most expensive DMM's. The instrument measures ac and dc voltage and current and resistance, with display on an expanded 3½-decade display, and polarity shown automatically. An autorange feature permits the user to turn on the power, select the function, and connect test leads to obtain an unambiguous display reading that doesn't have to be interpreted.

The DMM measures 8.1"D×6.6"W ×2.3"D (20.6×16.8×5.8 cm) and weighs 1 lb 9 oz (0.71 kg). It retails for $225 (ac operation only). It is also available in a rechargeable-battery model that permits ac/dc operation as the Model 3476B for $275. Optional items include: No. 11067A test-lead kit for $5; No. 11068A soft carrying case for $20; and No. 11096A r-f (10 kHz to 700 MHz) kit that includes adaptors for $87.

General Description. The DMM can measure from 100 μV to 1000 V on dc and from 300 μV to 700 V on ac. Typical accuracy on dc is better than 0.5%, while on ac it depends on the frequency of the voltage being measured. The dc input resistance is 10 megohms, and ac input impedance is 10 megohms, with less than 30 pF input capacitance.

Current can be measured from 100 μA to 1.1 A on dc and from 300 μA to 1.1 A on ac. Accuracy here is 0.1% or better on dc and depends on the frequency on ac. Input impedance is specified at a constant 1 to 1.5 ohms. The current-measuring functions are fuse-protected to 1.5 amperes.

The resistance measuring range is from 1 ohm to 11 megohms, with an accuracy of 0.6% at the high end of the range and 0.4% at the low end. The open-circuit potential at the probe tips is less than 4 volts.

The DMM is protected to 1100 volts peak on all voltage and current ranges. The fuse that protects the resistance function comes into play at 30 V rms. No special fuses are required. If ever a fuse must be replaced, there is no need to disassemble the instrument; you simply slide back a panel on the right side of the case, replace the fuse, and slide the panel back into place.

The front panel of the DMM contains the bright seven-segment LED displays behind a red filter window. A light shield molded into the instrument's case minimizes the possibility of overhead lighting washing out the display. The display is rather unique. Aside from providing the usual numerals 0 through 9 in the standard seven-segment format and minus sign (+ is implied), decimal points are located in each digit within the box formed by segments c, d, e, and g. When a decimal point is to be displayed, the digit in which it is to appear is blanked. This places the decimal point where it can be easily seen.

The control complement on the front panel includes six locking-type pushbutton switches. At the left, directly following the display, is the push-push POWER switch. Next comes the dc/ac selector switch, which has graphic legends to indicate which is selected. With this switch out, the DMM is set up for measuring dc, in for ac. The next three switches, labelled V (volts), A (amperes), and kΩ (kilohms), are interlocking types. The final (push-push) switch is labelled RANGE. This gives the user a choice of operating the DMM on autoranging (AUTO) or a specific range (HOLD). To use the HOLD function, you simply measure a parameter in the AUTO function and press in the RANGE switch. Thereafter, the autoranging circuits are switched out and the instrument will measure only the range selected.

Attached to the DMM's case is a bail that does double duty as a carrying handle and tilt stand. The bail can be adjusted to position the instrument for bench-top use. Alternatively, it can be swung back to allow the DMM to sit on the floor at an easy-to-view angle when there's no place on the bench to put it.

User Comment. The first thing we did with the DMM was check out its accuracy as best we could. (It is difficult to find calibration sources that will verify such tight accuracy.) Using our close-tolerance voltage and current sources and a number of special high-precision resistors, we verified that the DMM gave consistently accurate readings within our measurement limits.

One thing we liked during our tests and use was the fact that the least-significant digit at the far right of the display was free of the "bobble" usually characteristic of digital multimeters. We also noted that the overrange indication in any function was displayed as all g segments on.

The autoranging feature operated very smoothly. While the DMM may be automatic in operation, its autoranging circuit still works with ten ac/dc voltage, two ac/dc current, and five resistance ranges. As the ranges increase, there is a slight overlap. Consequently, the display counts up to slightly beyond its nominal top end, goes to an overrange indication, and then pops into the next range to continue the count. This is a good check to verify that the autoranging function is operating.

We couldn't resist the temptation to open up and look inside the DMM. What we saw was a relatively uncluttered circuit board. The bulk of the electronics is contained inside a custom hybrid IC, composed of two chips. One is an n-MOS control circuit, the other a tantalum-nitride thin-film precision resistor array. The control chip contains counters, buffer storage, display scanner, 3500-bit ROM storage, and solid-state analog switch circuits. The resistor array contains 19 precision resistors, matched to 0.02% tolerance by a laser trimming process. The resistor array keeps down the cost of the instrument. Had discrete high-tolerance resistors of the required values been used, the DMM's price would doubtlessly have cost more.

If you're considering shelling out more than $200 for a good DMM, we suggest you give the Model 3476 serious consideration. It has much to offer in terms of accuracy and operating convenience.

Solid State

By Lou Garner

A VERSATILE NEW IC

FOLLOWING a tradition established a number of years ago, Raytheon Semiconductor (350 Ellis St., Mountain View, CA 94040) has announced the world's first monolithic IC Voltage-to-Frequency Converter (VFC). Old timers will recall that Raytheon (then in Newton, MA) introduced the world's first low-cost experimenter's transistor way back in the early 1950's—the famous, though now obsolete, CK722.

Designated type 4151, Raytheon's newest device converts an analog dc input voltage (or current) into a stream of constant duration pulses; the higher the applied input voltage, the greater the number of pulses per second at the output. The IC's frequency range is from 0 to 10 kHz, while its operating bandwidth is 10 to 100 kHz. Its pulsed output signal is compatible with all standard logic, including TTL, CMOS, DTL, MOS, and I^2L. The chip is offered in three versions: the premium RM4151, with a temperature range of −55°C to +125°C; the commercial type RC4151, with a range of 0°C to +70°C; and the automotive type RV4151, with a range of −40°C to +85°C. The device is available in two standard packages, an 8-pin plastic mini-DIP, identified by an "NB" suffix, and a TO-5 style 8-pin metal case, carrying a "T" suffix. Suitable for operation on single-ended dc sources from +8 to +22 volts, all three versions have internal power dissipation ratings of 500 mW and are capable of sinking output loads up to 20 mA.

The 4151 can be used in a variety of experimenter and hobbyist projects. Depending on external connections, the single device can serve as either a voltage-to-frequency *or* frequency-to-voltage converter. With this dual capability, the 4151 can be used in control systems, programmable power supplies, electronic music instruments, medical monitors and tachometers. It can also be used in minicomputer and microprocessor interface applications and in digital AM, FSK, and opto-isolated analog data transmission and communications systems. As an analog-to-digital converter, the device can be used in many types of test instruments and in conjunction with temperature, pressure and light sensors. In fact, its range of applications is limited only by the imagination and skill of the circuit designer.

Referring to the simplified block diagram (Fig. 1), the 4151 comprises a voltage comparator, a one-shot, a logic buffer amplifier, and a switched current source. The positive input voltage is compared to the instantaneous dc voltage developed across an external RC network, R_BC_B. If the input voltage is higher than the network voltage, the comparator triggers the one-shot which, in turn, delivers an output signal to the buffer amplifier. At the same time, the one-shot switches on the current source momentarily, injecting a charge into the RC network, thus raising the instantaneous dc voltage across it by a small amount. If this charge has not increased the network's voltage enough to equal or slightly exceed the input voltage, the comparator again triggers the one-shot, repeating the operation. This process continues until the RC network's voltage equals or exceeds the input voltage. At this point, the current source remains off and the network voltage decays until it again equals the input voltage. When this condition is achieved, the circuit operates in a steady-state mode. The one-shot is triggered and switches on the current source at a rate fast enough to keep the network's voltage equal to or slightly greater than the input voltage. Since capacitor C_B's discharge rate depends on the ratio of the voltage across it to the value of resistor R_B the circuit's switching frequency is directly proportional to the input voltage.

Typical applications for the 4151 as a voltage-to-frequency converter and as a frequency-to-voltage converter are shown in Figs. 2A and 2B, respectively. Requiring single-ended dc power sources and standard passive components, both circuits are taken from the product specification bulletin for the 4151 published by Raytheon Semiconductor. Resistors can be either ¼- or ½-watt types, while the capacitors can be either low-voltage ceramic or plastic-film types. Neither circuit is overly critical as far as layout and lead dress are concerned. Any standard construction technique may be used, provided good wiring practice is observed.

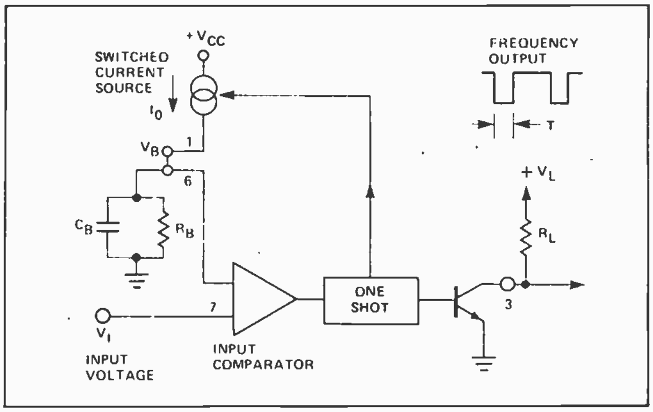


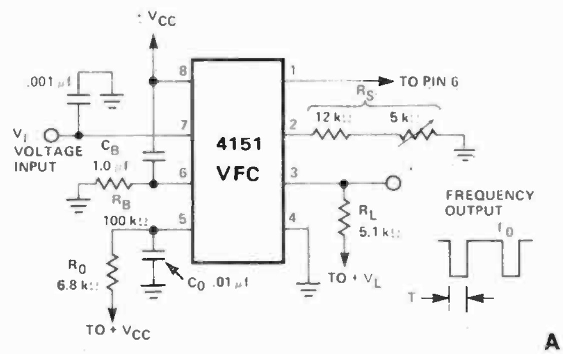
Fig. 1. Simplified block diagram of the 4151.

Suitable for operation on dc supplies of 15 to 22 volts, the voltage-to-frequency converter, Fig. 2A, is designed to accept dc input levels of 0 to +10 volts, delivering proportional pulse output signals of 0 to 10 kHz. The circuit's output frequency at 10 volts input can be established by adjusting the 5-k trimmer potentiometer which, with a 12-k fixed resistor, forms the current output set resistor, R_S. The one-shot's period (hence the duration of the output pulse) is determined by the equation $T=1.1\ R_0C_0$. With the component values specified in the diagram, T is approximately 76 microseconds.

The frequency-to-voltage converter (Fig. 2B) delivers a dc output of 0 to +10 volts proportional to the frequency of the square-wave input signal. The resistor bias networks connected to pins 6 and 7 hold the input comparator in an off state under zero signal conditions. A negative-going pulse applied to pin 6 (or a positive-going pulse to pin 7) will be detected by the voltage comparator. This triggers the one-shot which, in turn, delivers a current pulse to the output integrator C_BR_B. The dc voltage developed across the integrator's capacitor depends on the number of current pulses received in a given period and, therefore, on the frequency of the applied input signal.

For proper circuit operation, the triggering pulse width must be *less* than the period of the one-shot ($1.1\ R_0C_0$). If the input signal is a 5-volt, p-p, square wave of 10 kHz or less, the differentiator formed by the 0.022-µF coupling capacitor and the resistor bias network develops pulses adequate to trigger the one-shot. On the other hand, if the circuit is to be driven with a triangular or sinusoidal input, an external voltage comparator (such as types 311 or 339) or a Schmitt trigger should be used between the signal source and the 4151 input to "square up" the applied signal.

The circuit's component values can be changed to meet special operating conditions. For example, the coupling capacitor and bias network making up the input differen-



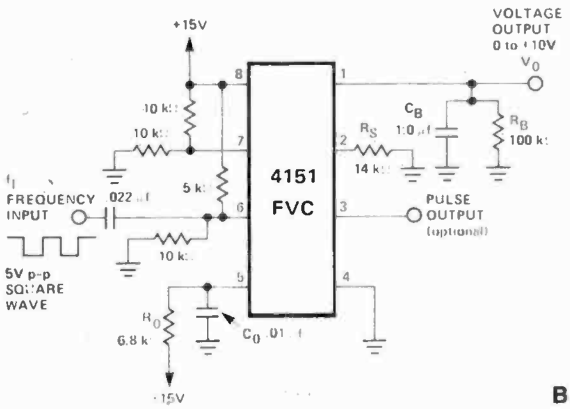


Fig. 2. Basic applications for the 4151: (A) voltage-to-frequency converter; (B) frequency-to-voltage converter.

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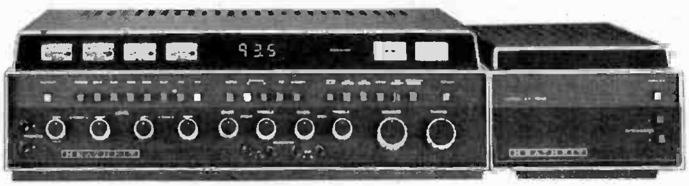

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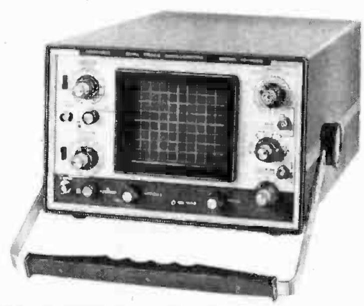

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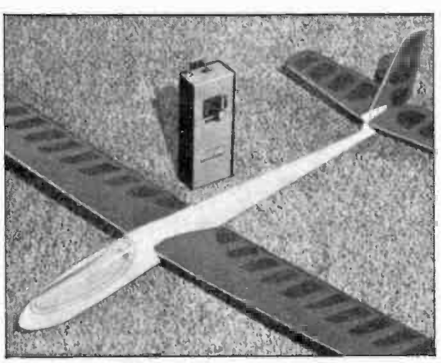

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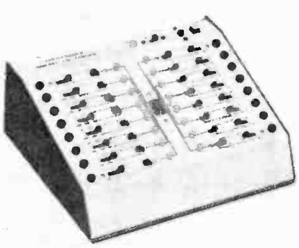

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tiator can be altered to accommodate square waves with different amplitudes and frequencies. In addition, the integrator capacitor's value can be increased to reduce the output ripple at lower frequencies.

Either of the basic converters discussed above can be modified by adding op amps and other support circuitry to alter response characteristics. According to Raytheon, typical voltage-to-frequency conversion linearities up to 0.05% can be achieved by using an op amp integrator in conjunction with the 4151. Where standard op amps are used with the 4151, dual, rather than single-ended, power sources may be required.

Reader's Circuit. Quite novel when first introduced, digital electronic clocks have become so commonplace today that they seldom warrent more than a passing glance. However, if you'd like something "really different" in the way of an electronic time keeper, you might consider the circuit shown in Fig. 3. Submitted by Kenneth B. Salomon of the Department of Mathematics, California State University, Hayward, CA 94542, the design has a rather unique readout display—individual lamps to represent 1-minute, 5-minute and 1-hour intervals! The actual time is "read" by totalling the time represented by the number of lamps illuminated in each group. For example, if four 1-hour, seven 5-minute, and three 1-minute lamps are lit, the time is 4:38. Similarly, nine 1-hour, eight 5-minute, and two 1-minute lamps would represent 9:42. With a little practice, the time can be read quickly, although friends and visitors may be somewhat mystified by the instrument.

The circuit consists of five functional sections: power supply furnishing 5 volts dc for the logic circuitry and 160 volts dc for the neon lamp displays; a Schmitt trigger (*IC1*) and divide-by-3600 counter (*IC2* to *IC5*); a 4-bit shift register (*IC6*) for the minute lamp displays; and two 11-bit shift registers, one for the 5-minute displays (*IC7* to *IC9*) and one for the 1-hour lamps (*IC10* to *IC12*). Individual npn driver transistors (*Q1* to *Q26*) are provided for each of the 26 display lamps (*I2* to *I27*), with series current-limiting resistors in both the base (*R4* to *R29*) and collector (*R30* to *R55*) circuits. The high-voltage power source comprises an isolation transfomer, *T1*, a surge limiting resistor, *R2*, a half-wave rectifier, *D1*, a filter capacitor, *C1*, and a neon pilot lamp assembly, *I1* and *R56*. The low-voltage power supply includes a step down transformer, *T2*, a full-wave bridge rectifier, *RECT 1*, a filter capacitor, *C2*, and a voltage regulator made up of series resistor *R3* and zener diode *D2*.

A 60-Hz signal obtained from *T2* is coupled through current-limiting resistor *R1* to a Schmitt trigger, *IC1*. The Schmitt trigger's output is coupled to two cascaded divide-by-six counters, *IC2* and *IC3*, and from there to a pair of cascaded divide-by-ten counters, *IC4* and *IC5*, providing a total division of 3600 and developing a 1/60-Hz (1 pulse/minute) square wave. This pulse is coupled to a 4-bit shift register, *IC6*, which actuates each of four 1-minute display lamps in order through its corresponding drive transistor. Initially, all four shift-register outputs are 0. As each pulse is received, the outputs switch to 1 in order, furnishing base drive to the driver transistor connected to each output and thereby activating the corresponding lamp. On the fifth count, the 1-minute register is cleared, with all outputs returned to 0, all lamps extinguished, and a clock pulse delivered to the 11-bit, 5-minute shift register, *IC7* to *IC9*. The cycle repeats at five-minute intervals. The

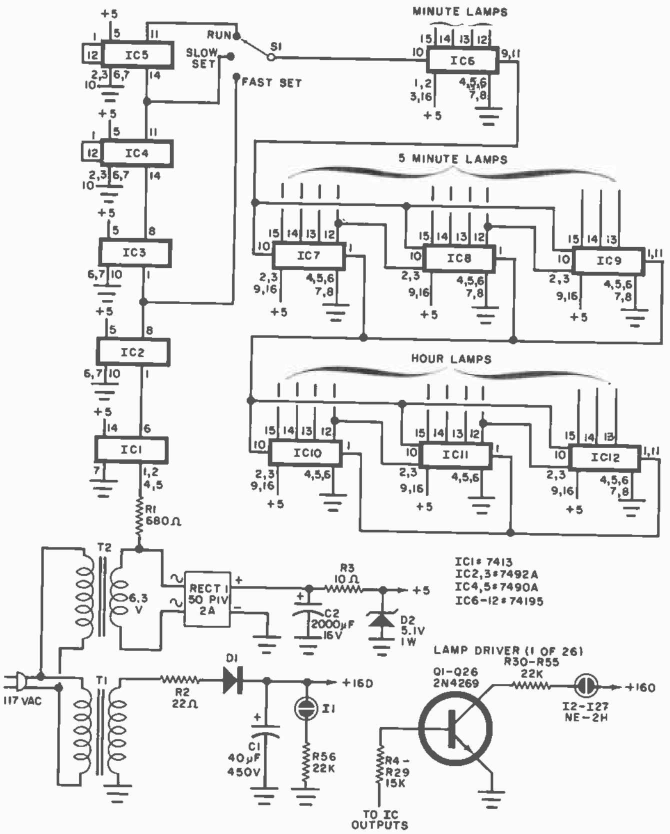


Fig. 3. Schematic of digital electronic clock with an unusual readout system.

5-minute shift register, in turn, delivers clock pulses to the 11-bit, 1-hour shift register, *IC10* to *IC12*, at hourly intervals, switching all of its own displays off as it does so. Thus, the 5-minute and 1-hour shift registers operate in similar fashion to the 1-minute shift register, with each lamp in the corresponding group lit in turn until all are on, then all extinguished simultaneously at the next clock pulse. Switch *S1* permits portions of the initial divider to be bypassed, providing a more rapid counting rate for setting the clock initially.

Although the clock circuit uses a relatively large number of IC's, it is not an overly costly project, for virtually all of the components are quite inexpensive. Kenneth writes that his total cost was less than thirty dollars. The integrated circuits are 7400 series devices which are available for less than a dollar each through most surplus outlets. Resistors *R1* and *R4* to *R29* are ¼-watt types; *R2* and *R3* are 1 watt; and *R30* to *R56* are ½-watt. The isolation transformer, *T1*, is a Stancor Model P-6441 (Lafayette 3380946), and *T2* is a 6.3-V, 1.2-A filament transformer (Radio Shack 273-050). The time set switch, *S1*, is a single-pole, 3-position, shorting rotary type (Centralab 1461).

With neither parts placement nor wiring dress critical, you can pretty much follow your own preferences in construction methods. Kenneth assembled his model on perf boards, mounting these behind a piece of plywood in which he drilled holes for the neon lamps. He enclosed the whole assembly in a frame and mounted a piece of smoked plexiglass in front of the lamps so that they would be visible only when on.

For some, the most interesting part of the project will be the design of the readout display pattern. Kenneth arranged the lamps in an arrow display, with the hour lamps forming the arrowhead, the 5-minute lamps the shaft, and the minute lamps the tail. A geometric pattern, such as concentric circles, or an abstract design might be suitable for a den, office, or recreation room.

Setting the clock is a relatively simple procedure. After the wiring has been double checked for errors and correct dc polarities, power is applied. At this point, the clock should read 1:00 (only pilot *I1* on). Switching *S1* to FAST SET will cause the hour lamps to cycle about once every 10 seconds. After establishing the correct hour, switch *S1* to SLOW SET for the correct 5-minute and 1-minute readings, then immediately switch to the RUN position. Finally, stand back and admire your masterpiece!

Device/Product News. The Fairchild Camera and Instrument Corp. (464 Ellis St., Mountain View, CA 94042) has introduced a new low-cost static n-channel 1,024-bit random-access memory (RAM) that will be of interest to experimenters, hobbyists or engineers working with minicomputers or microprocessors. Offered in two versions, the new device, No. 3542, features a maximum access time of 150 ns, while its companion type, the 3542-2, features a maximum access time of 120 ns over the temperature range of 0° to 70°C. Organized as a 1024 X 1 bit array requiring a single 5-volt dc supply, the new RAM's are completely compatible with standard TTL. Both versions are supplied in 16-pin ceramic DIP's

A single-package successive approximation register containing all the random logic needed for a TTL analog-to-digital converter is available from the National Semiconductor Corp. (2900 Semiconductor Drive, Santa Clara, CA 95051). Intended for use with a digital-to-analog converter, as shown in Fig. 4, the new device is offered in three versions. The DM2502 features an 8-bit capacity and serial capability but is not expandable; the 8-bit DM2503 is expandable but without serial capability; and, finally, a 12-bit version, the DM2504, is both expandable and has serial capability. Compatible with D-to-A converters using any logic code, the new IC's can operate in short-cycle or expanded as well as continuous or start-stop modes and offer either active-low or active-high logic outputs. All three are available in three different types of packages: ceramic flatpacks and molded Epoxy-B or ceramic DIP's. The 8-bit devices are manufactured in 16-pin and the 12-bit type in 24-pin packages.

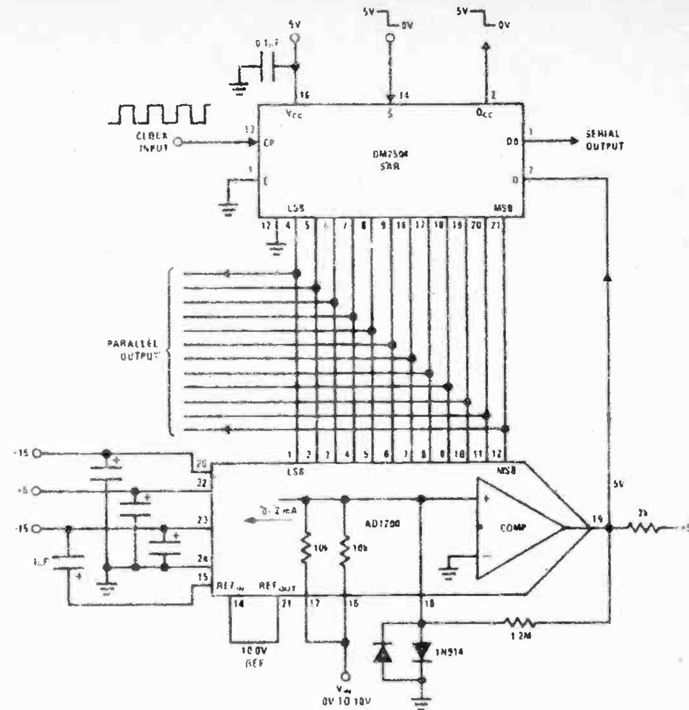


Fig. 4. A 12-bit A/D converter using National Semiconductor successive approximation register.

In addition to its new successive approximation register, National also has announced a new low-cost, six-digit, floating decimal point calculator circuit. Identified as the MM5777, the new IC uses a metal gate, p-channel MOS design and comes in a 24-pin Epoxy-B DIP. A complete four-function, six-digit calculator with leading and trailing zero suppression, algebraic key entry notation, floating point input and output, and provision for chain operation would require only a keyboard, an NSA1161 LED display, a DS8977 digit driver, and a 9-volt battery (in addition to the MM5777).

The General Instrument Corp. (600 West John St., Hicksville, NY 11802) is offering a new TTL compatible C/MOS quad multifet/multiplex driver. The new device, type MEM 4900, consists of four independent drivers on a single monolithic silicon chip. Each driver will accept input signals of 3 to 15 volts and supplies output signals up to 15 volts, p-p. An inhibit control is included to disable all four drivers when at logic one. Suitable for use in TTL-to-MOS level converters and as a driver for analog switches and multiplexers, the MEM 4900 is supplied in a 14-pin plastic DIP configuration.

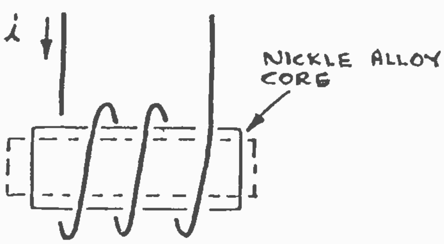
April Hobby Scene

By Marcia Swampfelder

ENCROACHING HI-FI

Q. ***I have a Colcord XW15 4-channel amplifier. The louder I play it, the longer it gets. It totaled a fourteenth century Ming vase by pushing it off the end of the bookshelf. Is this normal?***

A. Colcord has a policy of using as many interchangeable parts as possible on their electronic and small appliance lines. The output transformer in the XW15 is made of a special high-nickel alloy core. They were able to get a *magnetostriction effect* (change of core size with winding current—see diagram) that's far more than usual. This way, the same com-



ponent that's used as an output transformer on the XW15 doubles as the drive motor on the orange juicer and as the impulser on their power nut cracker.

Your instruction manual should clearly warn you not to put anything within 6 cm (about 2⅜") of the right side of the amplifier. Two other solutions to your problem are to buy the companion clip-on juicer and self-pour snout, or else simply put things on your bookshelf only while the unit is at maximum volume. This way, it will move *away* from other things on the shelf as volume is lowered.

IDENTIFYING SCOPE PROBES

Q. ***What is the meaning of the term "10 to one" or "10:1" on a scope probe?***

A. This is just engineering slang. There is no real technical meaning. The term apparently started due to the extreme amount of scope-probe pilferage that goes on in large electronics labs. If you turn your back on your probes, they ten to one away. Hence, the term.

GOLDEN OLDIES

Q. ***I found an apparently brand-new, unused 1934 Majestic "Mighty Monarch of the Air" radio in the hayloft of an old barn, still in its original factory carton. After I carefully reformed the wet electrolytics, it seems to work perfectly, except for one minor detail. All it gets is 1934 music. Why?***

A. This is a beautiful example of the time lapse or *Ohaco Retrograde*, named after the historian, Dr. Chevelon Ohaco, who has long been using factory-fresh 1942 surplus command receivers to reconstruct World War II battles.

Many people using the effect, prefer to keep their receivers as they are — rather than resetting them for more recent program material. If you really want to update, you can add a Time Lapse Compensator, such as the Springer Labs. TLC-995. You usually put the time lapse compensator module between the second detector valve and the grid leak of the first audio triode. The compensators are tapped for various amounts of update, so if you are a "golden oldies" fan, you can simply select a tap or two closer to the input. Full instructions are provided with the compensator. One tip — be extremely careful never to select a tap that exceeds the time difference between the exact date of manufacture and the date the unit was originally unpacked and powered.

NEW INTEGRATED CIRCUITS

Q. ***I've been wanting to get into T²L***

or "Tee Squared Ell" integrated circuits for quite some time now. However, I've never had a drafting course, and I don't even own a tee square. What do you suggest?*

A. Offhand, we'd recommend hang-gliding, decoupage, or aquaculture.

MOS PROBLEMS

Q. *Are there really any special problems when you use MOS integrated circuits?*

A. MOS IC's and transistors have extremely high input impedances. Early versions of these devices were extra easy to destroy by static electricity. Simply scuffing across a carpet or using a styrofoam storage block were enough to ruin the units. Just about all MOS IC's today include very good input and output protection methods, which almost entirely eliminate these problems.

However, one thing that's never mentioned in the MOS literature and hasn't yet been solved is the extreme geomagnetic sensitivity of MOS devices. They can only be used on the north side of your circuit. They are thus unsuitable for portable equipment of any sort unless a compass and clear alignment marks are provided.

NEEDS A MOUNTING BRACKET

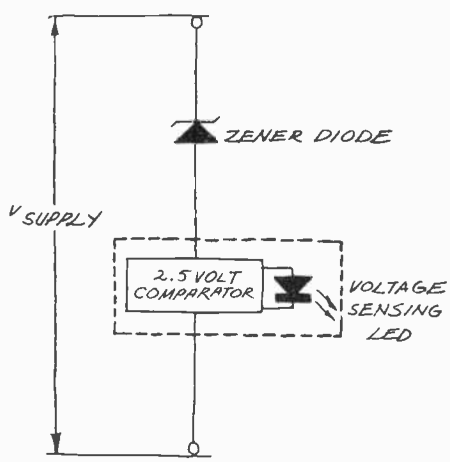
Q. *Where and when can I get the left mounting bracket for a Gentry-Heber PLX-201 combination home laser fusion power source and psychedelic lighting center?*

A. Between the energy crunch and the unique lighting fad, the demand for these 5-kilowatt home units has been incredible. This is particularly true after the writeup in the "Home Power Quarterly" (Deer Springs Press, Vol XII, No. 4, p 167-185). The main problem with the bracket is that Gentry-Heber is going through a metrication program so that export units will use the same parts as the standard model. They estimate another six months to work out the backlog on this part. Meanwhile, several readers have reported working out suitable substitutes using ordinary railroad ties. Be absolutely sure there is at least 10-cm (4") clearance between the bracket and the Deuterium return line.

Tips & Techniques

LED MONITORS BATTERY VOLTAGE

A new voltage-sensing LED (Hewlett-Packard 5082-4732) can be used to monitor battery voltages in-circuit. Since a good battery will keep its load voltage to at least 85% of its open circuit value, we can employ the LED and a zener diode to give a GOOD/BAD indication. The LED contains a reference voltage and a comparator, which triggers at a nominal threshold of 2.5 volts. The LED will abruptly extinguish below this



voltage. If we have a circuit powered by a 9-volt transistor battery, we want the supply voltage to stay above 7.6 V (85% of 9 V). In this case, we connect a 5.1-volt zener diode as shown, so that the LED will glow at the desired minimum voltage (5.1 V+2.5 V=7.6 V). Other zeners may be used to monitor various voltages. For example, connecting a 2.1-volt zener will have the LED indicate when a 5-volt TTL supply is within 90% of its optimum value (2.1 V+2.5 V=4.6 V). Other applications are limited only by the user's imagination.—*Sol D. Prensky*

HANDY WEATHERPROOF ENCLOSURES

It is sometimes necessary to have a small weatherproof enclosure for a circuit that must be mounted outdoors. Plastic "air-tight" containers, such as those used for storing leftover food, adapt themselves to this application. They come in a wide variety of shapes and sizes and are inexpensive. If it is necessary to bring leads into the enclosure, cut out or drill a small hole, and put in a tight-fitting rubber grommet. Feed the lead(s) through the grommet and fill any gaps with a good sealant.—*W. T. Howatt*

CHEAP SUBSTITUTE FOR ETCH RESIST PENS

An inexpensive alternative to etch resist pens can be found in your local stationery shop. "Permanent waterproof" markers work just as well at about a fourth of the price. To make any corrections, use a Q-tip dipped in acetone.—*Tom Dycus*

FILM SPOOL SOLDER DISPENSER

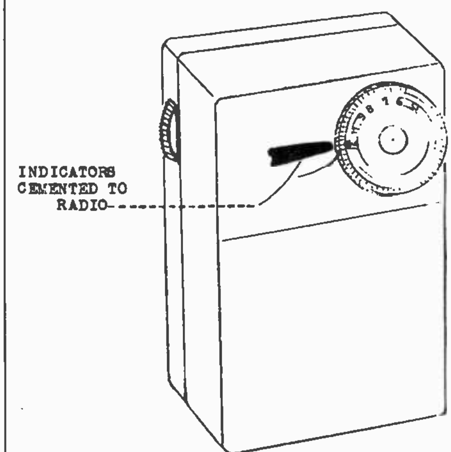
The most economical way to buy solder is in one-pound bulk spools. But a bulky spool is hardly the most convenient way to handle solder. A 35-mm film cartridge makes a handy, refillable solder dispenser. Open the cartridge and drill a small hole in the spool near the flange. Push the solder through the hole and wind it neatly in several layers. Reassemble the cartridge, passing the end of the solder through the film slot. The cartridge may be color-coded or labelled to designate the solder's composition and size.—*Raymond F. Arthur*

DATING BATTERIES & CAPACITORS

Components with a limited shelf life, such as batteries and some capacitors, present servicing problems when their installation date is unknown. A simple way to keep track of this is to attach self-adhesive labels on the package. Then write the purchase and/or installation date on the labels with a waterproof felt-tip marking pen.—*Ross Thompson*

ELECTRONIC EQUIPMENT INDICATORS

Excellent indicators can be made from the teeth of small plastic combs, as shown in the figure. They can be used as directional pointers for radios, tape recorders, etc.,



and will not wear off as printed indicators do. The teeth, which are available in many colors, are cut and filed to the required shape, and cemented in place with plastic cement.—*Frank Shore*

SERVICING CRT's

On some TV receivers, the picture tube's external aquadag coating is not grounded when the chassis is pulled from the cabinet. The coating can be connected to the chassis by folding a piece of aluminum foil into a 2"×1" (5.1×2.5 cm) rectangle. Tape half of the rectangle to the coating, and attach a clip lead to the free end of the rectangle. Then connect the other end of the lead to the chassis. When the servicing is finished, cut off the free end of the foil, since removing the tape will peel off some of the aquadag coating.—*Harry J. Miller*

TRANSISTOR STORAGE

Due to their small size, TO-92 plastic case transistors can be difficult to store. Common plastic drinking straws, however, make excellent storage tubes for them. Transistors can't rotate and jam, and all units may be quickly counted through the translucent plastic without opening. An eight-inch straw will hold about 15 devices. Pinch and seal one end of the straw with tape, or use a small tapered plug. The tubes can then be "flagged" with masking tape bearing the appropriate 2N numbers. For extra convenience, mount in a grooved or drilled wood block.—*John A. Haase*

(Continued on page 104.)


An ounce here, an ounce there
Turner puts a bit extra in all the right places.
When it comes to building antennas, Turner doesn't mind being a bit heavier. Frankly, Turner builds Signal Kickers to last. And they come out looking beautiful. Like this popular 200 series trunk lip mount. The sturdy mounting bracket is covered with a die-cast, chrome-plated metal base. The screw-on coil has a spring-loaded contact ball to make sure there's still a positive connection after repeated removals at the car wash.
The coil form and coil cover are molded of impact-resistant Noryl, not cut from stock plastic tubing. The Noryl doesn't get soft or brittle at extreme temperatures.
Optional swivel balls and shock springs are generously chrome plated for lasting luster. The stainless-steel whip is built to stand straight at highway speeds. And all Signal Kickers have a reserve power-handling capacity of 500 watts.
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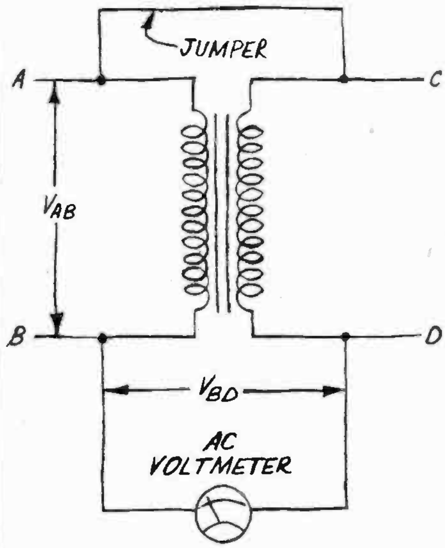
PROBE HOLDER

A broom holder can also be a convenient holding rack for scope or meter probes. These holders can be obtained in almost any hardware store—*Thomas LaChé*.

DETERMINING TRANSFORMER POLARITIES

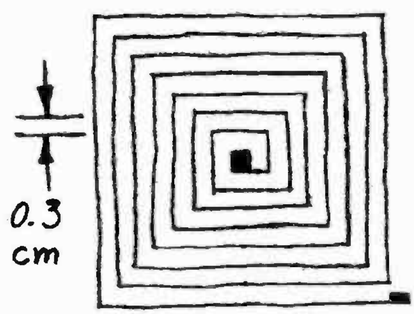
Here's a simple way to determine the phasing polarity of an unmarked transformer secondary. Apply an ac voltage across the



primary (points A and B) and read V_{AB} with an ac voltmeter. Then connect a jumper from point A to point C, and read V_{BD}. If this reading is higher than V_{AB}, point C has the same polarity as point B. If the reading is less, point C has the same polarity as point A. When there are more than two windings, the same test can be performed, but must be repeated for each set of coils.—*Douglas Koepke*

VHF / UHF LOOP ANTENNA

A fairly directional loop antenna can be made from a pc board about 5.1 cm (2 inches) square. Etch conductors 0.3 cm



(0.125 inch) apart. It will function well over a range of 470-890 MHz (the conductive path is 70 cm or 1.16λ at 500 MHz), and will also be useful at about 180 MHz (λ=140 cm).—*Henry Troup*

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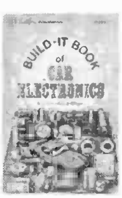

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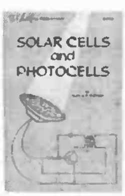

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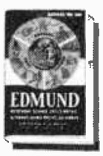

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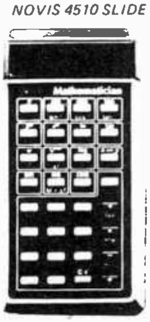

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SN7401N	.16	SN7454N	.41	SN74151N	1.25
SN7402N	.21	SN7459A	.25	SN74153N	1.35
SN7403N	.16	SN7460N	.22	SN74154N*	1.25
SN7404N*	.16	SN7470N	.45	SN74155N	1.21
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SN7408N	.25	SN7474N*	.32	SN74161N	1.45
SN7409N	.25	SN7475N*	.59	SN74163N*	1.35
SN7410N*	.16	SN7476N*	.32	SN74164N	1.65
SN7411N	.30	SN7479N*	5.00	SN74165N	1.65
SN7412N	.42	SN7480N	.50	SN74166N	1.70
SN7413N	.85	SN7482N	1.75	SN74167N	5.50
SN7414N	.70	SN7483N	1.15	SN74170N	3.00
SN7416N	.43	SN7485N	1.12	SN74172N	18.00
SN7417N	.43	SN7486N	.45	SN74173N	1.70
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SN7421N	.39	SN7490N*	.49	SN74176N	.90
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SN7423N	.37	SN7492N	.82	SN74180N	1.05
SN7425N	.43	SN7493N*	.57	SN74181N	3.55
SN7426N	.31	SN7494N	.91	SN74182N	.95
SN7427N	.37	SN7495N	.91	SN74184N	2.30
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SN7443N	1.05	SN74132N	3.00	SN74196N	1.25
SN7444N	1.10	SN74136N	1.80	SN74197N	1.00
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SN7447N*	.79	SN74143N*	4.50	SN74200N	7.00
SN7448N	.99	SN74144N*	4.50	SN74279N*	.90
SN7450N	.26	SN74145N	1.15	SN74251N	2.50
SN7451N	.27	SN74147N	3.00	SN74284N	6.00
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20% Discount for 100 Combined 7400's

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CD4000	.25	CD4035	1.85	74C04N	.75
CD4001	.25	CD4040	2.45	74C10N	.65
CD4002	.25	CD4042	1.90	74C20N	.65
CD4006	2.50	CD4044	1.50	74C30N	.65
CD4007	.25	CD4046	2.51	74C42N	2.15
CD4009	.59	CD4047	2.75	74C73N	1.50
CD4010	.59	CD4049	.79	74C74	1.15
CD4011	.25	CD4050	.79	74C90N	3.00
CD4012	.25	CD4051	2.95	74C95N	2.00
CD4013	.47	CD4053	2.95	74C107N	1.25
CD4016	.56	CD4060	3.25	74C151	2.90
CD4017	1.35	CD4066	1.75	74C154	3.00
CD4019	.55	CD4069	.45	74C157	2.15
CD4020	1.49	CD4071	.45	74C160	3.25
CD4022	1.25	CD4072*	.45	74C161	3.25
CD4023	.25	CD4081	.45	74C163	3.00
CD4024	1.50	CD4511	2.50	74C164	3.25
CD4025	.25	CD4518	2.50	74C173	2.60
CD4027	.69	74C00N	.39	74C193	2.75
CD4028	1.65	74C02N	.55	74C195	2.75
CD4029	2.90			MC4044*	4.50
CD4030	.65			MC14016*	.56

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LM301H*	3/1.00	LM380N	1.39	LM1414N	1.75
LM301CN*	3/1.00	LM380CN	1.05	LM1458C	.65
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LM340K-12	1.95	LM739N	1.29	CA3035	2.25
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LM340K-24	1.95	LM741CN*	3/1.00	CA3046	1.15
LM340T-5	1.75	LM741 14N	.39	CA3059	2.46
LM340T-6	1.75	LM747H	.79	CA3060	2.80
LM340T-8*	1.75	LM747N	.79	CA3080	.85
LM340T-18*	1.75	LM748H	.39	CA3083	1.60
LM340T-12	1.75	LM748N	.39	CA3086	.59
LM340T-15	1.75	LM1303N	.90	CA3089	3.25
LM340T-24	1.75	LM1304N	1.19	CA3091	8.25
LM350N	1.00	LM1305N	1.40	CA3123	1.85
LM351CN	.65	LM1307N	.85	CA3130*	1.49
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LM370H	1.15			RC4194	5.95
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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	1.35	XR-1310EP	3.20
XR-556CP	1.85	XR1800P	3.20
XR-2556CP	3.20	**WAVEFORM GENERATORS**	
XR-2240CP	3.25	XR-205	8.40
PHASE LOCKED LOOPS		XR-2206CP	4.49
XR-210	5.20	XR-2207CP	3.85
XR-215	6.50	**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

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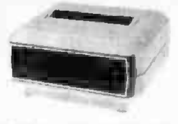
exelar DIGITAL WATCH
This watch is manufactured by National Semiconductor. It provides 5 functions: hours, minutes, seconds, date, A.M. indicator dot. Accuracy is assured to 5 seconds per month by precision quartz crystal. If something should go wrong with the watch, repair is assured within 48 hours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

ES4-WS Chrome Plate Bezel **$27.95**
ES4-YS 3 Micron Gold Plate Bezel **$29.95**
NOT A KIT

Novus



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 shooze alarm, a power failure indicator, and even an A.M., P.M. indicator.

NOT A KIT **$19.95**

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G - GREEN
Y - YELLOW
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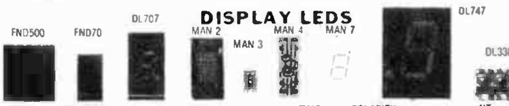
XC209R	5/$1	XC526R	5/$1	XC111R	5/$1
XC209G	4/$1	XC526G	4/$1	XC111G	4/$1
XC209Y	4/$1	XC526Y	4/$1	XC111Y	4/$1
XC2090	4/$1	XC5260	4/$1	XC1110	4/$1

.200" dia.		.200" dia.		.085" dia.
XC22R	5/$1	XC556R	5/$1	MV50
XC22G	4/$1	XC556G	4/$1	.085" dia. Micro
XC22Y	4/$1	XC556Y	4/$1	red led
XC220	4/$1	XC5560	4/$1	6/$1

DISPLAY LEDS



TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	COMMON ANODE	.270	$1.95	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	1.95
MAN 4	COMMON CATHODE	.187	1.95	DL750	COMMON CATHODE	.600	2.49
MAN 7	COMMON ANODE	.300	1.50	DL338	COMMON CATHODE	.110	1.95
MAN 7G	COMMON ANODE-GREEN	.300	2.50	FND70	COMMON CATHODE	.250	.50
MAN 7Y	COMMON ANODE-YELLOW	.300	2.50	FND500	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
				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 $1.75 PER ASST.

		10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	
ASST. 1	5 ea.	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	1/4 WATT 5% = 50 PCS.
		68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	
ASST. 2	5 ea.	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	1/4 WATT 5% = 50 PCS.
		470 OHM	560 OHM	680 OHM	820 OHM	1K	
ASST. 3	5 ea.	1.2K	1.5K	1.8K	2.2K	2.7K	1/4 WATT 5% = 50 PCS.
		3.3K	3.9K	4.7K	5.6K	6.8K	
ASST. 4	5 ea.	8.2K	10K	12K	15K	18K	1/4 WATT 5% = 50 PCS.
		22K	27K	33K	39K	47K	
ASST. 5	5 ea.	56K	68K	82K	100K	120K	1/4 WATT 5% = 50 PCS.
		150K	180K	220K	270K	330K	
ASST. 6	5 ea.	390K	470K	560K	680K	820K	1/4 WATT 5% = 50 PCS.
		1M	1.2M	1.5M	1.8M	2.2M	
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	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 .027 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, 2.5K, 10K, 20K, 25K, 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.

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Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
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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

DIP SWITCH

These switches feature four SPST Rocker switches in a molded dip. They are ideally suited for microprocessor applications. $1.95

MINATURE TOGGLE

DPDT				JMT	1	2-9	10-29	30-99
	ON	OFF	ON	221	3.08	2.65	1.97	1.78
	ON	NONE	ON	223	2.66	2.26	1.68	1.51
	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	123	2.05	1.65	1.21	1.10

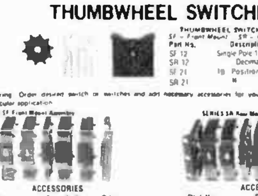
PUSH BUTTON

SPDT — SERIES PB, PB1
Maintained Action Switch: Push To Make Contact, And Push Again To Release 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	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

Quanity net prices
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.

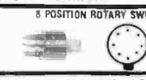
SERIES SF Front Mount Assembly — ACCESSORIES

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

SERIES SR Rear Mount Assembly — ACCESSORIES

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

8 POSITION ROTARY SWITCH



$79

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	PN3567	3/$1.00	PN4249	4/$1.00
MPS A06	5/$1.00	PN3568	4/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3569	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	2N3704	5/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3705	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3706	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3707	5/$1.00	2N4409	5/$1.00
PN2415	5/$1.00	2N3711	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3724	$.65	2N5087	4/$1.00
2N2906A	4/$1.00	2N3725	$1.00	2N5088	4/$1.00
2N2907A	5/$1.00	2N3903	5/$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3904	4/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3905	4/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3906	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N4013	3/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N4014	3/$1.00	2N5951	5/$1.00
2N3392	5/$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
10 pf	.05	.04	.03	.001μF	.04	.035	
22 pf	.05	.04	.03	.0047μF	.05	.04	.035
47 pf	.05	.04	.03	.01μF	.05	.04	.035
100 pf	.05	.04	.03	.022μF	.06	.05	.04
220 pf	.05	.04	.03	.047μF	.06	.05	.04
470 pf	.05	.04	.035	.1μF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+ 20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1 35V	.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

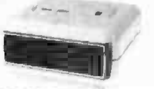
Axial Lead				Radial Lead			
.47 50V	.15	.13	.10	.47 25V	.15	.13	.10
1.0 50V	.16	.14	.11	.47 50V	.16	.14	.11
3.3 50V	.15	.13	.10	1.0 16V	.15	.13	.10
4.7 25V	.16	.14	.12	1.0 25V	.16	.14	.11
10 25V	.15	.13	.10	1.0 50V	.16	.14	.11
10 50V	.16	.14	.12	4.7 16V	.15	.13	.10
22 25V	.17	.15	.12	4.7 25V	.15	.13	.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

CRYSTALS

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
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

— AVAILABLE IN THESE FREQUENCIES ONLY —

CLOCK CASES



Nicely styled cases complete with red bezel for use in such applications as desk clocks, car clocks, alarm clocks, instrument cases.
DIMENSIONS: W-4" L-4½" H-2"

$5.95

64 Key Keyboard

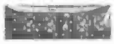
$24.95

This keyboard is composed of 64 Magnetic Reed Switches, in one molded unit. It is unencoded with each SPST switch brought out to two pins.

HD0165 Keyboard Encoder ROM $7.95

DIGITAL WATCH READOUT

FOR USE WITH WATCHES, DVMS, COUNTERS, ETC. $1.95



MOS LSI DEVICES

CLOCK 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

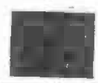
MM5725	6 Digit, Four Function, Less Decimal	$2.95
MM5738	8 Digit, 5 Function, +, −, ×, ÷, %	2.95
MM5739	8 Digit, 4 Function, Floating Decimal	2.95
CT5001	12 digit 4 Function	3.95
CT5005	12 digit 4 Function with Memory	5.95
CT5030	12 digit 4 Function and %	7.95

MISC. MOS

MK50C7	Complete 4 Digit Counter	$10.95
LD110/LD111	3½ Digital Voltmeter Chip Set	$25.00
MC1408L7	7 Bit Digital To Analog Conv.	9.95
MM5320	TV Camera Sync Generator	19.95
MM5841	Video Generator For MM5318	18.00

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. $2.95



1¼" x 1½" XFMERS P.C. Mount

That were designed for clock type applications. 110 Vac primary @ 60 Hz.
Secondaries: 8-10 Vac @ 30 mA-50 mA
50 Vac @ 30 mA-50 mA
Excellent for miniature power supplies & gas discharge displays

SPECIAL $.79

1/16 VECTOR BOARD

0.1" Hole Spacing P-Pattern

	Part No.	Length	Width	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 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 Vectorboard®. Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire.

Special $7.95

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

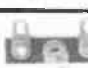
W36-3-A-Pkg. 3	250 ft. 36 AWG GREEN	$2.40
W36-3-B-Pkg. 3	250 ft. 36 AWG RED	$2.40
W36-3-C-Pkg. 3	250 ft. 36 AWG CLEAR	$2.40
W36-3-D-Pkg. 3	250 ft. 36 AWG BLUE	$2.40

9V BATTERY CLIP

STANDARD CLIP FOR USE WITH 9V TRANSISTOR BATTERIES WITH 4" LEADS

9/.99

TERMINAL STRIPS

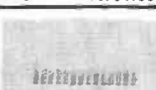


THREE TERMINAL STRIPS, WITH CENTER TERMINAL USED FOR MOUNTING 15/$1.00

MOLEX PINS

PINS USED AS INEXPENSIVE SUBSTITUTE FOR SOCKETS

SPECIAL 100/1.49
SPECIAL 1000/12.00



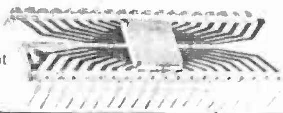
MICROPROCESSOR COMPONENTS

CENTRAL PROCESSOR UNITS

Each processor feature a 2μs instruction cycle, and are brand new from the manufacturer. The 8080 is a 2nd generation processor and the 8080A is a 2½ generation microprocessor.

8080 $24.95 — Direct Replacement For Intel C8080

8080A $39.95 — Direct Replacement For Intel C8080A



CPU'S			RAM'S			
8008	8 Bit CPU	$19.95	1101	256X1	STATIC	$2.25
8080	Super 8008	$24.95	1103	1024X1	DYNAMIC	2.95
8080A	Super 8008	$35.95	2101	256X1	STATIC	6.95
			2102	1024X1	STATIC	2.45
SR'S			2107	4096X1	DYNAMIC	19.95
2504	1024 DYNAMIC	$9.00	2111	256X4	STATIC	7.95
2518	HEX 32 BIT	7.00	7010	1024X1	MNOS	29.95
2519	HEX 40 BIT	4.00	7489	16X4	STATIC	2.45
2524	512 DYNAMIC	2.95	8101	256X4	STATIC	7.95
2525	1024 DYNAMIC	5.00	8111	256X4	STATIC	7.95
2527	DUAL 256 BIT	3.95	8599	16X4	STATIC	3.45
2529	DUAL 512 BIT	4.00	91L02	1024X1	STATIC	2.75
2532	QUAD 80 BIT	3.95	74200	256X1	STATIC	6.95
2533	1024 STATIC	7.95	93410	256X1	STATIC	1.75
3341	FIFO	6.95	5262	2048X1	DYNAMIC	2.95
74LS670	16X4 REG.	3.95				
UART'S			PROMS			
AY-5-1013	20K BAUD	$5.95	1702A	2048	FAMOS	15.95
ROM'S			5203	2048	FAMOS	14.95
2513	CHAR GEN	10.00	82S23	32X8	OPEN C	5.00
7488	RANDOM BITS	3.50	82S123	32X8	TRISTATE	5.00

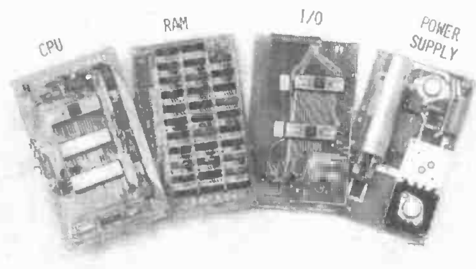
2K RAM SPECIAL

MM5262 Fully decoded 2Kx1 dynamic RAM. All inputs except clocks are TTL compatible. Provides a 635 n s 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)

BUILD YOUR OWN JOLT MICROCOMPUTER IN JUST 3 HOURS OR LESS FOR $159.95.

A COMPLETE MICROCOMPUTER IN A SINGLE CPU KIT INCLUDES: • An MOS Technology MCS6502 NMOS microprocessor • 512 bytes of program RAM, and 64 bytes of interrupt vector RAM • 1K bytes of mask programmed ROM containing DEMON, a powerful debug monitor • 26 programmable I/O lines • Internal RC clock, or crystal controlled clock with user supplied crystal • Serial I/O ports for use with a teleprinter current loop drive/receiver, or an EIA standard driver/receiver • Expandable address and data buses • Hardware interrupt • Control panel interface lines available on card connector • Complete assembly manuals and sample programs



JOLT ACCESSORY KITS

JOLT RAM Card — Fully static 4,096 bytes of RAM with 1 microsecond access time and on-board decoding. $199.95

JOLT I/O Card (Peripheral Interface Adapter) — 2 PIA LSI chips, 32 I/O lines, four interrupt lines, on-board decoding and standard TTL drive. Fully programmable. $95.50

JOLT Power Supply — Operates at +5, +12 and −10 voltages. Supports JOLT CPU, 4K bytes of RAM and JOLT I/O card — or, CPU and 8 I/O cards. $99.95

JOLT +5V Booster Option — Fits onto JOLT Power Supply card. Supports CPU, 8K bytes RAM and 8 I/O CPU and cards. $24.95

JOLT Universal Card — Same size (4¼" x 7"), same form factor as other JOLT cards. Completely blank, drilled to accept 14, 16, 24 or 40 pin sockets. $24.95

JOLT Accessory Bag — Contains enough hardware to connect one JOLT card to another, flat cable connectors, card spacers, hardware etc. $39.95

JOLT Resident Assembler — Fully symbolic single pass resident assembler, all mnemonics compatible with timesharing assemblers. Delivered on four 1702A PROMs, ready for plugging into JOLT PROM card. $149.95

JOLT 1702A PROM Card — Sockets for 2,048 bytes of PROM memory. Place anywhere in memory with jumper selectable addresses. $99.95

30 AWG WIRE WRAP WIRE

AWG	COLOR	25 FT. MIN.	50 FT.	100 FT.	1000 FT.
30 AWG	WHITE	$2.10	$2.75	$3.50	$24.00
30 AWG	YELLOW	2.10	2.75	3.50	24.00
30 AWG	RED	2.10	2.75	3.50	24.00
30 AWG	GREEN	2.10	2.75	3.50	24.00
30 AWG	BLUE	2.10	2.75	3.50	24.00
30 AWG	BLACK	2.10	2.75	3.50	24.00

26 AWG RIBBON CABLE

CONDUCTORS	1-9 ft	10-24 ft	25-99 ft	100 ft
10	.39	.29	.25	.23
20	.59	.49	.45	.43
26	.69	.59	.55	.52

6' 2 CONDUCTOR POWER CORDS 125V @ 5A

3/1$

THREE CONDUCTOR POWER SUPPLY CORDS

NUMBER	LENGTH	AWG	O.D.	RATING	COLOR	PRICE
17236	6	18(41X34)	.265	1250W 10A-125V	BLACK Special	79 ea.
17237	6	18(41X35)	.253	1250W 10A-125V	GREY	1.25
17238	8	18(41X34)	.265	1250W 10A-125V	BLACK Special	99 ea
17239	8	18(41X34)	.253	1250W 10A-125V	GREY	1.30
17000	4	18(41X34)	.253	1250W 10A-125V	BLACK	.59

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

P.O. BOX 822, BELMONT, CA. 94002
PHONE ORDERS — (415) 592-8097

JE SERIES KITS

JE700 CLOCK

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.

12 or 24 Hour

115 VAC—

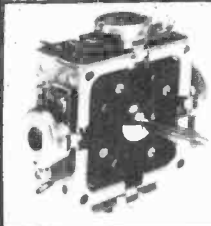
$17.95

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 (HI) 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

JOYSTICK

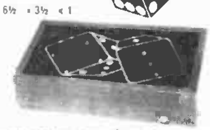


These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and Instrumentation.

$9.95 ea

ELECTRONIC CRAPS

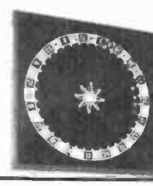
6½" x 3½" x 1"



Electronic craps is an entirely electronic game featuring a dice "roll down". 14 LED's form two dice that roll when activated by a push botton. Dimensions are 6½" x 3½" x 1½".

$19.95

ELECTRONIC ROULETTE



This kit comes complete with all components, including the case and line cord. Electronic Roulette, is entirely electronic, and features 32 LED's that form a wheel, that is activated by a push botton switch. Dimensions are 6½" x 6½" x 1½".

$29.95

Semiconductor Specials

1N2222 - NPN Si, High Frequency switching transistor. (typically 250 MHz). 0.5W, hFe = 100, Vceo 30V. 7/$1.00

MJ3055 - Same as TO3 CAN 2N3055 except that base and emmitter leads have solder lugs $.59

1N4308 - Excellent signal diode for uses in digital switching circuits 80 PRV @ 200 mA 20/$1.00

MCT2E - NPN Opto isolator which provides 2500 VDC isolation. $2.95

2N4123 - NPN Si, high frequency switching transistor. With an HFE = 120, it is ideally suited for most digital applications 8/$1.00

XL4403 - Red .2" LED with 2 piece plastic mounting 3/$1.00

74S287 - Outstanding 256 x 4 TTL PROM. Tristate outputs provide easy bussing. Access time of 40 ns $7.95

CA3081 - Common Emitter H.V. 7 transistors in a 16 PIN package. Ideal for segment drivers. $1.75

CA3082 - Common Collector H.V. NPN transistor array, packaged 7 transistors to each D.I.P. Excellent in uses with incandescent displays $2.00.

Continental Specialties

$15.95

PROTO BOARD 6

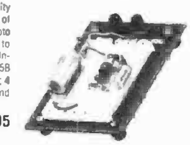
The PB-6 lets the user test and build circuits without soldering or patch cords: all interconnections between components are made with common #22 AWG hook-up wire. This quality breadboarding kit inludes 630 component tie points at less than 2.5c each. It measures 6" long by 4" wide. Designed specially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

FEATURE

PROTO BOARD 100

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 insturctions.

SPECIAL $17.95



APRIL SPECIALS

POCKET CALCULATOR
5 function plus constant — addressable memory with individual recall — 8 digit display plus overflow — battery saver — uses standard or rechargeable batteries — all necessary parts in ready to assemble form — instructions included.

Calc. Kit. Kit only	$10.95
Batteries (alkaline, disp.)	2.00
Adapter 60Hz	3.95
Kit, Batteries & Adapter	15.95

MARKED — NO FACTORY LOGO GUARANTEED FUNCTIONAL

7400	$.10	7420	$.11	7460	$.11
7402	.10	7437	.20	7474	.25
7403	.11	7440	.11	7493	.39
7404	.12	7445	.49	7496	.49
7406	.20	7450	.11	74195	.59
7408	.12	7453	.11		
7410	.11	7454	.11		

ALARM CLOCK CHIP
MM5375AA 4-6 digit, 12' hour, 60Hz snooze alarm, brightness control capability, alarm tone output 24 pin DIP **$4.95**

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All necessary transistors, resistors & capacitors
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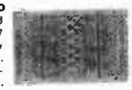

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74LS42	1.40
74LS74	.59
74LS90	1.30
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100 - 1000		.10	$.09
1000 -		.10	.08

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30.9	105	205	2.49K	18.2K	54.9K
34.8	110	232	3.57K	19.1K	60.4K
40.2	115	243	4.75K	19.6K	64.9K
45.3	137	499	5.49K	22.6K	69.8K
51.1	147	604	6.04K	24.9K	84.5K
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1 mfd	35V	.25 ea.	10 mfd	25V	40 ea.
2.2 mfd	20V	.25 ea.	15 mfd	10V	40 ea.
2.2 mfd	35V	.30 ea.	33 mfd	10V	40 ea.
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		7492	.71
7400	$ .14	7493	.60
7401	.16	7494	.94
7402	.15	7495	.79
7403	.16	7496	.79
7404	.19	74100	1.30
7405	.19	74105	.44
7406	.35	74107	.40
7407	.35	74121	.42
7408	.18	74122	.45
7409	.19	74123	.85
7410	.16	74125	.54
7411	.25	74126	.63
7413	.55	74141	1.04
7416	.35	74145	1.04
7417	.35	74150	.97
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7437	.35	74161	1.25
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7440	.17	74163	1.39
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7446	.93	74174	1.62
7447	.89	74175	1.39
7448	1.04	74176	.89
7450	.17	74177	.84
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7464	.35	74185	2.29
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7473	.35	74192	1.25
7474	.35	74193	1.19
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307	Op AMP (super 741)	mDIP	.26
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309K	5V 1A regulator	TO-3	1.35
310	V Follower Op Amp	mDIP	1.07
311	Hi perf V Comp	mDIP	.95
319	Hi Speed Dual Comp	DIP	1.13
320T	Neg Reg 5, 12, 15, TO-3		$1.39
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710	Hi Speed Volt Comp	DIP	.35
723	V Reg	DIP	.62
739	Dual Hi Perf Op Amp	DIP	1.07
741	Comp Op Amp	mDIP	.32
747	Dual 741 Op Amp	DIP	.71
748	Freq Adj 741	mDIP	.35
1304	FM Mulpx Stereo Demod	DIP	1.07
1307	FM Mulpx Stereo Demod	DIP	.74
1458	Dual Comp Op Amp	mDIP	.62
1800	Stereo multiplexer	DIP	2.48
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MV5020	Jumbo Vis. Red (Red Dome)	.22
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ME4	Infra red diff. dome	.54
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4001A	.25	4020A	1.49	4068A	.44
4002A	.25	4021A	1.39	4069A	.44
4006A	1.35	4022A	1.10	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.79	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
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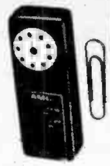

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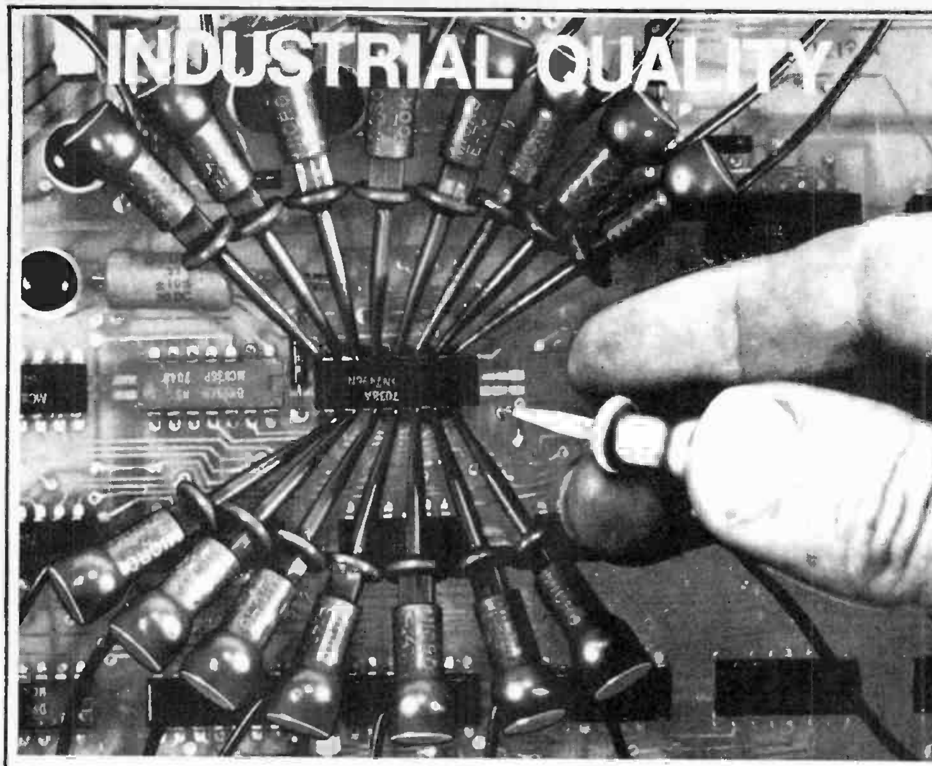

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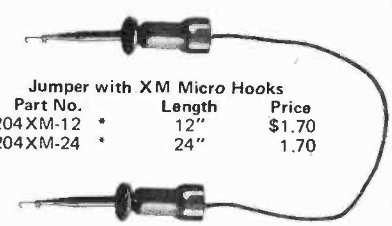

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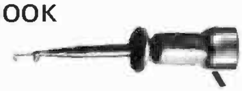

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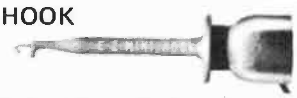

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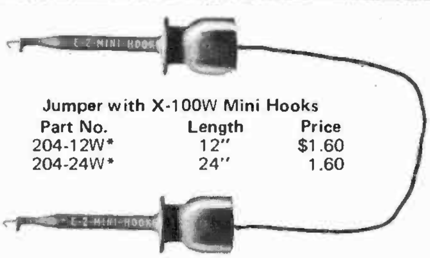

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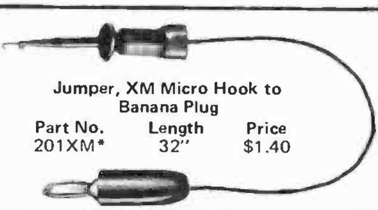

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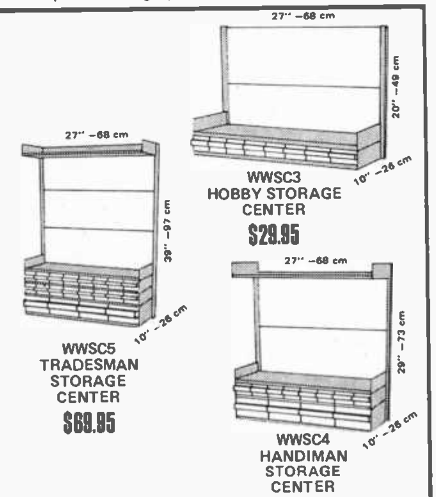

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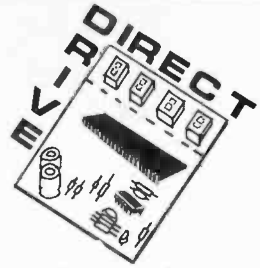

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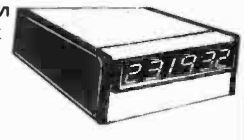

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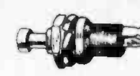

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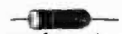

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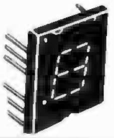

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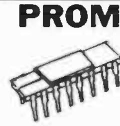

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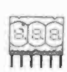

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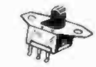

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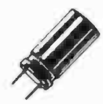

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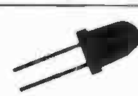

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74LS157	1.14	7490	.49	4001	.25	556A	.69
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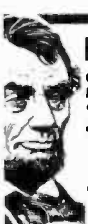

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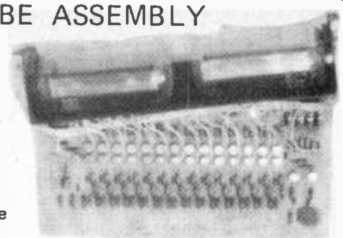

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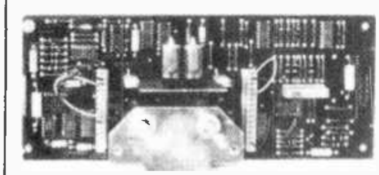

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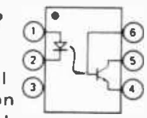

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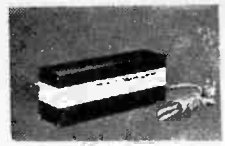

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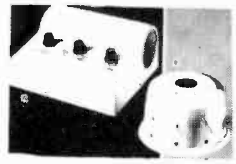

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(A)-No. 71,997AV . . . (7½ × 7 × 3½") 110V AC .... $89.95 Ppd.
(B)-AS ABOVE, BUT "WHITE SOUND" ONLY
No. 71,980AV . . . (6" Rd. × 3½" Hi) .... $28.00 Ppd.

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Stock No. 72,095AV .... $15.95 Ppd.
ULTRA SELECT-A-TENNA
No. 72,147AV (*OVER 1000 MI.) .... $22.95 Ppd.

AN ALPHA MONITOR FOR $34.95?

Yes, because *you* build it! Use your ability to tune in your brainwaves, an aid to relaxation, concentration. Kit incls. everything you need (except 9v trans. batt.) to own a portable self-cont. BIOFEEDBACK unit for a pittance: steth. earphones, electrode headband, solid-state circuitry; 5 microvolt sensitivity, more! Compl. assembly instructions & op. manual. With basic electronics knowledge, you can do it!

No. 61,069AV . . . (KIT) .... $34.95 Ppd.
No. 71,809AV . . . (FULLY ASSEMBLED) .... $55.00 Ppd.

KNOW YOUR ALPHA FROM THETA!

For greater relaxation, concentration, monitor your Alpha/Theta brainwaves w/ audible or visible signal on Biosone II. Has 3 feedback modes, outputs to monitor logic signal, filter sel. feedback, broad sensitivity control; other professional feats. of $200-up units. Easily operated 4-lb. portable has total brainwave monitoring capability! Req. 2 9v tr. batteries.

No. 1668 (9½×5⅝×4¼") .... $149.95 Ppd.
LOW COST STARTERS' UNIT (PORTABLE)
No. 71,809 AV (4½×2¾×4¼") .... $55.00 Ppd.

LOW COST 7X INFRA-RED VIEWER

For infra-red crime detection surveillance, security system alignment, I.R. detection, laser checking, nite wildlife study, any work req. I.R. detection & conv. to visible spectrum. Self cont. scope w/everything incl I.R. light source. 6v or 12v power, 6032 I.R. converter tube, f/4.5 objective lens, adjust. triplet eyepiece. Focuses from 10' to infinity.

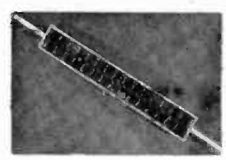
No. 1659AV (11×14¼×3") .... $285.00 Ppd.
WITHOUT LIGHT SOURCE
No. 1663AV .... $225.00 Ppd.

SEE MUSIC IN PULSATING COLOR

New 3-Channel Color Organ adds to music listening pleasure, lets you modulate 3 independent strings of colored lamps with intensity of your music to create an audio "light show." They flash, vary in brightness related to music's rhythm, pitch, volume—pulsating lighting performance to music! Fully assembled & priced half that of others, the Edmund Sound To Light Control is a terrific value. Plug in, turn on!

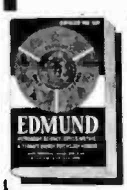
No. 42,309AV . . . (ASSEMBLED) .... $17.95 Ppd.
No. 42,336AV . . . (UNASSEMBLED) .... $13.95 Ppd.

SOLAR CELL CONCENTRATOR PANEL



World's first! *Takes up to 10 suns* . . . without burning out (normal ones can't use over 3)! Specially designed panel (four 2×2cm super cells) delivers .125 amps @ 1.5V w/1 sun; over 1 amp @ 1.5V w/ten! Requires concentration system (build Crab Eye or mount on std. telescope drive.) Water-cooled, so it's also a hot water generator. Detailed instructions incl.

No. 61,103AV . . . (6×2×¾") .... $175.00 Ppd.
LARGE CONCENTRATION PANEL (19×2×¾")
No. 72, 195AV . . . (30 CELLS; 15w) .... $575.00 Ppd.



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