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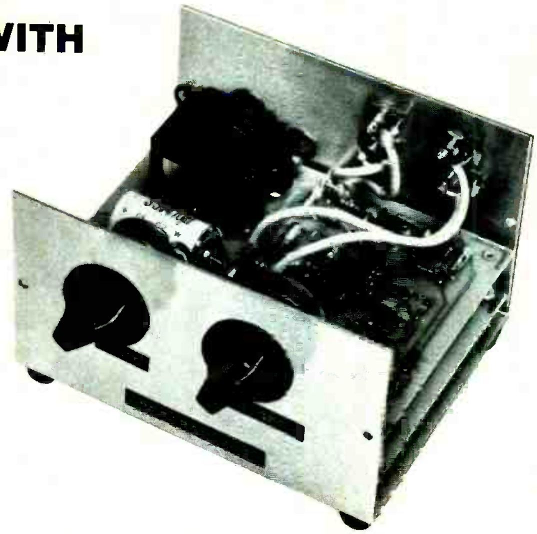

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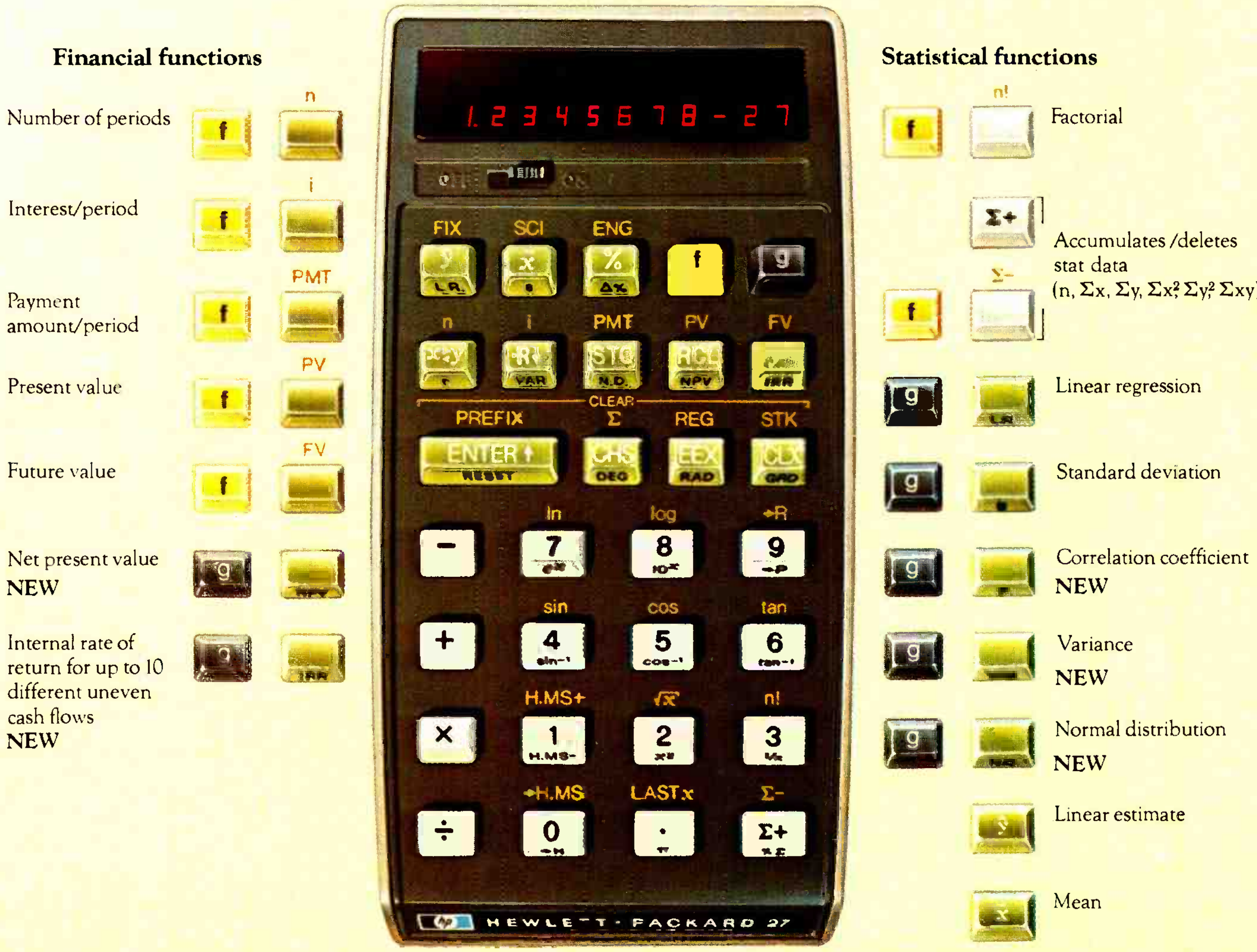

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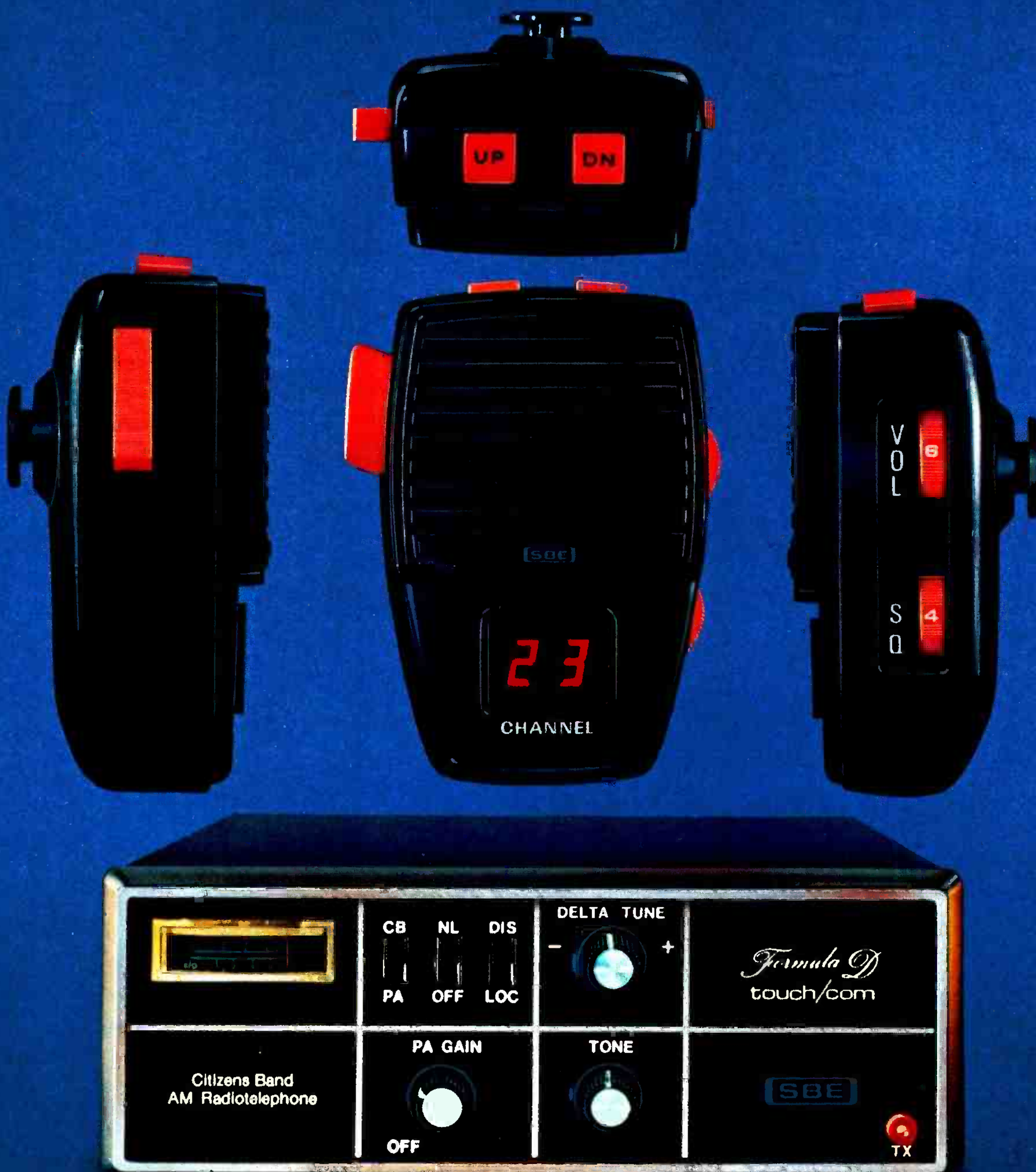

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Editorial

THE SECOND GOLDEN OPPORTUNITY FOR CB

When a market reaches the billion-dollar annual sales level, it is truly an important industry. That's where CB radio is today. Whereas unit sales in 1975 were about 4.2 million, projected unit sales for 1976 are for more than 9 million!

This huge growth has brought with it a host of problems—short supply of equipment, minimal discounting, high theft rate, and gross violations of the FCC Rules and Regulations. Solutions can be seen for all but the latter. How can CB'ers be compelled to follow the legal pattern set for them by the FCC? Even the welcome relaxed rules instituted September 15, 1975?

Without a substantial enforcement staff, which we aren't about to get, the FCC is depending heavily on self-policing by CB'ers. This is easier said than done. On sideband, it is successful for the most part. On AM, however, where most CB'ers operate, the rules are blithely ignored in many sections of the country. Some day, this practice is liable to stunt the continuing growth of the Citizens Band—unless something positive is done about it *now*.

IF CB had followed the original assumption that most users would be small-business people and "consumers" in the same household, this problem could have been handled. But now, with most communications taking place between stations with different licenses for purposes of both neighborliness and emergency motorist assistance, and with the vast number of CB'ers on the air, the situation is out of hand.

Here are some constructive steps that could be taken, with the assistance of far-sighted manufacturers, the FCC and CB'ers:

1. Establish point-of-purchase temporary licenses, making it mandatory to buy a license when the rig is purchased. (The FCC is finalizing thinking on this procedure right now.)
2. Include information with each CB rig on the obligations that go with the communication privilege and how they benefit users in the long run. Taking a page from the Boy Scouts' Merit Badge on Citizenship, an analogy could be drawn by pointing out the value of a library card and how everyone is eventually hurt when books are defaced or returned late.
3. Illustrate how local CB'ers perform self-policing for the good of all concerned. For example, in some areas, there are clubs to which a prospective member must supply name, handle, and license number before being admitted. He is then assigned a club number which is used as part of his handle (following his callsign). No member will talk to a CB'er unless he or she is a member of the club and follows the FCC rules. Other clubs reserve one night a week for a "signal hunt"—tracking down violators, getting their names or auto license numbers, and warning them that they will be reported to the FCC if another violation is heard.
4. Consider the possibility of equipping transceivers with an automatic transmitter identification system that transmits in code the CB'ers callsign everytime he presses the "talk" button. This would put the fear of God into CB'ers and also serve as a theft deterrant. This would have to be predicated on minimal cost to the manufacturer and user, or course.

At this juncture, with CB nowhere near a levelling off point and the promise of more allocated channels in 1977, there is a second golden opportunity to ensure future growth of CB.

Some manner of efficient regulation enforcement is necessary because most CB'ers are not restrained by the tradition that radio amateurs enjoy. Interestingly, if you speak to CB'ers who have lived with the *lack* of regulation enforcement, you will discover that the great majority would now welcome it. In the long run, it would be to the advantage of manufacturers as well as the citizenry.

Art Salsberg

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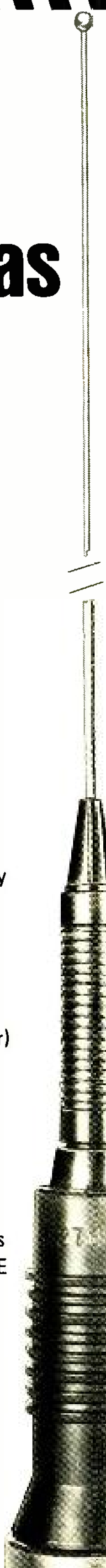

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Letters

COMMENTS ON CUTS

I am pleased to see computer-controlled tape motion for audio cassettes, to generate blocks, in the CUTS ("Computer Bits," March 1976). I had been thinking about the same thing because blocks can be very handy when they're written and read under computer control. However, it wasn't clear what would be read in the 5-second gap between blocks. I assume it is neither the 2400- nor the 1200-Hz tones. Assuming the tape has a leader, a block could then be positively identified by blank tape followed by 5 seconds of continuous 1's. (Remember that the user may rewind the tape into a previous block to find the next block and then let the computer search for a start-of-block.) If the characters are recorded asynchronously (for example, with a keyboard), a 5-second pause between characters would seem to be a start-of-block.—*Philip J. Tubb, Lakewood, CO.*

There are no blank spaces on the tape; both leader and "gaps" are filled with the 2400-Hz tone onto which the clock can lock.

BACKWARD CHART PEN

Come now, the graph in Fig. 1 of the March 1976 "Stereo Scene" is a month early for an "April fool" joke. The output of a spectral analyzer cannot loop backward as shown at about 100 Hz. If literally interpreted, this would mean that the sound source has two values at a range of frequencies—a physical impossibility. Whatever peaks and valleys appear in a spectrum, the curve is always smooth, with no negative slope.—*James J. Schmidt, Sunnyvale, CA.*

Quite right. A slip of a draftsman's pen was responsible for the error.

CREDIT WHERE DUE

With reference to the Tate Directional Enhancement System described in "New Trends In Hi-Fi Electronics" (December 1975), I would like to point out that I am the inventor of the system and the engineer who designed and developed the IC's in cooperation with National Semiconductor Corp. Wes Ruggles, who was erroneously credited with this, has been responsible for the management of the project and the marketing effort.—*Martin Willcocks, Huntington, England.*

"CARE & FEEDING" BOOSTERS

We found "The Care and Feeding of NiCd Batteries" (March 1976) to be very pertinent and of great interest to us. Many users feel that NiCd batteries should last forever, and we find it difficult to dissuade users of our products from this belief. Alex Burr's article is a simple-to-digest, detailed answer to our problem.—*Axel M. Fritz, Jr., President, Bison Instruments, Minneapolis, MN.*

. . . an excellent article on NiCd's. The article was clear and very informative and didn't shy away from the more sophisticated details.—*Hugh MacDonald, Menlo Park, CA.*

APRIL (FOOL) HOBBY SCENE

Particularly intriguing was the problem of working with MOS circuitry. The geomagnetic aspect is indeed a stickler! However, after spending considerable time wrestling with this dilemma, I believe I have come up with a solution. If the device is housed in a spherical silicate material (available at your local quarry) and if it can be kept in motion (via pushing, kicking, etc.), the result will be a device which cannot accumulate any MOS difficulties. (P.S. The column was outstanding!)—*Ron Simprini, Philadelphia, PA.*

Congratulations. It took me a while (well into "Golden Oldies") to realize what was going on. But then I nearly died laughing. I haven't seen anything this funny since "Blazing Saddles."—*Frank Grether, San Francisco, CA.*

These are excerpts from only a few of the many letters Ms. Swampfelder received. By the time this is in print, April Fool's Day will have come and gone, and we hope everyone will have gone back to read the April Hobby Scene and appreciate it for the fun with which it was intended.

Out of Tune

In "An LED-Readout Audio Power Meter" (March, p 35), note an error in Table II, "Ideal Threshold Voltages" for the comparators. The right column, "Voltage," is inverted. The last entry, 4.395, refers to Pin 7 of IC1; the next to last, 3.070, refers to pin 5 of IC1; and so on. The top entry, 0.011, is the threshold for pin 11 of IC3.—*Tim Henry*

See also "Out of Tune," May 1976.

In "Space War Game" (April, p 42), the parts list omitted the type numbers for *IC7* and *IC8* (4023) and *IC9* and *IC10* (4001).—*J.A. Weisbecker.*

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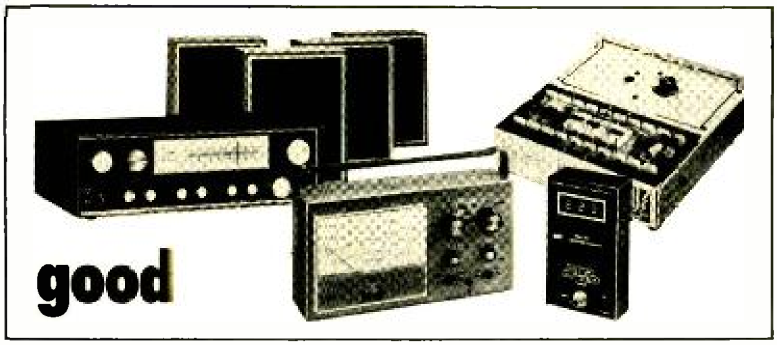

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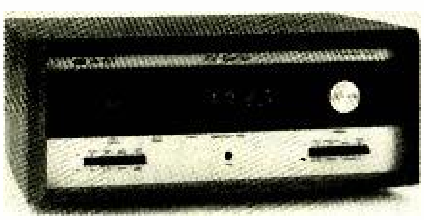
New Products

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

SAE DIGITAL FM TUNER

The SAE Mark VIII digital (stereo) FM tuner utilizes monolithic linear-phase filters and a phase-locked-loop multiplex section for alignment. The display consists of four seven-segment LED numeric indicators for



frequency readout, plus two meter movements for tuning. The tuning system is said to have a dial accuracy of 0.004%. Other ratings include: 1.6 μV IHF sensitivity, 100 dB spurious response rejection, 120 dB alternate-channel selectivity, 100 dB AM rejection, and 4 μV stereo switching threshold. There are eight push-push switches on the front panel, including one for selecting 25 or 75 μs deemphasis. 17"W × 10½"D × 5¾"H (43.2 × 26.7 × 14.6 cm); 23 lb (10.5 kg).

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CB ROOF-MOUNT MOBILE ANTENNA

Antenna Incorporated's Model 12510 is a base-loaded, stainless-steel 34" (86.4 cm) whip designed for roof mounting. Features a stainless steel impact spring, sealed base housing, and a 17-foot (5.2-m) length of RG-58U coaxial cable terminated in a PL-259 plug. Low-angle radiation and a VSWR of 1.5:1 or less are claimed. $21.25

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CROWN SINGLE/DUAL-CHANNEL AMPLIFIER

The Model D 150A power amplifier from Crown International features a switch that allows the user to select either mono or stereo operation without having to make internal wiring changes. The 80-watt/channel (rms into 8-ohm loads) unit is said to have a frequency range of 1 to 20,000 Hz at less than 0.05% harmonic and IM distortion (worst cases). Circuitry within the amplifier is designed to protect the amplifier against shorted, mismatched, and open loads without dc fuses and mode switches. Output power in mono is rated at 180 watts rms into 16 ohms at 0.1% THD. The outputs are unbalanced in stereo and balanced in mono. Overall dimensions are: 17"W × 8¾"D × 5¼"H (43.2 × 22.2 × 13.3 cm) and weight is 25 lb (11.4 kg). $479.

CIRCLE NO. 86 ON FREE INFORMATION CARD

TELCO CB CONVERTER FOR CAR RADIOS

Telco's Model 10-73 Hi-Way Alert® converter can turn any AM car radio into a CB receiver. The converter, measuring 4 1/8"W × 3 3/8"D × 1½"H (10.5 × 8.6 × 3.8 cm), is mounted by using adhesive-backed Velcro® pads supplied. The crystal-controlled converter provides 23-channel CB coverage and is said to provide a 1.5-μV (For 10 dB S/N) sensitivity and better than 80 dB down AM feedthrough. Its power cord plugs into the car's cigar lighter receptacle, and the existing AM radio antenna is used. A switch on the front panel provides for CB or radio.

CIRCLE NO. 87 ON FREE INFORMATION CARD

SHURE LIGHTWEIGHT MICROPHONE

The Model SM62 by Shure Brothers is a undirectional dynamic mike with a cardioid pickup pattern. It's designed for hand-held stage and remote interview applications, and is said to be especially suited for picking up brass, drums, guitar and vocals. Frequency response is claimed to be flat and uncolored with minimum feedback. The microphone is 4²⁹⁄₃₂" (124 mm) long. Other features include a "pop" filter to suppress wind noise and breath sounds, and internal shock isolation to attenuate noise caused by unstable stands, stages, etc. $84.00

CIRCLE NO. 88 ON FREE INFORMATION CARD

TEABERRY MOBILE CB TRANSCEIVER

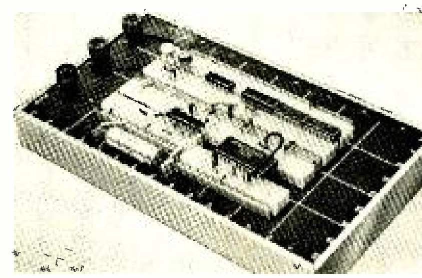
The Tele "T" AM CB transceiver, with 4 W r-f power output, features a telephone-type handset with a built-in transmit/receive bar. It is completely solid-state in design and has an S/r-f meter, delta tune, PA switch, hi/lo tone control switch, and au-

tomatic noise limiter switch. A loudspeaker is also built-in for use when it is not necessary to have private listening. Price is $199.99.

CIRCLE NO. 89 ON FREE INFORMATION CARD

VECTOR TWO-SIDED DIP BREADBOARD

Model 51X Klip-Blok breadboard from Vector Electronic, on an aluminum chassis, allows components to be mounted (solderless medium) and connections made from



both sides of the board. With a total of eight solderless Klip-Bloks, the breadboard accommodates 12 14- or 16-pin DIP's or four 24- or 40-pin DIP's on 0.1" pin centers and 0.3" and 0.6" row spacing. Additional Klip-Bloks can be mounted on the unoccupied perforated areas of the Vectorbord®. Numbers along the edges of the 8" × 4½" (20.3 × 11.4 cm) board identify component locations. The board in the Model 51X is unclad. The breadboard is also available with a ground-plane-clad board as the Model 51X-GP. Prices are $25.50 and $29.95 for the Models 51X and 51X-GP, respectively.

CIRCLE NO. 91 ON FREE INFORMATION CARD

EPICURE BOOKSHELF SPEAKER SYSTEM

The new Epicure 11 is a high-efficiency, two-way bookshelf system with a bass port. Drivers used are a 6-inch (15.2-cm) controlled-excursion woofer and a 1-inch (2.5 cm) cone tweeter with a claimed 180-degree dispersion. A tweeter level control is built-in. Frequency response is rated at 38 to 20,000 Hz ± 3 dB. Recommended driving power is 15 to 80 W rms. System impedance is 8 ohms, and system resonance is at 36 Hz. Measures 21½" × 13½" × 9½" (54 × 34.3 × 24.1 cm), and weighs 36 lb. (16.4 kg). $134.00

CIRCLE NO. 92 ON FREE INFORMATION CARD

E&L MICROCOMPUTER

The Mini-Micro Designer, introduced by E&L Instrument, is based on Intel's 8080 microprocessor chip. It has direct input via built-in keyboard and input/output buses through external card edge connections or the No. SK-10 interface/breadboarding socket that comes with the microcomputer. Internal status/data is shown by three sets of LED's. Included in the package is a memory card that accommodates 1024 bytes of read/write memory. Complete

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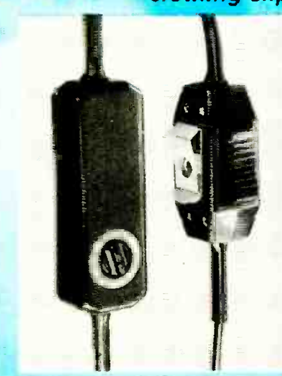
From out of the blue comes a significant improvement in CB from Telex, the aviation communications experts.

Push-to-talk switch with clothing clip



In-line variable gain power amplifier.

The first "wall to wall" lightweight.

Dramatically better transmission and reception.
New Telex aviation-type headset.
The first lightweight headset for CB'ers. The same style as worn by pilots around the world. So comfortable you may forget you are wearing it. Be heard better. Noise-cancelling power mike is always positioned properly. Ear piece lets you hear better. Your CB won't disturb others. And your hands are free. Try the new Telex CB-88. Made in U.S.A. You'll get the message loud and clear.

Telex CB-1200 Headset. Specially suited for high noise environments.

Telex CB-73 Double Header. Aviation-type. Power mike and noise cancelling.

The Pilot People

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COMMUNICATIONS, INC.

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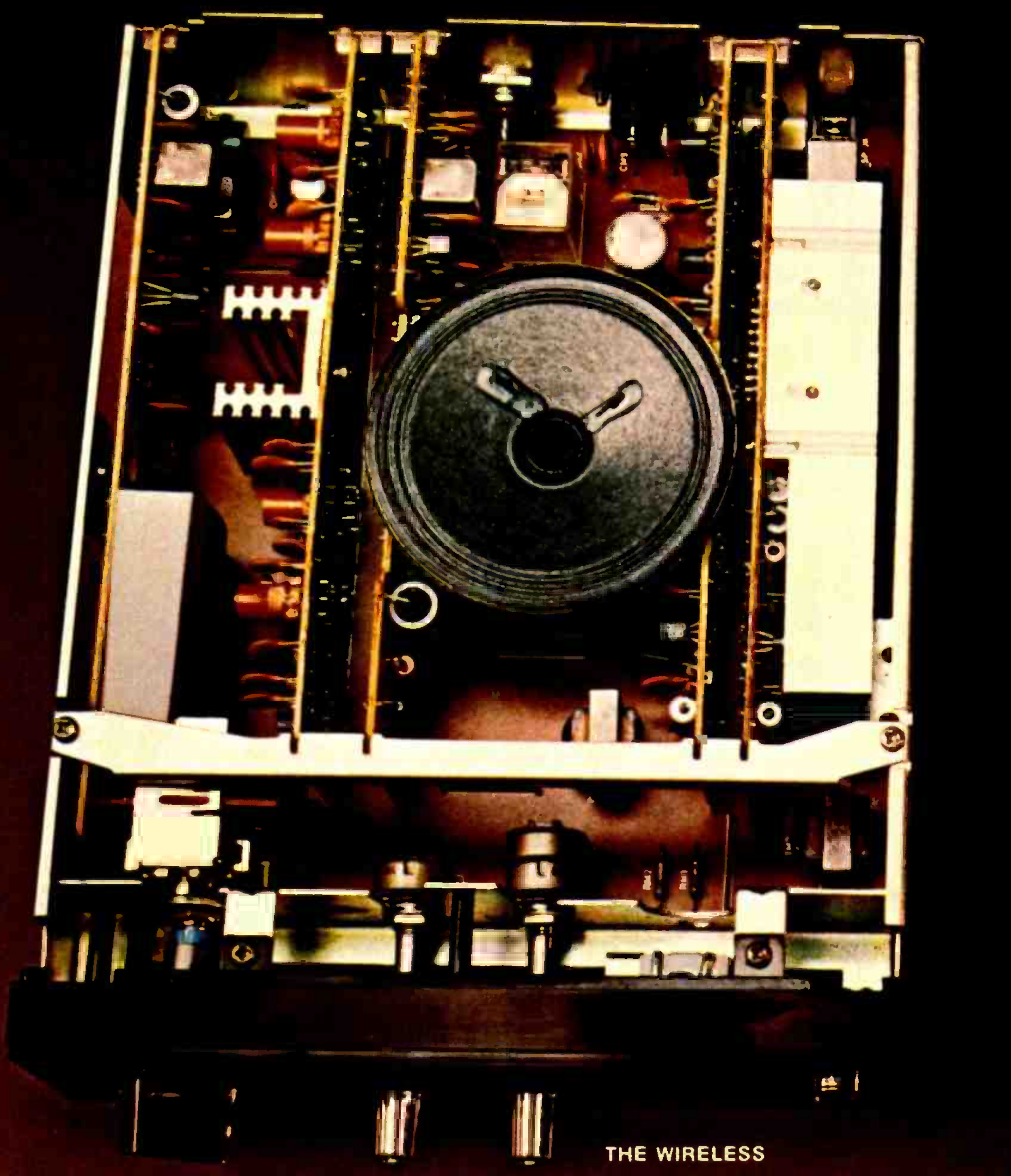
Royce re-invents



Biggest CB breakthrough since the transistor!

THE WIRELESS is here! Royce brings computer technology to CB!

THE OLD WAY. A tangled mass of wires and hand-soldered connections.

THE WIRELESS. Automated module assembly. Computer tuned and quality controlled.

That is why THE WIRELESS chassis promises less chance of failure.

Computer tuning and testing means peak power and performance.

And, automated module assembly assures uniform quality.

Here is greater CB reliability than ever before.

That is why THE WIRELESS by Royce is turning the personal communications world upside-down!

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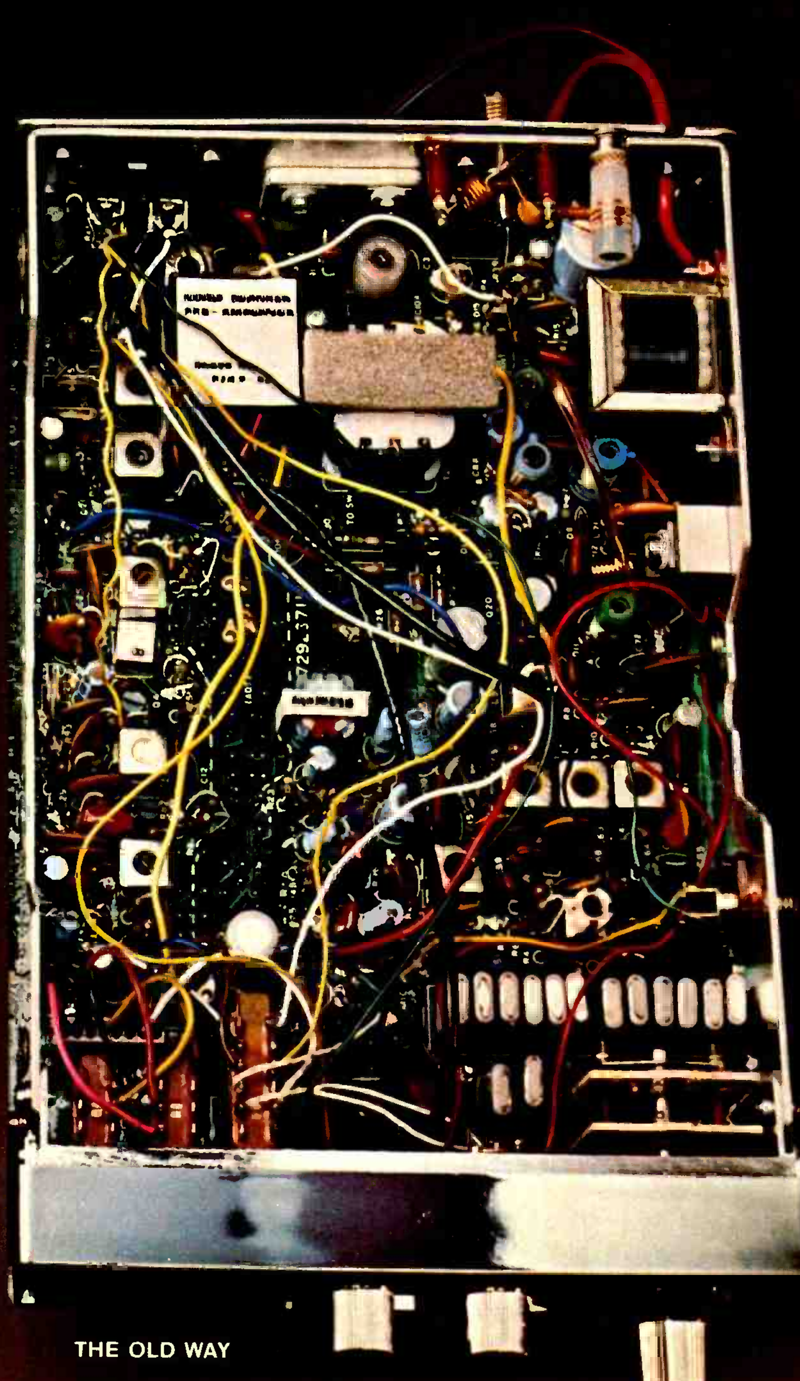
THE WIRELESS



THE OLD WAY

Write today for information on THE WIRELESS Models: 1-650; 1-653; 1-655; 1-658; 1-660, and 1-662. Plus details about the other reliables from Royce!

Follow the new leader!

Royce

Royce Electronics Corporation
1746 Levee Road
North Kansas City, Mo. 64116
Call: (816) 842-7505 • Telex: 426-145

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software takes the user from assembly to system usage. $125 for simplest kit to $500 for completely assembled, tested system.

CIRCLE NO. 93 ON FREE INFORMATION CARD

J.I.L. UNDER-DASH CASSETTE PLAYER

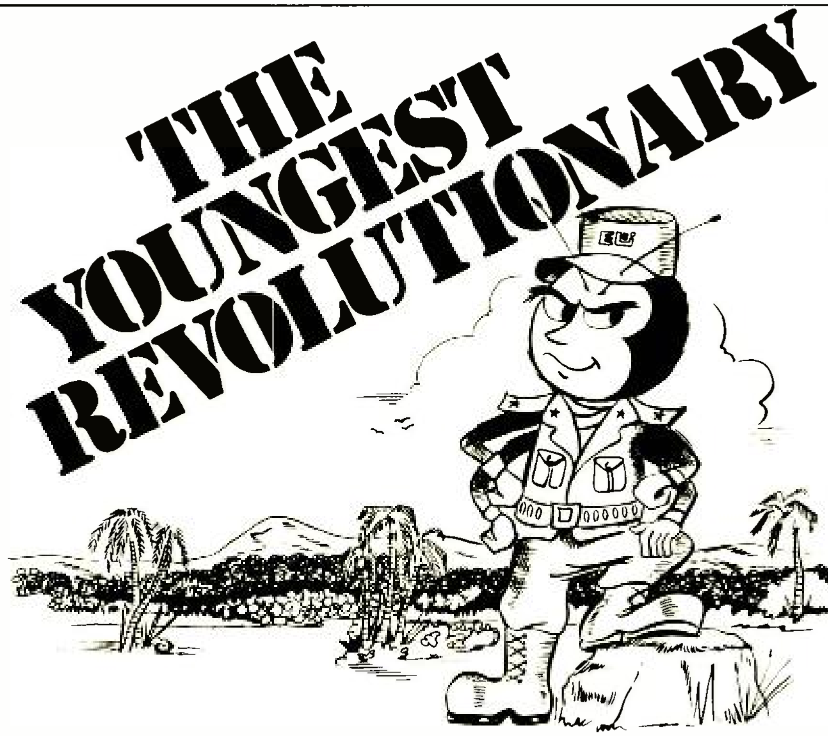
J.I.L. Corporation's Model 607 is a new miniature cassette player designed for under-the-dash installation in virtually all foreign and domestic cars. It can be tucked away in most glove compartments. To assure the most dependable sound performance, the player offers a full complement of features, including volume and tone controls, "play" indicator, left-to-right balance control, and fast-forward, rewind, and eject buttons.

CIRCLE NO. 94 ON FREE INFORMATION CARD

FIELD-STRENGTH METER

A compact, easy-to-operate field-strength meter for TV service technicians is available as the Model TVS from Castle Television Tuner Service, Inc. Called Mezzer™, the instrument measures signals from 300 to 30,000 μV; has dial marking for quick identification of signal level for proper color reception (1 to 4 millivolts); features integrated circuit amplifier and meter driver circuits; with electronic voltage regulation. Operates from 9-V transistor batteries, and has battery status indicator.

CIRCLE NO. 95 ON FREE INFORMATION CARD



From the deep jungles of jumbled software, from the rivers of mysterious circuits, he came. Mini-Micro Designer. He was tough and smart. And he glowed with purpose. To teach the people microcomputers.

Learn from the leader in the modern electronics revolution. E&L's Mini-Micro Designer (MMD-1) comes with a series of educational "modules" that teach you how to design and use a microcomputer. And you get complete documentation and full software support. MMD-1 features the 8080A central processor chip, direct keyboard entry of data/instructions, LED status indicators, and all the apparatus needed to make your first microcomputer. Novice or expert, MMD-1 gets you into action fast. Put a revolutionary on your side. Send for more information today.

Prices start at $125.00 in kit form.

CIRCUIT DESIGN, INC.
Division of E&L Instruments
P.O. Box 24
Shelton, Conn. 06484

SENCORE BENCH-TYPE DMM

The Sencore Model DVM34 digital multimeter features a basic 0.1% accuracy and a 15-megohm input impedance that minimizes circuit loading for increased accuracy and reliability. A range/function format supplies measuring capabilities from 100 μV to 2000 volts dc, 100 μV to 1000 volts ac, 10 milliohms (using the special 20-ohm range) to 20 megohms, and 100 nA to 2 amperes ac and dc. An optional high-voltage probe permits measurements up to 50 kV dc at 1% accuracy. A high-and-low-power-ohms system is built in for increased accuracy when measuring resistance in solid-state circuits. To take full advantage of the high-accuracy 3½-digit

display, the DMM employs a single-step autoranging circuit that automatically steps down to the next range on ac and dc volts whenever the reading is 108 or less. $295. ($25 for optional Model HP200 50 kV probe.)

CIRCLE NO. 96 ON FREE INFORMATION CARD

CB PREAMPLIFIER

According to Kris Inc., its "Antenna Fire" CB preamp will provide up to 20 dB receive gain and improve sensitivity when inserted in-line between the transceiver and antenna. The dual MOSFET preamp is pre-tuned. It offers two tuned circuits to improve image and spurious rejection figures. The preamp operates on 12-V mobile supply or 12-V ac adapter. It comes complete with connectors and mounting bracket and measures 5" × 4" × 3" (12.5 × 10 × 7.8 cm).

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CIRCLE NO. 12 ON FREE INFORMATION CARD

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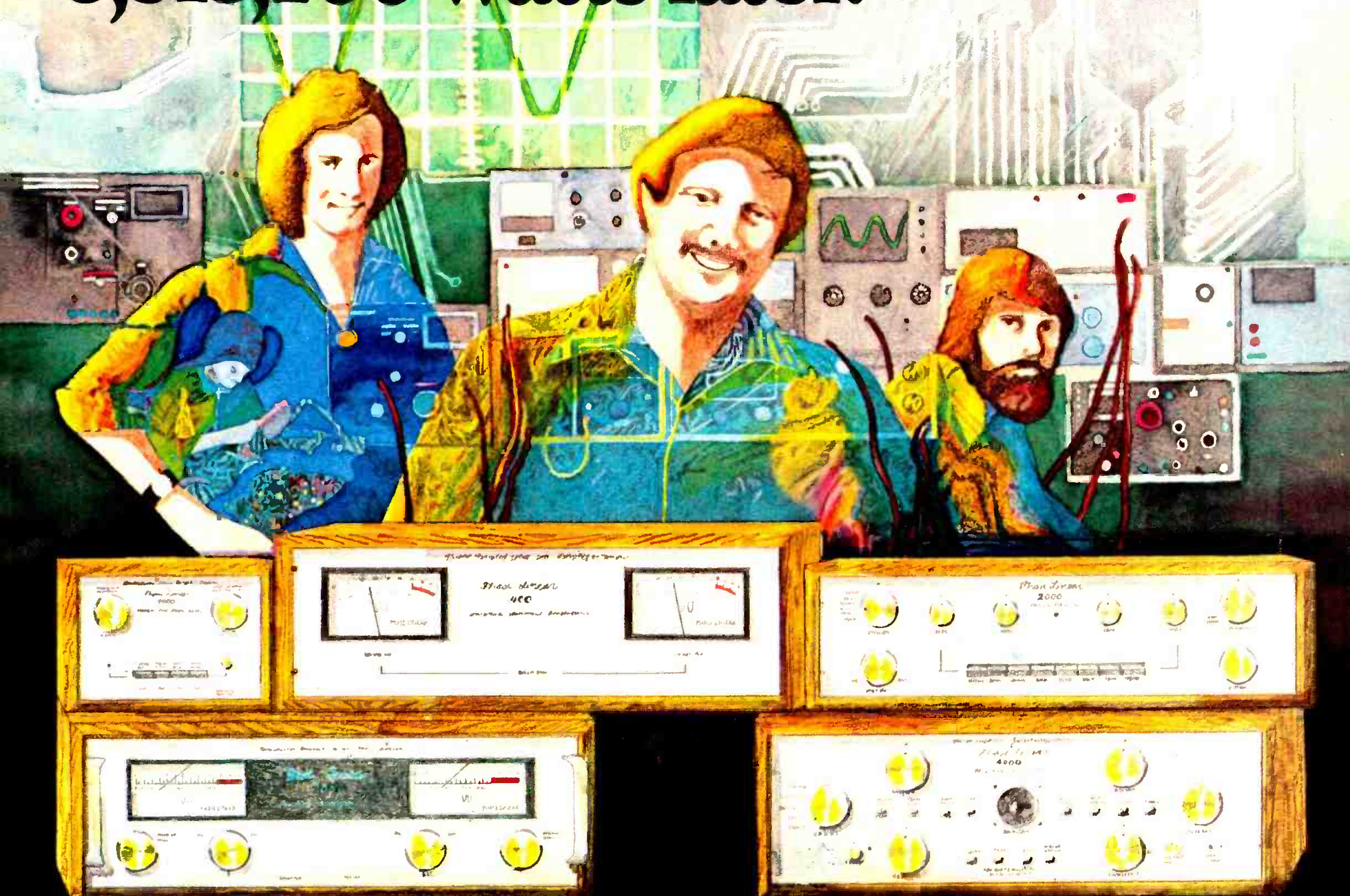
Phase Linear 8,515,200 watts later.



Back in '71 Phase Linear was Bob Carver, an audiophile with 200 square feet in the basement of an A & P store in the Pacific Northwest and one all-consuming obsession: to design and build the world's most powerful stereo amplifier.

Today Phase Linear Corporation is an acknowledged leader in high power technology, selling a complete line of amps and pre-amps throughout the world, operating out of one of the most advanced stereo component plants in the industry.

Phase Linear is now a household word among serious listeners, a word synonymous with power, quality, reliability and way-out-front technology.

And Bob Carver, Steve Johnson and A. P. VanMeter have come to be recognized as the gurus of state-of-the-art amplifier design and development.

Phase Linear has dispensed over 8½ million watts of power to music lovers everywhere, starting with the famous super reliable, virtually distortion free Phase Linear 700, the first successful 700 watt amplifier. The popular Phase Linear 400 watt amplifier quickly followed. The incredible Phase Linear 4000 pre-amplifier was then perfected followed by a smaller version, the Phase Linear 2000. Recently the Phase Linear 1000 Noise Reduction System was added to the line . . . and there are many more advanced products in the wings.

Technological milestones along the way have included a unique Amplifier Protection Circuit (Patent #3,727,148), the first practical Expansion System, the innovative Auto Correlator Noise Reduction System and a unique Ambience Injection System for pre-amps.

Phase Linear has come a long way from that basement lab of Bob Carver's. But products are still made one at a time, and one out of every three people in production is involved in quality control or testing.

And that's the way it'll be for the next 8,000,000 watts.

Phase Linear

A POWERFUL DIFFERENCE

Phase Linear Corporation,
20121 48th Avenue W.
Lynnwood, Washington 98036

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This is an echo chamber?

Yes, and much more! It is the first N-channel Bucket Brigade Device designed with the audio engineer in mind. The **SAD**-1024 **S**erial **A**nalog **D**elay will provide reverberation, echo, tremolo, vibrato and chorus effects in electronic organs and musical instruments. It will equalize speaker systems in an auditorium, or can be used in speech compression or voice scrambling systems. The SAD-1024, which contains two independent sections of 512 analog storage elements will accomplish all of these with a signal-to-noise ratio in excess of 75 dB. The two sections may be used independently or they may be connected in sequence to provide 1024 clock periods of delay. The delay provided by the device can be continuously varied by the clock rate from less than one millisecond to more than one second.

Other performance characteristics include: Signal bandwidth from 0 to 200 KHz, less than 1% total harmonic distortion, 0 dB insertion loss, and less than 5 mW power requirements from a single 15V power supply.

You get all of these features for less than 1¢ per storage element in OEM quantities.

We also offer a complete circuit card to help you evaluate this exciting new device. Other devices for applications such as time base correction in the video bandwidth are also available.

There are over 70 salesmen and 16 distributors to serve you worldwide.

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New Literature

GENERATOR AND SYNTHESIZER CATALOG

Dana Exact's new 8-page catalog describes 36 different models including function, phase, and pulse/sweep function generators. Frequency and complex waveform synthesizers are also covered. The catalog also contains a model capability cross-reference chart and prices. Address: Dana Exact Electronics, Inc., Box 160, Hillsboro, OR 97123.

LASER SAFETY GUIDE

A new laser safety guide has been published by the Laser Institute of America. The 31-page booklet covers laser, eye and skin hazards, associated hazards from high-power lasers, present laser safety standards, viewing laser radiation, eye protection, laser hazard classification, control of associated hazards, and laser calculations and measurements. Single copies are available to LIA members for $1, and to non-members for $2.50. Address: Laser Institute of America, 4100 Executive Park Dr., Cincinnati, OH 45241.

SOUND SYSTEMS BROCHURE

An 8-page, 3-color brochure describes the Argos Freedom Systems. Argos Sound's three portable sound systems are illustrated and described in terms of capacity, portability, and effectiveness. Address: Argos Sound, 600 South Sycamore St., Genoa, IL 60135.

ALL ABOUT CB

A new book from Radio Shack, *All About CB Two-Way Radio*, discusses what Citizens Band radio is and how to use it. Written in an easy-to-understand manner, the 116-page book is a guide to the equipment, rules and benefits of low-cost CB two-way radio. It also explains how to select and install a CB radio. Available at all Radio Shack outlets.

POWER TRANSISTOR DIRECTORY

An updated edition of the RCA Power Transistor Directory, PTD-187E, is now available from the RCA Solid State Division. This 44-page catalog lists the power transistors and power hybrid circuits currently available from RCA and provides selection charts and data on each of the devices. Also included are application information, a list of transistors which may be used as complementary pairs, and charts showing high-reliability and military-specification types. Address: RCA Solid State Division, Box 3200, Somerville, NJ 08876.

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Realistic® gives you more than Brands J and L...

and charges about $10 to $20 less*

Let's talk features! Delta tune. Dual conversion receiver. Noise blanker. S/RF meter. Brand J's comparable set gives you none of those things and Brand L's gives you just one. Another fact: Realistic has Auto-Modulation for full RF power always, whether you talk loud or soft. It's Radio Shack's new look in mobile CB — the 23-channel Realistic® TRC-56. With its telephone-type handset you get two big advantages: you can listen privately; you can talk and listen with greatly reduced background noise. And you can switch to the regular built-in speaker anytime, of course. FCC Type Accepted. Usable with plus or minus ground. Universal dash/floor/cab roof mount included. The money you may save will just about pay for your (Archer) antenna! **179.95***

TRC-56 SPECIFICATIONS

Sensitivity for 10 dB S+N/N: 0.5 microvolt
Selectivity at −6 dB: ±3 kilohertz
Adjacent Channel Rejection: 50 dB
Audio Power Output: 3 watts maximum
RF Power Output: 4 watts maximum
Size: 5" (maximum in front)x8¾x7"

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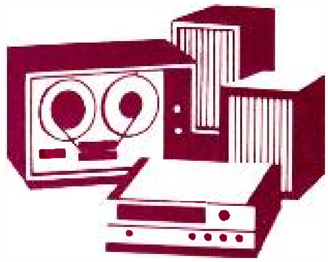


Stereo Scene

By Ralph Hodges

DATELINE 1976

JUNE is the "official" beginning of Model Year 1977 for the high-fidelity industry. But before we take on the future, let's have a final look at some of the recent developments of 1976, and some things that bode well to be of ongoing significance.

Nonlinear In, Linear Out. Except in the case of pure electronics, distortion-cancellation techniques haven't received a great deal of attention from audio designers in recent years. However, all of a sudden we have two new products that apply the principle in rather novel ways: the Nakamichi Model 600 cassette deck and the Phase Linear Andromeda III speaker system.

Nakamichi calls its version "IM suppression," and in theory at least its operation is pretty straightforward. It's based on the not-unreasonable assumption that it's possible to determine what types and amounts of distortion a recording medium (in this case tape) is going to exhibit when used under typical conditions (in other words, that you can predict with fair accuracy how the signal is going to be "bent" by the medium). Armed with this knowledge, it should then be possible to design a nonlinear circuit that will "bend" the signal by the same amount in the *opposite* direction. When put together, these two bends will have a combined effect that adds up to "straight." No doubt achieving this in practice is a little trickier than in this oversimplified theory, but the basis is sound.

According to the manufacturer, the IM suppression is aimed at compensating for nonlinearities introduced by tape saturation; and, in so doing, it reduces intermodulation and third-order harmonic distortion. Note that—again, in theory—you can apply the compensatory "bend" either before or after the signal is recorded. As it happens, Nakamichi chooses to do it after, during playback. The claim is cheerfully made that ultimate distortion can be kept to 3 per cent or less for recording levels up to +7 dB, so effective is the technique at extending the useful range of a tape under near-saturation conditions.

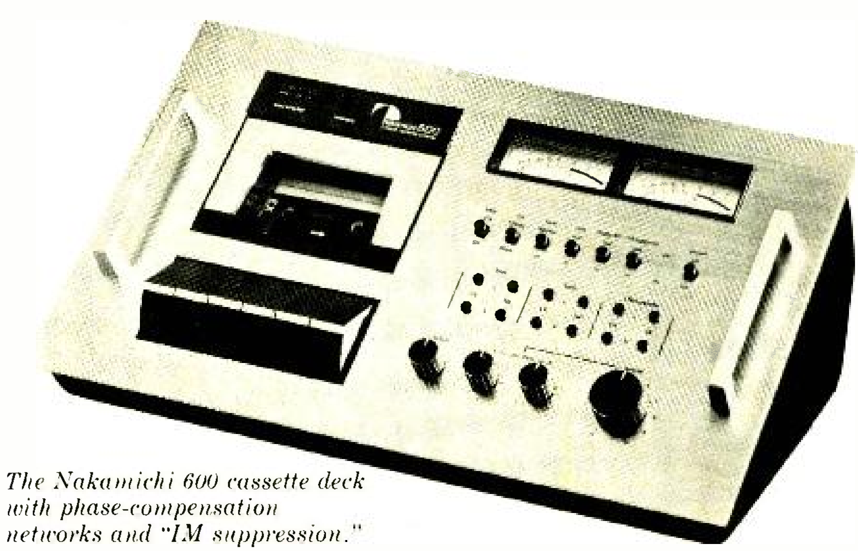
Two key points should be made about the IM suppression technique. First, for optimum results, the tape used should closely match the characteristics of the circuit. Nakamichi has set up the Model 600 for two of its branded cassette tapes, EX and SX, between which the machine is switchable. (Near-equivalents of these tapes are available in other brands also.)

Second, since the circuit operates in playback (and can be switched in or out), it is possible to use it with already-recorded cassettes—even those made on a different machine. This is not a specifically recommended practice, but most tapes and machines are evidently similar enough in their behavior near the tape-saturation point to permit some improvement—if not the maximum improvement—to be realized under a variety of conditions. The manufacturer does offer one caveat in this regard, however: should you ever encounter a tape with significantly less distortion than the Model 600 would normally introduce in its record mode, the IM suppression becomes a liability. This is because in attempting to compensate for more distortion than actually exists on the tape, it leaves behind a "remainder" of distortion.

The Massless Tweeter. The Andromeda III, scheduled for introduction very shortly, is Phase Linear's first speaker system, and a rather innovative one. It comes in four pieces: two large mid-range tweeter panels that closely resemble several popular electrostatic designs, a separate bass "commode," and an electronic equalizer/signal "conditioner" that is installed in the tape-monitor loop of the receiver or amplifier. This last item does some pretty surprising things to the signal driving the speakers.

As Phase Linear's president Bob Carver describes it, the speaker was sonically modeled on a pair of very high-quality electrostatic headphones. However, when it came down to the final analysis, the cone mid-ranges and tweeters selected for the system were simply not able to imitate the sound of the electrostatics. Carver attributed their deficiency to the relatively high mass of their cone diaphragms, which could not start and stop with the agility of the very light electrostatic film diaphragms. Yet it was his belief that this shortcoming could be compensated for electronically, and this conviction led to what is probably the most interesting aspect of the Andromeda III's design.

If you were to take the Andromeda's equalizer unit and feed it a known input—a brief pulse with a rise and decay time typical of demanding mus-



The Nakamichi 600 cassette deck with phase-compensation networks and "IM suppression."

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What are your opportunities in the electronics field? Here are some eye opening facts from ETI.

Q. What about the job market in electronics?

A. It's good. In fact, it seems to be one of the few fields that stays relatively steady in bad times. Today, for example, estimates indicate that several thousand jobs will be opening up for electronics technicians each year, for years to come. One reason for this is the fact that electronics are the basis of almost all communications, and this is a communications-oriented nation.

Q. What kind of jobs are you talking about?

A. For example, there are jobs available in electronic/industrial automation, electronic equipment repair and servicing, in the broadcast and radio telephone communications field, at airports, and even in medicine and in hospitals, where electronics are rapidly increasing in importance. And there are hundreds of other jobs opening up as electronics continues to make great strides, in new ideas and developments.

Q. Can such a complicated subject as electronics be successfully taught by the home-study method?

A. Of course it can. Electronics Technical Institute has proven that beyond a shadow of a doubt. Our graduates are working in practically every phase of electronics. This is largely due to the kind of instruction provided by ETI. For example, its course in the Fundamentals of Electronics features an exclusive teaching system called Autotext. And throughout all the courses the student is thoroughly monitored and carefully guided by a licensed instructor, whose professional and personal interest is to see that he masters every bit of information presented to him. Of course, we must give a lot of credit to our students themselves. They know that no matter how good the instructor and instruction may be, *they* have to make it work. So most of them apply themselves diligently, and they find the more they learn, the more they *want* to learn.

Q. But I have a job, and as much as I would like to get into electronics, I can't afford to take time off. How do I get around that?

A. You don't have to take time off from your job. You study at home, in your free time. We do advise, however, that you set aside a certain time for your study schedule and stick to it, even if it's only a couple of hours a day. The beauty of the ETI way of learning is that you work at your own pace, making sure you've completed your assignment thoroughly and completely. We think you'll find, as you go along, that learning the ETI way can be fun.

Q. But I was never very big on books and study. I like to work with my hands.

A. With your ETI course, you'll get plenty of work with your hands. In fact, the

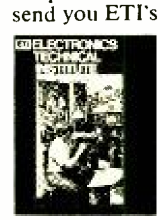
ETI system of teaching combines hands-on work with study, so that you actually learn by doing. As you move along developing your technical knowledge, you will use, in many phases, specially developed Project Kits. So you apply your knowledge in logical, hands-on sequences, from the first step through completion of basic units. It all adds up to knowledge and self-confidence gained by actually *doing* the job.

Q. It all sounds very interesting and inviting. But I wouldn't want to commit myself before knowing more.

A. We wouldn't want you to. In fact, we insist that you check it out first. All you do is fill out the coupon and mail it to us. We'll send you a colorful new 48-page ETI Career Book that will give you the facts and the many opportunities ETI can open up for you. If you like electronics, you'll enjoy reading this book.

Q. Do I obligate myself in any way by sending for your book?

A. Absolutely not. The ETI Career Book is free, and it involves no responsibility on your part, nor will a salesman call on you. All we want to do is to be sure you have all the facts about ETI and what it can mean to your future. And you can get these facts and complete information about ETI's 18 different courses and programs in electronics by filling out and mailing the coupon to us today. We'll send you ETI's Career Book by return mail. We think it will be a real eye opener for you. Mail the coupon today.



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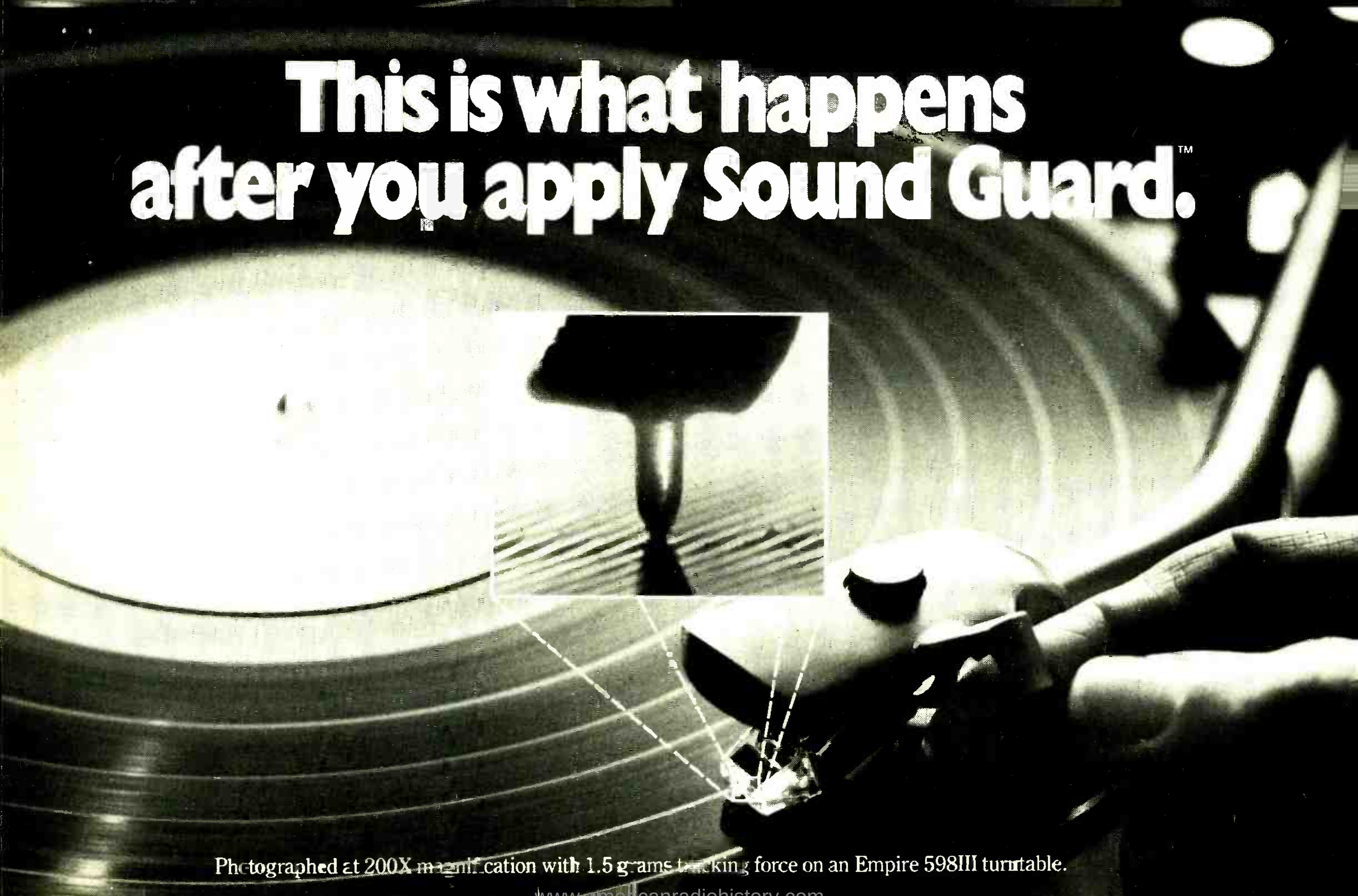
Photographed at 200X magnification with 1.5 grams tracking force on an Empire 598III turntable.



Photographed at 200X magnification with 1.5 grams tracking force on an Empire 598III turntable.

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Introducing Sound Guard.™

The first product ever that protects records against wear, without resulting loss in frequency response or fidelity.

Every time you play a record you destroy some of its sound. The culprit is friction. An inevitable result of a hard, diamond stylus tracking soft, vinyl grooves.

Under 200X magnification you can see the damage occur. Tiny shavings of vinyl curl off the record like metal off a lathe.

You literally see sound being worn away. After repeated playings your ears begin to confirm what your eyes have seen.

Until now, no product could protect records against wear without interfering with sound fidelity.

An answer from outer space

From Ball Corporation research into dry lubricants for NASA's Orbiting Solar Observatories came a breakthrough in micro-coatings that can function for long periods under extreme conditions.

One derivative of this new technology is a microscopically thin, dry film that molecularly binds itself to vinyl. Developed into a record preservative this product is now known as Sound Guard.*

How Sound Guard works

Just spray Sound Guard on (it has a non-aerosol pump sprayer). Then buff it with the soft, durable velvet buffing pad provided in the kit.

Sound Guard puts an ultra-thin, dry film on the groove surfaces to substantially reduce wear. (It's self-limiting and may be applied repeatedly without buildup. The film thickness is less than 0.000005".) One bottle will protect about 20 LP's.

Sound Guard is *dry*—not wet and sticky like silicone-type products—so dust or dirt won't accumulate on the stylus or in the grooves. And since it has an anti-stat built in, Sound Guard actually prevents records from attracting dust.

But does Sound Guard adversely affect frequency response or fidelity? For conclusive proof, we asked the most respected of the independent audio laboratories for an exhaustive evaluation. Their results were astounding!

Test results

1. The application of Sound Guard to a stereophonic or CD-4 quadraphonic disc does not in any way degrade audible frequency response.
2. Sound Guard increases the life of the records by significantly reducing record wear.
3. Sound Guard significantly retards increases in random noise content (surface noise) and total harmonic distortion caused by repeated playing.
4. Records treated with Sound Guard do not attract dust as readily as untreated discs.

(Complete test results will be mailed with every order.)

Like it or your money back

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Ball

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CIRCLE NO. 54 ON FREE INFORMATION CARD

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The 160-W/channel Pioneer SX-1250 is 21⅞" W x 18¾" D x 7⅜" H (56 x 47 x 18.5 cm) and weighs just over 6¼ pounds.

ical material, for example—the output would show the following significant alterations. First, the leading edge of the waveform would be steeper in slope than the input's. Second, where the input's waveform would ultimately return to the zero axis, the output signal would overshoot the axis for a brief time. What is happening is that the equalizer is attempting to offset the comparative slowness of the drivers by exaggerating the rise time of the signal (the steeper slope) and by braking the drivers (the overshoot) more drastically than the original input signal would.

Of course, the conditioning applied to the signal has been carefully adjusted to complement the characteristics of the individual drivers used. And according to Carver, conditioning is used throughout the audio range in the appropriate amounts. Certainly there will be skeptics to doubt that this kind of electrical manipulation could ever turn a cone into an electrostatic diaphragm. But to my ears, having been exposed to the Phase Linear product for about an hour, the speaker gave a very credible imitation of a good full-range electrostatic—except in the bass, where it was much more potent.

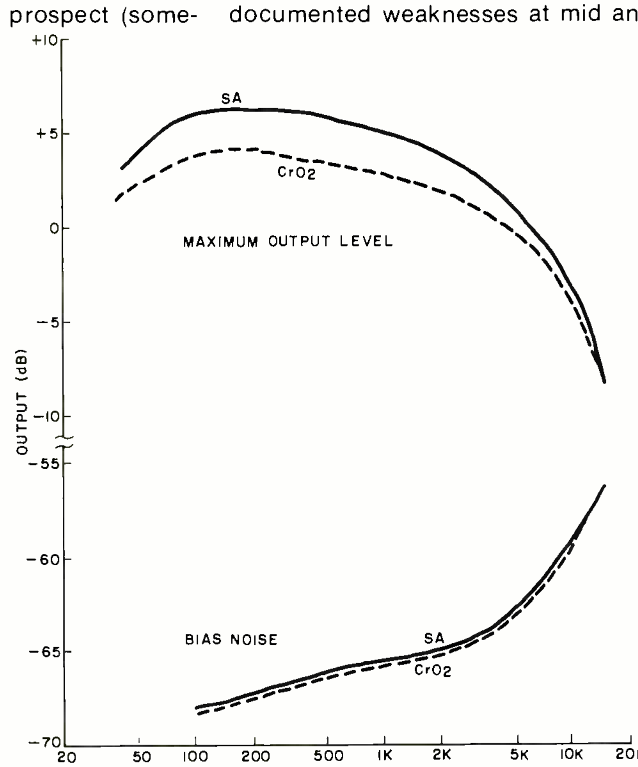
Heavyweight Receivers. The pioneer SX-1250, at 160 watts per channel, is now the most powerful receiver generally available. Among the runners-up are the Marantz 2325 (125 watts per channel), the Kenwood KR-9400 (120 watts), the JVC S600 (110 watts), and the Sansui 9090 (110 watts). Even bigger receivers could be made, certainly, but the question being asked within the industry—especially by those who have yet to break the 100 + 100 mark—is *should* they be? The issue seems to hinge on a further question: What is the essential appeal of the receiver (as a generic product) to the consumer? Does he buy it because it means fewer components to mess with; and if so, will he really find it a convenience to have all his electronics on a single chassis that is growing too heavy to lift and too big to fit on any shelf? Or does he choose a receiver because its built-in tuner eliminates one more agonizing buying decision he would otherwise have to make; or simply because his Uncle Fred has one? For consumers who don't want to get too deeply involved in system building, the receiver seems to have acquired a reputation as a practical, economical, good-sense approach to high-fidelity sound. Will a huge receiver with every imaginable feature and tremendous output capability miss the market by violating that image?

Many manufacturers are actively seeking answers to these questions right now. Their decisions are only complicated by the prospect (some-time in the future) of Class D and other innovations, promising high-power capability in rather small packages. In any case, in a short time we should have some indication of whether the super-receivers of 1976 are dinosaurs or the progenitors of a new breed.

The Tape Tangle. In semi-public announcements recently, Nakamichi and Tandberg have made it clear that they are going to drop—or at least de-emphasize—chromium-dioxide capability on their future cassette decks in favor of ferric-oxide tapes with cobalt additives, such as TDK's SA. Why this dramatic break with past practice? The companies cite several reasons.

First, both manufacturers are believers in the superiority of permalloy as a material for cassette record-play heads, and prefer to use ferrite heads only in other applications. Being a softer material, permalloy is said to wear at an accelerated rate with chromium-dioxide tape. (On the other hand, Advent Corp., which also uses permalloy record-play heads, has sponsored extensive wear tests with chromium dioxide and remains committed to the tape.)

Second, both companies share the opinion that chromium dioxide has uniformity problems that defy current manufacturing procedures. And third, although chrome's performance remains essentially unsurpassed at high frequencies, there are well-documented weaknesses at mid and



Dynamic ranges of CrO_2 and SA tapes.

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IMSAI announces a unique 4K RAM board for just $139.

Nobody has a 4K RAM board that gives you so much for your money. It's fully compatible with the Altair 8800.

Through the front panel or under software control, you can write protect or unprotect any 1K group of RAM's. Also under software control you can check the status of any 4K RAM board in 1K blocks to determine whether it's protected or not. The board has LED's that clearly show you the memory protect status of each 1K block and which block is active. And there's a circuit provided that will let you prevent the loss of data in the memory if there's a power failure. This low power board has a guaranteed 450 ns cycle time–no wait cycle required. There's nothing like the IMSAI 4K RAM board around.

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low frequencies. Overall, Tandberg and Nakamichi feel that the Super Avilyn (SA) type of formulation equals the performance of chrome at high frequencies and surpasses it for longer wavelengths, without being as abrasive on heads.

Well and good, but does this development presage any complex incompatibilities between tapes and machines? Yes and no. SA is designed for about the same bias and equalization requirements as chromium dioxide. Therefore, a cassette machine's bias and equalization switch positions should do about the same thing, whether they're labeled SA or CrO_2. However, the Dolby circuits are a different story. According to my information, SA is about 3 dB more sensitive than chrome, which is certainly enough to upset the tracking of the Dolby B noise reduction process. I have tried an SA cassette with a machine whose Dolby circuits were set up for chromium dioxide, and the compression of dynamics during playback was immediately obvious. Logically, the opposite effect should be obtained when chrome tape is used on an SA-adjusted machine. So, if you have hopes of using both types of tape on the same cassette deck, you had better choose a machine with readily accessible Dolby calibration controls.

AM Stereo. The idea of AM stereo—by no means a new one—is apparently gaining ground once more. There are several proposed methods for doing the job, all of them using the existing AM channels and employing a carrier that is both amplitude and, in effect, frequency modulated at the same time. To provide reasonable compatibility with existing mono receivers, the sum of the stereo channels (L + R) amplitude modulates the carrier and the difference (L − R) signal frequency or phase modulates it.

The only significant problem comes, predictably, from the restrictions on the spectrum space allotted each AM broadcaster. High modulation levels give rise to extensive sidebands that must be kept from interfering with adjacent stations. However, sideband limiting can result in significant amounts of distortion. A related difficulty, arising from "high" levels of frequency modulation, is distortion of the amplitude envelope. Consequently, troubles for existing receivers occur.

Arrayed in opposition to these problems (and also in more-or-less competitive stances toward one another) are the systems of CBS, RCA, General Electric, Philco, Westinghouse, Sansui, and other companies. Because none of the systems enjoys a clear margin of superiority, it looks as if we're due for another stand-off between industrial giants. However, the prospect of AM stereo seems likely to attract much more understanding and support than four-channel FM broadcasting has been able to muster so far.

Who of the general public will benefit from AM stereo? Certainly those who live in the FM fringes and can receive, at most, one or two FM stations with sufficient signal strength to permit stereo listening. Those who regularly drive long distances will have a much better chance of picking up usable stereo signals once they've installed the appropriate receiver. For those who live in urban and suburban areas well served with diverse FM programming, the direct benefits are not so obvious; but there may be some unexpected indirect ones. For example, during the recent period when the current four-channel matrix systems were taking shape, there was some fairly strong resistance to all the phase-shifting that would have to go on in matrixed recordings. Among the more vigorous protestors were some from the radio industry who argued—quite rightly—that phase shift between channels is a burden to the AM and mono FM broadcaster, who is at the mercy of the largely unpredictable cancellations and reinforcements of information that will take place when he tries to combine the signals.

I can recall some pretty feisty altercations, with the matrix proponents shouting that mono compatibility could go hang and the radio contingent saying that four-channel should go hang. However, AM stereo could be a long stride toward eliminating mono altogether. Record companies would then no longer feel constrained (if they do now) to pay special attention to phase in their products, with the possible result that more random-phase information would begin appearing on records. And it seems clear beyond a shadow of a doubt that a wealth of random-phase content greatly enhances the sonic spaciousness of a recorded performance, whether reproduced quadraphonically or in conventional stereo. ◈

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Can anyone beat the Altair System?

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When it comes to microcomputers, Altair from MITS is the leader in the field.

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Altair 8800 peripherals include a revolutionary, low-cost floppy disk system, Teletype,™ line printer, and soon-to-be-announced CRT terminal.

Software for the Altair 8800 includes an assembler, text editor, monitor, debug, BASIC, Extended BASIC, and a Disk Operating System. And this software is **not just icing on the cake**—it has received industry wide acclaim for its efficiency and revolutionary features.

But MITS hasn't stopped with the Altair 8800. There is also the Altair 680—complete with memory and selectable interface—built around the new 6800 microprocessor chip. And soon-to-be-announced are the Altair 8800a and the Altair 8800b.

MITS doesn't stop with just supplying hardware and software, either. Every Altair owner is automatically a member of the Altair Users Group through which he has access to the substantial Altair software library. Every Altair owner is informed of up-to-date developments via a free subscription to **Computer Notes.** Every Altair owner is assured that he is dealing with a company that stands firmly behind its products.

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Hobby Scene

Have a problem or question on circuitry, components, parts availability, etc.? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, NY 10016. Though all letters can't be answered individually, those with wide interest will be published.

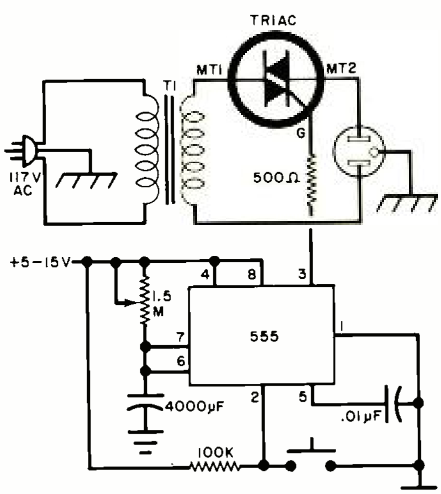
By John McVeigh

VARIABLE DELAY POWER SHUTOFF

Q. ***I need a timer (preferably solid-state) to turn off my stereo after I fall asleep. Maximum delay of 1 to 1½ hours would be fine.***

—David Custer, Timonium, MD

A. In the circuit shown, the 555 acts as a one-shot, providing gate current



for the triac. With the 1.5-megohm pot set for maximum resistance, power cutoff will occur about 1½ hours after the normally open pushbutton switch is depressed. Use two 2000-µF electrolytics to derive the required timing capacitance (try to get close-tolerance units). The 1:1 isolation transformer is included for safety reasons. Both the transformer and triac are not specified, since they will have to be chosen to accommodate whatever load you want to power.

SINAD

Q. ***I was reading receiver specs the other day, and came across the word SINAD. What does it mean?***

—Robert Wyatt, Oxford, CT

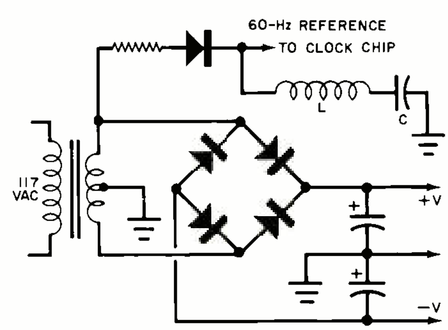
A. SINAD is an acryonym derived from signal (SI), noise (N), and distortion (AD). It is a figure of merit in communications systems. The noises referred to are Johnson or white noise; shot, thermal, and recombination noise, man-made impulses (electrical equipment, power lines, ignition systems, etc); and vibrational (microphonics). Distortion might be produced by improper amplifier conditions, detector nonlinearities, improper modulation, etc. Many consider the SINAD yardstick to be superior to the S/N and quieting ratings for communications, since it takes into account the distortion produced by the system. A SINAD ratio of 12 dB is generally considered to be the minimum acceptable figure. It is characteristically noisy and "hashy." A SINAD ratio of 20 dB or more represents a good, reliable grade for voice service.

CARRIER CURRENT AND DIGICLOCKS

Q. ***Will the operation of an electronic digital clock be affected by a carrier-current remote control system which injects a 120-kHz signal onto the ac line? Is there some way of keeping the signal from getting to the counters?***

—Allan Silburt, Downsview, Ontario

A. In most cases, the power transformer, which has considerable reactance at 120 kHz, will provide the re-



quired rejection. However, if the signal is very strong, it could cause the counting circuitry to act up. If this is the case, install the series-tuned LC trap shown in the figure at the 60-Hz reference tap-off. U,se a 0.02-µF, 75-V ceramic capacitor (Lafayette 33 F 69063) for *C* and a 1-10-mH width coil (Miller 6322, Lafayette 34 F 88525) for *L*. Adjust *L* for normal clock counting.

MEDIUMWAVE LISTENING

Q. ***How can I join a mediumwave listening club and where is the one closest to me?***

—W.E. Osborne, Eau Gallie, FL

A. National Radio Club, Box 127, Boonton, N.J. 07005. Also try ANARC, 557 N. Madison Ave., Pasadena, CA 91101. It's an association that can supply a list of affiliated clubs.

RECORD PLAYER RFI

Q. ***I've just moved to a new town, and find my record player picks up radio broadcasts as soon as it's turned on—even when no record is being played! What can I do about it?***

—Harry Birdsall, Bloomfield, N.J.

A. You are experiencing RFI (radio frequency interference). Somewhere within the record player, signals are getting in and being rectified (detected). Try shielding external speaker leads and/or bypassing them to ground with 0.001-µF disc capacitors. If this doesn't work, shielding the enclosure and/or installing bypass capacitors at other points may be necessary. Does the volume control have any effect? If not, the point of rectification is between the control and the final audio amp. If it does, look back toward the cartridge. Ferrite beads on the tone arm wires might help.

COAX IMPEDANCE

Q. ***Why does my supposedly 52-ohm coax line read less than 1 ohm on my VTVM?***

—Leon Brown, Bayside, NY

A. This type of coaxial line has an *impedance* (or opposition to r-f ac current) of 52 ohms, not a dc resistance of this value. That's what you're measuring with your VTVM. The impedance of a transmission line depends on the size of the conductors used, their spacing, their material composition, and that of the dielectric between them.

COMMERCIAL CODE STATION

Q. ***I occasionally pick up a CW station at about 8.100 MHz with the call letters WCC. While it appears to be commercial traffic, it makes excellent code practice. Where is it located?***

—Grenville Beem, Silver Spring, MD

A. The station you are listening to is located in Chatham, Massachusetts, and is engaged primarily in ship-to-shore traffic with ocean-going vessels. Although it is excellent practice to copy such stations, keep FCC regulations in mind. It's illegal to divulge the contents of any message you copy to a third party, nor can you use such information for personal (financial) gain.

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COMPARE

Feature	SWTPC–6800	Theirs–Your Choice
Processor–	The best "Motorola MC6800". Two accumulators, automatic vectoring, seven addressing modes and complete set of branch instruction. The more powerful instruction set and memory orientated architecture makes programming very straight forward and easy to learn. Operates from a single +5 Volt supply.	Some are almost as good in one respect or another. None can offer all of the features of a real MC6800.
Memory–	Static 2102-1 type memories. Fast enough to allow the processor to run at full speed at all times. No refresh cycles, no problems with glitches and flakey dynamic memories.	Various types available. Often not included in the basic kit, and must be purchased as an extra cost option. (this is an option?)
Power Supply–	10 Amp. Capacity. More than enough to power a fully expanded system. Power supply uses a rugged 25 amp bridge rectifier and a 91,000 mfd computer grade filter. Regulators on the individual plug-in cards.	Some expand more than others with the supply provided. Check carefully.
Expansion–	Seven slots for processor and memory boards. Eight I/0 slots. I/0's are programmable type. All decoding and clocking provided from mother board making additional interfaces very inexpensive. Baud rates may be independently selected for each interface card.	Varies from "0" to 16, or more.
Start Up–	Automatic start and reset provided by "Motorola" Mikbug® ROM. No fiddling with switches and status lights. Just push the button and go. Use of standard Motorola firmware makes software 100% compatible with Motorola evaluation module programs.	Anything from switch and status light to automatic ROM loading. If ROM is not a standard part, the software may be unique to that machine.
Clock–	Crystal controlled master clock oscillator with high power clock drivers. Insures reliable, consistant operation with no noise problems. Baud rate divider operating from the master clock oscillator provides the various baud rates for the I/0 devices with crystal accuracy. No adjustments necessary to lock everything in at the proper frequency.	Anything from cheap dual monostable systems to crystal control. Crystal oscillators are best. Dual one-shots can develop phase overlap problems and are more susceptible to noise problems.
Buffering–	Tri-state bi-directional buffers on all data lines, address lines and clock lines on ALL boards. Insures trouble free noise immune operation.	Various—from full buffering to almost no buffering. Lack of full buffering can lead to noise problems.
Documentation–	Very complete. Our own notebook, plus the "Motorola" Programming Manual and Applications Manual. Detailed instructions along with sample programs help you to understand programming. You will be ready and able to write your own programs after mastering these instructions.	
Price–	$395.00 **For the whole thing.** You get the case, power supply, processor 2K word memory and serial interface. No extras to buy. Just connect a terminal and start operating.	As we said—COMPARE.

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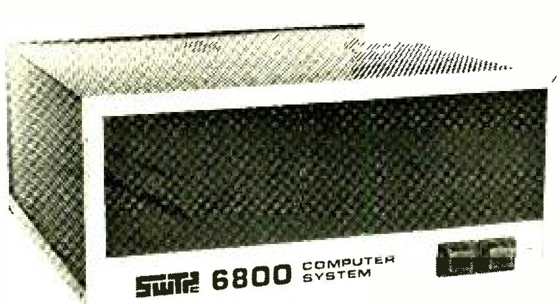

COMING ATTRACTIONS

CASSETTE INTERFACE—Our new AC-30 will make it possible to load and dump programs to cassette tape using ordinary inexpensive recorders. Uses the standard "Kansas City" recording format for compatibility.

LINE PRINTER—At last—hard copy at a reasonable price. Our new PR-40 printer will print program listings, or any other material you might want to keep in printed form. A dot matrix printer at a price you are not going to believe.

GRAPHICS TERMINAL—A universal—works with any computer—graphics terminal. With this connected to your computer you can play games in style. May be used with our CT-1024 to put both graphics and alphanumerics on the screen simultaneously.

PLEASE—Don't call or write. We will have details on these projects in our next ad. Government regulations prevent us from giving prices, or taking orders yet.

SOFTWARE—The flood is near. Editor and assembler now available. BASIC and more games right away. Yours for the cost of copying. WE DON'T SELL SOFTWARE—WE GIVE IT TO YOU. ENJOY IT, COPY IT, WE WON'T COMPLAIN. . .

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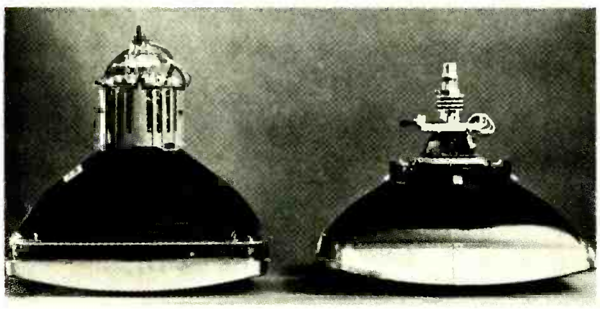
news HIGHLIGHTS

New Zenith Color Picture Tube

A cooperative venture between Zenith Radio Corp. and Corning Glass Works over a four-year period has resulted in a new color TV picture tube of decreased depth and weight. The deflection angle of the new tube is 100°. The narrow-neck tube has a striped negative guard band phosphor screen, slot-type aperture mask assembly, high-resolution electron gun, hybrid deflection yoke,



and lower-cost glass components. The tube (at right above) is 2½" (6.4 cm) shorter and more than 2 lb (1 kg) lighter than other 19" (48.3-cm) color picture tubes. Zenith plans to use the new picture tube in a portion of its 19" color TV receiver line in late summer.

RFI Bill Before Senate

On February 25, Senator Barry Goldwater introduced radio-frequency interference legislation into the U.S. Senate as Bill No. S. 3033. It is virtually identical to the RFI bill introduced into the House of Representatives last year by Mr. Charles A. Vanik. The bill places the responsibility of providing RFI suppression on the manufacturers, importers, and sellers to provide interference-reducing circuits in audio and visual electronic equipment.

Tubes Live!

Though solid state appears to have taken over, vacuum-tube equipment is still very much alive, even in hi-fi. LUX Audio of America, for example, is marketing a new monophonic power amplifier and matching stereo preamplifier using tubes. The Model MB-3045 power amplifier has a new triode tube developed by LUX and NEC, which is said to be the first triode that makes possible a high-power, low-distortion (50 watts at 0.3% THD) triode amplifier. The new Model CL-35 tube-type stereo preamp is rated at 0.06% harmonic distortion at 2 volts output. LUX developed the new components to satisfy the demands of sophisticated audiophiles who prefer "tube sound" to "transistor sound," especially when amplifiers are driven to clipping.

Heartbeat Digital Watch

A transducer capable of providing a digital readout (on a watch, for instance) is to be marketed by Pulse Watch, Inc., of Tiburon, CA. The Orr transducer (invented by Thomas Orr, of Warsash, England) consists of a light-emitting diode in the center of an annular, thin-film photovoltaic detector. The LED illuminates the skin and penetrates the tissue. Light reflected back from the skin onto the detector is modulated by the rhythmic changes in blood absorption in the tissue. The signal is then electronically processed and can be displayed or recorded.

Citizens Band in Europe

The current boom in Citizens Band activity in the U.S. is paralleled by similar interest in West Germany, Italy and other European countries. The German authorities have allocated frequencies from 26.965 to 27.275 MHz at a spacing of 10 kHz, providing 26 channels with certain exclusions. Power is limited to two watts input, and two types of transceivers are available—one requiring a license but no payment, and the other requiring payment of a monthly fee. CB, incidentally, is not yet allowed in Great Britain.

Holographic Credit Cards

As an aid to the prevention of falsification and fraudulent alteration of credit cards, ID cards, passports, etc., Siemens has developed a system of making a hologram of the original card and incorporating it in the card. Consequently, if the original is altered in any way, the hologram is unchanged, and the two can be compared in a special reader to check validity. A helium-neon laser is used to make the hologram and must also be used to read the hologram. During the checking procedure, two pictures appear on a liquid-crystal screen on the reader: a conventionally produced image of the card and a similar-sized reconstruction of the hologram.

Home Microprocessor By 1985?

Sperry Univac thinks so! According to Dr. Val E. Herzfeld, Vice President, Business Planning and Development, within the next ten years a new type of small, inexpensive computer may be monitoring the heating and cooling systems in your home, helping your wife plan her menus, and flashing a "paperless newspaper" on a screen in your den. Such a home microprocessor should cost no more than a major appliance like a refrigerator and would be small enough to fit into a desk drawer, says Dr. Herzfeld.

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Base Stations

CB 2700B — AM-deluxe transceiver, includes SSB receiver. Manufactured in the U.S. Suggested selling price $399.95.

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Popular Electronics
JUNE 1976

BY JOHN H. ROBERTS

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AUDIO DELAY LINE

Allows user to simulate larger listening room. Also used by recordists and musicians for special sound effects.

THE SOUND of recorded music being played is a listening experience that changes according to the room you are in. If the room is too "live" or too "dead", the sound appears to be unnatural. When the room has an ultra-modern decor and lots of glass window areas, the effect on the music is "bouncey." With heavy drapes, carpeting, and thickly padded furniture, plus a minimum of hard surfaces, the effect approaches that of an anechoic chamber—with very little sound reflection.

For the latter, you can either throw away your sofa pillows and pull down the drapes, or you can add a time-delay device to your audio system to create a more natural ambience. Since you may not care to redecorate, you can create an echo (audio signal time delay) and reverberation (later reflections) and achieve a livelier sound.

Until recently, the only means of obtaining an audio signal delay has been through the use of very expensive electronic equipment. Now there is a new type of IC—the "bucket brigade"—and you can build your own delay system for as little as $39 in mono and $59 in stereo. Connected between source and preamp or preamp and power amplifier (at the tape monitoring jacks possibly), it provides an adjustable, signal echo that can enhance the sound in most home listening rooms. With minor connection changes, it also can be used as a phasor/flanger, giving you a sound effect for tape recording purposes and electric-guitar playing used by the professionals.

The bucket-brigade IC is a MOS-type shift register that contains two 512-stage registers in a single 14-pin package. When an audio signal is applied to the input of the bucket brigade and a clock generator drives the IC, the signal is stepped along stage by stage until it comes out delayed a discrete interval in time. By adding this delayed signal to the original, reverberation is simulated.

In addition to providing real-time ambience, the bucket-brigade circuit can be used with a tape recorder to provide simulated stereo sound from mono sources, a means for "double voicing," and "phasor/flanging."

Technical Details. If you can delay an audio signal, you can create a number of useful sound effects. The most obvious is simulating echo, though delays provided by the bucket

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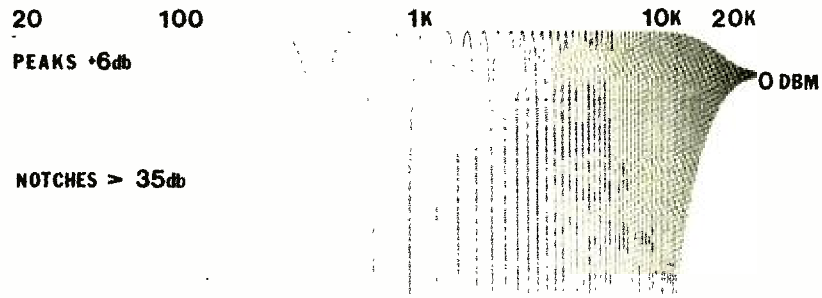

Fig. 1. Frequency between notches on a comb filter is adjusted by varying the clock frequency.

brigade are too short to be discerned as discrete echoes. Recirculating the delayed signal at reduced gain can approximate the natural decay of echoes in a reverberant room. By adding some gain during the recirculation of the delayed signal, you can create an unnatural "door-spring" effect on the music.

Delay an instrument or voice track by 30 or 40 ms and add the delayed signal back to the original signal, and you will make the output sound fuller and give it the effect of more than the original number of voices or instruments. This commonly used technique is known as "double voicing."

Another popular short-delay effect is a strange sound that results from a technique known as "phasing" or "reel flanging." The name is derived from its original implementation where a tape recorder was used to create the time delay and the friction of a well-placed hand on the outside edge of the tape-feed reel varied the delay to produce the acoustic effect. This effect can be created totally by electronic means by delaying the signal 0.5 to 5 ms while adding or subtracting the delayed signal from the original signal.

In the phasor/flanger mode, the frequency and its multiples whose wavelengths are equal to the time delay will be completely cancelled out while all other frequencies are reinforced. The result is a comb filter whose frequency between the notches is adjusted by varying the clock frequency (Fig. 1). In this manner, a tonal quality can be imparted to nontonal sound such as drums, cymbals, and even voices.

The phasor/flanger mode can be used to simulate stereophonic sound from a monophonic source. To do this, the phased output derived by adding the delayed signal goes to one channel, while the output derived by subtracting the delayed signal goes to the other. To the listener, the phasing effect cancels leaving a reasonable pseudo-stereo effect.

The basic block diagrams of the delay-line and phasor/flanger circuits are shown in Fig. 2. The hearts of the circuits, of course, are the bucket-brigade IC's, which can directly process analog signals. The circuits do not require costly analog-to-digital and digital-to-analog converters. When the clock pulse from the flip-flop is applied to the bucket-brigade IC, the dc voltage present at the input is shifted into the register. The discrete bits are transferred stage by stage with successive clock pulses until, after 256 pulses, they reach the end of the line and provide the output.

The output waveform is smoothed by a low-pass filter and duplicates whatever signal was present at the input but delayed in time by 256 times the period of the clock frequency. (Period is equal to the reciprocal of the frequency.) For example, if the clock frequency is 100,000 Hz, the delay would be $256 \times 1/100{,}000 = 2.56$ ms.

Since the audio signal at the input is being sampled at a rate determined by the clock frequency, a theoretical limit of half the clock frequency is the highest audio frequency that can be reliably passed. However, owing to practical limitations, a third of the clock frequency is a more reasonable design goal. Circuits can be cascaded to provide longer time delays at high clock rates, but the increase in noise in the series-connected circuits might outweigh the increase in bandwidth.

In the delay mode, the two shift registers are connected in series, which allows twice the clock frequency to be used. Therefore, twice the bandwidth of a single shift register can be programmed for the same time delay. Even in this double-bandwidth mode, the clock frequency required for a

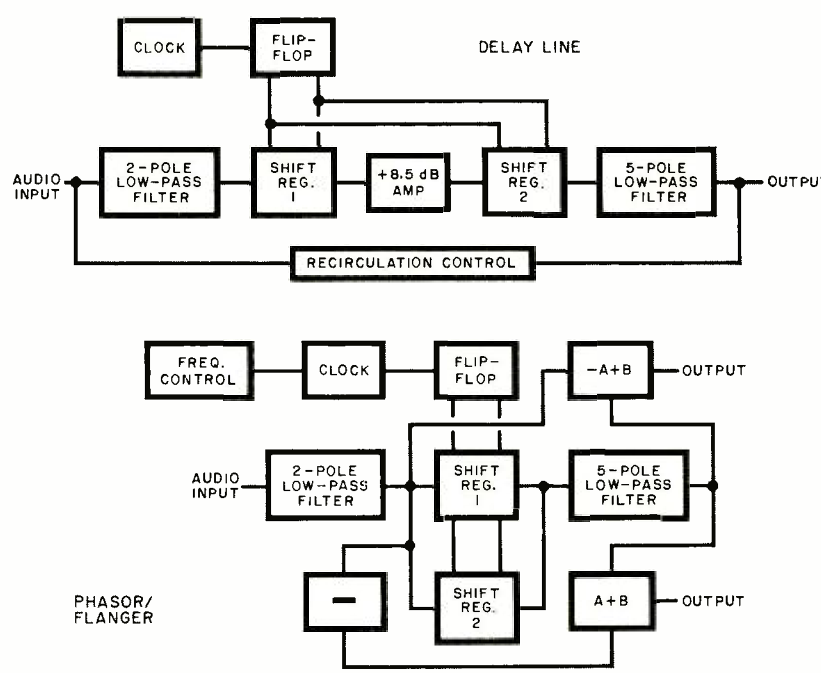

Fig. 2. Basic block diagrams of the delay line and the phasor/flanger circuits.

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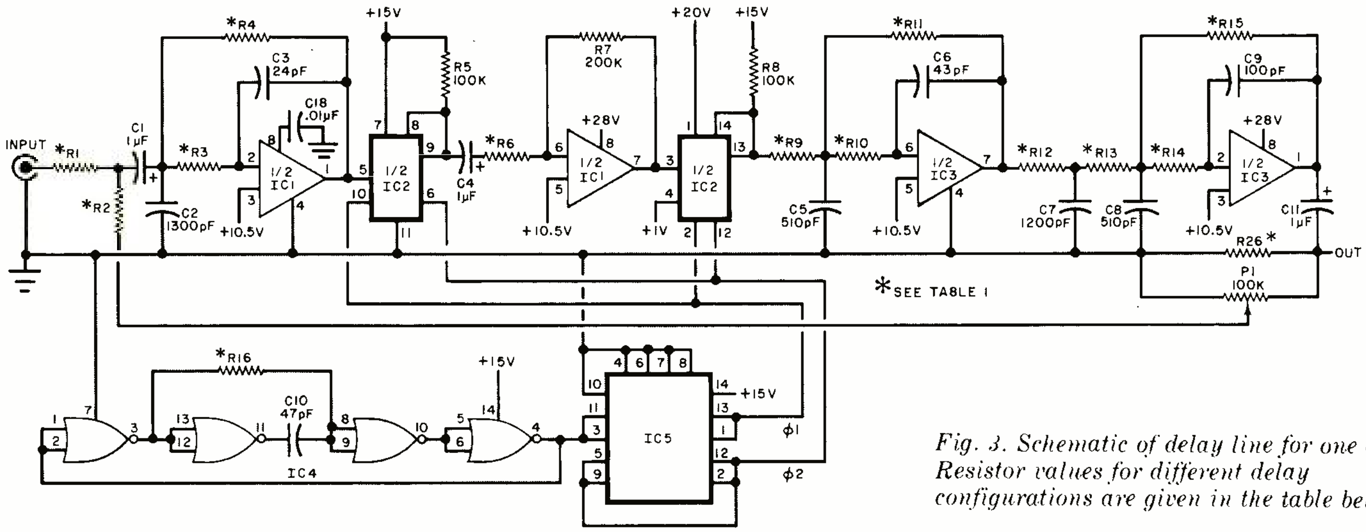


Fig. 3. Schematic of delay line for one channel. Resistor values for different delay configurations are given in the table below left.

TABLE OF FILTER RESITOR VALUES

	A	B	C	D
	(all values in kilohms)			
R1	100	200	300	390
R2	130	270	390	510
R3	36	75	110	150
R4	100	200	300	390
R6	75	75	75	75
R9	47	91	130	180
R10	43	82	130	160
R11	120	240	360	470
R12	10	20	30	39
R13	56	110	160	220
R14	33	68	100	130
R15	68	100	200	270
R16	110	240	360	470
R26	200	200	200	200

A = 10 ms or less, −3 dB at 15,000 Hz
B = 20 ms or less, −3 dB at 7500 Hz
C = 30 ms or less, −3 dB at 5000 Hz
D = 40 ms or less, −3 dB at 3800 Hz

PARTS LIST FOR FIG. 3

C1,C4,C11—1-µF, 25-volt electrolytic capacitor
The following are 5% polystyrene capacitors:
C2—1300 pF
C3—24 pF
C5,C8—510 pF
C6—43 pF
C7—1200 pF
C9—100 pF
C10—47 pF
C18—0.01-µF ceramic disc capacitor
IC1,IC3—1458 dual operational amplifier
IC2—MN3001 dual analog shift register (Matsushita)
IC4—4001 CMOS quad NOR gate
IC5—4013 CMOS dual D flip-flop
P1—100,000-ohm potentiometer
R1 through R4,R6,R9 through R16,R26—See Table
R5,R8—100,000-ohm, ¼-watt, 5% resistor
R7—200,000-ohm, ¼-watt, 5% resistor
Note—See Parts List for Fig. 5 for kit information.

40-ms delay limits the bandwidth to a maximum input signal frequency of 3750 Hz, which is adequate for voice but less than adequate for many musical instruments. In most applications where the delayed signal is added to the original signal, the reduction in bandwidth will be masked by the high-frequency signals present in the original. To compensate for normal signal attenuation, an 8.5-dB amplifier is used between the shift registers.

In the phasor/flanger mode, the maximum delay required is about 5 ms, which is short enough that a single shift register can be used without compromising the bandwidth. The second shift register is therefore connected in parallel with the first to improve the S/N ratio. The signals are added in-phase, while the noise adds and subtracts randomly.

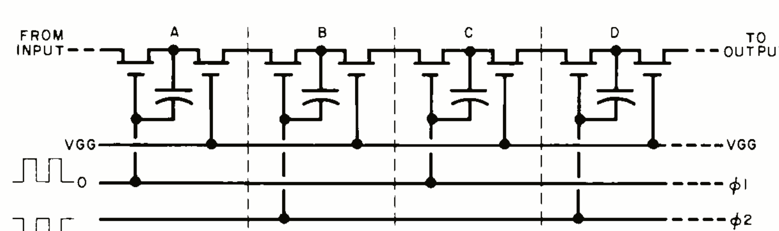
How It Works. The schematic diagrams of the delay-line and phasor/flanger configurations of the circuit

A BUCKET-BRIGADE SHIFT-REGISTER ANALOGY

The name "bucket brigade" conjures up images of a line of men passing along buckets of water to fight a fire. The bucket-brigade analog shift register operates in a similar manner, which is how it got its name. In the case of the shift register, however, the buckets are capacitors integrated right on the PMOS chip. There are more than 1000 such capacitors on each chip (one capacitor and two MOS transistors for each stage). What is being passed along are packets of electrical charge from stage to stage.

It is difficult to pour water both into and out of a bucket at the same time. So, too, it is difficult to simultaneously charge and discharge a capacitor. This problem is overcome in the shift register by utilizing two out-of-phase clocks. While the first clock is high, the "odd" buckets are dumped into the next consecutive "even" bucket. When the second clock is high, the even buckets are dumped into the next consecutive odd buckets. In this manner, individual charges are transferred along the line one stage at a time.

The drawing is a schematic representation of four typical stages of the MN3001 analog shift register. Each MN3001 IC contains two 512-stage shift registers. Note that stages A and C are connected to one clock, while stages B and D are connected to the other clock to provide the odd/even relationship.



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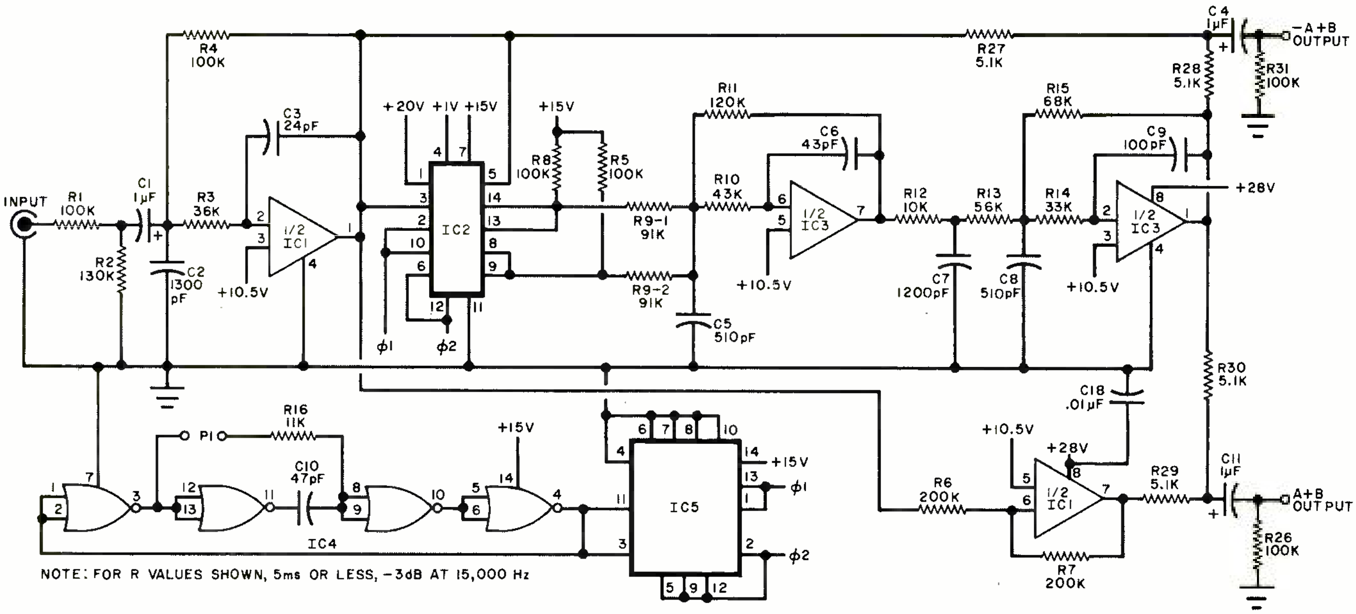

Fig. 4. Schematic of circuit for phasor/flanger.

PARTS LIST FOR FIG. 4

C1 through C11—Same as for Fig. 3
C18—0.01-µF ceramic disc capacitor
IC1 through IC5—Same as for Fig. 3
The following resistors are ¼ watt, 5% tolerance:
R1,R4,R5,R8,R26,R31—100,000 ohms
R2—130,000 ohms
R3—36,000 ohms
R6,R7—200,000 ohms
R9-1,R9-2—91,000 ohms
R10—43,000 ohms
R11—120,000 ohms
R12—10,000 ohms
R13—56,000 ohms
R14—33,000 ohms
R15—68,000 ohms
R16—11,000 ohms
R26—100,000 ohms
R27 through R30—5100 ohms
Note—See Parts List for Fig. 5 for kit information.

are shown in Fig. 3 and Fig. 4, respectively. In both cases, quad NOR gate *IC4* is wired as an astable multivibrator operating at twice the desired clock rate's frequency. The output of *IC4* goes to flip-flop *IC5*, which provides a pair of complementary (180° out of phase with each other) output clock pulses with 50% duty cycles. These pulses then "clock" the shift registers in *IC2*. Frequency determining resistor *R16* is fixed in the delay configuration, while resistance can be added via a pair of connectors to change the clock frequency in the phasor/flanger.

The audio input signal is conditioned by seven poles of low-pass filtering in which *IC3* and half of *IC1* are used. The filters provide a total of 42-dB/octave attenuation above the tuning frequency. For example, if the filter were tuned for 5000 Hz, a 10,000-Hz signal would be attenuated by more than 100:1.

When filters are designed with high-gain operational amplifiers (op amps), it is possible to have their outputs increase before rolling off at the rate of 6 dB/octave per pole. Such filters are termed "under damped." By carefully selecting the proper balance of under-damped and over-damped (RC) filter sections, it is possible to design a filter that is flat in the desired passband so that it is 3 dB down at the tuning frequency and has a roll-off rate of 6 dB times the number of poles. This is what has been done in the delay-line and phasor/flanger circuits.

Quite a bit of mathematical compu-

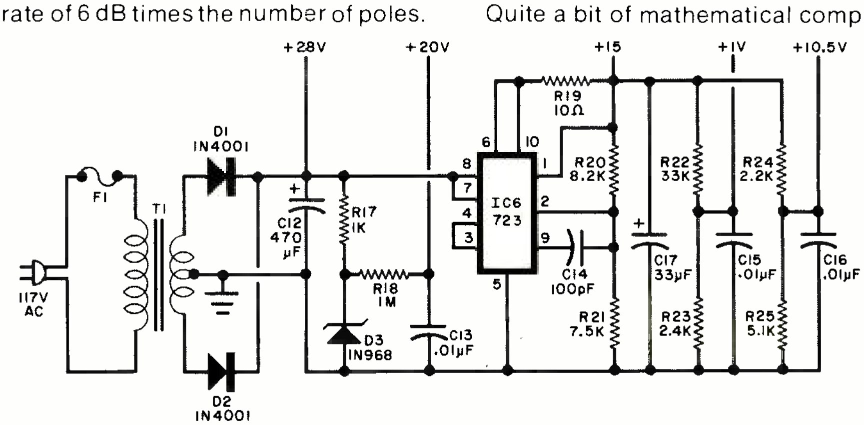

Fig. 5. Schematic of power-supply circuit. Parts List includes kit information for all circuits.

PARTS LIST FOR FIG. 5

C12—470-µF, 35-volt electrolytic capacitor
C13,C15,C16—0.01-µF disc capacitor
C14—100-pF disc capacitor
C17—33-µF, 25-volt electrolytic capacitor
D1,D2—1N4001 rectifier diode
D3—1N968 (20-volt) zener diode
F1—1/10-ampere fuse
IC6—723 precision voltage regulator
The following resistors are ¼ watt, 5% tolerance:
R17—1000 ohms
R18—1 megohm
R19—10 ohms
R20—8200 ohms
R21—7500 ohms
R22—33,000 ohms
R23—2400 ohms
R24—2200 ohms
R25—5100 ohms
T1—Power transformer with two 28-volt secondaries at 50 mA each
Misc.—Chassis; line cord; phono jacks (4); control knobs (2); rubber grommet; spacers; machine hardware; hookup wire; solder; etc.
Note: The following items are available from Phoenix Systems, P.O. Box 73, Saugatuck Sta., Westport, CT 06880: Complete kit of parts (delay line or phasor/flanger) No. P-1220-M (mono) for $39.00; complete kit of parts No. P-1220-S (stereo) for $59.00; etched and drilled pc board No. P-1220-B for $5.00; MN3001 analog shift register IC No. P-1220-C for $15.00. Add $1.00 for shipping and handling. Connecticut residents, please add sales tax.

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CLAIMED SPECIFICATIONS

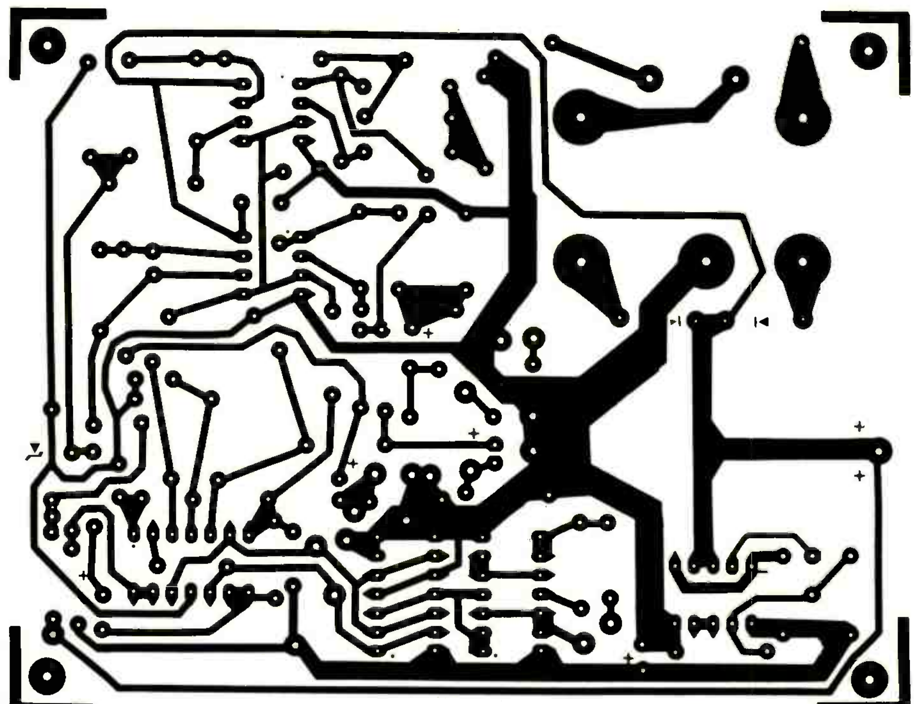
Delay Line:	
Frequency response	15 to 15,000 Hz (+2/−3 dB)
Distortion (THD)	Typically less than 1% (1000 Hz, 1 V rms)
Input impedance	Greater than 100,000 ohms
Clipping level	1.77 V rms (5 V p-p)
Signal-to-noise	Typically 50 dB below 0 dBm
Phasor/Flanger:	
Frequency response	15 to 15,000 Hz (+2/−3 dB)
Distortion (THD)	Typically less than 0.75% (1000 Hz, 1 V rms)
Input impedance	Greater than 100,000 ohms

tation is normally required to determine the values of the filter resistors to use. To simplify matters, you can select the appropriate resistor values from the Table of Filter Resistor Values. Use this Table for selecting resistor values for only the delay-line circuit. (The filter resistor values specified in Fig. 4 and its accompanying Parts List will provide an optimized 5-ms delay, with the output 3 dB down at 15,000 Hz for the phasor/flanger.)

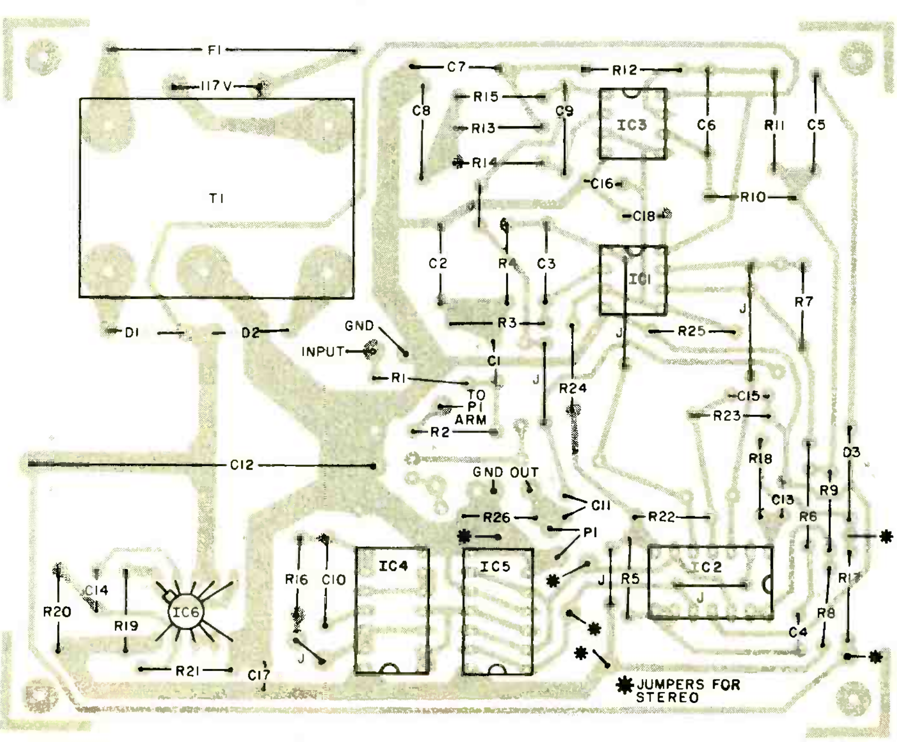
The power supply is shown in Fig. 5. It uses a voltage regulator, *IC6*, to generate the main 15-volt supply output. The shift register requires supplies of both +1 and +20 volts. The +20-volt line is obtained through the use of zener diode *D3*, while the +1-volt line is derived from the voltage divider consisting of *R22* and *R23*. Since the op amps are being operated from a single-ended supply, it is necessary to have the 10.5-volt supply line serve as the reference point in the circuit for these IC's.

Construction. The actual-size etching and drilling guide, the same for both circuit configurations but wired differently as required, is shown in Fig. 6A. The parts-placement guides for the delay-line and phasor/flanger configurations are shown in Figs. 6B and 6C, respectively.

Before installing any components on the board, mount and solder into place the wire jumpers. Then, wire the board as in Fig. 6B or Fig. 6C, depending on the desired mode of operation. Be careful to properly orient all semiconductor devices and electrolytic capacitors. Be sure to handle the MOS devices with care to prevent them from being damaged by static charges. You can mount the IC's directly on the board or use sockets. Use a low-power soldering iron (25 to 35



A



B

Fig. 6. Above (A) is etching and drilling guide for pc board. It can be used for either channel for delay-line circuit, or for the phasor/flanger. At left (B) is component layout for one channel of delay line. It includes the power supply. Component layouts for phasor/flanger and second channel of stereo delay line are on next page.

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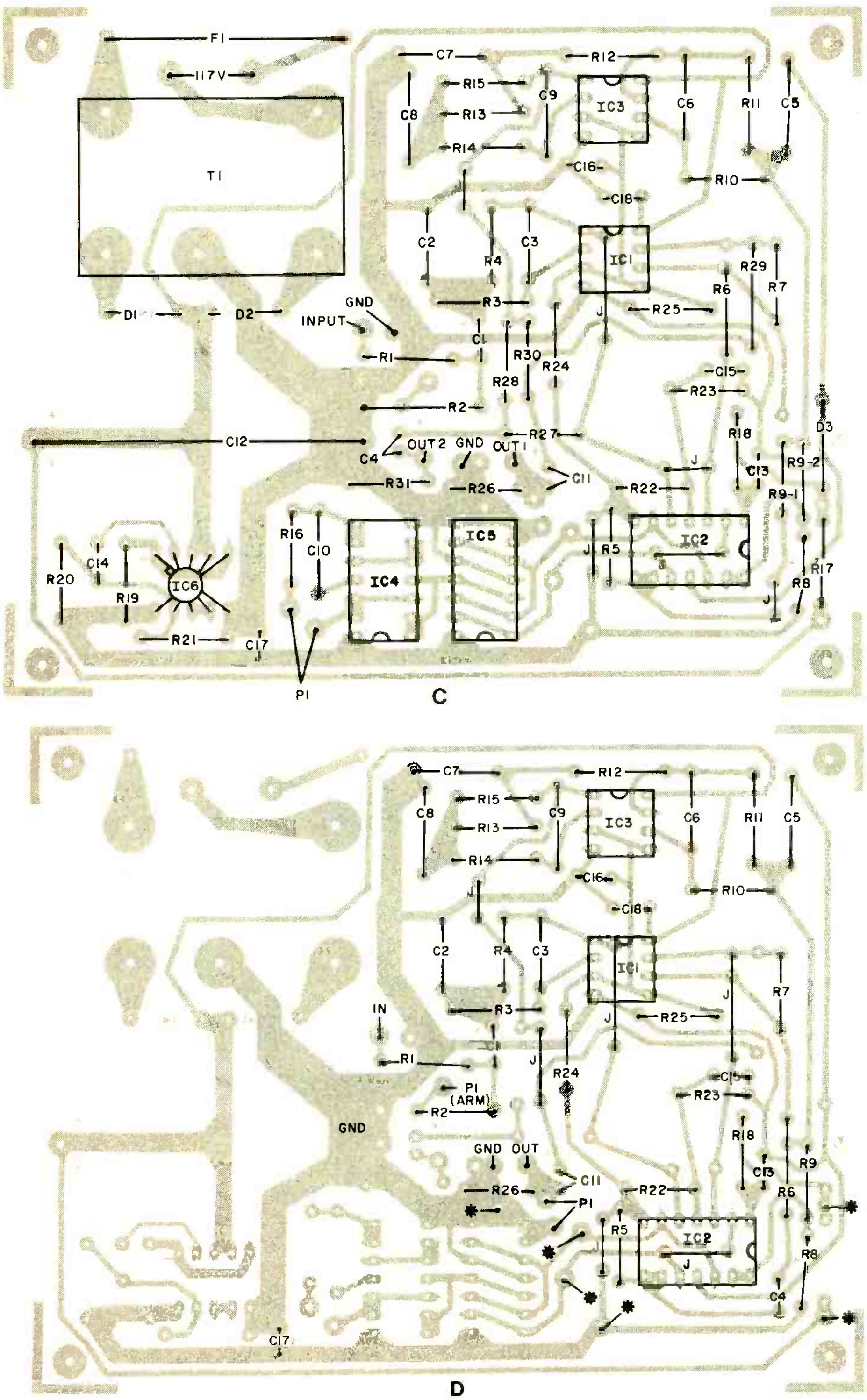

Fig. 6. Component layout at top is for phasor/flanger (C). Below (D) is for second channel of stereo system. It uses power supply in first channel.

HANDS-ON EVALUATION

Both the time-delay and phasor/flanger configurations of this circuit should keep the home recordist occupied for hours, if not days. While the effects are not as apparent as those obtained with professional delay and flanging systems, this system does not cost the $4000 or so demanded for such top-of-the-line professional system.

The flanging effect is heard only while the potentiometer is in motion, at which time the variable comb filter sweeps across the audio bandwidth to create the "flanging" sound. At rest, the comb-filtered sound is noticeable, but it is not as apparent as one would expect from looking at the peaks and dips that occur at regular intervals on the frequency response curve.

Although you might not have occasion to use the flanger as a mono-to-stereo generator, don't overlook this operating mode for the enhancement of a single-output reverberation device. Reverberation is very diffuse by nature, and the flanger outputs, when panned left and right, are a noticeable improvement over a regular mono reverb return. When used in this application, the potentiometer remains at rest.

Use only one output when applying flanging to a recording. For an interesting Doppler effect, try combining the two outputs while rapidly revolving the pot. Better still, replace the standard pot with a free-spinning pot. (Connect the resistance element in series with *R16* and the wiper to either end of the element.)

On the delay line, the recirculation control must be used sparingly. A little goes a long way, and the "door spring" effect can easily get out of control. If you build both circuit configurations, you can experiment by wiring the flanger into the delay line's recirculation path. The slight additional delay in feedback creates even more echoes at the delay line's output. It also helps to keep the door spring from becoming a steady-state squeal.

—John Woram,
Woram Audio Associates

watts) and fine solder, and watch out for solder bridges between the closely spaced pads on the board.

The wiring guide for the second pc board for a delay line for stereo is shown in Fig. 6D. Note that the power supply section is *not* repeated; you get power and clock pulses from the first board via wire interconnections.

Solder lengths of hookup wire to the pads that are to interconnect with the off-the-board pots and jacks. Then drill holes for the line cord, jacks, pots, and board mounting in a 5″ × 4″ × 3″ (12.7 × 10.1 × 7.6 cm) aluminum chassis box. Locate the line cord and jack holes on a wall directly opposite the wall through which the pot holes have been drilled.

Use machine hardware and spacers to mount the pc board assembly to the floor of the aluminum box. If you are assembling a stereo delay line mount the second board assembly over the first with short spacers and machine hardware after interconnecting the power-supply and clock-drive lines with hookup wire. (Be sure to make the interconnections before fastening the boards together.) Connect and solder the free ends of the hookup wires from the board(s) to the appropriate lugs in the jacks and pots. ◈

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Ten Speaker-Enclosure Fallacies

BY DAVID B. WEEMS

SEVERAL years ago the U.S. Patent Office granted a patent for a speaker enclosure that had some unique internal reflectors. Its inventor claimed that the reflectors, by bouncing the sound back and forth, enabled any speaker to reproduce longer wavelength bass in a compact box. The fact that the patent was issued shows that the inventor recognized a great need. Unfortunately it does not show that a new set of natural laws would be necessary to make the invention work.

Experimenters have contributed many interesting and imaginative (often flawed) speaker enclosures to the high fidelity and stereo scene. Many of them have been adopted and are commercially produced. But commercial production is no proof of merit. How about a cheap speaker buried in a thin-walled unpadded box? This commercial flop was called a "cavity generator." It really sounded as bad as you'd expect. Then there was the bass reflex with ports shaped like f-holes on a violin for (one supposes) a more musical bass. If you like to mix pets and audio components, how about the "cat's door" speaker? This one had a small swinging door in the back. Presumably this was the answer for anyone who couldn't choose between a sealed box and one with a port.

Some bizarre speaker systems are good, but they don't always work the way their designers think they will. Novices misinterpret speaker box theory. They overlook hidden snags, because after all, what looks easier to make than a simple box?

They are also often misled by old speaker box fallacies. Stories about speaker systems can be loaded with colorful misconceptions. Even well-known manufacturers sometimes promote them in their advertising. A current table model radio, for example, was introduced with the claim that its wooden cabinet gave it "the same mellow resonance that grandma's big console used to have." Aside from the suggestion that resonance is good, this statement gives credence to a fallacy that has been around a long time. Its roots probably go back some 300 years. In deference to its age we'll consider it first.

1ne

Wooden speaker cabinets have a good "tone."

This old one is surely a hangover from the mysterious art of violin making that reached its peak in the 17th century. That's when the families of Amati and Stradivari developed methods of using certain woods which produced instruments of great esteem. But a loudspeaker is not a musical instrument. Its function is to change electrical energy into acoustic energy without adding to the original signal.

Wood is only one of many materials suitable for speaker boxes. Its popularity is based on convenience and appearance. Dense materials, such as brick or concrete, are better. Having greater rigidity, they are less likely to vibrate and add false tones. Any material that is acoustically opaque, sufficiently rigid, and reasonably well damped can be used.

2wo

Enclosure wall panels should have a low resonant frequency.

This might be called a high-level fallacy because it is often believed by people who are otherwise well informed about speaker systems. They know that all panels, like speakers, have resonance. The general rule for speakers goes: low resonance, good; high resonance, bad.

For box panels the reverse is true. Unlike speakers, box walls should produce no sound at all. Making a panel more rigid helps in two ways. It reduces the amplitude of any vibration, lowering its sound level; and it raises the panel's resonant frequency. Upper-bass and midrange frequencies can be more easily absorbed by using acoustic damping material in the box.

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3hree

Panel braces should cross the short dimension of the panel.

There is a common belief, sometimes supported by mathematics, that braces around the mid-section of a box (Fig. 1A) add more rigidity than lengthwise braces (Fig. 1B). The reasoning is that a short brace is more rigid than a long brace. But the goal should be to produce greater rigidity in the walls, not the braces.

Another theory says that braces should be installed diagonally. The advantage of diagonal bracing, it is said, is that one brace can resist stress in two directions.

About 15 years ago Peter Tappan did some experiments to find the effects of various kinds of bracing. He found that a panel with a fundamental resonance of 60 Hz had the resonance raised to 100 Hz by a cross brace, to 115 Hz by a diagonal brace, and to 160 Hz by a lengthwise brace. He concluded that the lengthwise brace was most effective because it divided the panel into the narrowest possible sections. Ideally, a brace should be installed slightly off center so that it breaks the panel into two unequal parts. Opposite sides, which have the same dimensions, should have dissimilar bracing.

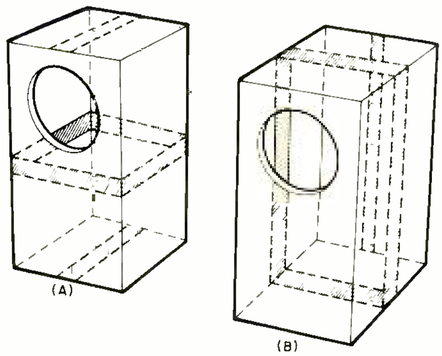

Fig. 1. Braces are usually put across short dimension of panels (A). Lengthwise braces (B) make panels stiffer.

4our

All speaker box walls should be ¾" thick.

This is an old rule of thumb. When most speaker enclosures were floor models made of plywood, it was good enough. Now, when speaker boxes take many sizes, assume various shapes, and contain unusual materials, wall thickness should be matched to individual box requirements.

Thick plywood is a good choice for large panels. Plywood backs, for example, should usually be at least ¾" thick. But to use ¾" walls for a miniature speaker would be wasteful.

For other materials, weight is a good guide to adequate thickness; but there are exceptions. Consider a thin-walled enclosure made of steel, for example. It could be satisfactorily rigid and yet produce inferior sound because of poor damping. If you suspect wall damping problems, use the knuckle test. Rap the sides with your knuckles and listen. You should hear a dead thump rather than a hollow drummy sound.

5ive

Damping material is useful in eliminating bass boom, but too much can cause rolloff at high frequencies.

Various damping materials, such as fiberglass, dacron batting, and other fuzzy substances, are used to absorb unwanted sound. These absorbents are most effective in the midrange frequency band. Don't underrate this ability. Midange reflections inside the box interact with the speaker cone to produce a rough frequency response. The proper use of damping material can greatly reduce listening fatigue.

Stuffing a box does little to control bass boom (much less than electrical damping on the speaker), but it can affect bass range. The stuffing, by absorbing and giving up heat, changes the condition of sound propagation in the box from adiabatic to isothermal. This change reduces the velocity of sound, shortening the wavelength. In effect, the enclosure "acts" larger. Because of increased acoustical resistance, a stuffed box reduces speaker efficiency.

The second part of fallacy 5, that acoustic treatment inside the box can depress the highs, is a common case of mistaken judgement. Padding the inside of a box often removes excessive brightness. Careless listeners sometimes interpret the reduction of midrange peaks as a loss of highs.

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6ix

The outside shape of a speaker box has no effect on the sound.

One problem with most speaker enclosures is that they are box-shaped. Opposite parallel walls produce internal reflections, but the problem is usually treatable. Externally, sharp corners and projections at the front edge of the box cause diffraction effects as the sound waves reach those corners. The diffracted waves overlap, producing destructive interference and uneven frequency response. Ideally the front of the enclosure should curve away from the speaker, like a sphere. As a compromise solution, the front corners of box-shaped enclosures can be made free of projections and even rounded off or chamfered.

7even

A speaker should be centered on the speaker board.

A speaker in the center of a speaker board looks right. It can sound bad. Equidistant from each side, it is positioned where it will promote standing wave formation in the box. Centered speakers also aggravate the diffraction problem discussed in 6.

8ight

To insure in-phase operation, woofers and tweeters need only be wired with proper polarity and installed on the same board.

Most audio fans know that they must "phase" speakers in a stereo or 4-channel system. Polarity should also be observed when wiring woofers and tweeters into a crossover network. But there are other, more subtle, causes of phase distortion. One of these is unequal sound-path length from multiple sources.

Speaker phase distortion was first recognized in 1935 when some Hollywood sound men noticed an echo in a tap dancing sequence by film star Eleanor Powell. They traced the source of the echo to the theater speaker, a large two-way horn system. Unequal path length was the demon. The bass horn was 8 feet longer than the treble horn. The dancer's sharp transients uncovered a kind of distortion that had gone unrecognized in music and speech.

Multiple speakers on a common speaker board can produce sound with unequal path length in at least two ways. The woofer cone, because of its greater depth, is usually located a few inches behind the shallow tweeter cone. And sometimes there is a lateral distance between the cones (Fig. 2). These two distances introduce phase shift in any sound reproduced by both cones. When the difference in path lengths is equal to one-half wavelength, the phase angle is 180°, causing cancellation. For woofers and tweeters the phase problem extends through the band of frequencies in which their response overlaps, usually about a half octave on each side of the crossover frequency.

Phase distortion can also occur when a well-designed speaker is placed on its side. If that placement puts a horizontal distance between drivers with overlapping frequency bands, it can cause phase distortion except at the one listening position where the path lengths are equal.

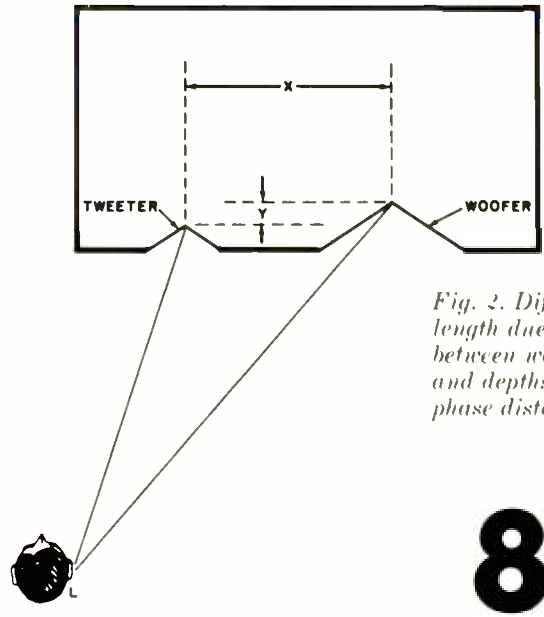

Fig. 2. Difference in sound path length due to horizontal distance between woofer and tweeter (X) and depths of cones (Y) produces phase distortion to listener.

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9ine

With proper design a small box can give both good efficiency and a full bass range.

This might be called the wishful thinking fallacy. Compact speakers can reproduce low-frequency bass (as proved by acoustic suspension speakers). But to get a woofer with an ultra-low resonance (a necessity in a small box), engineers must increase both the compliance and mass of the cone. Newton's Second Law of Motion tells us that the added mass requires more energy to accelerate it. So full-range acoustic suspension speakers are inefficient.

Can a light cone be made compliant enough to give both good efficiency and a full bass range in a small box? No. First, there are practical problems with ultra-high compliance. A floppy cone is hard to protect during shipment, for example. There are also theoretical limits. A speaker's fundamental resonance varies inversely with the square root of its compliance. So to reduce a speaker's resonant frequency by increased compliance alone from, say 60 Hz to 30 Hz, the compliance must be made 4 times as great.

To get a 15-Hz resonance with the same speaker, its compliance would have to be increased to 16 times the original value. But such a speaker, even if practical, would be defeated by a small box. An electrical circuit equivalent to the mechanical circuit of the speaker in the box (Fig. 3) shows that the compliance of the trapped air is in series with the cone compliance. When two capacitances appear in series, the smaller capacitance (Cmb) limits the total capacitance (or compliance) no matter how great the other capacitance (compliance).

The example shown here is for a closed box speaker system. Reflex speakers have a theoretical efficiency advantage of 3 dB over closed boxes, but the minimum box volume for satisfactory reflex operation is greater than that for a closed box.

Any speaker designer faces the conflicting requirements of efficiency, low-frequency response, and space. He can make a small speaker offer high efficiency and a limited bass range, or it can have low efficiency and a full bass response. He cannot give it all three.

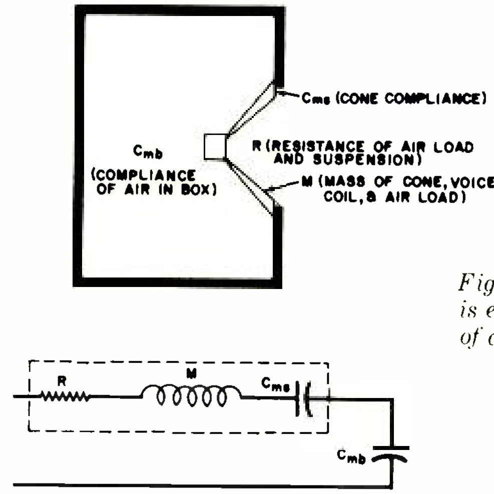

Fig. 3. Electrical schematic below is equivalent to mechanical circuit of a speaker in an enclosure.

10en

Bass reflex enclosures always boom. That's why they are called "boom boxes."

This fallacy has been promoted by both sides in the reflex/closed-box war. "I like bass," some say, meaning that any kind of bass is desirable. Closed-box fans say, "Reflex speakers give one-note bass."

The belief that a reflex system will inevitably have more boom than closed-box systems is wrong on two counts. Any kind of dynamic woofer, particularly if its Q is high, can boom. Cheap speakers with small magnets have a higher Q than speakers with adequate magnetic field strength in the voice-coil gap. Well-designed reflex enclosures produce no more obnoxious boom than other types.

If you have a reflex system that booms excessively, the box may be too large or too small for optimum performance. In either case, the solution is simple. Cover the port and operate the speaker as a closed-box system. If the boom persists, your problem is more basic than a mistuned bass reflex enclosure.

There are probably more fallacies having to do with speaker systems than about any other audio component. When you consider how difficult it is to measure and analyze speaker behavior, however, that's no wonder. Sometimes it is a case of mistaken identity. Fallacies crop up when somebody mistakenly identifies effect as cause, form as function, or even inferior performance as superior performance. The ten fallacies listed here are only a few samples. So stay alert. You may discover a brand new one yourself. ◈

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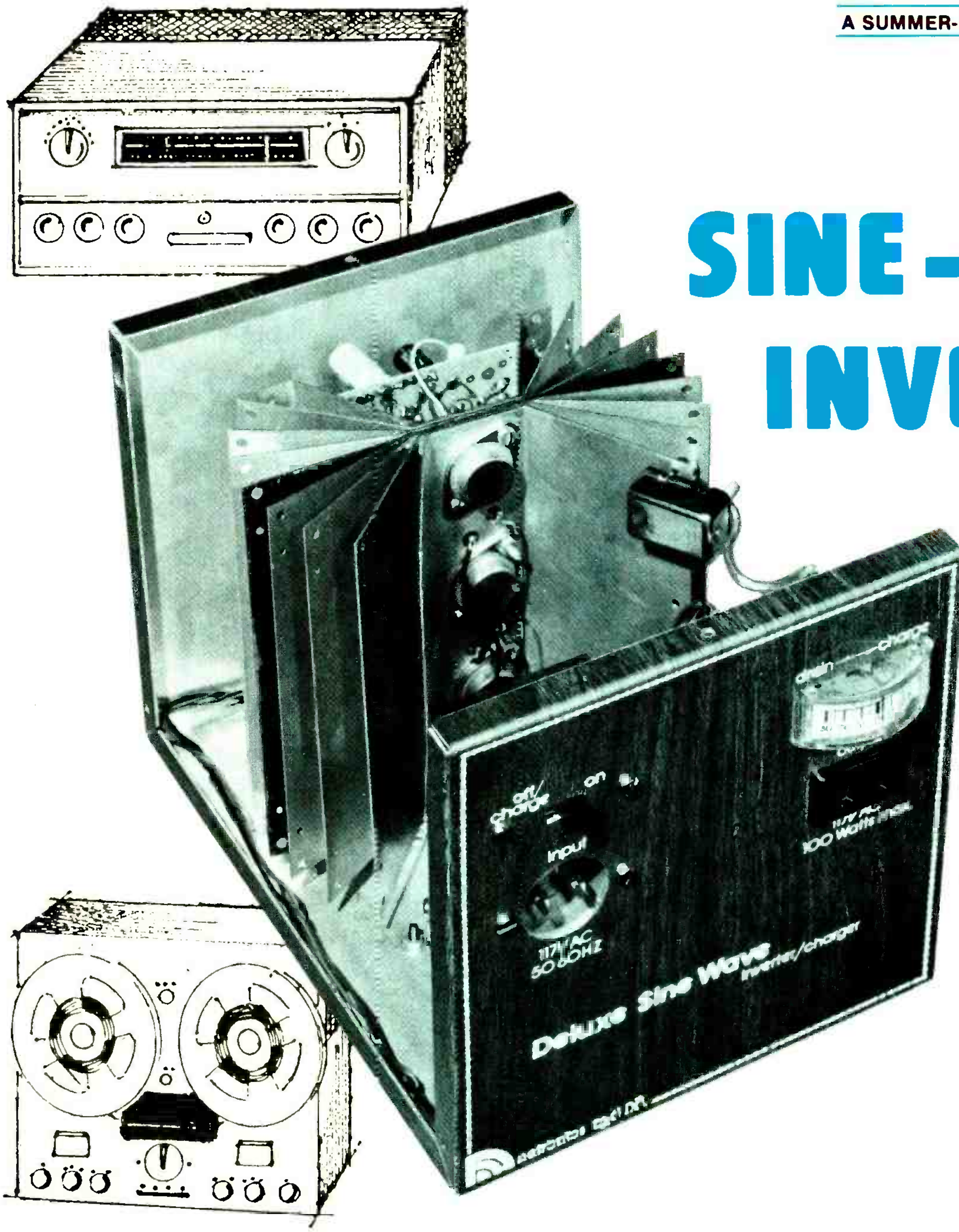
A SUMMER-USE PROJECT FOR CAMPERS

Build A SINE-WAVE INVERTER



Boosts 12 volts dc to 117 volts ac at 100 watts, and also recharges storage batteries.

BY MARTIN MEYER

"CAMPING OUT," whether it be in one of the new modern campers, a trailer, a tent, or even a boat, is one of today's most popular ways of "getting away from it all." There always comes a time, however, when we miss some of the creature comforts that we left at home—comforts that can only be provided by electrical appliances. Unfortunately, appliances that work on 12 volts dc are relatively expensive.

You can, however, use a dc-to-ac inverter, enabling you to utilize ac equipment you already own. As some readers might have already discovered, though, most of these devices deliver a form of square wave that prevents their use with equipment that is sensitive to the interference caused by square waves. This includes TV receivers, audio equipment, CB gear and some test instruments. With the inverter described here, you can now get 117 volts of 60-Hz sine-wave power at 100 watts from a conventional 12-volt battery system. In addition, the inverter can be used to recharge vehicle batteries at 15 amperes from any 117-volt, 60-Hz power source.

The inverter can also be preset to deliver power at any frequency from 50 to 400 Hz, making it useful for operating some surplus electronic gear designed for 400 Hz. As an integrated standby power source it can even be used for power-failure emergencies in the home.

SPECIFICATIONS

Input:	12 V dc at 14 A
Output:	117 V ac, 50-400 Hz, 100 W
Distortion:	Less than 10% at 100 W
Charge Current:	15 A max. (self-limiting)

How It Works. As shown in Fig. 1, the first stage in the inverter is a low-distortion sine-wave oscillator (*IC1A*) whose frequency can be adjusted by *R1*. The output of the oscillator is amplified and isolated from the load by a combination of an op amp and

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PARTS LIST

C1—0.082-µF Mylar capacitor
C2—0.002-µF disc capacitor
C3,C5,C6,C7—47-µF, 16-volt electrolytic capacitor
C4—220-µF, 16-volt electrolytic capacitor
C8—2.2-µF, 16-volt electrolytic capacitor
C9—1000-µF, 16-volt axial-lead electrolytic capacitor
C10—1000-µF, 16-volt, pc-type electrolytic capacitor
C11,C12,C13—0.01-µF disc capacitor
CB—18-A circuit breaker (Littlefuse)
D1 to D9—1N4001 diode
D10,D11—1N4148 diode
IC1—747 dual op amp
M1—30-0-30-A meter
P1—117-volt male socket
Q1—2N5232 transistor
Q2—2N5354 transistor
Q3,Q4—60407 transistor (RCA)
Q5 to Q10—2N3055 (matched gain at 5A)
R1,R11—50,000-ohm potentiometer
Following resistors are 10%, ¼-watt:
R2,R4—68,000 ohms
R3—2200 ohms
R5,R19,R22—220 ohms
R6,R7,R12,R13,R20,R21—10,000 ohms
R8—510 ohms
R9—4700 ohms
R10—1000 ohms
R14—1 megohm
R15—120,000 ohms
R16—470,000 ohms
R17—560,000 ohms
R18—220,000 ohms
S1—5-pole, double-throw switch
S01—117-volt chassis-mounting socket
T1—1:3 step-up driver transformer
T2—6-V/117-V, 18-A primary output transformer (see below)
Misc.—Suitable chassis, rubber feet, grommet for battery lines, press-on type, silicone grease, aluminum for heat sink, ¾" standoff insulators.
Note—The following are available from Netronics Research and Development Ltd., Rt. 6, Bethel Meadows, Bethel, CT 06801: complete kit including case and heat sink at $69.95, plus $3.00 postage and handling. Also available separately are: output transformer T2 at $27.95; driver transformer T1 at $4.00; S1 at $2.70; meter M1 at $4.50; circuit breaker at $3.00; six matched 2N3055 transistors at $12.00; pc board at $4.00. Separate part orders add $2.00 postage and handling. Connecticut residents add sales tax.

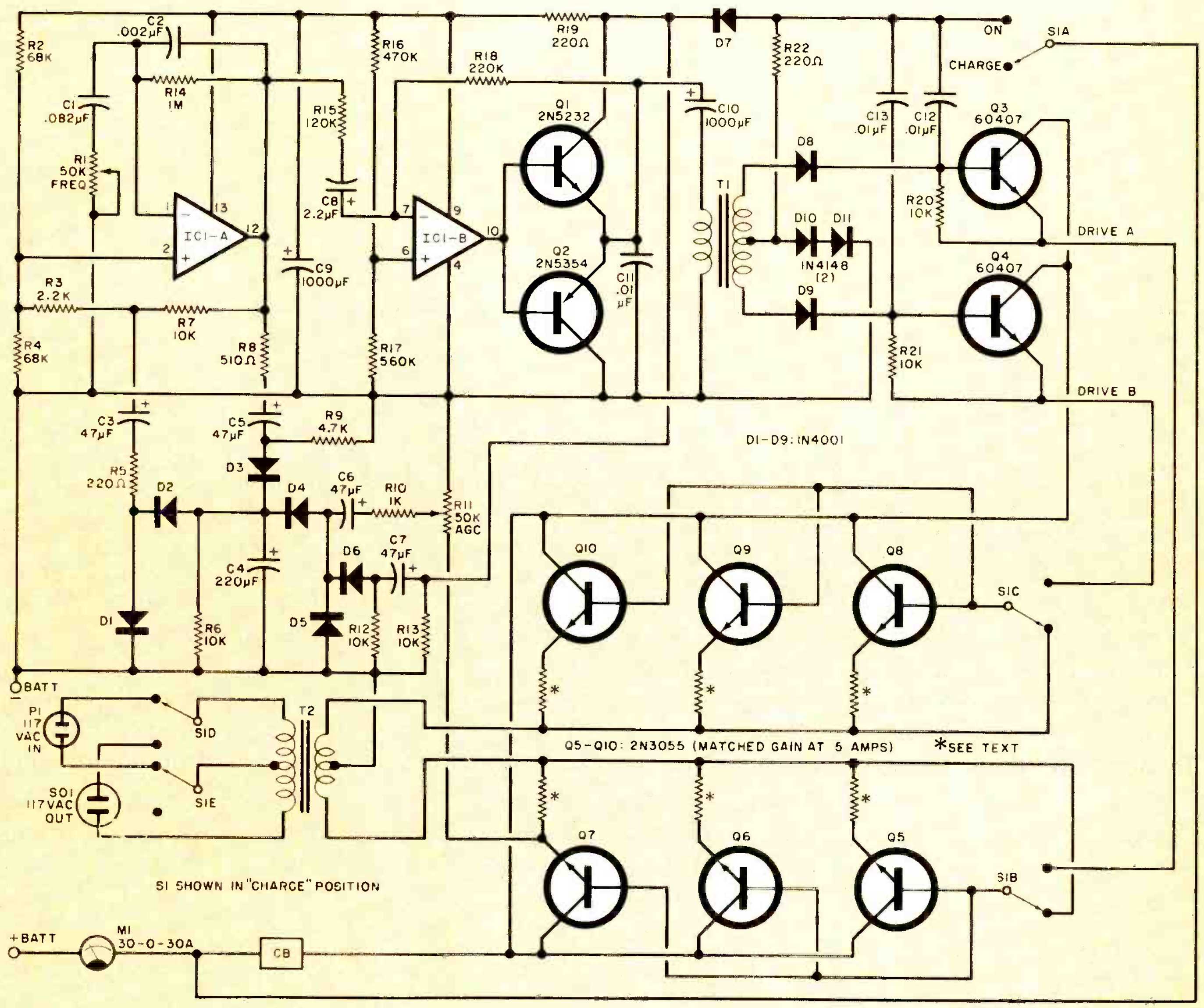

Fig. 1. A stable op amp audio oscillator is used to drive six high-power transistors, delivering 117 volts sine wave at any frequency between 50 and 400 Hz and with 100 watts of power.

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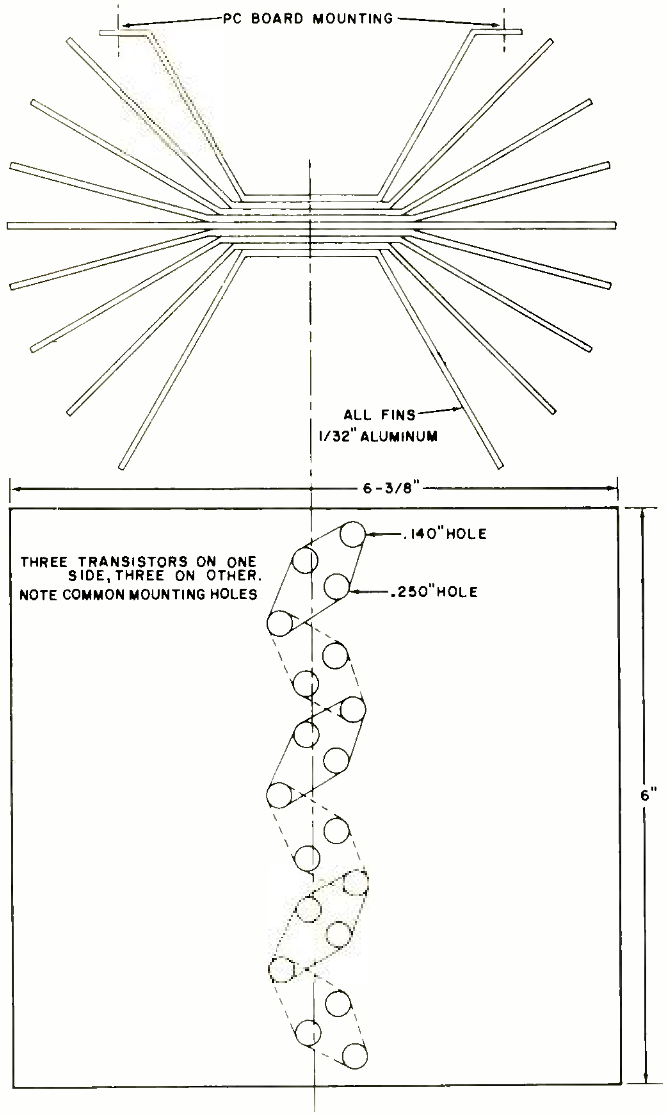

Fig. 2. Instructions and dimensions for making the heat sink. It must have at least 500 sq. in. of cooling surface.

discrete-transistor class-B pair (*IC1B*, *Q1* and *Q2*) and *T1*.

Transistors *Q3* and *Q4* are medium-power amplifiers, each one Darlington-connected to three high-power transistors (*Q8*, *Q9*, *Q10* and *Q5*, *Q6*, *Q7*). Transformer *T2* is the load for the high-power transistors and provides the 117-volt output at the preset sine-wave frequency.

Load regulation is provided by feedback from the emitter of *Q7* to potentiometer *R11* and then to the oscillator. Reguation from no load to full load is better than 6%.

When switch *S1* is set to CHARGE, the circuit (except for *Q5* through *Q10*) is disconnected from the battery, and the six high-power transistors act as rectifiers. The secondary of *T2* is connected so that the proper charging current is obtained.

An 18-ampere circuit breaker is mounted on the output stage heat sink to monitor the temperature and current drain. If the heat sink gets too hot due to improper ventilation, the current rating of the circuit breaker reduces proportionately. Thus, the inverter is protected from improper mounting or application.

The zero-center ammeter (*M1*) indicates the current drain when the circuit is inverting and the charging current when it is recharging a battery.

Construction. The crucial element in the assembly is the construction of the heat sink. To keep the operating temperature below 100°C, the heat sink must have more than 500 square inches of area. Details of the construction are shown in Fig. 2. Note that there are nine sections of 1/32"-thick aluminum in the heat sink, with holes drilled to mount the six power transistors.

After drilling the holes for the transistors, remove the burrs. The transistors share common mounting holes with three transistors on one side of the sink and three on the other. Use silicone grease under the transistors to insure intimate thermal contact with the heat sink. The transistor cases are not insulated from the sink as all collectors are connected in parallel. The heat sink is insulated from the metal case by four insulated stand-offs. Do not try to use a smaller heat sink or you will run the risk of damaging the transistors.

The remainder of the circuit is mounted on a pc board (Fig. 3). Note that the cases of diodes *D10* and *D11* are actually thermally bonded to the heat sink. The cutout in the board allows the diodes to contact the heat sink (with silicone grease to insure the contact). Transistors *Q3* and *Q4* are also mounted so they touch the heat sink. Their collectors are at the same potential as those of the power transistors. Drill suitable holes to attach the pc board to the lips on one end of the heat sink.

After selecting a chassis, mount the heat sink on four insulated stand-offs. The metal chassis must be floating, not connected to input or output.

The emitter resistors for transistors *Q5* through *Q10* are made of 14-inch lengths of #22 wire. It is important that the lengths of the resistors be as nearly the same as possible so that the transistors share equal amounts of the current. The secondary of *T2* is at 117 volts ac so use care in routing the leads. Dress leads away from the heat sink and use wire rated at 105°C.

The leads from the inverter to the battery (through the rear of the case) may carry as much as 18 amperes, so use heavy gauge wire or lengths of line cord with both leads in parallel for each side. If the connection is very long, use four parallel wires for each side to keep the voltage drop in the leads to less than 0.5 volt.

When assembly is complete, check again to make sure there is no connection between the case and the input or output.

Testing. With the cover off, set *R1* and *R11* to their mid-positions. Connect the battery leads to a high-current 12-volt source (vehicle battery). Turn the inverter on and note that the meter indicates less than 2 A drain. If this is not the case, immediately turn off the unit and determine the reason.

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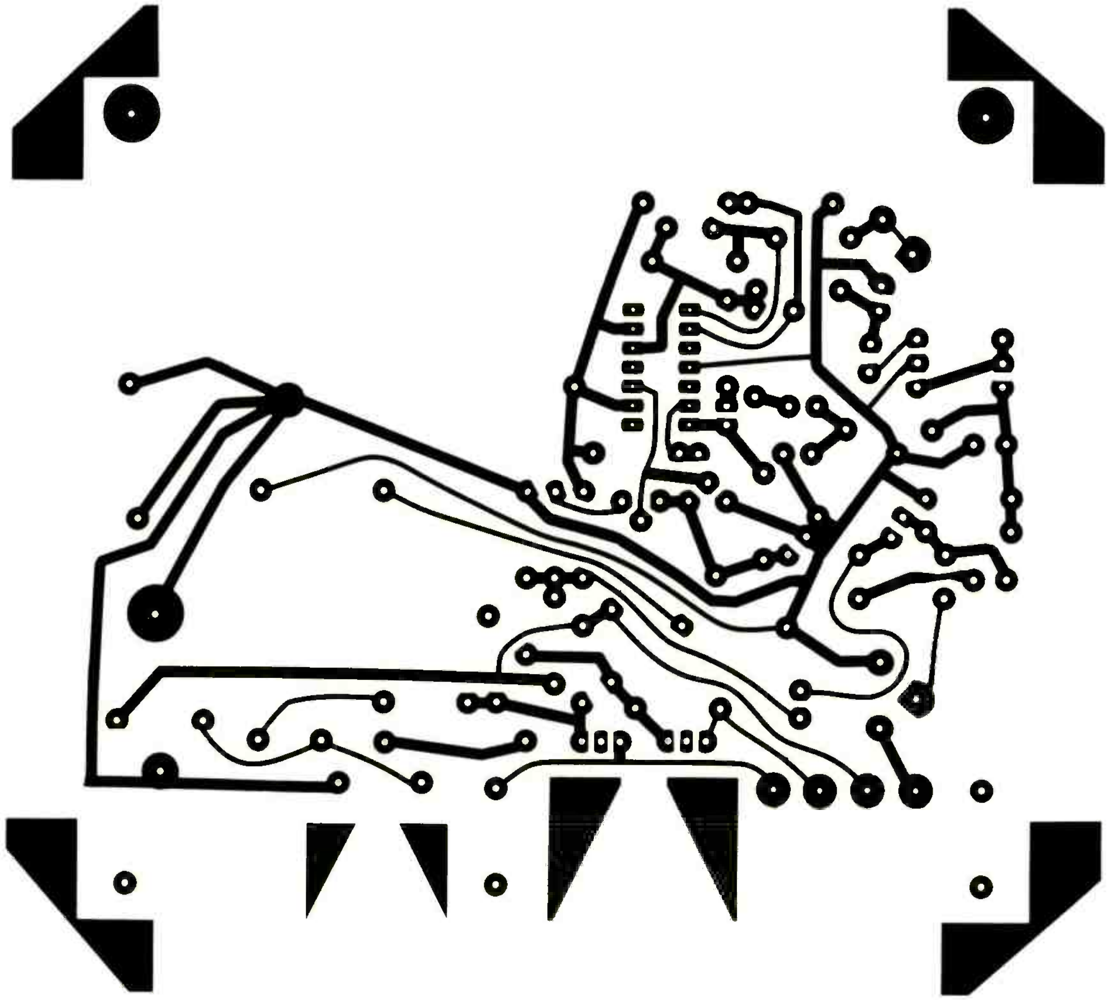

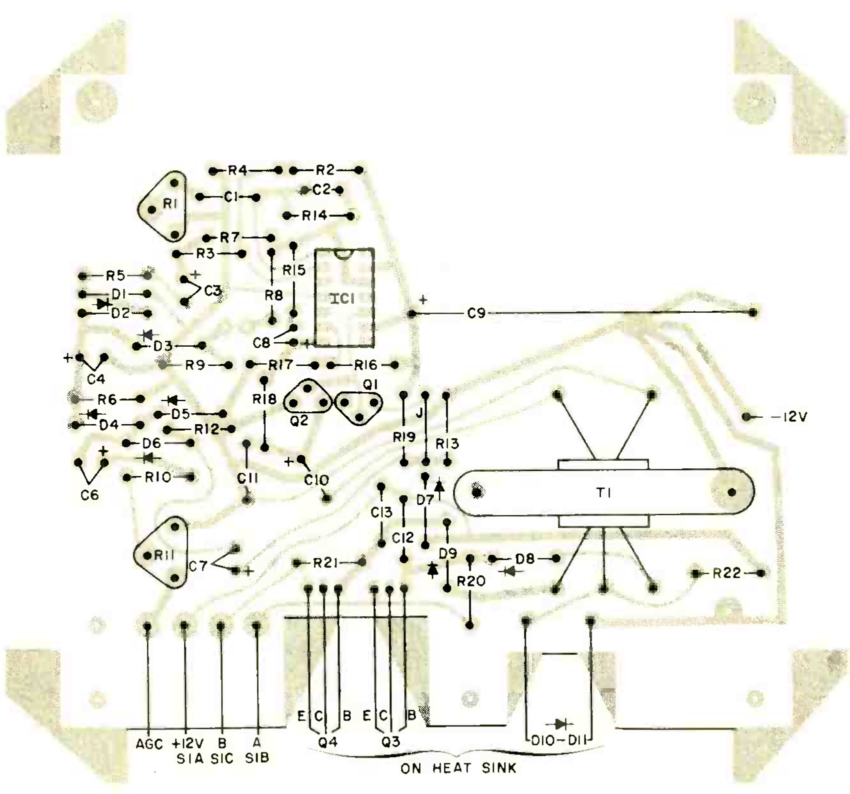

Fig. 3. Etching and drilling guide and component layout for pc board. D10, D11, Q3, and Q4 touch heat sink.

If the meter indication is correct, turn off the inverter and connect a 117-volt ac meter and a 100-watt lamp to *SO1*. Keep in mind that this is a hazardous voltage. Turn the inverter on and adjust *R11* to obtain 117 volts at *SO1*.

Use a frequency counter or the circuit shown in Fig. 4 to adjust *R1* for 60 Hz. In using the circuit in Fig. 4, adjust *R1* until the neon lamp does not flash (zero beat).

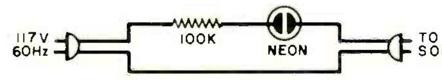

Fig. 4. Use this circuit to tune the inverter to 60 Hz.

Operation. This equipment, like any ac line-powered gear, must be treated with great care. The cabinet should be adequately ventilated at all times. The design is safe up to an ambient of 120°F. If the circuit breaker trips, check the ventilation and possibly reduce the output voltage slightly. It is good practice not to operate any electronic gear in an ambient in which a human is not comfortable. ◈

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SO YOU HAVE finally found what you hope is the last solder bridge on your homebuilt computer, put the case on, and turned the dining table back to your wife. Now you are ready to start using your computer; but after one long evening of working the switches and watching the lights, you realize you don't really know how.

Did you read the operating manual? If so, you would have found that there are a number of "input/output ports" available. However, you can't just feed data through an input port and expect it to come flowing from the output port. You have to have some peripheral devices to attach to those input and output ports.

A peripheral device can be a teletypewriter, card reader, paper-tape punch, CRT terminal, etc. Magnetic tape and discs are also part of the peripheral device scene. However, these devices don't just sit there and communicate with the computer automatically. You have to know how they work and how to "talk" to them through the input/output ports.

Every device has its own idiosyncracies. There are two main characteristics that we will consider here: character codes and speed.

Character Codes. The easiest way to get a good feel for the concept of a character code is to design an input device. First, we must decide upon its alphabet; that is, we must describe *precisely* the entire set of characters that this device will recognize. We then order these characters in whatever arrangement suits our fancy and number them from 0 to *n*, where *n* is the number of distinct characters in our alphabet.

The device is now constructed so that when it recognizes a specific character, say the 17th character in its alphabet, it transmits its *number*, 17, (in binary, of course) to the computer's input port.

The question arises: how many bits are needed to uniquely code an alphabet? The answer is that we need at

IN's and OUT's of COMPUTERS for BEGINNERS

BY EUGENE H. MITCHELL

Understanding character codes, flags, interrupts, DMA, and other computer terms.

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least $log_2 n$. Conversely, if a character code contains n bits per character, then the maximum number of characters is 2^n. Thus, an 8-bit code can describe a 256-character alphabet.

Another question is: how many characters do we need in an alphabet? In English, we need 26 letters, 10 digits, a number of punctuation characters, and a *blank*. Never forget that a *blank* is a character! If we allow for eleven punctuation characters we find we need a total of 48 characters. Note that we have 26 letters with no discrimination between upper and lower case. If we want both cases, we must add another 26 characters—upper and lower case of a given English letter are two completely different characters to a computer! The total is now 74 characters.

Five bits would give us 32 characters which is not enough. Six bits would permit 64 characters, so 6 bits is the minimum number we need for a reasonable alphabet, although we need at least 7 if we are to recognize both upper and lower case letters. For years the 6-bit code was a default industry standard and the default character set was the 48 characters available on the IBM model 026 keypunch. When IBM introduced the 360 computer they went to a model 029 keypunch with 64 characters. The computer, however, used an 8-bit character code.

You may have heard of a character code known as ASCII (American Standard Computer Information Interchange) which is used in the newer teletypewriters. This has an 8-bit code and 128 characters including upper and lower case. However, most teletypewriters have only upper case letters.

To build an output device, we go through a similar procedure. The major difference is that when the computer gives it a binary number, the output device produces the corresponding character of *its* alphabet, not necessarily the same as that of the input device.

Data Rate. Let's say the output device is a typewriter with a speed of 10 characters per second. Let's type the letters "AB". First, we put the code for an "A" in the output port, followed by the code for a "B". In your computer this would take a few microseconds. But it takes the device 1/10 of a second to type the A! Thus, it would do one of two things: type the A and never see the B, or never see the A and type out the B.

What we must do is put the code for the A in the output port, then do something else for 1/10 of a second (we may just have to waste 1/10 of a second by looping), then put the code for B in the port.

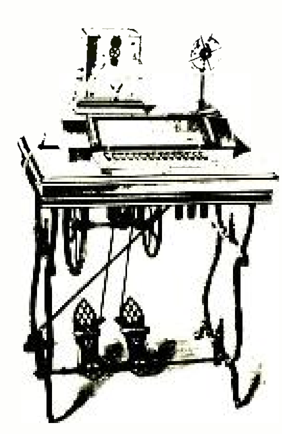
Let's leave the computer and look at the output port from the eyes of the device. First it "sees" the code for an A so it prints an A; then it looks back at the port and sees the code for a B and prints a B; then it looks back at the port and sees the code for a B (it's still there!) so it prints it. And so on, ad nauseum. We obviously need some method to avoid this. One way is to define a character code which means "do nothing" (this is NOT a blank). We will give this code a name; it is the *null* character. Then to send "AB" we output A (we really mean we output the code for an A), wait, output B, wait, then output *null*. The device prints the A, prints the B, then continuously does nothing so long as the *null* remains in the port. But this process can be improved.

One way to solve our problem is to use a special flip-flop, called a flag, for each output port. As long as the flag is reset (zero), the output device does nothing. If the flag is set, the device outputs the character from the output port and *resets the flag*. Thus, in general, we no longer need a *null* character; the flag bit takes its place. The control pulse generated by the computer to load the data into the output port is also used to set the flag.

We gained something else. If the computer can somehow determine the state of the flag bit, it can tell if the character previously in the output has yet been accepted by the device. This means that we no longer have to waste a programmed amount of time and *assume* the device has processed the character, but we can *verify*, by testing the flag. This is important when different models of the same computer run at different speeds. An Intel 8008-1 running at full speed cannot properly drive a teletypewriter using a program developed on a standard 8008, because the do-nothing loop has been programmed to waste the correct number of cycles for the 8008 clock. The do-nothing loop which tested the flag would work on either computer, because the device supplies the timing. This means that each output port must be associated with an input port to input the flag.

We must arrange the power-up logic so that all the flags are initially reset to prevent the output devices from outputting garbage when the machine is first turned on. Also, it would be nice to have a master clear button to force all the flags to zero if we need to manually stop and restart the computer. In some cases, it would be useful to have a special output port connected to the same master clear logic so the program could reset all flags with one instruction. We may also want the ability to set or reset individual flags under program control. This would require another output port for each output device. Thus, a full-blown flag facility would require two output ports and one input port for each output device. Similarly, it would need two input ports and one output port for each input device. Actually two output ports and one input port could handle all the flags if you dedicate one input and one output port to reading a flag and writing (setting or resetting) a flag, and another output port to specifying which flag is to be read or written.

Now let's look at an input using the flag bit. The input device would read a character, place its code in the input port, and set the flag. The program would then test the flag, find it set, and then read the character from the input port, resetting the flag. The problem here is that the operation is initiated by the device, not the program (this may be desirable in some applications). Usually, we don't want the input device to function until the program invites it to. This implies that we need two bits—one to tell the device to operate, and one to tell the computer that the operation is complete. Let us use our flag bit for the latter function and add an additional bit (a control bit) to control the device.



Input keyboard?

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Flag bits.

For output:

1. Set the control bit to start the device.
2. Put data in the output port, and reset the flag.
3. The device accepts the data and sets the flag.
4. The computer repeats from step 2 until all the data has been output.
5. The computer resets the control bit to stop the device.

For input:

1. Set the control bit to start the device and reset the flag bit.
2. The device puts data into the input port and sets the flag.
3. The computer reads the data from the port and resets the flag.
4. This repeats from step 2 until all the data has been input.
5. The computer resets the control bit to stop the device.

Call Me, I Won't Call You. If you are working when the phone rings, and you stop to answer it, you have been *interrupted*. The caller may have an urgent request for some information in which case you suspend what you are doing to supply the information, then return to your original task. On the other hand, the call may be simply to inform you that you are to be in a meeting at a later time. In this case, you post the request on your memo pad or calendar and at the proper time, stop what you are doing and attend the meeting. The call may also be to inform you that something you had previously requested of the caller has been completed. Such a facility, called *interrupt*, can be built into a computer.

If you have only one phone on your desk, you must ask the caller to identify himself when the phone rings, since many different people can interrupt you over the same phone. In a computer, this method is called a *basic interrupt* facility. Another method is a *vectored interrupt* facility. To illustrate, you may have a desk full of phones, with each number known to only one prospective caller. In this case, it is not necessary to have the caller identify himself. You know who it is by which phone is ringing. Alternatively, a small number of people may be given the same number so a particular phone does not uniquely identify the caller, but limits the possible callers to a small set. To implement an interrupt facility within the computer, we do the following:

1. Save the address of the next instruction in some specific place; in machines with a stack, it is usually convenient to stack it.
2. Force the program counter to a specific address.

In a *basic interrupt* facility, the address used in step 2 is the same, regardless of who interrupted. In a *vectored interrupt* facility, the address used is a function of the particular interrupt. (See the restart instruction on Intel machines.)

Now we can produce an even better input/output system than we have to date. Just wire the flag bit *true* output to the interrupt line. Actually, we should probably AND the flag and control bits and wire this to the interrupt line. Then, when the control bit is set (the device has been invited to operate) and the flag bit is set (the device has operated) the computer will be interrupted. Thus, we no longer need a timing loop to assume the operation is complete nor a test loop to verify the operation is complete. Simply go on with the program or go into a do-nothing loop until the interrupt occurs. No test is needed since the occurrence of the interrupt will automatically tap the computer on its shoulder and give it the address of another program to execute. This other program is called the interrupt service routine.

A Mind-Reading Machine. You may have noticed that we have been sending only one character at a time. Usually, a peripheral device has a line length that it prefers. Punched cards generally use 80 characters, printers 132, typewriters 72 to 90, etc. In many cases, these are specified in terms of the maximum number of characters. Such a group of characters is called a *record*. Some devices must transmit an entire record at a time, while others transmit *incrementally;* one character at a time. There is usually some character in a hard-copy machine's 'alphabet' which does not print, but causes the carriage to be returned, thus defining the end of the record. Some devices, such as discs, are built so that, once a transmission is started, an entire record must be transmitted. For this reason, a common method of programming prepares the entire record in the computer's memory, and then sends one character at a time. If the entire record is in memory, there must be a better way to output it!

Suppose we built an "intelligent" output port that operated as follows: In lieu of putting the individual characters in the port, we give the port the address of the first character and tell it the number of characters to transmit. Then we allow the "intelligent" port to reach into memory at its own speed to fetch the characters and pass them on to the device. Such an intelligent port is called a *direct memory access* device, since it reaches directly into memory as it performs its function.

But if the DMA is accessing memory and the computer is accessing memory, can't things get fouled up when they both attempt to access at the same time? They sure can! To use such a facility, the computer must be appropriately designed. Read your manual again. If you have a machine built around the Intel 8080 you will find a pin called HLDA (hold acknowlege) and another labeled HOLD. When HOLD is raised, the computer finishes its current cycle, switches the address and data buses to the high impedance state, and raises the HLDA line. At this point the memory bus is available to the DMA with no interference from the CPU (central processing unit). When HOLD is dropped, the CPU resumes its execution. Thus, the DMA can directly access the memory for either input or output. If the device attached to the DMA is medium- to low-speed, the HOLD line is dropped after every access to permit the CPU to operate. If the device is fast, the DMA can lock the HOLD line high and seize the memory for the duration of the transfer.

There are a number of methods to implement this DMA. The simplest assigns a particular address to each DMA when it is built or installed. The programmer must put the first character of each record for the DMA device at this address. Then, all he has to do is set the control bit and reset the flag, through an output port, to start the

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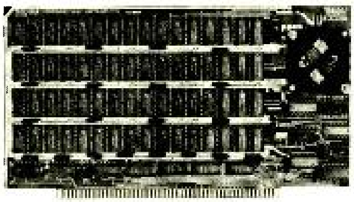

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transfer. When the operation is finished, the DMA sets the flag, and, optionally, an interrupt occurs. The problem here is that each record for the device must start in the same location and must be the same length.

A more flexible arrangement uses an output port to feed the address and the record length to the DMA. This would require a transmission of 4 characters in the proper order. At this time the DMA could start its function. Again, when the operation was finished, the flag would be set and/or an interrupt could be requested. An even more flexible arrangement would permit several devices to be attached to the DMA. The program would output 5 characters to the DMA to start it (2 characters for the address, 2 for the number of characters to transfer, and one to identify the device and specify the direction, input or output). Using an 8-bit character, we could use 1 bit to specify the direction (0 means output and 1 input, say) and the other 7 bits to specify one of 128 devices. By using an additional bit to inform the DMA whether to interrupt or not gives us more flexibility and still permits us to handle 64 devices. Of course, only one device can be in use at any given instant. A DMA such as that described above is sometimes referred to as a basic input/output channel. Note that, while the DMA is functioning, the CPU can still operate, possibly at a reduced speed due to the fact that the DMA is stealing memory cycles from the CPU. If the DMA is locking the HOLD line high, the CPU cannot operate, of course, until the transfer is complete.

Since the DMA can effectively lock out the CPU, we must arrange the power-up and master clear logic so that no DMA will attempt operation until the CPU directs it to.

Control And Status Signals. There are two types of transmissions yet to be considered: *control* signals sent to the device, and *status* signals received from the device.

Control signals cause the device to perform non-data operations such as start a new line, start a new page, backspace, etc. There are two ways to send such signals to the device. The first is to have a separate control path to the device from the computer, while the second is to define certain alphabetic characters as control characters rather than data to be printed. It is this second method that is used in ASCII. In many cases, the same bus which carries the data also carries the control signals, but a secondary line is raised to indicate that the information is control data and not alphabetic data. Control signals are used to cause tape drives to rewind or backspace over a record, a disc drive to select a different track, a hard-copy machine to return the carriage (and, usually, start a new line), printers to skip to a pre-defined spot on the page, erase the screen on a CRT, etc.

Status codes are sent from the device to the computer and generally are used to convey information about the device's condition. Common items of information which are conveyed to the computer are the status of the device's power supply (on or off); an indication that it is busy (for instance, a carriage return takes much longer than typing one character); that one or more characters were sent (or received) erroneously during the last transmission; that a tape drive is at the beginning of the tape and should not be backspaced further; that a tape drive is at the end of the tape and no further attempt should be made to read or write it; etc. Status information can be treated in much the same way as control information. It can be returned to the computer over a separate bus; it can come over the data bus accompanied by a signal which identifies it as status rather than data; or it can be built into the device's alphabet.

Notice that input devices now, in general, have an output type of characteristic, so we can send an input-device control signal. In the same way, output devices generally provide for input of their status. The two can also interact. A particular device may send status information to the computer only after it has been invited to do so by a command signal. In many cases, the system protocol requires a device to send status information at the end of every transmission. In some cases, the "standard" status is assumed to be that every thing is fine unless something goes wrong. In such cases, we frequently find that the status information is wired to an interrupt so that, as long as the transmission is proceeding according to plan, nothing happens; but an interrupt occurs if an unusual condition arises. At this time the interrupt program can request the status to obtain the details of what happened. ◈

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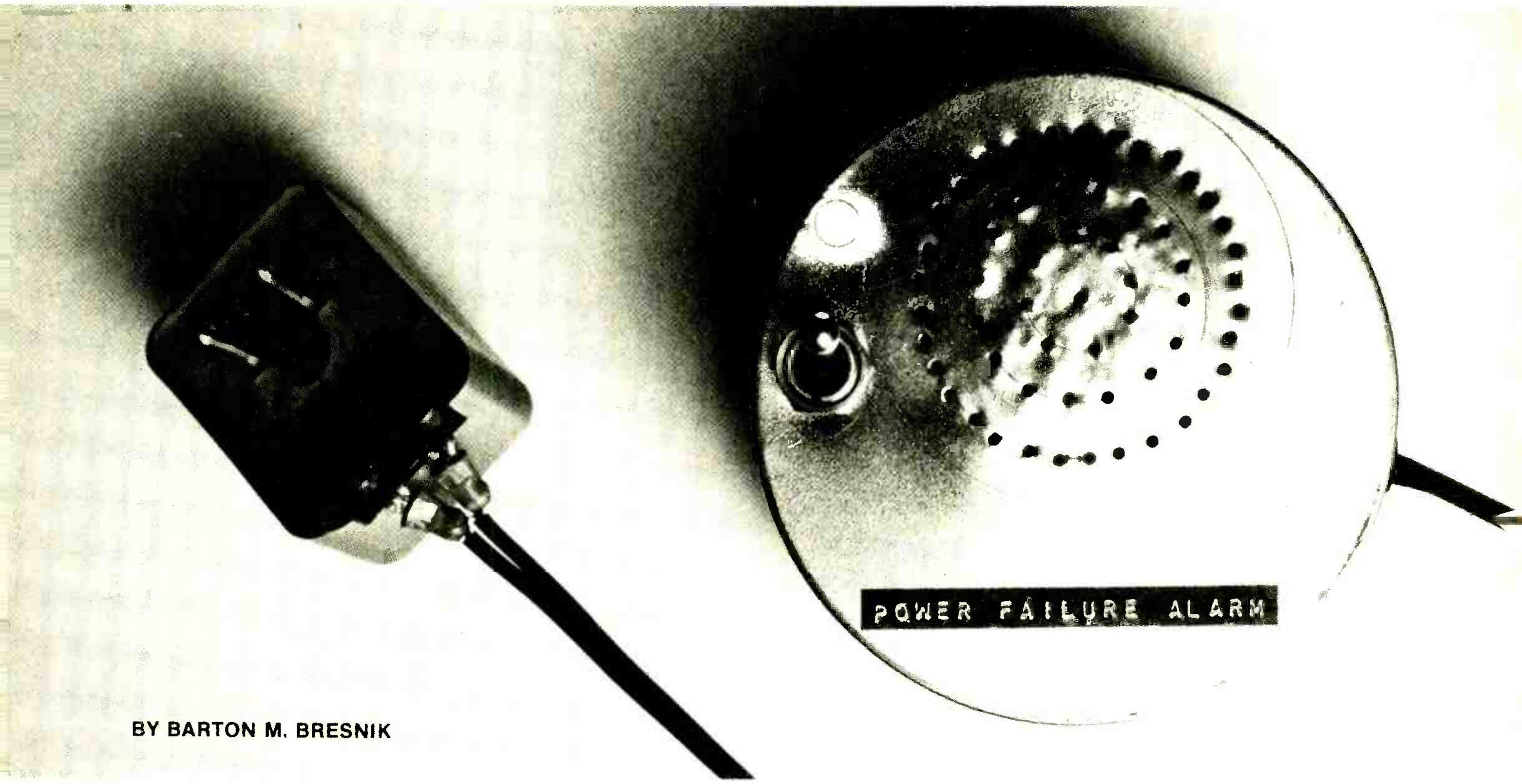


BY BARTON M. BRESNIK

POWER-FAILURE ALARM

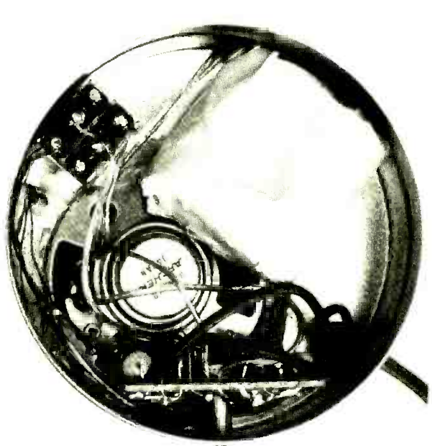
Lets you know when a power outage occurs.

SUMMER or winter, night or day, a power outage in your local utility system can cause all sorts of problems in your home. Heating and cooling systems shut down, refrigerators and freezers come to a halt, and your electric alarm clock stops, making you late for work.

The power-failure alarm is a battery-powered device that sounds an alarm when a power failure occurs. Then you can, at least, turn off devices that might blow fuses when the power returns and take what other steps are necessary to protect your property.

How It Works. Battery *B1* (Fig. 1) gets a constant trickle charge from the transformer through *D1* and *R1*. As shown here, the battery is made up of two 1.25-V NiCd cells. Sealed NiCd or lead-acid storage cells with higher voltage ratings could be used. Vented secondary batteries can be used if the electrolyte is checked every few months. If carbon-zinc or manganese-alkaline cells are used, the value of *R1* should be increased to 47,000 ohms. Remember also that manganese-alkaline and mercury cells may burst when recharged.

The alarm generator consists of a two-transistor astable multivibrator and associated loudspeaker, while the trigger portion uses an SCR and related bias components. The SCR is in a feedback loop from the emitter of *Q2*. The gate of *SCR1* is biased low enough to keep it from firing by the combination of *R3* and *R4*. When a power outage occurs, the voltage from the battery turns on the SCR, and the multivibrator provides an audio-frequency signal to the speaker.



Author's prototype was assembled in a 35-mm film container.

The time delay provided by *C1* and *R3* is used to keep the system from operating in case there is only a brief loss of power (which can be caused by lightning) or a line transient.

In standby operation, the circuit draws less than 1 mA, which is supplied by the trickle charging current. When an outage occurs, and the SCR turns on, the current increases to 15 mA for a 2.5-V battery and 50 mA for a 4.5-V source.

The lamp circuit is optional and can be used to check the battery. The lamp can also be made to glow during a power outage by connecting a silicon diode between the LAMP position of *S1* (anode of the diode) and the anode of *SCR1* (cathode of the diode).

Construction. The prototype of the alarm was assembled on a small piece of perforated board with point-to-point wiring. For transformer *T1*, use a standard recharging unit which plugs directly into a wall socket. This provides a safety feature in that only 6.3 volts is used in the chassis.

Mount the completed assembly in any type of enclosure with only *S1* and some speaker holes on the top. (The

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PARTS LIST

B1—Two 1.25-V NiCd cells (Lafayette 32F47400 or similar)
C1—100-μF, 10-V electrolytic capacitor
C2—0.05-μF disc capacitor
D1,D2—1N4001 diode
I1—2.5-to-3.0-V lamp (or #48)
Q1—2N3638 transistor
Q2—2N2621 transistor
R1—680-ohm, ¼-W 10% resistor (or 47,000-ohm, see text)
R2—3300-ohm, ¼-W 10% resistor
R3,R4,R5—10,000-ohm, ¼-W 10% resistor
R6—1000-ohm, ¼-W 10% resistor
R7—100-ohm, ¼-W 10% resistor
SCR1—Silicon controlled rectifier (GE-X5 or 2N5060)
SPKR—8- or 10-ohm speaker (Lafayette 99F60972 or similar)
S1—Spdt switch
T1—6.3 volt, low-current "wall-socket" transformer (Lafayette 33F37029 or similar)
Misc.—Suitable enclosure, rubber grommet, mounting hardware, circuit board, etc.

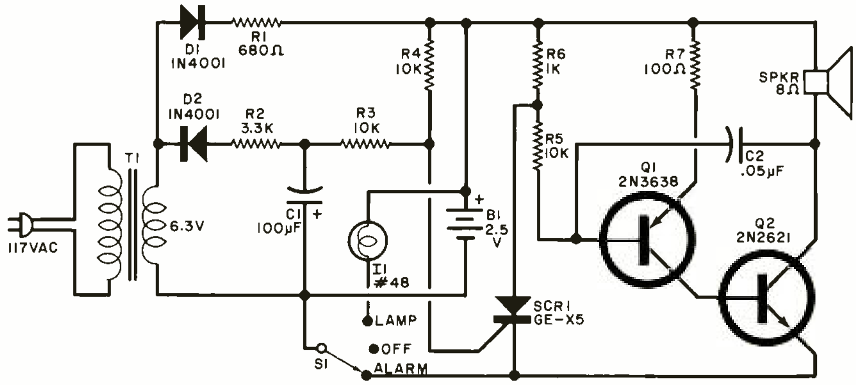
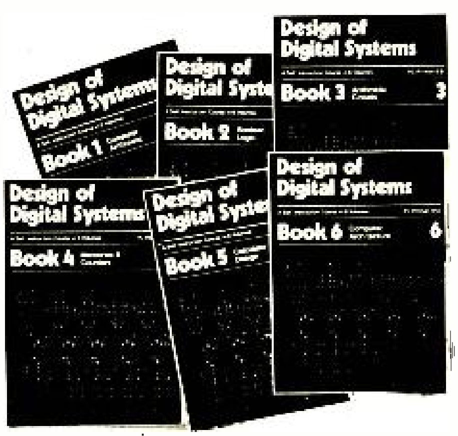


Fig. 1. The two-transistor audio oscillator is inoperable until the SCR conducts. This occurs when the power line fails and the battery voltage is applied to the SCR gate. Do not use an on-off switch with the unit.

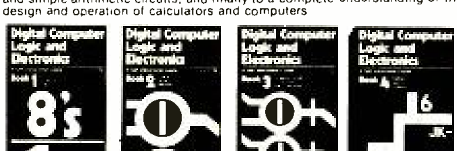
author used a 100-ft, 35-mm film container.) The optional "grain-of-wheat" lamp can be mounted in a hole drilled in the container using epoxy glue to secure it in place. Since none of the parts is critical, feel free to experiment with "junk box" items.

To test the device, turn the switch to OFF, plug the transformer in a power outlet, and then turn the switch to ALARM. Unplug the transformer from the wall socket. After a few seconds, the alarm should sound, continuing even when the transformer is put back in the socket. This locking feature reminds you to reset clocks if you were not at home when the outage occurred.

If you are using rechargeable cells, connect a current meter in series with the battery and check that, with the transformer plugged in, the charging current is within the limits prescribed for the cell. ◈



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each 11-1/2" x 8-1/4" — are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra, to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.



Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes — each 11-1/2" x 8-1/4" — and serves as an introduction to the subject of digital electronics. Everyone can learn from it — designer, executive, scientist, student, engineer.

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Book 3 Half adders and full adders, subtractors, serial and parallel adders, processors and arithmetic logic units (ALUs), multiplication and division systems.
Book 4 Flip flops, shift registers, asynchronous and synchronous counters, ring, Johnson and exclusive-OR feedback counters, random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators, keyboard encoding, decoding display data, register systems, control unit, program ROM, address decoding, instruction sets, instruction decoding, control program structure.
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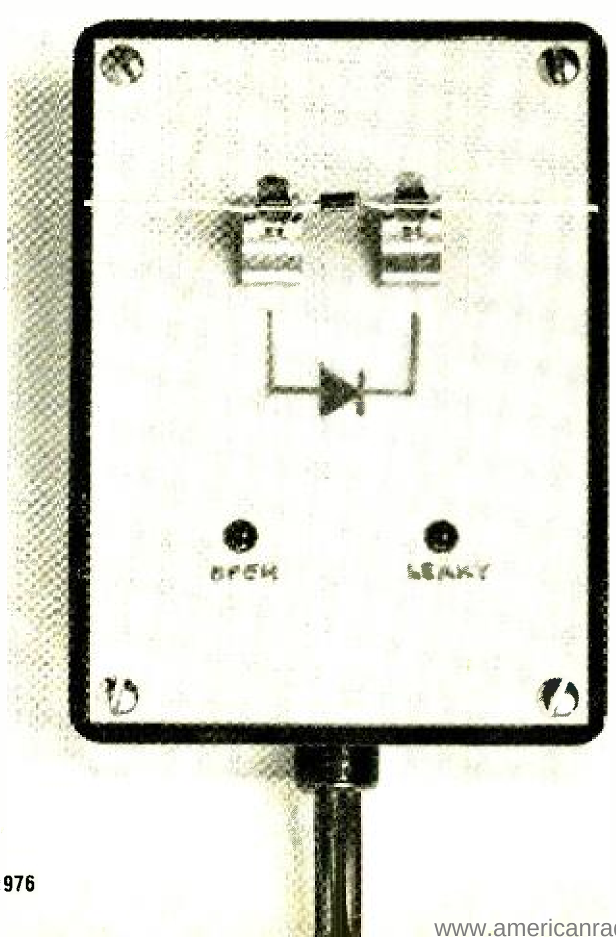
Automatic Diode Checker

Makes a complete check in 1/60th of a second.

BY R. M. STITT



MOST EXPERIMENTERS think that using an ohmmeter is the best way to test a semiconductor diode. However, some ohmmeters supply too much current to the device, causing an "open" where one does not really exist. Other meters indicate values of forward and reverse resistance, which hopefully give an indication of the diode's condition.

In the Automatic Diode Checker described here, the diode is tested in the forward-bias condition for excessive voltage drop and then in the reverse condition for excessive leakage current. Each test is made during one half of the power-line frequency, and the results are displayed simultaneously on two LED's labeled OPEN and LEAKY. The LED marked OPEN is illuminated when there is excessive voltage drop. The other is lit when there is excessive reverse leakage. If the diode fails both tests, both LED's are on. With no diode in the clips, the OPEN indicator is on.

When a good diode is inserted in the test clips (correctly oriented), both LED's should be off. There will be no damage to either the diode being tested or the diode tester if the diode is inserted the wrong way; but both LED's will glow.

The peak reverse voltage is less than 18 volts and the peak forward current is less than 4 mA. With the values shown in Fig. 1, OPEN indicates a forward voltage drop in excess of 1.3 volts at 3 mA; and LEAKY indicates a reverse leakage current of about 0.05 mA at 16 volts.

How It Works. On one half cycle of the ac supply, the OPEN circuit is active (*D1, D2, D3, R2, R3, Q1* and *LED1*). In this half cycle the upper ac line is positive. (*D4* and *D5* are reverse-biased to isolate the other part of the circuit.) Current, limited by *R2*, flows through *D1* and the diode being tested. The voltage across the test diode is applied through *D3* to the base of *Q1*. If this voltage exceeds 1.3 V, *Q1* turns on and sinks current through *LED1*, indicating high forward drop.

When the ac supply reverses, the lower part of Fig. 1 is active, with *D1* and *D2* reverse-biased to shut out the OPEN part of the circuit. Any reverse leakage current through the test diode flows through *R1*, creating a potential across it. This voltage is applied to the base of *Q2* through *R7* and *D5*. When this voltage exceeds about 2 volts, *Q2* is energized, turning on *Q3* and *LED2*.

Since the circuit uses a conven-

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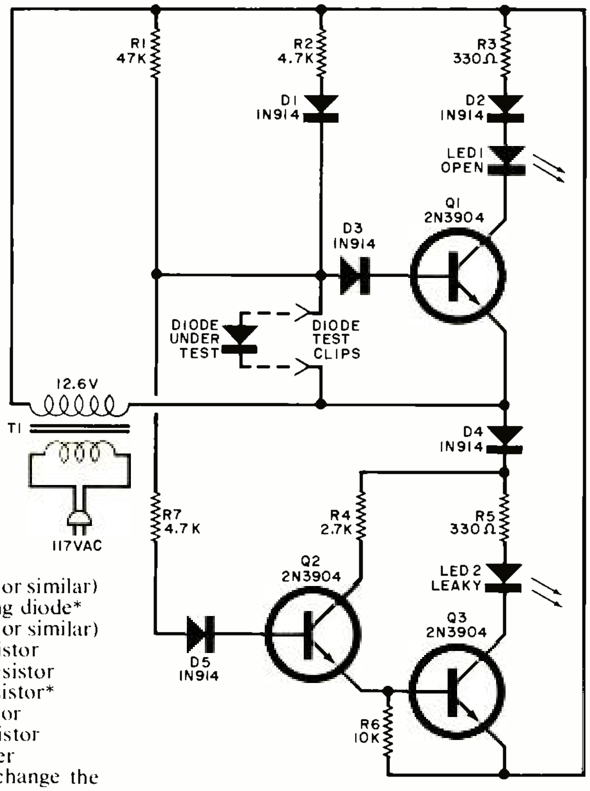


Fig. 1. The "open" circuit operates when upper ac line is positive. "Leaky" circuit operates when this line is negative. Both circuits test diode at line frequency.

PARTS LIST

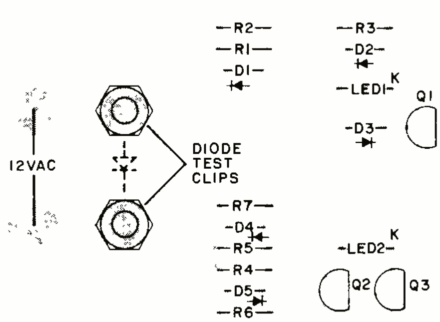
D1 to D5—Silicon diode (1N914 or similar)
LED1,LED2—Red light emitting diode*
Q1,Q2,Q3—Transistor (2N3904 or similar)
R1—47,000-ohm, ¼-W, 5% resistor
R2,R7—4700-ohm, ¼-W, 5% resistor
R3,R5—330-ohm, ¼-W, 5% resistor*
R4—2700-ohm, ¼-W, 5% resistor
R6—10,000-ohm, ¼-W, 5% resistor
T1—12.6-V, 100-mA transformer
*R3 and R5 can be varied to change the brightness of the LED's.
Misc.—Diode test clips, plastic case (Harry Davis #220 or similar), line cord, grommet, mounting hardware, etc.

Note: A complete kit of parts is available from: Atlantis, Box 12654, Tucson, AZ 85711, for $19.95.

tional 12-volt transformer, no dc supply is required and all switching is performed automatically at 60 Hz.

Construction. Although circuit layout is not critical and any type of construction can be used, a unique approach was used in the author's prototype as shown in the photographs. The pc board foil pattern shown in Fig. 2 can be used to make a board which has the components mounted on one side with the other side serving as the cover for the plastic case. The component holes are drilled only half-way into the board. The only holes drilled all the way through the board are those for mounting the LED's and the diode test clips. The other components are mounted by bending and cutting their leads so that they just fit on their pads. Solder must be applied quickly and properly to insure a good mechanical hold.

Transformer *T1* can be attached to the bottom of the plastic case, with plastic foam insulation between the transformer and the components on the board. Use a grommet on the hole for the line cord in the side of the case.



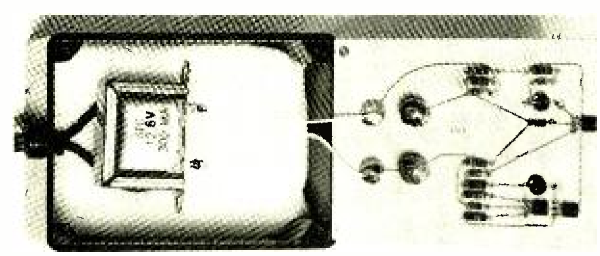
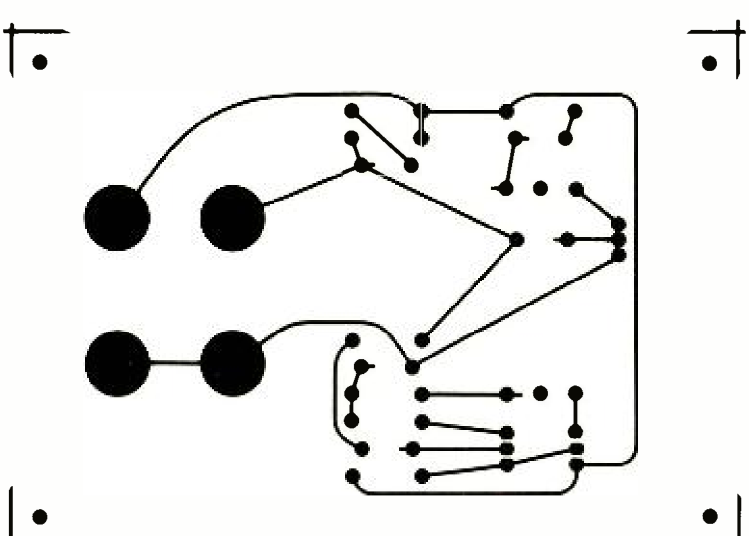


Photo shows how components are mounted on pc board with the transformer in the bottom of the case with foam insulation.

Fig. 2. Pc board can be used as case cover with component mounting as shown at left.



Identify the LED's on the front of the pc board, and draw a diode symbol between the two test clips with the anode side going to the junction of *D1* and *R1*.

Checkout. Check the pc board for correct installation of components, and then apply power to the tester. The OPEN indicator should come on. Connect a diode that you know is good between the test clips. Note that both LED's are off. Remove the diode and connect a 100,000-ohm resistor between the test clips. Note that both LED's are on. Remove the resistor and connect two or three good diodes in series across the test clips. Only the OPEN LED should turn on. ◈

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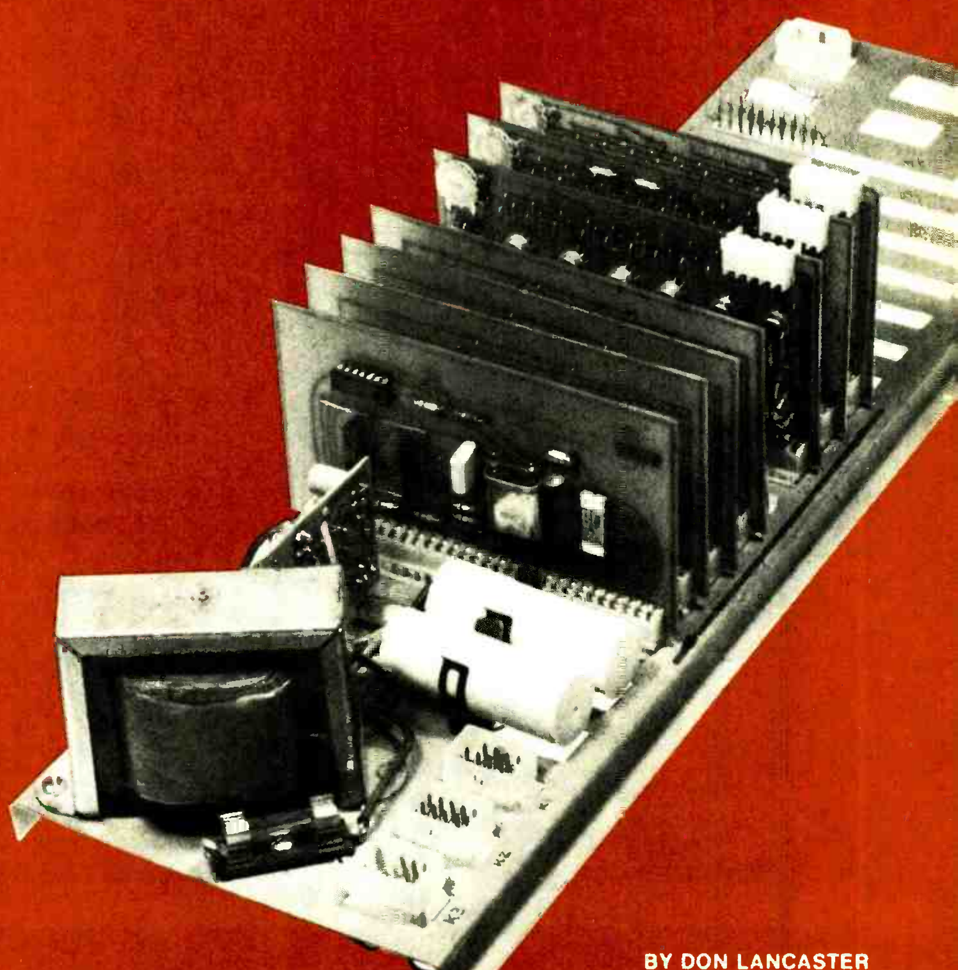
MUSIC MODULES

TO BUILD YOUR OWN SYNTHESIZER

Low-cost, easily assembled units can be used for a number of different instruments.

BY DON LANCASTER



HERE is a practical, low-cost way to build your own electronic music system. The "Music Modules" presented here are a series of snap-together blocks that let you build any instrument you want, of any desired complexity, using virtually any system architecture you can dream up. Like traditional organ circuits, the system can be equally tempered and fully polyphonic, and it generates up to 97 notes simultaneously with extreme, permanently tuned stability.

As with some synthesizers, the Music Modules give you a wide range of control over the attack, sustain, fallback, decay, snubbing, bite, and echo of a note. As an option, you can have complete control over glides, slide, and portamento effects in either single or multiple voices. The system is economical enough to permit you to make simpler things like pitch references, calliopes, computer music interfaces, composers, and sideman rhythm mates.

The basic system is composed of three modules: a top-octave generator and translator, a sawtooth divider, and a dual hex vca (voltage-controlled amplifier). You can combine as many of these modules as you want with a power supply and professional keyboard to form the heart of any instrument. What we have here, in effect, is the usually difficult-to-build and expensive repetitive circuit that is the core of any quality polyphonic system reduced to a few simple CMOS circuit blocks.

Some Basics. The top-octave generator schematic diagram is shown in Fig. 1. It starts with a 2.000-240-MHz crystal for single, fixed tuning. If you want to tune another instrument, do glides or vibrato, or add noise or other frequency-modulation effects, you can break the oscillator's output circuit and add a variable master pitch reference. A seven-stage binary divider follows the oscillator to reduce the octaves down the scale.

Four possible frequencies are selected from the divider by an electronic switch. These are the crystal frequency and one-half, one-quarter, and one-eighth of the crystal's frequency. The selected frequency goes to a special IC that automatically develops all the notes of the top octave. With the electronic selector switch, you can choose the top octave, which means you can use a short keyboard and only a few vca modules and still be

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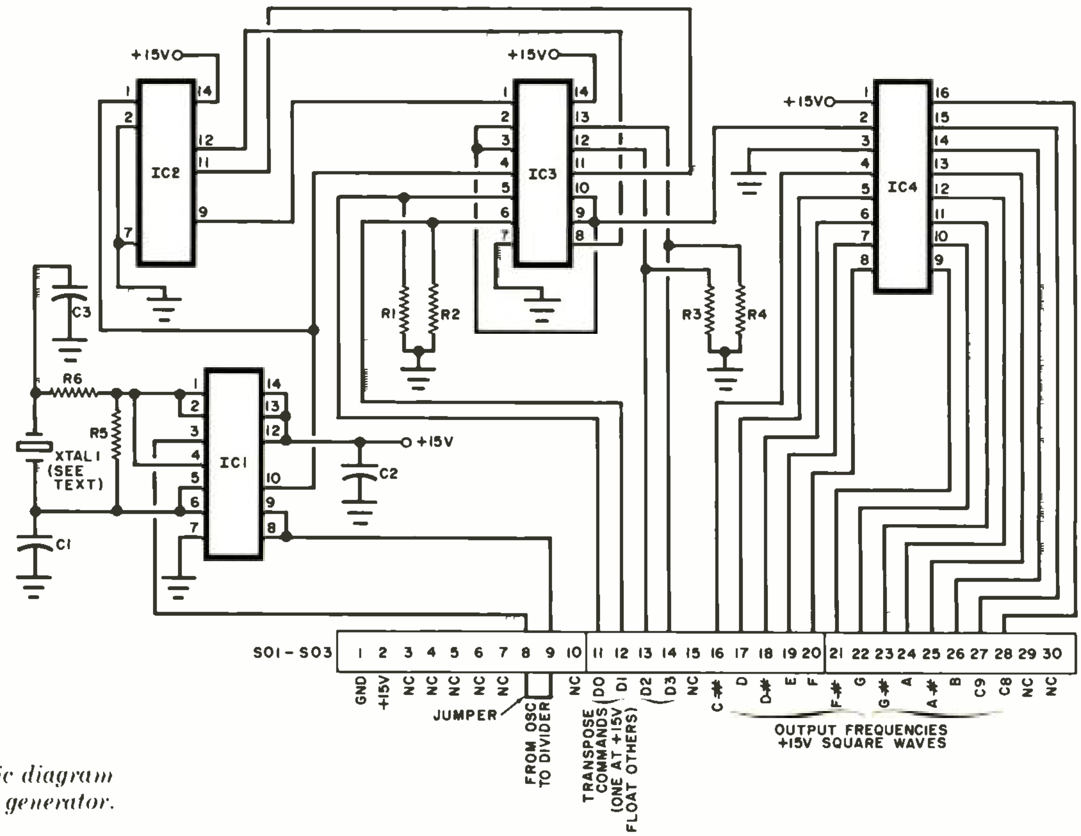

Fig. 1. Schematic diagram of the top-octave generator.

PARTS LIST

Top-Octave Generator & Translator

C1, C3—27-pF mica or polystyrene capacitor
C2—0.1-µF, 50-volt Mylar capacitor
IC1—CD4001 CMOS quad NOR gate IC
IC2—CD4024 7-stage CMOS binary divider IC
IC3—CD4016 quad CMOS switch IC
IC4—MK5024P-AA integrated circuit
R1 through R4—100,000-ohm, ¼-watt resistor
R5—10-megohm, ¼-watt resistor
R6—10,000-ohm, ¼-watt resistor
SO1 through SO3—10-contact Molex No. 09-52-3153 connector
XTAL—2.000240-MHz parallel-resonant crystal (30-pF load).
Misc.—Printed circuit board, hookup wire; solder; etc.

able to generate all the notes you need.

The pitch generator divides the 2-MHz reference 13 different ways to generate the 13 notes of top octave C7 through C8 (2093.01 to 4186.02 Hz). These note divisions approximate the equally tempered music scale with an accuracy better than can be determined by the best musician. Thirteen different references, each one of which corresponds to a different note, are produced simultaneously: C7, C#7, D7, D#7, E7, F7, F#7, G7, G#7, A7, A#7, B7, and, in the next octave up, C8. (For more information on musical pitch, see "Electronic Music Pitch Standards," POPULAR ELECTRONICS, January 1974.)

There are at least two ways to use the top-octave system. In traditional organ architecture, you provide 12 outputs simultaneously and route them to divider modules so that you have all the notes you need all the time. You can also use the translator and an external 1-of-12 selector to generate any single note under digital command. This is ideal for computer control, pitch references, and many synthesizer applications. Only an on/off keyboard without precision resistors is needed, and the normally troublesome exponential or logarithmic conversion circuitry is built into this module, which is essentially "free" and temperature, time, and voltage stable. All you do is provide a number or digital word to get the note out.

The divider module takes three of the notes of the top octave and generates all equivalent lower-octave notes down to zero (Fig. 2). For instance, suppose one input of one divider module is fed note A7. The outputs of the module will be eight notes (A7 down to A0), each one octave or 2:1 frequency lower in pitch. Each octave output is a square wave, which can be used directly for economy or where you want to imitate "woody" tones (clarinet or stopped organ pipe). The module also contains some resistor networks that convert the square waves into sawtooth outputs. More precisely, it converts them into a stepped approximation of a sawtooth, but the two are identical once you start to filter them. A sawtooth or its stepped approximation contains nearly all harmonics, compared to a square wave that has only odd harmonics. You can also filter the outputs of this module to recover sine or near-sine waves for flute-like tones.

One top-octave generator and four divider modules are needed to generate all 97 notes either as square or sawtooth waves.

The dual hex vca module provides a means of turning on and off 12 notes combined as two groups of six notes each (Fig. 3). There are several ways you can use this module. Connect the decay bus to −15V, and you obtain simple on/off control of each note without key clicks or other undesirable effects. Grounding a keying input produces a note, while leaving it floating stops the note. Connect the decay bus to +15V, and you get a sharp attack, gradual decay, or long sustain keying characteristic. If you connect

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your keying input to a source of controlled-width pulses, you gain complete control of attack, fallback, sustain, and decay of all notes simultaneously, independently and exponentially, with very little added complexity. A storage capacitor on each keying input averages out these control pulses and provides a wide range of independent control of each note.

PARTS LIST

Triple Divider Module
C1—0.1-μF, 20-volt disc capacitor
IC1 through IC3—CD4024 7-stage CMOS binary divider IC
The following resistors are ¼-watt, 10%:
R1 through R8, R35 through R42, R69 through R76—220 ohms
R9 through R16, R43 through R50, R77 through R84—100,000 ohms
R17 through R23, R51 through R57, R85 through R91—200,000 ohms
R24 through R29, R58 through R63, R92 through R97—390,000 ohms
R30 through R34, R64 through R68, R98 through R102—750,000 ohms
SO1 through SO3—10-contact Molex No. 09-52-3153 connector
Misc.—Printed circuit board; hookup wire; solder; etc.

Fig. 2. The divider module takes three of the notes of the top octave and generates equivalent lower-octave notes.

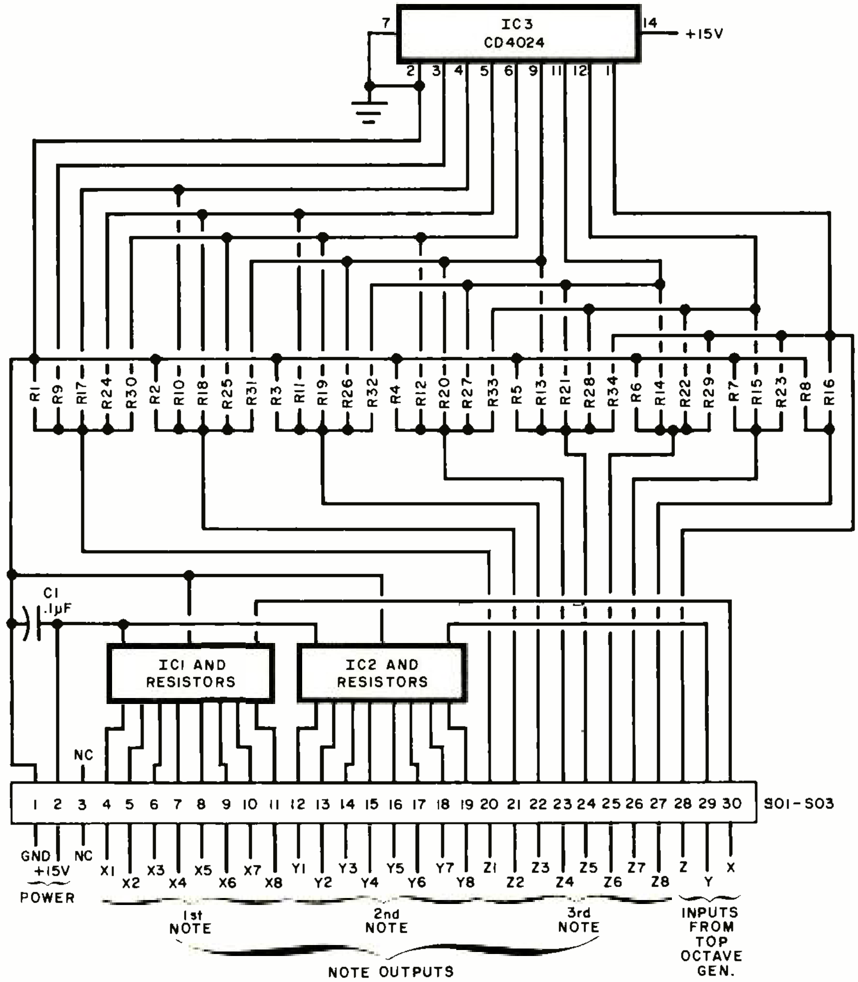
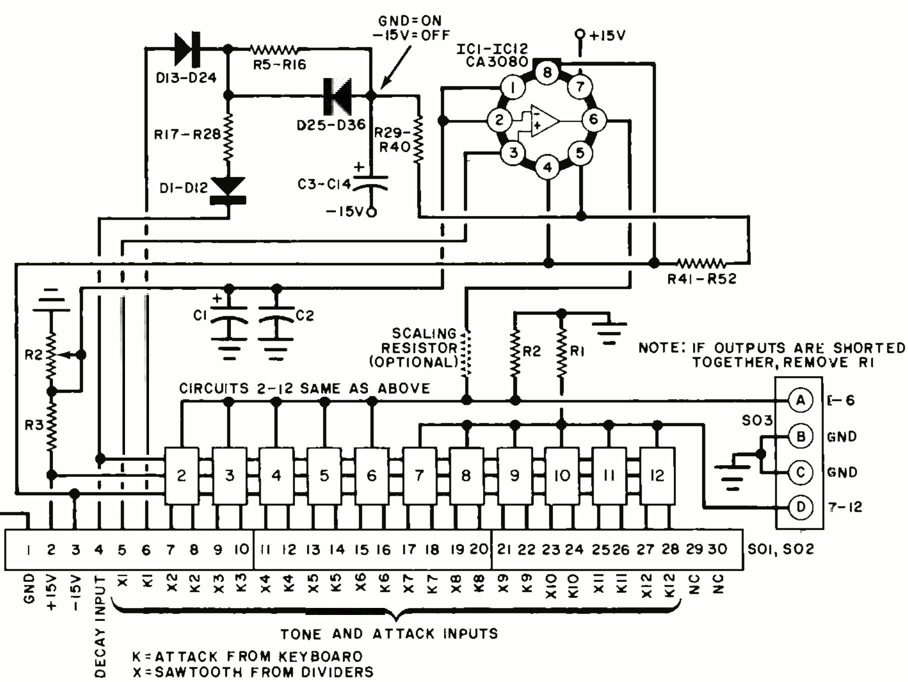


Fig. 3. The dual hex vca module provides for turning on and off 12 notes combined as two groups.

PARTS LIST

Dual Hex VCA
C1—500-μF, 3-volt electrolytic capacitor (14 mm maximum height)
C2—0.1-μF, 25-volt Mylar capacitor
C3 through C14—1-μF, 35-volt high-quality electrolytic capacitor with axial leads
D1 through D36—1N914 (or similar computer-type) diode
IC1 through IC12—CA3080 transconductance amplifier IC (RCA)*
The following resistors are ¼-watt, 10%:
R1, R2—22,000 ohms
R3—220,000 ohms
R5 through R16—10,000 ohms
R17 through R28—3300 ohms
R29 through R40—2.2 megohms
R41 through R52—680,000 ohms
R4—1000-ohm flat-mounting pc potentiometer
SO1 through SO3—10-contact Molex No. 09-52-3153 connector
SO4—4-contact Molex No. 09-52-3042 connector
Misc.—Printed circuit board; hookup wire; solder; etc.

*There are several different packages available for the CA3080, which fits the TO-5 pin circle shown in the foil pattern. The CA3080S and CA3080E fit 8-pin dual inline minidip patterns. Be sure your pc layout and IC's are compatible. All three package styles remain available from RCA.



Note—The following items are available from Southwest Technical Products Corp., 219 West Rhapsody, San Antonio, TX 78216: No. TOb printed circuit board for top octave generator for $5.50; complete top-octave generator kit, No. TO-1 for $17.25; No. TDb pc board for triple divider for $5.75; complete triple divider kit, No. TD-1, for $10.50; No. TXb dual hex vca pc board for $4.75; complete dual hex vca kit, No. TX-1, for $21.50; No. TP-1 regulated power supply kit for $17.50. A fully assembled 37-note professional keyboard designed to AGO standards, No. AGO-37, is available for $65.00 (includes $5.00 for handling) from PAIA Electronics, P.O. Box 14395, Oklahoma City, OK 73114. Allow four weeks for delivery.

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There are 12 IC's in the vca module. Each controls the gain of a single note. The outputs are normally wired so that six share a common load resistor. However, you can easily break out one or more individual vca's for such things as loudness control, quadrasonic fading, or position modulation, or to introduce tremolo or noise amplitude modulation.

You can use as many vca modules as you want in your system, adding one for each independent, polyphonic octave. Since keyboards are one of the major expenses in any electronic music system, it pays to keep the keyboard as short as reasonably possible. This also cuts down on the number of vca modules you'll need. Remember that you can still get all the notes you want by using the translator switches on the top octave module.

A 72-note polyphonic system, using a 36-note (three octave) keyboard, the top-octave module, four sawtooth dividers, and three vca modules, is shown in Fig. 4. A four-position switch selects which three octaves are to be played at any time. Note that this is only one possible polyphonic arrangement. You can add or eliminate as many parts as you want. In addition, there are all sorts of simpler monophonic variations. A top-octave module and part of a vca module can give you the heart of a synthesizer or a computer-controlled instrument.

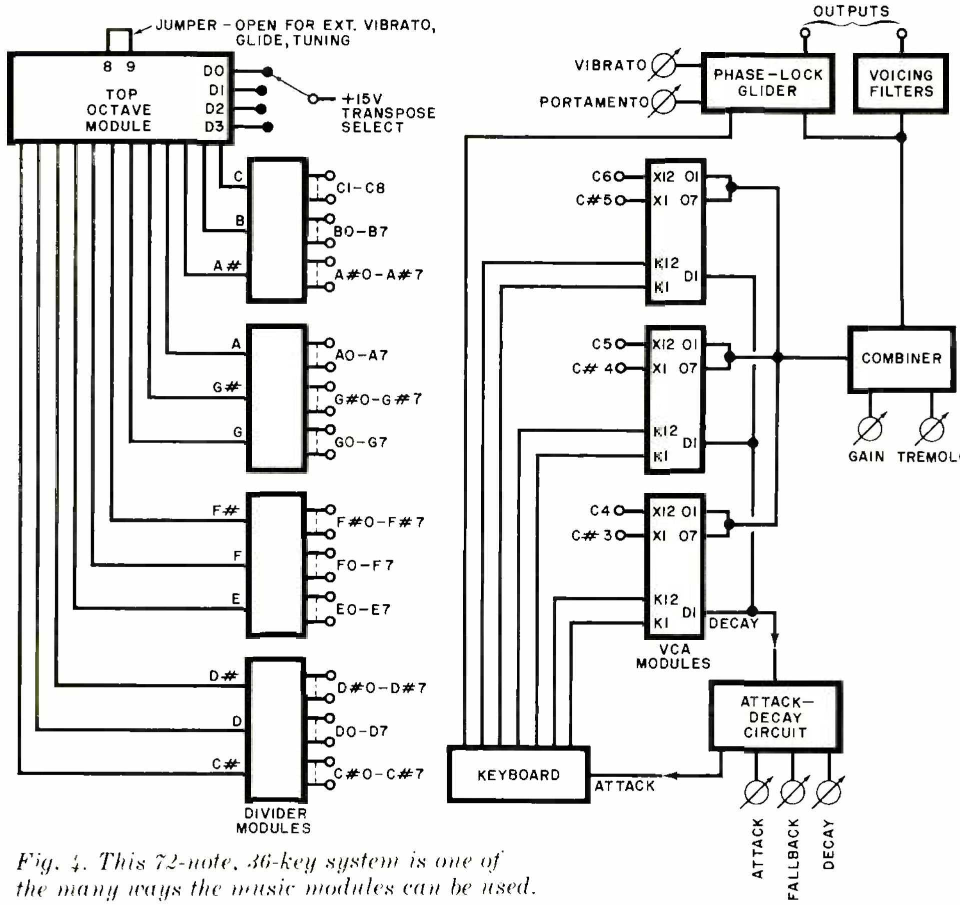

Fig. 4. This 72-note, 36-key system is one of the many ways the music modules can be used.

Construction and Checkout. In the top-octave generator, *IC1* is the crystal oscillator and buffer. It is followed by the binary divider in *IC2*, selector in *IC3*, and top-octave synthesizer *IC4*. This circuit should be built on a double-sided pc board, using one side of the board for the foil conductors as in Fig. 5A and the other side for a grounding shield as in Fig. 5B. Component layout and orientation are as shown in Fig. 5C.

Once it is assembled, you can test the top-octave module by connecting to it a 15-volt power supply and jumpering pad 8 to pad 9 and pad 2 to pad 11 (foil contacts that mate with the edge connector). Note that only pads 1 and 30 are labelled in Fig. 5C. Then check for the top octave note outputs at pads 16 through 28 using an oscilloscope or audio amplifier. Bear in mind that the outputs consist of 15-volt amplitude rectangular pulses that must be capacitively coupled and strongly attenuated before feeding them into an audio amplifier.

If you are using the internal oscillator, pads 8 and 9 must be jumpered. For external signals, break the jumper and route a 15-volt CMOS-compatible signal to pad 9. Note also that one and only one of the transpose commands must be at +15 volts at all times; the other three must be floating or grounded.

The foil-conductor etching and drilling, ground-plane, and components-placement guides for the divider module are shown in Fig. 6. Note that the resistors on this module mount upright.

You can test the divider module by connecting to it a 15-volt power supply and applying three notes from the top-octave generator. The output sawtooth waves should be approximately 70 mV in amplitude (check with a calibrated scope), and each of the three sections of the module should produce eight octave-related notes.

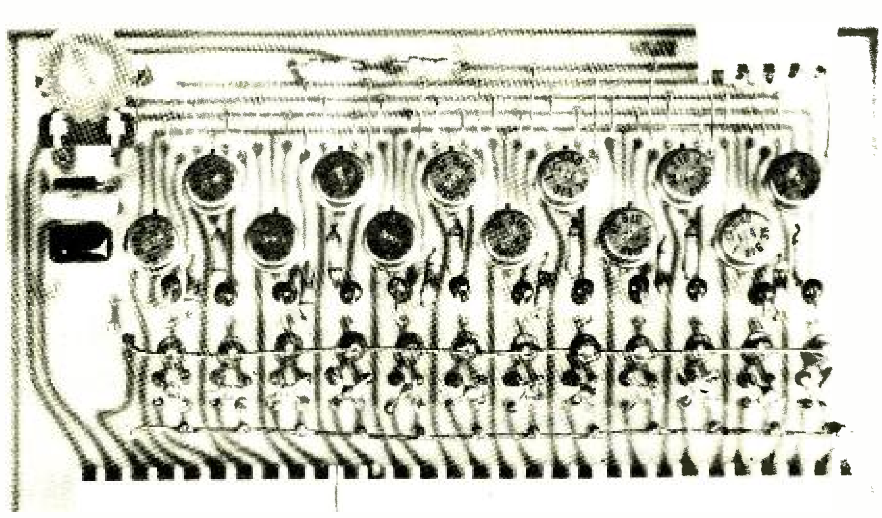
Photo shows details of upright component mounting on vca module and bus connections.

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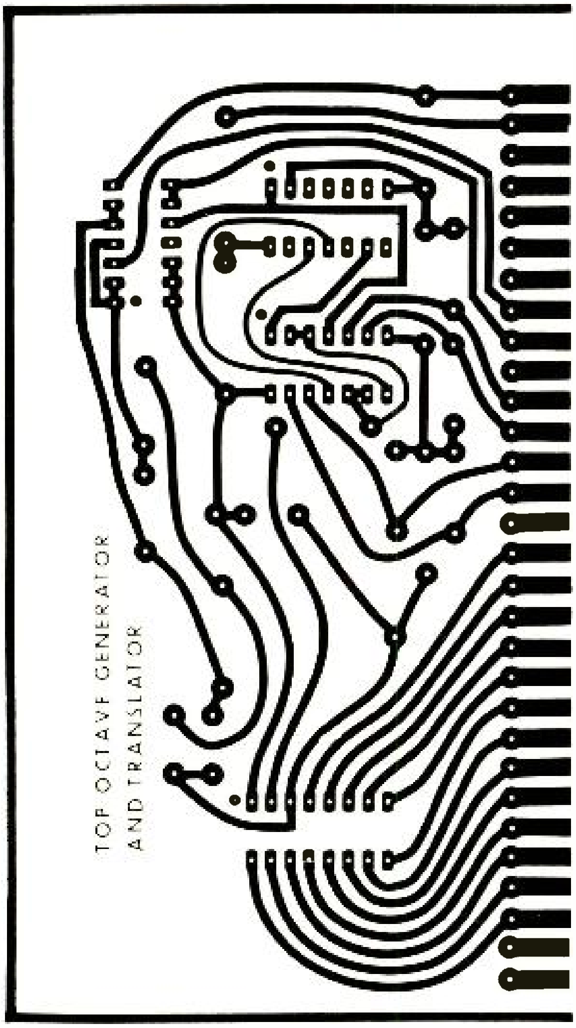
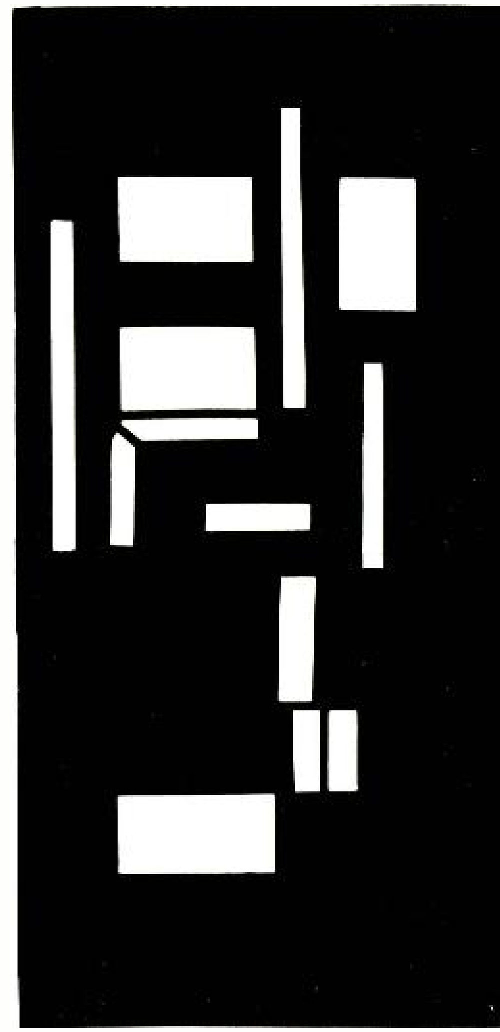
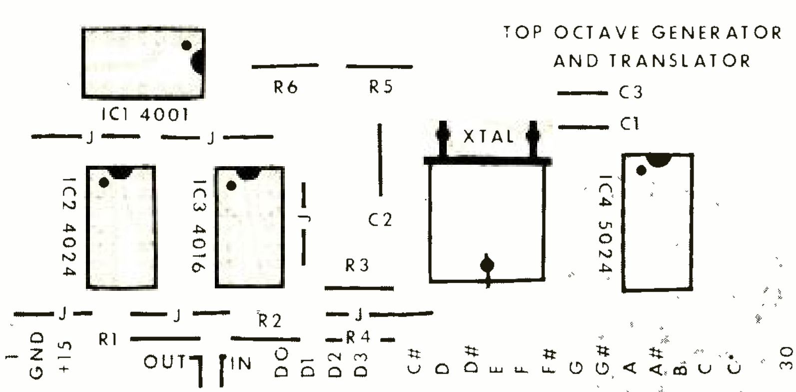


Fig. 5. Etching and drilling guide (A) for top-octave generator is at left, ground plane guide (B) right, component layout (C) below.





The highest note will be a square wave, followed by four-level and eight-level notes. Lower-frequency outputs will contain 16 levels. If one note sounds excessively loud or looks wrong on a scope, check your resistor matrix carefully for a missed solder connection or an interchanged value.

The etching and drilling and component-placement guides for the vca module are shown in Fig. 7. Note that *D1* through *D12* mount with the cathode (banded) end up and the cathodes to a length of bare wire that terminates in the decay hole. Next, *D13* through *D36* (cathodes up) and *R5* through *R28* mount upright, their free ends connected together in groups of four, with *D13*, *D25*, *R5*, and *R17* making up the first and *D24*, *D36*, *R16*, and *R28* the last group. Then mount *C3* through *C14* with their negative (−) leads up and connected to a length of bare wire that terminates in the −15V hole. Finally, mount *R29* through *R40* in the usual manner, without bus-joining the upright leads.

The best way to test the vca module is one stage at a time. Do this by leaving the IC pin 6 jumpers disconnected from the output buses, except for the jumper in the stage being tested. Start by connecting the dual-polarity +15/−15-volt power supply to the module via pads 1, 2 and 3 at the edge connector. Route a single note from the divider to the X1 input and monitor the output with an oscilloscope or audio amplifier. Connect the decay input to −15 volts. Now, grounding K1 should turn on the note and floating or connecting K1 to −15 volts should turn off the note. The note should turn on and off rather abruptly without key clicks, distortion, or transients. Offset potentiometer *R4* should be adjusted to eliminate any dc in the output or set for the best sounding note. Then, check K2 and X2, K3 and X3, and so on down the line, finishing up with K12 and X12.

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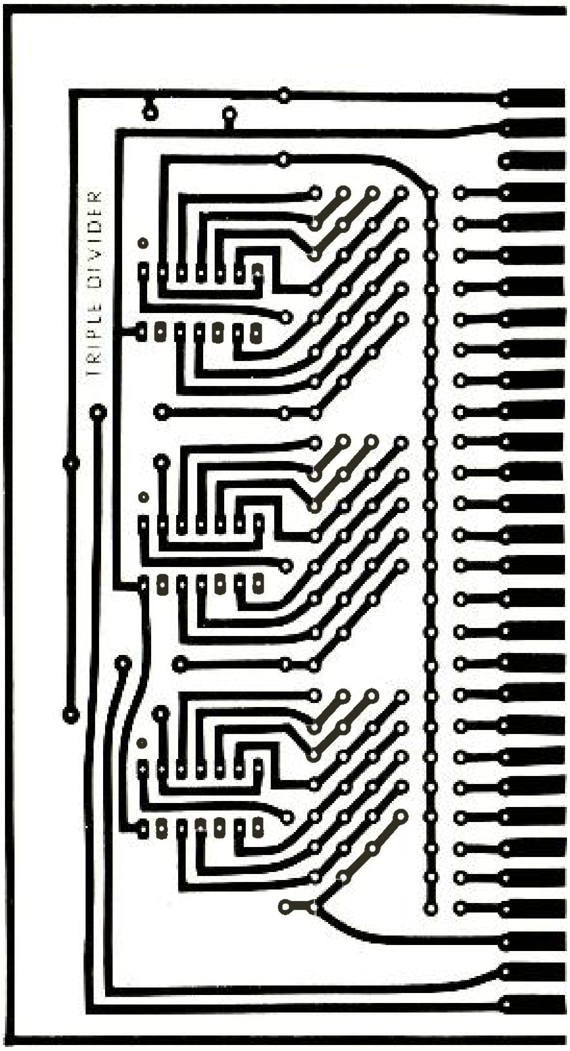
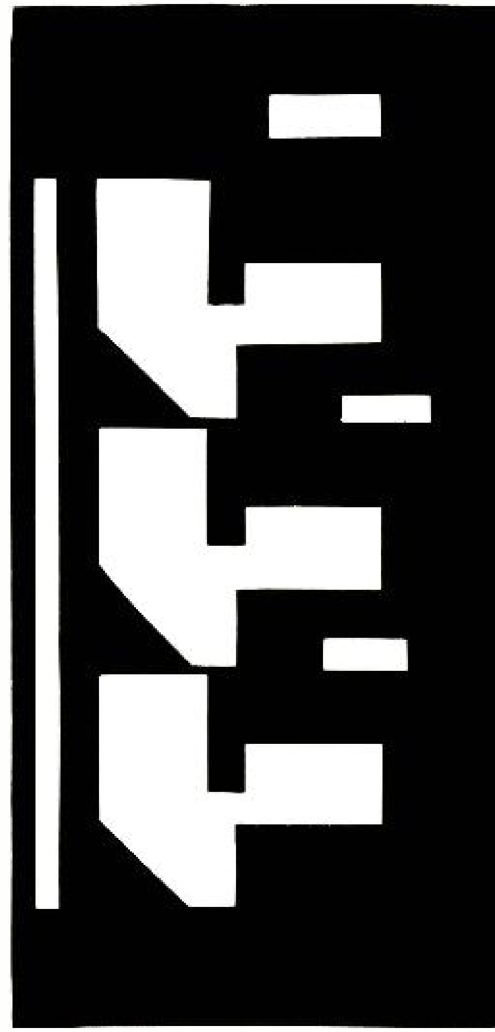
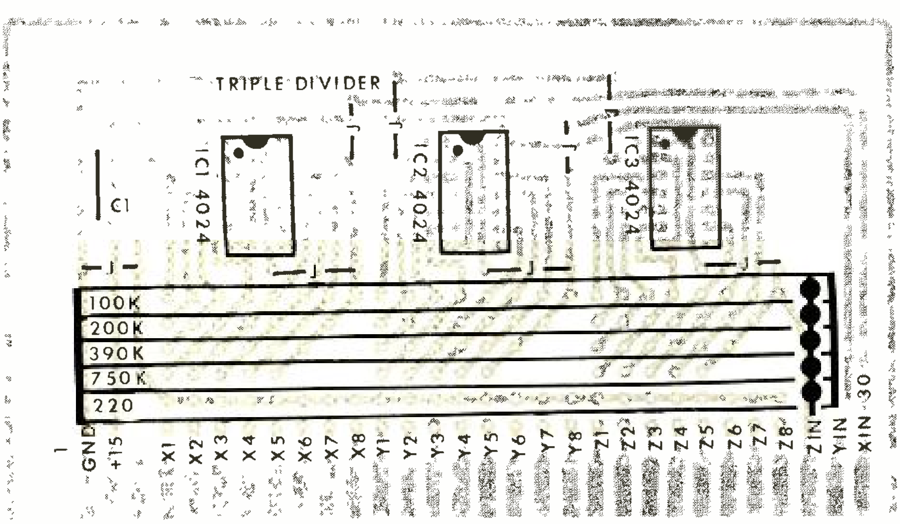


Fig. 6. Etching and drilling guide (A) for triple divider is at left, ground plane guide (B) right, and component layout (C) below.





The CA3080 IC's have a *high*-impedance (current-sourcing and -sinking) output, unlike the other op amps. This permits you to short as many outputs as you wish to a common load resistor to automatically sum all the outputs. The amount of maximum output signal is set by load resistors *R1* and *R2*. If you use both halves of the vca module, *R2* can be omitted.

An open circuit at any X input disrupts the summing process, so be sure that all connected IC's are in fact receiving tones from the divider modules. Connecting the decay input to ground should give you a fast-attack, long-decay characteristic. If any single note sounds odd or responds differently from the rest, check the resistor/diode/capacitor matrix for shorts, incorrect values, or unsoldered connections. All diode bands (cathodes) go up as do the negative sides of the electrolytic capacitors.

System Interconnections. No matter what arrangement you choose for your instrument, there are some important system-level things you'll have to watch for. First, be sure to use a well-regulated power supply. While CMOS devices will operate on a wide range of low voltages, the +15-V supply contributes directly to the stairsteps of the note. Hum or noise or interaction on the supply spells problems.

Be sure to use twisted-pair wiring or shielded cable between the top-octave outputs and the dividers to minimize any radiation of these high-level signals. You can put your modules on 20-mm centers, but be sure to skip one slot between the last divider and first vca modules, and place a fairly thick grounded sheet of steel between the two. Proper shielding and lead routing can mean the difference between a solid 85-dB or higher

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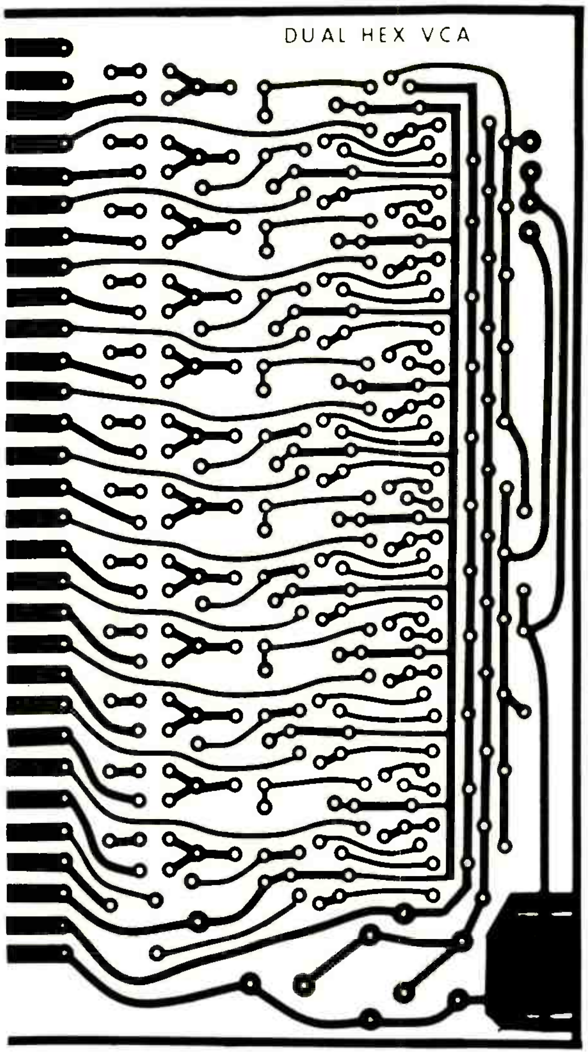


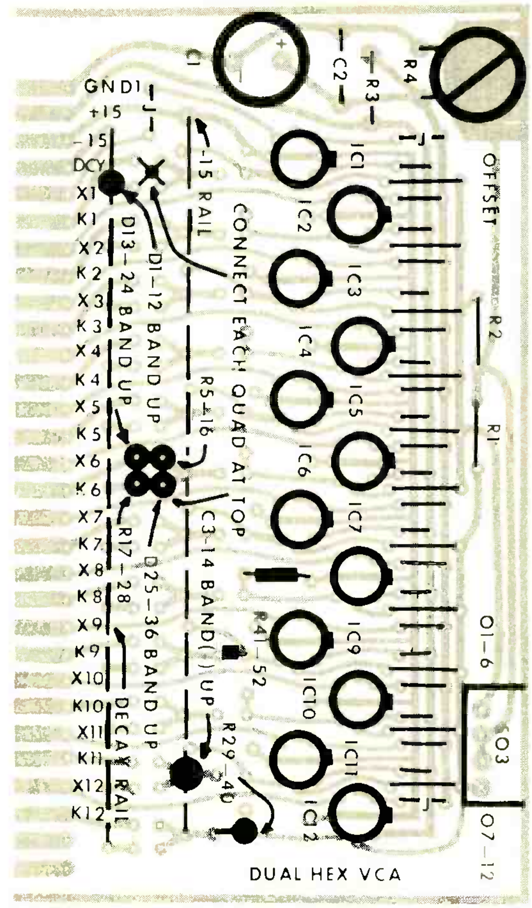
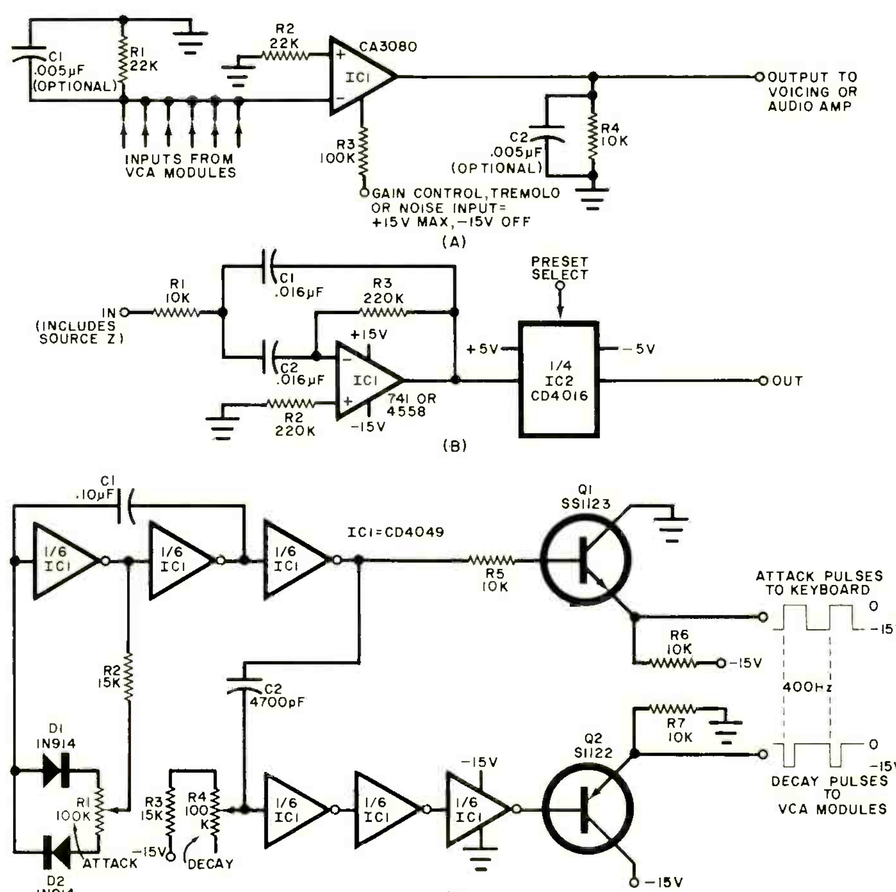


Fig. 7. Etching and drilling guide (A) for vca module is at left, component placement guide (B) at right. No ground plane is required.

Fig. 8. Add one or more of the circuits below to basic system to build a complete music synthesizer.



crosstalk and playthrough level and an intolerable 60-dB level.

Shields are also required on the vca module's outputs because of the fairly high impedances involved. Outputs are located on the top of the vca module to keep them well away from the tone-generator signals. The same care you give to the high-level tone signals should also be given to the attack and decay control pulses.

Some add-on circuits that will get you started on your system are shown in Fig. 8. In A, a CA3080 is used as a combiner and master gain control. The outputs of as many vca modules as you want can be shorted together and routed to this stage, but be sure to use shielded cable. Resistor *R1* can be adjusted to maintain the maximum input signal level to 100 mV peak-to-peak with several notes being played simultaneously. A variable voltage ranging from +15 volts (for maximum gain) to −15 volts (for off) will control the loudness of everything in the system. You can also sum a low-frequency sine wave or noise spectrum for tremolo, wind noise, or other

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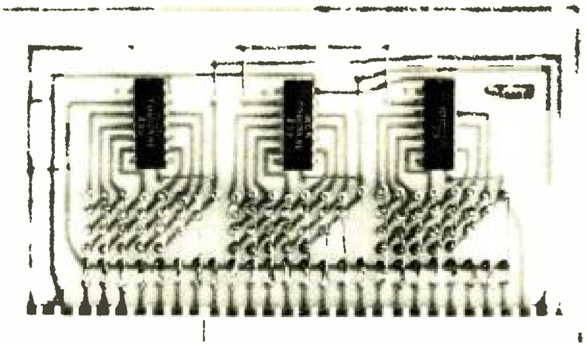

Photo of divider board shows all resistors mounted upright and bus-connected to socket pads.

amplitude-modulated effects. Capacitors *C1* and *C2* are optional. Installing them in the circuit yields a mellow sound; eliminating them permits the use of fancy voicing filters in the output.

A horn filter is shown in Fig. 8B. To change the center frequency, change the values of *C1* and *C2*, but keep both capacitor values identical. To change the Q, change the values of the resistors, keeping *R2* and *R3* at $4Q^2$ times the value of *R1*. Note that *R1* must include the source impedance of the circuit or circuits from which you are tapping the signal.

You can simultaneously control the attack and decay of all notes with the pulse-width system shown in Fig. 8C. To do this, you rapidly switch the 10k attack and 3.3k decay resistors in and out of the vca channel. (A 10k resistor in the circuit at all times has an effective value of 10,000 ohms. If it is in the circuit only 10% of the time, its effective value is 100,000 ohms.)

The circuit employs a single CMOS hex inverter and a pair of drive transistors. The attack portion is a variable-duty-cycle oscillator that operates at 400 Hz. The length of time that the attack remains grounded determines the attack time as a ratio of the total time. If you end up with too much interaction between frequency and duty cycle, a high-value resistor across one of the diodes should fix things. The frequency should remain nearly the same as you change the duty cycle.

The leading edge of the attack waveform can be shortened by operating DECAY potentiometer *R4* and capacitor *C2*. It is then amplified and routed to the decay inputs of the vca module. Note that attack goes to the keyboard, while decay goes to the vca's. The attack time has priority over decay, so a key fully pressed charges the vca capacitor that is storing the attack and decay information. Because of the resistor values in the vca circuit, up to a 3:1 reverse attack can be accommodated at the extremes of the control settings.

A second decay circuit connected to a driver transistor that catches at some negative voltage will provide fallback. This is important for percussion voices that simulate piano and guitar effects. With fallback, the note very rapidly decays to some low value when the key is released. It then gradually dies out.

Final Comment. With the three basic music module blocks we have presented, plus a keyboard, you have the heart of a sophisticated electronic music synthesizer. You can put add-ons into the system and modify it to suit your needs. In fact, you can expand it until you have a highly sophisticated and flexible polyphonic instrument. ◈

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BY PAUL E. MILLER

HOW TO USE THE HP-45 CALCULATOR AS A STOPWATCH OR ELAPSED-TIME INDICATOR

IF YOU own a Hewlett-Packard HP-45 calculator and would like to use it as a digital stopwatch and elapsed-time indicator the way the more expensive HP-55 programmable can, there's good news. You *can* use your HP-45 for these functions, even though Hewlett-Packard makes no mention of the fact in its Operator's Manual.

To gain access to the clock function in the HP-45, first clear the calculator by operating the gold alternate-function key. Then press RCL and *simultaneously* press CHS *and* the digits 7 and 8, or 5 and 4, or 1 and 2. (It is important that these keys be pressed simultaneously.) The display format will now be

HR	MIN	SEC	0.01XSEC
00.	00	00	00

To start the clock function, press the CHS key once. Pressing CHS again will stop the count without resetting the display to zero. To reset the display to zero, simply press the CLx key.

When operating the calculator on batteries, you can save power by blanking the last two digits (hundreths-of-seconds) by operating the EEx key. The clock will continue to run without upsetting the count. You can restore the blanked digits by pressing the EEx key again.

Elapsed-Time Indicator. The clock can also be used as an elapsed-time indicator for timing and storing the elapsed times of up to nine separate events. The only constraint is that all events must start simultaneously. This function can be quite handy for measurements of physical phenomena, chemical reaction experiments, etc.

While the clock is running, depressing any 1 through 9 digit key stores the displayed time up to that point in the respective register. The clock keeps running and is not otherwise affected by this action. After stopping the clock by operating the CHS key, pressing any of the digit keys recalls the time stored in the respective register.

Note that the STO key, while the clock is running, and the RCL key, after the clock is stopped, need not be operated. The "store" and "recall" functions are automatically executed, depending on whether the clock is running or stopped. (The CLx key should again be pressed after the last readout of stored time to permit the clock to continue from the reading on the display when it is again started.)

When the clock is no longer needed, you can return the calculator to normal operation by pressing ENTER or turning off and then on the power. The latter method is preferred because it clears the contents of the registers automatically. Even so, the registers don't have to be cleared if you wish to store new elapsed-time data. Whenever new data is entered into a memory location, it automatically clears previous data.

While the clock function is in operation, the only keys that have any effect are CHS, EEX, CLx, . (decimal point), and 1 through 9. All other keys, including the basic arithmetic (−, +, ×, ÷) keys, are inoperative.

Accuracy. It appears that the HP-45 was built with the HP-55 in mind and, hence, uses some of the same circuitry contained in the latter. However, while the HP-55 is "trimmed" for the required oscillator accuracy, the HP-45 is not. The result is that the HP-45, although reasonably accurate, will not be "on the nose." If you determine the percentage of inaccuracy by comparing the HP-45 against a known time standard and make a note of the deviation, you can calculate precise times.

Although the absolute accuracy of the HP-45 as a timer may not be equal to that of the HP-55, the time function used during relative measurements —and particularly for storing up to nine elapse-time measurements —can be very useful indeed. At least you won't have to trade up to a more expensive calculator. ◈

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Product Test Reports

ABOUT THIS MONTH'S HI-FI REPORTS

In a field as varied as high-fidelity reproduction, it is difficult indeed to design a product, or a system, which has all the features needed to meet today's requirements, but is still flexible enough to handle anything that might come along in the future. Heath's ambitious Modulus system is the most impressive effort we have seen toward meeting these requirements. In addition, the Modulus system is a superb performer in all respects, with a unique combination of styling, flexibility, and just plain good sound.

One of the presumed benefits in the introduction of quadraphonic sound was the recreation of the concert hall environment in the home. With rare exceptions, this has not even been approached, let alone achieved, by existing four-channel hardware and software. Now, it appears that we may be closer to the goal with almost any stereo (or even mono) program by means of electronic time delay and reverberation techniques. The Sound Concepts SD-50 Audio Delay unit uses the "bucket-brigade" technique to restore the "liveness" that has been removed from most recorded programs — or perhaps was never there. It is, at times, startlingly effective in that role, and, to a great extent, begins to fulfill the unkept promise of quadraphony.

—Julian D. Hirsch

HEATHKIT MODEL AN-2016 "MODULUS" CONTROL CENTER

Modular sections offer 2- and 4-channel system choices.

HIRSCH-HOUCK LABS REPORT

The Heath Company's new "Modulus" series of audio components takes a bold approach to solving the problem of obsolescence resulting from constant changes in audio technology. At least in principle, the Modulus system is capable of dealing with almost any conceivable 2- or 4-channel signal encoding system without the use of add-on accessories.

The Modulus system is built around the Model AN-2016 control center that consists of an AM/stereo FM tuner with digitally generated numeric frequency readout, a two/four channel preamplifier, and full control facilities for a highly flexible system. (See box for details on companion power amplifiers.) In its basic form, the control center is a stereo component, although it comes standard with four preamplifier channels to accommodate external discrete 4-channel program sources. It contains 11 plug-in circuit board assemblies that hinge up for adjustment and servicing without disturbing normal operation. Three additional spaces are provided for the optional plug-in modules: Dolby decoder for FM; full-logic, wave-matching, variable-blend SQ decoder; and CD-4 demodulator. All switching functions for the optional modules are standard on the control center.

The styling of the control center is rather unique. The front panel has a black wrinkle finish and is accented with an aluminum surround. The side panels are covered with walnut grain vinyl. Slightly sloping front-panel sections and contoured top give the control center a decidedly modern look.

The Model AN-2016 control center measures 19″ W × 14½″ D × 6½″ H (48.3 × 36.8 × 16.5 cm) and weighs 29 lb (13.2 kg). Available only in kit form, it retails for $599.95. The optional modules include the Model AM-1503 SQ decoder for $49.95; Model AN-1504 FM Dolby decoder for $39.95; and Model AD-1507 CD-4 demodulator for $79.95.

General Description. The front panel of the control center is divided into three full-width functional areas. At the top is the display section that contains four output-level meters, the numeric frequency readout system, and separate center-tune and signal strength tuning meters.

The output level meters have logarithmic scales that cover a range of more than 30 dB, with the 0-dB calibration marks corresponding to the 1.5-volt rated output of the preamplifiers. The meters have fast responses that provide true peak level indications of the signal. The 3½-digit frequency display consists of ½″ (12.7-mm) high seven-segment red LED numerals. The tuning is conventional (not synthesized) so that the numbers displayed are derived from a frequency counter and can be considered as a substitute for a very accurate and easily interpreted dial. FM frequencies are displayed to the nearest 0.1 MHz in odd-value units that conform to the FM broadcasting channels in the U.S. On AM, the display indicates to the nearest 10-kHz mark. When a stereo FM program is received or the system is switched to CD-4, identifying legends next to the numeric display light up when the 19- or 30-kHz carriers are detected. The tuning meters and numeric display light up only when the AM or FM tuner is used.

Below the display section is a row of 21 pushbutton switches above which are identifying legends that light up whenever a button is pressed. Also, when a button is engaged, it is internally illuminated in yellow, except for the POWER button, which glows red. Eight buttons permit selection of PHONO, CD-4, AUX, TAPE, DUB, and tape MON sources. Five additional buttons,

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labelled MONO, STEREO 2, STEREO 4, SQ, and 4 CHAN, provide for mode selection.

There are five more pushbuttons. One labelled TONE FLAT is used to switch in and out the tone controls. The rest are labelled LO and HI FILTER, LOUD (loudness compensation), FM DOLBY, and SQUELCH DEFEAT. (Pressing the FM DOLBY button simultaneously switches in the noise reduction system and changes the de-emphasis to the required 25 µs.) The final button is labelled OUTPUT. It disables the preamplifier outputs to permit private headphone listening.

On the lower portion of the front panel are 10 control knobs and six ¼"

HEATHKIT MODELS AA-1505 AND AA-1506 "MODULUS" POWER AMPLIFIERS

THE MODELS AA-1505 and AA-1506 basic power amplifiers flesh out the Heathkit "Modulus" system lineup. Rated at 35 and 60 watts/channel, respectively, their inputs are specifically designed for the output characteristics of the Modulus Model AN-2016 tuner/preamplifier control center. The two amplifiers are electrically and physically identical except for power transformers, ratings of output transistors, and output power rating. They are designed to deliver their rated output power over a frequency range of 20 to 20,000 Hz with less than 0.1% distortion.

The Modulus power amplifiers measure 14⅝" D × 8" W × 5⅝" H (37.1 × 20.3 × 14.3 cm) and weigh 21 lb (9.5 kg). Available only in kit form, they retail for $159.95 for the Model AA-1505 and $179.95 for the Model AA-1506.

General Description. The only controls on the power amplifiers are a pair of individual channel level potentiometers (on the rear panel) and three pushbutton switches (on the front panel). One switch is a red pushbutton that, when pressed, turns on the power and illuminates the legend POWER. The two remaining switches permit selection between two separate pairs of speaker systems. To minimize the possibiity of accidental short circuits and incorrect phasing, the amplifiers are provided with special polarized speaker plugs.

The amplifier circuits are direct coupled throughout, except for a dc blocking capacitor at the input. Electronic dissipation limiting circuits protect the output transistors. All circuits are assembled on two printed circuit boards that, together with the output transistor heat sinks, swing up to reveal a built-in test meter with attached clip leads. The meter is used only during initial setup to check resistance and voltage, after which it is not needed.

The amplifiers deliver their rated output power with 1.5-volt inputs, which is the rated output level of the Model AN-2016 control center. The input impedance is between 15,000 and 25,000 ohms, depending on the settings of the level controls. This relatively low impedance is easily driven from the 600-ohm output impedance of the control center and many other fine preamps.

With the amplifier inputs shorted, the hum and noise are rated at 95 dB below full power.

Laboratory Measurements. After the standard preconditioning period of one hour at one-third power and five minutes at full power, the amplifiers were only moderately warm. The Model AA-1505 clipped at 47.5 watts/channel into 8 ohms (69 and 27 watts into 4 and 16 ohms) at 1000 Hz.

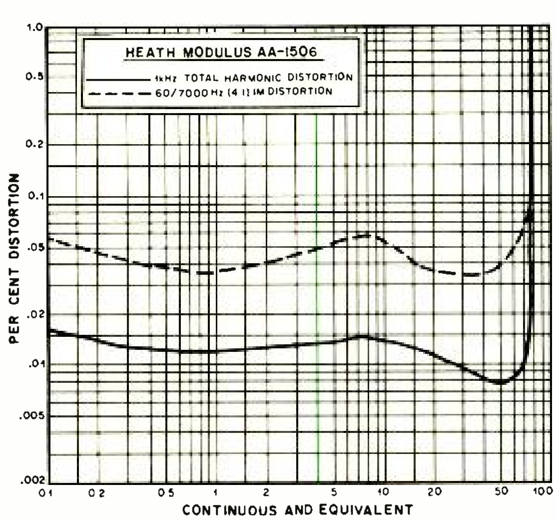
At its rated output (35 watts) or less, the amplifier's THD was less than 0.01% at 20 Hz and 0.05% at 20,000 Hz. It measured typically between 0.005% and 0.01% over most of the audio range. At 1000 Hz, the THD was 0.005% with outputs of 1 to 30 watts and less than 0.01% from a small fraction of a watt to 40 watts. The IM distortion was 0.01% at 0.1 watt, 0.03% between 5 and 30 watts, and 0.05% at 40 watts.

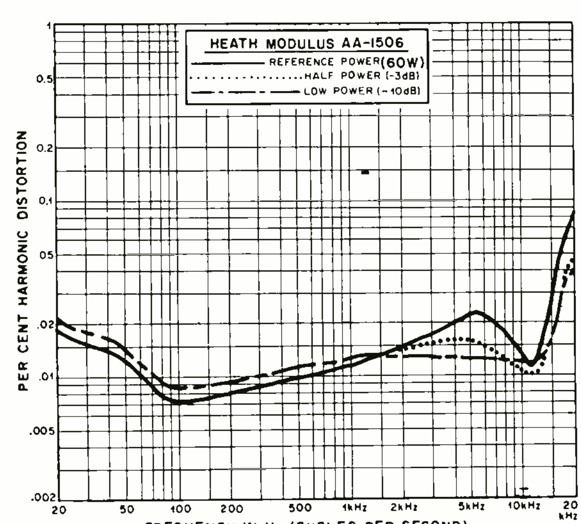
An input of 0.64 volt drove the amplifier to a reference 10-watt output, and hum and noise measured 80 dB below the output level. The frequency response was ±0.1 dB from 5 to 30,000 Hz, −1 dB at 150,000 Hz, and −3 dB at 320,000 Hz. The slew rate was 6 volts/µs.

The Model AA-1506 amplifier, rated at 60 watts/channel, clipped at 75.6 watts into 8 ohms (120 watts into 4 ohms and 45.6 watts into 16 ohms) at 1000 Hz. Its distortion characteristics were essentially the same as for the Model AA-1505 (extending the high power outputs, of course), as were its frequency response and noise level. Only 0.5 volt was needed at the input for a reference 10-watt output, and the slew rate was 10 volts/µs.

User Comment. The only differences between the two amplifier models are in output power and price. Both are handsome amplifiers, nicely complementing the tasteful styling of the Model AN-2016 control center. They are equally fine sounding, with distortion levels so low that the finest laboratory instruments are hard pressed to measure them.

While both amplifiers are good values at their respective prices, we feel that the slight added cost of the Model AA-1506 buys a very worthwhile increase in available power. This is especially true if you plan to drive 4-ohm speaker systems, considering that the Model AA-1506 can deliver 240 clean watts of power.





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(6.35-mm) phone jacks. Four LEVEL controls permit adjustment of the individual output channels, while a separate VOLUME control serves as the master gain control. Four BASS and TREBLE tone controls are provided for the front and rear channels. A large TUNING knob operates the smooth tuning system for both AM and FM reception. Separate front and rear PHONE jacks permit the use of 4-channel headphones. The four IN and OUT DUBBING jacks located at the bottom center of the front panel are for using a stereo or 4-channel tape deck, making copies of tapes played on the system's regular tape deck (and vice versa), recording the normal program source, or listening to pre-recorded tapes.

On the rear apron of the control center are all the standard input and output jacks, vertical and horizontal outputs for a multipath indicator oscilloscope, and two switched and two unswitched ac convenience outlets. In addition, there are screw terminals for 75- and 300-ohm FM antennas, a phono jack for an external shielded AM loop antenna (supplied with the kit), and a HI/LO PHONO SENSITIVITY switch. The AM loop antenna is used instead of the usual ferrite rod antenna to eliminate most of the electrical interference that can affect AM.

The circuits contained in the control center are so extensive that space does not permit a detailed description. But to give you an idea of how complex the system is, it contains 28 IC's, 134 transistors, and 55 diodes. The FM front end employs dual JFET r-f stages, and a linear-phase multipole LC filter in the i-f section provides high selectivity and stereo separation. A digital discriminator and phase-locked-loop multiplex demodulator contribute to the excellent distortion and stereo separation characteristics of the tuner. The AM section is also designed to give above-average performance. It features a dual-gate MOSFET front end and a nine-pole LC filter for i-f selectivity.

The preamplifier section uses differential amplification and is designed for low noise and distortion. The feedback-type tone controls permit adjustment at the frequency extremes with minimum effect on midrange response. The audio filters have 12-dB/octave slopes for minimum loss of program content.

Laboratory Measurements. The tuner/control center we tested came completely assembled and aligned. Looking over the supplied manuals, however, we determined that it should be possible for anyone to obtain the specified performance without having to resort to external test instruments.

The IHF usable sensitivity of the FM tuner measured 10.8 dBf (1.9 µV) in mono and 16.1 dBf (3.5 µV) in stereo. The 50-dB quieting sensitivity was 34 dBf (27.5 µV) with 0.4% THD. The ultimate signal-to-noise ratio was 68 dB in mono, 63 dB in stereo. Distortion at 65 dBf (1000 µV) was 0.35% and 0.2% in mono and stereo, respectively.

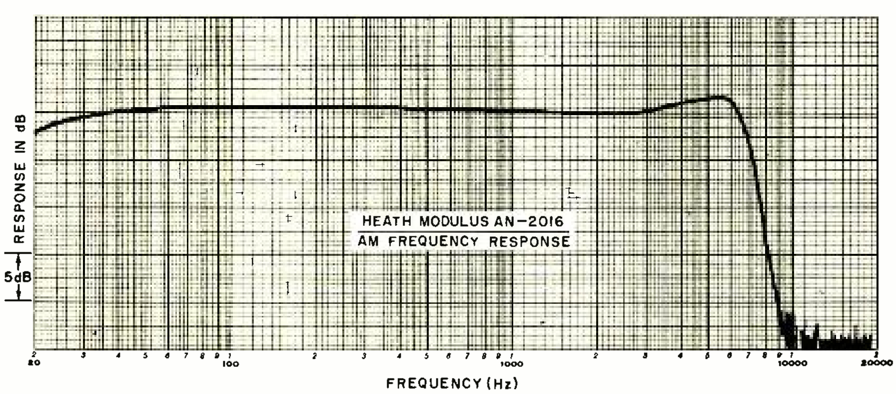
The capture ratio was 1.9 dB at a 45-dBf (100 µV) input. AM rejection was an excellent 71.5 dB, image rejection a very good 94 dB, and alternate-channel selectivity 80 dB. The internally set FM muting threshold was 22 dBf (7 µ V), while the stereo switching threshold was 11 dBf (2 µV). The stereo frequency response was ±0.4 dB from 30 to 15,000 Hz. Channel separation was 35 to 36 dB over most of the audio range, diminishing to 24 dB at 15,000 Hz. The 19-kHz pilot carrier leakage in the audio outputs was 63 dB below 100% modulation.

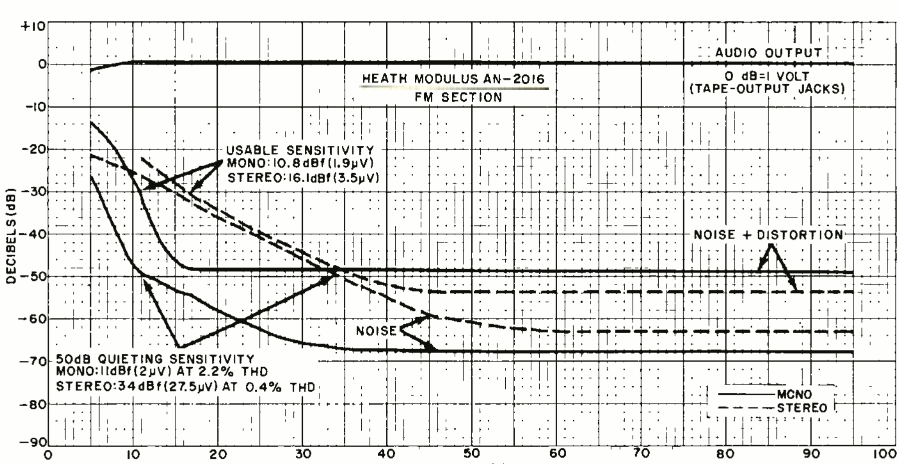
The frequency response of the AM tuner was ±2 dB from 20 to 7000 Hz, which is considerably better than the performance of the AM tuners in most receivers we have tested, regardless of price. Whistles and the usual interstation noises were notably absent.

In the audio section of the control center, the turnover frequency of the bass control varied from about 100 to 300 Hz, while the treble response was hinged at about 3000 Hz. The loudness compensation boosted both the lows and the extreme highs (above 10,000 Hz) to a moderate extent. It could easily be adjusted to individual tastes by setting the channel level and volume controls. The 3-dB frequencies of the filters were at 37 and 6500 Hz, beyond which their 12-dB/octave slopes could remove appreciable amounts of rumble and hiss without serious loss of program content.

With tone controls bypassed, the frequency response of the preamplifier section was ±0.25 dB from 20 to 20,000 Hz. It did not change appreciably when the tone controls were switched into the circuit and mechanically centered. The RIAA equalization was very accurate, changing less than 1 dB at any frequency when measured through the inductance of a phono cartridge coil.

To develop a reference 1-volt output, a 90-mV signal was required at the AUX inputs, while 3.7 or 1.3 mV (depending on the setting of the phono





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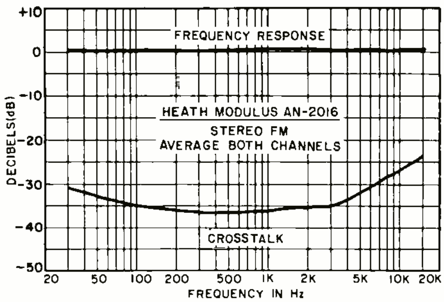

sensitivity switch) was required at the PHONO inputs. The S/N ratio through any input was 67 to 69 dB referred to a 1-volt output. The PHONO inputs overloaded at 55 and 175 mV with the HI and LO sensitivity settings. The overload level at the AUX inputs was 4.4 volts, a figure not likely to be encountered in practice.

The phono sensitivity through the CD-4 inputs was about 1 mV for a 1-volt output when the separation was optimized and using the CD-4 test record supplied with the demodulator. As is the case with most CD-4 demodulators, this one overloaded at a rather low 9 mV input. Although this would be intolerable for stereo operation, it is not a problem with CD-4 discs and cartridges. (The recorded level on most CD-4 discs is relatively low, and most CD-4 cartridges have a low output.)

The 1.5-volt output rating of the tuner/control center's preamplifiers proved to be quite conservative, since we measured 5.9 volts into a high-impedance load and 3.15 volts into a 600-ohm load at the clipping point. The 1000-Hz THD and IM were between 0.01% and 0.02% at all outputs from 0.1 to 3 volts.

We performed no measurements on the FM Dolby, SQ, and CD-4 modules. We judged performance subjectively with normal program material.

User Comment. The tuner/preamplifier system proved to be exceptionally easy to operate with maximum effectiveness. Both AM and FM tuning were smooth and not critical, and there was never any doubt as to the frequency or channel to which we were listening.

The FM tuner is extremely sensitive and has the selectivity, distortion figures, and frequency response characteristics typical of today's fine-quality tuners. The FM muting was positive and noise-free. The Dolby noise reduction system performed effectively with the stations using Dolby encoding. The effect produced was a sense of improved high-frequency response with reduced noise — a most unusual and welcome combination.

The AM tuner could legitimately be called "hi-fi" when compared with the other AM tuners we have tested. The background noise was negligible, and the frequency response was wide enough to eliminate the usual muffled quality AM reception.

The illuminated pushbutton switches and digitally generated numeric display allow you to see at a glance — even from across the room — the operating mode and station being heard. We also appreciated the headphone outputs, which were able to drive both high- and low-impedance phones to a healthy level. This is not the case with most preamplifier headphone output systems. Of course, electrostatic and other voltage-operated phones must still be driven by a power amplifier.

When playing SQ discs, the decoder produced the quality of separation and total sound effect that we have come to expect from modern logic decoders. Although we made no direct comparison between the Heath system and other good SQ decoders, our impression was that it was at least as good as the others we have used.

We were especially critical in our listening to the CD-4 operation of the system because of its apparently low overload limits. Using a couple of the latest and best cartridges and making A-B comparisons with a very good accessory CD-4 demodulator, we never heard anything that could be attributed to input overloading. The rare instances of breakup distortion were all on early disc releases and were almost certainly the fault of the records.

The high-frequency response through the Heath system was strikingly superior to the demodulator we used as a comparison. It was apparently one octave greater in range and gave some of our discs an entirely different sound character. All in all, when good discs and cartridges were used, we felt that the Heath system gave the best CD-4 reproduction we have ever heard through a home-entertainment system. Our only criticism of Heath's CD-4 design is the need for separate record players (or a well-shielded external switch box) for playing stereo or matrixed 4-channel and CD-4 records. A number of recent CD-4 cartridges are also outstanding stereo reproducers. It seems a pity that these fine and very expensive car-

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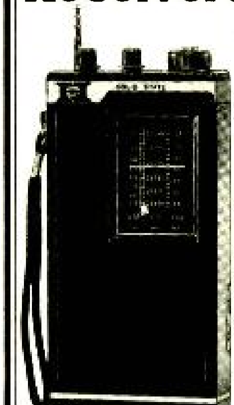
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tridges cannot be used for both functions in the Heath system.

It is clear that the combination of extreme flexibility and top-notch performance in a single hi-fi component is a noteworthy achievement. In our judgement, Heath comes very close to creating the ultimate obsolescence-free control center with the Model AN-2016. Perhaps because it comes so close to being the ultimate control center, we must note a few instances where it falls short of that goal. First, there is only one tape monitoring system where there should be a minimum of two. The user with two tape decks cannot connect both of them into the system with full flexibility. (The DUBBING jacks are not equivalent to a regular in/out monitor connection.) Also, some external signal-processing accessories, such as graphic equalizers, volume expanders, noise-reduction units, etc., are best connected into tape monitoring loops.

The Model AN-2016 would have been *the* complete 4-channel control center. However, it has no facilities for a QS decoder. Of course, if the choice of only one matrix decoder was possible, the much greater availability of SQ-encoded discs justifies Heath's choice of the full-logic, wave-matching SQ decoder. But it would have been nice to have the QS Vario-Matrix as well.

One final note about the kit itself. Although we did not assemble the tuner/preamp control center or the power amplifiers that make up the Modulus system, we know from past experience that this is a major assembly project that is likely to take a considerable amount of time. Fortunately, Heath's excellent manuals and the fact that no test equipment is needed for alignment make it possible for the kit builder to obtain full performance from this highly complex system.

While the Modulus is not exactly an economical hi-fi system approach, it is a highly sophisticated, nearly state-of-the-art product whose features simply cannot be purchased factory-wired from any source. The Model AN-2016 is also a strikingly handsome unit, especially when flanked by its matching power amplifiers.

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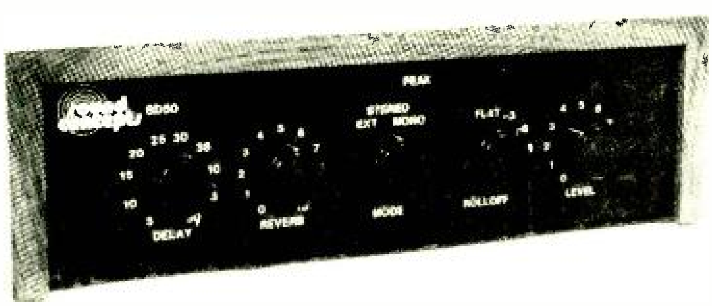
SOUND CONCEPTS MODEL SD-50 DELAY UNIT

Time-delay system creates "concert-hall" effect in home.



HIRSCH-HOUCK LABS REPORT

The time-delay device used in home audio systems to provide reverberation has traditionally been the economical coil-spring type. Unfortunately, this type of delay device has a severely irregular frequency response and tends to obliterate the transient characteristics of the input signal. Recently, all-electronic delay techniques have become feasible with the development of suitable IC's.

One way to delay a signal through all-electronic means involves analog-to-digital (A/D) conversion, passing the digitized signal through a series of shift registers to delay it, and converting the delayed signal back to analog form. The delayed signal then is amplified and fed to the rear or side speaker systems. Another technique employs analog techniques, with a "bucket-brigade" IC serving as the delay device. The analog signal is passed along through a series of capacitive elements at a rate determined by a clock (timing) signal. A consumer version of this approach to delaying a signal is the Model SD-50 delay unit developed by Sound Concepts, Inc.

The Model SD-50 processes stereo (and mono) signals available at the preamplifier or tape recording outputs of amplifiers and receivers. The front-channel (input) program is passed unchanged through the delay unit to the front-channel inputs of a power amplifier to drive the speakers. The delayed signals are then fed to the rear-channel amplifier for the rear speakers. For compatibility with 4-channel systems, whose rear-channel amplifiers and speaker systems can be used for the reverb signal, the delay unit also has a set of rear-channel inputs that accept the line-level, rear-channel outputs from a 4-channel preamp or receiver.

The Model SD-50 delay unit is 12" W × 7½" D × 3¾" H (30.5 × 19.1 × 9.5 cm). Designed to be powered continuously from the ac line to avoid problems with start-up transients, it consumes only 3.5 watts of power. Contained on its single printed circuit assembly are some 30 IC's, which should convey some idea of the circuit complexity. Price is $600.00.

General Description. The front panel of the delay unit has five control knobs. Calibrated from 5 to 50, the DELAY control introduces a time delay of the indicated number in milliseconds to signals available at the rear-channel outputs. These delays correspond roughly to acoustic path length differences of 5.5 to 55 feet (1.7 to 16.8 m). The program content of the rear signal is essentially the same as the input to the delay unit, except that it is delayed and modified as explained below. The two channels are separately processed, but the setting of the DELAY control applies to both channels.

Next is the REVERB control, which adjusts the proportion of the output of each rear channel that is fed back to the input of the opposite channel's delay circuit. This simulates the effect of multiple reverberations in the hall. Since room surfaces vary widely in reflective properties, the REVERB control provides the means of varying the "liveness" of the total sound by cross-coupling from zero to 90% of the delayed signal. The effect is multiple echoes of successively lower amplitude.

The MODE switch causes the delay unit to operate as described above

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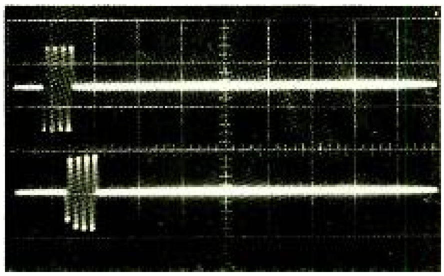
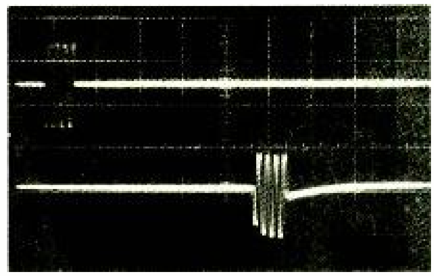
only when it is set to the STEREO position. Setting it to MONO causes the front-left and front-right channels to be mixed, producing a mono signal that is passed through both delay circuits in succession. The delay time calibrations around the DELAY control are, therefore, doubled to give a range of 10 to 100 ms. Both rear outputs carry the same signal. The delay unit does not modify the program delivered to the front speakers in any way.

ments for differences in amplifier gain and speaker sensitivity. A red PEAK LED flashes whenever there are excessive input signal levels.

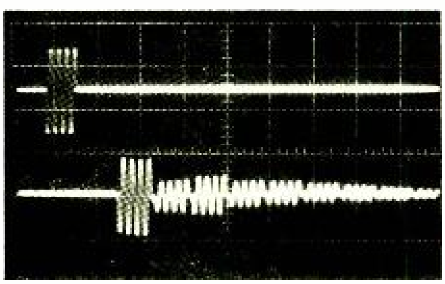
All input and output connectors are located on the rear apron of the delay unit, including a pair of outputs labelled 2CH MIX. These connectors make available the regular front-channel program mixed with an amount of the delayed signal set by the LEVEL control. If the combined signals are used



5 ms



50 ms



20 ms with reverb

Tone bursts of 500 Hz show delay for 5 ms, 50 ms, and 20 ms with reverb.

The EXT position of the MODE switch bypasses all circuits in the delay unit and passes the front and rear input signals directly to the outputs without modification. In this mode, a 4-channel system can be operated in the normal manner.

In a real concert hall, the reflected sound has a reduced high-frequency content that is a result of the greater absorption of higher frequencies by the acoustically treated surfaces and the occupants of the hall. The rear outputs of the delay unit are, therefore, designed with a high-frequency roll-off that increases with the setting of the DELAY control. In addition, there is a ROLLOFF switch that can be used to reduce the high-frequency response of the rear channels by nominal 3-, 6-, or 9-dB amounts at 7000 Hz with a 6-dB octave slope.

The final control, labelled LEVEL, is for adjusting the rear, or delayed outputs. When set to 30% of maximum, the rear-channel gain is unity (the same as the front channels). The reason for providing the LEVEL control is to allow the user to make adjust-

to drive the regular stereo speaker systems (through an amplifier), some of the benefits of the delay system can be realized without the need of a 4-channel playback system. The effect, of course, is not as dramatic as with a 4-channel playback system.

A more subtle use of the 2CH MIX outputs is to drive stereo headphones, which can be done directly or through an amplifier. It is possible to give stereo headphones a sense of spaciousness that is usually obtained only with the better 4-channel headphones. The effect is completely under the listener's control. Unfortunately, the 2CH MIX jacks are standard phono jacks; it would have been more convenient if they were standard phone jacks to accept the phone plugs normally fitted to the cords of headphones.

Laboratory Measurements. As rated, the gain through the delay unit at a LEVEL setting of 3 was 1.0 (unity). The gain was 3.5 at the maximum setting of the control. The PEAK LED began to glow as the signal input level

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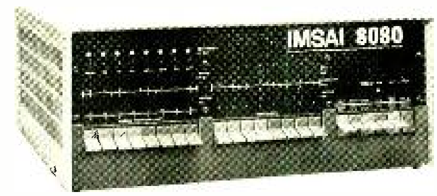

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approached 5 volts. The output noise referred to 1 volt was 66 dB down unweighted and below our minimum measurement capability of −80 dB (100 μV) with IEC A weighting.

The 1000-Hz harmonic distortion at the rear outputs was less than 0.5% for outputs of up to 1 volt. It reached 1% at 1.4 volts, after which it rapidly increased to 20% at 5 volts output. At a fixed 1-volt level, the distortion was about 0.5% over most of the audio range, 2% at 20 Hz, and 1.4% at 20,000 Hz.

Our rear-channel frequency response measurements confirmed the data supplied in the comprehensive operator's manual. The response varies with the amount of delay used. With longer delays, there is a reduction in high-frequency response, as required for a realistic effect. At the minimum delay of 5ms, the response was down 3 dB at 7800 Hz. Using a delay of 50 ms, the −3-dB frequency was 3000 Hz, while at the extreme setting of 100 ms (mono), the 3-dB down frequency was 1700 Hz. The ROLLOFF switch reduced the output at 7000 Hz by approximately the 3-, 6-, and 9-dB amounts indicated on the settings for the switch.

The delay characteristics of the unit can be best appreciated by examining the tone-burst photos, which were taken with a four-cycle burst of a 500-Hz signal. The time scale in the photos is 10 ms/cm. The upper burst in each photo is the input to the delay unit; the lower burst, the delayed output. Note that the delayed signal is not distorted in the manner that is typical of inexpensive spring-type delay units. When reverberation is added, a series of output bursts that decay in amplitude is obtained.

User Comment. Our laboratory tests confirmed that the delay unit performed according to its published specifications, with the single exception that the maximum output available was considerably less than the rated 10 volts.

The real value of this type of hi-fi accessory can be judged only by listening tests using a broad variety of program material. When we first used the delay unit, we yielded to the temptation to use relatively large delays combined with reverberation. While this is not the way the delay system would be used for normal listening, it is a good way to convince yourself that the system is working. (A properly adjusted delay system should normally be so unobtrusive that you are not consciously aware of its presence.)

After a familiarization period, we began to use smaller delay times (20 to 30 ms) for our more critical listening tests. The enhancement of almost any stereo (or mono) program by the proper combination of delay and reverb is unmistakable and impressive. On complex orchestral music, the contribution of the delayed signals is often difficult to detect when the recording contains sufficient ambience content. However, with chamber music and vocals, the effect is more apparent. In fact, a combination of long delay and reverb can make an announcer appear to be speaking in a huge empty hall or cavern. We obtained our most impressive results with organ music and a long 100-ms delay and reverb.

To some extent, a good quadraphonic system can give a similar subjective spatial effect only if the recording was made with this goal in mind. Few recordings are. The delay unit makes almost *any* stereo or mono program sound more real than 99% of the available quadraphonic programs. Also, unlike quadraphonic listening, the delay system does not alter the front speaker system imaging or place special demands on the listening environment or speaker placement. Although we used good-quality speaker systems in the rear and a fairly powerful amplifier to drive them, the low power and restricted frequency range of the delayed signal suggests that a relatively low-power amplifier and inexpensive speaker systems could be used effectively for the rear channels.

We enjoyed listening to the mixed headphone outputs, but the lack of standard phone jacks for plugging in the phones was an annoyance. We hope that, in the future, Sound Concepts will add phone jacks in parallel with the 2CH MIX phono jack outputs.

A nearly infinite number of acoustic perspectives can be created with headphones, but the special advantage of using the delay system is its ability to reduce the unnatural left-to-right separation effects of stereo programs heard through phones and the "center-of-the-head" effect with mono programs. Instead, the delay unit gives headphone listening a realistic spacious effect that is not unlike what we have heard through some of the best 4-channel phones.

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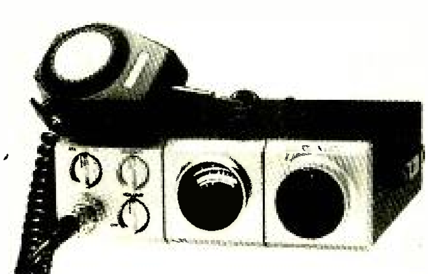
CRAIG MODEL 4104 MOBILE AM CB TRANSCEIVER

Moderately priced unit includes quick-release mounting and modern styling.



THE frequency-synthesized 23-channel Model 4104 AM CB transceiver from Craig features a quick-release mounting bracket that allows it to be conveniently removed for security or transfer to another vehicle. What sets this transceiver apart from most other mobile rigs is its rather unconventional, modernistic front-panel design. Instead of the usual edgewise S/r-f meter, there is a round, dark-faced area in the middle of the control panel that, when the transceiver is turned on, illuminates the meter face. The back-lighted channel selector gives a similar appearance.

The transceiver has a full-time automatic noise limiter (ANL), switchable noise blanker (NB), and PA operation, all selectable by a single switch. There are also separate VOLUME and SQUELCH controls. Among the other transceiver features are: external-speaker jacks, operation at full legal power, automatic modulation compression (amc), LED modulation indicator, detachable microphone with quick-connect plug, operation from a nominal 12-volt dc (positive or negative ground) source, and dual line filtering.

The transceiver measures 8¼" D × 7" W × 2⅝" H (21 × 17.8 × 6.7 cm). It retails for $169.95.

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The Receiver. The dual-conversion receiver section is conventional. It uses paired synthesizer crystals in the 37.700- and 10.160-MHz range to provide a 10.635-to-10.595-MHz first i-f and 455-kHz second i-f. An r-f input amplifier precedes the two mixers. This arrangement provided a measured sensitivity of 0.55 μV for 10 dB (S + N)/N with 30% modulation at 1000 Hz.

The receiver's selectivity is obtained with the aid of a 455-kHz ceramic filter, which provided good adjacent-channel rejection, measuring an average of 56 dB. Primary-image (CB frequency plus two times the first i-f) rejection measured 75 dB, while i-f and other unwanted spurious-signal rejection measured 75 and 55 (minimum) dB, respectively.

The anl is a series-gate configuration. The noise-blanker functions between the two mixers. It employs a FET pulse amplifier and a dual-diode gate.

The three-stage audio system employs a push-pull final stage whose output measured 4 watts with 5.5% THD at the start of clipping, using a 1000-Hz test tone and an 8-ohm load. The overall frequency response, including the i-f passband, was down 6 dB at 300 and 3500 Hz.

The characteristics of the agc varied, with negligible agc action at 1 to 10 μV (20-dB input range) on channels 1 through 16. On channels 17 through 23, the agc held the audio output to within 10 dB with a 20-dB input variation at 1 to 10 μV. Otherwise, the output change was around 8 dB for a 60-dB input change at 10 to 10,000 μV. An S9 indication was obtained with signals in the 50-to-100-μV range. The squelch range was nominally 0.5 to 500 μV.

The Transmitter. Crystals in the 10.615-MHz range paired with crystals in the 37.700-MHz range in the synthesizer provide the carrier at a mixer. A buffer, driver, and power amplifier complete the r-f transmitter circuit that terminates in a 50-ohm output-matching and harmonic-reduction network.

Modulation is obtained from the receiver section's audio system. The modulation scheme employs a compression-type amc in which a voltage-doubled potential from the modulator is fed back to the first audio stage (used as the speech amplifier on transmit). An LED, located just below the movement in the meter's blackout

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The chances are good that when you first bought a stereo system, it was a "package" that included a receiver, 2 speakers, and a record player with cartridge. But how much time was spent selecting the cartridge? Most probably it was just a minor element of the package. Even if it had a famous name, it probably was not a truly first-rank model.

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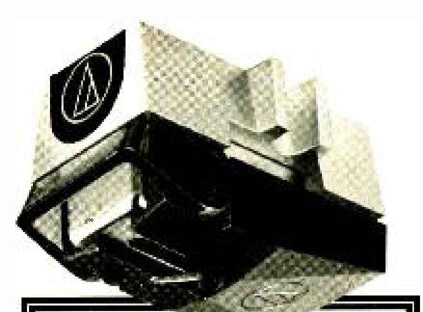

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area, blinks in step with the modulation. Transmit/receive switching is accomplished with a solid-state circuit.

Powering the transceiver from a 13.8-volt dc source, the measured r-f carrier output was 3.75 watts. Starting at 50% modulation and without compression, a 6-dB rise in the audio input level would normally cause the modulation to go up to 100%. With this transceiver, the amc held the modulation to just short of the 100% mark with a 16-dB rise above the same initial input level. This indicates a high degree of compression. Under this condition, sine-wave modulation was obtained with 6% THD at 1000 Hz. A further increase gave the transmitter a tendency to clip at 100% modulation, with distortion rising to about 20%.

With a 400-Hz test tone, the THD was somewhat higher. Adjacent-channel splatter, with voice operation, was down 55 to 60 dB. The audio response was nominally 225 to 6000 Hz, while the transmitter frequency tolerance was within 0.00185% on any channel.

User Comment. The transceiver's meter is calibrated in S units and relative power in watts, the accuracy of the latter depending on the SWR. The meter scales are recessed, which can make the S-unit scale, located at the top, difficult to read under some viewing conditions. The illuminated channel numbers on the selector dial are small and may be difficult to read.

Under most noise conditions, the full-time anl was less effective than the noise blanker. The noise blanker was good; however, it had the disadvantage of dropping the signal level quite a bit when 1-to-2-μV signals were being received.

The lower-than-usual rolloff point at the low end of the frequency response curve gave to transmitted signals a more natural sound than is usually the case.

The transceiver slides in and out of its mounting bracket relatively easily. Mating connectors at the back of the transceiver and mounting bracket automatically engage and disengage when the rig is slid into and removed from the bracket. This is true only for the dc power leads; the antenna connection must still be made through its own connector. The bracket itself is designed to be mounted above or below the dashboard.

The Model 4104 CB transceiver represents honest performance for its price and features. This, plus the fact that it has a distinct modern appearance, will make it appealing to CB'ers who are looking for something "different" in CB rigs.

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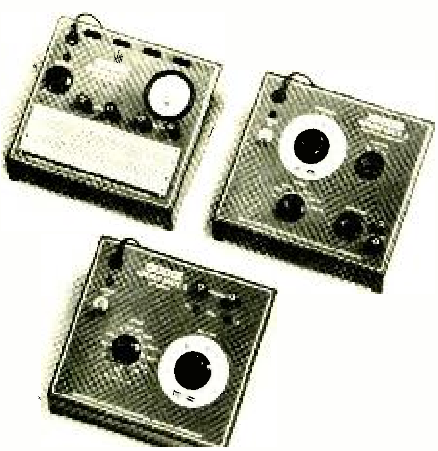
CONTINENTAL SPECIALTIES "DESIGN MATES"

Breadboards with power supply, meter, function generator and resistance/capacitance bridge.



WHETHER you're an avid experimenter or do circuit prototyping for a living, you'll appreciate the Design Mates from Continental Specialties Corp. The Design Mate 1 circuit designer is a solderless breadboarding system with its own built-in power supply and voltmeter. The Design Mate 2 function generator provides a source of sine, square, and triangle waves over a frequency range of 1 Hz to 100 kHz. The Design Mate 3 resistance/capacitance bridge measures resistances from 10 ohms to 10 megohms and capacitances from 10 pF to 1 μF. While each can be used independently of the others, the three Design Mates together comprise a highly flexible designer/experimenter lab.

Each Design Mate is in an enclosure that measures 7½" W × 6¾" D (19.1 × 17.1 cm) and slopes from 3¼" to 1½" (8.3 to 3.8 cm) high. All three units are designed for operation on 117-volt ac line power.

The Design Mate 1 solderless breadboard sells for $49.95, the Design Mate 2 function generator for $64.95, and Design Mate 3 R/C bridge for $54.95.

General Descriptions. The heart of the Design Mate 1 breadboard is its large solderless breadboarding socket, which contains a 59 × 10 hole matrix. Component leads and stripped hookup wires are plugged into the holes to make electrical (and mechanical) contact during circuit setup. The matrix is arranged in two 59 × 5 sets, with each of the 59 columns containing five electrically common contacts to provide multiple connection points for each component lead. The column-to-column and row-to-row hole spacing is 0.1" (2.54 mm), with 0.3" (7.62 mm) between matrix sets to accommodate standard DIP (dual in-line package) IC's. Above and below the main solderless socket are bus strips (each with 50 holes).

The internal regulated power supply delivers from 5 to 15 volts at 600 mA to the breadboarding system. The supply's ripple and noise are rated at less than 20 mV full load. Both line and load regulation are specified at less than 1%. The output of the power supply is available at a pair of color-coded binding posts (red for +, black for −). The 15-volt full-scale dc voltmeter is accessed through another pair of binding posts with the same color coding. Needless to say, the power supply and/or meter can be used for purposes other than simple breadboarding.

The Design Mate 2 function generator is built around an 8038 function generator IC and uses a 301 op amp and five transistors to generate the sine, square, and triangle waves. The 1-Hz to 100-kHz signal frequencies are tuned by first setting the RANGE switch to the desired range and then fine adjusting with the continuously tunable FREQUENCY control. The only other controls are the three-position FUNCTION switch and output signal AMPLITUDE control. The output from the function generator is available through color-coded OUTPUT binding posts on the control panel.

The sine-wave output has less than 2% THD; triangle-wave linearity is better than 1%; and the square-wave output rise and fall times are less than 0.5 μs into a 600-ohm, 2-pF termination. Output signal amplitude is variable from 0.1 to 10 volts peak-to-peak into an open circuit. The output impedance of the function generator is 600 ohms, constant over the amplitude and frequency range. The output circuit can easily be modified for driving TTL, HTL, RTL, DTL, and CMOS logic.

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The resistance and capacitance measuring accuracy of the Design Mate 3 is stated at better than 5%. A pair of HI and LO LED's are used as a unique NULL indicator that instantly tells the user whether the resistor or capacitor under test (connected via a pair of binding posts labelled UNKNOWN) has a value above or below the dial setting. The null is quite sharp to minimize ambiguities. The bridge circuit features a bootstrapped op amp whose high input impedance permits checking small capacitances without introducing loading errors.

The RANGE switch has separate positions for resistance and capacitance. The positions are labelled in decade steps from 10 to 10M and from 10PF to 1UF. The NULL ADJ control provides the means for producing the null condition in each range. When the null condition is obtained, the user merely checks the position to which the RANGE switch is set and reads the resistance or capacitance value directly from the NULL ADJ's calibrated scale.

User Report. We were anxious to see how well the Design Mates performed separately and as a team on our workbench. After living with these three units for several weeks, we have come to the conclusion that they do indeed make the task of breadboarding and testing a design simpler and less time consuming. In terms of frequency of use, the Design Mate 1 breadboarding system came out on top, followed closely by the Design Mate 2 function generator. Although we didn't have as much call for the Design Mate 3 R/C bridge, we found that there wasn't a better instrument for determining resistance and capacitance values and for matching components.

With a small circuit addition, spelled out in the manual that accompanied the Design Mate 2, we used the function generator as a variable-rate clock for several of our digital experiments. We have since used this unit for general-purpose audio testing and to check filters in our RTTY and slow-scan ham equipment. In all cases, it did a creditable job of testing.

The Design Mates, whether used singly or as a team, are a very practical addition to any workbench. They are relatively low in cost, simple to use, and eliminate much of the clutter normally attendant upon experimenting and design work.

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Solid State

By Lou Garner

PROGRAMMABLE SCHMITT TRIGGER

THERE is never a lack of new IC's on the market. Many of the latest ones are in the microprocessor area, but there are plenty of others that are also of interest to the imaginative expermenter or hobbyist. RCA's Solid State Division (Box 3200, Somerville, NJ 08876), for example, has recently introduced a versatile programmable Schmitt trigger with memory suitable for use in a variety of control circuit applications. Depending on its accessory devices and peripheral circuitry, the new IC, designated type CA3098, can be used to activate relays, heaters, LEDs, incandescent lamps, thyristors, solenoids, and similar units. It can serve as an on/off switch for pump, fan or positioning motors and in signal reconditioning, phase or frequency modulator, and square or triangular-wave generator circuits. The CA3098 can be used, too, for time-delay operations, for level control and sensing, or to provide overvoltage, overcurrent, or over/under temperature protection. With relatively low power requirements, it can be used effectively in either battery-powered or line-operated projects.

A monolithic silicon IC comprising more than 20 transistors and a number of diodes and resistors, as shown schematically in Fig. 1A, the CA3098 can be operated with either a single (16 volts max.) or a dual (±8 volts max.) power source. It can control currents up to 150 mA, having only microwatt power dissipation under standby conditions when the controlled current is less than 30 mA. Offered in three different package styles—an 8-lead DIP (type CA3098E), an 8-pin TO-5 case (type CA3098T), and an 8-pin TO-5 case with formed inline leads (type CA-3098S), as well as in chip form (type CA3098H)—the new device has an operating temperature range of −55 to +125°C, and can dissipate up to 630 mW at an ambient temperature of 55°C or, with a suitable heat sink, up to 1.6 W at the same temperature. When used at temperatures above 55°C, it is derated linearly at 6.67 mW/°C without a heat sink and at 16.67 mW/°C with a heat sink. It will accept sensors ranging in value from 100 ohms to 100 megohms, offers a programmable hysteresis characteristic from 20 mV to the supply-voltage level, and has an extremely low output leakage current of 10 μA max. As a switching device, the CA3098 has a low delay time of 600 ns, with fall and rise

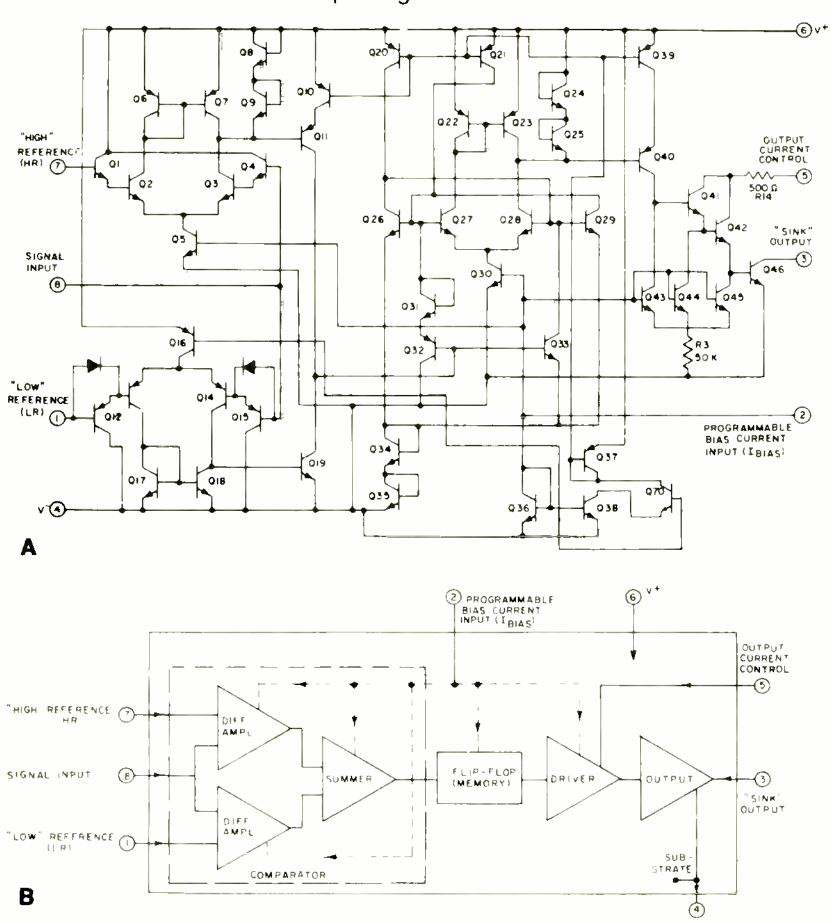

Fig. 1. RCA's CA3098 programmable Schmitt trigger: (A) internal schematic; (B) functional diagram.

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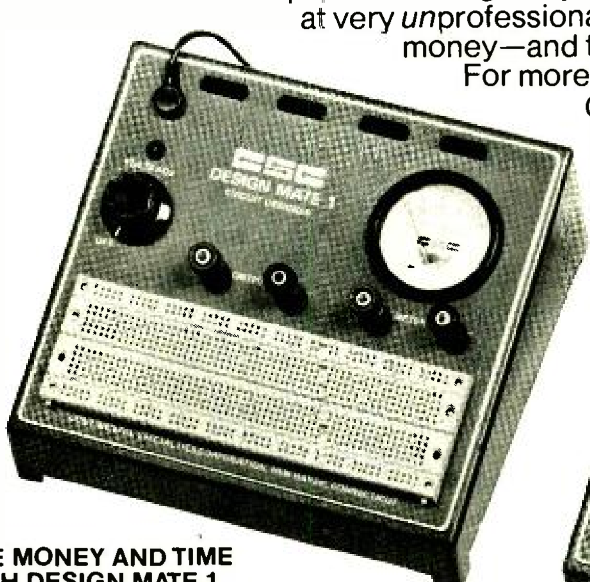

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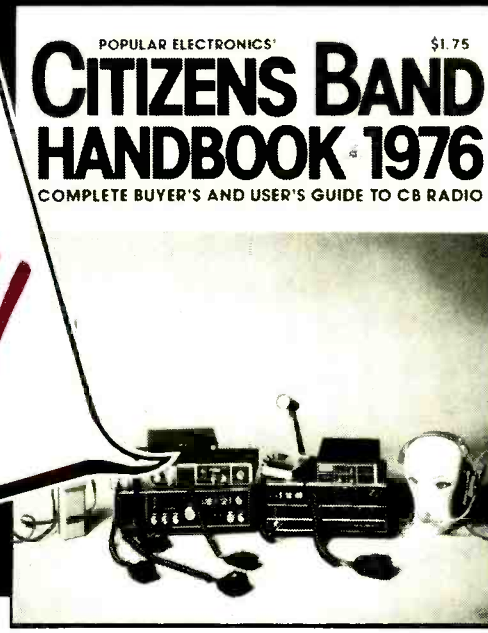

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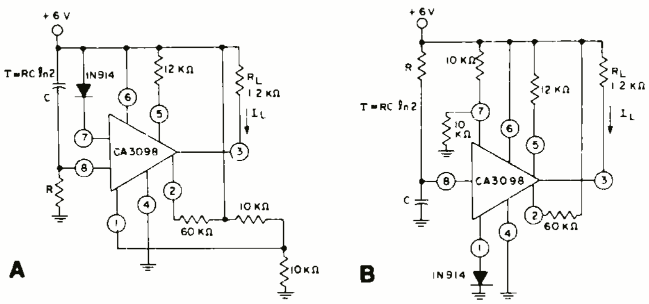
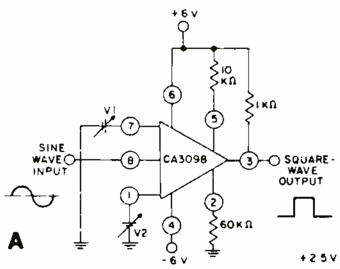


Fig. 2. CA3098 time-delay circuits: (A) switches on after delay; (B) switches off after delay.



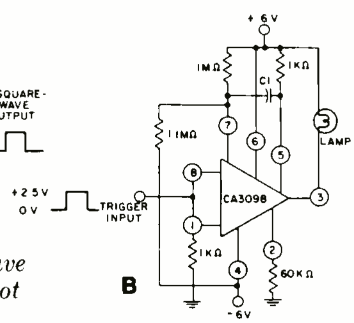
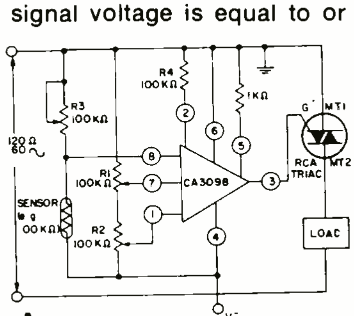


Fig. 3. Sine-to-square-wave converter (A) and one-shot multivibrator (B).

times of 50 and 500 ns, respectively, coupled with a storage time of only 4.5 μs under typical operating conditions.

Functionally, the device consists of two differential input amplifiers, a summing circuit, a flip-flop which serves as a bistable "memory" element, a driver amplifier, and a power output stage (Fig. 1B). The input signal voltage (pin 8) is compared to a prefixed higher reference voltage (HR, pin 7) by one differential amplifier and to a lower reference voltage (LR, pin 1) by the other, with the resultant output signals applied to the summer. The latter delivers a trigger signal to a flip-flop that changes state in response to each trigger command. The flip-flop, in turn, supplies a signal to the driver amplifier which controls the power output stage. The output stage serves to "sink" current from the power supply through an external load device, such as a lamp, relay, solenoid, or thyristor gate circuit. When the applied signal voltage is equal to or less than the present low



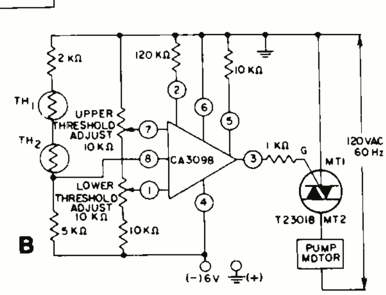


Fig. 4. Triac control circuits: (A) basic switch; (B) pump control.

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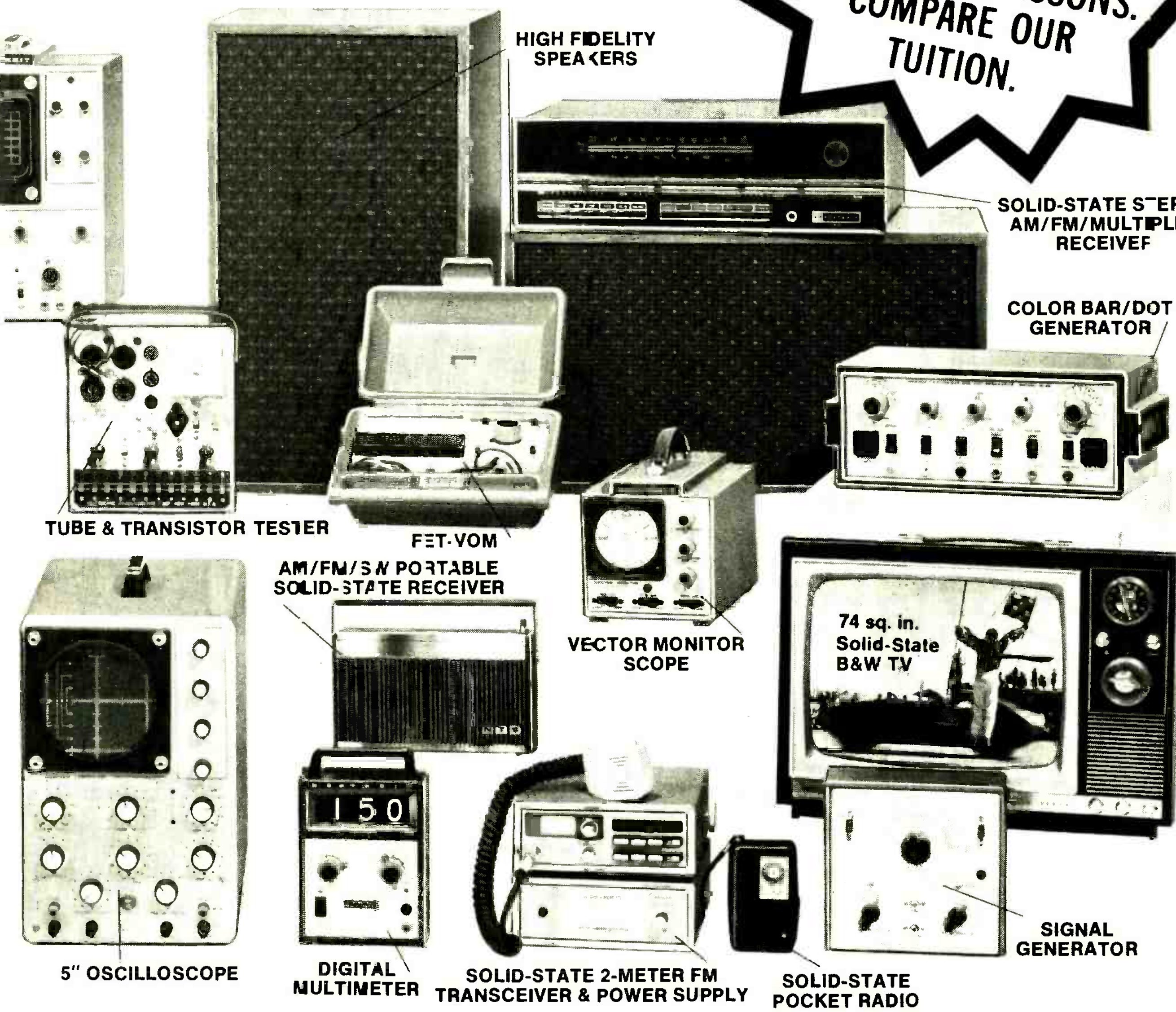

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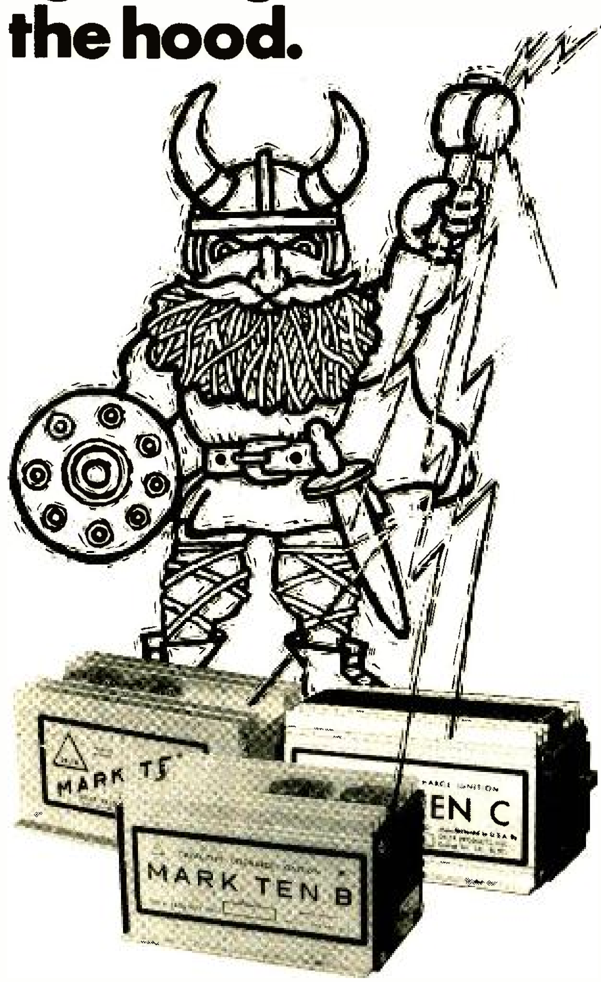

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reference voltage, the output stage is in a conducting state. This state is maintained until the input voltage rises to or exceeds the high reference voltage, at which point the output state switches to a nonconducting or "open" state. The "open" condition is maintained until the input signal again drops to or below the LR level, and the output stage is switched back to a conducting state. In addition to establishing the switching points by presetting the HR and LR levels, the device's operation may be programmed for optimum performance by means of an external bias current applied to the differential amplifiers, summer, flip-flop and driver stages through pin 2, while the maximum load current can be limited by the application of a separate bias current to the output stage through pin 5.

Representative examples of the CA-3098's potential circuit applications are illustrated in Figs. 2 through 4. These can be used either for the development of a specific projects or, if preferred, simply as guides in the design of original circuits. Abstracted from RCA's 8-page data bulletin for the CA3098, File No. 896, the circuits use standard components and, in most cases, can be duplicated quite easily in the home laboratory or workshop, for neither layout nor lead dress should be overly critical. Of course, good technical practice should be followed when wiring the circuits, with care taken not to overheat semiconductor device leads, and all dc polarities carefully observed.

The circuit shown in Fig. 2A is designed to switch the load current on following a predetermined delay after power is applied. The circuit in 2B switches the load current off after a suitable delay. Although resistive output loads are shown, relays, lamps, or other devices might be used in the circuits. In both, the time delay is dependent upon the time constant of the RC input network. Large values of *either* R or C will provide a longer time delay. If adjustable time delays are required, several capacitor values can be provided, selected as needed by a rotary switch. A fine adjustment can be provided by using a small trimmer rheostat in series with a fixed resistor for the R component.

Typical signal conditioning circuits featuring the CA3098 are illustrated in Fig. 3. The square-wave converter (Fig. 3A) features an adjustable duty cycle, achieved through the use of variable bias levels (V1 and V2) applied to the HR and LR inputs. The one-shot delivers an output pulse of fixed amplitude and duration to its lamp load when triggered by a positive-going input pulse. The output pulse width is determined by the value of the feedback capacitor *C1*. With a 0.01-µF unit, the pulse width is 15 ms, while a

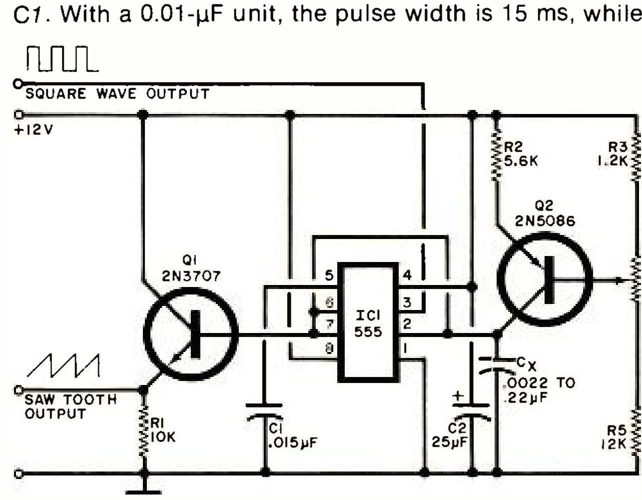

Fig. 5. Design for a function generator.

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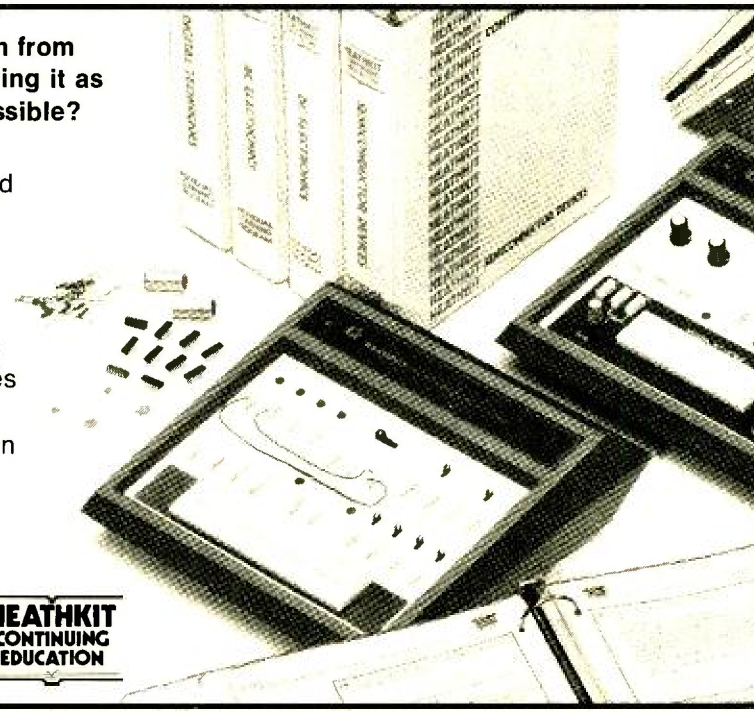

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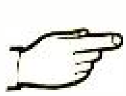

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300-ms pulse is obtained with a 0.2-μF capacitor. For optimum performance with the circuit values specified, the input pulse should have an amplitude of at least 2.5 volts and a duration greater than 1 ms, but less than the output circuit's "on" time. Naturally, other output loads can be used in place of the lamp shown on the diagram.

Finally, circuits featuring the use of the CA3098 in conjunction with bidirectional thyristors (triacs) are show in Fig. 4. In both examples, ac line power is supplied to the thyristor and its load, with a separate dc source provided for the CA3098 control circuit. In the basic switching circuit (Fig. 4A), a voltage divider made up of a single sensor (such as a photoresistive cell or thermistor) in series with a rheostat supplies the input control signal, while potentiometers *R1* and *R2* serve to preset the HR and LR levels, respectively. A modified version of the basic circuit intended specifically for maintaining the water level in a storage tank is given in Fig. 4B. Here, two thermistors, *TH1* and *TH2*, operated in self-heating modes, are used as sensors and the triac controls a pump-out motor. The thermistors are mounted in the tank on each side of the desired mean water level, with *TH2* at the top. In operation, the pump-out motor is activated when the water level rises above *TH2* and switched off when the water level falls below thermistor *TH1*.

Readers' Circuits. Most experimenters probably can discover a half-dozen or more applications for the simple function generator circuit illustrated in Fig. 5. Capable of supplying linear sawtooth and square-wave signals simultaneously, it might be used, typically, in test equipment, as a tone source for a basic electronic musical instrument, or as a linear sweep generator for an oscilloscope. Submitted by reader Craig K. Sellen (48 Briarwood Road, Wayne, NJ 07470), the design offers yet another application for the ubiquitous and inexpensive 555 timer IC. The circuit has an emitter-follower (*Q1*) as a buffer amplifier and an adjustable constant-current source (*Q2*) for the timing capacitor (*Cx*) to insure good linearity and optimum overall performance. Intended for operation on a 12-volt dc source, the circuit can be powered either by batteries or a well-filtered line-operated power supply.

Depending on individual preferences, the circuit can be breadboarded for experimental tests or duplicated on a perf or pc board, for neither the parts placement nor wiring arrangement should be especially critical. Aside from the active devices, *IC1* (type 555), *Q1* (2N3707), and *Q2* (2N5086), the fixed resistors can be ¼- or ½-watt types, potentiometer *R4* a standard linear control, bypass capacitor *C1* a paper or low-voltage ceramic type, and power-supply decoupler *C2* a 12-to-15-volt electrolytic

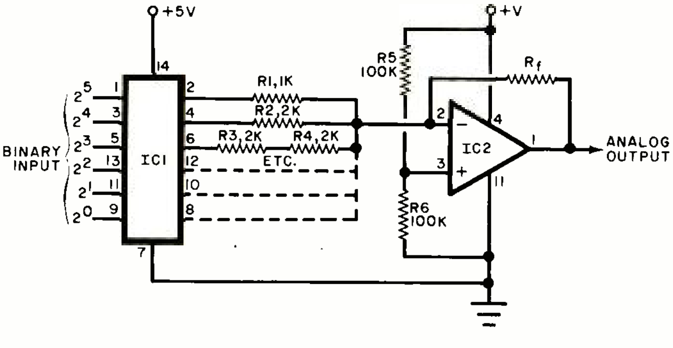

Fig. 6. Digital/analog converter circuit.

capacitor. The circuit's operating frequency is determined primarily by timing capacitor *Cx*, which can be a plastic film, paper or ceramic type, with values from 0.0022 to 0.22 μF, depending on application requirements. According to Craig, the circuit will deliver a linear sawtooth of approximately 4 volts, p-p.

Recognizing that many of today's hobbyists are working with digital projects, reader Robert L. Schuman (R.R. #2, Winthrop, IA 50682) has suggested the circuit given in Fig. 6 as an inexpensive solution for those requiring a simple digital-to-analog (D/A) converter. Using only two IC's, a hex inverter (*IC1*) and an operational amplifier (*IC2*), the circuit accepts digital binary input pulses and converts these to an equivalent analog signal. In operation, the actual conversion process takes place in a weighted resistive divider network (*R1, R2, R3, R4*, etc.) connected to the hex inverter's output terminals and which, in turn, becomes part of the op amp's inverting input feedback/bias circuit. The output resistance for each binary digit from 2^5 (32) to 2^0 (1) is doubled in value so that the summed resistive output connected to the op amp is inversely proportional to the input binary signal, thereby insuring that the op amp's output is directly proportional to the original binary number.

Robert has specified standard components in his design, with hex inverter *IC1* a type 7406 and *IC2* one section of a 324 quad op amp, a type amenable to operation on a single-ended power source. For optimum performance, precision resistors (1% or better) must be used in the divider network. Op amp input bias resistors *R5* and *R6* may be standard ¼- or ½-watt types, while feedback/bias resistor *Rf* should have a value less than half that of the smallest resistor connected to the hex inverter outputs (i.e., less than 500 ohms). The D/A converter circuit can be assembled using any construction technique, for neither layout nor wiring dress should be critical.

Data Sources. If our mail is any criterion, one problem plaguing many experimenters is that of finding technical data on IC's and discrete devices acquired through surplus stores and other outlets. As a general rule, of course, the best source of data is the original manufacturer, for virtually all of them publish detailed specification sheets, data bulletins, and, often, application notes covering their products. A number of the larger firms, including Motorola, RCA, and National Semiconductor, also publish comprehensive data books covering their entire product lines which are available at modest cost. Unfortunately, not all manufacturers will honor individual requests for data. This is often true of small-to-medium-size firms catering primarily to the large OEM market, even though their products may be available through surplus outlets and local distributors. In addition, original data sheets may not be available on obsolete or discontinued devices. However, if the need for information is great enough to justify the relatively high cost, complete specification data on virtually every semiconductor device ever manufactured is available from *D.A.T.A., INC.* (32 Lincoln Avenue, Orange, NJ 07050). This firm publishes a series of data books covering devices in every basic category from diodes to microcomputers. Each book is offered on an annual subscription basis and separate books are available covering discontinued devices. Prices range from, typically, $12.75 for the book on *Discontinued Thyristors* to $54.50 for the book on *Optoelectronics.*

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Device/Product News. Fairchild Semiconductor (4001 Miranda Ave., Palo Alto, CA 94304) has announced a new 190 x 244-element charge-coupled device (CCD) area image sensor for use in imaging and video systems. The second member of Fairchild's family of area sensors, the new solid-state device, type CCD211, contains 46,360 sensing elements organized in an array of 190 vertical columns and 244 horizontal lines, which is equivalent to one-quarter of the standard television resolution. The X-Y format of the array provides a 3:4 vertical to horizontal ratio, which is ideal for use with Super 8 movie camera lenses. Converting light focused by a camera lens into a video signal, the new CCD211 can operate at data rates up to 15 MHz, providing a picture frame rate up to 200 frames per second, in contrast to the 30 frames per second rate of broadcast TV and 18 frames per second rate of movie cameras. In addition to the image sensing elements, the device, which dissipates only 100 mW, includes 190 columns of 2-phase vertical analog transport registers, a 200-element horizontal analog transport register and a

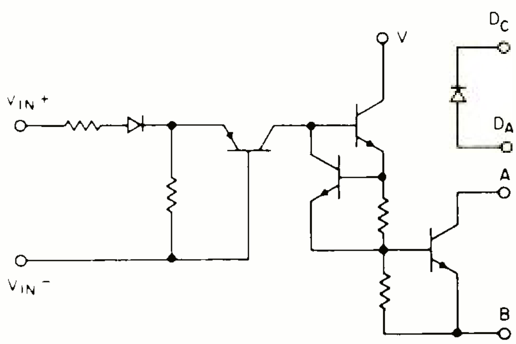

Fig. 7. Schematic of Dionics' power driver.

low-noise output amplifier. Featuring Fairchild's ion-implanted buried n-channel technology, the new CCD211 is offered in a 24-pin DIP.

A high-voltage, high-current power driver designed for use as an interface device between low-power MOS or TTL circuits and higher-power system elements, such as relays, lamps, and actuators, is now available from Dionics, Inc. (65 Rushmore St., Westbury, NY 11590). With an 80-volt maximum rating and the capability of controlling load currents up to 125 mA, the new device, designated type DI-445, has a power dissipation rating of 500 mW and features an adjustable logic threshold voltage. A monolithic silicon device comprising four transistors and several resistors, as shown in Fig. 7, the DI-445 includes an isolated high-current diode for transient suppression when used to drive inductive loads. The unit is supplied in a standard 8-pin plastic miniDIP.

Featuring an aluminum chassis and offering optional two-sided wiring, a versatile new breadboard system is now available from the Vector Electronic Co., Inc. (12460 Gladstone Ave., Sylmar, CA 91342). Designed for solderless interconnections, the new system includes eight *Klip-Bloks* capable of accommodating a maximum of twelve 14- or 16-pin DIP's, or four 24- or 40-pin devices, such as microprocessors and calculator or memory IC's. Additional *Klip-Bloks*, sockets, or discrete components can be added to expand the basic system's capacity. Two versions are currently available: the Model 51X, priced at \$25.50 and featuring a 4.5-by-8-inch glass-epoxy board, and the Model 51X-GP, which includes an etched ground plane on the underside of the board for improved high-frequency performance, priced at \$29.95.

The Hildreth Engineering Company (P.O. Box 3, Sunnyvale, CA 94088) has added a new member to its family of op amp design instruments, the Quadri QUICK-OP, a four position unit. Featuring 38 quad solderless connectors providing 152 tie-points, the new type is available in two versions, the Model 440-741, which includes four type 741 op amps, and the Model 440-MD, which offers 8-pin miniDIP sockets in each position, permitting the user to work with his choice of devices. Both models are priced at \$39.95 each, less batteries.

An exciting new *three terminal* adjustable voltage regulator IC has been announced by the National Semiconductor Corp. (2900 Semiconductor Drive, Santa Clara, CA 95051). Capable of supplying over 1.5 A output current at any output level from 1.2 to over 37 volts, the new device is supplied in *standard* power transistor packages which may be heat-sinked easily using conventional hardware. Functionally, the device comprises a constant current source, a 1.2-volt band-gap reference diode, a voltage comparator, and a Darlington pass transistor. The new IC offers 0.01%/volt line regulation, 0.1% load regulation over its full range, 80-dB ripple rejection, full overload protection, and a minimum input/output differential of 2.5 volts. Two external resistors are needed to set the output voltage. The new IC is offered in three basic versions: the LM117, rated for operation from −55°C to 150°C, the LM217, −25°C to 150°C, and the LM317, 0°C to 124°C. All three devices are available in both TO-3 and TO-5 packages, while the LM317 also is furnished in a TO-220 Epoxy package. ◈

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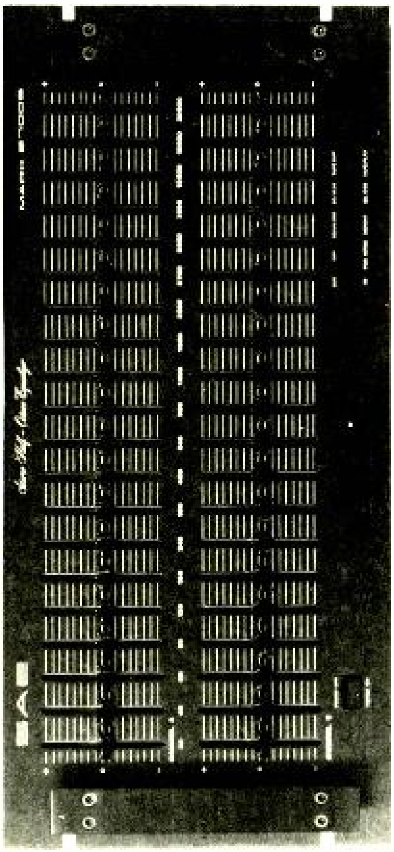

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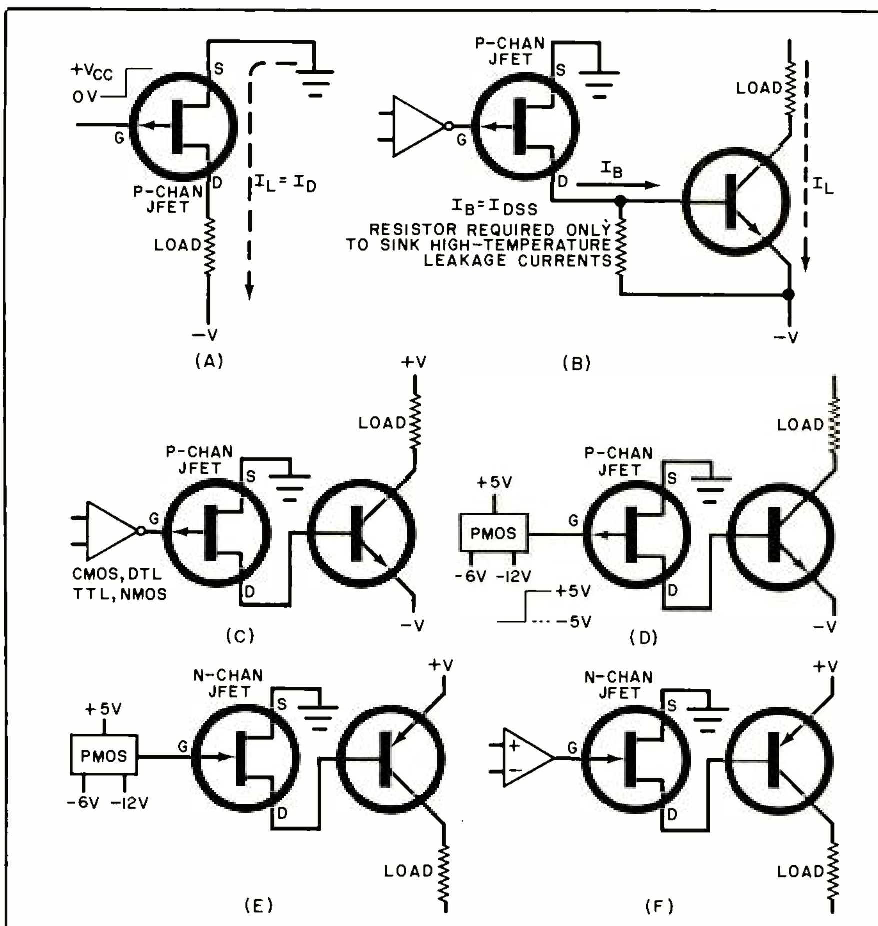
UNIVERSAL INTERFACE BETWEEN LOW-POWER LOGIC AND LOAD DRIVERS

BY VERN GREGORY

A PROBLEM that confronts the designer of MOS logic circuits is coupling these low-power devices to heavy loads. The job need not be too complicated, however, since there is a relatively simple circuit that can be used easily. It consists primarily of a conventional junction FET (JFET).

The basic circuit is shown at (A). The p-channel JFET is a normally conducting, depletion-mode device. That is, it conducts a fixed current (I_{DSS}) with transistor, without a current-limiting resistor, as shown at (B). Here, the interfaced voltage can be at any level within the ratings of the JFET and the bipolar transistor. The base current is selected to be about 1/15 of the required load current, by choosing the proper JFET. The load current is in phase with the input to the inverter driving the JFET. Since the JFET draws no gate current, the logic element is not loaded.



zero gate voltage. When the gate voltage is increased toward positive V_{CC}, I_D drops until pinch-off is reached. Then the current is zero.

The important feature is the fixed current at zero gate voltage. This means that the current is limited and can be selected to drive the base of a

Circuit (C) shows how to connect a 5-volt logic element (inverter shown) to a load, while (D) is a way to connect PMOS logic to a load on the negative supply. Circuit (E) is the same thing for a positive supply. The circuit at (F) illustrates an op amp or comparator interface. ◈

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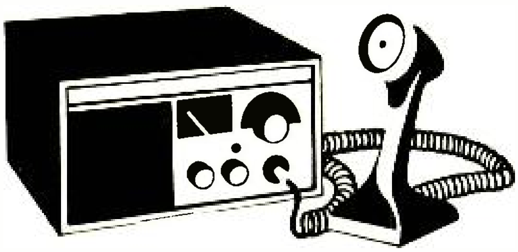


CB Scene

By Ray Newhall, KWI6010

AVOIDING CB RIPOFFS

THE THEFT of CB rigs from boats and vehicles has grown to epidemic proportions during the past year, and is becoming even more prevalent as each month goes by. There are few statistics available from official sources, but it is believed that as many as one in twenty mobile transceivers were stolen last year. Most CB marketers believe that about 80% of the estimated 10,000,000 CB transceivers now in use are installed in mobile environments. This could mean that nearly one-half million rigs, valued at more than $25 million on the street, were stolen from CB'ers in 1975. *That's not peanuts!*

The increase in CB larceny is inevitable, considering the increasing demand and the short supply. By EIA estimates, the demand for CB in 1975 resulted in 4.2 million units sold. Sales in 1976 are expected to surpass that figure by a wide margin. Manufacturers and distributors have simply been unable to keep up with the demand. So, when that guy from out-of-state promises you any rig you want at 50% of list price, within 24 hours, where do you think it will come from?

This subject was selected for discussion in this month's column after my own rig was neatly lifted from my car while it was parked in my driveway. After driving around "blind" for a few months, I recently installed a new CB radio. However, I couldn't complete an auto intrusion alarm installation to prevent a repeat theft because I was missing a few parts. But that was no problem (I thought), because the needed items could be easily obtained on Monday morning. But the new mobile didn't last that long! It was ripped off Sunday night, less than 36 hours after installation! Although my research has been somewhat more thorough than originally intended, I have learned a few lessons that I want to pass on to you.

Official Attitudes. I asked several local, state, and federal law enforcement agencies for their ideas on how the average CB'er can protect his investment in mobile equipment. Their unanimous answer was, "We are doing what we can, but we must have the help of the CB'ers themselves to stem this growing type of larceny." Most officials doubt that there is a single, foolproof countermeasure, but they believe that if each of us would take a few simple, common-sense precautions, CB larceny would soon become too risky to practice.

Some officials pointed out that insurance companies could do more than anyone to curb the rising tide of CB thefts, simply by insisting that those caught be charged and, if convicted, punished by the courts. All too often, the officials complain, the insurers of stolen property refuse to press charges against a thief who is caught because of trial expenses. Thus, the thief is out on the streets again in a few hours, ready to steal again. An alternative suggestion is that the insurance carriers relinquish their subrogation rights and urge owners with insurance to press charges, even though their claims have already been paid.

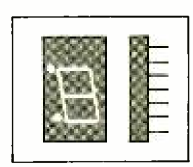
Fig. 1. Use a tag similar to that below to identify your rig and warn repairmen.

NOTICE TO CB REPAIRMAN

If the name and address on your repair order do not agree with those below, this set may be stolen. Please ask your local police to check the serial number through NCIC for possible theft. If it is stolen, please call collect the owner (number below) to notify him and arrange for a return.

(Owner's name, address and telephone)

(Date of purchase)



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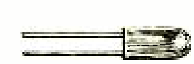

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I found little statistical information of value collected by these companies; but apparently, so many claims are being made that it is not profitable to insure mobile radios. As a result, many have advised that by the time this column is published, most policies will exclude *all* two-way radios (including CB, amateur, and vhf transceivers) from coverage.

Chief Francis Virgulak of the Norwalk (Connecticut) Police Department, his chief Crime Prevention Officer, Lieutenant Doug Lamb, and other department heads spent several hours in research and conferences to provide material and technical assistance for this column. In that city, the incidence of Auto Break and Entry cases increased only 9.4% in 1975, compared to the previous year. In the same period, however, the theft of tape decks increased 40.5%, and the theft of "radios" rose 425%. This police department does not differentiate between the types of radios stolen, but acknowledges that most of these were CB rigs.

Most sources I consulted indicated that, from personal experience, many (and possibly the majority) of CB thefts are not reported to the police. They could not explain why, but believed that many people feel that the police can do nothing about it, or that "illegal" (unlicensed) operators are afraid that the police will turn them in to the FCC. Lieutenant Lamb was quick to point out that the Police Department's concern was the prevention of larceny. No request to see a license is made when a theft is reported. He also said that any report of theft *which includes the serial number* of the stolen property will be put into the state and federal (NCIC) computers and remain on record for at least a year. Although authorities admit that the chances of a successful recovery are not great, they point out that their only hope of catching the thief is through these records. So they really depend on the cooperation of the CB'er to report all thefts.

Steps You Can Take. With the help of the police, we developed a list of "Do's and Don'ts" to reduce your chances of getting ripped off. In the long run, if followed by most CB'ers, they will make CB larceny so unprofitable that it will be reduced to a minor problem.

● When you buy a rig, deal with a reputable dealer and get a sales slip on a printed letterhead form. Be wary of any deal that offers much more than a 10% discount (based on list price), unless it's a "clearance" sale, an obviously hard-to-move unit, a sales "leader," a discount based on having a base-station antenna installed (antenna materials plus labor), or an older non-type-accepted unit.

● Save that sales slip! When you take your new rig out of the box, record the serial number on the slip. Put it in a

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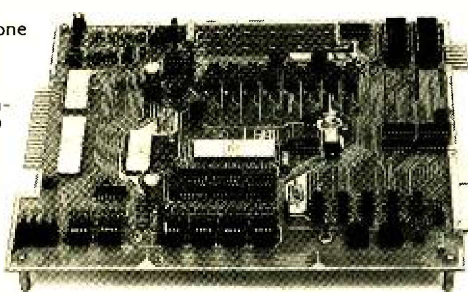

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Fig. 2. A tag like this from your local police and affixed to your vehicle window can be a theft deterrant.

safe place, and remember where it is. Besides its usefulness in case of theft, it is a valid proof of purchase for warranty purposes.

- Remove the chassis from the cabinet and paste in a label that identifies you as the owner, requesting the technician to compare your name with that on his repair slip. (Be sure not to hamper convection cooling.) If the two names do not match, request on the slip that the technician report the serial number to the police for a check against NCIC records. A sample label is shown in Fig. 1. Many service techs will cooperate, either because they are dealers hurt by the black market, or because of warranty problems. Most manufacturers insist that their authorized service stations check all serial numbers against a "hot list." A more permanent ID can be engraved with a suitable stylus on the chassis itself.
- If your rig is stolen, report it immediately to your local police department. Include the serial number in your report and ask them to have it registered with NCIC.
- Consider investing a few dollars in a locking security mount, such as SHUR-LOK's, which accommodates almost any transceiver and vehicle. These mounts usually require a key to gain access to the mounting bolts. An alternative, of course, is to remove your rig whenever you leave the vehicle. There are power-disconnect brackets sold by some auto radio and tape recorder installation companies that can accommodate some CB rigs.
- If you live in a high-theft area, you might choose a CB transceiver that is installed out of sight. For example, Royce has a model with a control head separate from a remotely mounted electronics package. The remote unit can be locked in your trunk.
- There is no questioning the value of an intrusion alarm installed in your vehicle. It not only protects your CB equipment, but may even save the car itself! These are available from many sources, but you might prefer to build your own. They take many forms, varying from a simple "lock-in relay" to sophisticated time-delay devices for both trip and automatic recycling. Some CB rigs incorporate a security mounting circuit which can be connected to the intrusion alarm to trigger it when the transceiver's mounting bolts are removed. It is also possible to have an alarm trigger when the transceiver's ground return lead is disconnected, though I'm not aware of a commercially available one.
- Check with your local police department to see if they have an "Operation Identification" plan. Some offer free decals similar to the one shown in Fig. 2. These decals, identifiable with a specific police organization, can be installed on a vehicle window. They are generally more effective deterrents than alarm warning decals that identify the type of alarm installed. (Here, the manufacturer's "advertisement" might be the tip-off to a smart burglar who knows how to bypass that particular alarm!)
- Efficient antennas are essential to effective mobile communications; but they tend to be very visible. For example, a pair of 108-inch phased whips mounted on a rear bumper practically "shouts out" the existence of a fancy rig. If you are willing to sacrifice performance, there are CB antennas that resemble the standard electric-powered auto antenna. Lowering the whip electrically into the cowling when you leave the car will hide the fact that you have a CB rig. (There are also nonelectrical whips that can be pushed into the cowl manually.)
- There are certain "booby trap" devices marketed that I believe should not be used. One is a tear-gas canister that is widely advertised. It is attached to the back of the set, and a mechanical trigger releases the gas when the transceiver is removed. Even though some cities and states may not consider installation of this device a violation of its criminal code, you are need-

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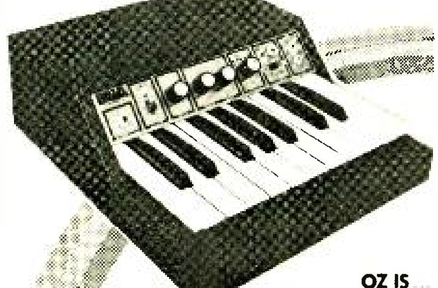

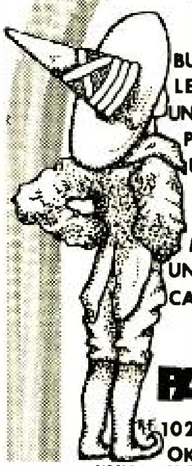

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lessly endangering yourself by installing it. First of all, the unit might faultily trigger itself, giving you a dose of teargas while driving—an invitation to disaster. Secondly, an inquisitive child, an innocent auto mechanic, or even a would-be thief might trip it, leaving you open to a civil lawsuit. If the thief is thus injured in pursuit of his "trade," it's very likely that. as soon as he is released on bond, he will file suit for personal injury. He might even win, and get a $100,000 judgment.

● There is a company in Oklahoma City which has advertised to register the serial number of your rig for a small fee. I asked this company in a letter how their service could help one recover a stolen rig. So far, they haven't responded. I have discussed this type of "protection" with law enforcement officers, and their concensus was that it could be a bonanza for the thief who got hold of a registry listing. Unless tightly controlled, it would provide him with all the information he needed to find the exact type of rig his "fence" requested him to acquire.

● How and where you leave your vehicle will have a great effect on how long you keep your rig. If you lock all doors, it will slow down the honest thieves. But car door locks offer no real barrier to professionals, who can open them faster than you can get your key in the lock! Your best bet is to park the car out of sight of the street. If you can't lock it in a garage at night, you might consider setting up an area alarm around your parking spot, using photo-relays, etc. (The Heathkit Model 1021 is just the ticket.) In addition to an intrusion alarm, I now have a system that floodlights my parking area and sounds an audible alarm. A garage door control disarms the system when moving vehicles in or out.

Conclusion. I believe that the growing threat of CB theft is one of the strongest possible arguments in favor of automatic transmitter identification, which is now under consideration by the FCC. I can't think of a better deterrent to putting a stolen rig on the air than the knowledge that each time the mike is keyed, the rig will transmit its very own ID number to any monitoring station within communications range. The operator will never know when someone is feeding his unit's number into a computer. But the automatic identifier concept may not be adopted. ◈

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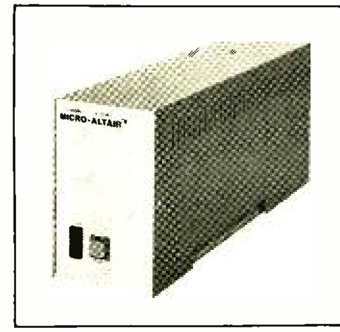

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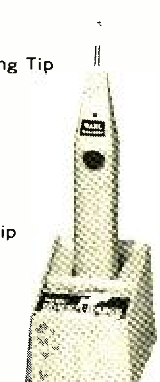

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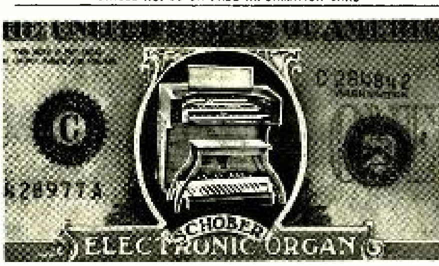

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WTFDA TV STATION GUIDE

The Worldwide TV-FM DX Association's new publication is a reference work of North and Central American television data. Features include maps (by channel) showing location, call letters, network, and offset frequency for most active stations; a station list giving city of license, state of transmitter location, satellite (rebroadcasting) information, effective radiated power, and antenna height.
Published by the Worldwide TV-FM DX Association, Box 163, Deerfield, IL 60015. 62 pages (8½" × 11"). $5.00.

INTEGRATED CIRCUIT PROJECTS

by Charles Rakes

Useful, fun-to-build, and educational circuits using IC's are described in this book. Among the areas covered are operational amplifiers, TTL circuits, and tone-signalling circuits. Basic design equations and device schematics are included. Commonly available parts are used.
Published by Howard W. Sams & Co., 4300 W. 62nd St., Indianapolis, IN 46206. 128 pages. $4.95 soft cover.

BASIC TELEVISION: PRINCIPLES AND SERVICING (Fourth Edition)

by Bernard Grob

This is an old friend but one which has undergone extensive "facelifting" to the point where it is scarcely recognizable. Not only has there been a complete redesign of the book itself but the contents have been updated with greater emphasis on color television, solid-state circuitry, and newer, more imaginative applications of TV. Written for the electronics or TV technician, the book can be used in the classroom or by those wanting to upgrade their skills. Each chapter carries a summary, a series of test questions, and suggestions for essays.
Published by McGraw-Hill Book Company, New York, N.Y. 10020. 718 pages. $13.95 hard cover.

ERRATUM

The book "Microcomputer Design Systems and Hardware for the 8008/8080," by Donald P. Martin, was incorrectly listed in this column in April 1976 as costing $75. It is $25. The publisher's correct address is: Martin Research, 3336 Commercial Ave., Northbrook, IL 60062.

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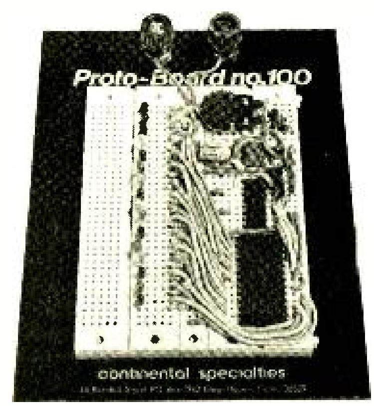

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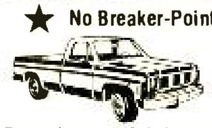

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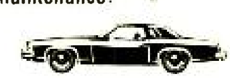

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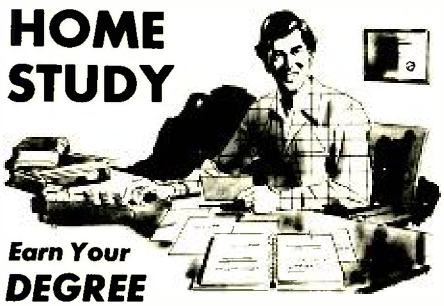

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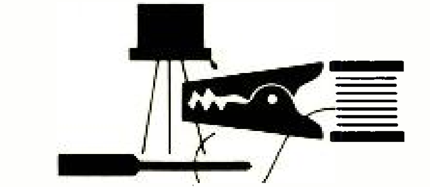


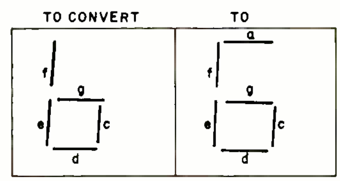
Tips & Techniques

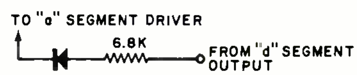
CASSETTE WINDER

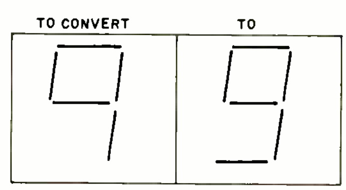
Want to get to a spedific point on a cassette without putting it in the deck? Just insert a 19-cent BIC pen barrel into the hole for the motor shaft. It fits very well, and you can easily twirl the pen barrel to wind the tape.—*Daniel. Eddins, Jr.*

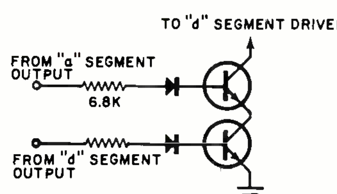
ADD MISSING SEGMENTS TO DIGITAL CLOCK

The "clock on a chip" IC's are very popular, but some of the displayed figures (6 and 9)









look a bit awkward. Here's a simple way to restore the missing segments which can also be used on any seven-segment display (DVMs, counters, etc.). Semiconductors are not critical—"junk box" silicon diodes and transistors will work fine.—*Alan Kong*

JAPANESE TRANSISTOR MARKINGS

While troubleshooting an audio amplifier, I came across an open transistor marked *C1060*. I checked several substitution guides and could not even find a listing for this number. After some research, I discovered that *C1060* is actually an abbreviated form of *2SC1060*. Each guide listed several replacements for this type number. I then inspected several pieces of equipment using Japanese transistors and found many devices using this kind of "shorthand." A note of caution—when making *any* substitution, check the parameters of the device to make sure that it is in fact a suitable replacement. Substitutes are often wide-tolerance devices.—*Alan W. Otto*

RTL POWER FROM OLD CAR RADIOS

Transformers salvaged from the vibrator supplies in old auto radios can often be put to use in noncritical RTL or other low-voltage supplies. However, they must be connected "backwards." When line voltage is applied across half of the secondary, an open-circuit voltage of 3.3 to 3.9 V ac will appear across the primary. Since both windings are usually center-tapped, various voltages are available through combinations of connections. The low-voltage windings can handle 4 to 6 amps dc, so fairly hefty loads can be used with them. (If the laminations get too warm to touch, you're overdoing it.) The reduced operating frequency and applied voltage will offset each other to forestall saturation problems. Of course, the method and degree of filtering needed depends directly on the particular load.—*Parke S. Barnard*

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Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Laboratory for Electronics Model 401 oscilloscope. Schematic and service manual. Michael Menninger, 3808 Hiawatha Blvd., Fort Wayne, TX 46809.

Operadio Model S-525-A plant broadcaster. Need schematic and operating manual. Dean Smith, 419 Collingwood Circle, Peoria, IL 61614.

Advance Electronics Model 405 phase meter. Schematic and/or service manual. Bene Brandt, Box 338, Concord, CA 94520.

Allen Model E319 distributor tester. Need any available information. David E. Gold, Box 538, Los Gatos, CA 95030.

Rec-o-cut Rondine Jr. L-37 phonograph. Need parts supplier. David Tovey, U.S.P.H.S. Hospital, 15th Ave., San Francisco, CA 94118.

Hallicrafters Model S-120 SW receiver. Schematic and instruction manual. Clayton B. Burton, Jr., 1141 Maple Forest Dr., Clearwater, FL 33516.

Filben Model EP300 juke box. Need schematics, operating manual and parts list. Tony Colera, 6767 Mineral Dr., San Diego, CA 92119.

United Scientific Labs. Model CB 7000 "Contact 23" CB receiver. Schematic and other technical data available. William H. Pierce, Box 1827, Key Largo, FL 33037.

Friden Model 132 calculator. Service manual needed. Tom Kitz, 648 Ceape Ave., Oshkosh, WI 54901.

Franklin Electronics Model 500 tube-type digital multimeter. Schematic and/or service manual. Steve Sekel, 708 Edward St., St. Marys, OH 45885.

Rycom Model 2174 A-610 frequency selective voltmeter and Bytrex HYT 140-15 variable power supply. Schematics for both models needed. Andy Fogt, R. 1, Rushylvania, OH 43347.

International Crystal Executive Model CTZ-5B CB radio. Need operating manual and source of power transformer. David A. Simmons, Box 27, Convoy, OH 45832.

Eico Model 221 VTVM. Calibration data and schematic. Fred P. Aquirre, 3509 S. Margo, Tempe, AZ 85282.

Hammarlund 400 Super-Pro 4-band receiver. Schematic and/or service manual. R. Fabris, 3626 Morrie Dr., San Jose, CA 95127.

International Crystal Executive Model No. 750 CB transceiver. Any available information. Stephen D. Rohrman, OE Division, USS Blue Ridge Lcc-19, FPO, San Francisco, CA 96601.

Knight Model Kg 635 oscilloscope. Schematic and/or construction manual. Ron Molland, 58 Princess Margaret Blvd., Islington, Ontario, Canada M9A 2A1.

National Model NC-33 4-band receiver. Schematic and parts source. R.L. Kirkland, 1102 S. Railroad, McKinney, TX 75069.

Out-Dated Switchboard of any kind needed. Randall Durham, 704 Greenslake Rd., Rossville, GA 30741.

Signal Corps. BC-221-AK (125-20,000KC) frequency meter. Maintenance and operating manuals needed. S.E. Stokes, 26006 Crenshaw Blvd., #115-B, Torrance, CA 90505.

Polarad Model LSA spectrum analyzer. Need schematics and operating manual. M. Parris, Dept. of Chemistry, Carleton University, Ottawa 1, Canada.

Brunswick Model BR60 (No. 278302) phonograph. Need hand crank handle. **Brunswick-Radiola** Model AR-813 superheterodyne 220-550 meters. Source of chassis parts and any other information available. Howard S. Blasczyk, 2115 Westover Dr., Palatka, FL 32077.

Atwater-Kent Model No. 37 radio. Schematic needed. Louis Hammond, 348 New Brooklyn Rd., Sicklerville, NJ 08081.

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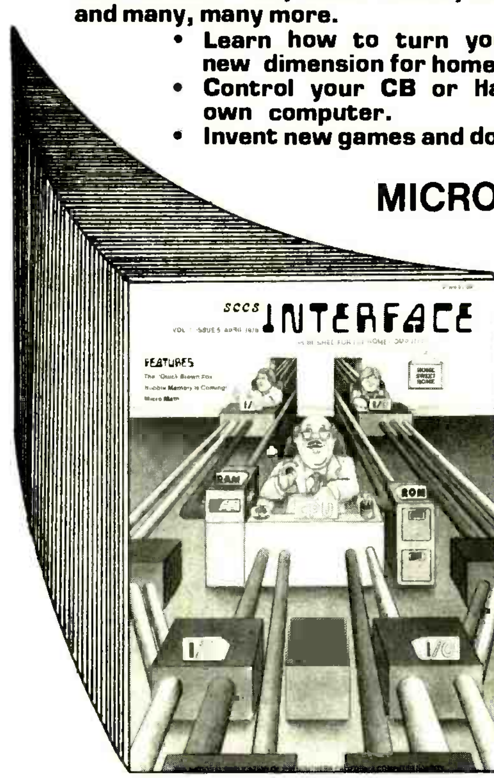

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Experimenter's Corner

By Forrest M. Mims

APPLICATIONS FOR THE TTL NAND GATE

BECAUSE they have so many complex applications, digital IC's may intimidate some electronics hobbyists. Impressive microphotographs of tiny silicon chips, complicated schematics, and a unique vocabulary sometimes combine to discourage both electronic novices and old hands.

This month we're going to expose the myth that digital IC's possess mysterious, even magical abilities by building several practical circuits from one of the simplest digital logic circuits, the NAND gate.

As most of you probably know, the gate is a circuit with two or more inputs and one output. A signal will appear at the output only if the appropriate combination of signals is present at the inputs.

The three basic logic gates are the AND, OR, and NOT circuits. The AND gate will provide an output signal only if an input signal is present at each of its inputs. The OR gate will provide an output signal only if an input signal is present at either or both of its inputs. The NOT gate is simply an inverter which reverses the phase of an input signal. Two compound circuits made by connecting an inverter to the output of an AND gate and OR gate are the NAND gate and NOR gate.

The logic symbols for each of the gates as well as their truth tables are shown in Fig. 1. Since a single gate usually has a couple of transistors plus a few resistors, the gate symbol greatly simplifies circuit diagrams. The truth table is simply a list of the output signals which result from various combinations of input signals. (For more details on digital logic, gates, and truth tables, see the "Basic Digital Logic Course," Parts 1 and 2, in the October and November 1974 issues of POPULAR ELECTRONICS.)

So you can see just how versatile and easy to use gates can be, let's assemble three versions of one of the most important circuits in electronics, the multivibrator. We will use only two of the gates in a TTL 7400 quad NAND gate (Fig. 2). The multivibrator is a two-state circuit, and each circuit will include one or two LED's to indicate which logic state the circuit is in. Incidentally, if you've gotten this far, but still have reservations about working with digital IC's, maybe this fact will turn you on: The 7400 is available for well under a nickel per gate from most of the dealers who advertise in the back of this magazine!

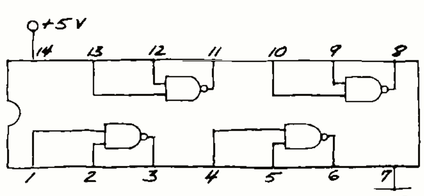


Fig. 2. The 7400 pin layout.

One-Shot. The first circuit is the *monostable multivibrator* shown in Fig. 3. Sometimes called a one-shot or single-shot, this useful circuit supplies a stable and predictable output pulse each time it receives an input signal, and this operating feature gives rise to several important applications.

Have you ever pressed a single digit key on a calculator and obtained a string of identical digits? This common phenomenon is usually the result of contact bounce in the calculator keyboard. A mechanical switch does not turn a circuit on or off in one clean operation since rough contact surfaces, pressure differences, wear, humidity, and dust interfere to produce a burst of on-off pulses each time the switch is actuated. A digital circuit will respond to each of these bounce-induced pulses as separate signals.

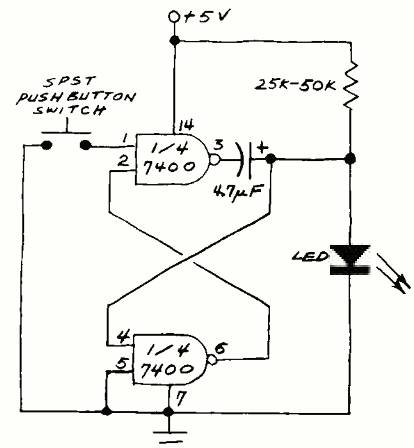
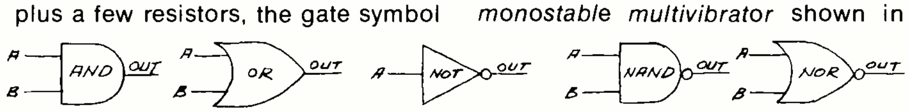


Fig. 3. Monostable multivibrator.

The one-shot circuit conveniently eliminates the bounce problem by providing a single, uniform pulse each time a mechanical switch connected to it is pressed. By adjusting the one-shot's pulse width to last longer than the bounce time, the bounce effects are completely eliminated.

Another important application for the one-shot is frequency division. Since you can adjust the one-shot for a variety of pulse widths by simply changing the value of its capacitor, you can block equal intervals of pulses in a pulse train. This application has uses in frequency generation and electronic music.

Flip-Flop. The second NAND gate circuit is the *bistable multivibrator* or, as it is more commonly known, flip-flop. The flip-flop can be switched back and forth between its two states by means of an input signal. This fea-



A	B	OUT
0	0	0
0	1	0
1	0	0
1	1	1

A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

A	OUT
0	1
1	0

A	B	OUT
0	0	1
0	1	1
1	0	1
1	1	0

A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 1. The five gates and their truth tables.

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ture makes possible numerous applications including shift registers, memories, dividers, and counters. For example, the popular TTL 7490 de-

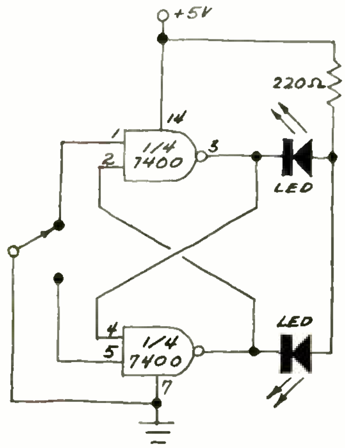


Fig. 4. Flip-flop circuit.

cade counter consists of four flip-flops on a single chip.

You can breadboard the flip-flop (Fig. 4) in just a few minutes since only three external components are required. When you first apply power to the circuit, one of the LED's will glow. By using the switch to ground first one and then the other input lead, the two LED's will alternately switch on and off as the circuit "flip-flops."

The one-shot has only one stable state, and it quickly resumes that state after each time it is called upon to supply an output pulse. But the flip-flop "remembers" the last input signal by keeping the appropriate LED on until the second input is activated or power is removed from the circuit. This operating principle is the basis for the memory, shift register, and counter applications for flip-flops.

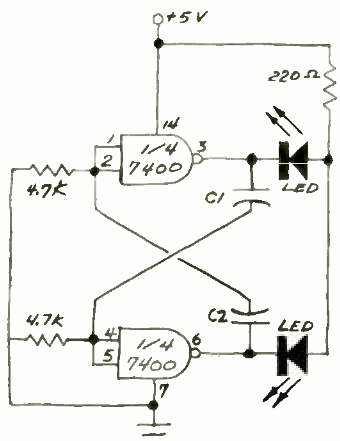
Astable Multivibrator. The third NAND gate circuit is the *astable multivibrator* shown in Fig. 5. This circuit is a free-running multivibrator which oscillates back and forth between its two permissible states automatically. Two LED's are used to show when the circuit changes state, but they are effective only when the multivibrator operates at a frequency below about 18 Hz. The human eye does not respond to a flicker rate any faster than this.

The circuit's period of oscillation is determined by capacitors *C1* and *C2* and a value of about 50 µF each will give you a rate of one or two flashes per second—and an inexpensive "quick-and-dirty" dual flasher with lots of attention-getting applications.

Smaller values for *C1* and *C2* will give you much faster flash rates, but you won't be able to see them. Here are some flash rates I measured with a frequency counter for two capacitor sizes:

Capacitance	Power Supply	Frequency
0.001 µF	4.5 volts	92.4 kHz
0.001 µF	5.0 volts	165.0 kHz
0.1 µF	4.5 volts	950.0 Hz
0.1 µF	5.0 volts	1610.0 Hz

As you can see, gates are not all that complicated, and they can be used to build some simple but useful circuits. By assembling and experimenting with these circuits, you'll be well on the way to understanding many of the more advanced digital construction projects which appear each month in POPULAR ELECTRONICS. Remember, if it's a digital project its operation is almost entirely dependent upon the gate! ◈



C1,C2 = .001 – 50µF (SEE TEXT)

Fig. 5. Astable multivibrator.

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This is a 64 key full ASCII encoded keyboard

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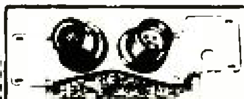

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BARREL KIT #51 HOBBY OPTO COUPLERS Untested. 40 for $1.98
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This is prime barrel material. Who wants DTL's? 930, 936, 946's. Your gain is our loss. They're marked too. Cat.No. 6E 2728

BARREL KIT #61 POLYSTYRENE CAPS 100% good 100 for $1.98
Finest caps made. As a gamble we bought 10 barrels from factory, mixed values; all good. Cat.No. 6E 2729

BARREL KIT #65 MIXED READOUTS 15 for $1.98
Factory returns — such numbers as MAN-4's, MAN-7's, MAN-3's, 11 barrels & no time to separate Cat.No.6E 2733 Untested.

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BARREL KIT #71 CAPACITOR SPECIAL 100 pcs. $1.98
Emptied stockrooms into barrels of mylars, poly's, micas, moldeds, plastics, ceramics, discs, etc. Nifty 100% good Cat.No. 6E 2738

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BARREL KIT #75 400MW ZENERS 150 for $1.98
Factory out of biz! Amazing offer: 6, 8, 10, 12 to 15V. You test. Hermetically sealed glass pak. Double plug. Cat.No.6E 2740

BARREL KIT #76 1-WATT ZENERS 100 for $1.98 Untested.
Factory same as 100-mw's. Never-to-see-again offer. 6, 8, 10, 12, 15V, under glass. Double plug. Cat.No. 6E 2741

BARREL KIT #77 "BROWN" BODY TRANSISTORS 40 for $1.98
G-E D-40 series, has hi-voltage, Darlingtons, hi-current, npn's. Factory line discontinued. Power tabs Cat.No.6E 2742 Untested.

BARREL KIT #78 "RED" BODY TRANSISTORS 40 for $1.98
D-42 series. You test—go into your own biz! High current, hi-V, NPN. Cat.No.6E 2743 Untested

BARREL KIT #81 SUBMINI RESISTORS 200 for $1.98 100% good.
PC, upright type, color coded, 1/8 watt. Asst values. Came to us in a barrel. Cat.No. 6E 2746

BARREL KIT #83 15 for $1.98 **LM-340T VOLTAGE REGULATORS** Untested
Factory rejected them for length of leads. May include 5, 6, 8, 12, 15, 18, 24 volts. Power tab Cat.No.6E 2635

BARREL KIT #87 NATIONAL IC BONANZA 100 for $1.98
Factory dumps into barrels. Types 8000, 7400 series, DTLs, ROMs, registers, clock & calc. chips, linears, etc. Cat.No. 6E 2860 Untested.

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For the first time silver micas so low in price! Axial, red case, variety of physical sizes & values. Big savings from distributor prices. Wt. 1 lb.

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DL-33B bubble magnifiers. Segs missing. Truthfully so many of 'em we don't care. Untested. 3 oz. No.6E 3046

BARREL KIT #99 PHOTO ELECTRIC CELLS 10 for $1.98
Asst. GE types, CDS types. Mixed by factory. Big job for us to separate. 100% good. Cat.No.6E 3052

BARREL KIT #102 CLOCK CHIPS 5 for $1.98 No.6E 3055
National is dumping! MM-5316 — what's wrong with 'em, we don't know, but we got barrels. Hobby special. Wt. 2 oz.

BARREL KIT #104 SLIDE VOLUME CONTROLS 10 for $1.98 Cat.No. 6E 3057
Used in hi-fi, volume control maker unloads. Asst. values, what a buy. Worth $1 ea. We've got barrels of 100% material.

BARREL KIT #107 SQUARE OHMS 60 for $1.98 Cat.No. 6E 3096
Factory people are sometimes "squares" when they topple prime square ohms mix 'em up in barrels. Asst. values watts. Wt. 1 lb.

BARREL KIT #108 TO-5 PLASTIC TRANSISTORS Cat.No.6E3101 40 for $1.98
Includes PNP, NPN, 2N-3638, 2N3641, 2N5000 series, etc. Untested, but guaranteed to a 60% yield.

BARREL KIT #109 TERMINAL STRIPS 150 for $1.98
Wide asst. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat.No 6E 3136

BARREL KIT #110 SUPPRESSOR DIODES 50 for $1.98 Cat.No.6E3137
Keeps ignition noises out axial. Untested, but the of your eqpt., car, industrial, etc. Double plug.

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barrels of blemished 3, 4 and/or 5 digit readouts to USA for "dump". Untested. Cat.No. 6E3138

BARREL KIT #112 MICRO MINI LEDS 40 for $1.98
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BARREL KIT #118 MINI SCRS 50 for $1.98
UNBELIEVABLE! TO-92 plastic SCRS in barrels . . . rite from factory. Includes all voltages up thru 200 prv. 6E3135

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Centralab "push-ON" switches. TV-makers excess. Dpdt, 6pdt, etc. Brand new. Cat. No.6E3150

BARREL KIT #120 TRIGGER DIODES 25 for $1.98
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BARREL KIT #121 "MINI" MAGNETS 100 for $1.98
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BARREL KIT #122 PLASTIC OPTICAL FIBERS 500-Ft. $1.98
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BARREL KIT #123 CD-4002 C-MOS IC 15 for $1.98
mostly good. But we have 250,000. Can never sell 'em out. YOUR GAIN! Their number is CD-5602. Cat. No. 6E 3217

BARREL KIT #126 UPRIGHT ELECTROS 40 for $1.98
Wide asst. of values from 1mf to 300mf in mixture of voltages. 100% marked 'n good. Why barreled? U-got-a-buy! Cat. No. 6E3226

BARREL KIT #127 AXIAL ELECTROS 40 for $1.98
Truthfully the factories (by mixing 'em in barrels) do all of us a favor. WUT A BUY! Asst. capacities and voltages. Cat. No. 6E 3227

BARREL KIT #128 MINI DIP ICS 75 for $1.98
Large mfgr dumped 100's of lbs. into barrels. Includes 741s, LM-380-8, 703, 567, 555, 558—but who knows? Factory to you. All mixed, you test. Wt. 1 lb. Cat. No.6E3245

BARREL KIT #131 TANTALUM ELECTROS 30 for $1.98
Mixed, marked prime, top grade asst. values, voltages. GE, Centralab, etc. Cat. No. 6E 3255

BARREL KIT #133 C-MOS IC'S 60 for $1.98
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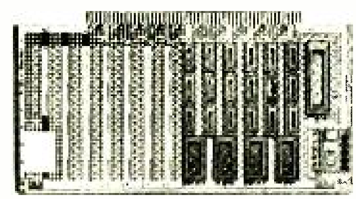

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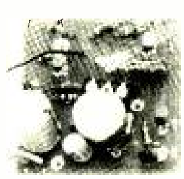

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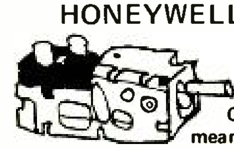

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MM5313	6 Digit BCD Outputs, 1PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit Alarm, 1PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calander, Alarm, 12 or 24 Hour	6.95

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

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

Continental Specialties

PROTO BOARDS

Build & test circuits as fast as you think!

PB100	10 IC cap breadboard kit 4.5 × 6.0 × 1.35	$19.95
PB101	10 14-DIP cap 5 way post 940 solderless tie points 5.8 × 4.5	$29.95
PB102	12 14 DIP cap like PB101 with 1 240 tie points 7.0 × 4.5	$39.95
PB103	24 14-DIP cap 4 5 way posts 2 250 tie points 6.0 × 9.0	$59.95
PB104	32 14 DIP cap 3060 solderless tie points 8.0 × 9.76	$79.95

PROTO-CLIP

For power-on hands off signal tracing. Bring IC leads up from PC board surface for fast troubleshooting.

PC14 14 pin $4.50

PC16 16 pin 4.75

LOGIC MONITOR

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

SOCKETS & BUS STRIPS

Plug in wire, test, modify or expand without patch cords or solder. Snap together to form breadboard needed.

PN/Description	L	Hole to Hole	Term Is	Price
QT59S Socket	6.5	6.2	118	$12.50
QT59B Bus	6.5	6.2	20	2.50
QT47S Socket	5.3	5.0	94	10.00
QT47B Bus	5.3	5.0	16	2.25
QT35S Socket	4.1	3.8	70	8.50
QT35B Bus	4.1	3.8	12	2.00
QT18S Socket	2.4	2.1	36	4.75
QT12S Socket	1.8	1.5	24	3.75
QT8S Socket	1.4	1.1	16	3.25
QT7S Socket	1.3	1.0	14	3.00

1/16 VECTOR BOARD

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

VECTOR TERMINALS

Series	Part No. Finish Gold	Part No. Finish Tinned	Post Size	25 pcs Gold	25 pcs Tin	50 pcs Gold	50 pcs Tin
T44	T44-1	T44	.025 sq	1.50 lot	1.00 lot	2.75 lot	1.75 lot
T46	T46-1	T46	.028 sq	1.75 lot	1.25 lot	3.00 lot	2.25 lot
T49	T49A	T49	.025 sq	1.75 lot	1.25 lot	3.10 lot	2.25 lot

VECTOR WIRING PENCIL

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

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

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

100 PER STRIP

MOLEX PINS

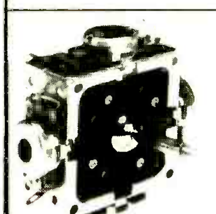
Intended for use as an inexpensive substitute for IC sockets. Also perfect for use as board connectors and in subassemblies.

SPECIAL — 100/1.49 — 1000/12.00

64 KEY KEYBOARD

The ideal item for the real homebrew computer hobbyist. This keyboard features 64 unencoded SPST keys unattached to any kind of P.C.B. A very solid molded plastic 13" × 4" base suits most applications.

$24.95 ea.



JOYSTICK

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

$9.95 ea.

MICROPROCESSOR COMPONENTS

8080A $37.95

8080 SUPPORT DEVICES

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

8080 $24.95

CPU'S		
8008	8 Bit CPU	$19.95
8080	Super 8008	24.95
8080A	Super 8008	37.95
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2504	1024 Dynamic	$9.00
2518	Hex 32 Bit	7.00
2519	Hex 40 Bit	4.00
2524	512 Dynamic	2.95
2525	1024 Dynamic	6.00
2527	Dual 256 Bit	3.95
2529	Dual 512 Bit	4.00
2532	Quad 80 Bit	3.95
2533	1024 Static	7.95
3341	Fifo	6.95
74LS670	16 × 4 Reg	3.95
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AY-5-1013	20K Baud	$6.95
ROM'S		
2513	Char. Gen.	$11.00
7488	Random Bits	3.50

RAM'S			
[illegible]601	256 × 1	FAST	5.00
1101	256 × 1	Static	$2.25
1103	1024 × 1	Dynamic	2.95
2101	256 × 4	Static	6.95
2102	1024 × 1	Static	1.95
2107	4096 × 1	Dynamic	19.95
2111	256 × 4	Static	7.95
7010	1024 × 1	MNOS	29.95
7489	16 × 4	Static	2.49
8101	256 × 4	Static	7.95
8111	256 × 4	Static	7.95
8599	16 × 4	Static	3.49
91L02	1024 × 1	Static	2.49
74200	256 × 1	Static	6.95
93410	256 × 1	Static	1.75
5262	2048 × 1	Dynamic	2.95
PROMS			
1024	1024 × 1	HPROM	5.00
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5203	2048	Famos	14.95
82S23	32 × 8	Open C	5.00
82S123	32 × 8	Tristate	5.00

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 microporcessor • 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**

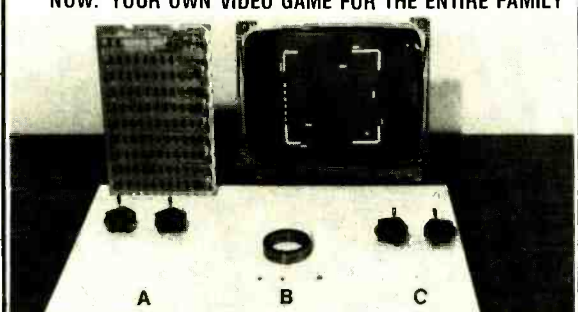
JOLT Universal Card — Sames size (4¼" × 7"), same form factor as other JOLT cards. Completely blank, drilled to accept 14, 16, 24 or 40 pin sockets. **24.95**

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 memonics 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**

NOW: YOUR OWN VIDEO GAME FOR THE ENTIRE FAMILY



This game comes pre-tested with two **PROFESSIONAL** Kraft joysticks. Joysticks allow 2 dimensional player control (rather than only one dimension, such as up and down.) If you require more than two players, order extra joysicks. All that's required is a 5V/2A power supply, a harness, and speaker. Comes with schematics, wiring information, and all necessary documentation. Game gives 1V composite video output, perfect for any TV monitor. Game designed so one, two, three, or four players can play at the same time. You can even play against the HOUSE. Score for each person is shown on TV set. These boards are production over runs of a well known video game manufacturer, and are **not** rejects, or in any way inferior to one presently being sold in games for over $1,000.00.

KIT A — $179.95 **PROFESSIONAL** game P.C. board, and 2 **PROFESSIONAL** joysticks. P.C. board size is 10½" × 17". This is the same **PROFESSIONAL** game as seen in commercial establishments. Dont't confuse it with the simple games sold in stores, or with analog kits.

ACCESSORY B — $3.95 Six feet of ribbon cable, three SPST switches (coin simulator, house/player, and start switch), for those of you who don't have extra wire or switches to build the harness.

ACCESSORY-C — $39.95 Two additional **PROFESSIONAL** Kraft joysticks, for third and fourth player.

DIGITAL CLOCK KIT — 3½ INCH DIGITS

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

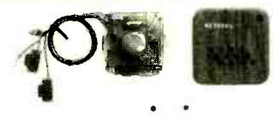
Specify 12 Or 24 Hr. When Ordering

4 DIGIT KIT $49.95 — 4 DIGIT ASSEMBLED $59.95

6 DIGIT KIT $69.95 — 6 DIGIT ASSEMBLED $79.95

AUTOTEL ™

WARNING LIGHTS ARE NOT ENOUGH



AN AUDIBLE ALARM INDICATING POTENTIAL ENGINE DAMAGE

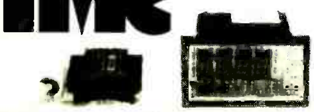
AUTOTEL is an effecient (15 ma current standby) device by which every owner of an automobile, truck or vehicle equipped with indicator lights for temperature and oil pressure can be assured of a reliable warning **before** an impending failure.

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

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

$14.95 Assembled — $9.95 Per Kit

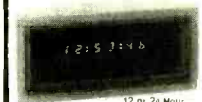
iMC 3½ DIGIT DVM KIT



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

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

JE700 CLOCK



12 or 24 Hour

115 VAC

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

$19.95

Liquid Crystal Temperature Display

Six Digit Light Emitting Diode Display — DL 33 Display

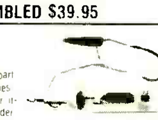
This clock makes an attractive addition to any desk. It has an extruded, black anodized aluminum case. It displays hours, minutes, and seconds with .11 inch displays, and comes complete with a liquid crystal thermometer. It operates off 115 VAC at 50 or 60 Hz. **$24.95**

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

KIT - ALL COMPONENTS & CASE $34.95

WIRED & ASSEMBLED $39.95

JE803 PROBE



The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) 1 (LOW) o (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

ELECTRONIC TOOLS

QUICK CHARGE CORDLESS SOLDERING IRON

This versatile tool weighs only six ounces, and can be operated without power anywhere. It gives the performance of a 50 watt iron with a tip temperature of over 700°F. It will solder an average of 160 3 twist 22 guage wire joints on one charge. It has a charge time of 4 hours, and heats in 5 seconds. Complete with recharger.

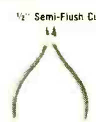
$29.95 EACH

NIBBLING TOOL

Nibbling Tool	$6.95
Replacement Punch	$3.75 Each

DIAGONAL CUTTER

½" Semi-Flush Cut Fine Diagonal



Light Blue Handle

A9/MS $8.50 ea.

SOLDER

Part No	Wire Dia	Price/1 lb Spool
SN60	.031	6.85/Spool
SN60	.040	6.50/Spool

Solder Wick

STOCK	WIDTH	PRICE
40-1	.025	$2.00 ea
40-2	.050	2.00 ea
40-3	.075	2.00 ea

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SN7423N	37	SN7491N	75	SN74177N	90
SN7425N	29	SN7492N	49	SN74180N	99
SN7426N	29	SN7493N*	49	SN74181N	2.49
SN7427N	37	SN7494N	79	SN74182N	95
SN7429N	42	SN7495N	79	SN74184N	1 95
SN7430N	26	SN7496N	89	SN74185N	2.20
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SN7439N	25	SN74121N*	39	SN74191N	1 25
SN7440N	15	SN74122N	39	SN74192N*	89
SN7441N	89	SN74123N*	70	SN74193N*	89
SN7442N	59	SN74125N	60	SN74194N	1 25
SN7443N	75	SN74126N	60	SN74195N	75
SN7444N	75	SN74132N	1 09	SN74196N	1 25
SN7445N	75	SN74136N	95	SN74197N	75
SN7446N	81	SN74141N	1 15	SN74198N	1 75
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CD4007	25	CD4046	2 51	74C42N	2 15
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CD4010	59	CD4049	79	74C74	1 15
CD4011	25	CD4050	79	74C90N	3.00
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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
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LM302H	75	LM381N	1 79	LM1496N	95
LM304H	1 00	LM382N	1 79	LM1556V	1 85
LM305H	95	NE501K	8 00	LM2111N	1 95
LM307CN	35	NE510A	6 00	LM2901N	2 95
LM308H	1 00	NE531H	3 00	LM3065N	69
LM308CN	1 00	NE536T	6 00	LM3900N	55
LM309H	1 10	NE540L	6 00	LM3905N	60
LM309K	1 25	NE550N	79	LM3909*	1 25
LM310CN	1 15	NE553	2 50	LM5556N	1 85
LM311H	90	NE555V*	45	MC5558V	1 00
LM311N	90	NE560B*	5 00	LM7525N	90
LM318CN	1 50	NE561B*	5 00	LM7535N	1.25
LM319N	1 30	NE562B*	5 00	8038B*	4 95
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LM320K-12	1 35	NE567H*	1 25	75453CN	39
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LM340K-12	1 95	LM739N	1 29	CA3046	1 15
LM340K-15	1 95	LM741CH	35	CA3059	2.46
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Includes monolithic function generator IC, PC board, and assembly instruction manual

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Same as XR 2206KA above and includes external components for PC board

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XR4136	2.00

DATA HANDBOOKS

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

ALL THREE HANDBOOKS $6.95

CONSUMER ELECTRONICS

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

NOT A KIT **$19.95**

OPTO ELECTRONICS

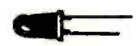
XCITON
LITRONIX
MONSANTO

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

DISCRETE LEDS

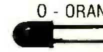
125'' dia.

XC209R	5/$1
XC209G	4/$1
XC209Y	4/$1
XC209O	4/$1



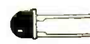
.185'' dia.

XC526R	5/$1
XC526G	4/$1
XC526Y	4/$1
XC526O	4/$1



.190'' dia.

XC111R	5/$1
XC111G	4/$1
XC111Y	4/$1
XC111O	4/$1



.200'' dia.

XC22R	5/$1
XC22G	4/$1
XC22Y	4/$1
XC22O	4/$1

.200'' dia.

XC556R	5/$1
XC556G	4/$1
XC556Y	4/$1
XC556O	4/$1

.085'' dia.

MV50
.085'' dia Micro red led
6/$1

DISPLAY LEDS

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	COMMON ANODE	270	$3 25	MAN 74	COMMON CATHODE	300	$1 50
MAN 2	5 x 7 DOT MATRIX	300	4.95	DL707	COMMON ANODE	300	$1 50
MAN 3	COMMON CATHODE	125	39	DL747	COMMON ANODE	600	2.25
MAN 4	COMMON CATHODE	187	1.95	DL750	COMMON CATHODE	600	2 49
MAN 7	COMMON ANODE	300	1 50	DL338	COMMON CATHODE	110	1.25
MAN 7G	COMMON ANODE-GREEN	300	2 50	FND70	COMMON CATHODE	250	50
MAN 7Y	COMMON ANODE-YELLOW	.300	2 50	FND503	COMMON CATHODE	500	1 75
MAN 72	COMMON ANODE	300	1 50	FND507	COMMON ANODE	.500	1 75

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

14 pin	$ 27	.25	24	28 pin	$ 99	.90	.81
16 pin	.30	27	25	36 pin	1 39	1.26	1 15
18 pin	35	32	30	40 pin	1 59	1 45	1 30
24 pin	49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$ 30	.27	24	24 pin	$ 70	63	.57
14 pin	35	.32	29	28 pin	1 10	1 00	90
16 pin	38	35	.32	36 pin	1 75	1 40	1.26
				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.

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	1/4 WATT 5% = 50 PCS.
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	1/4 WATT 5% = 50 PCS.
ASST. 3	5 ea.	470 OHM 1 2K	560 OHM 1 5K	680 OHM 1.8K	820 OHM 2 2K	1K 2 7K	1/4 WATT 5% = 50 PCS.
ASST. 4	5 ea.	3 3K 8.2K	3 9K 10K	4 7K 12K	5 6K 15K	6 8K 18K	1/4 WATT 5% = 50 PCS.
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	1/4 WATT 5% = 50 PCS.
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	1/4 WATT 5% = 50 PCS.
ASST. 7	5 ea.	1M 2 7M	1.2M 3.3M	1 5M 3 9M	1 8M 4 7M	2 2M 5 6M	1/4 WATT 5% = 50 PCS.

ALL OTHER RESISTORS FROM 2 2 OHMS - 5 6M AVAILABLE IN MULTIPLES OF 5 ea
5-25 PCS 05 ea 30-95 PCS 04 ea 100-495 PCS 03 ea 500-995 027 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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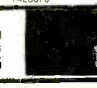
74LS00 TTL

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

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**

MINATURE TOGGLE

DPDT				JMT	1	2-9	10-29	30-99
	ON	OFF	ON	221	3 06	2.88	1 97	1 78
	ON	NONE	ON	223	2 85	2 28	1 88	1 61
	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

	Model Number	1 Each	2-9	10-29	30-99
Maintained Action Switch: Push To Make Contact And Push Again To Reverse Action	PB-123	$2 35	$1 95	$1 47	$1.30
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)	PB-126	$2.35	$1 95	$1 47	$1 30

5 AMP RATINGS

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY
SF – Front Mount SR – Rear Mount

Part No	Description	Price
SF 1?	Single Pole 10 Position	$2 50
SR 2	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.

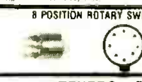
ACCESSORIES

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

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
FN2415	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	$ 69	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
	05	04	03	.001µF	.05	.04	.035
	05	04	03	.0047µF	.05	.04	.035
	05	04	03	.01µF	.05	.04	.035
100 pf	05	04	03	.022µF	.06	.05	.04
220 pf	05	04	03	.047µF	.06	.05	.04
470 pf	05	04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

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

20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1 35V	.28	.23	.17	1.5 35V	.30	.26	.21
.15 35V	.28	.23	.17	2.2 25V	.31	.27	.22
.22 35V	.28	.23	.17	3.3 25V	.31	.27	.22
.33 35V	.28	.23	.17	4.7 25V	.32	.28	.23
.47 35V	.28	.23	.17	6.8 25V	.36	.31	.25
.68 35V	.28	.23	.17	10 25V	.40	.35	.29
1.0 35V	.28	.23	.17	15 25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47 50V	.15	.13	.10	.47 25V	.15	.13	.10
1.0 50V	.16	.14	.11	.47 50V	.16	.14	.11
3.3 50V	.15	.13	.10	1.0 16V	.15	.13	.10
4.7 25V	.16	.14	.12	1.0 25V	.16	.14	.11
10 25V	.15	.13	.10	1.0 50V	.16	.14	.11
10 50V	.16	.14	.12	4.7 16V	.15	.13	.10
22 25V	.17	.15	.12	4.7 25V	.15	.13	.10
22 50V	.24	.20	.18	4.7 50V	.16	.14	.11
47 25V	.19	.17	.15	10 16V	.14	.12	.09
47 50V	.25	.21	.19	10 25V	.15	.13	.10
100 25V	.24	.20	.18	10 50V	.16	.14	.12
100 50V	.35	.30	.28	47 50V	.24	.21	.19
220 25V	.32	.28	.25	100 16V	.19	.15	.14
220 50V	.45	.41	.38	100 25V	.24	.20	.18
470 25V	.33	.29	.27	100 50V	.35	.30	.28
1000 16V	.55	.50	.45	220 16V	.23	.17	.16
2200 16V	.70	.62	.55	470 25V	.31	.28	.26

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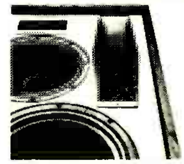

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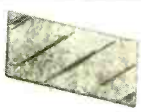

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3BN6	6AU6	6DR7	12AE7
3DG4	6AV6	6DW4	12AL5
3KT6	6AX4	6EB8	12AU7
3Q4	6AX5	6EM7	12AV6
4BC5	6AY3	6GF7	12BE6
4BN6	6BA6	6GH8	12BH7
4BU8	6BG6	6K6	18FW6
4BZ7	6BJ8	6K11	25L6
5V6	6BQ6	6LB6	35EH5
6AF4	6BZ6	6SN7	36AM3
6AG5	6CB6	6T8	50A5
6AG7	6CG7	6W4	50L6
6AL5			

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Wild Rover C-1380. Can be used with CT5001. 4 function, clear, clear entry and constant. 7 cm x 9 cm.

☐ **(CP175) 70 1/2W CARBON RESISTORS** **$1.00**
Asst. values. Some 5%.

☐ **(CP154) 150 CUT LEAD RESISTORS** **$1.00**
Carbon, all leads long enough for soldering.

☐ **(CP149) 20 POLYSTYRENE TOP GRADE CAPACITORS** **$1.00**

☐ **(CP132) 20 DUAL POTS** **$1.00**

24V. C.T. FILAMENT TRANSFORMER 1/2A. WITH 150V. TAP.
☐ (CP202) 99¢ ea 6 for $4.99

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Terms: Minimum order $4.00. Include postage. Either full payment with order or 20% deposit, balance C.O.D.

☐ **BONUS**
FREE CAPACITOR KIT With Every $5 Purchase

☐ **WRITE FOR FREE 1976 VALUE PACKED CATALOG**
Listing thousands of components, tubes, transistors, IC's, kits, test equipment.

THIS MONTH'S SPECIALS!

TTL

☐ 7400	16¢	☐ 7446	80¢
☐ 7401	18¢	☐ 7447	80¢
☐ 7402	22¢	☐ 7448	80¢
☐ 7403	23¢	☐ 7473	49¢
☐ 7404	23¢	☐ 7474	49¢
☐ 7405	23¢	☐ 7475	85¢
☐ 7406	23¢	☐ 7476	53¢
☐ 7410	23¢	☐ 7490	79¢
☐ 7411	27¢	☐ 7492	79¢
☐ 7413	40¢	☐ 7493	69¢
☐ 7420	23¢	☐ 7495	79¢
☐ 7430	23¢	☐ 74121	57¢
☐ 7440	30¢	☐ 74122	57¢
☐ 7442	$1.12	☐ 74123	67¢

LINEARS
☐ LM309K 5v 1a. reg. $1.15
☐ 555 Timer 75¢
☐ 556 Dual 555 $1.00
☐ 566 Function gen. $1.75
☐ 567 Tone decoder $1.95
☐ 741 comp. op amp 39¢
☐ 2102 1024 bit RAM $4.95
☐ 8038 volt cont osc $4.25

CLOCK CHIPS WITH DATA
☐ (MM5314) 6 dig clock $4.95
☐ CT7001 Alarm & Date $5.95

LED'S
☐ (CP223) 10 Asst LEDs $1.00
☐ (CP242) 5 Jumbo Green LEDs $1.00
☐ (CP242) 5 Med Yellow LEDs $1.00
☐ (CP001) 5 Jumbo Red LEDs $1.00
☐ (CP011) 5 Med Red LEDs $1.00
☐ (CP012) 5 Mini Red LEDs $1.00
☐ (CP293) DL707 (equiv.) 7 seg red LED, .3" char., comm anode $1.00
☐ (CP006) DL 704 (equiv.) same as DL707 except comm cath $1.35
☐ (CP007) DL747 7 seg red LED, .6" char., comm anode $1.95
☐ (CP013) MAN 5 (equiv.) 7 seg green LED, .27 char. comm. anode $1.49

IC BREADBOARDS & TERMINALS
Boards have .042 holes. Made of 1/16" polyester glass.
☐ (BB663) 3"x4" 94¢
☐ (BB664) 3"x6" $1.29
☐ (BB665) 4"x6" $1.65
☐ (BB666) 4"x8" $2.12
Push-in terminals
☐ (CP6601-20) pkg 20/90¢
☐ (CP6601-100) pkg 100/$2.98
Push-in flanged pins
☐ (BB6602-20) pkg 20/90¢
☐ (BB6602-100) pkg 100/$2.98
Push-in flea clips
☐ (BB6603-20) pkg 20/90¢
☐ (BB6603-100) pkg 100/$2.98
☐ (B008) 14 pin DIP sockets 3 for $1
☐ **(CP1104) IC REMOVAL AND INSERTION TOOL** **$4.95**
"Pul-n-sertic" extracts and inserts ICS without damage.

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☐ (CP203) SPST, 12V, 1000 ohms coil. Price 79¢
☐ (CP204) DPDT, 12V, 500 ohm coil. Price 99¢

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NEW ADJUSTABLE THREE OUTPUT REGULATED POWER SUPPLY, plus 900 parts worth $400.00 list. Solid state CARTRIVISION television recorder electronic unit. Schematics, parts cross reference. HEATHKIT television transistor substitutions. Power CB radios. MICROPROCESSORS $17.95 plus $3.50 S&H. USA. Free Brochure. MADISON ELECTRONICS COMPANY, INCORPORATED, Box 369, D55, Madison, Alabama 35758.

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LINEAR AMPLIFIER for C.B. Walkie-Talkie. Tiny Solid-State Portable Unit produces 100 Watt PEP from Milli-watts and can be inserted inside existing unit. Build for about $20. Send $5.00 for plans to: J. Martin Peter, P.O. Box 07071, Milwaukee, WI 53207.

Send for your information packet today—
which also includes circuit functions, component line-up, and accessories. Information Packet $1.00 (refundable with order).
visulex P.O. Box 4204P Mountain View, CA 94040

PLANS—Video Pong $2.00. Laser $2.00. Projection TV $2.00. Catalog 50 cents. Technologic, Box 5262, Orchard Lake, Michigan 48033.

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ALARM CLOCK KIT SIX DIGIT LED

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

THE KIT INCLUDES:

1 Mostek 50252 Alarm Clock Chip
6 Hewlett Packard .30 in. common cathode readouts.
15 NPN Driver Transistors
1 Etched and Drilled P.C. Board set
1 Step Down Transformer
2 Switches for time set
2 Slide Switches for alarm set and enable
1 Filter Cap
4 IN4002 Rectifiers
1 IN914 Diode
1 .01 Disc Cap
15 Resistors
1 Speaker for alarm
1 LED lamp for PM indicator.

$16.50
(COMPLETE KIT)

Why pay MORE MONEY for our competitor's clock that has LESS DIGITS that are SMALLER in size?

Please take note that we use only first run parts in our kits and include ALL the necessary parts. Not like some of our competitors who use retested readouts and chips or who may not even include switches in their kits.

60 Hz. Crystal Time Base

FOR DIGITAL CLOCKS $5.95
S. D. SALES EXCLUSIVE!

The kit you have been waiting for is here **NOW**, and at an unbelievable price! Thanks to S.D. Sales you can turn that digital clock of yours into a superbly accurate, DC operated, time piece.

KIT FEATURES:

A. 60 Hz output with accuracy comparable to a digital watch.
B. Directly interfaces with all MOS clock chips.
C. Super low power consumption (1.5 Ma typ.)
D. Uses latest MOS 17 stage divider IC.
E. Eliminates forever the problem of AC line glitches.
F. Perfect for cars, boats, campers, or even for portable clocks at ham field days.
G. Small size, can be used in existing enclosures.

BUY TWO FOR $10.00

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

ORDERS OVER $15 CHOOSE $1 FREE MERCHANDISE

2102 1K RAM's - 8 FOR $12.95
New units ———— We bought a load on a super deal, hence this fantastic price.
Units tested for 500NS Speed.

MOTOROLA RTL IC'S
Brand new, factory prime. Hard to find, but still used in a variety of projects. (See the RTL Cookbook by Howard W. Sams.)

MC724P-59c	MC780P-89c	MC791P-69c
MC725P-59c	MC785P-49c	MC792P-59c
MC764P-49c	MC787P-89c	MC799P-59c
MC767P-69c	MC788P-49c	MC9704P-89c
MC771P-49c	MC789P-59c	MC9709P-69c
MC775P-89c	MC790P-89c	MC9760P-69c

MV-50 TYPE LED's
by LITRONIX
10 for $1
Factory Prime!

3 DIGIT LED ARRAY — 75c

by LITRONIX
DL33MMB. 3 MAN-3 Size Readouts in one package. These are factory prime, not retested rejects as sold by others. compare this price! 75c 3 for $2.

SALE ON CUT LEAD SEMICONDUCTORS
Leads were cut for PCB insertion. Still very useable.

1N914/1N4148	100/$2
1N4002 1 Amp 100 PIV	40/$1
1N4745A 16V 1W Zener	20/$1
EN2222 NPN Transistor	25/$1
EN2907 PNP Transistor	25/$1
2N3904 NPN Driver Xstr.	25/$1
2N3392 GE Pre-amp Xstr.	25/$1
C103Y SCR. 800MA. 60V.	10/$1

ALL NEW. UNUSED. SOME ARE HOUSE #

SLIDE SWITCH ASSORTMENT
Our best seller. Includes miniature and standard sizes, single and multi-position units. All new, first quality, name brand switches. Try one package and you'll reorder more. *Special — 12 for $1* (Assortment)


DISC CAP ASSORTMENT
PC leads. At least 10 different values. Includes .001, .01, .05, plus other standard values.
60 FOR $1

UPRIGHT ELECTROLYTIC CAPS
47 mfd 35 V-10/$1 68 mfd 25V-8/$1
Brand new by Sprague. PC leads.

RESISTOR ASSORTMENT
1/4 W 5% and 10%. PC leads.
A good mix of values. 200/$2



1000 MFD FILTER CAPS
Rated 35 WVDC. Upright style with P.C. leads. Most popular value for hobbyists. Compare at up to $1.19 each from franchise type electronic parts stores. *S.D. Special 4 for $1*

FAIRCHILD BIG LED READOUTS
A big .50 inch easy to read character. Now available in either common anode or common cathode. Take your pick. Super low current drain, only 5 MA per segment typical.

FND - 510 Common Anode
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YOUR CHOICE $1.50 ea. 6 for $7.50

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Mini dip. New house numbered units by RAYTHEON.
4 FOR $1

FET'S BY TEXAS INSTRUMENTS — SPECIAL 5 for $1
#TIS-75 but with an internal house number. TO-92 plastic case. N. Channel, Junction type FET.

We do not sell junk. Money back guarantee on every item. No C.O.D. Texas Res. add 5% tax. Postage rates went up 30%! Please add 5% of your total order to help cover shipping.

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FND 807 cathode.
FND 800 anode.

.8 In. High. The Best on the market. Ideal for large readout application. $4.95

DL727

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

DL707

Red, .30 in. high 15mA per segment. Common anode.... $1.25

DL33

If you like an array of displays, we have it. Common cathode. $1.45

New .5 in. display by Fairchild. Common Cathode.

FND 503

$1.60
5/$7.50

MAN 5 GREEN
MAN 7 RED
MAN 8 YELLOW

Why not make a clock in 3 diff. colors. .27 in. high Common anode. $1.25

HP7730

.33 in. high red very bright 25mA per seg. Common anode.

TI

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

BURROUGHS 12 DIGIT

.25 in. high orange digit. 160v dc. Free socket. $2.50

LEDS

Mini red	.12
Jumbo red	.15
Jumbo green	.20
Jumbo yellow	.25

4 & 6 DIGIT PC BOARDS

PC Board for 4 digit display FND 800 or 807	$2.75
PC Board for 6 digit display FND 800 or 807	$3.50
PC Board for 4 digit display MAN series or DL707	$1.75
PC Board for 6 digit display MAN series or DL707	$2.25
PC Board for 4 digit display FND503	$2.00
PC Board for 6 digit display FND503	$3.00
PC Board for 4 digit display DL747	$2.50
PC Board for 6 digit display DL747	$3.00
PC Board for 4 digit display DL727	$2.29
PC Board for 6 digit display DL727	$3.00
PC Board for 4 digit display FND70	$1.75

All PC display boards are multiplexed for adding additional digits.

TRANSISTORS-DIODES

RCA200V 115W T05 NPN		1.25
GE D40C1 NPN Darl.		0.25
2N4443SCR 400v8A T0220		0.65
2N2222 NPN Gen. Ampl.		0.20
2N3904 NPN Driver		0.15
2N3906 PNP Compl. 2N3904		0.15
2N4400 NPN Low level noise		0.20
2N5401 PNP Nixie driver		0.25
1N4004	400PIV	15 for 1.00
1N4007	4000PIV	10 for 1.00
1N746	3.3 Zen.	4 for 1.00
1N4148	Switch	20 for 1.00

GE TRANSISTOR ASSORTMENT

T098 cased Darling., SCRs, NPN,PNP, etc.

50 for $0.95
100 for $1.75
300 for $5.00

TTL BOARDS

MEMOREX computer boards with TTL's Diodes and Transistors, etc.

5 Boards containing 150-250 IC's. $3.95

$$$ SAVE! 4-DIGIT ALARM CLOCK

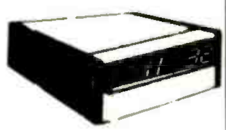
KIT NO.1 $13.95 (with PC Board)

FEATURES:

Direct drive display outputs, *Current control regulation on chip, *Low power brightness control on chip, *RFI eliminating slowup circuitry, *Sleep radio feature, *24 hour snooze alarm, *Independent digit setting, *Non multiplexed output circuitry. 12VAC CT 1/2 amp transformer for Kit No. 1 $2.00

***KIT NO. 2**

Complete kit with components, PC Board, Transformer, wood grain case, and filter for display window. Includes .25 in. readouts. $21.50



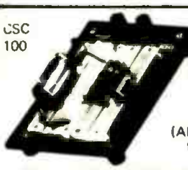
***KIT NO. 3**

Complete kit with components, PC Board, Transformer, wood grain case, and filter for display window. Includes .5 inch readouts. $22.50

*Components for Kit No. 2 or Kit No. 3 sleep radio feature, add $.95

CSC 100

NEW Proto Board $19.95 (Complete Kit)



(Allow 2 weeks for delivery)

We now offer a full line of Continental Specialties Proto Boards, Clips, Monitors, etc.

LOOK!

From Altaj to you, a special offer.

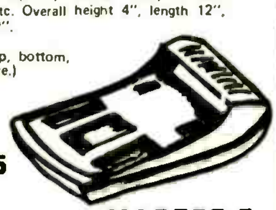
Power Supply Kit: 5 Volt 1 Amp. Reg.
Line regulation .005%
Load regulation 50mV

Kit includes Components, PC board, Transf., Fuse, Pilot Light
Nothing else to buy: $5.50

GOT A CASE? HERE'S THE CURE!

Ideal for Frequency counter case, function generator, etc. Overall height 4", length 12", width 7 1/2".

(Includes top, bottom, and hardware.)



$5.95

MASTER II

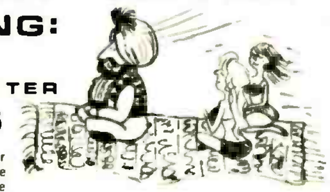
MUSIC LIGHTS

60 WATT COLOR ORGAN

Completely self contained unit with 120 volt power cord included. $1.50

THE KING OF ALTAJ INTRODUCING: DELILA

APPLIANCE STARTER $9.95



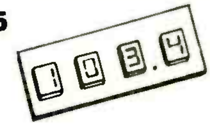
OPERATION:

(Example) Set your alarm for 7: a.m., set timer for 15 min. At exactly 7: a.m., the appliance will start, at 7:15, your clock alarm will wake you.

Kit includes all components, PC Board and instructions for interfacing with THE KING 6 digit alarm clock. Addition Number 2

FATIMA

4-DIGIT TEMP. KIT $19.95



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

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

THE KING

6-DIGIT ALARM CLOCK

$23.50

THE KING FEATURES:

1) 6 digit, 12 hr. 60 cycle or 24 hr. 50 cycle alarm clock
2) Time sharing capability for display of additional information.
3) Single 12v. supply and a minimum of interface components
4) AM-PM and automatic power failure indications
5) 10 minute snooze
6) Intensity control of LEDs.

Kit No. 70250-1R (Red readout)
Kit No. 70250-1G (Green readout)
Kit No. 70250-1Y (Yellow readout)
Kit No. 70250-2R (DL727 readout)... $28.50
Kit No. 70250-3R (FND807 readout). $29.50

All kits include components, PC Boards, Transformer, case, and construction manual.

TTL

7400	.16	7483	.85
7402	.16	7490	.69
7404	.16	7492	.75
7406	.24	7493	.75
7408	.16	7495	.75
7410	.16	7496	.75
7413	.49	74121	.38
7420	.16	74123	.75
7427	.24	74151	.75
7430	.16	74153	.89
7437	.39	74154	.95
7438	.35	74161	.99
7440	.16	74163	1.19
7442	.69	74164	1.89
7447	.89	74165	1.49
7448	.89	74174	1.29
7453	.16	74175	1.39
7473	.37	74181	2.75
7474	.37	74192	1.25
7475	.65	74193	1.25
7476	.39	74195	.79
		74197	.79

CMOS

4000	.24	4026	1.49
4001	.24	4027	.59
4002	.24	4028	.99
4006	1.49	4029	1.39
4007	.24	4030	.49
4008	1.15	4032	.24
4009	.59	4033	1.49
4010	.55	4034	3.25
4011	.24	4035	1.39
4012	.24	4037	4.50
4013	.59	4040	1.59
4014	1.49	4041	.89
4015	1.19	4042	.79
4016	.59	4043	.80
4017	1.29	4044	.59
4018	1.49	4047	.59
4019	.59	4049	.59
4020	1.59	4050	.59
4021	1.49	4066	.99
4022	1.19	4077	.39
4023	.24	74C92	.29
4024	.99	74C04	.29
4025	.24	74C107	1.29

LSI INTEGRATION

MM5316	4-6 digit alarm clock 40 pin dip w/spec	$ 4.25
7002	4 digit counter/latch decoder; 7 segment and BCD outputs. 28 pin dip w/spec	$12.50
7005	4 digit counter/latch decoder; 7 segment output only. 24 pin dip w/spec	$ 9.50
7007	4 digit counter/latch decoder with BCD output only. 16 pin dip w/spec	$ 7.00
70250	4-6 digit alarm clock 28 pin dip w/spec	$ 5.50
PC Board for 70250		$ 4.25
70380	4 digit non-multiplexed radio alarm clock featuring direct drive display output 40 pin dip w/spec	$3.50
PC Board for 70380		$ 3.75
8008	8 bit parallel CPU	$19.50
2102	1K static RAM for 8008	$ 2.25
MM5203	2K UV eraseable PROM	$12.25
75491	segment driver	$ 0.35
75492	digit driver	$ 0.45
7020	6 function calculator chip with direct segment drive. 8 digit	$ 2.25

LINEARS

555 Timer Mini dip	0.45
8038 Functional generator	4.25
RCA 3043 FM IF, Aud. Preamp	1.20
565 Phase Lock Loop	1.95
567V Tone Decoder	1.50
LM723 Pos. Volt. Reg.	0.55
LM309 5v. Lamp Reg.	1.10
LM380 2w. Audio Amp. 8 pin dip	1.00
LM741 Operational Amp.	0.25

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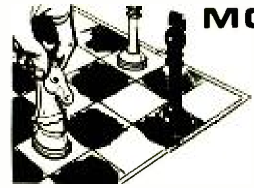

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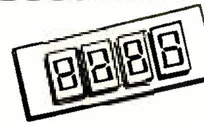
Now you can build some of the most advanced digital electronic instruments with our new series of low-cost modular scientific kits. These kits will expand the range of your electronic applications enormously--and all at a surprisingly low cost.

The heart of the system is our 4-digit Decade Counter (Kit 012) which features a full 4-digit LED readout (you choose the size best suited to your application). Combine this with a 5-volt regulated power supply (Kit 030) and you have the basis of a wide range of sophisticated electronic instruments, including:

A Digital Voltmeter (DVM) .. Kit 012 + Kit 030 + Kit 017
Frequency Counter................ Kit 012 + Kit 030 + Kit 016
RPM Counter......................... Kit 012 + Kit 030 + Kit 020 + Kit 018



4-DIGIT DECADE COUNTER KIT

$19.95 KIT 012

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

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

KIT 016 FREQ. COUNTER

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

KIT 017 DVM

1.999V as basic, with polarity indication. 1 M ohm input impedance and accuracy to 1% if properly adjusted **$13.50**

KIT 020 RPM COUNTER

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

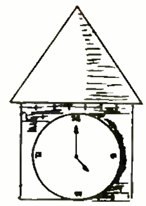
KIT 030 POWER SUPPLY

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

(Contains all parts except transformer)

TIME BASES

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



Kit 013 complete CMos with PC board **$15.75**
Buffer Circuit for TTL Interfacing

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

Kit 015 50Hz or 60Hz chain time base using line frequence as reference. Accuracy 0.1-0.05%. Outputs 10Hz-1Hz-0.1Hz. Complete with CMos shaping circuit and PC Board.. **$9.75**

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

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

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

$9.75

MORE TO COME

Watch this space in future issues for additional kits, including Multimeter, Timer, Capacitance Meter, Thermometer and many more. With our kits and your imagination, you'll find dozens of new and exciting applications.

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TV-GAMES, construction plans Pong series — 5 game set $5.00, big 12 game set $12.00. Jaws-2 and Space Race — both games for $8.00. ANTI-AIRCRAFT 1 & 2 — both for $8.00. Full description and specs — $1.00. ADVANCED ELECTRONICS, P.O. Box 1128, Cupertino, Calif 95014.

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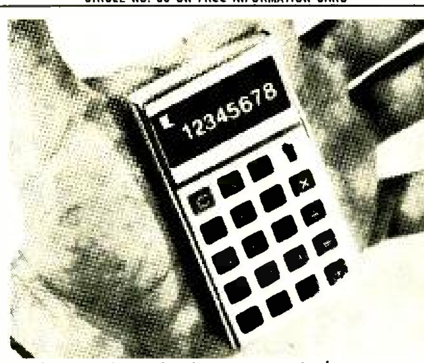

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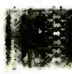

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R (OHMS)

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3.3	5	100	10	1.5K	10	15K	10	150K	10	2.2M	5
6.8	5	150	10	2.2K	20	22K	10	220K	10	3.3M	5
10	10	220	10	2.7K	10	27K	10	270K	5	4.7M	5
15	5	270	5	3.3K	10	33K	20	330K	10		
22	5	330	10	3.9K	10	39K	10	470K	10		
33	5	470	20	4.7K	20	47K	10	680K	10		
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1000 -		.10	.08

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22.6	71.5	182	887	11.8K	40.2K
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30.9	105	205	2.49K	18.2K	54.9K
34.8	110	232	3.57K	19.1K	60.4K
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45.3	137	499	5.49K	22.6K	69.8K
51.1	147	604	6.04K	24.9K	84.5K
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2.2 mfd	20V	.25 ea.	15 mfd	10V	40 ea.
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74LS32	.38	74LS193	2.50
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IN 904	Sw. Diode	30V	.10	10/ .65
IN 914	Sw. Diode	100V	.10	10/ .75
IN 967B	Zener	18V	.25	10/ 1.50
IN 2990A	Zener	33V (Stud Mt.)	1.25	10/ 7.50
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IN 3600	Sw. Diode	50V	.20	10/ 1.40
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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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7423	.29	74154	1.25
7425	.27	74155	1.07
7426	.26	74156	1.07
7427	.29	74157	.99
7430	.20	74158	1.79
7432	.23	74160	1.39
7437	.35	74161	1.25
7438	.35	74162	1.49
7440	.17	74163	1.39
7441	.98	74164	1.59
7442	.77	74165	1.59
7443	.87	74166	1.49
7444	.87	74170	2.30
7445	.89	74173	1.49
7446	.93	74174	1.62
7447	.89	74175	1.39
7448	1.04	74176	.89
7450	.17	74177	.84
7451	.17	74180	.90
7453	.17	74181	2.98
7454	.17	74182	.79
7460	.17	74184	2.29
7464	.35	74185	2.29
7465	.35	74187	5.95
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7474	.35	74193	1.19
7475	.57	74194	1.25
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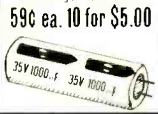

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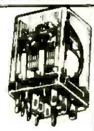

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7417	.40
7420	.12
74L20	.25
74H20	.18
7430	.10
74H30	.30
74L30	.30
7440	.10
74H40	.22
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7447	1.50
7450	.10
74H50	.30
7451	.10
74H51	.25
7453	.10
7454	.20
74L54	.25
74L55	.25
7460	.15
74L71	.20
7472	.40
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7473	.35
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7476	.35
74L78	.70
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7493	1.00
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SN7416N	39
SN7420N	[illegible]
SN7430N	[illegible]
SN7438N	37
SN7440N	17
SN7441N	78
SN7441AN	78
SN74[illegible]	17
SN74[illegible]	17
SN74[illegible]	39
SN74[illegible]	69
SN7489N	3.00
SN7493N	61
SN74107N	39
SN74121N	49
SN74145N	89
SN74150N	95
SN74154N	1.10
SN74157N	1.15
SN74161N	[illegible]
SN74162N	[illegible]
SN74163N	1.35
SN74164N	1.45
SN74166N	1.35
SN74174N	1.40
SN74175N	1.10
SN74181N	[illegible]
SN74190N	[illegible]
SN74193N	[illegible]
SN74198N	2.20
SN74251N	[illegible]
SN74298N	1.66

74LS00 TTL	
SN74LS00N	34
SN74LS04N	39
SN74LS08N	39
SN74LS10N	39
SN74LS20N	34
SN74LS38N	39
SN74LS74N	59
SN74LS75N	75
SN74LS90N	1.10
SN74LS93N	1.10
SN74LS95N	1.89
SN74LS107N	[illegible]
SN74LS132N	1.50
SN74LS151N	1.28
SN74LS157N	1.40
SN74LS160N	2.05
SN74LS170N	2.85
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NE567V	1.75
SN75450CN	47
SN75451CN	39
SN75452CN	39
SN75453CN	37
SN75454CN	37

CMOS	
CD4000	[illegible]
CD4001	[illegible]
CD4011	[illegible]
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2SC617	4.25	2SC798	3.10	2SC1239	3.50	2SC1957	1.50		
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2SC710	.70	2SC789	1.00	2SC1306	4.75	HEP-S3001	3.25	2SK30	1.00
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2SC735	.70	2SC799	4.25	2SC1307	5.75	MRF8004	3.00		
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2SC766	10.15	2SC839	.85	2SC1449	1.30	40080	1.25	3SK49	2.75

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2SA473	.75	2SB303	.65	2SC478	.80	2SC829	.75		
2SA483	1.95	2SB324	1.00	2SC491	2.50	2SC830	1.60	2SD30	.95
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2SA505	.70	2SB370	.65	2SC535	.75	2SC1010	.80	2SD68	.90
2SA564	.50	2SB405	.85	2SC536	.65	2SC1012	.80	2SD72	1.00
2SA628	.65	2SB407	1.65	2SC537	.70	2SC1051	2.50	2SD88	1.50
2SA643	.85	2SB415	.85	2SC563	2.50	2SC1061	1.65	2SD151	2.25
2SA647	2.75	2SB461	1.25	2SC605	1.00	2SC1079	3.75	2SD170	2.00
2SA673	.85	2SB463	1.65	2SC620	.80	2SC1096	1.20	2SD180	2.75
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2SA699	1.30	2SB476	1.25	2SC643	3.75	2SC1166	.70	2SD300	2.50
2SA699A	1.75	2SB481	2.10	2SC644	.70	2SC1170	4.00	2SD313	1.10
2SA705	.55	2SB492	1.25	2SC681	2.50	2SC1172B	4.25	2SD315	.75
2SA815	.85	2SB495	.95	2SC684	2.10	2SC1209	.55	2SD318	.95
2SA816	.85	2SB507	.90	2SC687	2.50	2SC1213	.75	2SD341	.95
		2SB511	.70	2SC696	2.35	2SC1226	1.25	2SD350	3.25
2SB22	.65			2SC712	.70	2SC1243	1.50	2SD352	.80
2SB54	.70	2SC206	1.00	2SC713	.70	2SC1293	.85	2SD380	5.70
2SB56	.70	2SC240	1.10	2SC732	.70	2SC1308	4.75	2SD389	.90
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1N914	.10	2N962	.40	2N2221	.25	2N2914	1.20	2N3771	1.75	2N4402	.20
		2N967	.50	2N2221A	.30	2N2916A	3.65	2N3732	1.90	2N4403	.20
2N173	1.75	2N1136	1.35	2N2222	.25	2N3019	.50	2N3773	3.00	2N4409	.20
2N178	.90	2N1142	2.25	2N2222A	.30	2N3053	.30	2N3819	.32	2N4410	.25
2N327A	1.15	2N1302	.25	2N2270	.40	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1305	.30	2N2322	1.00	2N3055	.75	2N3856	.20	2N4441	.85
2N336	.90	2N1377	.75	2N2323	1.00	2N3227	1.00	2N3866	.85	2N4442	.90
2N338A	1.05	2N1420	.20	2N2324	1.35	2N3247	3.40	2N3903	.20	2N4443	1.20
2N398B	.90	2N1483	.95	2N2325	2.00	2N3250	.50	2N3904	.20	2N4852	.55
2N404	.30	2N1540	.90	2N2326	2.85	2N3375	6.50	2N3905	.20	2N5061	.30
2N443	1.75	2N1543	2.70	2N2327	3.80	2N3393	.20	2N3906	.25	2N5064	.50
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.17	2N3925	3.75	2N5130	.20
2N501A	3.00	2N1549	1.25	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5133	.15
2N508A	.45	2N1551	2.50	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5138	.15
2N555	.45	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5198	3.75
2N652A	.85	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5294	.50
2N677C	6.00	2N557	.15	2N2712	.18	2N3442	1.85	2N3958	1.20	2N5296	.50
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5306	.20
2N706B	.40	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5354	.20
2N711	.50	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.20	2N5369	.20
2N711B	.60	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.20	2N5400	.40
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	2N5401	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.15	2N4142	.20	2N5457	.35
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2N918	.35	2N2218	.25	2N2906A	.30	2N3646	.14	2N4220A	.45	C103D	.40
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2N956	.30	2N2219	.25	2N2907A	.30	2N3731	2.75	2N4400	.20	C106D1	.75

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2N2647	.60	2N4870	.50
2N6027	.55	2N4871	.50
2N6028	.70	2N4891	.50
D5E37	.25	2N4892	.50
		2N4893	.50
		2N4894	.50
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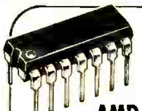

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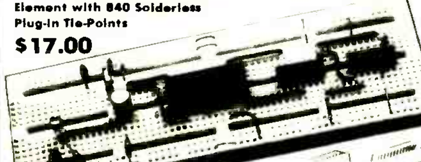
7402	.21	7475	.49	74176	.79	4006	1.23	4081	.23
7403	.21	7476	.32	74177	.79	4007	.23	4082	.23
7404	.21	7480	.70	74180	.70	4008	.79	4502	.79
7405	.21	7482	.70	74181	2.15	4009	.44	4510	1.14
7406	.25	7483	.70	74182	.79	4010	.44	4511	1.05
7407	.25	7485	.89	74184	2.19	4011	.23	4514	2.80
7408	.21	7486	.28	74185	2.19	4012	.23	4515	2.80
7409	.21	7489	2.19	74188	3.50	4013	.40	4516	1.23
7410	.21	7490	.44	74189	3.50	4014	.96	4518	1.14
7411	.21	7491	.70	74190	1.23	4015	.96	4520	1.14
7412	.21	7492	.44	74191	1.23	4016	.40	4527	1.68
7413	.25	7493	.44	74192	.88	4017	1.05	4528	.88
7414	.89	7494	.70	74193	.88	4018	1.05	4585	1.23
7416	.25	7495	.70	74194	.88	4019	.23	LM309K	1.80
7417	.25	7496	.70	74195	.88	4020	1.14	LM324N	1.28
7420	.21	74100	1.28	74196	.88	4021	1.14	LM340T-5	1.25
7421	.25	74107	.30	74197	.88	4022	.96	LM340T-6	1.25
7423	.35	74109	.33	74198	1.49	4023	.23	LM340T-8	1.25
7425	.35	74121	.35	74199	1.49	4024	.84	LM340T-12	1.25
7426	.25	74122	.44	74251	1.09	4025	.23	LM340T-15	1.25
7427	.33	74123	.61	74279	.58	4026	1.68	LM340T-18	1.25
7428	.28	74125	.40	74365	.67	4027	.40	LM340T-24	1.25
7430	.21	74126	.40	74366	.67	4028	.89	LM3900N	.88
7432	.25	74132	.70	74367	.67	4029	1.14	NE536T	3.24
7433	.30	74141	.88	74368	.67	4030	.23	NE540L	2.04
7437	.25	74145	.70	75150	1.31	4033	1.51	NE555V	.48
7438	.25	74147	1.63	75450	.88	4034	3.50	NE556A	.88
7440	.21	74148	1.30	75451	.61	4035	1.14	NE560B	3.83
7441	.88	74150	1.16	75452	.61	4040	1.14	NE561B	3.83
7442	.53	74151	.70	75453	.61	4041	.79	NE562B	3.83
7443	.63	74153	.65	75454	.61	4042	.79	NE565A	1.25
7444	.63	74154	1.03	75491	.81	4043	.70	NE566V	1.28
7445	.70	74155	.70	75492	.84	4044	.70	NE567V	1.36
7446	.70	74156	.70	75493	1.09	4046	1.86	uA709CV	.44
7447	.70	74157	.70	75494	1.19	4049	.40	uA710CA	.44
7448	.70	74160	.88	8093	.40	4050	.40	uA711CA	.53
7450	.21	74161	.88	8094	.40	4051	1.26	uA723CA	.60
7453	.21	74162	.88	8095	.67	4052	1.26	uA741CV	.44
7454	.21	74163	.88	8096	.67	4053	.72	uA747CA	.70
7460	.21	74164	.96	8097	.67	4060	1.58	uA748CV	.49
7470	.30	74166	1.26	8098	.67	4066	.79	MC1458V	.53
7472	.30	74170	2.64	82S25	2.19	4071	.23	2102	2.65
		74173	1.42	4000	.23	4072	.23	8080A	49.95

AP SUPER STRIP II—Universal Breadboarding Element with 840 Solderless Plug-In Tie-Points $17.00



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7 models for fast building and testing of circuits

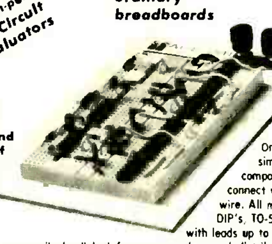

photo ACE 201K

On all models . . . simply plug in your components and interconnect with 22-ga. solid wire. All models accept all DIP's, TO-5's and discretes with leads up to .032" diameter. Multiple buses can easily be linked for power and ground distribution, reset and clock lines, shift command, etc. Bases: gold-anodized aluminum. Terminals: non-corrosive nickel-silver. Four rubber feet included.

ACE Model No.	Tie Points	DIP Capacity	No. Buses	No. Posts	Board Size (Inches)	Price Each
200-K (kit)	728	8 (16's)	2	2	4-9/16x5-9/16	$18.95
208 (assem.)	872	8 (16's)	8	2	4-9/16x5-9/16	28.95
201-K (kit)	1032	12 (14's)	2	2	4-9/16x7	24.95
212 (assem.)	1224	12 (14's)	8	2	4-9/16x7	34.95
218 (assem.)	1760	18 (14's)	10	2	6-1/2x7-1/8	46.95
227 (assem.)	2712	27 (14's)	28	4	8x9-1/4	59.95
236 (assem.)	3648	36 (14's)	36	4	10-1/4x9-1/4	79.95

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14 Pin Solder Tab	.20
16 Pin Solder Tab	.22
18 Pin Solder Tab	.29
24 Pin Solder Tab	.38
28 Pin Solder Tab	.45
40 Pin Solder Tab	.63
8 Pin Wire-Wrap	.24
14 Pin Wire-Wrap	.26
16 Pin Wire-Wrap	.30
18 Pin Wire-Wrap	.60
24 Pin Wire-Wrap	.86
28 Pin Wire-Wrap	1.23
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1N4001	.64/10	5.50/C	1N4005	.82/10	7.05/C
1N4002	.66/10	5.60/C	1N4006	.90/10	7.75/C
1N4003	.68/10	5.80/C	1N4007	.99/10	8.60/C

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— Radial Lead —			— Axial Lead —			— Axial Lead —		
luf/50v	.08	.65/10	luf/50v	.11	.90/10	47uf/25v	.17	1.30/10
2.2uf/50v	.08	.65/10	2.2uf/50v	.12	.90/10	100uf/16v	.17	1.30/10
3.3uf/50v	.08	.65/10	3.3uf/35v	.12	.95/10	100uf/25v	.20	1.55/10
4.7uf/25v	.08	.65/10	3.3uf/50v	.12	1.00/10	100uf/50v	.29	2.30/10
4.7uf/50v	.08	.70/10	4.7uf/25v	.11	.90/10	220uf/16v	.20	1.55/10
10uf/25v	.08	.65/10	4.7uf/35v	.12	.95/10	220uf/25v	.29	2.35/10
10uf/50v	.10	.75/10	10uf/16v	.11	.90/10	330uf/16v	.29	2.35/10
22uf/25v	.09	.70/10	10uf/25v	.12	1.00/10	330uf/25v	.32	2.55/10
22uf/50v	.12	1.00/10	10uf/50v	.14	1.15.10	470uf/16v	.32	2.55/10
100uf/6.3v	.09	.75/10	22uf/16v	.12	1.00/10	470uf/25v	.37	3.00/10
100uf/16v	.11	.85/10	22uf/25v	.13	1.05/10	1000uf/16v	.39	3.15/10
100uf/25v	.13	1.10/10	33uf/16v	.12	1.00.10	1000uf/25v	.56	4.50/10
			33uf/25v	.14	1.15/10	2200uf/16v	.62	4.95/10
			47uf/16v	.14	1.15/10			

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2-56 ½ Screw	.99/C	7.65/M
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4-40 ½ Screw	.60/C	4.05/M
6-32 ¼ Screw	.65/C	4.40/M
6-32 ½ Screw	.75/C	4.85/M
8-32 3/8 Screw	.90/C	5.85/M
2-56 Hex Nut	.55/C	3.60/M
4-40 Hext Nut	.55/C	3.75/M
6-32 Hex Nut	.60/C	4.00/M
8-32 Hex Nut	.60/C	4.15/M
No. 2 Lockwasher	.85/C	5.75/M
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4700pf/500v	.04	.32/10
.01ufd/500v	.06	.50/10
.01ufd/50v	.03	.24/10
.022ufd/25v	.03	.28/10
.047ufd/25v	.05	.42/10
.1ufd/25v	.08	.62/10

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1N5227B	3.6v	.15	$11/C	1N5237B	8.2v	.15	$11/C
1N5228B	3.9v	.15	$11/C	1N5238B	8.7v	.15	$11/C
1N5229B	4.3v	.15	$11/C	1N5239B	9.1v	.15	$11/C
1N5230B	4.7v	.15	$11/C	1N5240B	10v	.15	$11/C
1N5231B	5.1v	.15	$11/C	1N5241B	11v	.15	$11/C
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IN5230B	4.7	.45	.40	IN5253B	25	.45	.40
IN5231B	5.1	.45	.40	IN5254B	27	.45	.40
IN5232B	5.6	.45	.40	IN5255B	28	.45	.40
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IN5235B	6.8	.45	.40	IN5258B	36	.45	.40
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IN5238B	8.7	.45	.40	IN5261B	47	.45	.40
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IN5240B	10	.45	.40	IN5263B	56	.55	.50
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7400N	.14	.13	7470N	.40	.30	74152N	1.04	.94
7401N	.18	.16	7472N	.40	.30	74153N	.85	.75
7402N	.18	16	7473N	.42	.38	74154N	1.08	.94
7403N	.18	.16	7474N	.44	.40	74155N	1.02	.92
7404N	.21	.19	7475N	.55	.50	74156N	1.02	.92
7405N	.20	.19	7476N	.44	.40	74157N	.90	.80
7406N	.36	.28	7480N	.80	.72	74158N	1.50	1.30
7407N	.36	.28	7481N	1.30	1.25	74160N	1.02	.92
7408N	.24	.21	7482N	.98	.96	74161N	1.10	1.00
7409N	.28	.21	7483N	.82	.76	74162N	1.40	1.30
7410N	.22	.19	7484N	1.80	1.70	74163N	1.00	.90
7411N	.26	20	7485N	1.20	1.08	74164N	1.16	1.05
7412N	.34	.32	7486N	.44	.40	74165N	1.20	1.10
7413N	.45	.42	7489N	2.20	2.10	74166N	1.20	1.10
7414N	.98	.95	7490N	.56	.51	74167N	5.00	4.50
7416N	.35	32	7491N	.84	.76	74170N	2.00	1.80
7417N	.35	.32	7492N	.56	.50	74173N	1.66	1.50
7418N	.30	.27	7493N	.62	.56	74174N	1.00	.90
7420N	.15	.14	7494N	.88	.80	74175N	.96	.90
7421N	.30	.26	7495N	.80	.72	74176N	1.08	1.00
7422N	.50	.45	7496N	.75	.68	74177N	1.08	1.00
7423N	.37	.36	7497N	5.00	4.50	74178N	1.42	1.30
7425N	.30	.23	74100N	1.10	1.00	74179N	1.80	1.70
7426N	.28	.26	74104N	1.00	.90	74180N	1.12	1.02
7427N	.28	.25	74105N	1.00	.90	74181N	3.00	2.70
7428N	.40	.33	74107N	.40	.36	74182N	1.00	.90
7430N	.26	.20	74109N	.40	.36	74184N	2.80	2.50
7432N	.32	.30	74110N	1.00	.90	74185N	3.00	2.70
7433N	.44	.40	74111N	1.00	.90	74188N	5.00	4.80
7437N	.29	.20	74116N	2.00	1.80	74190N	1.20	1.10
7438N	.29	.27	74118N	2.20	2.00	74191N	1.20	1.10
7439N	.44	.40	74119N	4.00	3.60	74192N	.98	.90
7440N	.17	.16	74121N	.60	.54	74193N	.92	.88
7441N	.85	.83	74122N	.48	.43	74194N	1.36	1.23
7442N	.40	.39	74123N	.68	.62	74195N	.75	.70
7443N	.72	.65	74125N	.50	.45	74196N	1.40	1.30
7444N	.72	.65	74126N	.50	.45	74197N	1.40	1.30
7445N	.90	.81	74128N	.50	.45	74198N	1.40	1.30
7446N	.90	.81	74132N	.92	.85	74199N	1.40	1.30
7447N	.98	.90	74136N	.80	.72	74200N	9.00	8.00
7448N	.98	90	74141N	1.70	1.50	74221N	1.36	1.25
7450N	.14	.13	74145N	1.10	1.00	74247N	2.40	2.20
7451N	.14	.13	74147N	1.90	1.70	74251N	1.90	1.80
7453N	.14	.13	74148N	1.50	1.35	74278N	2.90	2.50
7454N	.14	.13	74150N	1.52	1.40	74279N	.66	.60
7459N	.20	.18	74151N	1.02	.92	74298N	2.00	1.80
7460N	.14	.13						

HIGH SPEED TTL

74H00N	.33	74H20N	.33	74H52N	.36	74H73N	80
74H01N	.25	74H21N	.33	74H53N	.36	74H74N	.80
74H04N	.33	74H22N	.33	74H54N	.36	74H76N	.75
74H05N	.33	74H30N	.33	74H55N	.36	74H102N	.75
74H08N	.40	74H40N	.36	74H60N	.36	74H103N	.90
74H10N	.33	74H50N	.36	74H71N	.75	74H106N	95
74H11N	.33	74H51N	.36	74H72N	.75		

LOW POWER TTL

74L00N	.24	74L10N	.24	74L51N	.34	74L90N	1.62
74L02N	.24	74L20N	.33	74L73N	.43	74L93N	1.51
74L03N	.39	74L42N	1.33	74L74N	.90	74L95N	1.62
74L04N	.33						

74LS00

	1-9	10up		1-9	10up		1-9	10up
74LS00N	.36	.35	74LS55N	.39	.38	74LS161N	3.00	2.70
74LS01N	.44	.40	74LS73N	.58	.55	74LS162N	3.06	2.80
74LS02N	.36	.35	74LS74N	.56	.54	74LS163N	3.00	2.70
74LS03N	.45	.43	74LS76N	.65	.64	74LS170N	5.80	5.30
74LS04N	.44	.40	74LS78N	.92	.90	74LS174N	2.20	2.00
74LS05N	.45	.44	74LS95N	2.08	2.00	74LS175N	2.40	2.20
74LS08N	.38	.37	74LS107N	.59	.58	74LS181N	3.69	3.68
74LS09N	.44	.40	74LS109N	.92	.86	74LS190N	2.85	2.70
74LS10N	.36	.35	74LS112N	.58	.55	74LS191N	2.85	2.70
74LS11N	.46	.42	74LS113N	.92	.85	74LS193N	2.50	2.40
74LS15N	.58	.54	74LS114N	.92	.85	74LS194N	2.25	2.20
74LS20N	.44	.20	74LS123N	1.60	1.50	74LS195AJ	2.40	2.20
74LS21N	.58	.54	74LS138N	1.89	1.80	74LS196AJ	2.76	2.50
74LS22N	.58	.54	74LS139N	2.00	1.80	74LS197AJ	2.20	2.10
74LS27N	.44	.40	74LS151N	1.68	1.50	74LS251AJ	2.08	1.90
74LS30N	.39	.38	74LS153N	1.80	1.79	74LS253AJ	2.42	2.20
74LS32N	.45	.44	74LS157N	1.55	1.54	74LS257AJ	1.89	1.80
74LS38N	.58	.53	74LS158N	1.68	1.60	74LS258AJ	2.06	1.90
74LS51N	.39	.38	74LS160N	3.00	2.70	74LS260AJ	.44	.40
74LS54N	.58	.54						

SCHOTTKY TTL

74S00	.44	74S32	.80	74S113	1.50	74S174	3.30
74S01	.76	74S40	.65	74S114	1.20	74S175	2.90
74S02	.60	74S50	.76	74S133	.80	74S181	6.00
74S03	.75	74S51	.80	74S138	2.20	74S189	4.40
74S04	.55	74S60	.80	74S139	2.20	74S194	3.30
74S05	.76	74S64	.80	74S140	.80	74S195	3.30
74S08	.80	74S65	.80	74S151	2.20	74S251	2.20
74S09	.76	74S74	.90	74S153	3.40	74S253	2.40
74S10	.55	74S76	1.15	74S157	2.40	74S257	2.40
74S11	.65	74S78	1.16	74S158	2.00	74S258	2.40
74S15	.76	74S85	6.10	74S160	3.90	74S260	1.20
74S20	.65	74S86	2.50	74S161	4.70	74S280	5.70
74S21	.76	74S112	1.00	74S172	6.00	74S289	4.00
74S30	.80						

9300 SERIES

9300PC	$1.00	9318PC	2.30	9366PC	1.75	93L18	3.50
9301PC	1.20	9321PC	1.20	93L00	1.50	93L21	1.50
9304PC	1.50	9322PC	1.30	93L01	1.60	93L22	1.80
9306PC	6.90	9324PC	2.00	93L08	3.20	93L24	2.80
9308PC	2.50	9328PC	2.50	93L09	1.80	93L28	3.70
9309PC	1.60	9334PC	2.95	93L10	2.80	93L34	4.00
9310PC	1.50	9338PC	3.30	93L11	4.20	93L38	4.20
9311PC	2.30	9340PC	5.00	93L12	1.80	93L40	6.50
9312PC	1.20	9341PC	4.10	93L14	1.70	93L41	6.50
9314PC	1.30	9342PC	1.15	93L16	3.20	93L60	3.00
9316PC	1.50	9360PC	1.75	93L18	3.50	93L66	2.70

LINEAR IC's

H=TO-5 N=DIP M=MINI-DIP D=CER-DIP K=TO-3

LM105H	3.90	LM311H	1.20	LM710CH	.90
LM108H	4.90	LM311D	.90	LM710CN	.90
LM114H	3.00	LM311M	1.75	LM711CH	.90
LM300H	1.20	LM312N	1.75	LM711CN	.90
LM300N	1.20	LM318H	1.50	LM715CH	3.50
LM301AH	.50	LM318M	2.40	LM715CD	4.60
LM301AM	.80	LM324N	1.90	LM723CH	.60
LM301AN	1.10	LM331N	1.25	LM723CN	.65
LM301M	.95	LM336K	2.40	LM725CH	1.50
LM302N	1.30	LM339N	2.20	LM725CD	5.00
LM302H	1.40	LM320-5K	2.90	LM733CH	1.40
LM304H	1.20	LM320-5T	2.50	LM733CD	3.50
LM305H	.85	LM320-12K	2.90	LM733CN	1.30
LM305AH	1.05	LM320-12T	2.50	LM741CH	.40
LM305N	1.00	LM340-5K	2.60	LM741CD	1.25
LM306N	.95	LM340-6K	2.60	LM741CM	.39
LM307H	.60	LM340-8K	2.60	LM747CH	.75
LM307M	1.50	LM340-12K	2.60	LM747CN	.90
LM308H	.85	LM340-15K	2.60	LM748CM	.55
LM308AH	5.00	LM340-18K	2.60	LM777CH	2.15
LM308D	2.25	LM340-24K	2.60	LM777CM	2.10
LM308M	1.00	LM555CM	.70	LM3046CN	.95
LM309H	1.75	LM556CM	1.30	LM3054CN	1.50
LM309K	1.50	LM567CM	1.70	SG4501T	2.40
LM310H	1.50	LM709CH	.75	SG4501N	2.40
LM310M	1.80	LM709CN	.75	LM5000K	7.50

CMOS

	1-9	10up		1-9	10up		1-9	10up
4000AE	.15	.14	4021BE	1.35	1.25	4056AE	1.99	1.98
4000AF	.28	.24	4022AE	1.05	1.00	4056BE	2.04	2.03
4000BE	.19	.18	4022BE	1.10	1.05	4060AE	1.70	1.68
4001AE	.24	.20	4023AE	.24	.22	4063AE	2.50	2.49
4001BE	.27	.24	4023BE	.30	.28	4066AE	.90	.89
4002AE	.24	.15	4024AE	.80	.70	4068AE	.44	43
4002AF	.34	.25	4024AF	95	.85	4068BE	.53	.48
4002BE	.30	.18	4024BE	.85	.75	4069AE	.44	.43
4004AE	4.00	3.80	4025AE	.24	.20	4069BE	.53	.48
4006AE	1.30	1.20	4025AF	.40	.35	4070BE	.60	.59
4006AF	1.50	1.30	4025BE	.30	.28	4071AE	.45	44
4006BE	1.35	1.25	4026AE	1.50	1.49	4072AE	.34	.33
4007AE	.24	.23	4027AE	.55	.50	4073AE	.40	.39
4007AF	.40	.35	4027BE	.60	.55	4075AE	.40	.39
4007BE	.27	.28	4028AE	.95	.90	4076AE	1.24	1.22
4008AE	1.15	1.14	4028BE	1.00	95	4077AE	40	.39
4008AF	1.30	1.25	4029AE	1.20	1.10	4077BE	.44	.43
4009AE	.50	.45	4029BE	1.25	1.15	4078AE	.40	.39
4009BE	.55	.50	4030AE	.48	.40	4078BE	.44	.43
4010AE	.50	.45	4030AF	.65	.60	4081BE	.40	.39
4010BE	.55	.50	4030BE	.55	.50	4082AE	.39	.38
4011AE	24	.23	4033AE	2.00	1.90	4082BE	.43	.42
4012AE	.24	.22	4035AE	1.20	1.10	4093AE	1.65	1.64
4012AF	.34	32	4035BE	1.25	1.15	4095BE	1.95	1.94
4012BE	.29	.27	4040AE	1.20	1.10	4098AE	1.30	1.29
4013AE	.30	.28	4040AF	1.50	1.40	4099AE	2.90	2.89
4013AF	45	43	4040BE	1.30	1.20	4502AE	1.50	1.49
4014AE	1.05	1.00	4041AE	1.25	1.00	4507BE	.60	.55
4014AF	1.30	1.15	4042AE	1.00	.85	4508BE	2.20	2.19
4014BE	1.10	1.05	4043AE	.95	.90	4510AE	1.40	1.39
4015AE	1.15	1.10	4044AE	.95	.90	4510BE	1.45	1.44
4015BE	1.20	1.15	4046AE	3.10	3.05	4511BE	2.00	1.99
4016AE	.55	.49	4047AE	2.00	1.90	4512BE	1.30	1.29
4016BE	.60	.54	4048AE	1.43	1.40	4514AE	5.00	4.99
4017AE	1.05	1.00	4049AE	.58	.53	4515AE	5.00	4.99
4017BE	1.10	1.05	4049BE	.63	.58	4516AE	1.75	1.74
4018AE	1.24	1.23	4050AE	.58	.53	4518AE	1.28	.98
4018BE	1.30	1.28	4051AE	1.49	1.48	4520AE	1.28	.98
4019AE	.54	49	4052AE	1.40	1.39	4528AE	2.20	2.19
4019AF	.70	68	4052BE	1.45	1.44	4528BE	2.25	2.24
4019BE	.60	.55	4053AE	1.40	1.39	4585AE	2.06	1.95
4020AE	1.45	1.35	4053BE	1.45	1.44	4901AE	.32	.31
4021AE	1.30	1.20	4055AE	1.95	1.94	4911AE	.32	.31

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What is more important?
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We have decided to offer only the highest quality components. When quality counts, you can count on Ancrona

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PIN	1-24	25	100
14	.45	.41	.37
16	.54	.49	.44

SOLDER – GOLD DIP

14	.34	.31	.28
16	.37	.34	.31

TEFLON TO-5

3 PIN	.55 EA
4 PIN	.65 EA
6 PIN	.90 EA
8 PIN	1.10 EA
10 PIN	1.40 EA

PLASTIC TO-5

8 PIN	.40 EA

SOLDER-TIN DIP

	1-24	25	100
8	.21	.19	.17
14	.25	.22	.20
16	.28	.25	.23
18	.34	.31	.28
22	.37	.36	.35
24	.47	.43	.40
28	.88	.80	.70
36	1.09	.98	.89
40	1.24	1.12	.90

INTERSIL 8038 PRECISION WAVEFORM GENERATOR & VCO

For simultaneous sine, square and triangular waveforms <.001 Hz to 1MHz.

Part No.	1-9	10 up
8038CCPD	$3.90	$3.70

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	10	100	1000
1N4001	1.00	7.00	60.00
1N4002	1.10	8.00	70.00
1N4003	1.20	9.00	80.00
1N4004	1.30	10.00	90.00
1N4005	1.40	11.00	100.00
1N4006	1.50	12.00	110.00
1N4007	1.60	13.00	120.00

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SI-1010G	10W	$6.40
SI-1020G	20W	9.90
SI-1030G	30W	18.70
SI-1050E	50W	24.90
SI-1050G	50W	24.90

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BU205	3A	1500V	4.95
BU206	3A	1700V	5.94
BU207	6A	1300V	5.85
BU208	6A	1500V	6.93
BU209	6A	1700V	8.64

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Only 1.70" x 1.00" x 0.85", output pre set ± 5%, 9 models:

V	mAdc	V	mAdc
5	140		
8	115	18	50
10	100	20	35
12	90	22	25
15	70	24	15

$39.80 each

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Model No.	Output Vdc	Output Amps	1-4	5 up
APS5-3	5	3.0	$29.95	$28.60
APS12-1.6	12	1.6		
APS15-1.5	15	1.5		
APS24-1	24	1.0		
APS28 0.8	28	0.8		
APS5-6	5	6	$48.45	$46.05
APS12-4	12	4		
APS15-3	15	3		
APS24-2.2	24	2.2		
APS28-2	28	2		
APS5-10	5	10	$72.25	$68.65
APS12-7	12	7		
APS15-6	15	6		
APS24-5	24	5		
APS28-4	28	4		

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8080A	$34.90
8080	27.50
AM2901	31.50

F8 MICROPROCESSOR KIT . . . $185.00

RAM'S

	1-9	10up
P1101A	2.20	2.10
P1101A1	3.50	3.30
P1103	2.90	2.70
P2101	5.00	4.80
P2101 1	5.10	4.85
P2101 2	5.20	4.90
P2102	2.48	2.30
P2102 1	2.80	2.65
P2102-2	2.70	2.60
P2102A	2.90	2.70
P2102A-2	3.00	2.80
P2102A-4	2.95	2.75
P2111	5.70	5.50
P2111-1	5.80	5.60
P2111-2	5.90	5.70
P2112	5.90	4.70
P2112-2	6.00	4.80
P2401	9.90	9.80
P2405	8.80	8.00
2602B	2.48	2.30
2602 1B	2.80	2.65
2602 2B	2.70	2.60
IM7552CPE	2.48	2.30
IM7552-1CPE	2.80	2.65
IM7552 2CPE	2.70	2.60
TMS4035NL	2.48	2.30
TMS4034NL	2.70	2.60
P8101	5.00	4.80
P8101-2	5.20	4.90
P8102	2.48	2.30
P8102-2	2.70	2.60
P8111	5.70	5.50
P8111-2	5.90	5.70
AM9101APC	3.50	3.30
AM9101BPC	3.90	3.80
AM9101CPC	5.50	5.30
AM9101DPC	7.80	7.00
AM9102PC	2.70	2.60
AM9102APC	3.00	2.80
AM9102BPC	4.90	4.50
AM9102CPC	6.20	6.00
AM9102DPC	7.80	7.00

LOW POWER RAM'S

AM91L02PC	2.75	2.70
AM91L02APC	3.90	3.70
AM91L02BPC	5.00	4.40
AM91L02CPC	7.00	6.00

PROMS

	1-9	10up
1702A	15.95	14.50

SHIFT REGISTER

	1-9	10up
P2401	23.00	19.00
P2405	10.85	9.90
P2505K	3.70	3.30
2512K	4.30	4.05
2521V	2.50	2.20
2524V	2.40	2.20
2525V	3.60	3.50
2533V	10.50	8.50
AM2802PC	4.40	3.50
AM2803PC	4.40	3.50
AM2804PC	4.40	3.50
AM2805HC	3.70	3.30
AM2806HC	7.00	5.60
AM2807PC	2.40	2.20
AM2808PC	3.60	3.50
AM2809PC	2.50	2.20
AM2810DC	10.00	8.00
AM2812ADC	24.00	19.20
AM2812DC	21.00	16.80
AM2813ADC	24.00	19.20
AM2813DC	21.00	16.80
AM2814DC	12.45	9.15
AM2825PC	18.75	15.00
AM2826DC	22.50	18.00
AM2827PC	18.75	15.00
AM2833PC	10.85	8.70
AM2841APC	10.50	8.40

SHIFT REGISTER

	1-9	10up
AM2841PC	8.25	6.55
AM2847PC	5.00	4.50
AM2855PC	7.15	5.75
AM2856PC	7.15	5.75
AM2857PC	7.15	5.75
AM2896PC	5.00	4.50
AM3341PC	8.25	6.50
AM3347PC	6.40	5.10
AM4025D	73.00	58.40

AMD-MSI

AM2501DC	9.00
AM2502PC	9.50
AM2503PC	9.50
AM2504PC	16.05
AM2505PC	15.00
AM2506PC	8.80
AM25L02PC	10.70
AM25L03PC	10.70
AM25L04PC	16.05
AM25L05PC	15.00
AM25L06PC	8.80
AM25S05PC	19.00
AM25S07PC	3.78
AM25S08PC	3.51
AM25S09PC	5.40
AM25S10PC	4.50
AM25S18PC	5.40
AM25LS07PC	2.79
AM25LS08PC	2.76
AM25LS09PC	3.49
AM25LS14PC	31.00
AM25LS15PC	2.14
AM25LS138PC	2.12
AM25LS139PC	2.12
AM25LS151PC	2.14
AM25LS153PC	2.14
AM25LS157PC	1.54
AM25LS158PC	1.54
AM25LS160PC	2.94
AM25LS161PC	2.94
AM25LS162PC	2.94
AM25LS163PC	2.94
AM25LS174PC	3.10
AM25LS175PC	2.76
AM25LS181PC	8.00
AM25LS190PC	3.87
AM25LS191PC	3.87
AM25LS194APC	2.62
AM25LS195APC	1.77
AM25LS251PC	2.66
AM25LS253PC	2.66
AM25LS257PC	2.00

COMPUTER INTERFACE

DM8820N	2.40
DM8820AN	6.90
DM8830N	2.40
DM8831N	5.20
DM8832N	6.00
N8T26B	4.40
9600PC	1.30
9601PC	1.20
9602PC	1.95
9614PC	2.30
9615PC	2.40
9616PC	5.00
9617PC	3.50
9620PC	4.00
9621PC	4.00

75107

75107BN	2.60
75108BN	2.30
75109N	2.20
75110N	2.20
75115N	2.25
75138N	2.95
75150N	3.10
75154N	4.10

75107

75208N	2.70
75224N	2.50
75450N	1.25
75451N	1.00
75452N	1.00
75453N	1.00

7520 SERIES SENSE AMPS

7520N	4.00
7521N	2.00
7522N	4.25
7523N	1.75
7524N	2.00
7525N	4.50

TWO-PHASE MOS CLOCK DRIVER

MH0026CN	5.50

MM

MM404H	12.00
MM405H	23.00
MM406H	6.50
MM407H	6.50
MM451H	11.40
MM454F	18.00
MM500H	2.00
MM506H	3.20
MM507H	3.20
MM550H	5.90
MM551H	5.60
MM555H	5.60

MOS-LSI

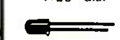
1402AN	3.80
1403AH	4.00
1403AN	3.80
1404AH	4.50
1404AN	2.90
1405A	4.00
1406	8.40
1407	8.40
1506	3.00
1507	3.00
1602	33.00
TMS3114J	9.40
TMS3120JC	7.00
TMS3120NC	6.00
TMS3133NC	7.50
3341ADC	8.00
3341APC	7.00
3347DC	5.80
3347PC	4.60
4102	4.95
7552	4.95
7552-1	5.40
7552-2	5.50
MM4055D	12.00
MM4056H	9.70
MM4057D	13.00
MM5025N	20.00
MM5026N	20.00
MM5027N	20.00
MM5055N	5.50
MM5056N	5.50
MM5057N	5.50
MM5058N	5.50

BIPOLAR MEMORY

C3101	6.50
P3101	4.90
C3101A	7.30
P3101A	5.80
IM5501CDE	7.30
IM5501CPE	5.80
MM5560D	7.30
MM5560N	5.80
DM8599N	5.80
93403PC	5.80

LEDs

.125" dia.

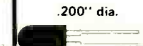


209	RED	$.25
209	YELLOW	.35
209	GREEN	.35

.160" dia.

216	RED	$.25
216	YELLOW	.30
216	GREEN	.30

.200" dia.



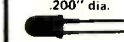
220	RED	$.25
220	YELLOW	.30
220	GREEN	.30

LOW PROFILE

.200" dia.

226	RED	$.25
226	YELLOW	.30
226	GREEN	.30
226	ORANGE	.30

.200" dia.



5053	RED	$.35
5053	YELLOW	.40
5053	GREEN	.40
5053	ORANGE	.40

MV50 RED $.30

216 = MV5024
5053 = MV5053

DISPLAYS

0.6" IN.

EP62R	RED	3.00
EP62G	GREEN	3.60
EP62Y	YELLOW	3.60

Data sheet for EP62 $.25

LARGE 1"

EP1000 RED	5.50
3 pcs EP1000	15.00
5 pcs EP1000	22.50

Data sheet for EP1000 $.25

XCITON

XAN72	RED	2.00
XAN52	GREEN	2.00
XAN82	YELLOW	2.00

LITRONIX

DL80	RED	6.00	DL44	RED	6.00
DL81	RED	6.00	DL402	RED	4.00
DL10	RED	6.00	DL701	RED	3.40
DL10A	RED	4.00	DL704	RED	2.25
DL101	RED	4.90	DL707	RED	2.35
DL57	RED	9.90	DL747	RED	2.50
DL61	RED	12.00	DL33	RED	4.00

OPTOISOLATORS

LITRONIX

IL1	$1.30	IL16	$1.80	ILD74	$1.00
IL12	1.40	IL74	1.35	ILQ74	3.40

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MCT2 .60

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TR-446.	25-Pc. Ass'td. SCR	1.49
SW-555.	90-120 V AC Relay	59c
SW-156.	Ctr.-Off Toggle Switch DPDT. Pkg. 2	2.49
SW-460.	3 Button Push Switch	24c
SW-636.	Thermostatic Switch 50-600 NO	39c
SW-752.	Unimax 15A Switch SPST	49c
SW-587.	5A Toggle SPST NO	39c
SW-431.	Phone Type Lever Switch 4 SPST	62c
SW-632.	Reed Switch W/Magnet SPST. Pkg. 10	1.29
MO-359.	1/30 RPM Timing Motor 120V AC	49c
TT-092.	2500 OHM Output Transformer	64c
TF-047.	6 V ½ A. Filament Transformer	44c
TF-050.	12V .2A Filament Transformer	47c
KN-030.	25-Pcs. Assorted Knobs	49c
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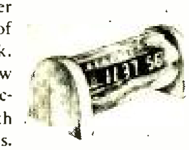

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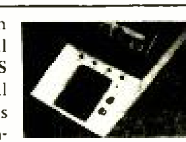

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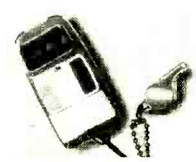

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