SPECIAL CONSTRUCTION ISSUE—6 GREAT PROJECTS

$1.00 ■ JUNE 1977

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

A GERNSBACK PUBLICATION

3 octave
MUSIC GENERATOR
uses pink noise

multi feature
TELEPHONE DIALER
has a memory

no digit
DIGITAL CLOCK
for your wall

easy to build
DIGITAL IC TESTER
and identifier

PLUS:

- ★ Quad Scope Adapter
- ★ CB Noise Limiters
- ★ Solving The dB Mystery
- ★ Hi-Fi Lab Test Reports
  Sony Elcaset Deck
  Sherwood HP-2000 Amp
- ★ Jack Darr's Service Clinic
- ★ Build This 2650 Computer

HOW NOT TO RUIN YOUR RECORDS

PART I

Don't "play" over micro-dust

THE PROBLEM:

The greatest cause of record degeneration is micro-dust. All records possess a static charge which attracts a very fine, virtually invisible micro-dust from room air. A record may "look clean" but contain a fine coating of micro-dust. When you play over this coating, even at one gram of stylus pressure, you grind the micro-dust into the record walls, often forever. Your record then gets "noisy."

COMMON ERRORS:

Most record cleaners are "pushers", and simply line up dirt without removing it from the disc. Skating a pusher off the record only spreads micro-dust into a tangent line of danger. Extra arm devices and all cloths are too coarse to do anything but pass over micro-dust—or gently spread it out.

AN ANSWER FROM RESEARCH:

The exclusive Discwasher System removes micro-dust better than any other method.

1. The slanted pile lifts up rather than lines up debris. The pile fibers are fixed in the fabric better than any other record cleaner, and "track" record grooves rather than scrape them (see figure 1).
2. Alternating "open rows" of highly absorbent backing *hold* micro-dust taken off the record, and demonstrate Discwasher's effectiveness over long term use (see figure 2).
3. The inherently safe D3 fluid delivery system and capillary fluid removal allows the most researched record cleaner to be the world's best.

UNRETOUCHED PHOTOS OF DISCWASHER BRUSH

Fig. 1 Line of micro-dust removed from a "clean" record.

Fig. 2 Accumulated micro-dust from long, effective use of the Discwasher System.

Discwasher Group

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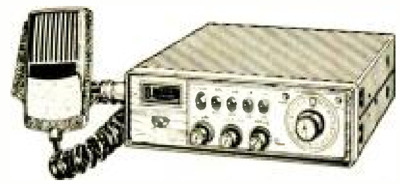
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

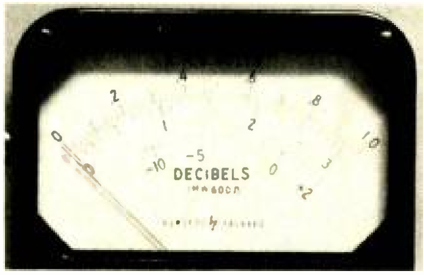
Electronics publishers since 1908 JUNE 1977 Vol. 48 No. 6

ON THE COVER

Four of the six projects in this issue are shown on this month's cover. In addition to those illustrated, you will want to see the Quad Scope Adapter and Build A Computer stories. See the listing at the left for page numbers.



AUTOMATIC NOISE LIMITERS are used extensively in CB transceivers. This story tells how they work. **. . . . turn to page 54**



VOLTMETER WITH dB SCALE referenced to 0.775 volt. See Solving The dB Mystery for more data. **. . . turn to page 65**

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looking ahead

Metafine IV: Remember the name—it just could become a household word. It's the working name 3M has given to its new super magnetic tape formulation, previewed in this column in September 1974. 3M now says it's ready to go into production of the new tape whenever equipment manufacturers can handle it. The only problem is that the tape is so advanced it will require a whole new generation of equipment to take advanatage of its capabilities.

Metafine has a coating of fine metal particles instead of the conventional oxide, and is claimed to have four times the efficiency of current tapes. 3M says it has 6-dB more signal-to-noise than today's best high-energy tapes, and the increased energy is used across the entire spectrum. The new tape probably will be aimed first at home videocassette use where it could operate at one-half the speed of existing tapes, producing the same results, according to 3M. This would mean, for example, recording for four hours on a single Betamax cassette (with suitably modified hardware). Along with parallel development work on CCD color cameras and other hardware, 3M sees the new tape as eventually making possible a combination portable camera-VTR or practical magnetic videodisc recorders.

Metafine also has potential in audio. The tiny micro-cassette could become a hi-fi instrument, and today's standard compact cassette could rival the open-reel deck in both frequency response and signal-to-noise ratio.

New RCA chassis: RCA has developed a completely new chassis which it will gradually adapt to most or all of its 19-inch-and-above color sets. Called "Xtended Life," it is compact and U-shaped and weighs 8.5 pounds less than the XL-100 chassis it has replaced in the 19-inch line. RCA claims it is the most easily serviced chassis it has ever developed. The eight-module chassis draws only 86 watts in the 19-inch size. RCA also says it operates an average of 24% cooler than its predecessor, with higher performance.

Introduced first in RCA's low-end (non-ColorTrack) 19-inch sets, it will soon be extended to 25-inch non-ColorTrak models and this summer to 19-inch ColorTrak. It features prominently in RCA's major effort to keep production down and is said to be considerably more "cost-effective" than previous models. A major feature is a new chroma IC that performs all color processing functions. It is RCA's third new chassis in as many years, following its new black-and-white unit and ColorTrak. A fourth is expected next year when RCA's Taiwan plant starts turning out a new chassis for sets with screens smaller than 19 inches.

One interesting development in RCA's color line is its acknowledgement that it made a mistake in proceeding to the self-converging slot-mask tube in its 19-inch sets. With the introduction of the new chassis, RCA announced it was returning to the "proven and more costly" delta-gun type for greater resolution. Zenith, faced with a similar problem, held off from using the slot-mask for 19-inch sets until it had developed a new type with a tripotential gun to provide a smaller spot size and resolution claimed to be better than that of a delta-gun tube.

CB at 900 MHz: Although the FCC has been keeping quiet about it for fear of triggering another market debacle of the type that accompanied the announced change to 40 channels, it is continuing a quiet study to find a home for a new CB service. The search has narrowed down to three bands—900 MHz, 220 MHz and further expansion of the current 27-MHz band. The odds strongly favor 900 MHz.

Expansion to more than 40 channels in the 27-MHz band is remote because it would merely aggravate the problems of interference and wouldn't do anything about susceptibility to sunspots. A total of 2 MHz is available at around 220 MHz, but this has serious drawbacks—a potentially serious TV interference problem and proximity to an amateur band. The Commission wants to keep CB as far as possible from ham radio frequencies in the future.

This leaves 900 MHz. The major questions at that altitude are whether 900-MHz is practical from the equipment standpoint and whether transceivers operating at that frequency can be manufactured economically. A demonstration by Motorola to FCC officials of a prototype 900-MHz transceiver was quite impressive. And initial estimates are that equipment to operate at those frequencies could be built to sell at about a 30% higher price than 27-MHz gear at first, with the differential eventually vanishing.

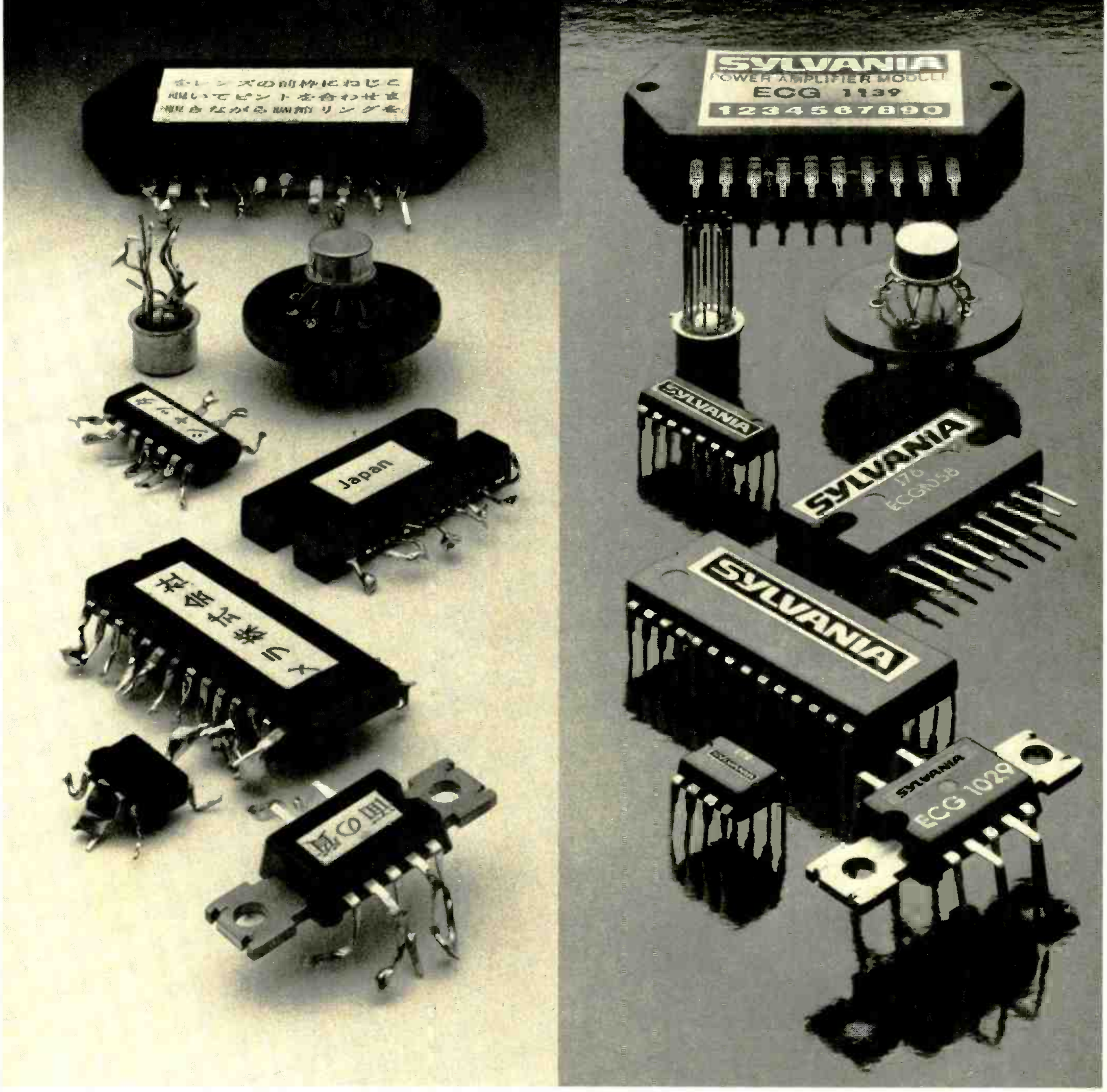
The FCC wants to get moving as soon as possible on the machinery to establish a new FM Citizens band, in view of the impending increase of sunspot activity. Thus the Commission would like to see the new service inaugurated by the end of 1979, when solar storms are expected to be on the increase and the "skip" phenomenon building up. But current and potential CBers are assured they needn't worry about the future of the 27-MHz band. Says FCC Chief Engineer Ray Spence: "It couldn't be eliminated even if we wanted to do it. That service is here to stay, as far as I'm concerned."

That giant screen: Projection television using current techniques, but with some improvements, offers the only near-future hope of providing wall-size TV for the home, two experts agree. Dr. Alex Jacobson, who heads Hughes Aircraft's liquid-crystal program, forecasts that a postage-stamp-sized light valve employing LCD will produce high-brightness giant-screen TV in the home. He said the liquid-crystal light-valve theory has now been proven (**Radio-Electronics**, March 1977), but home projectors using the principle are 5 to 10 years off.

The alternative to projection TV is the long-sought electro-luminescent display. Ben Kazan, Xerox Research Center, agrees with Dr. Jacobson that

continued on page 24

In replacement parts nothing is foreign to us.



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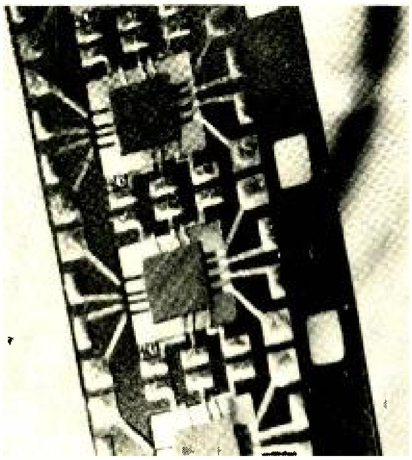
GTE SYLVANIA

new & timely

IC, movie technologies marry—chips now come on Super-8 film

Siemens is now producing integrated circuits on super-8 movie film. Nearly a dozen such circuits, which save vast amounts of space, are now being supplied by Siemens on film rolls.



AN INTEGRATED CIRCUIT ON FILM. The individual chips measure about 1.6 by 2 mm (about .06 by .08 inch).

Before the chips are mounted, the surface of the polyimide film is coated with copper, tinned and etched to produce conductors and terminal points for the chips. The inner ends of the conductors protrude into the "windows" of the film to support the chips physically as well as to connect them electrically.

About 1,000 IC's can be rolled up into a film. Since the film is perforated, manufacturers and users can use the transport technologies of the film industry in their production facilities.

Electronically controlled cameras and flat desk-top computers have so far been the main fields of application. Small measuring instruments in which space must be conserved to the utmost are also using the new caseless miniature circuits.

Magnetic bubble memories reach practical application

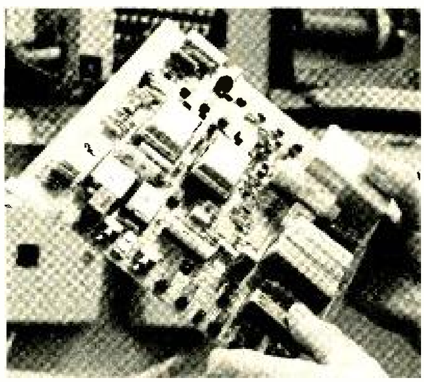
Magnetic "bubble" memories, invented at Bell Labs ten years ago, have found their first application in a recorded-message device that stores and repeats such messages as "You have reached a non-working number," to the telephone customer. The experimental application is being tested in a switching office of the Michigan Bell Telephone Co. in Detroit.

Magnetic bubbles, so called, are actually tiny magnetic domains in a thin film of crystalline magnetic garnet. They are highly mobile and can be moved about by magnetic forces. They can be made to follow precisely defined tracks in the garnet and be precisely placed and located, making it possible to write the binary language (magnetized = 1; unmagnetized = 0) with them.

The bubble memory for the new message device, about half the size of a cigarette pack, contains four garnet chips, each with a storage capacity of more than 68,000 bits for a total storage of 272,000 bits. Besides the bubble chips, the package contains a magnet to provide a uniform field over the chip, and two conducting coils to produce the rotating field that moves the bubbles.

Each 272,000-bit package can supply 12 seconds of digitized speech. The speech is encoded electronically into digital information before being stored in the bubbles. A special decoder reconstructs the voice signals when needed.

Bubble memories are faster than the drum technique used in the present recorded-message devices, but slower than semiconductor memories. They have one advantage over semiconductor memories—they do not lose their contents if the power is shut off or fails.

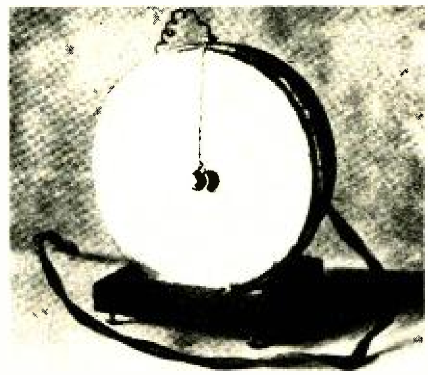


MESSAGE BOARD FROM THE BELL message system. This board forms part of a system that can record and announce up to eight messages.

The present tests will evaluate bubble memories not only on their technical but also their economic qualities, as their ultimate application will depend on their cost and performance as compared to competing technologies.

"Mike" celebrates centennial. Invention dates back to 1877

On April 14, 1877, a 25-year-old immigrant from Germany filed a caveat on a variable-pressure "transmitter" of voice sounds, just 14 days before Thomas Edison applied for a patent on a "telephone transmitter." Thus, Emile Berliner established a "first" in the competition for the honor of being the inventor of the contact microphone. (The term "microphone" was first used a year later, by David Hughes, who was apparently using a carbon-metal contact microphone at the same time Edison and Berliner were inventing theirs.)



THE FIRST CONTACT MICROPHONE. The upper photo is the original microphone of 1877; the lower one is the form in which it was used as a telephone transmitter. Emile Berliner's microphone used a metal-to-metal contact; Edison's used carbon contacts.

1877 can be set as the year of the invention of the contact microphone. (Alexander Graham Bell had already patented the electromagnetic—now usually called "sound-powered"—microphone a couple of years earlier.)

The Berliner microphone, incidentally, saved the Bell system from destruction at the hands of Western Union, owner of the Edison patent. Bell hired the young Berliner and filed interferences against the Edison patents on the basis of his invention. This kept the matter in the courts until 1892, and prevented Western Union from forbidding Bell the use of a contact microphone.

Meanwhile the two companies came to an agreement (in 1879) in which Western Union admitted the validity of the Bell patents, agreed to keep out of the telephone business, and assigned all its tele-

continued on page 12

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electronics at home.

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NRI can train you at home to service Color TV equipment and audio systems. You can choose from 5 courses, starting with a 48-lesson basic course, up to a Master Color TV/Audio Course, complete with designed-for-learning 25" diagonal solid state color TV and a 4-speaker SQ™ Quadraphonic Audio System. NRI gives you both TV and Audio servicing for hundreds of dollars less than the two courses as offered by another home study school.

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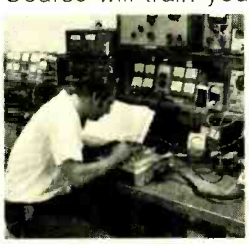

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new & timely continued from page 6

phone patents to the Bell company. Bell, on its part, agreed to keep out of the telegraph field and assigned Western Union 20 percent of all royalties from telephone rentals for the next 17 years.

Computer hobbyists recognized by National Computer Conference

Reflecting the dynamic growth of the personal computing field, the 1977 National Computer Conference, held in Dallas this June, features a Personal Computing Fair and Exposition, as well as special interest sessions for computer hobbyists.

The Fair, running through the four days of the Conference, features operational displays of individual and group-owned non-commercial projects. The display includes more than 100 small computing systems, featuring hardware and software implementations, games, music, art, amateur radio and scientific applications.

Nine hours of panel sessions cover hardware, software and the future of personal computing.

CB radio helps fire fighting in long-and-narrow towns

Municipalities like Big Sur, CA, which stretches 30 miles along a two-lane highway, call themselves "linear communities." Because dense brush and forest surround the homes and businesses, some of the advantages of this linear community are offset by the ever-present threat of fire. A combination of citizen cooperation and CB radio have helped solve the problem for Big Sur. A volunteer fire brigade organized for mutual fire protection, using fire-fighting equipment distributed along the length of the community, and instant communication by CB radio, have reduced the average time of response to an alarm from 60 minutes to a few, and has saved thousands of dollars and a few lives.

BIG SUR FIRE-FIGHTING VEHICLE, with slip-on in place and CB mast visible above the cab. Besides having their own tanks, the units can pump from an external water supply, such as a pond or stream.

Unique feature of the system is the eight fast-attack "slip-on" pumper units built by the brigade members. Each consists of a gas-powered pump, a tank of 140 gallons of water and 200 feet of hose. Members' pickup trucks back under the slip-ons, which are lowered and secured in seconds, reminiscent of the way harnesses were dropped onto the horses in the days of the horse-drawn "fire engines." The eight units are distributed along the length of the community, rather than being concentrated at a central station.

The whole system is kept together and organized through CB radio. Twelve model 4102 mobile CB units and a model 4201 base station were made available by Craig Corp, of Compton, CA, and an M400 Starduster base antenna was donated by Antenna Specialists. The members monitor the CB's continuously during the day, and a dispatch service is "manned" by the volunteers' wives at night. Not only does the communications system coordinate what would otherwise be an extremely awkward and difficult set-up, but provides an extra bonus. Passing motorists sometimes report a fire on their CB's, further reducing the time of response to the emergency.

Missouri bears find CB radio "most revolutionary idea."

"I am firmly convinced that cooperation between citizens and law-enforcement agencies through CB radio results in far better protection to the public, as well as providing a positive means whereby citizens can become directly involved in highway safety, crime prevention and crime control."

Thus spoke Colonel S.S. Smith, recently retired superintendent of the Missouri State Highway Patrol, speaking to a seminar of more than 800 CB manufacturers, distributors and dealers, sponsored by the Electronic Industries Association (EIA) in Las Vegas.

"During the first six months of our CB project, from August 1, 1975 to December 1, 1976," Colonel Smith said, "our officers and base stations received 122,533 CB reports. Approximately 18 percent or 22,200 of these were reporting violations of the law. They resulted in 5,811 arrests—2,014 of these were made for driving while under the influence of alcohol."

The Colonel continued: "We found the lapse time between the occurrence and notification of accidents that we investigated by conventional means was approximately 14 minutes, compared to about 8 minutes when notified by CB radio. In many cases the time saved proved to be the difference between life and death."

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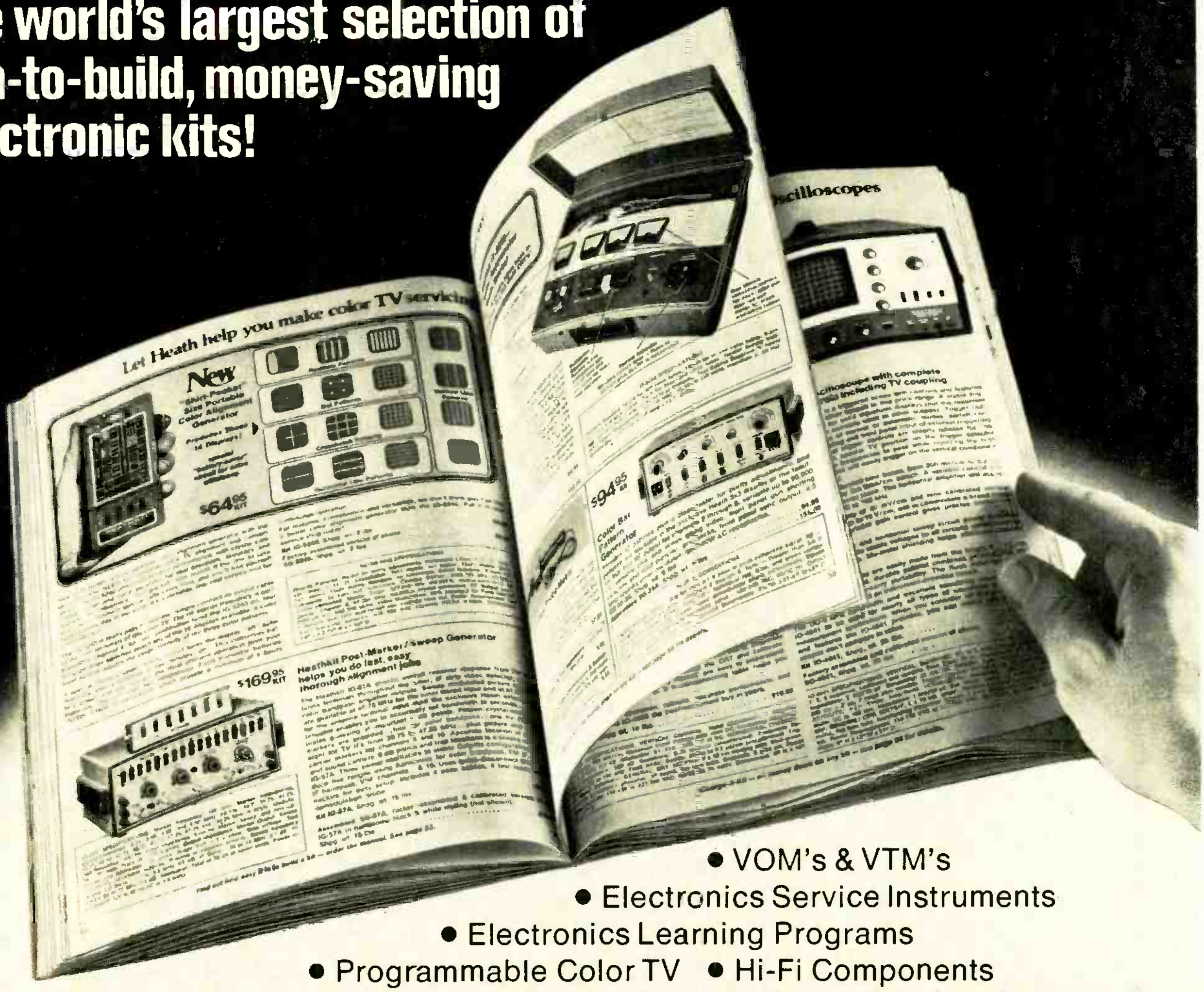

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letters

PROJECTS FOR SHUTTER BUGS

Mr. Maruk's comments in the "Letters Column" in the December 1976 issue are certainly appreciated. There is a growing need for more projects concerning photography.

The timer outlined by George R. Baumgras in the August and September 1976 issues is a prime example that meets Mr. Maruk's and my needs. As pointed out, the artist made some errors, but these apparently were more in depth than IC pins too far apart. It appears he failed to label some connections for the control board in the September issue. Being a neophyte in electronics, determination of the proper connections may be incorrect; however, my findings are from left to right: 6.3 VDC, START, CL, G, E, D4, D3, D2, D1. Also, the speaker relay and transformer were excluded from your September details. It is assumed these parts should be on the bottom of the power-supply board. Mr. Baumgras noted the prototype was installed in a custom cabinet 5 × 8½ × 6-inch case. However, the control boards in the article show a 9.8 × 6-inch board. Of course, the scale on the boards require some careful attention, particularly the alarm board which appears to be a 2:1 relationship.

RONALD L. WAGNER
Roswell, GA

Several corrections to the Countdown Timer were published in the "Letters Column" in the March 1977 issue.

We have also received several letters from our readers telling us that production of the CT-5001 IC has ceased and requesting the name of a supplier. This IC is still available from Poly Paks, Box 942R, Lynnfield, MA 01900, for $1 each. Order number is 92CU1343. Olson Electronics, 260 S. Forge St., Akron, OH 44327, is also supplying the IC in limited quantities for $2. Order number is XM-330.—Editor

CAR CLOCK KIT

Quest Electronics, Box 4430E, Santa Clara, CA 95054, has offered to sell a complete kit of parts for the Auto Digital Clock presented in the January and February issues of **Radio-Electronics.** Quest will be able to offer the boards at a much more reasonable price, and in addition, will offer the MM5396, a reverse lead, bend version (mirror image) of the MM5385.

ROBERT C. ARP, JR

TELESWITCH SURPRISE

Readers who construct James Gilder's Teleswitch (April 1977, Radio-Electronics) may be in for an unpleasant surprise when they discover that the ringback signal and the ringing signal are not necessarily synchronized, depending upon the equipment at the central office.

The ringback signal—that which lets the caller know that the called phone is ringing—may be produced by a separate ringing generator, or may be switched by a different cam on the same generator.

Callers who "let the phone ring just once" may, in fact, be ringing it once, twice—or not at all! In my (General Telephone) area, I often have confused callers by picking up after the first ring—they hadn't heard the ringback yet.

I would suggest that prospective Teleswitch builders perform a simple experiment: Call another phone nearby, and compare your ringback signal with the other phone's ringing. If the phones are in different exchanges, a pair of handie-talkies makes it easy, but you will need a helper.

There is another "confusion factor": to equalize the load on the ringing generator, the central office connectors draw their ringing current from different angles of the ringing cycle; the synchronism of the ringing/ringback tones, or lack thereof, may vary depending upon the numbers of the calling and called parties.

ERIC G. LEMMON
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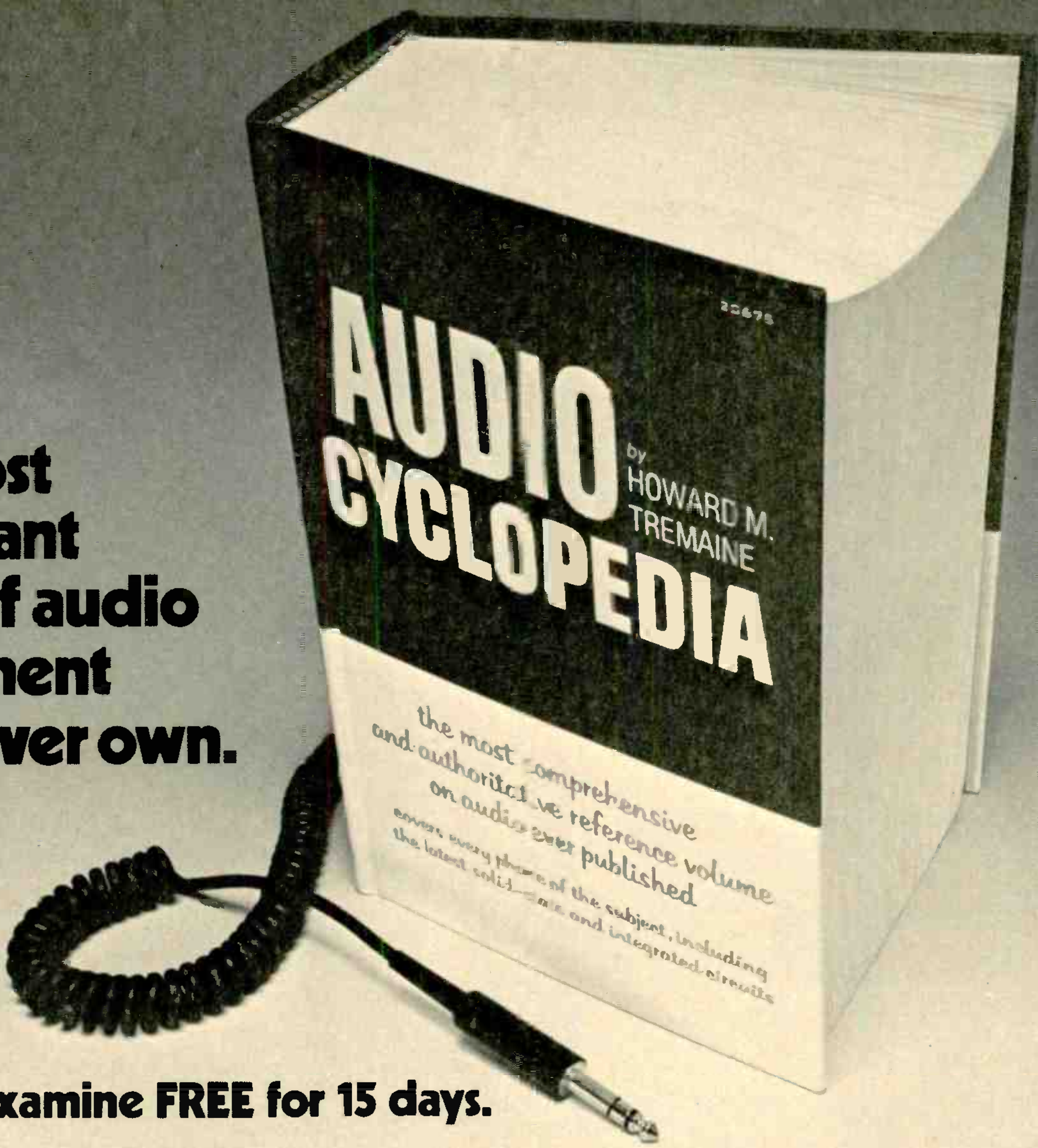

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computer corner

DAVID G. LARSEN, JONATHON A. TITUS and PETER R. RONY*

THIS MONTH'S COLUMN WILL FOCUS UPON THE concept of an interrupt. When used in the context of a computer, an *interrupt* can be defined as the suspension of normal program execution in order to handle a sudden request for *service,* i.e., assistance by the computer. At the completion of interrupt service, the computer resumes the interrupted program from the point where it was interrupted.[1] This specific interrupt use is consistent with the general meaning of the term: to stop a process in such a way that it can be resumed.

A given computer will typically communicate with a variety of external I/O devices. If it is a minicomputer, it may communicate with a teletype or alpha-numeric keyboard, a CRT display, a printer, a floppy disk, and perhaps one or more laboratory instruments. If it is a microcomputer, it may communicate with smaller devices—motors, solid-state relays, pushbutton switches, display lights, etc.—within a larger machine or instrument. When used as a replacement for discrete logic devices in a complex digital circuit, a microcomputer may communicate with other TTL integrated circuits such as latches, flip-flops, and three-state buffers.

When communicating with external I/O devices[2], microcomputers can operate in two general modes, *polled* and *interrupt*. Polling is the periodic interrogation of each I/O device that shares a communications link to the microcomputer to determine whether it requires servicing. A microcomputer sends a poll that has the effect of asking the selected device, "Do you have anything to transmit?", "Are you ready to receive data?", and similar questions. When a microcomputer services a polled device, it simply exchanges digital information with the device in a manner that is prescribed by software in a subroutine called a *software driver*.

In polled operation, the microcomputer sequences through the devices tied to the

continued on page 18

*Mr. Titus is president of Tychon, Inc., a microcomputer consulting firm in Blacksburg, Virginia. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University.

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

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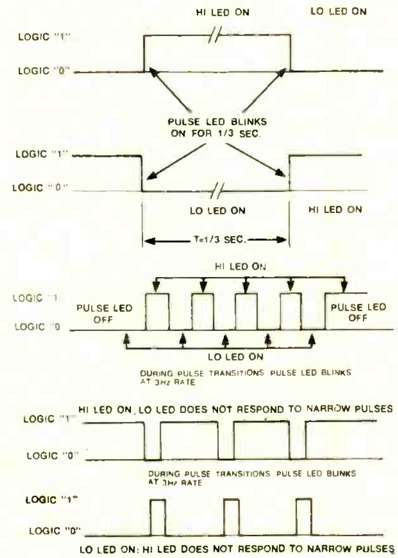

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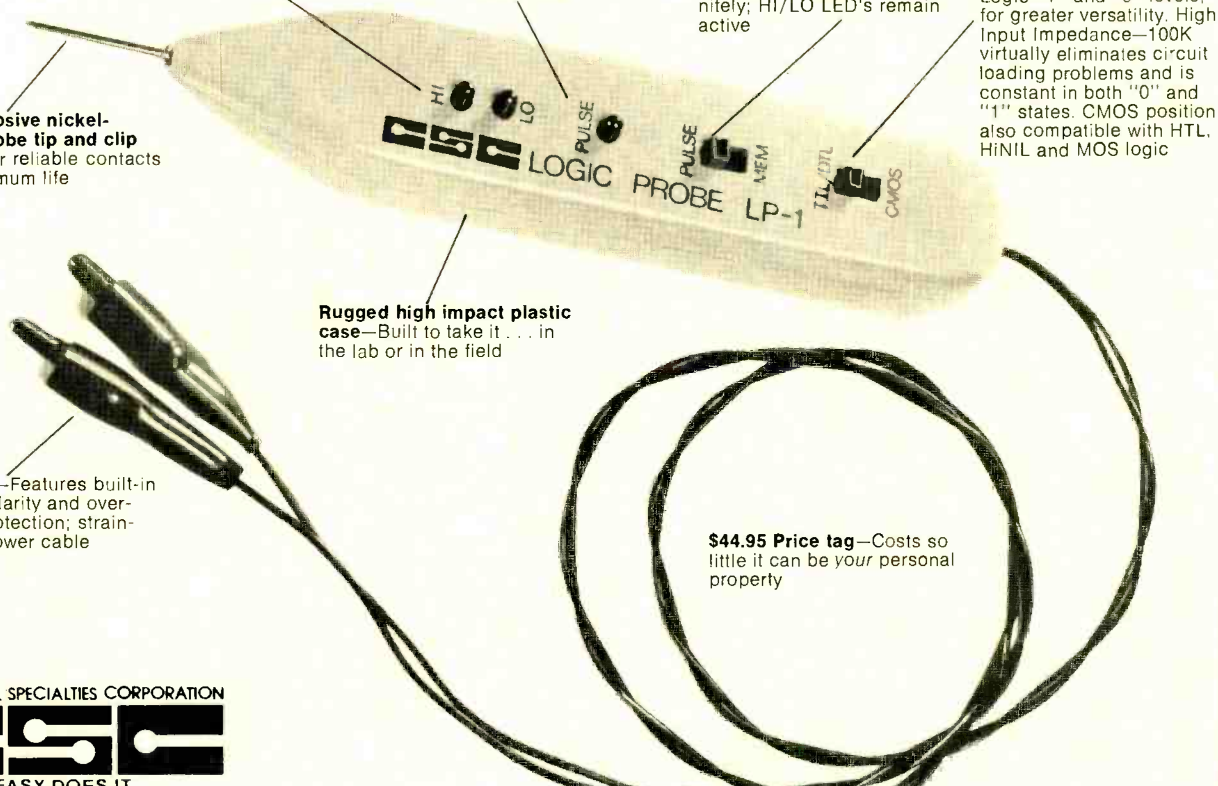

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CIRCLE 44 ON FREE INFORMATION CARD

continued from page 16

microcomputer looking for individual devices that need servicing. When it finds a device that requires service, it stops sequencing, calls a software driver, and services the device. Once it is finished, the microcomputer continues checking the devices. Polled operation is most useful with relatively slow devices that do not require frequent service, do not require attention from the microcomputer for excessive periods of time, and can wait to be serviced. Advantage is taken of the difference in speed of operations in the microcomputer and operations in the I/O device. Most common I/O devices are much slower than microcomputers. For example, in 100 ms (teletypewriter response time) an 8080A-based microcomputer can execute approximately 20,000 instructions when operated at a clock rate of 2 MHz. Although a microcomputer may give one the impression that it is doing several things simultaneously, this is only an illusion since it can manipulate data much faster than most I/O devices can respond to changes in data. *A single computer can perform only one task at a time.*

In interrupt operation, the microcomputer juggles the demands of the external I/O devices. There is a distinction between slow devices that require infrequent servicing and high-speed devices that demand the attention of the microcomputer for most of the time. The most appropriate description for interrupt operated systems is that they are *asynchronous,* i.e., they lack a common synchronizing signal and therefore give rise to generally unexpected or unpredictable program execution within the microcomputer. An *asynchronous device* is a device in which the speed of operation is not related to any frequency in the system to which it is connected.[3] The use of asynchronous devices is the rule rather than the exception.

There can exist *priority* in interrupt operation; all I/O devices can have an order of importance so that some devices take precedence over others. In contrast, there is usually no priority in polled operation; once a device is serviced, it waits its turn until all other devices are sequenced and, if necessary, also serviced. The time between the interrupt request by a device and the first instruction byte of the software that services it is known as the *interrupt response time.* For a high-speed device that has high priority, the response time can be very short—less than a millisecond. For a low-speed device that has low priority, the response time is variable since it depends upon the demands placed upon the microcomputer by all higher priority devices.

Interrupt Techniques

Three commonly used microcomputer interrupt techniques are the *single-line interrupt,* the *multilevel interrupt,* and the *vectored interrupt* (Fig. 1). In the single-line interrupt technique, multiple devices must be connected via an OR gate to a single interrupt line. Once an interrupt signal is received, all of the interrupt devices are polled to determine which one caused the interrupt. It is possible to assign software priorities to the various inerrupting devices, so that the first device polled that needs service is the one that receives the attention of the microcom-

continued on page 20

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COMPUTER CORNER

continued from page 18

puter. A common term used for that part of a program that polls interrupt devices is *flag checking routine*. We shall discuss the concept of a flag in a subsequent column. At the moment, consider a flag to be a single-bit memory that indicates when an operation has been completed or when a condition has been attained.

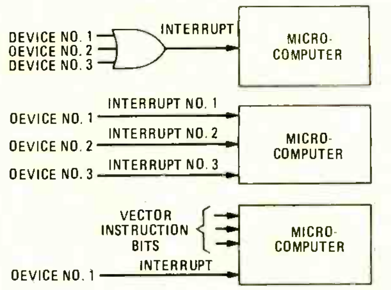

FIG. 1

In the multilevel interrupt technique, there exists several interrupt lines to the microcomputer, each line being tied to a separate I/O device flag. The microcomputer does not need to poll the devices to determine which one caused the interrupt. This is done internally within the microprocessor. Depending upon the nature of the microprocessor, this can be a very fast interrupt technique, but it is somewhat difficult to expand.

A vectored interrupt causes a direct branch

continued on page 22

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COMPUTER CORNER

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by the microcomputer to that part of the program that services the interrupt. This interrupt technique requires external IC's to supply the memory address of the *interrupt service routine* as well as to set the priority. With the 8080A microprocessor eight different service routine addresses can be readily specified, although one of these addresses coincides with the reset address for the microprocessor, location zero. If you are interested in vectored interrupts, we encourage you consider the Intel 8259 programmable interrupt controller, which became available commercially in July, 1976.

The use of interrupts should be considered very carefully. More complicated software is invariably required. For example, you will generally have to save the status of the microprocessor IC at the time that the interrupt occurred. This means placing the contents of the accumulator, the flags, and the registers into a specified region of memory where they can be retrieved at a later time, after the interrupting device has been serviced. Pay attention to priorities. Make certain that devices that require high priority and need immediate servicing are given the highest priority. Other devices, such as teletypes, should be low priority. Also, if you attempt to do too much with an interrupt system, you might find that your microcomputer becomes "interrupt bound," which means that the microcomputer is only working on interrupt tasks and is not working on the main task, which it should be doing while only infrequently servicing interrupt requests.

To end this column, we would like to provide one example of an interrupt system. Assume that your microcomputer is performing mathematical computations on 7-bit ASCII numbers that are entered via a UART IC[4] that is connected to a Teletype operated at 110 Baud, or ten ASCII numbers per second. The exchange of data between the microcomputer and the UART can be performed in 20 to 30 microseconds, which leaves 99.97 ms left for the microcomputer to do other things. With the Intel floating-point package, for example, each floating-point multiplication or division can be performed in 2 to 5 ms with an 8080A-based microcomputer operating at 2 MHz. Sixteen-bit binary multiplications and divisions can be performed even faster. Therefore, it is appropriate for you to consider that the main task of the microcomputer is to perform such computations, and that 0.05% to 0.10% of the time the microcomputer can service the interrupting teletype. **R-E**

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2. Larsen, D. G., Rony, P. R., and Titus, J. A., "Microcomputer interfacing: Microcomputer I/O devices," *Amer. Lab. 7* (11), 100 (1975).
3. Graf, Rudolf F., *Modern Dictionary of Electronics*, Howard W. Sams & Co., Inc., Indianapolis, IN, 1972.
4. Larsen, D. G. and Rony, P. R., "Computer interfacing: The universal asynchronous receiver/transmitter (UART), *Amer. Lab. 7* (2), 113 (1975).

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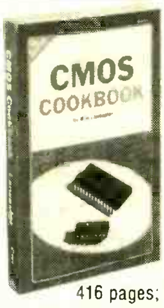

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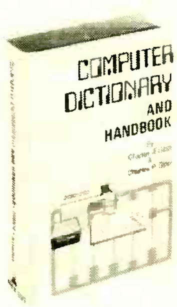

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LOOKING AHEAD

continued from page 4

nobody should hold his breath awaiting such major picture-display methods. As to electron-luminescent displays, Kazan said: "We know how to do it." However, brightness and resolution remain major problems.

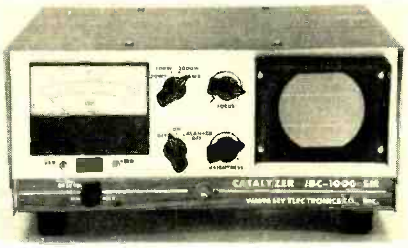
AM stereo tests: If things proceed on schedule, three AM stereo systems should be in the field-testing process by the time you read this, using the facilities of WBZ, Boston, and WTOP and WGMS in Washington. The tests are being conducted by the industry-wide National AM Stereo Radio Committee. The committee's task has been simplified by the withdrawal of systems developed by RCA, Sansui, Communication Associates and Hobart Wilson, leaving only three under consideration—those proposed by Magnavox, Motorola and Belar (Devon, PA). A fourth system, developed by Kahn Communication, has not been offered to the committee for testing but has been submitted directly to the FCC.

According to the latest timetable, the committee hopes to turn its field-test data over to the FCC by Labor Day. Any hopes for Commission approval of a system this year have now vanished, since the FCC's processes are expected to require about a year. AM stereo's path to approval is expected to be fairly smooth, since it is favored by all radio and audio manufacturers and automobile makers as well as AM broadcasters.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

equipment reports

Wawasee Electronics JBC-1000-SM Catalyzer Oscilloscope/RF Wattmeter and SWR Bridge



CIRCLE 89 ON FREE INFORMATION CARD

ACCORDING TO THE CATALOG DESCRIPTION, THE Catalyzer *model JBC-1000-SM* is a general-purpose device for continuously monitoring the transmitted signals from transmitters or transceivers having output ranges from 3 watts to 2000 watts in the 27 to 30 MHz frequency area. The *JBC-1000-SM* permits the operator to read the actual RF output being delivered to the antenna and visually view the RF and voice modulation on each transmission thereby giving positive assurance to the operator of positive operation of his transmitting equipment. For convenience, an SWR function has been incorporated for measurement of the standing-wave ratio.

What the catalog listing doesn't tell you is that the direct-connected scope is probably the only accurate method of measuring modulation. Unlike those $1000-plus 30-MHz oscilloscopes, there is no electronic circuitry in the *JBC-1000-SM* between the transceiver-under-test and the CRT deflection plates—just the connecting wires and a capacitive attenuator that reduces the RF level applied to the deflection plates. Without electronics in the circuit path, you see exactly

turn page

what the modulation looks like without any chance of limiting, clipping or distortion being introduced.

Most, if not all, modulation meters cannot follow rapid peaks of modulation—they need a sustained signal for the meter to indicate the maximum level. Mostly modulation meters indicate only the negative sustained modulation. You can't tell if a transmitter is overmodulating on speech peaks when using a meter. But you can't fool that electron beam in the CRT. If your eyes are fast enough, you can see the 100-plus percent negative modulation that causes a transmission to splatter or bleed over too many channels. But you'd have to be nearly blind to miss the excessive negative modulation that bleeds across the whole CB spectrum.

The *JBC-1000-SM* is easy to connect into the output system of any transmitter or receiver . . . even single-sideband ham transmitters with 1000-watts output. It hooks into the circuit like any SWR meter—a short coax connects the transceiver to the coax connector on the rear of the *JBC-1000-SM*. The antenna coax connects to the other rear-panel connector.

The RF wattmeter and scope attenuators are not set with one control knob. To keep RF wiring short, the capacitive attenuator is mounted on the rear panel. Other controls and switches are in DC circuits where lead length is not a problem. To observe a CB carrier, set the rear-panel attenuator to minimum attenuation (the *JBC-1000-SM* has a top range of 2000 watts for "ham" transmitters).

To determine the modulation percentage,

just "key" the transmitter and feed a tone or whistle into the microphone—either method is perfectly legal when operating the transmitter on a dummy load instead of an antenna, just as all transmitter tests should be done. There are no controls to adjust! There are no scales to read! All you have to do is observe that the carrier waveform just about doubles in height during voice peaks, sustained whistles or tones (see Fig. 1-a) without breaking down into a short, straight bright green line between those peaks (see Fig. 1-b).

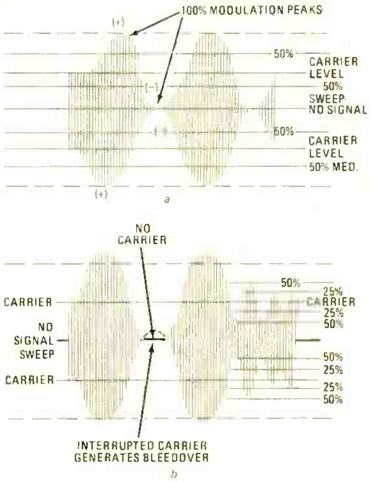


FIG. 1

A blanker circuit is incorporated that deflects the beam from the screen when there is no RF signal present. Unfortunately this

turn page

does not occur for very weak RF signals and will not necessarily work with a 3-watt transceiver but will work properly with a full 4-watt output signal. Blanking the trace has no other purpose than to prevent the constant sinusoidal horizontal sweep from burning the phosphor of the CRT face. Turning down the brightness will do the same job of protection.

Put a handle on the *JBC-1000-SM* and you can easily carry it to any base station to checkout the modulation, RF power output and antenna SWR—it only weighs 10½ pounds (quite a bit heavier than those pocket-sized CB testers). But what the transceiver puts out is what you see—positive and negative—and is a lot more impressive than a slow-moving meter pointer. For more information contact: Wawasee Electronics Co., Inc., P.O. Box 36, Syracuse, IN 46567. **R-E**

Ohio friend of Citizens band now Director of Highway Safety

Robert M. Chiaramonte, member of the Board of Directors of the CB organization REACT (Radio Emergency Associated Citizens Teams) has been appointed Director of the Ohio Department of Highway Safety by Governor James A. Rhodes.

Chiaramonte joined the Ohio State Highway Patrol in 1942, serving in every patrol rank up to that of Superintendent, to which he was appointed in 1965. He retired in 1975 with the title of Colonel. More recently he served as project director of Operation Crime Alert, building up a strong state-wide crime prevention program.

He recognized the potential value of CB as an aid to highway safety very early, and Ohio was one of the first states to put police-CB cooperation into effect. Under Chiaramonte's direction, a series of police-CB tests were organized as early as 1970. Results were so encouraging that before 1975, all 57 Ohio State Patrol posts were equipped with CB and monitored channel 9 (see **Radio-Electronics,** January 1976, page 62).

USER PROGRAMMABLE MESSAGE WATCH

PROGRAMMABLE MESSAGE WATCH, in addition to being a full-function digital timepiece giving time, month and date, displays a message of up to five words of not more than five letters each. Message can be programmed into the watch with the special computer at top right, or the owner can "print" his own by depressing a button and adjusting the watch for the desired message.

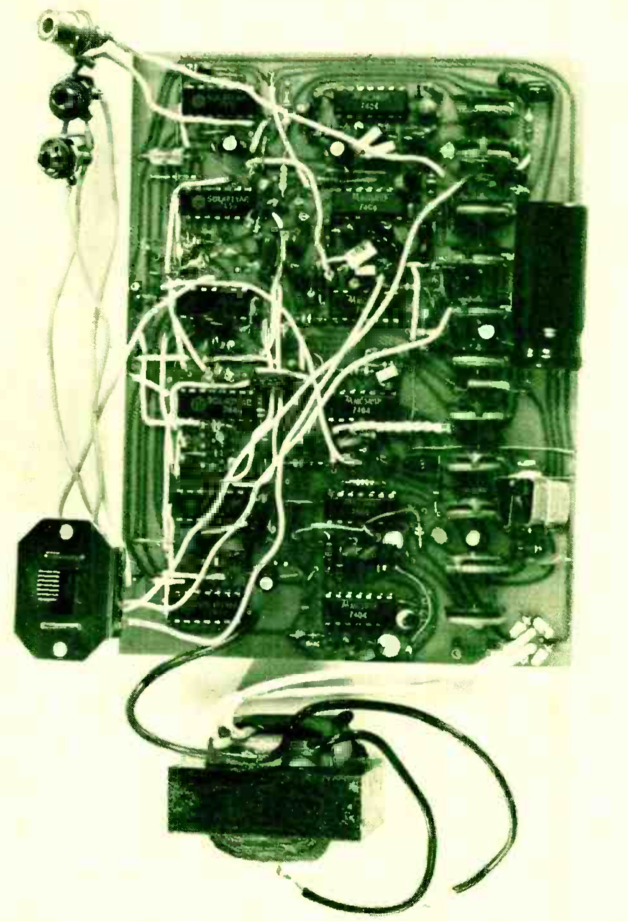
Modules for this type of watch, with a five-word message pre-programmed during manufacture, were first announced by Hughes early in 1976. The present watch (also a Hughes module) differs in that the user can set up and change his own message at will without having to send it back to the factory. **R-E**

ON-SCREEN TV CLOCK

The July issue of **Radio-Electronics** will feature a construction project that puts the time on your TV screen. Built around a National Semiconductor character generator IC, the clock can be installed in any TV set. The clock IC is also from National Semiconductor and it derives its time-base from the 60-Hz AC power line.

Build this

Electronic Music Box



Here's an electronic music box that uses pink-noise sources to select the pitch and duration of each musical note. Called the Infinitune, it selects the notes from three octaves of a pentatonic scale.

RAYMOND A. CHAMBERLIN

THE INFINITUNE IS A MUSIC GENERATOR THAT uses pink-noise sources to select the pitch and duration of each musical note. The pitches are selected from three octaves of a pentatonic scale. Most Eastern music is based on the pentatonic scale which has five notes per octave with simple frequency ratios. Eastern music lacks much of the formal structure of Western music and is most successfully imitated by simple pink-noise sources.

The Infinitune, when connected to any audio system, continually produces a pleasant form of pink-noise music. It also provides the opportunity to experiment with random-composition music. Provision is made for adding an additional channel or for changing the scale in which the music is played. The Infinitune can also be used as a controller for more advanced synthesizers. External noise sources can be used (such as the electrical activity of the brain or the flickering light of a candle) to drive the synthesizer to produce music based on external activity.

How it works

Figure 1 shows the block diagram of the Infinitune. Each noise source generates a randomly varying analog voltage with a pink-noise energy spectrum. The noise source used for pitch selection has a frequency spectrum that covers approximately .05 to 100 Hz: the source for duration selection covers 0.2 to 200 Hz.

Each noise source is connected to a scaling circuit that quantizes the analog voltage into discrete voltage levels. A clock oscillator drives both scalers. The two scalers are quite different. The Pitch Scaler divides the output voltage range of the Pitch Noise Source into 15 equal-amplitude voltage ranges. Its output is a random varying succession of discrete values that can change at each system clock time. The 15 ranges correspond to three octaves of five musical tones each. The Pitch Scaler output appears on three lines, one for each octave. A line representing the five tones of a given octave carries a voltage that can change among five levels at each clock time. Two additional lines that can change binary value at the same time as the five-level line, code the selected octave.

The five-level line determines the frequency of a voltage-controlled oscillator (Pitch VCO). The squarewave output of the oscillator proceeds through two binary frequency dividers. Whether division occurs in both, one or neither divider is determined by the binary lines, resulting in the appropriate octave.

The Duration Scaler, on the other hand, quantizes its analog input voltage into only three output values (four under special adjustment). These outputs are in the form of pulse widths lasting 1, 2 or 4 clock periods (7 if so adjusted) that determine the length of each note sounded, and hency the rhythm.

The duration pulse is fed through an R-C network (Envelope Shaper) where it is shaped by various manual controls to provide the desired envelope shape to the tone signal.

The Envelope Modulator circuit amplitude modulates the tone signal with the output of the Envelope Shaper and a tremolo (6-Hz sinewave) signal from Vibrato/Tremolo Oscillator. The Vibrato/Tremolo Oscillator also modulates the Pitch VCO to add vibrato to the tone.

Circuit operation

The circuit, shown in Figure 2, uses quad operational amplifiers and transistors for analog circuits and the same op-amps, to-

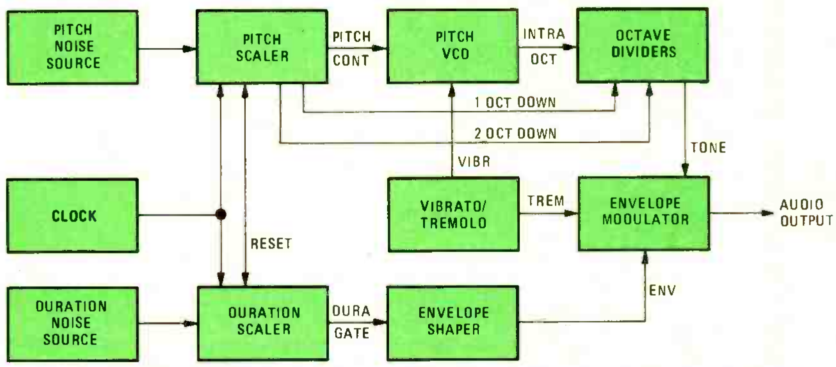


FIG. 1—PINK NOISE SOURCES are used to select the pitch and duration of the musical notes.

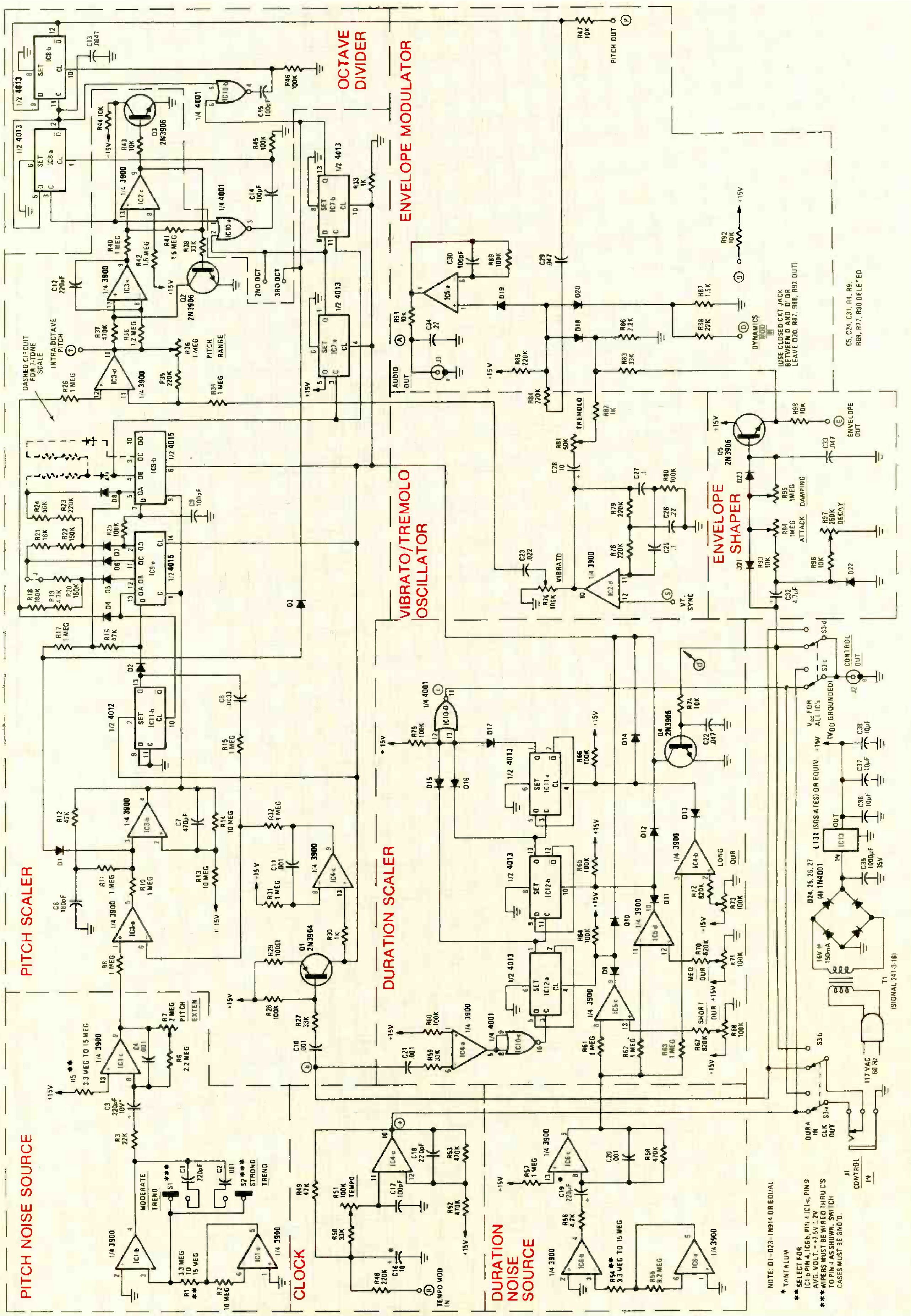


FIG. 2—MUSIC IS GENERATED solely by the circuitry in accordance to the pink noise sources. Trimmers and external tie points are provided on the circuit board for varying the musical composition and for special effects.

PARTS LIST

All resistors are ¼-watt, 10%, unless otherwise noted.

R1, R5, R54—selected value between 3.3 and 15 megohms (Select for average voltage on IC1-b pin-4, IC6-b pin-4 and IC1-c pin-9 to be +7.5 volts ±2 volts.)
R2, R55—8.2 megohms
R3, R88—22,000 ohms
R6—2.2 megohms
R7—2 megohm trimmer, PC mount
R8, R10, R11, R15, R17, R26, R31, R32, R34, R40, R57, R61, R62, R63—1 megohm
R12, R16, R49—47,000 ohms
R13, R14—10 megohms
R18—180,000 ohms, 5%
R19—4700 ohms, 5%
R20—150,000 ohms, 5%
R21—18,000 ohms
R22—150,000 ohms
R23, R35, R48, R78, R79, R84, R85, R90—220,000 ohms
R24—56,000 ohms
R25, R28, R45, R46, R60, R64, R65, R66, R75, R80, R89—100,000 ohms
R27, R39, R50, R59, R83—33,000 ohms
R29—100 ohm
R30, R33, R82—1000 ohm
R36, R94, R95—1 megohm trimmer, PC mount
R37, R52, R53, R58—470,000 ohms
R38—1.2 megohms
R41, R42—1.5 megohms
R43, R44, R47, R74, R91, R92, R93, R96, R98—10,000 ohms
R51, R68, R71, R73, R76, R81—100,000 ohm trimmer, PC mount
R56—4700 ohms
R67, R70, R72—820,000 ohms
R86—2200 ohms
R87—1500 ohms
R97—250,000 ohm trimmer, PC mount
C1, C12, C18—220 pF ceramic
C2, C4, C10, C11, C20, C21—.001 µF polyester
C3, C19—220 µF, 10 volt, tantalum
C6—180 pF mica
C7—470 pF ceramic
C8—.0033 µF polyester
C9, C14, C15, C17, C30—100 pF ceramic
C13—.0047 µF polyester
C16—10 µF tantalum
C22, C29, C31, C33—.047 µF polyester
C23—.022 µF polyester
C25, C27—0.1 µF polyester
C26, C34—0.22 µF polyester
C28, C36, C37—10 µF, 15 volt, electrolytic
C32—4.7 µF tantalum
C35—1000 µF, 35 volt, electrolytic
D1-D23-1N914 or any silicon signal diode
D24-D27—1N4001
IC1-IC6—LM3900, CA3401 or MC3401
IC7, IC8, IC11, IC12—CD4013
IC9—CD4015
IC10—CD4001
IC13—+15 volt, 200 mA, regulator (SGS-Ates L131 or equal.)
Q1—2N3904
Q2-Q5—2N3906
J1—miniature phone jack, closed circuit
J2—miniature phone jack
J3—phono jack
S1, S2—SPST subminiature slide switch
S3—4PDT slide switch
T1—117-volt primary; 16-volt, 150 mA, secondary
Misc.—PC board, 8½ × 6 × 2½-inch enclosure (Ten-Tec JW8 or similar), 4½ × 6-inch plastic insulator sheet for under PC board, hardware, etc.
Note: The following parts have been deleted and do not appear on the parts list, schematic or component placement diagram: R4, R9, R69, R77, C5 and C24.

The following parts are available from Inner Space Electronics, Box 308, Berkeley, CA 94701: A complete kit of parts (single channel), including case, for $75.00. Etched and drilled PC board for $12.00. Postpaid. California residents add 6% sales tax (6½ in transit districts).

gether with 4000-series CMOS logic, for the digital circuits.

The two noise sources—(IC1 and IC6) are identical except for time constants and controls. The PITCH EXTENT control (R7) varies the resistive feedback of the pitch output stage. The Pitch Noise Source has two slide switches (S1 and S2) to control the upper frequency spectrum. When both switches are in the open position, the pink-noise characteristic extends over the useful range of frequencies. The other positions roll-off the frequency characteristic successively closer to a red-noise spectrum. Both switches and leads must maintain minimal capacitance to ground for a pink-noise response.

The Pitch Scaler is formed by a ramp generator (Q1 and IC4-c), a voltage comparator (IC3-a), a gated oscillator (IC3-b), a D-type flip-flop (IC11-b), a dual shift register (IC9), a tapped resistor string (R18 through R24) and two D-type flip-flops (IC7-a and IC7-b) for octave coding. The negative-going trailing edge of the system clock pulse initiates a negative-going ramp that is determined by R31 and C11. This ramp is continuously compared by IC3-a to the analog signal from the Pitch Noise Source. A negative-going pulse appears at the output of IC3-a during the fast rise of the ramp. The pulse terminates when the ramp becomes more negative than the noise signal.

The continuous random voltage variation is converted to a continuous random pulse-width variation by the Pitch Scaler. Only during the time the gate is low does IC3-b operated as an astable multivibrator. The output of the gated clock is a measure of the original continuous signal expressed as the number of pulses in a train starting at each trailing edge of the clock-pulse.

The clock pulse out of Q1 presets D-type flip-flop IC11-b, clears the dual shift register IC9 and clears the octave-control flip-flops IC7-a and IC7-b. IC11-b produces a high level that is shifted through the register by the pulse train from the gated clock. Since the first stage of the register is fed back to clear IC11-b as soon as this stage goes high, each shift-register stage is high for only one clock period at a time. Since the fifth stage is fed back to the first as well as to the sixth, bits in the register will recycle every sixth pulse from the gated clock.

The sixth stage of the shift register provides a clock input to the octave-control flip-flops (IC7-a and IC7-b). Since the D input of IC7-a is held high and the D input of IC7-b is tied to the Q output of IC7-a, the Q output of IC7-a will go high on the sixth gated-clock pulse, while the Q output of IC7-b will go high on the eleventh pulse. The octaves are selected as follows: The highest octave when both Q outputs are low; the middle octave when the Q output of IC7-a is high and the Q output of IC7-b is low; the lowest octave when both Q outputs are high.

The output of flip-flop IC11-b is also applied, through R15 and C8, to the comparator so as to cause a minimum of one pulse to result at each clock, regardless of the noise-source signal level at the time. The output of IC7-b is AND'ed by D2 and R16 with the fifth stage of the register and applied to the gated clock so as to inhibit the latter from producing more than fifteen pulses. Each of the first five stages of the shift register is connected through a diode to a tap in the resistor string tied to the Pitch VCO input. The output of each of these stages produces a different voltage at the input of the VCO, thus producing different frequencies. The values of the resistors are chosen within ±5% to produce the specific tone ratios.

The Pitch VCO has a current-summing amplifier at its input that combines a 6-Hz

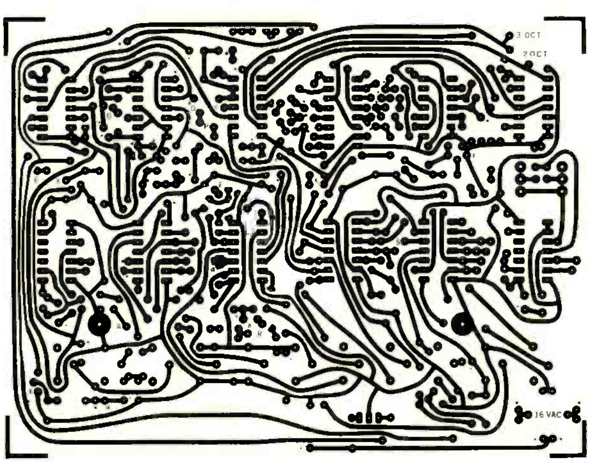


FIG. 3—FOIL PATTERN of single-sided PC board shown half-size.

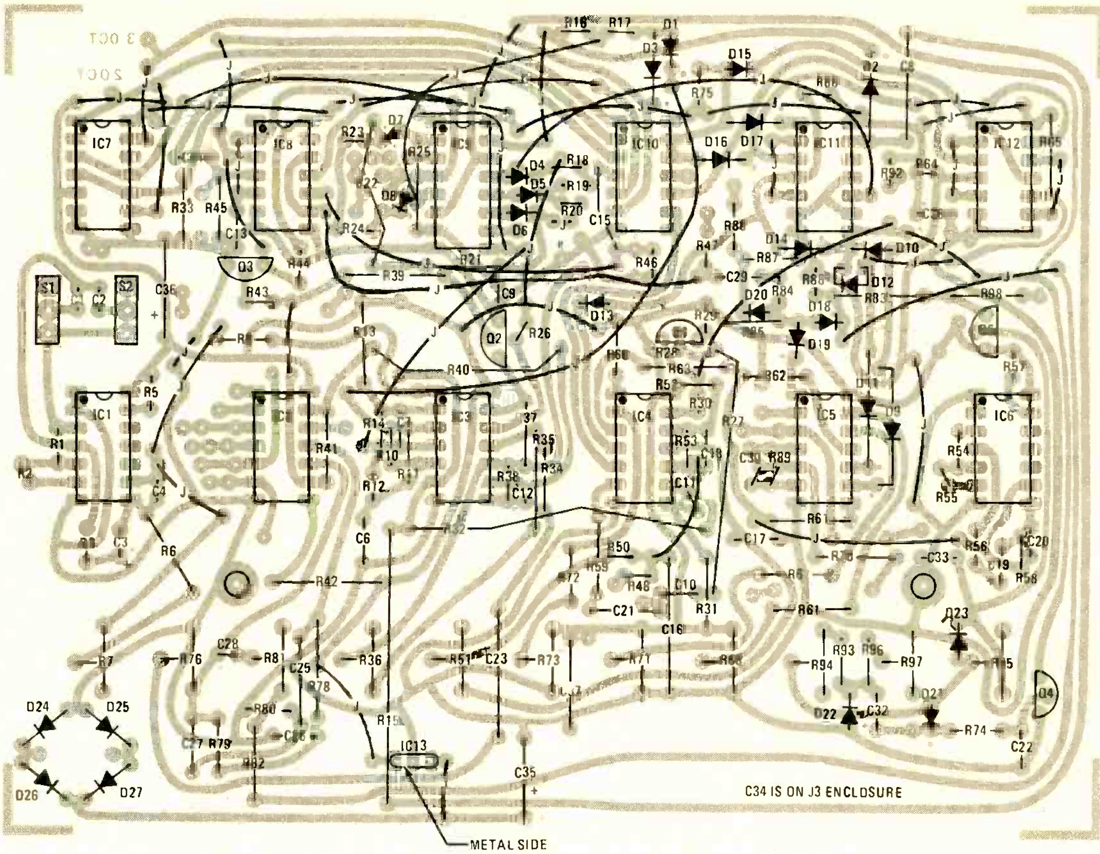
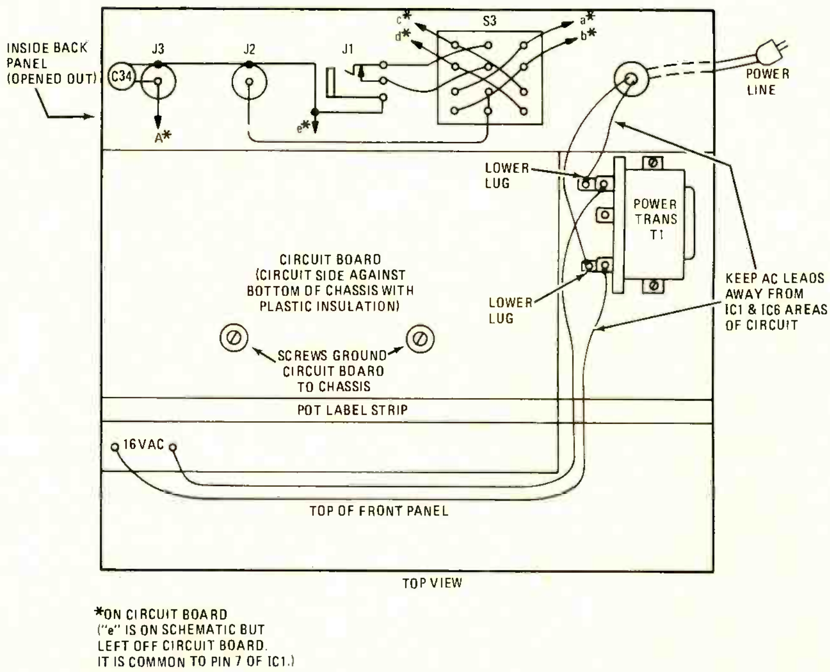


FIG. 4—COMPONENT PLACEMENT diagram.

vibrato sinewave with the current level produced by the shift register and resistor string to produce a tone-control voltage. The VCO consists of the usual integrating amplifier (IC3-c) that produces a triangular wave, a limiting amplifier (IC2-c) that converts the triangular wave to a squarewave and a transistor clamp (Q2) that is connected to the plus input of the integrating amplifier. The PITCH RANGE control changes the gain of the summing amplifier. This tunes the Infinitune to any absolute pitch over a wide range.

Transistor Q3 forms an inverting buffer to drive the Octave Dividers. The Octave Dividers consist of two cascaded flip-flop stages (IC8-a and IC8-b.) Each flip-flop is controlled by a NOR gate (IC10-a and IC10-b) connected to the octave control flip-flops. If the output of an octave control flip-flop is high, frequency division by the associated Octave Divider occurs. However, if the output of the octave control flip-flop is low, the low cycle of the applied squarewave is NAND'ed and produces, after differentiation, a positive-going pulse at the clear input to the Octave Divider. This clears the Octave Divider between each clocking transition and, therefore, no division takes place.



*ON CIRCUIT BOARD
("e" IS ON SCHEMATIC BUT LEFT OFF CIRCUIT BOARD. IT IS COMMON TO PIN 7 OF IC1.)

FIG. 5—WIRING DIAGRAM for the chassis and front panel.

The Duration Scaler contains three voltage comparators (IC4-b, IC5-a and IC5-d) that are referenced to three fixed voltages. Normally, the lowest voltage is applied to IC4-b, the next highest to IC5-c, and the highest to IC5-d, by means of R67, R70 and R73. For the duration ratios 1:2:4 only, R73 is set to +15 volts and the two comparators (IC4-b and IC5-c) convert the noise-voltage into three threshold codes on two lines. (The shortest duration range is selected when both outputs of IC4-b and IC5-c are high; the intermediate range when the output of IC4-b is low and IC5-c is high; and the longest range when both outputs are low.) At the end of a note, the three ripple-counter stages of IC12 are high, causing the NOR-gate output to go low and Q4 to cut off.

The reset pulse from the pitch scaler is AND'ed by D9 through D14 with the comparator outputs and clears only corresponding ripple-counter stages. The cleared stages cause the output of NOR gate IC10-d to go high. Transistor Q4 then clamps any further clock pulses, preventing them from clearing counter stages.

The leading edges of the clock signal from IC10-c decrement the ripple counter through 000 to 111, at which time the output of NOR gate IC10-d, which determines the note-duration, goes low again. With the settings mentioned, the note duration will either last 1, 2 or 4 clock periods. Using R73 for the highest setting brings in a questionably useful duration of 7 periods. Other relative settings of the potentiometers can produce any four integral durations up to 7 periods in length.

The Envelope Shaper allows for separate control of rise (attack), sustain (decay) and fall (damping) of the duration pulse (output of IC10-d). Transistor Q5 is an emitter-follower buffer. *continued on page 76*

TERRY A. WALTERS

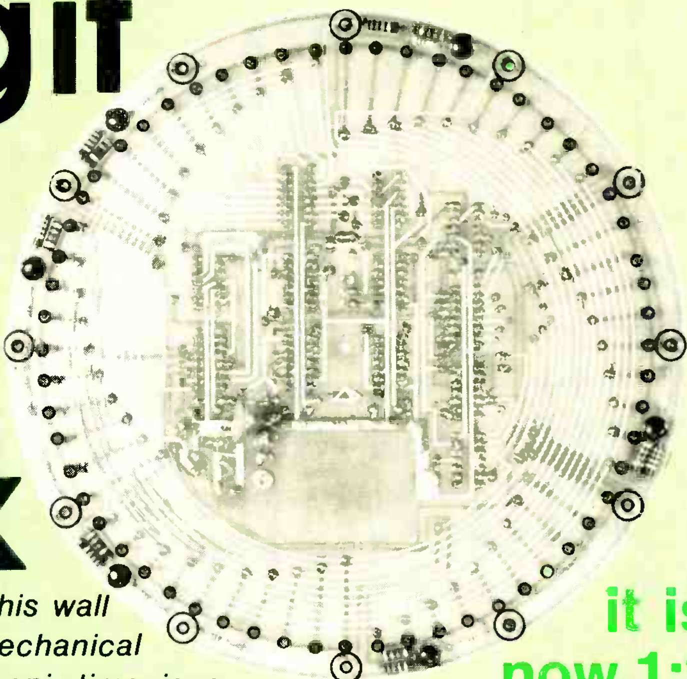
HAVE YOU EVER STOPPED TO THINK THAT IN twenty years or so, not many people will remember how to "tell-the-time" when they come face to face with one of those antique mechanical clocks? With so many digital clocks and watches appearing on the market, our children will learn to "read" the time from the familiar digital display. The clock described here however, combines the traditional round face with the accuracy of the all-electronic clock.

The face of the clock consists of a circle of 12 green LED's that are located at the hour positions. A circle of 60 red LED's displays the minutes. The 60-Hz line frequency is divided down and decoded to drive the proper LED's corresponding to the conventional hour and minute hands. Thus the electronic clock is read in the same manner as the mechanical clocks with the hour and minute hands.

How it works

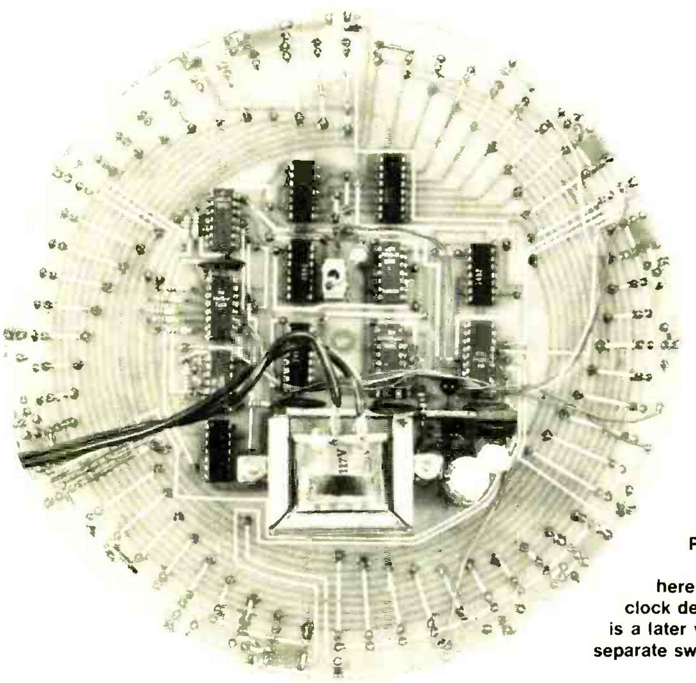
The schematic is shown in Fig. 1. Transistor Q1 converts the signal from the power supply transformer to a TTL compatable 60-Hz squarewave. IC1 divides the frequency by 10 and IC2 divides it by 6, so that a 1-Hz signal appears at pin 8 of IC2. IC3 and IC4 divides the 1-Hz signal by 60 to produce a pulse every minute.

Build this No-Digit Digital Wall Clock



Using discrete LED's and a round face, this wall clock displays time much like a standard mechanical clock and has the accuracy of the all-electronic timepiece

it is now 1:23



REAR VIEW of clock. The clock shown here is a prototype. The clock described in the article is a later version that includes separate switches for setting the hours and minutes.

To minimize the parts count, a multiplex technique is used to individually light each of the minute LED's. IC5 divides the one-minute signal by ten and IC6 decodes the BCD output of IC5 to one-of-ten outputs. IC7 divides IC5's once-every-ten-minutes output by 6. This signal is decoded by IC8 to one of six outputs. When pin 1 of IC8 is low, Q2 conducts. This provides power to LED1 through LED10. IC6 counts through its ten numbers and turns on LED1 through LED10 in consecutive order to display each of the first ten minutes. During the second ten minutes, pin 1 of IC8 goes high and pin 2 goes low. This supplies power through Q3 to LED11 through LED20, and IC6 turns these LED's on in consecutive order just as the first ten. This method is used to turn on each of the 60 LED's in order. Then the count begins again at the top of the dial.

The output of IC7 provides a pulse

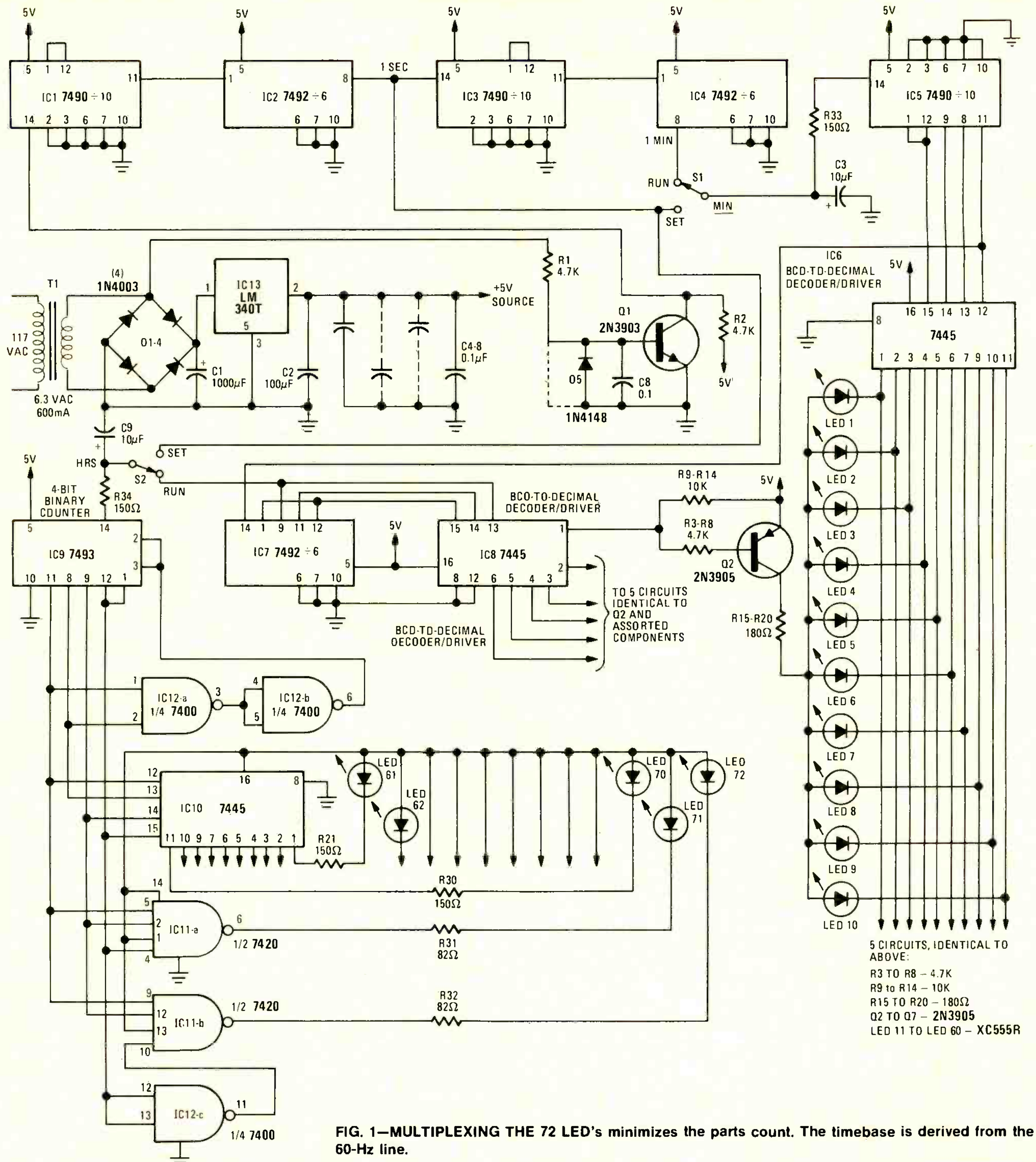


FIG. 1—MULTIPLEXING THE 72 LED's minimizes the parts count. The timebase is derived from the 60-Hz line.

PARTS LIST

All resistors ¼-watt 10%, unless noted

R1-R8—4700 ohms
R9-R14—10,000 ohms
R15-R32—180 ohms
R33, R34—150 ohms
C1—1000 μF, 16-volt electrolytic
C2—100 μF, 16-volt electrolytic
C3, C9—10 μF, 16-volt electrolytic
C4-C8—0.1 μF, 50-volt ceramic disc
LED1-LED60—discrete red LED; 0.1-inch lead spacing, 20 mA. (Xciton XC555R, Monsanto MV5053, or equal.)
LED61-LED72—discrete green LED; 0.1-inch lead spacing, 20-mA. (Xciton XC555G, Monsanto MV5253, or equal.)
D1-D4—1N4003
D5—1N4148
Q1—2N3903
Q2-Q7—2N3905 or 2N3638
IC1, IC3, IC5—7490 Decade Counter
IC2, IC4, IC7—7492 Divide-By-Twelve Counter
IC6, IC8, IC10—7445 BCD-To-Decimal Decoder/Driver
IC9—7493 4-Bit Binary Counter
IC11—7420 Dual 4-Input NAND Gate
IC12—7400 Quad 2-Input NAND Gate
IC13—LM340T-5 or MC7805PC; 5-volt 3-terminal positive voltage regulator
T1—power transformer; 117-volt primary, 6.3 volt 0.6-amp secondary (Triad F-13X or equal.)
S1, S2—SPDT toggle switch, PC board mount
Misc.—PC board, case, hardware, wire, solder, etc.

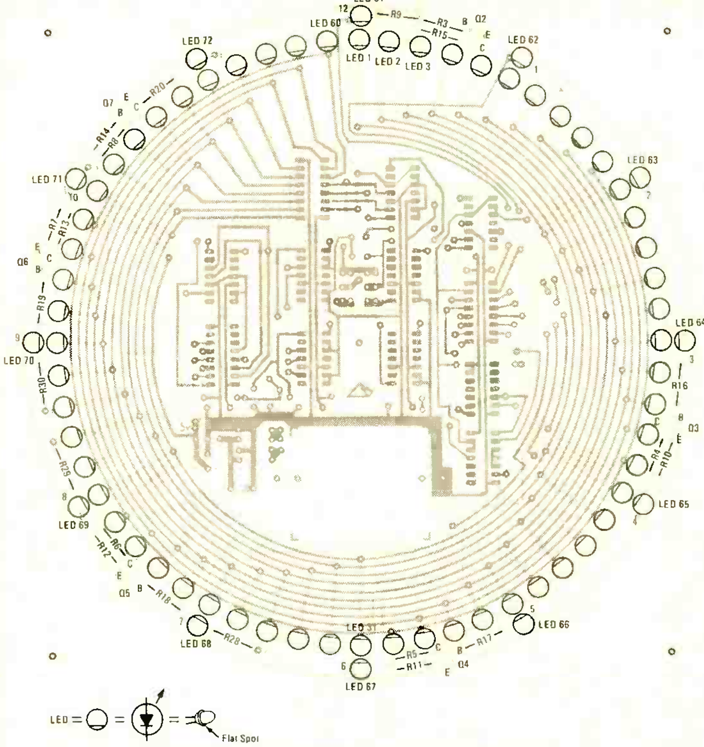


FIG. 4—COMPONENT PLACEMENT for front of PC board.

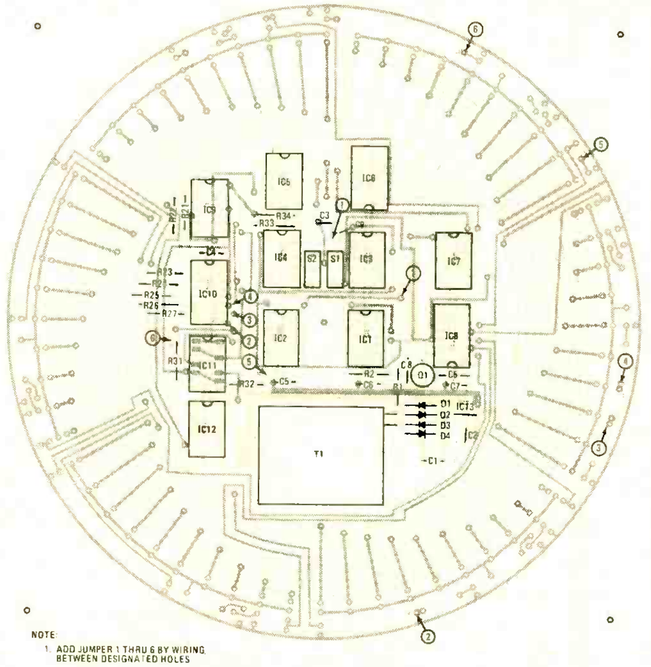


FIG. 5—COMPONENT PLACEMENT for rear of PC board.

each hour. This signal is sent to the input of IC9, pin 14. IC9 is wired through IC12-a and IC12-b to function as a divide-by-twelve counter. The BCD output of IC9 is decoded by IC10 to one-of-ten outputs to display each of the first ten hour-positions. Since IC10 has only ten outputs, it is necessary to use IC11-a and IC12-c as decoder/drivers for the last two numbers.

Switch S1 is used to set the minutes.

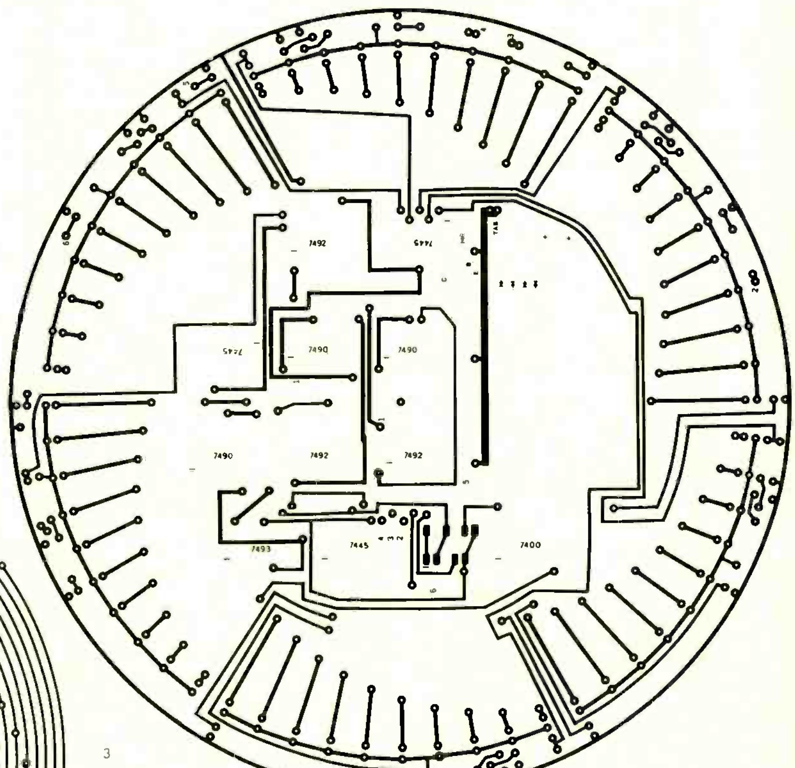


FIG. 3—REAR FOIL PATTERN of double-sided PC board shown half size.

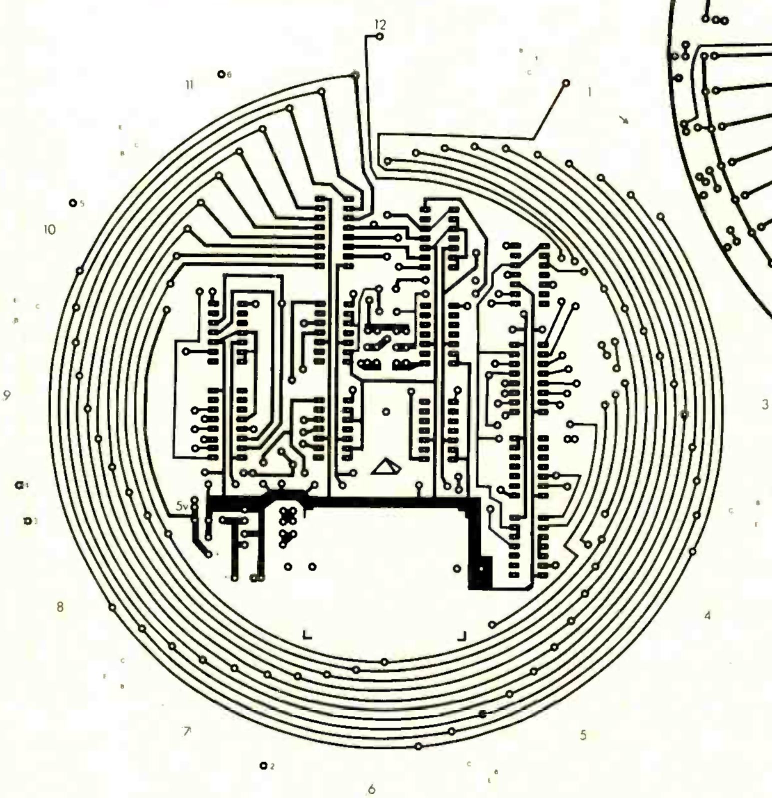
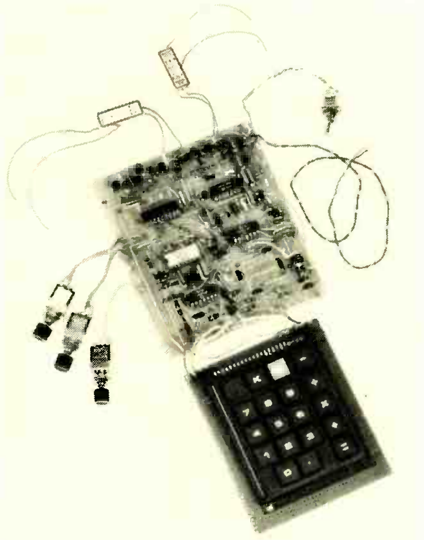


FIG. 2—FRONT FOIL PATTERN of double-sided PC board shown half size.

To accomplish this, a faster signal is used to trigger IC5. The signal at pin 8 of IC2 is a 1-Hz squarewave that runs the minute "hand" around the face of the clock as if it were a second hand when S1 is in the SET position. When the correct minute is displayed, S1 is returned to the RUN position. Switch S2 is used to sweep the hours LED's at a 1-Hz rate. As you look at the rear of the

continued on page 84



Pushbutton Dialer With Memory

Add-on device connects to any telephone and permits dialing via a separate keyboard. It has a redial mode and a 20-digit 10-number expandable memory

DICK FEINWELL

THREE MOS INTEGRATED CIRCUITS FROM General Instrument and a demonstrator PC board layout, make the construction of a deluxe telephone dialer a fairly routine procedure. The circuit is a pulse dialer that interfaces with a telephone type 2-of-7 keyboard. Or, with the addition of a diode encoder, a 1-of-12 calculator keyboard.

The dialer has three basic modes of operation. First it converts any conventional dial phone into a pushbutton phone. A series of up to 20 digits are stored and sent out sequentially at a fixed pulse rate.

Second is the very convenient redial mode. If the number you dial is busy, you hit the REDIAL key twice to automatically redial the number without reentering the digits. The first push of the REDIAL key holds the last number dialed in a series of memory registers while the hook switch is depressed to get another dial tone. The second REDIAL key closure starts the actual dialing.

Third, the system has storage for ten 20-digit numbers including access pauses. Access pauses are required when dialing code prefixes are used to connect through automatic telephone routing systems. Often you must wait for dial tones after these codes are entered. The dialer stops the dialing sequence when it reads an access pause code from memory. Upon receipt of the next dial tone, the CONTINUE button is pushed to finish dialing the number, or to dial out up to the next access pause code.

Before getting too deep into this project, I offer a word of caution. If you add this gadget to a privately owned home or company internal phone system, you're on firm ground. The telephone company on the other hand tends to be a little fussy about hooking things to their lines. This device is not intended to be connected directly to a subscriber's telephone set without compliance to local phone company regulations.

How it works

Figure 1 shows the schematic diagram of the telephone dialer. Pushbutton to Dial-Pulse Converter IC4 is the focal point of the system. A logic zero on the reset-input (pin 3) clears all internal shift register stages and resets the counters. Transistor Q6 is turned on for a short interval when V_E is switched on by the hook switch. Base current to Q6 flows through R33 and C4 for the time it takes capacitor C4 to charge. The collector of Q6 remains low for the short interval and then switches high to trigger the monostable multivibrator formed by IC2-c and IC2-d.

The Pushbutton to Dial-Pulse Convertor IC4 accepts a keyboard parallel input on lines C0 through C4 coded as listed in Table 1. Figure 2 shows the connections for a telephone-type 2-of-7 keyboard. The C1, C2, C3 and C4 inputs to IC4 are all negative or logic 1 levels except when pulled down by the keyboard outputs. Hitting any key pulls the COM line to ground, which through the COM input terminal of IC5, operates the Keyboard Strobe Input (KBS) of IC4. Ten milliseconds later, IC4 reads the state of the parallel inputs C0 through C4. This debouncing interval gives the keyboard contacts time to settle.

Pressing the "1" key grounds only KE

PARTS LIST

All resistors ¼-watt, 10%, unless noted
R1, R2*, R3*, R4, R5*, R6*, R7-R12, R15-R19, R22, R33, R35, R39, R42—100,000 ohms
R14, R20, R21, R44**—1 megohm
R23, R25, R27, R29, R31—100 ohms
R24, R26, R28, R30, R32—10,000 ohms
R34, R38—470,000 ohms
R41—1000 ohms
R42**, R43**, R45**-R51**—560,000 ohms
C1-C4, C7-C11—0.1 µF disk, 50 volt
C12—56 pF disk, 50 volt
C14—.005 µF disk, 50 volt
D1-D4, D5*-D8*, D9-D24, D25**-D36**, D37-D39—1N914
Q1-Q5, Q8—2N3704
Q6, Q7*—2N3703
IC1*—CD4081, quad 2-input AND gate
IC2, IC3—CD4011, quad 2-input NAND gate
IC4—AY-5-9100 (General Instrument)
IC5—AY-5-9200 (General Instrument)
IC6—AY-5-9500 (General Instrument)
RY1, RY2—SPST normally-open relay, 100-ohm coil (Magnecraft 103MX-10 or equal.)
RY3—SPST normally-closed relay, 100-ohm coil (Magnecraft 103MX-10 or equal.)
S1-S3—SPST, normally open
LED1-LED5—MV5053 (Monsanto)
Note: The following component designations are not used and do not appear in the parts list, layout and schematic: R13, R36, R37, R40, C5, C6 and C13.
Asterisks: See Fig. 1.

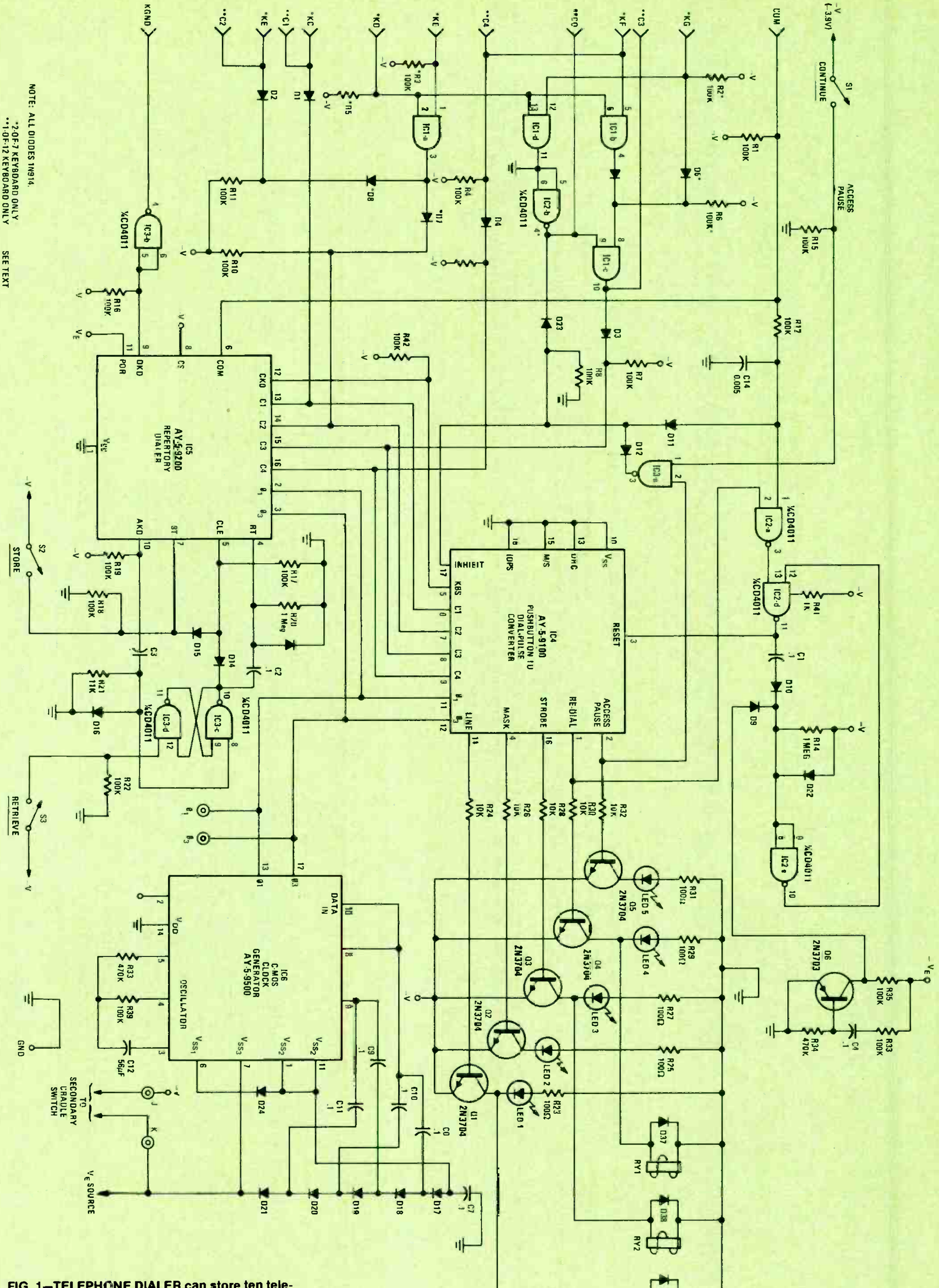


FIG. 1—TELEPHONE DIALER can store ten telephone numbers, has memory-expansion capability and can interface to either a calculator- or telephone-type keyboard.

which is *one* of the two inputs to AND gate IC1-a. The output of IC1-a goes to logic 0 only when both its inputs are at a logic 0. Since pin 2 of IC1-a is high, the output of this gate remains high. Therefore, C1 through C4 are all at a logic 1 level corresponding to digit 1 in Table 1.

Key "2" brings KF and C4 to ground. Depressing key "3" grounds C3 through IC1-c. Keys "4" through "9" work by

TABLE 1

Digit	C1	C2	C3	C4
1	1	1	1	1
2	1	1	1	0
3	1	1	0	1
4	1	0	1	1
5	1	0	1	0
6	1	0	0	1
7	0	1	1	1
8	0	1	1	0
9	0	1	0	1
0	1	1	0	0
Access Pause	0	0	1	1

their direct connection to C1, C2, and C4 and the indirect connection to C3 through IC1-c.

Depressing "0" switches C3 through IC1-b and IC1-c. IC1-b senses the coincidence of KD and KF corresponding to the "0." Access pauses are sensed by IC1-a.

The Redial mode is initiated when KE and KF go low. When this occurs, C0 is grounded by IC1-d without affecting C1 through C4.

The 1-of-12 keyboard encoder shown in Fig. 3 produces the C0 through C4 outputs directly. IC1 and the components associated with the K inputs are not used.

A series of pins control the dialing rate, mark/space ratio and the inter-digital pause. In the circuit shown in Fig. 1, these pins are grounded for standard timing. This is a dialing rate of 10 pulses-per-second, a mark/space ratio of 66⅔%/33⅓%, and an 800 ms inter-digital pause. A pre-digital pause equal to the inter-digital pause precedes the first digit of a number. For special systems, these pins can be wired to either of the two clock phases or logic 1 to change the parameters.

Don't all integrated circuits have a power supply pin? Not this one! Energy is supplied to IC4 from the two clock inputs, q1 and q2. The clocks must swing at least 13.5 volts negative and are produced by a special clock generator IC.

The INHIBIT input has the dual purpose of inhibiting the dial pulses when access pauses are required and initiating a redialing output. The remaining pins are the outputs that drive the LED indicators and output relays.

The Repertory Dialer, IC5, is the ten number memory. Although it has the capability for 22 digit storage when used in touch-tone systems (using other GI IC's), the phone number length is limited to 20 digits in this circuit by IC4. Although the circuit in Fig. 1 uses only one AY-5-9200 IC for a total storage capacity of 10 telephone numbers, this IC was designed to be "stacked" for additional storage capacity by paralleling the inputs and outputs and using the CHIP-SELECT input (pin 8) to select the memory block.

Figure 4 is an oscilloscope photo of a dialing sequence of the digits 1, 2, 3, 4, 5, 6, 1. The upper trace is the line output (collector of Q1), and the lower trace the

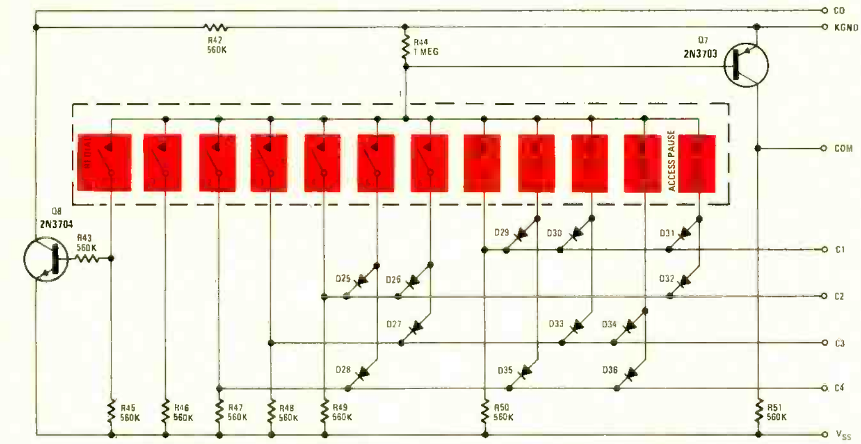


FIG. 2—TELEPHONE-TYPE KEYBOARD connects directly to telephone dialer.

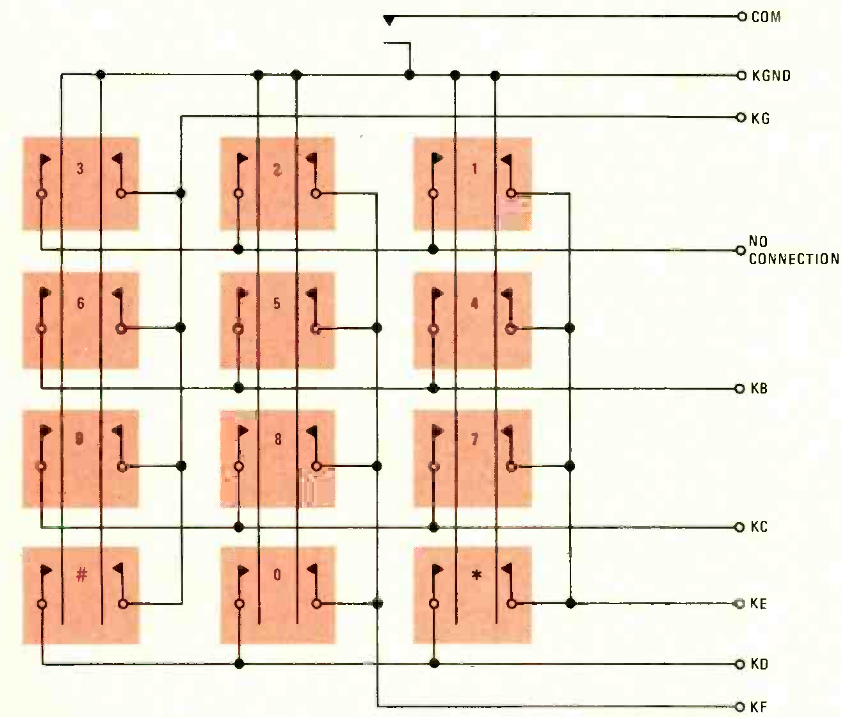


FIG. 3—CALCULATOR-TYPE KEYBOARD requires diode encoder to connect to telephone dialer circuit.

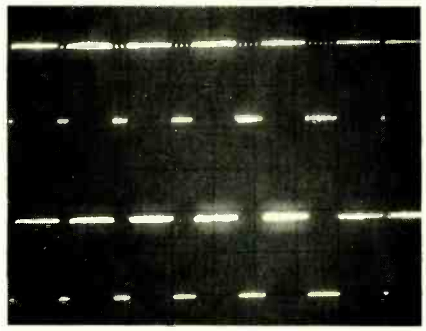


FIG. 4—OUTPUT PULSE TRAIN from telephone dialer circuit. Upper trace shows waveform at collector of Q1 and lower trace is collector of Q3.

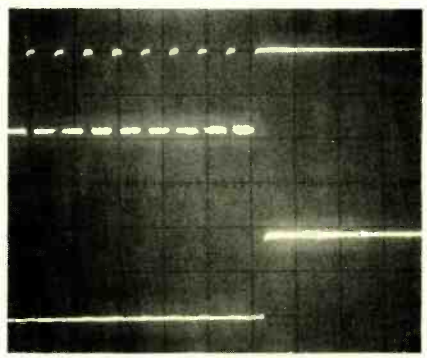


FIG. 5—SINGLE-DIGIT PULSE TRAIN is obtained by expanding the trace shown in Fig. 4.

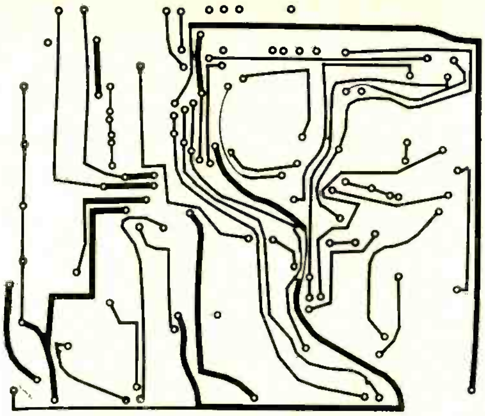


FIG. 6—FOIL PATTERN of component-side of PC board. Actual board measures 5 x 4¼-inches.

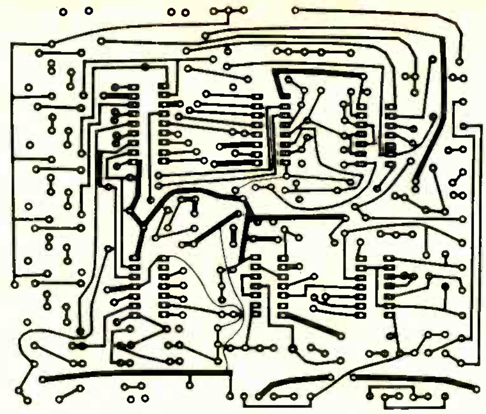


FIG. 7—FOIL PATTERN of bottom-side of PC board shown half size.

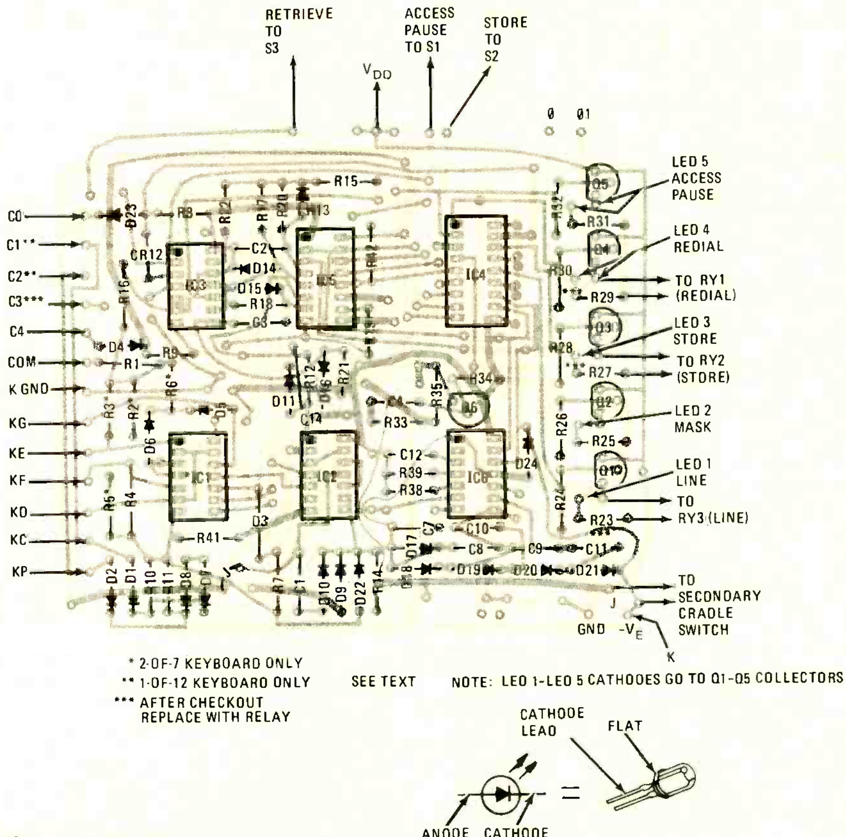


FIG. 8—COMPONENT PLACEMENT diagram.

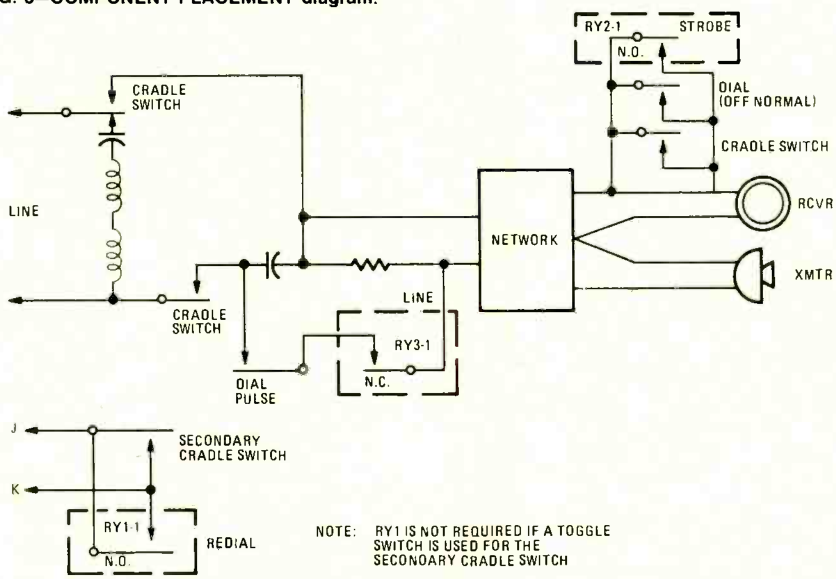


FIG. 9—RELAY CONNECTIONS to telephone.

collector of Strobe transistor Q3. Figure 5 is an expanded photo showing a single digit output.

The COM output of the keyboard feeds the COM input (pin 6) of IC5. The COM input is transmitted to the AY-5-9100 through its KBS input only when a dial or redial operation is in progress.

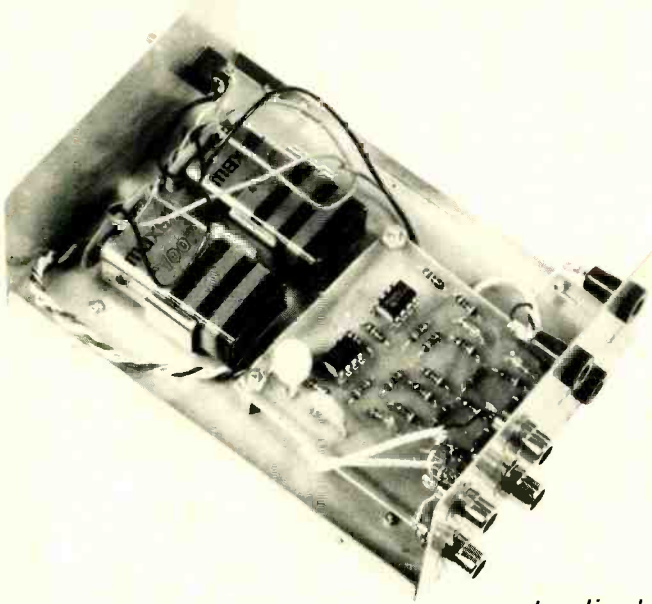
During a Store operation, the keyboard signals are entered into the AY-5-9200 and the CKO line (IC5, pin 12) is inhibited so the signals on C0–C4 do not cause any dial pulses to be transmitted. The CLE line (pin 5) is activated at the same time as the Store line (pin 7). The first digit then depressed is latched as the memory address, and that location is cleared. The number to be stored is entered into the location and the STORE button is released. The CLE line is simultaneously released.

The Retrieve mode is selected by applying a logic 1 level to the CLE input and pulsing the Retrieve input for at least 10 ms through capacitor C2 by the flip-flop formed by IC3-c and IC3-d. The following digit entered on the keyboard is latched as the memory address. The dial pulses are transmitted at least 60-ms later.

Address Keyboard Disable (AKD) output line (pin 10) is held at a logic 0 level during the Store and Retrieve operations. The positive going transition at the end of a Retrieve operation resets flip-flop IC3-c/IC3-d. IC5 is also powered from the two-phase clock signals. IC5 is cleared on initial turn on when $-V_E$ is applied to pin 11.

The CMOS Clock Generator (IC6) is wired as a voltage multiplier to convert the 3.9-volt supply to nominal 15-volt clock outputs using a Cockroft-Walton voltage multiplier. An internal D-type flip-flop is connected as a divide-by-two by tying the Q output to the D input using the jumper between pins 8 and 10. The Q output drives capacitors C8 and C10, and the Q output drives capacitors C9 and C11. Diodes D17 through D21 and capacitors C8 through C11 boosts the −3.9-volt supply to −15 volts on

continued on page 80



HI-FI PROJECT

Display Quad Signals On Your Scope

Add-on device to your oscilloscope permits you to display quadriphonic signals from your hi-fi system

STEPHEN DUNIFER

IF YOU SERVICE QUADRIPHONIC AUDIO equipment or have a quad set-up of your own, you will surely realize the value of a display that shows the relative levels, balance and phase of the four audio channels. Such a display will provide, at a glance, an indication of whether the quadriphonic decoder is operating properly. This four-channel display adapter and your general-purpose oscilloscope are all you need to produce a display that shows phase, separation, informational quality, level and balance of the four channels.

The circuit design is based on a rotational matrix composed of resistors R1 through R12 and four diodes as in Fig. 1. The signals from the four channels are rectified by series diodes and then processed by the matrix and differential amplifiers IC1 and IC2. The outputs of IC1 and IC2 are fed to the vertical and horizontal inputs, respectively, of the scope.

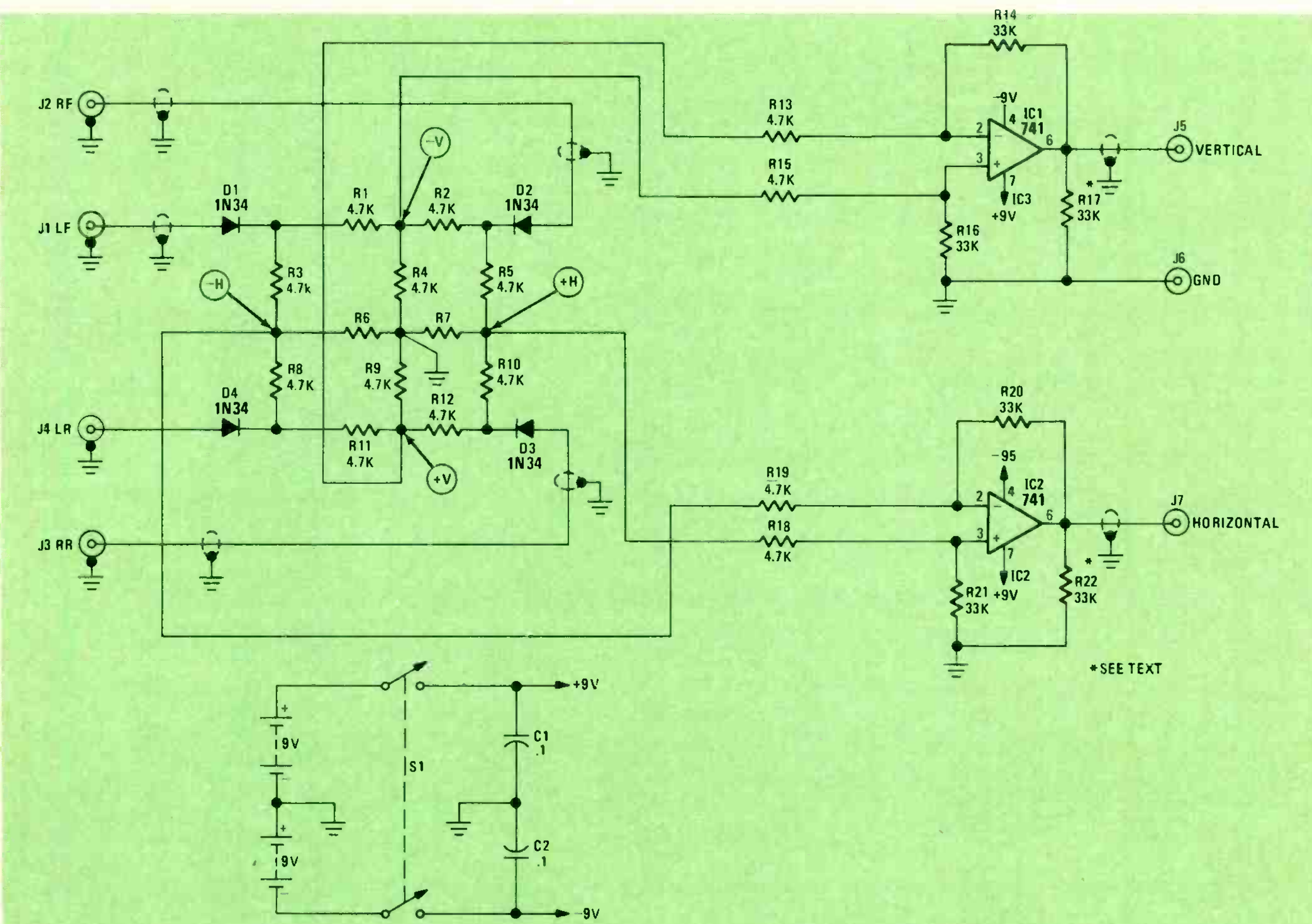


FIG. 1—QUADRIPHONIC DISPLAY ADAPTER uses a resistor matrix to derive the scope's horizontal and vertical signals.

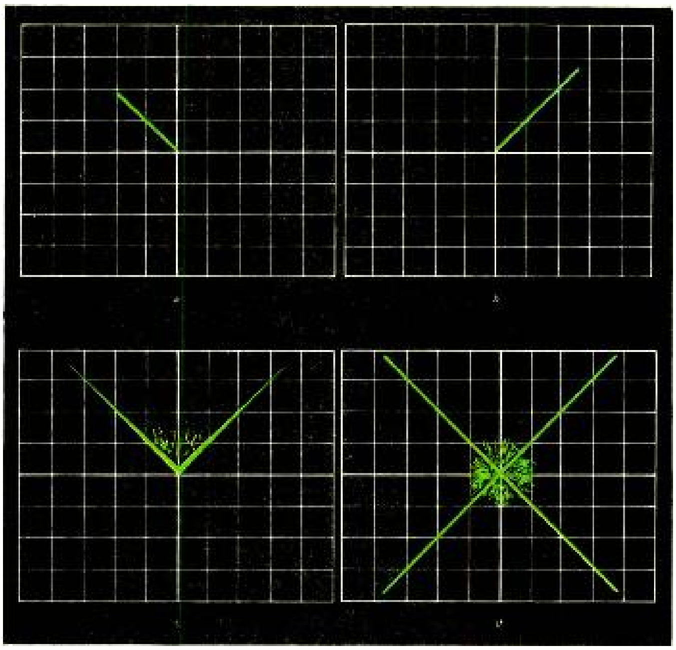


FIG. 5—TYPICAL DISPLAY PATTERNS. A left-only signal is shown in *a* and a right-only signal is shown in *b*. A stereo signal is shown in c and a quadriphonic signal is shown in *d*.

Construction

Construction is straightforward and you shouldn't have any difficulty if you watch diode and voltage polarities and make sure the IC's are properly inserted into the PC board or sockets. A PC board, shown in Fig. 2, was used but you can use perforated circuit board and solder clips or wirewrap. Diodes D1–D4 are 1N34's. The germanium 1N34 was selected rather than a silicon type because of its more desirable knee characteristic.

Use an ohmmeter to match, as closely as possible, the 4700-ohm matrix resistors. If you can get metal-film resistors from the same lot number, matching may not be required. Badly mismatched resistors will tend to skew the display. An angular displacement of 17 degrees can result from one central resistor being 10% high and an adjacent one 10% low. One-percent resistors can be used but, considering cost and availability, matching 5-percent'ers should suffice.

Resistors R17 and R22 are included in the design as they might be needed when using a basic CRT monitor scope with a very high input impedance. Omit them if yours is an ordinary service scope with vertical amplifiers.

Insert the components in the printed-circuit board following the layout in Fig. 3. I suggest mounting the integrated circuits in sockets or Molex pins. Wire the channel inputs to phono jacks and the differential amplifier outputs to banana jacks on the panel.

Setting up

Connect the adapter and scope to the quadriphonic amplifier as shown in Fig. 4. The adapter inputs are connected in parallel with the speakers across the amplifier's output terminals. Be sure that the ground side of each speaker output is connected to the adapter ground. Apply a signal to the left-front channel. Set the scope's horizontal and vertical input attenuators to either the 1- or 10-volt range—depending on the scope sensitivity. While watching the display, adjust the horizontal and vertical gain controls until the trace in the top left quadrant of the screen is at a 45° angle as in Fig. 5. Touch-up the controls so the 45° trace starts at the center of the screen and extends one-half to two-thirds the way to the edge. Now, apply the audio signals to the other three inputs. The resulting display will depend on the program source. It can be used to determine the quality of various decoders and four-channel source materials. Figure 5 shows some typical display patterns. A monophonic signal will show a straight vertical trace on the oscilloscope. A left-only signal is shown in Fig. 5-a and a right-only signal is shown in Fig. 5-b. A stereo signal is displayed as a combination of the left-only and right-only displays, as shown in Fig. 5-c. A quad display is shown in Fig. 5-d. **R-E**

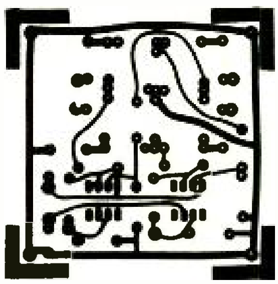


FIG. 2—FOIL PATTERN is shown half-size.

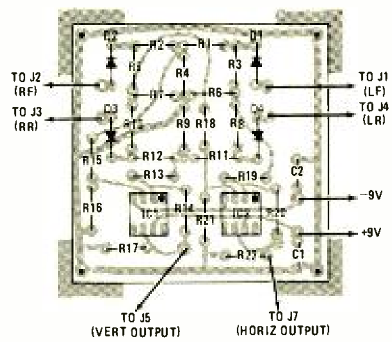


FIG. 3—COMPONENT PLACEMENT diagram.

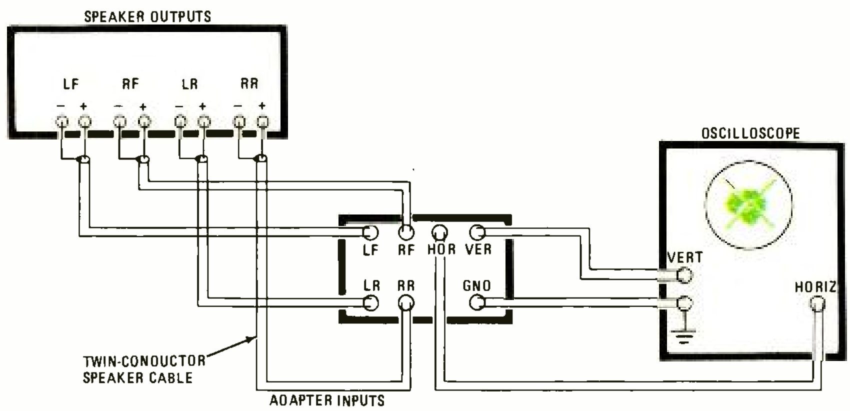
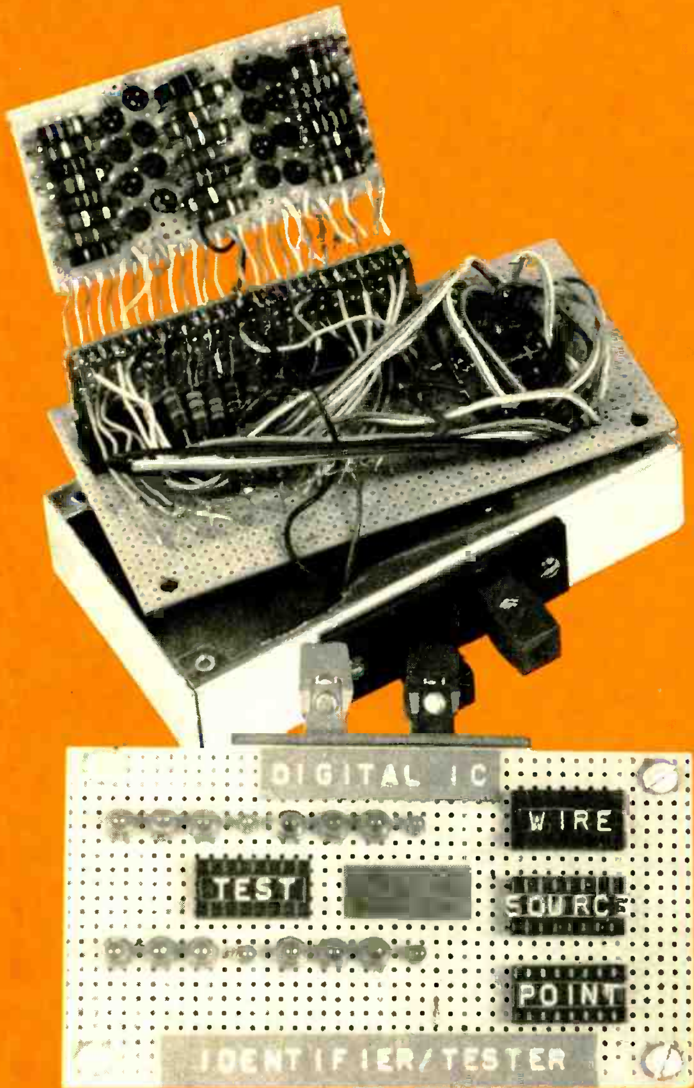


FIG. 4—HOOK-UP of the scope adapter.

PARTS LIST

All resistors 1/4-watt, 5% metal-film
R1-R13, R15, R18, R19—4700 ohms
R14, R16, R17, R20-R22—33,000 ohms
C1, C2—0.1 μF, 25V disc ceramic
D1-D4—1N34 germanium diode
IC1, IC2—741 op-amp
J1-J4—RCA-type phono jack, single-hole mount
J5-J7—banana jack
B1, B2—9-volt transistor battery
Miscellaneous: hookup wire, shielded cable, solder, enclosure, etc.

A drilled PC board is available for $3.00 plus 25¢ for postage and handling from O.H.M.S Research, PO Box 604, Georgetown, KY 40324. Kentucky residents add state and local taxes as applicable.



Build A Digital IC Identifier/Tester

Simple device tests digital IC's and identifies many of the unknown ones

EARL R. SAVAGE

YOU HAVE JUST FINISHED A PROJECT using digital IC's and after applying power, the darned thing just sits there or goes up in smoke! Several hours of troubleshooting leads to the discovery that one (or more) of the IC's is defective. Out comes the old soldering iron and a lot more time is wasted.

Sound familiar? Well, it happens all the time unless you pay premium prices for your IC's. This kind of trouble surely takes much of the pleasure out of building projects. But take heart—help is here. A small investment of time and money to build this Identifier/Tester will pay handsome dividends. With this instrument on your workbench, you can save your blood pressure and your money.

This easily built device will enable you to quickly and easily test any 8- 14- or 16-pin digital IC whether it is RTL, DTL, TTL, CMOS or several other types if you exercise some care. Of course, it works like a charm with the old standby TTL's. Now, instead of paying for first-quality IC's, you can buy the "cheapies" knowing that you can assort out the rejects and never again wire in a bad IC. If that is not enough for you, there is a hidden bonus in this little device.

You don't even have to buy the "cheapies"—you can buy the "super cheapies." These are the bulk packs of mixed, untested IC's of which some are marked, some are unmarked, and some are marked with factory numbers that may as well be Greek. Best of all, these IC's cost only about two cents each!

The Identifier/Tester (if you haven't already guessed) will *identify* IC's as well as test them. Actually, it will enable you to identify *many* IC's—some are simply too complex to decipher. So, you pay a couple of cents per IC and, even if you throw out two-thirds as bad or unidentifiable, that is still just six cents per IC. While that is not bad at all, the "throw-outs" run only one-third to one-half of the big economy packs.

How it works

The Identifier/Tester is really quite simple. It is nothing more than three IC sockets (labeled WIRE, TEST and POINT) connected in parallel and 16 LED indicators (Fig. 1), one indicator per socket pin. The LED indicators are transistor-driven to reduce loading on the IC being tested. This is necessary to prevent false indications and erratic operation of some IC's, which would occur if the LED's were connected directly to the pins.

Four of the LED's are smaller than the others. They correspond to pins 4, 8, 9, and 13. The purpose of having these LED's smaller (or a different color) is to make it easier to count the pin numbers.

A fourth socket is labeled SOURCE. It

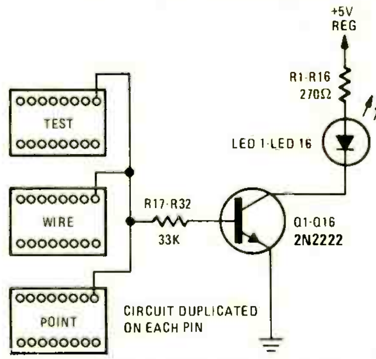


FIG. 1—IDENTIFIER/TESTER circuit. The corresponding pins on each socket are connected in parallel and connected to an LED indicator circuit.

PARTS LIST

R1-R16—270-470 ohm, 1/4 watt, 10% (see text)
R17-R32—33,000 ohm, 1/4 watt, 10%
R33—1000 ohm, 1/2 watt, 10%
R34—330 ohm, 1/2 watt, 10%
Q1-Q16—2N2222 or similar switching transistor
LED1-LED16—LED's of size and color to suit (MV5054 or equal.)
Misc.—perforated board, binding posts, four 16-pin IC sockets, 4 1/2 × 2 1/2 × 1-inch chassis.

serves as a source of four different voltages. When working with TTL's, these voltages are: HI (+5 VDC), LO (0 VDC), LO5 (+5 VDC through a 1K resistor), and HI0 (0 VDC through a 330-ohm resistor). The HI0 voltage is not used in testing but is necessary in the IC identification procedure. These voltages are wired to the pins as shown in the detail drawing of the SOURCE socket (Fig. 2).

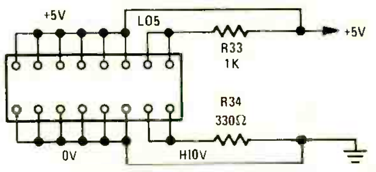


FIG. 2—LOGIC LEVELS are obtained from the front-panel source socket.

The three sockets on the right side of the panel (WIRE, SOURCE, and POINT) are not used as sockets at all. They are used as compact connectors for temporary application of voltages to the pins of the IC in the TEST socket. Though the POINT socket may be omitted, it is very convenient for making touch-and-go voltage-applications without getting mixed up with the connections already made to the WIRE socket.

Construction

Parts used in the construction of the Identifier/Tester are *not* critical. Your junk box will probably provide most of them. If not, the parts are readily available.

The LED dropping resistors should be adjusted for the general IC families that are most often encountered. The 270-ohm value shown on the schematic is best for TTL's and their 5-volt power-supply. Resistors of 390 ohms were used in the prototype in anticipation of testing higher voltage IC's. They also work fine with 5V TTL's; the LED's are just a little dimmer.

As to transistors, almost any small-signal NPN transistor will be suitable. Low cost switching transistors are ideal. The type certainly is not critical—apparently anything that will wiggle the needle on a simple transistor checker will work fine.

Point-to-point wiring was used in the prototype. It looks like a rat's nest but operates fine since there is no interaction between various parts of the circuit. A printed-circuit board could be used but that seems such a waste of effort when building only one or two.

Perforated board is used for the front panel and for mounting the resistors and transistors internally. The internal board is attached to the panel by a "wire hinge" so that it can be folded parallel to the panel. The boards were cut to fit a small chassis. A plastic box could be used as well.

The prototype was built on a chasis measuring 11.5 × 6.5 × 2.5 cm (4 1/2 × 2 1/2 × 1 inch). That is about as small as one can use with point-to-point wiring. Even with a printed-circuit board, the box should not be smaller or the instrument will be too difficult to handle conveniently.

Note that a power supply is *not* included in the prototype. For TTL's, a *regulated* positive 5 volts DC is brought in through the binding posts at the top. This arrangement permits easy use with other voltages when testing other IC families. The supply may be built-in if a larger box is used. A suitable internal or external 5-volt supply is shown in Fig. 3. It is strongly recommended that the power be regulated with one of the IC regulators that provides for both thermal and over-current shutdown. This will offer protection in cases involving shorted IC's and mistakes in wiring between the SOURCE and WIRE sockets.

POWER SUPPLY

R1—50 ohm, 10 watt, 10%
R2—270 ohm, 1/4 watt, 10%
C1—1000 μF, 35 volt DC
D1—1N4002
IC1—7805 5-volt regulator
S1—SPST switch
LED1—red LED (MV5054 or equal.)
T1—117-volt primary; 12.6-volt, 1.2-amp secondary
F1—1/2-amp fuse

When construction is completed, test the instrument as follows:

Check for continuity (ohmmeter) between corresponding pins of the TEST, WIRE, and POINT sockets.

Check for shorts between any pins on one of these three sockets.

Apply power to the device through the binding posts—*NO* LED's should turn on.

Check for proper voltage on each pin of the SOURCE socket.

Apply +5 volts from the SOURCE socket to each pin in turn on the POINT socket. The corresponding LED (only) should turn on as each pin is touched.

If any of these checks fail, remove power and correct the wiring error(s) in the instrument.

Testing digital IC's

When first using the tester, the listed steps should be followed exactly. It will be possible to take some shortcuts without too much risk after you have gained some experience.

Step 1. Remove all power from the tester.

Step 2. Insert IC into the TEST socket. IC's with less than 16 pins should always be mounted on the left end of the socket to avoid confusion in pin numbering while testing. (This is where the smaller LED's are very helpful.)

Step 3. Wire +5 volts and 0 volts to the appropriate power pins of the IC by placing jumper wires (No. 22 or 24 wire) between the SOURCE and WIRE sockets.

Step 4. Apply power to the tester.

Step 5. Quickly observe the LED's; if *all* are on, remove power and check Step 3. If Step 3 is correct, IC is shorted; discard it. If wiring change is made, return to Step 4. If V+ and some LED's (but not all) are on, proceed.

Step 6. Apply "finger test" to IC. If it is hot or warm to the touch, remove power. Check wiring and return to Step

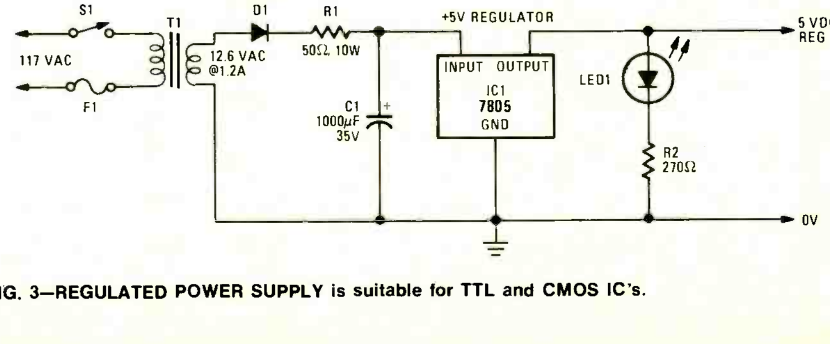


FIG. 3—REGULATED POWER SUPPLY is suitable for TTL and CMOS IC's.

4. If IC again comes up hot, there is an internal short—discard it.

Step 7. Observe the LED's. If only the LED connected to the V_{cc} pin is on, suspect an open circuit in the internal power wiring of the IC. Normally, unconnected input pins will float high and some output pins will be high, thus lighting some of the LED's. Proceed to the next several steps to confirm the open circuit before discarding the IC.

Step 8. Remove power from the tester.

Step 9. Wire 1's (+5) and 0's to the input pins (jumpers between SOURCE and WIRE) as required by the function and pinout of the IC under test.

Step 10. Wire LO5 from the SOURCE to any pins that are open collector outputs. This is a pull-up voltage which makes it possible for the LED to accurately indicate the outputs.

Step 11. Apply power.

Step 12. Observe the output pin LED's to determine whether or not they are behaving as expected.

Step 13. When testing such IC's as flip-flops, counters, registers, multivibrators and the like, it will be necessary to make and break a connection several times while observing the LED's. This is most conveniently done by just touching the wire to the proper pin on the POINT socket rather than inserting it into the WIRE socket.

Step 14. If the outputs do what the pinout (or data book) indicates they are supposed to do as you manipulate the inputs, the IC is good and can be wired into your project without fear that it will cause a problem.

That is about all there is to testing an IC. The simple ones such as gates, flip-flops and counters, can be checked out very quickly. The more complex IC's require more time, but even they are easy and a little experience will make checking them quick, too.

Identifying Unknown IC'S

Identifying an unknown IC can be a tricky business, especially if it is one of the more complex ones. The less complex are rather straightforward. The following procedure has been found to produce the best results:

Step 1. Insert IC into the TEST socket.

Step 2. Briefly touch each pin of the POINT socket with +5 volts (from the SOURCE socket) observing the LED's as you do so.

Step 3. If all or many LED's turn on as +5 volts is applied to *every* pin, discard the IC.

Step 4. If only the LED for the pin with +5 volts applied turns on *every* time, discard the IC.

Step 5. [14-pin DIP's] If pin 7 and pin 14 turn on many LED's and most other pins do not, pin 7 is GND (0V) and pin 14 is V_{cc} (+5V).

Step 6. [16-pin DIP's] If pins 8 and 16 turn on many LED's and most other pins do not, pin 8 is GND (0V) and pin 16 is V_{cc} (+5V).

Step 7. Most non-military IC's (TTL) will display the pin 7 and pin 14 or the pin 8 and pin 16 combination.

Step 8. If one of those combinations does not appear, note which pins turn on many LED's—one is GND and one is V_{cc}.

Step 8.1 Check your catalogs of IC pinouts; the odd combination itself may identify the IC.

Step 8.2 If not, make a guess—apply +5 to one and 0 to the other.

Step 8.21 If the IC gets warm to the touch, reverse the leads and try again (the IC may not be damaged).

Step 9. Apply power to the IC (V_{cc} and GND).

Step 9.1 Since floating inputs go high, the input LED's will be on.

Step 9.2 Some output pin LED's will be on.

Step 10. Briefly, apply HI0 (GND through 330 ohms) to each pin with a high logic-level.

Step 10.1 Each pin pulled low (LED turned off) by the applied HI0 may be labeled an input pin since few high outputs will be pulled low by this procedure.

Step 10.2 Those that are not pulled low *and* those that are low may be labeled output pins.

Step 11. Knowing V_{cc}, GND, INPUT and OUTPUT pins, match this information with the pinout diagrams in your catalogs and/or data books.

Step 11.1 If positive identification is made, test the IC and mark it with its proper number using a carbide scriber.

Step 11.2 If several possible identifications are made, test the IC for each possibility.

Step 11.3 If no identification can be made, further experimentation may reveal additional facts to make identification possible.

Step 11.31 Generally, flip-flops will change output states (toggle) when the T output is grounded and ungrounded.

Step 12. If an IC cannot be identified, put it aside to try again after you have gained some experience.

Step 13. Do not expect to identify them all; some are very complex little monsters—even some of the 14-pin DIP's!

Note that you will sometimes find an IC that is part good and part bad. For example, there may be only two or three good gates in a 7400 or a 7473 may have one good flip-flop and one bad one. Of course, you can throw them out but, if they don't get mixed up with your good ones, they can come in quite handy.

The solution is to mark a partly-bad IC so that you won't wire it into a circuit requiring a fully operational IC. Then, you can keep it until you run into a project that requires fewer functions than are to be found in one IC.

TTL and CMOS are the most popular IC families. Probably most of your work will be with these types. If so, consider wiring up for and building in a 5-volt supply. The TTL's use 5 volts and most CMOS devices will operate with the same voltage.

Now you have an instrument for testing and/or identifying many types of IC's. You will find it good practice to test *every* IC before wiring it into a circuit. Even premium quality IC's are sometimes bad and the testing can be done quickly. The Identifier/Tester will prevent a lot of grief on the work-bench. **R-E**

CB training workshops start in Indianapolis

More than 50 technicians attended the first of a series of Forest Belt Training Workshops, held in the Airport Holiday Inn, Indianapolis, during the last week of January.

The first three days of the five-day program were spent in exploring the basics of CB servicing—studying phase-locked loops, single sideband, modulators and demodulators, AGC, ANL and other CB fundamentals. The third day treated specific troubleshooting.

The fourth and fifth days were devoted to studies in preparation for the FCC Second Class Radiotelephone license.

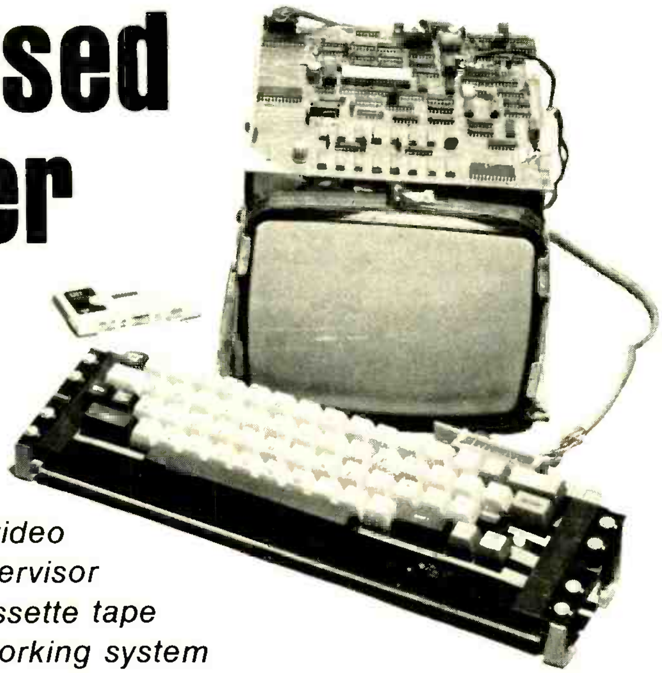
A number of awards were given out at the banquet that concluded the program. NESDA (*N*ational *E*lectronic *S*ervice *D*ealers *A*ssociation) awarded three gift memberships. High point of the banquet was the Hickok Prize, which consisted of the right to choose between a Hickok

AUTHOR-INSTRUCTOR FOREST BELT, former editor of Radio-Electronics, explains a point in his trademarked *Easi-Way Servicing*.

model 388 In-Line frequency counter and power/VSWR/modulation meter, or to put the ticket into a grand-prize drawing at the last of the series of fifteen 1977 workshops. The winner of that 15-person drawing will receive an entire Hickok COMM-Line six-instrument service center.

Further workshops are planned at Atlanta, Baltimore, St. Paul, Boston, Chicago, again at Indianapolis and probably one at Toronto. Enrollment fee for a five-day workshop is $280. For further information, write for Brochure 24 to: Forest Belt's Training Workshops, Box 68120, Indianapolis, IN 46268. **R-E**

Build 2650-Based Microcomputer System



Part III. Built on a single printed-circuit board, this 2650 microcomputer contains a video and cassette tape interface and resident supervisor program. Add a keyboard, video monitor, cassette tape recorder and power supply for a complete working system

JEFF ROLOFF

THE FIRST TWO PARTS OF THIS ARTICLE appeared in the April and May issues and provided the construction details and an in-depth look at how the circuit works.

This month, the article concludes with a look at the software associated with the 2650 microcomputer and a look at how it's programmed.

Using the supervisor

In all, there are nine basic functions of the supervisor program. First, you can alter or display any position of memory. (You cannot, obviously, alter data that is in ROM.) This will allow you to enter and inspect your own programs in the RAM. After entering and checking your program, you can use the supervisor to jump to your program and execute it. When your program returns control to the supervisor (by a branch instruction), it saves the contents of the CPU registers so that you can inspect them. You can also set the CPU registers before you jump to your program. When the program is finished and you want to turn off the microcomputer, the program can be transferred to cassette tape in blocks of two-256-bytes and then transferred back to the microcomputer at a later time. There is also a command to turn on the tape recorder so that you can manually rewind it, etc. To troubleshoot the program, a breakpoint (a point in the program where processing will be interrupted) can be set. When this address is reached, a message is written on the screen and the CPU registers or any memory location can be inspected to see what they were immediately before the breakpoint address. You can also clear this address if you wish to change it. Another command permits verification of what is on tape against any block of memory.

The specific instructions for the operation of the supervisor are provided. In the examples, all underlined characters are ones entered by the operator. Everything else is printed on the screen by the supervisor program. A period (.) indicates that the supervisor program is ready for a command. An A indicates that it is waiting for you to type in an address. At any time the supervisor is looking for a keyboard input, you can press ES (escape) which will terminate the present command and wait for a new one.

To alter or display memory, depress the A on the keyboard. It will then ask for an address, which should be entered in hexadecimal form. The address and the data then appear on the next line of the video monitor. You can now do one of three things: depress the ES key to quit the alter/display routine, enter C to change the data at that location, or depress the space-bar to display the next memory location. If you decide to alter the memory, the supervisor will wait for you to type in two hex characters to fill the memory location. The following is an example of this routine:

.A A100A	
100A 05	data is 05, space indicates go on
100B 10C3B	data is 10, change to 3B
100C 38ES	data is 38, press escape to terminate routine

To execute a program, type an E for the command. The supervisor will then ask for the address that it should start executing at. It will then jump to the address and start executing instructions:

.E A163B	execute at 163B, press space to start

If the program returns to the supervisor (by a branch instruction), all of the CPU registers are saved, and then it asks for a new command.

If you did return from your program by a branch instruction, or because of a breakpoint, you can inspect the memory using the alter routine, or you can inspect the CPU registers entering I. It will then ask you to type in a register number corresponding to the register that you want, as follows:

Enter	For
0	Register 0
1	Register 1, Bank 0

2	Register 2, Bank 0
3	Register 3, Bank 0
4	Register 1, Bank 1
5	Register 2, Bank 1
6	Register 3, Bank 1
7	Program Status Word, Lower
8	Program Status Word, Upper

The microcomputer will then display the data that was in this register right before the program returned to the supervisor. Similar to the alter/display routine, you now have three options: to stop by depressing the ES key, to change the register value by entering C, or to inspect another register by depressing the space-bar:

.I
R3 2CC 02 register 3, bank 0 has 2C, change to a 02
R4 C3_ space to go on
R8 B7ES escape to quit

To transfer your program to tape, enter a D. The supervisor will then ask for the beginning address and the length (in bytes—up to 256) of the data to be transferred. Remember that everything must be entered in hexadecimal for the supervisor to interpret it correctly. The supervisor actually dumps one-byte more than the length that is entered, so that a length of FF (255 in decimal) will cause a dump of 256 bytes. Also, a length of zero indicates that this is the last block that the load routine should read in, and will cause any load of this data to be completed. This allows the load routine to load multiple blocks without having to re-enter the L (load command) and allows it to stop itself automatically when all the data has been loaded. Therefore, a block with length of zero should be inserted after all of your data blocks have been transferred to the cassette tape:

.D A10DB LFF dump 256 bytes start at 10DB
.D A11DB L10 dump the next 17 bytes
.D A0000 L00 dump an end of file block

After all of the data has been transferred, the supervisor will automatically ask for a new command.

If you wish to check the data that has been transferred to the cassette tape, use the verify (V) command. After entering V, the supervisor will then ask for an address. After this has been entered, the supervisor will start the tape recorder and will look for a block starting with this address. When the block is found, the data in the block is compared with the actual data in memory at the time of the verify. If the data is not the same as what is on the tape, an error occurs. Also, if the first block on the tape has an address different than the one that you typed in you will get an error message.

It should be noted that the dump routine transfers the data along with the address and the length of the block:

.V A1000 be sure that the first block on tape is for address 1000, and that the data is correct

The verify routine returns to ask for a new command if the verify was all right.

When using the cassette tape routines, the supervisor takes care of turning the recorder off and on. To implement this feature, you must hook the auxiliary control wires of the tape recorder to a relay, and drive this relay with the TD ON line from the board. You must be sure to have the recorder in the correct mode (i.e., record or play).

To load data from a tape, simply enter L for the command and be sure the recorder is in play mode. All of the data is recorded on the tape along with the address to load it at and the length of the load. The supervisor will ask for a new command when it is done loading the tape:

.L load from tape

Recorded on tape are sumcheck characters also. Their purpose is to check against errors while recording or playing back data. The first sumcheck is sent after the address and length, while the second is sent after the block of data. Therefore, you can receive an error indication while loading or verifying in either of two places.

To set a breakpoint address in your program, enter a B as the command. It will then ask you for the address of the breakpoint:

.B A1703 set breakpoint address to be 1703

When this address is reached in the program, the supervisor will save all of the registers and wait for a new command. It signifies that the breakpoint address has been reached by writing the message:

BP 1703 indicates breakpoint address was reached

The registers and memory can now be examined as you see fit. After the breakpoint has been executed, it is cleared and the program will be allowed to run past the point next time through.

If you decide that a breakpoint that you set was at the wrong address, you must clear the breakpoint address by entering C. If you do not do this, the program will still have a supervisor inserted instruction and will not operate correctly:

.C 1703

The supervisor responds by typing the address that the breakpoint was set at. Note that you must set breakpoints in an address position where an instruction would begin. In other words, you cannot set a breakpoint to be executed at an address which is the second or third byte of an instruction.

To run the tape recorder (to rewind the tape, etc.) enter R. Pressing escape will return you to the supervisor.

Subroutines

The supervisor program includes many useful subroutines that can be used by branching to them. The more useful ones are shown in Table I.

All registers used are in the bank currently selected.

More information about the 2650 microprocessor and its language can be found in the *2650 Microprocessor Manual*, which is available from Signetics.

TV typewriter

Now that your system is finished and you know how to use the supervisor program, what can you do with it? One obvious use is for a TV typewriter display, which is also quite simple to do. Table 2 has the listing for the TV-typewriter program that accepts any printable character along with the backspace code and carriage return. The first thing that the program does is branch to

TABLE I

Address	Mnemonic	Description
0396	WCHR	writes the character that is in R3 on the screen and updates the cursor position.
0024	LFCR	moves the cursor to the leftmost position of the next line.
030F	KBIN	inputs one ASCII character from the keyboard and puts in R3.
006A	HXOT	takes the binary data in R2 and displays it as two hex characters.
01B6	INHX	inputs two hex characters and converts them to binary in R3.
0083	RETU	branch to this address to return to the supervisor and save the register values.

the keyboard input routine (KBIN) with a branch-to-subroutine instruction (BSTA). This subroutine receives one character from the keyboard and prints it on the display, if it is not a control character. After the character has been printed (if it is printable), the subroutine returns to the program to check if it was a backspace or a carriage return. If it was either of these two, the result of the respective compare instruction will be to clear the condition code. Then the branch instructions immediately following the compare instructions check the condition code to see if the compare was equal. If it was equal, the program branches to the correct subroutine. The carriage-return subroutine is simply a branch to the line feed-carriage return (LFCR) subroutine in the monitor, while the backspace routine is contained in the TV typewriter program.

The backspace routine simply takes the cursor pointer and decrements it. It also writes a space at the present cursor position and writes a new cursor at the new position.

The RAM positions 17FE and 17FF are used to store the present address of the cursor. To store a character in the cursor position, indirect addressing is used. This causes the processor to read what is in 17FE and 17FF and use this data as the actual address where it should do the operation.

TABLE II—TV TYPEWRITER PROGRAM

Line	Address	Instruction	Label	Operation	Operand	Comments
1	0000		LFCR	EQU	0024	ADDRESS OF LINE-FEED ROUTINE
2	0000		KBIN	EQU	0309	ADDRESS OF KEY-BOARD INPUT ROUTINE
3	0000			ORG	1600	START AT ADDRESS 1600 IN HEX
4	1600	75 08	TVT	CPSL	08	SET OPERATIONS WITHOUT CARRY/BORROW
5	1602	3F 03 09		BSTA,3	KBIN	GET KEYBOARD IN-PUT NOTE THAT KBIN ALSO WRITES THE CHAR
6	1605	E7 08		COMI,R3	08	COMPARE THE CHARACTER TO A BACKSPACE
7	1607	18 07		BCTR,0	BACK	IF A BACKSPACE, DO BS ROUTINE
8	1609	E7 0D		COMI,R3	0D	COMPARE THE CHARACTER TO A RETURN
9	160B	3C 00 24		BSTA,0	LFCR	IF A RETURN, DO CARRIAGE RETURN ROUTINE
10	160E	1B 70		BCTR,3	TVT	JUMP BACK TO BE-GINNING—GET NEW CHAR
11	1610	07 20	BACK	LODI,R3	20	ASCII FOR A SPACE
12	1612	CF 97 FE		STRA,R3	I17FE	STORE THE SPACE AT THE CURSOR LOCATION
13	1615	0F 17 FF		LODA,R3	17FF	LOAD THE LOW ORDER CURSOR ADDR INTO R3
14	1618	A7 10		SUBI,R3	10	SUBTRACT ONE CHAR POSITION FROM IT
15	161A	CF 17 FF		STRA,R3	17FF	STORE THE NEW CHARACTER
16	161D	77 08		PPSL	08	OPERATIONS NOW WITH CARRY/BOR-ROW
17	161F	0F 17 FE		LODA,R3	17FE	HIGH ORDER CURSOR ADDRESS
18	1622	A7 00		SUBI,R3	00	SUBTRACT BORROW FROM PREVIOUS SUBRACT
19	1624	CF 17 FE		STRA,R3	17FE	STORE THE NEW HIGH ORDER ADDR
20	1627	07 5C		LODI,R3	5C	CODE FOR THE CURSOR
21	1629	CF 97 FE		STRA,R3	I17FE	STORE THIS IN THE NEW CURSOR POSITION
22	162C	1B 52		BCTR,3	TVT	JUMP BACK—DO NEXT CHARACTER
23	162E			END		

Tape format

The cassette tape routines take care of all data encoding and decoding needed to interface with your tape unit, but if data is to be transferred between two different types of machines, you must have the format of the tape. That format is as follows:

Character	Description
1	colon indicating the start of a block
2	high order address byte for load
3	low order address byte for load
4	length of data block
5	sumcheck character for bytes 1-4
6 to n–1	data
n	sumcheck for data

Character 4 is the length of the data block. If it is zero, it represents the fact that this is the last block and that the load routine can stop. If it is from 1 to 255 (H01 to HFF), it is one less than the length of the data field. This allows transferring data blocks of exactly 256 bytes.

All characters are 8 bits wide, with one start and two stop bits. The least significant bit is recorded first, with the other bits following in order.

The sumcheck is generated by feeding each data byte into an EXCLUSIVE-OR gate with the sumcheck character and then rotating the resulting byte to the left one bit. The sumcheck is cleared before data is started. When read back, each byte (including the sumcheck) goes through this routine. If no errors have occurred, the ending sumcheck character should be zero. Each block has two sumchecks and they are totally independent of one another.

Loading a program

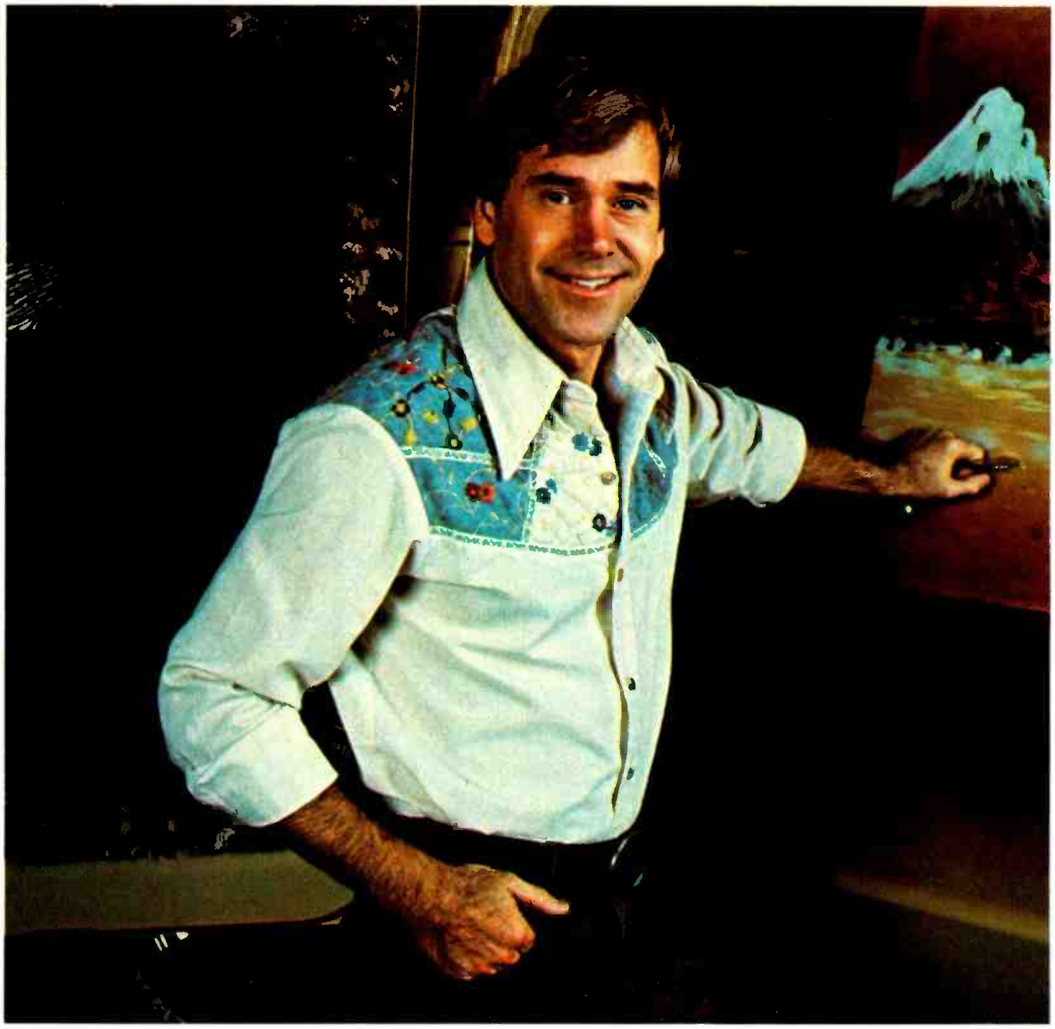
After you have written a program, how do you load it? To many people who have been around microcomputers, the answer is obvious: use the alter routine that the supervisor provides. To people who are having their first computer experience, this solution may not be so clear.

Recall that the alter routine allows you to change the data contained in any RAM memory location. Thus, by using this routine to change all of the memory locations that your program needs, you can enter your program into the system.

A question comes up immediately: At

continued on page 84

You gotta shop around.



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

Automatic Noise Limiters—How they work

Many circuits have been developed and incorporated into CB transceivers to automatically reduce noise. Here's an in-depth look at several of these circuits and how they work

ROBERT F. SCOTT
TECHNICAL EDITOR

INTERFERENCE EXPERIENCED IN THE RECEPTION OF CB SIGNALS IS OF three basic types. One is the annoying hiss and atmospheric noises that can be heard when no station is transmitting on a monitored channel. The second type varies from a continuous hiss to a loud roar and is caused by overlapping electrical pulses generated by leaky power lines, neon signs, furnace ignition systems, small electric motors and many similar electrical devices.

The third type of electrical noise consists of "rapid-fire" high-amplitude pulses generated by automobile ignition systems. This is the type of interference that is most common and most troublesome to the CB operator. It generally consists of short-duration pulses that are many times stronger than the incoming radio signal. When a strong pulse of this type reaches the receiver, it can overload the RF or IF circuits or increase the AVC voltage enough to desensitize the RF and IF circuits to the point where incoming signals cannot be heard. Also, a strong noise pulse can shock-excite high-Q IF circuits and cause ringing which, in effect, lengthens the duration of the individual pulses until they practically overlap and completely obliterate the desired signal.

Interference suppressors are of three basic types. A *squelch* circuit—originally called CODAN, for *C*arrier-*O*perated *D*evice, *A*nti-*N*oise—that mutes or silences the radio in the absence of a carrier on the channel to which the set is tuned. A *peak noise limiter* consists of a biased diode or diodes connected at the detector output to clip off the part of the noise pulses that exceed a preset audio level. The clipping threshold usually is set high enough so that modulation peaks are not clipped enough to cause distortion. A *noise silencer* or *noise blanker* is a circuit connected at the front-end of the receiver to eliminate or reduce noise pulses before they can be amplified and broadened by the action of the highly selective IF circuits. This month we will examine peak noise limiters and see how they are applied to CB receiver circuits. Later, we'll take a look at noise blankers and squelch circuits.

Basic noise limiters

First, let's clearly understand that a noise limiter does just that—limit. It is not a noise eliminator. It simply holds the amplitude of the noise pulse to a preset level—usually set to the amplitude of a 70% modulated signal.

Figure 1 shows a basic half-wave series-gate noise limiter—the type most often used in CB radios. In this circuit, the ANL (*A*utomatic *N*oise *L*imiter) diode D2 is biased so it is normally conducting. It takes the signal that detector D1 develops across the detector load (R1) and passes it on to the audio amplifier circuits. The limiter diode conducts as long as its anode is positive with respect to the cathode. However, if a noise pulse momentarily drives the anode negative with respect to the cathode, conduction is interrupted and that high-amplitude portion of the noise pulse is clipped so it cannot reach the audio amplifier. The level at which the limiter clips is determined by the setting of the THRESHOLD control.

The series-gate noise limiter acts only on noise pulses exceeding the positive-going or upward-modulation peaks. The diode detector—by the nature of its action, automatically limits negative-going RF or noise peaks to the 100% modulation level where detector output drops to zero. However, when receiving a signal with a low average modulation percentage, negative noise pulses can be annoying. The solution is to use a full-wave series-gate limiter as in Fig. 2. Positive pulses are clipped by D1 and negative pulses by D2. The THRESHOLD control sets the clipping level.

Figure 3 shows two basic shunt-type peak noise limiters. The shunt noise limiter is not as effective on ignition noise as the series type and so is seldom used alone in CB radios. It is quite often used alone and in combination with the series type in many amateur-band and communications radios. In the circuit in Fig. 3-a, limiter diode D2 is connected with reverse polarity across detector D1 and its load R1. It is normally reverse-biased by a voltage from the THRESHOLD control. It cannot conduct until a noise pulse on the modulated RF carrier applied to its anode exceeds the cutoff bias applied to its cathode. At this time, D2 conducts and virtually short-circuits the detector so there is no output from the detector.

In Fig. 3-b, the limiter diode is shunted between the detector's AF output line and ground. A noise peak drives the cathode more negative than the anode so D2 conducts and

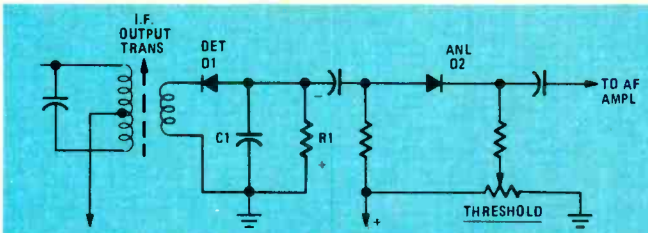


FIG. 1—HALF-WAVE SERIES-GATE NOISE LIMITER. The threshold control determines the clipping level of the noise peaks.

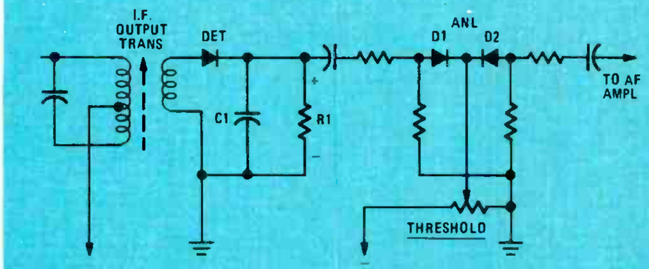


FIG. 2—FULL-WAVE SERIES-GATE NOISE LIMITER clips both the positive and negative noise peaks.

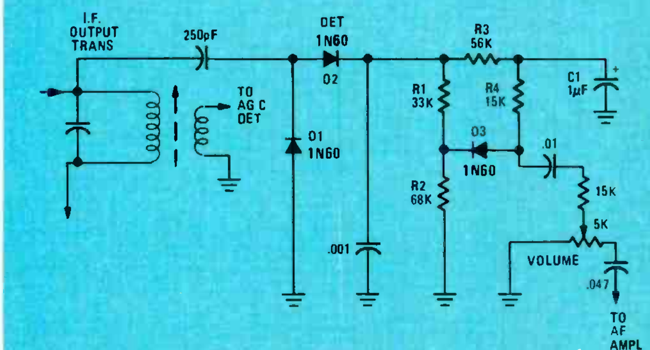


FIG. 4—SERIES-GATE ANL circuit used on the Pace model 133 transceiver.

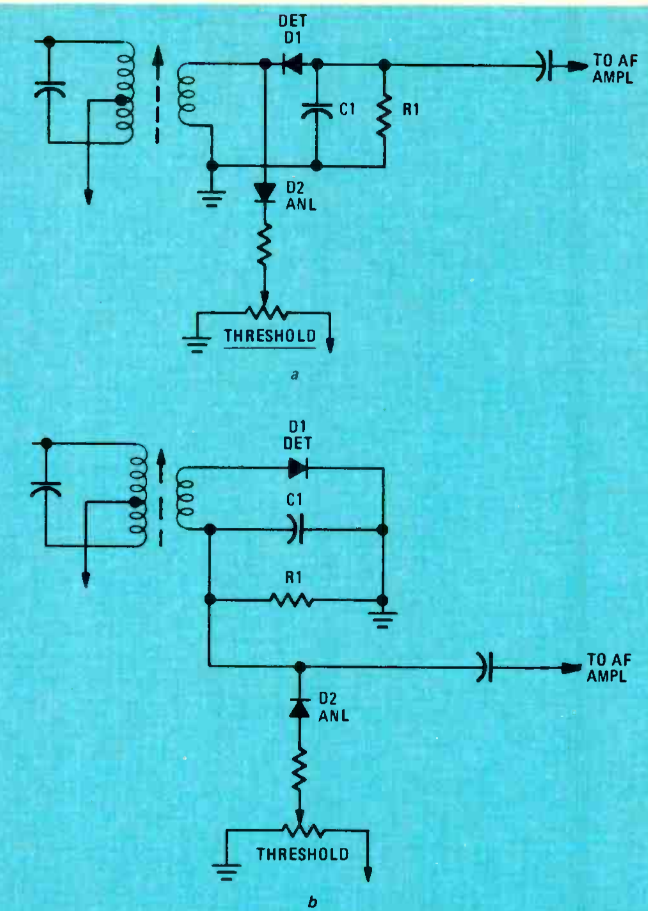


FIG. 3—TWO SHUNT-TYPE PEAK NOISE LIMITERS. These are not as effective on ignition noise as the series type.

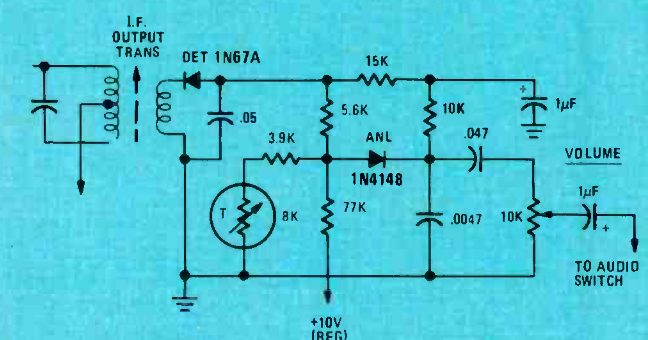


FIG. 5—SERIES-GATE ANL circuit. This version is used on the Johnson Messenger model 123A.

short-circuits the audio line for the duration of the time that the pulse amplitude is above the threshold level set by the THRESHOLD control.

In both the series and shunt noise-limiters, the threshold level must be set low enough to minimize the effect of the noise pulses but not so low that modulation peaks are clipped to the point where distortion is so excessive that it affects intelligibility.

The peak amplitude of the modulation envelope depends on signal strength and the instantaneous percentage of modulation, so optimum operation would require continuous operation of the manual THRESHOLD control. For this reason, nearly all noise limiter circuits in CB radios are designed to automatically adjust the clipping level in response to the level of the incoming signal. Instead of using manually adjusted bias to set the threshold or clipping level, ANL (*A*utomatic *N*oise *L*imiter) circuits use the AVC voltage or a similarly derived DC control voltage as a reference. A few of the CB rigs we have run across use a combination of automatic and manual bias. By being able to control the clipping level, the operator is able to adjust the circuit for best performance under varying operating conditions.

ANL circuits are incorporated in all of the many CB radio circuits that we have examined. The simpler and the more compact models used full-time ANL circuits. The others have a switch to permit the operator to disable the ANL circuit when it is not needed or when trying to receive a weak signal and every bit of the available audio gain is needed. All ANL circuits attenuate the AF signal to some degree. Generally when full-time ANL is used, the clipping level is set at about 75%; with switchable ANL, the clipping level tends to be lower.

Practical ANL circuits

A typical series-gate ANL circuit, used in the Pace *model 133* transceiver, is shown in Fig. 4. The circuit is a full-wave detector (D1 and D2) with R1 and R2 as the detector load. The detector develops a negative voltage proportional to signal strength at the junction of R1 and R3. The audio signal voltage and a bias of approximately 70% of the DC level is applied to the cathode of the ANL diode from the junction of R1 and R2. At the same time, the full DC voltage is applied to the anode through R3 and R4. The audio signal is filtered out by C1.

An ANL diode is forward-biased for signal amplitudes up to the designed clipping level so the AF signal passes through D3 and the volume control to the audio circuits. Positive noise peaks greater than the bias on D3's cathode will turn D3 off so signal voltages above the clipping level do not reach the audio amplifiers. The clipping level—determined by the values of R1 and R2—is fixed at about 70%. Modulation changes and noise peaks do not affect the anode voltage because of the relatively long time constant of R3-C1. However, the anode voltage follows slow changes in carrier level caused by fading or when two or more stations transmit intermittently on the same channel.

Another version of the series-gate ANL is used in the Johnson Messenger *model 123A*. A simplified circuit is shown in Fig. 5. The detector load consists of the 5.6K and 3.9K resistors and the 8K thermistor in series. A part of the negative DC bias developed across the load network is bucked out on the ANL anode by a positive voltage from the +10-volt line. The anode is fixed at a voltage level determined by signal strength.

Figure 6-a and 6-b illustrate two circuits whose perform-

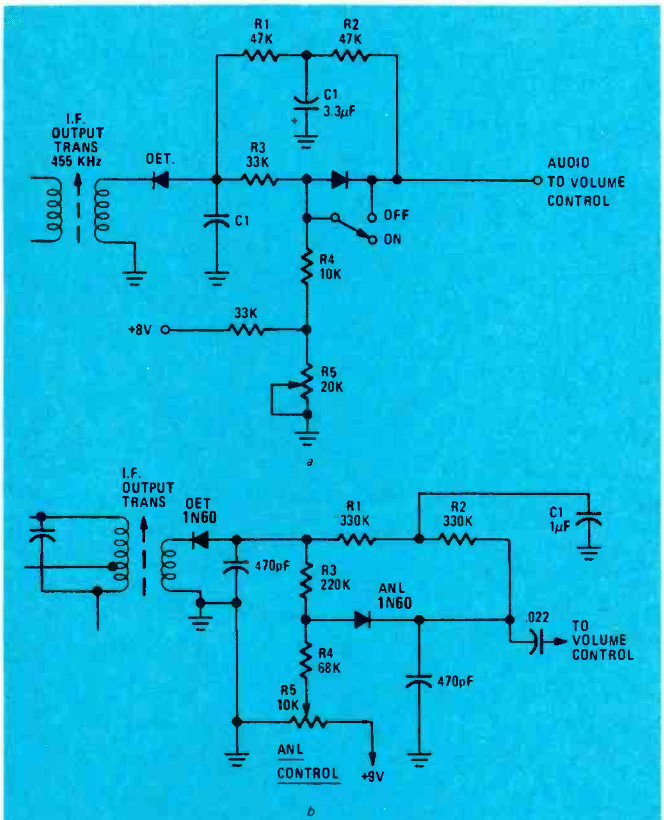


FIG. 6—TWO DIFFERENT ANL circuits. The circuit shown in *a* is used on the Tram models D12 and D42. The circuit shown in *b* is used in the J. C. Penney Pinto model 6235.

ances should be almost identical yet equivalent component values in one circuit are about one-seventh the values in the other. The detector and the circuits preceding it should be designed to deliver a solid 10-volt audio signal into a typical ANL circuit. Thus, in each case, the detector and ANL component values are designed to develop an average 10-volt AF signal.

A series-shunt combination

Some Hy-Gain CB transceivers use an ANL circuit that has both shunt and series diodes. The circuit in the Hy Range IV, *model 673A,* is shown in Fig. 7. Detector D1 develops the rectified audio signal and a negative DC voltage across load resistors R1 and R2. Series diode D2 is forward-biased by a voltage from the +13-volt line while shunt diode D3 is back-biased from the same source. Positive noise peaks exceeding

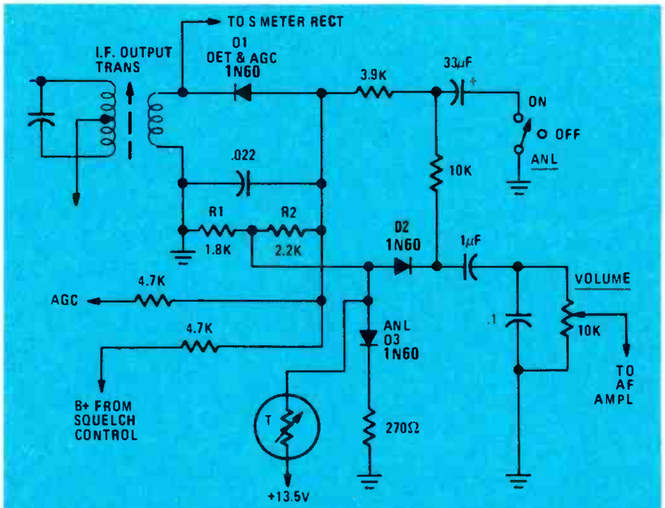


FIG. 7—COMBINATION SHUNT AND SERIES TYPE used in the Hy-Gain Hy Range IV model 673A.

the fixed bias on D3's cathode cause it to conduct, shunting the noise to ground.

The Hy-Gain Ranger V ANL circuit shows a variation in which shunt-diode D3 is reversed and connected with its cathode going directly to ground. A 56K resistor is in series with the thermistor and the junction of D2 and D3. It appears that D2 works on short pulses such as ignition noise while D3 will be effective on noise of a more continuous nature.

Some top-of-the-line CB transceivers include automatic noise limiters and noise blankers. In some, both circuits work full time; in others both circuits may be switchable or the operator has a choice of using either one or the other. Typical noise blanker circuits will be discussed in the next part of this series. **R-E**

Firefighters improve technique by CATV instruction

Rockford, IL, firefighters are studying prefire planning by videotape, in an experimental TV teaching system funded by the National Science Foundation. The unique system was designed by television and computer experts from Michigan State University, working with Broadband Technologies, Inc. and engineers from Rockford Cablevision. The first station receives the video instruction via the regular cable TV hookup of Rockford Cablevision.

The highly technical subject of prefire planning involves a complete survey of major buildings, so that if a fire erupts, the firefighters will know where the occupants are located, understand the floor plan and recognize hazards inside and outside the building.

Firefighters view videotaped lessons and respond to multiple-choice questions on the screen by pressing buttons, thus transmitting their answers to the control point at the headquarters of Rockford Cablevision, where a minicomputer controls all components of the training system. These include the videotape, the feedback that tells the student his answer is right or directs him to another answer, and the line printer that generates several reports during and after each lesson. After a short quiz at the end of the lesson, the computer prints out the percentage score for each participant. It also takes attendance—the firefighters "log in" by punching in their code letters as they take their places in class.

CB Radio song wins author $18,000

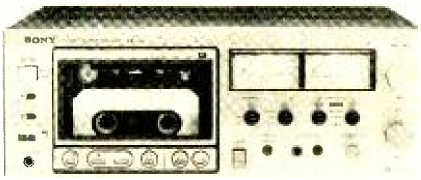
James A. Cox, Muncie, IN, was the first-place entry in the Radio Shack 1976 *Realistic CB Song Search*, winning $18,000 for his "Talking on the CB." Cox has played with a group called "The Cedar Valley Boys" for the past seven years and has been writing music seriously for the last year and a half.

Second-place entry was "Ernie's Talking Kitchen," by Robert Miller of Huntington, WV, who wins $13,000. Miller is program director of Huntington's WGNT. Jeffrey Boyan of Hammond, IN, won the third prize of $8,000 for "Heart Breaker."

The 1976 *Realistic CB Song Search*, sponsored by the Radio Shack chain, offered a total of $100,000 for the best songs—music and lyrics—about CB radio. The top ten submissions will be recorded by Radio Shack.

(A record about CB was produced some years ago. Its top title was "Talking Skip.") **R-E**

Radio-Electronics Tests Sony Elcaset EL-5 Tape Deck



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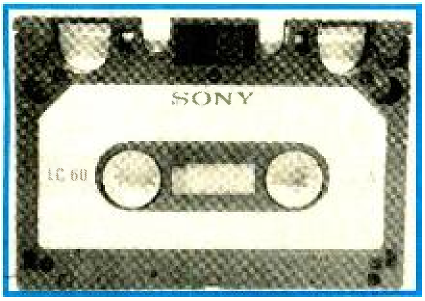
CIRCLE 99 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

SOME MONTHS AGO WE REPORTED THE INTRODUCTION of a new tape format, known as Elcaset. Readers may remember that the new tape package contains quarter-inch wide tape and is designed to operate at 3¾ IPS tape speed—twice the speed of standard cassettes. In basic concept, the Elcaset is not unlike the smaller, standard cassette, but its faster speed, wider tape and method of transport promised improved frequency response, lower noise, greater dynamic range and more even motion of the tape than is possible with the more familiar standard cassette.

After a long wait, we were able to obtain the first commercially available Elcaset tape deck so that we might evaluate these claims and its overall performance. Sony's *model EL-5* (distributed in this country by Superscope, Inc.) is shown in Fig. 1. The Elcaset tape package is shown in Fig. 2.



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The front panel arrangement of the *EL-5* is not unlike that of the many front-loading cassette decks, in that all controls and the tape compartment are up front, permitting stacking of the component above or below other high-fidelity components in a system. Controls located to the left of the Elcaset compartment include a POWER on/off push-button switch, a TIMER switch (that permits automatic recording or playback at any desired time when any commercially available timer clock is used to power the unit), a MEMORY switch that is used to rewind tape to a predetermined "000" point on the digital counter or, in its alternate position, will start forward play of tape automatically from that same point, the tape counter itself and its reset button and a headphone jack.

The see-through Elcaset compartment door is smoothly opened by depressing the EJECT button just to the right of the compartment and Elcaset's are inserted in the compartment with the open (tape) side facing up. Below the compartment door are solenoid-operated logic function buttons. These include fast rewind, stop, play, fast forward, record (which must be depressed simultaneously with the play button to get into the record mode) and pause.

The right section of the front panel contains the electronic controls. At the top are a pair of record level meters, calibrated from −20 dB to +5 dB, that also read during playback, indicating levels recorded on the tape. At the extreme right are two pairs of dual concentric level controls, one pair for line level adjustment, the other for stereo microphone input level adjustment. With this arrangement, microphone and line mixing is made possible. Below the meters are four toggle switches. The first of these is an MPX filter switch, useful when recording FM stereo programs with Dolby. The presence of 19 kHz or 38 kHz subcarrier products at the input to the Dolby circuits (if they are not sufficiently suppressed in the tuner or receiver) could upset Dolby action, and so the MPX filter circuit in the EL-5 attenuates these unwanted signals. The DOLBY NR switch is equipped with an FM position (for recording Dolbyized FM programs), an ON position (for other Dolby recording) and an OFF position. The remaining two switches take care of correct tape equalization and bias.

Happily, the Elcaset tape format has standardized three types of tape, numbered, quite logically, Types I, II and III. Type I tape is equivalent to a good, ferric-oxide low-noise high output tape. Type II tape corresponds to Ferri-Chrome tape, while Type III tape equals chromium dioxide tape (or other ferric based compounds which require the same bias and equalization as chromium dioxide tape). The tape packages themselves are equipped with sensing notches that, in more expensive decks, can be used to automatically set bias and equalization. In the case of the EL-5, this selection must be made manually with the two switches on the front panel.

Along the lower right section of the panel, near the EJECT switch, are a stereo line-input three-terminal phone jack (which over-rides the line-input phono-tip jacks on the rear panel), a pair of microphone input jacks, and a level control that adjusts volume heard through the headphones.

In addition to the LINE IN and LINE OUT jacks, the rear panel is equipped with a LEVEL ADJUST control, two FM CAL controls, a REMOTE CONTROL socket and two convenience AC receptacles. The LEVEL ADJUST control serves to alter output levels during playback for matching such levels to other program sources and its setting in no way affects VU meter readings. The FM CAL controls are used to adjust record level when recording a Dolby FM program. With the Dolby switch set to DOLBY FM, the front-panel record level controls become inoperative, and level is set (once only) by listening for a broadcast station's Dolby tone and rotating the rear panel FM CAL controls for a 0-dB reading on the meters. The remote control socket is intended for connection of an optional remote control box (Sony's *model RM-30*).

Laboratory measurements

We were supplied with samples of Type I (Sony SLH) low-noise high-output tape and Type II (Sony FeCr) dual layer tape, both in LC-60 lengths. (LC-60 and LC-90 lengths are now available and, just as "C" followed by a number indicates the playing time in both directions for standard cassettes, so LC followed by a number means the length of playing time of the Elcaset tapes).

The *EL-5* deck was tested thoroughly using each of these tape samples, and results are shown in Table I. Though no standard levels of recording have been established for making frequency response record/play tests with Elcasets, we reasoned that we should follow the same procedure that we normally use when checking frequency response of open-reel decks operating at their slowest (3-¾ IPS) speed. That meant using a −10 dB record level rather than the −20 dB we normally use when plotting frequency

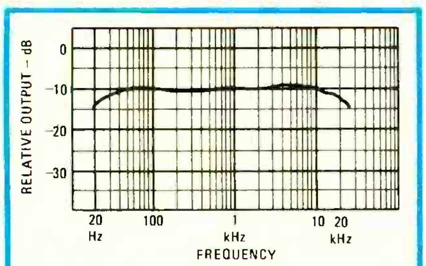
MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Tape Speed: 3¾ IPS (9.5 cm/sec). **Fast Forward and Rewind Time:** 75 seconds for LC-60. **Track Configuration:** 4-track, 2-channel. **Bias Frequency:** 160 kHz. **Signal-to-Noise Ratio:** 62 dB with Type II FeCr tape; 59 dB with Type I SLH tape, both improved by 5 dB at 1 kHz and 10 dB at 10 kHz with Dolby. **Total Harmonic Distortion:** 0.8%. **Frequency Response:** FeCr Type II: 25 Hz to 20 kHz, ±3 dB; SLH Type I: 25 Hz to 18 kHz, ±3 dB. **Wow and Flutter:** 0.06% WRMS. **Input Sensitivity:** Mike: 0.3 mV; Line: 95 mV. **Output Level:** 0.775 volts. **Headphone Output Impedance:** 8-32 ohms. **Dimensions:** 17 wide by 6¾ high by 12⅝" deep. **Weight:** 23 lbs, 2 oz. **Suggested Retail Price:** $629.95.

response of standard cassette machines or tapes. If one were to check a standard cassette's frequency response at this relatively high record level, one would invariably experience tape saturation at the high frequency end of the test and response would drop off beginning at around 10 kHz or even lower. Thus, the excellent results obtained with both Elcaset tapes (shown in Fig. 3 for the Type I tape and in Fig. 4 for the Type II tape) are even more remarkable than might at first be apparent. No standard cassette tape we know of, regardless of which machine it might be used with, is capable of such wide frequency response at this recording level.

Distortion, at 0-VU record level, was about half that which we normally encounter even with the best cassette tapes used on top-quality decks. Signal-to-noise ratios, with or without Dolby, were roughly 6 dB better than the best numbers we usually obtain.

The extremely low wow-and-flutter measurements obtained attest to the superior method of tape transport that has been developed for the Elcaset. For those who are not already familiar with this method, it should be noted that all tape guidance structures, pinch roller, capstan and tape heads are completely external to the Elcaset package when the tape is in motion. Accordingly, the



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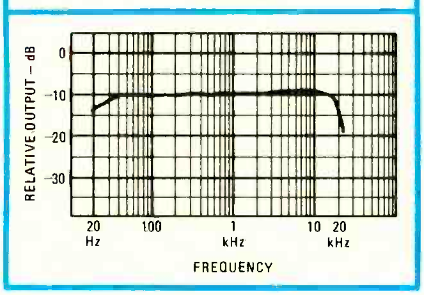

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Elcaset package itself has little to do with determining smoothness of tape run. Resultant wow-and-flutter is therefore almost exclusively determined by the quality of the tape transport mechanism within the deck which, in the case of the *EL-5*, was found to be very good indeed.

Use and listening tests

The logic solenoid operated transport controls of the *EL-5* Elcaset deck operated flawlessly during all of our many tests and listening sessions. We deliberately recorded some musical passages with the record level meters exceeding their 0-dB readings very frequently and were delighted to note that the system could handle such large signal peaks without introducing audible distortion during playback.

Our overall product analysis, together with summary comments concerning the *EL-5* Elcaset Deck will be found in Table II. Our chief reservation concerning this first Elcaset deck has to do with the fact the the full potential of the new format has not really been realized in this first model. We realize,

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sony** Model: **EL-5**

ELCASET TAPE DECK MEASUREMENTS

	R-E Measurements		R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS			
Frequency Response, Standard Tape (Hz-kHz ± dB)	25-19.5		Excellent
Frequency Response, Other (See text) (Hz-kHz ± dB)	25-21.0		Excellent
	See Figs. 3, 4		
DISTORTION MEASUREMENTS (RECORD/PLAY)	**TYPE I**	**TYPE II**	
Harmonic Distortion at -10 VU (1 kHz) (%)	0.5	0.85	Mostly noise
Harmonic Distortion at -3 VU (1 kHz) (%)	0.6	0.6	Very good
Harmonic Distortion at 0 VU (1 kHz) (%)	0.6	0.65	Excellent
Harmonic Distortion at +3 VU (1 kHz) (%)	1.0	0.9	Superb
Level for 3% THD (dB above 0)	+8	+9	Excellent
SIGNAL-TO-NOISE RATIO MEASUREMENTS			
Standard Tape, "Dolby" off (dB)	61.0		Superb
Standard Tape, "Dolby" on (dB)	70.0		Superb
FeCr tape, Dolby off (dB)	62.5		Excellent
FeCr tape, Dolby on (dB)	71.0		Excellent
MECHANICAL PERFORMANCE MEASUREMENTS			
Wow and flutter (%, WRMS)	0.045 (0.07 RMS)		Excellent
Fast wind and rewind time, C-60 (seconds)	75		
COMPONENT MATCHING CHARACTERISTICS			
Microphone input sensitivity (mV)	0.3		
Line input sensitivity (mV)	65		
Line output level (mV)	750		
Phone output level (mV)	90		
Bias frequency (kHz)	160		
TRANSPORT MECHANISM EVALUATION			
Action of transport controls			Excellent
Absence of mechanical noise			Very good
Tape head accessibility			Excellent
Construction and internal layout			Excellent
Evaluation of extra features, if any			Fair
CONTROL EVALUATION			
Level indicator(s)			Very good
Level control action			Good
Adequacy of controls			Very good
Evaluation of extra controls			Very good
OVERALL TAPE DECK PERFORMANCE RATING			Excellent

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sony** Model: **EL-5**

OVERALL PRODUCT ANALYSIS

Retail price	**$629.95**
Price category	**High**
Price/performance ratio	**Excellent**
Styling and appearance	**Very good**
Sound quality	**Excellent**
Mechanical performance	**Excellent**

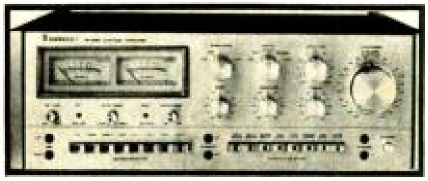
Comments: There is, quite naturally, a tendency on our part to evaluate the first Elcaset deck we have ever tested in terms of how it compares in performance and features with similarly priced standard cassette decks. Clearly, the higher speed and wider tape give the *EL-5* a distinct edge over even costlier standard cassette units, though the success of this new tape format will depend entirely upon public acceptance, which at this early date is highly questionable. We would have hoped that *all* Elcaset decks, even this "lower priced" model, would offer three-head capability, since that configuration no longer poses the physical problems that it does with standard cassette units (some of which have managed to incorporate three heads nonetheless). Sony's higher priced ($900 or so) Elcaset, *model EL-7*, does offer that capability, and with it the important tape monitoring facility which is almost universally available on open-reel machines which Elcaset's proponents hope to displace. Neither the presently reviewed *EL-5* nor the more expensive *EL-7* decks offer any means of taking advantage of those extra control-tracks that are a part of the Elcaset format and which permit such added professional touches as synchronizing signals (which might be used to trigger photo slides) and other cueing facilities. Thus, the *EL-5* realizes only a small percentage of the total potential of the Elcaset format, as described by its three sponsors (of which Sony is one). On the other hand, viewed simply as an alternative to a high quality two-headed cassette deck, the *EL-5* Elcaset deck wins hands down. Its frequency response capability is actually better than that of most open-reel units operated at the same 3¾ IPS speed, and headroom, compared to even the best cassette decks around, is way ahead. Remember, our frequency response checks were made at a −10 dB level, fully 10 dB higher than is normal practice for checking the frequency response of standard cassette decks and even at that we achieved response to 20,000 Hz (and beyond, using the FeCr Type II Elcaset samples supplied).

of course, that more expensive models in the future will very likely take advantage of the various sensing features built into the Elcaset tape package and may even avail themselves of the control-track facilities envisioned for this new tape format.

As far as the *EL-5* is concerned, one must think of it as superior to any standard cassette deck in performance, but not really quite up to the performance of better open-reel decks that, even at this price, can be found with three-head configurations and 7½-IPS speeds. While it is certainly possible to edit Elcaset tapes more easily than would be the case with standard cassettes, the ease of editing with precision is not quite up to that possible with any open-reel tape machine, since it is a bit difficult to locate or mark points on the tape to be cut with any degree of precision. Along with you, our readers, we will be watching for further developments of this tape format and will report to you concerning them as they occur. **R-E**

Sherwood HP-2000 Amplifier

SHERWOOD ELECTRONIC LABORATORIES, INC. IS one of the more venerable names in high-fidelity components, having introduced its first high-fidelity products in the 1950's. Their new *model HP-2000* integrated amplifier, from all outward and inward indications, displays the skill Sherwood has gained during those years.



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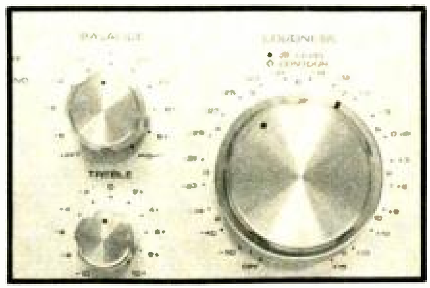
CIRCLE 101 ON FREE INFORMATION CARD

As shown in the photo of Fig. 1, the front panel of the *model HP-2000* is flanked by two end panels and the amplifier is encased in a black vinyl-laminated cover. Two power meters are framed by a bezel at the left and these are calibrated in watts (from 0 to 240) and dB (relative to the rated 120-watts-per-channel output across 8 ohms). Centered below the meters is the METER RANGE pushbutton that increases meter sensitivity by 10 dB so that meaningful readings are obtained even at low listening levels. Also located below the meter area are left- and right-channel PEAK LIMIT LED indicators that flash when the amplifier is driven into clipping levels, a microphone-input level control and a phono preamplifier level control. At the lower left of the panel are a pair of microphone input jacks and eight unusually constructed pushbuttons for program selection. When any pushbutton is depressed, it pops back out again, flush with its neighboring buttons, but a colored disc appears on the front surface of the button to indicate that it is operational. The eight pushbuttons in this area are labelled MIC, PHONO-1, PHONO-2, AUX-1, AUX-2, TAPE-1 and TAPE-2. These pushbuttons are interlocked with the exception of the MIC pushbutton that is used to mix microphone signals with any of the aforementioned other program sources. A pair of DUBBING jacks (output and input) come next and permit attachment of tape deck via the front panel for dubbing purposes. Along the right lower section of the panel are eight more of these unusual pushbuttons that take care of such functions as TAPE-1 or TAPE-2 monitoring, 4-CHANNEL ADAPTER insertion, HIGH- and LOW-cut FILTERS, LOUDNESS, CONTOUR, TONE DEFEAT and –20 dB MUTING (useful for listening interruptions such as phone or doorbell answering). Two independent phone jacks and the POWER on/off pushbutton switch are located to the right of these pushbuttons.

The upper right section of the front panel contains rotary controls including a SPEAKER selector switch (with OFF, A, B, A+B settings and, what Sherwood calls its Ambience Retrieval System for simulated four-speaker/four-channel listening), a MODE switch (with positions for STEREO, REVERSE, MONO, LEFT-only and RIGHT-only listening), a BALANCE control, click-stop BASS, MIDRANGE and TREBLE controls and a huge pair of concentrically mounted controls that take care of master volume (dB LEVEL) and LOUDNESS CONTOUR.

The rear-mounted LOUDNESS-CONTOUR control (see Fig. 2) of this pair requires a bit of explanation.

Most loudness controls on amplifiers and receivers are really of minimal usefulness. That is because their designers assume (incorrectly) that maximum clockwise settings of the volume control will always correspond to live, loud listening levels, at which point loudness compensation is not required. As most readers surely realize, maximum-volume control settings may or may not correspond to "live" levels depending upon such diverse factors as output level of all program sources (which may vary greatly), loudspeaker type and efficiency, room size, etc. Thus, with the simple volume-control/loudness-switch arrangement, activa-



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tion of the loudness feature seldom if ever introduces the correct amount of bass and treble compensation dictated by the now-familiar Fletcher-Munson loudness-contour studies of the 1930's. Too often, compensation is exaggerated and the loudness feature is no more useful than an arbitrary additional bass boost control.

Not so with the Sherwood arrangement. The rear knob of the pair of LOUDNESS controls (dB LEVEL) permits the user to set up the degree of compensation that will be afforded when the LOUDNESS switch is depressed for low-level listening. Both the dB LEVEL knob and the CONTOUR knob have separate dB calibrations so that once you become familiar with the settings required by your different program sources, the loudness contour feature of the Sherwood *model HP-2000* can be used effectively and correctly. The effectiveness of this desirable feature was confirmed in our subsequent listening.

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

POWER AMPLIFIER SECTION

Power Output: 120 watts-per-channel minimum continuous into 8 ohms, 20 Hz to 20 kHz. **Rated Harmonic Distortion:** 0.08%. **Rated IM Distortion:** 0.08%. **Input Sensitivity:** 830 mV. **Signal-to-Noise Ratio:** 100 dB. **Damping Factor:** 70 (8 ohms).

PREAMPLIFIER SECTION

Input Sensitivities: Phono 1 and 2, 2.2 mV (adjustable); High Level and Tape, 110 mV; Mike, 2.2 mV (adjustable). **Maximum Photo Input:** 160 mV. **Maximum Mike Input:** 200 mV. **Maximum High-Level Input:** 6.0 V. **Frequency Response:** Phono (RIAA), ±0.5 dB; High Level, 20 Hz to 20 kHz, ±0.5 dB; Mike, 50 Hz to 15 kHz, ±1.5 dB. **Bass Control Range:** ±14 dB at 50 Hz. **Treble Control Range:** ±14 dB at 15 kHz. **Midrange Control:** ±6 dB at 1 kHz. **Low Filter Cutoff:** –3 dB at 40 Hz. **High Filter Cutoff:** –3 dB at 8 kHz.

GENERAL SPECIFICATIONS

Power Requirements: 115-125 VAC, 50/60 Hz, 30 to 420 watts maximum. **Dimensions:** 20 W × 6[13]/16 H × 15¼-inches D. **Net Weight:** 42 lbs. **Suggested Retail Price:** $700.00.

Laboratory measurements

Results of our lab measurements are listed in Table 1 and can be compared with the published specifications listed in this test

continued on page 64

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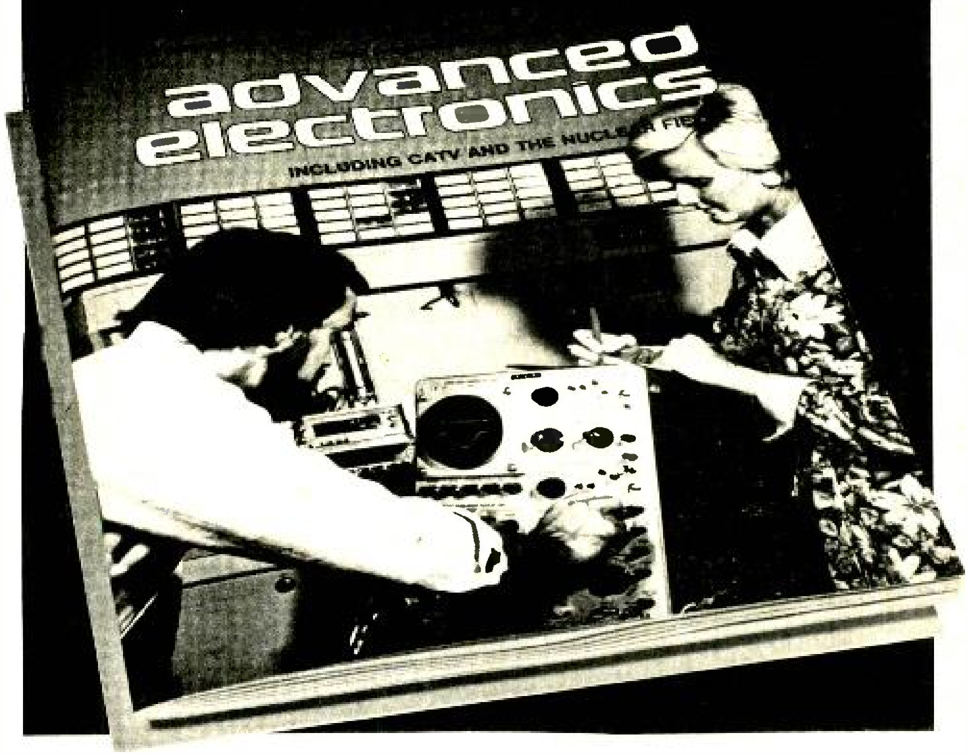

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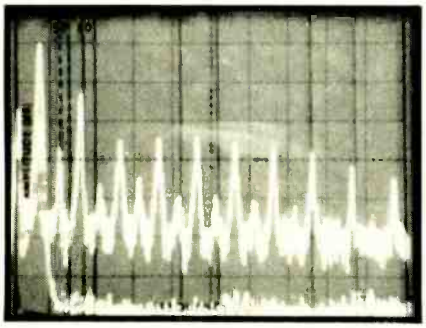
report. Contrary to what we find in most amplifier designs, the ultimate power rating of this amplifier is determined by the high-end power limit (at 20 kHz) rather than at 20 Hz.

At 120 watts-per-channel output (rated), total harmonic distortion measured a mere 0.017%. Since this value is too low for spectrum analysis (to determine the components of the distortion), we devised a new system of low-distortion analysis. In this system, we filter out the fundamental by some 60 dB which thereby permits us to increase the dynamic range of our spectrum analyzer to well over 120 dB. In the highest peak, at the left of the scope photo of Fig. 3, is repre-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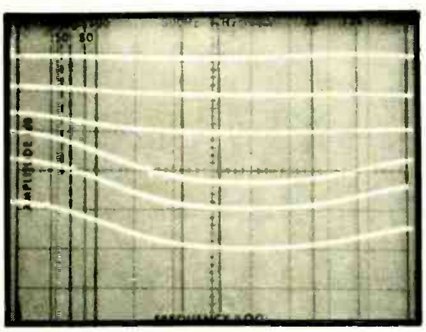
sented the residual fundamental, some 60 dB lower than it is in actuality (because of filtering). Thus, that reference point corresponds to a 0.1% distortion level. A linear rather than a log sweep is used to spread out the tiny harmonic distortion contributions so that the next spike observed (second harmonic of 1 kHz) is down some 88 dB (compared to the fundamental). The larger third-harmonic component is around 74 dB below the fundamental (60-dB reference plus an extra 1.4 boxes on the scope, with each box representing an additional 10 dB). In fact, all successive harmonics beyond the third are actually produced by our test-signal source itself, which is known to have a residual distortion of around 0.002%.

To further illustrate the effectiveness of the loudness-contour arrangement incorporated in the Sherwood *model HP-2000*, we photographed the complete action of the loudness control (down to 60 dB below full clockwise setting of the volume control in approximately 10-dB increments) for two different contour settings of the rear knob of that dual control arrangement. In Fig. 4, the contour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control was set for the most extreme compensation and, examining the -40-dB curve (fourth from the top), we see bass boost of around 10 or 12 dB at 50 Hz relative to mid-frequency levels. In Fig. 5 the CONTOUR control was backed off to provide more

continued on page 84

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sherwood** — Model: **HP-2000**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	130.00	Very good
RMS power/channel, 8-ohms, 20 Hz (watts)	125.00	Very good
RMS power/channel, 8-ohms, 20 kHz (watts)	120.00	Good
Frequency limits for rated output (Hz-kHz)	16-20	
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.017	Excellent
Intermodulation distortion at rated output (%)	0.05	Very good
Harmonic distortion at 1 watt output, 1 kHz (%)	0.013	Excellent
Intermodulation distortion at 1 watt output (%)	0.045	Good
DAMPING FACTOR, AT 8 OHMS	73	Excellent
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± _ dB)	0.3	Very good
Maximum input before overload (mV)	160	Very good
Hum/noise referred to full output (dB) (at rated input sensitivity)	72	Very good
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± _ dB)	14-30, 1.0	Good
Hum/noise referred to full output (dB)	77	Good
Residual hum/noise (minimum volume) (dB)	85	Very good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls		Good
Action of secondary tone controls		Good
Action of low frequency filter(s)	See Fig. 6	Excellent
Action of high frequency filter(s)	See Fig. 6	Excellent
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.2/2.2 (Variable)	
Input sensitivity, auxiliary input(s) (mV)	110	
Input sensitivity, tape input(s) (mV)	110	
Output level, tape output(s) (mV)	110	
Output level, headphone jack(s) (V or mW)	1.0V/8 ohms	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Very good
Adequacy of input facilities		Excellent
Arrangement of controls (panel layout)		Excellent
Action of controls and switches		Excellent
Design and construction		Excellent
Ease of servicing		Very Good
OVERALL AMPLIFIER PERFORMANCE RATING		Very good

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Sherwood** — Model: **HP-2000**

OVERALL PRODUCT ANALYSIS

Retail price	**$700.00**
Price category	**High**
Price/performance ratio	**Very good**
Styling and appearance	**Excellent**
Sound quality	**Excellent**
Mechanical performance	**Excellent**

Comments: Unlike many of today's integrated amplifiers, the new model HP-2000 is much more than a "receiver with the tuner left out." Sherwood has incorporated an intelligent assortment of controls on the front panel of this unit which more than justify its price and offer a good reason for selection of a preamplifier-amplifier combination. Among the most useful of these are the dual loudness control arrangement which, besides its precision calibration, finally offers users an opportunity to properly use the loudness contour feature as it was intended to be used. The power output meters are extremely effective and useful, too, thanks to the -10-dB range switch which makes readings possible even at lower listening levels. Other refinements, such as independent drive of the two headphone output jacks (which permit you to use widely differing phone types and impedances) and dual microphone inputs on the front panel (for true stereo microphone use, as opposed to many amplifiers which include only a single 'mono' microphone input) add to the feeling of total control afforded by this magnificently crafted instrument. The novel pushbuttons used for program selection and various other functions do away with energy-wasting indicator lamps while at the same time providing clear indication of program source and mode of operation and maintaining a uniform and symmetrical front panel configuration.

If there is one slight flaw in the overall control arrangement it is in the area of phono-level adjustment. While Sherwood provides two independent phono input pairs, level adjustment is common to both, somewhat defeating its purpose.

dB SPL? dBM? dBV? VU?

Solving The dB Mystery

3dB? 0dB? 10dB? 6dB?

Here's a rundown and explanation of the various dB notations used in specifying hi-fi equipment

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

HAVING MORE OR LESS "GROWN UP" IN THE high fidelity and audio era, most of us take the decibel in stride and accept the numerous "dB" readings and specifications without giving them a second thought. Every now and again, though, I am surprised to find how misunderstood most "dB" notations are by people just beginning their involvement in audio and hi-fi. Rather than discuss some new esoteric audio breakthrough or refinement this month, I thought it might be a good idea to take another look at the lowly "dB" and to try to clarify its many uses, meanings, reference points and what have you.

To begin with, let's talk about the origin of the term dB. It stands for decibel, of course, which means "one tenth of a Bel". As for the term Bel, it was named in honor of Alexander Graham Bell, the inventor of the telephone, whose work also delved deeply into studies of hearing and the problems of the deaf.

The most difficult thing for most people to understand is that the decibel, unlike all other measurement terms, has no absolute value. When you hear someone say that a certain sound measured 100 dB, the statement in and of itself has no real meaning, since decibel notations *must* be referenced to some arbitrary point. Thus, we can say that a given sound is "100 dB louder" than some other sound, but to say that a sound "measures" 100 dB is really quite meaningless. Still, by convention, we do hear and read about sound pressure levels that are "100 dB" or "120 dB" or some other value. The present debate regarding the advisability of allowing the supersonic British and French Concorde aircraft to land at New York's JFK Airport has shifted the "dB" from technical journals into daily newspapers as different agencies argue whether or not a 126 dB sound level during take-off would or would not be injurious to nearby residents. What these and other seemingly "abolute" statements of decibel levels really mean is that a given sound level is "126 dB above the threshold of human hearing"—the least loud sound that people can hear.

The threshold of human hearing's softest sound was long ago defined as 0.0002 dynes-per-square-centimeter. The dyne is a unit of pressure or force, and when two-thousandths of a dyne of force is applied over an area of one square centimeter, the intensity of such a sound corresponds to the lowest level of sound that most human beings can detect. Since most of us are more familiar with "watts" of power, rather than dynes, it might be useful to mention that 0.0002 dynes-per-cm^2 is equal to 0.000000000001 watts-per-square-meter, or 1×10^{-12} watts-per-m^2. Of course, not *everyone* can hear a sound level that low, and perhaps some people can detect sounds that are even lower in intensity, but some reference point for the threshold of human hearing had to be established, and this figure was chosen as a good average.

In order to understand dB notations and their relationship to each other, it is important to understand just how our hearing system works—at least in terms of its responsiveness to softer and louder sounds. The sound of a jet during take-off may well approach an intensity level of 10 watts-per-square-meter. If you divide 10 watts by 1×10^{-12} watts (the level of the threshold of human hearing), you come up with a number that looks like this: 10,000,000,000,000. The sound of the jet is that many times greater than the lowest level of sound most humans can detect.

It may surprise you to learn that your ears can handle such extreme ranges of sound level, but they can. Our ears, in fact, respond anything but linearly to increasing sound. Rather, they respond logarithmically. If one sound is ten times as powerful as another, it will seem to be only twice as loud as the first sound. Increase the sound intensity by a factor of ten once more, and the apparent sound level will only double once more (even though by now, the actual power behind the sound has increased by 100 times–10 times 10). So, we see that working in powers of ten gives good correspondence between the way we actually perceive loudness and the way we should note loudness levels.

Logarithms, as you may remember from high school algebra, are based upon powers of ten. The Log_{10} of the number 10, is 1, the Log_{10} of 100 is 2 while the Log_{10} of 1000 is 3 and so forth. The formula for finding the difference in two sound or power levels therefore works out to be $10\text{Log}_{10}\ (P1/P2)$, where P1 is one power level and P2 is the second power level.

Let's see how this works out for two sound levels, in which one is twice as powerful as the other. Substituting in the formula, we get $10\text{Log}_{10} \times 2/1$ or, $10\text{Log}_{10} \times 2$. We can look up the logarithm of 2.0 in a table and find out that it is 0.30103 or very close to 0.3. So, the difference between the two power levels is 10×0.3 or 3.0. In other words, a change in power or sound level of two to one results in a 3 dB increase (or decrease) of sound level.

A change of sound level of 3 dB will be audible to most people, though it will

TABLE I—SOUND PRESSURE LEVELS

160	
	Jet Engine, Close Up
150	
140	
	Threshold of Pain
130	
	Pneumatic Hammer
120	Airport Runway
	Thunder
110	Power Tools
100	
	Subway
90	
	Heavy Truck Traffic
80	
	Average Factory
	Busy Street
70	
	Small Orchestra
60	Average Conversation
50	Average Office
40	Subdued Conversation
30	Quiet Office
20	Quiet Living Room
10	Quiet Recording Studio
0	Threshold of Hearing = .0002 dynes/cm^2

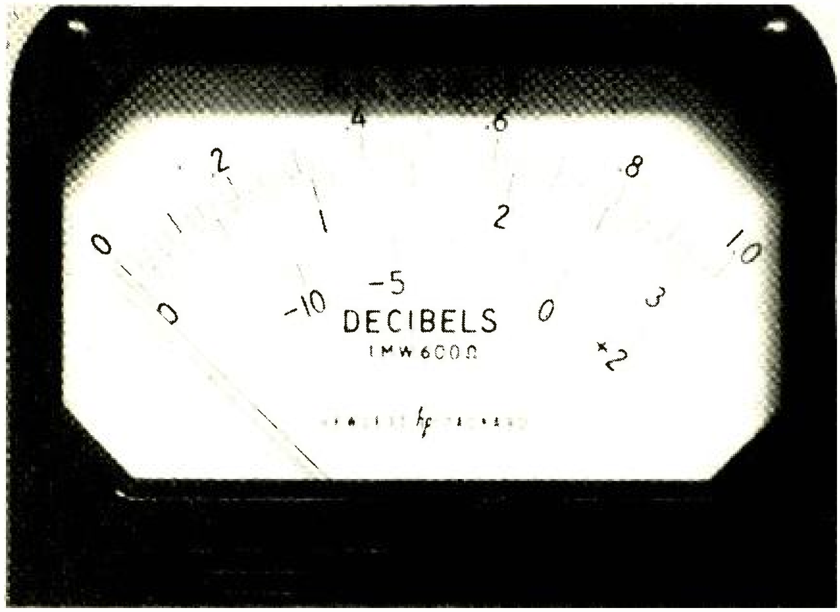

FIG. 1—dB SCALE on voltmeter is referenced to 0.775 volts.

not sound "twice as loud". For one sound to seem twice as loud as another, the sound must be ten times as powerful as the first sound. Let's see what that means in dB. $10\text{Log}_{10}\ 10/1 = 10\text{Log}_{10} \times 10$. But the Log of $10 = 1$, so the change in dB would be 10. In other words, a change in level of 10 dB seems like an apparent doubling (or halving) of sound level to most listeners. A sound power change of 100 to 1 would turn out to be a dB change of 20 dB and would sound *four* times as loud (twice as loud times twice as loud again).

If we refer back to the threshold of human hearing and call that sound level 0-dB SPL (Sound Pressure Level), we can relate all other sound levels to that 0-dB starting point as shown for some typical sound pressure levels in Table I.

dB meters

If you own a tape recorder or even a voltmeter that is calibrated in dB, you may be wondering how the dB notations on the recording meters or your voltmeter relate to everything we've said about sound pressure levels and loudness. Well, they don't. As stated earlier, dB's are applied when measuring any two amplitudes, and where we set the 0-dB reference point is strictly up to us. So, the 0-dB mark on your recorder's level meters has absolutely nothing to do with the 0-dB threshold of human hearing.

Before discussing the zero reference levels used on such meters and others, let's first consider the fact that dB's can be used to compare voltages and currents as well as power levels. But, to keep things straight, the formula for calculating dB changes must be altered somewhat. Here's why. Suppose we had a battery connected to a 4-ohm load, and that the battery's voltage was 4 volts. The power dissipated in the load would be E^2/R (E-voltage, R-load resistance in ohms), or $4^2/4 = 16/4 = 4$ watts. Now, suppose we replaced the battery with one that had an 8 volt rating. The new value of power delivered to the load would be $8^2/4$ or 64/4 or 16 watts. The new power level is four times that of the first power level.

If we want to use dB's in describing changes of voltage (or current) and want the results to be consistent with dB representations of power change, we must arrange the formula so that a doubling of voltage (or current) will show up as a 6-dB change (equal to a *quadrupling* of power) and not a change of 3 dB. To make this all work, the formula for calculating dB changes when we are talking about voltage or current works out to be dB = $20\ \text{Log}_{10}\ E_1/E_2$ (or I_1/I_2), where E_1 and E_2 or I_1 and I_2 are the first and second values of voltage or current to be compared.

Meters referenced to dB_M

In professional sound work, most input and output impedances are matched to 600-ohms. Long ago, it was decided that a good 0-dB reference point when dealing with audio signals would be one which corresponded to a 1 milliwatt power level across 600 ohms. We can easily calculate the voltage level required for this power level. Since $P = E^2/R$, E equals, in this case, 0.775 volts.

The meter face shown in Fig. 1 carries both a voltage scale and a dB scale. A notation at the bottom of the meter face indicates that 0 dB is referenced to 1 mW into 600 ohms and, indeed, we can see that 0 dB on the scale lines up with 0.775 volts. While the voltage read by means of such a meter will be accurate regardless of the load across which that

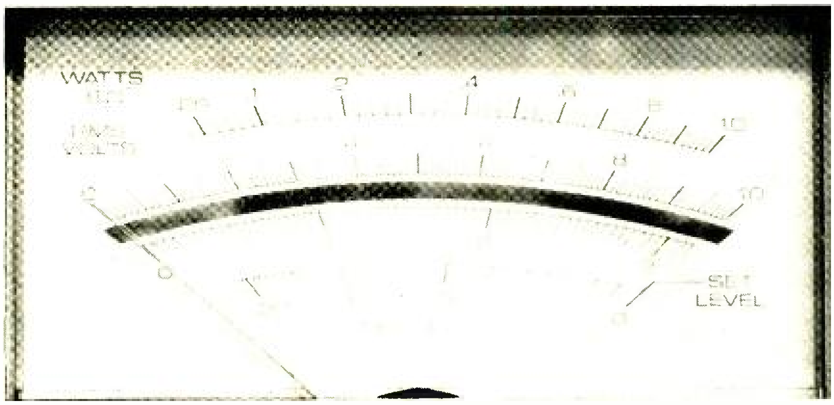

FIG. 2—AUDIO METER has dB scale referenced to 1 volt.

voltage is being measured, it should be emphasized that the dB_M readings will only be meaningful and accurate *as* dB_M readings if a 600 ohm load is used.

Meters referenced to dB_V

Sometimes, we want to read dB's and are not particularly interested in the load (as, for example, when comparing two voltages fed into a high impedance or even into an open circuit). Often, under such circumstances, a meter is calibrated in dB_V, or dB with respect to 1.0 volt. The meter face shown in Fig. 2 is on a piece of test equipment used to measure audio amplifier performance and, as you can see, its scale reads 0 dB at a point corresponding to 1.0 volt on its voltage scale. This particular piece of equipment has an additional control that switches the sensitivity of the meter movement in 10 dB steps, as can be seen in the closeup view of Fig. 3. If the control were moved to the −20-dB range, full scale reading with respect to 0 dB_V would be −20 dB or 0.1 volt, since a change of 20 dB in voltage represents a change of 10 to 1.

VU meters

If you own a good tape recorder, you may have noticed that its record level meters are calibrated using yet another term—the VU, which stands for volume units. Basically, the meter that is labelled VU would read exactly the same as one calibrated in dB_M if a steady-state tone or electrical signal were fed to it. However, under musical conditions, most meter movements are not sufficiently fast-acting to correspond

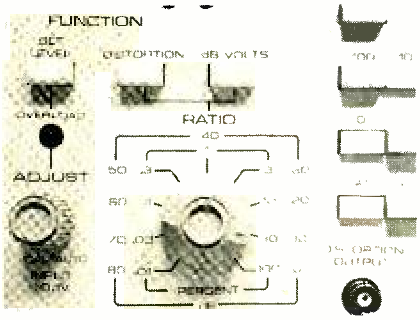

FIG. 3—RANGE SWITCH on audio meter changes sensitivity in 10-dB steps.

to actual voltage levels caused by short-term peaks in the musical signal level. Before the meter pointer has a chance to read up-scale to a peak value, that peak has already come and gone. So, an ordinary VTVM, even if calibrated in dB_M, might read much lower than peak values when responding to electrical signals equivalent to music waveforms. Such a meter might read average values or, if the music contains frequent peaks, it might read a bit higher than average voltage levels.

The recording industry long ago came up with a meter equipped with specific ballistic characteristics that are designed so that the meter scale movement approximates the response of the human ear. When using such a VU meter for making recordings, it is important to remember that even though the meter may be reading below 0-VU, peaks in the music may be ten or even twenty dB higher and may cause distortion in resulting recordings.

Some tape recorders are equipped with peak-reading meters that are more responsive to actual peaks in program material. Usually such meters have a fast risetime (so that the pointer can move up quickly to register loud peaks in program content) and a slower decay time, to make the pointer's movements easier to track by eye.

Hi-Fi specifications

On the basis of what we have said so far, it should be fairly simple to understand those high fidelity equipment specifications that are quoted in dB. When frequency response is quoted as extending, say, from 20 Hz to 20,000 Hz within ±3 dB, that simply means that if a steady signal were fed into the equipment at all of those frequencies, at no time would the output of the equipment vary by more than 3 dB in either direction, positive or negative. Remember, that while a 3 dB deviation from flat response does represent a two-to-one power change (and a 1.414 to 1 voltage change), subjectively such a change in loudness will seem very small as perceived by human ears. A change of 1.0 dB, in fact, is considered to be the least change that most people can perceive at all—yet it does represent a power change of nearly 26 percent!

Signal-to-noise ratios, expressed in dB, should be simple to understand, too. If a phono preamplifier is said to have a signal-to-noise ratio of 60-dB below full output, and we know that full or rated output of the particular amplifier associated with that preamp circuit is 100 watts, we can easily calculate that the noise level produced by the system in the phono operating mode will amount to 0.0001 watts, or one tenth of a milliwatt.

A tone control that can boost the output at 10 kHz by 10 dB is capable of delivering 10 times as much power from an amplifier at that frequency (for a steady level of input signals at all frequencies) than it can when the tone control is set to its mid- or flat-response position (providing, of course, that such "boosting" does not raise power output levels beyond the capability of the amplifier's maximum power rating).

Microphone sensitivity

The negative dB numbers associated with specifying the output of microphones tend to confuse many users. There are two popular methods used to arrive at mike output specifications. The first is called the open-circuit voltage rating, in which the reference 0-dB point is taken as 1 dyne-per-cm^2 of sound pressure referred to 1 volt. Thus, if a microphone had 1 dyne-per-cm^2 sound pressure applied to its diaphragm and delivered a 1 volt output, its sensitivity would be 0 dB. Actually, microphones deliver far smaller signal voltages and, based upon this reference, may be expected to have ratings from about −85 dB to −40 dB or so.

Some microphone ratings are specified in terms of power, rather than voltage, and in this system, the mike is connected to a matching load (equal to its own internal impedance) and the 0-dB reference is considered to be an output of 1 milliwatt when the sound pressure level applied to the microphone is 10 dynes-per-cm^2.

Decibels provide a convenient way of expressing sound levels, voltage levels, power levels and more, simply because they compress the scale of numbers that we would otherwise have to use to express the same comparative quantities. The fact that the dB scale is logarithmic rather than linear, and that it corresponds more closely to the manner in which we perceive loudness changes, might be considered a happy coincidence or perhaps it is because we hear in this logarithmic manner that dB's were invented in the first place. In any case, once you understand their usefulness they will become less intimidating every time you are confronted with them on the printed page. **R-E**

R-E's Service Clinic

The PUT

Quick-response voltage-regulator

JACK DARR
SERVICE EDITOR

WE ARE SEEING SOME NOVEL CIRCUITS lately in the new TV sets. Some of them are really novel in that they make use of solid-state devices that we haven't run across before. So, we have to keep up with them. Here's one that has been around for a couple of years. I first ran into it in a Sears set and then again in a Magnavox T985.

What is it? It's a PUT (*P*rogrammable *U*nijunction *T*ransistor). Unijunction transistors (UJT's) have been around for some time. Figure 1 shows a typical application of a UJT in a time-delay circuit. The UJT has two bases and one emitter.

The PUT is a four-layer device similar to an SCR—and is often considered as being an SCR with N-type gate. Figure 2 shows the equivalent time-delay circuit as in Fig. 1 using a PUT. Don't confuse the PUT with an SCR. Note that the *gate* of a PUT is drawn connected to the *anode*. The gate of an SCR is connected to the cathode.

The PUT is turned on by a gating pulse just like an SCR. They also turn on if the anode voltage exceeds the gate voltage, and turn off when the anode voltage drops below the gate voltage. Remember this. It's one of the things applied to the circuit. The PUT is used to replace the UJT in the same application. It has a much faster response time.

The PUT can also be used in voltage regulator circuits. Regulator circuits

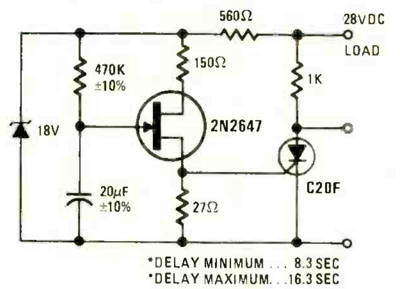

FIG. 1

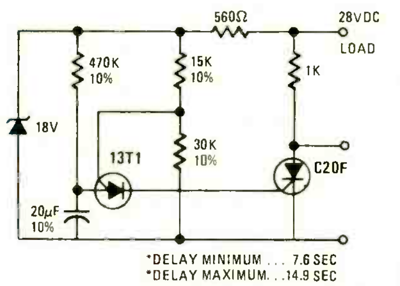

FIG. 2

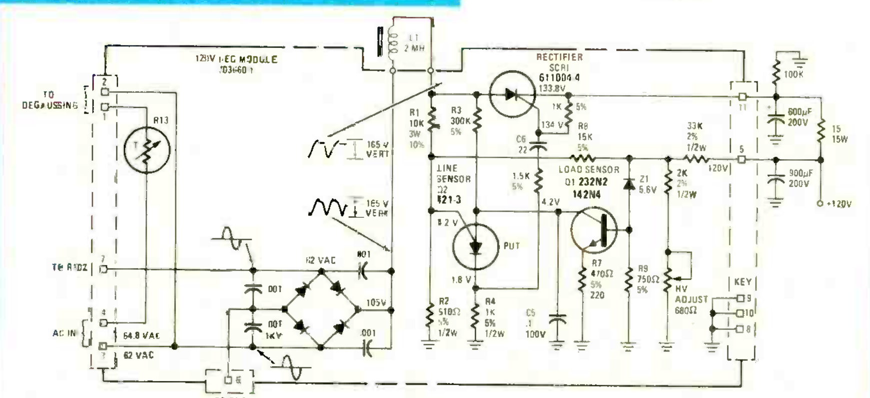

FIG. 3

used in the circuits to be discussed.

One of the first applications of UJT's was to control the firing point of SCR's. The circuits shown in Figs. 1 and 2 are ten-second time-delay circuits from the G-E *Transistor Manual*, and *Application Note No 761.13*. The delay time is controlled by the time constant of the 470K resistor and the 20μF capacitor. Delay time is initiated when power is have become very common in solid-state TV and other circuits. So, let's look at a typical DC regulator as used in the Magnavox T985 and T986 chassis.

Figure 3 shows the complete circuit of the 120-volt regulator. The AC line voltage comes straight into a full-wave bridge rectifier. The output of this is *not* filtered, so it consists of positive-going

continued on page 74

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

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

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SERVICE CLINIC
continued from page 68

pulses at a 120 pulse-per-second rate. The pulses are fed through a 2-mH choke for transient suppression and then to the anode of SCR1. The 120-volt DC output comes from the cathode of SCR1 and is filtered. The longer SCR1 is turned on, the more current flows to the filter capacitor and the +120-volt supply.

Programmable unijunction transistor Q2 controls the firing of the SCR. Its gate is connected to the pulsating DC output through a voltage divider formed by R1 and R2. As the voltage on the anode of SCR1 rises, the gate voltage of Q2 increases proportionally. The PUT's anode is also connected to the pulsating DC, but this is delayed by resistor R3 and capacitor C7.

The anode of Q2 is also connected directly to the collector of Q1, the load-sensor transistor. The base of Q1 is connected to the +120-volt line through a Zener diode.

When the gate voltage of Q2 equals its anode voltage, the PUT conducts. This sends a pulse of current through R4 in its cathode circuit. This pulse is coupled to the gate of the SCR through C6, causing it to conduct. Now we get to the regulation part of the circuit. The gate voltage is strictly a function of the peak amplitude of the full-wave bridge rectifier's pulsating DC output. The anode voltage is a *combination* of the bridge-rectifier output and the +120-volt supply.

Figure 4 shows the anode waveforms of the SCR under different conditions. Figure 4-a shows the trigger point for an average load. Figure 4-b shows what happens if the load increases, tending to make the output voltage decrease. The drop is fed back through the load-sensor transistor Q1 and the Zener diode to the anode of the PUT. The rising voltage at the gate of Q2 catches up with the rising voltage on the anode much *sooner*. The SCR fires earlier, causing more current to flow through it to the load to take care of the increased loading. (Remember that all of this happens during one half-cycle of the AC line. It happens for each half-cycle.)

If the load on the +120-volt line drops, the output voltage tries to increase. This rise is coupled to the anode of the PUT and its bias voltage also rises. In this case, the PUT fires later causing the SCR to be turned on for a shorter period and thus bringing the voltage back down to normal (see Fig. 4-c).

The same thing happens if the pulsating DC output from the bridge rectifier increases due to a rise in the AC line voltage. The PUT turns on sooner, reducing the output to +120 volts.

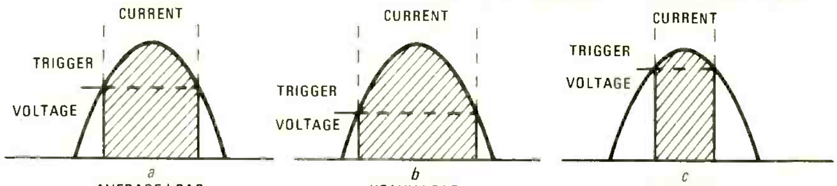


FIG. 4

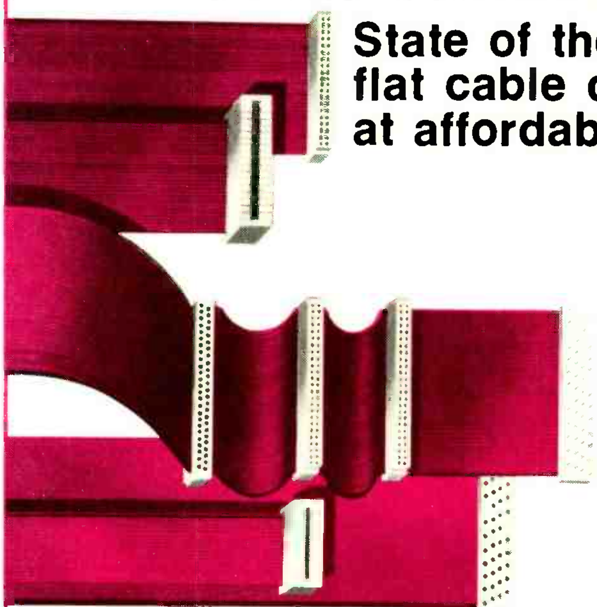
This looks very complex but it isn't. The key test points, as in any solid-state power supply, are the bridge rectifiers, the PUT, the SCR and the transistor/Zener combination. Look for DC voltages that are way out of the ballpark. In one case, the complaint was: "Plenty of voltage on the SCR anode but only 2 volts on the +120-volt line." Diagnosis: the SCR was not being turned on and it was replaced. The problem was due to a bad PUT. It could also have been due to an open gate-pulse coupling capacitor C6, or an open PUT anode resistor R4, etc.

A key voltage is the DC voltage on the SCR anode, which reads +108 on a DC voltmeter, but shows a half-wave rectified series of pulses at 165-volts P-P on a scope. Sams Photofact schematic shows this, and also shows the gating notch on the SCR-anode waveform. If you don't see a notch, check out the PUT circuitry and the load-sensor Q1.

Basically the same circuit is used in the Sears sets with a few differences. The PUT gates the SCR through a small pulse-transformer. The PUT pulse goes through one winding which develops the SCR gating pulse in the other winding. In some, you may even find the PUT anode directly connected to the SCR gate. I have not seen this one used in commercial TV yet, but it is shown in G-E's Application Notes on the PUT.

One other thing that should be mentioned before we leave. If a TV set has a full-wave bridge rectifier connected directly to the AC line, the chassis will be hot *at all times.* There will be at least 60-volts RMS AC to ground, for there will always be a couple of diodes conducting in the bridge. You *must* use an isolation transformer, not only for your safety but for the safety of your test instruments.

(For data used in preparing this, many thanks to Ray Guichard of Magnavox and to G-E for the Application Notes on the PUT's) **R-E**



MUSIC BOX

continued from page 34

The Vibrato/Tremolo Oscillator produces a low-voltage 6-Hz sinewave using a twin-T filter. Separate potentiometers allow controlling the amplitudes of the tremolo (R81) and virbrato (R76) signals applied to the Envelope Modulator and Pitch VCO, respectively.

The Envelope Modulator uses diodes D18 and D19 and a voltage follower (IC5-a) to amplitude modulate the tone frequency with the output of the Envelope Shaper and the Tremolo/Vibrato Oscillator. Diode D20 is added to allow amplitude control by an external voltage. The external voltage is applied to the DYNAMICS IN jack.

The CONTROL IN and CONTROL OUT jacks and associated switches are added to allow synchronization between two or more units. Other inputs are marked for further control capability, while other outputs are marked for use in controlling music synthesizers or similar equipment.

Construction

All circuitry for the music generator is contained on one single-sided PC board except for the power transformer, switch S3, output jacks and audio-output roll-off capacitor C34. Although a fair number of jumpers are required, the choice of a single-sided board was made to keep cost at a minimum. The foil pattern is shown in Fig. 3 and the component placement diagram is shown in Fig. 4.

Resistor R1 is selected so that the voltage on pin 4 of IC1-b is between +3 and +12 volts. Resistor R54 is similarly selected so that the voltage on pin 4 of IC6-b is between +3 and +12 volts. Note that only about 80% of all LM3900, CA3401 or MC3401 op-amps will have suitable noise characteristics. Some will have excessive "popcorn" noise and some too low a level of pink noise.

The assembled circuit board is mounted component-side up on the bottom of the enclosure. A sheet of insulating material is placed between the circuit board and enclosure. The circuit board is mounted with No. 6-32 hardware through the holes in the circuit board and insulator. The transformer is mounted to the left of the circuit board near the bridge rectifier. The chassis and front-panel wiring diagram is shown in Fig. 5.

The PC board allows additional resistors to be added to provide a 7-tone scale if desired.

Operation

The variable resistors should be set as follows for initial trial: R7, R51, R73 and R81—full counter clockwise: R94, R95 and R97—center of rotation; R36—full clockwise, R71—slightly counter clockwise from center, R68—slightly clockwise of center. The slide switches on the PC board should be set to the rear, while the slide switch on the rear panel may be set in either position. (Note: The unit shown in the photographs is a prototype with switches S1 and S2 omitted.—Editor) The audio output may be connected to the input (preferably high-level) of any audio amplifier. Turn the volume control of the amplifier down and turn it on. Plug in the music generator and allow one minute for the circuit to settle before turning up the amplifier volume, unless you want to hear quite unmusical sounds.

If sound consisting of various pitches and durations is not heard when the volume is turned up, there are circuit errors or defective components. If many notes of the same low-extreme pitch or same high-extreme pitch are heard, the PITCH EXTENT control (R7) should be appropriately adjusted.

The VIBRATO (R76), TREMOLO (R81), PITCH (R36) and TEMPO (R51) controls may be independently adjusted. There is some interaction between the envelope controls—ATTACK (R94), DECAY (R97) and DAMPING (R95). The three duration controls can be tried in any positions, but generally something near the initial settings is most listenable. If these are not kept in the same position sequence as the initial settings, the duration ratios will be other than 1:2:4:7.

System connections

With the full back-panel switch-and-jack complement, the music generator can be connected to other identical units or other different devices to allow more than one sound channel with either completely synchronized note durations or else durations on a common time reference. When the rear switch of an Infinitune is in the CLK IN/DURA OUT position, a clock from another Infinitune or other source connected to the CONTROL IN jack can set the time that note changes occur. Also, with the switch in this position, the given unit can supply the duration pulse to another Infinitune or other equipment that will then follow the durations of the notes in this unit.

With the rear panel switch in the CLK OUT/DURA IN position the unit provides note durations equal to the duration of a pulse signal applied to CONTROL IN jack, while supplying a clock signal out of the CONTROL OUT jack that may be used to synchronize another Infinitune or other equipment.

If the five-tone-per-octave configuration is used, two Infinitunes with their pitch noise-sources uncorrelated will sound very good together with either a common clock or a common duration pulse signal. If the seven-tone configuration is used, however, considerable discord will be noted from the more complex harmonic relationships possible. Additional pink-noise sources with the proper time constants can be applied to the TEMPO MOD IN, DYNAMICS MOD IN and V/T SYNC points on the circuit board to vary the tempo, loudness and vibrato/tremolo of the music. An antenna can be placed on the output of any noise source to permit varying the musical character by changing the capacitance from the signal to ground with a move of a hand. Care should be taken to minimize increased correlation by such coupling.

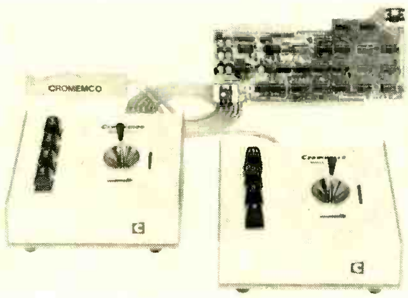
The PITCH OUT and ENVELOPE OUT or CONTROL OUT (with switch S3 in DURA OUT position) signals may be applied to music-synthesizer circuits. The INTRA-OCTAVE PITCH, 2ND OCTAVE and 3RD OCTAVE signals may be combined by means of a weighted summing-amplifier to produce a signal that is an analog equivalent of the pitch. This may then be applied to a higher-quality VCO that is connected to other synthesizer circuits.

Finally, voice or other musical sources may be used as control or modify inputs, and an external sound may be modulated in duration and shape by applying it to the EXT TONE IN jack. **R-E**

new products

More information on new products is available from the manufacturers of items identified by a Free Information number. Free Information Card follows page 88.

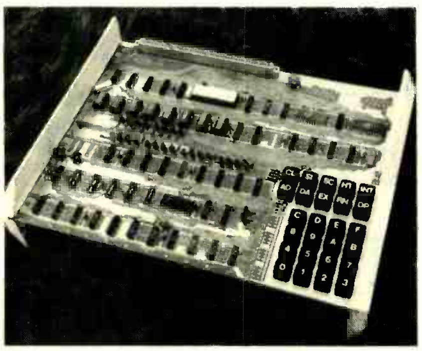
COMPUTER JOYSTICK CONSOLE includes a speaker, speaker amplifier and joystick. Facilitates uses such as sound effects for computer and other games, plus provides an easy way to obtain such features as acoustic warnings in other applications. Interfaces easily with micro-



computers and can be used with color graphics interface such as the TV Dazzler™. Price of the new console is $65.00 in kit form or $95.00 assembled.—**Cromemco, Inc.,** 2432 Charleston Rd., Mountain View, CA 94043

CIRCLE 78 ON FREE INFORMATION CARD

DATA HANDLER; a complete system on a single circuit board that combines the 6502 microprocessor with the latest state-of-the-art technology. The *Data Handler* combines multi-functions with the ease of operation that makes it ideal for the beginning computer enthusiast. The unit



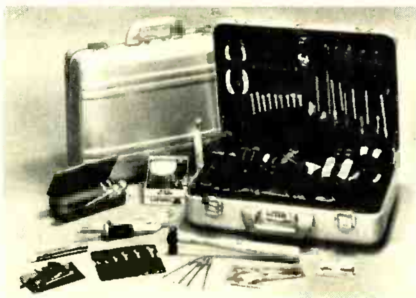
can be programmed to control any eight devices simultaneously. It is available in kit form for $179.95.—**Western Data Systems,** 3650 Charles St., Suite G, Santa Clara, CA 95050

CIRCLE 79 ON FREE INFORMATION CARD

ALUMINUM SOLDER, *Alu-Sol 45D* is a new cored solder with much improved flux, makes it possible to solder pure or lightly-alloyed aluminum almost as easily as copper, with a joint strength at least equal to tin-zinc.—**Multicore Solders,** Westbury, NY 11590

CIRCLE 80 ON FREE INFORMATION CARD

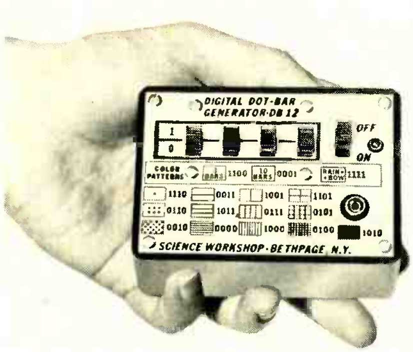
TOOL CATALOG, *tool kit-JTK-17 Aero-Lyte,* designed for the field engineer or electronic technician who frequently travels by air. Features a jet-smooth molded aluminum case with two removable pallets. The case measures 17 × 12½ × 5 inches and comes complete with more than 100 tools required for field adjustment and service work. Among the tools included are, pliers, wrenches, screwdrivers, nutdrivers, alignment tools, soldering equip-



ment, tweezers, measuring devices, and optical aids. A VOM is offered as an optional accessory. $380.00 with VOM; $328.00 without VOM.—**Jensen Tools and Alloys,** 4117 N. 44th St., Phoenix, AZ 85018

CIRCLE 81 ON FREE INFORMATION CARD

COLOR CONVERGENCE GENERATOR, for servicing color TV sets, amateur TV, computer terminals, closed-circuit TV, video tape equipment, TV broadcast subsystems and cable TV. This very special dot/bar generator provides 16 different patterns needed for servicing color TV receivers. The unit, *model BB-12* is a pocket size 1¾ × 2¾ × 4 inches and is available in kit or wired form. The kit is $49.95; wired $64.95. A simpler version, the *DB-11*, provides 13 pat-



terns. $39.95 in kit form and $49.95 assembled.—**Science Workshop,** Box 393, Bethpage, NY 11714

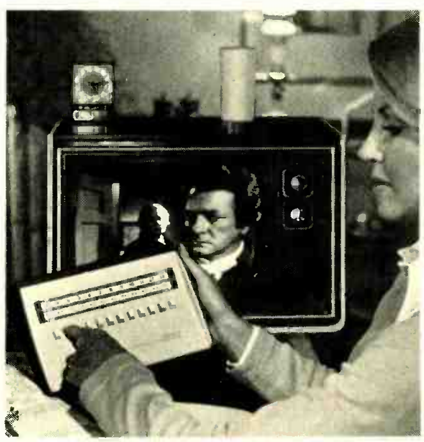
CIRCLE 82 ON FREE INFORMATION CARD

TWO-METER ANTENNA is a ⅝-wave magnetic mobile antenna described as approaching the theoretically maximum power gain of the ideal antenna. Average gain measured with the

antenna mounted on the center area of the roof of a truck cab is 3 dB above isotropic. The average VSWR is less than 1.3 without making any attempt to optimize this figure. *Model A-280* is base-loaded, mobile, magnetic-mount with a 47-inch heat-treated, stainless steel whip. Antennas are factory matched to resonate at 146 MHz. A chart is provided allowing adjustments ranging from 144 MHz to 156 MHz.—**Antler Antennas,** 6200 South Freeway, Fort Worth, TX 76134

CIRCLE 83 ON FREE INFORMATION CARD

TV REMOTE CONTROL, *Model TRC-82* provides instant push-button selection of VHF and UHF channels (2 through 83). Electronically,



without motors, this solid-state unit provides direct-access channel changes, fine tuning and remote on-off of a TV set from anywhere in the room. The device consists of two units; an all-channel converter and a control unit interconnected by a 25-foot, plug-in, control cord. The converter is connected behind and beneath the TV set. The only wiring necessary is to connect the downlead from the TV antenna into the converter, and then connect the converter output to the antenna terminals of the TV set. All necessary jumper cables and accessories are supplied. Extension lengths of control cord are available if desired. Suggested list price is $124.50. The extension control cord, *Model TRC-82-25CD* is $8.95.—**Jerrold Electronics Corp.,** 200 Witmer Rd., Horsham, PA 19044

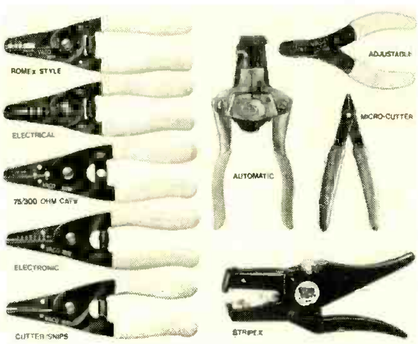
CIRCLE 84 ON FREE INFORMATION CARD

LOUDSPEAKERS, *Models VL300, VL400, VL500 and VL700.* The series is priced from $69.00 to $167.00 each. *Model VL300* and *VL400* are 2-way systems; the *VL500* and *VL700* are 3-way

systems. Specifications of the new units have not yet been released.—**Visonik of America Inc.,** 1177 65th St., Oakland, CA 94608

CIRCLE 85 ON FREE INFORMATION CARD

WIRE-STRIPPING TOOLS; an assortment of 10 tools that will handle most types of wire and cable in the range of 38 to 10 AWG. New items include manual strippers for electrical applications, Romex-style cable, electronic applications, 75– and 300-ohm TV antenna cable, and a versatile cutter/snips. Other new entries include the *Micro-Cutter* for electrical and electronic applications, a *Deluxe Micro-Cutter* with



safety retaining clip and an automatic stripper for electrical applications.—**Vaco Products Co.,** 510 North Dearborn St., Chicago, IL 60610

CIRCLE 86 ON FREE INFORMATION CARD

SWR BRIDGE, the base version, housed in a 3 × 7 × 4-inch aluminum extruded case, uses two 200-μA meters for very sensitive readings.

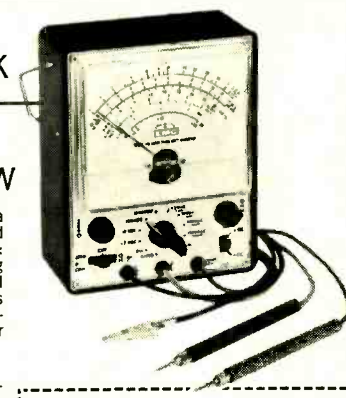
The mobile version, illustrated, is in a 3 × 4 × 5-inch high-impact plastic case with a single 200-μA meter with a two-color scale.—**Kris, Inc.,** Pioneer Rd., Cedarburg, WI 53012

CIRCLE 87 ON FREE INFORMATION CARD

FIBREGLASS CB ANTENNA, *Model 225C "Broadcaster",* is a convertible trunk-lip or roof mount deluxe antenna with base loaded coil, black coil jacket and black fibreglass whip. The

antenna comes with 17-feet of RG-58/U coaxial cable with PL-259 connector. Has SWR adjustment 2 HEX key wrenches.—**Electronics Industries, Inc.,** 333 Taft Dr., South Holland, IL 60473 **R-E**

CIRCLE 88 ON FREE INFORMATION CARD



TELEPHONE DIALER
continued from page 41

capacitor C7 and powers the clock generator on pins 1 and 11.

Construction

Figures 6 and 7 are the component and bottom-side PC board foil patterns. Figure 8 is the components placement diagram. You have the option of using either one of two types of keyboards. The 1-of-12 keyboards (Fig. 3) are listed in the ads in the back of this magazine as calculator keyboards. The dialer uses the standard 0 through 9 keys plus two more for REDIAL and ACCESS PAUSE. The actual number of switches on the keyboard you use will exceed twelve if the calculator is designed for extra functions.

Keyboards listed as telephone keyboards are usually the 2-of-7 type (Fig. 2). Conventional telephone keyboard layouts have digits 0 through 9 plus * and # keys for a total of twelve. Each key has DPST contacts that are switched along a matrix of three vertical buses (KG, KF and KE) and four horizontal buses (KB, KC, KD and the one marked "no connection"). Pressing any key makes contact with one horizontal and one vertical bus. The total of seven buses and two contacts per key accounts for the 2-of-7 nomenclature.

All six IC's are used if the telephone-type 2-of-7 keyboard is used. If the calculator-type keyboard is used, a separate encoder is needed. In this case, IC1 is eliminated since its purpose is to encode the 2-of-7 keyboard signals. The parts list and the diagrams reflect the component variations for either keyboard.

Transistors Q1 through Q5 are the output drivers that control the five LED's and the relays. Connections to a typical telephone are shown in Fig. 9.

Relays RY1, RY2, and RY3 are best mounted right in the phone. I used Magnecraft relays with a 100-ohm coil because they were handy. But they are relatively expensive and you can probably do better by looking around. The supply feeding the emitters of the output transistors can be isolated and increased in voltage if you need more than 3.9 volts for your relay selection. Resistors R25, R27, R29 and R31 will have to be changed accordingly.

Two normally-open relay contacts, the Strobe and Redial contacts, and a third normally-closed Line relay are needed. The relays are connected to the collectors of Q2, Q3 and Q4. After checkout of the system, you may elect to remove the LED's.

Either IC sockets or Molex pins should be used to mount the IC's. If you have to replace a defective IC or remove one for troubleshooting, you'll be glad they come out easily.

Unless you go to the trouble of making your PC board with plated-through holes, you have to solder the components to the foil on both sides of the board. Jumpers must be inserted and soldered to both sides in all empty holes that connect to foil runs.

Since IC2 is a CMOS device, when it is not used, the input of IC2-b becomes unterminated and must be grounded for proper operation of the other gates in the IC2 package. A short jumper is added on the rear of the board. The output of the gate must also be disconnected so it does not interfere with the C0 keyboard output. The best way to do this is to simply leave out the jumper between the front and rear of the boards indicated with an asterisk on the component placement diagram.

The telephone dialer described here uses a 1-of-12 type keyboard and the encoder was mounted on a Veroboard. The parallel conductor runs of the Veroboard are perfect for matrix circuits like the encoder shown in Fig. 3. A specific layout for the encoder board has not been included since it depends on the particular keyboard pin arrangement. Again, Molex pins are recommended so the keyboard can be mounted right over the encoder components yet can be easily removed for troubleshooting.

Momentary pushbutton switches are used for the Store, Retrieve and Continue functions. An additional hook switch contact is needed to apply power to the Clock Generator, IC6. If a spare normally-closed contact is not available on the cradle switch, a microswitch can be rigged to the bracket switch assembly. Although somewhat less convenient, a separate toggle switch can be used. Relay RY1 is not required if a toggle switch replaces the secondary hook switch.

The system is powered from a 3.9 volt ($\pm 5\%$) negative voltage supply. A zener regulated supply will do the job. Remember that the number memory is volatile and power must be kept on continuously. The supply should not be designed to supply more than the 200 mA peak current drain of the LED's and relays. Standby power drain is very low, essentially only the 2.25-mW typical drain of IC5.

Checkout

Once everything is together, you will be anxious to put the circuit through its paces. Initial testing is done by watching the response of the LED's to pushbutton sequences.

Connect the -3.9-volt supply to the $-V_E$ pad on the PC board, and the power-supply ground to the GND pad. Turn on the power and flip the hook switch. Operating the switch simulates lifting the receiver and resets the registers in IC4.

Now try keying in a number. Each key closure stores the corresponding digit in internal registers and dials them out with precise timing. Because of the memory, the keys can be pressed at a faster rate than they are dialed out.

The MASK, STROBE and LINE LED's should operate in the following way: The MASK LED should be lit during the entire dialing sequence. The STROBE LED is illuminated during the time it takes to dial out the series of pulses that make up one digit. The LINE LED will flash once for each output pulse, so each key pressed will flash this LED a number of times corresponding to the numeral printed on the key (0 flashes the LED 10 times). Of course they flash at a 10 Hz rate so you will not be able to count the individual pulses by eye, but you can roughly discern between the shorter and longer sequences.

After verifying the individual digit operation, check the redial facility. On the calculator-type keyboard used here, the C (constant) button was wired and used as the REDIAL key. Dial a sequence of digits representing a phone number and then press the REDIAL key. The REDIAL lamp should light in preparation for sending the number. Hit the REDIAL key again to start the redial pulsing. Redialing can be repeated as many

Turn page

TELEPHONE DIALER
continued from page 81

times as desired. The reason for the flip-flop action is that in normal use, the hook switch must be cycled before redialing to get a new dial tone. The hook switch is in series with the power supply to IC4 so it interrupts the power and resets the IC4 registers. The first operation of the REDIAL key will close a relay contact that parallels the hook switch. At that point the receiver can be hung up and picked up again without interrupting power to and resetting IC4. Now when the REDIAL button is depressed the second time, the power-bypass relay contact across the hook switch is disconnected and the transmission of the stored digits starts.

Proceed to the checkout of the ten number memory. Numbers are stored by pressing the STORE button and continuing to hold it for the entire Store operation. The first digit entered is the storage address. It can be a digit from 0 to 9 for each of the 10 storage locations in memory. The digits that follow the address are the numbers to be stored. The keyboard used here was wired so the decimal point is the ACCESS PAUSE key. Be sure to enter one or two of these intermixed with some of the test numbers.

After the first number is entered, the hook switch is flipped back and forth. Do this fairly slowly to give the reset capacitor time to charge. Then press the STORE button, the next storage location, and your next phone number. Repeat this sequence up to a total of ten times for the numbers you want to store. Switch the temporary-hook switch to the off-hook position and get ready for recalling your first number by pressing the RETRIEVE button. In contrast to the STORE button, the RETRIEVE switch is closed momentarily and does not have to be held. The next 0-9 digit entered addresses the memory originally tagged by the same digit during a Store operation, and begins the dialing of the stored number.

When an access pause is reached, the system stops with the ACCESS PAUSE LED lit. Momentary closure of the CONTINUE switch should resume the dialing sequence.

If everything checks out at this point you are ready to complete the relay connections to your phone as shown in Fig. 9. Retain the REDIAL and ACCESS PAUSE LED's in your system as visual aids in using these functions. **R-E**

PART NUMBER OF ON-OFF RELAY

I need a part number for the big on-off relay in an Admiral K18-1 chassis, and I can't find it on the service data! I don't understand this.—S.S., Delray Beach, FL.

I thought it would be simple too but it wasn't. After a protracted search through all of the factory data I finally found it. It's listed in the Tuner Cluster parts list! This is On-Off Relay K261, part no. 83A53-1, and it's used only in the 2K18-1A chassis with remote control.

BURNT RESISTORS

This Sears model 528. 42000400 came in with no picture, no sound, and no raster. Four resistors were badly charred; R361, R368, R367 and R360; diode D361 was bad. I replaced them all, and two of them burned up again—R367 and R360. Something is drawing a lot of current through these, but what?—J.G., Birmingham, AL.

After some chasing around in the schematic, I found a common source: these parts all go to the H-Pulse source, and it is shown as zero DC voltage. They come from small windings on the flyback that must be working. There is a 0.0068-μF capacitor C710-b from this point to the collector of the horizontal-output transistor. If it is shorted, the +115-volt DC supply goes directly through the pulse windings and these resistors. Replace it and see what happens.

Another possibility might be shunt capacitor C710-a on the collector of the horizontal-output transistor. If it opens, the pulses could go very high and cause this damage.

new books

TRANSISTOR IGNITION SYSTEMS, by Carroll A. Brant. TAB Books, Blue Ridge Summit, PA 17214. 252 pp. Hardcover $8.95; Paperback $5.95.

Conventional and electronic ignitions are covered in this new book. Starting with a section on basic, modern electronics for mechanics and laymen, the author branches out to transistor circuits and ignitions. All the theory needed to understand the modern ignition is presented along with illustrated and carefully explained ignition data. There are detailed instructions for tuning up new cars that follow the procedures recommended by the makers themselves.

The book includes a complete catalog and buyer's guide to the aftermarket systems that are available, making it easy to find the parts needed. Also, for the do-it-yourself'er, there are complete construction plans for a dwell extender and high-power CD ignition. All the popular makes and models are here, with complete instructions on installing, troubleshooting and tuning them.

SCANNER-MONITOR SERVICING GUIDE, by Robert G. Middleton. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46206. 96 pp. 11 × 8¼ in. Softcover $4.95.

Scanner-monitor receivers (for monitoring police, fire and other agencies who use the public service bands) have become very popular and the need for this kind of servicing has increased. Although much of the circuitry in a scanner monitor is the same as in a conventional FM receiver, there are also some highly specialized networks associated with the automatic tuning (scanner) section.

The purpose of this servicing guide is to give the technician a working knowledge of the circuits unique to scanner-monitor receivers and the troubleshooting procedures necessary to service them. The scanner-monitor technician must be familiar with noise amplifiers, squelch gates, multivibrators, diode switching, counter and decoder/driver devices, and display devices such as LED's. The guide proceeds step-by-step through the complete scanner-monitor system, with particular emphasis in specialized circuit action and troubleshooting.

HOW TO HEAR & SPEAK CB IN A SHORT-SHORT, by Whacky World Productions. TAB Books, Blue Ridge Summit, PA 17214. 172 pp. Hardcover $6.95; Paperback $3.50.

This book on CB radio is written like a novel—not in technicalese—and helps to turn meaningless CB slang into familiar language that the reader can hear loose and speak loose with the best of them.

Marvin and Bunny, the heroes, visit Whiskerman's CB mecca—The Catpatch. Whiskerman explains to them what CB radio is, who uses it, and how it is used at home and on the highway; and shows them how to use the mike, what the other controls do, the channel setup and what the strange language means—in short, all that is needed to become an active, fluent participant.

The reader accompanies Marvin (now 'Mystery Man' in CB) and Captain Beaver (Bunny's CB handle) as they cruise the interstate with Whiskerman into the unfolding CB world.

ELECTRONIC ORGANS, Volume 3, by Norman H. Crowhurst. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46206. 143 pp. 11 × 8¼ in. Softcover $7.95 (in Canada $9.50).

First generation electronic organs used vacuum tubes that were later replaced by discrete transistors. This volume presents organs incorporating third generation technology (IC's and LSI's) produced by ten well-known organ manufacturers. Being more of a state-of-the-art report than a definitive discussion of each model, the reader becomes acquainted with the latest electronic developments of various models covered in Chapters 2 through 11. Chapter 1 covers some general considerations and a review of basic transistor theory. Chapter 12 covers tuning methods and commercial tuning aids. A comprehensive glossary of organ and electronic terms is also included.

SERVICING ELECTROCARDIOGRAPHS, by Elliott S. Kanter. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46206. 224 pp. 11 × 8½ in. Softcover $12.95 (in Canada $15.50).

The electrocardiograph (ECG or EKG) has come a long way from a machine that used four buckets of ice water as electrodes and had a bulky electronics section to the current portable solid-state device. The majority of service problems are caused by improper use, poor electrode contact techniques, broken lead wires, and burned out or dirty styli, leaving a small percentage of nitty-gritty troubleshooting to carry out. Written for the electronics technician, this book presents a collection of data, parts information, schematics, and troubleshooting hints on representative sampling of the equipment found in a general hospital. **R-E**

BUILD A COMPUTER

continued from page 49

which memory location should I start the program? The answer is that your program can be put in any RAM area, so you can start your program anywhere from address H1510 to H17E9. This is the usuable RAM space that the board provides you. If you expand the RAM you could, of course, put your programs in that space also.

For an example, suppose you have the following program and want to load it into the system:

```
07 00      LODI,R3     00
06 10      LODI,R2     10
1F 00 00   BCTA,UN     0000
```

If you choose to load this program at the start of RAM, then you would alter location 1510 first. The supervisor displays the contents of 1510, and permits you to change it. Once it is changed, the next byte is displayed (1511) and you are again allowed to change it. This process continues until the entire program is loaded.

TABLE III

```
A A1510
1510 00C07
1511 00C00
1512 00C06
1513 00C10
1514 00C1E        ***note that
                  this line has a
                  mistake on it
1515 00e
A A1514
1514 1EC1F
1515 00C00
1516 00C00
1517 00e          ***done!
```

(e) represents the pressing of the escape key.

If you should make a mistake, simply press escape, and alter the location with the mistake and continue on. The way the screen would look for program would appear on the video monitor is shown in Table 3. **R-E**

NO DIGIT DIGITAL CLOCK

continued from page 37

clock, both switches are in the RUN position with the switch bats down. If you should overshoot the correct time when setting, let the hand sweep around again.

Construction

Although the actual circuit is simple, the wiring can get complex. Multiplexing to the 72 LED's necessitates the use of a double-sided printed circuit board. The foil patterns for the PC board are shown in Figs. 2 and 3. If the board is square, the clock can be mounted by the corners in a square enclosure or if cut round, it can be mounted by a single screw in the center of the round case.

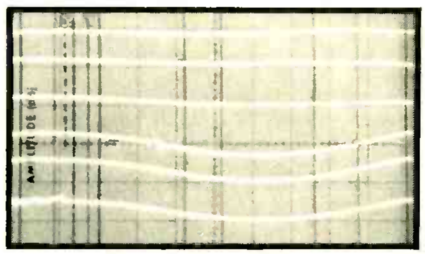
The LED's and driver transistors are mounted on the face side as shown in Fig. 4 and the balance of circuitry mounts on the rear as shown in Fig. 5. Care should be taken when mounting the LED's to insure that they are of equal height and are aligned to give an even display.

The clock can be mounted in a number of different cases. The one shown here is a clear plastic tube with a clear front. The hour positions are indicated by white plastic squares glued to the front. The old fashioned octagonal wall clock cases can also be used. This makes for an interesting combination of old craftsmanship and modern technology. **R-E**

HI-FI LAB TESTS

continued from page 64

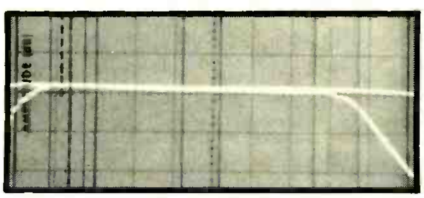
moderate compensation at progressively lower dB LEVEL control settings and again, examining the –40-dB line. we now see a bass boost of only around 6 dB at 50 Hz for this setting. It should be noted that this variable



5

loudness compensation applies only to the bass end, while the moderate amount of treble boost incorporated in the loudness circuitry remains constant regardless of the CONTOUR control position.

Figure 6 illustrates the steep and effective action of the low-cut and high-cut filters, both of which have 12 dB-per-octave slopes with the –3-dB cutoff points falling exactly as specified by Sherwood.



6

Our overall product analysis, together with our summary comments concerning features and listenability of the *model HP-2000* will be found in Table II. Even on the basis of superficial price/performance ratios, the Sherwood *model HP-2000* is a winner in every sense. But, aside from good clean power, the *model HP-2000* offers a degree of flexibility and control that rivals that of many preamplifier/basic-amplifier two-component systems costing considerably more. **R-E**

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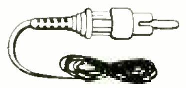

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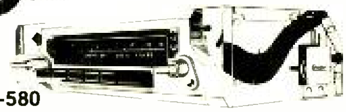

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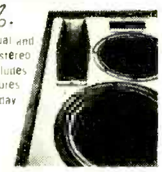

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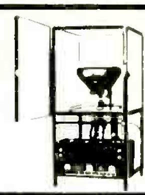

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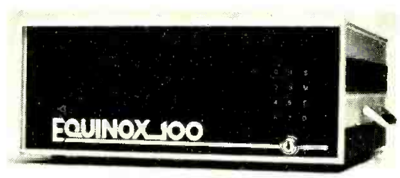

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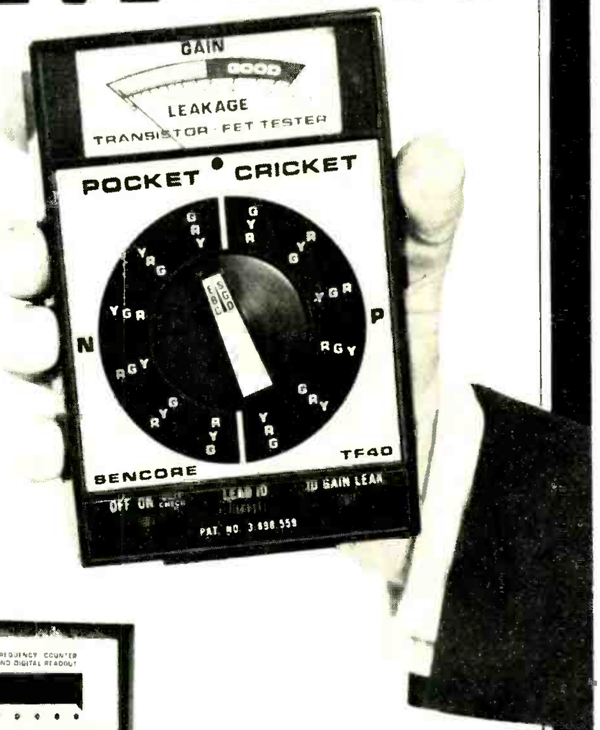

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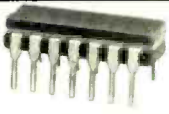

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7408	276-1822	$ 49	29¢
7410	276-1807	$ 49	29¢
7413	276-1815	$1 19	69¢
7420	276-1809	$ .49	29¢
7427	276-1823	$ .69	39¢
7432	276-1824	$ .69	39¢
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7447	276-1805	$1.99	89¢
7448	276-1816	$1 99	89¢
7451	276-1825	$ .49	29¢
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7474	276-1818	$ .79	39¢
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74145	276-1828	$1.49	1 19
74150	276-1829	$1 79	1.39
74154	276-1834	$1 79	1 19
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74C90	276-2315	$2.29	99¢
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74C193	276-2322	$2 49	1 29
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4013	276-2413	$1 29	89¢
4017	276-2417	$2 49	1 49
4020	276-2420	$2 49	1 49
4027	276-2427	$1 29	89¢
4049	276-2449	$ 99	69¢
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4518	276-2490	$2 49	1 49

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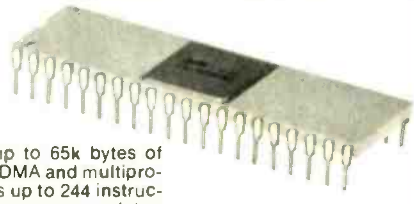

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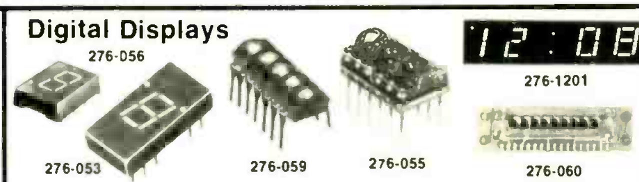
Digital Displays



Digits	Size	Drive	Cat No.	Reg	SALE
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1	0 6"	Anod	276-056	$3 99	2 99
1	0 6"	Cath	276-066	$3 99	2 99

Digits	Size	Drive	Cat. No.	Reg.	SALE
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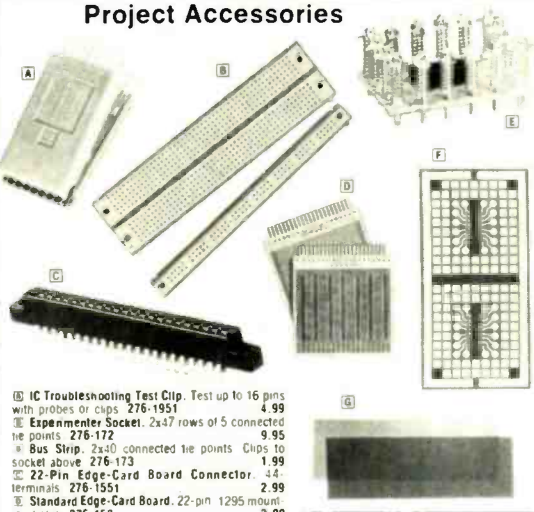
9	0 150"	Cath	276-060	$2.99	1 99
4	0 5"	Anod.	276-1201	$9.95	7 95
4	0.5"	Cath	276-1202	$9 95	7.95

Project Accessories



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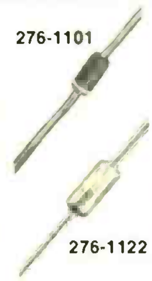

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1N4739	276-562	2/$.89	2/69¢
1N4742	276-563	2/$.89	2/69¢
1N4744	276-564	2/$ 89	2/69¢
1N5401	276-1141	2/$.69	2/59¢
1N5402	276-1142	2/$.89	2/69¢
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1N5404	276-1144	2/$1.19	2/89¢
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Triac	100V, 6A	276-1002	$1.29	79¢
Triac	200V, 6A	276-1001	$1 39	89¢
Triac	400V, 6A	276-1000	$1 49	99¢

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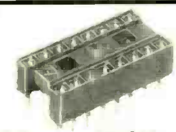

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74LS05	35	74LS85	2.49	74LS162	2.25
74LS08	29	74LS86	.49	74LS163	2.25
74LS10	29	74LS90	1.25	74LS164	1.95
74LS13	69	74LS92	1.25	74LS175	1.95
74LS14	1.75	74LS93	1.25	74LS181	3.69
74LS20	29	74LS95	1.95	74LS190	2.85
74LS26	39	74LS96	1.89	74LS191	2.85
74LS27	39	74LS107	.59	74LS192	2.85
74LS28	39	74LS109	.59	74LS193	2.85
74LS30	29	74LS112	.59	74LS194	1.89
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XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC111	Orange	4/$1

.200" dia			.185" dia			.200" dia			.085" dia.	
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XC22	Green	4/$1	XC526	Green	4/$1	XC556	Green	4/$1		
XC22	Yellow	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1	INFRA-RED LED ¼" x ¼" x 1/16	
XC22	Orange	4/$1	XC526	Orange	4/$1	XC556	Orange	4/$1	Flat	5/$1.00
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DISPLAY LEDS

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MAN 3	Common Cathode	125	3/1.00	DL701	Common Anode-red ±	300	99
MAN 4	Common Cathode	187	1.95	DL704	Common Cathode	300	99
MAN 7	Common Anode	300	1.25	DL707	Common Anode	300	99
MAN 7G	Common Anode-green	300	1.95	MAN 4740	Common Anode-Red	400	99
MAN 7Y	Common Anode-yellow	300	1.95	DL741	Common Anode	600	1.50
MAN 52	Common Anode-green	300	99	DL 747	Common Anode	600	2.25
MAN 64	Common Anode-red	400	99	DL 750	Common Cathode	600	2.49
MAN 74	Common Cathode	300	1.50	DL 338	Common Cathode	110	50
MAN 82	Common Anode-yellow	300	99	FND70	Common Cathode	250	75
MAN 84	Common Cathode-yellow	300	99	FND503	Common Cathode	500	1.00
MAN 3620	Common Anode-orange	300	1.75	FND507	Common Anode	500	1.00

FACTORY REJECTS ATARI GAME BOARDS

BOARD A — 8½" x 16 — Over 60 each reusable IC's, Misc. Transistors, Resistors, Diodes, Caps, Crystals, Switch, etc — **$6.95 ea.** ONLY 500 EA AVAILABLE

DELUXE BOARD 8 — 11½" x 18" — Over 100 each reusable IC's, Misc. Transistors, Resistors, Diodes, Caps, Crystals, Switches, LEDS, etc — **$9.95 ea.** ONLY 500 EA AVAILABLE

HP 5082-7300 Multi-Digit Series

- ⅛" Ht. • Common Cathode • Dip Package
- 3 to 5 volts @ 5 mils per segment
- 7 segment Monolithic • Red Display

2 Digit	$ .79
3 Digit	.89
4 Digit	.99
5 Digit	1.19

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

14 pin	$ 27	25	24	28 pin	$ 99	90	81
16 pin	30	27	25	36 pin	1.39	1.26	1.15
18 pin	35	32	30	40 pin	1.59	1.45	1.30
24 pin	49	45	42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$ 30	27	24	24 pin	$ 70	63	57
14 pin	35	32	29	28 pin	1.10	1.00	90
16 pin	38	35	32	36 pin	1.75	1.40	1.26
18 pin	52	47	43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

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

Plastic Push Button Switch

- 18 AWG Solid Wire - 5" Long
- .50 (wide) X .60 (high) ⅜-27 Thread
- 8 AMP @ 14 Volt - 1 AMP @ 110 Volt

		1-9	10-Up
J-188-1	Push On-Push Off	59	49
J-188-2	Normally Open	.59	49
J-188-3	Normally Closed	59	.49

MINATURE TOGGLE SWITCH

JMT-221	DPDT	on/off/on	$1.95
JMT-223	DPDT	on/none/on	$1.75
JMT-121	SPDT	on/off/on	$1.50
JMT-123	SPDT	on/none/on	$1.25

CLIPLITE 8/$1.49

LED MOUNTING SYSTEM
use with XC556 LEDS
Specify Colors — Red - Green - Amber - Yellow

DIP SWITCHES

SPST Slide Action

#206-4 (8 pin dip) 4 switch unit	$1.75 ea.
#206-7 (14 pin dip) 7 switch unit	$1.95 ea.
#206-8 (16 pin dip) 8 switch unit	$2.25 ea.

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.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$10.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1977A Catalog
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WIRE WRAP CENTER

HOBBY-WRAP TOOL-BW-630

- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)
Complete with built-in bit and sleeve

$34.95
(batteries not included)

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

$11.95

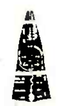
WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

CUTTER CRIMPER TOOL (CS-8)



- Plier Nose (serrated-jaw)
- Scissors Action Cutting
- 6 Bolt Cutters (4-40, 5-40, 6-32, 8-32, 10-32, 10-24)
- Crimp Stations (7mm Auto — 22-20 to 12-X0 elect.)
- "Up-Front" Wire Cutting
- Scissors Action Stripping (No. 22-20 to No. 10)
- Crimp Stations — insulated (2w-20 to 12-10 elect.)

Actual Size - 8¼" length **$8.50**

Permacel Electrical Tape

- ¾" (wide) X 66 ft (long) • All weather • Not import

$1.25 per roll — $9.95 per 10 roll package

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS

MPS A05	5/$1.00			PN4249	4/$1.00
MPS A06	5/$1.00			PN4250	4/$1.00
2N2219A	3/$1.00	PN3567	3/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3568	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	PN3569	4/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3704	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3705	5/$1.00	2N4409	5/$1.00
2N2484	4/$1.00	2N3706	5/$1.00	2N5086	4/$1.00
2N2906A	4/$1.00	2N3707	5/$1.00	2N5087	4/$1.00
2N2907A	5/$1.00	2N3711	5/$1.00	2N5088	4/$1.00
2N2925	5/$1.00	2N3724	$ .65	2N5089	4/$1.00
2N3053	2/$1.00	2N3725	$1.00	2N5129	5/$1.00
2N3055	$ .89	2N3903	5/$1.00	2N5138	5/$1.00
MJE3055	$1.00	2N3904	4/$1.00	2N5139	5/$1.00
MJE2955	$1.25	2N3905	4/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N3906	4/$1.00	2N5951	5/$1.00
2N3398	5/$1.00	2N4013	3/$1.00	C106B1SCR	2/$1.00
		2N4014	3/$1.00	2N5432	$2.00
		2N4123	10/$1.00		

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

CIRCLE 5 ON FREE INFORMATION CARD

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

XR-2206KB Kit $27.00 **Special** XR-2206KA Kit $17.00

EXAR

WAVEFORM GENERATORS		MISCELLANEOUS		TIMERS	
XR-205	$8.40	XR-2211CP	$6.70	XR-555CP	$ .39
XR-2206CP	4.49	XR-4136	.99	XR-320P	1.55
XR-2207CP	3.85	XR-1468	3.85	XR-556CP	1.85
STEREO DECODERS		XR-1488	5.80	XR-2556CP	3.20
XR-1310CP	$3.20	XR-1489	4.80	XR-2240CP	3.25
XR-1310EP	3.20	XR-2208	5.20	**PHASE LOCKED LOOPS**	
XR-1800P	3.20			XR-210	5.20
XR-2567	2.99			XR-215	6.60
				XR-567CP	1.95
				XR-567CT	1.70

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out

Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100 (.100 Spacing)	PINS (Solder Eyelet)	$6.95

25 PIN-D SUBMINATURE

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95

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

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. **SPECIAL $7.95**

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

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

1/16 VECTOR BOARD

	0.1" Hole Spacing Part No	P-Pattern L	W	Price 1	2-Up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

HEAT SINKS

205-CB	Beryllium Copper Heat Sink with Black Finish for TO-5	$ .25
291-.36H	Aluminum Heat Sink for TO-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum	$1.60

HEXADECIMAL ENCODER 19-KEY PAD

- 1 - 0
- ABCDEF
- Return Key
- Optional Key (Period)
- — Key

$10.95 each

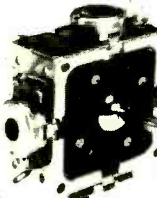
63 KEY KEYBOARD

This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications.

$19.95

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four 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.

Special *5K Pots $4.95
*100K Pots $7.95

MICROPROCESSOR COMPONENTS

8080A	CPU	$19.95	8228	System Controller - Bus Driver	$10.95
8212	8 Bit Input/Output	4.95	MC6800L	8 Bit MPU	35.00
8214	Priority Interrupt Control	15.95	MC6820L	Periph. Interface Adapter	15.00
8216	Bi-Directional Bus Driver	6.95	MC6810AP1	128 x 8 Static RAM	6.00
8224	Clock Generator/Driver	10.95	MC6830L7	1024 x 8 Bit ROM	18.00
CDP1802	- with user manual	39.95	Z80	CPU	49.95

CPU'S

8080	Super 8008	24.95
8080A	Super 8008	19.95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	7.00
2519	Hex 40 BIT	4.00
2524	512 Dynamic	2.49
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	Special 5.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95

UART'S

AY-5-1013	30K Baud	$5.95

ROM'S

2513	Char Gen	$ 9.95
2516	Char Gen	10.95

RAM'S

1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107/5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
7489	16 x 4	Static	2.49
8101	256 x 4	Static	6.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
91L02	1024 x 1	Static	2.25
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	2 for 1.00

PROMS

1702A	2048	Famos	$ 9.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	5.00
74S287	1024	Static	[illegible] 95
3601	256 x 4	Fast	3.95
2708	8K	Eprom	29.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95
6331-1	256	Tri-State Bipolar	2.95

SPECIAL REQUESTED ITEMS

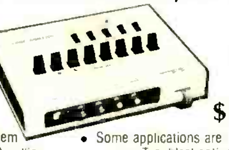
AY-3-8500-1	$19.95						
MC3061P	3.50	CD4508	6.75	82S115	25.00	3341	6.95
MC4016P (74416)	7.50	CD4515	6.50	5841	9.95	9368	3.95
MC14583	3.50	CD4520	2.70	MK50240	17.50	MC1408L7	9.95
MC14562	14.50	MCM6571	17.50	11C90	19.95	LD110/LD111	25.00/set
CD4059	9.95	MCM6574	17.50	DS0026CH	3.75	AY-5-9100	17.50 ea
CD4070	.95	MCM6575	17.50	TIL308	10.50	95H90	13.95

PARATRONICS

ALLOW 1 TO 3 WEEKS DELIVERY

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit



MODEL 100A
$189.00/Kit

- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Some applications are
  - Troubleshooting microprocessor address, instruction, and data flow
  - Examine contents of ROMS
  - Tracing operation of control logic
  - Checking counter and shift register operation
  - Monitoring I/O sequences
  - Verifying proper system operations during testing
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

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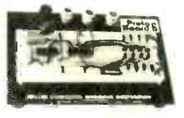
Introductory Offer — all 6 books (worth $49.95)
SPECIAL - $42.95

CONTINENTAL SPECIALTIES

PROTO BOARD 6
$15.95
(6" long X 4" wide)



Other CS Proto Boards

PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	75.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	120.00

Logic Monitor $84.95
for DTL, HTL, TTL or CMOS Devices

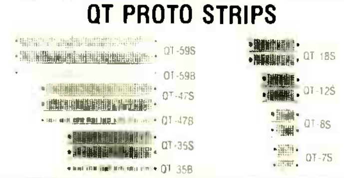
PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50

DESIGN MATES

DM1 - Circuit Designer 54.95
DM2 - Function Generator 69.95
DM3 - RC Bridge 59.95

QT PROTO STRIPS



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

Experimentor 300	$ 9.95
Experimentor 600	$10.95

$5.00 Minimum Order — U.S. Funds Only
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- Doze Button
- 100% Solid State
- Large Red Led Display (.8" high)
- AM PM Indicator
- Seconds display at touch of button
- Power failure indicator
- One year factory warranty

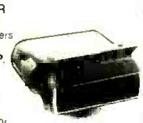
C-500 - Ivory Case
C-500B - Ebony Case
$16.95

C-8211
Woodgrain Case
$19.95

DIGITAL AUTO INSTRUMENT

SEVEN DIFFERENT INSTRUMENTS!
MEETS OR EXCEEDS ORIGINAL AUTOMOTIVE SPECS

Please specify which one of the seven models you want when ordering – these do not all come in one unit. Each model must be bought separately



1. TACHOMETER 0-9900 RPM 4, 6 or 8 Cyclinders
2. WATER TEMP. 100-250° F
3. FUEL LEVEL Percentage Low Fuel Indicator
4. SPEEDOMETER* 0-99 MPH
5. OIL PRESSURE 0-80 PSI
6. OIL TEMP 200-350° F
7. BATTERY MONITOR ±1 Volts From 11-15 VDC

BRIGHT YELLOW ORANGE .3" LED DISPLAY!

Kit includes case, bracket and all components — complete
Nothing else to buy! 12 Volt NEG GRD
DIMENSIONS 4½ x 4 x 2 **KIT: $49.95**
* Add $10.00 for required speed transducer **ASSEMBLED: $59.95**

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

ELECTRONIC 'PENDULUM' CLOCK

- Swing Pendulum
- .7" Hours and Minutes Display
- 12 or 24 Hour Mode
- Time Set Push Buttons
- Alarm Feature

Kit-unfinished (case unassembled) $59.95
Assembled-stained (case assembled) $69.95

QUARTZ DIGITAL AUTO CLOCK OR ELAPSED TIMER!

Elapsed Timer: Hrs, Mins and Secs
12 or 24 Hr Capacity
Simple Reset - Start Pushbutton Control

Complete kit includes mounting bracket, case and all components, nothing else to buy. Features MM5314 chip. Large .4" LED's. Accuracy better than ± min per mo. internal battery backup. 12 volt non-polar operation.

DIMENSIONS 4½ x 4 x 2
12 or 24 HOUR MODE

Kit: $29.95
Assembled: $39.95

CASE ONLY (includes hardware, mounting bracket and bezel) **$6.50**

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" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

$17.95

DIGITAL CLOCK KIT — 3½ INCH DIGITS

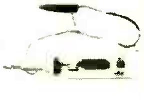
4 DIGIT KIT $49.95 **4 DIGIT ASSEMBLED $59.95**
6 DIGIT KIT $69.95 **6 DIGIT ASSEMBLED $79.95**

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

Specify 12 or 24 Hour When Ordering

JE803 PROBE

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



$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

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

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CB SPECIALS—R.F. DRIVERS—R.F. POWER OUTPUTS—FETS

2SC481	1.85	2SC767	15.75	2SC866	5.85	2SC1449-1	1.60	40081	1.50
2SC482	1.75	2SC773	.85	2SC1013	1.50	2SC1475	1.50	40082	3.00
2SC495	1.10	2SC774	1.75	2SC1014	1.50	2SC1678	5.50	2SC608	4.85
2SC502	3.75	2SC775	2.75	2SC1017	1.50	2SC1679	4.75	SK3046	2.15
2SC517	4.75	2SC776	3.00	2SC1018	1.50	2SC1728	2.15	SK3047	3.75
2SC614	3.80	2SC777	4.75	2SC1173	1.25	2SC1760	2.15	SJ2095	3.50
2SC615	3.90	2SC778	3.25	2SC1226A	1.25	2SC1816	5.50	SK3048	3.25
2SC616	4.15	2SC797	2.50	2SC1237	4.50	2SC1908	.70	SK3054	1.25
2SC617	4.25	2SC798	3.10	2SC1239	3.50	2SC1957	1.50		
2SC699	4.75	2SC781	3.00	2SC1243	1.50	2SF8	3.00	2SK19	1.75
2SC710	.70	2SC789	1.00	2SC1306	4.75	HEP-S 3001	3.25	2SK30	1.00
2SC711	.70	2SC796	3.15	2SC1306-1	4.90	2SD235	1.00	2SK33	1.20
2SC735	.70	2SC799	4.25	2SC1307	5.75	MRF8004	3.00		
2SC756	3.00	2SC802	3.75	2SC1307-1	6.00	4004	3.00	3SK40	2.75
2SC765	9.50	2SC803	4.00	2SC1377	5.50	4005	3.00	3SK45	2.75
2SC766	10.15	2SC839	.85	2SC1449	1.30	40080	1.25	3SK49	2.75

JAPANESE TRANSISTORS

2SA52	.60	2SB187	.60	2SC458	.70	2SC815	.75	2SC1569	1.25
2SA316	.75	2SB235	1.75	2SC460	.70	2SC828	.75	2SC1756	1.25
2SA473	.75	2SB303	.65	2SC478	.80	2SC829	.75		
2SA483	1.95	2SB324	1.00	2SC491	2.50	2SC830	1.60	2SD30	.95
2SA489	.80	2SB337	2.10	2SC497	1.60	2SC839	.85	2SD45	2.00
2SA490	.70	2SB367	1.60	2SC515	.80	2SC945	.65	2SD65	.75
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
2SA679	3.75	2SB471	1.75	2SC627	1.75	2SC1098	1.15	2SD201	1.95
2SA682	.85	2SB474	1.50	2SC642	3.50	2SC1115	2.75	2SD218	4.75
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
2SB77	.70	2SC261	.65	2SC733	.70	2SC1347	.80	2SD-390	.75
2SB128	2.25	2SC291	.65	2SC739	.70	2SC1383	.75	2SD437	5.50
2SB135	.95	2SC320	2.00	2SC715	1.75	2SC1409	1.25		
2SB152	4.50	2SC352	.75	2SC762	1.90	2SC1410	1.25	MPS-U31	4.00
2SB173	.55	2SC353	.75	2SC783	1.00	2SC1447	1.25	MPS8000	1.25
2SB175	.55	2SC371	.70	2SC784	.70	2SC1448	1.25		
2SB178	1.00	2SC372	.70	2SC785	1.00	2SC1507	1.25		
2SB186	.60	2SC394	.70	2SC793	2.50	2SC1509	1.25		

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BU204	1300V	3.90	BU207	1300V	5.40	2SC1172B	1100V	4.25
BU205	1500V	4.70	BU208	1500V	6.25	2SC1308	1100V	4.95
BU206	1700V	5.90	2SC1170	1100V	4.00	2SC1325	1100V	4.95

OEM SPECIALS

1N270	.10	2N960	.55	2N2219A	.30	2N2913	.75	2N3740	1.00	2N4401	.20
1N914	.10	2N962	.40	2N2221	.25	2N2914	1.20	2N3771	1.75	2N4402	.20
		2N967	.50	2N2221A	.30	2N2916A	3.65	2N3772	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	1.25	2N2270	.40	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1305	.75	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	.75	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	2N1557	1.15	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
2N720A	.50	2N2102	.40	2N2906	.25	2N3645	.15	2N4143	.20	2N5458	.30
2N918	.35	2N2218	.25	2N2906A	.30	2N3646	.14	2N4220A	.45	C103y	.25
2N930	.25	2N2218A	.30	2N2907	.25	2N3730	1.50	2N4234	.95	C103d	.40
2N956	.30	2N2219	.25	2N2907A	.30	2N3731	2.75	2N4400	.20	C106b1	.50
										C106di	.75

SILICON UNIJUNCTIONS

2N2646	.50	2N4871	.50
2N2647	.60	2N4891	.50
2N6027	.55	2N4892	.50
2N6028	.70	2N4893	.50
D5E37	.25	2N4894	.50
2N2160	.65	MU10	.40
2N4870	.50		

INTEGRATED CIRC.

UA703C	.40
709C OP. AMP.	.25
741C OP. AMP.	.25
7400	.15
TA7061P	3.50
TA7205P	8.00
UPC1001h2	6.00
Ne555	1.25

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IN4001	.60	5.00
IN4002	.70	6.00
IN4003	.80	7.00
IN4004	.90	8.00
IN4005	1.00	9.00
IN4006	1.10	10.00
IN4007	1.20	11.00

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74LS01	.28	74LS32	.33	74LS92	.57	74LS158	.75	74LS249	.79
74LS02	.28	74LS37	.33	74LS93	.57	74LS160	1.02	74LS253	.84
74LS03	.28	74LS38	.33	74LS107	.39	74LS161	1.02	74LS257	.75
74LS04	.29	74LS40	.28	74LS109	.39	74LS162	1.02	74LS258	.75
74LS05	.29	74LS42	.67	74LS112	.39	74LS163	1.02	74LS266	.39
74LS08	.29	74LS47	.79	74LS113	.39	74LS164	1.02	74LS283	.79
74LS09	.29	74LS48	.77	74LS114	.39	74LS168	1.14	74LS290	.65
74LS10	.28	74LS51	.28	74LS125	.49	74LS169	1.14	74LS293	.65
74LS11	.28	74LS54	.28	74LS126	.49	74LS170	1.73	74LS365	.67
74LS12	.28	75LS55	.28	74LS132	.81	74LS173	1.34	74LS366	.67
74LS13	.47	74LS73	.39	74LS136	.39	74LS174	1.06	74LS367	.67
74LS14	1.02	74LS74	.39	74LS138	.73	74LS175	.84	74LS368	.67
74LS15	.28	74LS75	.53	74LS139	.73	74LS190	1.18	74LS386	.39
74LS20	.28	74LS76	.39	74LS151	.75	74LS191	1.18	74LS670	2.34
74LS21	.28	74LS78	.39	74LS153	.75	74LS196	.86	71LS95	.77
74LS22	.28	74LS83	.79	74LS154	1.10	74LS197	.86	71LS96	.77
74LS26	.33	74LS86	.39	74LS155	.75	74LS247	.79	71LS97	.77
74LS27	.33			74LS156	.75			71LS98	.77

INTEGRATED CIRCUITS — TTL, CMOS, LINEAR & MOS

7400	.21	7476	.32	74181	2.15	4012	.23	4520	1.14
7401	.21	7480	.70	74182	.79	4013	.40	4527	1.68
7402	.21	7482	.70	74184	2.19	4014	.96	4528	.88
7403	.21	7483	.70	74185	2.19	4015	.96	4585	1.23
7404	.21	7485	.89	74188	3.50	4016	.40	2102-1	1.99
7405	.21	7486	.28	74189	3.50	4017	1.05	8080A	24.95
7406	.25	7489	2.19	74190	1.23	4018	1.05	CA3046	.75
7407	.25	7490	.44	74191	1.23	4019	.23	LM2111N	1.25
7408	.21	7491	.70	74192	.88	4020	1.14	LM309K	1.80
7409	.21	7492	.44	74193	.88	4021	1.14	LM324A	1.28
7410	.21	7493	.44	74194	.88	4022	.96	LM340T-5	1.25
7411	.21	7494	.70	74195	.88	4023	.23	LM340T-6	1.25
7412	.21	7495	.70	74196	.88	4024	.84	LM340T-8	1.25
7413	.25	7496	.70	74197	.88	4025	.23	LM340T-12	1.25
7414	.89	74100	1.28	74198	1.49	4026	1.68	LM340T-15	1.25
7416	.25	74107	.30	74199	1.49	4027	.40	LM340T-18	1.25
7417	.25	74109	.33	74251	1.09	4028	.89	LM340T-24	1.25
7420	.21	74121	.35	74279	.55	4029	1.14	LM3900N	.88
7421	.25	74122	.44	74365	.67	4030	.23	LM3909N	.69
7423	.35	74123	.61	74366	.67	4033	1.51	MC1456V	1.00
7425	.35	74125	.40	74367	.67	4034	3.50	MC1458V	.53
7426	.25	74126	.40	74368	.67	4035	1.14	MC3302P	1.15
7427	.33	74132	.70	8093	.40	4040	1.14	NE536T	3.24
7428	.28	74141	.88	8094	.40	4041	.79	NE540L	2.04
7430	.21	74145	.70	9095	.67	4042	.79	NE555V	.48
7432	.25	74147	1.63	8096	.67	4043	.70	NE556A	.88
7433	.30	74148	1.30	8097	.67	4044	.70	NE560B	3.83
7437	.25	74150	1.16	8098	.67	4046	1.86	NE561B	3.83
7438	.25	74151	.70	75150	1.16	4049	.40	NE562B	3.83
7440	.21	74153	.65	75450	.88	4050	.40	NE565A	1.25
7442	.53	74154	1.03	75451	.61	4051	1.26	NE566V	1.28
7443	.63	74155	.70	75452	.61	4052	1.26	NE567V	1.36
7445	.70	74156	.70	75453	.61	4053	1.26	uA709CV	.44
7446	.70	74157	.70	75454	.61	4060	1.58	uA710CA	.44
7447	.70	74160	.88	75491	.81	4066	.79	uA711CA	.53
7448	.70	74161	.88	75492	.84	4071	.23	uA723CA	.60
7450	.21	74162	.88	75493	1.09	4072	.23	uA733CA	.75
7451	.21	74163	.88	75494	1.19	4073	.23	uA741CV	.44
7453	.21	74164	.96	82S25	2.19	4075	.23	uA747CA	.70
7454	.21	74165	1.15	4000	.23	4081	.23	uA748CV	.49
7459	.21	74166	1.26	4001	.23	4082	.23	uA7805CU	1.25
7460	.21	74170	2.64	4002	.23	4502	.79	uA7806CU	1.25
7470	.30	74173	1.42	4006	1.23	4510	1.14	uA7808CU	1.25
7472	.30	74174	.98	4007	.23	4511	1.05	uA7812CU	1.25
7473	.30	74175	.93	4008	.79	4514	2.80	uA7815CU	1.25
7474	.30	74176	.79	4009	.44	4515	2.80	uA7818CU	1.25
7475	.49	74177	.79	4010	.44	4516	1.23	uA7824CU	1.25
		74180	.70	4011	.23	4518	1.14		

WIRE WRAPPING WIRE IN BULK

Red or Black 30 ga. Kynar

100' $2.00 500' $8.50 1000' $15.00

SILICON DIODES

1N4001	.64/10	5.50/C	$49/M
1N4002	.66/10	5.60/C	$51/M
1N4003	.68/10	5.80/C	$52/M
1N4004	.70/10	5.95/C	$54/M
1N4005	.82/10	7.05/C	$63/M
1N4006	.90/10	7.75/C	$69/M
1N4007	.99/10	8.60/C	$77/M
1N4148	.40/10	3.50/C	$29/M

Double Digit Discounts Save You Even More!

½ WATT ZENER DIODES

1N5226B	3.3v	.15	$11/C	1N5236B	7.5v	.15	$11/C
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
1N5232B	5.6v	.15	$11/C	1N5242B	12v	.15	$11/C
1N5233B	6.0v	.15	$11/C	1N5243B	13v	.15	$11/C
1N5234B	6.2v	.15	$11/C	1N5244B	14v	.15	$11/C
1N5235V	6.8v	.15	$11/C	1N5245B	15v	.15	$11/C

BUY A-P PRODUCTS & BISHOP GRAPHICS FROM DIGI-KEY

PLESSEY SAMPLER

An Assortment of Metalized Polyester Capacitors

300 Caps 18 Values $26.00

LED LAMPS

NSL5053 T-1¾ .... .18 $15/C
NSL5056 T-1¾ .... .18 $15/C

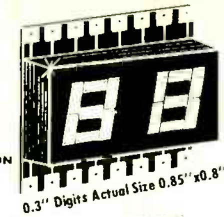
LED DUAL DIGITS

PRICED PER PAIR OF 2 DIGITS

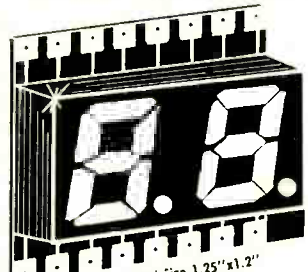
NEW!

NSN373 0.3" CC . $2.20/Pair
NSN374 0.3" CA . $2.20/Pair
NSN584 0.5" CC . $2.60/Pair
NSN584 0.5" CA . $2.60/Pair
NSN783 0.7" CC . $3.00/Pair
NSN784 0.7" CA . $3.00/Pair

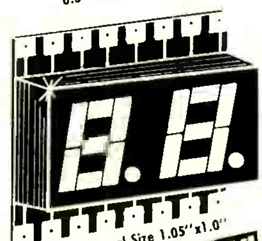
ALL LEADS BROUGHT OUT FOR EASE OF APPLICATION



0.3" Digits Actual Size 0.85"x0.8"



0.7" Digits Actual Size 1.25"x1.2"



0.5" Digits Actual Size 1.05"x1.0"

NEW!

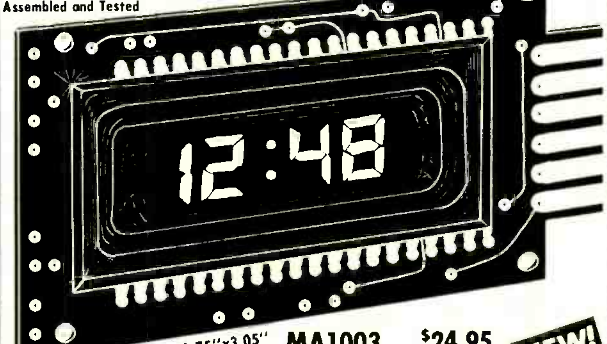
MA1003 CAR CLOCK

NEW — FOR CAR OR BOAT!

12 Hour Only
12 Volt DC
Crystal Time Base
Bright Green Digits
Assembled and Tested

NEW!

The MA1003 bright green flourescent display offers a brilliance that cannot be achieved by LED displays, a feature that sold Detroit!



0.3" Digits Actual Size 1.75"x3.05"

MA1003 ..... $24.95
Includes 3 Push Button Switches

NEW!

MA1002 0.5" High Digits

Actual Size: 1.375"x3.05"

MA1002A 12 Hour AM-PM $10.50
MA1002C 24 Hour $10.50
SPECIAL TRANSFORMER & SWITCHES $3.45

ABOUT OUR CLOCKS

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transofmer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module with Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$24.95
MA1010A	84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module with Transformer & Switches	$16.45
MA1010C	84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module with Transformer & Switches	$16.45

RADIAL ELECTROLYTICS

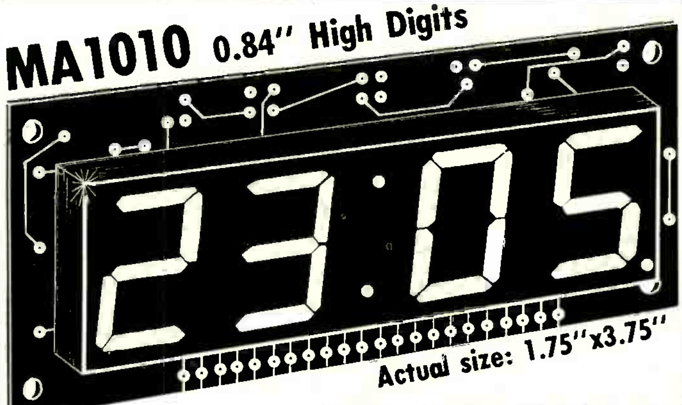
.47/50V	.08	.65/10	22/50V	.12	1.00/10	330/25V	.23	1.86/10
1/50V	.08	.65/10	100/6.3V	.09	.75/10	470/10R	.21	1.71/10
2.2/50V	.08	.65/10	100/10V	.10	.77/10	470/16V	.23	1.81/10
3.3/50V	.08	.65/10	100/16V	.11	.85/10	470/25V	.29	2.35/10
4.7/35V	.08	.65/10	100/25V	.13	1.10/10	1000/10V	.24	1.96/10
4.7/50V	.08	.68/10	100/50V	.21	1.71/10	1000/16V	.29	2.35/10
10/16V	.08	.65/10	220/10V	.13	1.08/10	1000/25V	.42	3.33/10
10/25V	.08	.65/10	220/16V	.15	1.16/10	2200/10V	.42	3.33/10
10/50V	.10	.75/10	220/25V	.21	1.71/10	2200/16V	.54	4.30/10
22/16V	.08	.67/10	220/50V	.29	2.35/10	2200/25V	.58	4.67/10
22/25V	.09	.70/10	330/10V	.15	1.16/10	3300/16V	.89	7.14/10
			330/16V	.21	1.66/10			

AXIAL ELECTROLYTICS

.47/10V	.11	.90/10	33/25V	.14	1.15/10	330/16V	.29	2.35/10
1/30V	.11	.90/10	33/50V	.19	1.52/10	330/25V	.32	2.54/10
3.3/35V	.12	.95/10	47/16V	.14	1.15/10	470/16V	.32	2.55/10
3.3/50V	.12	1.00/10	47/25V	.17	1.30/10	470/25V	.37	3.00/10
4.7/25V	.11	.90/10	47/50V	.21	1.17/10	1000/10V	.33	2.65/10
4.7/35V	.12	.95/10	100/10V	.14	1.13/10	1000/16V	.39	3.15/10
4.7/50V	.12	1.00/10	100/16V	.17	1.30/10	1000/25V	.56	4.50/10
10/25V	.12	1.00/10	100/25V	.20	1.55/10	2200/10V	.50	3.96/10
10/50V	.14	1.15/10	100/50V	.29	2.30/10	2200/16V	.62	4.95/10
22/16V	.12	1.00/10	220/10V	.18	1.42/10	2200/25V	.79	6.36/10
22/25V	.13	1.05/10	220/16V	.20	1.55/10	3300/16V	.95	7.63/10
22/50V	.17	1.32/10	220/25V	.29	2.35/10	4700/16V	1.09	8.70/10
33/16V	.12	1.00/10	220/50V	.40	3.23/10	10000/10V	1.15	9.19/10
			330/10V	.14	1.16/10			

Double Digit Discounts Save You Even More!

MA1010 0.84" High Digits



Actual size: 1.75"x3.75"

MA1010A 12 Hour AM-PM $13.00
MA1010C 24 Hour $13.00
SPECIAL TRANSFORMER & SWITCHES $3.45

DATA BOOKS

TTL IC's 595 p.	$4.00
Linear IC's 957 p	$5.00
CMOS 74C 256 p	$3.00
Memory IC's 592 p	$3.00
Interface IC's 464 p	$4.00
Volt. Regs. 128 p.	$3.00
Linear Appl. 1 432 p.	$4.00
Linear Appl. 2 246 p.	$3.00
Audio 196 p	$3.00
MOS/LSI IC's 713 p	$4.00
CMOS 4000 278 p	$3.25
Analog Manual 637 p	$5.95

SLIDE SWITCHES

SPST	.15	1.20/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

STRANDED HOOK UP WIRE

20 ga PVC	2.50/100'	10.00/500'
22 ga PVC	2.80/100'	11.25/500'
24 ga PVC	2.10/100'	8.50/500'
26 ga PVC	2.10/100'	8.50/500'

50 VOLT DISCS

100 pf	.40/10	3.50/C
220 pf	.40/10	3.50/C
470 pf	.40/10	3.50/C
.001 uf	.40/10	3.50/C
.0022 uf	.40/10	3.50/C
.0047 uf	.40/10	3.50/C
.01 uf	.45/10	3.65/C
.022 uf	.50/10	4.00/C
.047 uf	.70/10	5.60/C
.1 uf	1.35/10	11.50/C

WIRE-WRAPPING TOOL

$5.95
Wraps, Unwraps & Strips 30 ga. Wire

¼ & ½ WATT 5% CARBON FILM RESISTORS

5c each in multiples of 5 per value
$1.70/100 & $12.00/1000 of same value

1 ohm thru 1.0 megohm

I.C. SOCKETS

8 Pin Solder	.17	1.60/10
14 Pin Solder	.20	1.90/10
16 Pin Solder	.22	2.10/10
18 Pin Solder	.29	2.75/10
24 Pin Solder	.38	3.60/10
28 Pin Solder	.45	4.25/10
40 Pin Solder	.63	6.00/10
8 Pin W-W	.24	2.30/10
14 Pin W-W	.26	2.50/10
16 Pin W-W	.30	2.85/10
18 Pin W-W	.60	5.70/10
24 Pin W-W	.96	9.10/10
28 Pin W-W	1.12	10.00/10
40 Pin W-W	.92	8.75/10

HARDWARE

2-56 1/4 Screw	.99/C	7.20/M
2-56 1/2 Screw	.99/C	7.65/M
4-40 1/4 Screw	.55/C	3.60/M
4-40 1/2 Screw	.60/C	4.05/M
6-32 1/4 Screw	.65/C	4.40/M
6-32 1/2 Screw	.75/C	4.85/M
8-32 3/8 Screw	.90/C	5.85/M
8-32 5/8 Screw	.99/C	7.00/M
2-56 Hex Nut	.55/C	3.60/M
4-40 Hex 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
No. 4 Lockwasher	.45/C	3.00/M
No. 6 Lockwasher	.45/C	3.00/M
No. 8 Lockwasher	.45/C	3.00/M

DOUBLE-DIGIT DISCOUNT SCHEDULE

Merchandise	Discount	Merchandise	Discount
$ 0.00-$24.99	NET	$100.00-$499.99	Less 15%
		$500.00-$999.99	Less 20%
$25.99-$99.99	Less 10%	$1000.00 & Up	Less 25%

Then Add the Standard Charge Below

STANDARD SHIPPING/HANDLING CHARGE

If your merchandise total after discount is between

$ 0.00-$ 4.99	add $2.00	$ 50.00-$99.99	add $0.25
$ 5.00-$24.99	add $0.75	$100.00 & up	No Charge
$25.00-$49.99	add $0.50		

Includes shipping and insurance to USA & Canada

COD ORDERS ACCEPTED FOR SAME DAY SHIPMENT — CALL 218-681-6674

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your BANKAMERICARD welcome here

Memorex computer boards with IC's, diodes, transistor, etc. 5 Boards containing 100 – 200 IC's
ONLY $ 4.25

BRIDGE RECTIFIERS

1 Amp	50V	.85
6 Amp	50V	1.10
10 Amp	50V	1.25
25 Amp	50V	1.39

RESISTORS

Over 50,000,000 in stock

*330 ohm	22K ohm
470 ohm	27K ohm
**680 ohm	33K ohm
1K ohm	39K ohm
1.2K ohm	43K ohm
2.2K ohm	47K ohm
3.3K ohm	82K ohm
4.7K ohm	100K ohm
6.8K ohm	150K ohm
10K ohm	220K ohm
20K ohm	

*1/8 W only
**1/2 W only

All resistors are P.C. Lead but are not pull offs.
100 min. order for each value

NO MIX 100/.99

MK 5005

4 digit counter/latch decoder; 7 segment output only. 24 pin dip with specs.
$ 8.00 EACH

UNSCRAMBLER KIT

for all Scanners

- Tunes easily
- Full instructions included
- Easy to install
- 3½" x 3½" x 1½"

ONLY $14.95

PLASMA DISPLAY KIT

Kit Includes: 12 digit display .4" Character Power supply for display above Complete specs for hookup.

Line cord Not Included. **ONLY $ 3.95**

RCA 200V 115W
NPN Transistor
ONLY $ .95

PROJECT CASES

Small	Med.	Large
$1.50	$2.00	$2.75
D-2-1/2"	D-2"	D-2-1/2"
W-4-3/4"	W-4-7/8"	W-7"
H-1-7/8"	H-3-1/2"	H-4"

All cases have a sloped front, white with black wrinkle finish.

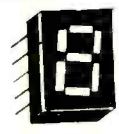
REGULATORS

7805	7818
7806	7824
7808	7905
7812	7912
7815	7915

Your Choice $ .85

READOUTS

Best Value!



FND70 .4"C.C. .59
FND800 .8"C.C. 1.69
TI 6 digit array C.C. 3/1.00
MAN 8 .3"CA Yellow .89
LT767 .7" C.C. 4 digit stick $ 3.95

WATERGATE SPECIAL

Telephone Relay automatically starts and stops tape recorder. No batteries required. Kit complete with drilled P.C. Board.

Parts and Case ONLY $9.95

VARIABLE POWER SUPPLY KIT NO. 1

*Continously variable from 5V to 20V
*Excellent regulation up to 300 mil.
*4400 Mfd of filtering
*Drilled fiberglass PC Board
*One hour assembly
*Kit includes all components
*Case included

ONLY $ 9.00

VARIABLE POWER SUPPLY KIT NO. 2

Same as above but with 1 amp output, also with case.

ONLY $ 12.00

CLOCK CHIPS

FCM 7010 w/specs $ 3.75
MK 50380 w/specs $ 3.75
MK 50252 w/specs $ 4.50

CLOCK KIT

Kit includes
- LT701 clock module
- Power Supply
- Punched case
- 12 or 24 hour operation

Complete except for line cord

LT701E 12 hour clock
LT701G 24 hour clock

ONLY $14.95

BATTERY CLIPS

Standard 9V battery clip with 4-1/2" tinned leads. **25/$1.00**

TRANSISTORS DIODES

*MJE1103	3/1.00
MJ3001	1.30
2N2222	6/1.00
2N2369	6/1.00
2N2905	4/1.00
*2N2907	15/1.00
2N3906	6/1.00
2N4400	6/1.00
2N4443 SCR	3/1.00
1N4004	15/1.00
1N4007	10/1.00
1N4148 (1N914)	20/1.00
3N201 VHF Pre amp	.80
D40C1 Power Darl	8/1.00

*House numbered and P.C. Lead

PC BOARDS

4 digit PCB for FND800 or 807	2.50
6 digit PCB for FND800 or 807	3.50
4 digit PCB for DL707	1.50
6 digit PCB for DL707	2.00
4 digit PCB for FND503 or 510	2.00
6 digit PCB for FND503 or 510	3.00
4 digit PCB for DL747	2.50
6 digit PCB for DL747	3.00
4 digit PCB for DL727 or 728	2.00
6 digit PCB for DL727 or 728	3.00
4 digit PCB for FND359 or 70	1.75

NOTE: All PC Boards are multiplexed for adding additional digits.

HARDWARE

New, includes 2-56, 4-40, 6-32 and 8-32 screws and nuts. A very usable selection.

½ pound $1.50
1 pound $2.60

T T L

7400	.17	7473	.21
7401	.17	7474	.35
7402	.17	7475	.55
7403	.17	7476	.35
74H04	.25	7480	.45
7404	.17	7483	.76
7406	.25	7485	.89
7408	.17	7486	.35
7409	.17	7490	.71
7410	.17	7491	.71
7411	.25	7492	.71
7413	.45	7493	.67
7420	.17	7494	.90
7421	.17	7495	.71
7423	.35	7496	.85
7425	.27	74100	.96
7426	.25	74121	.31
7427	.17	74123	.61
7430	.25	74125	.44
7432	.30	74141	.71
7437	.35	74145	.97
7438	.35	74151	.71
7440	.17	74153	.81
7442	.60	74154	.97
7443	.60	74161	.91
7444	.65	74163	1.05
7446	.85	74164	1.05
7447	.81	74174	.91
7448	.81	74175	1.40
7450	.20	74180	.76
7451	.17	74181	2.25
7453	.17	74191	1,20
7454	.17	74192	1.20
7470	.35	74193	.95
7472	.21	74195	.65

L S

74LS00	.25
74LS02	.25
74LS04	.30
74LS08	.25
74LS10	.25
74LS11	.32
74LS20	.31
74LS21	.33
74LS22	.33
74LS27	.30
74LS30	.31
74LS32	.33
74LS37	.40
74LS38	.35
74LS74	.49
74LS90	.85
74LS132	.90
74LS138	.89
74LS139	.89
74LS155	.90
74LS157	1.00
74LS162	1.39
74LS163	1.39
74LS175	1.09
74LS193	1.09
74LS258	1.09
74LS367	.70
74LS368	.70

CMOS SALE

CD4000	.16	CD4040	1.00
CD4001	.16	CD4041	.69
CD4002	.16	CD4042	.59
CD4007	.16	CD4043	.60
CD4009	.45	CD4044	.59
CD4010	.45	CD4047	.59
CD4011	.16	CD4049	.35
CD4012	.16	CD4050	.35
CD4013	.29	CD4051	.90
CD4014	.75	CD4053	.90
CD4015	.75	CD4056	1.00
CD4016	.29	CD4058	.90
CD4017	.80	CD4060	1.00
CD4018	.80	CD4066	.69
CD4019	.39	CD4069	.30
CD4021	.90	CD4071	.16
CD4022	.90	CD4076	.99
CD4024	.70	74C04	.29
CD4025	.19	74C107	.29
CD4027	.39	CD4116	.39
CD4028	.75	CD4507	.40
CD4029	.99	CD4512	.50
CD4030	.16	CD4516	.85
CD4034	2.30	CD4518	.85
CD4035	.99	CD4520	.85

LINEARS

LM301	.30
LM307	.30
LM309K	.95
LM311	.85
LM377	1.85
LM380 (8 pin)	.75
LM3900	.30
LM710	.25
LM711	.25
LM723	.40
LM741	.25
LM748	.25
NE553	1.95
NE555	.35
NE556	.95
NE565	.95
NE566	.95
NE567	1.10
1458	.49
RCA3043	.75
75491	.25
75492	.25

---

60 Hz Crystal Time Base Kit

– Kit enables a MOS clock circuit to operate from a DC power source. Ideal for car, camper, van, boat, etc.

60Hz output with an accuracy of .005% (typ.) Low power consumption 2.5 ma (typ.). Small size will fit most any enclosure. Single MOS IC oscillator/divider chip 5-15 volts DC operation.

ONLY $ 5.95
2 for $10.00

ORDER BY PHONE. Charge your order to BankAmericard or Master Charge.

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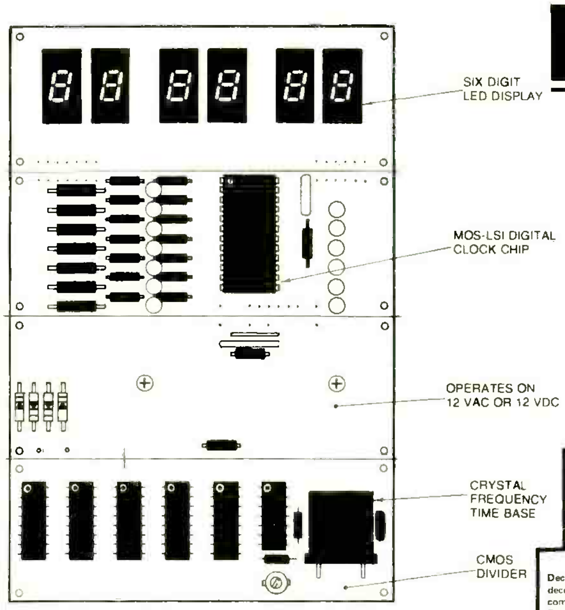
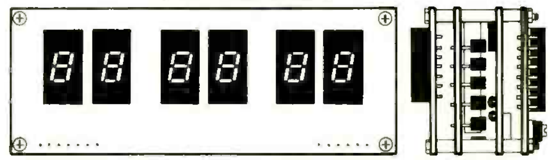
If you are not satisfied with any of our products NO MATTER WHAT THE REASON we offer you a full money back guarantee if the product or products are returned within 14 days after you receive them.

MODU-CLOCK

THOUSANDS SOLD NATIONALLY !!!



MODU-CLOCK



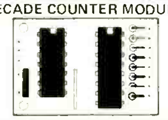
Our most popular project

- 1.5" x 4"
- 6 digit LED
- 4 stackable boards
- CMOS timebase for DC operation
- Drilled, etched, plated boards

High quality 6 digit LED clock project with CMOS time base. Comes with readout board (DL 707, MAN 1 type etc.), clock board (MM5314), power board, CMOS time base board. All boards stack behind each other. 4 board set. Clock may be constructed for AC or DC operation.

ONLY............ $5.95

DECADE COUNTER MODULE



Decade counter board for building counters. Utilizes a 7447 decode driver and a 7490 decade counter. Directly drives common anode LED readouts. Use with our DM-6 and DM-8 Digit Modules.

ONLY 70¢ ea   10 for $6.00

REL

REL PRINTED CIRCUIT BOARD PROJECTS

DIGITAL INTEGRATED CIRCUITS

TTL

7400	.20
7401	.20
7402	.20
7403	.20
7404	.20
7405	.20
7406	.24
7407	.24
7408	.20
7409	.20
7410	.20
7411	.20
7412	.20
7413	.24
7414	.88
7416	.24
7417	.24
7420	.20
7421	.24
7423	.34
7425	.34
7426	.24
7427	.32
7428	.27
7430	.20
7432	.24
7433	.29
7437	.24
7438	.24
7440	.20
7442	.52
7443	.62
7445	.69
7446	.69
7447	.69
7448	.69
7450	.20
7451	.20
7453	.20
7454	.20
7459	.20
7460	.20
7470	.29
7472	.29
7473	.29
7474	.29
7475	.48
7476	.31
7480	.69
7482	.69
7483	.69
7485	.89
7486	.27
7489	2.18
7490	.43
7491	.69
7492	.43
7493	.43
7494	.69
7495	.69
7496	.69

74100	1.27
74107	.29
74109	.32
74121	.34
74122	.43
74123	.60
74125	.39
74126	.39
74132	.69
74141	.87
74145	.69
74147	1.62
74148	1.29
74150	1.15
74151	.69
74153	.64
74154	1.02
74155	.69
74156	.69
74157	.69
74160	.87
74161	.87
74162	.87
74163	.87
74164	.95
74165	1.14
74166	1.25
74170	2.63
74173	1.41
74174	.97
74175	.92
74176	.78
74177	.78
74180	.69
74181	2.14
74182	.78
74184	2.18
74185	2.18
74188	3.49
74189	3.49
74190	1.22
74191	1.22
74192	.87
74193	.87
74194	.87
74195	.87
74196	.87
74197	.87
74198	1.48
74199	1.48
74251	1.08
74279	.54
74365	.66
74366	.66
74367	.66
74368	.66
8093	.39
8094	.39
8095	.66
8096	.66
8097	.66
8098	.66

75450	.87
75451	.60
75452	.60
75453	.60
75454	.60
75491	.80
75492	.83
75493	1.08
75494	1.18
82S25	2.18

CMOS

4000	.22
4001	.22
4002	.22
4006	1.22
4007	.22
4008	.78
4009	.43
4010	.43
4011	.22
4012	.22
4013	.39
4014	.95
4015	.95
4016	.39
4017	1.04
4018	1.04
4019	.23
4020	1.13
4021	1.23
4022	.95
4023	.22
4024	.83
4025	.22
4026	1.67
4027	.39
4028	.87
4029	1.13
4030	.22
4033	1.50
4034	3.49
4035	1.13
4040	1.13
4041	.78
4042	.78
4043	.69
4044	.69
4046	1.85
4049	.39
4050	.39
4051	1.25
4052	1.25
4053	1.25
4060	1.57
4066	.78
4071	.22
4072	.22
4073	.22
4075	.22
4081	.22
4082	.22
4502	.78
4510	1.13
4511	1.04
4514	2.79
4515	2.79
4516	1.22
4518	1.13
4520	1.13
4527	1.67
4528	.87
4585	1.22

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Only $1.00

HEP R0170 DIODE

1000 PIV
2.5 A

The famous HEP 170 GENERAL PURPOSE DIODE. A universal replacement power diode. For TV's, audio manufacturing, and experimenting. Brand new. Now at lowest prices ever.

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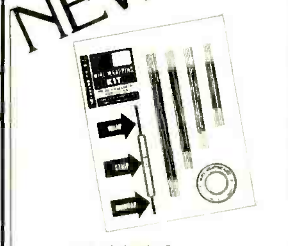
KYNAR WIRE WRAP

AWG	COLOR	100 FT.	1000 FT.
30 AWG	BLUE	$3.00	$14.95

NEW



WIRE WRAPPING KIT

Contains Hobby Wrap Tool, Roll of Wire (50ft. blue) Pre stripped wire (1 to 4 lengths blue). ONLY $9.95

WRAP / UNWRAP

Hobby-Wrap-30 $5.95

Strips, Wraps and Unwraps 30 ga. wire on standard wire wrapping pins

NEW

HOBBY-WRAP Model BW-630

Battery **wire wrapping** tool

ONLY $34.95 (batteries not included)

COMPLETE WITH BIT AND SLEEVE

FREE FREE

Order a BW-630 battery wire wrap tool and get a FREE 100 ft. roll of 30 ga. Kynar wire wrap wire.

THE LONG RANGER

The ultimate long range detector. Detects police radar at ranges over one mile. Suggested list $99.95. Save 25% over retail. Proven Effective.

only $79.95, lowest price, highest performance!

FELT FEET

Stick-on felt for equipment and protects 3/8" diameter 1/32" thick. Non scratch surface. Comes in peel off strips of 10 feet/strip.

25¢

POTENTIOMETER HEX NUTS

Standard hex nuts for all 3/8" potentiometer bushings. High quality, chrome plated.

25 FOR $1.00

1N4004 DIODE

400 PIV
1A

400 PIV @ 1A. Manufacturer prebent these units to .5 inches but did not cut leads. Straighten leads and save!!!

10 FOR $1.00

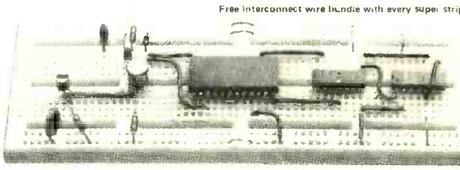
UNIVERSAL BREADBOARDING ELEMENT WITH SOLDERLESS, PLUG-IN TIE POINTS

SUPER-STRIPS

FREE FREE FREE

Free interconnect wire bundle with every super strip.

- Combine distribution system with universal .1" x .1" matrix
- 840 solderless, plug-in tie-points
- Accommodates up to 9 14-pin DIPs
- Compatible with all DIP's and discretes with lead diameters to .032"
- Require no special patch cords



SS-2 (Nickel silver terminals)....923252 $17.00

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24 HR SHIPMENT FOR CASHIERS CHECK OR MONEY ORDER
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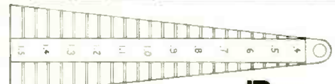
3 1/2% STATE TAX (COLO. RES.)



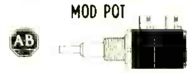
SPEEDY BEND

production devices

PD 801 Component Bender. Bend one component or a hundred in less time than it takes to set up and run any automatic bender. Bend diodes and 1/4 W resistors on one side, bend 1/2 W resistors on other. Durable Plastic. Only 3 inch thick. A MUST FOR EVERY BENCH !!!!!

ONLY $1.95

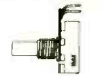
MOD POT



High quality dual concentric pot, front pot 100k log, rear pot 20K linear. Internal elements may be interchanged. Buy two and make identical dual pot. 1/8 and 1/4 inch shafts. Brand new Allen Bradley. 5/8 inch square. Cermet elements.

$1.75 EA   2 for $3.00   10 for $12.00

100K POT



High quality potentiometer. New from Central Lab 3/4" diameter, 1/4" shaft, linear taper, 1/2" long shaft, screwdriver slotted shaft. Brand new.

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We specialize in fast, prompt service with total customer satisfaction!! All items are guaranteed for 30 days from date of shipment, providing that no user inflicted damage has occured.

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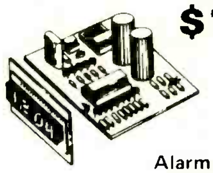
JUMBO LED CAR CLOCK



$16.95 KIT

Alarm Option – $1.50
AC XFMR – $1.50

THE HOTTEST SELLING KIT WE EVER PRODUCED!

You requested it! Our first D.C. operated clock kit. Professionally engineered from scratch. Not a makeshift kluge as sold by others. Features:

A. Bowmar Jumbo –.5 inch LED array.
B. MOSTEK – 50250 – Super Clock Chip.
C. On board precision crystal time base.
D. 12 or 24 Hr. Real Time Format.
E. Perfect for cars, boats, vans, etc.
F. P.C. Board and all parts (less case) included.

50,000 SATISFIED CLOCK KIT CUSTOMERS CANNOT BE WRONG!

THIS MONTH'S SPECIALS

AMD – 8080A	$14.95
Z-80 CPU	49.95
82S129 1K PROM	2.50

1702A 2K EPROM

We tell it like it is. We could have said these were factory new, but here is the straight scoop. We bought a load of new computer gear that contained a quantity of 1702 A's in sockets. We carefully removed the parts, verified their quality, and are offering them on one heck of a deal. First come, first served. Satisfaction guaranteed! U.V. Eraseable. NEW PRICE! $2.95 ea.
(2.3 US access time)

UP YOUR COMPUTER! 21L02-1 1K LOW POWER 500 NS STATIC RAM

Time is of the essence! And so is power. Not only are our RAM's faster than a speeding bullet but they are now very low power. We are pleased to offer prime new 21L02—1 low power and super fast RAM's. Allows you to STRETCH your power supply farther and at the same time keep the wait light off.
8 for $12.95

60 HZ CRYSTAL TIME BASE
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$5.95 ea. 2/$10.00

KIT FEATURES:
A. 60HZ 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.
Kit includes Crystal, Driver IC, PC board, plus all necessary parts and specs. At last count – over 20,000 sold!

S.D. SALES EXCLUSIVE
$12.95 MOS 6 DIGIT UP—DOWN COUNTER $12.95

40 PIN DIP. Everything you ever wanted in a counter chip. Features: Direct LED segment drive, single power supply (12 VDC TYPE.), six decades up/down, pre-loadable counter, separate pre-loadable compare register with compare output, BCD and seven segment outputs, internal scan oscillator, CMOS compatible, leading zero blanking. 1MHZ. count input frequency. Very limited quantity! WITH DATA SHEET

7400—19c	7411—29c	7451—19c	7490—65c	74153—75c
74LS00—49c	7413—50c	7453—19c	74LS90—95c	74154-1.00
7402—19c	7416—69c	7473—39c	7492—75c	74157—75c
74LS02—49c	7420—19c	7474—35c	7493—69c	74161—95c
7404—19c	7430—19c	74LS74-59c	7495—75c	74164-1.10
74L04—29c	7432—34c	7475—69c	7496—89c	74165-1.10
74S04—44c	7437—39c	7476—35c	74121-38c	74174—95c
74LS04-49c	7438—39c	7480—49c	74123-65c	74181-2.50
7406—29c	7440—19c	7483—95c	74132-1.70	74191-1.25
7408—19c	7447—85c	7485—95c	74S138-1.95	74192-1.25
7410—19c	7448—85c	7486—45c	74141-75c	74193-1.00
				74195—69c

TTL INTEGRATED CIRCUITS

1000 MFD Filter Caps

Rated 35 WVDC Upright style with PC leads. Most popular value for hobbyists. Compare at up to $1.19 ea. from franchise type electronic parts stores. S.D. Special 4/$1.

Slide Switch Assortment

Our best seller. Includes miniature and standard sizes; single and multi-position units. All new, first name brand. Try one package and you'll reorder more! Special 12/$1.00

RESISTOR ASSORTMENT

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

P.C. LEAD DIODES

1N4148/1N914 100/$2.00
1N4002-1A. 100 PIV 40/$1.

HEAVY DUTY Full Wave Bridge

25 AMP 50 PIV
$1.25

Disc Cap Assortment

PC leads. At least 10 different values. Includes .001, .01, .05, plus other standard values. 60/$1.00

$9.95 KIT

P.C. Board – 3.00
AC XFMR – 1.50

Do not confuse with Non-Alarm kits sold by our competition! Eliminate the hassle – avoid the 5314!

SIX DIGIT ALARM CLOCK KIT

We made a fantastic kit even better. Redesigned to take advantage of the latest advances in I.C. clock technology. Features: Litronix Dual ½" displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Greatly simplified construction. More reliable and easier to build. Kit includes all necessary parts (except case). P.C.B. or XFMR optional. *NEW! WITH JUMBO LED READOUTS!*

Motorola SCR

2N4443. 8 AMP 400 PIV. P.C. Leads 3/$1.

FAIRCHILD - TBA 641

4W. Audio power Amp. Just out! In special heat sink DIP. One super audio IC. $1.50 with data

FND-359 -Led Readout

.4 IN. Common Cathode. High effeciency. Has FND-70 PIN OUT. 79c

COMPUTER POWER SUPPLY

$15.95

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Factory Prime Units. Brand New.
1.5 micro-seconds access time.
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Buy 10 BARREL KITS AND CHOOSE THE 11TH KIT Free

KIT #237 LED DISPLAY MOLEX PINS 200 for $1.98. Pins 3/8" long, 1/10" spacing. For displays, keyboards. Wt. 4 ozs. 6R3594

BARREL KIT #229 MULTI-DIGIT READOUTS 10 for $1.98. Barrels of 3's, 6's, & 9-digit readouts, some with driver chips. Wut a buy! Untested. No. 6R3628

BARREL KIT #225 SOUND TRIGGERS 3 for $1.98. 6 ozs. "Hand clap" sensitizes crystal mike amplifier, triggers SCR. Cat. No. 6R3625

BARREL KIT #221 IC SOCKETS 8 for $1.98. Mfr unloads! Four 14-pin, four 18-pin. Solder tail, lo-profile. No. 6R3621

MIXED READOUTS KIT #219 15 for $1.98. Barrels of untested .17", .3", .6", 7-segs. Like FND-357, 500, 503, MAN-3's. Wut a buy! No. 6R3619

BARREL KIT #217 LAMPS! 25 for $1.98. Distributor unloads barrels of asstd bulbs, pop'l'r voltages to 24V. Screw & bayonet. Wt. 4 ozs. No. 6R3561

BARREL KIT #211 LO-PROFILE TO-5 50 for $1.98. NPN power transistors, mostly good. Bvceo 40V, Ic 2A, Hfe 30-100. Up to 250 MHZ! Like RCA 2N5189. Wt. 12 oz. No. 6R3551

BARREL KIT #210 GLOWIN' PANELS 3 for $1.98. 1" x 1" panels that glow blue-green with 110VAC. Use for nite lites, indicators, etc. Cat. No. 6R3550

BARREL KIT #205 MINI BLOCK CAPACITORS 50 for $1.98. Unbelievable! Worth $50. High precision submini caps for all applications. Wt. 3 ozs. Cat. 6R3528

BARREL KIT #203 CALCULATOR KEYBOARDS 10 for $1.98. It's true! 20-key, 4 function keyboards at ridiculous give-away. Wt. 12 ozs. Cat. No. 6R3524

KIT #202 100 for $1.98. PLUGS, SOCKETS. Distributor unloads! Includes AC, DC, RF, audio, 4-9 pin, all kinds. Wt. 1 lb. Cat No. 6R3527

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BARREL KIT #188 400 Parts $1.98. Includes resistors, caps, transformers, rectifiers, diodes, etc for p.c. work. Preformed, dumped into barrels by factories. 100%. Cat. No. 6R3401

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BARREL KIT #184 1/4-WATT METAL FILM 150 for $1.98. 100% metal film resistors. Long leads. 6R3413

BARREL KIT #182 JUMBO RED LEDS 15 for $1.98. 100% material, user cancellation from factory dumps, 3V 10 mils. For 100's of projects, red lens. Cat. No. 3369

BARREL KIT #181 MICRO ZENERS 100 for $1.98. 1-Watt, tiny, 100% material, from 2V to 30V. Axial leads. No shorts, no opens, DO-7 & micro epoxy units. Cat. No. 6R3368

BARREL KIT #163 MINI TRIM POTS 30 for $1.98. 1 oz. Asst. values 100 to 1 meg. What a buy. Single turn, 1/4 W. Wt. 6 oz. 6R3345

BARREL KIT #161 'POP' PLASTIC TRANSISTORS 25 for $1.98. 2N3904's with some 2N3906's of 100% material. TO-92. Preformed. Cat. No. 6R3343 1 oz.

BARREL KIT #160 V. REGULATORS 10 for $1.98. No. 6R3330. LM309KC TO-3 V.R.'s barreled. Bot by the pound.

BARREL KIT #159 MODULAR SWITCHES 25 for $1.98. Centralab switches. TV-makers excess. Dpdt. 6pdt. etc. Brand new. Cat. No. 6R3150

BARREL KIT #158 MAGNIFIED MAN-3's 20 for $1.98. MAN-3, 7-seg readout, with built-on magnifier. Factory discontinued line. 100% material. Cat. No. 6R3325 1 oz.

BARREL KIT #154 CLOCK CHIPS 20 for $1.98. We gathered an assortment of clock chip, alarm, calendar, beepers, who knows, all mixed. Cat. No. 6R3308

BARREL KIT #149 ROCKER SWITCHES 12 for $1.98. No. 6R3302

BARREL KIT #145 MINI TRANSFORMER 15 for $1.98. outputs, interstage and audio. Only 1" sq. Wt. 2 lbs. 6R3294

BARREL KIT #144 RCA PHONO PLUGS 40 for $1.98. 1,000,000 RCA phono plugs for this one. You hi-fi-ers know wut they are ... 100% material. 6R3293

BARREL KIT #138 PANEL SWITCHES 30 for $1.98. Did you hear of OAK? Another eqpt maker barrelled all types of rotaries, electric, slides, etc. 6R3268

BARREL KIT #135 MICRO MINI LAMPS 20 for $1.98. 1 oz. Imagine! Micro size (1/4 x 1/4) with wire leads, 3 to 5 VDC, 40 mils. 6R3259

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BARREL KIT #127 AXIAL ELECTROS 40 for $1.98. Asst. capacities and voltages. Cat. No. 6R3227

BARREL KIT #126 UPRIGHT ELECTROS 40 for $1.98. 1mf to 300mf in mixture of voltages. 100% marked 'n good. 6R3226

BARREL KIT #115 MOLEX SOCKETS 100% good. 200 for $1.98. Cat. No. 6R3144. Calculator maker dump! We got a zillion of 'em.

BARREL KIT #112 MICRO MINI LEDS 40 for $1.98. All the tiny leds, axial, upright of Monsanto, Litronix, variety of colors. Yield 50% or better. 6R3135

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BARREL KIT #104 SLIDE VOLUME CONTROLS 10 for $1.98. Cat. No. 6R3057

BARREL KIT #101 RESISTOR SPECIAL 200 for $1.98. Includes: 1/8, 1/4, 1/2, 1, 2-watters, carbon. 8 oz. 100% good. 6R3054

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. 6R3052

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7420	.20	7492	.50	74191	1.20
7425	.28	7493	.45	74192	.85
7426	.25	7494	.70	74193	.85
7427	.30	7495	.70	74194	.85
7430	.20	7496	.70	74195	.75
7432	.25	74107	.32	74196	.88
7437	.25	74121	.38	74257	1.25
7438	.25	74123	.65	74279	.90
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74LS08	.25	LM 308	.95
74LS10	.25	LM 311	.95
74LS11	.25	LM 319	.95
74LS20	.25	LM 324	1.05
74LS21	.25	LM 339	1.10
74LS22	.25	LM 370	1.15
74LS27	.29	LM 377	2.50
74LS30	.25	LM 380	.95
74LS32	.37	LM 381	1.25
74LS37	.37	LM 382	1.25
74LS38	.37	LM 537	2.50
74LS74	.49	LM 553	2.50
74LS90	.95	LM 555	.44
74LS132	1.10	LM 556	.85
74LS138	1.40	560	2.00
74LS139	1.40	562	2.00
74LS155	1.40	565	1.10
74LS157	1.20	703	.90
74LS160	1.75	709	.25
74LS162	1.75	710	.35
74LS163	1.75	711	.35
74LS175	1.35	741 C or V	.31
74LS193	1.80	747	.65
74LS258	1.45	1310	2.50
74LS367	.75	1456	.95
74LS368	.75	1458	.60
		CA 3046	.75
		CA 3047	.95
		3900	.49
		8038	3.90

TRIACS / SCR'S

PRV	TRIACS 1A	TRIACS 10A	TRIACS 25A	SCR'S 1.5A	SCR'S 6A	SCR'S 35A
100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
600	1.70	2.30	3.60		1.50	3.00

Terms: FOB Cambridge, Mass. Send Check or Money Order. Include Postage, Minimum Order $5.00, COD'S $20.00

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PRIME - HIGH SPEED RAM

21L02-3 400 NS

LOW POWER - FACTORY FRESH

1-24	$1.95 ea	100-199	$1.60 ea
25-99	1.75 ea	200-499	1.45 ea

OVER 500 PCS. **1.39** ea.

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout.
Specify for 7001 *B, C or X* - $ 7.95

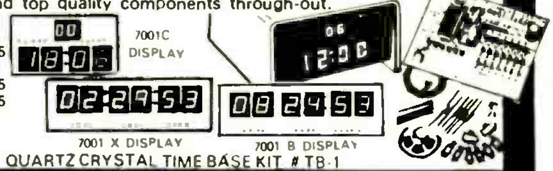
6-DIGIT LED CLOCK CALENDAR KIT

DATE-TIME-SNOOZE ALARM & MORE... KIT 7001

FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM, SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

KIT - 7001B WITH 6 - .5" DIGITS $39.95
KIT - 7001C WITH 4 - .6" DIGITS & 2 - .3" DIGITS FOR SECONDS $42.95
KIT - 7001X WITH 6 - .6" DIGITS $45.95



7001C DISPLAY

7001 X DISPLAY

7001 B DISPLAY

KITS ARE COMPLETE (LESS CABINET)
ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

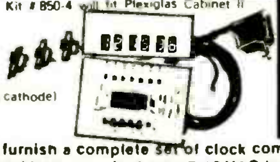
6 DIGIT LED CLOCK KIT #850-4

12/24 HR. OPERATION BIG .4" DIGITS - 50/60 HZ OPERATION.

KIT INCLUDES
- INSTRUCTIONS
- QUALITY COMPONENTS
- 50 or 60 Hz OPERATION
- 12 or 24 HR OPERATION

6 LED Readouts (FND-359 Red, com. cathode)
1 MM5314 Clock Chip (24 pin)
13 Transistors
3 Switches
6 Capacitors
5 Diodes
9 Resistors
24 Molex pins

Kit # 850-4 will fit Plexiglas Cabinet II



$11.95 ea. QTY. 1-5
$10.95 ea. QTY. 6-11
$9.95 ea QTY. 12 OR MORE

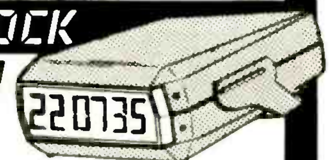
"Kit #850-4 will furnish a complete set of clock components as listed. The only additional items required are a 7-12 VAC transformer, a circuit board and a cabinet, if desired."

PRINTED CIRCUIT BOARD FOR KIT # 850-4, SCREEN PRINTED DRILLED AND SOLDER PLATED FIBERGLASS $2.95
MINI-BRITE RED LED'S (FOR COLON IN CLOCK DISPLAY) ... Pkg. of 5-$1.00
MOLDED PLUG TRANSFORMER 115/10 VAC (WITH CORD) $2.50

NOTE: Entire Clock may be assembled on one PC Board or Board may be cut to remote display.

MOBILE LED CLOCK

12/24 HR **.4" DIGITS!**



MODEL #2001

12 VOLT AC or DC POWERED

- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24 Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY (Use When Key Off In Car, Etc.)
- TOP QUALITY PC BOARDS & COMPONENTS - EXCELLENT INSTRUCTIONS
- MOUNTING BRACKET INCLUDED

KIT #2001 COMPLETE KIT (Less 9V. Battery) 29.95 EA — 3 OR MORE $27.95 EA — 115 VAC Power Pack #AC-1 $2.50 EA.

ASSEMBLED UNITS ORDER #2001 WT — WIRED & TESTED (LESS 9V BATTERY) $39.95 EA — 3 OR MORE $37.95 EA
WIRED FOR 12 HR. OP. IF NOT SPECIFIED OTHERWISE

60 HZ.

XTAL TIME BASE

Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC.
1"x2" PC Board
Power Req: 5-15V (2.5 MA. TYP.)
Easy 3 wire hookup
Accuracy: ± 2PPM
#TB-1 (Adjustable)
Complete Kit $4.95 ea
Wir & Cal $9.95

PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I
3"H, 6¼"W, 5½"D

CABINET II
2½"H, 5"W, 4"D

Black, White or Clear Cover

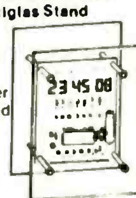
$6.50 ea.

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS
3"x6"x1/8" 95¢ ea. 4/$3

SEE THE WORKS Clock Kit

Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr. time
- 3 set switches
- Plug transformer
- all parts included



Plexiglas is Pre-cut & drilled

Kit #850-4 CP

Size: 6"H, 4⅓"W, 3"D

$23.50 ea. 2/$45. A SUPER CLOCK!

JUMBO DIGIT CLOCK

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC 12/24 Hr. time, 50/60 HZ., Plug Transformer, Line Cord, Switches and all Parts. (Ideal Fit in Cabinet II)
Kit # 5314-5 — $19.95 2/$38.
With PC Boards

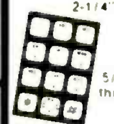
JUMBO DIGIT CONVERSION KIT $9.95 ea.

Convert small digit LED clock to large .5" displays. Kit includes 6 LED's, Multiplex PC Board & easy hook-up info.
Kit # JD-1CC For common Cathode
Kit # JD-1CA for common Anode

TELEPHONE FORMAT KEYBOARD

BY Chomerics
EF-21360

2-1/4"x3"



5/32" thick

$4.95
6/$28.

25 AMP BRIDGE
$1.95 ea.
3/$5.00

NEW LSI TECHNOLOGY

FREQUENCY COUNTER KIT

8 LARGE .4" RED LED DIGITS

Kit #FC-50 • 8 IC's • XTAL TIME BASE

A truly "State of the Art" counter using quality components throughout.

KIT INCLUDES: DETAILED INSTRUCTIONS, XTAL, TOP QUALITY FIBERGLASS DOUBLE SIDED PC BOARD, IC'S WITH SOCKETS AND ALL PARTS LESS POWER SUPPLY AND CABINET.

50 MHZ COUNTER KIT	#FC-50	$69.95
5 VOLT REGULATED 1 AMP POWER SUPPLY KIT	#PS-02	$9.95
350 MHZ PRESCALER KIT	#PSL-350	23.95
650 MHZ PRESCALER KIT	#PSL-650	$29.95
CABINET (& MTG HARDWARE)	#CAB III	$19.95

(CABINET WILL HOUSE #FC-50, #PS-02, AND A PRESCALER)

Fairchild Super Digit FND-359

.4" Char. Ht. 7 segment LED RED Com. Cath. Direct pin replacement for popular FND-70.

95¢ ea, 10/$8.50
100/$79.00

SET OF 6 FND-359 WITH MULTIPLEX PC BOARD $6.95

NYLON WIRE TIES

8" TIE-WRAP	100/$1.95
4" TIE WRAP	100/$1.75

PLUG TRANSFORMERS

12 VAC at 150 MA	$ 2.50
12 VAC at 500 MA	3.50
7VAC at 1.75 VA	$3.50

SCHOTTKY TTL

74S00	$ .35
74S01	.40
74S04	.55
74S05	.60
74S09	.55
74S10	.40
74S20	.50
74S22	.45
74S40	.45
74S50	.45
74S51	.55
74S60	.85
74S64	.55
74S74	.85
74S75	1.75
74S78	1.50
74S86	.95
74S107	.95
74S112	.95
74S113	1.40
74S114	.95
74S133	.75
74S134	.75
74S138	1.75
74S139	1.50
74S151	1.95
74S153	1.95
74S155	1.95
74S156	1.95
74S157	1.80
74S158	2.50
74S174	2.50
74S175	2.50
74S181	2.95
74S182	1.95
74S251	2.75

DIGITAL CLOCK IC's

MM5312	$ 4.95
MM5314	3.95
MM5375AB	3.95
CT 7001	7.95
CT 7002	13.95
MM5369	2.50

LED DRIVERS

7447	$ .95
7448	.95
75491	.65
75492	.65
9368	2.50

PRESCALE

11C90DC	$15.95
95H90	9.95

VOLTAGE REGULATORS

LM 309 H	TO 5	$ .95
LM 309 K	TO 3	1.25
7805	TAB	.95
7812	TAB	1.25
7812	TO-3	1.50
7815	TO-3	1.25
7815	TAB	1.25
78L 15	TO-5	.75
7824	TO-3	1.25
723	DIP	.75
723	TO-5	.75

PROM

1702	E Prom	$8.95
5203	E Prom	$8.95

SPECIAL IC'S

7207A	INTERSIL	
7208	INTERSIL	
MC14553	MOT	$ 9.95
MC14410	MOT	$12.50
2513	SIG	$ 9.95

IC SOCKETS

PINS	1-24	25	100
8	$ .25	$ .22	$ .20
14	.25	.22	.20
16	.28	.25	.23
18	.31	.28	.26
24	.50	.45	.40
28	.60	.55	.50
40	.75	.70	.65

XTAL

5.242880 MHZ	$4.95
3.579545 MHZ	$1.95

MOLEX PINS

$9.95 Reel of 1000
100 for $1.25

TRANSISTORS

2N2222 A	TO 18	3/$1.00
2N2712	TO 98	5/$1.00
2N3415	TO 9	5/$1.00
2N3704	TO 92	5/$1.00
2N4400	TO 92	5/$1.00
2N4125	TO-92	5/$1.00
2N4249	TO-92	5/$1.00
2N4437	TO-92	5/$1.00
2N6027	PUT	2/$1.00
2N5457	N J-Fet	2/$1.00

DIODES

IN 4002	1A 100 PIV	12/$1.00
IN 4005	1A 600 PIV	11/$1.00
IN 4007	1A 1000 PIV	10/$1.00
RECTIFIER	2.5A 1000 PIV	4/$1.00
IN 914	SIL. SIGNAL	20/$1.00
IN 4148	SIL. SIGNAL	20/$1.00
DYAC	28V	4/$1.00

LINEAR

555	TIMER	2/$1.00
556	DUAL TIMER	.95
565	PLL	.95
566	FUNCTION GEN.	1.75
567	TONE DECODER	1.75

TRANSISTOR SOCKET TO-5/18 GOLD PINS
5/$1.00

7-SEG LED

COMMON CATHODE

	COLOR	HT	DEC PT	PR EA
FND 359	RED	.4"	RHDP	$ .95
FND 503	RED	.5"	RHDP	$1.35
DL 750	RED	.6"	LHDP	$2.95
XAN 654	GREEN	.6"	NDP	$1.95
XAN 664	RED	.6"	NDP	$1.95

COMMON ANODE

	COLOR	HT	DEC PT	PR EA
DL 747	RED	.6"	LHDP	$1.95
XAN 72	RED	.3"	LHDP	$1.25
MAN 72	RED	.3"	LHDP	$1.25
XAN 81	YELLOW	.3"	RHDP	$1.75
XAN 351	GREEN	.3"	RHDP	$1.50
XAN 362	ORANGE	.3"	LHDP	$1.50
XAN 662	RED	.6"	NDP	$1.95
XAN 692	RED	.6"	NDP	$1.95

OP AMPS

3/$1.00

301	TO-5
709	DIP
709	TO 5
741	DIP
741	M-DIP
741	TO-5
747	TO 5

DISCRETE LED's

JUMBO RED
10 FOR $1.00
100 FOR $9.50

PC TRIM POTS

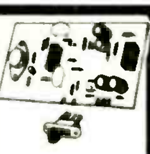
25K	6/$1.00
4.7K	6/$1.00

SPECTROL 10K 10 TURN 95c 4/$3.00

CMOS

	ea.
4001	$ .20
4002	.20
4010	.40
4011	.20
4013	.40
4015	.95
4016	.40
4023	.20
4025	.20
4027	.40
4028	.85
4030	.35
4042	.75
4044	.60
4046	1.75
4049	.40
4050	.40

AUTO BURGLAR ALARM KIT



AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND. KEYLESS ALARM HAS PROVISION FOR POS. & GROUNDING SWITCHES OR SENSORS. WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN. KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH - REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED. CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED

KIT #ALR-1 $9.95
#ALR-1WT WIRED & TESTED $19.95

VARIABLE REGULATED 1 AMP POWER SUPPLY KIT

- VARIABLE FROM 4 to 14V
- SHORT CIRCUIT PROOF
- 723 IC REGULATOR
- 2N3055 PASS TRANSISTOR
- CURRENT LIMITING AT 1 Amp

KIT IS COMPLETE INCLUDING DRILLED & SOLDER PLATED FIBERGLASS PC BOARD AND ALL PARTS (Less TRANSFORMER) KIT #PS-01 $8.95

TRANSFORMER 24V CT will provide 300MA at 12V and 1 Amp at 5V. $3.50

OPTOELECTRONICS, INC.

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SEE OUR BOOTHS AT THE ATLANTA HAMFESTIVAL - JUNE 18-19, 1977

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INTERNATIONAL ELECTRONICS UNLIMITED

10% OFF WITH $25 ORDER
15% OFF WITH $100 ORDER

THESE DISCOUNTS APPLY TO TOTAL OF ORDER — SPECIALS INCLUDED

TTL

7400	.13	7451	.17	74153	.89
7401	.16	7453	.17	74154	1.20
7402	.15	7454	.17	74155	.97
7403	.15	7460		74156	.97
7404	.16	7464	.35	74157	.99
7405	.19	7465	.35	74158	1.79
7406	.20	7470	.30	74160	1.23
7407	.28	7472	.30	74161	.97
7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
7411	.25	7476	.30	74165	.99
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

LOW POWER

74L00	.29	74L51	.29	74L90	1.40
74L02	.29	74L55	.29	74L91	1.20
74L03	.23	74L71	.29	74L93	1.50
74L04	.29	74L72	.45	74L95	1.50
74L06	.29	74L73	.56	74L98	2.25
74L10	.29	74L74	.56	74L164	2.25
74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

LOW POWER SCHOTTKY

74LS00	.36	74LS32	.38	74LS95	2.09
74LS02	.36	74LS40	.45	74LS107	.59
74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
74LS20	.36	74LS93	1.30		

HIGH SPEED

74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.58
74H10	.25	74H52	.25	74H102	.58
74H11	.25	74H53	.25	74H103	.60
74H20	.25	74H55	.25	74H106	.72
74H21	.25	74H60	.25	74H108	.72

SCHOTTKY

74S00	.59	74S08	.68	74S22	.65
74S02	.59	74S10	.65	74S32	.68
74S03	.59	74S20	.65	74S74	.68
74S04	.72				

8000 (NATIONAL)

8091	.61	8220	1.49	8811	.65
8092	.61	8230	2.19	8812	1.02
8095	1.25	8288	1.49	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8552	2.19	8831	2.19
8200	2.33	8563	.62	8836	.29
8214	1.49	8810	.70	8880	1.19

8000 (SIGNETICS)

8263	5.79	8267	2.59

9000

9002	.40	9309	.79	9601	.61
9301	1.03	9312	.79	9602	.79

ELECTRONIC GAMES

We have available in kit form **Electronic Roulette** and **Electronic Craps.** Both kits contain P.C. boards, LED's, all necessary components, transformer, case and instructions for easy assembly. Included with each kit is a 55 page booklet explaining the entire game.

Electonic Roulette
Dimensions 6½" x 6½" x 1½" **$23.95**

Electronic Craps
Dimensions 6½" x 3½" x 1½" **$14.95**

CALC. KIT ONLY **$9.95**
ADAPTER –60Hz **$3.95**

CALCULATOR KIT
LITRONIX 1502 MEMORY

- **FULL ACCUMULATING MEMORY** — STORES AND RECALLS SUBTOTALS
- **% KEY** — PERFORMS ALL PERCENT FUNCTIONS INCLUDING ADD-ONS, DISCOUNTS, MARKUPS AND YIELDS
- **ARITHMETIC LOGIC** — LETS YOU ENTER PROBLEMS IN ADDING MACHINE MODE
- **FLOATING DECIMAL SYSTEM** — AUTOMATIC DECIMAL POINT POSITIONING FOR FULL 8-DIGIT ACCURACY
- **OVERFLOW SAVE** — IN CASE OF OVERFLOW IN DISPLAY, THIS CLEARS THE CONDITION AND ALLOWS CALCULATOR TO CONTINUE USING THE OVERFLOWED RESULTS DIVIDED BY 10^8
- **AUTOMATIC TIMEOUT TO SAVE BATTERIES**

OPTO ISOLATORS

MCD2	Opto isolator diode	1.09
MC12	Opto isolator transistor	.70

CMOS

4000A	.26	4018A	1.39	4066A	.89
4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
4006A	1.35	4022A	.94	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		
74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
74C42	1.61	74C160	2.48	80C97	.96
74C73	1.04	74C161	2.49		

MULTIPLE DISPLAYS

NSN33	3 digit .12" red LED	1.79
HP5082-7405	5 digit .11 red LED	3.49
HP5082-7414	4 digit .11 red LED	3.25
SP-425-09	9 digit .25 gas disch	1.79

LED DISPLAYS

MAN 5	2.25
MAN 7	1.49
MAN 8	2.25
MAN 66	2.25
MAN 72	1.25
MAN 3620	1.50
FND 359	.95
FND 500	1.89
FND 507	1.49
DL10A	2.19
DL33B	.45
DL33-	.35

DISCRETE LED'S

ME 4	.29
MV10B	.25
MV50	.12
NSL100	.12
MV5020 RED	.15
CLEAR	.15

MEMORIES

1101	256 bit RAM MOS 16 pin	1.39
1103	1024 bit RAM MOS dynamic 18 pin	1.95
1702A	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
2102	1024 bit RAM static 16 pin	1.95
5203	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
5260	1024 bit RAM MOS dynamic 16 pin	1.95
5261	1024 bit RAM MOS dynamic 16 pin	1.95
7489	64 bit ROM TTL 16 pin	2.25
82S23	256 PROM-SCHOTTKY 16 pin	3.69
F93410	256 bit RAM bi-polar 16 pin	1.95
74187	1024 bit ROM TTL 16 pin	5.75
74200	256 bit RAM tri-state 16 pin	5.45

CLOCK CHIPS

MM5311	6 digit multiplexed BCD, 7 seg, 12-24 Hr, 50-60 Hz — 28 pin	4.45
MM5312	4 digit multiplexed BCD, 7 seg, lpps, 12-24 Hr, 50-60 Hz — 24 pin	3.95
MM5314	6 digit multiplexed 12-24 Hr, 50-60 Hz 24 pin	4.45
MM5316	4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	4.95
5375AA	4-6 digit, 12 hour, 60 Hz snooze alarm brightness control capability, alarm tone output — 24 pin	4.95
CT7001	6 digit, 12-24 Hr, 50-60 Hz, alarm, timer and date circuits — 28 pin	6.95

CALCULATOR CHIPS

CT5002	12 digit, 4 function fixed decimal battery operation — 40 pin	1.95
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MM5725	8 digit, 4 function, floating decimal 18 pin	1.98
MM5736	6 digit, 4 function, 9V battery operation — 18 pin	2.95
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation — 24 pin	3.95
MM5739	9 digit, 4 function, 9V battery operation — 22 pin	3.95

8008 $19.95
8080A $19.95

4 Digit Clock Kit

MM5312 and 4 NS71 .27" displays 12-24 hours, 50-60 Hz. One P.C. board accommodates clock, displays, and all necessary transistors, resistors, capacitors, diodes, 2 switches, complete instructions and schematics for assembly.

CK4-2 **$10.95**

SHIFT REGISTERS

MM5013	1024 bit accum. dyn. 8 pin	1.75
MM5016	500/512 bit dyn. 8 pin	1.59
SL5-4025	Quad 25 bit	.99
2504	1024 bit multiplexed dyn 8 pin	3.95

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MM5330 — P channel device provides all logic for 4½ digit volt meter. 16 pin DIP with data **$6.95 ea.**

2519 **$2.95 ea.**
HEX 40-BIT STATIC SHIFT REGISTER

2518 **$2.95**
HEX 32-bit STATIC SHIFT REGISTER

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$6.95

2102
1024 bit static RAM 16 pin
$1.29

MM5369 Divider mDIP $2.35
Crystal 3.58 MHZ color TV $1.50

7489 **$1.75 ea.**
64 bit ROM TTL 16 pin

UART
AY51013A **$6.95**

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1310	FM Stereo Demodulator DIP	2.90
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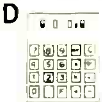
ULN2209	FM Gain Block 48db (typ) mDIP	1.35
2513	Character Generator 64x8x5 DIP-24	10.20
3046	Transistor Array DIP-14	.73

6 Digit Clock Kit

MM5314 with 6 NS71 .27" displays 2 P.C. boards — Display board may be remote. Internal or wall transformer can be used. 50-60 Hz, 12-24 hour. Includes all necessary transistors, resistors, capacitors, diodes, 3 switches and complete assembly instructions.

CK6-3 **$14.95**

KEYBOARD
20 KEYS
2 SLIDE SW
3" x 3½"



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308	Mciro Pwr Op Amp mDIP TO-5	.89
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310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
319	Hi Speed Dual Comp DIP	1.13
320T	Neg Reg 5, 12, TO-220	1.39
320K	Neg Reg 5.2, 12 TO-3	1.39
322	Precision Timer DIP	1.70
324	Quad Op Amp DIP	1.52
339	Quad Comparator DIP	1.58
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340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.49
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376	Pos V Reg mDIP	.68
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380-8	.6w Audio Amp mDIP	1.25
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382	Lo Noise Dual preamp DIP	1.75
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567	Tone Decoder mDIP	1.95
709	Operational AMP TO-5 or DIP	.26
710	Hi Speed Volt Comp DIP	.35
711	Dual Difference Compar DIP	.26
723	V Reg DIP	.62
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741	Comp Op Amp mDIP TO-5	.32
747	741 Dual Op Amp DIP or TO-5	.71
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1458	Dual Comp Op Amp mDIP	.62
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75452	Dual Peripheral Driver mDIP	.35
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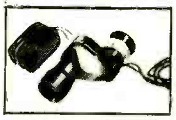

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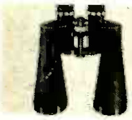

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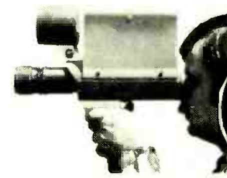

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