PROJECTS—HI-FI—COMPUTERS

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part 2: phone accessory
BUILD DIGI-TOLL
keep track of call costs

which type is best
DISPOSABLE BATTERIES
carbon, alkaline, mercury

digital comes to hi-fi
DIGITAL HI-FI RECORDING
learn how it's done

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for precision delays

build full featured
DIGITAL DARKROOM TIMER
controls enlarger and safelight

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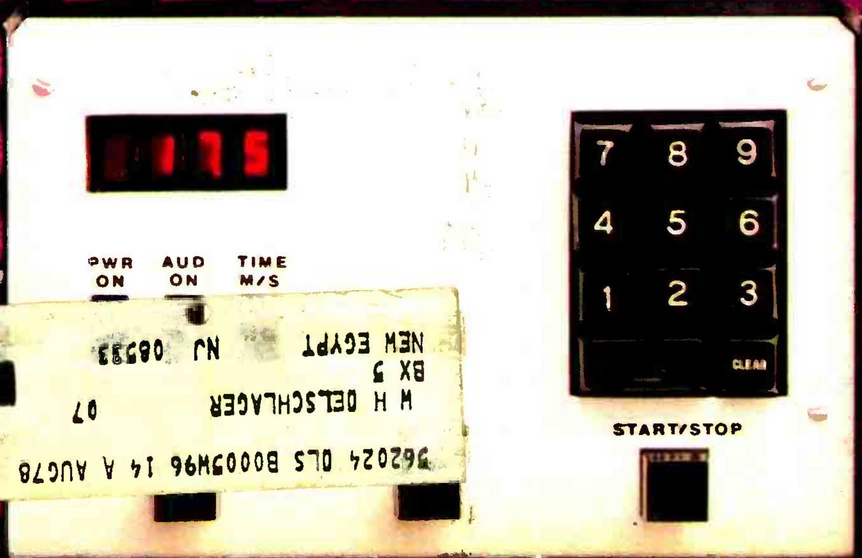

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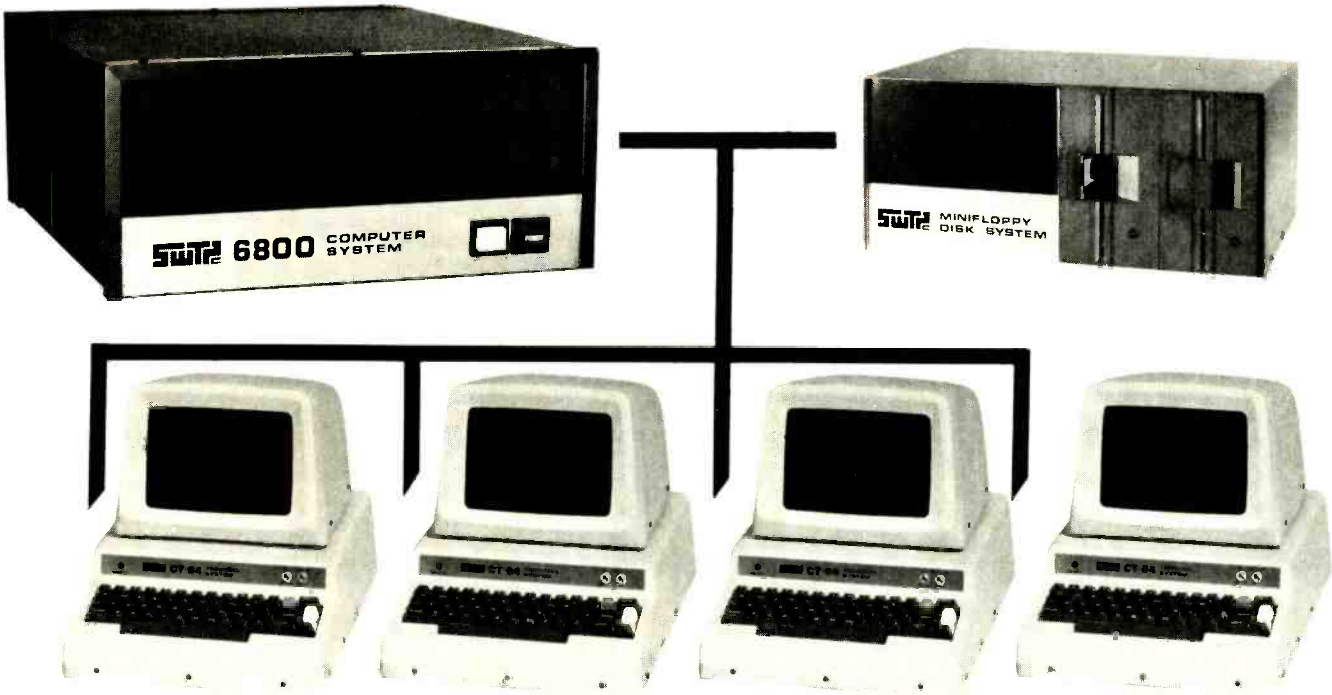

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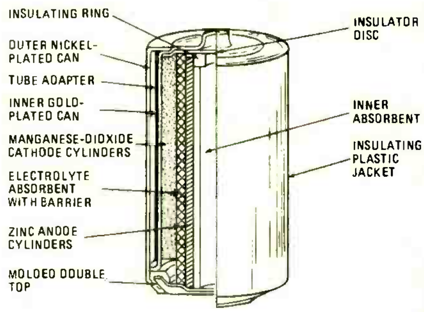
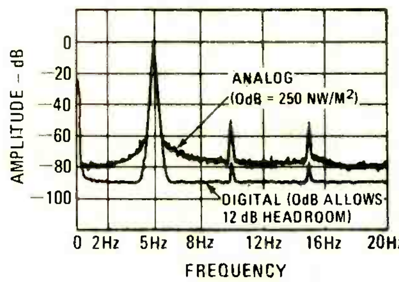
ON THE COVER

Unique darkroom timer counts down in either seconds or minutes and seconds. Precise digital readout and audible pulses too. See page 33.



TYPICAL ZINC-CARBON CELL is one of the three basic disposable cells described in this story. **Turn to page 44.**



SPECTRAL PURITY of analog recorder vs digital recorder. For complete details on recording sound as a digital signal, **turn to page 57.**

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looking ahead

TV-audio wedding: For years, audiophiles have been irked by the quality of television sound, and for years the TV networks have been blaming the television set manufacturers, while the manufacturers have been blaming the public for being too stingy to pay extra for good sound systems in their sets. And for years, almost everybody has been blaming AT&T, whose TV audio lines have been limited to the same frequency bandwidth as AM—so that while TV sound channels may theoretically be capable of passing frequencies as high as 15 kHz, most network broadcasts have had an upper limit of 5 kHz.

The logjam may finally be breaking. The limited substitution of satellites for land lines in long-distance TV transmission as well as some special musical simulcasts, mainly by the Public Broadcast System, have led to an increased awareness that good TV sound is both possible and desirable. But the biggest boost probably came from the AT&T's recent switchover of its intercity television relay system to a new diplexing system that boosts the sound bandwidth to a full 15 kHz (see **Radio-Electronics**, April, 1978). This widely publicized move, perhaps triggered by the new competition from satellites, began to spur public demand for receiving systems that can take advantage of this better sound. And, as the FCC's current inquiry into the desirability of stereophonic sound for TV progresses, it's expected to stir up more interest in TV sound.

Short of waiting for TV makers to improve their sound systems, there hasn't been much the public could do. Until now. For years, stereo component manufacturers have been experimenting with TV tuner components for audio systems, but haven't moved them to market because of the general inadequacy of the transmitted sound. Now they're beginning to dust them off, geared to the networks' new sound capability. The first to appear probably will be a component from Pioneer, to list at around $250, which permits the substitution of the home stereo system for the sound circuits in the TV set. Complete details weren't available at presstime.

More than a year ago, Sony introduced in Japan its *Audioscope TV Tuner*, a similar component which also included a tiny black-and-white monitor that could be switched to display either the incoming picture or the audio waveform. It was shown in the U.S., but never actively marketed here, presumably because of the generally poor quality of transmitted audio. Panasonic has a TV sound component waiting for introduction. Now other audio manufacturers can be expected to go forward with long-delayed plans to make TV sound easily available to home audio systems.

GE's home projector: The concept of home projection television got a huge boost when General Electric introduced its highly engineered rear-screen unit. The one-piece furniture-styled console, called "Widescreen 1000," has a picture area of 1,003 square inches, with a diagonal of 45.7 inches—or three times the size of a 25-inch set. The relatively compact cabinet is 50 inches high, 70 inches long and 24 inches deep.

What make's GE's projector different from many others is that it was designed from the ground up as a projection set, that it is backed by one of the major domestic manufacturers and that it is the first rear-screen unit with a truly bright picture. The heart of the new set is a specially designed extremely bright 13-inch picture tube with the electron gun and shadow mask made especially for projection. Although GE didn't give any figures, one knowledgeable observer said its brightness was five times that of a conventional direct-view 13-inch tube. It uses a three-element coated plastic lens and two float-glass mirrors to focus and direct the picture to the one-piece acrylic viewing screen with a fresnel lens pattern molded into the rear surface. The optical components, including the screen cabinet, are sealed against dust.

How well does it work? The picture is surprisingly bright—brighter than any other single-tube projection set on the market. The picture is clear and undistorted from corner to corner. The viewing angle is restricted, to perhaps 30 degrees. The set is tuned by digital wireless remote control and contains VIR color-adjusting circuitry. The suggested retail price, which hadn't been determined at presstime, was expected to be around $2,800. GE estimated industrywide sales of about 125,000 projection TV sets in 1978, 220,000 in 1979 and 500,000 by 1983.

New TV highlights: Microprocessor tuning will be coming to American TV in a big way starting this year. Although the first programmed TV set in this country has been available for some time from Heathkit, the floodgates may now be opening in mass-market television. Toshiba has introduced a 21-inch model with a programmable 12-channel tuner (list price about $950). The set can be preprogrammed to tune in 16 different shows during the course of a day—turning on and off and changing channels. Up to eight selections can be stored permanently and repeated daily, so you don't have to miss your favorite soap opera just because you forgot to turn on the set. A similar set is on its way from Hitachi. Other microprocessor-based tuners are expected this year. Not all of them are programmable—some merely use the microprocessor circuitry for extremely accurate tuning.

Radio's future: British Broadcasting Corporation is looking into several new radio broadcast services, which were recently outlined to American broadcasters by its engineering director, James Redmond. Among them: (1) BBC has proposed to the government an information network of low-power stations, all operating on the same frequency and using time-division multiplexing to prevent mutual interference. These stations would give motorists detailed information about traffic in the area in which they are driving. A special low-cost fixed-tuned receiver in the car is arranged so it interrupts the regular car radio when there is a message for the specific area. (2) The addition of inaudible signaling to radio broadcasts to provide a station identification or other information on a liquid-crystal display built into radio receivers. (3) Quadriphonic sound on FM, stereo on AM. (4) Data and facsimile transmission multiplexed into audio broadcasting.

DAVID LACHENBRUCH
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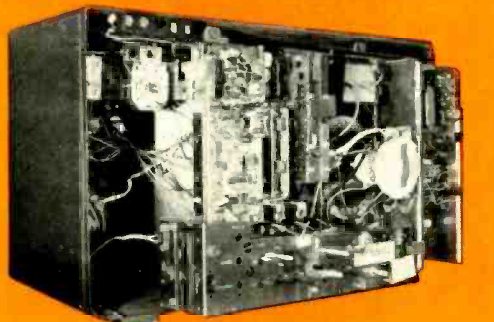

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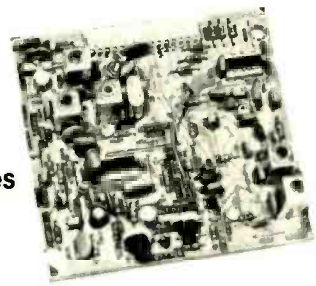

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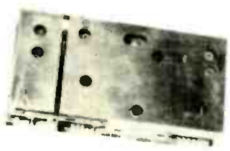

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CB'ers are heroes in storms of '78

The first two months of 1978 provided blizzards, ice storms and severe weather conditions to much of the U.S.; it was also a time when CB operators performed many acts of heroism and neighborliness by helping those stranded by snow, providing emergency fuel deliveries and aiding local authorities in coordinating rescue and relief operations.

"For many of those stranded in the recent blizzard," said John Sodolski, vice president of EIA and head of its communications division, "CB radio was the only communications device available for emergency rescue."

It is certain that without the volunteer efforts of CB'ers, snowmobile owners and four-wheel-drive organizations, rescue efforts would have taken longer and many lives would have been lost. CB radio provided the essential communications link during rescue efforts, since in many cases police vehicles were out of commission due to the storms.

Among the thousands of reports of CB'ers' heroism, some stand out:

—In Massacusetts, CB'ers directed oil deliveries into stricken areas, facilitated emergency transportation to and from hospitals, delivered food and rescued stranded motorists and people whose homes had lost heat.

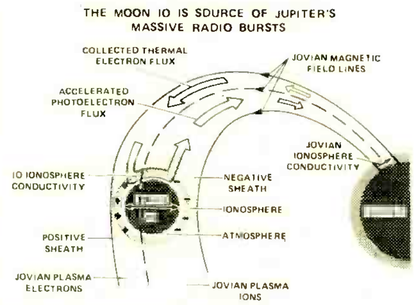
—In Ohio, when the power failed, CB operators helped bring over 2000 people through freezing temperatures to shelter in churches and other homes.

—In West Virginia, React Club members routinely delivered groceries and performed other neighborly acts for elderly people trapped by the snow in remote areas.

—On the West Coast, during recent rainstorms and floods, CB'ers took an active part in aiding the local Red Cross with emergency communications at two flood shelters housing 25 homeless families. Manned vehicles with CB radios shuttled flood victims and volunteers to Red Cross headquarters and the shelters. And once the immediate emergency was over, several members of the CB emergency team volunteered to stay on to help the victims and assess flood damage.

Planet Jupiter emits surf-like radio signals

It has been discovered that radio signal bursts emitted from the planet Jupiter and one of its moons, IO, resemble the rushing sound of waves on the shore—a phenomenon well-known for its soothing qualities. Shield Products, Inc., of Cleveland has used highly sophisticated receiving equipment to record these signals (originating from a distance of over 390 million miles) on magnetic tape, and have dubbed the project *Jupiter Tranquil*. These recordings are available to the general public.



PLANET JUPITER'S MOON IO is source of massive radio signal bursts recorded for *Jupiter Tranquil*. Diagram shows signal path.

The signals are produced when satellite moon IO passes through Jupiter's intensely charged magnetic field, at which point the moon's ionosphere becomes both positively and negatively charged. When IO is in the optimum orbital position, an electrical current of more than 100 megawatts flows along Jupiter's magnetic field down to the planet's own ionosphere and back to IO. This tremendous flow of energy is responsible for the signal bursts that so resemble the sounds of the sea. For further information, write to Shield Products, Inc., Space Technology Div., 1104 Prospect Ave., Cleveland, OH 44155.

Telesat Canada Anik C spacecraft to help link south Canada cities

Telesat Canada has awarded a contract to Hughes Aircraft, El Segundo, CA, to build three new communications satellites, the Anik C series (*anik* is Eskimo for brother). The satellites will open up interurban telecommunications in the vast, 3000-mile area stretching from coast to coast in the southern half of Canada. This area also lies within 1000 miles of the United States border.

The spacecraft, scheduled to be sent into orbit in 1981 via NASA's Space Shuttle, will operate over the Equator between 105 and 120 degrees west longitude, south of Alberta, Canada. It will operate in the super-high-frequency range of 12 to 14 gHz-per-second. The use of such high frequencies allows the antenna to produce the narrow beam necessary for such concentrated radiated power. This narrow-beam capability will allow earth stations receiving the frequencies to be located in high-density areas without interfering with terrestrial or lower-frequency space signals.

Other Anik C features include 16 communications channels to supply audio, video and data telecommunications services; and polarization diversity that permits using the same frequency twice. Its solar array consists of two concentric cylindrical panels; when the satellite is in orbit, the outer solar panel extends downward exposing both panels to the sun and boosting power generation to more than 900 watts.

ANIK C SPACECRAFT, being built by Hughes Aircraft for Telesat Canada, will link southern Canada's cities from coast to coast (shown in artist's conceptual above). The satellite will provide telecommunications services in super-high-frequency range of 12 to 14 gHz.

U.S. investigative agency reports dangers of microwave radiation

The General Accounting Office, which is the investigative arm of the U.S. Congress, has released a report that warns the public may be exposed to dangerous microwave-radiation levels. This represents the first time any Government agency has recognized such hazards. The report further states that microwave transmission facilities are being built at a rate of 15% a year, and there is as yet no Government agency to monitor them or set safety standards.

Prior Environmental Agency Protection lab tests are described in the report as having concluded that microwave radiation may "affect the immune system" in laboratory animals as well as produce a "trend toward lowered behavioral performance."

Studies conducted in the Soviet Union and Eastern European countries reported that individuals exposed to radiation levels much greater than the U.S. Government's standard of 10/1000'ths of a watt complained of a host of symptoms, including

continued on page 12

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headache, eyestrain, irregular heartbeat, etc.

William Mumford, a retired Bell Labs scientist who helped devise the U.S. standard for microwave radiation, asserted that this standard was safe under normal environmental conditions, and that of the 4000 medical cases of alleged microwave radiation reported since the 1950's not one fatality had been reported.

World's most powerful vacuum tube switch used in nuclear-fusion tests

A 20-man engineering team from RCA's Department of Electro-Optics and Devices (Lancaster, PA) has designed and developed what they term "the world's most powerful vacuum switch tube." The RCA tube switches 25 megawatts (MW) or enough energy to turn on 300,000 TV sets simultaneously. It will be one of 12 similar tubes that are to be installed in Princeton University's Plasma Physics Lab for use in a fusion-test reactor. This reactor will be used to determine the feasibility of generating electrical power via nuclear fusion.

320-POUND VACUUM TUBE designed by RCA switches 25 MW—enough power to turn on 300,000 TV sets— and will be used in Princeton University nuclear fusion tests. Computers were used in designing the tube, constructed by engineers of RCA's department of Electro-Optics and Devices in Lancaster, PA.

The reactor, which is destined to become operational in 1981, will use the vacuum switch tubes to regulate power systems that will provide the major heating of the plasma used in the fusion reaction. Dr. Ralph E. Simon, division vice president, explained that the tube's function "is to switch and control ion beams as they are injected into the fusion test reactor . . . The tube will supply 25 million watts of energy to the ion beams in pulses varying in duration from several millionths of a second to several seconds."

Made of copper, stainless steel, tungsten and ceramic, the RCA tube weighs 320 pounds and measures 42 inches long and 22 inches in diameter. Tube design was facilitated by the use of computers that were able to analyze the tube's electrical characteristics and help determine the shape of the tube's anode. The power dissipated by the anode is 2 MW. Sixteen kilowatts is required just to heat the cathode. The tube is completely water cooled with a flow rate of 250 gallons-per-minute through the tube's anode section.

New FCC legislation cracks down on unlicensed CB operators

In March, 1978, President Carter signed legislation that at long last empowers the Federal Communications Commission to enforce its rules against *unlicensed* as well as licensed CB violators.

Until recently, a Federal court order was necessary to act against unlicensed violators of the Commission's CB regulations; these regulations were really effective only against licensed violators. James C. McKinney, the FCC deputy chief of field operations, stated, "We can now make it economically unfeasible to be unlicensed. I suspect fines . . . will be greater than for licensed violators."

The new law increases the maximum fine for violations from $500 to $5000, and extends the time period from 90 days to a year during which the FCC can issue a citation for a violation.

Present-day color TV set prices lower despite inflation

According to Roy Pollack, vice president of RCA's Consumer Electronics Division, the cost of a color TV set has declined during the past 25 years. In 1954, the average price for such a set was $1000; today, it is $575, representing a 43% drop. This price drop occurred despite an inflationary period that saw skyrocketing prices on other household items such as washing machines, refrigerators and the like.

Pollack attributed this counter-inflationary price trend to be a reflection of "improved production techniques, new materials, new technologies, bigger markets and severe competition." He added that during the past 25 years, the average price of a new car rose 134% and the median cost of a new one-family home mounted a whopping 290%.

Earth satellite uses infrared band for 24-hour monitoring

The Landsat 3 earth satellite developed

MULTISPECTRAL SCANNER (MSS) can take thermal photos of the earth at night. Here, Hughes Aircraft technician examines instrument's aperture, housing reflective mirror and telescope to record earth-surface images.

by General Electric has had an infrared (IR) channel added to its multispectral scanner (MSS). This IR channel, designed by Hughes Aircraft, will enable round-the-clock photography of terrestrial resources such as water, snow, glaciers, etc. The satellite (scheduled for a West Coast NASA launch) is planned to act in tandem with its sister satellite, Landsat 2, already in orbit.

NASA spokesman asserted that the earth resolution of the IR band of the MSS will allow a 24-hour monitoring of water temperature variations, water pollution, ocean currents and geothermal sources and enable scientists to determine more precisely the ecological impact on earth resources of such large heat-producing facilities as nuclear power plants and industries as well as expanding urban areas.

The vehicle's MSS system traps the earth's radiation with a flip-flop mirror that moves from side to side during the orbit. A precision telescope inside the scanner channels the radiation to detectors in five spectral bands, including the IR band. The detectors then convert the light into voltages, which are, in turn, translated into numerical values. This data is stored on tape recorders for later transmission to a ground station, or in real time at a 15 million bits-per-second rate.

The satellite will circle the globe 14 times daily as the scanner photographs strips of land below. Each time the satellite passes over the Equator it will do so at a distance about 1800 miles west of the last trip.

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editorial

Contest Of Contests

Our readers deserve a really great contest—one that will test their skills to the limit—one that will let them show the world just how great they are. So, we here in the editorial offices of **Radio-Electronics** have given much thought to running a really terrific contest for our readers.

We first thought of a design contest—like build the best circuit. The problem here is how can anyone pick a winner. Is a mini flat-screen color TV better than a wristwatch computer or a portable telephone?

So, we need your help. We need some reader to dream up the very best contest that has ever been held. We need a contest that will put before the electronics community a real challenge and yet permit us to select a definitive clear-cut winner. Like who built the frequency counter that could read to the highest frequency; or who built a CB radio with the least number of parts; or who built the fastest electronic car.

In addition, we need a handicap factor since the cost of the item built must also be considered. And this handicap must increase as the cost goes up. As we all know, if we spend enough dollars we can reach the moon. But how do you get to England for $2.98?

Send us your ideas. We'll reward the contributor of the one that we do use with two items—first, a 10-year subscription to **Radio-Electronics;** second, a check for $250. The editors are the judges and our decision is final. If two similar winning ideas come along, the one with the earliest postmark wins. No prizes for second place, and all entries become the property of Gernsback Publications Inc. Now, start filling our mailbox.

LARRY STECKLER
Editor

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Geostationary satellites aid federal antismuggling efforts

Recently, General Electric communications experts ran a six-week-long series of communications and position-fixing tests involving the use of two NASA experimental geostationary satellites. The purpose: to demonstrate that the satellites could help the federal government reduce significantly the present rate of contraband drug and illegal alien smuggling occurring across the U.S.-Mexico border. These tests, conducted together with the U.S. Drug Enforcement Administration (DEA) and the Immigration and Naturalization Service (INS), showed that a geostationary satellite, orbiting about 23,000 miles above a fixed area of the earth, can help keep government field agents in contact not only with their colleagues but with their base station, even in very remote locations.

A geostationary satellite stays in a permanent location, its line of sight coinciding with about 43% of the earth's surface. It receives the signal from the agent's mobile radio transmitter, amplifies it, then sends it back to earth, either to another agent's two-way radio or to a base station. The base station uses a system called tone-code ranging to pinpoint the location of the agent's car to within 600 feet—a distinct advantage when much of the tracking must be done through mountainous and often roadless territory.

The two NASA space vehicles, the ATS-3 (positioned above the Amazon River) and the ATS-1 (over the Equator south of Hawaii) plus a station wagon were used in the tests. The station wagon contained a special antenna and radio equipment consisting of a GE two-way mobile radio, with a special tone-code data responder that reacts automatically when addressed by a coded signal, plus a low-noise preamplifier to increase sensitivity and a power amplifier to boost signal output to 250 watts. General Electric's network of transponders located around the globe were used to determine precisely the location of the two NASA satellites, at which point range measurements were transmitted via satellite to the station wagon, whose automatic responder returned the signal to the satellite. A computer was then able to use the travel time of the signal to calculate the location of the station wagon in real time.

RCA American satellites beam pay TV programming

A pay TV program supplier, Showtime Entertainment Inc. has started using RCA's American Communications satellites to transmit quality programming to cable TV subscribers throughout the U.S. on a daily basis. The service provides an average of nine hours of programming, with most of the shows planned for the popular evening hour and weekend time slots.

The *Showtime* programs are transmitted via two RCA American satellites (in orbit 22,300 miles above the Equator), and are beamed on two separate feeds—one for the Eastern and Central time zones, the other for the Mountain and Pacific time zones. It is also planned to eventually extend this programming service to Hawaii. **R-E**

letters

MONEYMAKING IDEAS

Here are two moneymaking ideas that might interest your readers:

Games and money: Doesn't almost every TV sales and service organization have old TV sets (trade-ins, etc.) that just "sorta work"? These sets may be almost unsaleable as receivers . . . but, with minimum repair, they might be ideal as *second* sets for video games only.

We had an old set in the garage with a torn speaker that would receive only one channel. With *no* work, the set became just fine for use with a TV game . . . and the set was 14 years old! Some advantages of this old TV "retirement job" are:

1. No conflict between kids wanting to play the video game vs. adult viewing time.
2. No worry about "burning in" the game image on your good set through accidentally leaving it on overnight, etc.
3. The set can have many faults—poor contrast, poor AGC, nonworking channels, poor audio tone—and yet be just fine for video game use.
4. A customer can try his game on the used set in just minutes to determine whether it's usable . . . and there will be no questions or variable performance due to location, type of antenna, etc.

Program stores: in the *near* future, tape programs for video games and home computers will become a rapidly growing business, especially if standardization is such that tape readers, video displays and keyboards are used in both systems. This market may also include plug-in PROM's and, of course, video entertainment tapes.

They could even become combined. A tape of a well-known novel could (for students) even have a question-and-answer section at the end to emphasize comprehension and interpretation.

The point is—those stores that are now just hi-fi and record stores should be learning just as much as they can about the new technology. It's all interrelated . . . tapes, records and the machine to play them. Five years from now I predict such businesses will be known as "Program Stores," featuring game programs, video programs, music programs (both live and computer-produced), computer programs, etc., etc.

PETER LEFFERTS
San Martin, CA

NO AM DATA

The logic shown by Len Feldman in the Letters column of the December 1977 issue escapes me completely. Apparently he is saying that since most AM sections of AM-FM tuners are poor, they shouldn't be mentioned.

Good FM performance is easy to find; one hardly needs a product report to locate a tuner with FM that is as good as the transmitting station's characteristics. The difference in tuner performance will show up in the AM section, which varies from terrible to fairly good. Isn't that where the emphasis should be?

Mr. Feldman states that most AM stations use "standard" 5000-Hz lines. I don't know the source of his data, but there isn't one single audible AM station in the Washington, DC, area that isn't audibly better

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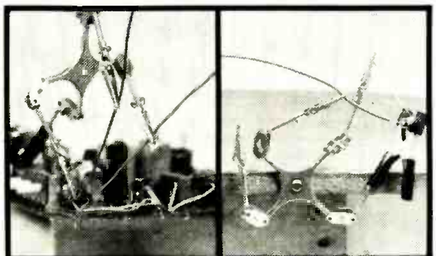

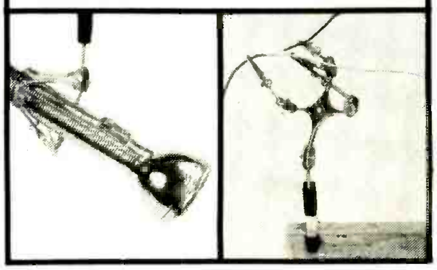

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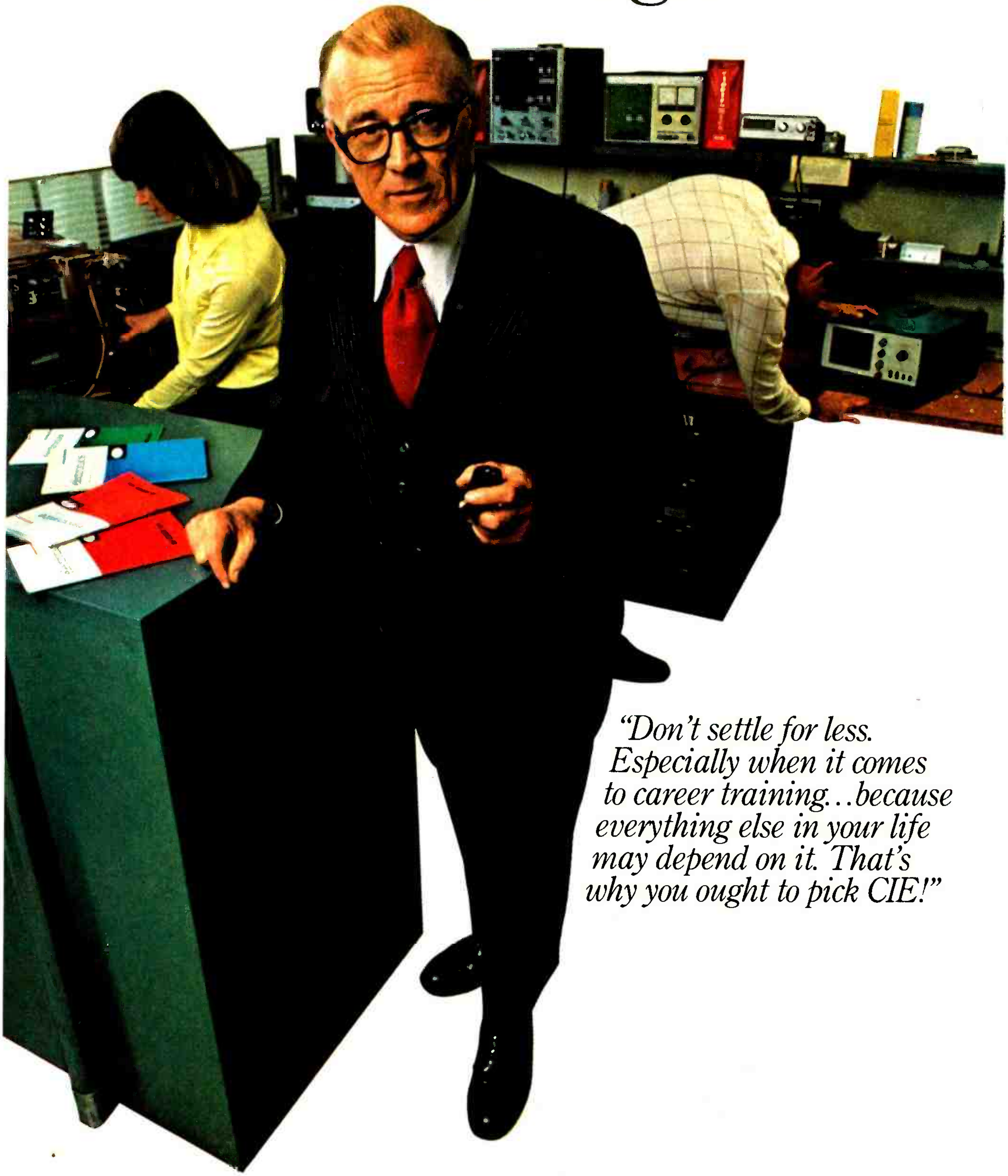

"Don't settle for less. Especially when it comes to career training...because everything else in your life may depend on it. That's why you ought to pick CIE!"

LETTERS

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than that on a wideband receiver. Broadcast lines are nearly always "unloaded" and stations do equalize them to much better performance than 5 kHz.
CDR. HAROLD W. CORNELIUS
Arlington, VA

On the contrary, Commander Cornelius, it is precisely because I do know how good AM can be made to sound that I seldom bother to discuss the AM sections of the tuners and receivers that I measure. There is one station in the New York area that, in fact, boasts a "proof of performance" from the FCC showing that it is essentially flat to 15,000 Hz (just like FM stations). The only time I was ever able to take advantage of that excellent capability was when I was testing a little-known AM-only tuner known as McKay-Dymek. That tuner had virtually flat frequency response to beyond 9 kHz and an excellent 10-kHz whistle filter as well (a necessity if the response of an AM tuner is to be extended to that degree).

I see little point in discussing the fact that one AM tuner rolls off at around 3 kHz (typical of the breed, by the way), while another goes "all the way" to 4 kHz. If and when I run into a tuner that does measurably better than that, I will certainly devote more space to that fact in my product test reports.

I would also like to take issue with your statement that "one hardly needs a product report to locate a tuner with FM that is as good as the transmitting station's characteristics." There are still several FM stations that do an exemplary job of transmitting a clean signal, and such tuner parameters as selectivity, distortion, separation, 50-dB quieting and signal-to-noise ratio (not to mention capture ratio and AM suppression in multipath-laden reception areas) are very important if one wants to hear the best that these stations have to offer.

I would hope that if and when the FCC provides us with standards for stereo AM, stations (and receiver manufacturers) may find an additional incentive for creating, broadcasting (and receiving) higher-fidelity AM programming than has been the case up to now. If and when that happens, I shall be happy to demonstrate that I do know a little bit about AM too.—Len Feldman

FREQUENCY/TIME DISPLAY CORRECTIONS

With reference to my article, "Build AM/FM Frequency Display," in the January 1978 issue, there are a few corrections that should be made in it.

First, in the Parts List, R7 was left off—it should be 15K, as per the Fig. 2 schematic. In Fig. 9, there is a jumper shown going to Q3; this is really R21, or 3.9K. Also in Fig. 9, the "C11" shown just above the crystal, XTAL1, is really R11, or 15 megohms. Finally, the photograph entitled "View of a Partially Constructed Board" shows Q3 through Q6 turned the wrong way. Turn 'em around and everything will be fine.
GARY McCLELLAN

PET COMPUTER NEWSLETTER

Some of your readers may be interested to know of a new coast-to-coast newsletter we are publishing called *The PET Paper,* which is intended to provide "something for everyone" who owns a Commodore PET computer.

Both beginners and experts should find articles in *The PET Paper* of interest, as well as the news it contains of User Groups in their communities, reviews of known and available software, plus hardware how-to's, sources and costs of peripherals as they become available. We even plan to print sections from local User Group newsletters. The cost of a year's subscription to the newsletter is $15.

For further information, contact Terry L. Laudereau and/or Rick S. Simpson, *The PET Paper,* P.O. Box 43, Audubon, PA 19407.
TERRY L. LAUDEREAU
RICK S. SIMPSON
Audubon, PA

PINK-NOISE GENERATOR

I encountered one difficulty with the pink-noise generator described in the January 1978 issue.

As mentioned in the article, pink or white noise is used to produce the sounds of wind, rain, or surf, and one of the uses of this sound is to provide a steady background for masking out unwanted noises. The pink-noise generator as described in the article is unsuitable for these purposes for one major reason:

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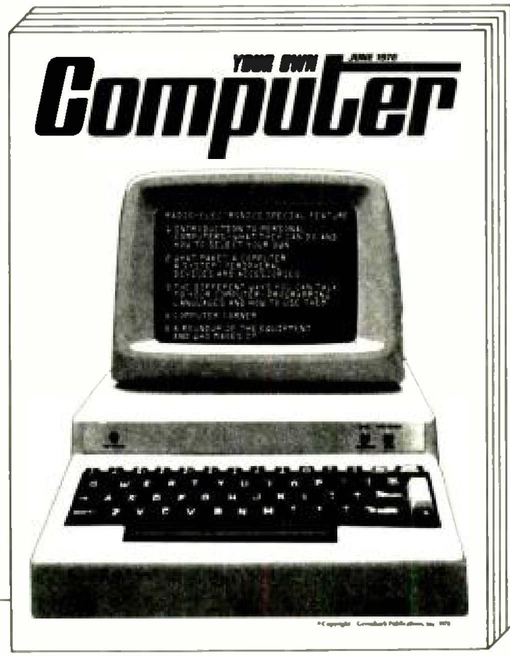

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LETTERS

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A pseudorandom noise generator such as the MM5837 has a periodicity of about 1½ seconds. This is because the noise is produced by an internal shift register and at the internal clock frequency, the register is reset when the random sequence is exhausted—at the periodicity frequency.

The sound the noise source makes is a combination of noise and sounds associated with this cycling. Without the pink-noise filter, the sound resembles metallic machinery with a rotating gear that has a "tinking" sound. With the filter, the sound is much like that of a slow heartbeat.

When I contacted National Semiconductor, manufacturers of the MM5837, the company confirmed this condition. For the purpose for which the IC was intended, namely, for *short*-duration white noise, the cycling effect is unnoticeable. For those interested in avoiding this, a much longer shift register can be constructed, say 28 bits, and the periodicity now becomes over 12 hours, virtually unnoticeable.

W. CURTISS PRIEST
Lexington, MA

Your pink-noise generator is a simple, no frills gem. It is the greatest, cheapest piece of audio gear that I ever bought, and has done more to balance my system to the room than anything.

I have an SL meter, and the results of using the ⅓-octave pink-noise record never seemed right. I know my Dynaco 10-band equalizer does its job so the results were puzzling. A five-minute adjustment using your generator and it sounded better than ever.

However, nowhere do you specify the reasonable lower and upper frequency limits of the unit. I am also sure that the 3-dB octave filter must be a trade-off, and I wish you could specify ±dB limits for the slope—or supply a frequency plot showing the notches.

If as one of your projects you could offer a reasonably priced sweeper or 10-octave filter set, it would be great to have a variable source of pink noise. Of course, then you get into the question of whether it should be ⅓ octave.

I fear most equalizers are of the op-amp cut-and-boost type and there is somewhat of a problem at the frequency extremes. Since one can only cut all frequencies about −12 dB, the noise floor approaches the normal output at very low and high frequencies, and an accurate plot is questionable. The noise floor through my system seems to be only about 6 to 8 dB down from a 0–70 dB or 80 dB middle (I mean residual pink noise from the equalizer, not system noise) and trying to find the plot in a system that is only −5 dB at *26* cycles gets sticky.

It seems one can test and experiment cheaply at mid-audio band but playing with the top and bottom costs plenty of money! Thanks for an excellent economical product.

FRANK B. HORNER
Allenhurst, NJ

In response to Mr. Horner, let me assure you that the PNG covers the entire audio spectrum (20 Hz–20 kHz). In fact, an actual spectrum analysis shows the noise to extend from below 10 Hz to beyond 40 kHz. As for the −3 dB/octave filter, it is accurate to ±½ dB. There is a low frequency beat that may cause the meter to swing back and forth. The correct setting is when the needle bounces equally on either side of the reference. As Mr. Priest points out, this beat may make the PNG unsuitable for psychological testing and sound effects generation. For these uses, a more conventional semiconductor junction noise source may be required.
JEFFREY G. MAZUR

ENGLISH VS. AMERICAN TV'S

I agree with E. M. Kubilus' letter in the January 1978 issue of **Radio-Electronics.** I have been repairing English TV's for 5½ years in my spare time. The English sets are a dream to repair compared with American models. I think the American manufacturers could benefit from the English design. Also the English picture quality is better than the American quality.

ALFRED R. WATERS
APO, NY

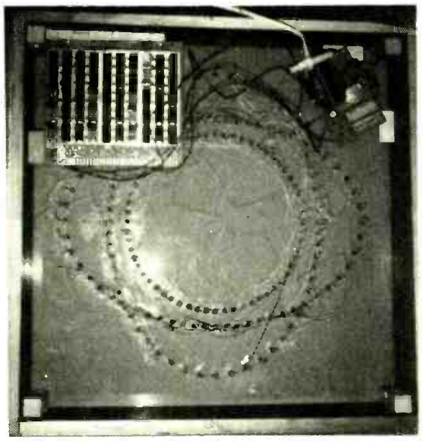
IN THIS ISSUE

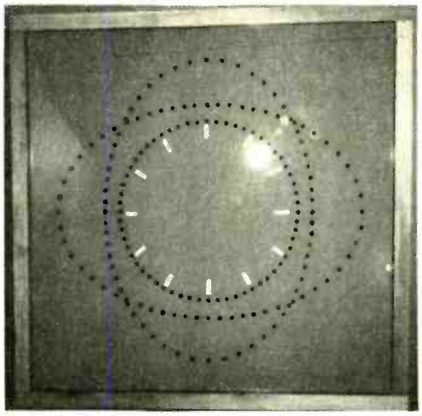
Everything you wanted to know about long duration IC timers. A feature you won't want to miss.

DIGITAL CLOCK VARIATIONS

I thought you might be interested in my version of the No-Digit Digital Wall Clock featured in the June 1977 issue of **Radio-Electronics.** I added a couple of features that I think make the clock more interesting:

1. I added a ring of LED's that indicate the seconds and give a sense of motion.
2. I made the minutes and seconds rings into ovals to add interest.





3. I used 60 LED's for the hours instead of 12 to more closely approximate the motion of a mechanical clock.

I wired the clock to a surplus wire-wrap board and modified the author's circuit to allow for the ring of seconds. Also I allowed for the extra hours LED's, plus the minutes circuits had to be modified to allow moving the hours every 12 minutes. In order to synchronize the minutes and hours I added a power-up reset circuit. The time-setting circuits are more complex to permit setting the seconds and to keep the minutes and hours in sync.

In the fast-set mode, the clock is fascinating to watch, with the minutes and seconds whizzing around and the hours ticking along. I'm thinking of building a similar project that doesn't keep time at all (or can be read as a clock only with great difficulty) but is just visually interesting.

Thanks a lot for the informative article.
MICHAEL MORSE
Garrett Park, MD

R-E

equipment reports

Chemtronics Electro-Wash Degreaser

CIRCLE 101 ON FREE INFORMATION CARD

CHEMTRONICS INC. (45 HOFFMAN AVENUE, Hauppauge, NY 11787) has developed a new handy spray-can product called *Electro-Wash*. This compound is a freon degreaser/cleaner that is very effective for loosening and flushing away grease and dirt that can cause problems in sensitive electronic circuits. It's nonflammable, has a fast wetting action, and will not affect plastics or any electronic component.

The manufacturers claim *Electro-Wash* can dissolve oxidation. I had an excellent test subject in my own antique TV set, which is a jewel but has some problems with dirty tube-socket contacts. So I pulled a few strategically located tubes and sprayed *Electro-Wash* on the sockets and tube bases. This seems to have cleaned up a cute little intermittent that had been bugging me for some time. It also helped the tuner on Channel 13 as well as a couple of controls!

My test sample was a 24-ounce can, a good size for bench use. The can comes with a long plastic needle for getting into tuners and similar places while the TV set is on. Along with the can came a *Vibra-Jet (model VJ-1)* which has a 26-inch-long plastic hose with a fitting that plugs right into the top of the spray can. The nozzle is a 7-inch-long plastic tube, and the handle is a slightly bent piece of larger tubing. This design makes it exceedingly handy for getting into those tight places the big can has problems reaching.

The *Vibra-Jet* delivers the spray in a fast series of pulses (similar to a "flutter" action) for better cleaning. I cleaned up a couple of filthy PC boards with this and they look like new. This device is also very handy for getting at color codes on resistors that are covered with a ⅛-inch layer of gook, and for identifying resistors that have been overheated and discolored.

The *Vibra-Jet* tubing is made of polyurethane, which is safe for use with any other Chemtronics products: coolant spray, moisture displacers, lubricants, etc. (If you worry about the environment, *Electro-Wash* uses CO_2 propellant, which is harmless.)

Electro-Wash can be used on any kind of electronic equipment from computers to little transistor radios. I also used it to clean up a sticking "U" key on my nonelectronic typewriter with the greatest of ease! *Electro-Wash* sells for $4; the *Vibra-Jet* costs $1.98. **R-E**

Advanced Video Model FSII Video Camera

CIRCLE 102 ON FREE INFORMATION CARD

IF YOU ARE ONE OF THE MANY THOUSANDS of people who recently bought a videocassette recorder, or if you plan on purchasing one, then a video camera is something you'll want before long. Color cameras still cost $1500 and up, but good black-and-white video cameras are available for less. An outstanding buy is a black-and-white zoom-lens video camera, the fully assembled *model FSII*, which sells for $149 from Advanced Video Products, 5835 Herma, San Jose, CA 95123. If you lack an 18-volt DC supply at about 350 mA, you can purchase the *model PSVI Power Supply* for $29 more.

The monochrome *model FSII* can be used indoors or outdoors, and extra lighting is not

continued on page 28

For a limited time only WESTON offers this handsome carrying case...FREE...with any Model 6000 DMM you buy.

That's right! With any Weston Model 6000 DMM you buy between May 1 and August 31, you will get . . . absolutely FREE . . . this handsome, sturdy carrying case. Leather grained for a look of elegance, the expanded vinyl is rugged and easy to keep clean. The pouch style makes it simple to remove or replace the meter. The case, worth more than $15, comes with a handle for easy carrying, and a snap-loop for hanging from a belt.

The Model 6000 is the renowned "Drop-Proofed" digital multimeter with standard built-in autoranging for its five measurement functions over 26 broad ranges. All ranges, including resistance, are provided with complete overload protection and automatic zero calibration.

The Model 6000 comes with a "Hold" feature to retain the LCD reading after the probe is removed. This allows measurements to be made in crowded circuitry or high voltage areas with greater safety. The meter is housed in a high impact molded plastic case to isolate inputs and to provide greater ruggedness and durability. The inside of the 6000 is coated with a conductive paint to shield the circuits from industrial radio frequency interference noise and insure more accurate readings. A sturdy, patented plastic handle makes the meter easy to carry, acts as a tilt stand during bench operation, and folds down to protect the display face during storage.

The Model 6000 also has two new optional features . . . a manual range hold button to override autoranging, and a display backlight button for reading the meter in very low illumination areas.

You get all of these features in the Weston Model 6000 DMM . . . and you also get, absolutely FREE, a handsome, sturdy carrying case for extra protection. Be sure to get in on this FREE, limited-time offer. Call your nearest Weston sales office now!

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CIRCLE 38 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

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usually required since the camera "sees" well in normal room lighting. This camera has an f/1.9 zoom lens with a focal range of 9 to 30 mm (over a 3:1 zoom ratio) and an optical through-the-lens viewfinder with a built-in sliding lens protector and adjustable-focus eyepiece. The dual-range automatic light control gives usable pictures from 3.72 candlepower to 9293 candlepower, with only one bright-dim control—there is no iris to adjust!

The camera weighs only 2.7 pounds and comes with a quick-release pistol-grip handle. Dimensions (without the pistol-grip handle) are 9 inches long by 4¼ inches high by 2¼ inches wide. Snap off the pistol grip, remove a large screw and you have a standard ⅜-inch tripod socket. A PAUSE-CONTROL pushbutton on the top of the camera lets you remotely start or stop a video recorder at the camera, if the videocassette recorder has a compatible pause circuit. (With the RCA *SelectaVision* videocassette recorder, remove the camera PAUSE pushbutton cap, unscrew and remove the miniature "on" bulb and replace the cap. This remote control works perfectly when connected to the *SelectaVision* pause-control jack.)

All connections are made through a 15-foot five-conductor cable that screws onto the side of the camera. A female connector is provided to mate with the plug at the other end. The five conductors carry the camera video signal, the sync pulses from the power supply (60 Hz), the positive supply voltage, ground return and pause control. The *model FSII* output has standard composite video specifications: 1 volt, 75 ohm, negative sync, with 525-line scan and full 1:2 interlace. The *model FSII* is all solid-state construction, except for the 8844 vidicon tube and the incandescent "on" bulb.

A wide-angle lens is available for $55, and a close-up lens set, which gives up to ×6 magnification, costs $10.

The camera can be used with a video recorder—for amateur TV film production, for home or business security purposes, or for any other closed-circuit use. Since the camera does not have an RF output, a *Video Modulator Kit* ($12) is available from the manufacturer. This kit converts the camera video output to RF on Channels 2 to 6 (slug-tunable) so that the camera can be "played" into any regular TV set. This modulator can also be operated from the same 18-volt power supply as the camera.

Using the *model FSII* is simple. Plug one end of the conductor cable into the camera and the other end into the power supply. The *model PSVI power supply* has a BNC connector for the camera video output that connects to the video monitor or recorder (or to a video modulator to use with a TV set). After about a 15-second warmup, a picture appears on the TV screen (unless you've forgotten to lift the sliding lens protector or turn on the power supply!). Depending on the lighting, set the switch on the side to OVERCAST or BRIGHT. As you watch the TV set, zoom in on some subject, using the lever on either side of the lens mount. Adjust the focus for the clearest picture. Now you can zoom in or out, and the picture will not need refocusing. Incidentally, the focus ring has two convenient detents for average and distant subjects.

Full technical information, including a schematic and alignment data, plus a full guarantee come with the camera.

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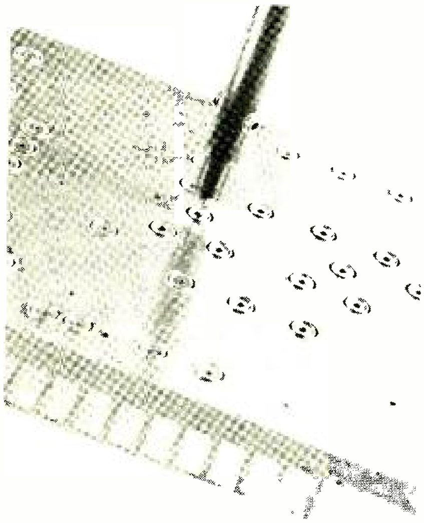
EQUIPMENT REPORTS
continued from page 28

A. F. Stahler Tools



CIRCLE 103 ON FREE INFORMATION CARD

SEVERAL BREADBOARDING SYSTEMS USE PC boards with etched or stamped conductors that you cut and jumper according to your schematic. Other systems use socket buses into which you plug components and wires. While these are very convenient, timesaving alternatives to conventional PC board layout and etching, sometimes less-disciplined methods are preferable. Improved layouts often result when IC's and other components can be positioned at nonparallel angles. Radio-frequency circuit optimization requires painstaking attention to lead length, positioning and shielding. A. F. Stahler Company (P.O. Box 354, Cupertino, CA 95014) manufactures tools and accessories that can be used to create a flexible breadboarding technique that overcomes these shortcomings for small-quantity development work.

The basic concept is to create terminal islands within a larger sea of a single- or double-sided PC ground plane. Two tool types in three sizes each are used either to insulate or isolate terminal areas on the PC layout: The first, a *series IS6000* isolated-pad-drill tool (shown), drills a pilot hole and a larger-diameter coaxial ring, leaving a component hole surrounded by an isolated terminal. Surface tension tends to prevent the melted solder from bridging the gap between the isolated terminal and the surrounding foil. A replaceable No. 60 or No. 69 bit is used to drill the component hole; and, depending on tool size, the outer concentric milling edges form a metal circle with a diameter of 0.01, 0.15 or 0.20 inch. The smallest-diameter tool is just right for drilling IC patterns with 100-mil pin spacing. The recommended drilling speed is 600 RPM.

The second type, the *series IS6900* tool, is an insulated-spot-drill that removes all the conductive material within the outer diameter of the tool. If, for example, you want to mount an IC or feedthrough terminal on a double-sided PC board, this tool removes the metal on the component side to prevent the terminals from shorting against the metal. A *model IS6010* tool could be used for additional mechanical support on the component side, but soldering IC pins on the top of the board makes removal of the IC more difficult and increases capacitance between terminals. The *series IS6900* is also convenient for wire-wrapping terminals and sockets. In this case, the tool is used to insulate the terminals from the surrounding metal so that wire-wrapped leads can be used to complete the circuit.

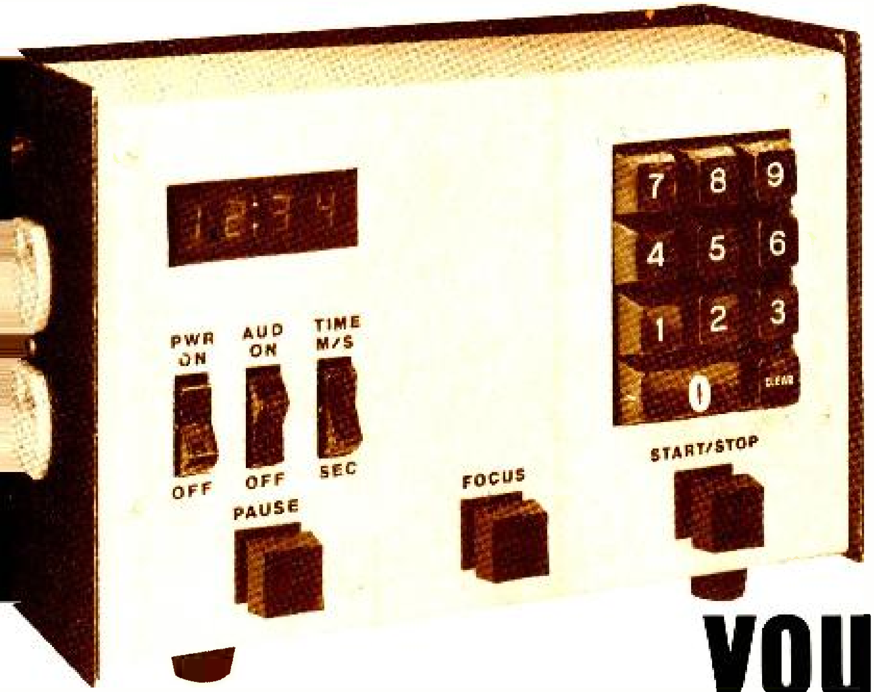
After initial layout, the hole center pattern is transferred to the PC board directly. For single-quantity designs, the layout can be done right on the PC board itself. Isolated and insulated holes are drilled and the metal is polished with emery cloth to remove burrs and prepare the surface for soldering. Components are inserted, with their leads extending a fraction of an inch from the board to act as wire terminations. The final steps are wiring, soldering and cleaning the board with a flux remover.

These drilling tools are also very handy if you want to modify existing PC boards; you can easily add pads to unetched areas.

The isolated and insulated drills are available in both high-speed steel at $10.50 each, or carbide-treated, costing $12.50 each. Sets of the three sizes are priced at $25 and $30 for steel and carbide, respectively.

A. F. Stahler also markets the *model RSDT-DIP16* template set that prints the drill pattern for 16-pin (or fewer) DIP IC's. This $12.50 set includes a rubber stamp, a 1-ounce bottle of fast-drying ink and a stamp pad.

For additional information, write A. F. Stahler Company, P.O. Box 354, Cupertino, CA 95014. **R-E**



BUILD Digital Timer for your Darkroom

Modern photographic processes require precise timing for the best overall results. Mechanical timers are going out and electronics are in. This digital timer is the last word.

RAYMOND G. KOSTANTY

HERE'S A MODERATELY PRICED, HIGH-ACcuracy, high-repeatability digital timer with a displayed range from 0.1 seconds to 99 minutes and 99 seconds, and an internal range up to 694.45 days (when 8 nines are entered in the minutes/seconds range). Although originally intended for photo darkroom use, it can be used in any application that requires switching on up to 150 watts for a precise time period.

The desired time is entered via a keyboard and displayed on four 7-segment displays. As the timing interval progresses, the display counts down and shows the remaining time, either in minutes and seconds or in seconds and tenths of seconds. An audio signal consisting of 0.1-second bursts of a 1000-Hz sinewave, once a second, is available as an aid in dodging and burning-in operations, when looking at the display would divert too much of the printer's attention. At the end of the timing interval, the last selected time will automatically be entered into the display and be ready for repeat use. This allows multiple prints from the same negative to be made without the nuisance of entering the same time over and over.

Calculator IC controls operation

The heart of the timer is a General Instruments calculator IC. In conjunction with peripheral logic IC's, it functions as shown in Fig. 1. Initially, the desired time is entered with the mechanical keyboard, and the START/STOP button pressed. Internal control circuits now come into play and activate an *electronic* keyboard. First, the selected time is entered into the calculator's memory and the "minus" function is activated. If the TIME switch is in the SECONDS position, the number 1 is next entered. Then, the "equals" key is electronically pressed at a 10-Hz rate, and .2 seconds later the enlarger and then the audio are turned on. Each operation of the "equals" key subtracts one (decrements) from the display until the contents of the display are −1. Then the enlarger is shut off and the audio is terminated. Next the contents of the calculator's memory are recalled, and finally the memory is cleared. At this point we are back to where we originally started, with the display showing the last selected time, and the memory cleared. If the same timing interval is still required, merely press the START button to start the sequence again. If a new time is desired, enter it via the keyboard. The first key pressed automatically clears the previous time out and enters the new number in the extreme right position. Additional entries always appear in the rightmost position and shift previous entries to the left.

If the TIME switch is in the MIN/SEC position, the selected time is stored in memory and then a loop whose sequence is −, delay, 4 and 1 is executed once a second until the contents of the D8 display become minus. Although the loop's sequence is −, delay, 4 and 1, the entry of the 4 is inhibited unless the two rightmost digits are both zero as determined by the zero-zero detector. So for 59 cycles out of each 60, the sequence is effectively −, delay, blank and 1. When a whole number of minutes is displayed, such as 3:00, 41 is subtracted so the display next shows 2:59. After the display shows minus in the D8 position, the same ending sequence described above is executed.

Time intervals up to 9999999.9 seconds or 999999 minutes and 99 seconds may be entered, but only the last four entries will be displayed. If more than 4 digits are entered, the OVERFLOW LED between the first and second digits of the display lights to remind you that the interval will be longer than the display contents. It extinguishes when the remaining time becomes 99:59 minutes or 999.9 seconds.

When the TIME switch is in the MIN/SEC position, the last two entries are always interpreted to be seconds (even if they are greater than 60), and earlier entries become minutes. Thus, an entry sequence of 4, 8, 5 will give an interval of 4 minutes and 85 seconds. The same interval could also be obtained by entering 5, 2, 5 (5 minutes and 25 seconds).

The CLEAR button sets the display to zero and allows you to correct mistaken time entries. Since it does not clear the memory or reset the audio latch, it should not be pressed during a timing interval.

The timing cycle can be halted by either pressing the START/STOP button, which will shut off the audio and the enlarger, reset the display to the last selected time, and clear the memory, or by pressing the PAUSE button, an alternate-action switch, which will halt the timing cycle and shut off the enlarger and audio. A second tap on the PAUSE button allows the interval to continue from where it was interrupted.

The FOCUS button, also an alternate-action switch, turns the enlarger on for focusing the first time it is pressed. Its next operation turns the enlarger off and restores control to the timer.

How it works

Figure 2 shows the block diagram of the timer, and Fig. 3 its schematic. The calculator portion consists of IC7, the four displays, four of IC2's buffers, and the mechanical keyboard. The display segment outputs a–g of IC7 contain the numerical information to be displayed in seven-segment format. Each segment output is connected to its corresponding anode of all four displays. The digit outputs, D1–D9, go high, one at a time, starting from D1 and going through D9 (and two additional internal states), and complete the cathode circuits of each display sequentially, thus determining which readout will display the information on the segment lines. The segment outputs are open-drain current sources to

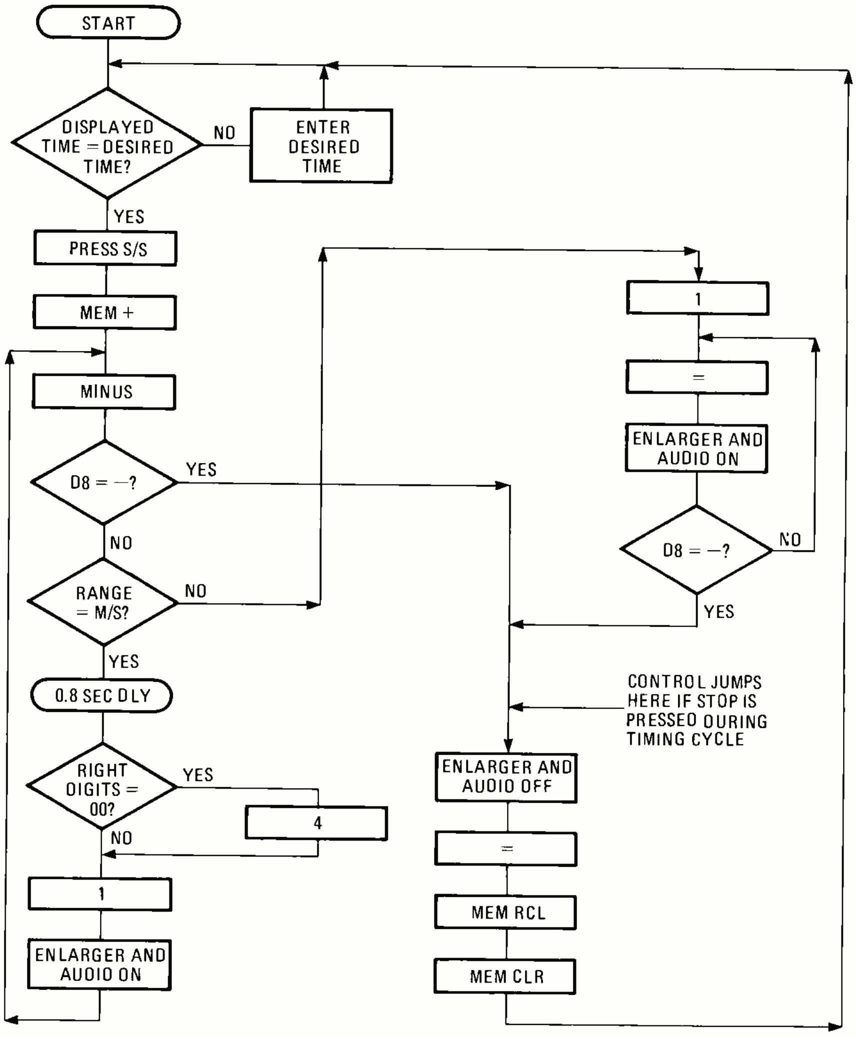


FIG. 1—OPERATIONAL DIAGRAM of the digital darkroom timer. An electronic calculator IC and its memory are vital to the timer operation.

MAIN BOARD PARTS LIST

Resistors ¼ watt, 10% unless otherwise noted
R1—10,000 ohms
R2—22,000 ohms
R3-R5, R10-R13, R15, R17, R19, R20—100,000 ohms
R6-R8—2700 ohms
R9—100 ohms
R14, R16, R18—5600 ohms
R21—75,000, 5%
R22—510,000 ohms
Capacitors 10%, 15 VDC ceramic discs
C1—100 pF
C2, C6-C9—0.1 μF
C3—.02 μF
C4—.05 μF
C5—.01 μF
D1-D3—1N4001, 1N459 or equal silicon diode
LED1-LED3—light-emitting diode, Monsanto MV-50 red or equal
DIS1-4—7-segment LED digits. Fairchild FND357 (0.362 in.) or FND70 (0.250 in.)
IC1—4018 resettable divide-by-N counter
IC2—75492 6-digit MOS to LED driver
IC3, IC15—4001 quad 2-input NOR gate
IC4, IC16—4011 quad 2-input NAND gate
IC5—4071—quad 2-input OR gate
IC6, IC10—4017 decade-counter/divider, 10-line output
IC7—C-685 calculator (General Instruments)
IC8, IC11—4016 quad bilateral switch
IC9, IC12—4081 quad 2-input AND gate
IC13—4019 quad AND-OR select gate
IC14—4027 dual J-K master-slave flip-flop
PB0-PB10—SPST momentary push-button switches. Part No. DC-61-05 (Datanetics, 18065 Euclid St., Fountain Valley, CA 92708)
Key caps for PB0 to PB10. Datanetics part numbers:

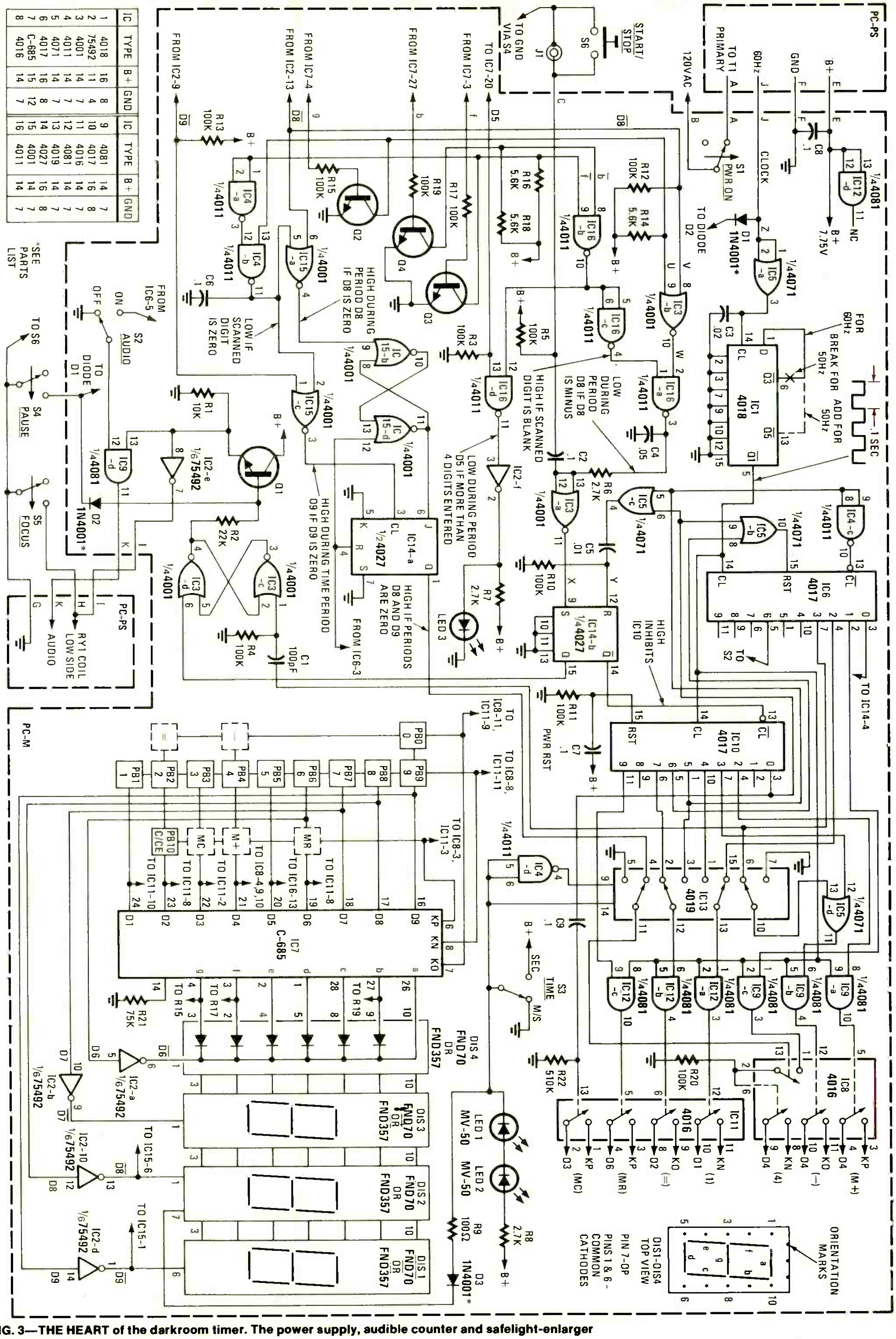
40-3091-03	40-3097-03
40-3092-03	40-3098-03
40-3093-03	40-3099-03
40-3094-03	40-3100-03
40-3095-03	40-7170-03
40-3096-03	

S1-S3—SPDT rocker switch, UID type RSW-06-12-SD-BB-S-B1-BK or RSW-06-12-SD-B1-S-B1-BK (UID Electronics Div., 4105 Pembroke Rd., Hollywood, FL 33021)
S4-S5—SPST alternate (push-to-pock, push-to-release) action switch, Switchcraft UP-501L with PB-11-02 caps
S6—SPST momentary switch, Switchcraft UP-101M with PB-11-02 cap.
J1—RCA-type phono jack
Miscellaneous—Four rubber or plastic feet, 1¼ X 2½-inch red filter for display cutout, duplex receptacle, IC sockets, nuts, bolts, wire and solder.

Note that the following parts are available:

IC7 (C-685) $6.50; case $11.00; main PC board, glass-epoxy etched and drilled with plated-through holes $15.00. The power supply PC board, etched and drilled $6.00. Switches S1-S3 $2.25; S4-6 $2.50; PB0-10 $7.00. Relay $2.30. Complete kit of all parts except solder $90.00. Assembled, tested, ready-to-use timer $120.00. All prices include postage California residents add sales tax as applicable.

Order from R. Kostanty, PO Box 1042, Gardena, CA 90249. Allow 3-4 weeks for delivery; add 2 weeks for non-California checks to clear. Foreign orders same as above, U.S. funds. Power transformer not shipped to foreign countries.



IC	TYPE	B+	GND	IC	TYPE	B+	GND
1	4018	16	8	9	4081	14	7
2	75492	11	4	10	4017	16	8
3	4001	14	7	11	4016	14	7
4	4011	14	7	12	4081	14	7
5	4071	14	7	13	4019	16	8
6	4017	16	8	14	4027	16	8
7	C-685	15	12	15	4001	14	7
8	4016	14	7	16	4011	14	7

FIG. 3—THE HEART of the darkroom timer. The power supply, audible counter and safelight-enlarger switching will be covered next month.

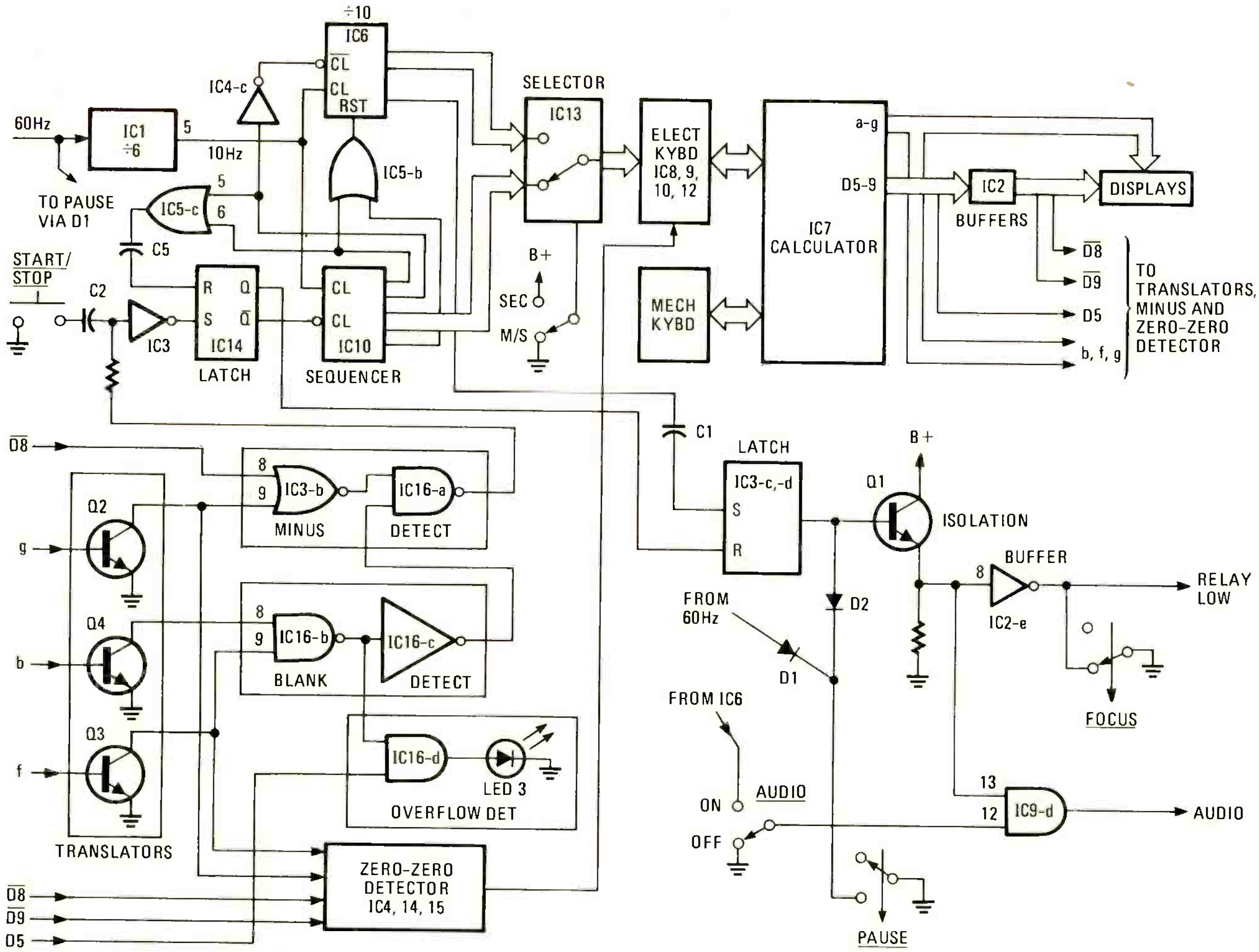


FIG. 2—FUNCTIONAL BLOCK DIAGRAM of the timer. Timing input is via a mechanical keyboard. The electronic keyboard operates from internal commands.

B+ which can directly drive one segment of a LED readout. The digit outputs, also open-drain current sources to B+, do not have the capability of handling up to seven times the current of each segment, so they are inverted through the high-power buffers in IC2 before being connected to the common cathodes of the displays. Each digit output from IC7 is high 1/11 of the time, at a frequency of about 130 Hz.

The calculator IC (IC7) also uses the digit outputs to determine which functions or numbers are being entered. In Fig. 3, PBO to PB10 (the solid squares) are the mechanical keyswitches which, when pressed, short one of the 9 digit lines to one of the 3 "K" inputs. (Functions electronically activated are shown in dotted squares.) The calculator decides what to do based on a combination of the voltage present at KP, KN or KO, and the timing of this voltage with respect to the digit outputs. If, for example, KN is high simultaneously with D5 (as it will be if PB5 is pressed), the number 5 is entered as input data. Similarly, if pins 3 and 4 of IC11 are shorted by the electronic switch inside IC11, a high will appear on KP during interval D6 and the memory recall function will be activated.

(Yes, a complete calculator could have been included as a function of the timer. But in view of the $8.00 cost of ready-to-use commercial units, the additional cost of 5 extra mechanical keyswitches and the 4 extra displays required to display the answer to noneven division could not be justified.)

Each time the START/STOP button is pressed, differentiator C2–R6 produces a negative pulse which lasts about 250 microseconds at IC3 pin 12. This pulse is latched by half of IC14. When pin 14 of IC14 goes low, sequencer IC10 is enabled.

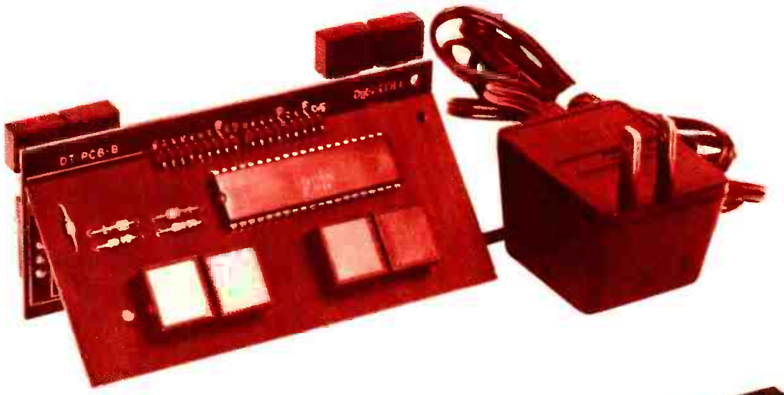
Device IC10 is a decade divider whose 10 outputs sequentially go high, non-overlapping, in the direction from 0 to 9, each time its clock input on pin 14 goes high if pins 13 and 15 are both low. Just prior to the pressing of the START button, the divider is inhibited because pin 13 of IC10 is high, and is resting with only its 0 output high. When IC14's pin 14 is latched low, divider IC10 outputs 1, 2, 3 and 4 sequentially go high at a rate of 0.1 second per step, and in conjunction with IC8, 9, 11, 12 and 13 perform the Memory Add, Minus and, if in the seconds range, 1 functions as shown in the flow chart. When the 5 output of IC10 goes high, the latch which feeds pin 13 of IC10 is reset, causing pin 1 IC10 to remain high for the duration of the timing cycle, IC6 to be enabled, and pin 6 IC12 to be high. Succeeding clock pulses advance decade divider IC6 (which is identical to IC10) and activate the Equals function, which decrements the display once each time it is activated.

The outputs from IC6 reset the zero-zero detector, provide a signal to turn on the audio oscillator and set the latch formed by 2 of IC3's gates 0.2 second after the Equals function is first performed. (The zero-zero detector, IC4-a and b, IC15 and IC14-a, produces a high when zeroes are in the rightmost position on whole-minute intervals.) This delay compensates for a one-time delay in the calculator IC the first time the Equal function is performed. (The fact that latch IC3 is set once a second by IC6-7 is incidental.) IC3's output, after being buffered by Q1, drives a relay on the power supply board which turns on the triac that energizes the enlarger. The relay simplifies gating the triac from low-level logic.

Countdown continues until a minus is detected in the D8 position or until the STOP button is pressed. Either event causes a positive pulse at IC14-9. Integrated circuit IC14 changes state and resets IC3 to turn off the enlarger and allows IC10 to continue sequencing. Output 7 from IC10, which is only required when in the minutes/seconds range, ter-

(continued on page 86)

BUILD DIGI-TOLL



THE DIGI-TOLL BACKBOARD (foreground photo) carries the switches and most small components. The front board (in background) has clock IC and displays.

Save On Long Distance Phone Calls

Part II—Special-purpose electronic timer helps you effect considerable savings in telephone toll charges as you time calls the same way Ma Bell does

FRED BLECHMAN, K6UGT

BEFORE STARTING TO BUILD ANY OF THE *Digi:Toll* versions, take care in component selection and substitution. Certain electrical parts are critical for maximum performance. For example, components T1, D5 and R6 are carefully balanced to provide maximum within-specification segment current to the displays. Since the 3817 IC can only drive 8 mA-per-segment, specially graded displays (brightness code 08 or 09) are a *must*. Also, D3 and D4 are special low-voltage-drop germanium diodes needed to equalize DIS1 segment brightness.

The *Digi:Toll* circuitry can be hand-wired on perforated board, if desired, using "junk-box" components, but the results will reflect this approach. You can make your own PC boards, as shown in Figs. 3, 4 and 5; however, note that the back board, shown in the foil patterns of Figs. 3 and 4, is two-sided with plated-through holes; this is not exactly a beginner's PC board project. In addition, both boards must be precision-cut when using the *Digi:Toll* enclosure.

Also, several special mechanical components, such as the header strips used to join the PC boards, the specified switches, the extruded aluminum case, the display lens and the screened data plate, are necessary to reproduce a high-quality unit. Since some components may be hard to obtain in single quantities, a complete kit is available.

Assembly of the standard *Digi:Toll* from the complete kit is very simple, and shouldn't take more than an hour. The instructions provided are detailed and complete. However, since you may want to purchase partial kits, or use some of your own components, the construction described in this article will assume you've decided to "roll your own," using the PC boards and critical components specified.

The standard *Digi:Toll* 12-hour display/24-minute elapsed timer does not require any foil breaks or special jumpers. If you plan to construct any of the optional versions, you should first make the specified foil breaks shown on the schematic table of Fig. 2 and in Figs. 6 and 7. You can make the breaks easily using an *X-Acto* knife or a razor blade, being careful not to cut *other* foil traces. All foil breaks, except for F and D, are on the back board, and all breaks on the back board, except for C, are on the *component* side of the board. Do *not* add any jumper wires yet.

The back board

Start by assembling the back two-sided PC board, oriented as shown in Fig. 6. Install a few components at a time into the board in the locations shown. Solder on the bottom side, using a 25- to 50-watt soldering iron and 60/40 resin-core solder, then clip off the excess leads. Save the cutoff leads for jumper wires if you make a modified unit. Install resistors R1, R2 and R3 first, then diodes D1 and D2, observing diode polarity. Next, install the bridge rectifier, making sure the marked pins (+ and −) face capacitor C1. Remove the excess coating from the leads of the small capacitors before installation so that the coating doesn't interfere with proper soldering; twist the coating off with pliers, even with the bottom of the capacitor body. Install capacitors C2, C3, C4, C5 and C6 in the positions shown. Insert resistor R6 into the board and then raise it about ⅛ inch above the board; this resistor runs hot in normal operation and should be given some "breathing" space. Next, install large capacitor C1 (be careful of the polarity!), then the switches. When soldering the switches to the board, make sure that all the terminals are seated in the board holes, that the switch bodies are parallel with the board and that the plungers face upward. After soldering the switches to the board, snap the switch pushbuttons onto the plungers—it takes firm pressure. Next, insert the AC-cord leads from the transformer into the *bottom* of the PC board and solder them on the *component* side. Set this subassembly aside while you work on the front PC board.

The front board

Assembling the front PC board is even

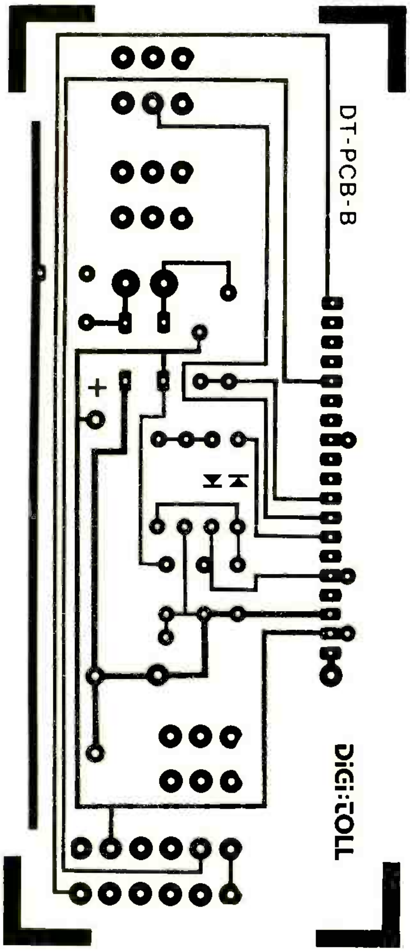


Fig. 3—FOIL PATTERN for rear (solder side) of back board is shown full-size. Switches are on this board.

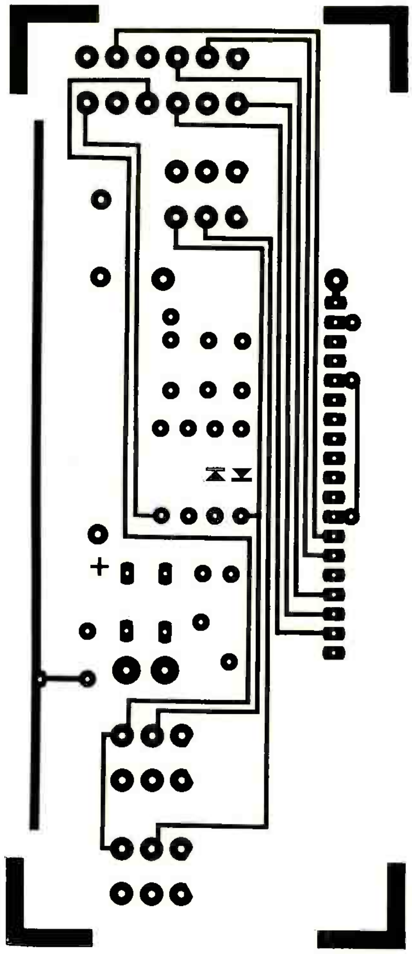


Fig. 4—BACK BOARD component side has this foil pattern (also full-size). Plated-through holes connect front and rear foils.

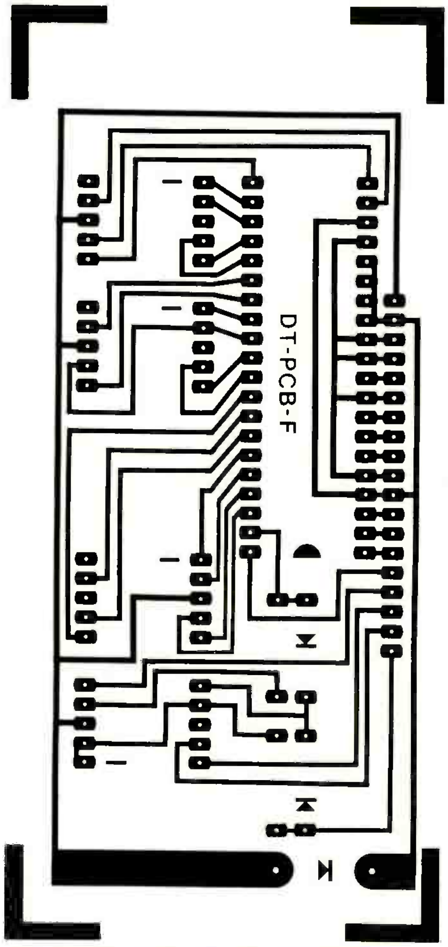


Fig. 5—FULL-SIZE FOIL PATTERN for the front board. This board holds the clock IC and 7-segment displays.

easier. Figure 7 shows the components layout. Insert all components into the blank side of the board, and solder on the foil side of the board. Resistors R4 and R5 are installed first, followed by diodes D3 and D4, and then by diode D5. The colored ends of D3 and D4 are the cathodes (the bars in diode symbols). The cathode of D5 is clearly marked with a black band. Next, solder the wire jumpers into all the 19 holes at the top of the board *except* for the center hole. These jumpers will mate with the back board, so their length and type will depend on whether you intend to place the display a remote distance from the switches that are installed on the back board. You might, for example, want to use some ribbon cable between the boards. You should be aware, however, that this could cause some spurious signals to be generated, and the boards should be as close as your application will allow. The best arrangement is to close-couple the boards using header strips. If you cannot locate header strips, then you must use the more tedious (and structurally inferior) approach of installing individual bare-wire jumpers. The header strips (supplied with the kit) are bent at a right angle at one end, to be used for right-angle panel-mounting (see Fig. 8). If you are using the *Digi:Toll* cabinet, use a bending tool to form the free ends of the jumpers or header strips to a 45-degree angle. Fig. 9 shows how this is done with the bending tool provided in the complete kit. (The header-strip wires are very tough, and while they can be bent with pliers, multiple flexing to achieve just the right angle can cause them to break—hence, we recommend using the bending tool.)

Next, install the displays, being careful to orient them properly; the scalloped edge is the top of the digit, but DIS1 must be installed *inverted* so that its decimal point can be used as an indicator dot.

Install the clock IC last. Be careful when you handle this device, since it can be damaged by static discharges when not in its conductive carrier. Before installing the IC in the PC board, it will first be necessary to make the pins perpendicular to the body (they are manufactured bowed-out). Figure 10 shows how to preform the pins on a flat (and non-charged) surface. When you install this IC into the board, be *very sure* the index notch faces the left side, as shown in Fig. 7, unless you enjoy unsoldering 40 pins simultaneously to remove the IC! A socket was not used in the *Digi:Toll* since it would not allow the unit to clear the extruded custom case; if you use a different enclosure, you could install a low-profile 40-pin socket here.

Joining boards and modifications

The front and back boards are mated by inserting the 18 projecting header-strip pins (or jumper wires) from the front board into the holes at the top of the back board. Do not solder these pins or wires until you align the boards. If you intend to mount the unit behind a panel, as shown in Fig. 8, make sure to provide enough space between the boards so that the display and switches can be properly located behind the panel openings. If you mount the *Digi:Toll* in its custom enclosure, the boards must be properly spaced and aligned at a 45-degree angle, as shown in Fig. 11. The easiest way to insure proper alignment is to use the enclosure itself as an assembly "jig." Insert about ½ inch to 1 inch of the boards into one end of the extrusion, which has slots for the boards, and space the boards $\frac{1}{32}$ inch apart at the top, using the two plastic strips supplied with the cabinet.

If no modifications are being incorporated in the version you build, solder all the header-strip pins, or jumper wires, on the component side of the back board. If

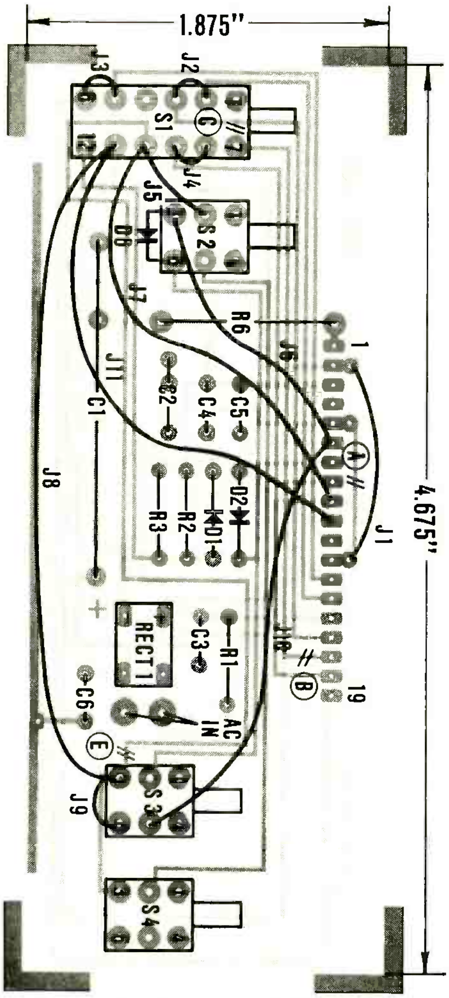


Fig. 6—COMPONENT PLACEMENT for the back board. Check locations of jumpers and foil breaks used in the various *Digi-Toll* options.

modifications *are* being made, do not solder those pins that connect to modification jumpers.

The Modification Table of Fig. 2 defines which jumper wires are required for each version. The longer jumpers are made from an appropriate length of insulated wire, with 1/16 inch of insulation stripped from each end. The shorter switch jumpers can be bare wire, or salvaged cutoff component lead wires. Figure 6 shows all 11 jumpers; but use only those that are required for the chosen modification! Diode D6 (used only with modification "L") and the jumpers going to the switches should be connected to the solder lugs on the switches. Jumpers going to pins 6 and 9 on the header strips should be wrapped once around the header pin and soldered. The top end of jumper J11 can be soldered in the empty hole (position 10). Keep jumper J1 clear of the top of the board by at least 1/8 inch so that it does not interfere later on with installation into the custom cabinet.

Testing & final assembly

The unit should be tested before being installed in a cabinet or behind a panel. For the unmodified units, follow this procedure:

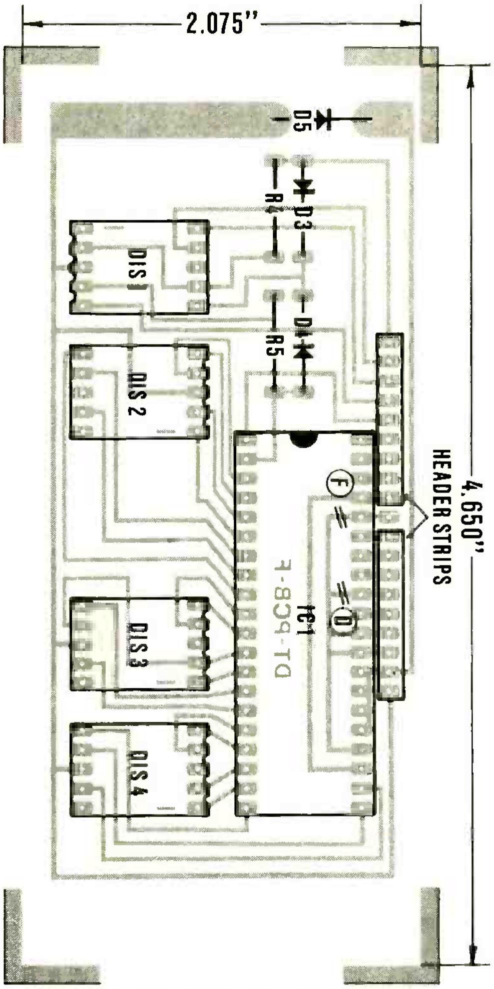


Fig. 7—THE CLOCK IC, four displays and five other components are on the front PC board.

1. Place switch S1 in the up (time-mode) position and plug in the transformer. The display should light up, with the dot indicator blinking to indicate a power interruption. Pressing either switch S3 or switch S4 (SLOW-SET or FAST-SET) will stop the blinking.
2. Set the proper time using switches S3 and S4, checking the segments as the time advances to see that they all light up when they should.

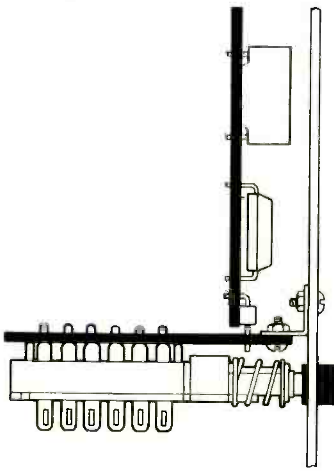


Fig. 8—THE *DIGI-TOLL* can be panel-mounted if desired. This is a suggested installation scheme.

3. Press switch S1 once so that it stays down (elapsed-time mode). The indicator dot should disappear and the display should count seconds.
4. Press switch S2 to reset the elapsed-time display to 00 00.
5. After several minutes, return switch S1 to the up position by pressing it again. The time-of-day and indicator dot should reappear, and should have advanced to the current time. Pressing S1 down again should display the elapsed time at the point where it was stopped, and seconds-counting should continue from that reading.

For version "T," the test procedure is similar to that for the standard unit, except that there is no dot indicator, and power interruption is signaled by the blinking of one or more segments of DIS1.

Version "L" is the same as modification "T," except that depressing switch S2 (ELAPSED-TIME RESET) while in the *time* mode (switch S1 is up) will reset the *time* display to 00 00.

For modification "W," the testing procedure is somewhat different:

1. Place switch S1 in the up (TIME) position and plug in the transformer. The display should light up, and power interruption is indicated by one or more missing segments in DIS1 (the segments do not blink, since counting is inhibited). The display should *not* change until the elapsed timer is used.
2. Place switch S1 in the down (ELAPSED-TIME) position and the display should start counting seconds.
3. Reset the elapsed-time display by pressing switch S2. The display should go to 00 00 and resume seconds-counting when switch S2 is released. Allow the unit to run for 20 minutes to verify that all segments light up when they should.
4. Return switch S1 to the up position. The display should read the total time that the elapsed timer was on. This display should *not* change (you must watch it for more than a minute to verify this). When the elapsed timer is used again (switch S1 is down) it will "add" to the total-time display (S1 is up), thus accumulating (or totalizing) the individual elapsed times to 23 hours and 59 minutes, and then repeat.
5. When switch S1 is up, pressing switches S3 and S4 *simultaneously* should reset the *total-time* display to 00 00.

Modification "P" does not change any of the operating modes, therefore testing is the same as that for any of the above versions. When operated on a 50-Hz line with the recommended transformer, the display may dim a little, and the transformer will become warmer than when the unit is operated on a 60-Hz line. Finally, it should be noted that a power failure in the elapsed-time mode (switch S1 is down) is indicated by flashing DIS1 segments on all versions.

If problems develop in testing, the display indicates the symptoms, and Fig. 2 can be used for examination and diagnosis. Be particularly wary of incorrect polarity of RECT1, capacitor C1 and all the diodes. Also, make sure the IC1 index

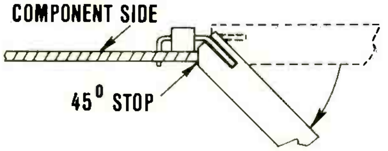


Fig. 9—A SPECIAL BENDING TOOL—supplied in the complete kit—is recommended for forming the header strip lugs.

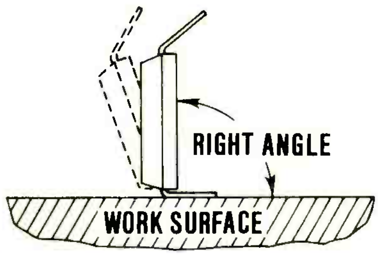


Fig. 10—HOW IC PINS ARE PREFORMED so they are perpendicular to the body before the device is mounted on the PC board.

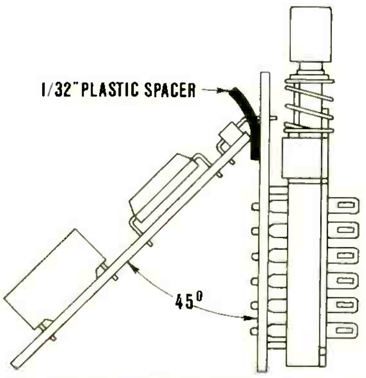


Fig. 11.—HOW THE PC BOARDS ARE ALIGNED prior to mounting in the custom *Digi-Toll* cabinet.

notch and all the display digit notches are properly located. Remember that DIS1 is inverted! If all the components are properly installed, check for bad solder joints—continuity checks should find those. Of course, there is always the possibility of a defective component, but this is less likely than the troubles just described.

When your checkout is complete, you must provide a suitable enclosure or mounting. If you mount the unit behind a panel (Fig. 8) be careful not to short-out or drill through any circuit paths when making mounting holes in the PC boards.

If you use the *Digi:Toll* custom case, slide the completed and tested assembly into the right end of the extrusion with the line cord extending to the right. The display should face you. It is necessary to slightly depress switches S3 and S4 when they reach the end of the right-hand switch notch so that the assembly can continue to slide into the case. You can use the long plastic strip provided with the case to protect the switches from scratches. Insert the strip from the left end of the extrusion and fit it between the pushbuttons of switches S3 and S4 and the underside of the extrusion as you move the pushbuttons into the case and slide the strip along with the buttons until they pop up into the left-hand case notch.

Using screws, attach the left-end cap loosely. Slide the plastic data plate into the upper slots. Remove the protective covering from the display lens and insert it into the lower front slots, making sure the antireflective dull side of the lens faces out. Now, screw on the right-hand end cap with the two remaining screws, dressing the power cord through the notch in the rear of the right-hand end cap. Before tightening each end cap,

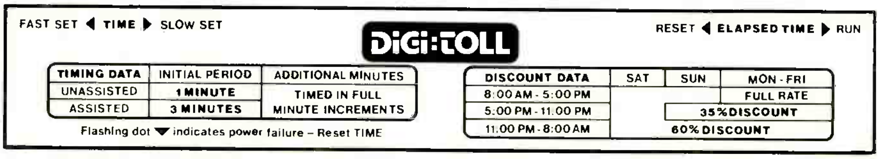


Fig. 12—DATA PLATE helps you save 15% or more when you use it while making long-distance calls.

make sure the display lens is properly seated in the end-cap pockets. Finally, attach the four adhesive foam feet to the bottom of the cabinet near the corners.

Put it to work

With or without a *Digi:Toll*, the real key to significant telephone savings is for you to understand the phone company timing and discount schedules and use them to the best advantage. Just timing calls for logging purposes, or using a timer to become aware of the seconds and minutes, is not enough! It is how you use this timing data that will *really* add up to dollars saved.

The timing and discount schedules are summarized in the data plate in Fig. 12. It is not only how *long* you talk that's important, but *when* you place the call. For example, if you originate a long-distance call between 8:00 AM and 5:00 PM, local time in your area, on Monday through Friday, you pay the *full* rate. On Saturday and Sunday, however, during the *same* hours, you are only charged 40% of the full rate—a 60% discount. The same applies to calls made from 11:00 PM to 8:00 AM *any day*, and from 5:00 PM to 11:00 PM on Saturdays. On all other days (Sunday through Friday), the 5:00 PM to 11:00 PM calling period costs only 65% of the full rate (35% discount); so, obviously, there is a considerable savings in placing calls at the best time of day, and in taking advantage of East-West time differences (i.e., when it is 5:30 PM in New York (35 % discount) it is only 2:30 PM in California). Conversely, Californians dial New York early (before 8:00 AM) and reach New Yorkers at work at the lowest possible rates!

Figure 12 summarizes the three least known facts about company billing:

1. The initial period rate for *unassisted* calls (no operator), such as direct-distance-dialed calls, is for only *one* minute, not three minutes, as generally thought. Although this first minute costs more, you are *not* charged this rate for additional minutes.
2. On operator-assisted calls, the initial period rate is for *three* minutes, so any amount of time up to three minutes cost the *same*.
3. Additional minutes are timed in full-minute increments.

In other words, you pay for a full minute even if you are on the phone for only one second of that minute! For example, a five-minute, one-second call is billed as six minutes. Hang up a few seconds sooner, and you save the charge for one whole minute. At 15¢ to 40¢ per minute, this can add up!

Now, with this information, you can use your *Digi:Toll* to save yourself a lot of money. When using the standard *Digi:Toll* on a long-distance or timed local call, first select the time-of-day display and check the discount data on the data plate (Fig. 12) to see if you should reschedule your call to a discount period, or to a *higher*-discount period. Then, *immediately* after dialing, push switch S1 down (into the elapsed-time mode) and *hold down* the RESET pushbutton, switch S2, until the other party *answers* (or when conversation starts on person-to-person calls). When you release switch S2, the count starts and you have synchronized the *Digi:Toll*'s elapsed timer with phone company timers.

Since the *Digi:Toll* now tells you exactly how long you've been on the phone, you can use several methods to save money: (1) You can limit your call to some pre-established average maximum length. (2) You can eliminate unnecessary additional minute charges by trying to complete calls before a new minute begins. (Telephone company timing ends when *either* party hangs up.) (3) You can use time that you have paid for but, without a seconds timer, would normally lose to the telephone company. If you must begin a new minute or do so accidentally, take advantage of the unused portion of the minute by making sure you've covered everything you want to and avoid making another call.

When the call is completed, record the elapsed time in a long-distance log if you use one and return switch S1 to the up (time-of-day) position. If you can't log the call immediately, the "memory" feature allows you to recall the elapsed time by just pressing switch S1 down when you want it displayed. It will, of course, continue counting from that point as long as switch S1 is down.

If the elapsed timer of a standard unit is used when the *real* time goes from 12:59 to 1:00, it is possible for the nondisplayed time-of-day to be altered because the internal clock logic doesn't know whether to go to 1:00 or 13:00. To minimize this possibility, return the unit to the time-of-day mode when the elapsed timer is not actually in use. (On any modified unit, such a condition will not occur since all display modes are in the 24-hour format.)

When you use the 24-hour modification "T," cost-cutting techniques are similar. However, ham radio operators can set the time-of-day display to Greenwich Mean Time (GMT) for international contacts, and can use the elapsed-time display to remind them to identify their station every 10 minutes, or to time "phone-patch" calls out of the local area. For international phone calls, a time chart can help you determine the best times for the best discount, yet not call someone in the middle of the night at their end!

The modification "L" *Digi:Toll* can be used for long-distance calls just as a standard unit, but you can also use it for timing conferences and consultations, or for time periods longer than 24 minutes. These timed periods can be used for billing or other record-keeping purposes. This modification also makes an excellent research or test-lab 24-hour elapsed timer. At the beginning of the timing period, just press RESET pushbutton S2 while in the time mode, and the display will go to 00 00 and start counting and displaying hours and minutes. Of course, the time-of-day function is temporarily lost, but can be reset whenever desired by using switches S3 and S4.

Modification "W" provides you with a 24-hour totalizing timer that is valuable on "limited WATS" calls where telephone time is purchased in blocks (soon *all* WATS time will be limited this way). When the 24-minute timer is used in the usual fashion, the 24-hour totalizing timer will keep a continuous record of how much block time has been used or how much remains. At the end of your specified accounting period, just zero the totalizer with switches S3 and S4 and start totalling a new accounting period.

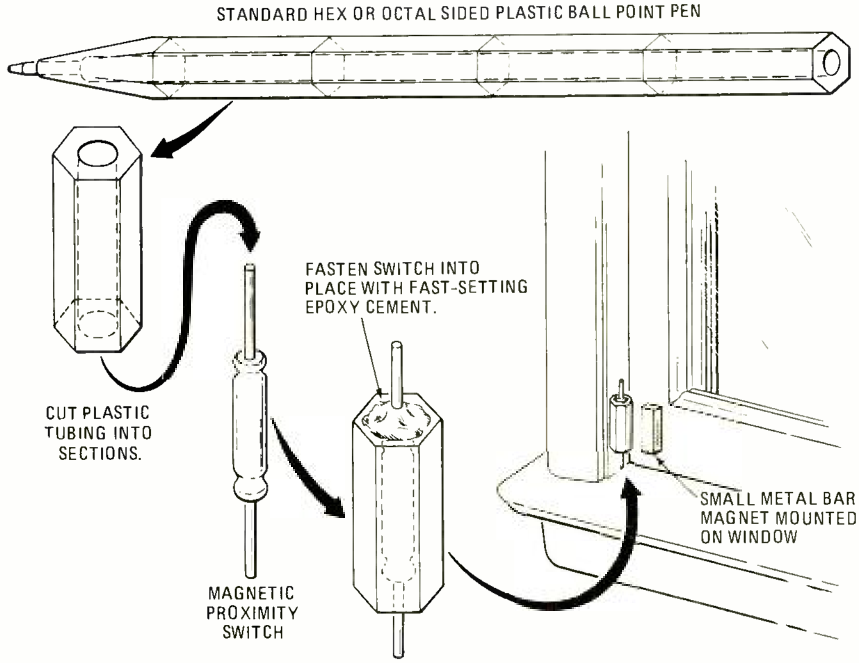
With this minicourse in telephone charges and a *Digi:Toll* to put you in "sync" with Ma Bell's billing equipment, you can now pick up your phone, sit back, put your feet up on the desk and start saving your money! **R-E**

Burglar Alarm Switches Made Easy

HAROLD PALLATZ

WITH JUST A SMALL SAW, SANDPAPER AND a few parts, a good, inexpensive type of burglar alarm switch can be made. If purchased on the open market, the Magnetic Proximity Switch costs from $3 to $5 per unit. You can build it yourself for under 50¢. Each unit takes 10 minutes to make and the materials are readily available. If you have, say, 20 windows and doors in your home or shop, the switches would cost only $8 instead of $80.

These magnet-activated switches are good for many reliable operations; they are used by the armed forces in many critical electronic applications. They are most dependable; they have a magnetic reed that flexes to open or close the switch contact when a small magnet is brought near it. Since there is no mechanical linkage or plungers and there is no physical contact with the magnet, there is very little that can go wrong. The switch itself is cemented to the window frame, and the sliding member of the window has a small bar magnet cemented to it. The body of the switch is stationary at all times.



INEXPENSIVE MAGNETIC INTRUDER SWITCH is made from a tiny magnetic reed switch encased in sturdy plastic housing made from a ball point pen. Mounting in window or door frame is simple.

Construction

Take the plastic casing of an old ball point pen—the type with a clear plastic hexagonal or octagonal body. Saw the pen into sections, removing the center ink supply after the first saw cut. It is important to use a fine-tooth saw and to work very slowly to prevent the plastic from cracking or overheating and then melting back together during sawing. File or sandpaper smooth the plastic end sections. Insert the magnetic switches into place and epoxy the ends of the plastic tube with a fast-setting epoxy cement. (Do not get any cement on your fingers, as some types may react with the skin.)

The wire ends of the switch should protrude from the plastic sections. When the cement is hard, the body of the switch can be glued (or fastened with a small metal or plastic clamp) to the stationary side of the window. A small 1-inch-long bar magnet is cemented, stapled or taped to the door or moving side of the window so that it comes within 1/8 inch or so from the switch. For connection to the switch ends, the intruder alarm wire is simply soldered to the switch leads. However, solder quickly so as not to overheat the glass or the epoxy.

The uncased magnetic proximity switches can be bought new from most of the larger electronic supply stores. They are also available from electronic surplus outlets for 15¢ to 25¢ each. The small 1- × 3/16-inch bar magnets can usually be obtained from the same sources at about the same prices, as well as from local hobby supply stores. **R-E**

All About Audio Oscillators

Part 2—The audio oscillator most-often-used today is a sophisticated instrument that is a far cry from the simple AF signal source. This is a continuation of the story on the latest types.

CHARLES M. GILMORE*

THIS IS ONE OF A CONTINUING SERIES OF articles on test instruments, their theory of operation and applications. This story on audio oscillators began in the April issue.

Synchronization output signal

Frequently audio oscillators not offering a squarewave output provide a squarewave of very limited capability. The purpose is to obtain a high-level waveform that can be used for triggering oscilloscopes or synchronizing other equipment. The difference between a synchronizing output and a true squarewave output may be subtle. However, a synchronizing output cannot be expected to have an output attenuator, a constant or controlled output impedance, controlled output amplitude or control symmetry.

Output metering circuits

A metering circuit connected at the power amplifier output permits precise output-level settings with the variable attenuator. This feature eliminates connecting an AC vacuum-tube voltmeter to the audio oscillator for level setting, as is often necessary with oscillators without internal metering circuits where the absolute value of the output signal amplitude is not known. These metering circuits are generally peak-reading and RMS-calibrated. However, such a meter is completely adequate on low-distortion sinewave oscillators. It may begin to jitter as the output frequency is reduced from 20 Hz. In the 1-Hz or 2-Hz range, the meter may actually follow the output waveform, swinging from zero to a peak value. When this occurs, the output amplitude of the generator should be established at a frequency greater than the jitter point.

Some audio oscillators offer a switch-selected internal load. With the internal load connected, the output amplitude is reduced by a factor of two, compared to the no-load voltage. This internal load is necessary because metering circuit calibration depends on a proper load at the attenuator's output terminals. Often the load connected to an audio oscillator is essentially an infinite impedance. Such a load can be metered correctly by simply switching the internal load in parallel with the output terminals.

Frequency synchronization

A number of higher-priced audio oscillators offer a feature that permits synchronization of the audio oscillator frequency to an external standard. This is useful when a high degree of frequency or phase relationship control is necessary, but when the reference signal is not pure enough to use in the particular experiment. Frequency synchronization specifications indicate the synchronization lock range—that is, how closely the oscillator must be tuned to the reference frequency to establish synchronization. The amplitude and waveshape required of the synchronizing signal is also specified.

Such locking schemes frequently result in a phase shift between the reference signal and the phase of the audio oscillator output. If the two frequencies are identical—that is, if the audio oscillator has been tuned to the reference frequency—the phase shift is a constant. However, it is common for the phase shift to vary when tuning the audio oscillator frequency away from the signal. Of course, the instrument must remain within its lock range to achieve any synchronization at all.

Low-distortion modes

Some audio oscillators have a special low-distortion feature, in which an increased time constant for amplitude feedback control is used to reduce distortion. The effect is primarily intended to improve the distortion specification at low frequencies. The increased time constant increases the settling time of the oscillator. This means that amplitude variations, caused by changes in frequency, last longer than under normal conditions.

Battery operation

Battery operation, which is offered by a number of oscillator manufacturers, should be used in two cases: When oscillator portability is important, such as in an area where power is difficult to obtain; or where power connections limit operational flexibility.

Battery operation can serve another purpose in the laboratory. Battery power means that the oscillator can be operated with no true connections to earth ground. In other words, the oscillator can be floated at any desired potential. Certain basic precautions must be taken to insure that no contact with an audio oscillator case floating at a high potential is made by either the operator or some object at earth ground; such a contact could cause circuit damage or personal injury.

High output levels

A less commonly advertised feature of the oscillator is its ability to create much higher output levels than a generator. For special applications, audio oscillators can be obtained with levels approaching 100 volts. Such instruments are not considered conventional, but only serve a specialized purpose.

Attenuator range

As noted earlier, the attenuator can vary from a very simple, limited-range device to a complex circuit with a great number of step ranges. Depending upon the intended use of the oscillator, one feature may be more desirable than another. The Hewlett-Packard *model 204C* and *model 204D* audio oscillators are examples of the alternatives available. The *model 204C* offers a single continu-

* Manager, Design Engineering, Heath Co., Benton Harbor, MI.

ously adjustable control with a 40-dB range; the *model 204D* offers a single continuously adjustable control with a 10-dB range, combined with an 80-dB step attenuator (in 10-dB steps).

Where precise amplitude control is necessary, attenuator accuracy must be considered. Even on metered audio oscillators, the output setting accuracy is influenced by the attenuator, since the metering circuits do not read attenuated signals but simply the power amplifier output before attenuation.

As indicated previously, audio oscillators are available in special models with extra high output levels. They can also have extended or specialized frequency ranges for certain kinds of work. Oscillators of this type may vary to an upper frequency of 10 MHz, achieved at the sacrifice of some lower frequencies. Some oscillators also offer a few selected discrete frequencies for production, testing and other limited applications.

Transformer output

Transformer-coupled output, available in a few oscillators, offers complete DC isolation from the rest of the generator. This is particularly useful in driving a bridge. If supplied with multiple secondary taps, the oscillator with a transformer-coupled output can drive extremely low impedance or provide high-voltage output. Usually such oscillators have a limited output frequency range, due to the transformer's limitations.

Applications

It is difficult to enumerate all the applications for an audio oscillator. Briefly, the instrument can be used in any situation requiring a source of relatively pure sinewaves within the frequency range covered. A large majority of applications are found in audio measurements because of the high degree of concentration on reproduction fidelity. However, there are enough applications for a good audio oscillator that a general laboratory or service shop should place it on the priority list for low-frequency sources (right after a function generator). Of course, if the shop specializes in audio measurements and repairs, the audio oscillator is a *must*.

Total harmonic distortion

The THD measurement determines the amount of harmonic energy added to the output signal of a device by the device itself. With the audio amplifier—or any other amplifier for that matter—the test is performed by supplying a distortionless signal to the input and then measuring the harmonic content at the output. Most THD analyzers reject the fundamental signal with a notch filter and measure all other energy within the audio spectrum. The THD then becomes:

$$\%\ \text{THD} = \frac{\text{Harmonics} \times 100}{\sqrt{(\text{Fundamental})^2 + (\text{Harmonics})^2}}$$

The THD measurements for audio equipment are usually made at a number of input and output levels, since the harmonic distortion introduced by the amplifier depends on the gain and the power output at which it is operated. Harmonic distortion is a direct result of nonlinearities within the amplifier.

Note that the described technique for measuring THD includes noise, hum or other nonharmonically related signals not rejected by the notch filter tuned to the fundamental frequency. Two points therefore must be considered. First, the amplifier itself must be thoroughly analyzed for its own hum and noise prior to using it for THD measurements. Any such components should be eliminated before the measurement. Second, the oscillator supplying the distortion-free signal must also be free of hum and noise.

A method of measuring THD that eliminates this problem uses a wave analyzer. This consists of an extremely sharply tuned filter followed by an AC voltmeter. Although measuring THD with a wave analyzer is more tedious, the result is more accurate. The ultra-low distortion characteristics of the generator are still required, and, of course, there must be no hum and noise. However, levels of hum are permitted with this system of measurement.

The wave analyzer is first tuned to the fundamental frequency and an amplitude measurement is taken. It is then tuned to the second, third, fourth, fifth, etc., harmonics, and amplitude measurements are taken. THD is then calculated using the following formula:

$$\%\ \text{THD} = \frac{\sqrt{(2\text{nd})^2 + (3\text{rd})^2}}{\text{Fundamental}} \times 100\%.$$

Although truly broadband noise contributes throughout to this measurement, hum and other nonharmonically related spurious signals are eliminated.

When making THD measurements with an analyzer that uses the notch filter, a few basic testing precautions are necessary. Since hum contributes significantly to the harmonic distortion measurement, ground loops must be carefully avoided. A ground loop consists of a second path through which the ground or return signals for the test may pass. Frequently, this second path also contains significant line-frequency currents, which could enter into the measurement and contribute an undesired signal to the output. This signal is generated by neither the amplifier nor the oscillator, but affects the measurement.

Two forms of THD analyzers use the notch technique: With the first and simplest form, the notch filter is manually tuned. The second technique uses manual tuning to within a few percent of the desired center frequency, when an automatic nulling circuit takes over to center the analyzer on the fundamental frequency. Errors can occur in the analysis if the generator drifts from the fundamental frequency to which the analyzer was tuned. An analysis with automatic null compensates for minor drifts. However, drifting introduces errors to measurements made with the manually tuned analyzer.

A note of caution regarding THD measurements: It seems logical that one could measure both the THD of the generator and the THD at the output of the unit under test, and subtract, thus arriving at the THD contributed by the device under test. Unfortunately, because of the complex qualities of the signals, this technique does not lead to a proper measurement. The THD of the audio oscillator must be substantially less than that expected from the amplifier being tested.

In a later issue, we will continue this story on audio oscillators and will show how they are used in measuring audio amplifier paramaters such as response, distortion and impedances. **R-E**

Which Battery Type Is Best

How to choose between Carbon-Zinc, Alkaline and Mercury

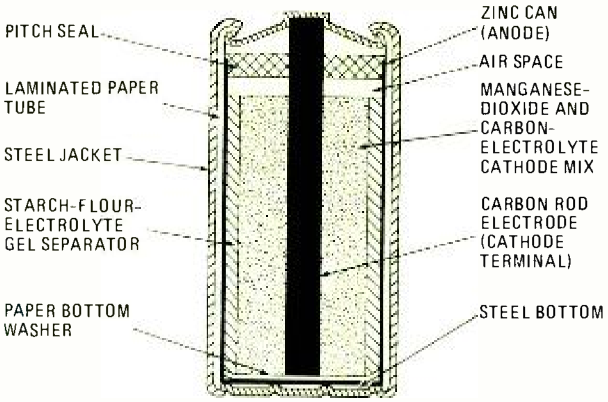


FIG. 2—CROSS-SECTION VIEW shows the construction of a typical cylindrical zinc-carbon dry cell.

There are several types of batteries and dry cells available for use in radios, calculators, electric and electronic toys, and numerous other appliances and gadgets in the home. This is a rundown on how they differ and which to use for different applications.

ALEX F. BURR

THIS ARTICLE GIVES YOU ALL THE INFORMATION NECESSARY TO intelligently select one of the common small nonrechargeable batteries for any routine application. This is not an exhaustive study, but just an article giving the highlights of pertinent characteristics. Some information on the most popular sizes (AA, C, D and rectangular 9-volt) and the most popular types (carbon-zinc, alkaline and mercury) are given.

Battery sizes

The smallest of the popular sizes is the AA penlight cell. It is a cylindrical cell nominally $^{17}/_{32}$ of an inch in diameter and $1\,^{7}/_{8}$ inches long. It is a very popular size for equipment that must be kept small.

The C-cell is also cylindrical. It is $^{15}/_{16}$ of an inch in diameter and $1\,^{13}/_{16}$ inches long. It is used where considerble current is required yet size is also important.

The standard flashlight cell is the D-cell. It is a cylinder $1\,^{1}/_{4}$ inches in diameter and $2\,^{1}/_{4}$ inches long, and is used where current capacity is more important than size.

For those applications that require a relatively high voltage at a small current, the rectangular 9-volt transistor radio battery is ideal. It is $^{21}/_{32}$ of an inch thick, $1\,^{1}/_{32}$ inches wide and $1\,^{29}/_{32}$ inches high, including the two snap terminals on top. Figure 1 shows these four most popular sizes drawn to scale.

There are several other sizes that.are not as popular but are easily available. These include the AAA-size, slightly smaller than the AA-cell and often used in pocket calculators, small photoflash guns and electric novelties, and the N-cell, which is a little larger than one-half of an AA-cell and used in certain calculators. Some equipment will use a ½ C- or ½ D-size, but these sizes are rare in a disposable cell. Then, there are the cells designed for electric watches. They come in a bewildering variety of sizes, all small. If the current demands are small and if the size must be small, they can be considered although their cost is great.

Zinc carbon

The most popular type of disposable battery is based on the zinc-carbon cell (see Fig. 2). Despite its name, the positive carbon electrode does not play any part in the chemical reaction that supplies the energy of the battery. The negative zinc case does, however, The positive electrode in the electrochemical sense is the manganese dioxide that is packed around the central porous carbon electrode. This electrode serves as a conductor for the current and for some of the gases generated during the current producing chemical reaction.

The third essential part (after the positive and negative electrodes) of any battery is the electrolyte, a solution serving as an ion-transfer medium between the positive and negative electrodes. In dry cells this solution is in the form of a paste, and in the zinc-carbon cells this paste is a gelatinous mixture of corn starch and flour containing ammonium chloride, zinc chloride and water.

In the modern zinc-carbon cell the positive electrode (manga-

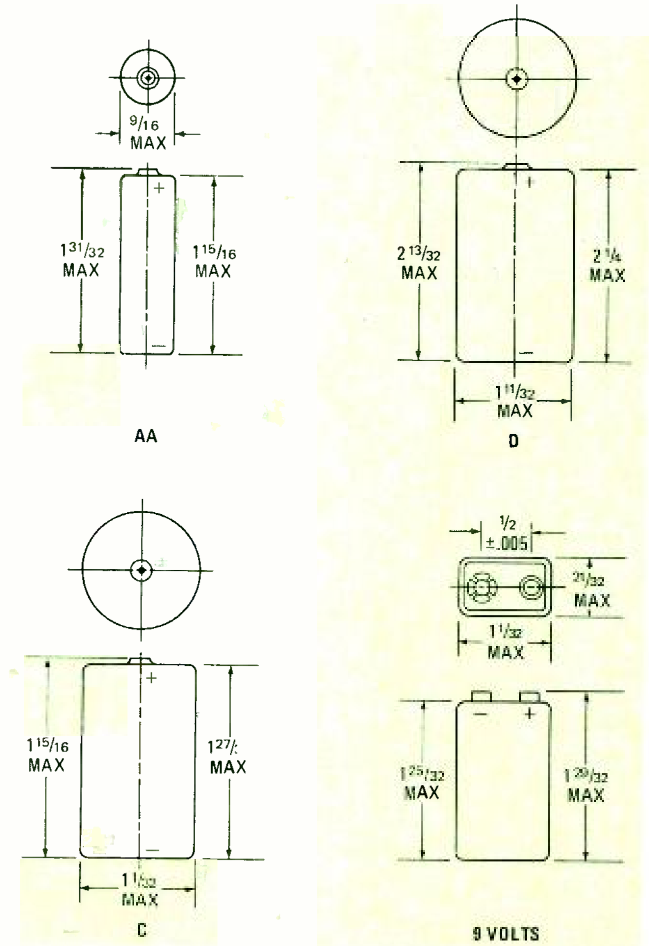


FIG. 1—THE DIMENSIONS of the popular sizes of disposable (not rechargeable) dry cells and batteries.

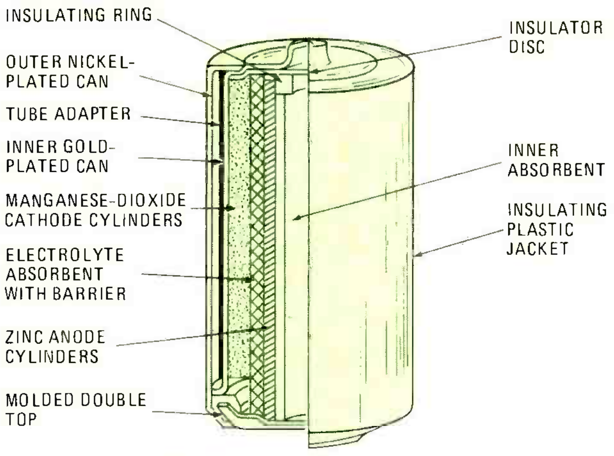


FIG. 3—THE ALKALINE CELL has the familiar zinc and manganese-dioxide electrodes, but the electrolyte is a potassium-hydroxide solution.

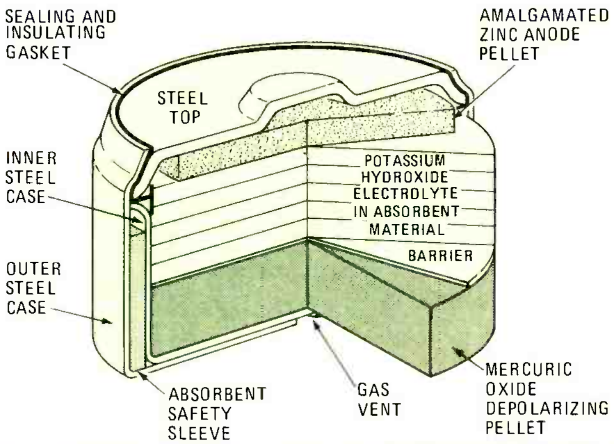


FIG. 4—SECTION THROUGH a typical mercury cell. The construction of this tablet-type cell differs from that of the cylindrical cell or battery.

nese dioxide) also serves as a depolarizer or absorber of gases created during the generation of electricity. The whole cell is encased in a steel jacket to retard the escape of the corrosive materials contained in the cell. During the chemical reaction, the zinc inner case is eaten up as the electricity is produced.

All zinc-carbon cells of a given size are basically the same. There are relatively minor variations in such quantities as the electrolyte and depolarizer-to-electrode ratio that change some characteristics. For example, some batteries are constructed to deliver a *large current for a short time*, while others deliver a *smaller current for a longer time*. Some are optimized for *continuous operation*; others for *intermittent operation*.

There is quite a difference in quality of construction and the purity of materials used. In general, the higher the price paid, the better the cell or battery and the longer it will last in any application. However, a battery twice as expensive as a similar one in many cases will not quite give twice the life.

Alkaline

A popular premium type of disposable battery is the alkaline cell. Its use is often called for when a high current must be supplied. Alkaline cells have the same zinc-manganese dioxide electrodes as the zinc-carbon cells; but the electrode structure is different (see Fig. 3) and the electrolyte is a solution of potassium hydroxide. The result is a cell with the same 1.5-volt open-circuit voltage with a relatively constant energy capacity over a wide range of current drains. Thus, alkaline cells do not have any particular advantage over regular zinc-carbon cells at lower current drains but do have a higher efficiency at high current drains.

Mercury

Another widely used primary battery is the mercury cell. The construction of a mercury cell is shown in Fig. 4. This cell, more correctly called the zinc-mercuric oxide battery, uses red mercuric oxide as the positive electrode and depolarizer and a zinc-mercury amalgam as the negative electrode. The electrolyte is a solution of potassium hydroxide and zinc oxide. The different electrodes give these batteries an open-circuit voltage of 1.4 volts. Mercury cells have a greater energy capacity per unit volume and weight and a better shelf life than zinc-carbon cells. A very important feature is their flat voltage-time discharge curve. That is, the voltage produced by the cell does not decrease until the battery is completely discharged. In fact, these cells are sometimes used as precise voltage-reference sources. The various advantages and disadvantages of these different types of cells are summarized in Table 1.

TABLE I—ADVANTAGES AND DISADVANTAGES of different types of primary cells

Type	Advantages	Disadvantages
Zinc-carbon	Inexpensive	Limited energy capacity
Alkaline	High current efficiency	More expensive
Mercury	Constant output voltage High energy density Good shelf life	Expensive Not for cold weather use

There are other types of primary cells such as small zinc-silver cells often used in watches and the newly developed lithium cell, which has a very high energy density. However, the price of these cells permit them to be used only in special applications.

Current drain

The single characteristic that most are interested in is the amount of current a given battery will supply. Unfortunately, there is no simple answer to that often-asked question. However, some general indications can be given. The larger the individual cell, the lower the internal resistance and the larger the maximum current that can be supplied. Table II gives some typical values of the internal resistance and the short-circuit current of various sizes of zinc-carbon cells.

TABLE II—TYPICAL VALUES of short-circuit current and internal resistance found in zinc-carbon cells

Cell Size	Maximum Current (amps)	Internal Resistance (ohms)
AA	4.6	0.31
C	5.4	0.28
D	6.6	0.23
9 volts	0.5	19

Of course, don't expect the battery to supply the short-circuit current for very long. What you really need is some idea of the amount of current a given cell will supply for a reasonable time. Unfortunately, what is reasonable in one situation may not be reasonable in another. However, it is possible to give a rough idea of the current that a given type of cell can supply. This data

TABLE III—CURRENT SUPPLIED by different types of batteries

Battery Size	AA			C		D		9 Volts		
Battery type	zinc-carbon	alkaline	mercury	zinc-carbon	alkaline	zinc-carbon	alkaline	zinc-carbon	alkaline	mercury
10-hr current (mA)	60	150	240	110	230	250	500	15	30	30
100-hr current (mA)	10	20	25	20	40	50	100	4	8	4

is given in Table III. The first line of the table lists the current that a typical cell of the type named can supply intermittently to a load for 10 hours before the terminal voltage is reduced to two-thirds of the initial value. (This end-point voltage is 1.0 volt for the zinc-carbon cells.) The second line in Table III lists the maximum current a typical cell will supply for 100 hours under the same conditions. These figures should be used only as a rough estimate of the current to be expected because all sorts of factors will enter to decrease or increase the current that the battery can supply. Some of the factors are temperature, the lowest voltage the specific circuit will operate on, the length and frequency of any rest periods, the quality of construction and the age of the battery.

We must emphasize that the current listed in Table III is only a rough estimate—the best that can be made without exactly specifying a great many conditions in addition to the discharge time. We can easily see, especially by considering the data on the C-cell, that the amount of current drawn has a great effect on the total energy that can be extracted from a cell. The table implies that a zinc-carbon C-cell can supply 1100 mA-hours of energy (current drain multiplied by time) in 10 hours, but that 2200 mA-hours of energy can be obtained if the cell is discharged over a 100-hour period.

Table IV gives the mA-hours available from a typical C-cell at

TABLE IV—ENERGY AVAILABLE from a C-cell vs. current drain

Continuous current drain (mA)	5	10	20	50	100
Hours to 1 volt	540	220	90	23	8
Energy supplied (mA-hours)	2700	2200	1800	1200	800

a variety of continuous current drains. It is clear that the higher the current drain, the less energy is obtainable from the cell. A similar reduction in energy is found with the AA- and D-cells. The energy from an alkaline cell also decreases with increased current but not by as large a factor.

Other factors enter, too. For example, if a C-cell subjected to a 50-mA drain will be discarded after its voltage drops to 1 volt, it will last for about 23 hours. If the end point is lowered to 0.8 volts, then it will last for about 40 hours. At moderate current drains, intermittent use instead of continuous use will increase the number of useful hours by 25% to 50%. Temperature also greatly affects the amount of energy supplied. Table V shows the effect of temperature on zinc-carbon and mercury cells.

TABLE V—EFFECT OF TEMPERATURE on the capacity of zinc-carbon and mercury cells

Temperature (°F)	Zinc-Carbon Capacity (%)	Mercury Capacity (%)
−20	6	—
0	27	4
20	48	10
40	69	58
60	90	93
70	100	100
80	115	103
100	140	106

We can go into all these factors that affect the lifetime of a battery in great detail but most of you will not use the information developed. For most purposes, the simplified current capacities given in Table III will allow you to balance the three main factors of size, current capability and cost to fit the particular application you have in mind. **R-E**

CONVERGENCE PROBLEM

This Heathkit model GR-269 has been working quite well. Now there is a convergence problem at both the top and bottom of the screen. The convergence panel was returned to Heath and checked out. The potentiometers that should affect this area don't seem to have any effect at all.—J. W., Nova Scotia.

Since the convergence board was already checked, there's another likely cause: Check the convergence plug, socket, and *all* the wiring going to the controls that don't operate. Two things can cause these controls not to work: first, bad components on the board, and second, the loss of the *pulses* that do the work! Check for an open circuit, a bad solder joint, or poor socket contact. Every control on that board should do *something*.

VERTICAL PROBLEM

Without a signal, I get a full vertical scan in this Philco model 16M91; however, with a signal it drops to about 80% full. I tried new 6GF7 tubes, changed the 50-µF electrolytic capacitor in the 6GF7 cathode, etc., but got nowhere. The stability and sync are good. Can you help? I've been in poor health and reading your column always makes me feel better!—C. G., Derry, NH.

That's nice, and much appreciated!

Looking at the *model 16M91* schematic, I see it resembles my own RCA *model 15*. Check those 150K resistors in the height-control circuit, as well as all the resistors, particularly those in the input grid, etc. Also, quick-check that VDR (*V*oltage-*D*ependent *R*esistor) in the feedback loop: just disconnect it; it's used as a clamp to keep the vertical scan from being too high. Finally, try unhooking the lead from the pin 2 (output) grid of the 6GF7 tube to the service switch; there might be some leakage.

FUSE IN CATHODE

I found a burned-out fuse in the cathode of the 6LB6 tube in this Zenith model 14A9C50. And there's no high voltage. The Sams schematic does not show this fuse. What's it for?—O. K., Oceanside, NY.

Zenith's service data for late runs of the *model 14A9C50* chassis *does* show this fuse: it's a 0.4-amp Bel-Fuse and is used to protect the flyback, etc., against damage. Since normal current is about 220 mA, a 400-mA fuse should be fine. Be sure to use a fast-blow type of fuse. You can obtain an easy cathode-current reading in TV sets like this. Just pull the fuse and connect your DC milliammeter right across the terminals.

FLOATING BARS, BAD COLOR

I've two floating bars on the screen, bad color, but a fair picture on an Admiral model 3G11. The DC power supply has been checked. Where do I look now?—S. C., Lansing, MI.

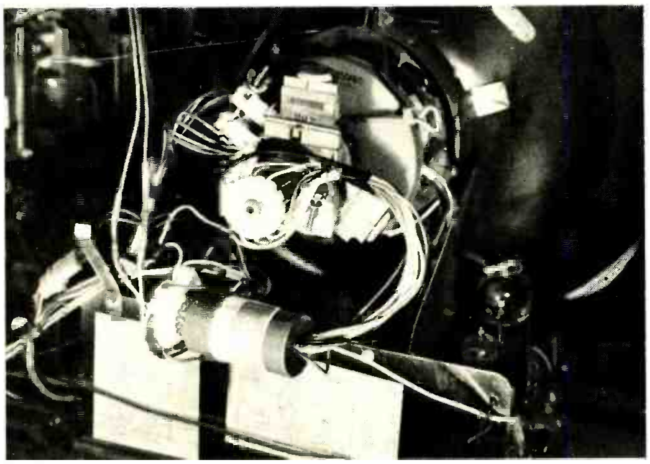
You're close to it. Look at that thermal switch in the autodegaussing circuit. These have caused some funny problems.

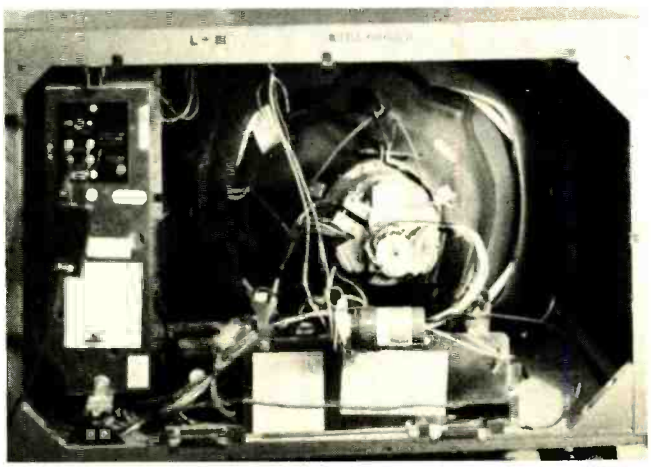
(Feedback: "That did it! It took me only two minutes. I'm amazed.") **R-E**

HOW AND WHY

Picture Tube Brightener$ Can Save You Dollar$

Television picture tube brighteners have been around for quite a few years. Here is a fresh look at what they are all about.





NORMAN A. ACKERMAN*

THE USEFUL LIFE OF A TV PICTURE TUBE IS usually determined by the weakening of the electron beam. Yet the phenomenon of electron emission in the beam from the oxide-coated cathode is largely unexplained. However, exhausted cathode emitters do have remarkable recuperative power. When certain restoring devices are used, picture tube life can be extended. This article will attempt to explain the process that makes this regeneration possible.

The picture tube

The TV picture tube is a special kind of vacuum tube in which a narrow beam of electrons behaves like an electronic pencil and draws a visible trace or pattern on a specially prepared screen. In many respects, its operation parallels that of an ordinary receiving or transmitting vacuum tube. In an ordinary vacuum tube as well as in a CRT or picture tube, electrons are created by a heated cathode located at the base of the tube inside the glass envelope. Thermionic emission in a

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vacuum tube occurs when the electrons in the cathode material contain enough thermal energy to overcome the forces at the emitter surface and escape.

In an ordinary vacuum tube, the emission occurs over the entire outside surface of the cathode (emitter). (See Fig. 1.) In

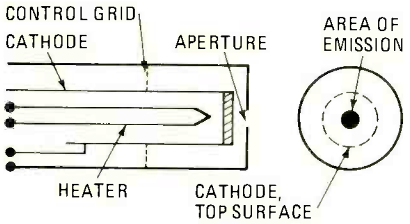

FIG. 1—THE CATHODE STRUCTURE in a TV picture tube. The black dot in the center shows the cathode area that is actually used.

the picture tube, the emission comes from only the top surface of the cathode. More precisely, emission occurs only under the area projected by the aperture in the control grid. To fully comprehend why this happens requires some information about the effect of the control grid and the first anode on emission.

Thermal agitation of the cathode coating material causes the cathode to emit electrons. Since this cathode coating is located in one particular place—on the cathode face opposite the control-grid aperture—principal emission moves in a forward direction from this surface. Because of the shape of the cathode, the emission does not come from a point source. So, while the emission is generally in a forward direction, it takes place randomly. Some electrons leave the cathode in a direction that is parallel to the axis but off to one side, and some leave at various angles to the axis.

Moreover, the velocity of the electrons varies. Some electrons leave the cathode at high speed, but the majority are low-velocity charges. For simplicity, assume that the initial velocity of the emitted electrons is substantially zero and any forward motion they exhibit after leaving the cathode is attributable to acceleration by the voltages applied to the first anode, in opposition to the negative voltage at the control grid.

An electrostatic field (called the first lens) exists between these elements and varies with the control-grid voltage, thus controlling the emission from the cathode. For any fixed voltage applied to the first anode, the control-grid voltage controls the number of electrons that can pass through the aperture.

Figure 2 shows the field distribution for two assumed grid-bias values, 0 (Fig. 2-a) and −30 volts (Fig. 2-b), and a fixed voltage value on the first anode. With a bias of 0 volt, the area adjacent to the cathode (between the cathode and control-grid aperture) has a comparatively high positive potential as a result of the field.

"Under such conditions of 0 grid volt-

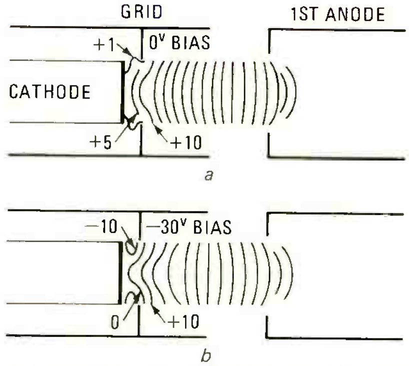

FIG. 2—FIELD DISTRIBUTION FOR two grid-bias values; (a) 0 bias. (b) 30 volts bias.

age, it has been found that the area of the cathode which is emitting corresponds approximately to a projection of the area of the grid aperture; the maximum number of electrons are passing through the grid opening and the beam current density is high.

"When the control grid is made negative by an increase in the bias (−30 volts in the figure), the field distribution in the vicinity of the cathode is altered so that only the center of the emitter surface is behaving as an emitter. The other areas are influenced by the space charge and effectively are not emitting. The result is a reduction in beam density and several other related effects."[1,2]

It should be emphasized that showing the electric field and lines of force schematically is strictly a device to help you visualize certain phenomena. The lines of force having certain physical properties are convenient working tools to explain what happens.

The thermionic emission that comes from under the aperture opening of the picture tube emitter continues until there

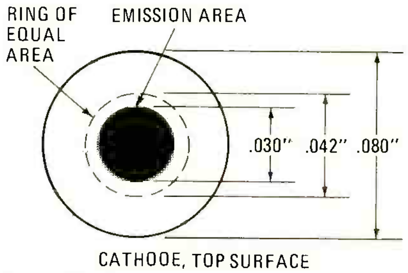

FIG. 3—WHEN BRIGHTENER IS USED, diameter of emitting area is increased slightly as shown.

is a depletion of electrons. Even after emission from the electron gun *appears too low* to provide enough density for a good picture, the cathode emitter material is almost *90% unused*. At this point the useful end-life of the tube has apparently been reached, because the picture is not bright enough for proper viewing.

This apparent contradiction can be better understood by examining the cathode. It is typically a metallic cylinder that is about .080 ($^5/_{64}$) inch in diameter and .340 ($^{11}/_{32}$) inch long, and is closed at one end (see Fig. 3). The heater is inside this cylinder with its leads through the open end, and it is coated to provide electrical insulation. The outside closed end of the cylinder is coated with an emitter material (i.e., magnesium oxide) that looks pure white when it is new. When the tube is depleted, there is a metallic dot near the middle of the white surface of about .030 inch in diameter. This diameter corresponds to the aperture opening of the control grid.

The cathode is held permanently in place by a metallic ring molded into the ceramic supports of the electron gun. The control grid is an inverted dish or cup that almost completely covers the cathode, and also is held in place by the ceramic supports. There is a space between the grid cup and top of the cathode on the order of .055 inch. Because of this spacing and type of construction, the cathode cylinder is barely visible through the glass neck of the tube, and the top of the cathode is virtually impossible to inspect once the electron gun has been manufactured.

Picture tube manufacturers rarely run a control sample picture tube to normal emission depletion and then inspect the cathode surface. Quality control samples are generally tested only for about 4000 hours, equivalent to two years of normal use, and then they are inspected. (Normal viewing is considered to be six hours a day.) When a picture tube is operated beyond that 4000-hour period to electron beam depletion and apparent end-life, it seems unlikely that the tube engineer would break the tube apart to check the gun parts let alone saw or cut open the metal control grid to inspect the used-up cathode surface. Yet, if he did he would find new emitter material surrounding the tiny metallic dot of depleted surface.

The size of the dot and the new material surrounding it suggests that the picture tube life could be prolonged if the new electrons could be moved to the area under the control-grid aperture. Again, take a look at the dimensions involved. The aperture opening produces a narrow beam and an electrostatic lens that can project an image on the picture tube screen. This opening is about .030 inch in diameter (.015-inch radius). The unused emitter area is about .0043 square inch compared with a .0007-square-inch depleted emitter area, yet the picture tube can no longer produce a picture that is bright enough for normal viewing. Contrast is lacking because there is not enough electron beam density to fully activate the picture-tube-screen phosphor dots. Warm-up time is unusually long since the cathode temperature slowly increases to give the last electrons sufficient energy to escape.

TV tube brighteners

In the late 1940's, a transformer device was designed by the Perma-Power Company to increase the power applied to the heater and raise the temperature of the cathode in the emission-depleted picture tube. (A patent was filed in 1952 and granted in 1956.) This device (called a TV tube brightener) is permanently installed in the TV set, and the increased power it feeds to the older heater is applied whenever the set is on. Thus, the kinetic energy of the electrons in the cathode emitter surface is increased. As a result, the electrons in the ring surrounding the depleted area can migrate to the area under the control-grid aperture opening, and this area of new material is thus used.

It is interesting to observe how small a ring of cathode material of equal area to the depleted area is. This ring has an outside diameter of .042 inch and a radius of a .021 inch. You can easily understand that if only three-thousands of an inch of material surrounding the depleted emitter area emits electrons that migrate under the aperture opening, then this emission includes almost 50% new material.

Early studies of black-and-white picture tubes were made in which cathodes from tubes that had reached end-life were compared with some that had reached a second end-life after using a brightener. The depleted areas in the tubes using brighteners were on the order of 1¼ to 1½ times larger. The increase in viewing time was often more than 50 percent (see Fig. 4).

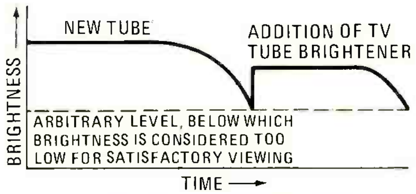

FIG. 4—INCREASED LIFE EXPECTANCY of picture tube with brightener attached is shown here.

While these early studies involved black-and-white tubes, the same observations are true of color picture tubes. In the latter, however, one of the three guns, usually the red gun, loses its electron beam density before the others. Although a separate heater is used for each gun in a color picture tube, the three filaments are tied together and only two leads are available at the picture tube socket. To raise the (heater) power on one gun, the power on all three guns must be raised.

Fortunately, no ill effects result from this procedure. Since the electron gun is a controlled emission device, you use the CRT bias controls on the set to readjust the electrostatic fields in order to keep beam-current densities balanced. This is a function of the electrostatic field distribution. The fact that more electrons are available than are needed does not affect how many are drawn off and used.

In the manufacturing process, picture tubes are processed through exhaust-and-aging cycles. This process includes procedures that decontaminate the tube elements and remove gases. The aging process also initiates emission from the cathode surface, to assure consistent emission from tube to tube. Procedures vary, but elevated temperatures and heater power are always used. The control grid and first anode areas can be heated to 800 °C for 10 to 20 minutes, and twice the normal heater voltage can be applied for these intervals. One and one-half times the normal heater voltage is generally applied for an extended period of time with normal voltage on the first anode.

Since the cathode heaters and other tube elements are designed to withstand this exhaust-and-aging process, it is easy to understand why a TV tube brightener can be used without damaging the picture tube.

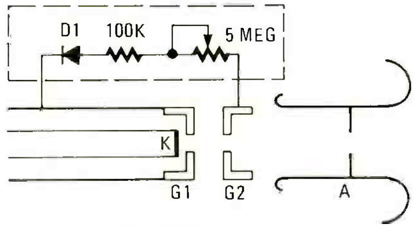

FIG. 5—ADDING RESISTANCE between G1 and G2 reduces the field and tends to open the beam.

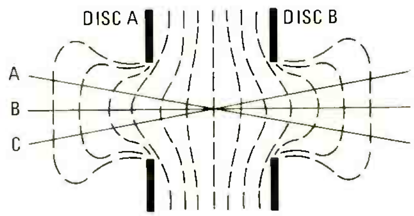

FIG. 6—THE EQUIPOTENTIAL SURFACES between two discs, each having an aperture at its center.

In addition to applying more heater power to regain emission, the electrostatic field can be readjusted as follows: The leads for control grid G1 and first anode G2 are accessible outside the picture tube so that a potentiometer can be installed between them. Since the voltages on the control grid and first anode are essentially fixed with reference to cathode K, applying resistance between the G1 and G2 leads reduces the field and tends to open the beam. The accelerating voltage is constant, resulting in an increase in beam current (see Fig. 5).

However, any condition that alters the distribution of the field also affects the focus. Figure 6 shows the equipotential surfaces between two discs, each having an aperture at its center. The equipotential surfaces bulge through the holes, causing some electrostatic field to leak outside the normal region. If electrons a, b and c are placed to the left of plate A, electrons a and c will converge as they cross the convex equipotential lines that protrude through the opening in plate A. Electrons a and c will tend to cross each other within the field between the two apertures, and then continue along a diverging path as they cross the concave equipotential lines that protrude through the opening in plate B. This procedure is

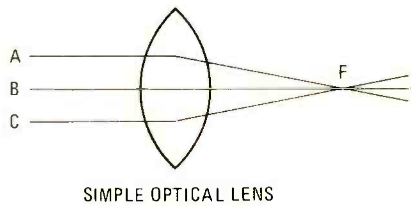

FIG. 7—SIMPLE OPTICAL LENS is similar to electron lens described in the text.

similar to what occurs in an optical lens having three incident rays (see Fig. 7).

Although it is true that any set of curved equipotential lines resemble a simple electron lens because they refract the electron path, the complete electron gun field is more complex (see Fig. 8).

However, it should not be difficult to visualize how the charged cylinders in an electron gun form an electrostatic field that controls the electron beam and focuses it. The dimensions of the crossover point, as determined by the control-grid and first-anode voltages, are also the dimensions of the beam when it is properly focused by the second electron gun lens and strikes the screen.

However, any device that changes the designed field distribution can produce some undesirable effects. It can affect the dimensions of the first crossover point and the angle of divergence at which the electron beam leaves the crossover point and, to a limited extent, it can affect the position of the first crossover point.

Emission slump

One of the least understood and most prevalent picture tube problem is known as emission slump. It is generally accepted that the cathode slowly becomes con-

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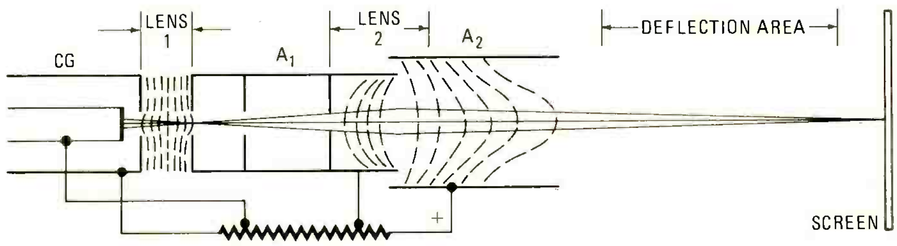


FIG. 8—ELECTROSTATIC FOCUSING SYSTEM as it is used in a TV picture tube.

Radio-Electronics Tests JVC Model RC-828 Radio-Cassette

CIRCLE 104 ON FREE INFORMATION CARD

1

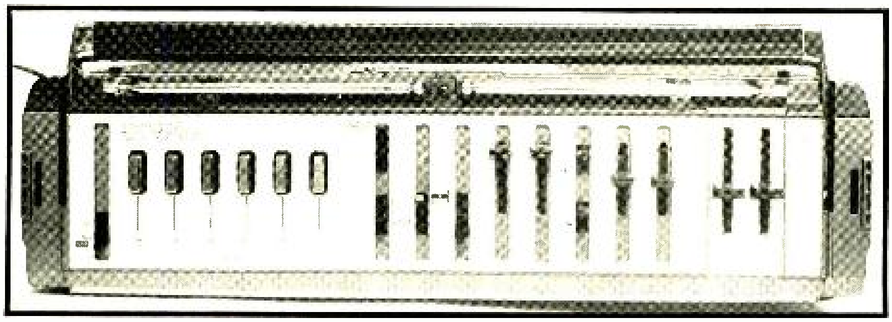
LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WHEN YOU LOOK AT THE FRONT PANEL OF the JVC *model RC-828JW* radio cassette (Fig. 1), you may wonder why we decided to test and discuss what looks like a "low-fi" portable radio cassette unit. Reading on, however, you will discover that this is not an ordinary entertainment portable. Its tuner sections and cassette record/play sections equal the quality of those found in low- to medium-cost separate receivers and stereo cassette decks. Additionally, although its amplifier has minimum power, this fact is offset by the *model RC-828*'s ability to drive an external amplifier of any wattage rating by its unique biphonic and stereo-expansion circuitry.

The lower section of the front panel shows a central cassette compartment, below which are the usual transport pushbuttons (fast rewind (REVIEW), RECord, PLAY, fast forward (CUE), STOP/EJECT and PAUSE). You can use the fast rewind and fast forward buttons to review (i.e., rewind in measured sections by holding down both pushbuttons while also pressing the PLAY pushbutton) and to cue forward. Above the cassette compartment are a three-digit tape counter and its associated reset button. To either side of the cassette mechanism are 6½-inch-diameter woofer drivers. The decorative areas above the woofers, near the outer edges of the unit, are actually built-in microphones that enable you to make stereo live recordings without having to connect separate mikes.

The upper section of the front panel contains a tuning knob for any of the six available RF bands (AM, FM, medium wave and three shortwave) whose frequencies are calibrated in the dial area. A stereo indicator light is located to the left of the frequency scales, while two meters are on the right. These meters are used to indicate reproduced level, recording input level, signal strength during tuning and even battery condition. A pair of 2-inch tweeters flank the dial-scale area, and just below the left-channel tweeter is a momentary switch that provides dial-scale lighting. The dial light is normally off (unless this switch is depressed) to conserve battery life when the unit is being powered from D-cells.

When the carrying handle is swung out of the way, a second panel on the top surface of the unit becomes accessible (see Fig. 2). This panel contains a power ON/OFF switch, six pushbuttons that determine the desired frequency band, a three-position function switch (for selecting LINE-IN, RADIO or TAPE), a Binaural Equalizer/Meter switch (that determines the meter function and applies special equalization when you listen to binaurally recorded tapes), two mode switches (with settings for biphonic processing, expanded stereo listening, or ordinary stereo listening), individual channel recording-level slide controls, tape-selection switches (for standard ferric or CrO_2 tape) a record-selection switch (for activating an automatic level control or ALC circuit, if desired), separate bass and treble boost and cut controls, and separate master volume controls for each channel. The volume controls do not affect levels available at the line-out jacks located on the side of the unit.



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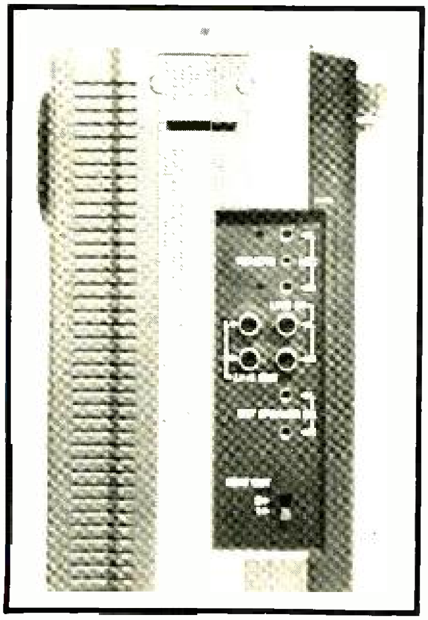
The side panel, shown in Fig. 3, also contains line input jacks, twin external microphone input jacks, external speaker jacks and a switch labeled BEAT CUT to help eliminate beat tones that might occur when recording shortwave broadcasts. The alternate side panel (not shown) has an AC receptacle as well as a connector for a car-battery adapter that can also be used to power the *model RC-828*.

Binaural and biphonic

Binaural recording involves recording sound using two microphones that are spaced as far apart as two human ears, and often a dummy head is used for making such recordings. This dummy head is equipped with tiny microphones where ears are normally located. Until the advent of JVC's biphonic processor, such recordings needed to be heard via headphones.



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When headphones are used, the left ear of the listener hears only what was received by the left "ear" of the dummy head, and the same

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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

RADIO FREQUENCY BANDS:
FM: 88–108 MHz; **AM:** 540–1600 kHz; **MB:** 1.6–4.3 MHz; **SW-1:** 4.3–11.0 MHz; **SW-2:** 11–18.5 MHz; **SW-3:** 18.5–26.0 MHz.

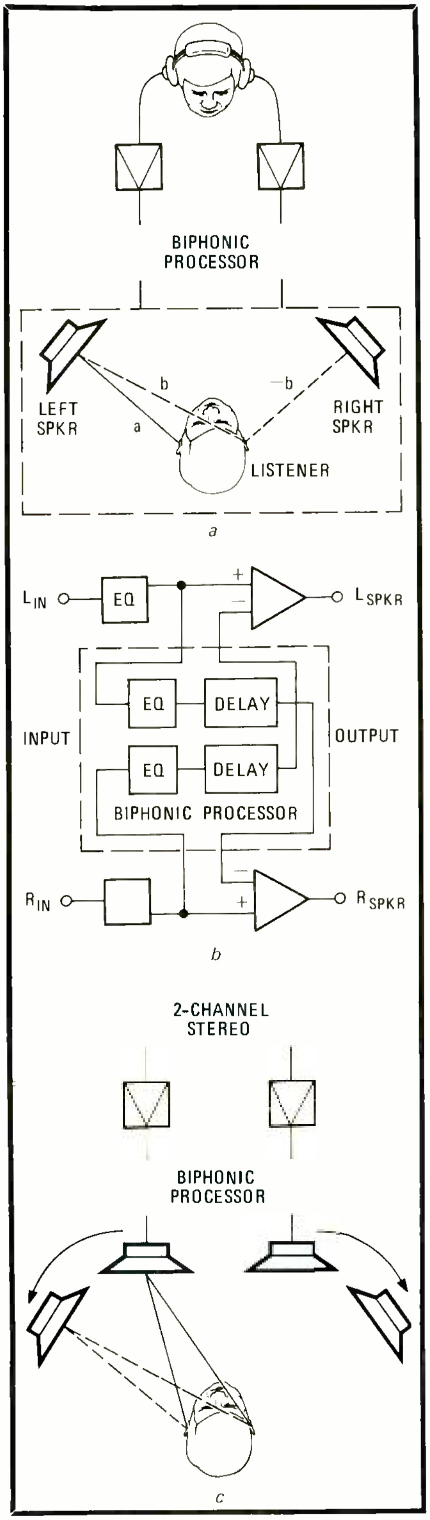
TAPE RECORDER SECTION:
Frequency Response: (Standard tape), 50 Hz–11 kHz; CrO_2 tape, 40 Hz–12 kHz. **Wow and Flutter:** 0.09% WRMS. **Signal-to-Noise Ratio:** 50 dB. **Fast Wind Time:** 110 seconds.

AMPLIFIER SECTION:
Power Output: 2.3 watts-per-channel (FTC). **Line Input Level:** 13 mV. **Line Output Level:** 300 mV.

GENERAL SPECIFICATIONS:
Power Requirements: 12 VDC (8 D Cells) or 120 VAC, 60 Hz. **Power Consumption:** 19 watts. **Dimensions:** 18½ W × 10¾ H × 5 inches D. **Weight (Including Batteries):** 14.1 lbs. **Suggested Retail Price:** $250 (approx.).

holds true for the right ear-microphone. If binaural recordings are played back on a stereo speaker system, *both* the listener's ears hear sounds that were intended for only one ear, and the subtle timing and amplitude differences resulting from such closely spaced microphone recordings are all but lost.

Figure 4-a shows that the biphonic processor circuit contained in the *model RC-828* can reproduce binaural recordings via speakers



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successfully. Crosstalk signals that reach the right ear of the listener from the left speaker (shown as line b in Fig. 4-a) is cancelled by introducing a time-delayed, out-of-phase quantity of signal b (shown as line −b). Fig. 4-b is the block diagram of the action of the biphonic

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **JVC** Model: **RC-828JW**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (µV) (dBf)	3.5 (16.1)	**Good**
Sensitivity, stereo (µV) (dBf)	5.0 (19.2)	**Very good**
50-dB quieting signal, mono (µV) (dBf)	5.5 (20.0)	**Very good**
50-dB quieting signal, stereo (µV) (dBf)	65.0 (41.5)	**Fair**
Maximum S/N ratio, mono (dB)	65	**Very good**
Maximum S/N ratio, stereo (dB)	63	**Very good**
Capture ratio (dB)	2.0	**Good**
AM suppression (dB)	50	**Good**
Image rejection (dB)	75	**Good**
IF rejection (dB)	80	**Very good**
Spurious rejection (dB)	85	**Very good**
Alternate channel selectivity (dB)	60	**Very good**
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	1.5	**Very good**
Harmonic distortion, 1 kHz, mono (%)	0.4	**Excellent**
Harmonic distortion, 1 kHz, stereo (%)	0.5	**Excellent**
Harmonic distortion, 100 Hz, mono (%)	0.4	**Excellent**
Harmonic distortion, 100 Hz, stereo (%)	0.63	**Very good**
Harmonic distortion, 6 kHz, mono (%)	0.45	**Very good**
Harmonic distortion, 6 kHz, stereo (%)	0.5	**Excellent**
Distortion at 50-dB quieting, mono (%)	2.5	**Fair**
Distortion at 50-dB quieting, stereo (%)	0.75	**Good**
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (µV) (dBf)	10 (25.2)	**Very good**
Separation, 1 kHz (dB)	39	**Excellent**
Separation, 100 Hz (dB)	28	**Good**
Separation, 10 kHz (dB)	31	**Very good**
MISCELLANEOUS MEASUREMENTS		
Muting threshold (µV)	N/A	**N/A**
Dial calibration accuracy (±kHz at MHz)	200	**Good**

TABLE II

AMPLIFIER PERFORMANCE MEASUREMENTS

POWER OUTPUT CAPABILITY	**R-E Measurement**	**R-E Evaluation**
RMS power/channel, 8-ohms, 1 kHz (watts)	1.3	**See text**
RMS power/channel, 8-ohms, 20 Hz (watts)	0.4	**See text**
RMS power/channel, 8-ohms, 20 kHz (watts)	0.32	**See text**
RMS power/channel, 4-ohms, 1 kHz (watts)	2.0	**See text**
RMS power/channel, 4-ohms, 20 Hz (watts)	0.25	**See text**
RMS power/channel, 4-ohms, 20 kHz (watts)	0.35	**See text**
Frequency limits for rated output (Hz-kHz)	100-10	**See text**
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.3	**Good**
Intermodulation distortion, rated output (%)	1.5	**Fair**
Harmonic distortion at 1-watt output, 1 kHz (%)	0.3	**Good**
Intermodulation distortion at 1-watt output (%)	1.5	**Fair**
DAMPING FACTOR, AT 8 OHMS	25	
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ±dB)	N/A	**N/A**
Maximum input before overload (mV)	N/A	**N/A**
Hum/noise referred to full output (dB) (at rated input sensitivity)	N/A	**N/A**
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ±dB)	See text-16 kHz	**Good**
Hum/noise referred to full output (dB)	70	**Very good**
Residual hum/noise (minimum volume) (dB)	75	**Very good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 6	**Excellent**
Action of secondary tone controls	N/A	**N/A**
Action of low-frequency filter(s)	N/A	**N/A**
Action of high-frequency filter(s)	N/A	**N/A**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	N/A	
Input sensitivity, auxiliary input(s) (mV)	120	
Input sensitivity, tape input(s) (mV)	120	
Output level, tape output(s) (mV)	200	
Output level, headphone jack(s) (V or mW)	1.33 V/8 ohms	
OVERALL AMPLIFIER PERFORMANCE RATING		**See text**

processor. Because the equalization, crossfeed and delay constants are specifically calculated, it is necessary to sit at a distance of between 60 cm and 80 cm (24–32 inches) from the front surface of the *model RC-828*, but once you are positioned properly, the effect is uncanny. Sounds seem to emanate from points well beyond the extent of the receiver itself and you would swear that there are additional speakers located several feet apart. Similarly, ordinary stereo program material played back via the two speakers in the *model RC-828* can be "expanded" via the biphonic processor, as shown in Fig. 4-c. JVC has developed a single IC that performs all these functions for each channel.

FM measurements

Table I summarizes our measurements of the FM tuner section. Obviously, these measurements fall short of what one could expect from a state-of-the-art stereo FM tuner, but not by a significant margin. The 50-dB quieting exhibited in mono at a signal input of only 5.5 μV (20 dBf) is quite satisfactory (even in terms of high-fidelity components) as are the mono and stereo FM distortion figures, each well below 1.0%. Stereo separation (shown by the two sweep traces in Fig. 5) is also quite impressive, approaching 40 dB at midfrequencies and remaining above 30 dB at the more difficult 10-kHz test frequency. The automatic switchover from mono to stereo FM occurs at a signal input strength of 10 μV (25.2 dBf), and the maximum signal-to-noise ratio in both the mono modes is well above 60 dB. Tuning is relatively noncritical as a result of a moderately applied amount of nondefeatable AFC.

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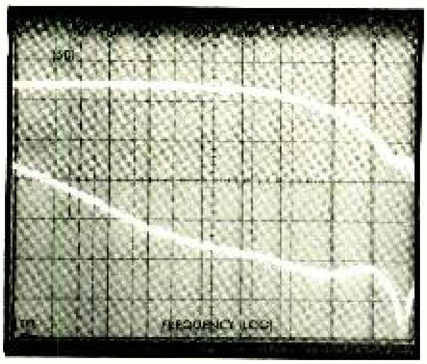


We did not measure the performance of the various medium-wave and shortwave bands of this receiver, but experienced excellent nighttime signal reception from such diverse locations as Great Britain, Japan, Israel, the Scandinavian countries and Germany using nothing more than the dipole antenna components on the receiver.

Amplifier measurements

The less said about the amplifier section of the *model RC-828* the better. The rating of 2.3 watts-per-channel applies to a 6-ohm load for which the output circuitry was optimized. Since our lab is equipped only with precision 8-ohm and 4-ohm loads, we could not obtain the rated power output level, but read 2.0 watts (with 4-ohm speaker loads) at a 1.0% distortion level. The efficient built-in two-way speaker system makes this nominal amount of audio power produce surprisingly loud sound levels before audible clipping or distortion is perceived. The saving grace is the fact that line output terminals are provided, and the signals available at these terminals are taken ahead of the power amplifier section and are, therefore,

TABLE III

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **JVC** Model: **RC-828JW**

CASSETTE TAPE DECK MEASUREMENTS

	R-E Measurements		R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS			
Frequency response, standard tape (Hz-kHz ± dB)	40-12.0		**Very good**
Frequency response, CrO_2 tape (Hz-kHz ± dB)	40-13.0		**Very good**
Frequency response, other (see text) (Hz-kHz ± dB)	N/A See Fig. 7		**N/A**
DISTORTION MEASUREMENTS (RECORD/PLAY)	**Std**	**CrO_2**	
Harmonic distortion at −10 VU (1 kHz) (%)	N/A	N/A	**N/A**
Harmonic distortion at −3 VU (1 kHz) (%)	1.5	6.5	**Very good/ poor**
Harmonic distortion at 0 VU (1 kHz) (%)	2.3	6.5	**Good/poor**
Harmonic distortion at +3 VU (1 kHz) (%)	3.0	N/A	**Good**
SIGNAL-TO-NOISE RATIO MEASUREMENTS			
Standard tape, "Dolby" off (dB)	53		**Excellent**
Standard tape, "Dolby" on (dB (dB)	N/A		**N/A**
CrO_2 tape, Dolby off (dB)	51		**Fair**
CrO_2 tape, Dolby on (dB)	N/A		**N/A**
MECHANICAL PERFORMANCE MEASUREMENTS			
Wow and flutter (%, WRMS)	0.06		**Superb**
Fast wind and rewind time, C-60 tape (seconds)	100		**Fair**
COMPONENT MATCHING CHARACTERISTICS			
Microphone input sensitivity (mV)	0.5		
Line input sensitivity (mV)	120		
Line output level (mV)	200		
Phone output level (mV) (V)	1.33 V		
Bias frequency (kHz)	100		
TRANSPORT MECHANISM EVALUATION			
Action of transport controls			**Excellent**
Absence of mechanical noise			**Superb**
Tape head accessibility			**Excellent**
Construction and internal layout			**Very good**
Evaluation of extra features, if any			**Superb**
CONTROL EVALUATION			
Level indicator(s)			**Good**
Level control action			**Excellent**
Adequacy of controls			**Excellent**
Evaluation of extra controls			**Excellent**
OVERALL TAPE DECK PERFORMANCE RATING			**Very good**

TABLE IV

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **JVC** Model: **RC-828JW**

OVERALL PRODUCT ANALYSIS

Retail price	**$250 (approximately)**
Price category	**Low**
Price/performance ratio	**Superb**
Styling and appearance	**Very good**
Sound quality	**Good**
Mechanical performance	**Excellent**

Comments: The *model JVC RC-828JW* radio-cassette unit is one of the most unusual products ever tested in our labs. Far from being a typical low-fi portable, this all-in-one entertainment center lets you enjoy good FM and AM reception (not to mention shortwave reception) as well as cassette tapes wherever you are. Its amplifier section is not qualified to drive good external speakers, but thanks to the available line outputs, you can connect the system's program sources to your home-based hi-fi system when you are not traveling. With that sort of hookup, you can avail yourself of both the biphonic processing features and the expanded stereo features. The expanded stereo feature will be especially useful (even if you own a regular components system) if your speakers are too closely spaced in a small listening room. In addition, when you *are* away from your main hi-fi system, this feature lets you enjoy wide-separation stereo reception from FM sources and from cassettes even when you must monitor such results from the *model RC-828* itself.

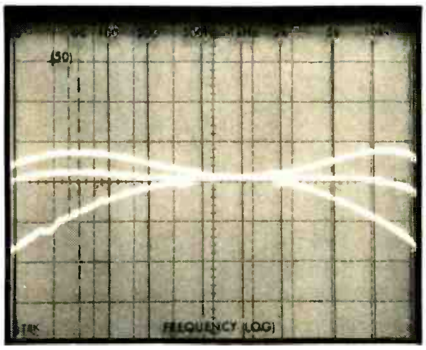
The relatively high quality of the FM section was a surprise and, if your present hi-fi system lacks a tuner, connecting the line outputs to the auxiliary inputs of your main amplifier will provide you with adequate FM and stereo FM reception when you are not using this portable away from home.

Despite the low power output of the self-contained amplifier, listening to the unit via its own speakers offers surprisingly faithful reproduction—thanks in part to the built-in twin two-way speaker systems. The twin-element built-in antenna was satisfactory for FM reception (the elements are expandable in length and can be oriented for any directional pattern) and even better for shortwave reception. By offering four separate shortwave bands, it is possible to adequately separate closely spaced shortwave signals.

distortion-free and suitable for a high-fidelity amplifier of your choice, or even to the auxiliary inputs of a home-based stereo high-fidelity receiver.

Line input jacks also enable you to copy program sources (such as records) from your hi-fi component system to the unit's built-in cassette deck. It is our experience with the *model RC-828* that the available external speaker jacks are not really necessary since few speakers could produce enough sound when fed with the low power levels provided by the power amplifier. Since the stereo-enhance feature is so effective, the use of external speakers fed directly from the built-in amplifier is not justified even on the basis of increased stereo separation.

Tone control range for bass and treble (as shown in the scope photo of Fig. 6) has been kept to a relatively low amount of boost capa-



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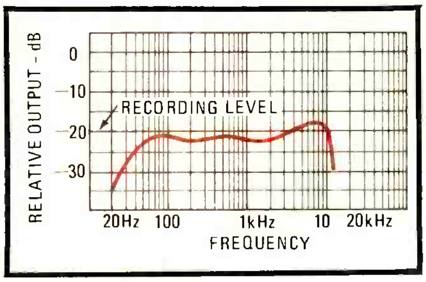
bility so that you will not tend to overdrive the limited power capability of the built-in amplifier. A moderate amount of bass boost is permanently in the circuit (even with the BASS control set to its flat or mid-position) to add a bit of depth to music reproduced over the relatively small built-in low-frequency speakers.

Cassette deck measurements

Table III summarizes results of tests made on the cassette recorder section. Record/play frequency response, using TDK-type AD ferric tape, extended from 40 Hz to 12.0 kHz, somewhat better than that claimed. Figure 7 shows a point-by-point plot of the response using this tape at a −20-dB recording level.



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While CrO_2 tape yielded somewhat better results (with response out to 13 kHz), we do not recommend using this type of tape with the *model RC-828* (at least not with our sample). For some reason, when CrO_2 tape was used, distortion at a 0-dB record level was excessive (we checked the switch setting several times to make sure that it was the correct one) and since the signal-to-noise ratio obtained using this tape (even referred to the higher distortion point) was not as good as that obtained using the high-quality ferric tape from TDK, there is no reason to use the CrO_2 variety.

Because of the extremely low price tag of the *model RC-828*, JVC undoubtedly could not incorporate either Dolby noise-reduction circuitry or their own ANRS hiss-reducing scheme. We almost wish that they had added $50 or so to the cost of the instrument and used either the Dolby or ANRS circuitry. For many listening applications, however, the signal-to-noise values greater than 50 dB are satisfactory, and the reasonably good frequency response and the superbly low wow-and-flutter characteristics of this cassette tape deck mechanism make it a true high-fidelity tape deck in every sense of the word. We have tested many $200 cassette deck components that performed no better than the cassette section of the *model RC-828*, which, after all, contains six radio bands, a complete stereo amplifier/speaker system and that amazing biphonic circuitry.

Summary

An overall evaluation, together with our summary comments, is contained in Table IV. We do not suggest that the *model RC-828* is a suitable substitute for a true high-fidelity component system in your home. But there may be occasions when you want reasonably good reproduction such as when traveling, residing in a dormitory or in a hotel, or at other times when you are away from your primary hi-fi system. To ears accustomed to good clean sound, the *model RC-828* offers sound that comes amazingly close to the real thing and permits you to record cassette tapes to be played back later on your primary system or cassette stereo system in your car. JVC also offers an unusual headphone/microphone combination (*model HM-200E*) that allows you to make your own binaural recordings. That product, plus the *model RC-828*, makes an unbeatable combination. **R-E**

CONVERGENCE PROBLEM

After changing the picture tube in this Quasar TS-934, I have a convergence problem. I don't understand this.—A. R., East Haven, CT.

Sometimes, a new picture tube will have slightly different tolerances than the original tube. However, this doesn't seem to be too common. The most frequent cause appears to be something that was *disturbed* during the changing operation, such as loose contacts, broken wires, etc. Check out all the convergence pulses on the plug and make sure they're all normal.

(Feedback: "Right! I had a couple of problems in the vertical circuitry that were upsetting the pulses going to the convergence board.")

NO HORIZONTAL SWEEP

All I can get on this RCA CTC-71J is a thin, bright vertical line. The high voltage seems to be OK. The horizontal-deflection yoke winding checks out. What is this?—J. R., Detroit, MI.

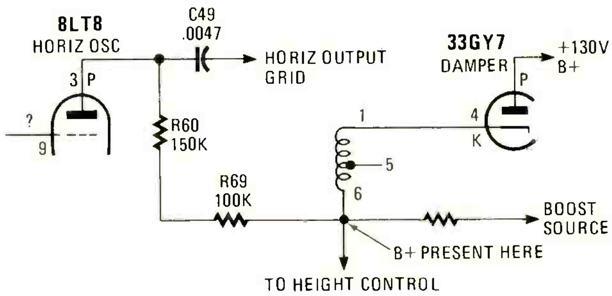
You have several things that are normal (high voltage, etc). So, the horizontal-output stage is working. Your yoke is OK, but you're not getting *through* it! Check the horizontal yoke *return* circuit, which goes through the pincushion transformers, a 0.55-µF capacitor and the plug-socket contacts. Something in this circuit is probably open.

(Feedback: "Bingo! The PC-board conductor between the yoke return contact and the first pin transformer was open.")

VOLTAGE PROBLEMS

This Admiral T12H4-1A has no high voltage, no boost or plate voltage on the horizontal oscillator. I can get the B+ voltage as far as the height control. I tried changing tubes, etc.—no luck. No shorts that I can find. Where am I losing it?—B. T., Delta, IA.

Follow the DC path from the horizontal oscillator plate back to the B+ voltage (see diagram). Note that there's no starter resistor connected directly to the B+ 130-volt line: this goes back to the damper cathode of the 33GY7. So, your damper tube *must* be conducting before you can get anything out of the horizontal-output stage at all. (Found a set once with a broken cathode ribbon on the damper tube! That was weird.)

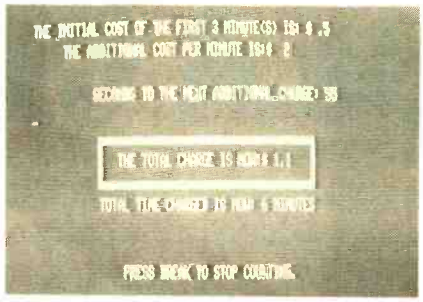


Your path leads from the oscillator plate through R60 (150K) and R69 (100K) to terminal 6 of the flyback, then through two small windings back to the damper cathode. You do have B+ voltage as far as terminal 6, which is connected directly to one end of the height control. So, that much is OK. Resistor R69 may be breaking down under load.

Start checking at terminal 6 on the flyback to see just where you lose the voltage. If the resistor checks good cold, try bridging another resistor across it to see what happens. There is one fairly unlikely possibility that should be checked if nothing else works. Read the control-grid voltage on the horizontal oscillator. If this measures too far *positive*, the tube will draw so much current that the plate voltage will drop to zero. There is no coupling capacitor to a high voltage that could short in this chassis, but you may have a leakage across the socket or something equally weird! **R-E**

Computer Program

Know what your long-distance calls cost as you make them



ACTUAL SCREEN PHOTOS of program as it is running during a real phone call. Display tells you actual cost of call moment by moment.

FRED BLECHMAN, K6UGT

WOULD YOU LIKE TO KNOW EXACTLY WHAT YOUR TOLL AND long-distance calls are costing you, *as you are making them*? With a simple computer program, you can synchronize yourself with the phone company billing machine, and have your computer screen print out your accumulated charge, and the time (in seconds) to the next added charge!

I used a Radio Shack TRS-80 computer, so the program is written in Radio-Shack Level 1 BASIC. If you have a different computer, you should be able to adapt it with no trouble. The program is written so that it allows the operator to request information on rates and discount periods, or bypass these instructions and go right into entering the three variables that determine the cost of the call: the initial time period, the initial time charge and the additional charge per minute. Once this data is entered, the operator places the phone call in the regular manner, and presses the ENTER key on the computer keyboard when the party at the other end picks up their phone. That synchronizes your computer with the phone company timer—with absolutely **no connection to the phone lines!** From that point on, the computer display shows the initial cost and time period, counts down the seconds to the next added charge and (after the initial time period) displays the total time and cost continuously. To make the total cost more readable, it is enclosed in a graphic rectangle.

You must account for the operating speed of the computer. This is done in lines 130 and 140 by delaying the start of the countdown a few seconds, since it takes time for the computer to get to this point in the program on the first pass (mostly graphic delay). Also, I found my TRS-80 ran a FOR-NEXT loop at a rate of 490 loops-per-second, as shown in line 225. You might have to change this number slightly if your computer runs a bit faster or slower. This program uses 2495 bytes of memory of the 3583 available in the TRS-80 4K memory unit.

Telephone Toll Totalizer Program


```
5 REM ★ PROGRAMMED FOR TRS-80 LEVEL I BASIC ★
10 REM ★ COPYRIGHT 1978 FRED BLECHMAN ★
15 REM ★ THREE LINES AFFECT THE TIMING OF THIS PROGRAM ★
16 REM ★ LINES 130 AND 140 DETERMINE THE STARTING COUNT★
17 REM ★ (THIS LETS YOU CORRECT FOR THE GRAPHIC DELAY) ★
18 REM ★ LINE 225 CONTROLS THE SECONDS COUNTING ACCURACY ★
20 CLS:P.:P.P.
21 P."                    TELEPHONE TOLL TOTALIZER":P.:P.
25 IN."DO YOU WANT SPECIFIC INSTRUCTIONS? YES=1,NO=2";A
26 IF A=1 GOTO 300
28 CLS:P.:P.:P.
29 P."                    TELEPHONE TOLL TOTALIZER":P.:P.
30 IN."WHAT IS THE INITIAL TIME PERIOD (MINUTES)";P
35 P.:P.
40 IN."WHAT IS THE INITIAL CHARGE (CENTS)";I
45 P.:P.
50 IN."WHAT IS THE ADDITIONAL CHARGE PER MINUTE (CENTS)";M
51 CLS:P.:P.:P.:P.
55 P."WHEN THE PARTY AT THE OTHER END PICKS UP THE RECEIVER"
57 IN."PRESS ENTER TO START TIMING. . . .";A$
60 CLS:P.:P.
70 P."THE INITIAL COST OF THE FIRST";P;"MINUTE(S) IS:$":I/100
80 P."     THE ADDITIONAL COST PER MINUTE IS:$";M/100
90 P.AT 847,"PRESS BREAK TO STOP COUNTING."
100 C=I/100:D=1
110 FOR X=22 TO 93
115 SET (X,22):SET(X,28):NEXT X
120 FOR Y=22 TO 28
125 SET(22,Y):SET(93,Y):NEXT Y
130 T=56
140 IF P=3 THEN T=176
150 GOTO 221
200 P.AT 526,"THE TOTAL CHARGE IS NOW:$";C
210 SET(93,24):SET(93,25):SET(93,26)
215 P.AT 651,"TOTAL TIME CHARGED IS NOW:";P+D;"MINUTES"
220 T=59:D=D+1
221 C=C+(M/100)
225 FOR X=1 TO 490: NEXT X
230 P.AT 330,"SECONDS TO THE NEXT ADDITIONAL CHARGE:";T
240 T=T-1
250 IF T=-1 GOTO 200
255 GOTO 225
300 CLS:P"YOUR CHARGES ARE BASED UPON THREE THINGS:"
310 P."     (1) INITIAL TIME PERIOD (1 or 3 MINUTES)"
320 P."     (2) INITIAL CHARGE (FOR THE INITIAL PERIOD)"
330 P."     (3) ADDITIONAL CHARGE PER MINUTE AFTER INITIAL PERIOD"
340 P.:P."IF YOU USE AN OPERATOR TO ASSIST YOU, THE INITIAL"
350 P."TIME PERIOD IS 3 MINUTES. DIRECT DIAL IS 1 MINUTE."
360 P.:P"THE CHARGES ARE BASED ON THE DESTINATION CALLED. . . ."
370 P.". . . . THESE ARE USUALLY LISTED IN THE FRONT OF THE PHONE BOOK"
380 P.". . . OR. . . . CALL OPERATOR FOR THE RATES."
390 P."DO YOU WANT INFORMATION ON DISCOUNT PERIODS?"
400 P.:IN."YES=1,NO=2";B
410 IF B=2 GOTO 28
420 CLS:P."THERE ARE TWO DISCOUNT RATES IN THE CONT. U.S.A.:"
430 P."     35% DISCOUNT:   5PM-11PM SUNDAY-FRIDAY"
440 P."                     8AM-11PM HOLIDAYS":P.
450 P."     65% DISCOUNT:   11PM-8AM EVERY NIGHT"
460 P."                     8AM-11PM SATURDAY"
470 P."                     8AM-5PM SUNDAY"
475 P.:P."CHARGES ARE BASED ON TIME AT CALLING POINT!"
476 P.:P.:P.
480 IN."PRESS ENTER TO INPUT TIME AND CHARGE DATA. . . .";A$
490 GOTO 28
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DIGITAL HI-FI RECORDING

Its Time Is Now!

For years, audio engineers have sought practical ways to increase the signal-to-noise ratio and dynamic range in audio recordings. Here's a look at what's coming from the giants in the recording industry.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THREE SEPARATE EVENTS HELD IN THE last several months have convinced me that we are on the brink of a major revolution in recording technology: the High Fidelity Show held in Tokyo, Japan, in late September, 1977; a press conference held by the 3M Company in New York just prior to the Audio Engineering Society (AES) convention in early November, 1977; and the AES convention itself. The revolution, of course, has to do with the coming transition from analog audio recording to digital audio recording.

It is fitting that this transition should be taking place exactly 100 years after Thomas A. Edison inscribed those first recorded words onto a tinfoil cylinder. As crude as that first recording was, its basic concept has remained the same for a century. All presently available recordings are analog representations of sound waves. In the case of discs, the analog is represented by continuous wiggles or undulations in the disc's groove walls. In the case of tape, the analog consists of continuously varying magnetization patterns on a ribbon of tape coated with particles that can store such continuous magnetization patterns.

Analog-to-digital conversion

Any amplitude or number can be represented by a binary numbering system in which only "0" and "1" are used. The way to represent a continuous sinewave (see Fig. 1) in binary language would be to sample the amplitude at several points and express the results in binary form. If a 6-bit system is used, for example, you could express any amplitude level from 0 (000000) to 63 (111111). The table in Fig. 1 shows how a waveform is expressed in binary language, using a 6-bit system.

SINEWAVE SAMPLE VALUES

SAMPLE NO.	DECIMAL AMPLITUDE	6-BIT BINARY AMPLITUDE
1	20	010100
2	23	010111
3	24	011000
4	21	010101
5	16	010000
6	13	001101
7	9	001001
8	8	001000
9	11	001011
10	16	011000

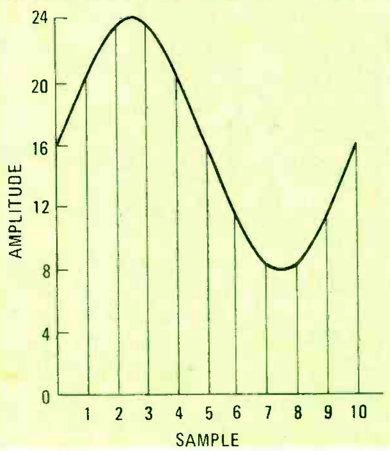

FIG. 1—SINEWAVES can be converted to digital form by sampling at specific points and then converting the amplitude into a binary representation, as shown in the accompanying table.

Assume, also, that you are sampling at a rate of 50,000 times-per-second. If the single sinewave shown in Fig. 1 were part of a 5000-Hz tone, you would have ten chances to sample one complete wave, as summarized in the table in Fig. 1. Note, however, that some of the bit values expressed are not totally accurate. In any bit or binary-number expression, only whole numbers can be used (as shown in the accompanying decimal system equivalents of the 6-bit code). Thus, to make the digital equivalent of any waveform *more* accurate, *more* bits must be used. Furthermore, in the example, a 5000-Hz signal has been used. If the same sampling rate (50,000-per-second) were used to dissect a 20,000-Hz waveform, you would only have 2½ chances per cycle to sample the waveform amplitude. Even though it would seem that such a low sampling would not be enough to represent a pure 20,000-Hz sinewave, it is possible to reconstruct the 20-kHz sinewave as long as it has been sampled at least twice (once for its positive-going peak amplitude, and again for its most negative value).

Advantages of digital recording

Once an analog or continuous waveform signal has been converted to a series of pulses (for example, a positive pulse for "1" and an absence of a pulse for "0"), these pulses can be recorded on tape. For tape recording, the advantages are obvious since the pulses can all be recorded at a constant amplitude. That means that every pulse can be recorded at a level well above the residual noise level of the tape and well *below* the saturation level. Thus, the system's dynamic range is no longer limited by the parameters of the magnetic tape itself. It can be shown that in a digital recording system, each bit of storage capability offers 6 dB of dynamic range. So, for 96 dB of dynamic range (that's about 30 dB better than the best analog tape recorders can deliver), all you have to do is create a 16-bit digital recording system.

The 3M/BBC system

The 3M Company and the British Broadcasting Company have jointly developed such a recording system. Figure 2 shows their new Digital Audio Mastering System that is designed to replace analog systems in professional recording studios.

FIG. 2—NEW DIGITAL AUDIO MASTERING SYSTEM is manufactured by the 3M Company and contains 32 audio tracks.

It records 32 audio channels on special 1-inch-wide tape. A matching stereo recorder (not shown) is included in the complete digital recording system, comparable in size and style to present analog professional mix-down recorders. Figure 3 shows the operator's panel for the system. This panel can be removed from the cabinet for use at nearby remote locations.

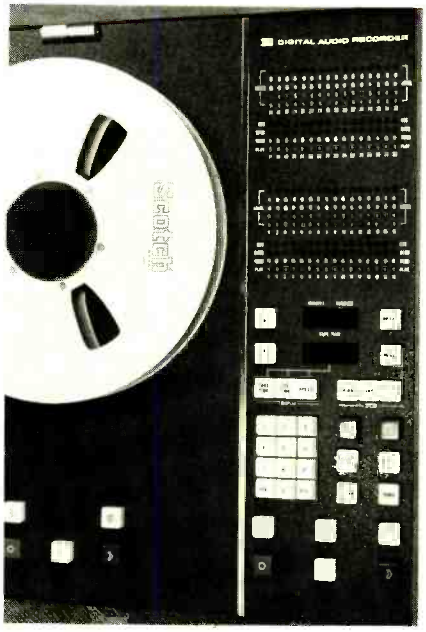

FIG. 3—FRONT PANEL of the new Digital Audio Recorder.

The frequency response is flat within 0.3 dB from 30 Hz to 15 kHz, and within 3 dB out to 20,000 Hz. Signal-to-noise ratio is an incredible 90 dB or better, and harmonic distortion is less than 0.03% at any frequency from 20 Hz to 20 kHz at +15-dBm input levels. Intermodulation distortion is equally low for any two frequencies mixed. By way of comparison, Fig. 4 shows the harmonic distortion in a recorded 5-kHz pure tone for a top-quality analog recording system com-

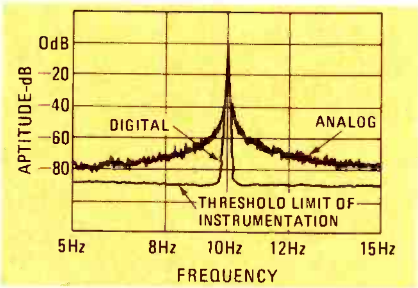

FIG. 4—HARMONIC DISTORTION curves of an analog recorder vs. a digital recorder.

pared with that for the digital mastering system. Second- and third-harmonic components for the analog system are around 55 dB below the 5-kHz fundamental signal, whereas in the case of the digital system, these distortion components are some 80 dB or so below reference record level.

There are other advantages to the system. Because equal-amplitude digital pulses are used to represent all audio signal waveforms, the problem of tape saturation at high frequencies becomes meaningless. The full dynamic range of all types of music (even electronic music, which often has disproportionately high levels of high frequency signals) can be recorded without using compressors, limiters or manual gain riding. In professional recording, it is a common practice to make several dubbings from the original multitrack master recording before arriving at the final two- or four-channel mix-down recording. In an analog system, each such dubbing adds approximately 3 dB of noise. In a digital system, any number of dubbings can be made with absolutely no degradation of signal-to-noise ratio. Furthermore, using a digital system eliminates such problems as tape print-through, in which high magnetization levels on one layer of tape can become imprinted on adjacent layers to produce pre- or post-echoes.

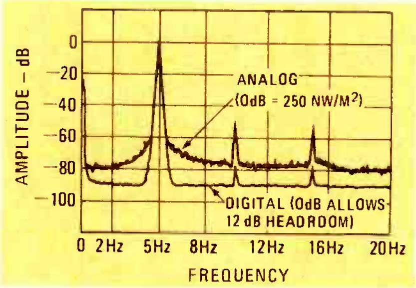

FIG. 5—SPECTRAL PURITY of an analog recorder vs. a digital recorder.

Because of slight motion irregularities in a conventional analog system, recorded tones are often accompanied by modulation noise—that is, the noise tends to rise at frequencies just above and below the frequency of the recorded tone, as shown in the upper trace of Fig. 5. By comparison, the lower trace, representing the results obtained using the 3M digital mastering system, shows no measurable modulation noise surrounding the same 10-kHz recorded test frequency. This spectral purity is a distinctly audible improvement when listening to playback of digitally recorded audio programs.

Wow-and-flutter for the new system is not measurable. Obviously, even the best tape transport is not totally free of such speed variations, but in a digital system it is possible to store the millions of bits corresponding to the audio signal in short-term memory, and then to release them in perfect, uniform sequence determined by a reference quartz-crystal oscillator clock.

Tape dropouts can, of course, pose a serious problem in a digital system if the missing information is not compensated for. In an analog system, a short dropout is often undetectable, since our ears tend to fill in the gaps if they are sufficiently short. In a digital system, dropouts mean an absence of pulses, which the system would interpret not as *missing* music but as a different bit-code altogether. Accordingly, in the 3M system, each track contains a degree of track redundancy and, with the aid of computer memory, such dropout errors are automatically corrected. This requires 1½ times the normal tape length needed if such a correction scheme were not included, but it is well worth the extra tape. The tape in the 3M system operates at a speed of 45-inches-per-second; 7200 feet of recommended tape wound on a 12½-inch reel provides 30 minutes of recording time. Of course, the 3M Company has developed a high-storage density tape to go with the machines. At the AES Convention we were also shown Ampex's new Series 460 digital audio recording tape specifically designed for digital-recording applications. Digital dropout for this new tape is less than an average of 1 μs per-100-feet of tape per track, measured across the entire tape width and length.

Consumer digital systems

The new 3M professional mastering system is expected to cost a recording studio around $150,000. If this seems extremely high to home recordists, it should be pointed out that a comparable first-quality analog system costs around $80,000, and provides 24-track capability (as opposed to 32 tracks), using 2-inch-wide tape (as opposed to 1-inch tape). Therefore, in terms of per-track cost and tape usage, the prices are not that disparate. Still, this new system would probably never be bought by a home recordist.

On the consumer front, things seem to be moving along just as quickly. Sony, for example, has developed a PCM add-on tape accessory that can be attached to its Betamax home videotape recorder. For some reason, the Japanese digital audio recording systems are called PCM (*P*ulse *C*ode *M*odulation), but these systems are, in fact, true digital tape recording systems and operate on the same digital code principle as the more elaborate multi-track 3M system.

At the AES show, we also saw a PCM recorder from Mitsubishi, as well as a new PCM cassette tape deck that features an oversized cassette of specially formulated 2-hour tape, a frequency response from DC to 20 kHz, ±0.5 dB, 80 dB of dynamic range, distortion of under 0.3% and undetectable wow-and-flutter. This cassette deck uses 13-bit digitization, a 47.52-kHz sampling frequency as well as a sophisticated system of dropout compensation.

Soundstream, Inc. displayed a 4-channel digital mastering system with a digital editing feature that produces inaudible splices with resolution to less than 30 μs. The editing system can even be used to produce splices at different places on each track and, since the tape is never physically cut, a selection can be repeatedly spliced and auditioned while the all-electronic digital editing system keeps track of acceptable final results.

Direct-to-disc

It can be argued that digital tape recording will mean little if, in the end, these superior master tapes are used to cut only conventional lacquer discs from which vinyl pressings are made. However, this is not really the case. Readers may be familiar with some of the new limited-edition direct-to-disc records that are now available. In this process, a master lacquer disc is cut during an actual musical performance expressly to eliminate the intermediate analog-tape recorder process. Anyone who has heard these discs can attest to their better sound quality. Making a direct-to-disc record, however, means bypassing all the sophisticated multitrack capabilities that have been developed over the years and are responsible for present-day high-quality recordings, since later editing or mixing is not possible. By introducing digital master tape recording as the initial studio recording technique, the advantages of multitrack recording can be combined with the sound quality of direct-to-disc techniques since the digital master tape system introduces no intermediate degradation of the music signals.

Home disc system

The final development in this conversion from analog-to-digital audio technology has already appeared. Several Japanese companies have already perfected a PCM disc and its required player. At the AES convention, two seemingly identical machines were shown—one by Teac, the other by Mitsubishi. These discs contain tiny pits or photoetched depressions beneath a PVC coating. A monochromatic laser beam reads the presence or absence of these tiny pits on the disc; these readouts are then converted into pulses or digital code that is then amplified and converted back to audio waveforms.

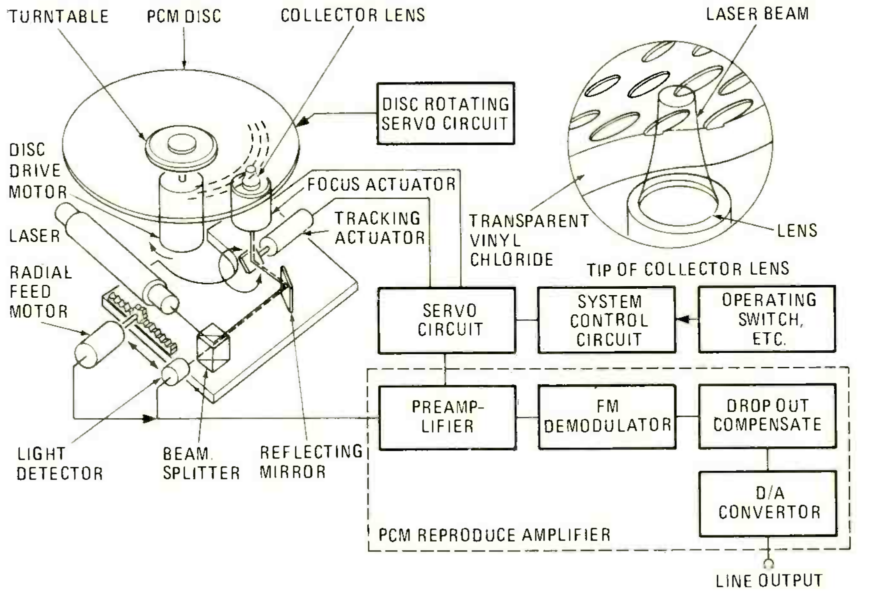

FIG. 6—PCM RECORD PLAYER uses a laser to reproduce music from a transparent vinyl chloride disc.

The end of signal processing?

Because of the limitations of analog tape recorders, recording studios have used many kinds of signal processors to try to get around the noise and dynamic-range limitations of the analog tape system, using such schemes as Dolby noise reduction and *dbx* companders and the like. The widespread use of digital master recording systems could well make such devices obsolete—at least insofar as studio use is concerned. Of course, as long as vinyl long-playing discs are used as the final playback software, some compression of dynamic range will still be necessary before the master disc is cut, since even the best LP's are not capable of much more than 65 dB of dynamic range. However, digital master taping techniques may insure that more discs will reflect that full range along with lower distortion.

Figure 6 shows a simplified diagram of the laser PCM disc system. The turntable platter rotates at a speed of 1800 RPM, controlled by a precise quartz-crystal oscillator locked servo system. For some idea of the system's potential performance, consider the following projected specifications: a dynamic range of 98 dB; a frequency range from 10 Hz to 20 kHz within 0.5 dB; distortion less than 0.1%; and wow-and-flutter (typically) less than 0.001%. Thirty minutes of playing time can be had from a single disc.

While it may be several years before digital PCM discs are as common as LP records, the possibilities exemplified by these outstanding specifications are too good to be ignored. The lack of contact between the disc and the pickup arm means that there should be no performance deterioration no matter how many times the disc is played. There will be no tracking distortion, pinch effect, or tracking error as with mechanical systems. Nor will there be any acoustic feedback (howling) and surface noise in a disc that requires no more delicate handling than present-day LP's. This is a very attractive prospect for the program source of the future. **R-E**

Little Pro Beep

Easy to build programmable beeper can be used as the heart of a call system

ISAAC QUEEN

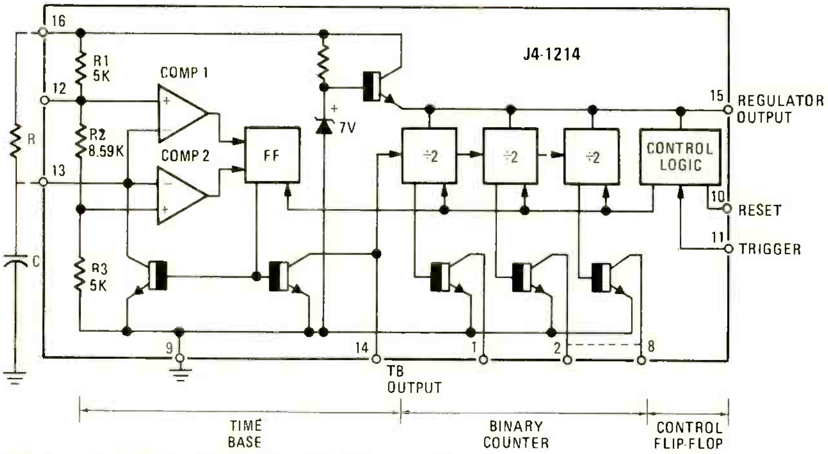

FIG. 1—CALECTRO J4-1214, simplified diagram. (Courtesy Calectro Handbook No. 98-102.)

CALL SYSTEMS ARE COMMONLY USED IN supermarkets and in department stores to summon personnel to the office or the phone. A bell repeats an identification number until the desired person answers. This very simple system may prove ample for many call purposes.

It is a *programmable beeper*. It can be switched to beep once, twice or four times, repeating the signal automatically. If desired, it may be set for a continuous sound. In addition, there is a choice of two audio frequencies—a buzz (about 105 Hz) and a tone (about 210 Hz). A total of eight distinct signals is available.

The beeper uses a programmable counter, Calectro type J4-1214 (an equivalent to the XR-2240), the simplified diagram of the programmable counter is shown in Fig. 1. The timebase section functions somewhat like that of the popular 555 timer. Capacitor C and resistor R are external timing components. The capacitor charges through the resistor. When terminal 13 reaches the critical value, comparator-2 triggers the flip-flop. C is quickly discharged, a negative pulse appears at pin 14, and the sequence repeats. The formula for the time period is T = RC (seconds = megohms × microfarads).

The timebase pulses feed a string of eight divider stages (only stages 1, 2, 8 are shown in the diagram). Their outputs are available at pins 1 through 8, respectively. Each pin has half the frequency of the previous one. All eight pins are normally at a logic-1 level. At the trigger instant, all the pins go to a logic-0 level (to ground). Refer to Figs. 2-a and 2-b. For example, pin 1 remains at a logic-0 level for an interval T, then snaps back to a logic-1 level for a time T, and so on. At pin 2, the interval is 2T, at pin 3 it is 4T, etc.

The squarewave outputs from J4-1214 are available from pins 1 through 8, individually or in any desired combination. Figure 3 shows how to tie pins 1 and 8 to the output. The AC output appears across load R_L and the output terminals. The battery is assumed to have negligible impedance.

Figure 3 is a wired-OR connection. If either pin 1 *or* pin 8 goes to a logic-0 level, there can be no output at the output terminals. As an example, take R

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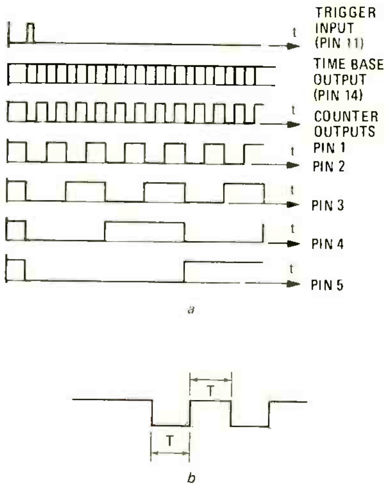


FIG. 2—TIMING DIAGRAM. The counter outputs are shown in a, and the output at pin 1 is shown in b.

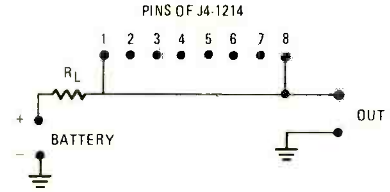


FIG. 3—STRAPPING TECHNIQUE.

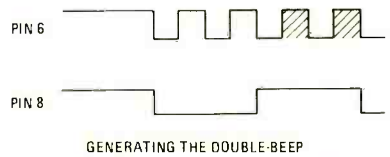


FIG. 4.—GENERATING DOUBLE BEEPS.

PARTS LIST

All resistors ¼ watt, all capacitors 50 volts.

R1—47,000 ohms
R2—20,000 ohms
R3, R4—10,000 ohms
C1, C2, C3—.05 μF
C4—0.1 μF
J1—earpiece jack
J2—phono jack
S1, S3—SPST toggle switches
S2—SPDT toggle switch with "off" center position.
IC—J4-1214 (Calectro)
16-pin DIP socket for above
IC socket adapter (Radio Shack 276-024)XChassis box, metal, 3¼ × 2 × 1½ inches
Miscellaneous hardware

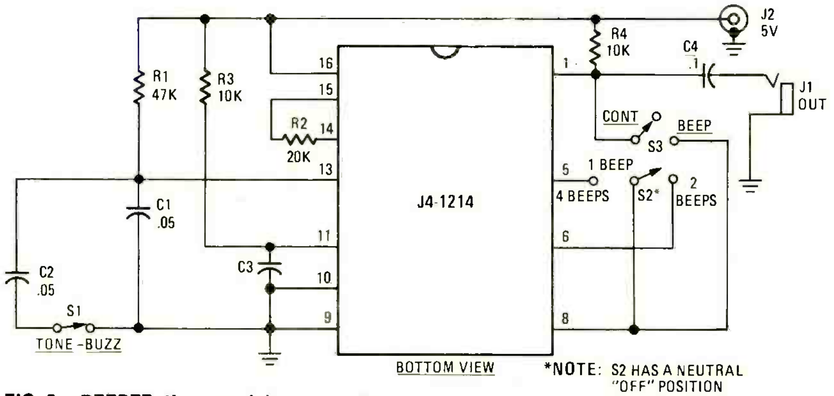


FIG. 5.—BEEPER, the complete schematic.

Long Duration IC Timers That Really Work!

Programmed delays and intervals of many hours can be precisely timed by combining the short-term accuracy of the one-shot multivibrator with the precision of the binary counter. Here is how the setup operates.

JOSEPH J. CARR

ELECTRONIC TIMER CIRCUITS USUALLY CONSIST OF MONOSTABLE multivibrators (i.e., one-shots), and their periods are controlled by an R–C time constant. The 555 IC timer, for example, has an output duration of 1.1 RC. Most literature dealing with 555 applications claim that 10 megohms and 100 μF are the maximum values for R and C, respectively. However, at these maximum limits, *precision* components are difficult to obtain and, when available, tend to be expensive. Precision resistors in the 10-megohm range are relatively available, but capacitors with better than 5% tolerance in the above 1-μF range become increasingly difficult to obtain as the capacitance value goes up. In addition, many capacitors, even tantalum types, tend to be leaky; this deteriorates the precision of the R–C circuit. Also, most electrolytic capacitors are rated to be within −20% to +100% in the over 10-μF region.

Using the maximum values specified by 555 manufacturers produces an output period of $(1.1)\ (10^7)\ (10^{-4}) = 1100$ seconds, or about 18 minutes. If you cascade several 555 devices so that the first device triggers the second and so forth, you can obtain long time delays between the occurrence of the trigger and the trailing edge of the last output pulse; these signals could be gated together to produce a long-duration timer using lower-value components of higher precision. However, even if six 555 IC's were connected in that manner, they would only produce a duration of not quite two hours.

A better alternative is to use a *countdown* technique in which a precision timebase oscillator drives a binary or BCD counter. If we build this circuit using TTL or CMOS IC's, the timer will accomplish our purpose, but still have a relatively high IC count.

The Exar Integrated Systems XR-2240, XR-2250 and XR-2260 timers (with counterparts being Intersil's 8240, 8250 and 8260, respectively) contain a timebase that is similar to the 555 timer, as well as a built-in binary or BCD counter.

Figure 1 is the block diagram of these IC's, and Fig. 2 shows the simplified internal circuitry for the XR-2240. The internal circuitry for the XR-2250 and XR-2260 is similar, except that the binary counter is BCD-coded, and the regulator output (pin 15) becomes an overflow output for the counter.

There are three basic sections in the timer IC: the timebase, the binary counter and the control logic (see Fig. 1). The timebase is an R–C multivibrator that produces output pulses with a duration equal to R × C. The counter in the XR-2240 is a straight 8-bit binary counter with outputs weighted in the standard 2^0, 2^1, 2^2, 2^3, 2^4, 2^5, 2^6 and 2^7 format to produce time weights of 1, 2, 4, 8, 16, 32, 64 and 128 times the timebase period.

The XR-2250 uses a BCD-weighting in which pins 1 to 4 form the least-significant digit (weighted 1, 2, 4 and 8), and pins 5 to 8 form the most-significant digit (weighted 10, 20, 40 and 80). The XR-2250 produces output times that are weighted 1 to

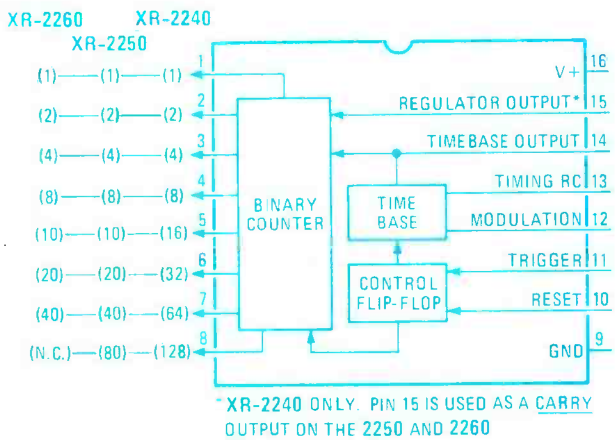


FIG. 1—TIMER IC PINOUT diagram for the XR-2240, XR-2250 and XR-2260. Numbers in parentheses are the binary weighted time durations.

99 times the timebase period.

The XR-2260 timer is similar to the XR-2250, except that the most-significant digit is limited to a maximum count of 5 (with a weighting of 50); output pin 8 on the XR-2260 is not used. This IC is designed for use in hours, seconds and minutes timers.

In all three IC timers, the timebase oscillator produces the pulses that are fed to the counter input, and the control flip-flop triggers the timebase and sets all counter outputs initially to 0.

The XR-2260 timebase, like the popular 555, consists of two voltage comparators, a flip-flop and two NPN transistors (see Fig. 2). This design allows an R–C timer to achieve better stability because there is less dependence upon temperature fluctuations and, especially, on changes in the power-supply voltage.

Transistor Q1 in the timebase is the discharge switch, which keeps capacitor C discharged whenever Q1 is turned on. Transistor Q2 is an open-collector output switch that drives the input of the binary counter. In normal operation, where the counter is driven by the internal timebase, the collector of Q2 (pin 14) is connected to the regulator output through a 20,000-ohm resistor.

The two voltage comparators are biased by voltage-divider network R1–R3. The noninverting (+) input of comparator 2 is biased to approximately 0.27+ (pin 16 is V+).

When a trigger pulse is applied to the control-logic section, the timebase flip-flop is placed in the SET condition, thereby turning off transistors Q1 and Q2. In this condition the timebase output terminal is forced high, and capacitor C starts charging through resistor R from the V+ voltage source. When the capacitor voltage reaches 0.27+, comparator 2 toggles, reset-

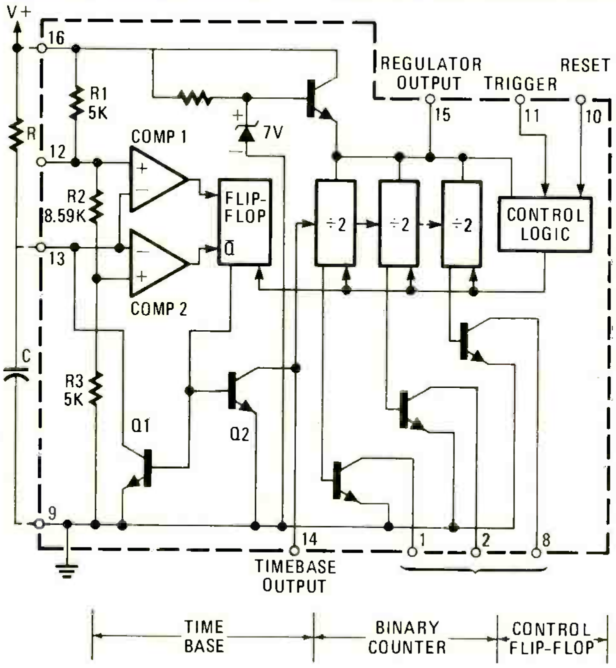


FIG. 2—XR-2240 IC contains a timebase circuit and a binary counter.

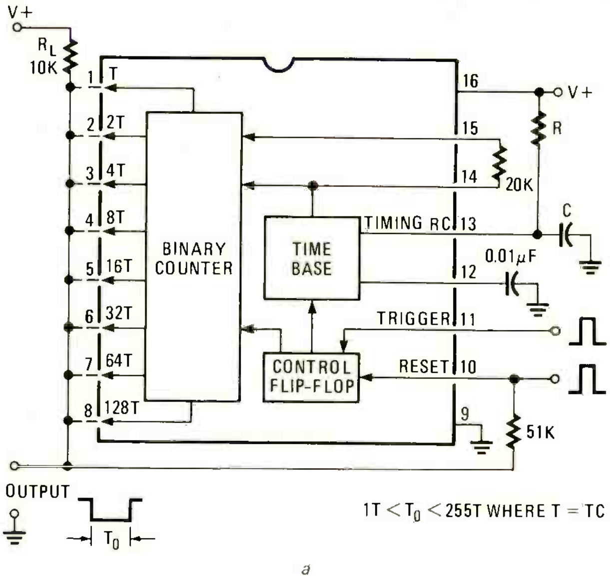
ting the flip-flop and turning on Q1 and Q2. When Q1 is turned on, the capacitor is discharged rapidly. When Q2 is turned on, the timebase output terminal drops low. The length of time that the timebase output terminal remains high is the R–C time constant, or R × C (R is in ohms, C in *farads* for time in seconds).

Each counter output is an open-collector NPN transistor capable of sinking a maximum of 5 mA, and must be connected to the V+ voltage through a pull-up resistor. Since the IC will operate with V+ supplies between 4.5 volts and 18 volts DC, the ***minimum*** value of the pull-up resistor is 900 ohms at the minimum supply voltage and 3600 ohms at the maximum supply voltage. A resistance of 10,000 ohms is typically specified.

The basic timing circuit is shown in Fig. 3-a. When a trigger pulse is received, the timebase begins producing pulses and the counter starts incrementing. It continues to increment until a positive-going reset pulse is applied to pin 10. Figure 4 shows the XR-2240 timing diagram for the first eight timebase pulses (only pins 1 to 4 are involved, pins 5 to 8 remain low until *after* the eighth timebase pulse).

If two or more outputs are wired together through a single pull-up resistor (a wired-OR configuration), then the output remains low for as long as any *single* output is low. This feature allows you to program the output period by connecting together the appropriate pins and selecting the timebase frequency. If only pin 1 is used, then the output duration is 1 × RC, and if all eight pins are wire-OR'ed together, then the output duration is 255 × RC.

If, for example, you wanted a 67-second timer, you could set the R–C time constant to 1 second (i.e., R = 1 megohm, C = 1 μF, or R = 10 megohms and C = 0.1 μF), and then wire-OR



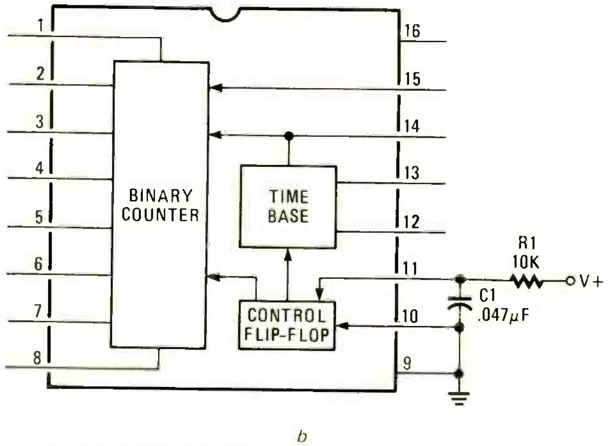


FIG. 3—EXTERNAL CIRCUITRY required for timer IC is shown in *a*. Timer starts counting after receiving trigger pulse. Modification shown in *b* is for free-running mode.

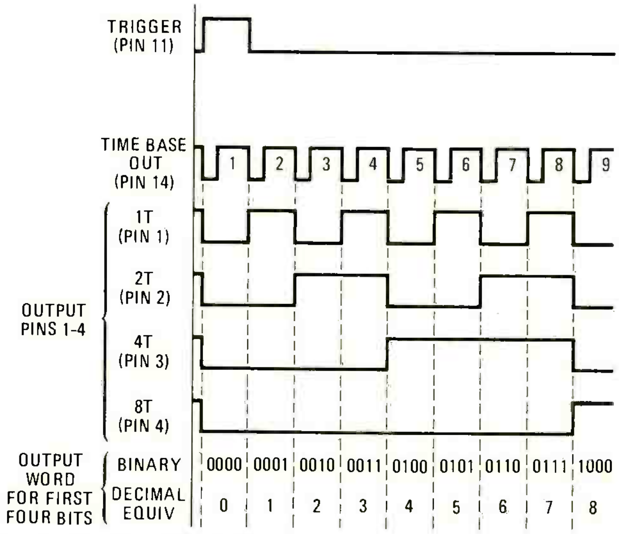


FIG. 4—TIMING DIAGRAM FOR XR-2240 for the first eight clock pulses after triggering.

pins 1, 2 and 7 together to obtain weightings of 1, 2 and 64, respectively. The output duration will then be (1 + 2 + 64)RC, or 67RC. Since the R–C time constant is 1 second, the total output duration is 67 seconds. Any time duration between 1RC and 255RC can be programmed using the XR-2240, or between 1RC and 99RC using the XR-2250, or between 1RC and 59RC using the XR-2260.

The circuit shown in Fig. 3-a is self-resetting because reset terminal pin 10 is connected to the output through a 51,000-ohm resistor. At the end of the output period, the output terminal snaps high, forming the positive-going reset pulse that shuts off the timebase oscillator.

The modification of the basic circuit shown in Fig. 3-b allows for continuous operation of the timebase. The trigger is tied permanently high, and the reset is grounded and therefore inhibited. You could also use this circuit in other applications besides simple timing procedures.

Precision in an R-C oscillator is often difficult to achieve because of changes in the power-supply voltage and thermal changes in the component values. The comparator timebase used in the Exar IC's and the 555 reduces the effects of power-supply changes because they operate on a fixed percentage of the V+ voltage, rather than being dependent upon the absolute voltage. The timebase can be partially freed of thermal effects by using precision (or at least metal-film) resistors and either silver mica, polycarbonate or polyethylene capacitors in the R-C network.

Figure 5 shows two alternate approaches to achieving greater precision. In Fig. 5-a, the internal timebase is disabled and an external clock is used instead. The external clock can be derived from the 60-Hz power line for moderate precision, or from a crystal oscillator/divider chain similar to the timebase used in a frequency counter for high-precision applications.

Figure 5-b shows an external reference being used to synchronize the internal R-C timebase oscillator. A series network consisting of a 5100-ohm resistor and a 0.1-μF capacitor is connected between the reference frequency source and the timer IC's modulation terminal, pin 12. The frequency source must have a pulse amplitude of at least 3 volts P-P and a duration between 0.3RC and 0.8RC. The repetition rate of the sync pulses can have a 12:1 ratio with the output pulses.

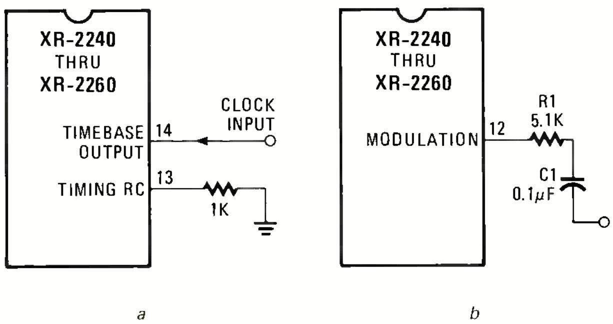


FIG. 5—EXTERNAL TIMEBASE can be connected to timer IC as shown in *a*. Internal timebase can also be synchronized to an external source as shown in *b*.

Cascading timers

The output-pulse duration can be extended by cascading two or more timers. Because it is possible to wire-OR the outputs, this procedure is easier than in 555 circuits and results in longer durations-per-IC because of the countdown construction of each timer IC. Figure 6 shows two cascaded XR-2240 timers. In this scheme timer IC1 is the input section, therefore, its timebase oscillator is operating. The time period is set by R1 × C1. The 128 (R1 × C1) terminal (pin 8) forms the external timebase for IC2.

Both timer IC's have their respective trigger and reset terminals connected in-parallel. The IC2 outputs are OR'ed together through resistor R4, forming the timer output terminal. Feedback resistor R5 resets both IC1 and IC2 at the conclusion of the time period.

The total period generated by Fig. 6 is (2^{16}) (R1 × C1), or 65,536 (R1 × C1)! If the R1C1 time constant is set to 1 second, then the total period is 65,536 seconds, or more than 18 hours! Cascading allows you to use very short timebase periods to produce extremely long output durations. Of course, using short timebase periods means that the values used for R1 and C1 are small, which results in the use of more readily available precision stable components.

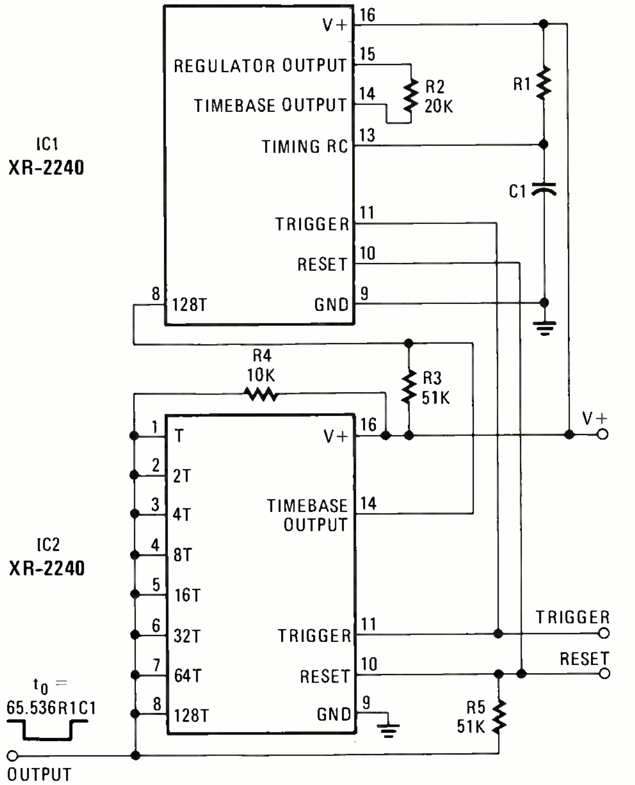


FIG. 6—EXTENDED DELAYS can be obtained by cascading two (or more) timer IC's together.

For example, let's design a simple 1-hour (3600-second) timer using the circuit shown in Fig. 6. The timebase period (i.e., R1 × C1) must be 3600/65,536, or 0.055 seconds. We must select a combination of R1 and C1 that will produce a 0.055-second time constant. The proper combination can be found by some pencil-and-paper trial and error calculation (thinking with a pencil saves hours of breadboarding and doesn't risk burning out IC's).

First, select a convenient value for C1. You could just as easily select a standard resistance, but it is easier to use a potentiometer to trim a fixed resistor to an oddball value than it is to use a variable capacitor to trim a standard-value capacitor to an oddball value. So, let's select 0.1 μF for C1.

Next, calculate the value of the resistance required from the equation R1C1 = 0.055. Since C1 is 0.1 μF (10^{-7} Farads), the formula becomes R1 = $0.055/10^{-7}$, or 5.5×10^5 ohms (550,000 ohms). If R1 is made from a standard 510K resistor and a 100K trimmer (a ten-turn type is preferred), then the timebase period can be adjusted to a precise 0.055 second. Make sure not to use carbon composition resistors (metal film is better) for R1 or unstable capacitors for C1.

Programmable timers

Figure 7 shows a timer that can be programmed using an external digital word. The basic circuit is the one shown in Fig. 3-a, except that the output terminals are connected to a pair of 7485 four-bit magnitude comparators.

The 7485 is composed of a set of TTL exclusive-OR gates connected to compare two 4-bit words and issue outputs indicating whether word A is greater than word B, word A equals word B, or word A is less than word B. Each IC has both magnitude inputs and outputs that allow several 7485 IC's to be cascaded. In this case, you must compare the 8-bit output of the counter with an 8-bit command from an outside source such as a microcomputer output port or a set of thumbwheel switches.

The timing diagram for Fig. 7 is shown in Fig. 8. Since word A programs the timer, the output durations are given in terms of the value of word A and the RC timebase period.

When the trigger pulse is received, word A has previously

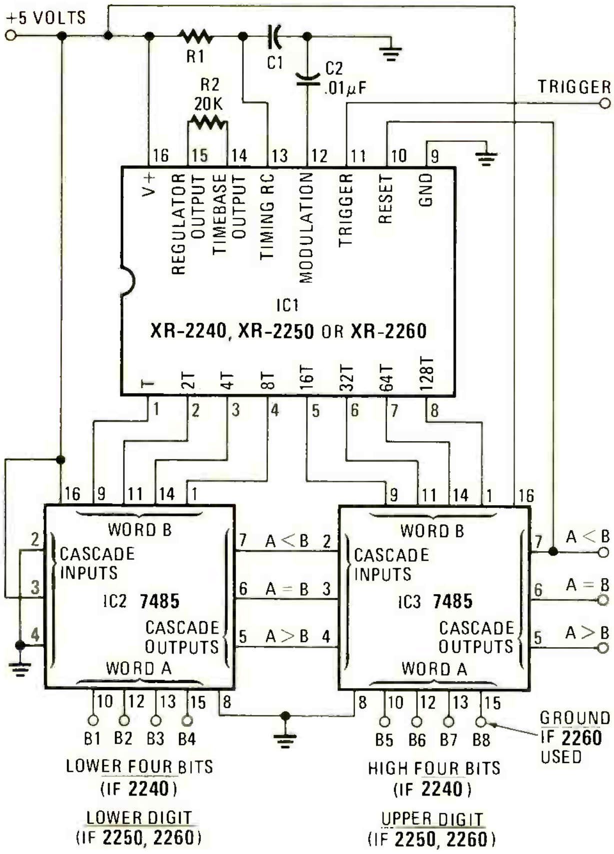


FIG. 7—PROGRAMMABLE DELAY TIMER can be obtained with the addition of two magnitude comparators.

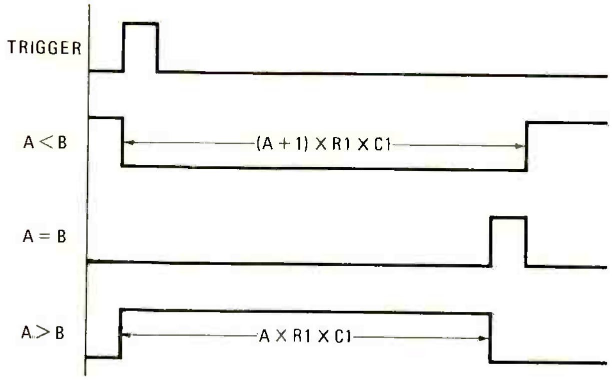


FIG. 8—TIMING DIAGRAM for the programmable delay timer.

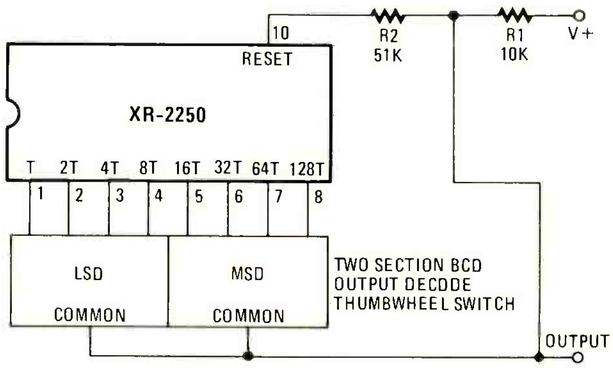


FIG. 9—PROGRAMMABLE DELAY TIMER using BCD thumbwheel switch.

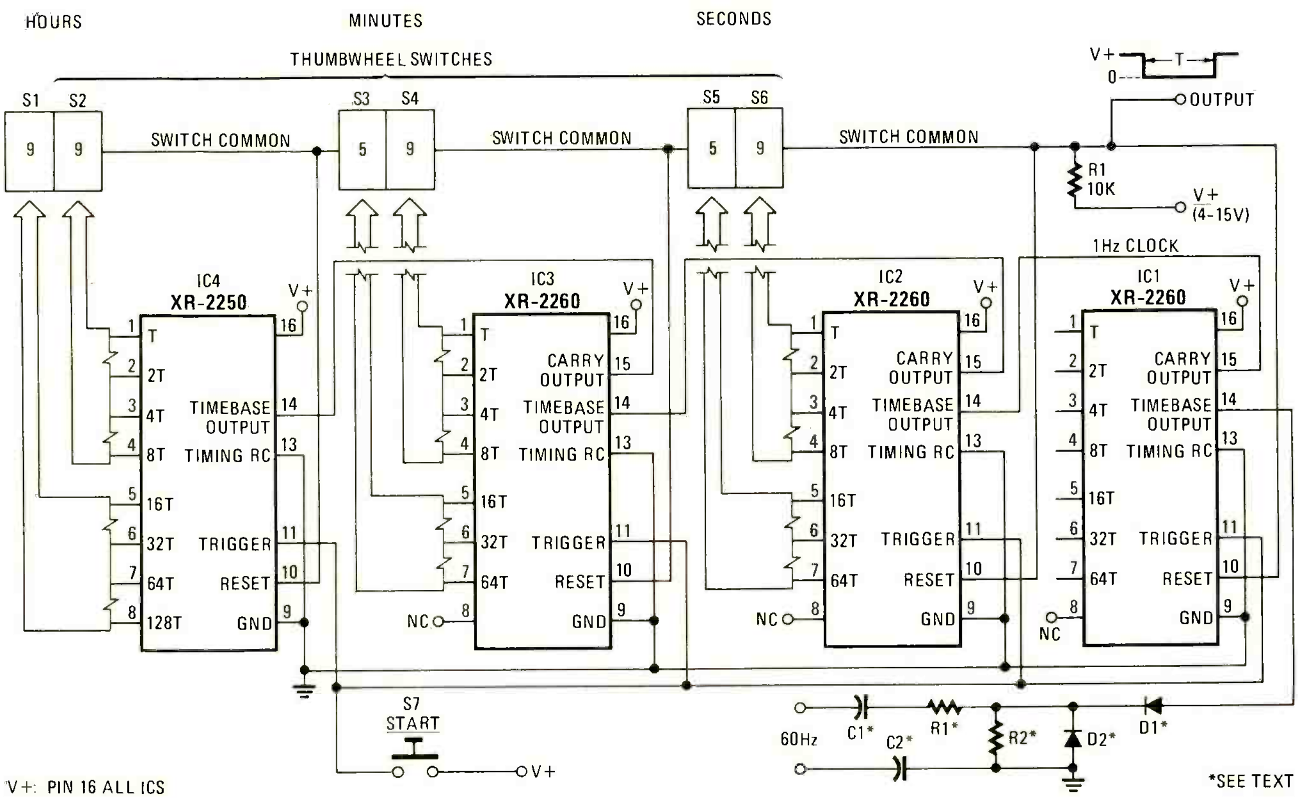


FIG. 10—100-HOUR PROGRAMMABLE TIMER uses BCD thumbwheel switches.

been set to some value between 00000000_2 (0_{10}) and 11111111_2 (255_{10}). All the timer outputs drop low, so word B is initially 00000000_2. At this time, word A is either greater than word B, or equal to it if word A is also 00000000_2. In the former case, the A>B output from IC3 is high and the other two outputs are low. When the counter has incremented so that word A and word B are equal, then the A = B output goes high for one clock period, after which word B is greater than word A, so the A<B output goes high. The timing durations are (A+1)R1C1 for A less than B, and AR1C1 for A greater than B. The A = B output produces a single pulse at time AR1C1.

Assume that the Fig. 7 circuit is programmed so that word A is 178_{10} (10110010_2), and that the R–C time constant is 5 seconds. What is the duration of the A>B pulse? The duration is A × R1 × C1, or (178) (5 seconds), or 890 seconds (about 14.8 minutes).

Thumbwheel switches with binary, BCD, or octal-output codes can be used to program these IC timers. Figure 9 shows a BCD thumbwheel switch that programs an XR-2250 timer. The BCD switches are connected to the output lines on the timer IC, and the switches are in turn connected to pull-up resistor R1. The switches provide a simple way to build circuits (such as that of Fig. 3-a) using convenient front-panel switches to change the output duration when desired.

Figure 10 shows the circuit of a precision 100-hour timer using the Exar XR-2250 and XR-2260 timer IC's. Four timers are in cascade and are programmed by thumbwheel switches.

Timer IC1 is used as a timebase to generate a 1-Hz clock from the 60-Hz AC power line. The values of C1, C2, R1 and R2 depend on the amplitude of the 60-Hz line used for the timebase.

The XR-2260 counts to 59, and on the 60th count generates a carry pulse on pin 15. This output pulse represents a frequency division of 60 for the XR-2260 and a division of 100 for the XR-2250.

As shown in Fig. 10, the *seconds* and *minutes* sections of the circuit are thumbwheel-programmed, cascaded XR-2260 IC's, while the *hours* section is a thumbwheel-programmed XR-2250 IC allowing a maximum of 99 hours. Both XR-2260 IC's use the carry-output pulse to drive the timebase input of the following stage.

The thumbwheel switches program the total duration of the output pulse, but some applications might require a continuous monitoring of the time that has *elapsed* since the trigger pulse started the counters. To do this, you can use an events counter or a clock IC that uses a 1-Hz input. Another alternative is to use an hours-minutes-seconds counter circuit with its reset terminal connected to the timer output. The timer output is active-low and so will allow counting during its time duration, but it will reset the counter when it goes high at the end of the time duration.

Precision is a word not ordinarily used in conjunction with the AC power-line frequency. Digital frequency counters and short-duration timers that use 60-Hz AC power lines as the timebase are often described as being only of moderate precision. The accuracy specification is usually given in terms of 1% or a little less as a result of small variations in the line frequency. The actual frequency varies above and below 60 Hz as the generator speed changes, but the average frequency is quite close to 60 Hz over a period of time. This timer, then, possesses good accuracy for long durations but only moderate accuracy for short time spans. Using a precision crystal-controlled 1-Hz or 60-Hz clock will insure that the accuracy remains the same over the *entire* range.

SWITCHING TRANSISTOR SHORTS

This Quasar TS-938 came in with no picture or sound. Found Q8 (power supply switching transistor) shorted. I replaced it and two days later it was back with Q8 shorted again. I need some help before I blow another one of those expensive transistors! With the replacement in, it worked fine. I could use some help.—H. Y., Baltimore, MD.

You sure could! This can be highly nonhabit forming. I ran across the same thing not very long ago. A friend used the same replacement transistor you did. We checked and found that this was a good transistor but had only a 700-volt peak-surge rating. The original transistor apparently had an 800-volt peak rating. We used a Sylvania ECG-165, which has a 1400-volt peak rating, and it is still working several months later. Always check the peak-voltage rating of this kind of transistor, and use a substitute with the highest rating you can find, of which there are several.

LOSS OF RASTER

This Zenith 19EC45 chassis loses the raster intermittently. I've checked everything I can think of, with no luck. Doesn't seem to damage anything! Where do I go from here?—D. L., Ridgefield, CT.

There is one problem we've run into in this and other Zeniths using the 9-90 horizontal module. Check resistor R808, 330 ohms. If this resistor is bad, it upsets the horizontal sweep. Replace it with a 1-watt resistor.

(Feedback: "That did it! Resistor R808 was almost open. The set is working fine now.")

TURN-ON SQUEAL

This Admiral M10 chassis "popped" at turn-on and finally quit. Resistor R818, in the horizontal driver collector, was open. Replacing this resistor brought the set back on. However, the horizontal oscillator/output would squeal at turn-on, now and then, and also at turn-off. All waveforms became normal after the unit stabilized, but fuse F1000 would blow after 5 to 8 hours of operation. After quite a bit of checking, I found electrolytic capacitor C811 (10 µF, 25 V) was intermittently opening up and allowing some kind of screwball feedback at turn-on and turn-off, and somehow making it blow that fuse.

Thanks to Leon Caldwell, Caldwell's TV, Mena, AR.

NO TINT CONTROL

Several things such as the IC, etc., were replaced in this Zenith 23DC14 chassis after a lightning hit. Now, I do have color and good tints, but no tint control at all. I don't get it.—L. C., Mena, AR.

This chassis uses a DC-voltage tint control, with presets in the color circuitry. Your tint-control DC voltage-supply circuit goes through the chromatic switch. Check for normal DC voltages and follow them through the switch.

(Feedback: "Right, the DC voltage on the tint control wouldn't vary at all. I found a burned-up 470-ohm resistor in the DC voltage-supply circuit. I also finally traced the DC supply voltage through the chromatic switch and found that *both* conductors going to the tint controls were completely blown. Two short pieces of wire fixed that!")

SCOPE PROBLEM

I've got all kinds of odd distortion in a Heath OM-2 scope. I've tried new tubes, with no luck. Do you have any bright ideas?—J. H., Chicago, IL.

Maybe not any *really* bright ideas, but, from my experience in working over old scopes, I recommend checking *all* the coupling capacitors in the vertical amplifier stages. While you're at it, check all the plate, grid and cathode resistors, too, and replace any that are off-value. Doing this fixes most of them.

I had a strange horizontal nonlinearity in an old scope. Replacing the coupling capacitors in the *vertical* amplifier stages cured it. I haven't explained that one yet, but it worked!

(Feedback: "That did it. Changed two 0.1-µF coupling capacitors and now the scope works fine!") **R-E**

hobby corner

An easy-to-build crystal oscillator that is a must for your workbench.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH WE'LL DISCUSS HOW TO BUILD a device that should be on every workbench. It is a wide-range, multipurpose crystal oscillator that you can use to perform dozens of tasks.

Crystal oscillator

In order for a crystal oscillator to be most useful, it should:

1. Operate over a wide frequency range.
2. Operate with different types of crystals.
3. Have an output containing the fundamental and adequate harmonic frequencies.
4. Require no tuning.
5. Be easy to construct.

The crystal oscillator described here meets these requirements and more. It functions with fundamental crystals from 100 kHz to 17 MHz or more—a very wide range. Overtone crystals will oscillate on their fundamental frequencies—in fact, every crystal I put in causes the unit to take right off. (Incidentally, overtone crystals do not oscillate at an *exact* submultiple of the marked frequency. This is the nature of such crystals—the oscillation will be close but not exact.)

This little oscillator has quite a rich harmonic output for a one-transistor circuit. The harmonics of a 100-kHz crystal can be heard well above 20 MHz.

How you can use it

Before we describe the circuit in detail, let's take a look at some of the ways you can use this oscillator. First, of course, you can use it as a crystal calibrator for a receiver. Most receiver dials are not very accurate, and a 100-kHz crystal in the oscillator will show "marker signals" every 100 kHz across the dial so that you know where you are. Other crystals can also be used for this purpose. For example, a 500-kHz crystal produces a marker every 500 kHz; a 1-MHz crystal, one every 1 MHz; and so forth.

The oscillator can be used for aligning receivers. It is worthwhile even if you have a signal generator because most hobbyist generators are not very accurate themselves. A crystal at the intermediate frequency (IF)—usually 455 kHz—permits you to tune up (align) the IF strip of the receiver. The fundamental and harmonic frequencies of one or two other crystals will generate the signals you need to align the radio frequency (RF) circuits.

Do you use a transistorized portable radio with shortwave bands or an SWL receiver without a beat-frequency oscillator? If you have ever attempted to tune in ham or commercial transmissions that are CW (code) or SSB (single sideband), you know they sound like gibberish. This little oscillator can clear up the confusion nicely. Simply use a crystal at or very near the intermediate frequency and run its antenna near the IF section of the receiver. Then careful tuning produces readable CW and SSB signals.

Another interesting oscillator application is for frequency spotting. Suppose you want to hear a favorite broadcast or shortwave station that is sometimes hard to locate. Just pop a crystal of the station frequency into the oscillator, and you know just where to look. For example, hams and those studying to be hams sometimes have difficulty locating station W1AW for their code practice sessions on 3580 kHz. An inexpensive 3579.54-kHz crystal of the type used in digital clocks or a 3.58-MHz "rock" as used in TV color oscillators will put you almost right on it.

Often it is desirable to change the frequency coverage on a receiver; for instance, you want to receive a shortwave signal on a broadcast set or the WWV time signals (5, 10, 15 MHz, etc.) on a receiver that does not tune to one of those frequencies. The usual solution is to build a small converter, the main part of which is (you guessed it) a crystal oscillator.

Circuit description

Now that you know some of the ways you can use the crystal oscillator, let's look at the circuit.

Figure 1 shows that only a few standard components are used. In fact, two, C1 and S1, can be omitted entirely and the oscillator will still perk right along. None of the components are highly critical so you can use those with 10% or 20% tolerance, and, in most cases, you can use the next closest standard value.

If you use a socket for the transistor, the oscillator can be used for a transistor tester provided you put in DPDT switch S1. Then, with the switch in the proper position, pop either an NPN or PNP transistor into the socket for testing. If oscillation occurs, the transistor is good. This test does not tell you *how* good, just

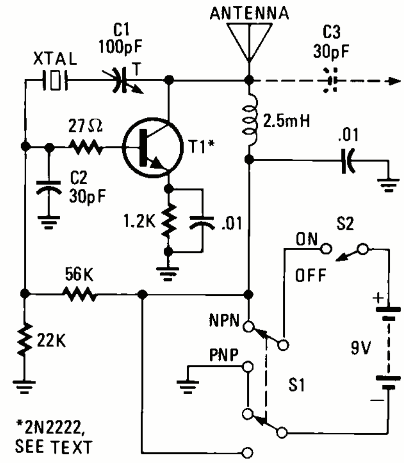


FIG. 1

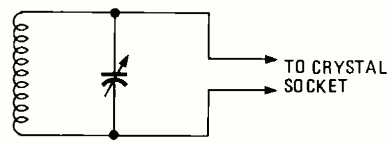


FIG. 2

that it *is* good. However, a transistor that oscillates also amplifies, switches, and does most other tasks it may be called upon to perform.

You can omit switch S1 and the socket if you don't plan to test transistors. In this case, just wire the circuit for an NPN transistor and solder in either a Radio Shack No. RS-2009, a 2N2222, a 2N4124, or any comparable NPN transistor from your junk box.

The current drain on the 9-volt battery is less than 1.5 mA, so it should last for a long time under normal intermittent use.

Variable capacitor C1, if it is used, should be a compression-type padder, and the maximum value can be anything from 40 pF to 200 pF. Space permitting, you can use a physically larger capacitor type. The purpose of C1 is to permit fine adjustments to be made in the oscillation frequency so that it exactly matches a standard; for example, WWV. If this feature is not needed, you can omit C1 and connect the crystal directly to the transistor collector.

Capacitor C3 (shown as two dotted lines in Fig. 1) is needed only if the output is to be connected directly to another circuit. Normally, the short length of wire functioning as the antenna can be placed near a receiver antenna.

Switch S2 is the on-off switch. Depending upon the major use of the oscillator, you may prefer a toggle or a momentary pushbutton switch.

One final note: You may find it advantageous to replace the 30-pF fixed capacitor C2 with a 100-pF compression padder. If you run into a sluggish crystal that is hard to start, adjusting variable capacitor C2 will usually cure it.

Construction

After collecting the components, you should put the circuit together on a breadboard before hard-wiring it. Breadboarding is *always* a good idea because you can find bad components and other problems while they are still easy to correct.

When the circuit is functioning properly, wire it up using your favorite method—wiring pencil, point-to-point, wire-wrap, or circuit board. It should fit easily into a box measuring 1½ ×4 × 2¼-inches unless you have some outsized components.

At least two sizes of crystal sockets should be used. Wire them in parallel. If one will accommodate the HC-6U holder and the other, the FT-243 holder, you can then handle the common crystal sizes.

Capacitors C1 and C2 (if you use a variable capacitor there) should be mounted so that they can be reached for adjustment through holes in either the main panel or a side panel. Don't forget to use an externally mounted socket for the transistor if you also plan to use the oscillator as a tester.

Oscillates without crystal

This circuit will oscillate *without* a crystal. Wire up a coil and a capacitor (as shown in Fig. 2) and you have a variable oscillator; that is, one in which you can change the frequency. For example, a loopstick coil and a 365-pF variable capacitor taken from an old broadcast-band radio enables you to swing the signal frequency across the broadcast band.

You can experiment with other coil and capacitor values to obtain higher and lower frequency ranges. Just plug the coil and capacitor into the crystal socket. You may find it necessary to short-out C1 for some combinations to oscillate, but do not expect every combination of values to create oscillation.

The frequency of the crystal-less or L–C (for inductance-capacitance) oscillator is not very stable. It wobbles and shifts with mechanical vibrations and body capacitance (as when you place your hand nearby). However, for less exacting requirements, it may serve just as well.

This L–C oscillator has one additional use that may be helpful. Many hobbyists have no means of determining the inductance value of a coil. (A grid-dip meter is the best way to do this at reasonable cost.) However, if you can find a combination of a known capacitance that will oscillate with the unknown inductance, you are in business.

Simply find the oscillating frequency on your receiver and plug the values in the formula below. Make sure that you have the fundamental frequency and not one of the higher harmonics. Also, you must use the correct units of measurement as shown in parentheses below:

$$L_{(microhenrys)} = \frac{25{,}330}{f^2_{(MHz)} \times C_{(picofarads)}}$$

The same procedure can also be used to determine the value of an unknown capacitance if it will oscillate with a known inductance. Just use this formula with the same units as before:

$$C = \frac{25{,}330}{f^2 \times L}$$

It would be hard to find a more versatile device than this crystal and L–C oscillator. You will surely discover many more uses for it around your workbench, and it is so useful that you may find yourself building more than one. **R-E**

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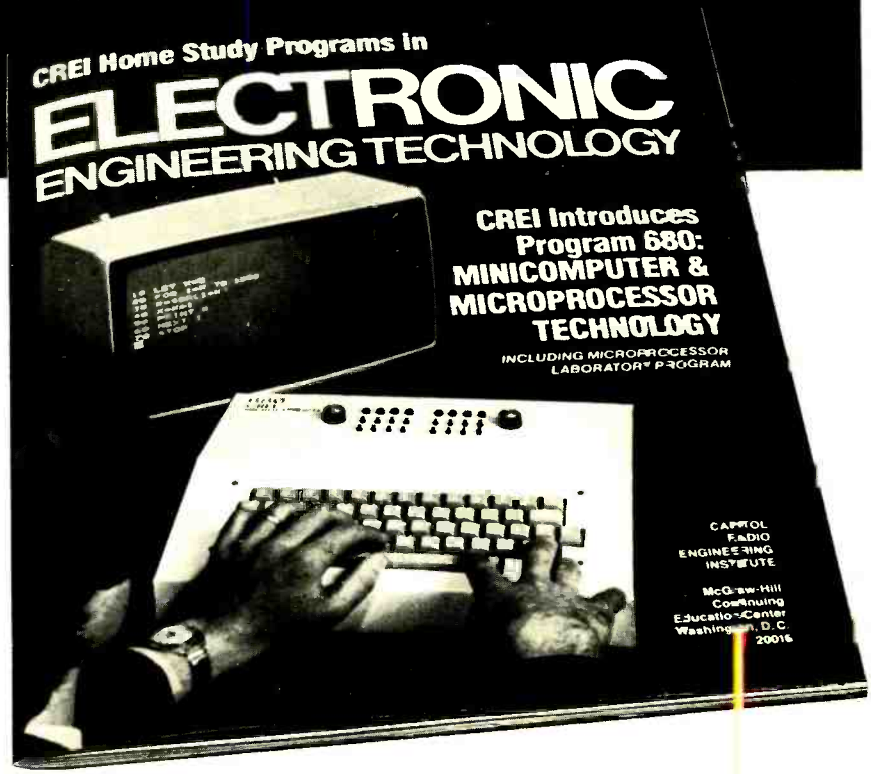

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state of solid state

A look at several interesting applications for National's IC pressure transducers, including a solid-state barometer and blood-pressure meter.

KARL SAVON, SEMICONDUCTOR EDITOR

THE HYBRID PIEZORESISTIVE IC PRESSURE transducer is the modern replacement for the mechanical sensor. It is a compact device that functions reliably in harsh industrial, consumer, medical, military and automotive environments. The same IC that contains the pressure transducer itself also contains the power-supply regulator, temperature compensation circuits and a low-output-impedance operational amplifier. The transducers are manufactured with standard integrated technology and are laser-trimmed for accuracy. Their frequency response enables them to perform through the audio frequencies. They are insensitive to vibration and operate over wide pressure ranges, from 0 to 5000 psi (pounds-per-square-inch). National Semiconductor manufactures IC pressure transducers for absolute, gauge and dual-port differential pressure applications. The transducers are available in a hybrid IC package for PC mounting or a zinc alloy housing for mechanical isolation.

Solid-state barometer

The electronic barometer circuit in Fig. 1 uses the LX1701A absolute-pressure transducer. Absolute pressure is referenced to zero pressure (a vacuum). The LX1701A is designed for pressure ranges of 10 to 20 psia (pounds-per-square-inch-absolute), including the 15-psi normal atmospheric pressure. This barometer has a temperature coefficient of ±0.0054 psi-per-°C and a stability of ±0.05 psi. The integrated transducer operates from a nominal supply of 15 volts and can source 20 mA and sink 1 output current of 10 mA. Its output impedance is less than 50 ohms. The output of the LX1701A varies from 2.5 volts to 12.5 volts over its rated input-pressure range.

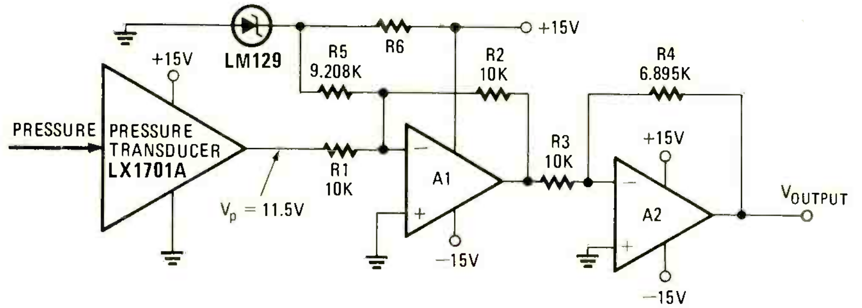


FIG. 1—SOLID-STATE BAROMETER uses two operational amplifiers and pressure transducer. Circuit can be calibrated for any particular pressure scale.

Figure 1 shows two operational amplifiers connected to the pressure transducer that allow independent adjustment of gain and DC offset. Adjusting the gain and offset calibrates the system to any particular pressure scale, whether it be psi, millibars (1 millibar = 1000 dynes-per-cm²), or millimeters of mercury.

For negative feedback amplifiers, the gain is the ratio of the feedback resistor to the input resistor. Output amplifier A2 in Fig. 1 has a gain of R4/R3. Grounding the noninverting input (the + terminal) results in a zero output voltage for a corresponding zero voltage applied to the input through the input resistor.

Using two inverting amplifiers provides an output-voltage change in the same positive direction as the input voltage. The output-level contribution from the pressure transducer is its own output, V_p, multiplied by the gain through amplifier 1 (R2/R1) multiplied by amplifier 2's gain (R4/R3). The DC offset at the output is the 6.9 volts from the LM129 reference multiplied by R2/R5 and R4/R3. Once R2, R3 and R4 are selected, the output can be calibrated by choosing R1 for the scale factor and R5 for the DC offset.

Blood-pressure meter

Before proceeding with the medically related circuit discussed in this section, it must be emphasized that National Semiconductor does not recommend that its circuits be used in life-support equipment.

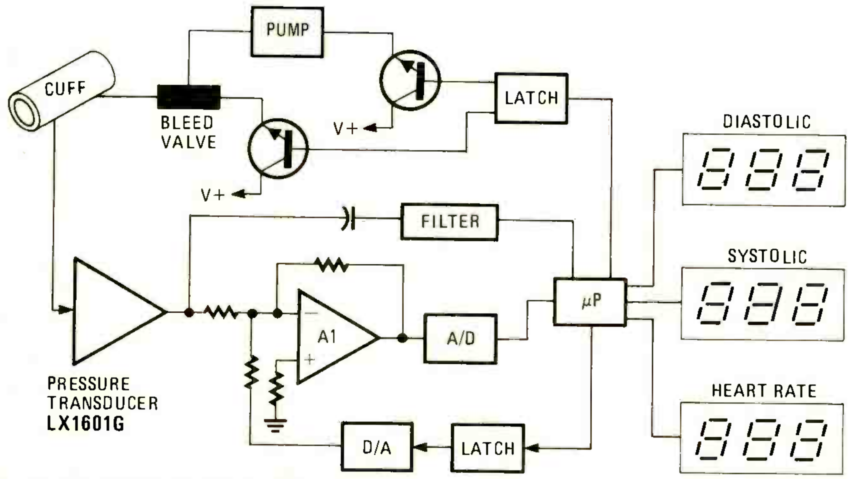


FIG. 2—BLOOD-PRESSURE METER uses an air pump for automatic readings. Circuit operation is controlled by a microprocessor.

Figure 2 is the block diagram of a sphygmomanometer or simply a blood-pressure meter. Here, an LX1601G (−5 to +5 psig) is used for the transducer. The "G" suffix stands for gauge pressure, which is a differential pressure measured between ambient pressure and another source—in this case, the arm cuff. The blood-pressure meter displays diastolic and systolic blood pressure as well as the heart rate. Substituting the electrical output-pressure transducer for the usual mechanical sensor permits its control by a microprocessor, so the blood-pressure machine can be made completely automatic. Blood pressure is taken with respect to air pressure. In other words, when no blood pressure is being taken, the meter output should read zero.

First, the microprocessor must develop

an autocorrection signal that gives a zero output reading before the cuff is inflated. A latch circuit stores a multidigit binary number from the microprocessor. The number in the latch is changed into its equivalent DC voltage by the D/A converter.

The circuit is designed so that when the summing amplifier (A1) output is 7.5 volts, the pressure display reads zero. This autocorrection scheme corrects for temperature and offset drifts anywhere in the system. Autocorrection performs the function of the manual zero-adjust screw on an analog meter. Summing amplifier A1 adds the latch correction voltage to the output of the pressure transducer. The amplifier output is connected to the microprocessor through the A/D converter. The output of the summing amplifier and the A/D converter has an AC component due to the pulsing blood pressure.

To take a reading, the cuff is gradually inflated on command of the microprocessor, and a digital display shows the point at which the AC component is at a minimum. This corresponds to the systolic pressure. The cuff is then deflated at a constant rate, and again the minimum AC component corresponding to the diastolic pressure is recorded. There is a direct AC signal path from the transducer to the microprocessor through the filter. This signal is used to measure the frequency of the blood pulses or the heart rate. No DC correction component is necessary since the frequency is not changed by temperature or time drifts in the sphygmomanometer system.

Precision weight scale

Figure 3 shows how you can build a precision weight scale. An open-loop system could be used, in which a hybrid

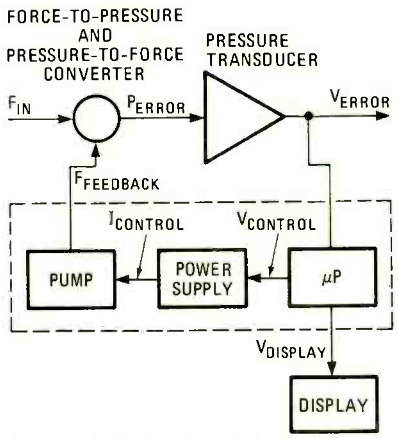


FIG. 3—PRECISION WEIGHT SCALE uses a pump to reduce the transducer's input signal to within range. Circuit is controlled by a microprocessor.

pressure transducer drives a voltmeter through the necessary calibration amplifier. But if you want a true precision scale, the linearity and accuracy of the transducer may not be good enough. The feedback system in the diagram balances the force produced by a pump against the force produced by the unknown weight. The pump in the feedback circuit, under microprocessor control, produces a force that is equal to the weight, so the output of the differential pressure transducer approaches zero.

The resolution of the system is excellent because the transducer can be much more sensitive than the total weight range of the system. In operation, the weight only has to move the tiny amount necessary to generate the small output from the transducer that is amplified and drives the meter. Initially, there will be a larger movement until the feedback loop has time to build up the pump pressure. Mechanical limiting mechanisms protect the transducer from exceeding its maximum pressure rating until the pump restores the initial location of the scale platform. Once again, a microprocessor is used, this time as an integrator of the pump control current that keeps track of the accumulated weight. **R-E**

computer corner

Data acquisition for microcomputers. PETER R. RONY, JONATHAN A. TITUS, DAVID G. LARSEN, CHRIS A. TITUS*

THE SOFTWARE IN A PREVIOUS COLUMN provided an example of a program used to acquire a single analog point in digital form. (See October 1977 issue.) We are generally interested in applications in which a series of points are to be acquired, stored, displayed and perhaps manipulated. This month we will explore the use of microcomputers for data acquisition.

It will be assumed that the analog-to-digital converter (A/D) is interfaced as shown in the previous column. The software routine to run the A/D converter is shown in Table 1. The digital value of the analog voltage is returned in the B and C register (register pair B).

In most data acquisition programs, a fixed number of points must be acquired over a fixed period of time. In our example, 100 points will be taken, one every second. The 100 data points will be stored in read/write memory so that they can be used later. In writing data acquisition software we are now faced with three tasks that must be performed in addition to the actual A/D task:

1. **Provide a software counter** to count 100 points.
2. **Provide a one-second timer.**
3. **Provide software** to store the data values.

Software counter

The software necessary to count the 100 acquired points will actually count 100 passes through the data acquisition software. A general-purpose register within the 8080 IC is well suited for this; conditional jump instructions can be used to detect when the count is decremented to zero. The counter can be either incremented or decremented, but decrementing is probably easiest if you are just starting to program microcomputers.

Storing the data in memory is not difficult. Once the converter value is stored in a register pair, the H and L registers (register pair H) can be used as memory pointers to point to a read/write memory location. Note that a complete 16-bit address must be specified for the MOV M,r instructions. Since the data is ac-

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

```
                  /         TABLE 1   TYPICAL ADC INPUT ROUTINE FOR A
                  /         10 BIT ANALOG-TO-DIGITAL CONVERTER

                            *100 000
100 000 365  ADC,    PUSHPSW /SAVE REGISTER A & FLAGS
100 001 323          OUT     /STROBE THE ADC TO START A CONVERSION
100 002 037          037
100 003 333  TEST,   IN      /INPUT STATUS BIT AND 2 MSB'S
100 004 066          066
100 005 306          ADI     /ADD 1 TO THE FLAG BIT
100 006 200          200     /TO CAUSE A CARRY IF IT IS SET
100 007 322          JNC     /NO OVERFLOW, CHECK IT AGAIN
100 010 003          TEST
100 011 100          0
100 012 107          MOVBA   /OVERFLOW, FLAG=1, SO SAVE MSB'S
100 013 333          IN      /INPUT THE 8 LSB'S
100 014 065          065
100 015 117          MOVCA   /STORE THEM IN REGISTER C
100 016 361          POPPSW  /RESTORE REGISTER A & FLAGS
100 017 311          RET     RETURN TO MAIN PROGRAM
```

```
                      /        TABLE 2  100 POINT DATA ACQUISITION
                      /        ROUTINE FOR ONE POINT PER SECOND

                      DW ADC 100 000

                      *070 000
070 000 061  START,   LXISP   /LOAD THE STACK POINTER
070 001 377           377
070 002 070           070
070 003 041           LXIH    /LOAD THE DATA STORAGE STARTING
070 004 000           000     /ADDRESS IN REGISTERS H & L
070 005 072           072
070 006 315  CONVRT,  CALL    /CALL THE ADC SOFTWARE
070 007 000           ADC     /SHOWN IN TABLE 1
070 010 100           0
070 011 161           MOVMC   /STORE THE 8 LSB'S TO MEMORY
070 012 043           INXH    /INCREMENT THE MEMORY POINTER
070 013 160           MOVMB   /STORE THE 2 MSB'S TO MEMORY
070 014 043           INXH    /INCREMENT THE POINTER AGAIN
070 015 175           MOVAL   /GET THE LOW ADDRESS VALUE
070 016 376           CPI     /COMPARE IT TO THE 201ST ADDRESS
070 017 310           310     /310 = 200 DECIMAL
070 020 312           JZ      /DONE YET?
070 021 047           DONE    /YES, JUMP TO "DONE"
070 022 070           0
070 023 315           CALL    /NO, DO THE 1 SECOND DELAY
070 024 031           DELAY
070 025 070           0
070 026 303           JMP     /AFTER THE DELAY, GET THE NEXT
070 027 006           CONVRT  /ADC DATA POINT
070 030 070           0

                      /THIS IS THE ONE SECOND TIME DELAY
                      /SUBROUTINE

070 031 365  DELAY,   PUSHPSW /SAVE REG A & FLAGS
070 032 325           PUSHD   /SAVE REGISTERS D & E
070 033 021           LXID    /LOAD COUNTER REGISTERS
070 034 000           000
070 035 110           110
070 036 033  DEC,     DCXD    /DECREMENT THE REG PAIR
070 037 172           MOVAD
070 040 263           ORAE
070 041 302           JNZ     /IF NOT ZERO, DO IT AGAIN
070 042 036           DEC
070 043 070           0
070 044 321           POPD
070 045 361           POPPSW
070 046 311           RET

                      /THE PROGRAM WILL CAUSE THE COMPUTER TO
                      /JUMP HERE WHEN IT HAS ACQUIRES ALL THE
                      /DATA POINTS.  A DISPLAY OR OTHER ROUTINE
                      /MIGHT BE PLACED HERE INSTEAD OF THE HALT

070 047 166  DONE,    HLT
```

quired from a 10-bit A/D converter, two successive memory locations must be used to store each *point*. The INXH instruction (increment register pair H) provides an easy means of pointing to the next successive memory location. We will store the data by placing the eight least significant bits in location n, and the two most significant bits in location n + 1.

Real-time clock

The one-second timer may present some problems, depending upon the type of system used. It is relatively easy to write a one-second software delay program using a series of register decrementing loops, nested one within the other. However, to accurately time a one-second period, the computer must be doing nothing else. In a system dedicated to data acquisition for the 100-second period, such a procedure is valid.

If interrupts occur or if the computer cannot be allowed to "do nothing" most of the time, an alternate solution is needed. One possibility is to use an external clock, often called a *real-time clock*.

Real-time clocks are unaffected by computer execution times, interrupts, slow I/O devices, etc. Once started, they will continue to run at an accurate rate until they have timed the particular period of interest and sent an interrupt to the microcomputer.

Some clocks are free running, always keeping time; others are programmable or preset for a particular period. The free-running clock interrupts the computer at repetitive intervals while the programmable clock interrupts the computer only once, at the end of its pre-programmed period. Integrated circuits such as the Intel 8253 and Texas Instruments TMS 5501 contain time-keeping circuitry that is easily interfaced to most 8080's.

Data storage

For simplicity, we will use the software clock in our example rather than an interrupt-based real-time clock. The software for the 100-point data acquisition program is shown in Table 2. After completing the program, the computer might be programmed to jump to the type of data display software discussed in the previous column.

If you look at the program carefully, you will not find a separate register to count the 100 passes through the data acquisition software. Since the memory address stored in registers H and L is already a counter, we have chosen to detect the 200th address rather than the 100th loop. This saves an internal register. Instead of decrementing a counter and detecting the zero condition, the contents of register L are compared with the final address and the equality is used to signal the end of the loop.

Analog-to-digital converters are not "instantaneous" devices that take only a few microseconds to perform a conversion. In many real situations, the analog input to the converter will vary while the A/D converter is trying to perform a conversion. This presents the converter with a problem. How does it know what the real value of the voltage is? In most systems the A/D converter module has a *sample-and-hold* device on the analog input. The sample-and-hold circuitry samples the analog voltage when pulsed to provide a steady analog output to the A/D converter for conversion; the A/D converter is then pulsed to start the conversion. The Intersil IH 5110 is a typical sample-and-hold device. **R-E**

At least we know while junior is tinkering with his electronic equipment his mind is off girls!

service clinic

How to troubleshoot faulty high-voltage shutdown circuits in solid-state color sets.

JACK DARR, SERVICE EDITOR

THERE'S ONE COMMON TROUBLE AREA IN solid-state TV sets (mainly in color sets but in a few black-and-white models) that is all-too-often overlooked. This is the high-voltage regulation circuitry, which includes the high-voltage shutdown circuitry. Note: these are two *separate* circuits, but they interact.

The high voltage in solid-state sets is seldom regulated directly, as in tube sets with 6BK4 tubes, etc. In practically all the solid-state sets, the high voltage is directly proportional to the DC voltage fed to the horizontal-output stage, or B+ supply. So, they do it the easy way and regulate the B+ supply. There are several circuits that can hold the B+ voltage very steady. Here is the simple test that is often overlooked. When there is any problem in or associated with high-voltage regulation (it reads either too high or too low) *always check the B+ voltage first*!!

The B+ value shown in Fig. 1 is critical. If +127 volts is indicated, +127 volts is exactly what is meant and *not* +124 volts or +130 volts. This value must be right on the nose and stay there over a fairly wide range of input-line voltages. If this B+ value is high or low, check out the regulator circuitry. A fault in the B+ line that makes it go too high will make the high voltage rise with it, trip the over-voltage protection circuitry, and shut the whole circuit down. It usually does this by killing the drive to the horizontal-output stage.

The Quasar *model TS-961* and *model TS-963* sets use some typical over-voltage protection circuitry (see Fig. 1). Using the same simple test, read the DC output voltage with an accurate DC voltmeter (digital meters are handy). If the voltage does not read exactly right, go through the voltage regulator and check for a leaky pass transistor or error amplifier transistor, a bad Zener diode, etc. A leaky pass transistor allows the B+ voltage to become too high. If it shorts, you'll see the same B+ output voltage as the DC input voltage.

Here's a helpful hint: The B+ adjustment potentiometer and over-voltage adjustment potentiometers on several Quasar sets are factory-sealed. Several readers have asked, "How do you get these unsealed for adjustment?" You don't, you take the originals out and put in new ones. A new control, sealant and full instructions can be had in a kit from a Quasar distributor. You cannot break the seal without tearing up the control. (If you take it out, don't throw it away yet! You might have some other problems and, if so, you can put the control back.)

The Quasar part number for the kit used in the *model TS-961* is No. 18M25000A09; for the *model TS-963*, it's No. 18-25000A11. The potentiometer number is R811 for the *model TS-961*, and R812 for the *model TS-963*.

The test for over-voltage protection circuitry in both these models is shown in Fig. 1. If the B+ voltage is normal, then the shutdown circuit should be checked causing a shutdown.

If this happens, you can readjust the control. Use the same method described above: take out the old control (remember to save it!) and put in the new one from the kit (the same part numbers apply as before for each chassis). If the shutdown circuit cannot be set up to trip correctly, see if the adjustment will help. If not, check out the components used in the circuit. In the *model TS-961*, a silicon-controlled rectifier (SCR) is used; a pair of transistors are used in the *model TS-963*; however, the circuit action is the same. Several Zener diodes are also used, so check them for leakage, shorts, opens, etc. A flyback pulse is fed into the shutdown circuitry through a diode, so you

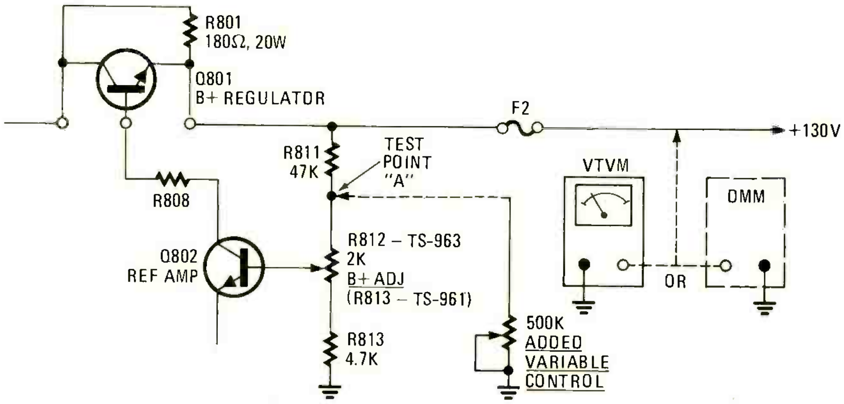


FIG. 1

to see if it's operating. Connect a variable potentiometer across the B+ voltage error-amplifier base circuit, as shown. The value of this control is not critical—from about 100K to 500K. Monitor the B+ supply with an accurate DC voltmeter. Adjust the brightness so that you can barely see a raster because doing this reduces the beam current to a minimum.

For the test, slowly reduce the resistance of the shunt potentiometer. Watch the B+ voltmeter. It will rise slowly and when it reaches the point where the B+ voltage reads from +144 volts to +146 volts, the shutdown circuit should trip and the raster go out. This will happen at about 29.5 kV in the *model TS-961*, and in the *model TS-963*. If the shutdown circuit is not working, the high voltage can be raised above the limit without should check also for this pulse.

You may run into premature shutdown problems. If the B+ voltage is normal and the high voltage is shut down (for a quick check, look for the drive pulse to the horizontal-output transistor), turn the set off and wait for one minute to be sure the SCR has unlatched and the capacitors have discharged. Then try again. If the circuit shuts down even though the high voltage is within limits, then make the suggested tests described above.

As I said, and continue to stress, check the B+ voltage *first*. Since this voltage can cause so many different problems if it's out of the ballpark, it's advisable to investigate it before you go tearing around through the rest of the circuitry! Just making this one test can save you lots of time. **R-E**

service questions

DOUBLE TROUBLE

The symptoms on this Zenith *model 12B14C52* are: a very pale picture, plenty of brightness, no snow, color present, and good sound. The contrast and brightness controls react properly. The AGC level control has no effect at all. I check the 6KT8 (AGC) voltages. The cathode voltage varies, the AGC doesn't. After some confusion due to reading on the wrong socket, I finally replace the 6KT8 tube. Now the AGC reacts properly. But the symptoms are still there!

There's a very low signal on the output of the sound-sync detector. This should be 9 volts P-P. I pulled the IF strip and checked it—nothing. There are no normal signals anywhere through the AGC/sync stages. There's a video signal on the 6BA11 pin 6 plate, which should be composite sync.

Finally, I get to the IF strip. The first and third IF transistors show zero emitter volts. This is bad! (The IF strip is now out of the chassis and on the bench, hooked up with jumper leads.) I pull the third IF transistor: the curve tracer says no. I replace it. Is it the first IF transistor? Whoa! I separate the IF strip test shown in manual as being OK for *some* versions. But if the AGC lead is in the wrong place, the first IF base circuit is *open*. Therefore, no emitter voltage, no output, just a small amount of signal leaking through the third IF transistor. I add one new jumper. (I use push-on, insulated connectors for these to avoid shorts to the shield.)

The problem here is aggravated by a bad tube in the AGC. This and the IF problem caused similar symptoms for double-trouble.

POWER-LINE FREQUENCY ACCURACY?

When I made a clock, I took the power-line frequency, divided it by 60 for the seconds, then by 60 again for the minutes, then again for the hours. Then I fed this to a binary-number display using lamps. After about a month or six weeks, the clock is always off by two to four minutes. My regular electric clock keeps better time. Isn't it also dependent on line frequency? I don't understand.—F. A., Gulf Breeze, FL.

That's a good question. I have heard of a few cases in which line frequencies were not really accurate. (In the NY area for one.) Now, let's look into that crystal ball.

Your electric clock does depend on the line frequency for its accuracy since it uses a synchronous motor. However, it is possible for a *momentary* (i.e., a glitch of only a few milliseconds' duration) interruption to have no effect on the standard clock because its flywheel effect wouldn't let it slow down too much.

However, digital counter circuits are quite fast. A glitch of a few milliseconds would make them lose a couple of counts, and the cumulative effect over a period of time would result in considerable inaccuracy.

This is pure crystal-ball conjecture, but it could be right. I've heard other cases of complaint about digital clocks that do use a 60-Hz line frequency as half-wave rectified pulses.

VOLTAGE REGULATOR PROBLEM

I had an oddball problem in a GE transistor TV some time ago. The B+ voltage was quite low, the AC current drain was high and the power transformer heated up—all the classic symptoms of too much current drain! However, the B+ current, at 1.2 amp, wasn't so bad.

Checking the circuits showed they didn't seem to be taking too much current. The set worked fine on an external car battery. So I went back to the power supply and checked the voltage regulator; everything was OK. Then I unhooked the load from the regulator and used external load resistors. When I raised the load current to about 1.2 amp (what it drew in normal operation) the ripple on the output went way up. A closer examination showed the classic *half-wave ripples* instead of full-wave ripples.

Additional checks showed no AC on one of the full-wave rectifier diodes. The AC was read at the secondary of the transformer. I discovered a foil break between the transformer and one diode! When this was fixed, there were no more problems. (Thanks to Rodney Schrock, Somerset, PA.)

BAD CAPACITOR

A customer brought in a Zenith model 19FC45 with a bad capacitor in the horizontal output. He had tried to change it himself. The old capacitor is gone and I am not sure just how it should be connected. I don't find this on the Sams service data.—G. H., Panama City, FL.

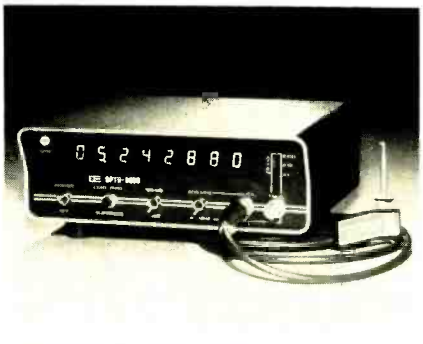
On the 22-7504-01 replacement for the four-legged capacitor, terminal A goes directly to the collector of the horizontal-output transistor, terminal B goes to the lead from the flyback/damper anode/etc., terminal C goes to the emitter of the output transistor (which is ground), and terminal D goes directly to the ground lug nearby. There should be continuity from terminal A to terminal B, and from terminal C to terminal D, but *never* from one pair to the other!

Check the output transistor, the triple, the damper, etc., for possible shorts. Ordinarily, if this capacitor shorts, it trips the breaker; if it opens the high voltage can do lots of damage! R-E

new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside back cover.

600-MHz FREQUENCY COUNTER, *model OPTO-8000.1* (prewired) and *model OPTO-8000.1K* (kit), provides 8-digit LED display and guaranteed ±0.1 PPM TCXO timebase stability, plus selectable input attenuator, selectable timebases (1 sec. and 0.1 sec.) and 9–15 VDC, 115 VAC or 220 VAC, 50-Hz–60-Hz operation. Available options include 220-volt AC operation and a NiCad battery pack. Unit comes in heavy-duty aluminum case with tilt-up bail, and measures 3 H × 7¼ W



× 6½ inches D. Prices: *Model OPTO-8000.1* (prewired) $299.95; *model OPTO-8000.1K* (kit) $249.95; *model 220 VAC* option, $10; *model NCAA 8000* NiCad battery pack with charging circuit, $19.95; *model P-100 DC Probe,* $13.95; *model P-101 Lo-Pass Probe,* $16.95; *model P-102 Hi-Z Probe,* $16.95. Add 5% shipping, handling, insurance to a maximum of $10. Outside U.S and Canada, add 10%.—**Optoelectronics, Inc.,** 5821 N. E. 14th Ave., Ft. Lauderdale, FL 33334.

CIRCLE 105 ON FREE INFORMATION CARD

SOLID-STATE OSCILLOSCOPE, *model PDC-200,* is available as a kit or assembled. The unit measures 4⅜ × 7¾ × 3 inches and weighs 2 lbs, making it ideal for field servicing. The instrument features LED-type display; sweep ranges from 0.1 second to 0.5 µs-per-division with voltage range

from 100-mV to 100V-per-division; and internal/external triggering. The circuitry is contained on a single PC board and powered by two 9-volt batteries. Probes are also available. Prices: the *model PDC-200* kit, $99.95; assembled, $155; probes, $9.95. Prices do not include shipping.—**Pyramid Data Corp.,** Box 532, Barrington, IL 60010.

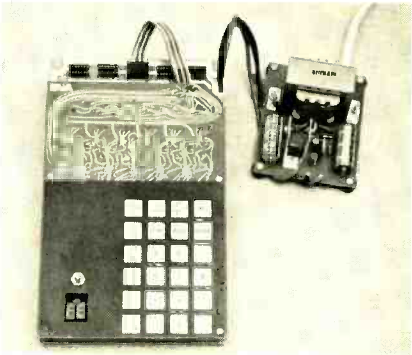
CIRCLE 106 ON FREE INFORMATION CARD

OPEN REEL TAPE DECK, *model A-6600,* provides two speeds (3¾ ips and 7½ ips) and four heads (erase, record, playback and reverse playback). The system also incorporates full IC logic control, two-capstan servo tension system, 20-dB mike attenuator, cue control, automatic space

and individual mike and line controls. The front panel contains bias and equalization switches, two VU meters, input- and output-level controls and left- and right-channel selector switches. Also available are optional remote control, mikes, demagnetizer and recorder maintenance kit. Suggested retail prices: *model A-6600,* $1299; *model RC-80* remote control, $65; *model MM-100* mike, $100; *model MM-120* mike, $120; *model E-1* demagnetizer, $25; and *model RMK* recorder maintenance kit, $9.—**TEAC Corp. of America,** 7733 Telegraph Rd., Montebello, CA 90640.

CIRCLE 107 ON FREE INFORMATION CARD

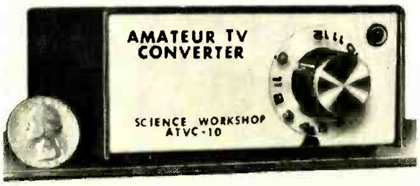
OEM MICROPROCESSOR DEVELOPMENT SYSTEM, 8700 Computer/Controller, comprising CPU board and optional *model PS-87* power



supply, is based on 650x processor family. Socketed, plated-through board has space for 1K bytes of RAM and 1K bytes of PROM, both in 256-byte increments, five 8-bit parallel input ports, one 8-bit parallel output port, plus connectors for system expansion. Monitor program (*Piebug*, interactive editor debugger) controls code entry and debugging. Other features include relative address, back-space key, pointer high and low keys, and audio beeper (used with optional *model CS-87* cassette interface). A variety of video display options is also available, including upper and lower case ASCII, color and black-and-white graphics. System comes as a kit or assembled, with prices starting around $90. Other prices: *model PS-87* power supply, $24.95; *model CS-87* cassette interface, $22.50.—**PAIA Electronics, Inc.**, OEM Sales, 1020 Wilshire Blvd., Oklahoma City, OK 73116.

CIRCLE 108 ON FREE INFORMATION CARD

AMATEUR TV CONVERTER, *model ATVC-10,* provides reception of fast-scan ATV in 450-MHz band with any TV set. Device connects to VHF



antenna terminals on TV set. Features high-gain RF amplifier, mixer and oscillator (all varactor-tuned), plus adjustable RF gain. The converter tunes from 420 to 450 MHz and the output can be tuned to VHF Channels 2 through 6. Unit has built-in regulated AC power supply. The converter is housed in a wood-tone aluminum cabinet measuring 1⅞ × 4¼ × 4⅛ inches, and is available in both prewired and semi-kit form (critical circuits are prewired and aligned). Prices: *model ATVC-10,* $49.95; kit, $39.95.—**Science Workshop,** Box 393, Bethpage, NY 11714.

CIRCLE 109 ON FREE INFORMATION CARD

NI-CAD BATTERIES, *Dynacharge* line, come with a five-year warranty for 1000 discharges. Line includes AA penlight cell, C-cell, D-cell, 9-volt transistor cell, plus the *Dynacharger* to be used for all size cells. The *Dynacharger* lets you recharge penlight cells to 100% capacity in five

hours; unit can recharge four cells simultaneously, two different pairs at a time. Point-of-sale battery display contains blister-packed cards of cells plus boxed *Dynachargers*, and can be either pegboard-mounted or used as counter display.—**Dynamic Instrument Corp.,** 933 Motor Parkway, Hauppage, NY 11787.

CIRCLE 110 ON FREE INFORMATION CARD

EPROM PROGRAMMER, *model POP-1,* low-cost unit interfaces to manufacturer's P-38-1 and P-38-FF EPROM boards which are SS-50 bus compatible. The device is designed to program 2708 EPROM's. Comes with software on audio cas-

sette; special programming technique allows most 2708's to be programmed in 15 seconds. Power is supplied from separate self-contained source. Price: $149.—**Smoke Signal Broadcasting,** Box 2017, Hollywood, CA 90028.

CIRCLE 111 ON FREE INFORMATION CARD

POWER BREADBOARDS, *Powerace model 101* (center), *model 102* (right), and *model 103* (left), accept all DIP IC packages, plus TO-5's and discrete components with leads up to .032-inch in diameter. All three models offer 256-5 tiepoint terminals and 16-25 tiepoint buses, fused power supply and ground plane.

The *model 101* has a variable 5–15 VDC, 600 mA, power supply with line- and load-regulation, a 0–15 VDC meter (5% full-scale accuracy). The *model 102* has a fixed 5 VDC 1-amp power supply, 4 slide switches with logic outputs, 2 momentary slide switches with debounce circuitry, 4 LED's, a debounce pushbutton and a clock generator (1, 10, 100, 1K, 10K, 100 kHz). The *model 103* has fixed 5 VDC 750-mA, fixed +15 VDC 250-mA and −15 VDC 250-mA power supplies, with tracking. It also includes a 15-0-15

VDC meter, 2 LED's, 2 slide switches with logic outputs, and 2 momentary slide switches with debounce circuitry. Prices: *model 101*, $84.95; *model 102*, $114.95; *model 103*, $124.95.—**A P Products,** Box 110, 72 Corwin Dr., Painesville, OH 44077.

CIRCLE 112 ON FREE INFORMATION CARD

CASSETTE INTERFACE SYSTEM, *model CIS-30+*, which comes in kit form or preassembled, interfaces two cassette recorders and a data terminal to 6800 based computers. Long popular with SWTP 6800 users, newly released technical memos describe interfacing to the MITS 680b. The *model CIS-30+* features include selectable data rates of 30, 60 or 120 bytes/sec., and terminal rates of 300, 600 and 1200 baud; self-clocking cassette data recording; resident firmware; front-

panel "off-line" switch for sending recorded data to terminal; and an instruction manual. Optional program control of recorders is available. Other options include an IC socket kit, remote control kit, and a test cassette with software. Recording format is KC Standard/Bi-Phase-M. Prices: *model CIS-30+* kit, $79.95; assembled, $99.95; socket kit, $4.95; remote control kit, $14.95; test cassette, $4.95. Prices include shipping charges; Texas residents add state and local taxes as applicable.—**PERCOM Data Co.,** 318 Barnes, Garland, TX 75042.

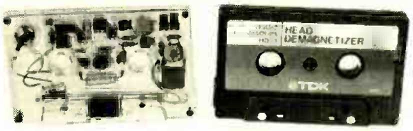
CIRCLE 113 ON FREE INFORMATION CARD

SOLDER EXTRACTING SYSTEM, *model SX-300, Universal Power Desoldering System*, has

three operational modes—pressure, vacuum and hot-air jet—for many kinds of solder-removal applications. System has built-in vacuum and pressure-generating capabilities, and includes a tip-temperature control, flow controls, pressure and vacuum regulation, cleaning unit, soldering iron and remote-control pedal switch. Optional power switch prevents transients or spikes from reaching workpiece, making system usable with CMOS and MOS/FET devices. Prices: *model SX-300*, $460; optional power switch, $150.—**PACE, Inc.,** 9329 Fraser St., Silver Spring, MD 20910.

CIRCLE 114 ON FREE INFORMATION CARD

TAPE DECK ACCESSORIES, *Head Demagnetizer* (shown) and *Head Cleaner* kit. The *Head Demagnetizer* comes in cassette form with built-



in circuitry, powered by 1.5-volt dry cell battery. Just slip the unit into your tape deck, press PLAY, and red LED display shows when tape heads are completely demagnetized.

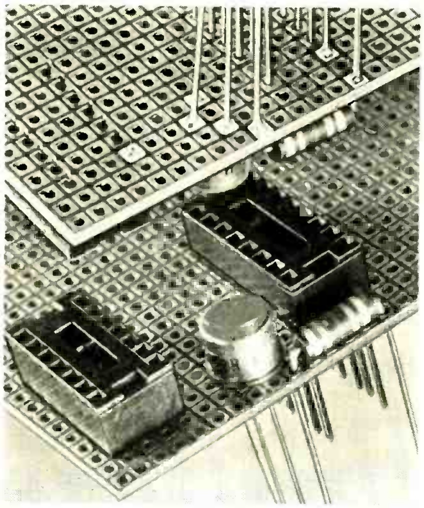
The *Head Cleaner* kit includes mirror, brushes, pads and liquid tape head cleaner, also in cassette box. Prices: *Head Demagnetizer*, $19.95; *Head Cleaner* kit, $5.95.—**TDK Electronics Corp.,** 755 Eastgate Blvd., Garden City, NY 11530.

CIRCLE 115 ON FREE INFORMATION CARD

BREADBOARDS, *model 45P80-1*, *model 106P106-1*, *model 8801*, permit convenient assembly of custom circuits or S-100 bus-compatible boards. All units feature an isolated array of square solder pads around 0.1-inch-spaced holes, and accept 8- to 64-lead DIP packages plus special modules with leads spaced on irregular multiples of 0.1 inch.

The *model 45P80-1* (measuring 4.5 × 8.08

inches) and the *model 106P106-1* (10.6 × 10.6 inches) comes without card connectors and can be cut to any desired shape. The *model 8801* is S-100 bus compatible and can accomodate DIP devices, modules and necessary discrete components. This unit has card-edge connectors on 0.125-inch centers, with a copper-free area for attachment of flat cable connectors. One corner

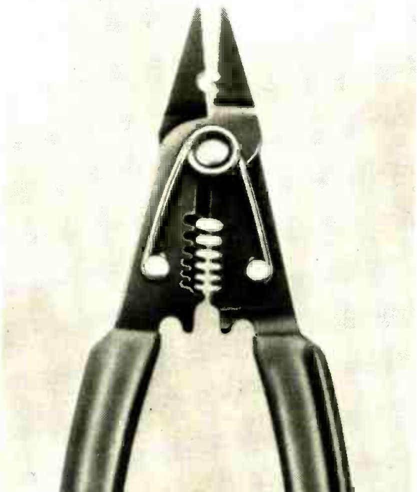


of the *model 8801* has an area for two TO-220-packaged regulators mounted in a low-profile heat sink. The leads of one regulator are prewired to power, ground and primary power buses. The leads of the other regulator are uncommitted.

The boards are made of copper-clad blue epoxy glass with solder-tinned pads and buses and gold/nickel-plate edge connectors. The *model 8801* sells for $19.95; the *model 45P80-1*, $9.96; and the *model 106P106-1*, $18.99.—**Vector Electronic Co., Inc.,** 12460 Gladstone Ave., Sylmar, CA 91342.

CIRCLE 116 ON FREE INFORMATION CARD

FOUR-IN-ONE ELECTRICAL TOOL, *model 25502, The Plike,* functions as a pliers with serrated tips for bending, gripping and pulling; a crimper for solderless terminals; a stripper with 6-wire stripping holes for AWG Nos. 12–22 solid-



wire and Nos. 14-24 stranded wire; and a ⅜-inch cutter. Unit is made of high carbon steel, with heavy plastic handles. Suggested retail price: $4.74 per unit.—**Hunter Tools,** 9674 Telstar Ave., El Monte, CA 91731. **R-E**

CIRCLE 117 ON FREE INFORMATION CARD

new lit

More information on new lit is available from the manufacturers of items identified by a Free Information number. Use the Free Information Card inside the back cover of this issue.

COMPONENT ASSORTMENT CATALOG, *M-946A*, is a 12-page tabloid brochure that features the most frequently used electronic components. Assortments come in plastic 6- and 9-drawer cabinets with drawer fronts prelabeled as to contents, and include aluminum electrolytic, dipped mica, ceramic and tantalum capacitors; carbon-film resistors and Zener diodes; small-signal and power transistors; and switches.—**Sprague Products Co.,** Technical Literature Service, 81 Marshall St., North Adams, MA 01247.

CIRCLE 121 ON FREE INFORMATION CARD

SHORT FORM TEST INSTRUMENT CATALOG is a 12-page brochure describing manufacturer's new line of instruments, including single- and dual-trace oscilloscopes; DMM's, both pushbutton and conventional models; system analyzers, including a 7-instruments-in-one unit; color bar generator; counters, bridges and testers; CB, audio and RF signal generators; audio test instruments; and communications testers, including antenna couplers and impedance/dip meters. Numerous service aids and accessories are also listed.—**Leader Instruments Corp.,** 151 Dupont St., Plainview, NY 11803.

CIRCLE 118 ON FREE INFORMATION CARD

COMPOSITE TEST EQUIPMENT CATALOG, 13 full-color booklets and brochures in one handy looseleaf binder. Contains latest specs and information on products by B&K-Precision, Continental Specialties, Data Precision, ECD Corp., Fluke, Hickok, Leader, Nonlinear Systems, Philips, Sanwa, Simpson, Triplett and Tif Instruments. Available for $5.00; separate mail order form.—**Advance Electronics,** 54 West 45th St., New York, NY 10036.

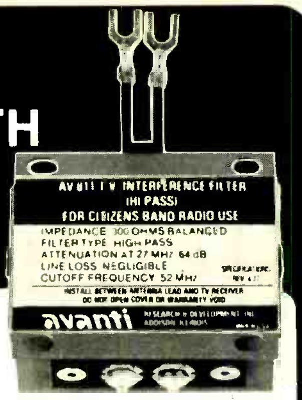
ELECTRONIC SWITCH CATALOG, *No. C-77*, contains 47 pages of information on a wide spectrum of switches, ranging from keyboard types to thumbwheel and lever wheel models. Featured is the *Rotocode* switch that combines thumbwheel and rotary characteristics. Complete thumbwheel product listing and truth tables are in the back. Comes with a separate price list.—**Cherry Electrical Products Corp.,** 3600 Sunset Ave., Waukegan, IL 60085.

CIRCLE 120 ON FREE INFORMATION CARD

COMPONENT CATALOG, *No. C-651*, provides 28 pages of information on manufacturers *Q-Line* components most used in TV/radio servicing, hobbyist and experimental electronics, lab breadboarding and home audio and marine installation and repair. Catalog lists all types of capacitors (including trimmers), carbon-film and vitreous-enamel resistors, silicon and germanium transistors, rectifiers, diodes, IC's, quartz crystals, LED's, switches, wiring components, pulse transformers and CB noise filters.—**Sprague Products Co.,** Technical Information Service, 81 Marshall St., North Adams, MA 01247. **R-E**

CIRCLE 122 ON FREE INFORMATION CARD

AVANTI SOLVES TV INTERFERENCE WITH TVI FILTERS THAT REALLY WORK!



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CIRCLE 53 ON FREE INFORMATION CARD

DIGITAL DARKROOM TIMER

continued from page 36

minates internal calculator modes by activating the Equals function. The 9 output from IC10 recalls the memory's contents and the 0 output clears the memory and resets latch IC14, which, in turn, halts IC10 with its 0 output high.

The 1 and 8 logic outputs of IC10 are not used. By skipping them, more time is allowed for the calculator IC to prepare for its following operation. This gives even a slow calculator IC enough time to complete its preceding operation before the next one is initiated.

Operation in the minutes/seconds range is similar to the operation in the seconds range. The outputs from IC6 and IC10 are combined by IC13 so the algorithm in Fig. 1 is executed.

AND gates IC9 and 12, combined with the 10-Hz signal from IC1-5, are required to satisfy the calculator IC's requirement that to recognize successive inputs, there must be a period (about 6 ms) after each input during which no inputs are allowed. The 10-Hz signal disconnects IC9 and IC12's inputs from IC8 and IC11 for 50 ms each cycle.

The electronic keyboard is formed by IC8 and IC11. Each contains four single-pole single-throw switches, which are closed when "pressed" by a high at the gate inputs (pins 5, 6, 12 and 13).

The circuit which detects a minus (this means that only segment "g" is on) in position D8 works as follows. If you make a table that shows which segments are on for each of the numerals from 0 to 9, you will see that segment "b" is on for all numbers except 5 and 6. If we connect segment "b" to one input of a two-input OR gate and connect the gate's second input to any of the segments which are on (high) for both numerals 5 and 6 (segment "f" is used here), the output will be high if any numeral is being displayed. This also means that the output is low only if no numerals are being displayed. Thus by looking at only two of the seven segment signals, we can determine if the display is blank. (Eight other pairs of segments could also have been used—ab, ac, bc, bd, cd, ce, cg or bg.) By combining IC16-4 with D8 and segment "g," IC16-3 will be low only when a minus is in the D8 position.

Transistors Q2–Q4 and their base and collector resistors amplify the small 1.7-volt signal change across the on segments to the higher levels required by CMOS gates for reliable switching.

Next month we conclude the circuit description and will go into details of assembling, testing and operating this versatile timer. **R-E**

next month

AUGUST 1978

■ Build A Digital Thermometer

Inexpensive add-on turns any digital voltmeter or multimeter into an accurate digital thermometer.

■ Video Modulator Roundup

Want to use your TV set as a computer terminal, or as a monitor for a TV camera, or as the playing field for a TV game? Then you need a video modulator. Here's a rundown on every video modulator we could locate.

■ All About RF Generators

A special Forest Belt "What You Need To Know" section.

PLUS

Darkroom Timer Construction Details

Lab Tested Hi-Fi Reports

Computer Corner

Computer Investment Program

CET Study Guide

And that's only the beginning . . .

PICTURE TUBE BRIGHTENERS
continued from page 49

taminated, limiting emission. This contamination is caused by out gassing of tube elements or from slow air leaks. Examining the cathodes of such tubes reveals heavy crystalization in the center of the cathode. When a contaminated tube is turned on, the electron cloud under the grid aperture opening is rapidly depleted and the tube becomes emission-limited. In some cases, after the tube is on for some time, heat builds up around the cathode and raises the temperature of the cathode sufficiently to increase emission.

The effect of low emission is to limit the beam current and diminish picture brightness. If the brightness level is too low for normal viewing, the tube has apparently reached end-life.

Using a brightener on a contaminated tube causes a rapid decontamination of the cathode surface and raises the emission level. A satisfactory beam current is obtained almost instantly.

Restorers

Devices known as restorers or rejuvenators are also designed to improve picture tube emission by removing contamination and restoring the emitter surface under the grid aperture. This technique involves elevating the heater voltage and simultaneously applying a high positive voltage between the grid and cathode, thereby causing an abnormally high cathode current. Unless this technique is carefully controlled, the cathode can be easily damaged. Several early restorers were hazardous and caused a fair number of picture tubes to be destroyed. In the capacitative discharge method, an arc is actually produced that provides intense localized cathode heating. However, the field, can be strong enough to actually remove material from the cathode.

Improved rejuvenators have automatic controls and can apply the required high voltage levels in increasing steps to limit the energy level. However, they generally do so at some sacrifice in the duration of the improvement.

The most recently developed rejuvenators use more effective control circuits so that the duration of the high cathode current is long enough to assure good restoration, but short enough to reduce damage to a minimum. Automatic controls are used to prevent user error.

One of the problems of the rejuvenator is that the cathode current flows from the entire cathode surface during rejuvenation. However, to be successful, the emission restoration must occur in the cathode area directly beneath the grid aperture. Fortunately, this is usually the area of greatest heat because the heater is in the center of the cathode cylinder.

To know if rejuvenation has been successful it is necessary to measure the quality of the beam current after rejuvenation. Unfortunately, the grid current cannot indicate emission quality from the cathode area directly under the grid aperture; only a true beam-current-emission test can do this. This is why you may obtain disappointing results, even with tests indicating success.

In color sets, restoring one gun may mean one or both of the other guns must be rejuvenated. Rejuvenating the low-emission gun of a color picture tube can increase the emission to the original beam-current level, so that it may not track with the other aged guns whose beam currents may have declined from the original level, even though their brightness level is satisfactory.

Unsatisfactory picture tube performance can often be diagnosed visually by a repair technician, and modern test equipment and performance data help substantiate the visual judgment. A tube brightener can always be tried without risk (unlike many restorers), and it can be used in all applications in which a restorer is effective and in many in which it might not be. A brightener will work longer than a restorer; therefore, it can be implemented in all low-brightness-level situations. **R-E**

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7445N	69
7447N	60
7448N	69
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7474N	29
7475N	49
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7492N	43
7493N	43
7495N	69
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74LS00 TTL	
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74LS10N	25
74LS13N	40
74LS14N	90
74LS20N	25
74LS22N	.25
74LS28N	41
74LS30N	25
74LS33N	.39
74LS38N	30
74LS74N	35
74LS75N	.47
74LS90N	51
74LS93N	51
74LS95N	1.89
74LS107N	35
74LS112N	35
74LS113N	.35
74LS132N	72
74LS136N	35
74LS151N	67
74LS155N	67
74LS157N	67
74LS162N	91
74LS163N	91
74LS174N	95
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CD4049	36
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CD4051	1.13
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CD4066	71
CD4068	40
CD4069	40
CD4070	40
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CD4518	1.02
CD4520	1.02
CD4527	1.51
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74C04	33
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18	27	40	61
22	30		

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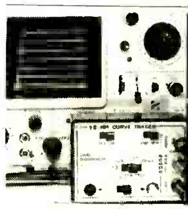

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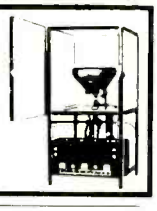

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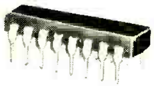

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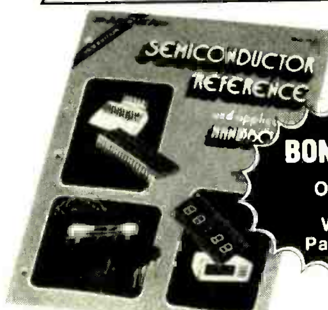

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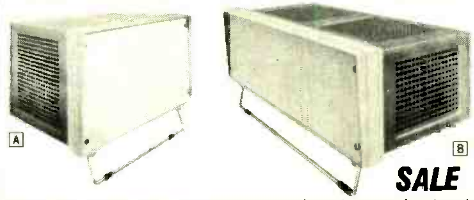

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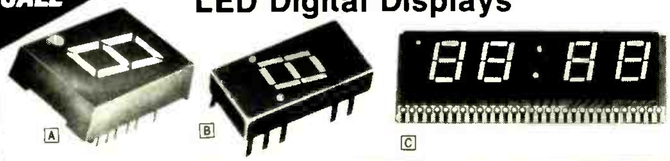

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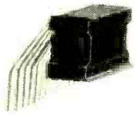

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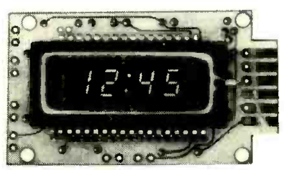

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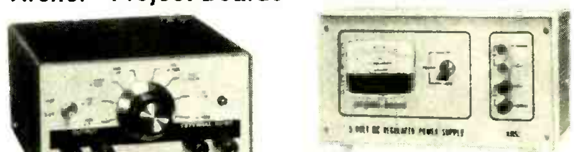

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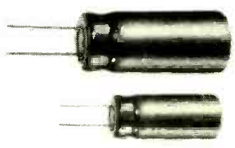

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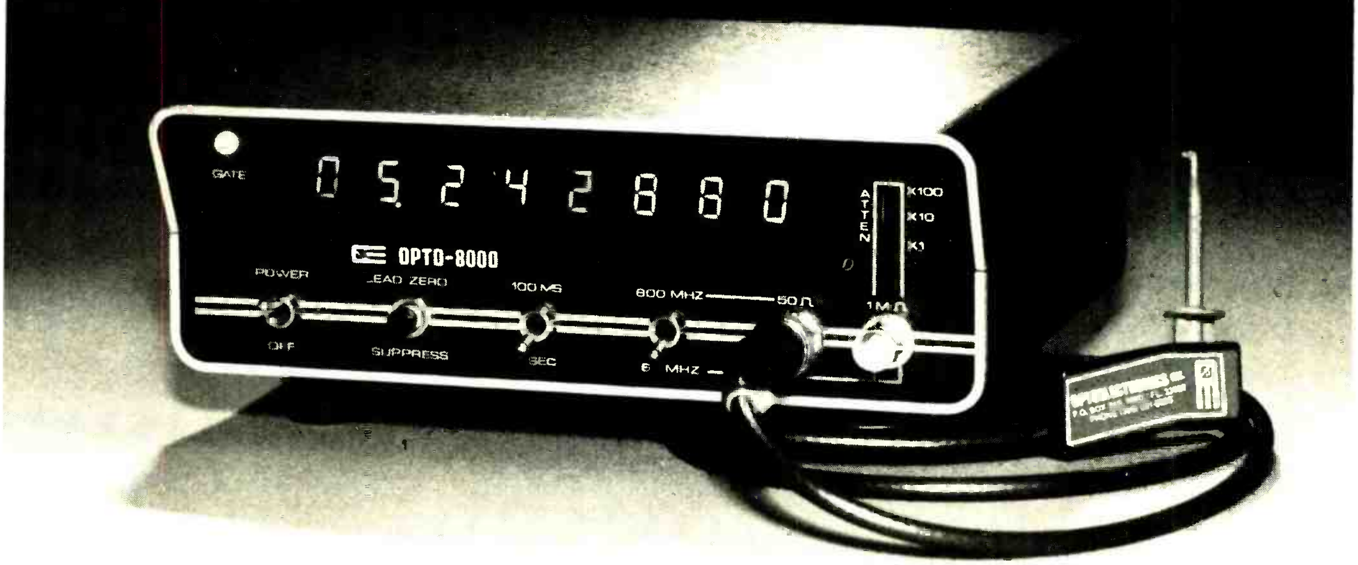
OPTO-8000.1



This new instrument has taken a giant step in front of the multitude of counters now available. The Opto-8000.1 boasts a combination of features and specifications not found in units costing several times its price. Accuracy of ±0.1 PPM or better — *Guaranteed* — with a factory-adjusted, sealed TCXO (Temperature Compensated Xtal Oscillator). **Even kits require no adjustment for guaranteed accuracy!** Built-in, selectable-step attenuator, rugged and attractive, black anodized aluminum case (.090" thick aluminum) with tilt bail. 50 Ohm and 1 Megohm inputs, both with amplifier circuits for super sensitivity and both diode/overload protected. Front panel includes "Lead Zero Blanking Control" and a gate period indicator LED. AC and DC power cords with plugs included.

OPTOELECTRONICS, INC.

5821 NE 14 Avenue
Ft. Lauderdale, FL 33334
Phones: (305) 771-2050   771-2051
Phone orders accepted 6 days, until 7 p.m.

SPECIFICATIONS:
Time Base—TCXO ±0.1 PPM GUARANTEED!
Frequency Range—10 Hz to 600 MHz
Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
Decimal Point—Automatic
All IC's socketed (kits and factory-wired)
Display—8 digit LED
Gate Times—1 second and 1/10 second
Selectable Input Attenuation—X1, X10, X100
Input Connectors Type —BNC
Approximate Size—3"h x 7½"w x 6½"d
Approximate Weight—2½ pounds
Cabinet—black anodized aluminum (.090" thickness)
Input Power—9-15 VDC, 115 VAC 50/60 Hz or internal batteries

OPTO-8000.1 Factory Wired	**$299.95**
OPTO-8000.1K Kit	**$249.95**

ACCESSORIES:

Battery-Pack Option—Internal Ni-Cad Batteries and charging unit	**$19.95**
Probes: P-100—DC Probe, may also be used with scope	**$13.95**
P-101—LO-Pass Probe, very useful at audio frequencies	**$16.95**
P-102—High Impedence Probe, ideal general purpose usage	**$16.95**
VHF RF Pick-Up Antenna-Rubber Duck w/BNC #Duck-4H	**$12.50**
Right Angle BNC adapter #RA-BNC	**$ 2.95**

FC-50 — Opto-8000 Conversion Kits:
Owners of FC-50 counters with #PSL-650 Prescaler can use this kit to convert their units to the Opto-8000 style case, including most of the features.

FC-50 — Opto-8000	**Kit $59.95**
*FC-50 — Opto-8000F	**Factory Update $99.95**
FC-50 — Opto-8000.1 (w/TCXO)	**Kit $109.95**
*FC-50 — Opto-8000.1F	**Factory Update $149.95**

*Units returned for factory update must be completely assembled and operational

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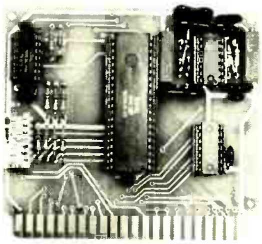
NEW

Part no. 600

- Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232
- Two separate circuits
- Requires +12 and -12 volts
- Board only $4.50, with parts $7.00

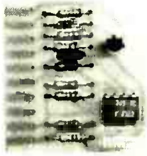


UART & BAUD RATE GENERATOR*

Part no. 101

- Converts serial to parallel and parallel to serial
- Low cost on board baud rate generator
- Baud rates: 110, 150, 300, 600, 1200, and 2400
- Low power drain +5 volts and -12 volts required
- TTL compatible
- All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity.
- All connections go to a 44 pin gold plated edge connector
- Board only $12.00; with parts $35.00

RS-232/TTL INTERFACE*



Part no. 232

- Converts TTL to RS-232, and converts RS-232 to TTL
- Two separate circuits
- Requires -12 and +12 volts
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Part no. 6085

- Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp.
- Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps.
- Board only $12.50; with parts $42.50 excluding transformers

Part no. 111

TAPE INTERFACE*

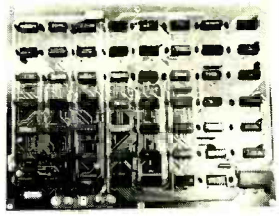
- Play and record Kansas City Standard tapes
- Converts a low cost tape recorder to a digital recorder
- Works up to 1200 baud
- Digital in and out are TTL-serial
- Output of board connects to mic. in of recorder
- Earphone of recorder connects to input on board
- Requires +5 volts, low power drain
- Board $7.60; with parts $27.50
- No coils

Part no. 107

RF MODULATOR*

- Converts video to AM modulated RF, Channels 2 or 3
- Power required is 12 volts AC C.T., or +5 volts DC
- Board $7.60; with parts $13.50

TELEVISION TYPEWRITER



Part no. 106

- Stand alone TVT
- 32 char/line, 16 lines, modifications for 64 char/line included
- Parallel ASCII (TTL) input
- Video output
- 1K on board memory
- Output for computer controlled curser
- Auto scroll
- Non-destructive curser
- Curser inputs: up, down, left, right, home, EOL, EOS
- Scroll up, down
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- Char. gen. 2513
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Part no. 300

- 8K Altair bus memory
- Uses 2102 Static memory chips
- Memory protect
- Gold contacts
- Wait states
- On board regulator
- S-100 bus compatible
- Vector input option
- TRI state buffered
- Board only $22.50; with parts $160.00

TIDMA*

Part no. 112

- Tape Interface Direct Memory Access
- Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate.
- S-100 bus compatible
- Board only $35.00; with parts $110.00

Apple II Serial I/O Interface*

Part No. 2

- Baud rates up to 30,000
- Plugs into Apple Peripheral connector
- Low-current drain
- RS-232 Input and Output

SOFTWARE

- Input and Output routine from monitor or BASIC to teletype or other serial printer.
- Program for using an Apple II for a video or an intelligent terminal. Board only – $15.00; with parts – $42.00; assembled and tested – $62.00.

MODEM*

Part no. 109

- Type 103
- Full or half duplex
- Works up to 300 baud
- Originate or Answer
- No coils, only low cost components
- TTL input and output-serial
- Connect 8 ohm speaker and crystal mic. directly to board
- Uses XR FSK demodulator
- Requires +5 volts
- Board $7.60; with parts $27.50

To Order:

Mention part number and description. For parts kits add "A" to part number. Shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. Dealer inquiries invited. 24 Hour Order Line: (408) 374-5984.* Designed by John Bell.

LITTLE PRO BEEP

continued from page 60

$=47,000$ ohms and $C = .05\ \mu F$ as the timing components (Fig. 1). Then $T = 2.35$ ms. A *complete* cycle at pin 1 would last 4.7 ms, which converts to a frequency of about 210 Hz. After 7 stages of divide-by-2, the frequency would be 210/128 or nearly 2 Hz, at pin 8. We mentioned previously that when any of the counter outputs goes to a logic-0 level, there can be no signal output regardless of what happens at any other counter output. Therefore, during the long "0" state of pin 8, we cannot hear the audio from pin 1. The 210 Hz becomes available *only* while pin 8 is at a logic-1 level. We hear beeps, intermittent sound.

Now suppose we strap pins 1, 6 and 8 to the output terminal. (See Fig. 4.) We know that the logic-1 state of pin 8 will block all output. During the logic-1 state, there are four alternations at pin 6: two of them logic-1 and two logic-0. As we know, there can be no output during the logic-0 intervals. However, the tone or buzz from pin 1 *will* be audible during the 2 logic-1 intervals, shown shaded. This provides the *double* beep.

To obtain a 4-beep sequence, we can strap pins, 1, 5, 8 to the output, and so on. If you strap pins 1, 4, 6, 8, you will obtain a sequence of 2 double-beeps.

Figure 5 is the schematic of the beeper. Use a 16-pin DIP socket for the IC, and a socket adapter for the capacitors and resistors. Most of the wiring can be done at or near the socket. The switches, earpiece jack (for output) and power plug can be mounted on a small metal box, 3¼ × 2 × 1½". A source of 5 volts at 6 mA will operate the beeper.

The volume is loud in a high-impedance earpiece, but you will probably need an amplifier. Any radio or record-player amplifier will do. **R-E**

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- ★ Address on 1K boundary
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KIT
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IMS 16K STATIC RAM

- ★ Memory mapping
- ★ Phantom
- ★ Address 16K Bound
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- ★ Power 2.1 amps typ.
- ★ Uses 2114

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- ★ Address 32K Boundary
- ★ Power 450ns. 2.8 amps typ.
- ★ No wait states on 2MHz
- ★ Fully Buffered
- ★ Phantom can be added
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★ Phantom ★ TMS4044
★ Addressable 4K Blks ★ Independed reg.

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- ★ Software programmable
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21L12-1	4.25	4.10	3.95
2112-1	2.95	2.85	2.65
21L01-1	3.95	3.75	3.65
2101-1	2.90	2.70	2.55
2114-3 300ns	12.95	10.95	9.95
2114-4 450ns	11.25	10.25	9.50
TMS4044	11.25	10.25	9.50
TMS4045	11.25	10.25	9.50
EMM4200A	12.50	11.95	9.95
EMM4402	9.95	9.95	8.25
5101C-E	10.95	10.50	9.90
upd410 (4200)	10.95	10.25	9.25
AMD9140/41	10.95	10.25	9.25
AMD9130/31	12.95	11.95	10.25
FSC 460/46416K CCD Only $18.95 Each			
1101	1.95	1.75	1.25

WAVEFORM GENERATORS

8038 Function Gen	3.95
MC4024 VCO	2.45
LM566 VCO	1.75
XR2206 Function Generator	5.25

CHARGE COUPLED DEVICES

16K CCD -First time offered Fairchild 460 CCD 16K Memory (now you can experiment with CCD technology at a reasonable price. 17 page Application note supplied with each order. Quantity Limited)

$18.95 each (reg. 43.00)

CRYSTALS

Microprocessor Timebases TV Game

Frequency	Application	Price
1.0MHz	6800/S6860	$5.85
1.8432	MC14411	4.95
2.0MHz	G-8/TV Games	5.85
2.01MHz	TV Games	2.95
2.097152MHz	MM5378/79 Auto	5.85
2.4576MHz	34702 Bit Rate Gen	5.85
3.579545MHz	MM5369 (TV Color)	1.50
4.0MHz	4004/4040	4.95
4.194304MHz	8038	5.95
4.91520MHz	Std. CLK Freq.	5.95
5.0MHz	Several MPU's	4.95
5.0688	COM5016	4.95
5.7143MHz	PACE	5.95
6.0MHz	Misc	4.95
6.144	Intel 80885	4.95
6.5536	ICM7045	4.95
10.0MHz	Several MPU's	4.95
13.0MHz	Misc	4.95
14.31818	Misc	4.95
18.0MHz	8080/8008/8224	4.95
18.432MHz	8080/8008/8224	5.95
20.0MHz	Several MPU's	4.95
22.1184MHz	8080A	5.95
27.0MHz	8080A	5.95
36.0MHz	8080A	5.95
48.0MHz	TIM9904	5.95
100KC	Misc	12.95

DISPLAYS/OPTO

DL 704/707/CC/CA .300	1.25
FND359 CC .357	95
FND 500/507/CC/CA .500	1.35
FND 503/510 CC/CA .500	95
FND 800/807 CC/CA .800	2.50
Bowmar 9 digit bubble	99
FSC 8024 4 digit CC .800	4.95
HP7340 HEX Display	15.95
TIL 305 5 × 7 Array	4.50
TIL 306 7 seg w/logic	8.95
TIL 308 7 seg w/logic	8.95
TIL 309 7 seg w/logic	7.95
TIL 311 HEX Display	9.25
MA 1003 12 auto clock	17.95
MA 1002 4 digit clock module	9.95
MA 1010 4 digit clock module	9.95
NSN 373/374 dual CC/CA .300	2.20
NSN 583/584 ddual CC/CA .500	2.60
NSN 783/784 dual CC/CA .700	3.00
4N25 Opto Isolater	3/1.99
MCT 2 Opto Isolater	89
4N33 Darlington ISOL	1.75
Red Led's .185 Dia	5/1.00
Green/Yellow	4/1.00

MONTHLY SPECIALS

14 Pin S/T sockets 1000 pcs	10
16 Pin S/T sockets 1000 pcs	11
22 Pin S/T sockets 1000 pcs	.12
FSC460/464 16K CCD's	18.95
AMD 9140CDC Static Ram	10.95
4116/416 16K Dynamic Ram's	8 for/200.00
1488 or 1489 RS232 Driver	1.25
8T97 Buffer	1.25
8130 or 8131	2.45
8833 or 8835	1.99
74367 or 74368	6/5.00
75451/52/53	10/2.50
8T26 Bus Driver	2.39
78L05 Regulator	2/1.00
4N25 Opto-isolator	3/1.99
MCT2 Opto-isolator	.89
2510A Shift Register	2.95
2519A Shift Register	2.95
MM5056 Shift Register	2.95
LM760N 14 Compartor	1.10
DS0025CN Clock Driver	1.49
DS0026CN Clock Driver	2.50
8T20 Bidirect oneshot	3.49

NEW
1978 CATALOGUE
AVAILABLE FEB.
SEND .25 POSTAGE

DISCOUNT COMPUTER CORNER

	Cash	Credit Card
Soroc IQ 120	895.00	925.00
Imsai w/22 slots	629.00	647.00
Speechlab	269.00	278.00
Cromemco 2-2	536.00	551.00
Horizon 1	1439.00	1479.00
North Star	599.00	617.00
TEI MCS122	450.00	462.00
Apple w/16K	1198.00	1234.00
Decwriter II	1475.00	1525.00
Computalker	365.00	380.00
Persci 277	1230.00	1266.00
Shugart 800-2	575.00	590.00
Low cost S100 Bus	149.95	155.95

P. O. BOX 17329 Irvine, California 92713 New Phone (714) 558-8813
TWX: 910-595-1565

Retail Store Open Mon. – Sat.
Located at 1310 "B" E. Edinger,
Santa Ana, CA 92705

CIRCLE 2 ON FREE INFORMATION CARD

SOCKET SALE

WIRE WRAP SOCKETS

14 Pin Wire Wrap	.30	.27/400
16 Pin Wire Wrap	.32	.29/350

EDGE CARD CONNECTORS

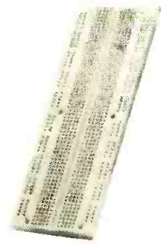
44 Pin ST Edge Card Connector	1.75	1.50/10
100 Pin ST Edge Card Connector	3.50	3.00/10
100 Pin WW Edge Card Connector	3.50	3.00/10

All Sockets & Connectors Include Gold.

SOLDERLESS BREADBOARDS

2.2" x 6.5"

SK 10 $16.50



INCLUDING:
Over 100 pieces of precut wire in assorted lengths — free!
Choose 1 color: Red, Black, Blue, Yellow, Green, White, Orange Or Assortment.

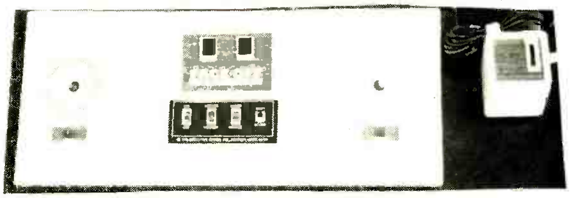
PAGE DIGITAL ELECTRONICS
135 E. Chestnut Street 4A
Monrovia, California 91016
Phone (213) 357-5005

ORDERING INFORMATION
- Orders under $25 and COD's, add $2
- All others, shipped Ppd in U.S. via UPS
- For Blue Label (Air) or 1st Class, add $1
- We accept Visa & Master Charge
- Most orders shipped same day

Dealer Inquiries Invited

CIRCLE 54 ON FREE INFORMATION CARD

TV HOCKEY SOCCER GAME PLUS VIDEOCUBE-TV INTERFACE



The game we have been selling for $27.50 in kit form. NOW complete, ready to go including VIDEOCUBE, the TV interface,used for iterfacing minicomputers and cameras, as described in August RADIO-ELECTRONICS. Games have 2 levels of skill, LED readouts for scoring, 2 joysticks which move players in all planes, not just vertical & horizontal. Game sold for $79.50 in Boston stores.
STOCK NO.5495R Complete TV game & VIDEOCUBE $18.95

NEW TRANSFORMERS

115 V primary. Sec.1—12.6V@1.0 A. ct. Sec.2—33.5V, tapped @ 13.1 V @1.0A. Sec.3— 140V @100 ma. 2Lbs. 4"x2"x2¾".
STOCK NO.6772R $2.95 ea. 2/5.00

Two 115 volt primaries,(can be used on 230V). 4 secondaries. 11.5V @ 4.8 A, 23V @ 9.0 A., 14 V. @ 20 A. and 125 V 1.5 A.
13 lbs. 4½"x4¾"x3¾"
STOCK NO.6554R $16.95 ea. 2/30.00

TRIAD —N67A ISOLATION transformer. 115 or 230 VAC to 115 AC. 150 VA. Limited quantity. 7 lbs. 4"x4"x3½".
STOCK NO.6788 $7.95 ea. 2/15.00

DELTA ELECTRONICS

P.O. Box 2, 7 Oakland St.
Amesbury, Mass. 01913
617-388-4705

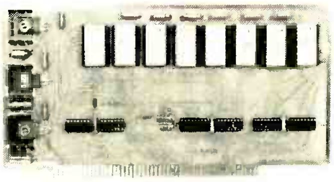
RETAIL OUTLET
ATLANTA, GA. DELTA ELECTRONIC HOBBIES
5151 Buford Hwy. Doaraville, (Atlanta) Ga. 30340

CIRCLE 65 ON FREE INFORMATION CARD

ELECTRONIC DISCOUNT SALES

Dept. R, 138 N. 81st Street, Mesa, Arizona 85207

- ★ ★ **S-100 bus compatible**
- ★ ★ **Optional wait states: none, one or two (selectable with plug-in jumpers)**
- ★ ★ **Epoxy board with plated thru holes (double sided)**
- ★ ★ **Address any one of 8 different 8K blocks or any one of 16 different 4K blocks**
- ★ ★ **All sockets provided**
- ★ ★ **Gold plated connectors**
- ★ ★ **On board regulation (heat sinked)**
- ★ ★ **Convertible for use with 2716 EPROMS**
- ★ ★ **Complete instructions**



2708 EPROM BOARD
★★★★★★★★★
AVAILABLE SOON: (S-100 BUS)
★★ Phase encoded cassette interface with programmable serial port: Dual recorder, tarbell or K-C method supported ★★ 2708 Programmer

4th OF JULY SPECIAL (July & August)

ASSEMBLED & TESTED (without EPROMS) $55.50

COMPLETE KIT (without EPROMS) $42.50

BARE BOARD ONLY $25.50

2708 SPECIAL 8/$68. (with purchase of board)

TVT-III (with 2K memory capability)

This system provides 16 lines of 32 characters each. It is composed of all TTL except for the 2513 and 2102's. Basic kit includes: Main board, 2K Memory board, six 2102's (1K of memory), plus other components. (Keyboard, case and power supply not included.)

All boards are double sided and plated thru. Small boards plug into main board at right angles.

	KITS	ASSEMBLED	BOARD ONLY
Basic TVT-III	$99.95	$135.45	$32.50
Screen Read	12.65	17.30	8.10
Manual Cursor	9.95	13.95	6.50
U.A.R.T.	29.95	39.95	15.50

Construction packet sold separately: $2.95

AVAILABLE NOW! 64 CHARACTER CONVERSION AND/OR SCROLLING OPTION FOR THE TVT-III. Complete documentation. Kit: $6.95. Data only: $1.00

MEMORY BARGAIN: 16K *STATIC* RAM ON ONE BOARD: (32 ea µPD410); S-100 BUS; Low Pwr., 200NS 4K Chips. Kit includes all IC's, discrete parts & sockets: $295.00

PROGRAMMING SERVICE

1702A: $5. original program, copies $2. (same order)
2708: $10. original program, copies $4. (same order)
2716: $20. original program, copies $8. (same order)

WE REQUIRE A WRITTEN PROGRAM IN EITHER HEX OR SPLIT OCTAL or a CHIP ALREADY PROGRAMMED.

CPU's	
Z-80A	$19.50
8080A	9.50
6800	19.95

EPROMS		
2716,	16K	$29.50
2708,	8K	9.50
1702A,	2K	3.95

RAMS

21L02 (250ns)	1.50 ea.; 8/$11.50
21L02 (450ns)	1.35 ea.; 8/$10.00
2107B, 4K DYNAMIC	$3.50
µPD410, 4K STATIC	9.50
2114, 4K static (low pwr)	14.50
MK4116 (200ns), 16K DYN.	28.00

MISCELLANEOUS CHIPS

2813, 32 word x 9 BIT FIFO	$5.50
AY5-2376, keyboard	12.95
MM5320 TV SYNC. GEN.	5.50
AY5-1013A UART	4.50
2513 upper case	5.50
MM5330 4½ DIGIT DVM CHIP	7.95
CT7001 clock/cal. chip	5.75
SC5889 volt converter	$1.85
LM1889 TV video mod.	10.95
MC1488, 1489—RS232 & TTL interface	1.95

DIP SWITCHES

4 PIN SLIDE	$1.50
6 PIN ROCKER	1.80
8 PIN ROCKER	1.95
BLACK PADDLE SW., DPST, OR DPDT CTR-OFF	$.95
1 POLE, 10 POS. ROTARY SWITCH W/KNOB (mini)	$.95
10 POS. BCD THUMBWHEEL SW.	$1.25

DUAL, GOLD PLATE EDGE CONN. (.156'')

6 POS. 12 CONTACT	$.40
10 POS. 20 CONTACT	.50
18 POS. 36 CONTACT	1.20
22 POS. 44 CONTACT	1.75
MODULAR (make your own) 2 & 3 POS. SECTIONS, EACH SECTION	$.15
100 PIN, S-100	$4.50
RG179 (75Ωcoax)	10¢/ft
110V fan motor	$2.50
570mfd, 350v, elect. cap	.99
10mfd, 250v, elect. cap	.50
26mfd, 250v, non-polarized elect. cap	.50

MINIMUM ORDER $15.
FREE SHIPPING (in U.S.) FREE CATALOG
ALL PARTS PRIME & SATISFACTION GUARANTEED

CIRCLE 46 ON FREE INFORMATION CARD

SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp

Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power ½dB response from 20–100,000 Hz. This amplifier has QUASI–Complimentary class B output. Output max is watt (10 watt RMS) at 4Ω.

ONLY $23.50 each

FM WIRELESS MIC KIT

This new model FM wireless MIC kit uses 3 high freq. transistors, works in the FM range (88-108 MHz). It transmits the sound wave fidelity clearly over long distances (up to 2500 ft.). Kit comes with all electronic parts, P.C. Board and mini microphone!

$6.95 EACH KIT

SOUND ACTIVATED SWITCH

All parts completed on a PC Board
SCR will turn on relay, buzzer or trigger other circuit for 2～10 sec. (adjustable)
Ideal for use as door alarm, sound controlled toys and many other projects
Supply voltage 4.5V～9V D.C.
$1.75 ea./2 for $3.00

30MHZ FREQUENCY COUNTER KIT

Take advantage of this new state-of-the-art counter featuring the many benefits of custom LSI circuitry. This new technology approach to instrumentation yields enhenced performance, smaller physical size, drastically reduced power consumption (portable battery operation is now practical), dependability, easy assembly and revolutionary lower pricing!

- 0.5" red LED 6 digits display
- Resolution: 1 Hz at 1 sec. 10 Hz at 1/10 sec.
- Sensitivity: 10 Mv RMS to 30 Hz
- Internal power supply: 5.2V at 1 amp regulated
- Input connector: BNC type
- Input power required: 117V AC 50/60 Hz
- Diode protected for over voltage input

Only $59.50

Includes all parts, PC Board and Transformer

Model 250-30A

Sub-Mini Size Condenser Microphone

3/8"

$2.50 each

FET Transistor Built-in

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED
Lights up 8～15 Watt Fluorescent Light Tubes
Ideal for camper, outdoor Auto or Boat

Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

ONLY $5.50 PER KIT

CALCULATOR with STOPWATCH

6 Functions with % and memory
8 Digits big green display
*Built-in X'tal controlled stop watch count to 1/10 of a second.

Special Price Only
$16.50 Ea.
BATTERIES NOT INCLUDED

MECHANICAL DIGITAL CLOCK

WITH DAY AND DATE OF THE WEEK

This clock is beautifully designed. Case is made from high quality die cast alloy. Movement is the popular flip type with a back up light

Supply Voltage 110V AC. limited quantity **$15.50 ea.**

1Watt AUDIO AMP

All parts are pre assembled on a mini PC Board
Supply Voltage 6～9V D.C.
SPECIAL PRICE $1.95 ea.

12V DC MINI RELAY

P.C. Board Solder Type

2AMP Contact SPOT $1.30 EA
2AMP Contact DPDT $1.75 EA
5AMP Contact 4PDT $2.20 EA

12V D.C. AUTO DIGITAL CLOCK

Complete Unit
Not a Kit!

0.4" blue color 4 digits display. Turn off readouts when car is not running. X'tal controlled time base for time accuracy. Special designed case for easy mounting on top of your dashboard. Ideal for car, boat and campers.

ONLY $28.50 ea.

HEAVY DUTY CLIP LEADS

10 pairs – 5 colors
Alligator clips on a 22" long lead. Ideal for any testing.

$1.85/pack

"FISHER" 30 WATT STEREO AMP

(15W X 2)

Kit includes: 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF = 1% ± 3dB). Voltage gain: 33dB, 20Hz – 20KHz.

Super Buy Only $22.50 each kit

ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch on Touch Off
use 7473 I.C and 12V relay
$5.50 each

MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!!
Receives all AM stations
Batteries and ear phone included

Only $8.50

5W AUDIO AMP KIT

2 LM 380 with Volume Control
Power Supply 6～18V DC
only $5.00 ea.

NEW! 4 KIT

EASY-TO-BUILD LED PROJECTS ON ONE BOARD

- HO-Guage railroad crossing blinker
- Variable LED flasher
- Six-bit binary counter
- Wheel of fortune

Kit includes all electronic components and PC Board
Especially designed for experimenters
Guaranteed – they all work!!
(Battery not included)

$12.50 PER KIT

NI-CD RECHARGEABLE BATTERIES

AA	SIZE	$1.25 EA.
C	SIZE	$1.50 EA.
D	SIZE	$2.50 EA.
5 Sub C pack	SIZE	$4.90 EA.

*12V Mini Size
Motorcycle rechargable wet battery 6AMP/Hour
Brand new, but ltd. quantity
$12.50 EA.

TIMER KIT

Time Controlled from 1-100sec.

Ideal to be used as time delay unit for burglar alarm, photo service, and other purposes. Max. loading 110V, 2 AMP. Supply voltage 12-18V D.C.

FT-80 ELECTRONIC IC TIMER

$11.50 each

Sub Mini Size PANEL METER

3/4" 1/2"

500 UA
ONLY $1.20 ea

MINI-MINI TOGGLE SWITCH

Half-size of submini toggle switch rated 3 amp 125V AC contact

		1–9	10–99
MS 2432P	SPST	0.90	0.80
MS 244	SPDT	1.00	0.90
MS 245	DPDT	1.20	1.10

LARGE QUANTITY AVAIL FOR OEM

PANEL METER (D.C. Type)

Size 60MM X 66MM
White Face Type

$5.50 ea.

0-50 UA	0-30V
0-1MA	0-50V
0-5MA	0-100V
0-100MA	

ELECTRONIC ALARM SIREN

COMPLETE UNIT

Ideal for use as an Alarm Unit, or hookup to your car back up to make a reverse indicator
Light Output up to 130 dB.
Voltage Supply 6～12V

AU—999

$7.50

LED ALARM CLOCK

COMPLETE UNIT NOT A KIT

- 0.5" RED LED READ OUT
- 24 HRS. ALARM SET
- 10 MINS. SNOOZE SET
- AM/PM ALARM INDICATORS
- SECOND DISPLAY SWITCH
- AUTOMATIC BRIGHTNESS CONTROL
- COMPACT AND HANDSOME PACKING
- 110V AC 60HZ INPUT

$17.50 EACH

TRANSFORMERS

ALL 117 VOLT INPUT

30V	4AMP	$7.50 EA.
36V CT	3AMP	$6.50 EA.
48V CT	3AMP	$6.50 EA.
24V CT	3AMP	$6.50 EA.
12 or 24V	2AMP	$3.90 EA.
24V CT	0.8AMP	$1.80 EA.
12V CT	0.8AMP	$1.80 EA.

SUBMINIATURES TOGGLE SWITCHES

SPDT	On Off	$1.30 ea.
DPDT	On Off	$1.50 ea.
3PDT	On Off	$1.75 ea.

Mini Size Rocker Type
Also Available at the Same Price

19 KEY HEXADECIMAL KEY PAD

- 1–0
- ABCDEF
- Homekey
- ←→ Key

SPECIAL $10.50 ea.

Low Cost Hexadecimal 16 Key Pad

Designed for Calculator
Can be used for Computer Data Entry Pad or Digital Lock
All key tops blank with super good touch feeling $0.95 ea.

5" MUFFIN FAN

HEAVY DUTY
5 Blade Type
110V 50/60HZ
Case made of Die-Cast metal used but almost brand new
SPECIAL PRICE $9.60 ea.

AC POWER SUPPLY

Wall Type Transformer

12V AC	Output	200MA	$2.75 EA.
16V CT AC	Output	100MA	$2.10 EA.
6V DC	Output	120MA	$1.90 EA.
12V DC	Output	100MA	$1.90 EA.

MINI SIZE REED RELAY

Approx. 1" square
SPST Normal Open
Contact rated 1AMP
Coil 6～12V DC
All brand new by AMF
3 for $2.00

DIGITAL ELECTRONIC LOCK KIT

$6.50 ea.
CMOS I.C. IN CIRCUIT

for auto ignition, entry door, burglar, alarm, etc.
4 Digits Programable to Any Combination

400Ω RELAY AND KEY PAD NOT INCLUDED

BIPOLAR LED

Jumbo Size red/green change color when reverse polarity of voltage. Ideal for go/nogo indicator.
Two for $1.50

150UA METER

only
$1.50 ea.

PUSH-BUTTON SWITCH

N/Open Contact
Color: Red, White, Blue, Green, Black. 4/$1.00
N/Close also Available 50¢ ea.
LARGE QTY AVAILABLE

POWER SUPPLY KIT

0-30V D.C. REGULATED

Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.

0-30 POWER SUPPLY $10.50 each

Transformer for Power Supply, 2 AMP 24V x 2 $6.50
30V DC Panel Meter $4.20

I.C. TEST CLIPS

Same as the E-Z clips
With 20" Long Leads
In Black and Red Colors
$2.75 per pair

HOUR INDICATOR

This unit is 1 5/8" long operating voltage 4V D.C. will tell you how many hours your circuit or machine has been in service up to 100 hours.

Limited Quantity ONLY $1.75 ea.

SOLIO STATE ELECTRONIC BUZZER

Mini Size 1"x3/4"x3/4"
Supply voltage 1.5V 12V
Ideal for Alarm or Tone Indicator
$1.50 each

MA1003, 12V DC CLOCK MODULE

Built in X'TAL controlled time base. Protected against automotive volt transients. Automatic brightness control with 0.3" green color display. Display turnoff with ignition "OFF".

$19.50

MINIMUM ORDER $10.00. California residents add 6% sales tax and 10% shipping.
Out of state add 15% of total purchase for shipping charges, out of USA and Overseas add 25% of total purchase.
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STORE HOURS 10-7 Monday - Saturday

master charge

your BANKAMERICARD welcome

CIRCLE 7 ON FREE INFORMATION CARD

FREE PROBES FREE PROBES FREE PROBES

NLS MS-215 DUAL TRACE MINISCOPE $395.00

NLS 1¢ SALE

LM3A 3 dig 1% DC	$125.
LM3.5A 3½ dig .5% DC	$147.
LM40A 4 dig .1% DC	$190.
LM4A 4 dig .03% DC	$227

- Rechargeable batteries and charger included
- Measures DC Volts, AC Volts, Ohms and Current
- Automatic polarity, decimal and overload indication
- Rechargeable batteries and charger
- Measures DC Volts, AC Volts, Ohms and Current
- Automatic polarity, decimal and overload indication
- No zero adjustment and no full-scale ohms adjust
- Battery-operated — NiCad batteries; also AC line operation.
- Large LED display for easy reading without interpolation
- Size: 1.9"H x 2.7"W x 4"D
  Parts & labor guaranteed 1 year
  Tilt stand option .... $ 3.50
- Leather case $16.00

Purchase any of the LM series Meters and buy the LEATHER CASE for 1¢

$289 MS-15 MINISCOPE
With Rechargeable Batteries & Charger Unit

- 15 megahertz bandwidth.
- External and internal trigger.
- Time base — .1 microsec. to 0.5 Sec/div - 21 settings ± 3%.
- Battery or line operation.
- Automatic & line sync modes
- Power consumption < 15 watts
- Vertical Gain — .01 to 50 V/div - 12 settings ± 3%
- Viewing area 1.1" x 1.35"
- Case size 2.7"H x 6.4"W x 7.5"D, 3 pounds
- Parts & Labor guaranteed 1 year
- 10 to 1, 10 meg probe $24.50
- Leather carrying case $30.00

PROBE 1¢
PROBE 1¢ with the purchase of SCOPE and the MENTION of this MAGAZINE

- MS-215 Dual Trace Version of MS-15 $395.00

3 LEVEL GOLD WIRE WRAP SOCKETS

	1-24	25-49	50-99	100-249	250-999	1K-5K
8 pin	41	38	35	31		23
14 pin	39	38	36	32		27
16 pin	44	42	39	35		30
18 pin	63	58	54	47	42	38
20 pin	80	75	70	68	58	53
22 pin	90	85	80	70	61	57
24 pin	90	84	78	68	63	58
28 pin	1.10	1.00	90	84	76	71
40 pin	1.50	1.40	1.30	1.20	1.04	89

3 LEVEL GOLD WIRE WRAP SOCKETS

Sockets purchased in multiples of 50 per type may be combined for best price.
All sockets are GOLD 3 level closed entry, End and side stackable. 2 level, Solder Tail, Low Profile, Tin Sockets and Plugs available. CALL FOR QUOTATION

SALE S-100 BUS EDGE CONNECTORS SALE

S100-WWG 50/100 Cont. .125 ctrs. 3 LEVEL WIRE WRAP .025" sq. posts on .250 spaced rows. GOLD plated.

1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-WWN 50/100 Cont. .125 ctrs. 3 LEVEL WIRE WRAP .025" sq. posts on .250 spaced rows. NASGLO tin-nickel plated

1-4	5-9	10-24
$3.50	$3.25	$3.00

S100-STG 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR and IMASI motherboards GOLD plated.

1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-STN 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR and IMASI motherboards. NASGLO tin-nickel plated.

1-4	5-9	10-24
$3.50	$3.25	$3.00

RG81G 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .140 spaced rows for ALTAIR motherboards. GOLD plated. $5.00

R681-3 50/100 Cont. .125 ctrs. PIERCED SOLDER EYELET tails. GOLD $7.35

Other Popular Edge Connectors

R644-G 22/44 Cont. .156 ctrs. PIERCED SOLDER EYELES tails. GOLD plated

1-4	5-9	10-24
$3.00	$2.75	$2.50

R644-3 22/44 Cont. .156 ctrs WIRE WRAP tails. GOLD $4.71

ATTN: OEM'S and Dealers, many other connectors available call or quotation.

Vector 8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS

- Kit includes 12 tantalum capacitors for +5, +12, −12 buses and insulated mounting spacers
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads
- Solder mask with solder windows on etched circuits to avoid accidental short circuits
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2 or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active pull up or floating terminations
- Large buses: +5V and GND (10 AMPS), ±12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10ºC rise
- Fits in Vector pak enclosures
- Fits in IMSAI 8080 microcomputer as expander board

Price: $29.50

Vector Plugboards

8800V Universal Microcomputer/processor plugboard use with S-100 bus. Complete with heat sink & hardware 5.3" x 10" x 1/16

1-4	5-9	10-24
$19.95	$17.95	$15.96

8801-1 Same as 8800V except plain, less power buses & heat sink

1-4	5-9	10-24
$14.95	$13.46	$11.96

3682 9.6" x 4.5" $10.97
3682-2 6.5" x 4.5" $9.81
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156

3677 9.6" x 4.5" $10.90
3677-2 6.5" x 4.5" $9.74
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156

3662 6.5" x 4.5" $7.65
3662-2 9.6" x 4.5" $11.45
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156

3690-12 CARD EXTENDER
Card Extender has 100 contacts-50 per side on .125 centers-Attached connector is compatible with S-100 Bus Systems $25.00
3690 6.5" 22/44 pin .156 ctrs. Extenders $12.00

1/16 Vector BOARD
.042 dia holes on 0.1 spacing for IC's

PART NO.	SIZE	PRICE 1-9	10-19
Phenolic			
64P44XXXP	4.5x6.5"	$1.49	1.34
169P44XXXP	4.5x17"	$3.51	3.16
Epoxy Glass			
64P44	4.5x6.5"	$1.70	1.53
84P44	4.5x8.5"	$2.10	1.89
169P44	4.5x17"	$4.30	3.87
169P84	8.5x17"	$7.65	6.89

SLIT-N-WRAP
Wraps insulated wire on .025" square posts
FOUR TIMES FASTER than regular manual wrap post tools

P180 with two 100' spools of 28 ga wire $24.50

P160-4T includes charger, wire $75.00

Vector
NO PRE-STRIPPING*
NO PRE-CUTTING*
SPOOL-FED WIRE*

*The spooled wire passes through the tool past a slitting edge next to the wrap post. A narrow longitudinal cut is made in the insulation, where it presses the square post corner, the bared copper is indented by the sharp edge (7 turns = 28 contacts). Insulation is cut where a wrap but not between terminal posts when led straight out of the tool.

Daisy chain runs. Reliable and easy to use. Manual or power operation

SLIT-N-WRAP WIRE
NO. 28 GAGE INSULATED WIRE, 100' SPOOLS
$2^15 Package
W28-2-A Pkg. 3 Green · W28-2-C Pkg. 3 Clear
W28-2-B Pkg. 3 Red · W28-2-D Pkg. 3 Blue

2708
8K 450 ns
EPROM
FACTORY PRIME
$10.00 EA.
25 + Call For Price

WOW 14 & 16 PIN GOLD 3 LEVEL WIRE WRAP SOCKETS
14 - G3 100 for $30.00
16-G3 100 for $30.00
50 of each for $32.00
Sockets are End & Side stackable, closed entry

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR
- For Auto, Home, Office
- Small in size (2x2¼x½)
- Push button for seconds release for date
- Clocks mount anywhere with either 3M double-sided tape or VELCRO, included.
- 2 MODELS AVAILABLE:
  LCD-101, portable model runs on self-contained batteries for better than a year.
  LCD 102, runs on 12 Volt system and is back lighted
- LCD 101 or LCD 102 your choice $34.95 ea.
- Clear desk stand for $2.00

LEDU MG 10A List $72
Perfectly balanced, fluorescent lighting with precision magnifier lens. For prof'l, techn'l & hobbist. Has die cast protective shade, inst. start 3 diopter lens 42" reach $44.95
with 1.9 fluorescent lamp (required) $4.95
colors: Gray or Black, Chocolate Brown
$44.95 SPECIAL

FM-7 With Rechargeable Batteries & Charger Unit $195
SC-5 With Rechargeable Batteries & Charger Unit $89

Features include: • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands). • The FM-7 utilizes an LED readout, providing 7 digit resolution. • The FM-7 can be calibrated to an accuracy of 0.00001%. • The SC-5 is accurate to one part per million. • Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included. • Dimensions of each are 1.9" H x 2.7" W x 3.9" D. • The units may be obtained separately or as a "Frequency Duo". • Parts & Labor guaranteed 1 year
Tilt stand option $3.50
Leather case $16.00

MICRO-KLIP
for .042 dia. holes (all boards on this page)
T42-1 pkg. 100 $ 1.50
T42-1 pkg. 1000 $11.00
P-149 hand installing tool $ 2.03

.8" LED ALARM CLOCK
12 hr. LED Alarm Clock uses 3½ digit .8" LED Display with AM/PM indicators and colons. Direct drive, PIN to PIN interface with #1998A I.C. Just add switches, AC Supply, Alarm. Display and I.C. only
$7.95 or 2/$15.00

Price Breakthrough! $17.50
MA1003 CAR CLOCK
Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC.

SPECIAL
14CS2 100 for $14.00
16CS2 100 for $16.00
14 pin CS2 10 for $2.00
16 pin CS2 8 for $2.00
These low cost DIP sockets will accept both standard width plugs and chips.
For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are end stackable.

Vector WRAP POST
for .042 dia. holes (all boards on this page)
T-44 pkg. 100 $ 2.28
T-44 pkg. 1000 $14.00
A-13 hand installing tool $ 2.80

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24 PIN DIP PLUGS WITH COVERS
3 / $1.00
40 / $10.00

NLS MS-215 DUAL TRACE MINISCOPE $395.00

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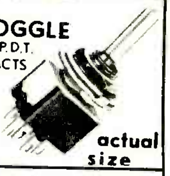
CIRCLE 20 ON FREE INFORMATION CARD

MINI MINI TOGGLE

EXTRA SMALL D.P.D.T.
3A 125VAC CONTACTS

each $1.50
8 – 10.
100 –$105.

actual size



ACTUAL SIZE

$1.35 10·$12

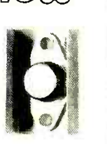
C & K #7103
Single pole double throw center off (3 position) toggle switch..........

LOOK new

RCA 40374
250V - 2A NPN T066

POWER TRANSISTOR MOUNTED ON A FACTORY ASSEMBLED HEAT SINK - 5.8 WATTS @ AMBIENT OF 25C

$.75 ea. 10 for $6



1/8 WATT RESISTORS

10 ea.-390, 1.8k, 3.9k, 6.8k, 11k
43k, 68k, 240k - 5 percent tol.

80 FOR $4

BISTABLE RELAY

SPDT 6VDC 200 OHM COILS
1 AMP 20 WATT DC CONTACTS
LONG LIFE (1 X 10⁹) OPER.
HIGH SPEED (500 HZ)
HERMETICALLY SEALED 3/8X3/8X3/4"

$2.95 ea.

2A,50V bridge 39¢ea

ultra sensitive relay

Single pole normally open dry reed relay. Unbelievable sensitivity,1800 ohm coil with 3 volt pull-in (that's less than 3 ma.) A TTL gate will directly drive many of these. A CMOS buffer will directly actuate this nifty relay.... MFG. unknown, but I was told they came from IBM. 600 available

$2.95 ea.

ELEC-TROL REED RELAY

12 vdc
440 Ω coil
4 dpst n.o.

sale

1.1"

PICTURE IS APPROXIMATION, RELAY HAS FOUR PINS ON ONE END AND TWO ON OTHER, PINS ARE SPACED .1" X 1". 1/2A CONTACTS.

79¢ ea. 10 - $6

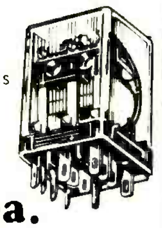
-SUPER SPECIALS-

DIAC 27 TRIGGER DIODE . . .		.20
PULSE XFMR. 1/1 TOROID-ENCASED		.25
600MFD. 360VDC PHOTO FLASH CAP.		.90
1702A 2K, 1us, EPROM		7.95
SP425 SPERRY 9 digit ¼" HV multiplexed 7 seg.		1.25
MM5369 time base osc. chip		1.75
T.V. crystal for above.....		1.75
1101A 256 x 1 MOS RAM		.59
93410 256 x 1 45NS RAM . . .		.85
75451 peripheral driver . .		.40
7402 TTL nor gate		.16
7430 TTL nand gate		.14
CERAMIC FILTER 10.7 MHz. . .		1.20
MM5058 1024 bit static SR . .		1.50
UA715 60MHz. op-amp		1.20
74S206 256 x 1 45NS RAM . . .		.90
78L2.6 2.6V TO92 .1A +regul.		.29
78L05 5.0V " " "		.29
78L6.2 6.2V " " "		.29
78L12 12V " " "		.29
78L15 15V " " "		.29
78M05 5V tab .5A + regul.		.59
78MG 4 term. adj. .5A + reg.		1.29
79MG " " " " - reg.		1.39
7805T tab 1A 5v regul		.89
7812 to-3 1A +12V regul.		.59

POTTER BRUMFIELD

Type KHP Relay
4 PDT 3A Contacts
24VDC COIL
650 ohms
120VAC
10.5MA

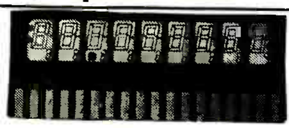
$1.60 ea.



DIP TRIMMER

12 TURN, ¼"x¼"x¼
5K or 200K only
mfg. DALE

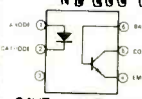
$.50 TEN FOR $4



SPERRY 9 DIGIT PLASMA DISPLAY, COMMON CATHODES, 1/4" HIGH DIGITS--
DM8880 IC DRIVER FOR "NIXIE" ABOVE DISPLAYS 0123456789AbCdEF WITH 0-15 BINARY INPUT............

DISPLAY or IC $1.50 BOTH $2.75

FANTASTIC OPTO ISOLATOR



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DRIVE TTL GATES DIRECT

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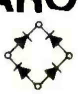
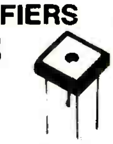


EPOXY BRIDGE RECTIFIERS
10 AMP 50V VJ048

$1.39 ea. - 10 for $12 100-$99



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95841
916 334 2161

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P. O. BOX 19442R Dallas, Texas 75219
PHONE ORDERS ON MASTERCHARGE/VISA (214) 823-3240

8 GOOD REASONS TO BUY FROM BULLET:

1. We are an established company, in business since 1976.
2. Mail order is our only business ..... Full Time.
3. Components & unassembled kits may be returned for full refund
4. Full repair service on any kit we sell
5. Our customers are important We are always available for help.
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7. We tell it like it is! Parts are as described.
8. We try harder - We want your business from now on.

THE SMALL PRINT

- No COD's
- Check or MO
- MC/VISA
- TX residence add 5% Sales tax
- Orders under $10 add .75 handling
- All orders add 5% for shipping & handling
- Orders over $50 take 10% discount
- Foreign address add 10% for shipping

MOBILE CLOCK CALENDAR KIT

Seems like everybody sells digital clock kits, however we have the only low cost DIGITAL CLOCK / CALENDAR for Mobile operation. We provide quality plated through hole boards and step-by-step instructions, parts overlays and schematics. This clock has many features and we supply all the parts but a small speaker. Fantastic for car, boat or Van.

- Intergral Timebase (.01% ACC)
- Large 4 DIGIT LED display with AM/PM indicators
- Flashing color at 1HZ rate
- Special noise and overvoltage protection for mobile use
- Auxiliary output will drive relay or TRIAC to control external equipment
- 5¾ Wx1⅝x2½D
- Built in ignition blanking turns off readouts when not in use
- Presettable alarm with Snooze
- Special "SleepTimer"

23.50 NO CASE

12 VAC XFMR for 110 VAC 1.50
24 Hour Format add 2.00

MG-01 ELECTRONIC GRANDFATHER CLOCK

While we are talking about clocks check out the MINI GRANDFATHER CLOCK Reviewed in April 1978 RADIO ELECTRONICS. We have the *only* kit in the world with all the below listed features. The biggest problem is to describe how unique and fascinating this timepiece really is! The LED "Swinging" Pendulum and Matching Tick-Tock Sound are available only on our clock. In addition the electronic "bell" notes each hour (ie 3 times for 3 o'clock) Housed in the optional Solid Hardwood Case, the unit makes a beautiful addition to any room.

- ½"4 DIGIT LED READOUT
- Adjustable tone & duration on chime
- Simulated swinging LED Pendulum
- All CMOS Construction
- Quality plated boards
- All electronics switches and XFMR included

39.95 KIT 59.95 ASEMB.

WE STOCK A COMPLETE LINE OF QUALITY LOW COST PANEL METERS. SEND FOR FREE CATALOG TODAY.

Optional Solid Hardwood Case for MG-01 Clock over 10 inches tall. Includes Ruby front. Unassembled SOLID HARDWOOD 17.95 SOLID WALNUT 19.95

ULTRASONIC SENDER RECEIVER KIT US-02

TOTAL SECURITY! Completely invisible ultrasonic (23KHZ) Sound beam works like a photoelectric beam but is uneffected by light, heat or noise. Seperate Transmitter and Receiver can be used from 6 inches to 25 feet! A solid object breaking the beam causes an output to go low that will sink up to 150 MA to Drive a Relay, TRIAC, etc. Complete electronics are provided. Works on 12VDC (unregulated) and draws less than 100 MA. Use it for burglar alarms, object counters, automatic door openers, automatic door bells, electronic rat trap(?) and more.

COMPLETE KIT LESS CASES 21.50

Optional entry delay and Alarm Timeout Circuit 3.95 will source or sink up to 200 MA OC.

10 WATT WARBLE ALARM KIT

It's hard to believe this little gem puts out 10 Watts of alternating dual tone screams. A real great attention getter. Great for alarms, games, toys, etc

2.50 with PC Board speaker not included Requires 12VDC @ 1A

OTHER GREAT KITS! We have 15A power supplies, CDI's, OVP's, mini mobile clocks, clock-timers, sound circuits and many more. It's all in our latest catalog. FREE ON REQUEST

PARTS (many more listed in catalog)

MC1469R	½A positive Voltage Reg	House •	1.25
MC1351P	FM IF and Sound System		.50
CA3011	Wideband IF Amp IC	House •	.50
MM5375	6 Digit Alarm Clock Chip		2.95
555	Timer & Pulse Gen Chip		.49
741	Op amps 8 pin MINI DIP		.20
LM3900	QUAD OP AMP		.45
723	Pos Voltage Reg DIP		.65
725	Ultra low noise high gain Op amp	House •	.99
NE565A	PLL DIP		.50
TCA430	Quad Audio Oscillator Dip		.69

MJ900, MJ1000	Matched Pair 8A Darlington	Pair/3.00
1N4148	Switching Diodes	25/1.00
2N3569	NPN Silicon Switching	6/1.00
2N2712	NPN Small Signal	8/1.00
2N4343	P Channel J Fet	4/1.00
2N6028	Programmable Unijunction	2/1.00
2N6111	PNP Med Power 30W T0220	3/1.00

ZENER GRAB BAG. A very nice assortment of 10 different voltages between 2.7v and 30 VDC in 400 MW, ½W and 1W. All are prime units but most have Mfg's numbers. We supply a cross reference sheet to standard numbers.
SPECIAL PRICE 10 pieces 1.00

CAPS

.022	@ 100VDC Mylar	8/1.00
.22	@ 50VDC Mylar	6/1.00
1.5mfd	@ 400VDC Mylar	4/1.00
.1mfd	@ 35V Tant Axial	6/1.00
.47mfd	@ 35V Tant Axial	6/1.00
2.2mfd	@ 35V Tant Axial	5/1.00
22mfd	@ 20V Dip Tant	4/1.00
33mfd	@ 10V Dip Tant	4/1.00
220mfd	@ 25V Alum. Axial	7/1.00
500mfd	@ 35V Alum. Axial	5/1.00
1100mfd	@ 35V Alum. Axial	4/1.00

HEATSHRINK TUBING
A very good Asst. of 3/32", 1/8" 3/16" & 1/4" in 6 inch lengths 12 pieces total .75
This item FREE with purchase of 15.00 or more

Miniature 7k Pot w/switch PC Mount or panel mount 1/8" shaft .49
Black plastic knob for above FREE

LIMITED QTY Computer Grade FILTER CAP Screw Terminals 2" X 5½" 9500 mfd@75V 2.95 or 4/9.95

SPECIAL SALE TIL 312 LED Common Anode 7 Segment Readout .3" Character Size Standard Pinout while they last .65 6/3.00

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540 Weddell Drive, #4, Sunnyvale, CA 94086 (415)969-7827

TTL

7400	.16
7401	.17
7403	.17
7404	.19
7406	.40
7407	.40
7409	.25
7410	.18
7413	.78
7414	.68
7417	.38
7420	.18
7421	.35
7427	.35
7430	.15
7432	.30
7437	.44
7440	.18
7442	1.00
7445	.70
7446	.70
7448	.70
7450	.25
7451	.25
7453	.25
7454	.35
7460	.22
7472	.40
7473	.40
7474	.40
7475	.55
7476	.45
7483	1.05
7485	1.10
7486	.43
7489	2.00
7493	.65
7495	..78
7496	.85
74121	.35
74122	.49
74123	.65
74126	.65
74132	1.25
74141	1.15
74145	1.10
74153	1.10
74154	1.25
74157	1.00
74161	1.00
74163	1.30
74164	1.45
74165	1.35
74173	1.70
74175	1.05
74177	.90
74182	.95
74192	1.45
74193	1.35
74195	1.00
74196	1.10
74197	1.10
74199	2.25
74367	.90

H TTL

74H00	.40
74H04	.40
74H08	.40
74H10	.40
74H11	.40
74H30	.65
74H40	.65
74H53	.65

S TTL

74S00	.40
74S02	.40
74S04	.45
74S10	.40
74S40	.50
74S64	.75
74S74	.65
74S112	.65
74S114	1.58
74S134	.85
74S153	1.89
74S157	1.55

8000 TTL

8092	.95
8094	.60
8095	.80
8096	.90
8098	.90
8121	2.25
8136	3.25
8220	3.25
8231	2.25
8242	1.75
8250	1.75
8260	2.25
8281	1.00
8284	[redacted]
8285	[redacted]
8334	4.00
8553	6.50
8556	3.25
8599	3.25

Interface

0025	3.50
0026	1.75
8640	1.25
8641	2.75
8806	3.00
8819	1.25
8820	5.00
8830	4.90
8833	2.45
8835	2.45
8836	1.25
8837	2.45
8838	2.45
8859	1.50
8865	1.50
8866	1.50
8867	1.85
8869	1.75
8879	2.25
8880	2.75
8884	2.45
8973	2.95
8974	2.95
8976	2.95
75107	3.25
75450	1.00
75451	.80
75452	.80
75453	.80
75491	1.25
75492	1.40
75494	1.50

Peripheral

8212	3.50
8214	8.50
8216	3.75
8224	4.75
8228	9.90
8251	11.50
8255	10.50
2513	9.50
2516	9.50
1013	6.50

PPL

561	5.00
566	1.70
567	1.65

Op. Amps.

301N	.35
307	.35
308H	1.00
318H	1.50
324N	1.75
709H	.30
741H	.35

V. Reguls.

309K	1.25
309H	1.00
320H-5	.85
320T-5	1.25
320T-12	1.25
340T-5	1.25
340T-12	1.25
340T-15	1.25
340T-24	1.25

TIMERS

555	.39
556	.85

74LSxx *

74LS374	2.25
74LS375	1.25
74LS377	3.25
74LS378	2.35
74LS379	2.25
74LS386	.95
74LS390	3.75
74LS393	2.75
74LS395	2.85
74LS399	2.60
74LS490	3.75
74LS668	2.25
74LS669	1.85
74LS670	3.95
74LS368	.95

* For more 74LSxx, refer to our ad in the June issue of this magazine.

If what you need is not listed, ask for it. Send self-addressed stamped envelope.

SPECIAL - - 21L02/450ns (1.50/10up; 1.35/50up; 1.25/100up)
± Digit A/D LD130 $5.50

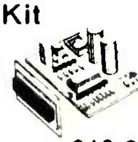
Minimum order $5.00 US currency. Check or money order only. Add 5% to cover shipping and handling charges. Calif. residents add 6% sales tax. Santa Clara County residents add 6.5% sales tax.

CIRCLE 68 ON FREE INFORMATION CARD

RADIO HUT

1-800-527-2304
Use Our Toll Free Watts Line
For Master Charge and BankAmericard Orders

Jumbo LED Car Clock Kit



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 hour Real Time format
- E. Perfect for cars, boats, vans, etc
- F. PC board and all parts (less case) inc

Alarm option — $1 50
AC XFMR — $1 50

$16.95

MUSICAL HORN

One tune supplied with each kit. Additional tunes — $6.95 each. Special tunes available. Standard tunes now available: — Dixie — Eyes of Texas — On Wisconsin — Yankee Doodle Dandy — Notre Dame — Pink Panther — Aggie War Song — Anchors Away — Never on Sunday — Yellow Rose of Texas — Deep in the Heart of Texas — Boomer Sooner — Bridge over River Kwai

CAR & BOAT KIT	HOME KIT	Special Design Case $3.50	Assembled & Tested
34.95	29.95		Add $10.00

TELEPHONE RELAY

Assembled & Tested **$29.95**

Automatically Starts & Stops Tape Recorders

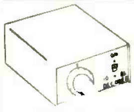
Surreptitious interception of telephone conversation is a violation of Federal Law and this device is not intended for such use.

6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2'' displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Kit includes all necessary parts (except case). Xfmr optional. Eliminate the hassle.

AC XFMR — **$1.50 Case $3.50** **$12.95**

NEW IMPROVED UNSCRAMBLER!



$25.00

Punched and Printed Case

Plugs into earphone or external speaker of any Scanner or Monitor. Guaranteed to unscramble any 1085 call

- **Easily tuned**
- **Full instruction included**
- **Drilled fiberglass P.C. Board**
- **One Hour Assembly**

12V 1 AMP POWER SUPPLY

INPUT VOLTAGE 25V MAX. OUTPUT CURRENT 1 AMP. MAX. LOAD REGULATION 50mV. OUTPUT VOLTAGE 12V. LINE REGULATION 0.01%. KIT CONTAINS ALL PARTS EXCEPT FOR LINE CORD AND TRANSFORMER.

ONLY **$4.50**

7400 TTL DIGITAL CIRCUITS

7400	11	7442	47	7490	65	74156	89
7401	13	7443	59	7491	61	74157	55
7402	13	7444	59	7492	43	74160	55
7403	13	7447	68	7493	43	74161	65
7404	15	7448	71	7494	67	74163	65
74L04	29	7450	13	7495	67	74164	85
74S04	44	7451	13	7496	67	74165	89
7406	16	7453	13	74100	30	74174	85
7408	19	7460	19	74104	49	74175	85
7410	13	747C	27	74107	28	74180	67
7411	18	7472	25	74109	31	74181	1 93
7412	26	7473	29	74121	29	74182	68
7416	15	7474	29	74123	48	74191	98
7420	13	7475	47	74132	99	74192	79
7423	25	7476	31	74136	99	74193	81
7425	29	7480	31	745138	1 95	74194	81
7433	26	7481	55	74141	75	74195	69
7437	23	7482	57	74151	61	9316	85
7438	23	7483	67	74153	61	9601	3/$1
7440	13	7485	89	74154	98	9L04	35
7441	76	7489	1 25	74155	89		

LINEARS

709	Operational Amplifier	25
710	Differential Comparators	40
711	Dual Differential Comp	35
712	Half Adder	25
749	Stereo Pre-Amp by Fairchild	2/$1
LM 301	Operational Amplifier	30
LM 307	Operational Amplifier	30
LM 308	Operational Amplifier	95
LM 309K	5V Lamp Regulator	1 49
LM 710	Voltage Comparator	25
LM 311	Voltage Comparator	85
LM 318	Operational Amplifier	1 15
LM 723	Voltage Comparator	69
LM 324	Quad Operational Amplifier	1 20
LM 377	Dual 2W Amplifier	1 85
LM 3900	Quad Op Amplifier	40
LM 741	Operational Amplifier	25
LM 748	Operational Amplifier	25
NE 553	Quad Timer	1 95
NE 555	Timer	40
NE 556	Dual Timer	95
NE 567	Tone Decoder	1 25
1458	Dual Op Amplifier	55
75491	Quad Segment Driver	35
75492	Hex Digit Driver	35
3043	IF Amplifier	75
8038	Voltage Cont Osc	3 95

MICROPROCESSOR SUPPORT CHIPS

8212 - I/O port	3.50
8214 — P.I.C.	12.95
8216 — Non Invert Bus	4.95
8224 — Clock Gen.	4.95
8226 — Invert Bus	3.95
PIO for Z—80	14.95
CTC for Z—80	14.95
8228 Sys. Controller	8.20
8251 Prog. comm. interface	10.95
8255 Prog. perp. interface	13.50
8820 Dual Line Recr.	1 75
8830 Dual Line Dr.	1.75
2513 Char. Gen.	7.50
8838 Quad Bus. Recvr.	2.00
74LS138N — 1/8 decoder	.99
8T97-Hex Tri-State Buffer	1.25
1488/1489 RS232	1.50
TR1602B Uart	3.95
TR1863 Uart	8.50

CLOCK & COUNTER CHIPS

MK50252	Clock Chip	$4 99
MK50250	Alarm Clock	3 75
MK50380	Alarm Chip	2 95
FCM7010	Direct Drive Clock Chip	4 95
MK5005	4 Digit Counter w/Latch	8 50
MK5002	4 Digit Counter	8 95
MK50395	6 Digit UP/Down Counter	12 95
MK50397	6 Digit Elapsed Timer	8.95
CT5005	Calculator Chip w/Specs	1 25
MK5021	Cal Chip w/sq rt	2.50

SOCKET SPECIAL! 28 PIN IC SOCKET 3 FOR $1 WHEN PURCHASED W/CLOCK IC

HOUSE # TTL IC's

7400	10/1 00	7437	6/1 00
7404	10/1 00	7438	6/1 00
7408	10/1 00	74141	3/1 00
7420	10/1 00	74153	3/1 00

Please specify that you are ordering House Number TTL

CRYSTALS

300 KHz	$1 50
3 57945	1 25

74LS00 LOW POWER SCHOTTKY

74LS00	21	74LS47	73	74LS136	37	74LS258	71
74LS02	21	74LS51	26	74LS138	71	74LS260	26
74LS03	21	74L654	26	74LS139	71	74LS266	26
74LS04	28	74LS55	26	74LS145	1 00	74LS279	55
74LS05	28	74LS73	35	74LS151	70	74LS290	75
74LS08	21	74LS74	35	74LS153	70	74LS293	61
74LS09	28	74LS76	49	74LS155	69	74LS295	95
74LS10	21	74LS83	73	74LS156	70	74LS298	95
74LS11	21	74LS85	1 35	74LS157	75	74LS365	55
74LS13	45	74LS86	36	74LS158	71	74LS366	55
74LS14	99	74LS90	55	74LS160	85	74LS367	55
74LS15	24	74LS92	55	74LS161	85	74LS368	55
74LS20	24	74LS93	55	74LS162	85	74LS390	1 75
74LS21	28	74LS109	38	74LS163	85	74LS393	1 45
74LS22	28	74LS112	38	74LS164	1 49	74LS670	2 30
74LS26	32	74LS113	38	74LS168	85	74LS192	95
74LS27	32	74LS114	38	74LS169	85	74LS193	95
74LS30	26	74LS122	49	74LS170	1 69	74LS194	95
74LS32	32	74LS124	99	74LS173	1 10	74LS195	85
74LS37	32	74LS125	47	74LS174	1 00	74LS196	85
74LS38	32	74LS126	47	74LS175	81	74LS197	85
74LS40	26	74LS132	79	74LS190	95	74LS251	85
74LS42	65	74LS133	35	74LS191	95	74LS253	81
						74LS257	71

TTL SPECIAL!

9002/7400	10/1 00
9003/7410	10/1 00
9004/7420	10/1 00
9006/7460	6/1 00
9007/7430	10/1 00
9009/7440	10/1 00
9016/7404	8/1 00
9024/74109	3/1 00
9300/74195	3/1 00

9000 series parts prime from ITT Pin for Pin compatible with 7400 series

PROMS

1702A - 1K - 1 5us 3 95 or 10/35.	
2708 - 8K Intel - 450ns	14.95
5204 - 4K	7.95
82S129 — 1K	2 50
2708S - 8K signetics 650ns	9.95

TRANSISTORS

INTERSIL DUAL TRANSISTORS
Originally Cost $3 each
Similar to 2N913
2 Per Pack 2/$1

GENERAL PURPOSE		POWER TRAN	
2N 2905 PNP	4 $1	115 W 200V NPN	95
2N 3904 NPN	6/$1	TIP 29 (EP967) NPN	4 $1
2N 3906 PNP	6/$1	TIP 30 (EP929) PNP	4 $1
2N 3392 Pre.Amp	25/$1	TIP 31 P C Leads NPN	5 $1
2N 4400 NPN	10 $1	MJE 2370	3 $1
2N 4402 PNP	10 $1	2N 3055	75
EN 2222 NPN	8 $1	TN 2021 By RCA	95
EN 2907 PNP	8 $1	FET TIS 75 HOUSE #	5/$1

DIODES

IN 4002 1 Amp 100 PIV	40/$1
IN 4004 1 Amp 400V	15/$1
IN 4007 1 Amp 1000V	10/$1

GERMANIUM DIODES

IN 54A	$8/$1
IN 270	10/$1

ZENER DIODES

IN 746 3.3V 400M	4/$1
IN 752 5.6V 400M	4/$1
IN 1958 8.2V 400M	4/$1
IN 5259 39V 500M	10/$1
IN 5271 100V 500M	10/$1
IN 5280 180V 500M	10/$1

HOUSE # ZENER

4.7V 500 MW	10/$1
9. V 500 MW	10/$1
10V 1 Watt	8/$1
15V 500 MW	10/$1
22V 5 Watt	6/$1

SWITCHING DIODES

IN 4148/IN914 Long Leads	20/$1
IN 4148/IN914 Cut Leads	40/$1
IN 4148/IN914 PC Leads	100/$2

VOLTAGE REGULATORS

7805 Pos	5V 1 Amp	99	7818 Pos	18V 1 Amp	99
7806 Pos	6V 1 Amp	99	7824 Pos	24V 1 Amp	99
7808 Pos	8V 1 Amp	99	7905 Neg	5V 1 Amp	1 10
7812 Pos	12V 1 Amp	99	7912 Neg	12V 1 Amp	1 10
7815 Pos	15V 1 Amp	99	7915 Neg	15V 1 Amp	1 10

723 VOLTAGE REGULATORS

Output voltages variable from 2 volts to 37 volts
A very versatile and popular device —14 PIN DIP
69c

MOTOROLA VOLTAGE REGULATOR

MC1469R TO-66 9 lead package for 3 to 30V outputs. Provides 600 MA direct output or more by using an external power transistor. Regular catalog price — $4 00 each! With specs **$1.95 each**

CMOS

CD400	19	CD4017	95	CD4040	1 00	CD4071	19
CD4001	19	CD4018	95	CD4041	69	CD4081	19
CD4002	19	CD4019	19	CD4042	69	CD4507	35
CD4006	1 20	CD4020	97	CD4043	60		
CD4007	19	CD4021	97	CD4044	60	CD4510	1 00
CD4009	47	CD4022	97	CD4046	1 39	CD4512	1 10
CD4010	39	CD4023	19	CD4047	1 50	CD4516	79
CD4011	19	CD4024	75	CD4049	35	CD4518	1 10
CD4012	29	CD4025	19	CD4050	39	CD4520	69
CD4013	32	CD4027	39	CD4051	1 19	CD4528	85
CD4014	78	CD4028	85	CD4053	1 19	74C02	45
CD4015	78	CD4029	99	CD4056	1 15	74C04	32
CD4016	32	CD4030	35	CD4066	78	74C107	79

ITT LED DRIVERS

ITT 501 Quad Seg Dr	35
ITT 502 Hex Digit Dr	49
ITT 503 Quad Seg Dr	49
ITT 506 Hex Digit Dr	49
ITT 508 8 Digit Dr	49
ITT 509 8 Seg Dr	49
ITT 511 Quad Seg Dr	55
ITT 514 8 Digit Dr	59

We have 100's of thousands of listed parts. These parts are 100% prime

TO -5 HEATSINKS

Similar to Thermalloy 2205G Finned with insert. **5/$1.**

TO -5 HEATSINKS

STANDARD SLIP - ON **6/$1.**

HEATSINKS FOR VOLTAGE REGULATORS

Black anodized aluminum "U" shaped. Fits TO-220 cases.
4 FOR $1.00

FAIRCHILD RTL's

The most popular digital IC's ever Produced. Very hard to find!

UL914	DUAL 2 INPUT NOR	.99
UL923	JK FLIP FLOP	$1.19

SOCKETS

8 Pin Low Profile	20	18 Pin Low Profile	30
14 Pin Low Profile	22	28 Pin Low Profile	69
16 Pin Low Profile	25	40 Pin Low Profile	89

Bowmar 4 Digit LED Readout Array

Full ½'' Litronix Jumbo Dual Digit LED Displays

4 JUMBO .50'' DIGITS ON ONE STICK! WITH COLONS & AM/PM INDICATOR
$3.95

DL 722 - C.C.	DL 728 - C.C.
DL 721 8 C.A.	DL 727 - C.A.
99c	$1.29

CAPACITORS

ELECTROLYTIC

AXIAL TYPE		RADIAL TYPE	
20MFD 250V	5/$1	47MFD 35V PC Leads	10/$1
35MFD 25V	15/$1	68MFD 25V PC Leads	8/$1
500MFD 35V	5/$1	330MFD 50V PC Leads	5/$1
		1000MFD 35V PC Leads	4/$1
		150 PF MICA 5%	10/$1

COMPUTER GRADE

1,900MFD 35WVDC (Mini)	3/$2
8,000MFD 15WVDC	95 cents each
33,000MFD 40WVDC	$4.00 Each

TANTALUM		CERAMIC DISC	
1MFD 20WVDC PC Leads	15/$1	68PF 50V	.001MFD 50V
4 7MFD 10WVDC PC Leads	5/$1	100PF 100V	.002FMD 200V
33MFD 10WVDC	6/$1	150PF 50V	.01MFD 200V
22PF 10	10/$1	220PF 50V	0.2MFD 200V
		330PF 50V	3.3PF 500V
		.001MFD 500V	100PF 500V

PC Leads 25/89 cents No Mix

BRIDGE RECTIFIERS

1 Amp	200V	6/$1
6 Amp	50V	1 10
10 Amp	50V	1 25
25 Amp	50V	1 39

RAMS

21L02-500NS	8/11.50
21L02-250NS	8/15.95
2114 — 4K	14.95
1101A — 256	8/$4.00
1103 — 1K	.35
MK 4115 - 8K	19.45
74S 200 - 256	3.95

UNMARKED 1702A EPROMS

3.50 Ea. or 10/$32.00
LIMITED SUPPLY

IMSAI SPECIAL

S-100 Connector
$3.95 Ea.

★ ★ JOY STICKS ★ ★

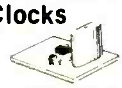
FOUR 100 K-OHMS POTS

Ideal for electronic games **$3.95**

MICRO-DIP $1.95

New — Series 2300
The World's Smallest Coded BCD Dual-In-Line Switch! PC Mount
2300 02G BCD 1-2-4-8
2300 12G BCD 1-2-4-8
Compliment

60 Hz. Crystal Time Base for Digital Clocks



$4.50
Buy 2 for $8.

- A. 60 Hz output with accuracy comparable to a digital watch
- B. Directly interfaces with all MOS clock chips
- C. Super low power consumption (1 5 ma type)
- D. Uses latest MOS 17 stage divider IC
- E. Eliminates forever the problem of AC line glitches
- F. Perfect for cars, boats, campers, or even for portable clocks at ham field days
- G. Small size, can be used in existing enclosures

KIT INCLUDES CRYSTAL, DIVIDER IC, P C BOARD PLUS ALL NECESSARY PARTS & SPECS

RADIO HUT

(All prices subject to change without prior notice.)

P.O. BOX 38323C
DALLAS, TEXAS 75238
AN EMPIRE INC CO

Money back guarantee. NO COD'S. Texas residents add 5% sales tax. Add 5% of order for postage and handling. Orders under $15.00 add 75 cents. Foreign orders add 20% for postage.

For your convenience, call your Bank Americard or Master Charge orders in on our Toll Free Watts Line. 1-800-527-2304. Texas residents call collect. 1-214-271-8423.

CIRCLE 74 ON FREE INFORMATION CARD

SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for Instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

DIP JUMPERS

Mates with standard 1C sockets
24" length • Fully Assembled & Tested

CONTS	DESCRIPTION	PART NO.	PRICE
14	sgl. end	924-102-24	$ 1.92
14	dbl. end	924106-24	3.02
16	sgl. end	924112-24	2.13
16	dbl. end	924116-24	3.34
24	sgl. end	924122-24	3.30
24	dbl. end	924126-24	5.20
40	sgl end	924132-24	5.53

Also Available in 12" and 36" lengths

CRYSTALS

THESE FREQUENCIES ONLY

PART NO.	FREQUENCY	CASE	PRICE
CY1A	1.000MHz	HC33	5.95
CY1.84	1.8432MHz	HC33	5.95
CY2A	2.000MHz	HC33	5.95
CY2.01	2.010MHz	HC33	1.95
CY2.50	2.500MHz	HC33	4.95
CY3.27	3.2768MHz	HC33	4.95
CY3.57	3.579545MHz	HC33	4.95
CY3A	4.000MHz	HC18	4.95
CY4.91	4.916MHz	HC18	4.95
CY7A	5.000MHz	HC18	4.95
CY5.18	5.185MHz	HC18	4.95
CY6.14	6.144MHz	HC18	4.95
CY6.40	6.400MHz	HC18	4.95
CY6.55	6.5536MHz	HC18	4.95
CY12A	10.000MHz	HC18	4.95
CY14A	14.31818MHz	HC18	4.95
CY19A	18.000MHz	HC18	4.95
CY18.43	18.432MHz	HC18	4.95
CY22A	20.000MHz	HC18	4.95
CY30A	32.000MHz	HC18	4.95

TRIMMERS

10MM size trimmers -.394" Dia.

Part No.	1-9	10-24	25-49	100+
TR-11(valve)	.35	.30	.25	20

Resistance values - 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1 meg

TRIMPOTS

Single-Turn - 1/2 Watt
Square - Top Adjust - 3/8" Size

Part No.	1-9	10-24	25-49	50-99
63P(value)	.99	.89	.80	.70

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg

15-Turn - 3/4 Watt

Rectangular Side Adjust 3/4" x 1/4" Size

Part No.	1-9	10-24	25-49	50-99
43P(value)	1.35	1.25	1.20	1.15

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg.

1/16 VECTOR BOARD

	0.1 Hole Spacing Part No	P-Pattern L	P-Pattern W	Price 1-9	Price 10 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 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

SLIT N WRAP

Model P180 includes 2-100' spools #28 AWG wire wrap wire

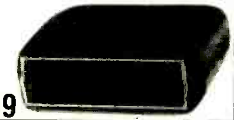
Supplies insulated wire from spool to wrap-posts without prestripping and precutting using "daisy chain" method.

Model P180 $24.50

REPLACEMENT WRAP BIT for P180 Slit N Wrap No. P180A $12.95 each

Replacement wire-wrap wire for P180 #28 AWG (pkg. of 3) $2.75 each
W28-2-A green W28-2-B red
W28-2-C clear W28-2-D blue

INSTRUMENT/CLOCK CASE



Injection molded unit
Complete with red bezel
4½" x 4" x 1-9/16"
$3.49

MICROPROCESSOR COMPONENTS

P8085	CPU	$29.95	CDP 1802	CPU	$19.95
8080A	CPU	10.95	Z80	CPU	24.95
8212	8-Bit Input/Output	4.95	2650	MPU	26.50
8214	Priority Interrupt Control	7.95	MC6800	MPU	19.95
8216	Bi-Directional Bus Driver	4.95	MC6810API	128 x 8 Static Ram	5.95
8224	Clock Generator/Driver	5.95	MC6820	Periph. Interface Adapter	7.95
8228	System Controller/Bus Driver	5.95	MC6821	Periph. Interface Adapter	11.50
8251	Prog. Comm. Interface	9.95	MC6830L8	1024 x 8 Bit ROM	14.95
8255	Prog. Periph. Interface	10.95	MC6850	Asychronous Comm. Adapter	14.95

RAM'S

1101	256 x 1	Static	$ 1.49
1103	1024 x 1	Dynamic	.99
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
2112	256 x 4	Static	5.95
2114	4K x 1	Static 450ns	9.95
2114L	4K x 1	Static 450ns Low Power	10.95
2114-3	4K x 1	Static 300ns	10.95
2114L-3	4K x 1	Static 300ns Low Power	11.95
7489	16 x 4	Static	1.75
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
21L02	1024 x 1	Static	1.95
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	3/1.00
MK4027 (UPD414)	4K	DYNAMIC 16 PIN	5.95
MK4116 (UPD416)	16K	DYNAMIC 16 PIN	29.95
TMS4044-45NL	4K	STATIC	14.95

ROM'S

2513(2140)	Character Generator (upper case)	$ 9.95
2513(3021)	Character Generator (lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048 Bit Read Only Memory	1.95

USER MANUALS

1802M	CDP1802 Manual	$ 7.50
Z80M	Z80 Manual	7.50
2650M	2650 Manual	5.00

PROMS

1702A	2048 x 1	Famous	$ 5.95
5203	2048 x 1	Famous	14.95
82S23	32 x 8	Open C	5.00
82S115	4096 x 1	Bipolar	19.95
82S123	32 x 8	Tristate	5.00
74S287	1024 x 1	Static	7.95
2708	8K	EPROM	10.95
2716 T.I	16K	EPROM	29.95
2716 Intel	16K	EPROM	59.95
6301-1	1024 x 1	Tri-State Bipolar	3.49
6330-1	256 x 1	Open C Bipolar	2.95
74186	512 x 1	TTL Open Collector	9.95
74188	256 x 1	TTL Open Collector	3.95

SHIFT REGISTERS

MM5013N	1024 BitAccumulator Dynamic	2.95
MM5016H	500/512 Bit Dynamic	.89
MM5017N	Dual 500/512 Bit Dynamic	2.95
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2519	Hex 40 Bit Static	4.00
2522	Dual 132 Bit Static	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4 X 4 Register	1.95

UART'S

AY-5-1013	30K BAUD	$ 5.95

SPECIAL REQUESTED ITEMS

TELEPHONE KEYBOARD CHIPS

AY-5-9100	$14.95
AY-5-9200	14.95
AY-5-9500	4.95
AY-5-2376	14.95
HD0165	7.95
74C922	9.95

ICM CHIPS

ICM7045	$24.95
ICM7205	19.95
ICM7207	7.50
ICM7208	19.95
ICM7209	6.95

NMOS READ ONLY MEMORIES

MCM6571	$13.50
MCM6574	13.50
MCM6575	13.50

TV GAME CHIP SET
AY-3-8500-1 Chip and 2.010 MHz Crystal $7.95

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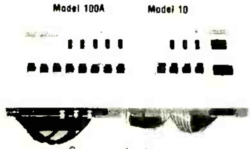
11C90	$19.95	MK40240	$17.50
MC3061P	11.95	DS0026CH	3.75
MC1408L7	4.95	TIL308	10.20
MC1408L8	5.75	95H90	11.95
LO110/111	$25.00/set		
MC4016(74416)	7.50		
4N33	3.95		

PARATRONICS

Logic Analyzer Kit Model 100A
$229.00/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
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4.95)

- 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

PARATRONICS TRIGGER EXPANDER - Model 10
Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit)
Model 10 Kit - $229.00
Baseplate — $9.95
Model 10 Manual — $4.95

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage - 0-1000V
AC Voltage 0-1000V
Freq. Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4 x 4.4 x 2"

Model 2800 $99.95
Comes with test leads, operating manual and spare fuse

Accessories:
AC Adapter BC-28 $9.00
Rechargeable Batteries BP-26 20.00
Carrying Case LC-28 7.50

CSC 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:
Mobile Charger Eliminator — use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator — use 110 V AC — Model 100 — CAI $9.95

KEYBOARDS

63-Key Unencoded

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most applications. IN STOCK **$29.95/each**

Hexadecimal Encoder

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

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

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The Incredible "Pennywhistle 103"

$129.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf. In addition, it is free of critical adjustments and is built with non-precision readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable: Low (normal) 1070 space, 1270 mark, High 025 space, 2225 mark
Receive Sensitivity	46 dbm accoustically coupled
Transmit Level	15 dbm nominal. Adjustable from 6 dbm to 20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

The Original the 3rd Hand

$9.95 each

- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

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

IMK 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model KB503 5V Power Kit $17.50

JE700 CLOCK

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

12 or 24 Hour
115 VAC
KIT ONLY **$16.95**

JE803 PROBE

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

$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **JE225 $9.95 Per Kit**

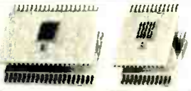
CSC PROTO BOARDS

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

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	80.00
PB203A - 9.75 x 6½ x 2¾	129.95

(includes power supply)

PROTO CLIPS



14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

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SN7403N	.18	SN7475N	.49	SN74163N	.89
SN7404N	.18	SN7476N	.35	SN74164N	.89
SN7405N	.20	SN7479N	5.00	SN74165N	.89
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SN7412N	.25	SN7490N	.45	SN74175N	.79
SN7413N	.40	SN7491N	.59	SN74176N	.79
SN7414N	.70	SN7492N	.43	SN74177N	.79
SN7416N	.25	SN7493N	.43	SN74179N	1.95
SN7417N	.25	SN7494N	.65	SN74180N	.79
SN7420N	.20	SN7495N	.65	SN74181N	1.95
SN7421N	.29	SN7496N	.65	SN74182N	.79
SN7422N	.39	SN7497N	3.00	SN74184N	1.95
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SN7429N	.39	SN74121N	.35	SN74191N	1.25
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SN7432N	.25	SN74123N	.49	SN74193N	.79
SN7437N	.25	SN74125N	.49	SN74194N	.89
SN7438N	.25	SN74126N	.49	SN74195N	.69
SN7439N	.25	SN74132N	.75	SN74196N	.89
SN7440N	.20	SN74136N	.75	SN74197N	.89
SN7441N	.89	SN74141N	.79	SN74198N	1.49
SN7442N	.49	SN74142N	2.95	SN74199N	1.49
SN7443N	.75	SN74143N	2.95	SN74200N	5.59
SN7444N	.75	SN74144N	2.95	SN74251N	1.79
SN7445N	.75	SN74145N	.79	SN74279N	.79
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SN7450N	.20	SN74151N	.59	SN74365N	.69
SN7451N	.20	SN74153N	.59	SN74366N	.69
SN7453N	.20	SN74154N	.99	SN74367N	.69
SN7454N	.20	SN74155N	.79	SN74368N	.69
SN7459A	.25	SN74156N	.79	SN74390N	1.95
SN7460N	.20	SN74157N	.65	SN74393N	1.95
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CD4001	.23	CD4029	1.19	CD4071	.23
CD4002	.23	CD4030	.49	CD4072	.49
CD4006	1.19	CD4035	.99	CD4076	1.39
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CD4009	.49	CD4041	1.25	CD4082	.23
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CD4021	1.39	CD4059	9.95	CD4508	3.95
CD4022	1.19	CD4060	1.49	CD4510	1.39
CD4023	.23	CD4066	.79	CD4511	1.29
CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.25			CD4520	1.29
CD4027	.69			CD4566	2.25

74C00

74C00	.39	74C89	6.49	74C163	3.00
74C02	.55	74C90	3.00	74C164	3.25
74C04	.75	74C93	2.00	74C173	2.60
74C08	.75	74C95	2.00	74C192	3.49
74C10	.65	74C107	1.25	74C193	2.75
74C14	3.00	74C151	2.90	74C195	2.75
74C20	.65	74C154	3.00	74C922	9.95
74C30	.65	74C157	2.15	74C923	8.95
74C42	2.15	74C160	3.25	74C925	14.95
74C48	4.75	74C161	3.25	74C926	11.95
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LM301CN	.35	LM340T-18	1.25	LM741CN	.35
LM302H	.75	LM340T-24	1.25	LM741-14N	.39
LM304H	1.00	LM350N	1.00	LM747H	.79
LM305H	.60	LM351CN	.65	LM747N	.79
LM307CN/H	.35	LM370N	1.15	LM748H	.39
LM308H	1.00	LM373N	3.25	LM748N	.39
LM308CN	1.00	LM377N	4.00	LM1303N	.99
LM309H	1.10	LM380N	1.25	LM1304N	1.19
LM309K	1.25	LM380CN	.99	LM1305N	1.40
LM310CN	1.15	LM381N	1.79	LM1307N	.85
LM311H	.90	LM382N	1.79	LM1310N	2.95
LM311N	.90	NE501N	8.00	LM1351N	1.65
LM317K	6.50	NE510A	6.00	LM1414N	1.75
LM318CN	1.50	NE529A	4.95	LM1458CN/H	.59
LM319N	1.30	NE531H	3.00	MC1488	1.95
LM320K-5	1.35	NE536T	6.00	MC1489	1.95
LM320K-5.2	1.35	NE540L	6.00	LM1496N	.95
LM320K-12	1.35	NE550N	1.30	LM1556V	1.75
LM320K-15	1.35	NE555V	.39	MC1741SCP	3.00
LM320K-18	1.35	NE556	.99	LM2901N	2.95
LM320K-24	1.35	NE560B	5.00	LM3053	1.50
LM320T-5	1.25	NE561B	5.00	LM3065N	.69
LM320T-5.2	1.25	NE562B	5.00	LM3900N(3401)	.49
LM320T-8	1.25	NE565H	1.75	LM3905N	.89
LM320T-12	1.25	NE565N	1.25	LM3909	1.25
LM320T-15	1.25	NE566CN	1.75	MC5558V	1.00
LM320T-18	1.25	NE567H	1.25	LM7525N	.90
LM320T-24	1.25	NE567V	.99	LM7534N	.75
LM323K-5	5.95	NE570	10.50	8038B	4.95
LM324N	1.80	LM703CN/H	.45	LM75450	.49
LM339N	.99	LM709H	.29	75451CN	.39
LM340K-5	1.35	LM709N	.29	75452CN	.39
LM340K-6	1.35	LM710N	.79	75453CN	.39
LM340K-8	1.35	LM711N	.39	75454CN	.39
LM340K-12	1.35	LM723H	.55	75491CN	.79
LM340K-15	1.35	LM723N	.55	75492CN	.89
LM340K-18	1.35			75494CN	.89
LM340K-24	1.35			RC4151	5.95
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LM340T-6	1.25			RC4195	4.49

74LS00 TTL

74LS00	.23	74LS74	.35	74LS155	.69
74LS02	.23	74LS75	.49	74LS157	.69
74LS03	.23	74LS76	.35	74LS160	.89
74LS04	.29	74LS83	.75	74LS161	.89
74LS05	.29	74LS85	.99	74LS162	.89
74LS08	.23	74LS86	.35	74LS163	.89
74LS10	.23	74LS90	.49	74LS164	.99
74LS13	.49	74LS92	.59	74LS175	.79
74LS14	.99	74LS93	.59	74LS181	2.49
74LS20	.23	74LS95	.79	74LS190	.89
74LS26	.29	74LS96	.89	74LS191	.89
74LS27	.29	74LS107	.35	74LS192	.89
74LS28	.29	74LS109	.35	74LS193	.89
74LS30	.23	74LS112	.35	74LS194	.89
74LS32	.29	74LS123	.99	74LS195	.89
74LS40	.29	74LS132	.79	74LS253	.79
74LS42	.69	74LS136	.39	74LS257	.69
74LS47	.69	74LS138	.69	74LS260	.55
74LS51	.23	74LS139	.69	74LS279	.59
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.125" dia.			
XC209	Red	5/$1	
XC209	Green	4/$1	
XC209	Orange	4/$1	
XC209	Yellow	4/$1	
.200" dia.			
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XC22	Green	4/$1	
XC22	Yellow	4/$1	
XC22	Orange	4/$1	
SSL-22	RT	4/$1	
.185" dia.			
XC526	Red	5/$1	
XC526	Red	100/$8	
XC526	Green	4/$1	
XC526	Yellow	4/$1	
XC526	Clear	4/$1	
.190" dia.			
XC111	Red	5/$1	
XC111	Green	4/$1	
XC111	Yellow	4/$1	
XC111	Orange	4/$1	
.200" dia.			
XC556	Red	5/$1	
XC556	Red	100/$8	
XC556	Green	4/$1	
XC556	Yellow	4/$1	
XC556	Orange	4/$1	
XC556	Clear	7/$1	
.085" dia.			
MV50	Red	6/$1	
.170" dia.			
MV10	Red	4/$1	
INFRA-RED LED	1/4 x 1/4 x 1/16 Flat	5/$1.00	

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6680	Common Cathode-orange	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6710	Common Anode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6730	Common Anode-red ±1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 52	Common Anode-green	.300	1.25	MAN 6750	Common Cathode-red ±1	.560	.99
MAN 71	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	.99
MAN 72	Common Anode-red	.300	.99	MAN 6780	Common Cathode-red	.560	.99
MAN 74	Common Cathode-red	.300	1.25	DL701	Common Anode-red ±1	.300	.99
MAN 81	Common Anode-yellow	.300	.99	DL702	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.99	DL707	Common Anode-red	.300	.99
MAN 3620	Common Anode-orange	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3630	Common Anode-orange ±1	.300	.99	DL746	Common Anode-red ±1	.630	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 4610	Common Anode-orange	.400	.99	DL749	Common Cathode-red ±1	.630	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL750	Common Cathode-red	.600	1.49
MAN 4710	Common Anode-red ±1	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4730	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Anode	.350	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode (FND500)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6630	Common Anode-orange	.560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6640	Common Cathode-orange-D.D.	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6650	Common Cathode-orange ±1	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6660	Common Anode-orange	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA2023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3130	1.39
CA3059	3.25	CA3140	1.25
CA3060	3.25	CA3160	1.25
CA3080	.85	CA3401	.49
CA3081	2.00	CA3600	3.50

CALCULATOR CHIPS AND DRIVER

FCM3817	$5.00
MM5725	2.95
MM5736	1.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
5030	7.95

CLOCK CHIPS

MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
7001	5.95

9374 - 7-segment LED driver common anode LEDs $ .99

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$ .17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$ .27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$ .30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.75	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$ .40	.38	.35	22 pin WW	.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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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

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- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

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EXAR

XR2206KA $14.95 Function Generator Kit (includes chip, P.C. Board and instructions)

XR2206KB $19.95 Function Generator Kit (includes all components, P.C. Board and instructions)

XR-L555 $1.50
Micro-Power version of the popular 555 Timer and directly interchangeable. Dissipates 1/15th the power and operates down to 2.7 volts. Perfect for battery operation and CMOS circuits.

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Precision timing circuit for generating timing pulses in **minutes, hours** and days or up to 1 year by using two. Reduces cost of time delay circuits. Basic 555 Timer with built-in 8-bit Counter.

XR205	$8.40	XR1489	1.39	XR2556	$3.20
XR210	4.40	XR1800	3.20	XR2567	2.99
XR215	4.40	XR2206	4.40	XR3403	1.25
XR320	1.55	XR2207	3.85	XR4136	1.25
XR555	.39	XR2208	5.20	XR4151	2.85
XR556	.99	XR2209	1.75	XR4194	1.45
XR567CP	.99	XR2211	5.25	XR4202	3.60
XR567CT	1.25	XR2212	4.35	XR4212	2.05
XR1310P	1.30	XR2240	3.45	XR4558	.75
XR1468CN	3.85	XR2264	4.25	XR4739	1.15
XR1488	1.39			XR4741	1.47

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	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	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
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(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
TIS133	5/1.00	PN3567	3/1.00	PN4249	4/1.00
TIS135	5/1.00	PN3568	4/1.00	PN4250	4/1.00
40409	1.75	PN3569	4/1.00	2N4400	4/1.00
40410	1.75	MPS3638A	5/1.00	2N4401	4/1.00
40673	1.75	MPS3702	5/1.00	2N4402	4/1.00
2N918	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2219A	3/1.00	MPS3704	5/1.00	2N4409	5/1.00
2N2221A	4/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2222A	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2906	4/1.00	2N3724A	.65	PN5138	5/1.00
2N2907	5/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	4/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	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

	1-9	10-99	100+		1-9	10-99	100+
.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

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.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

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Axial Lead	1-9	10-99	100+	Radial Lead	1-9	10-99	100+
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

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4006–	.95	4018–	.78	4029–	.77	4066–	.58
4007–	.16	4019–	.37	4030–	.33	4071–	.24
4009–	.37	4020–	.84	4035–	.97	4076–	.97
4010–	.37	4021–	.77	4042–	.58	4518–	.89
4011–	.16	4022–	.85	4046–	1.45	74C10–	.22
4012–	.16	4023–	.16	4047–	1.50	74C193	1.50
4013–	.29	4024–	.66	4049–	.34		
4015–	.74	4025–	.16	4050–	.34		

2708-8K EPROM (450 ns)	$ 9.75
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MM5270 4K X1 DYN	$ 3.48
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2101-1-254 x 4 STATIC	$ 2.45
2111-1-256 x 4 STATIC	$ 3.45
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- FND 503 C.C. .5" $ .85
- FND 510 C.A. .5" $ .85
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- DL-704 C.A. .3" $ .85
- DL 747 C.A. .6" $1.65
- FND 800 C.C. .8" $1.95
- FND 807 C.A. .8" $1.95

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2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG UJT	$ .65

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- MCM 6571A 7 x 9 character gen $10.75

Silicon Power Rectifiers

PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.30	.80	3.70	5.00
200	.07	.20	.35	1.15	4.25	6.50
400	.09	.25	.50	1.40	6.50	9.50
600	.11	.30	.70	1.80	8.50	12.50
800	.15	.35	.90	2.30	10.50	16.50
1000	.20	.45	1.10	2.75	12.50	20.00

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- 79 MG $1.35

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MRF-8004 a CB RF Transistor NPN	$ 1.50
2N3772 NPN Si TO 3	$ 1.00
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2N4908 PNP Si TO 3	$ 1.00
2N6056 NPN Si TO 3 Darlington	$ 1.70
2N5086 PNP Si TO-92	4/$ 1.00
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TTL IC SERIES

7400–	.13	7445–	.65	74151–	.61
7401–	.13	7446–	.68	74153–	.61
7402–	.13	7447–	.58	74154–	.94
7403–	.13	7448–	.68	74155–	.58
7404–	.15	7450–	.15	74157–	.55
7405–	.13	7472–	.25	74161–	.55
7406–	.16	7473–	.28	74163–	.55
7407–	.20	7474–	.28	74164–	.85
7408–	.18	7475–	.45	74165–	.95
7409–	.18	7476–	.30	74170–	1.68
7410–	.13	7480–	.31	74173–	1.20
7411–	.18	7483–	.65	74174–	.95
7412–	.13	7485–	.87	74175–	.85
7413–	.36	7486–	.28	74176–	.75
7414–	.60	7490–	.42	74177–	.75
7416–	.22	7491–	.58	74180–	.65
7417–	.25	7492–	.43	74181–	1.90
7420–	.13	7493–	.43	74190–	1.00
7425–	.25	7494–	.67	74191–	1.00
7426–	.22	7495–	.65	74192–	.79
7427–	.19	7496–	.65	74193–	.79
7430–	.13	74107–	.28	74194–	.80
7432–	.22	74121–	.29	75325–	1.50
7437–	.21	74122–	.38	74196–	.86
7438–	.21	74123–	.45	74279–	.55
7440–	.13	74125–	.40	74367–	.65
7441–	.70	74126–	.40	75491–	.50
7442–	.37	74150–	.94	75492–	.50

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- 16 PIN .28 40 PIN .60
- 18 PIN .30

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- Si 1050 G 50 WATTS $25.90

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74LS03	.21	74LS136	.39	LM307	.30
74LS04	.28	74LS138	.70	LM 308	.75
74LS05	.28	74LS139	.70	LM 311	.75
74LS08	.21	74LS151	.70	LM 318	1.20
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74LS11	.21	74LS156	.70	LM 339	1.10
74LS13	.44	74LS157	.72	LM 358	.70
74LS15	.25	74LS160	.88	LM 370	1.15
74LS20	.24	74LS161	.85	LM 377	2.50
74LS21	.26	74LS162	.85	LM 380	.95
74LS22	.26	74LS163	.85	LM 381	1.25
74LS26	.32	74LS168	.88	LM 382	1.25
74LS27	.32	74LS169	.85	LM 537	2.50
74LS30	.26	74LS170	1.68	LM 553	2.50
74LS32	.32	74LS173	1.10	LM 555	.39
74LS37	.32	74LS174	1.00	LM 556	.85
74LS38	.32	74LS175	.80	NE540L	2.25
74LS40	.26	74LS190	.95	560	2.00
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74LS47	.79	74LS192	.95	566	1.25
74LS51	.26	74LS193	.95	567	1.30
74LS54	.26	74LS195	.95	703	.90
74LS90	.95	74LS196	.95	709	.25
74LS74	.35	74LS197	.95	710	.35
74LS76	.35	74LS221	1.25	741C or V	.31
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74LS93	.55	74LS366	.55	CA3046	.75
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74LS112	.38	74LS368	.55	8038CC	3.90
74LS113	.38	74LS390	1.40	791	1.95
74LS114	.38				
74LS125	.47	MC14680	1.35	LF356H	1.20

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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		1.5[illegible]	3.00

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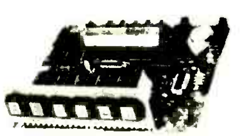

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SN7414N	70	SN7491N	75	SN74177N	79
SN7416N	35	SN7492N	49	SN74179N	2.49
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SN7427N	37	SN74109N	95	SN74188N	3.95
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SN7430N	25	SN74121N	39	SN74191N	1.25
SN7432N	25	SN74122N	39	SN74192N	89
SN7437N	35	SN74123N	50	SN74193N	89
SN7438N	35	SN74125N	60	SN74194N	1.25
SN7439N	25	SN74126N	60	SN74195N	75
SN7440N	21	SN74132N	1.25	SN74196N	1.00
SN7441N	89	SN74136N	95	SN74197N	1.00
SN7442N	69	SN74141N	1.15	SN74198N	1.75
SN7443N	75	SN74142N	2.95	SN74199N	1.75
SN7444N	75	SN74143N	3.25	SN74200N	5.59
SN7445N	75	SN74144N	3.00	SN74251N	1.79
SN7446N	89	SN74145N	1.15	SN74279N	90
SN7447N	69	SN74147N	2.35	SN74283N	2.25
SN7448N	89	SN74148N	2.00	SN74284N	6.00
SN7450N	25	SN74150N	1.25	SN74285N	6.00
SN7451N	25	SN74151N	79	SN74365N	75
SN7453N	25	SN74153N	89	SN74366N	75
SN7454N	25	SN74154N	1.25	SN74367N	75
SN7459A	25	SN74155N	89	SN74368N	75
SN7460N	25	SN74156N	89	SN74390N	2.25
SN7470N	45	SN74157N	89	SN74393N	2.25

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CD4000	23			CD4069	45
CD4001	23			CD4070	55
CD4002	23	CD4027	69	CD4071	23
CD4006	1.19	CD4028	89	CD4072	49
CD4007	25	CD4029	1.19	CD4076	1.39
CD4009	39	CD4030	49	CD4081	23
CD4010	49	CD4035	99	CD4082	23
CD4011	23	CD4040	1.19	CD4098	2.49
CD4012	25	CD4041	1.25	MC14409	14.95
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CD4019	49	CD4050	49	CD4510	1.39
CD4020	1.19	CD4051	1.19	CD4511	1.29
CD4021	1.39	CD4053	1.19	CD4515	2.95
CD4022	1.19	CD4056	1.49	CD4518	1.29
CD4023	23	CD4059	9.95	CD4520	1.29
CD4024	79	CD4060	1.49	MC14562	14.50
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CD4026	2.25	CD4068	39	MC14583	3.50

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74C10	65	74C93	2.00	74C164	3.25
74C14	3.00	74C95	2.00	74C173	2.60
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74C30	65	74C151	2.90	74C195	2.75
74C42	2.15	74C154	3.00	80C95	1.50
74C73	1.50	74C157	2.15	80C97	1.50

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LM301H	35	LM340T-12	1.25	LM741CN	35
LM301CN	35	LM340T-15	1.25	LM741-14N	39
LM302H	75	LM340T-18	1.25	LM747H	79
LM304H	1.00	LM340T-24	1.25	LM747N	79
LM305H	60	LM350N	1.00	LM748H	39
LM307CN	35	LM351CN	65	LM748N	39
LM308H	1.00	78MG	1.75	LM1303N	90
LM308CN	1.00	LM370N	1.15	LM1304N	1.19
LM309H	1.10	LM373N	3.25	LM1305N	1.40
LM309K	1.25	LM377N	4.00	LM1307N	85
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LM340K 6	1.35	LM709H	29	75453CN	39
LM340K 8	1.35	LM709N	29	75454CN	39
LM340K 12	1.35	LM710N	79	75491CN	79
LM340K 15	1.35	LM711N	39	75492CN	89
LM340K 18	1.35	LM723H	55	75494CN	89
LM340K 24	1.35	LM723N	55	RC4194	
LM340T 5	1.25	LM733N	1.00	RC4195	
LM340T 6	1.25	LM739N	1.19		

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74LS27	39	74LS95	1.50	74LS192	2.49
74LS26	39	74LS96	1.89	74LS193	2.49
74LS30	29	74LS107	59	74LS194	1.89
74LS32	39	74LS109	59	74LS195	1.89
74LS40	39	74LS112	59	74LS253	1.75
74LS42	1.25	74LS123	1.25	74LS257	1.75
74LS47	1.25	74LS132	1.25	74LS260	55
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7402	.21	74LS02	.28	74C04N	.25	75454	.61
7403	.21	74LS03	.28	74C08N	.25	75491	.81
7404	.21	74LS04	.29	74C10N	.25	75492	.84
7405	.21	74LS05	.29	74C14N	.90	75493	1.09
7406	.25	74LS08	.29	74C20N	.25	75494	1.19
7407	.25	74LS09	.29	74C30N	.25	MC1488N	.90
7408	.21	74LS10	.28	74C32N	.25	MC1489N	.90
7409	.21	74LS11	.28	74C42N	.98	LINEAR	
7410	.21	74LS12	.28	74C48N	1.28	CA3046	.75
7411	.21	74LS13	.47	74C73N	.72	CA3086	.50
7412	.21	74LS14	1.02	74C74N	.48	LF351N	.76
7413	.25	74LS15	.28	74C76N	.72	LF356N	1.20
7414	.89	74LS20	.28	74C83N	1.38	LF357N	1.20
7416	.25	74LS21	.28	74C85N	1.38	LF13741	.76
7417	.25	74LS22	.28	74C86N	.40	LM301AN	.44
7420	.21	74LS26	.33	74C90N	.98	LM307N	.64
7421	.25	74LS27	.33	74C93N	.98	LM308N	1.00
7423	.35	74LS28	.33	74C95N	1.10	LM309K	1.80
7425	.25	74LS30	.28	74C107N	.70	LM311N	.90
7426	.25	74LS32	.33	74C150N	2.90	LM317T	3.00
7427	.33	74LS33	.33	74C151N	1.90	LM317MP	1.90
7428	.28	74LS37	.33	74C154N	2.90	LM318N	2.70
7430	.21	74LS38	.33	74C157N	1.90	LM320MP-5	1.30
7432	.25	74LS40	.28	74C160N	1.18	LM320MP-6	1.30
7433	.30	74LS42	.67	74C161N	1.18	LM320MP-8	1.30
7437	.25	74LS47	.79	74C162N	1.18	LM320MP-9	1.30
7438	.25	74LS48	.77	74C163N	1.18	LM320MP-12	1.30
7439	.50	74LS51	.28	74C164N	1.10	LM320MP-15	1.30
7440	.21	74LS54	.28	74C165N	1.10	LM320MP-18	1.30
7442	.53	74LS55	.28	74C173N	1.30	LM320MP-24	1.30
7445	.70	74LS73	.39	74C174N	1.16	LM323K	7.50
7446	.70	74LS74	.39	74C175N	1.16	LM324N	.72
7447	.70	74LS75	.39	74C192N	1.38	LM325N	2.70
7448	.70	74LS76	.39	74C193N	1.38	LM326N	2.70
7450	.21	74LS78	.39	74C195N	1.10	LM327N	2.70
7451	.21	74LS83	.79	74C221N	1.90	LM339N	1.15
7453	.21	74LS85	.49	80C95N	.48	LM340T-5	1.25
7454	.21	74LS86	.39	80C96N	.48	LM340T-6	1.25
7460	.21	74LS90	.57	80C97N	.48	LM340T-8	1.25
7470	.30	74LS92	.57	80C98N	.48	LM340T-10	1.25
7472	.30	74LS93	.57	74C901N	.48	LM340T-12	1.25
7473	.30	74LS95	.88	74C902N	.48	LM340T-15	1.25
7474	.30	74LS96	.88	74C909N	1.78	LM340T-18	1.25
7475	.49	74LS107	.39	74C926N	7.80	LM340T-24	1.25
7476	.32	74LS109	.39	4000 CMOS		LM341P-5	.98
7480	.70	74LS112	.39	4000	.23	LM341P-6	.98
7483	.70	74LS113	.39	4001	.23	LM341P-8	.98
7485	.89	74LS114	.39	4002	.23	LM341P-10	.98
7486	.28	74LS125	.49	4006	1.23	LM341P-12	.98
7489	2.19	74LS126	.49	4007	.23	LM341P-15	.98
7490	.44	74LS132	.81	4008	.79	LM341P-18	.98
7491	.70	74LS136	.39	4009	.44	LM341P-24	.98
7492	.44	74LS138	.79	4010	.44	LM348N	1.60
7493	.44	74LS139	.79	4011	.23	LM349N	1.60
7494	.70	74LS151	.79	4012	.23	LM358N	.72
7495	.70	74LS153	.75	4013	.40	LM1310N	2.84
7496	.70	74LS154	1.10	4014	.96	LM1800N	.94
74100	1.28	74LS155	.75	4015	.96	LM1801N	1.70
74107	.30	74LS156	.75	4016	.40	LM1812N	1.70
74109	.33	74LS157	.75	4017	1.05	LM1830N	1.30
74116	1.26	74LS158	.75	4018	1.05	LM1889N	2.00
74121	.35	74LS160	1.02	4019	.40	LM2111N	1.25
74122	.44	74LS161	1.02	4020	1.14	LM2907N	1.50
74123	.61	74LS162	1.02	4021	1.14	LM2917N	1.50
74125	.40	74LS163	1.02	4022	.96	LM3089N	1.90
74126	.40	74LS164	1.02	4023	.23	LM3900N	.88
74128	.48	74LS165	1.14	4024	.84	LM3905N	1.40
74132	.70	74LS168	1.14	4025	.23	LM3909N	.69
74141	.88	74LS169	1.14	4026	1.68	LM3911N	1.40
74145	.70	74LS170	1.73	4027	.40	MC1456V	1.00
74147	1.63	74LS173	1.34	4028	.89	MC1458V	.53
74148	1.30	74LS174	1.06	4029	1.14	MC1496N	.90
74150	1.16	74LS175	.84	4030	.23	MC3302P	1.15
74151	.70	74LS181	2.50	4033	1.51	NE536T	2.50
74153	.65	74LS190	1.18	4034	3.50	NE540L	2.04
74154	1.03	74LS191	1.18	4035	1.14	NE555V	.48
74155	.70	74LS192	.98	4040	1.14	NE556A	.88
74156	.70	74LS193	1.06	4041	.79	NE558N	2.40
74157	.70	74LS194	.86	4042	.79	NE559N	2.40
74160	.88	74LS195	.86	4043	.79	NE560B	2.50
74161	.88	74LS196	.86	4044	.79	NE561B	2.50
74162	.88	74LS197	.86	4046	1.86	NE562B	2.50
74163	.88	74LS221	1.90	4049	.40	NE565A	1.25
74164	.96	74LS240	1.90	4050	.40	NE566V	1.25
74165	1.15	74LS241	1.90	4051	1.26	NE567V	1.36
74166	1.26	74LS242	1.70	4052	1.26	UA709CV	.44
74170	2.44	74LS243	1.70	4053	1.26	UA710CA	.44
74174	.98	74LS244	1.70	4060	1.58	UA711CA	.53
74175	.93	74LS247	.79	4066	.79	UA723CA	.60
74176	.79	74LS248	.79	4071	.23	UA733CA	.75
74177	.79	74LS249	.79	4072	.23	UA741CV	.35
74180	.70	74LS251	.84	4073	.23	UA747CA	.70
74181	2.15	74LS253	.84	4075	.23	UA748CV	.49
74182	.70	74LS257	.75	4081	.23	UA7805UC	1.25
74184	2.15	74LS258	.75	4082	.23	UA7806UC	1.25
74185	2.19	74LS260	.34	4502	.79	UA7808UC	1.25
74189	3.50	74LS266	.39	4510	1.14	UA7812UC	1.25
74190	1.23	74LS273	1.28	4511	1.05	UA7815UC	1.25
74191	1.23	74LS283	.79	4514	2.80	UA7818UC	1.25
74192	.88	74LS290	.65	4515	2.80	UA7824UC	1.25
74193	.88	74LS293	.65	4516	1.23	UA78L05ACZ	.40
74194	.88	74LS295	1.12	4518	1.14	UA78L06ACZ	.40
74195	.88	74LS298	1.30	4520	1.14	UA78L08ACZ	.40
74196	.88	74LS365	.67	4527	1.68	UA78L12ACZ	.40
74197	.88	74LS366	.67	4528	.88	UA78L15ACZ	.40
74198	1.49	74LS367	.67	INTERFACE		UA78L18ACZ	.40
74199	1.49	74LS368	.67	8093	.40	UA78L24ACZ	.40
74221	.86	74LS377	1.50	8094	.40	UA7905UC	1.70
74251	1.09	74LS386	.39	8095	.67	UA7906UC	1.70
74298	.94	74LS395	1.74	8096	.67	UA7908UC	1.70
74365	.67	74LS670	2.34	8097	.67	UA7909UC	1.70
74366	.67	81LS95	.77	8098	.67	UA7912UC	1.70
74367	.67	81LS96	.77	75450	.88	UA7915UC	1.70
		81LS97	.77	75451	.61	UA7918UC	1.70
		81LS98	.77	MISC IC		UA7924UC	1.70
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1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
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1N5241B	11V	1N5257B	33V

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MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
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VALUE	RADIAL LEADS			AXIAL LEADS		
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1/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	.95/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.08	.67/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.11	.87/10	7.62/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.11	.90/10	8.48/C	.17	1.34/10	11.30/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.10/10	10.13/C	.19	1.51/10	12.89/C
47/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.18	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.30/C
220/25V	.17	1.21/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.44/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.21	1.66/10	14.14/C	.30	2.51/10	21.37/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	26.05/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.20	1.61/10	13.71/C	.26	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.22	1.76/10	14.97/C	.35	2.76/10	23.41/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/10	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

MINIBOX METALIZED POLYESTER CAPACITORS

.001	.14	1.15/10	9.00/C	.033	.15 1.25/10	10.00/C
.0022	.14	1.15/10	9.00/C	.047	.15 1.25/10	10.00/C
.0033	.14	1.15/10	9.00/C	.068	.15 1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17 1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23 1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30 2.50/10	20.00/C
.022	.15	1.25/10	10.00/C	.47	.36 3.00/10	24.00/C

MA1002 0.5" High Digits

Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits

Actual size: 1.75"x3.75"

Digits Actual Size 1.25"x3.45" · MA1003 $15.95 NEW!

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MA1002C SET	Module w/Transformer & Switches	~~$13.50~~ 9.95
MA1003	12 Volt Car Clock with Switches	~~$17.50~~ 15.95
MA1010A	.84" LED 12 Hour AM-PM Clock Module	~~$13.50~~ 9.95
MA1010A SET	Module w/Transformer & Switches	~~$16.50~~ 11.95
MA1010C	.84" LED 24 Hour Clock Module	~~$13.50~~ 9.95
MA1010C SET	Module w/Transformer & Switches	~~$16.50~~ 11.95

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 transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using 4 high brilliance green fluorescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volt DC so no transformer is needed. Our price includes three push button switches for setting the time.

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SOLDERLESS BREADBOARDING WITH POWER FROM AP

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NSN374	.3" Dual Digits, CA, Red	2.20
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NSN584	.5" Dual Digits, CA, Red	2.60
NSN783	.7" Dual Digits, CC, Red	3.00
NSN784	.7" Dual Digits, CA, Red	3.00
NSL5053	Dif. Red T-1¾ Lamp w/Mtg. Hdwe.	.18/10 16.00/100
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$100.00 & Up	No Charge

VOLUME DISCOUNT & HANDLING CHARGE

All items (except those with catalog numbers ending with the suffix ND may be combined for discount. First, total all discountable items and apply the volume discount. Then add to this sub total the nondiscountable items. Add the handling charge. This is your total cost. We pay all shipping and insurance to addresses in the U.S.A. and Canada.

VOLUME DISCOUNT

$ 0.00-$ 24.99	NET
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Bishop COOLGLO Light Table

110 Vac. 18"x20" Portable Light Table
Cat. No. 3200-ND . . . $139.50
(Net Discountable)

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	

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 2.80/100' 11.25/500'

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Quality Electronic Components

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CIRCLE 70 ON FREE INFORMATION CARD

THIS SPECIAL ONE CENT SALE IS FOR MAGAZINE ADS ONLY

POLY PAKS' 1¢ REVOLUTION

THESE ONE-CENTERS ARE THE CENT-CIBLE WAY TO SHOP AND SAVE!

Cat. No. 7R5115B Men's LED

LED WATCH GUTS

Factory "lay-arounds". Do they work? Who knows! A micro-digital technician's bonanza. Guts are there. Some units even have batteries. LED types display HOURS, MINUTES, SECONDS, MONTH, and DATE. Sorry, no specs.

$1.95 2 for 1.96

1¢ SALE

BUY ONE AT SALE PRICE, GET 2ND FOR ONLY 1¢ MORE.

Easy to build. Both units are 12 or 24 hours. Easy to breadboard, uses MM5316 clock chip and a minimum of external components. AM/PM indicator, includes options for alarm, clock radio, snooze, and more. Basic kits include IC's, sockets, transistors, readouts and all other necessary components. (case, PC board, transformer, and line cord not included). Fluorescent basic includes .57" BRIGHT BLUE "NIXIE" TUBES. LED basic includes .35" RED LED READOUTS.

4 DIGIT
Wt 1 lb.

Your Choice **$9.95**
2 for $9.96

FLUORESCENT - LED CLOCK BASICS

☐ Cat. No. #7R3791 Fluorescent Basic Clock Kit	$9.95	2 for $9.96
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Order By Cat. No. 7R1981 & Type No.

TTL'S AT "CENT-CIBLE" PRICES

Type	Each	2 For
☐ SN7400	$ .19	$ .20
☐ SN7401	.19	.20
☐ SN7403	.25	.26
☐ SN7405	.19	.20
☐ SN7406	.19	.20
☐ SN7407	.39	.40
☐ SN7409	.39	.40
☐ SN7410	.25	.26
☐ SN7411	.59	.60
☐ SN7413	.69	.70
☐ SN7414	.99	1.00
☐ SN7416	.35	.36
☐ SN7417	.35	.36
☐ SN7420	.32	.33
☐ SN7421	.49	.50
☐ SN7423	.29	.30
☐ SN7426	.19	.20
☐ SN7430	.29	.30
☐ SN7432	.32	.33
☐ SN7437	.19	.20
☐ SN7438	.25	.26
☐ SN7440	.19	.20
☐ SN7442	.69	.70
☐ SN7443	.59	.60
☐ SN7444	.39	.40
☐ SN7445	.99	1.00
☐ SN7446	1.25	1.26
☐ SN7447	1.25	1.26
☐ SN7448	1.35	1.36
☐ SN7450	.19	.20
☐ SN7451	.19	.20
☐ SN7453	.19	.20
☐ SN7454	.29	.30

Type No.	Each	2 for
☐ SN7455	.19	.20
☐ SN7460	.19	.20
☐ SN7462	.19	.20
☐ SN7464	.19	.20
☐ SN7465	.19	.20
☐ SN7470	.19	.20
☐ SN7471	.19	.20
☐ SN7472	.19	.20
☐ SN7473	.59	.60
☐ SN7474	.29	.30
☐ SN7475	.69	.70
☐ SN7476	.79	.80
☐ SN7480	.19	.20
☐ SN7482	.29	.30
☐ SN7483	.99	1.00
☐ SN7486	.49	.50
☐ SN7488	.79	.80
☐ SN7489	3.49	3.50
☐ SN7490	.99	1.00
☐ SN7491	1.29	1.30
☐ SN7492	.69	.70
☐ SN7493	.69	.70
☐ SN7494	.79	.80
☐ SN7495	.59	.60
☐ SN7496	.29	.30
☐ SN7498	.79	.80
☐ SN74100	1.99	2.00
☐ SN74107	.29	.30
☐ SN74112	.39	.40
☐ SN74113	.39	.40
☐ SN74114	.25	.26
☐ SN74121	.49	.50
☐ SN74123	.69	.70
☐ SN74125	.99	1.00
☐ SN74126	.99	1.00

Type No.	Each	2 for
☐ SN74132	1.35	1.36
☐ SN74136	.49	.50
☐ SN74140	.49	.50
☐ SN74141	1.79	1.80
☐ SN74145	.69	.70
☐ SN74151	1.29	1.30
☐ SN74153	1.29	1.30
☐ SN74154	1.75	1.76
☐ SN74115	.79	.80
☐ SN74156	.39	.40
☐ SN74157	.99	1.00
☐ SN74158	.99	1.00
☐ SN74161	1.25	1.26
☐ SN74164	.79	.80
☐ SN74165	.99	1.00
☐ SN74166	1.99	2.00
☐ SN74173	.99	1.00
☐ SN74174	1.49	1.50
☐ SN74175	.99	1.00
☐ SN74177	.79	.80
☐ SN74179	1.49	1.50
☐ SN74180	.49	.50
☐ SN74182	.49	.50
☐ SN74190	1.99	2.00
☐ SN74191	1.75	1.76
☐ SN74192	.85	.86
☐ SN74193	.99	1.00
☐ SN74194	1.25	1.26
☐ SN74195	.29	.30
☐ SN74197	.75	.76
☐ SN74199	1.50	1.51
☐ SN74200	3.50	3.51
☐ SN74251	.79	.80
☐ SN74284	6.00	6.01
☐ SN74298	3.75	3.76

POP-AMPS AT "CENT-CIBLE" PRICES

Case code: T=TO-220 Power Tab: V=Mini dip: K=TO-3: H=TO-5: N=DIP.

Type No.	Each	2 for
☐ LM300H	$ .79	$ .80
☐ LM300N	.49	.50
☐ LM301V	.45	.46
☐ LM301H	.45	.46
☐ LM307V	.45	.46
☐ LM308V	.69	.70
☐ LM308H	.69	.70
☐ LM309K	1.49	1.50
☐ LM311V	.79	.80
☐ LM311H	1.49	1.50
☐ LM318V	.99	1.00
☐ LM320H-5	.99	1.00
☐ LM320H-12	.99	1.00
☐ LM320H-15	.99	1.00
☐ LM320T-5	1.49	1.50
☐ LM320T-6	1.49	1.50
☐ LM322N	1.19	1.20
☐ LM324N	1.79	1.80
☐ LM339N	1.79	1.80
☐ LM340K-5	1.49	1.50
☐ LM340K-6	1.49	1.50
☐ LM340K-8	1.49	1.50
☐ LM340K-12	1.49	1.50
☐ LM340K-15	1.49	1.50
☐ LM340K-18	1.49	1.50
☐ LM340K-24	1.49	1.50

Type No.	Each	2 for
☐ LM340T-5	1.49	1.50
☐ LM340T-6	1.49	1.50
☐ LM340T-8	1.49	1.50
☐ LM340T-12	1.49	1.50
☐ LM340T-15	1.49	1.50
☐ LM340T-18	1.49	1.50
☐ LM340T-24	1.49	1.50
☐ LM350N	.49	.50
☐ LM370N	1.99	2.00
☐ LM376V	.29	.30
☐ LM377N	2.25	2.26
☐ LM380N	1.39	1.40
☐ LM381N	1.99	2.00
☐ LM386N	1.49	1.50
☐ LM531H	1.49	1.50
☐ LM532N	.25	.26
☐ LM532H	.25	.26
☐ NE540H	5.95	5.96
☐ LM555V	.75	.76
☐ LM556N	1.79	1.80
☐ LM558V	.39	.40
☐ LM558H	.39	.40
☐ LM561N	1.00	1.01
☐ LM565N	1.00	1.01
☐ LM565H	1.00	1.01
☐ LM566	2.49	2.50

Type No.	Each	2 for
☐ LM567	2.39	2.40
☐ LM703N	.59	.60
☐ LM704H	.19	.20
☐ LM709H	.19	.20
☐ LM709N	.49	.50
☐ LM710N	.39	.40
☐ LM733N	.79	.80
☐ LM741V	.25	.26
☐ LM741H	.30	.31
☐ LM747H	.59	.60
☐ LM1304	1.49	1.50
☐ LM1310	1.79	1.80
☐ LM1312	2.49	2.50
☐ LM1414V	.19	.20
☐ LM1458V	.39	.40
☐ LM1800N	.79	.80
☐ LM3028H	.65	.66
☐ LM3900N	.49	.50
☐ LM3909V	1.75	1.76
☐ LM4250	1.20	1.21
☐ LM75451	.69	.70
☐ LM75453	.69	.70
☐ LM75491	.80	.81
☐ LM75492	.80	.81
☐ LM75494	.60	.61
☐ PA263	1.50	1.51
☐ DM8864N	1.29	1.30

RIBBON CABLE!

Order by Cat. 7R 3939 - and Conductors

Cond.	Sale	1¢ Sale
☐ 20	7-ft. $1.98	14-ft. $1.99
☐ 26	4-ft. 1.98	8-ft. 1.99
☐ 34	3-ft. 1.98	6-ft. 1.99
☐ 40	3-ft. 1.98	6-ft. 1.99

25 AMP BRIDGE RECTIFIERS

Order by Cat. No. 7R2273 & voltage

V	Each	1¢ SALE
☐ 50	$1.95	2 for $1.96
☐ 100	1.49	2 for 1.50
☐ 200	1.69	2 for 1.70
☐ 400	1.99	2 for 2.00
☐ 600	2.25	2 for 2.26
☐ 800	2.50	2 for 2.51

25 AMP POWER STUD SCRS, TRIACS

Cat. No. 7R-14A147 (SCRs)
Cat. No. 7R-60B86A (Triacs)

V.	Each	1¢ SALE
☐ 50	$ .95	2 for $ .96
☐ 100	1.25	2 for 1.26
☐ 200	1.95	2 for 1.96
☐ 400	2.50	2 for 2.51
☐ 600	2.95	2 for 2.96

1N4000 Epoxy Rectifiers

• Miniature! • 1.5 Amp! Order by Cat. No. and Type No.

Cat. No.	Type No.	PIV	Price	1¢ MORE!
☐ 7R 2377	1N4001	50	10 for $.65	20 for .66
☐ 7R 2378	1N4002	100	10 for .75	20 for .76
☐ 7R 2379	1N4003	200	10 for .85	20 for .86
☐ 7R2380	1N4004	400	10 for .99	20 for 1.00
☐ 7R2381	1N4005	600	10 for 1.29	20 for 1.30
☐ 7R2382	1N4006	800	10 for 1.39	20 for 1.40
☐ 7R2383	1N4007	1000	10 for 1.49	20 for 1.50

10 AMP - POWER TABS!

#7R1448 - TRIACS
7R1730 - SCR
#7R1590 - QUADRACS

PRV	Sale	2 for
☐ 50	$ .55	$ .56
☐ 100	.69	.70
☐ 200	.88	.89
☐ 400	1.19	1.20
☐ 600	1.59	1.60

1.5 AMP

BULLET RECTIFIERS!

Order by Cat. No. 7R60B84 and voltage

☐ 50V	10 for $.59	20 for $.60
☐ 100V	10 for .69	20 for .70
☐ 200V	10 for .79	20 for .80
☐ 400V	10 for .89	20 for .90
☐ 600V	10 for 1.09	20 for 1.10
☐ 800V	10 for 1.19	20 for 1.20

MICRO MINI

TOGGLE SWITCHES!

3 Amps, 125 VAC contacts, with chrome handles, complete with mounting hardware.

Cat. No	Type	Sale	2 for
☐ 7R3936	SPST	$1.19	$1.20
☐ 7R5085	SPDT*	1.39	1.40
☐ 7R4037	DPDT	1.45	1.46

BUY 1 AT OUR SALE PRICE

GET 2 FOR 1¢ MORE

LYTIC KLINIC

Electrolytic capacitors

Order by Cat. No. 7R3269 and value

UF	V	Style	Sale	1¢ SALE
☐ 10	15	P.C.	10 for $1.00	20 for $1.01
☐ 50	15	P.C.	8 for 1.00	16 for 1.01
☐ 15	25	P.C.	8 for 1.00	16 for 1.01
☐ 50	25	P.C.	6 for 1.00	12 for 1.01
☐ 20	15	Axial	10 for 1.00	20 for 1.01
☐ 20	15	P.C.	10 for 1.00	20 for 1.01

6 AMP CARTWHEEL RECTIFIERS

Cat. 7R 3584

AXIAL LEADS

V.	Each	1¢ SALE
☐ 50	$ .36	2 for $ .37
☐ 100	.45	2 for .46
☐ 200	.61	2 for .62
☐ 400	.79	2 for .80
☐ 600	.90	2 for .91
☐ 800	1.19	2 for 1.20
☐ 1000	1.39	2 for 1.40

LEDS!

YOUR CHOICE 5 for $1.00
1¢ SALE 10 for $1.01

Order by Cat. No.
☐ #7R2135 JUMBO RED LEDS
☐ #7R2137 MICRO RED LEDS
☐ #7R2790 JUMBO RED CLEAR LEDS
☐ #7R2792 JUMBO TAPERED AMBER
☐ #7R2140 MICRO GREEN LEDS

ZENERS!

Order by Cat. No. 7R5210 & voltage & wattage!

1 Watt	Sale	1¢ SALE
☐ 7.5V	5 for $1.	10 for $1.01
☐ 8.2V	5 for 1.	10 for 1.01
☐ 9.1V	5 for 1.	10 for 1.01
☐ 11.V	5 for 1.	10 for 1.01
☐ 12.V	5 for 1.	10 for 1.01
☐ 15.V	5 for 1.	10 for 1.01

5 WATTS	Sale	1¢ SALE
☐ 3.3V	3 for $1.	6 for $1.01
☐ 6. V	3 for 1.	6 for 1.01
☐ 6.2V	3 for 1.	6 for 1.01
☐ 8.2V	3 for 1.	6 for 1.01
☐ 9.1V	3 for 1.	6 for 1.01
☐ 12. V	3 for 1.	6 for 1.01
☐ 15. V	3 for 1.	6 for 1.01
☐ 18. V	3 for 1.	6 for 1.01
☐ 24. V	3 for 1.	6 for 1.01
☐ 30. V	3 for 1.	6 for 1.01

Quan. Description (Order by Cat. No. in parenthesis)	Sale	1¢SALE
☐ 5 PANCAKE PHOTOCELLS, 600 to 15K ohms (7R2939)	1.00	10 for 1.01
☐ 1 100KHZ MARKER CRYSTALS, approx for marker gen. (7R3896)	1.95	2 for 1.96
☐ 1 MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (7R3987)	3.50	2 for 3.51
☐ 1 48-PIN EDGE CONNECTOR, .156" spacing (7R3963)	1.95	2 for 1.96
☐ 1 — WOODGRAIN CABINET, 3½ x 10 x ¼" deep, spkrs, alarms. (#7R5201)	$1.49	2 for $1.50
☐ 2 — LCD THERMAL INDICATORS, 88-108°F, 7x1", flexible (#7R5195)	1.00	4 for 1.01
☐ 1 — JOYSTICK, four 100K pots, with knob (#7R3808A)	4.95	2 for 4.96
☐ 1 — EECO THUMBWHEEL SWITCH, BCD, 0-7 (#7R2870A)	1.49	2 for 1.50
☐ 1 — 8-TRACK TAPE TRANSPORT, with preamp (#7R3010)	9.95	2 for 9.96
☐ 1 — PLESSEY TV SIDEBAND FILTER, for chan. 3 or 4 (#7R3975)	1.95	2 for 1.96
☐ 30-ft. WIRE WRAP WIRE, 30 gage, for ICs, terminals (#7R3803)	1.00	60-ft for 1.01
☐ 1 — METER, 50uA, 1½" square, 0-20db (#7R3705)	1.19	2 for 1.20
☐ 1 — SPST RELAY, norm. open 12-24 VDC, 1250 ohms, dip style (#7R5175)	1.00	2 for 1.01
☐ 1 — VEEDER ROOT COUNTER, 000-999, resettable, panel mt. (#7R5081)	1.49	2 for 1.50
☐ 2 — DUAL GATE MOSFET, sim. to 3N200, 3N187, for RF & Mixer (#7R5101)	1.00	4 for 1.01
☐ 1 — 8-TRACK TAPE HEAD, with plug' n' cord (#7R3468)	2.50	2 for 2.51
☐ 10 CALCULATOR KEYBOARDS, 20 keys and more (7R3524)	$2.00	20 for $2.01
☐ 15 SLIDE VOLUME CONTROLS, asstd values (7R3057)	2.00	30 for 2.01
☐ 10 CRYSTALS, may include CB, Ham & more (7R3250)	2.00	20 for 2.01
☐ 150 MOLEX IC SOCKETS, on a strip, cut to length (7R3144)	2.00	300 for 2.01
☐ 100 TERMINAL STRIPS, from 2 lugs up (7R3136)	2.00	200 for 2.01
☐ 30 NE-2NEON LAMPS, all 100% good (7R2613)	2.00	60 for 2.01
☐ 40-ft. SHIELDED CABLE, 1 cond, mikes, phonos, (#7R3577)	2.00	80 ft. for 2.01
☐ 50 TRANSISTOR ELECTROS, asstd values, styles (7R2747)	2.00	100 for 2.01
☐ 3 SOUND TRIGGERS, sound triggers scr w/amp (7R3625)	2.00	6 for 2.01
☐ 10 - CB CRYSTALS, for phase lock loop, HAM, HC/18 (#7R5050)	2.00	20 for 2.01
☐ 100 - DISC CAPACITORS, long leads, marked, asst'd (#7R2598)	2.00	200 for 2.01
☐ 100 CAPACITOR SPECIAL, discs, mylar, lytics, more (7R2738)	2.00	200 for 2.01
☐ 10 VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (7R3330)	2.00	20 for 2.01
☐ 30 PANEL SWITCHES, slides, rotaries, mod, etc (7R3268)	2.00	60 for 2.01
☐ 200 RESISTOR SPECIAL, ¼ to 1W, carbon, metal (7R3054)	2.00	400 for 2.01
☐ 200 HALF WATTERS, resistors, carbon, metal (7R3046)	2.00	400 for 2.01
☐ 100 NATIONAL IC BONANZA, linears, 7400s ROMS (7R2860)	2.00	200 for 2.01
☐ 40 HOBBY LEDS, asstd types, mostly useable (7R2859)	2.00	80 for 2.01
☐ 15 LM340T VOLTAGE REGULATORS, 5 to 24V, TO-220 (7R2635)	2.00	30 for 2.01
☐ 100 TWO WATTERS, resistors, carbon-metal marked (7R2735)	2.00	200 for 2.01
☐ 100 POLYSTYRENE CAPS, asstd values, voltage, hi-Q (7R2729)	2.00	200 for 2.01
☐ 50 THERMISTORS, resistors that change with temp (7R4089)	2.00	100 for 2.01
☐ 20 BRIDGES, untested, 2, 4, 6, 10, amp, full wave (7R4022)	2.00	40 for 2.01
☐ 25 LAMP'N'SOCKET SETS, micro, 1.5V, T2 (7R3957)	2.00	50 for 2.01
☐ 15 MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (7R3619)	2.00	30 for 2.01
☐ 150 QUARTER WATTERS, resistors, metal film, marked (7R3413)	2.00	300 for 2.01
☐ 100 PLASTIC TRANSISTORS, untested, TO-92 (7R2604)	2.00	200 for 2.01
☐ 200 PREFORMED RESISTORS, ¼, ½, 1W, marked, asstd (7R2608)	2.00	400 for 2.01
☐ 200 PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (7R2428)	2.00	400 for 2.01
☐ 60 DIPPED MYLARS, shiny finish, asst values (7R2597)	2.00	120 for 2.01
☐ 30 VOLUME CONTROLS, audio, linear, asstd values (7R2421)	2.00	60 for 2.01
☐ 150 - PREFORMED DISC CAPACITORS, marked values, asst'd (#7R2605	2.00	300 for 2.01
☐ 150 - TRIMMER CAPACITORS, mica compression, piston, asst'd. (#7R3714)	2.00	120 for 2.01
☐ 60 - YELLOW JACKET MYLAR CAPACITORS, marked, pop values (#7R3476)	2.00	150 for 2.01
☐ 150 - GLASS ZENERS, 400 MW, untested, better than 50% yield (#7R2740)	2.00	300 for 2.01
☐ 75 - CARBOFILM RESISTORS, ¼, ½ watt, 5 & 10%, marked, asst's (#7R3534)	2.00	150 for 2.01
☐ 250 - UNMARKED CAPACITORS, polystyrene, molded, pop values (#7R3805)	2.00	500 for 2.01
☐ 300 - SILICON SIGNAL DIODES, micro, glass, zeners too! 50% yield (#7R2628)	2.00	600 for 2.01
☐ 8 - IC SOCKETS, 14, 18 pin, solder tail. (#7R3621)	2.00	16 for 2.01
☐ 100 - 1N4148/914 SWITCHING DIODES, 50% + yield. Untested! (#7R2418)	2.00	200 for 2.01
☐ 30 - PC TRIM POTENTIOMETERS, thumbwheel, screwdriver ass't. (#7R3345)	2.00	60 for 2.01
☐ 15 - SLIDE VOLUME CONTROLS, asst'd values, duals, singles (#7R3057)	2.00	30 for 2.01
☐ 71 - 4" CABLE TIES, plastic, like "Ty-wrap" (#7R5218)	2.00	150 for 2.01
☐ 1 JOYSTICK, two 10K pots, for computers, TV games (7R5037)	2.95	2 for 2.96
☐ 1 CHARACTER GENERATOR, 5 × 7 Mostek MK 2002P (7R3898)	4.95	2 for 4.96
☐ NOISE CANCELLING MIKE, Ham-CB, 500 ohms (#7R3902)	6.95	2 for 6.96

7-SEGMENT READOUTS

		ONE CENT SALE
☐ 3½ DIGIT LCD WRISTWATCH DISPLAY, (#7R3960)	3 for $1.19	6 for $1.20
☐ 2 — SPERRY FLAT NIXIES, orange, .3" dual digit (#7R5014)	2 for 1.19	4 for 1.20
☐ SPERRY FLAT NIXIES, orange, .3", 1½-dig (#7R5015)	2 for 1.19	4 for 1.20
☐ MAN-3 BUBBLE READOUT, .19" red, com cath. (#7R3338)	6 for 1.00	12 for 1.01
☐ 2 — MAN-4 READOUTS, bubble, red, com. anode, .19" (#7R1503)	2 for 1.00	4 for 1.01
☐ FND-10 BLOCK READOUT, .122" com cathode (#7R2082)	2 for 1.19	4 for 1.20
☐ 8-DIGIT READOUT, led, com cathod, red (#7R5190)	1 for 1.95	2 for 1.96
☐ FND-503, .5" red, com cathode, 7-seg. (#7R2949)	1.50	2 for 1.51

RELAYS!

	Each	2 for
☐ SPDT 12V BLOCK RELAY, 5A contacts (#7R4032)	$1.98	$1.99
☐ SPDT 12V REED RELAY, 1A contacts (#7R4094)	1.49	1.50
☐ SPDT 12V SENSITIVE, 2000 ohm coil (#7R3044A)	1.95	1.96
☐ 1 — SPST 24V REED RELAY, norm open, dip style, 1250 ohms (#7R5175)	1.49	1.50

AMPLIFIERS!

	Each	2 for
☐ 9 WATTS ON A CHIP, Toshiba TA7205 (#7R5057)	4.95	4.96
☐ 3 WATTS ON A CHIP, G-E PA 263 (#7R1522)	1.50	1.51

TRANSFORMERS!

	Each	2 for
☐ 12V TRANSFORMER, 300ma, oc leads, 110pri. (#7R3412)	$1.49	$1.50
☐ 2.9V NI-CAD CHARGER PAK, plug-in, 125ma, 125 VAC pri (#7R4098)	1.49	1.50

DIP SWITCHES!

	Each	2 for
☐ 2 SWITCHES ON A DIP (#7R3668)	$ .77	$ .78
☐ 3 SWITCHES ON A DIP (#7R3669)	.88	.89
☐ 6 SWITCHES ON A DIP (#7R3671)	1.29	1.30

IC SOCKETS!

☐ 8-PIN MINI-DIP (#7R2123)	4 for $1.19	8 for $1.20
☐ 14-PIN DIP (#7R1308)	3 for 1.19	6 for 1.20
☐ 16-PIN DIP (#7R1309)	3 for 1.19	6 for 1.20
☐ 18-PIN DIP (#7R3378)	6 for 1.19	12 for 1.20
☐ 24-PIN MSI/DIP (#7R3886)	2 for 1.19	4 for 1.20
☐ 28-PIN MSI/DIP (#7R3887)	2 for 1.19	4 for 1.20
☐ 8-PIN TO-5 (#7R1307)	4 for 1.19	8 for 1.20

FULL WAVE 10 AMP BRIDGE RECTIFIERS!

Order by Cat. No. 7R2447 & voltage

PRV	Sale	2 for
☐ 50	$1.29	$1.30
☐ 100	1.49	1.50
☐ 200	1.69	1.70
☐ 400	1.99	2.00
☐ 600	2.25	2.26
☐ 800	2.50	2.51

WRITE FOR **POLY PAKS 1978 CATALOG** FREE!

FEATURING:
- Computer Components!
- Over 400 Assortments!
- Digital Clocks, DPM's, and Stopwatches!
- Hi-Fi Stereos-Speakers!
- Solar Energy! Semi's!
- Test Equipment!
- Fiber Optics! Plus More n' More!

Terms: Add postage Rated: net 30
Phone: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield.

MINIMUM ORDER — $6.00

C.O.D.'s MAY BE PHONED

POLY PAKS®
P.O. BOX 942-R7
LYNNFIELD, MA.
ZIP 01940

CIRCLE 5 ON FREE INFORMATION CARD

INTERNATIONAL ELECTRONICS UNLIMITED

SUMMER SALE

SPECIAL SALE

LOW POWER SCHOTTKY 74LS00
First Quality - Full Spec
Buy $15 -any mix- deduct 10%
Buy $25 -any mix- deduct 15%

74LS00	.19	75LS54	.20	74LS157	.59	74LS251	.79
74LS01	.19	74LS55	.21	74LS158	.69	74LS253	.79
74LS02	.19	74LS74	.34	74LS160	.79	74LS256	1.15
74LS03	.19	74LS83	.75	74LS161	.79	74LS257	.69
74LS04	.21	74LS85	.79	74LS162	.79	74LS258	.69
74LS05	.21	74LS86	.35	74LS163	.79	74LS259	1.39
74LS08	.21	74LS90	.50	74LS165	1.39	74LS260	.29
74LS09	.20	74LS92	.50	74LS168	.89	74LS266	.29
74LS10	.20	74LS93	.50	74LS169	.89	74LS279	.50
74LS11	.20	74LS95	.85	74LS170	1.49	74LS283	.72
74LS13	.39	74LS109	.34	74LS173	.97	74LS290	.59
74LS14	.79	74LS112	.35	74LS174	.73	74LS293	.64
74LS15	.21	74LS113	.35	74LS175	.73	74LS295	.89
74LS20	.21	74LS114	.35	74LS181	2.45	74LS298	.89
74LS21	.21	74LS122	.69	74LS190	.89	74LS365	.49
74LS22	.21	74LS123	.83	74LS191	.89	74LS366	.49
74LS26	.29	74LS125	.45	74LS192	.88	74LS367	.49
74LS27	.24	74LS126	.45	74LS193	.88	74LS368	.49
74LS28	.26	74LS132	.71	74LS194	.83	74LS378	.89
74LS30	.21	74LS133	.29	74LS195	.65	74LS390	1.49
74LS32	.25	74LS136	.34	74LS196	.79	74LS393	1.29
74LS33	.28	74LS138	.68	74LS197	.79	74LS395	1.69
74LS37	.28	74LS139	.69	74LS240	1.85	74LS490	1.78
74LS38	.28	74LS151	.59	74LS241	1.85	74LS670	2.19
74LS40	.23	74LS153	.59	74LS242	1.70		
74LS42	.60	74LS155	.69	74LS243	1.70		
74LS51	.21	74LS156	.69	74LS244	1.70		

TTL - 7400

Buy $10.00 -any mix- deduct 10%
Buy $25.00 -any mix- deduct 15%

7400	.11	7441	.85	7493	.48	74168	1.19
7401	.18	7442	.58	7494	.75	74170	1.80
7402	.14	7443	.85	7495	.75	74173	1.48
7403	.14	7444	.73	7498	.75	74174	1.18
7404	.16	7445	.65	74100	1.15	74175	.95
7405	.18	7446	.81	74107	.37	74176	.84
7406	.29	7447	.59	74121	.37	74177	.84
7407	.28	7448	.79	74122	.38	74180	.95
7408	.22	7450	.17	74123	.45	74181	2.30
7409	.17	7451	.20	74125	.54	74182	.85
7410	.18	7453	.20	74126	.58	74185	2.20
7411	.25	7454	.20	74132	.75	74190	1.25
7413	.43	7480	.20	74141	.85	74191	1.15
7414	.85	7484	.35	74145	.80	74192	.88
7415	.25	7486	.35	74150	.88	74193	.85
7416	.35	7470	.38	74151	.68	74194	1.15
7417	.35	7472	.35	74153	.80	74195	.74
7420	.18	7473	.35	74154	1.20	74196	.86
7423	.37	7474	.31	74155	.75	74197	.85
7425	.35	7475	.48	74156	.76	74198	1.69
7426	.22	7476	.34	74157	.85	74199	1.69
7427	.35	7483	.68	74158	1.39	745200	3.85
7430	.20	7485	.88	74160	1.23	74279	.79
7432	.23	7486	.38	74161	.85		
7437	.25	7489	2.25	74162	1.38		
7438	.25	7490	.43	74163	.85		
7439	.50	7491	.75	74164	.95		
7440	.15	7492	.48	74165	.95		

EXAR

320	1.19
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	.69
[illegible]	.69

7400 series TTL
tested and passed logic test-
not full parametric specs
minimum 10 of item

7400	$.05	7460	.05
7401	.07	7472	.12
7402	.05	7473	.12
7403	.05	7474	.10
7404	.06	7476	.12
7405	.06	7483	.18
7406	.09	7485	.25
7407	.09	7486	.12
7409	.07	7491	.20
7410	.05	7493	.14
7416	.12	7495	.20
7420	.06	74100	.40
7423	.12	74107	.12
7425	.12	74123	.18
7426	.09	74125	.22
7427	.09	74126	.22
7430	.07	74132	.22
7432	.08	74141	.25
7437	.07	74145	.25
7438	.07	74150	.40
7440	.05	74151	.20
7441	.30	74153	.15
7442	.20	74154	.40
7443	.20	74163	.35
7444	.20	74164	.35
7445	.20	7417.	.25
7446	.30	74180	.25
7448	.30	74182	.25
7450	.06	74191	.30
7451	.07	74192	.28
7453	.06	74194	.28
7454	.05	74195	.18

LINEAR CIRCUITS

Buy $10.00 -any mix- deduct 10%
Buy $25.00 -any mix- deduct 15%

LM300H	$ 71	LM372N	2 93	LM733H	79
LM301CN	29	LM376CN	59	LM739N	99
LM302H	65	LM380N	1 29	LM741CN(8)	32
LM304H	80	LM380-8CN	95	LM741CN(14)	32
LM307CN	28	LM381N	1 75	LM741CH	35
LM307H	30	LM382N	1 75	LM747H	79
LM308H	89	LM385K	45	LM747N	71
LM309H	1 05	NE531V	2 90	LM748CN	35
LM309K	99	NE540L	2 90	LM1310N	2 80
LM310CN	1 07	NE546A	1 09	LM1414N	1 59
LM311CN	89	NE550A	75	LM1456CN	1 29
LM311H	89	LM555CN	39	LM1458CN	59
LM311N	89	NE556A	85	LM1496N	89
LM319N	1 13	LM560N	2 95	LM1800N	2 48
LM320K		LM561N	2 95	ULN2208	89
5, 5 2, 12, 15	1 29	LM565N	1 19	ULN2209	89
LM320T		LM565H	1 39	CA3048	1 19
5, 12, 15	1 19	LM566H	1 39	CA3081	1 49
LM322N	1 59	LM566CN	1 19	LM3900N	49
LM324N		LM567CN	1 29	LM7524	79
(LM2902N)	1 52	LM567H	1 49	LM7525	79
LM339N	1 58	LM703H	59	8038B	4 59
LM340K		LM703CN	39	75451CN	35
5, 6, 8, 12,		LM709N	25	75452CN	35
15, 18, 24	1 29	LM709H	29	75453CN	35
LM340T		LM710N	59	75454CN	35
5, 6, 8, 12		LM711N	39	75491N	71
15, 18, 24		LM723H	55	75492N	85
(78 — — Equiv) 1 19		LM723N	52		

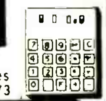
LEDs

MAN 1	.27" Red CA LHD	.99	MAN 6610	2 Dig .56" Orng CA RHD	.69
MAN 2	.30" Red 5x7 LHD	3.95	MAN 6630	1-1/2 Dig .56" Orng CA RHD	.59
MAN 5	.27" Green CA LHD	.99	MAN 6650	1-1/2 Dig .56" Orng CC RHD	.59
MAN 8	.27" Yellow CA LHD	.49	MAN 6710	2 Dig .56" Red CA RHD	.69
MAN 54	.30" Green CC RHD	1.19	MAN 6730	1-1/2 Dig .56" Red CA RHD	.59
MAN 66	.60" Red CA LHD	1.19	MAN 6740	2 Dig .56" Red CA RHD	.69
MAN 72	.30" Red CA LHD	.59	MAN 6750	1-1/2 Dig .56" Red CC RHD	.59
MAN 82	.30" Red CA LHD	.99	DL 33B	3 Dig .17" Red CC	.29
MAN 361D	.30" Orange CA RHD	.69	DL 33B	2 Dig .17" Red CC	.49
MAN 364D	.30" Orange CC RHD	.69	NSN 33	3 Dig .17" Red CC	.39
MAN 4610	.40" Orange CC RHD	.59	HP 5082	4 Dig .11" Mag. RHD	.39
MAN 6660	.56" Orange CA RHD	.59	HP 5D82	5 Dig .11" Mag. RHD	.49
DL 10A	.27" Red CA LHD	.99	SP425-D9	9 Dig Gas Discharge	.69
DL 702	.30" Red CC LHD	.79	Calc Disp	9 MAN 3s on board Red	.79
DL 707	.30" Red CA RHD	.79	TI 434	9 Dig Red	.49
DL 747	.60" Red CA LHD	1.19			
FND 359	.375" Red CC RHD	.59			
FND 500	.50" Red CC RHD	.69			
FND 507/510	.50" Red CA RHD	.69			
NSN 74R	.30" Red CC RHD	.69			

Jumbo Red LEDs 12/$1.00
MV10B TO-18 clear 15/$1.00
JUMBO LED White- red light
14/$1.00 150/$10.00

MM5314	Clock Chip	2.95
MM5316	Clock Chip	.95
MM537D	Clock Chip	3.95
MM5375AA	Clock Chip	2.95
CT7001	Clock Chip	4.95
2513(caps)	Char. Gen.	3.95
2513(L.C.)	Char. Gen.	3.95
MM11D1	256 bit RAM	.65
MM11D3	1K RAM	.75
MM5261	1K RAM	.55
MM5262	1K RAM	.95
F93410	256 bit RAM	.95

UNTESTED PROM - Hi Yield
Same pin-out as 8223
5600 4/$1.00
561D 3/$1.0C



KEYBOARD
20 Keys - 2 slide switches
3" x 3-3/4" $1.D0/3

5 BACK ISSUES OF ELEKTOR MAGAZINE containing a variety of electronic projects, with schematics, PC layouts, parts list. PC boards are available. Regular $1.50/copy $4.00/5 issues

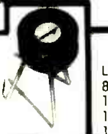
25 26 29 30 31

CAPACITOR KIT - ceramic disc

50V, 24 values, 1D capacitors each

1pf	33pf	82pf	220pf	820pf	.022uf
5pf	47pf	100pf	270pf	.001uf	.030uf
10pf	56pf	150pf	470pf	.0047uf	.050uf
22pf	68pf	180pf	600pf	.01uf	.1uf

capacitors only...$11.95
Packeged in 15 drawer, 60 compartment cabinet....$19.95 plus $2.00 shipping



TRIMPOT - Single Turn
Mepco - Cermet 8014
.5w, + 100 PPM/°C + 20%
500 ohm, 2K, 10K, 25K, 50K, 100K, 500K, 1M.

1-9	10-99	100-999	1000-
$.75ea	.69	.63	.57

TRIMPOT - 25 turn
Bourns - Cermet 3299W
PC Mount, vert. adj.
2K, 10K, 20K $1.75 ea

1-9	10-999	100-
$1.65e	1.50	1.35

IC SOCKETS

Low Profile Solder Tail				Wire Wrap	
8 pin	$.16	24 pin	$.36	8 pin	.45
14 pin	.19	28 pin	.44	14 pin	.49
16 pin	.21	40 pin	.61	16 pin	.55
18 pin	.28				

TANTALUM CAPACITOR KIT

solid dipped, 12 values, 5 each

.1uf/35V	2.2/35	10/25	33/10
.33/35	4.7/16	15/20	47/25
1/35	6.8/16	22/16	56/6

capacitors only......$14.95
supplied in styrene utility box.. ....$19.95

METAL FILM RESISTORS

Rohm
QUALITY RELIABILITY

+ 1%, 1/4w, + 50 PPM/°C
Standard Decade Values 10.5 - 464K

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.20	$.15	
100-999	.20	.10	$9.00/100
1000-			8.00/100

PLASTIC CASES

VERO - dark and light gray
nominal O.D.

2514F	2"x4"x1"	$4.34
2516G	2"x4"x1.6"	4.90
2518H	2.6"x 4.7"x1.6"	5.48
252DJ	3.2"x6"x2"	6.24
2522K	4.3"x7.4"x2.4"	8.28
2755G	2.6"x4.7"x2.6"	6.74
2760D	4.3"x7.4"x2.4" (w/ handle/stand)	10.78
2525F	2.8"x5.4"x2.4" (ventilated)	5.40
HAMMOND - blue		
1591C	2.6"x4.8"x1.6"	2.65

CERAMIC DISC CAPACITORS - 50V

1pf	22pf	56pf	120pf	270pf	820pf	.022uf
5pf	27pf	68pf	150pf	390pf	.001uf	.030uf
7pf	33pf	82pf	180pf	470pf	.0047uf	.050uf
10pf	47pf	100pf	220pf	600pf	.01uf	.1uf

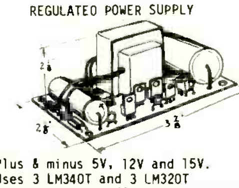
0-10 per value..$.10ea 10-up per value $.05ea
10-up per value $.05ea

	1pf/.050uf	.1uf
1-10 per value	$.10ea	$.15ea
10-100	.05ea	.10ea
100-	.04ea	.08ea

PRECISION RESISTOR PACKAGE

Metal Film + 1% 1/4 watt
Starter Kit - 2ea. 60 values
120 Resistors 10.5 ohm- 464K
$14.95
Supplied in 15 Drawer 60 Comp. Cabinet - $26.50 + $2.00 Sh.

REGULATED POWER SUPPLY



Plus & minus 5V, 12V and 15V.
Uses 3 LM340T and 3 LM320T regulators, 115V/29V CT transformer plus PC board capacitors & diodes.
All parts, schematic, instructions
PS-29.........$12.95 + $1.00 Shppng.

Carbon Film Fesistors + 5% 1/4w, 1/2w

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.10	$.D5	
100-999	.10	.04	$3.00/100
1000-			2.50/100

TANTALUM CAPACITORS - solid dipped

.1u/35V	$.20	6.8/6	$.25	15/50	$.40
.22/35	.20	6.8/16	.25	22/16	.40
.33/35	.20	6.8/50	.30	33/10	.50
1/35	.20	10/16	.30	47/6	.50
2.2/20	.25	10/25	.35	47/25	.55
2.2/35	.25	10/50	.35	56/6	.65
3.3/35	.25	15/10	.35	100/20	1.25
4.7/16	.25	15/20	.35		

RESISTOR PACKAGE

Carbon Film + 5% 1/4 w or 1/2 w
15 ea. of 12 values:
100, 220, 470, 1K, 1.5K, 3.3K
4.7K 6.8K, 10K, 33K, 100K, 1M.
$5.45

Carbon Film + 5% 1/4w or 1/2w
Usage Evaluated Assortment
5 to 20 ea of 44 values.
$12.95
Supplied in 15 Drawer 60 Comp. Cabinet. $22.95 + $2.00 Sh.

VECTOR BOARD - Phenolic

169P44-062 (.1"spacing .42" dia.)
4-1/4" x 4-1/2" x .0625"...$1.15 ea.

BEZELS - with red filters

140-2 cut-out 1.125" x 2.375"
max .062" panel thickness $1.75
140-4 cut-out 1.160" x 4.375"
max .125" panel thickness $2.75

ELECTRONIC DOOR CHIME KIT

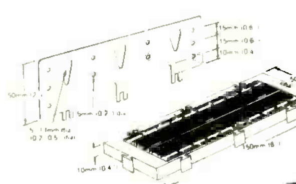
WITH TI TMS 1000 MICROPROCESSOR CHIP PROGRAMMED TO PLAY 24 DIFFERENT TUNES

INTERNATIONAL FLAVOR — PLAYS NATIONAL ANTHEMS OF U.S., BRITAIN, FRANCE AND WEST GERMANY PLUS OTHER FOLK TUNES, CLASSICAL AND TRADITIONAL MELODIES.

- SUPPLIED WITH ALL PARTS INCLUDING PC BOARD, SPEAKER, CASE AND COMPLETE INSTRUCTION MANUAL WITH FULL CIRCUIT DETAILS.
- USES 2-9V TRANSISTOR BATTERIES (NOT SUPPLIED).
- LOW POWER CONSUMPTION
- INTERNAL SELECTION OF TUNE, VOLUME, TEMPO AND TIMING FUNCTIONS.
- PROGRAMMED MATHEMATICALLY TO PLAY IN PERFECT PITCH PERMANENTLY
- ATTRACTIVE CASE, CONVENIENT WALL MOUNT

$39.50 SHIPPING $1.00

BIMBOARD - BREADBOARD KIT



Solderless breadboard section has 94 breadboard strips of 5 sockets each. 2 bus strips of 40 sockets each. Component bracket for switches lamps etc., accepts leads .01" to .035" diameter. $11.95 ea.

ELECTRONIC BUZZER

Miniature, Solid State
6V 15ma (4-9V oper.) $1.29 ea.
12V 15ma (8-20V oper.) $1.29 ea.

I C BREADBOARD

Silver plated copper circuits holds 5 - 16 pin DIP IC's and interconnection holes. $1.00

UNIVERSAL BREADBOARD

Silver placed copper circuits fits any IC and related components. 2 triple rows of 27 holes for DIP. 3-3/16"x5-1/16" $1.00

PC BOARDS -

for use with ELEKTOR MAGAZINE PROJECTS

ELEKTOR #31 Nov 77..................		$ 1.50
music synthesiser	9723-1	18.35
CCIR TV pattern generator	9800-3	5.65
video biofeed back display generator	9825-1	5.60
alpha amplifier	9825-2	4.60
electrometer	9826-1	1.50
sensors for electometer	9826-2	1.40
magnetiser	9827	1.45
CPU-SC/MP RAM-1/0	9846-1	12.70
SC/MP Board	9846-2	3.95
model car track (E24-E30) transmitter power supply	9218	2.20
chassis	9850	6.35
ELEKTOR #32 Dec 77.,..........		1.50
music synthesiser (E25-31)	9724-1	7.45
CPU - SC/MP	9851a	18.80
UHF TV modulator	9864	2.95
microphone preamp	9866	1.30
ANALOG FREQ. METER	9869	2.40
heating controller	9877	7.05
MW reflex receiver	9880	1.85
sensitive lightmeter	9886	1.30
stylus balance (E12)	9343	1.05
signal generator (E24)	9765	1.10
knotted handkerchief (E27/28)	9830	.45
ELEKTOR #33 January 78.............		1.50
simple funtion generator	9453	6.00
formant (E25...E32): ADSR	9725-1	7.05
UAA 180 LED voltmeter	9817	3.90
elektor equaliser	9832	7.65
experimenting with the SC/MP(E31,E32)" bus board	9857	6.65
memory card	9863	28.20
CMOS noise generator	9859	3.20
peak programme meter	9860	2.80
ELEKTOR #34 February 78............		1.50
formant (E25...E33): DUAL-VCA	9726-1	7.40
development timer	9840	4.60
experimenting with the SC/MP(E31...E33): HEX 1/0	9893	37.60
infra-red light gate" transmitter	9862-1	1.40
receiver	9862-2	1.85
ELEKTOR #35 March 78...............		1.50
formant (E25...E34): LFO module	9727-1	7.90
noise module	9728-1	6.75
4K RAM card	9885	32.90
colour TV games: VHF games board	9892	4.65
UHF converter	9864	2.95
SC/MP power supply	9906	6.85
ELEKTOR #36 April 78		1.50
formant (E25...E35): COM	9729-1	6.20
elektornado	9874	6.50
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- 8-SLOT EXPANDABLE BACKPLANE—in line male and female connectors enable backplanes to be plugged together, or the female may be used in place of an extender board.

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RELIABLE—SAE 8100 phenolic body, gold contact connectors.

COMPLETE KIT $66.00 ASSEMBLED $89.00

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ALL BOARDS ARE G-10 GLASS EPOXY. HAVE Vcc AND GROUND PLANES. PLATED THROUGH HOLES, & GOLD PLATED EDGE CONNECTORS

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- 53 key main keyboard
- 10 auxiliary & cursor control keys
- 11 key numeric pad
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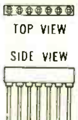
MAKE UNIVERSAL END AND SIDE STACKABLE WIRE WRAP BOARDS

7 PIN STRIP



12 PIN 3 LEVEL 48c
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QUAD	
LM3900	49c

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IN270	12c
IN914	15c
IN3600	15c
IN4148	10c

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2N3904	12c
2N3906	12c
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3-1/2 DIGIT L.C.D.'s

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No. 1 0.4" CHARACTER WITH CONNECTOR $6.95

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CIRCLE 52 ON FREE INFORMATION CARD

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CIRCLE 3 ON FREE INFORMATION CARD

We're so convinced our high-performance K40 will outperform every CB antenna you're selling now,

WE'LL SELL YOU ONE FOR $38.50 TO PROVE IT!

The K40 is more than just a premium antenna.

It's specifically guaranteed, in writing, to outperform any antenna it replaces.

1 TRANSMITS FURTHER. RECEIVES CLEARER.

We mean just that! We'll back your customers 100% if the K40 doesn't transmit further or receive clearer than the antenna it replaces. We know it will. We've tested it with 771 CB'ers for one year.

2 WHEN YOU PAY MORE, YOU EXPECT MORE.

For a full year we'll let you replace *any* part your customer is not happy with. You make that decision, not us. Our guarantee includes rust. It includes broken whips. It includes everything.

3 IT'S AMERICAN MADE.

No need to be concerned about replacement parts. There is not one component that is made anywhere else but in America.

4 MOUNTS ANYWHERE, EVERYWHERE.

With the spectacular Unimount, you can fit your customer's K40 to any mounting surface — anywhere. And that's guaranteed too. 100%. That means this single K40 antenna can easily reduce your inventory by 50% by having one model that mounts anywhere. And still make more money because you get much, much more for each antenna sale.

5 SOLD BY PROFESSIONAL DEALERS THAT TAKE PRIDE IN SERVICING CBER'S.

Like pro-golf clubs, the K40 antenna is sold through pro-CB/ELECTRONIC stores only. It's not being sold to mass merchandisers. It's not being sold to Sears or Penney's or any retail outlets that cannot offer full time professional services to support the service full time CB'ers need. We control that because we personally qualify each and every retailer before we sign him on.

6 HERE'S OUR DEAL.

If *you* qualify (not every dealer does) we'll send you a complete Dealer Profit Package that includes 12 K40's, 3 Unimounts, and an award winning floor display. Take one and keep it for yourself. Sell the other eleven. If we can't prove the $38.50 K40 will sell faster than any antenna you're selling now, we'll refund all your money. And you still keep your K40. Fair?

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