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Radio-Electronics

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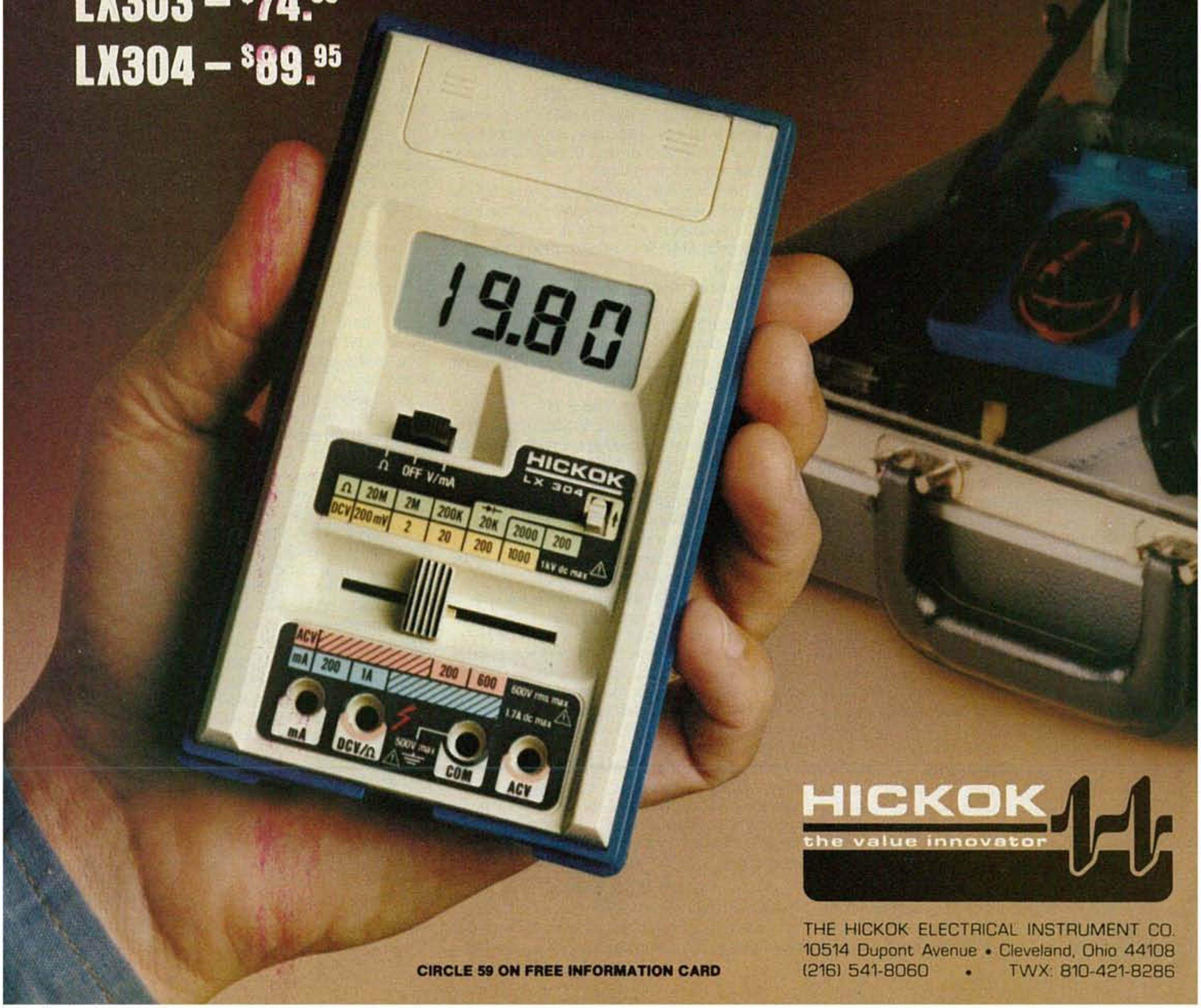

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FEBRUARY 1980 Vol. 51 No. 2

ON THE COVER

The LED bar-graph audio power level meter shown is not a wattmeter, but a level indicator that is calibrated to your amplifier's clipping level. Use the device to protect your amplifier and speakers from power overloads. Shown in contrast to the LED bar-graph display is an analog power level meter. Get started building your own LED bar-graph power level meter today. Construction details start on page 43.

ANNUAL INDEX JANUARY—DECEMBER 1979

To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a *stamped self-addressed envelope (legal size)* to:

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looking ahead

Seeing & hearing: Medical electronics is growing at an accelerated pace, thanks to microprocessors and superminiaturization. Two of the newest products are designed as aids to the blind and deaf: (1) IBM plans to offer a talking typewriter this year (1980). Equipped with a voice-synthesis device, the typewriter pronounces the words as they're typed into a magnetic memory. The material can be corrected before it's transferred to paper. IBM says the system has an unlimited vocabulary and will help blind typists produce "error-free copy." Prices of the typewriters will range from $4,900 to $7,400, the speech-synthesis unit an additional $5,300. (2) Working with funds from NASA and Veterans Administration, the Research Triangle Institute in North Carolina is developing a microprocessor-based system to help the deaf lip-read. A trained lipreader can properly identify only about 25% of syllables, but NASA claims the *Autocuer* could increase comprehension to about 90%. The *Autocuer* uses an LED display to project representations of sounds as nine simple patterns in the viewer's field of vision, each pattern corresponding to a different sound. The goal is to build the LSI circuitry into a pair of eyeglasses, using the lenses to project the LED symbols into the wearer's field of vision, where they can be seen alongside the speaker's lips.

Voice-activated: While many American semiconductor manufacturers are preoccupied with speech synthesis, the Japanese are intrigued by what could be considered the opposite—voice activation. At the Japan Electronics Show, Sanyo showed a whole roomful of appliances that respond to the human voice. When someone observes vocally, "it's warm here," an electric fan turns on automatically. "Let's watch TV" is the cue for the television set; "it's dark," activates the lights, and so on.

Combining voice activation with speech synthesis, Toshiba has demonstrated a TV set that it says it plans to introduce in the United States this year. It can be programmed to accept verbal commands from 2 different people, can be ordered to turn on, change channels, and so forth. The TV set has a two-word vocabulary. When a command is accepted, a female voice replies "O.K." When it can't perform as ordered, it requests "repeat."

Video programming: With home videocassette-recorder ownership now past the million mark, there's an attractive new market for pre-recorded cassette programming, principally feature films. Almost every major movie maker is distributing some titles on videocassettes, and most—including Paramount, Allied Artists, Columbia and Warner Brothers—are handling their own distribution. Fotomat is now renting videocassette movies through its more than 3,700 retail outlets. A research company, Esselte Video, estimates that 80 different program sources are now offering a total of 3,500 different programs. Two major video clubs—patterned after the Book-of-the-Month Club—have become established nationwide: Time-Life Video and VidAmerica. The actual size of the home video software market is something of a mystery, and there are estimates that it could go as high as 2 to 3 million cassettes in 1980. The difficulty of estimating is compounded by the uncounted number of bootleg cassettes now on the market.

Pirate cassettes pose a sticky problem because of the ease with which magnetic tape may be duplicated and the big money involved. One source estimates that 50% of the bootlegged titles are copied from cable TV, and many of them show up in the Middle East as well as on the U.S. market. There are reports of a pirate who is making $4,000,000 a year on bootlegged cassettes. At one point, he paid $500 for a copy of "The Deerhunter" on ¾-inch tape and sold $30,000 worth of ½-inch duplicates in Saudi Arabia in four months. The FBI has conducted many raids on allegedly illegal duplicators, but so far has only scratched the surface.

Most legitimate pre-recorded cassettes are encoded to prevent casual copying. This generally involves changing the frequency and amplitude of the vertical sync pulse during the vertical interval. Although this makes copying difficult for non-technical amateurs, the system is easily defeated by the professional bootlegger. These encoding systems have become controversial, since they can throw some home TV sets out of sync—and many videotape program suppliers will exchange encoded tapes for non-encoded ones when there are customer complaints.

How many screens? Another Toshiba marvel, scheduled for introduction this year, is a 25-inch color TV which can display four 10-inch color pictures on its screen simultaneously. It has a built-in frame-grabber to freeze any picture on remote-control command. Two-picture sets were introduced in Europe in 1977 by many manufacturers without great success—they're all off the market now. Sharp is currently selling a color set that can superimpose a small monochrome picture from another channel in the corner of the screen. Sampo has a set with one big color screen and two small black-and-white ones. If people really do want to watch two or more pictures at once, the next step could be the application of the same principle to audio. How about a hi-fi that lets you listen to two musical selections at the same time—one with each ear?

Projection TV multiples: Although total sales of projection TV sets last year probably were equal to only two or three days' production of direct-view sets, the giant screen seems to be a growing part of the business. With the exception of RCA (as of press time), every major American and Japanese TV set maker was offering or preparing to offer projection sets—in addition to specialist companies such as Advent, Kloss Video, Projection Systems Inc. and Muntz. Quality is improving rapidly, thanks largely to improvements in optics, and prices appear to be poised for a decline. Both of these developments probably have been influenced most by the recent introduction of a plastic lens with a speed of F1, which is beginning to rival the quality of glass lenses at a lower price.

Despite the relatively low sales of projection sets and their rather grandiose space requirements, the life-sized screen has captured the public imagination, and it's probable that no other product in history has ever gotten so much publicity per dollar of sales.

DAVE LACHENBRUCH
CONTRIBUTING EDITOR

Dial precise tip temps

with new Weller® electronic-controlled, variable temperature soldering stations.

Now you can precisely dial-in any soldering tip temperature you want from 350°F to 850°F, and lock the setting, with new Weller Models EC1000 and EC2000 Variable Temperature, Electronically Controlled Stations. No tip changing to change temperatures.

Temperature setting and tip temperature are displayed on a three-digit LED readout (Model EC2000) with a resolution and setability of ±1°F. *An exclusive Weller feature!*

Dynamic response to soldering load variation is assured by a high precision platinum sensor—*another Weller exclusive*—that is mounted deep inside the solid copper iron plated tip and by full proportional heater control. If an iron is damaged or misplaced, another one can be plugged into either EC power unit without recalibrating temperature settings. *Still another Weller exclusive.*

Power units are calibrated to within ±10°F. Temperature control is maintained over line voltage variations of ±10% and ambient temperature range of 60°F to 110°F.

Thyristor power control with zero voltage thyristor drive insures that there will be no high voltage spikes or magnetic fields on the soldering tool tip. In addition the power unit is isolated from the A.C. line by a transformer so that only 24 V.A.C. isolated voltage drives the heating element, and the tool tip is grounded through the power unit three-wire line cord. These features combine with the calibrated temperature control to provide ultimate safety for sensitive, costly electronic circuit hand soldering.

Zero crossing control of heater current eliminates RFI/EMI and accurate time proportioning reduces tip temperature hysteresis.

Power unit is furnished with extra large sponge, iron holder, tip holding tray, solder drip shield, circuit breaker and lighted on-off switch. Soldering tool has high temperature plastic handle and heat shield, burn-resistant silicone rubber cord, and locking plug that mates with power unit receptacle. Unit is U.L. listed.

Stations are normally supplied with ETA 1/16" screwdriver tip. Eight other iron plated tips from 1/32" to 3/16" diameter are optional accessories.

In stock at leading electronic distributors nationwide. In-plant, on-the-job demonstrations can be arranged.

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CIRCLE 22 ON FREE INFORMATION CARD

what's news

New remote-control TV is commanded by voice

Sanyo Electric has produced a prototype television receiver in which all the functions ordinarily controlled manually—or with various manual remote controls—can be effected by two-word voice commands. The words "television power" for example, turn the set on or off, and "channel 8" tunes it to that channel.

With a two-word system, 16 words, including the numbers from 2 to 13, are sufficient. A two-word format has been found best to assure correct performance. Since the set has been designed for operation by two persons, 32 words are used.

The commands have to be registered on the receiver's memory by the operator, to form a model to which the commands will be compared. The words are registered by throwing a registration switch on the panel and speaking the commands into a microphone on the set. The commands are then stored in memory by an Intel 8085 central processing unit.

When a command is given—either into a remote control radio mike or into the microphone on the set, it is compared with the registered commands in the standard pattern memory, and the command most closely similar to that given by the input voice is executed.

Voice control of devices is the most natural and least complicated, and requires a minimum of effort. Sanyo believes that other home appliances can be controlled by voice, and is working on such products.

New lithium batteries meet wide range of needs

A new line of high-energy lithium batteries has just been announced by Electrochem Industries of Clarence, NY. Three variations have been developed to meet specific customer needs.

The bromine complex (BCX) cells are designed for lightweight, long-life portable power sources for the electronics, the communications, and the photographic industries. Solid-cathode (SCX) cells find special application in the computer field, where reliable, long-life batteries are needed for such applications as "keep-alive" power supplies for CMOS and NMOS memories. The high-temperature (HiT) cells are designed to deliver continuous power at temperatures as high as 150°C (302°F). They serve in such applications as power sources in high-temperature locations for well-logging.

"We expect the bulk of our business to be in designing primary sources to meet specific customer applications," says Electrochem president, Dr. C. C. Liang.

NEW LITHIUM BATTERIES, a sampling of custom and off-the-shelf types.

Satellites will get better, not necessarily bigger

Though some persons have imagined the future advances in satellite communication to lie in the direction of "truly giant satellites" that would have to be assembled and maintained in space, the greatest improvement in future satellite design will be the attainment of longer lifetimes, Hughes Aircraft's Dr. Harold A Rosen told a meeting at the International Telecommunications Union's *Telecon 79* in Geneva.

Advances in ground technology will also be an important feature in future satellite improvements. The additional of several advanced digital processors to ground equipment has resulted in significant improvement in the transmission of voice, data and video signals by satellite, he reported. A system that compresses bandwidths to about one-tenth, which increases satellite capacity and consequently reduces charges, has been developed. This makes a substantial increase in video conferencing via satellite probable.

The ultimate satellite size will be one that can be launched in one piece and that will reach the end of its normal life unattended, Dr. Rosen believes.

Microprocessor developer to receive Ballantine Medal

The Stuart Ballantine Medal, one of the nation's most important awards for scientific and technical achievement, was awarded last October to Marcian E. (Ted) Hoff, of Intel Corp., Santa Clara, CA., for his development of the microprocessor. The medal is awarded annually by the Franklin Institute of Philadelphia, and in the past has been bestowed on such persons as John Bardeen, co-inventor of the transistor, and Claude Shannon, developer of information theory.

DR. MARCIAN E. HOFF

Dr. Hoff, in addition to his work on digital microprocessors, contributed to the development of the first high-density computer memory devices, and was also responsible for the development of the first analog microprocessor.

Install-your-own telephones bring trouble to Ma Bell

Since it has become possible for telephone customers to buy their own phones on the open market, the phone company has been troubled with an increasing number of illegally-owned phones. A recent study showed that over half the phones sold at retail are used without phone company knowledge.

To add to the problem, many telephone owners are using phones they obtained illegally. Most phones picked up at flea markets, for example, are suspected to be "hot." The study states: "29.9 percent of the owners of Western Electric phones are using stolen merchandise."

Phone owners may buy decorative phones to replace their present ones, may wish to add extensions, or get extra phones for extension lines already installed. Since (in every state but Massachusetts) the company makes a monthly charge for each subscriber-owned phone, many owners see no reason to report their purchases to the company.

Legal or illegal, unreported phones pose

continued on page 12

Facts from Fluke on low-cost DMM's

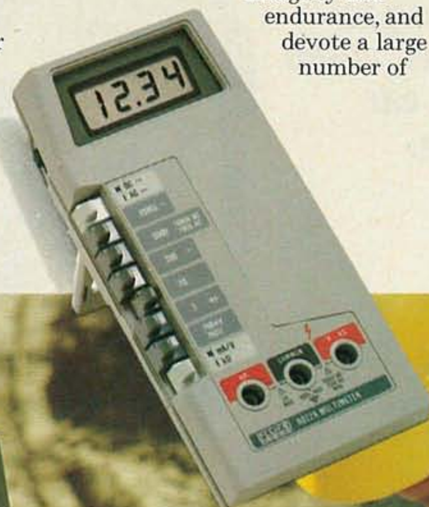
Is this any way to treat a $129 multimeter?

In the rough world of industrial electronics, even a precision test instrument can get treated like dirt. You need all the ruggedness and dependability you can get in a DMM for field use.

You'll find these qualities and more in the Fluke line of low-cost DMM's. Our DMM's have been dropped from towers, stepped on, and run over by construction equipment. And they've survived because we never cut corners on quality, even on our lowest-priced, six-function Model 8022A Troubleshooter at $129 U.S.

Take a close look at a low-cost DMM from Fluke and you'll notice tough, lightweight construction that stands up to the hard knocks of life. Sturdy internal design and high-impact, flame-retardant shells make these units practically indestructible. Right off the shelf, they meet or exceed severe military shock/vibration tests.

Even our LCD's are protected by cast-tempered plastic shields. We use rugged CMOS LSI circuitry for integrity and endurance, and devote a large number of components to protection against overloading, accidental inputs and operator errors.



We go to these lengths with all our low-cost DMM's to make sure they are genuine price/performance values. You can count on that. Because, that's what leadership is all about.

For more facts on DMM reliability and where to find it, call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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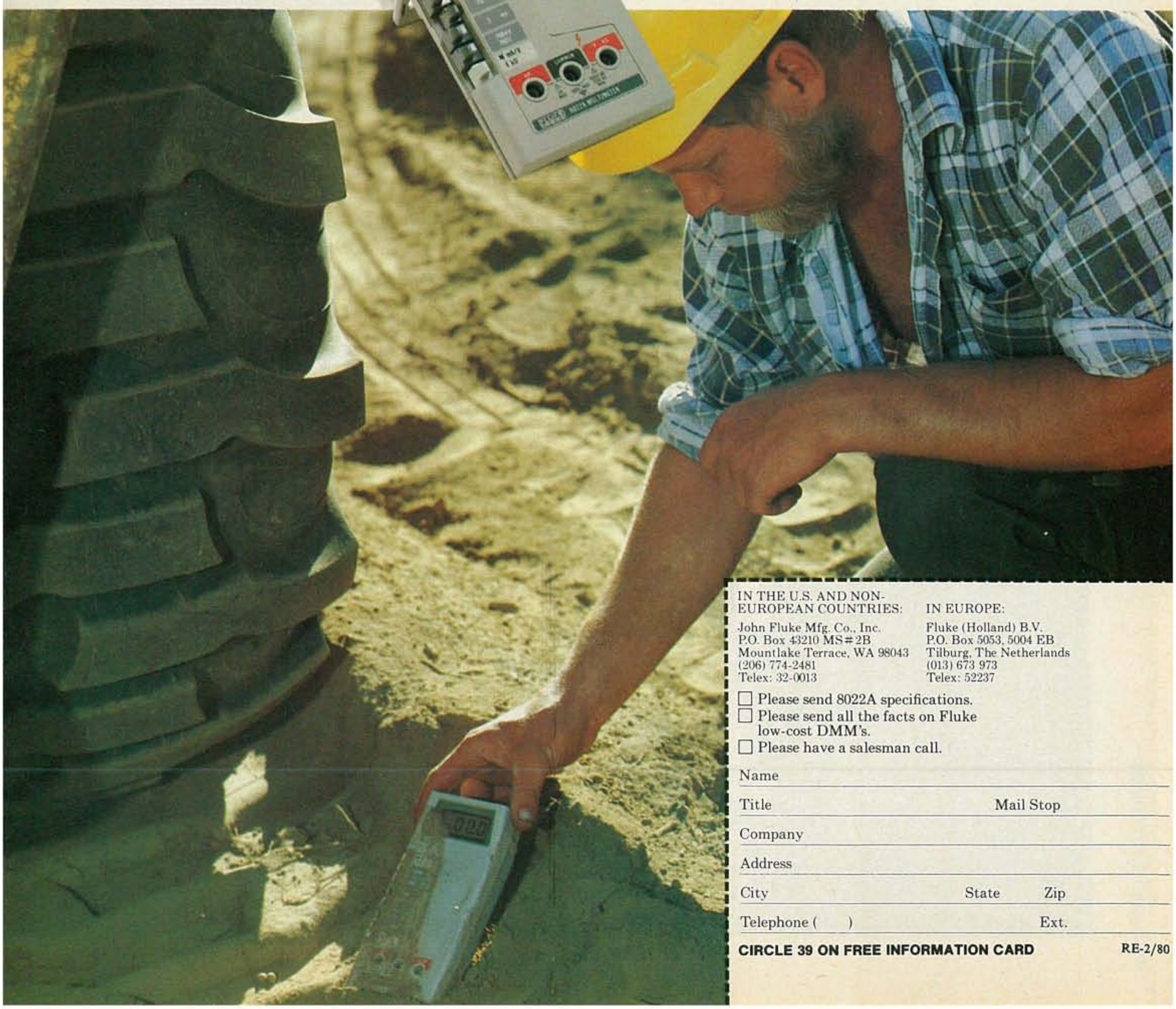

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CIRCLE 39 ON FREE INFORMATION CARD

RE-2/80

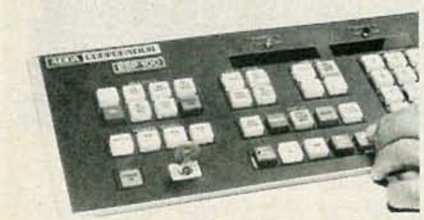
what's news

continued from page 6

two problems for the telephone company: lost revenues from monthly charges or from extensions the company might have provided, and additional power problems if too many phones with ringers are added to a local loop.

In many areas, the phone company has actually encouraged customers who move to take out and re-install their own phones. (The company has found that often the cost of sending a man to remove an old phone is greater than the value of the phone.) Customers are thus trained to hook up phones. Modular plugs on all recent installations make the job simple, and more phone owners begin to feel confident about their ability to hook up a "hot" phone.

SATURN PIX STORED IN DIGITS



THE PIONEER SATURN SPACE ENCOUNTER pictures you saw recently on your television screen were assembled from digital storage on disc. The photo above shows a picture being encoded and entered into the still store system for future recall. The process—the ESP-100 Electronic Still Storage System, developed by Adda Corp of Campbell, CA—is microprocessor-controlled and stores color stills in digital form on high-speed, high-capacity computer-fixed disc packs. The stored pictures can then be recalled at any remote location and put on the screen.

Counterfeit video cassettes being sold in the U.S. Northeast

TDK Electronics, a Garden City, NY, manufacturer of audio and video recording products, warns that its SA-C90 cassettes are being counterfeited. Bogus tapes of inferior quality have been offered in the East Coast area for $2.95, as against the market price of $5.69.

The counterfeits have a number of differences from the genuine tapes that enable a buyer or dealer to spot them:

1. **Liner index card:** The printing on the counterfeit is dark and smudgy, the "C90" on the front being especially noticeable. The section detailing performance and warranty information is not found on the counterfeit.
2. **Outer wrapper:** The counterfeits have a nonfunctional cellophane strip for opening, sloppily glued on the top of the wrapper; the genuine cassettes do not.
3. **Norelco box:** The genuine TDK box has a finger indentation at the top for opening. The counterfeit box is plain.
4. **Shell:** The printing on the shell label is dark and of poor quality. The viewing window is smaller and has a raised edge around the outside; the genuine TDK window is flat. There is no production code number on the edge of the shell.
5. **Tape:** Genuine TDK tape is brown; the counterfeit is dark gray.
6. **Carton:** The carton that holds ten tapes is printed in brown only instead of brown and green. It has no lot number stamped on top.
7. **Quality:** The performance and overall sound reproduction of the counterfeit cassettes are significantly inferior to authentic TDK SA-C90 cassettes.

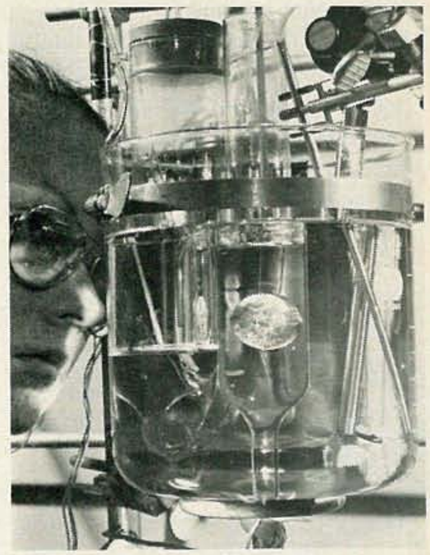
New earth-station antenna cuts interference by 10 dB

A new narrow-beam earth-station antenna exhibited by GTE International Systems at Telecom '79 (Geneva) has a beam so sharp as to make it feasible to position earth stations closer together, as well as permitting closer "parking" of transmitting satellites. The beam width is less than 0.5 degree wide at its 3-dB points as opposed to at least 1 degree for conventional parabolas used in typical earth-stations. Secret of the new antenna is that the horn that picks up the signal reflected from the dish surface is offset, rather than placed at the parabola's focal point. This also increases the gain of the antenna, because the horn is not in the path of the incoming waves, and reduces sidelobes.

The Gregorian-feed configuration coupled with microwave absorption material placed around the circumference of the antenna further reduces the energy coming from the sides, resulting in a reduction of unwanted signal and noise by at least 10 dB. (Because of the offset mounting of the horn, the "dish" departs somewhat from a perfect parabolic shape.)

Since the FCC licenses earth stations on a basis of immunity to interference from nearby stations, the new antenna with its narrower beam and smaller sidelobes will permit earth stations to be placed closer together.

SOUND MAKES PLASTIC FIBERS



PLASTIC FIBERS STRONGER THAN STEEL are being produced by the Hughes Aircraft Co. laboratories, by vibrating a wire coil in a polymer solution at sonic frequencies and at constant temperature. The material can be seen forming inside the coil in the solution.

Hughes researchers have demonstrated that the fibers can be grown directly on devices to be encapsulated, and thus fill tiny openings and narrow passages often found in resin-encapsulated components. Besides its uses in encapsulation, the new fibers—whose strength per unit weight is several times that of the highest strength steel, show promise for a variety of commercial and industrial applications.

Hughes physicist Joanna Ready is shown making a close-up inspection of the process.

Heath Co. of Benton Harbor is now part of Zenith Corp.

Heath, Michigan-based producer of electronic do-it-yourself kits, instruments, adult educational materials and microcomputer products, has been purchased by and will be operated as a wholly-owned subsidiary of Zenith Corp. New Zenith subsidiaries have been established to operate the 55 Heathkit Electronic Centers in the United States and the Heath business in Canada and Europe.

Heath was founded in 1926 by two aviators, Anthony and Edwards, and originally sold airplane kits. It entered the electronic kit market in 1947. Upon the death of the proprietor, Anthony, in an airplane accident, the company was sold, first to Daystrom, then to Schlumberger interests, from whom it was purchased by Zenith.

R-E

OUR $69 SOLAR ALARM. A CHALLENGE TO EVERY CHRONOGRAPH IN THE WORLD.

People are bumping into more watch ads these days than at any other point in history.

And if you think companies like Seiko with their $295 solar alarm chronographs are fighting hard for a place on your wrist, you should see the battle in the Under-$100-Watch Category.

It's Dog eat Dog.

So where did we get the gumption to offer *another* popular-priced mini-genius through the mail? You'd have it too, if you had this watch.

Our $69 Xernus (its price in stainless) provides every watch and stopwatch function you could ask for (see description below).

Even more important, it offers a level of workmanship and design that you just won't find elsewhere—at even $20 or $30 more.

We know, we've looked.

Its display is liquid crystal; the digits are crisp and clear. You get the uncommon convenience of a 24-hour alarm, precise time information for two different time zones. Plus, the latest solar cell technology—to keep your Xernus working for up to 5 years on its original set of batteries. And with an uncanny ± 15 seconds per month quartz accuracy. By the way, Xernus is pronounced *zer'nus.*

Its case, bracelet and back are machined from solid stainless steel. Instead of the thinly plated chrome construction you find on virtually all other chronographs at or near its price.

It's also an incredible 8mm thin.

Much thinner than the Texas Instruments alarm chronograph; much, much thinner than both the widely advertised Advance and Windert. Xernus is even trimmer than the comparably clever $295 Seiko. By more than 2 mm.

Want more? You get a face crystal that's made from tough, hard mineral glass. Most other chronographs in this price field give you nothing better than scratch-prone plastic.

As a Xernus owner, you can also feel secure about moisture and perspiration. We know, because Xernus has even survived our 12-hour water immersion test.

Save $60 while Xernus is hungry.

This isn't a small watch company, or even a very new one. In fact, this pioneer in microcomputer timepieces, has already sold a phenomenal number of chronographs around the world; in countries like Germany, Switzerland and France.

Normal time display:	12:13 14 / 3 8 9 / SU MO TU WE TH FR SA T2 PM AL	See hours, minutes, seconds (or date), plus AM/PM and day of the week.
Stopwatch display:	11:49 05 ST / 6	12-hour timing to 1/10 second. Even lap and 1-2 finishes.
Alarm setting display:	9:45 AL / 8 9 / PM AL	Set for AM or PM. Audible beep lasts a full minute.
Calendar setting display:	12:00 25 DT / 4 / SU MO TU WE TH FR SA T2 PM AL	Set time/date for 2 time zones. End-of-month adjustment is automatic.
Extra light at night.	3:09 26	Push a button for bright face illumination.

This superb timepiece has been practically everywhere but the U.S. And for that reason, Xernus has agreed to let us offer their chronograph at a dramatic discount. In stainless, it lists for $129, but you get it at a $60 saving.

You save even more when you order the Xernus solar alarm in gold (a generous 5 microns over stainless). To be exact, $70 less than your friends overseas have had to pay.

Each Xernus comes gift-boxed with full instructions, service-by-mail convenience, if needed, and a full one-year guarantee against defects by its manufacturer.

And The Sharper Image gives you two weeks to decide if it's really the watch for you. If not, simply send it back as new for a full and prompt refund. But order now to take advantage of this special introductory price.

ORDER TOLL-FREE.

Credit card holders may use our toll-free ordering number. Or send check for $69 for stainless, $89 for gold plus $2.50 delivery. (In California, add $4.14 tax for stainless and $5.34 for gold).

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editorial

Let's not forget analog circuits

Just about every piece of electronic equipment being introduced today contains digital circuitry. At the present rate, it won't be long before every electronic device around us will contain at least one digital circuit. The reasons for this digital explosion are numerous; but perhaps the most noteworthy is that engineers find it easier and economically practical to meet their design goals using digital circuits. Today's IC's closely resemble function modules containing whole circuits. As a result, engineers can design on a block-diagram level rather than be intricately involved with discrete components. That's not to say that designing a digital circuit is easy—its not. But *it is easier* to design a digital circuit than its analog counterpart.

We electronic activists find ourselves becoming more and more involved in designing, prototyping and troubleshooting digital circuits. We read more about them and train ourselves to become digital experts. However, we must not lose sight of the fact that we live in an analog world. As a result, most digital-based devices must interface to analog signals. (I use the word "most" because I don't want to answer dozens of letters pointing out that pocket calculators are digital all the way from keyboard to the seven-segment LED display.) Also, there are many circumstances that don't permit the use of digital circuits. For example, the low-noise amplifier described in our current series on Satellite TV Receivers must handle a 4-GHz input signal. The task of designing a circuit to digitally amplify a 4-GHz signal would be monumental to say the least. So, for the forseeable future at least, digital circuits will not replace analog circuits entirely.

While we train ourselves to become digital experts, we must also train ourselves to become analog experts. If I were to ask, I'd bet most of you could not describe the circumstances that would require a ground plane on a PC board. Nor would you be able to tell me how large a heat sink is required for a specific transistor output stage. So, while we're having fun and reaping all the benefits we can from digital circuits, let's not forget analog circuits.

Art Kleiman

ART KLEIMAN
MANAGING EDITOR

Radio-Electronics®

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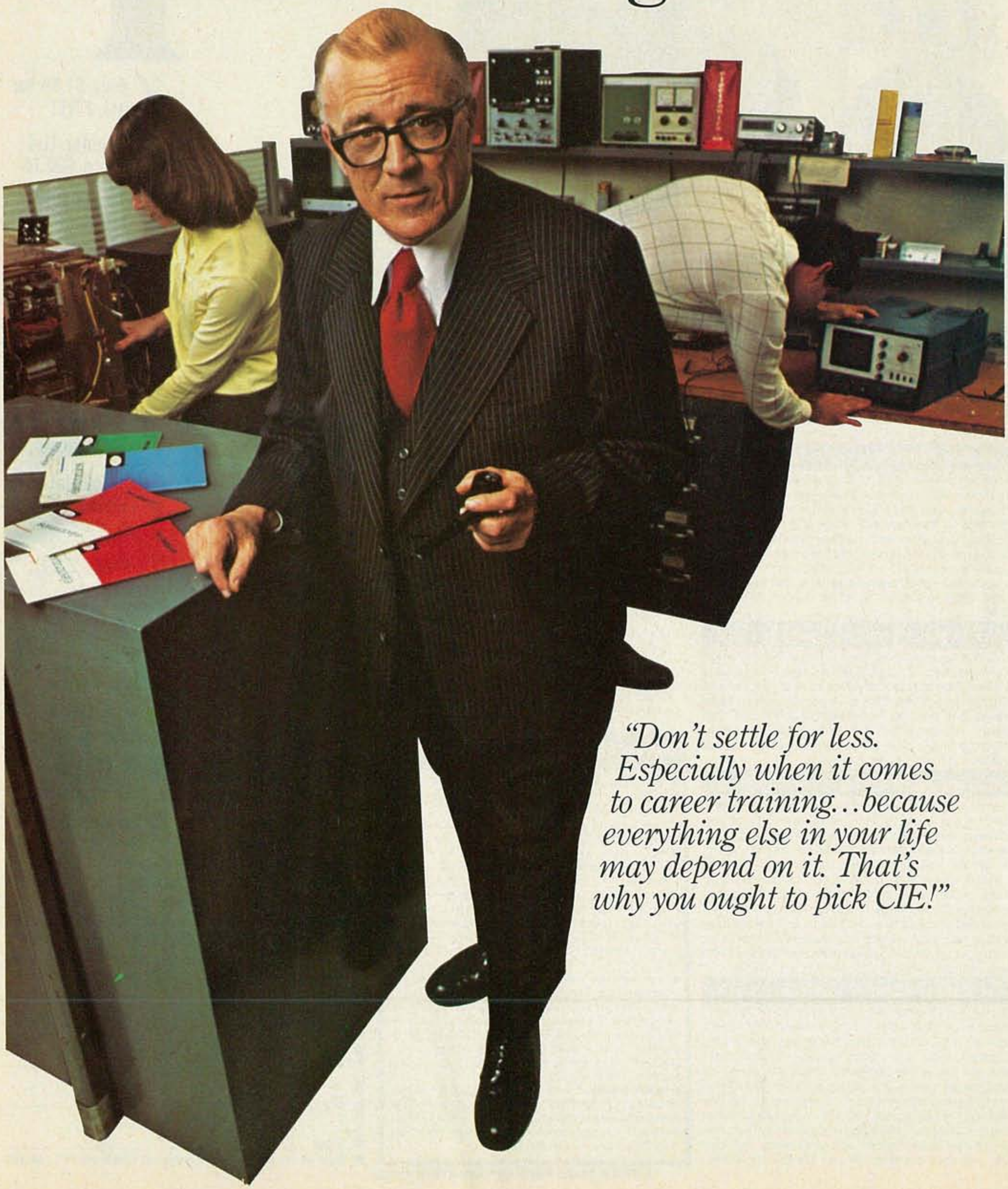

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letters

THE EQ-2

We have recently redesigned our graphic equalizer kit mechanically. (That is the one I wrote about in the May 1978 issue.) The new design is wider and lower, and, I think, more attractive. It uses solid walnut end-panels, rather than the previous three-sided cover. As the walnut is now an integral part of the structure, the unit is no longer available without it. By simplifying the unit, we are able still to sell it for $100 postpaid, despite the inflation of all the parts costs. Your readers may be interested to know that we sell the assembly manual for $2.50, refundable with purchase of the unit. The circuit and its excellent performance are unchanged.
JOE GORIN
Symmetric Sound Systems,
1608 South Douglas Avenue,
Loveland, CO 80537

OOOOOPS!

Regarding "Fifty Years of Electronics:" On the bottom right of page 65 of your October 1979 issue, the CBS tube plants mentioned were at Danvers and Newburyport, Massachusetts—not Connecticut, as stated there.

Just the same, this is certainly an issue of *Radio Electronics* to keep!
NEIL F. DUNN
Danvers, MA

Right!—Editor

Many oldtimers (and some youngtimers as well) celebrated with Dr. K. Vladimir K. Zworykin his 90th birthday last July, at his Princeton home. He is healthy, alert, and active; so it comes as a surprise that, on page 45 of the 50th anniversary issue of **Radio-Electronics**, Baron Manfred von Ardenne implies that Dr. Zworykin's death had occurred in 1977. We are happy to say that the report is incorrect, and your readers may also be pleased so to learn.
EDWARD W. HEROLD
Princeton, New Jersey

We regret that, in the process, a phrase of Baron von Ardenne's manuscript was misunderstood, resulting in the erroneous report that Dr. Zworykin had died in 1977. We did receive a correction of that error; unfortunately, we didn't get it in time for us to make any changes in our October issue. We join you in your pleasure at knowing that Dr. Zworykin is alive and well.—Editor.

Your article on logic circuits in the 50th Anniversary issue is very interesting, but the truth table in Fig. 2 for the "simple AND gate" on page 111 may contain an error in its first line. The output symbol given for that line is a binary one when, if my interpretation of the second paragraph under the "AND gate" heading is correct, it should be zero.

From other sources, I understand that the output symbol of an AND gate is obtained by a multiplication of the inputs. Since $0 \times 0 = 0$ in binary multiplication, that also seems to indicate the use of zero for the output in that first line of the table.

Thank you for a fine Anniversary issue.
REGINALD TODD
Kansas City, MO.

The first line of the truth table in chart 2 is incorrect. The output should be a zero instead of a one. Also, the logic symbol is incorrect as it shows a NAND gate. Remove *the small circle at the output to obtain the correct AND gate symbol.*—Editor

HEART MONITOR

In my opinion, a technical magazine (which I consider ***Radio-Electronics*** to be) should be technically correct. The article on the heart rate monitor is interesting from the electronic point of view but has a technical error. Figure 1 depicts a tracing of an electrocardiogram. The instrument described does not use the electrocardiogram but rather the pulse pressure wave in the finger as a trigger source. The waveform of the pulse pressure wave is more like that shown in the diagram, depending on where it is recorded.

I have used either the electrocardiogram or the pulse pressure wave to trigger a cardiotachometer. Both work, sometimes one better than the other.

LESLIE P. McCARTY, PH.D.
Research Specialist, Bio-Medical Research
Dow Chemical
Midland, MI

RADAR DETECTORS VS. THE LAW

The legal, moral and constitutional issues are with us again as the rights of citizens to own radar detectors or receiving devices capable of monitoring frequencies assigned to police.

First, by order of the FCC, the radar band is not specifically assigned to police. The Commission has ordered this band to be shared by radio listeners, astronomers, public service agencies, hams and other private and government microwave users. A state agency has no such authority. The twisted misinterpretation of Penal Code MCLA 750.508 cannot and should not be used against a citizen. Police radios are on a different frequency than police radar. The FCC says citizens also have the right to use the radar frequency.

Regardless what the legislators vote on, states don't have the right to regulate federal FCC-controlled monitoring. If anything, the legislature should abolish or rewrite MCLA 750.508. In my opinion, MCLA 750-508 is unconstitutional and discriminatory because it overrides federal law giving the FCC exclusive authority over who uses what frequency, and because it allows one class of individuals to legally receive radar or police signals while all others are excluded. The ACLU (*A*merican *C*ivil *L*iberties *U*nion), the ARRL)*A*merican *R*adio *R*elay *L*eague), the FCC and the citizens of the state of Michigan should make sure the law is changed and the U.S. Constitution followed.

Radar detection has been used and is being used by people of all classes and ages. An Ohio mayor claims that such devices make a driver aware of his speed and slows him down to the legal limit, and says slower speeds lessen accident rates.

Restraints on enforcement (of the Michigan law) could avoid the trouble that happened to a physician who was awakened in the middle of the night and arrested for having a detector in his car when an officer on patrol spotted it in his driveway!

Some judges and police are divided over this present band as it stands, and a speedy reversal should be enacted. As a tourist from out of state, how would you feel if you were not aware of this "so-called law" banning detectors, there was no posting for same and you were arrested for possession of a detector? This alone is in violation of due process (no signs posted) and federal preemption of the airways.

Radar operates on the Doppler principle, and has come under severe attack recently—especially moving radar. It's a fact that a CB set can trigger a false reading with a whistling tone with readings to 90 mph; reflections from vehicles traveling at slightly different speeds can cause higher readings—this is called "batching." A fast-moving truck behind a slower moving car will register a stronger signal than will the car—and the innocent car will be cited. And how does an officer distinguish a speeder from a nonspeeder in a group?

Drone radar (jamming devices to trigger detectors) that police in some states were using for the past couple of years has been put down by the FCC as being illegal. The misuse of radar and radar laws should be challenged by anyone, and the ACLU should look into all laws past and present. The abuse is placing undue burdens on courts, police and citizens in terms of cost, time, and embarrassment.

While I believe that criminals should be charged and prosecuted, I don't believe

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LETTERS

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vesting total power in law enforcement at the expense of the ordinary citizen was a principle this country was founded on. the laws are there to be applied equally.

A legal defense fund is being established for test cases and class action suits as needed. Anyone interested can contact the writer of this letter for details.

L. C. MAYNARD
Maycom Communication Products, Inc.
1134 W. John Beers Rd.
Stevensville, MI 49127

ELECTRONIC SYNTHESIZER

I read Mr. A. P. Campione's letter on the electronic synthesizer in your July issue, and was interested in his suggestion about using a tuning fork and a pickup coil for the purpose of generating a C-Major scale.

I suggest that he could get far more accurate results—generating, by the way, complete musical scales (12 notes per octave) for as many octaves as he wishes—by using a Top Octave generator. That is made in integrated circuit form by many companies, such as National Semiconductor and General Instruments. Using that device and driving it with the proper frequency crystal oscillator, one may obtain far more accurate musical frequencies than by using a tuning-fork oscillator. Such a crystal-controlled system is also much lighter and cheaper.

HAROLD ZIBKOFF
Brooklyn, NY

X-BAND MISINFORMATION

Boy, oh boy! Where did Robert E. Williams (Letters, September 1979 **Radio Electronics,** page 24) get his store of misinformation?

I cannot quibble with the first three paragraphs, but the fourth paragraph is full of inaccuracies.

First of all, it is common knowledge (maybe not?) that X-band police radar is on 10.525 GHz ± 25 MHz and the K band is up around 24 GHz somewhere, not the 9.32-9.5 and 10.5-10.7 GHz ranges as he suggests. (Actually, the only band lower than X is the old S band, which is not used much any more.)

Secondly, if there is an amateur transceiver available for the X band, please let me know where I can find it; I could really use a 10-watt X-band transceiver. I think, just maybe, that he is confused by the common two-meter radios that have a 1 and 10-watt position. Besides, can you really picture a *10*-watt X-band signal source? Only TWT's or KPA's can kick out that much punch.

Thirdly, at my last checking with the FCC, pulse is not permitted on the X band, and never has been.

Fourth and last (and what a way to go): Really, when was the last time you measured the same thing coming back as was sent out? Especially at 10 GHz where propagation effects take a bad toll. Are we really supposed to believe that 100 mw comes back after going down the highway several hundred feet, bouncing off a very "scattering" reflector, and coming back another two hundred feet?

ROBERT T. SESTRO
Hunt Valley, MD

equipment reports

Speakerlab Model 2.5 Speaker System

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NOT MANY HI-FI MANUFACTURERS OFFER speaker systems in kit form. One of the manufacturers that does, Speakerlab Inc. (Dept. R-E, 735 N. Northlake Way, Seattle, WA 98103), offers several different models ranging from a miniature bookshelf speaker to large floorstanding systems. So, we decided to assemble their middle-of-the-line "best selling" system to find out just how difficult it is to put together and how it sounds.

The Speakerlab 2.5 is a three-way acoustic suspension system that measures $26\frac{1}{4} \times 15\frac{1}{4} \times 10\frac{3}{4}$ inches and weighs 56 pounds. The manufacturer's specifications list the impedance at 8 ohms, sensitivity at 91 dB at 1 meter with a 1 watt input, a minimum recommended power amplifier rating of 15 watts-per-channel RMS and a maximum power handling capability of 150 watts-per-channel RMS.

The three drivers include a 10-inch woofer, a 6-inch midrange and a 1-inch dome tweeter. The woofer uses a high-density foam roll suspension, a $1\frac{1}{2}$-inch diameter voice coil and a 26 ounce magnet. The 6-inch midrange has a butyl rubber surround and the entire driver is housed in a separate sub-enclosure within the speaker system. Crossover frequencies occur at 600Hz and 4 kHz. The L-C crossover network uses switches rather than controls to adjust the level of the tweeter and midrange drivers.

Two enclosures are available for the model 2.5. We received the "utility" enclosure that consists of a 6-mil thick polymer bonded to a $\frac{3}{4}$-inch thick particle board. The polymer is embossed and printed in an attractive simulated walnut pattern. Also available is an oiled walnut veneer enclosure. The grille cloth extends to the edges on both enclosures and is mounted on a removable frame for easy access to the drivers.

Assembly

Surprisingly few individual pieces make up the Speakerlab 2.5 kit. In fact, a better term would be "partial kit" since so many of the individual pieces come pre-assembled. For example; the top, bottom, both sides and rear panels of the enclosure come pre-assembled. The rear panel also contains the necessary cutout for the crossover network. The front panel contains the required cutouts for the drivers, and the frame that holds the grille cloth is pre-assembled. The crossover network is also pre-assembled and even has push-on connectors on the ends of the wires that connect to the drivers. The only tools that are necessary for assembly are a caulking gun, a pair of scissors and a staple gun.

The assembly manual is well written and clearly illustrated. The first step in assembly is to paint the unfinished wood surfaces black.

continued on page 32

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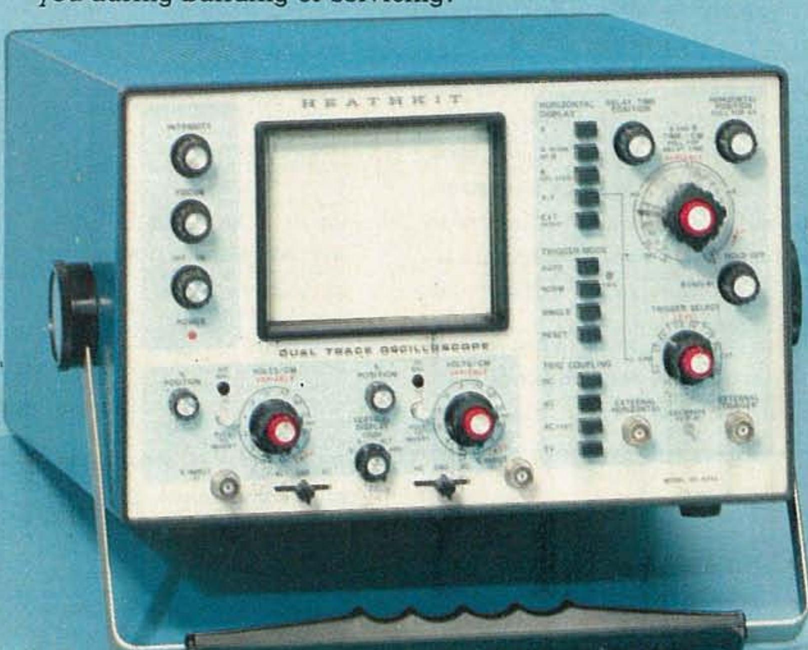

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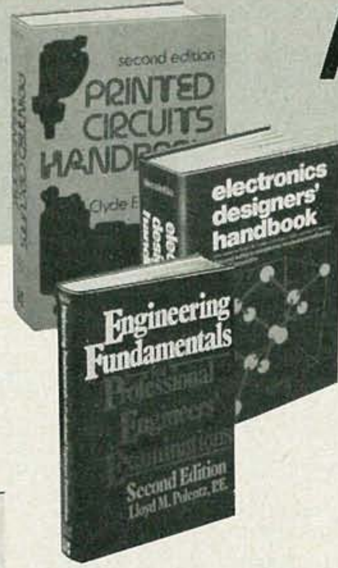

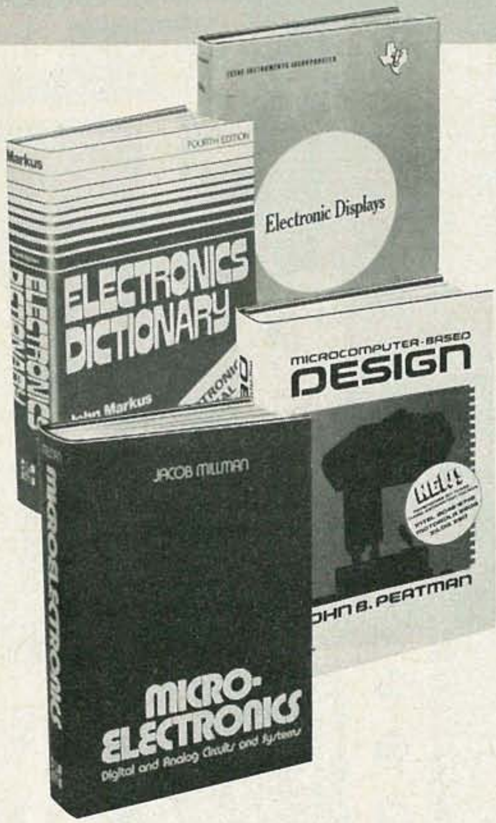

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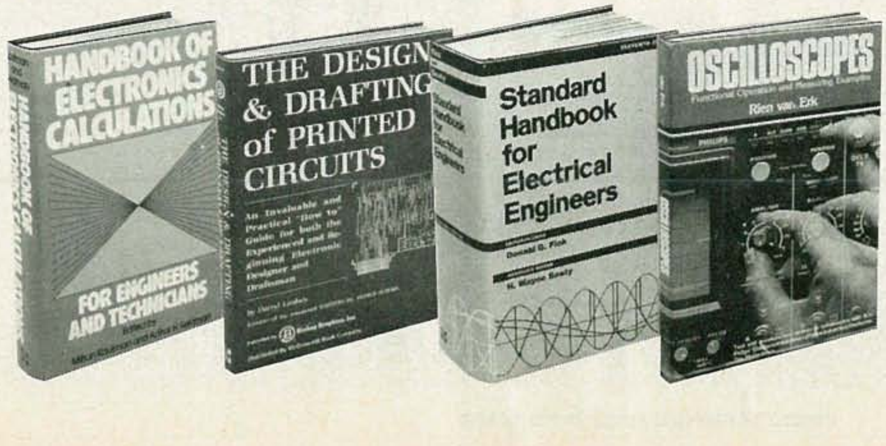

EQUIPMENT REPORTS
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The top, bottom and sides have the simulated walnut finish. However, the exterior surface of the rear panel is unfinished and should be painted black. Also, the exterior surface of the front panel and the grille cloth frame should be painted to prevent the unfinished wood surfaces from showing through the grille cloth. Flat black latex paint is provided along with a foam paint applicator. Two coats are required for each surface. Each coat took about ½-hour to apply with about 1-hour drying time in between. At the end of the first coat, the foam applicator had just about had it. So, in between coats, a trip to the local hardware store was made to purchase a new one. After applying the second coat, the surfaces were allowed to dry overnight.

The next step consists of mounting the midrange sub-enclosure on the interior surface of the front panel. The sub-enclosure consists of a plastic "cup" with a terminal block and push-on connectors on the ends of the wires that connect to the midrange driver. To mount the sub-enclosures, as well as assembling the rest of the kit, a silicone rubber cement is provided in a cartridge that is used with the caulking gun. The cement is applied to the interior surface of the front panel around the edges of the midrange cutout. The sub-enclosure is then pressed into place.

The crossover network is mounted next using the silicone rubber cement. The cement is applied to the interior surface of the rear panel around the edges of the crossover cutout. The crossover network is then pressed into place. The cement was allowed to dry overnight although the assembly manual stated that the setting time is two hours.

Next, the front panel is cemented into place. First, a brace that extends between the front and rear panels is cemented in place. Then cement is applied to the grooves in the front edges of the enclosure. These grooves permit the front panel to be flush mounted. The front panel is then pressed into place and the cement allowed to dry overnight. The damping material is installed next. A large roll of damping material is cut into three pieces; two large and one small. The two large pieces are rolled up and stuffed into the enclosure. The small piece is rolled up and stuffed into the midrange sub-enclosure. After this is done, the drivers are connected and the system connected to a power amplifier to test each of the drivers. If all the drivers are functioning, they are then cemented in place.

Cement is applied to the exterior surface of the front panel around the edges of the driver cutouts. The drivers are then pressed into place. The cement is allowed to dry overnight and then any excess cement protruding around the edges of the drivers is peeled away.

The final step is to mount the grille cloth. The grille cloth is stretched over its frame and held in place with a staple gun. The frame is attached to the enclosure with push-on fasteners that are provided in each corner of the frame and on the front panel of the enclosure. The frame is simply pressed into place.

How it sounds

Considering the price and size of this speaker system, its performance pleasantly surprised us. We placed a pair of the 2.5's in a medium-sized listening room and listened to a wide variety of program material over a 3 week period. The speakers were placed on the floor and we found that the "flat" setting of the crossover network provided the best response.

The bass response was surprisingly accurate considering the size of the speaker system. It was not at all boomy, but simply there. As expected, it did not extend into the lower bass regions as it does in some larger, more expensive systems.

Horns and cymbals were reproduced cleanly and brilliantly, attesting to the good frequency and transient response of the tweeter. The Speakerlab 2.5's provided a sense of presence and the stereo imaging was sharp. Overall, we liked the sound of the 2.5's.

If you are looking for a speaker system in this price range, you would be making a mistake not to consider the 2.5's. The complete kit featuring the utility enclosure is $139.00 each. The same kit with the walnut enclosure is $159.00. The model 2.5 is also available completely assembled for $215.00. Or, if you're a real do-it-yourselfer, you can purchase just the drivers and crossover along with plans of the enclosure for $109.00. The Speakerlab catalog also features individual drivers, crossover networks and publications describing how to design your own speaker systems. **R-E**

Simpson Model 380 Microwave Leakage Tester

CIRCLE 102 ON FREE INFORMATION CARD

MICROWAVE OVEN LEAKAGE IS A HOT SUBJECT, (sorry about that!). Anyone working with microwave ovens must have testers that can detect leakage, and make sure that this leakage is below the Performance Standards of the U.S. Department of Health, Education and Welfare. The HEW standards call for a maximum of 1.0 mW per-square-centimeter at any point that is 5 cm from the oven's external surfaces prior to purchase. After purchase and use, the leakage limit goes up to 5 cm-per-square-centimeter.

Simpson Electric Company (853 Dundee Avenue, Elgin, IL 60120) has developed the *model 380* microwave leakage tester. The tester is a self-contained instrument, calibrated at 2450 MHz. It has four power-density ranges: 0–2.5 mW per-square-centimeter; 0–10 mW per-square-centimeter; 0–25 mW per-square-centimeter; and 0–100 mW per-square-centimeter, with an accuracy on all ranges of ±1.0 dB. The ranges are selected by a handy thumbwheel knob designed for using your right thumb.

For special testing, it provides two response
continued on page 34

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EQUIPMENT REPORTS
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times: 1.2 seconds maximum (Fast) and 3.0 seconds (Slow). The meter scale is calibrated in two arcs, 0–2.5 and 0–10. The response time in the FAST mode is well below the minimum specification called for in the HEW standard that reads "90% of maximum reading within 3.0 seconds." The range accuracy also meets the HEW standards at ±1.0 dB.

A special probe comes with the *model 380*. This probe measures a full 13 inches long, and has a coiled cord that extends to 43 inches and retracts to only 6 inches. The probe plugs into the top of the *model 380* case, and the plug has a screw locking ring. The probe tip houses the microwave detector, which is a pair of cross-polarized antenna/thermocouples. The electromagnetic field that is being read induces a current in the antennas. This current is dissipated in the thermocouples and converted into heat, which, in turn, causes the thermocouples to generate a small DC voltage. This voltage is amplified and displayed on the meter.

The probe head has a special cone-shaped plastic cover, which is exactly 5 centimeters thick at all points. The probe head is simply held in contact with the surface of the unit being tested, and there you are. The plastic cover is removable and can be replaced if it is damaged.

The *model 380* is a two-hand instrument; one hand holds the meter and the other the probe. With the long probe, you can keep away from possible radiation. The manual warns that the instrument should be turned on and zeroed before the test is made. If you observe a reading above 100 mW while you are still approaching the unit, stop! Something has to be repaired immediately—before you can make further tests.

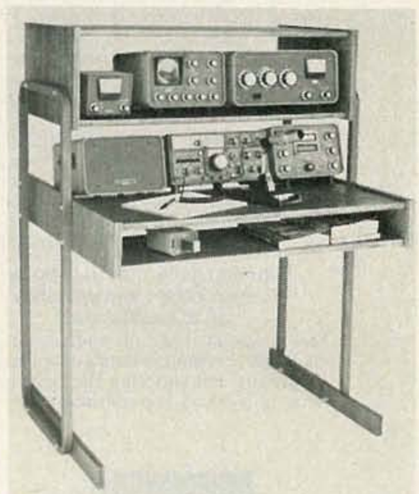
The zero-adjust control is a thumbwheel 10-turn potentiometer on the right side of the case. This control is also used for a quick probe-test. Zero the *model 380* with the probe connected (in a location with zero radiation, of course). Then, disconnect the probe; if the meter stays on zero, the probe is defective. It should jump backward off-scale.

The slow 3.0-second response time is provided so you can test home-type ovens that have stirrer mechanisms and similar devices. These devices can cause a reading to fluctuate. By switching to the slow mode, the fluctuation can be eliminated for a more accurate reading. The *model 380* can also be used for any industrial application that involves microwave heating or drying, etc. For safety's sake radiation leakage levels on these units should be read at stated intervals.

The *model 380* comes in a neat plastic carrying case that looks like an attache case. The case is foam-lined with holes cut to fit the meter, probe, cable, manual, and even a couple of spare 9-volt batteries. The batteries fit in a compartment on the back of the case, with a cover held on by two screws. The case even has a neat plastic nametag with space for name and address, etc.

This is a beautifully made instrument that should be invaluable. It carries a suggested list price of $270. **R-E**

SF STD-36 Radio Operating Desk



CIRCLE 103 ON FREE INFORMATION CARD

IN SPITE OF THE ENORMOUS NUMBER OF MANUfacturers of consumer electronic equipment, very few manufacturers are making anything to *set* it on! Naturally, tables may be fabricated from plywood and composition board, wooden doors may be called into service or even old kitchen tables will do in a pinch. When money is no object, the affluent buyer can go to an office supply store and purchase a desk. But amateur radio installations have special requirements. Usually, there are numerous pieces of peripheral equipment as well. SWR meters, antenna matchboxes, clocks, receivers, transmitters, antenna rotators, microphone . . . all take up considerable room. While a spacious wrap-around console would be nice, it

continued on page 36

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EQUIPMENT REPORTS

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isn't very practical. A multi-tiered console would be just the thing to put all operating controls within easy reach.

SF Amateur Radio Services is now offering a series of radio operating desks, featuring different styles, colors, and sizes. The desk we decided to sample was the model *STD-36*, a 36" wide, walnut finished standard model. Other models range from unfinished ($135) to solid walnut ($275). In addition, the handsome line is now supplemented with a series of consoles for home computers. Any of the styles and sizes may be furnished in walnut, teak, or clear lacquer. All models are finished in oil stain with two coats of clear lacquer. Metal braces are finished in baked black enamel. The braces themselves are fabricated from 1" square 18-gauge steel. At present, delivery may be expected within three weeks of receipt of order.

Our *STD-36* arrived in two shipping cartons. Packing was adequate, and no marring or scratching of the components was evident and no components were lost.

The desk is a semi-kit. All pieces are completely finished, and drilled for assembly. Our kit included 11 wood shelves and panels, 6 metal legs and braces, and a bag of hardware. To assemble the kit, what we needed to provide was glue, a standard screwdriver, a hammer, and a pick (to set a couple of pilot holes for two small screws).

As beautifully designed and prefabricated as the desk is, we had considerable difficulty in assembling the unit. A job which shouldn't have taken much more than an hour turned into several hours. The difficulty was that although engineering drawings are supplied, there are no instructions whatever provided. No parts count, no description, no helpful step-by-step instructions or other hints. At one point we had to tear a subassembly apart after gluing it, and start all over again. Although SF Amateur Radio Services shows a picture of the assembled unit in their advertising, none is supplied with the kit. As a result, unless the buyer has one of the promotional flyers that features a large picture of a typical unit, he has to guess at what the finished product should look like.

The various subassemblies are securely held in place by eighteen ¼-inch socket head screws provided. Matching T nuts are used to draw the assembly snugly in place. An Allen wrench is included in the semi-kit in order to torque up the screws.

Once finally assembled, the desk is quite substantial. It is built to withstand at least 200 pounds of equipment, and resists shear with its internal braces.

When properly assembled, the handsome desks from SF lend an elegance to the decor of a hobby communications installation. The model *STD-36* Radio Desk has a $149.95 suggested retail price and is available from SF Amateur Radio Services, 4384 Keystone Avenue, Culver City, CA 90230. **R-E**

Panasonic Model RF4900 10-Band Receiver

WHILE MOST OF US THINK OF PANASONIC AS A consumer appliance manufacturer of TV sets, calculators and the like, the company does

continued on page 38

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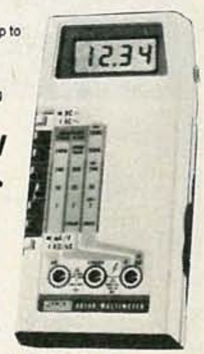
The 8020A has been designed with the user in mind and features exclusive one-hand operation. For harsh service environments, the 8020A has a ruggedized case and extensive overload/transient protection backed up by a 1-year warranty. Long term stability (1-year calibration cycle) is excellent with only three cal adjustments. Up to 200 hours of continuous operation can be expected from a single 9V alkaline battery.



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ADVANCE ELECTRONICS

EQUIPMENT REPORTS

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produce a quality line of receivers called the *Command Series.*

The 10-band *model RF4900* is the top of the line, and it is an eye opener! Its exceptionally handsome styling—a black military-style cabinet with chrome trim—features a brilliant 4-digit fluorescent display that works accurately on all frequency ranges. The receiver tunes continuously from 525 kHz through 30 MHz (AM/CW/SSB), and from 88 MHz through 108 MHz (FM).

CIRCLE 104 ON FREE INFORMATION CARD

A dual-speed main tuning drive makes frequency selection a snap. There is, however, some dial backlash that must be tolerated. RF preselection is self-tracking, so manual peaking is unnecessary.

Transparent, high-fidelity sound is heard through the internal speaker on FM. For communications, the IF selectivity can be switched from wideband to narrowband. Separate treble and bass controls allow audio contouring as desired; and a calibrated S-meter doubles as a battery tester.

The automatic noise limiter is moderately effective against impulse noise, but more clipping would be desirable. Three separate antennas are required for the 0.525–3-MHz, 3–30-MHz and FM ranges.

A separate main tuning dial is used on the lowest frequency range that provides very rapid tuning, making accurate dialing a little touchy. A high number of images can be heard throughout the 0.525–3-MHz range.

In the frequency range from 3–30 MHz, the *model RF-4900* is a different receiver. Images are nearly undetectable even in the most crowded portion of the frequency spectrum; this may be attributed to up-conversion of the double superheterodyne design. A variable beat-frequency oscillator pitch control allows the adjustable selection of LSB/USB modes, and a front-panel trimmer provides easy frequency calibration.

The unit's up-conversion capability substantially reduces IF images. A crystal-controlled first oscillator provides remarkable stability; good enough in most cases to copy teletype signals as well as SSB and CW signals. Band switching is very positive. There are no erratic switch contacts to cause instability.

It's a pleasure to tune through all the frequency ranges and not have to continually peak a preselector control; tracked RF tuning makes this possible.

A separate RF gain control can be adjusted to reduce pumping on CW or SSB signals, as well as to cut down background interference. It can provide up to 45-dB signal attenuation. An antenna trimmer may be adjusted to accommodate variations in antenna impedance for optimum matching.

Although most users will power the receiver on 120 VAC, battery operation is provided. Power consumption is 10 watts.

The dial lights and frequency display can be switched off to conserve power during battery operation (eight D cells are required). A 12-volt jack is accessible on the rear apron for mobile use and front-panel jacks are included for an external speaker (or earphones), a recorder output and an audio input to make use of the excellent internal 2-watt amplifier. The metal wrap-around cabinet provides distinctly superior shielding.

Sensitivity is reasonably good. Remember, the general use of reasonably large antennas for the shortwave frequencies makes exceptionally high receiver sensitivity unnecessary.

The *model RF-4900* is a pleasure to use, and a worthy competitor in the growing field of general-coverage receivers. It is available for a suggested retail price of $499.95 from Panasonic Company, One Panasonic Way, Secaucus, NJ 07094. **R-E**

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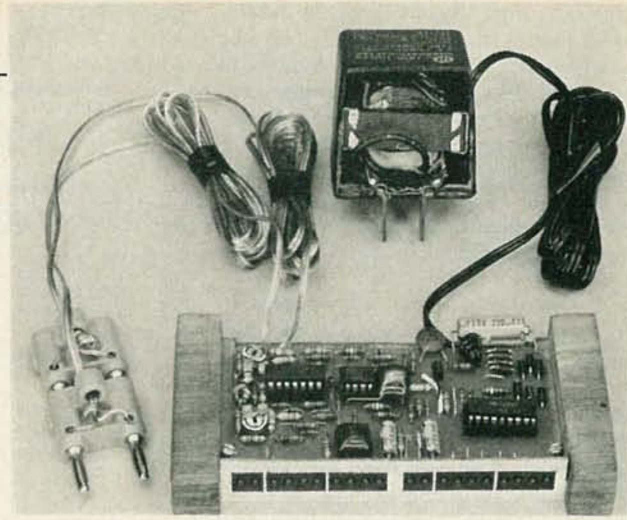


AUDIO POWER LEVEL METER

Not a wattmeter but an honest-to-goodness power level indicator calibrated on your amplifier's clipping level. Use it to protect your speakers. Inexpensive and easy to build.

JOSEPH M. GORIN

OUTPUT METERS ARE BECOMING INCREASingly common on high-end audio amplifiers and receivers. They add visual excitement to a product and thus help its sales, but they have enough other uses so that many companies have introduced accessory meters in the over-$100 price region for audiophile use. The purpose of this article is to allow you to build a high-quality power-level meter (PLM) for a low price.

Before "moving up" to a higher power amplifier, an investment in a PLM, will tell you how often (if ever) you drive your current equipment into clipping. After a short period of use, the PLM will give you a good feel for the effects of doubling power (adding 3 dB) and answer the question of how much power is needed in a given installation. Users of biamplification (a system with separate power amplifiers for woofers and tweeters) can use the PLM to see how much more power is needed for the woofers than the tweeters. I found that my system with 300 watts available for the woofers and 25 watts for the tweeters, the tweeter amplifiers never come close to clipping while the woofer amplifiers clip frequently. This knowledge saved a lot of time and money by showing the folly of building higher power amplifiers for the tweeters.

The PLM can help prevent loudspeaker damage. Most loudspeaker failures are caused by running power amplifiers into frequent clipping. Although musical signals contain very little high-frequency energy—almost never enough to destroy a tweeter even at high levels, an amplifier driven into clipping creates a waveform with sharp edges that produce lots of high-frequency distortion. The crossover passes this energy on to the delicate tweeters; causing them to burn out. This happens most often with amplifiers in the 25-watt region. Lower-power amplifiers do not have enough power to destroy the tweeters and larger ones are run into clip-

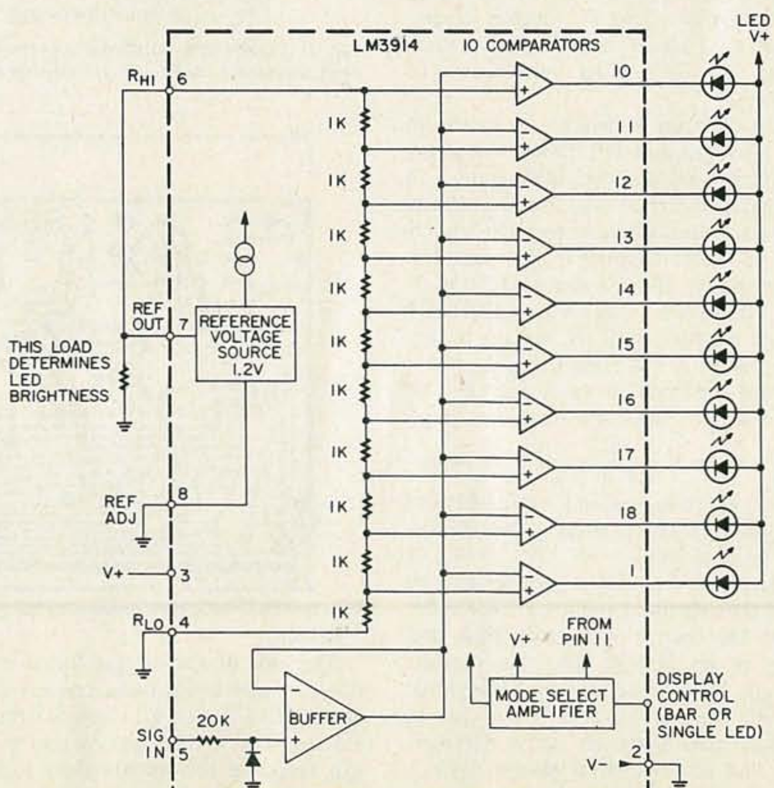


FIG. 1—BLOCK DIAGRAM of the LM3914 dot/bar display driver monolithic IC.

ping less often. By watching the power-level meter, frequent clipping can be observed and the level turned down to prevent it. This power-level meter is actually a *voltage* rather than power-reading device, as virtually all solid-state power amplifiers clip at a constant voltage (independent of load impedance), especially during transients, and therefore measuring voltage is a viable method of measuring maximum power.

A power-level meter can be used to compare the dynamic range of program sources (and explain much of the difference between FM broadcasts and records). It can help you set up the balance of your system. Since it is fast and peak-responding, it can be modified (see the construction section of this article) to aid in setting tape recording levels. But, like a seconds readout on a digital clock, it is very useful for making you feel good about your equipment's operation and just plain fun to watch.

How It Works

A new LED driver IC (LM3914) from National Semiconductor has allowed a truly low-cost circuit design which, when combined with the economies of kit construction, allow the PLM to sell in kit form for only $42. The LED driver IC takes an analog input and drives up to ten LED's in a bar-graph mode with constant current. It also provides a reference voltage. A block diagram is shown in Fig. 1.

The use of this IC for both channels with a "free" multiplexing technique allows the entire circuit to be constructed on a tiny 2 × 4-inch PC board and housed in a single piece of ¾-inch walnut 5½ inches wide and 2⁵⁄₁₆ inches deep—less than 0.1 board foot—thus saving lots of the cost and adding the elegance of smallness.

The complete schematic is shown in Fig. 2. Right and left channels operate identically. I'll use the right channel in discussing the circuitry. Pot R2 adjusts the gain of the system so that the highest LED indicates clipping in the amplifier. If the voltage of the wiper of R2 is positive (I'll call this voltage V_{in}), pin 4 of IC1 will go negative until the voltage on the anode of D1 is $-R5/R4$ times V_{in}. Since negative feedback always keeps pin 1 of IC1-b at zero volts, the current through R6 then is $-V_{in}\frac{R5}{R4 \times R6}$. This is twice as great as the current in R7 ($V_{in}/R7$) but of opposite polarity, making the net current approximately $-V_{in}/R7$. If V_{in} is negative, pin 4 of IC1-a goes positive by about 0.6 volt to keep pin 6 at zero volts. Diode D1 then is non-conducting, and there is no voltage on, nor current through, R6. The net current through R6 and R7 then is $V_{in}/R7$. IC1-a and its resistors thus form an active rectifier, such that the current is always $-|V_{in}|/R7$. In this way, the circuit responds equally to positive and negative peaks.

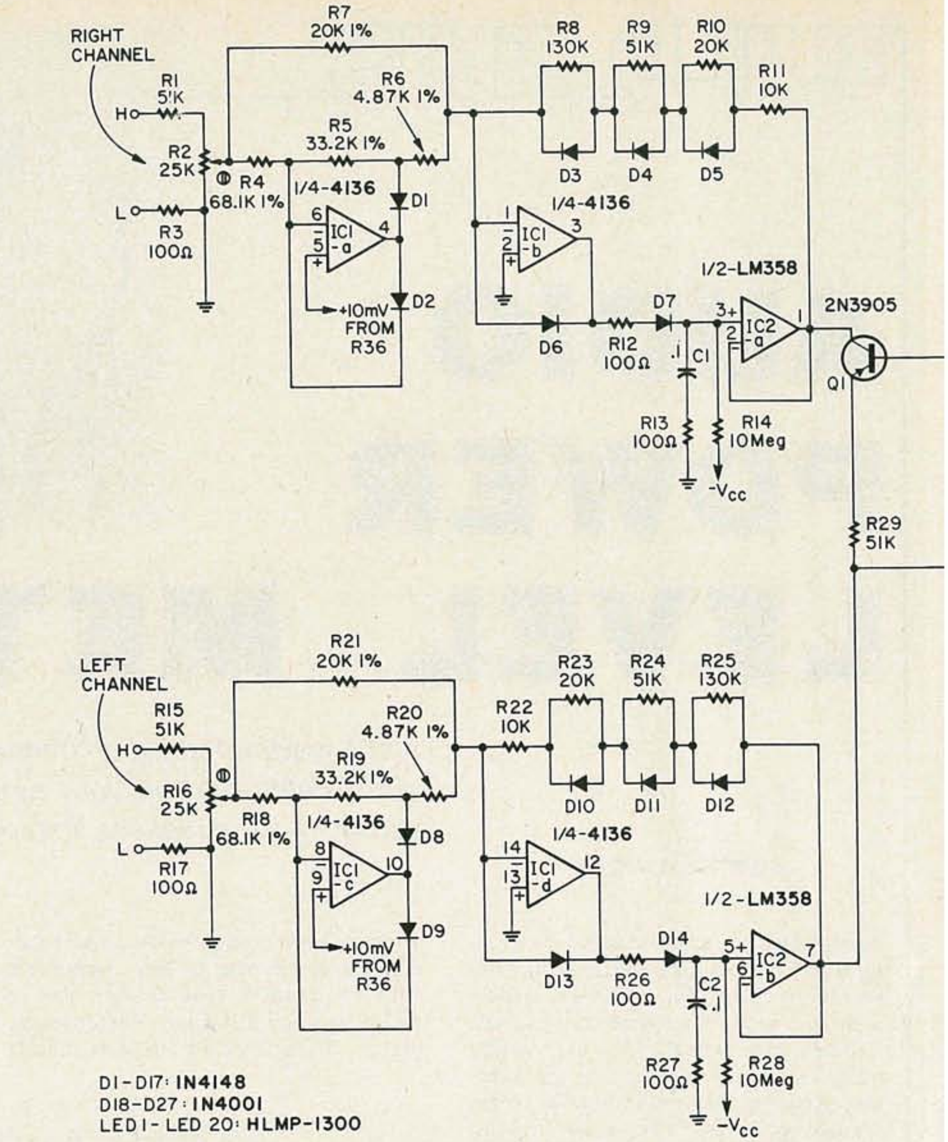


FIG. 2—COMPLETE SCHEMATIC of the LED power-level meter. The LED's in the two channels are multiplexed at a 60-Hz rate by half-sine voltages from the power transformer

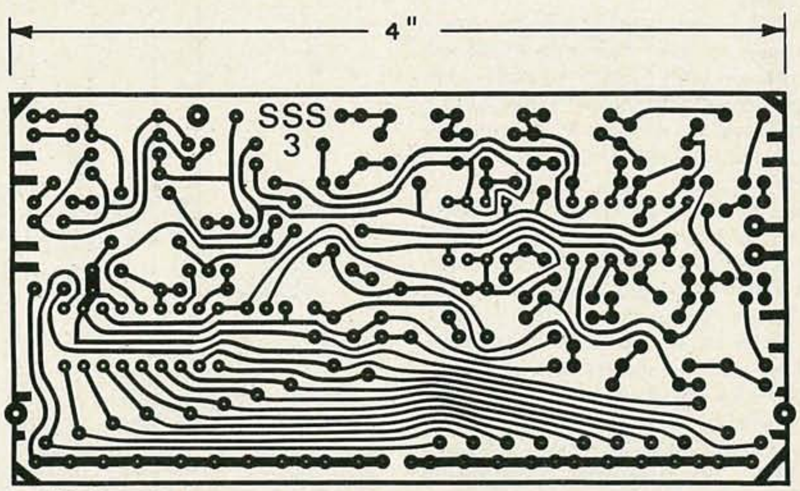
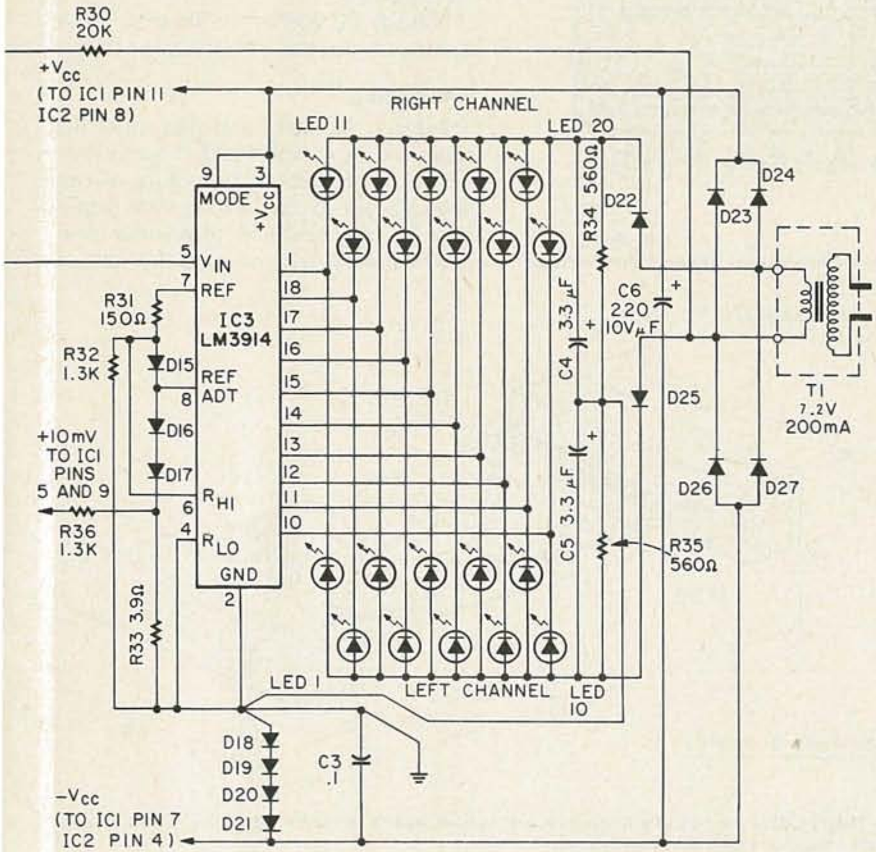


FIG. 3—FULL-SIZE FOIL pattern for the printed-circuit board. The single-sided design makes copying easy.

The rest of the circuit forms a peak detector and logarithmic converter. Resistors R8 through R11 and D3 through D5 are wired so that their current vs. voltage response is approximately logarithmic. Therefore, if the logarithm of the output voltage is less than the input, IC1-b pin 3 will turn on D7 and charge up C1 until the output voltage is equal to the log of the input. If the log of the input is less than the voltage on C1, IC1-b will turn on D6 and C1 will slowly discharge through R14. Capacitor C1 then can charge very fast and discharge very slow-



PARTS LIST

All resistors ¼ watt, 5% unless otherwise noted

R1, R9, R15, R24, R29—51,000 ohms
R2, R16—25,000 ohms trimmer potentiometer
R3, R12, R13, R17, R26, R27—100 ohms
R4, R18—68,100 ohms, 1%
R5, R19—33,200 ohms, 1%
R6, R20—4,870 ohms, 1%
R7, R21—20,000 ohms, 1%
R8, R25—130,000 ohms
R10, R23, R30—20,000 ohms
R11, R22—10,000 ohms
R14, R28—10 megohms
R31—150 ohms
R32—1300 ohms
R33—3900 ohms
R34, R35—560 ohms
R36—13,000 ohms
C1, C2—0.1 μF, polyester film, 10%
C3—0.1 μF ceramic disc
C4, C5—3.3 μF, 50 volts, electrolytic
C6—220 μF, 10 volts, electrolytic
Q1—2N3905
D1—D17—1N4148
D18—D27—1N4001
LED1—LED20—HLMP-1300 series LED's (Hewlett-Packard)
IC1—4136 quad op-amp (Exar, Fairchild, TI or equal)
IC2—LM358 low-power dual op-amp (National)
IC3—LM3914 dot/bar display driver (National), Radio Shack catalog No. 276-1707
T1—wall-plug transformer, 7.2 volts AC, 200 mA
Miscellaneous: walnut cover, aluminum front panel, PC board, mounting hardware.

Note: The following parts are available from Symmetric Sound Systems, 912 Knobcone Place, Loveland, CO 80537. Complete kit model PLM-1 with unfinished walnut case and unpainted front panel $42.00. Semi-kit model PLM-SK consisting of PC board, IC1, IC2 and T1 $15.00. Both prices include postage in North America. Colorado residents add 3% tax. The semi-kit will not be available after September 30, 1980. No other separate parts or different combinations are available.

ly, allowing the eye to see peaks that don't exist for very long.

The right channel or left channel is routed to the LED driver IC depending on the polarity of the 60 Hz power input. If the power input is positive, D22 provides current to the right channel LED's, and the low voltage on the bottom side of the transformer pulls current through R30 to turn on Q1 and short the right channel output to the input of IC3. For negative transformer outputs, Q1 is turned off and the left channel is connected to IC3 through R29, and the left channel LED's are turned on through D25. Thus, the right channel and left channel operate alternatively 60 times a second, too fast for the eye to notice.

The LED's used should be high-efficiency T-1 (3.18 mm, 0.125 inch diameter) LED's, as the average current through each is limited to about 10 mA. Xciton's XC-309-R and Hewlett-Packard's HLMP-1301 both have typical and minimum brightnesses of 2 and 1 mcd (millicandella—a unit of brightness) at 10 mA, respectively, and thus are recommended. Monsanto's MV5774 is .75 mcd min. The 209 series of LED's is not recommended as the typical brightness is usually only .5 mcd at 10 mA and many manufacturers don't even specify minimums. Also, high-efficiency types have even greater advantages in pulsed applications, which is how they run here due to the multiplexing.

Diodes D23, D24, D26 and D27 form a full-wave rectifier that charges C6, the main power supply capacitor. Capacitor C6 can be small because the large LED currents do not come from it, just the power supply currents of the IC's. The power supply current of IC3, as well as any LED currents, flow out pin 2 of IC3 and through D18–D21. This biases the point defined to be ground at about 2.5 volts above the negative side of D6 and creates the dual supplies necessary to run IC1 and IC2. It also reduces the voltage across the outputs of IC3 by 2.5 volts, thus reducing the power dissipation.

Construction

The use of a PC board is almost mandatory unless you decide on a different mechanical design than mine. Should you wish to redesign the system, keep LED leads short, and C4 and C5 must have short leads to pin 2 of IC3 and the LED anodes. A note about the layout is in order. The "circles" (the unbroken trace from pin 2 that completely encircles the three pads connected to pin 3) around pins 3 and 5 of IC2 are a "guard;" they reduce leakage from these inputs through any contamination of the PC board on humid days. It is still wise to clean these areas with flux remover after assembly. If you are building without a PC board, D7, C1, R14 and IC2 pin 3 should all be soldered together in mid-air, away from any breadboard surface.

Construction with a PC board (Figs. 3 and 4) is straightforward. Load the resistors first, then the trimmers, diodes, LED's, capacitors and IC's. Because of the large number of polarity sensitive devices (almost everything but the resistors), extreme care must be exercised

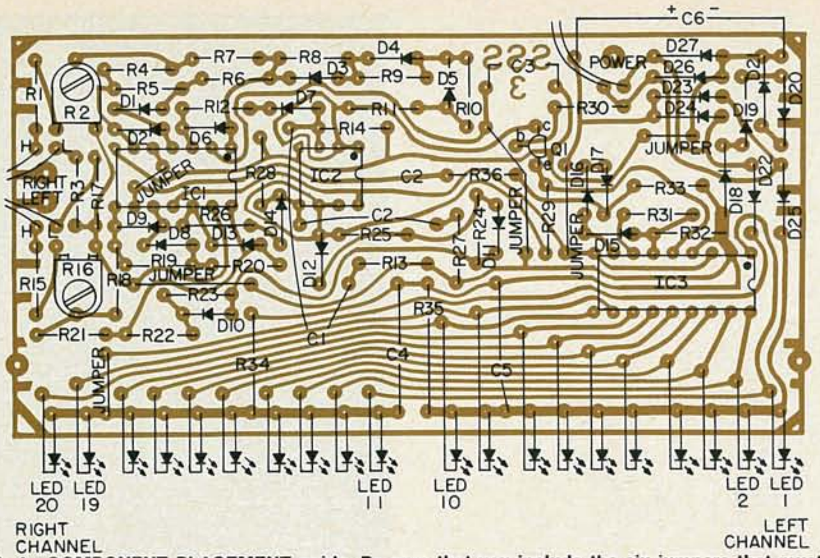


FIG. 4—COMPONENT PLACEMENT guide. Be sure that you include the six jumpers that must be installed.

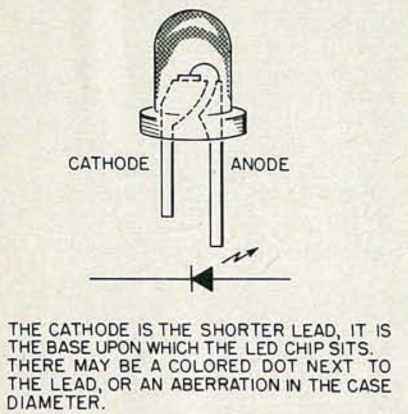


FIG. 5—OUTLINE of a typical T-1 size LED shows how the diode is polarized.

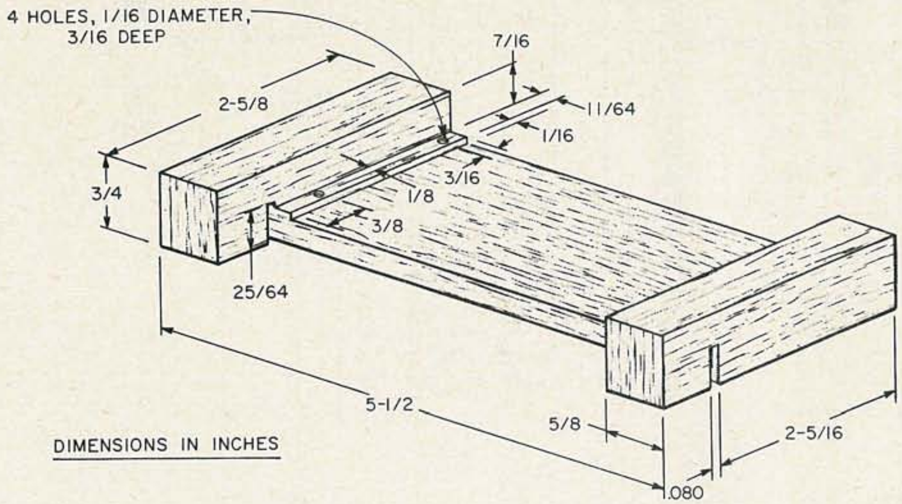


FIG. 6—THE CASE is cut out of a single piece of ¾-inch walnut or similar hardwood. Work can be done with a table or radial-arm bench saw.

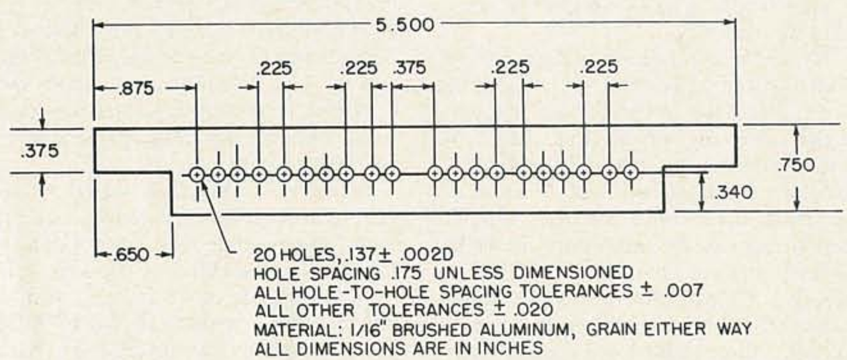


FIG. 7—THE FRONT PANEL is formed from a sheet of 1/16-inch brushed aluminum.

when mounting components. The LED's are particularly easy to reverse, see Fig. 5 for polarity clues.

The LED's should be mounted as close as possible to flush with the PC board's edge for a uniform appearance. Some LED's might not have long enough leads for the holes on LED 7–10, in which case another lead can be soldered into the board and then onto the LED lead that was not long enough. Leads of all components should be cut very short after soldering because of the small clearance below the board. The construction of the walnut case and brushed aluminum as shown in Figs. 6 and 7, respectively.

Use No. 24 speaker wire for connections to the right and left channels and power transformer. Pass the wires through the holes in the PC board from the foil side and knot them on the component side. The knot will serve as a strain relief. Then solder the leads into the PC Board. The polarity is very important on the speaker connections; use the copper-colored side for low (L) and be sure to connect it to the ground or low side of the speaker terminals. A polarity error could damage R3 and R17 and the PC board.

Should you wish to use the PLM in a low-level circuit (such as at the tape monitor jacks) instead of at the speaker terminals, substitute a jumper for R1 and R15, and lift the ground pins of R3 and R16 off the board.

Slip the PC board into the case, screw it into position, and you are ready to go.

Calibration

Table 1 shows the performance of the calibrated prototype PLM. Your instrument can be calibrated in either of two ways when used with a solid-state amplifier. To use the PLM to monitor calibrated peak power, an oscillator and an accurate AC meter are required for calibration. Disconnect your speakers and drive your power amplifier with the oscillator at 1 kHz. Adjust the oscillator level until the amplifier output voltage is V_{out} (RMS) equals $\sqrt{P \times 8}$ where P is the power level in continuous watts desired for the maximum indication on the PLM and 8 is the load impedance in ohms. For example (V_{out} = 28.3 volts for P = 100 watts, 20 volts for P = 50 watts, etc.). Connect the PLM inputs to the amplifier

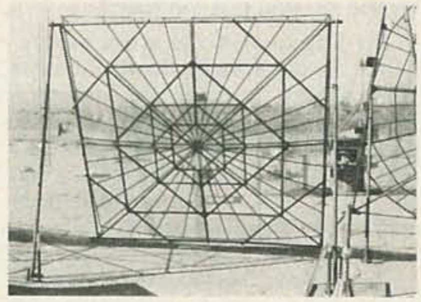
continued on page 81

TABLE 1

Number of LED's lit	Input Right	Input Left
10	0 dB	0 dB
9	−2.22	−2.15
8	−4.90	−4.78
7	−7.87	−7.53
6	−10.96	−10.46
5	−14.16	−13.52
4	−17.44	−16.67
3	−21.03	−19.84
2	−24.62	−23.32
1	−28.28	−26.61

Frequency Response
Left: 0—20 kHz @ −.75dB
Right: 0—20 kHz @ −.73dB

Pulse Response
Both channels with 2 dB in 40μS.



TEN FOOT SWAN SPHERICAL is almost opaque although aluminum screen mesh reflector surface is in place. Note Swan's use of squares and spokes to create sandwich layers that rigidly support antenna and reflective surface. Antenna tilt is handled by telescopic rear support rods with lower-ground-lip on hinges.

LOW COST BACKYARD SATELLITE TV EARTH STATION

Now you can build your own Satellite TV Earth Station in your own backyard for less than $999. This month we'll take a look at antenna design and how a spherical antenna can be built and erected.

ROBERT B. COOPER, JR.

IN THE AUGUST SEPTEMBER AND OCTOber 1979 issues of **Radio-Electronics**, we discussed the evolution of the geostationary satellite service for North America and described the basics of its operation. In the January issue we looked at the hardware in the receive portion of the system and discussed the various approaches to hardware design. We are now ready, with this foundation, to begin the task of designing your first satellite television earth receiving terminal.

Design versus cost

If money is no object, you probably are more apt to buy a private satellite terminal than to build one (or portions of one). A list, current through the preparation of this article, of firms specializing on a national or regional basis in the sale of complete TVRO receiving systems (either 'turn-key installed' or on a hardware piece by piece basis) appears in Table 1. The bottom line is that you can purchase a first-rate commercial grade terminal for around $5,000 in hardware costs (and install it yourself) or have the job done for you with every wire in place and every nut and bolt secured for less than $10,000.

By building the terminal yourself, you are able to look carefully at the many design variations available and thus select the various module and sub-assembly approaches that best suit your own needs and talents. And in fact, because there are so many excellent designs around, we have already engaged in a bit of this selection process for you. We will lead you step-by-step through the various choices so that you will wind up with a complete terminal that best fits your needs.

Our approach is not to follow any single design philosophy. The *Howard Terminal* system, widely copied and very good in performance, may be a bit on the complicated side for a non-experienced builder. The *Coleman Terminal*, originally largely assembled from surplus (Bell-system discarded) microwave equipment, is in turn perhaps too much of a hit-and-miss proposition since the builder must locate many suddenly hard-to-find second hand microwave pieces to make it all play.

TABLE 1

Suppliers currently offering turn-key-installed home satellite receiving terminals and those who also offer hardware for do-it-yourself installations (*):

1. **Channel One, Inc.,** 68 Avalon, Newton, MA 02168
2. **HOMESAT, Inc.,** 3845 Pleasantdale Rd., Atlanta, GA 30340 (*)
3. **Gardiner Communications Corp.,** 1980 S. Post Oak Rd., Houston, TX 77056 (*)
4. **Microdyne-AFC,** 627 Lofstrand Lane, Rockville, MD 20850 (*)
5. **Satellite Television Systems,** Box 11249, Reno, NV 89510
6. **USTC,** P.O. Drawer 'S', Afton, OK 74331
7. **Spacecoast Research,** Dept. B, Box 442, Altamonte Springs, FL 32701

The antenna portion is a similar case in point. Six months ago you had three choices; *locate* a surplus or used parabola, *buy* a new parabola, or, *build* a parabola. Many hundreds of people were turned onto satellite TV and then subsequently turned off because they couldn't locate a surplus parabola, didn't have the spare cash to purchase a new parabola, and felt unqualified to construct a homebrew one. Now, with the passage of time, a really low-cost, high-performance *non-parabolic* antenna has made its appearance, we shall shortly see.

Our design philosophy here will be to simply borrow the best technology that exists at this time from several different sources. We'll make you this promise. Over the next few issues of **Radio-Electronics**, you'll learn how to build your own complete terminal, including antenna, an ultra-low noise GaAs-FET LNA, and a twenty-four-channel frequency-agile receiver that ends up at VHF channel 3, 4 or 5 with a modulated NTSC RF output for under $1,000. You read right ... the whole, complete terminal, including antenna, for under $1,000.

Where do you put the gain?

There is passive and active gain required in the system. In the antenna portion (passive gain) the minimum gain required is a function of where your location falls on the satellite's EIRP pattern (see the September and October 1979 issues for a complete explanation). For discussion, we'll say you need at least 40 dB of passive gain in the system. That's a ten-foot minimum reflector surface any way you cut it. However, a 12-foot surface is even more desirable.

The decision on how much gain to design into the active portion (i.e., the LNA and the receiver) is more difficult to make. That's because we need signal gain for two reasons:

1. To amplify the 4 GHz signal voltage to a level where the demodulator can recover video (and audio) from the satellite signal, and,
2. To overcome (or override) the receiving system noise temperature.

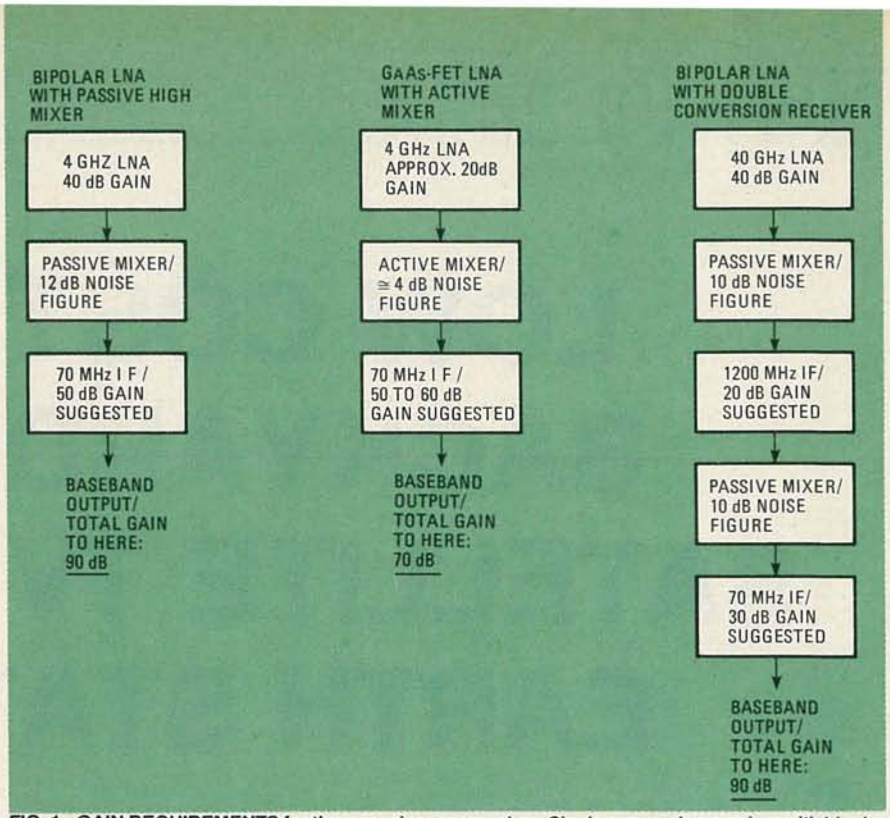


FIG. 1—GAIN REQUIREMENTS for three receiver approaches. Single-conversion receiver with bipolar LNA and passive mixer is shown in *a*. Single-conversion receiver with GaAs FET LNA and GaAs FET active mixer is shown in *b*. Double-conversion receiver with a bipolar LNA is shown in *c*.

Ideally, system noise temperature is set entirely by the low-noise capabilities of the first LNA stage(s). In the real world, the noise factor for the system is typically set by this *plus* the internal noise figure of the receiver stages. There are two types of 'noise' to be considered in the receiving system. Every amplifier stage (even a video amplifier) has a noise factor. However, when computing noise figure, it is often convenient to look at any device in the receiver that has 'loss' as a noise source as well. In this regard, a mixer stage (i.e., a stage that converts one incoming frequency to another outgoing frequency) has loss and therefore it contributes 'noise' to the overall system.

In modern receivers there are two approaches to getting the 4-GHz satellite input signal down to a low enough frequency where the modulation contained on the carrier can be demodulated to baseband. A single conversion receiver (i.e., the Coleman approach) takes you from 4 GHz to an IF of 70 MHz in a single conversion (or mixing) step. A double-conversion receiver gets you to 70 MHz from 4 GHz in two steps; the first typically takes you down into the 1.2-GHz region (although the selection of a high IF is entirely up to the receiver designer and could be any place from 500 MHz to 2,000 MHz) while the second mixes on down to the pretty much standard 70-MHz region.

The design approach we are going to follow here is the single-conversion option. However, this is offered with the understanding that in some ways the performance of a double-conversion receiver is superior to the single-conversion design set forth. In a double-conversion receiver, image rejection, stability and perhaps even selectivity can be better than in a single-conversion design. But, double-conversion techniques are more costly. They require that you have access to test equipment that you probably do not have available (adjusting and aligning a 1.2 GHz high IF does require some equipment not commonly available); and for home use, the trade offs seem to favor the single-conversion approach.

At the risk of oversimplifying the rationale for choosing a single-conversion approach, see Figure 1. Here we see that double conversion has a price tag attached to its 'perhaps' superior performance; you need more total system gain in order to make the double-conversion system perform properly. And gain not only costs money in parts and time, it also increases the complexity of the receiver.

Note in Fig. 1 that we are looking at:

1. A single-conversion receiver using a bipolar LNA and a totally passive mixer (left hand side); the gain required is 90 dB.
2. A double-conversion receiver using a bipolar LNA; the gain required is 90 dB (minimum).
3. A GaAs-FET LNA front end followed by a GaAs-FET active mixer that single-converts down to the 70 MHz IF; the gain required is 70 dB.

In all fairness, one could design a double-conversion receiver with an active GaAs-FET high mixer and this would in turn reduce the total gain requirements of the system since our 40 dB of LNA gain is largely predicted upon the noise-factor contribution of that first mixer stage (the one that gets us away from 4 GHz). However nobody has yet done this and as we are sticking with proven designs at this point the comparison of gain requirements remains valid for now.

What does all of this mean? Simply this. If you wish the system-noise temperature to be determined by the first LNA stage(s), and we do, we have to build enough total gain into the system at 4 GHz to insure that the noise contribution of that first mixer is overridden by the LNA stage(s) in front of it. By replacing the passive mixer (the mixer that gets us away from 4 GHz down to a lower IF) with an active mixer, we shift the noise contribution (i.e., mixing loss) of the first mixer out of the loss column and replace it with a gain or in the worse case a unity-gain device that makes no *significant* contribution to the system-noise factor. So where we previously required gobs of gain at 4 GHz to overcome the noise factor or mixing loss of the high (or only) mixer stage, we now require much more modest amounts of gain to establish our LNA first-stage noise figure as the primary noise factor in our electronic receiving system.

Electronic gain is least expensive to come by at the lowest frequency to be used in the RF portion (the 70 MHz IF) but unfortunately we cannot place all of the gain here. Some gain must go at 4 GHz as well. In Fig. 2 we see two options open to us.

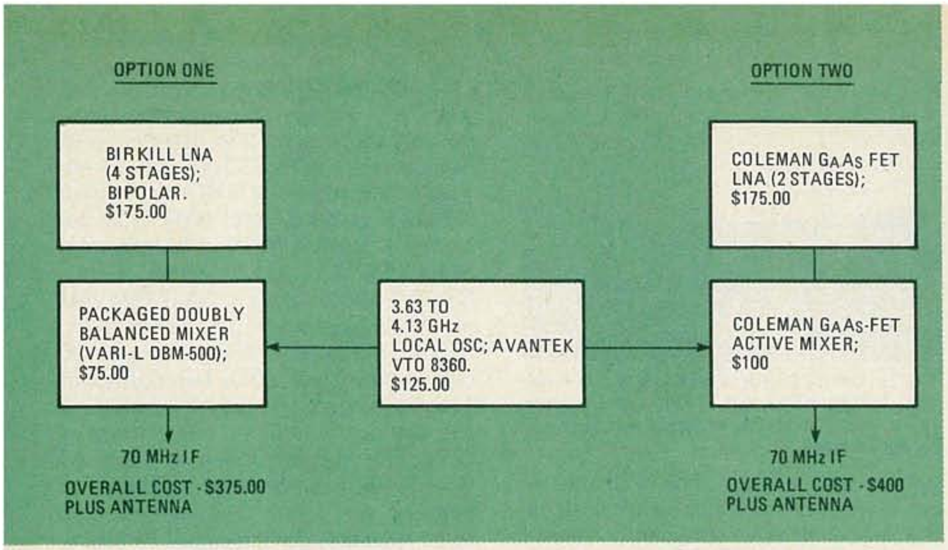


FIG. 2—TWO DESIGN APPROACHES to receiving satellite broadcasts. The Birkill approach is shown in *option 1* while the Coleman approach is shown in *option 2*.

1. As the balance of this article installment shall show, the most cost-effective approach to the antenna today is the *Swan Spherical TVRO* antenna. If you are not a particularly sharp trader or buyer you will still be hard pressed in most sections of the U.S.A. to spend more than $300 building this antenna.
2. In *option one* (Fig. 2) we could build a four-stage bipolar LNA (the so-called Birkill HXTR series LNA named after its developer Steve Birkill), follow this with a state-of-the-art doubly-balanced (passive) mixer such as the VARI-L DBM 500 4 GHz to 70 MHz (IF) package, and end up at 70 MHz with a total cost to that point of $675 including the antenna.
3. In *option two* (Fig. 2) we can build a two-stage Coleman GaAs-FET LNA and follow this with a single-stage Coleman GaAs-FET active mixer, again ending up at a 70 MHz IF for a total material cost of $700 including the antenna.

This would seem to suggest that the two approaches in getting 4 GHz energy out of the air and down to a manageable IF such as 70 MHz are very similar in cost. The truth is that the option-one approach has probably just about come to a resting place in costs (for the next year or so) while the GaAs-FET-approach is still largely dependent upon the $80 to $100 price tags on the GaAs-FET's themselves. With GaAs-FET prices starting to tumble, the cost of this approach may well be down another $100 or so before spring. That's one reason to seriously consider this approach. Another more compelling reason is that this approach uses far fewer devices overall; and as those Murphy Law believers know well, the more stuff you cram into a box, the more apt something is to go wrong when you can least afford the time or expense to fix it. Note that in both approaches we are using a newly available Avantek VTO 8360 oscillator module to provide the local-oscillator drive to our chosen mixer. We'll look more closely at the VTO 8360 in the next part of this series of articles.

Finally, in Fig. 3, we see how we are going to process the 70 MHz IF signal and what it is going to cost us. We have some gain stages at 70 MHz, a demodulator to extract the video modulation from the 70 MHz IF signal along with a few relatively simple baseband processing circuits, a demodulator to create audio from our 6.8 (or 6.2) MHz aural subcarrier, a VHF modulator to convert our baseband video and audio back to a NTSC compatible VHF TV channel (such as channel 3, 4 or 5) and a power-supply section which will provide operating voltages for the system. The total system cost (if you want to start budgeting your pennies now) is as follows:

1. Swan Spherical TVRO Antenna; $300 (or less)
2. 4 GHz front end to 70 MHz IF segment; $375 to $400
3. 70 MHz IF, baseband processing and VHF TV channel modulator with power supply; $250.

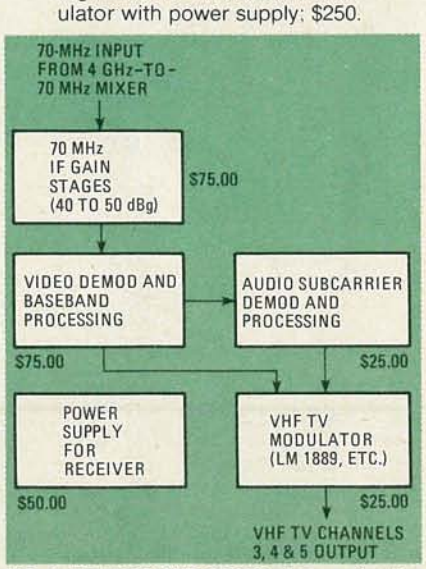


FIG. 3—METHOD AND COSTS of converting the 70-MHz IF to a VHF RF signal suitable for connecting to the antenna terminals of a TV receiver.

That brings us sufficiently in under $1,000 to allow you to indulge in some packaging of the system following a card cage approach if you wish and still have a little change left over for unexpected expenses.

Swan spherical TVRO antenna

There are several excellent reasons why the Swan TVRO antenna design is the best and most logical choice for the home builder:

1. **Materials**—Everything called for can be procured locally. Steel or aluminum pipe, tubing (round or square stock) plus aluminum window screening, and common hardware such as machine bolts, are all that is required for the reflector system. The feed-antenna is constructed from galvanized sheet metal.
2. **Cost**—$300 Give or take very little. Although, if you are a good shopper in metal yards you might shave as much as $100 from the total cost.
3. **Complexity**—Far less complex to create the 'spherical surface' design than to create a comparable parabolic surface. The principle is easy to grasp and uncomplicated to duplicate.

These factors alone should make the antenna very appealing. However there is a golden bonus with the spherical sections; the antenna is capable of 'looking at' many satellites at the same time. See Fig. 4.

The spherical antenna has such a gentle curve to its surface that it can "see" a 40 degree wide portion (or span) of the orbit belt effectively. The antenna is fixed, permanently, on the ground with the center pointed in a predetermined direction. We'll see how that works shortly. Every geostationary point-source in front of the antenna has a focus point out in front of the reflector surface. But this focus point changes for different angles of arrival. A satellite located directly on boresight will have its focal point directly in front of the center of the Spherical surface while a satellite west of the boresight point will focus slightly east of the center point. Conversely, satellites east of the boresight focus slightly west of the center point.

With this geometry, one moves the location of the focal- or feedpoint-antenna (left and right along a line parallel to the reflector surface) to switch from one satellite to another satellite. If you can leave the reflector stationary and move only the focal-point (or pickup) antenna, could you not actually install two or more pickup antennas so as to simultaneously receive two or more satellites? The answer is yes; something that cannot be done with a normal parabolic antenna.

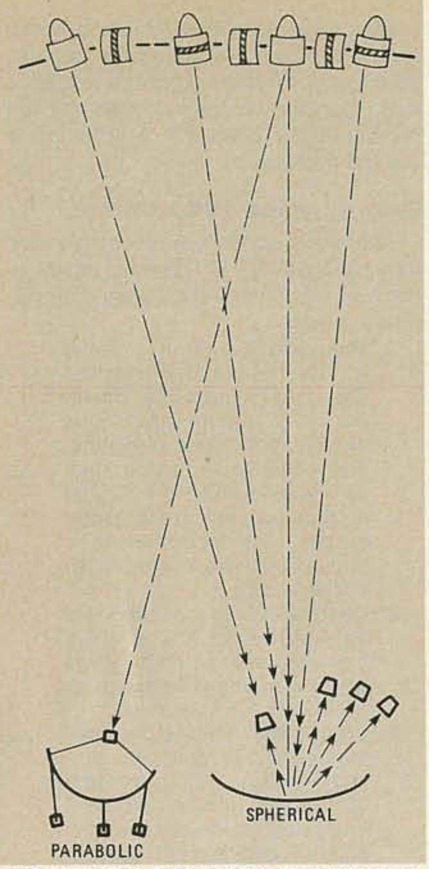


FIG. 4—PARABOLIC VERSUS SPHERICAL antennas. Normal parabolic dish antenna focuses all incoming energy onto a single focus point and as a result receives only one satellite at a time. To receive a different satellite the parabolic antenna must be redirected. The less radical curvature of a spherical antenna permits simultaneous reception of numerous satellites spread over up to 40 degrees of sky arc. Different satellites within the 40-degree arc can be received by moving the focus-point antenna or multiple satellites can be simultaneously received by using multiple focus point antennas.

How does it work?

Both the parabolic and the spherical reflector surfaces work on the same principle. The reflector surface is curved, in both dimensions. A 'cup' is formed and the center of the cup on a parabolic is directly in line with the satellite. All of the energy that is intercepted by the reflector surface is redirected towards a central focus-point. In a good efficiency parabolic antenna, approximately 55% of the total energy intercepted by the reflector surface ends up within the feed- or focal-point antenna.

But, the curve of the spherical antenna is very shallow; it is curved (or indented) sufficiently to cause the energy to focus but not so curved as to cause the RF energy to only focus when the reflector's center and the satellite are in-line together. In Fig. 4, we have a slightly exaggerated illustration of the primary difference between the parabolic (on the left) and the spherical reflector surfaces. The parabolic, because of its boresight requirement, 'sees' only a single satellite (or

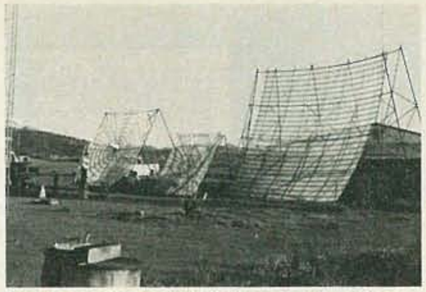


FIG. 5—THREE SWAN SPHERICALS at the Bisbee, Arizona test range of Oliver Swan. From left to right, 14-footer, 10-footer and huge 19-footer on right.

spot in the sky) at a time. The spherical sees every satellite location along the orbit belt over a region ± 20 degrees from boresight (the center of the reflector straight ahead). Actually, the spherical surface can 'see' farther than that but the focal-point antenna has difficulty recovering wavefront energy offset from the boresight heading by more than 20 degrees. Look closely at Fig. 4; several separate feed-point antennas (the squared-off cups) are in place, each receiving energy from a separate satellite along the belt. Figure 5 shows three spherical antennas.

Aiming the antenna

If the spherical can see a 40-degree portion of the orbit belt, how do you decide where to center or 'boresight' the reflector surface? Most logically, you want the antenna to look (effectively) at as many satellites as possible. If one of those satellites is to be RCA's SATCOM FI (located now at 136 degrees west), it follows that since all other U.S. and Canadian satellites are east of that point, the 40-degree arc taken in by the spherical shall have as its most western point 136 degrees. That says that the boresight or center shall be 20 degrees less than 136 degrees (136-20) or 116 degrees. And this suggests your useful view will extend from 96 degrees west to 136 degrees west. Which takes in WESTAR I at 99 degrees, the three ANIKs (of which ANIK-B at 109 degrees is the most important), SATCOM FI at 119 degrees, WESTAR II at 123.5 degrees, COMSTAR I at 128 degrees, SATCOM FIII at 132 degrees and FI at 136 degrees. Since you have nothing between 96 (the eastern end when boresighted at 116 degrees) and 99 degrees, and FI at 136 degrees contains a fair amount of (cable TV related) video, it might be wise to shift the boresight a couple of degrees west to say 118 degrees so as to be sure that the important FI bird is well within the visible orbit belt for the antenna.

How do you do this? Drive a stake in the ground representing where you would like the center of the reflector to be. Use a surveyor's transit or quality compass and find *true* north. That's true north, *not* magnetic north; you'll have to correct for the difference in your area. The local airport control tower can tell you what your correction factor is. Drive a second stake so that the first one and the second one make a corrected-for-magnetic-north line that runs north and south.

Now take a transit or quality protractor and determine from your location a point in the sky that is over the equator 118 degrees west of Greenwich. Drive a third stake in line with the first stake and the line between stake 1 and 3 will be your boresight line. Left, or east (for northern hemisphere readers) 20 degrees and right (west) 20 degrees will be the extent of your orbit arc view with the Swan spherical antenna.

Now to create the spherical reflector surface. The photos here show how Oliver Swan, who developed the an-

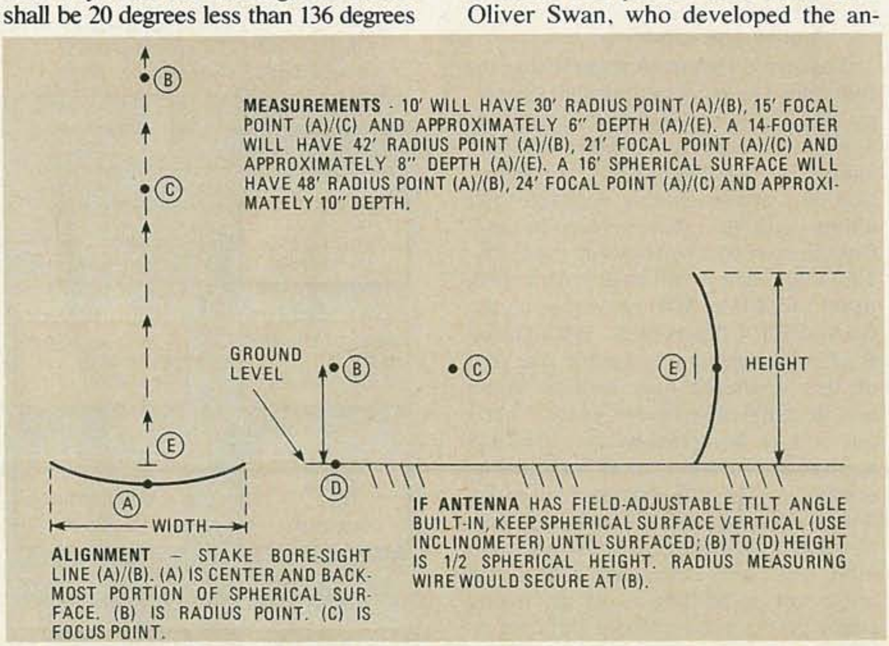


FIG. 6—DETERMINING RADIUS point and focal point of the spherical reflector surface. The spherical reflector surface is as high as it is wide.

tenna, has assembled them in the past. A detailed construction manual is available but an alert person can quickly see what is involved:

1. A ten-foot spherical antenna will have the gain of a 12-foot 55%-efficient parabolic antenna. A 14-foot spherical will have the gain of a 16-foot parabolic. A 16-foot spherical will operate like an 18-foot parabolic. (The height of the spherical surface is the same as the width. Therefore, when we speak of a 12-foot spherical surface, the surface is actually 12 feet high by 12 feet wide.)
2. All initial ground-staking measurements are made with three reference points; the center of the reflector-surface point (point A in Fig. 6), the radius point (point B in Fig. 6) and ultimately the focal point (point C in Fig. 6). The radius-point distance is three times the desired width or aperture of the spherical; a 30-foot radius for a 10-foot reflector surface. The focal point (which will become important after the reflector is completed) is 1.5 times the aperture (or 1/2 the radius point) and this is where your feed-horn pickup antenna will mount.

Having established the boresight line and the radius measurement point, create a system to measure within 1/16 of an inch from the radius point to any point on the reflector surface. The radius-point tie-down for the measuring wire/tape must be 50% of the height of the spherical reflector surface (if the width is 10 feet, the height will be 10 feet; which places the radius point tie-down 5 feet *above* ground, at a distance of 3 times the aperture of the antenna out along the boresight line).

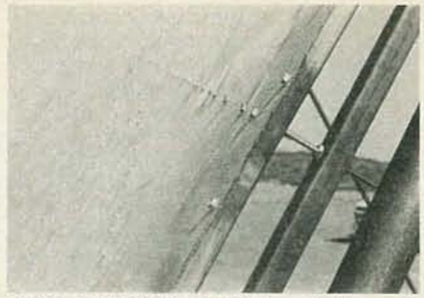


FIG. 7—SPHERICAL SHAPE is created by gently shaping the contour with 10×24 adjusting screws spread from center of reflector surface outward along spokes. Actual tweeking is done with a measuring device extended from radius point stretched taut to antenna surface.

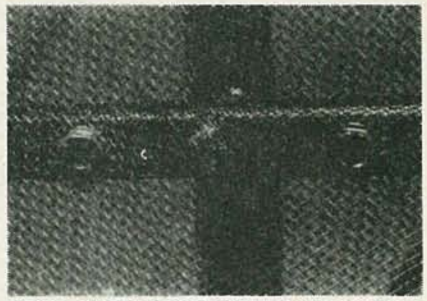


FIG. 8—SURFACE IS COVERED with aluminum window screen and tacked into place at 2- to 3-inch intervals with self-tapping metal screws.

To create the spherical curvature the framework for the reflector surface needs to be adjustable so that you can pull in the surface area to the 1/16-inch accuracy required using the radius point as a measurement tie-down. Swan's approach is shown here photographically; 2- and 4-inch 10:24 machine screws are simply adjustable jack screws that allow the outermost square tubing pieces to flex slightly to achieve the required curvature. See Fig. 7.

Surfacing of the spherical is handled with common aluminum window screening. Using 32- to 36-inch-wide material (it must be aluminum or metal to be reflective), the holes should be no more than 1/8th inch across to maximize the reflector surface efficiency and minimize RF signal leakage through the surface. Figure 8 shows how the screen is attached to the frame.

There are a few caveats concerning the construction of your own Swan spherical antenna:

1. Be accurate. The gain of the antenna is directly related to the care put into the surface accuracy. In turn, the surface accuracy (as measured from the radius point such that every point on the reflector's covered surface is within a ± 1/16th inch accuracy of all other points on the surface) is

ADDITIONAL SATELLITE DATA

Satellite television enthusiasts interested in learning more about the mechanics of satellite TV reception, and the wide variety of hardware and programming options available may find one or more of interest:

1. **Satellite Study Package**—Designed to gently lead you into the world of geostationary satellite communications; includes 72-page handbook that explains in lay terms the complete satellite TV story, shows how the system works, what services are available, lists dozens of sources for hardware and equipment. Plus - includes 22 × 35-inch four-color two-sided wall chart depicting all 30-plus TV carrying geostationary satellites, what each carries and how each operates. Order "Satellite Study Package" for $15 (first class mail shipment) in U.S. and Canada, $20 elsewhere (in U.S. funds) from: Satellite Television Technology, P.O. Box 2476, Napa, CA 94558.
2. **Satellite Terminal Construction Manuals**—Three separate manuals designed to help you build your own TVRO terminal. *Swan Spherical TVRO Antenna* manual completely describes the spherical TVRO antenna system with elaborate photos and drawings. *Howard Terminal* manual describes complete bipolar LNA system plus 24-channel frequency agile (tuneable) receiver using off the shelf parts and state-of-the-art technology. Very high quality receiver that can be duplicated (with bipolar LNA) for well under $1,000 in parts. *Coleman TD-2* manual describes starting off with surplus electronic equipment and building complete terminal for approximately $500; but, also includes Robert Coleman-designed GaAs-FET LNA stages, active GaAs-FET mixer and Avantek tuneable LO package. Manuals are priced at $30. each in U.S. and Canada, $35 each elsewhere (U.S. funds); or order all three manuals for package price of $80 from: Satellite Television Technology, P.O. Box G, Arcadia, OK 73007.
3. **Satellite Seminars**—A series of three-day seminars held periodically throughout the year at various U.S. locations; current *Satellite Private Terminal Seminar* (SPTS) is being held February 5, 6 and 7 in Miami, Florida. Conducted as a teaching seminar with course instructors, course guide books, manuals included, plus exhibits from satellite TV hardware manufacturers. Sessions are evenly divided between the technology of building low-cost terminals and business sessions designed to help people enter the field of marketing private terminals to homeowners. Next session after Miami is scheduled for San Francisco Bay Area of California in June. For information contact: SPTS '80, P.O. Box G, Arcadia, OK 73007 (405-396-2574).
4. **Satellite TV Monthly Publication**—A monthly magazine prepared in a newsletter format; *Coop's Satellite Digest* is edited and published by Bob Cooper. Mailed first class mail, covers the latest changes in satellite programming, satellite operations, and the technical progress of the low-cost receiving terminals. Subscription price is $50 per year in U.S. and Canada, $75 (in U.S. funds) elsewhere from: Coop's Satellite Digest, P.O. Box G, Arcadia, OK 73007. Sample copy for $5.00.

a result of the care you put into the supporting structure. The framework must be rigid, capable of taking wind (and, if applicable, ice) loads and advisably, easy to work with.

2. Be careful. No unsupported surface areas on the antenna should be larger than approximately 5 inches by 5 inches. Think of the surface as a gigantic patchwork quilt rather than a single reflector surface. Each patch is an area of some dimension and shape supported on three or four sides by tubular steel members on the backside. The total surface is the sum of all of the patches added together and the accuracy of the sum is the final result of how closely the *flat* (i.e. non-curved) surface of each patch is within the ± 1/16-inch accuracy required. So think out the support structure carefully and design it so that you have no patch areas larger than say 5 inches on a side.

FIG. 11—DEEP-THROAT FEEDHORN (right) with commercial LNA (left). Feedhorn is constructed from galvanized steel, uses carefully welded seams following the pattern shown in Fig. 10. Flange at rear (narrow) end of feedhorn tapers to mate with WR-229 flange on input to LNA.

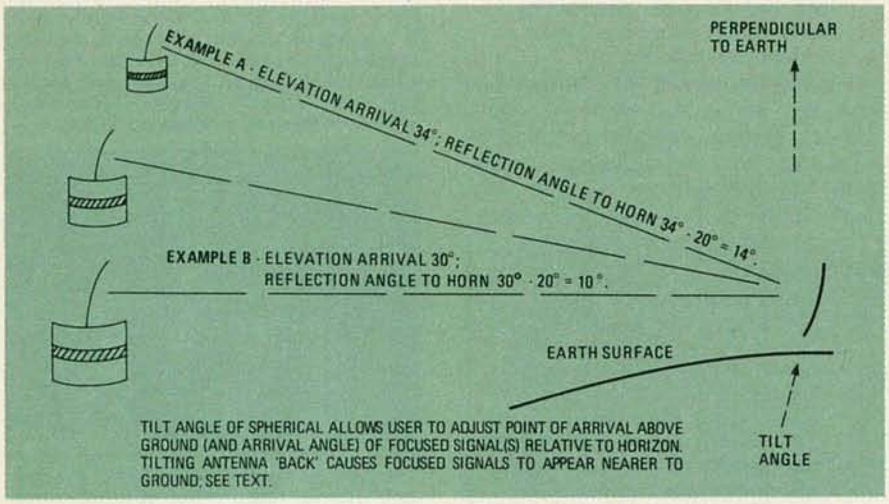


FIG. 9—TILTING THE SPHERICAL reflector surface back permits the user to adjust the angle of the reflected signals with respect to the ground.

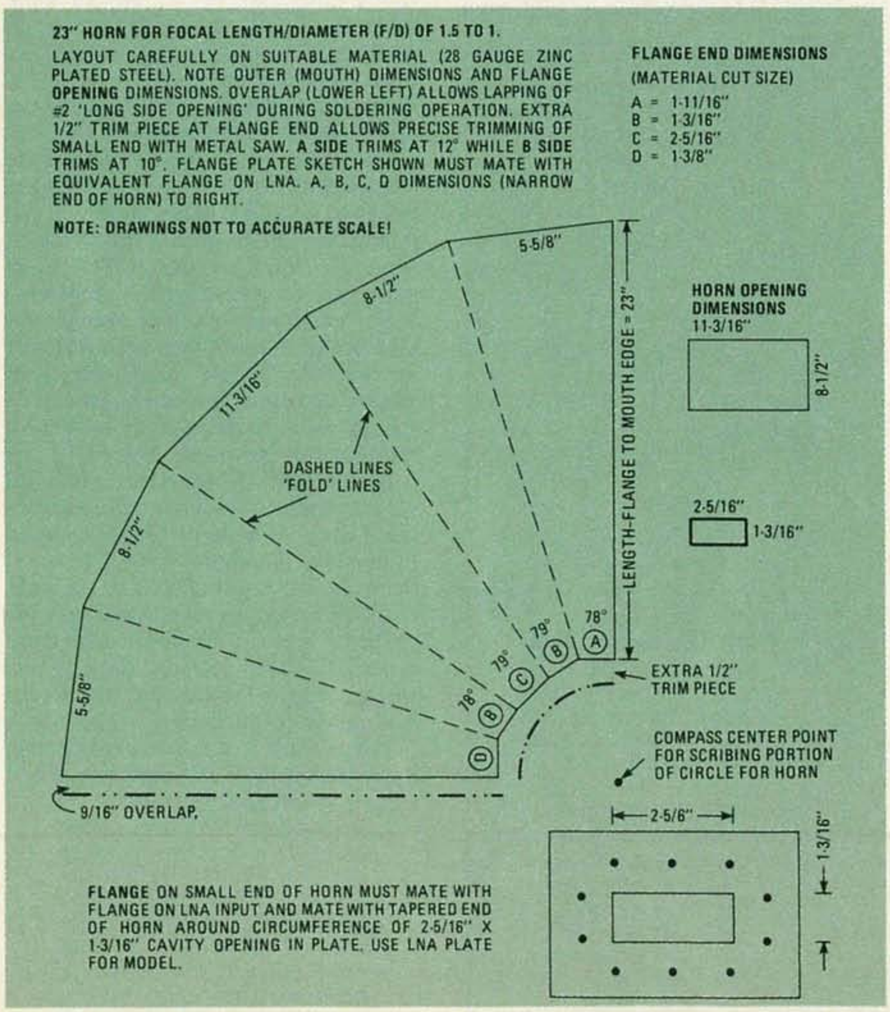


FIG. 10—23-INCH HORN PATTERN shows how to cut and form horn of focal-point antenna out of sheet metal.

The feed theory

The feedhorn is a very unusual design and there are proprietary rights of value here for the developer Oliver Swan. Suffice to say that the basic spherical antenna shown has phase *advance* (as in lead) while the feedhorn has phase delay. The advance of the reflector surface is self correcting with the delay of the special feedhorn as long as the incoming plane wavefront is within ± 20 degrees of the antenna's boresight. It is this phase relationship which falls apart beyond the 20-degrees-off-boresight point, destroying the effectiveness of the antenna system over off-boresight points beyond the 20 degree limits.

Keep in mind that the focus point varies for different azimuth angles of arrival. Remember that a signal from a satellite located dead-on the boresight path will be directly in front and in the middle of the antenna. But, signals from satellites stationed to the left or right of boresight will arrive at a focus point right and left (i.e., reversed) from the center boresight point.

There is also one other factor to be aware of in designing the antenna system; tilt angle. As shown in Fig. 9 the designer can decide just where he wants his signal above ground (i.e., how close to the ground or how high up) by changing the up-and-down angle of the reflector surface. For discussion, a reflector surface straight up and down is said to be perpendicular to the earth. In fact this is how you build and surface it regardless of the ultimate tilt angle that is to be used. After construction, on hinged pieces, the antenna is tilted back to the desired tilt angle for your location. A simple string and plumb-bob can be used to establish a vertical reference line and an inexpen-

continued on page 83

DESIGN YOUR OWN ANDROID

Part 2—If you've wished for an intelligent robot to do your chores, you'll be interested in some design problems and their solutions.

MARTIN BRADLEY WEINSTEIN

LAST MONTH WE BEGAN THIS SERIES ON android design with definitions of relevant terms and discussions of physical and mechanical goals. Now, we'll take a look at how we can satisfy the design goals.

Defining the problem of vision

Exactly what can we hope to accomplish by providing our machine with a visual input? For that matter, what should we *want* to accomplish?

We have set collision avoidance as one of our goals. So we might ask that obstacle recognition be assigned to a visual subsystem.

We have to locate both external objects and the position of manipulator arms and hands in three-dimensional space. That certainly is a visual task, and one that calls for binocular parallax vision.

In addition to observing objects as obstacles, there are a given number of objects we will want our machine to be able to recognize and identify. Those include doors, doorknobs, stairways, and power receptacles at the very least.

If we were to deal with even as complex an image as a low-grade video camera yields, we would need enormous amounts of very fast memory and huge chunks of processor time.

Would we be as well off with something as crude as a 64 × 64 or even 32 × 32 pixel array?

Figure 3 shows a portrait of the author, adapted from a photograph using high contrast techniques and mezzo dot inking. The artistry was performed by John Scavnicky, to give credit where it is due. Figure 4 shows the same portrait resolved into a 32 × 32 array of single-bit (black/white) data.

Is that 1K array fine enough for object recognition? That depends on what you want your machine to be able to do. A 4K array might be better, and we might want to consider more than one bit of video. But you can get the 32 × 32 array by scanning a CCD or photodiode matrix!

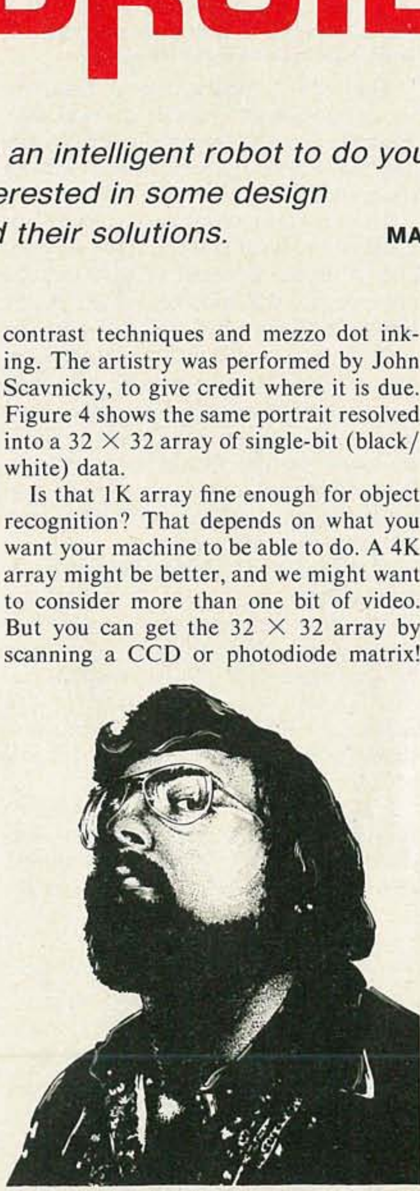


FIG. 3—RESOLUTION is a significant parameter to consider when designing the visual system. The above is a high contrast portrait of the author.

There are other simple digital scanning techniques available, too, which we hope to cover in future articles.

Is one picture worth 1000 bits?

If we wanted our visual system to see any given image exactly, time after time, we could establish a mask within its memory and match every incoming image

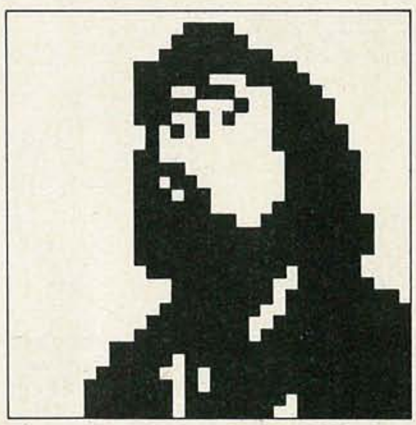


FIG. 4—WHAT THE ANDROID SEES. Above shows the portrait in Fig. 3 resolved into a 32 × 32 array of single-bit black-and-white data.

until one matched perfectly. That approach might be valid, for example, if we wanted our machine to recognize dollar bills placed in a receiving tray that was always centered at arm's length.

So even with the reduced data requirements of a fairly crude scan, we will want to include some mechanism—probably in software—for extracting salient features and applying them to the recognition task.

Of great help in this task is a memory scheme called *C*ontent-*A*ddressable *M*emory, or CAM. One company, Semionics (41 Tunnel Road, Berkeley, CA 94705) has available a 4K byte static CAM board for Z-80 and 8080 systems called REM, for Recognition Memory. The board itself is $325, a 4K firmware package of REM routines another $80.

Content Addressable Memory, as its name implies, is an arrangement of standard memory with a large number of logic gates which permits the memory to be searched according to its contents.

All CAM in a system is searched in parallel. The search can be designed to extract either all data identical to a search cue, or all data in a set corresponding to a subset used as a search cue (for example, from a personnel file, all blonde-haired blue-eyed former employees from California), or the data most closely matching the search cue.

Because the search is conducted in parallel, it is very fast. And the ability to score for closest match makes it particularly useful to pattern recognition tasks.

Depth perception

Let's make two assumptions: first, that our visual information is addressable from the perspective of a defined X-Y matrix; and second, that we can use identical feature extraction software on each of two image sensors.

Then, if we arrange the two electronic "eyes" so that they can rotate separately from the platform they sit on, and the platform can rotate; and if we arrange so that the "crosseye" angle from perpendicular is kept complementary and equal;

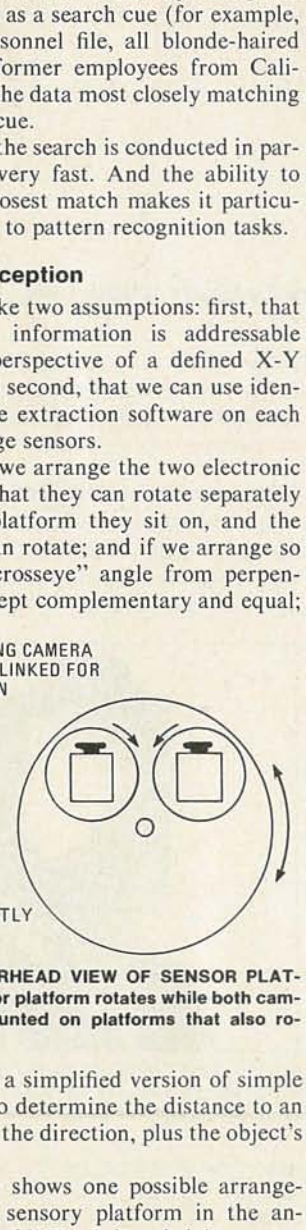


FIG. 5—OVERHEAD VIEW OF SENSOR PLATFORM. Sensor platform rotates while both cameras are mounted on platforms that also rotate.

we can use a simplified version of simple geometry to determine the distance to an object, and the direction, plus the object's height.

Figure 5 shows one possible arrangement of a sensory platform in the android's "head." The left and right camera turntables could be linked by gears or belts, if desired, or electronic means could be employed.

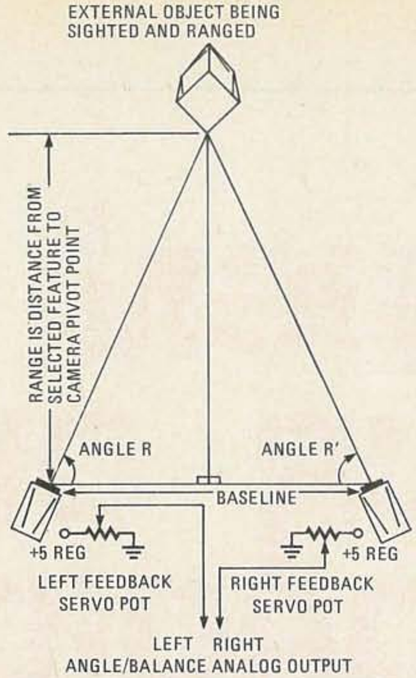


FIG. 6—PARALLAX RANGE MECHANISM can be used to calculate range information.

The servo feedback pots in Figure 6, for example, could provide the necessary inputs to a circuit designed to drive independent motors until equal angles balance the circuit.

The *baseline* of Figure 6 is the distance between the pivot points of the two cameras. A little trigonometry shows that the distance to the external object being sighted and ranged is equal to half the baseline times the tangent of Angle R, as long as Angle R and Angle R′ are equal.

To attain that condition, we can compare the X-Y matrix address of any single extracted feature in the two cameras. When R and R′ are equal and the grid addresses are equal, range information is just one more step away.

That last step involves digitizing the servo outputs. For best results, a logarithmic taper pot arranged with its compression highest when Angle R approaches 90° can serve as the servo feedback pot. An 8-bit analog-to-digital converter then addresses a ROM lookup table to give either calculated or actual measured values for range.

Figure 7 shows one possible elevation adjusting platform, permitting our machine to look up about 30°, straight ahead, or down—as steeply as straight

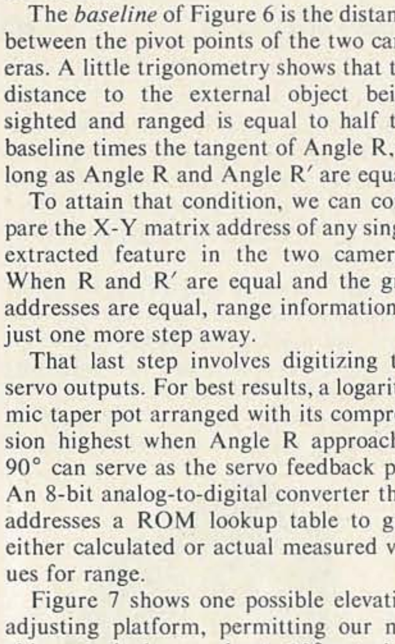


FIG. 7—ELEVATION ADJUSTING PLATFORM can be used to determine object's height above ground.

down, 90°. Again, the digitized output of a potentiometer can be applied to calculate both the object's distance from the machine and its height above ground.

Track drive design

We said earlier that the ability to negotiate a stairway would have to be one of our design criteria, as stairways were a special but common obstacle in our human environment.

Another is doorways. If there is a standard for doorways—a point that appears more and more moot the more you investigate it—it seems to be 30 inches in width. But often, the heel of the open door occupies two inches of that space, so a robot more than about 27 inches wide would be folly.

Still another significant obstacle commonly encountered is the narrow, usually 36-inch, hallway—and especially 90° corners in such hallways.

Those three hazards—stairs, doors, and halls—can help us define the maximum dimensions and geometry for our machine, and especially its drive.

Stairway geometry

We are going to make a marginally dangerous assumption: We will assume that the robot will never encounter a case

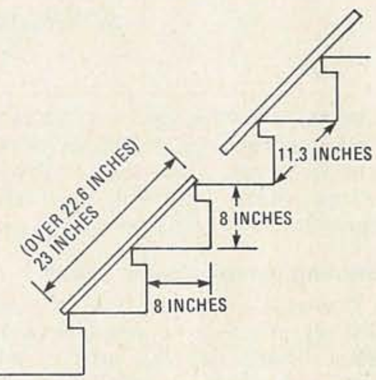


FIG. 8—NEGOTIATING standard 45 degree 8-inch stairway can be difficult.

worse than a "standard" 45° 8-inch step stairway.

Figure 8 shows a model of such a stairway, 8 inches step height (rise) and 8 inches step offset (tread). Note that the offset lip at the top edge of each step does not affect the following calculations.

The linear distance from corner to corner along a climbing diagonal is 8 times the square root of 2, or roughly 11.3 inches. Good design sense requires that the drive contact at least two step corners at any time, which requires a "grounded contact" length of just over twice this distance, or roughly 22.6 inches. So let's set 23–24 inches as the minimum dimension for the base of our vehicle's track.

Next we face the problem of getting the little monster to leave a level surface and climb that initial step. The configuration in Figure 9 shows our approach to the problem.

Here, the first surface to contact the

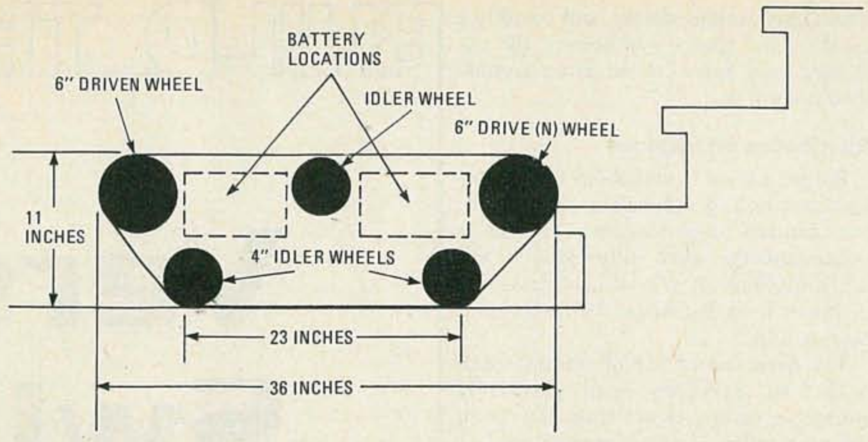


FIG. 9—STAIRWAY PROBLEM might be solved with the above track drive mechanism. The geometry of the mechanism is such to permit the android to climb standard 8-inch stairs.

step corner is the track at roughly the 4 o'clock position on the front drive wheel. The forward motive thrust pushing the vehicle then more or less makes the drive wheel "roll uphill."

The idler wheels are spring tensioned in narrow slots and permit some vertical motion. Notice that on first approach, the track surface approaches the step corner at about a 35° angle. As the front drive (or *driven*, depending on your point of view) wheel climbs, the weight of the vehicle is lifted from the front idler wheel, allowing it to drop to the bottom of its travel slot, with pressure maintained by spring tension. That increases the contact area of track-against-step (especially on a carpeted step), aiding the climb.

For a more natural understanding of the interactions here, buy yourself a small plastic model tank kit, preferably motorized.

The top track dimension (here, 36 inches) results from calculations of the necessary height of the step contact point and the necessary approach angle of the track. Plus a trip down the hall.

Tight corners

The tight corner we talked about earlier, 90° in a 36-inch-wide hallway, is one of the most ticklish situations our vehicle is ever likely to encounter; indeed, it might require the addition of some sort of electronic "curb feelers" to avoid scarring the walls.

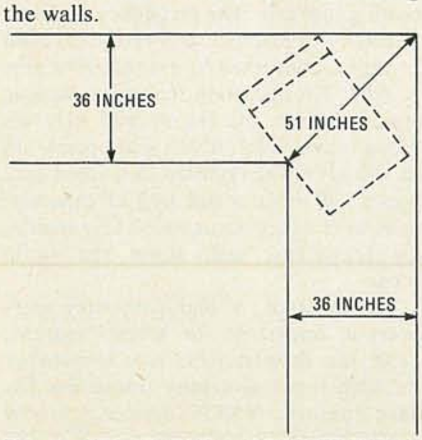


FIG. 10—NEGOTIATING A 90 DEGREE TURN in a narrow hallway is also difficult.

Figure 10 shows the situation in question. It also includes a red herring: the 51-inch diagonal dimension has nothing to do with the available turning circle area. Used as a diameter, it describes a circle whose circumference exists outside the hallway walls at all but four points.

The circle we are interested in exists within those walls, and has a diameter equal to the hallway width, or 36 inches.

The dotted rectangle at the corner shows the most critical part of the turn as vehicles both 36 and 40 inches long (by 27 inches wide) would negotiate it.

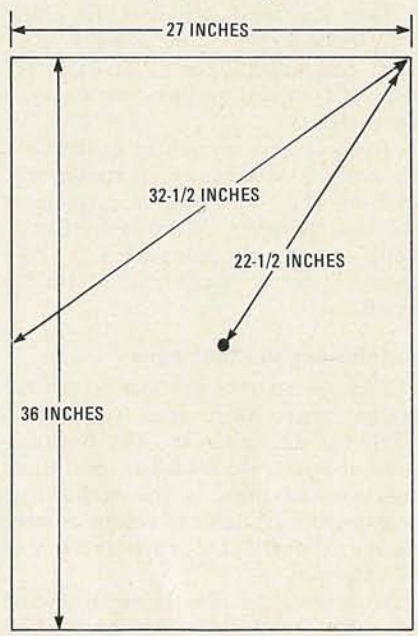


FIG. 11—DIMENSIONS and turning radius of track drive mechanism.

The problem reduces quite nicely to the geometry shown in Figure 11. We must turn the vehicle so that the pivot for the turn is midway along one flank. That yields a turning radius of approximately 32½ inches, a tight enough squeeze in a 36-inch circle.

That *must* be done with the inside track moving more slowly than the outside track. To run it the same speed but in the opposite direction makes the vehicle pivot about its geometric center. And while that is a nice stunt for dancers, and certain other vehicle tasks, here it would yield a turning diameter of 45 inches. This makes almost any kind of turn an impossible maneuver.

Experimentation in a clear, chalked-off area is urged.

Leaning and trunk rotation

It is good design practice for stability in any vehicle to keep the center of gravity close to the ground. That involves either designing wide, flat configurations—like sports cars—or assigning most of the mass of the vehicle to its lowest quarters.

Unquestionably, the most massive components of our machine are going to be its batteries and charger, its track drive and drive motors, and its supporting framework. Refer back to Fig. 9 to see where the batteries and drive motors might be located within the base of the unit to insure good stability.

One method of adjusting a center of gravity is by adjusting the geometry of the mass. One splendid example of this phenomenon, which you may be experiencing even now, is leaning. The upper body can be made to lean forward or backward to maintain equilibrium as the robot goes up and down stairs.

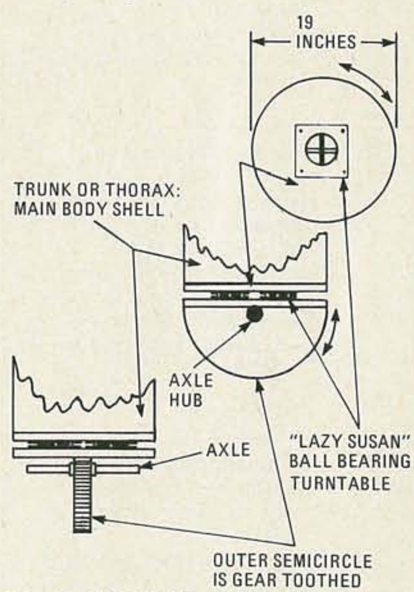


FIG. 12—THE TRUNK OR THORAX of the android should be affixed to the drive mechanism in such a way as to permit both twisting and leaning. The above shows one possible mounting configuration.

Figure 12 illustrates the mechanics that can permit the upper torso of the robot to lean forward or backward while preserving freedom of rotational motion.

The 19-inch shell diameter was arrived at by assuming that manipulator arms on each side could be trimmed to protrude no more than 4 inches from each shoulder, which conserves the 27-inch overall width.

Figure 13 proposes a fishbowl-shaped head to enclose the sensory platform of Fig. 5. Since that area really ought to also enclose a microphone or two, a headlight,

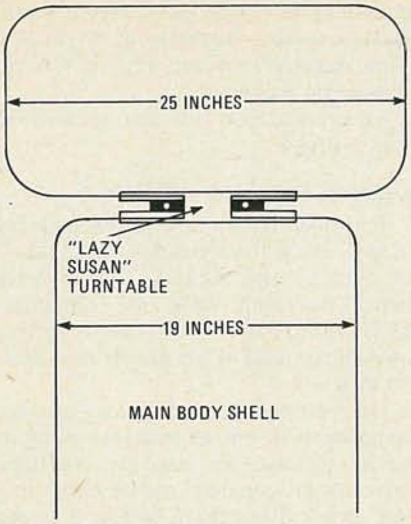


FIG. 13—THE HEAD or sensory platform rests atop the main body shell and rotates independently of the body and of the TV cameras that serves as the robot's eyes.

TABLE II

- **I. Overseer processor**
  - A. Receives instructions from humans
    1. Voice
    2. Keyboard
    3. Override (panic)
  - B. Responds to alarm conditions
    1. Collision
    2. Entrapment
    3. Low energy
  - C. Sets immediate operational goals
    1. Responds to instructions
    2. Responds to alarm conditions
    3. Maps immediate area
       - a. Analyzes visual inputs
       - b. Analyzes contact inputs
    4. Learns about new objects
       - a. Learns to recognize by sight
       - b. Learns to recognize by name
       - c. Asks questions, may format answers
    5. Searches for and locates known objects, enhances map
    6. Learns new operations (e.g., vacuuming rug or pouring a cola).
    7. Performs subset of known operations
- **II. Intelligent peripherals**
  - A. Visual subsystem
    1. Obstacle recognition
    2. Free path recognition
    3. Object recognition
    4. Range calculation
    5. Mapping input
  - B. Drive subsystem
    1. Collision, obstacle avoidance
    2. Mapping
    3. Navigation
    4. Drive motor control
  - C. Speech recognition subsystem
  - D. Speech synthesis subsystem
  - E. Left, right manipulator control subsystem
  - F. Future features

a SODAR ranging device, and possibly a speaker, and speech synthesizer, the enclosure may prove to be more trouble than it's worth.

Distributed intelligence

Before a word is said about the following approach to providing intelligence and control to a machine, you must understand that such information is entirely speculative. We, at least, have yet to prove it in hardware. Perhaps you'll beat us to it.

The basic theory behind our approach is that no reasonably small, reasonably affordable computer available now or in the near future is smart enough, or fast enough, to handle all of the information analysis and control systems an android requires without botching the job badly and often.

We resort instead to multiprocessing. Here, relatively inexpensive single-IC microcomputers are used to simplify the overall task by providing preprocessing at each of the I/O (input/output) on-board "peripherals."

(We're planning on the CMOS version of the 8048/8031 family now being introduced by Intersil, who are interested in supporting our one specific effort with a generous amount of hardware and software cooperation.)

Thus the visual subsystem, for example, provides data to the central "overseer" controlling processor at a rate and level of complexity equivalent to, say, a keyboard.

Table II gives an outline of the tasks for each of those centers of intelligence, each of which may also be using more than one processor. We would prefer to build and test the subsystems to prove them out before going into any further detail.

A definitely un-final word

There is no area of robot or android design where there isn't tremendous room for improvement. The contributions of innovative hobbyists can inspire enormous advances in this technology. And there is no detail of design or technology too small for your attention to it to be welcome.

The android we hope to watch develop from the groundwork you see here will be an infant. Your dog will have more intelligence, more agility, and possibly more practical value.

Until, that is, someone suggests some improvement to our design, or some application of it to improve the nonhuman condition.

Write us. Suggest techniques or hardware. Suggest tasks for robots or androids to perform. Be supportive or critical. Tell us whether or not you're interested in more information on androids and robots. Or have your android write us. The day isn't all that far away. **R-E**

BUILD THI

Vers
Swit

ROBERT FROSTHOLM*

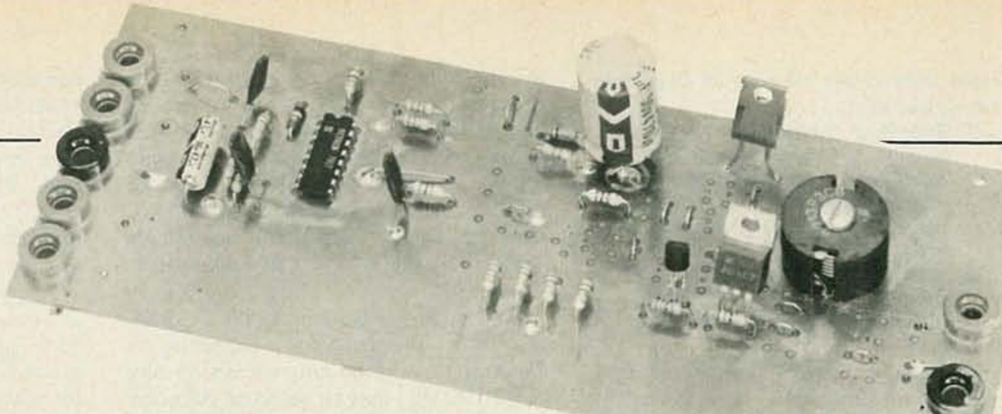
TWO PREVIOUS ARTICLES ON SWITCHING Power Supplies (June and July 1979 issues of **Radio-Electronics**) dealt with the basics of switching regulator theory and presented several typical circuits using IC's for basic DC-to-DC conversion. This article will present a universal regulator that can be programmed with simple jumper wires for step up, step down, or an inverting output. It is much more than the simple DC-to-DC converters discussed earlier. This approach to switching regulator design incorporates all the essential protection and control circuitry needed to maintain high efficiencies and a fully protected system.

The heart of the design is a new Switched Mode Power Supply Control circuit, the Signetics NE5560N. Unlike the simple DC-to-DC circuits on the market, this IC was developed as a "Power Supply System Controller." The following description will bare this out in detail while providing insight into the operation of the regulator.

Figure 1 shows a block diagram of the NE5560. A quick glance tells you it's much more than a DC-to-DC circuit. The oscillator consists of a highly stable sawtooth generator. The frequency is determined by an external resistor and external capacitor connected to ground from pins 7 and 8. The operating frequency range is specified from 50 Hz to 100 kHz although most NE5560N's will operate up to 150-kHz. The regulator described here uses a 20K resistor and .003 μF capacitor to achieve an approximate 30 kHz oscillator frequency, well above the audio range.

The capability of high-frequency operation is important for several reasons. First, the threshold for new technology for high-speed switching transistors has been reached. VMOS devices are now

*Strategic Marketing Manager, Standard Linear Products, Signetics Corp. Sunnyvale, CA.



atile ching Regulator

The switching-type voltage regulator offers much greater efficiency than conventional regulated supplies. This design lets you invert the output polarity or program the output for step-up or step-down.

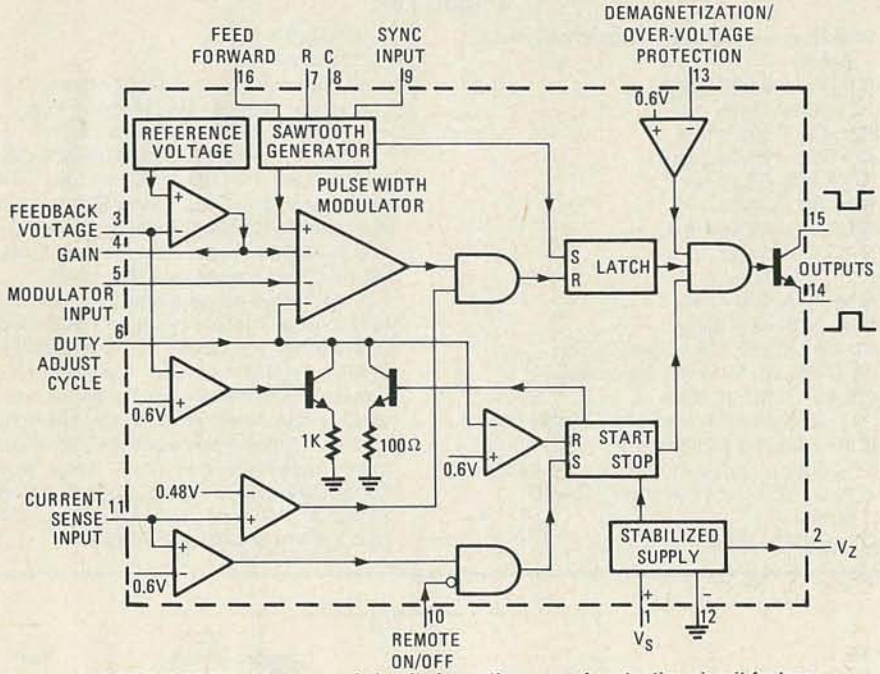


FIG. 1—BLOCK DIAGRAM of the control circuit shows the array of protective circuit features.

commercially available along with fast-recovery diodes making extremely high power switching regulators smaller, lighter, and less expensive than ever before. High-frequency operation also means small energy storage elements i.e. greatly reduced magnetics (transformers and chokes) resulting in further size, weight and cost reductions.

The ability to synchronize the oscillator to an external TTL signal is important in switching power supply design. Although it is not necessarily applicable in this project, the pin is available and brought out on the board for experimentation purposes. The oscillator can be synchronized to a frequency lower than the free-running frequency as determined by the external resistor and capacitor connected to pins 7 and 8. For example, in a video display system it is desirable to sync the switcher to the horizontal deflection signal to minimize noise and beat signal problems.

There are two basic techniques to vary output pulses to the switching elements. Many DC-to-DC converters use a frequency-modulation technique that is easy to achieve but hard to control. The system described here uses a pulse-width modulation scheme that allows precise cycle-by-cycle control of the output. The duty cycle range of the NE5560 is 0 to 98%.

With pins 5 and 6 not connected and a low feedback voltage on pin 3, the output pulse will have approximately a 98% duty cycle. In switched-mode power supplies, large output duty cycles can cause problems, especially in forward converters (see box) where duty cycles in excess of 50% can cause the magnetics to saturate. For this reason it is important to be able to control the maximum duty cycle. Applying a DC voltage to pin 6 of the NE5560 controls the duty cycle maximum limit. This relationship is illustrated in Fig. 2.

Establishing a maximum duty cycle is best done with a resistor divider from V_z

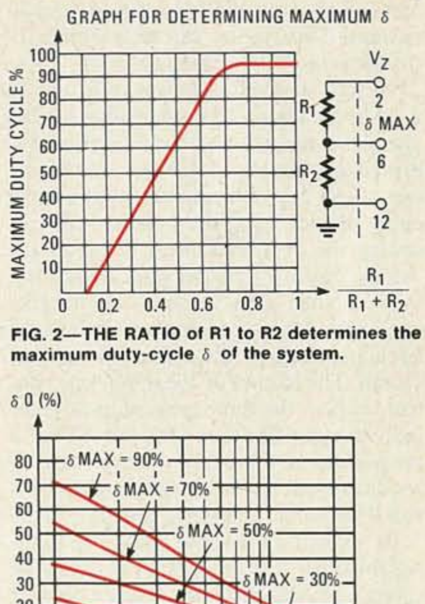


FIG. 2—THE RATIO of R1 to R2 determines the maximum duty-cycle δ of the system.

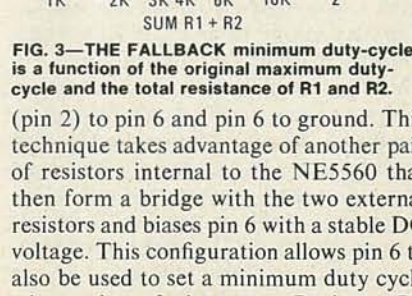


FIG. 3—THE FALLBACK minimum duty-cycle is a function of the original maximum duty-cycle and the total resistance of R1 and R2.

(pin 2) to pin 6 and pin 6 to ground. This technique takes advantage of another pair of resistors internal to the NE5560 that then form a bridge with the two external resistors and biases pin 6 with a stable DC voltage. This configuration allows pin 6 to also be used to set a minimum duty cycle when a loop fault occurs. Resistors R1 and R2 have been selected at 10K. These may be modified to experiment with different duty cycles so long as two basic criteria are kept:

1. The duty cycle must be large enough to insure that at maximum load and minimum input voltage, the resulting feedback voltage to pin 3 must exceed 0.6 volts.
2. It must be small enough to limit the amount of energy to the output stage when a loop-fault occurs.

The relationship of the minimum duty cycle and maximum duty cycle to the values of R1 and R2 is shown in Fig. 3.

Another critical feature of switched-mode power supply design is to be able to control the duty cycle during "power up" conditions—to gradually increase the amount of power to the load until full output is reached. An electrolytic capacitor from pin 6 to ground will provide this function. During "power up" C1 (Fig. 4) is initially discharged. When power is applied C1 begins to charge through R1 and the voltage on pin 6 gradually increases to its final value (determined by R1 and R2).

Capacitor C1 serves another important function; that of protecting the entire system when an over-curent condition exists. The output current is monitored by pin 11 on the NE5560. This pin senses a rise in voltage across a sense resistor (R15–R18 in parallel) indicating a rise in current. This feature can be examined in the step-up configuration (Fig. 4).

In actuality four 2.2-ohm resistors are used in parallel in this application so that you can experiment with the over-current protection feature of the IC. With only one of the 2.2-ohm resistors in place, the effect of increasing the load current (reducing the load resistance) increases the voltage on pin 11 greater than .48 but less than .6 volt. This activates an internal comparator that in turn resets an internal latch and shuts off the pulse to the output switch. The feature of cycle-by-cycle control reduces the duty cycle of each pulse individually. The new duty cycle is a function of how quickly the over-current condition can cause a greater than .48-volt drop across the sense resistor.

By reducing the sense resistance (adding the other three 2.2-ohm resistors) the voltage sensed will now exceed .6 volt that activates another comparator internal to the NE5560 which in turn sets a latch that completely inhibits the output. The latch also turns on a transistor whose collector is connected internally to pin 6. This discharges C1. When the voltage on C1 drops below .6 volt, another comparator resets the latch. Capacitor C1 then begins to charge creating the soft-start effect of gradually increasing duty cycles. If the fault condition remains the procedure repeats itself. This is called the "hiccup mode." In major systems it is not advised to let a system oscillate in the hiccup mode for long periods of time.

Use of the remote on/off (pin 10) can prevent this problem. A simple CMOS counter can be used to sense hiccups by connecting the input to the slow-start capacitor (C1), programming for some number of counts (i.e. 5, 10 etc.) and the output can then be connected to pin 10. This way with a permanent major fault the entire system will be shut down after say five hiccups.

Switching-power supplies use feedback techniques to sense what's happening at the output and internally correct for any deviations that may be detected. An error amplifier is provided on the NE5560 to sense the output voltage sampled through R3 from the divider R4–R5 (see Fig. 4). The gain of the error amplifier is controlled by the feedback resistor R6. Capacitor C3 is for loop compensation. Typical open-loop gain of the error-sense amplifier is 60 dB.

Special protection features not found in any other control circuit include a completely protected loop. If for some reason the loop opens, an internal current source pulls pin 3 voltage up giving the false impression that the output voltage is high. This information is then delivered to the pulse-width modulator and the duty cycle is reduced to a safe level preventing a runaway condition.

A second safety feature on the loop protects the system in the event the feedback loop somehow gets shorted to ground. In this case an internal comparator senses that the amplifier input (pin 3) is below 0.6 volt. This too reduces the duty cycle by affecting the pulse-width modulator. A shorted loop also results in the soft-start capacitor being discharged through an internal 1K resistor. This short remains as long as the voltage on pin 3 remains below 0.6 volt. This results in a greatly reduced duty cycle (a function of the forced voltage on pin 6) further protecting the switching power supply.

PARTS LIST

Resistors ¼ watt, 10% unless otherwise noted
R1, R2—10,000 ohms
R3—1000 ohms
R4, R7—3600 ohms
R5, R12—20,000 ohms
R6—100,000 ohms
R8—8200 ohms
R9, R13—2000 ohms
R10—180 ohms
R11—68 ohms
R14—360,000 ohms
R15–R18—2.2 ohms
C1—47 μF, 16 volts, electrolytic
C2—470 μF, 50 volts, electrolytic
C3–C5—.003 μF disc
D1—BYW29-150 (Amperex) or equivalent
IC1—NE556ON (Signetics)
L1—0.9 mH inductor (Ferroxcube 2213 PL00-3C8 pot core and 2213 F1D bobbin)
Q1—BU407 (SGS)
Q2—2N3638A
Q3—2N2222A
Miscellaneous—double-sized PC board, 3 feet of No. 18 enameled magnet wire, nylon screw and nut for mounting L1.

Note: A kit of two 2213 PL00-3C8 pot cores (two are required for one enclosed inductor) and a 2213 F1D bobbin is available for $3.00 including postage and handling, from Elna Ferrite Labs, PO Box 395, Woodstock, NY 12498.

A complete kit of parts (No. SMP-1) to build the power supply as described is available for $36.50. A boost kit No. SMP-2 includes higher power drive transistors and larger pot core for converting the basic SMP-1 for approximately 3 amperes output; $13.50. California residents add 6½% sales tax. Order these kits from Advanced Analog Systems PO Box 24, Los Altos, CA 94022. Phone: (408) 377-7148.

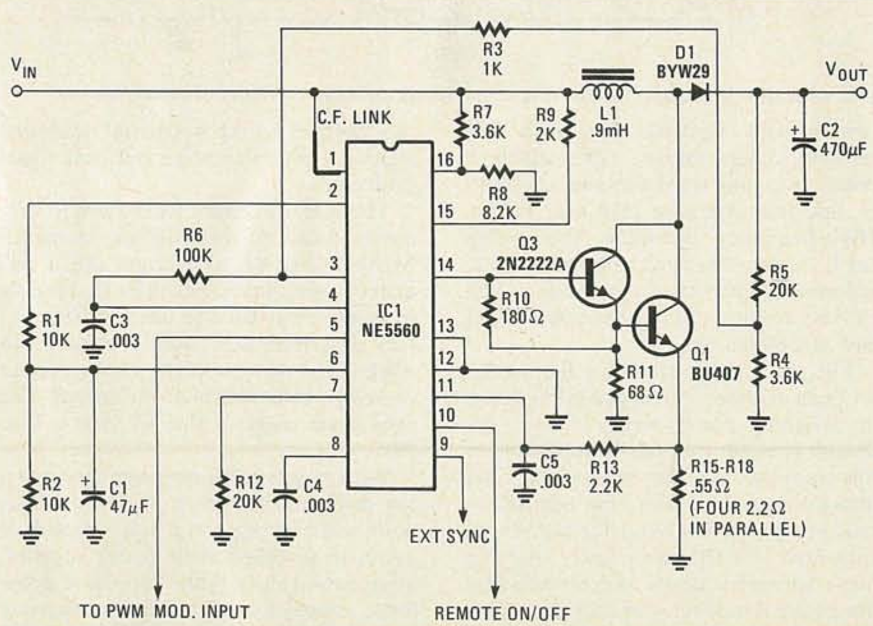


FIG. 4—STEP-UP CONFIGURATION. Output voltage V out is 24 volts and can be adusted by changing the value of R5. Output changes 1 volt for every 1000 ohms change in R5.

These two protective features can be investigated by looking at the output duty cycle with a scope while opening then shorting the loop.

While the feedback loop looks at the output and tries to compensate for changes due to such things as load variation, a *feedforward* circuit looks at the input line and modifies the duty cycle to compensate for line variations. Resistors R7 and R8 sample the input voltage to the feedforward circuit (pin 16.) When the voltage on pin 16 exceeds an internal reference voltage (V_z, typically 8.4 volts), the charging current for the timing capacitor on pin 8 is increased. The higher the voltage the larger the charging current and consequently the shorter the duty cycle. Conversely, if the voltage on the feedforward pin decreases, the duty cycle increases to compensate for the change. Ideally, the NE5560 should be operated with the feedforward in its active area, i.e. between V_z and V_{cc}, so that it has plenty of headroom to compensate for variations in the line voltage, up or down. The feedforward function improves the line regulation of the switching power supply by almost a factor of 15.

Another area where protection must be provided against a fault is the switching regulator output. Of primary concern is the power switching elements. Excessive currents, due to output shorts, shorted windings in a choke or transformer etc., can quickly destroy the switching transistor.

Two types of output problems can develop. The first, excessive current, was discussed earlier and was resolved with the aid of pin 11. The second is saturation of the magnetics, especially critical in forward-converter transformers. Pin 13 is used to sample the voltage present in the transformer. Again its output is a comparator with a 0.6-volt threshold which, when activated, will completely inhibit the output pulse until the saturation problem goes away and the voltage drops below 0.6 volt.

Since switched-mode power supplies operate at extremely high efficiencies they can easily control very high power systems where low voltages are not necessarily available to power the NE5560. This potential problem is overcome due to a unique ability of the NE5560 to operate in either a *voltage-fed* (conventional operation) or a *current-fed* mode. When only high voltages (30 volts or above) are available, the IC can be current-driven through a limiting resistor. In this mode internal Zener diodes will limit the drop across the NE5560 to typically 23 volts at 10-mA and 30 volts at 30 mA. A provision for the limiting resistor is made by removing the link connecting pin 1 to V_{in} on Figs. 4, 5, and 6 and inserting a proper resistor with sufficient power dissipation.

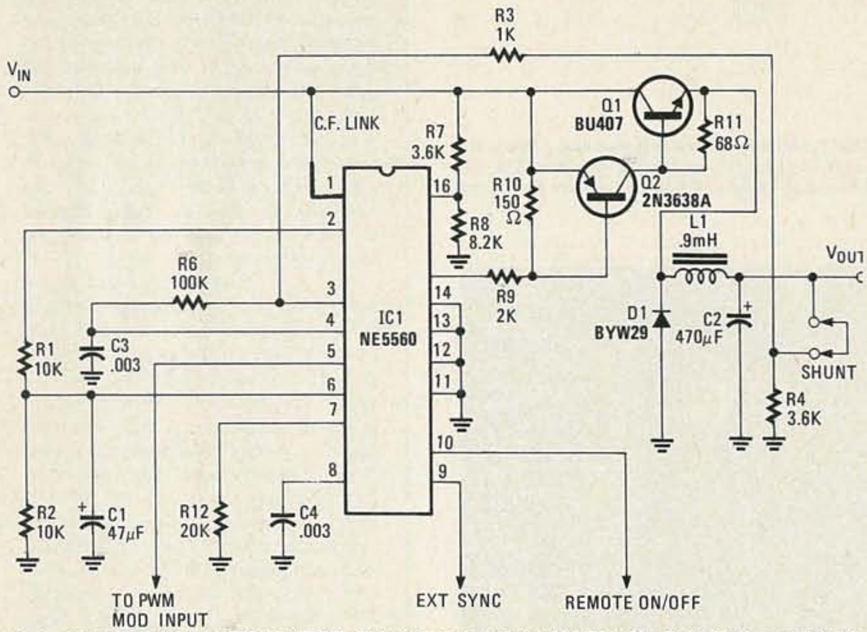


FIG. 5—STEP-DOWN CONFIGURATION. Output is approximately 3.75 volts. Substitute a resistor for the shunt and output can be increased by 1 volt for each 1000 ohms of resistance inserted.

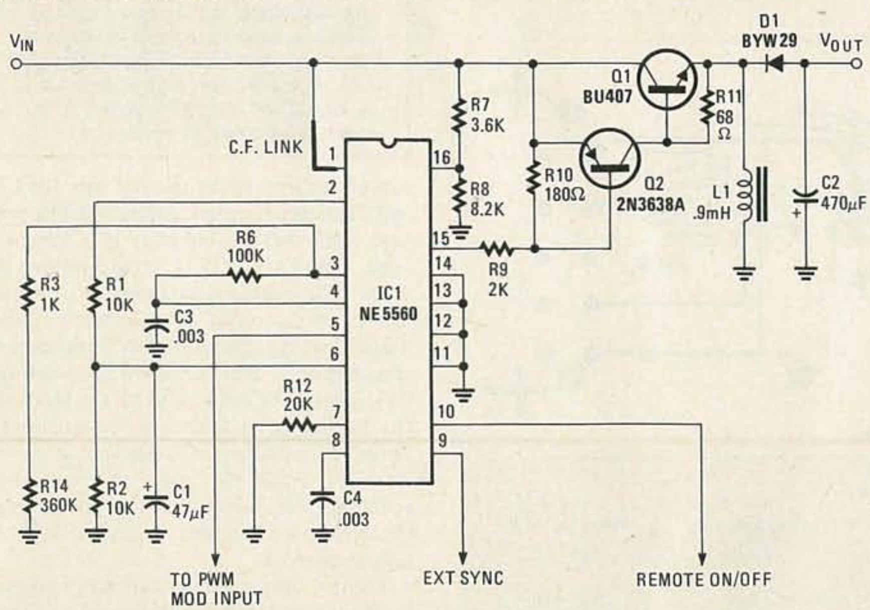


FIG. 6—INVERTING CONFIGURATION. Output voltage polarity is opposite that of the input. This circuit delivers −5 volts.

Voltage-fed and current-fed modes

The NE5560 operates with either a forced voltage or forced current as the primary power. In the current-fed mode where V_{in} is greater than 30 volts, a series resistor (or current source) is placed between the power source supplying the device and pin 1. [The current-fed (CF) link is removed and replaced by the resistor.] This resistor or current source must be selected to provide a minimum of 10 mA and a maximum of 30 mA. An extra capacitor from pin 1 to ground may be needed to filter noise.

When operated in the current-fed mode, an internal shunt regulator limits the voltage on pin 1 to about 23 volts—this voltage varies from one IC to another and ranges from 20 to 30 volts.

In the voltage-fed mode supply voltage V_{in} must be greater than 9.5 volts (to make the IC active) and less than 18 volts to guard against exceeding the shunt regulator's 20-volt maximum. With V_{in} connected to pin 1 through the CF link. In this mode the IC draws about 8.5 mA.

Remember that any current drawn from pin 2 (V_z) must ultimately come from pin 1 and should be added to the 8.5 mA.

Construction

This switching regulated power supply, although designed primarily as a learning tool to familiarize oneself with the three unique modes of operation, does have practical applications as a supply. Both the switching transistor Q1 (BU407) and the switching diode D1 (BYW29) are capable of switching currents in excess of 5 amps at voltages greater than 100 volts.

The actual current capabilities of the

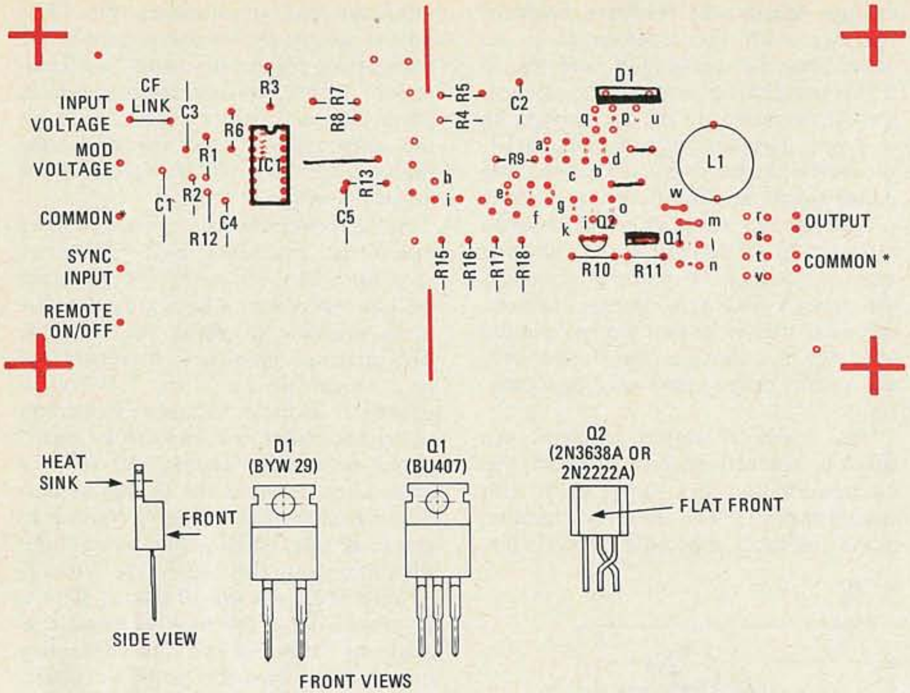


FIG. 7—COMPONENT LOCATION DIAGRAM. Be sure that both common leads (input and output) are soldered to the top side of the ground plane. Note the pin-outs for D1, Q1 and Q2. The board layout makes it necessary to transpose two leads on Q2. The heatsink sides of Q1 and D1 should be toward the center of the PC board.

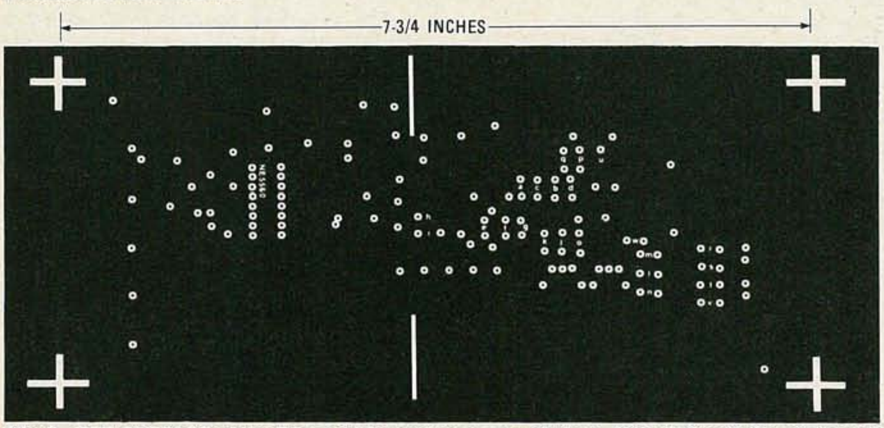


FIG. 8—TOP SURFACE of the PC board is used as a ground-plane. Note that only the circles and lettering are etched away.

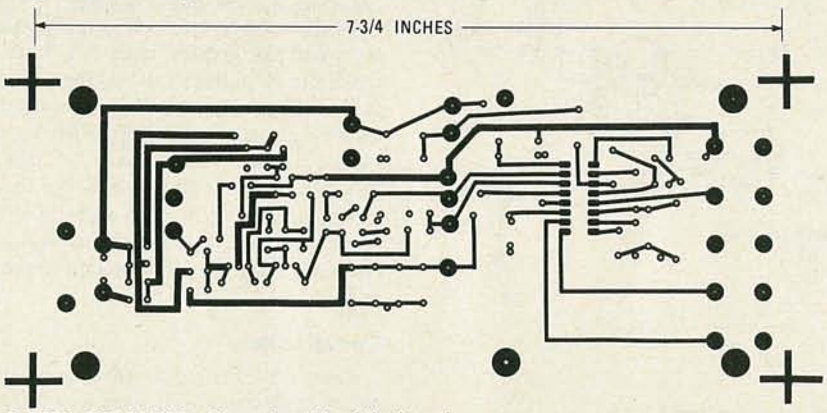


FIG. 9—FOIL PATTERN for the under side of the board.

TABLE 1

Oscillator Freq	No. of Turns	Inductor	Max Current
20 kHz	14	.9 mH	300 mA
40 kHz	10	.5 mH	500 mA
80 kHz	7	.25 mH	700 mA

FORWARD VS. FLYBACK

There are two basic types of converters used in Switched Mode Power Supplies: the *forward converter* and the *flyback converter*. In both types of converters an inductor is used as an energy-storage element. In the forward converter the inductor is connected in series with the load. Thus energy is passed to the load and the coil during the "ON" condition of the output transistor. In the flyback converter the coil is connected in parallel with the load. Energy is stored in the coil during the "ON" period and transferred to the load during the "OFF" period. These are sometimes known as series or parallel converters respectively. Each approach has its advantages and disadvantages. In the forward converter, for example, the switching transistor conducts current to the load only during the "ON" condition, and the peak value of V_{CE} that the device must withstand is only equal to the input DC voltage. Also the inductor can be smaller and the capacitor has a lower ripple current to deal with. Disadvantages include difficulty in achieving isolation from the input and the full input DC being applied to the load in the event of a shorted switching transistor.

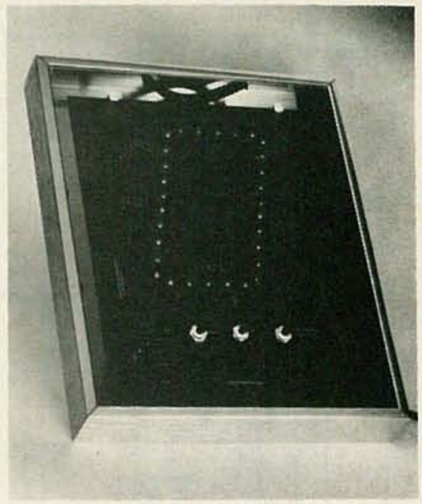
The advantages of the flyback converter are the opposite of the disadvantages of the forward converter. Input/output isolation is very easy to achieve by adding a secondary to the inductive element. Also it is not necessary to protect the load against excess voltage in the event of a shorted switching transistor. Disadvantages complement the advantages of the forward converter. The peak value of V_{CE} the switching transistor must withstand is the sum of the input DC voltage and the output voltage ($V_{CE} = V_{in}\ max + V_O$). Thus both the inductor and diode have to pass higher peak current and withstand higher peak voltage. The inductor is larger and the capacitor must pass higher ripple current. And of course the higher switching voltages and currents generate increased amounts of noise.

supply are limited by the pot core for L1 and oscillator frequency selected. The pot core used for the inductor is a Ferroxcube, type 2213-3C8. The core volume is 2 cm². The bobbin is wound with 14 turns of No. 18 enameled wire (approximately 3 feet) leaving approximately 3 inches for connection to the PC board. Depending on the gauge of the wire used, the holes of the PC board may have to be enlarged. Nominal inductance of the pot core is .9 mH. Trade-offs may be made by reducing this inductance, and increasing the oscillator frequency to achieve higher output currents.

Table 1 shows how maximum current is affected by oscillator frequency and the inductance of L1. Another way to in-

continued on page 80

Not Just Another DIGITAL CLOCK



Digital electronic clocks are no longer a novelty, except when they are designed in an unusual format. This electronic digital clock is unique in that hours and minutes are flashed sequentially in a specific pattern on a single 7-segment display nearly five inches high.

JOHN D. WAROBIEW

DIGITAL CLOCKS ARE CERTAINLY PLENTIFUL thanks to the many large-scale integrated circuits currently being produced by several major electronics manufacturers. This clock uses one of the readily available LSI clock IC's, but what makes it unique is the novel approach used to display the time. Instead of the four small 7-segment displays that can be found on most digital clocks, this clock has one 7-segment display that is nearly five inches high. The time is flashed sequentially on the single readout in a specific pattern. The pattern is set so that the time is easily interpreted but it also gives an intriguing effect, especially to those who haven't been told that this strange device in really a clock!

The bright readout is clearly visible, even from across a large room. In addition, the completed clock is less than one inch thick. This means the project can be placed in a standard picture frame and hung on a wall to make an attractive addition to anyhome or office.

Circuit description

The basis of the circuit (Fig.1) is the MM3518 clock IC. This device contains all the logic required to set and maintain a 4-digit representation of the time, with the timebase derived from the 60-Hz AC line frequency. It also provides 7-segment outputs that are multiplexed for each digit through a 3-line input code.

The supporting circuitry selects the proper code in the correct sequence. The 555 timer is wired in an astable mode and used to provide a clocking signal to the CD4060 counter (IC3). The 4060 is a 14-stage ripple binary counter/divider and oscillator that gives a repeating binary count of 0 to 15 on its Q5, Q6, Q7 and Q8 outputs. The count is used to alternately select each of the eight output lines of a CD4051 analog switch. Only four of the eight lines are used. These are combined in a diode matrix to generate the codes on the MM5318 to flash properly the sequence of digits and blanks in the display. (See Fig. 1 and Table 1.) The blank intervals are developed during the periods that the four unused output lines of the CD4051 are selected.

Since the clock IC is normally intended

TABLE 1

Count	4060 Outputs	4051 Line Selected	MM5318 Inputs XYZ	Time Digit Displayed
0	000 0	0	000	Blank
1	000 1	Inhibit	000	Blank
2	001 0	1	000	Blank
3	001 1	Inhibit	000	Blank
4	010 0	2	111	Tens Hours
5	010 1	Inhibit	000	Blank
6	011 0	3	011	Unit Hours
7	011 1	Inhibit	000	Blank
8	100 0	4	000	Blank
9	100 1	Inhibit	000	Blank
10	101 0	5	101	Tens Minutes
11	101 1	Inhibit	000	Blank
12	110 0	6	100	Unit Minutes
13	110 1	Inhibit	000	Blank
14	111 0	7	000	Blank
15	111 1	Inhibit	000	Blank

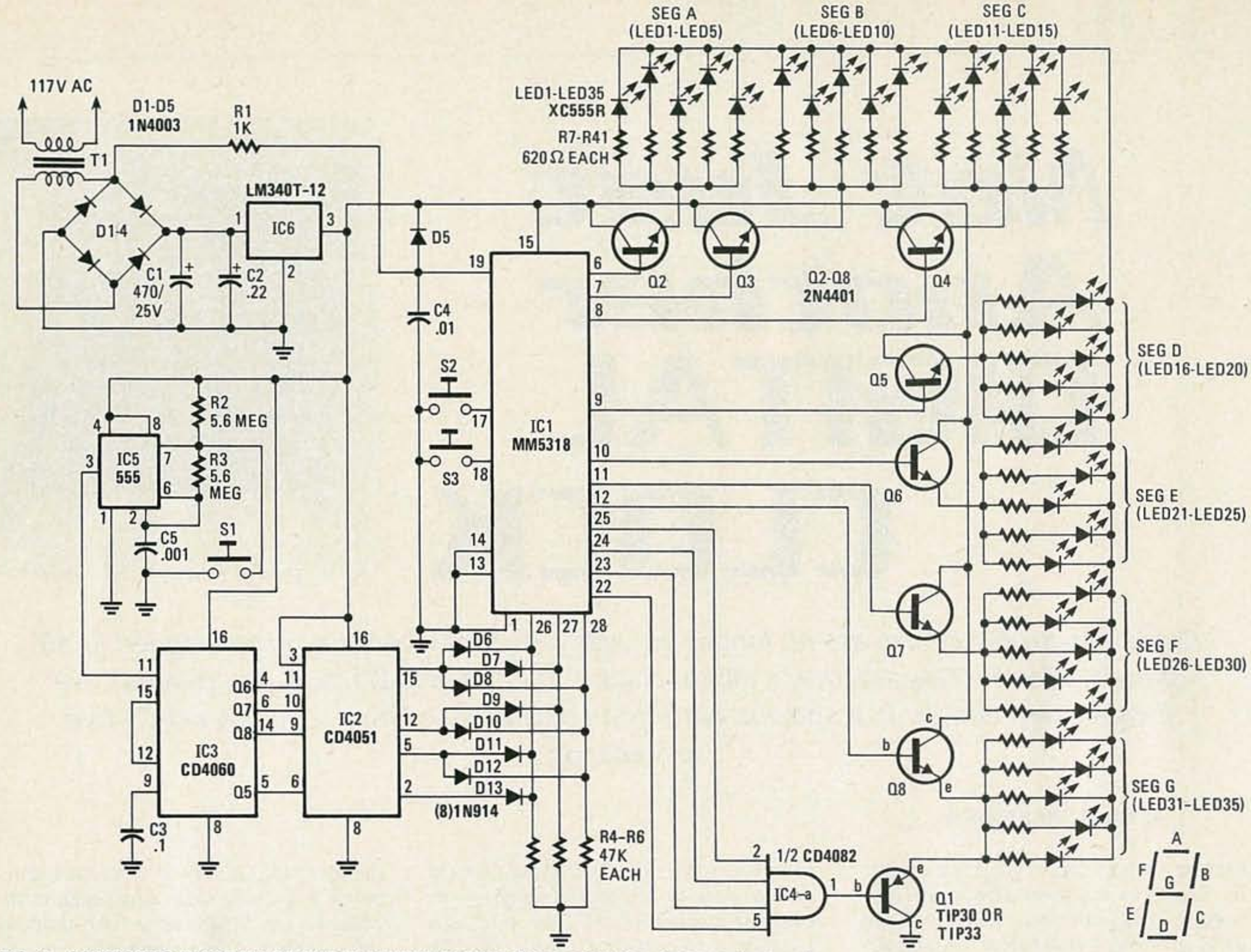


FIG. 1—SCHEMATIC DIAGRAM OF THE FLASHING CLOCK. The readout is a 7-segment numeric display with each segment consisting of five jumbo LED's.

to drive four separate displays, the digit-select lines are combined by the CD4082 AND gate so they all activate the single readout.

Construction

The printed circuit board makes assembly fast and straightforward. The foil pattern is in Fig. 2 and component positions are shown in Fig. 3. Begin by installing and soldering the six jumpers. Diodes and resistors are done next, making sure to observe diode polarities as indicated. A low-profile IC socket should be used for the MM5318 clock IC. Sockets for the other integrated circuits are optional. Note that pin 1 of all IC packages is oriented in the same direction on the board. Bend the leads of the voltage regulator and the TIP30 transistor so that they lie flat against the board when soldered in place.

The seven NPN transistors (Q2-Q8) are in two groups; three on the left and four on the right. Be sure to follow the lead orientation indicated for each group. Capacitors C1 and C2 are polarized and must both be installed in the proper direction for the clock to work correctly. Check the parts layout diagram carefully when installing the 35 LED's. The flat

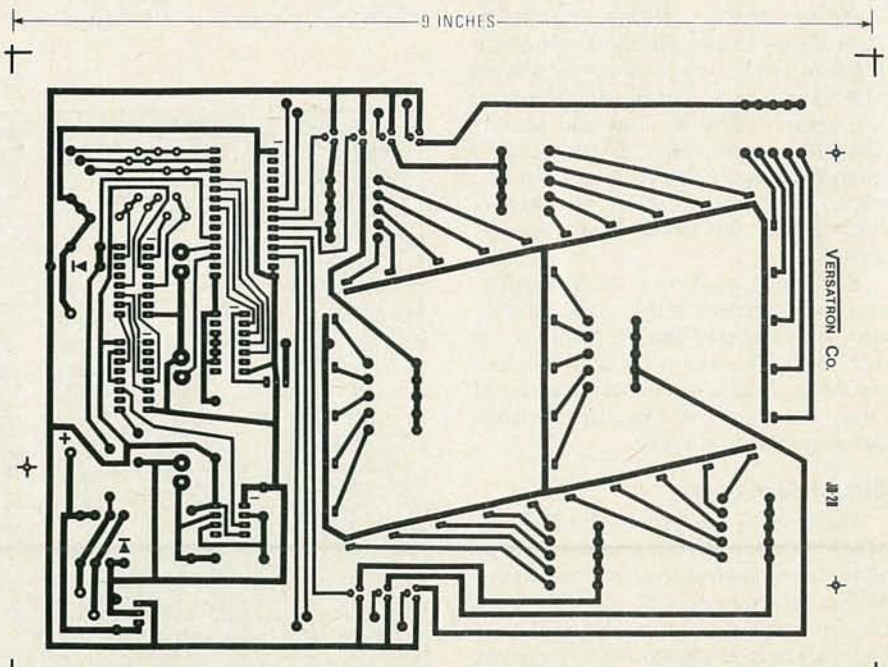


FIG. 2—PRINTED-CIRCUIT FOIL PATTERN is easy to duplicate photographically or by other means. An etched and drilled board is available at a moderate cost.

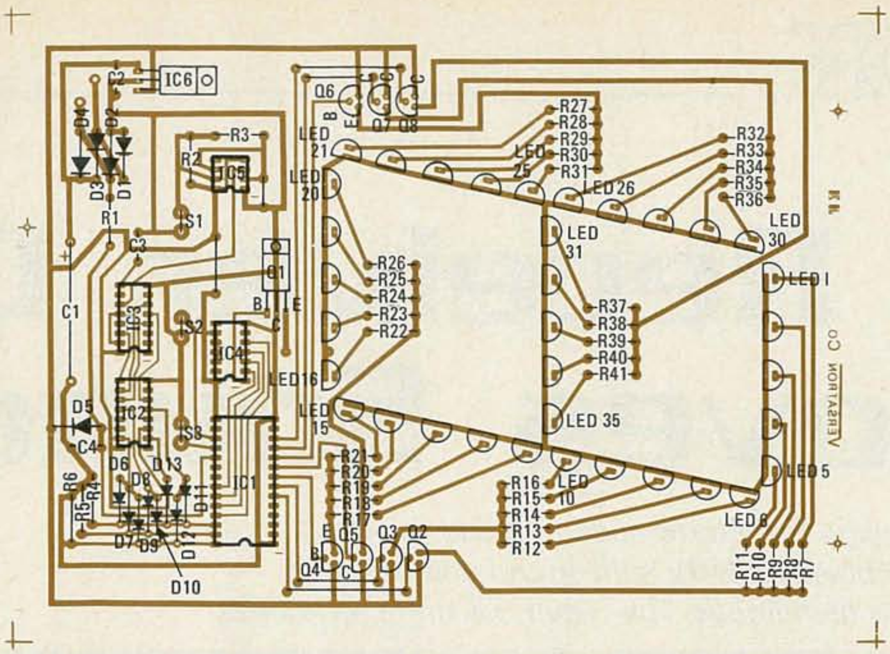


FIG. 3—COMPONENT PLACEMENT LAYOUT. Be careful and check the polarity of each diode and LED before installing it in the board. Use exceptional care when handling the COS/MOS IC's. They are easily damaged by static electricity.

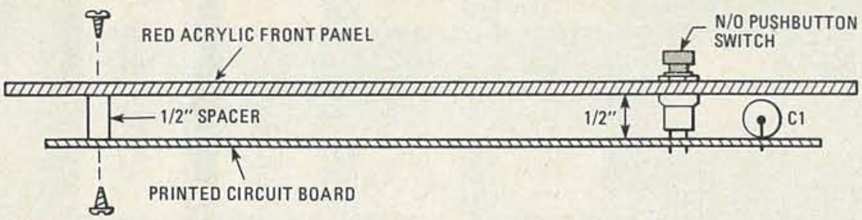


FIG. 4—DRILLING GUIDE for the front panel. The two holes near the top are for mounting screws and spacers. The ones at the bottom are for the three pushbutton switches.

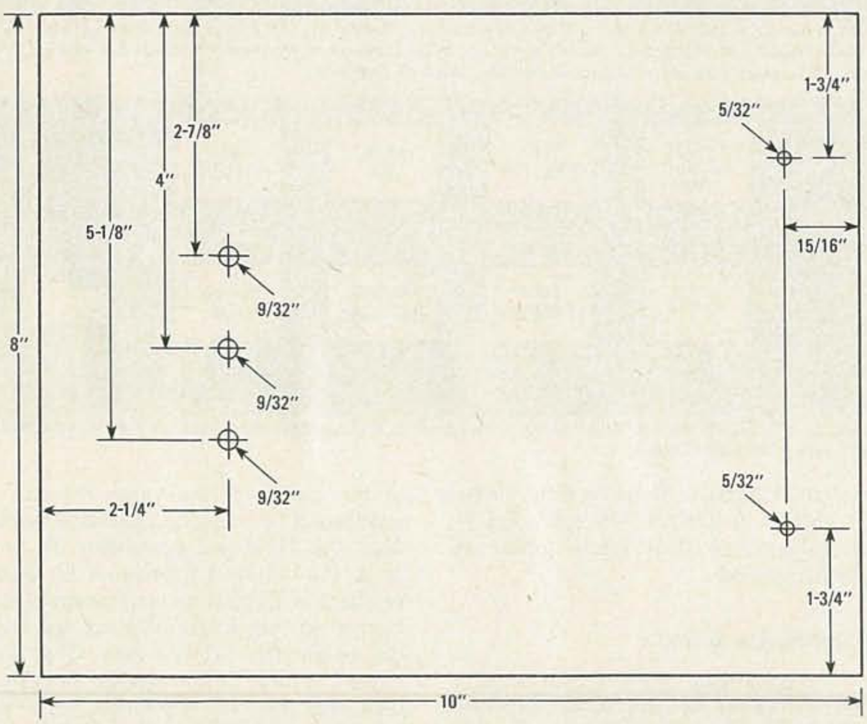


FIG. 5—SIDE VIEW shows how the panel and PC board go together. Adjust the switch heights carefully before soldering the switch to the PC board.

side indicates the proper orientation and corresponds to the flat spot on the base of each LED.

Install two ½-inch plastic standoffs in the holes at the top edge of the circuit board. (The drilling guide is in Fig. 4.) These are used to hold the acrylic front parallel in front of the clock. The three pushbutton switches are installed as shown in Fig. 5. They must be soldered at the proper height so they protrude through the front panel correctly.

Feed the transformer leads through the hole on the lower edge of the circuit board, starting from the foil side. Tie a knot in the leads so they cannot get pulled back through the hole and then install and solder the ends in the proper locations. This keeps the wires from becoming detached if they are accidentally pulled sharply.

PARTS LIST

Resistors ¼ watt, 5% carbon unless otherwise noted

R1—1000 ohms
R2, R3—5.6 megohms
R4–R6—47,000 ohms
R7—R41—620 ohms
C1—470 μF, 25 volts, electrolytic
C2—0.22 μF, 35 volts, dipped tantalum
C3, 0.1 μF, 50 volts, ceramic disc
C4—.01 μF, 50 volts, ceramic disc
C5—.001 μF, 50 volts, ceramic disc
D1-D5—1N4003 rectifier diode
D6-D13—IN914 switching diode
IC1—MM5318 digital clock (National)
IC2—CD4051 8-line analog switch (RCA—analog multiplexer/demultiplexer)
IC3—CD4060 14-stage ripple-carry binary counter (RCA)
IC4—CD4082 dual 4-input AND gate (RCA)
IC5—555 timer
IC6—LM340T-12 positive 12-volt regulator (National)
Q1—TIP30 or TIP32 pnp transistor (Texas Instruments)
Q2-Q8—2N4401 or equal
LED1-LED35—jumbo red LED (XC555R or equal)
S1, S2, S3—push-button switches, normally open, PC mount
T1—plug-type transformer: 12 VAC, 930 mA (Dormeyer model PS-7204)
Miscellaneous: 28-pin low-profile IC socket, two ½-inch long standoffs and screws, 8 in. x 10 in. sheet of ⅛ in. thick red acrylic plastic.

Note: The following kit and parts may be ordered from Versatron Co., PO Box 23573, Pleasant Hill, CA 94523. Phone 415-935-2419:
No. JD-28 PC board, drilled and etched $13.00
8 × 10 inch metal frame $4.95
Complete No. JD-28 clock kit (includes all parts except metal frame) $49.95. California residents add appropriate tax.

Checkout

Before installing the 5318 clock IC and acrylic front panel, recheck all components against the location guide in Fig. 3. Double check polarities and positioning of the integrated circuits and LED's. Turn the board over and carefully check for any solder bridges. If all components appear to be installed properly, insert IC1 and plug in the transformer.

Operation

When the clock is plugged in and set to
continued on page 81

New Receiver Ci
Improves Sound

New design for interference-free television sound combines early-TV split-sound and today's intercarrier sound techniques. The result; no more sync buzz.

ROBERT F. SCOTT
TECHNICAL EDITOR

FROM THE EARLY DAYS OF COMMERCIAL television until around mid-1950, television receivers used "split-sound" or "parallel-sound" signal processing. That is, the sound IF carrier was "split" off from the composite IF video signal at the tuner output (Fig. 1) or at some point in the video IF amplifier chain. The sound and video IF carriers then followed "parallel" paths to the video and sound detectors. The sound IF was usually between 21.25 and 21.6 MHz—we called it megacycles, then—and the video IF carrier was 4.5 MHz away in the 25.75-26.1-MHz range.

Usually, the nearer the sound takeoff point was to the tuner output the more elaborate was the sound IF system. When the sound takeoff was at the output of the first video IF amplifier, it was not uncommon to find two or three sound IF amplifiers and one or more FM limiters ahead of the sound detector. In those days, the ratio detector was just coming to the fore and the "better" sets still used the Foster-Seeley FM discriminator.

The split-sound TV receiving system had a number of drawbacks. One of the most annoying to the viewer was that a slight drift in the local oscillator frequency caused the sound to distort or drop out completely. This was because the sound IF bandwidth was 400 kHz and an oscillator drift of only 200 kHz was enough to throw the carrier out of the passband. The higher the channel, the more noticeable was the problem of drift. The other drawback was cost. Split-carrier sets had several more tubes and associated circuitry than intercarrier sets.

For example, when a typical split-sound TV set was tuned to Channel 13 (video carrier 211.25 MHz; sound carrier 215.75 MHz) the local oscillator was tuned to 236.75 MHz. This developed a video IF at 25.50 MHz and sound IF carrier at 21.00 MHz. If the oscillator drifted to 236.95 or 236.55 MHz (only .084%) sound was lost while picture quality was still acceptable.

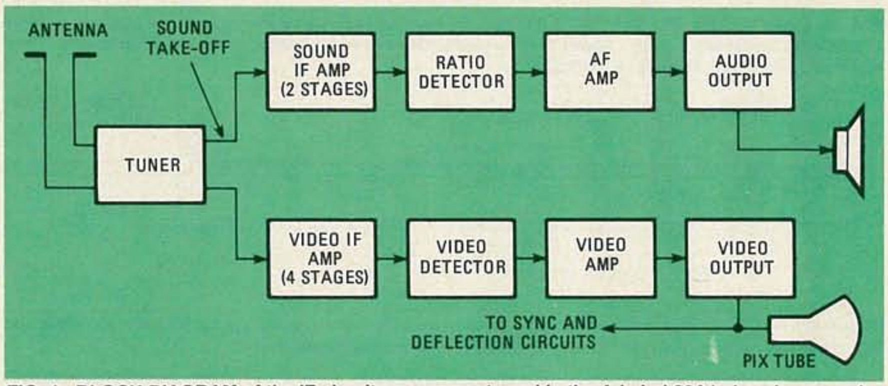


FIG. 1—BLOCK DIAGRAM of the IF circuit arrangement used in the Admiral 30A1 chassis, a popular 1949 model. In it, the sound take-off point was in the tuner. In many other models of this vintage, the sound take-off was at the output of the first video IF amplifier.

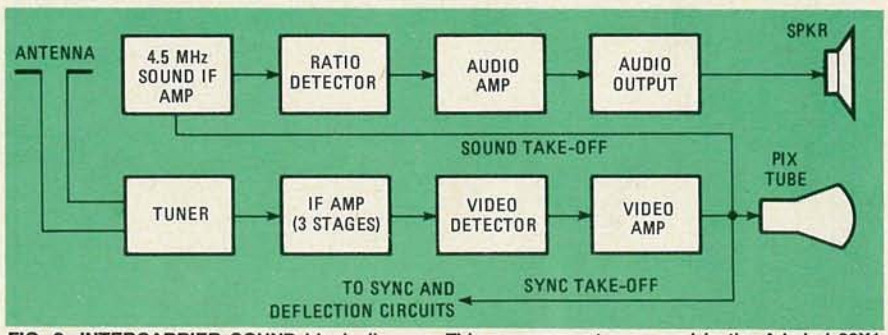


FIG. 2—INTERCARRIER SOUND block diagram. This arrangement was used in the Admiral 20X1 chassis produced in 1950.

Intercarrier sound

The advantage of intercarrier sound is that it does not depend on a precise local oscillator frequency for reception of the sound signal. A block diagram of a typical intercarrier sound set is shown in Fig. 2. The intercarrier sound IF carrier frequency is 4.5 MHz—the precise spacing between the sound and video carrier frequencies on all stations using NTSC TV standards. The 4.5-MHz intercarrier beat developed at the output of the video detector is modulated by the same signal that modulated the TV sound transmitter. To produce the 4.5-MHz intercarrier IF sound carrier, the TV circuits were designed and aligned so the sound carrier was about 20 dB *below* the video carrier. This was done because, in the heterodyning process, the resultant difference frequency has the exact modulation as the *weaker* of the two beating signals.

So, if in an intercarrier TV receiver the oscillator drifts 200 kHz high or low, the video and sound IF carriers will both be shifted. But, the difference between them will still be 4.5 MHz—the frequency of the intercarrier sound carrier signal.

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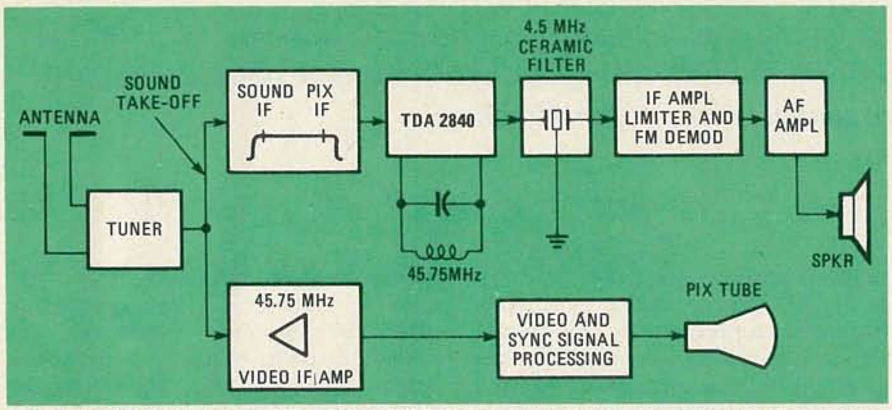


FIG. 3–BASIC QUASI-PARALLEL SOUND SYSTEM is illustrated in this block diagram. The new system has the advantages of split-sound and intercarrier sound systems while eliminating their disadvantages.

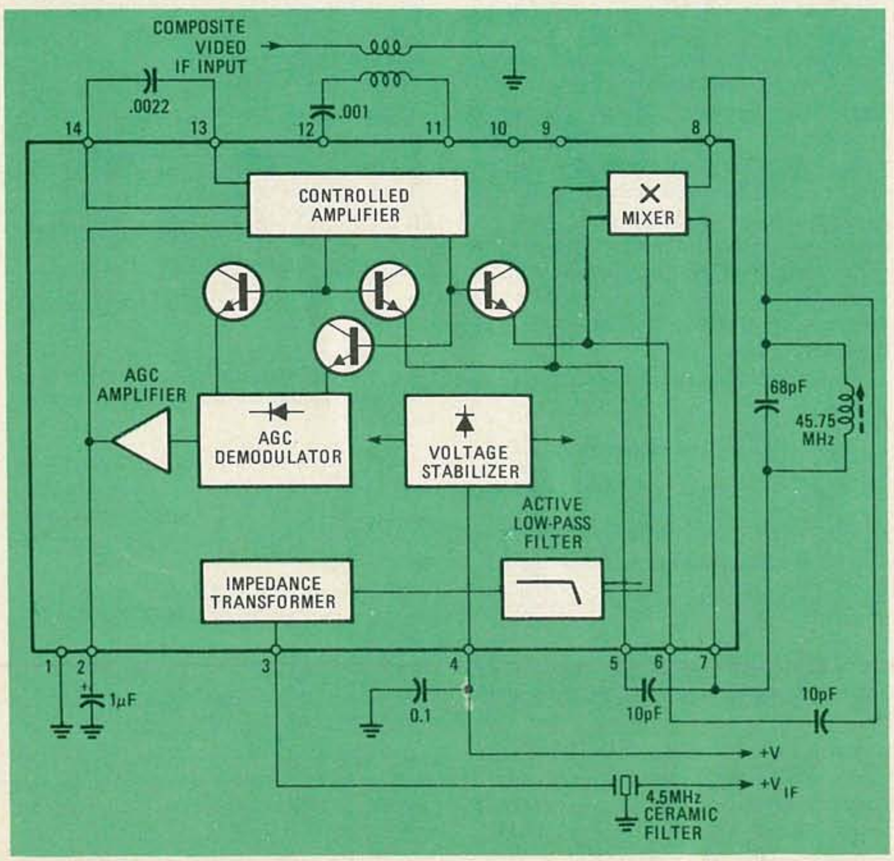


FIG. 4–TEST AND APPLICATION CIRCUIT for the TDA 2840 IC developed for quasi-parallel sound designs used in TV receivers.

An annoying drawback of the intercarrier sound system is *sync buzz* or *intercarrier buzz* that is often heard accompanying a predominantly white picture or white lettering superimposed on a black background. Although the sound is most often identified as a rough 60-Hz buzz, it is actually a combination of 60-Hz buzz and 15,750-Hz hiss developed by the horizontal and vertical sync and blanking pulses. The 15,750-Hz hiss is seldom heard because of the limited response in the audio systems of most TV sets.

Sync buzz is most pronounced when: 1) the TV set's FM detector is unbalanced, 2) one or more IF stages are overloaded, 3) the station's video transmitter is overmodulated and 5) quadrature distortion develops in the video detector.

Quasi-parallel sound system

In a joint effort to produce interference-free TV sound, the West German firms of Grundig and Siemens have developed what they call the Quasi-Parallel sound system. Siemens developed the TDA 2840 for TV sets employing this new technology. Tests have shown that the new system has all the advantages of both parallel-sound and intercarrier-sound systems while their drawbacks have been eliminated.

In the quasi-parallel system, the sound and video carriers are tapped off at the tuner output where their amplitudes are equal. (See block diagram in Fig. 3 and functional diagram of the TDA 2840 in Fig. 4. The carrier and beat frequencies have been changed from the European to NTSC standard.) The extracted sound and video IF carriers are then fed into the TDA 2840 quasi-parallel sound IC. This IC contains a 3-stage controlled IF amplifier with peak-value regulation and a coincidence detector. The picture and sound IF carriers are mixed, as in the intercarrier sound system, and the resulting 4.5-MHz sound IF carrier is obtained; thus eliminating the dependency on a precise local oscillator frequency as required in the parallel-sound system.

The two IF carriers are processed in the TDA 2840 in such a manner that the 42.25-MHz sound IF carrier is "effectively" boosted by 20 dB as compared to the level in a conventional intercarrier sound circuit. Thus, the resulting 4.5-MHz detector output is 20 dB higher than any possible quadrature distortion. Now, the quadrature distortion can no longer appear in the output because it is effectively rejected by the 4.5-MHz limiter.

If we rehash the performance and characteristics of the quasi-parallel sound system, we can readily understand the designers' claims that with the quasi-

continued on page 82

Understanding TURNTABLE SPECIFICATIONS

Part 2—A record player is far from the simple mechanical device it appears to be. If it is not properly designed, you won't get the best from your hi-fi system. A good turntable is essential to top performance.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

LAST MONTH I DISCUSSED SOME OF THE design considerations involved in insuring optimum performance of the pickup arm/cartridge combination. That discussion was based upon information supplied by Thorens, the Swiss turntable manufacturer. Now, I would like to examine some of the design elements involved in the turntable drive and suspension systems of a record player, again based upon information that I obtained during my recent visit to the Thorens engineering and production facilities.

In evaluating turntable performance, most audiophiles look to three published specifications: rumble, wow-and-flutter, and speed accuracy. Indeed, under ideal laboratory conditions, these are the only three specifications that would ordinarily have to be considered. But most of us do not play records under ideal laboratory conditions and, what's worse, the records we play are anything but perfect, especially in recent years. Certainly, susceptibility to acoustic feedback is a fourth quality of any turntable system that the prospective purchaser should consider. We will examine the importance of a turntable's suspension system presently, but for the moment, let's discuss turntable rumble.

It is not uncommon to run across two turntables, one that boasts of a rumble figure in excess of 70 dB, while another claims a much more modest 50 dB or even less. Listening to records on both turntables may show that the turntable having the lesser rumble figure may actually produce less noise than the one having the higher figure.

The National Association of Broadcasters (NAB) formulated a method of rumble measurement in 1964. In the NAB measurement system, only those frequencies between 10 Hz and 250 Hz are included at their full amplitude when making the measurement. Below 10 Hz, a filter rolls off response of the measurement system at a rate of 6 dB-per-octave, while the 3-dB-cutoff at the high end of the range is at 500 Hz with a slope of 12 dB-per-octave above the range. The weighting curve, as it is called, is shown in Fig. 1. An associated test record, having a reference level of 1.4 cm-per-sec peak recorded velocity in lateral modulation at 100 Hz also contains a "silent groove" following the reference signal. The rumble, or signal-to-noise ratio, is expressed as the difference between the reading obtained on a standard VU meter when the modulated groove is playing and the reading observed during playing of the silent groove.

Two additional rumble measurement

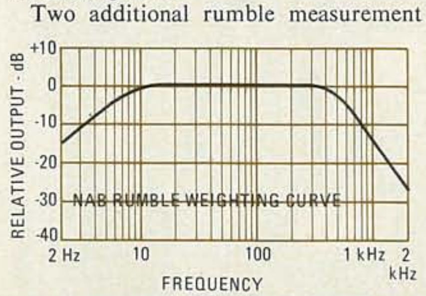


FIG. 1—THE NAB WEIGHTING CURVE used with a test record to measure turntable rumble.

standards were developed by DIN (the German Standards organization). Their standard, DIN 45-539 uses two different weighting networks, as illustrated in Fig. 2. Curve "A", (the unweighted DIN rumble weighting curve) is practically equivalent to the NAB curve. Curve "B" however, used for making a weighted, or DIN "B" measurement, attempts to deliver test results or numbers that correspond as nearly as possible to the subjective impression of rumble. Because human hearing is less sensitive to low frequencies than to mid-frequencies, the filter attenuates the low frequencies at a rate of 12 dB-per-octave on each side of a center frequency, 315 Hz.

The DIN test record, 45-544 used in

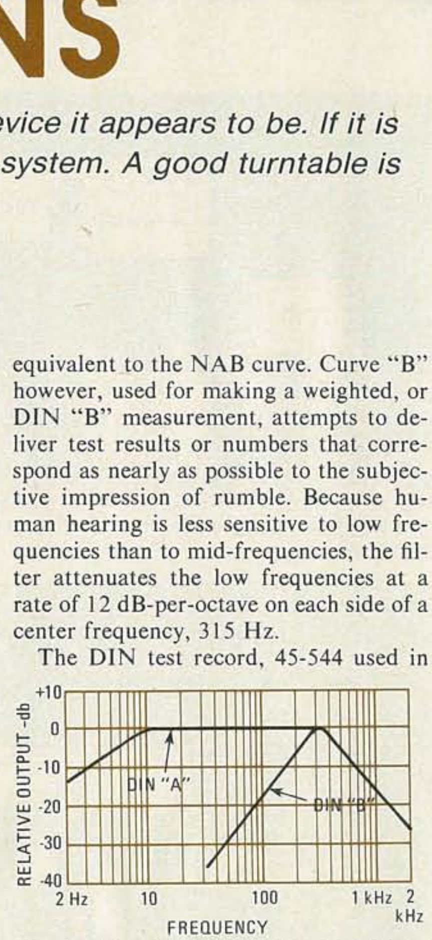


FIG. 2—TWO RUMBLE WEIGHTING CURVES developed by DIN, the German standards organization.

making DIN rumble measurements contains a 315-Hz reference signal recorded at a velocity of 5.42 cm-per-sec (single channel) in addition to the required "silent groove."

In 1966, CBS Laboratories (now known as CBS Technology Center) developed a new weighting curve for measurement of rumble. High-frequency rolloff used in this weighting curve is almost identical to that used in the DIN standard; but at low frequencies, a dropoff of only 6 dB-per-octave is used. The test record developed for this measurement system, known as RRLL (*R*elative *R*umble *L*oudness *L*evel) has a 100-Hz reference tone recorded at 5 cm-per-sec later-

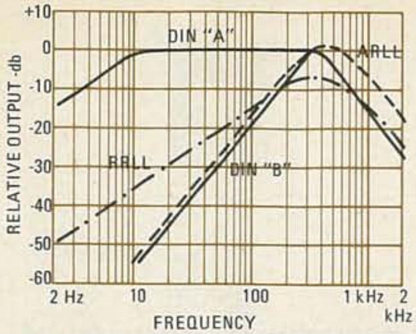


FIG. 3—FOUR POPULAR RUMBLE WEIGHTING CURVES. Text explains their uses and why they differ.

ally and readings are made on an RMS responding meter. This new reference frequency at reference level results in a fundmental difference of readings (compared with the 315-Hz reference level used in DIN) of 7 dB, even before you take into account the difference in the weighting curves.

Finally, there is the ARLL (A*udible* Relative Loudness Level) used by some laboratories and publications. This one starts out using the basic NAB procedure, but adds a filter that corresponds to the standard "A" weighting network used in sound-level meters and in making IHF signal-to-noise measurements for amplifiers, tuners, etc. The four most popular weighting curves have been superimposed in Fig. 3 to give readers some idea how widely rumble measurement may vary, from system to system, both because of differences in reference levels against which the residual noise is measured and because of the differences in the weighing curves themselves. Clearly, there is no way to meaningfully compare an NAB rumble figure with a DIN "B" specifica-

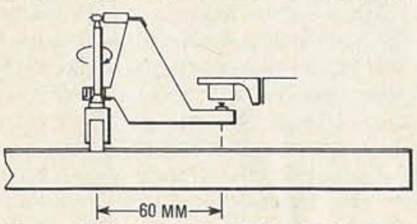


FIG. 4—NEW RUMBLE TEST ADAPTOR, by Thorens, consists of a spindle and a swiveled platform to support the pickup cartridge of the turntable system under test.

tion, or a DIN "A" result against an RRLL result. The important point here is that when you compare rumble figures of competing products you make sure that both figures were arrived at using the same test procedure. The IHF (*I*nstitute of *H*igh *F*idelity) is now trying to arrive at a standard to be used by the high-fidelity industry, but until that standard is adopted and used, it's up to the consumer to beware of specsmanship. Needless to say, most turntable manufacturers in recent years tend to favor the DIN "B" method simply because it yields higher dB numbers. Unfortunately, infrasonic rumble components, though inaudible as such (and therefore not included in the DIN "B" method) can have a serious effect on sound reproduction. This is especially true with the new DC amplifiers that amplify signals down to "0 Hz". Severe rumble components in the 6-Hz to 12-Hz region, as we pointed out last month, can aggravate pickup-arm resonance problems. Also, large woofer cone excrusions at subsonic frequencies, though in themselves inaudible, can push the speaker cone out of its linear operating region, thereby introducing IM distortion at audible frequencies.

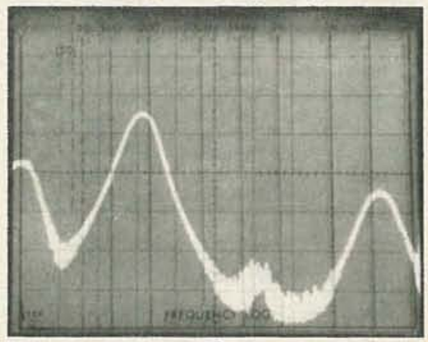
New Rumble Measurement Instrument

Rumble measurements are further complicated by the fact that rumble is also contained in the test records themselves, besides being generated by turntable drive mechanisms. Engineers at Thorens discovered that the average rumble of many of the rumble test records popularly used was approximately the same as that of many high quality turntable systems. The record may therefore contribute as much to the rumble measurement as the turntable itself. For this reason, Thorens developed a new device (Fig. 4) to replace the test record for rumble measurements. Figure 5 shows the Thorens Rumble Test Adaptor being used to check a Thorens TD-126 Mk III turnta-

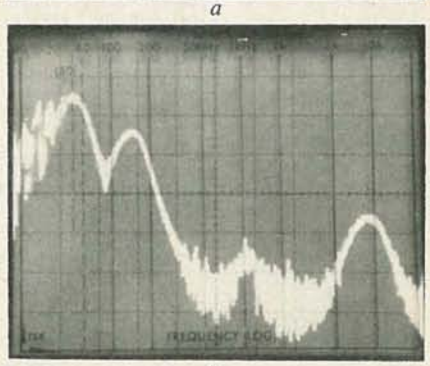
FIG. 5—ILLUSTRATION shows the Thorens rumble test adaptor in actual use. A special test record is used.

ble. The device consists essentially of two elements: a spindle and a swiveled frame, upon which the stylus of the pickup cartridge is placed. The spindle, which is rigidly connected to the turntable shaft, is carefully polished and plated, first with copper and then with nickel. The bearing contact is equipped with high-polymer parts. The two elements of the Rumble Test Adaptor are rigidly connected, allowing any vibration or noise to be transmitted to the pickup cartridge for subsequent measurement. The test record seen in Fig. 5 is now used only to establish a reference level against which to measure the rumble value. The construction of the bearing of this device enables vibrations in both vertical and lateral directions of each stereo channel to be detected.

Whether rumble is measured this way or with a test record, a great deal of information can be gained with the aid of a spectrum analyzer, since it is important to know the content (frequencies) of the rumble as well is its overall single-number value. Using the Rumble Test Adaptor just described, we tried to analyze the rumble content of a typical high-quality turntable that uses a synchronous 1800-RPM motor and belt drive. Even using a low-noise, hum-free (we thought) setup in the tests we were plagued by hum and some noise pickup which threatened to mask the results. To differentiate between electrically generated hum and noise and low-frequency rumble content, we therefore made two plots on the analyzer. The first, shown in Fig. 6-a is a linear sweep from 0 Hz to 200 Hz (20 Hz per linear horizontal division on the scope face) taken with the arm at rest, but with the turntable rotating (motor on). The peak at the extreme left of the display is the "zero beat" of the analyzer and may be ignored. Approximately three divisions to the right is the expected peak at 60 Hz (line frequency) and to the right we see a second major peak at 180 Hz (third harmonic of the line frequency). A much



a



b

FIG. 6—SPECTRUM ANALYZER RECORDS. The trace at *a* was made with pickup arm at rest while turntable was rotating. Trace at *b* was made with pickup resting on platform of the test adaptor.

lower amplitude peak is also detectable at 120 Hz (second harmonic of 60 Hz).

Compare these results with those obtained when the stylus was positioned on the frame of the Thorens Rumble Test Adaptor while the turntable revolved, as shown in Fig. 6-b. The first thing we notice is a brand new peak at 30 Hz which is actually taller than the "hum" peak at 60. If you divide the rotation of the motor (1800 RPM) by 60 seconds, sure enough you come up with 30 Hz. In other words, a severe rumble component is being contributed by the motor on a once-per-revolution basis. Even more interesting are additional spikes observed at the extreme left of the display, in the region below 20

TABLE 1

Turntable	Test Record	Rumble Adaptor
Average direct-drive model	−46 dB	−60 dB
High-quality direct drive with quartz speed control	−48 dB	−51 dB
Thorens TD 126 Mk III	−50 dB	−72 dB

Hz. These spikes, too, are greater in amplitude than the electrically generated hum noise observed earlier and one or more of them may well lie in the exact frequency region of pickup-arm/cartridge resonance. Clearly, a single meter measurement of rumble, by whatever standard, could not disclose this much information about the nature of the noise itself.

Thorens maintains that their new Rumble Test Adaptor can provide help in explaining the audible differences between various turntables which, using test records to establish rumble figures, come up with rumble figures which at first glance are not significantly different. As proof of this, they offer a summary of measurements made the "old" (test record) way and using their Rumble Test Adaptor. The summary is shown in Table 1 and note that, in all cases, the more severe DIN "A" (unweighted) measurements were used.

Improving Turntable Suspensions

The fourth factor which determines the quality and performance of a turntable system is its suspension system. Unfortunately, few manufacturers of turntables are able to say much about their efforts in this direction, largely because the quality of a suspension system does not lend itself to a measurement. Acoustic feedback, whether it be a continuously howling sound when volume is turned up too loud, or partial feedback which falls short of that extreme but nevertheless causes coloration of reproduced sound, is a problem known to all-too-many audio buffs. Acoustic feedback may be airborne (sound waves from the speaker vibrate against the turntable's structure and are picked up by the stylus riding in a record groove) or it may result from vibration carried through the floor, the surface upon which the turntable is mounted, etc.

The classical floating suspension system, shown in Fig. 7, does offer a number of advantages such as high insensitivity to solid-borne vibrations above 20 Hz and great immunity to mechanical and acoustic feedback. However, there are also disadvantages. It is sensitive to ultra-low frequncy disturbances, such as those transmitted to the turntable from the movement of people on a wood floor or from external jolts. Studies have shown that when this conventional suspension system is used, choosing a low resonant frequency for the system is not sufficient for achieving optimum behavior. Difficulties arise when so-called "mode conversion" effects take place. For example, a simple horizontal excitation may produce an intricate combination of translational and rotational displacements. Figure 8 illustrates such an effect in a conventional suspension system.

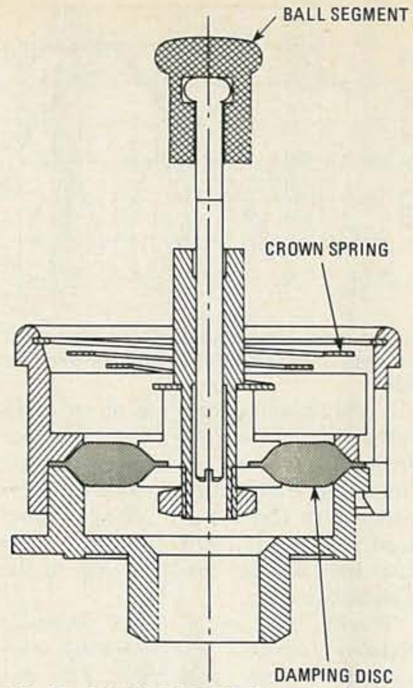


FIG. 10—CROSS-SECTION view of the ball-segment mounting arrangement used by Thorens.

According to Thorens, their newly developed *Ortho-Inertial* suspension system eliminates many of these problems. The suspension system is illustrated in simplified form in Fig. 9. The chassis of the turntable is supported by ball-segment bearings and by separate spring elements for horizontal and vertical displacments. The bearing faces on the chassis are in the same plane as the center of gravity and each ball segment bearing is supported at its midpoint by a spring possessing freedom only in the vertical direction. A detailed cross-sectional view is shown in Fig. 10.

If this system is set into motion by a horizontal excitation, the chassis rolls over the ball segments. Since the center of gravity and the bearing faces lie in the same plane, no rotational motion occurs. Furthermore, since the height of the chassis does not change when it rolls over the ball segments, the vertical springs retain their fixed length and vertical displacment does not take place. The ball-segment bearings are fabricated of rubber and afford isolation and damping of disturbance frequencies within the audio range. This reduces the turntable's sensitivity to acoustic feedback as well.

It has been repeated in print many times that all a turntable has to do is rotate at a constant speed and so so quietly. As you can see from this and last month's discussion of pickup arm design, that is more easily said than done. **R-E**

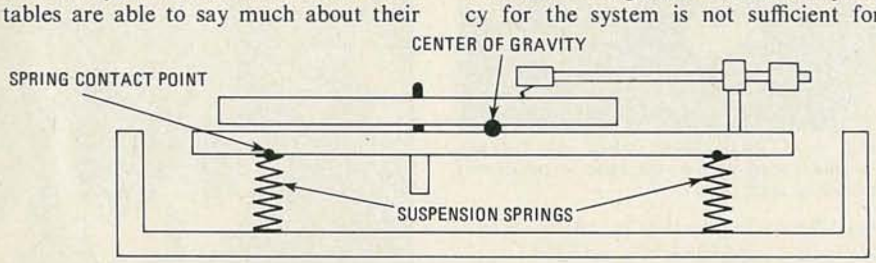


FIG. 7—TYPICAL TURNTABLE SUSPENSION SYSTEM as it appears when at rest.

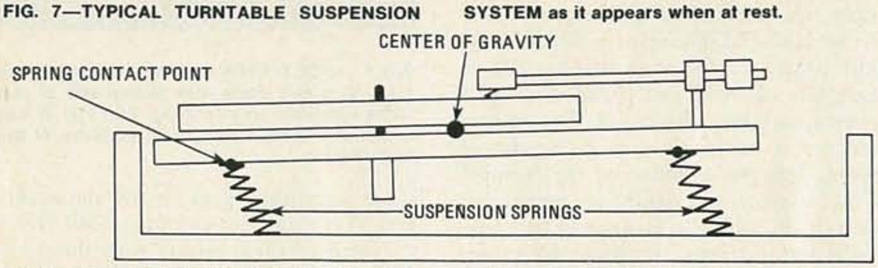


FIG. 8—HORIZONTAL DEFLECTION of the typical turntable mounting board causes complex rotational and vertical movements.

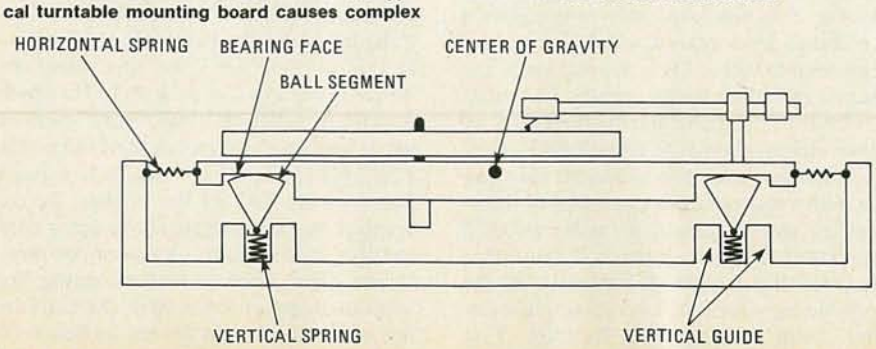
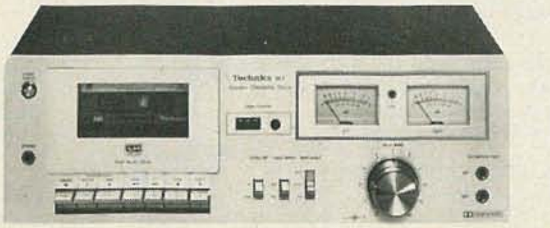


FIG. 9—BASIC DRAWING of the Thorens *Ortho-Inertial* turntable suspension system.

R.E.A.L. SOUND

Technics Model RS-M7 Cassette Deck



1

CIRCLE 107 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WHEN MONEY IS NO OBJECT IT IS FAIRLY EASY to find a stereo cassette deck that can deliver recorded results that are almost indistinguishable from the original program source. But what happens if you are on a limited budget and want to purchase a low-cost cassette deck that provides good basic performance for under \$200? Technics (Panasonic Company, 1 Panasonic Way, Secaucus, NJ 07094) appears to have provided the answer with the low-cost *model RS-M7* stereo cassette deck.

This front-loading unit, shown in Fig. 1, is one of the lowest-priced decks we have tested that include Dolby circuitry. The gold-colored aluminum front panel contains a POWER on/off pushbutton switch and a stereo headphone jack on the left. A swing-down cassette compartment door permits the easy insertion and orientation of tape cassettes. Just below the cassette door are seven mechanically operated piano-key-type transport controls, including pause, record, play, rewind, fast forward, stop and eject. The PLAY and STOP pushbuttons are somewhat larger than the other controls, for quick visual identification, and in order to activate the record mode, both the RECORD and PLAY pushbuttons must be depressed simultaneously.

A three-digit tape counter is located at center-panel together with a reset pushbutton, and just below the counter are three toggle switches. The first switch turns the Dolby circuitry on or off. The middle switch selects line or microphone inputs, while the third switch with three positions selects proper equalization and bias levels for normal (ferric-oxide), ferri-chrome and chromium-dioxide or high-bias ferric-cobalt tapes.

Record-level controls for each channel are concentrically mounted below a pair of record-level meters that are calibrated from −20 dB to +5 dB. Dolby level is indicated as +3 dB on the scales, and since this level is standardized at 200 nWb-per-meter, this places Technics' arbitrary "0-dB record level" at approximately 142 nWb-per-meter.

Between the record-level meters is an LED indicator light that glows red when the tape deck is in the record mode, while at the lower right of the panel are a pair of microphone input jacks. The rear panel contains a pair of line input and line output jacks.

The *model RS-M7* uses 12 transistors in addition to the four IC's. A single tape head is used for record and playback, and a double-gap ferrite head is provided for tape erasure.

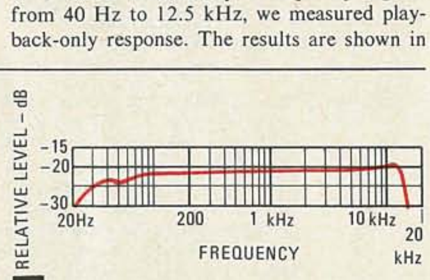
Lab measurements

For our laboratory measurements, we used Maxell UD-XLI tape as our ferric-oxide tape sample, Sony Duad tape for FeCr tape and TDK-type SA tape for measurements using the CrO_2 tape setting. Results of these lab measurements are shown in Table 1.

Frequency response when Maxell tape was used is shown in Fig. 2 for a record-playback level of −20 dB relative to the arbitrary 0-dB point on the level meters. While the manufacturer deserves a mild rebuke for not publishing tolerance figures (±dB's) in their frequency-response specifications, we found that the frequency response between the −3-dB rolloff points, was nearly as good as the Technics claims that omit tolerance values.

Both the ferri-chrome tape sample and the cobalt-ferric high-bias tape sample performed a bit better in record/play response, with the 3-dB rolloff point occurring at 14 kHz for each tape sample, as shown in Figs. 3 and 4.

Using our standard test tape TDK No. AC-337, which contains spot frequency signals from 40 Hz to 12.5 kHz, we measured playback-only response. The results are shown in Fig. 5 and were flat within ±1 dB over the 40-Hz to 12.5-kHz range.



2

RADIO-ELECTRONICS AUDIO LAB

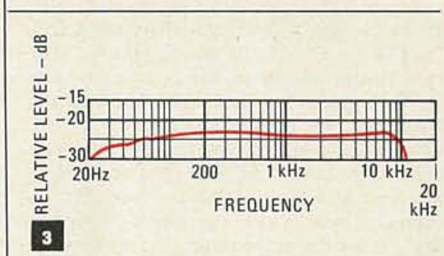
R.E.A.L. SOUND

RATES

TECHNICS RS-M7
CASSETTE DECK

VERY GOOD

While the maximum recording level for 3% total harmonic distortion seems to be incredibly high (+11 dB for standard tape, +8 dB for cobalt-ferric tape), you must remember that these levels are referenced to 0 dB on the tape deck's own meters and the recording level that Technics chose for the 0-dB mark is lower than on many other tape decks. Even if you subtract 3 dB from the measurements and assume a standard 0-dB level of 200 nWb-per-meter, the tape deck's headroom is very good, at least when used with these high-quality tapes.



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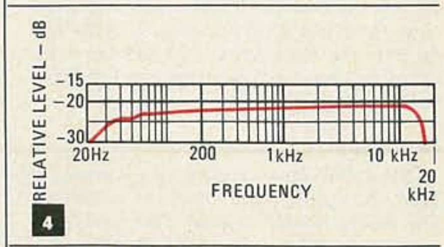

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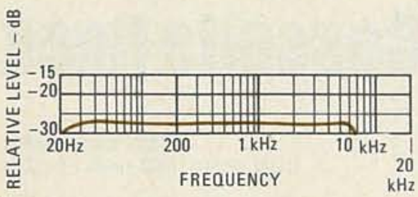
MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: standard tape, 30 Hz to 14 kHz; CrO_2/FeCr tape, 30 Hz to 15 kHz. **Wow and flutter:** 0.08% WRMS. **Signal-to-Noise Ratio:** with CrO_2 tape or equal, 56 dB (below maximum record level) without Dolby; 66 dB (above 5 kHz) with Dolby. **Fast Forward or Rewind Time (C-60 Cassette):** 86 seconds. **Bias Frequency:** 80 kHz. **Input Sensitivity:** line, 60 mV; microphone, 0.25 mV. **Microphone Impedence:** 400 to 10,000 ohms. **Output Level:** 0.42 volt. **Headphone Output Level:** 65 mV (8-ohm impedance). **Power Requirements:** 120 volts, 50 to 60 Hz, 19 watts. **Dimensions:** 16⅛ W × 5⅝ H × 9⅞ inches D. **Weight:** 10 lbs. **Suggested Retail Price:** \$175.

We subjected the *RS-M7* to a two-tone IM distortion test, using a pair of 9-kHz and 10-kHz tones at a 0-dB peak recording level. For comparison Fig. 6 shows the components of the signal source. The spectrum analyzer was swept linearly rather than logarithmically, and the sweep is 2 kHz-per-horizontal division. The 9-kHz and 10-kHz tones are centered in the display. Disregard the small peaks on the right.



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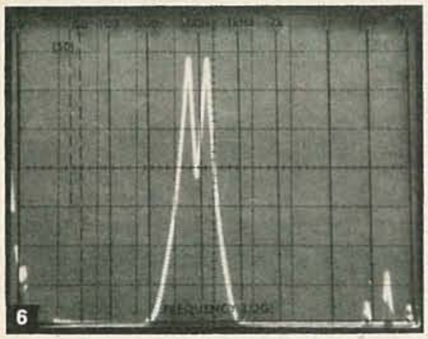

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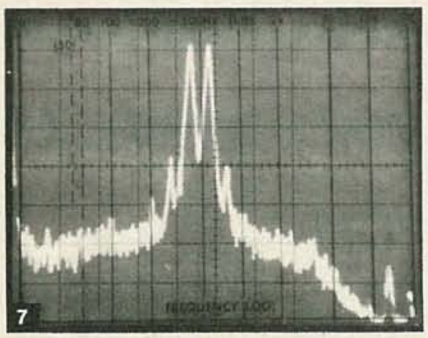

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Figure 7 shows the playback signals recorded on the tape sample at 0-dB record levels. Note that in addition to the noise floor, two or more distinct IM signals are now visible—one at 8 kHz, the other at 11 kHz. These signals are respectively 31 dB and 33 dB below the test tones. To calculate the two-tone IM distortion under these conditions, 3 dB must be added to the level of either test tone to establish an equivalent peak level of the reference signal so that the two distortion values are, in effect, 34 dB and 36 dB below the reference level. Summing these two distortion values results in a net distortion level that is 32.24 dB below the reference level, corresponding to an IM distortion level of 2.44%.

Summary

Our overall product evaluation is shown in Table 2, together with summary comments. The *model RS-M7* cassette deck performed extremely well for its low price. Our R.E.A.L. sound rating of very good must be considered in the light of that price, and it reflects the fact that as recently as two years ago cassette decks at this quality level might easily have cost between $250 and $300. **R-E**

TABLE 1

Manufacturer: **Technics by Panasonic** — Model: **RS-M7**

RADIO-ELECTRONICS PRODUCT TEST REPORT

CASSETTE TAPE DECK MEASUREMENTS

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS		
Frequency response, standard tape (Hz-kHz ±dB)	30-13, 3	Good
Frequency response, CrO_2 tape (Hz-kHz ±dB)	40-14, 3	Very good
Frequency response, other (see text) (Hz-kHz ±dB)	35-14, 3	Good
	See Figs. 2, 3, 4	
DISTORTION MEASUREMENTS (RECORD/PLAY)	Std/High Bias	
Harmonic distortion at −3 VU (1 kHz) (%)	1.0/1.0	Excellent
Harmonic distortion at 0 VU (1 kHz) (%)	1.0/1.0	Excellent
Harmonic distortion at +3 VU (1 kHz) (%)	1.0/1.1	Excellent
Level for 3% THD (dB)	+11/+8	Excellent
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Standard tape, "Dolby" off (dB)	59	Very good
Standard tape, "Dolby" on (dB)	68	Very good
Hi-bias tape, Dolby off (dB)	61	Very good
Hi-bias tape, Dolby on (dB)	69	Very good
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow and flutter (%, WRMS)	0.04	Excellent
Fast wind and rewind time, C-60 tape (seconds)	90	Fair
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)	0.25	
Line input sensitivity (mV)	50	
Line output level (mV)	350	
Phone output level (mV)	54 (8 ohms)	
Bias frequency (kHz)	80	
TRANSPORT MECHANISM EVALUATION		
Action of transport controls		Good
Absence of mechanical noise		Very good
Tape head accessibility		Very good
Construction and internal layout		Good
Evaluation of extra features, if any		Good
CONTROL EVALUATION		
Level indicator(s)		Good
Level control action		Good
Adequacy of controls		Good
Evaluation of extra controls		Good
OVERALL TAPE DECK PERFORMANCE RATING		Very good

TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Technics by Panasonic** — Model: **RS-M7**

OVERALL PRODUCT ANALYSIS

Retail price	**$175**
Price category	**Low**
Price/performance ratio	**Excellent**
Styling and appearance	**Very good**
Sound quality	**Very good**
Mechanical performance	**Good**

Comments: In evaluating a stereo cassette deck such as the Technics *model RS-M7* one must, above all, keep in mind its low price. Just a year or two ago, a cassette deck with a suggested retail price of $175 equipped with Dolby noise reduction and the more-than-adequate level of performance obtained from this unit would have been considered a near miracle. Of course, this unit lacks some of the sophisticated features found on costlier decks, but the features it does have make you quickly realize that all the basics are there. For a mechanically operated transport system, the mechanism operates smoothly and quietly. It has the important auto-stop feature when end of tape is reached, so that idler wheel-to-capstan pressure is released when you are not there to turn off the machine. While there are no user-accessible adjustments for Dolby calibration, our test unit has been almost perfectly factory-adjusted for proper Dolby noise-reduction tracking, and the noise-reduction capability of the built-in Dolby circuitry was fully as great as it is on much more expensive tape decks.

Recordists who consider overall frequency response to be the major specification may find this unit's response a bit disappointing; but those who are more knowledgeable will realize that in this budget design, Technics has managed an intelligent trade-off and balance between frequency response, distortion and signal-to-noise ratios that results in as good sounding a tape deck as could possibly be achieved at this price level. Then, too, when you consider that not many years ago a wow-and-flutter figure of 0.1% WRMS was considered to be quite good even in expensive tape decks, Technics' achievement of 0.04% in this deck is all the more remarkable.

In sum, the *model RS-M7* stereo cassette deck offers very good basic tape recording facilities, and with the money you would save by purchasing it, you can afford to use the best cassette tapes available.

service clinic

Here's an automatic brightness limiter circuit problem with a strange twist.

JACK DARR, SERVICE EDITOR

THE IDEA FOR THIS MONTH'S CLINIC CAME from a Magnavox T995-01 chassis that involved a good but incomplete diagnosis, and a lot of work; and the story has a pure Alfred Hitchcock ending.

After replacing a bad high-voltage tripler, everything was fine. The high-voltage was normal, etc. Only one problem: no raster. Off we went. After some tests, we wound up in the *Low Level Video* module (LLV), which contains the video amplifiers and the automatic brightness limiter stage. Figure 1 shows a simplified schematic of this module.

Note that the automatic brightness limiter transistor is shown with +1.4 volts on the collector. It measured about +10 volts. This transistor controls the maximum brightness automatically by sensing the beam current. As the beam current increases, the automatic brightness limiter transistor (Q6) goes farther into conduction. Transistor Q6 affects the bias on the video amplifier transistor, Q4. From the voltages, it was apparent that the video amplifier and video driver were cut off. The collector voltage on Q5 was zero. (Here's an oddity: on the RGB module we did read some video signal. Only about 25 volts P-P, instead of the normal 100 volts plus. Evidently, this was simply leaking through the cutoff transistor, by capacitance.)

Transistor Q6 seemed to be leaky. By replacing this, we got a raster and a good picture. (Now comes the kicker!) However, while the brightness control did work, putting the raster out at one end, at the other end the raster was far too bright. The video was burned out. The video amplifier and video driver has apparently been cut off, but now we had no automatic brightness limiter action at all. Rechecking, we found that someone had forgotten to solder the collector of the transistor Q6; it was open. Fixing this, we found that we were back right where we started! The collector of Q6 measured +10 volts and the video was cut off. Back to the drawing board.

The automatic brightness limiter circuit isn't complex, but it is interesting. In normal operation, transistor Q6 is cut off. At a "typical" beam current, it does nothing. Its base is clamped at +23.5 volts by a 1K resistor to the emitter and the +24 volt line. A connection from the base goes outside the module to dropping resistor R18. See Fig. 1. This is in the return circuit for the high voltage winding of the flyback transformer so that the beam current flows through it, to ground. This voltage is mixed with the fixed bias. (According to Ohm's Law, at the maximum beam current of 1500 microamps, this should develop about −49.5 volts. A median beam current of say 750 μA should develop about +25 volts.)

At maximum drop, this voltage bucks the +23.5 volts, and if it goes far enough negative, it develops a net negative bias on the base of Q6. Since this is a PNP transistor, it turns on, and it in turn cuts off the video amplifier. As we laid out this circuit in a simplified form, we found an oddity. Resistor R18, the dropping resistor, is actually in two different circuits at the same time. One is in the +23-volt clamp circuit and the other is in the high voltage beam current return. So, it's a kind of "one-resistor matrix" that develops not one but two voltage drops at the same time. Rather, this is the sum of the two. If it's to work, this must be just enough to cut off the transistor Q6 with average beam current.

So here we were; obviously it was not doing it. We had a good transistor in the brightness limiter stage, and all other resistors checked out. What was left? Might be a change in value of R18 under load. Capacitor C10 was checked and found good. In desperation, we removed R18 and tacked in a 50K pot. By varying this, we did find a setting where things worked. This value turned out to be almost exactly 35.0 K. Checking the resistor stock dug up one with exactly this value. It worked. However, something kept tapping me on the shoulder! I had a queasy feeling that we had not fixed it, but simply "jury-rigged it." I was right.

Checking back to the Magnavox Service News, I read the circuit description. Going farther, I read the whole thing. On the next page, there was a note on brightness problems *due to ABL overconduction!* Woops! Just what we had. The note said: "be sure to check R5, 820K, 4.9W, which is in the ground-return circuit of the high voltage tripler". This is on the High Voltage/Scan Sweep module, on the far side of the mother board. Checking R5, it seemed to be OK. So, we

continued on page 78

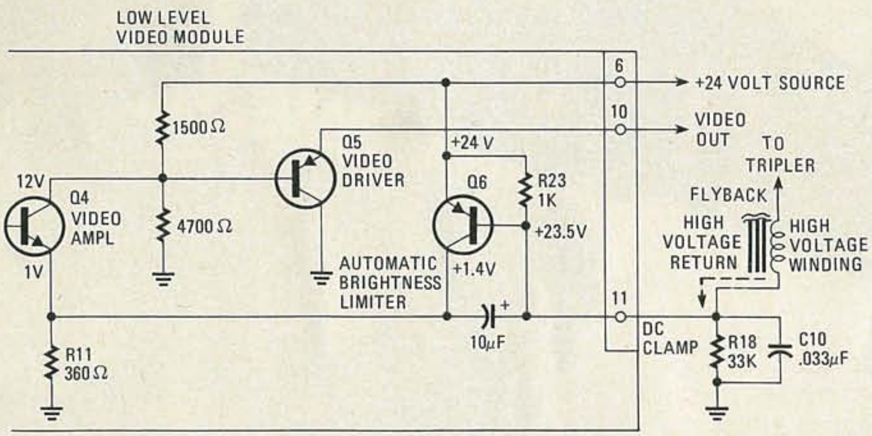

FIG. 1

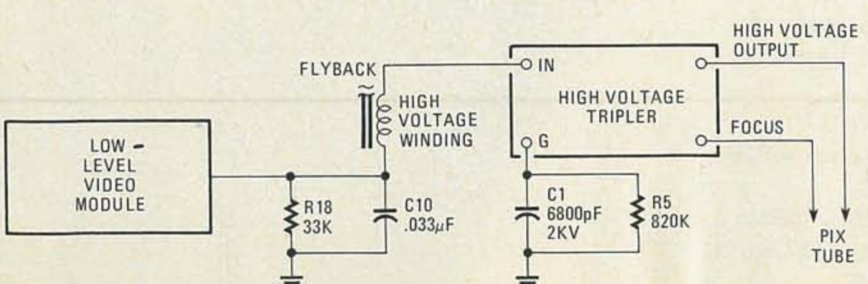

FIG. 2

EQUIPMENT AND TRAINING NO OTHER SCHOOL CAN MATCH.

NTS HOME TRAINING INVITES YOU TO EXPLORE MICROCOMPUTERS, DIGITAL SYSTEMS AND MORE, WITH STATE-OF-THE-ART EQUIPMENT YOU ASSEMBLE AND KEEP.

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1.

2.

We believe that training on production-model equipment, rather than home-made learning devices, makes home study more exciting and relevant. That's why you'll find such gear in all 14 of NTS's electronics programs.

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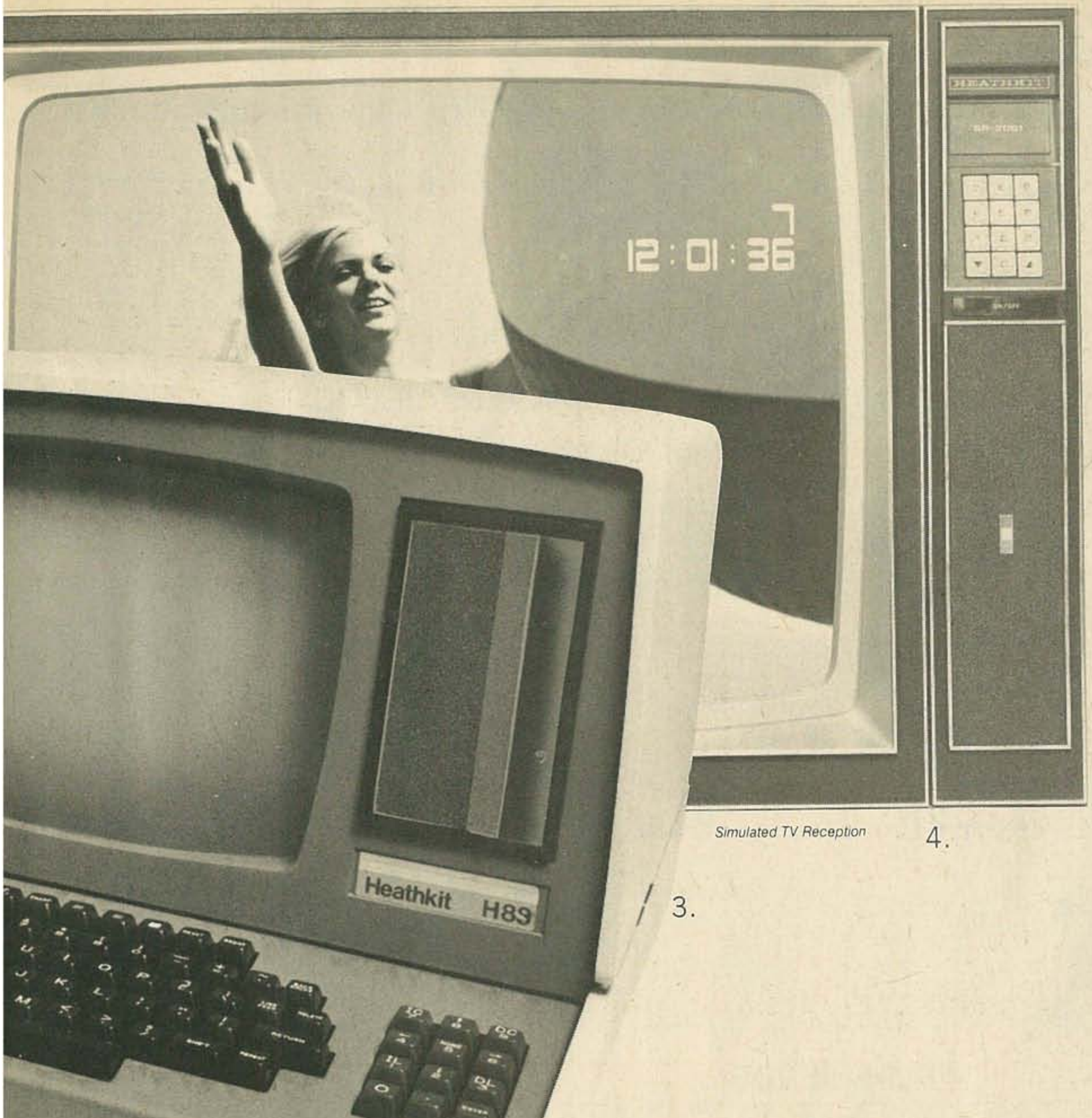


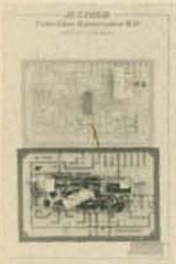
Simulated TV Reception

4.

3.

Jim-pak electronic components — Quality Kits

Function Generator Kit



Provides three basic waveforms: sine, triangle and square wave. Frequency range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

JE2206B........$19.95

Digital Thermometer Kit

Dual sensors — switching control for indoor/outdoor or dual monitoring. Continuous LED .8" ht. display. Range: -40°F to 199°F / -40°C to 100°C. Accuracy ±1° nominal. Set for Fahrenheit or Celsius. Simulated walnut case. AC wall adapter included. Size: 3¼"h x 6-5/8"w x 1-3/8"d.

JE300 ....$39.95

Digital Stopwatch Kit

Use Intersil 7205 Chip. Plated thru double-sided P.C. Board. Red LED display. Times to 59 minutes, 59.59 seconds with auto reset. Quartz crystal controlled. Three stopwatches in one: single event, split (cummulative) and taylor (sequential timing). Uses 3 penlite batteries.

Size: 4.5" x 2.15" x .90"

JE900 ....$39.95

4-Digit Clock Kit

Bright .357" ht. red display. Sequential flashing colon. 12 or 24 hour operation. Black extruded aluminum case. Pressure switches for hours, minutes and hold functions. Includes all components, case and wall transformer. Size: 3¼" x 1¾" x 1¼"

JE730.............$14.95

6-Digit Clock Kit

Bright .300 ht. common cathode display. Uses MM-5314 clock chip. Switches for hours, minutes and hold functions. Hours easily viewable to 20 ft. Simulated walnut case. 115VAC operation. 12 or 24 hour operation. Includes all components, case and wall transformer. Size: 6¾" x 3-1/8" x 1¾"

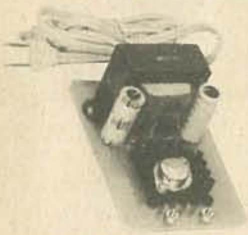
JE701 .... $19.95

Jumbo 6-Digit Clock Kit

Four .630" ht. and two .300" ht. comm. anode displays. Uses MM5314 clock chip. Switches for hrs., mins., and hold functions. Hours viewable to 30 ft. Sim. walnut case. 115VAC operation. 12 or 24 hour operation. Incl. all components, case and wall transformer. Size: 6¾" x 3-1/8" x 1¾"

JE747 ....$29.95

Regulated Power Supply Kit



Uses LM309K. Heat sink provided. PC board construction. Provides solid 1 amp @ 5 volts. Includes components, hardware & instructions. Size: 3½" x 5" x2"h

JE200 ....$14.95

Multi-Voltage Board Kit

ADAPTS TO JE200 SUPPLIES ±5V, ±9V and ±12V

Independent load rating at single terminal. ±12V:160mA, ±9V:200 mA, −5V:250mA. DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE200 board. Size: 3½" x 2" x 9/16"h

JE205 .... $12.95

Variable Power Supply Kit

Full 1.5 amp @ 5-10V output. Up to .5 amp @ 15V output. Heavy duty transformer. Three-terminal I.C. voltage regulator. Heat sink provided for cooling efficiency. PC board construction. 120VAC input. Size: 3½" x 5" x 2"h

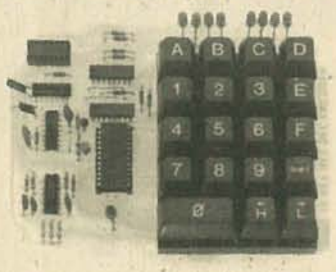
JE210 .... $19.95

62-Key ASCII Encoded Keyboard Kit

The **JE610 ASCII KEYBOARD KIT** can be interfaced into most any computer system. The JE610 kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation. Features: 60 keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 .... $79.95

Hexadecimal Encoder Kit



FULL 8-BIT LATCHED OUTPUT — 19-KEY KEYBOARD

The **JE600 ENCODER KEYBOARD** provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.

JE600 .... $59.95

(Prices Subject To Change)

CIRCLE 17 ON FREE INFORMATION CARD

SERVICE CLINIC

continued from page 71

replaced it just for luck. This fixed it. The "rest" of the circuit, the part we didn't see or think of, is shown in Fig. 2. This resistor is evidently in the high voltage beam-current circuitry; so, it has a very definite affect on its operation. There's the Alfred Hitchcock ending. We were really very happy to find it.

The moral is this. If you have a stage that controls something else, and its parts are all good, then stop suspecting the controller, and suspect the circuit that controls the controller. In other words, the voltage or current or frequency that operates the control circuitry! This applies to a lot of stages! **R-E**

service questions

TRANSISTOR BLOWS

The horizontal-output transistor was blown in this Sylvania EO-2. I replaced it, and now the horizontal driver runs very hot and the output takes far too much current. Do you have anything in your files on this?—W. G., Mena, AR.

Oddly enough, yes! Check C428, the coupling capacitor into the horizontal-output transistor. If this capacitor is leaky or shorted, that will do it. While you're at it, also check Q500 in the DC voltage-regulator circuit; if this is leaky, the excessively high voltage on the + 160-volt line will also cause troubles.

VOLTAGE REGULATOR

Help! After 20 years of TV service I finally ran into one that has me baffled. This Panasonic model T-124A (made for J.C. Penney) works fine at 70 volts AC, but at 90–110 VAC it blows the horizontal-output transistor. I tried using several transistors with higher breakdown ratings, but they went too.—G. S., Brookfield, WI.

I think we have a very good clue here. If the set works (safely) at a greatly reduced line voltage and blows things at normal voltage, the most likely thing would be a regulator problem.

Check the +105-volt source with a reduced line voltage. Run the line voltage up until this voltage reads exactly +105. Now very carefully increase the line voltage. If this +105 volts goes *UP*, watch out!

This indicates that the voltage regulator is not working at all. Raise the supply voltage and you raise everything in the high-voltage stage. The most likely cause is a shorted pass transistor.

SOLID-STATE TROUBLES

Have I got a tough dog. It's a solid-state black-and-white TV set, and I'm not familiar with solid-state sets. I get the full B+ voltage of +163 at all test points in this circuit. There's no high voltage and no low voltages. Can you help?—T. S., Everett, MA.

Stand by for an instant course in solid-state troubleshooting. Your readings show the B+ voltage supply is normal, but it is obviously drawing no current at all. Check the horizontal-output transistor with an ohmmeter. With the positive lead to the base, you should get a low resistance reading to both base and collector. Reverse the leads and put the negative lead to the base; you should get a high reading on collector and base. I strongly suspect the transistor (an NPN) is open.

If so, check ALL the loads on the flyback, including the rectifier diode that develops these voltages for the transistor circuits. Before you turn the set on after replacing the output transistor, plug it into a variable voltage transformer. Place the current meter in series with the B+ voltage, and a DC voltmeter across it. Bring the voltage up slowly and watch for any excess current drain. If you see it, stop and fix it! **R-E**

SWITCHING REGULATOR
continued from page 60

crease the output current is to increase the core volume of the inductor (larger pot core). When attempting to achieve higher currents, the drive circuitry to the switching transistor may have to be replaced with devices that provide more base drive to the BU407 (Q1). Recommended replacement for the 2N3638A (Q2, Fig. 5) is a 2N2905A; Q3, a 2N2222A is useful as it is. Reduce R9 to 510 ohms and the four 2.2-ohm sense resistors should be replaced with an equivalent resistance of .1 ohm.

The step-up configuration (Fig. 4) is designed for approximately 24 volts output. This can be altered by replacing R5 (20K) with another value resistor (or potentiometer). The output changes about 1 volt for every 1000-ohm change in R5.

The step-down configuration (Fig. 5) has a nominal output of about 3.75 volts. This value can be raised by replacing the jumper wire shown at the output with a resistor. The output voltage will increase beyond the point where the output voltage is within 5 volts of the input voltage.

When investigating the inverting mode (Fig. 6), the polarity of C2 must be reversed from the other modes.

TABLE 2

Step Down
Short: B,C,G,H,J,L,M,T,U
Step Up
Short: A,D,I,K,N,O,P,Q,S,W
Inverting
Short: B,C,G,H,J,L,M,R,V
Note that R14 is 360K for this configuration. In the two other modes it is called R4 and is 3.6K.

Table 2 shows which jumpers need to be installed to create step-up, step-down, or inverting output. These links are shown in the component layout diagram of Fig. 7.

All holes on the board not relieved by artwork should have the wire soldered to both top and bottom sides. Components with grounded ends have holes for this purpose. Be sure to solder to the top side ground plane. Complete artwork for the double sided PC board is provided in Figs. 8 and 9. If the modulation input (pin 5) is not used, solder pins 5 and 6 together.

The 3C8 ferrite material used in the pot core for L1 is quite brittle so take care not to drop the parts because they will shatter. Also when mounting the core be sure not to overtighten the mounting screw as that, too, could be the cause of an unpleasant cracking problem. **R-E**

LEVEL METER
continued from page 46

output, and adjust R2 and R16 until the highest LED lights up at half its maximum brightness.

To use the PLM as a clipping indicator, disconnect your speakers from your amplifier while leaving the PLM connected to the output. Dial your tuner to an FM rock station (these are usually the most compressed and limited stations) and turn your volume control all the way up. Adjust R2 and R16 until the highest LED just barely lights up. Then turn them higher by about 20% of the total angle they have been turned. When you reconnect your speakers, the highest LED will represent transient clipping of your amplifier.

When using the PLM with a vacuum-tube amplifier, always connect a load of approximately the right value (8 ohms for example) across the output in the first calibration technique. Vacuum-tube amplifiers are not safe to use without a load, and full-power sinewave testing with speakers connected isn't good either for the speakers or your ears! The second calibration procedure isn't of much use with vacuum-tube amplifiers, as they clip very differently. This wraps it up. Use and enjoy! **R-E**

DIGITAL CLOCK
continued from page 63

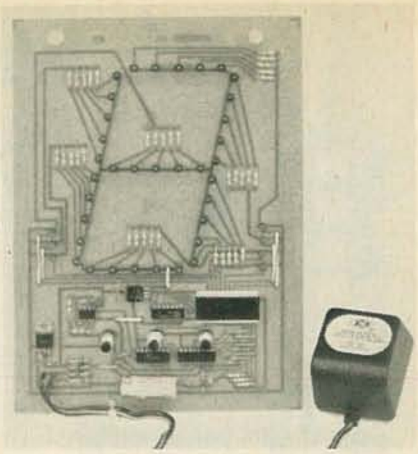
the proper time, it displays the time by flashing the digits sequentially through a single seven-segment display. The sequence of digits is: HHxMMxxx where x represents a blanked pause period. (The clock features leading-zero blanking so the sequence can also be: xHxMMxxx)

The three pushbutton switches on the front panel are, from left to right, S1, S2 and S3. Switch S1 is a "freeze" button and will stop the flashing sequence anywhere in its cycle. Switch S2 is the slow-set button and S3 is fast time set.

Upon plugging in the power transformer, the clock comes up in an undefined state and usually flashes two zeros. Pressing S3 for approximately 1 second will toggle the counters and put the clock in a correct timekeeping state. Now the correct time can be set.

This is best done by watching whatever time is currently sequencing so you can identify the first hour digit and anticipate when it will flash again on the next cycle. By depressing S1 at just the right instant, you can "capture" the hour digit in the display and hold it there by continuing to hold down S1. (This may take a few tries for someone who has never set the time before). With the hours digit captured in the display, simultaneously depressing S3 will advance that digit at the rate of 1 hour per second. When the hours are properly set, release S3 and S1 to continue the flashing cycle. Now S1 is used again, this time to capture the tens of minutes digit. S2 or S3 may be used to advance that digit to the proper setting. Then repeat the procedure once more for the unit minutes, this time using S2 to set that digit.

The procedure is complicated to describe, but with a little practice becomes very simple to do. This clock "grows on you" and attracts lots of attention so you had better be prepared to build others for your friends. **R-E**



TOP VIEW of the PC board as it appears when the red plastic panel is removed. The six jumpers are clearly visible.

SOUND QUALITY
continued from page 65

parallel sound system, the signal-to-noise ratio is improved to better than 50 dB and that when the scene has a predominantly white background with black lettering, the signal-to-noise ratio is still about 40 dB better than in a conventional intercarrier sound system.

Siemens recently announced the TDA 4280 IC, a modified version of the TDA 2840 that includes a video output terminal for feeding video recorders and has electronic record/play switching circuits that can be controlled by voltages developed in the recorder.

We have not found any indication that quasi-parallel sound technology has been adapted, or is even being considered, in the U.S. But, we feel sure that, if this new technique is as good as promised and has no hidden drawbacks, you can expect quasi-parallel sound to be featured in some mid-1980 and later models, particularly now that network TV sound quality has been upgraded and there is a valid reason to improve receivers' sound systems. **R-E**

SATELLITE TV
continued from page 52

sive protractor can be used when adjusting the tilt angle.

Remember that the spherical can look at signals off boresight ± 20 degrees and with a corresponding repositioning of the focus point antenna you can receive different satellites (or alternately look at more than one satellite simultaneously with multiple feed horns). The same thing is true with the vertical ('tilt') angle. It reciprocates. If at your location the angle of arrival of the incoming signal is 34 degrees and the reflector is vertical (perpendicular to the earth), the focused energy will leave the reflector going down towards the ground at a 34-degree angle as well. Since this would result in your having to point the feedhorn antenna 'up' at the reflector at a 34-degree angle, it might also result in your having to dig a hole in the ground to properly drop the feedhorn-antenna 1.5 times the antenna aperture away from the antenna. The obvious solution is to tilt the antenna back. If the antenna is tilted back 20 degrees (the base stays on the ground, the top tilts backward) then your 34-degree elevation arrival angle will leave the antenna at an angle of 14 degrees (34-20=14) with respect to the ground. This will raise the focus point up above ground level and reduce the upward tilt required for the feed antenna. In any case, the same ± 20-degree reception ability we find true with incoming signals left and right of the boresight line also holds true with the tilt angle. This simply says that you must have your tilt angle at least within 20 degrees of the highest arrival (elevation) angle of the incoming signals. A computer derived chart customized for your location was footnoted in the October 1979 issue. You need one before you can start laying out your antenna!

The feedhorn dimensions are given in Fig. 10. The feedhorn is flanged so as to mount directly to the type WR-229 waveguide flange found on the input side of most LNA's. Study the feedhorn drawing shown in Fig. 10 carefully and the photo in Fig. 11 Material is galvanized sheet metal and accuracy required is ± 0.1 inch.

Note: The preceding material may not prove sufficiently detailed for the novice in this field. The *Swan Spherical TVRO Antenna* manual is some 30 pages in length and provides complete step-by-step instructions for those uncomfortable with the brevity of this quick outline.

Next month we will give details on construction of the LNA (low noise amplifier) plus the VTO 8360 tunable oscillator and GaAs-FET active mixer assembly. **R-E**

new products

More information on new products is available. Use the Free Information Card inside the back cover.

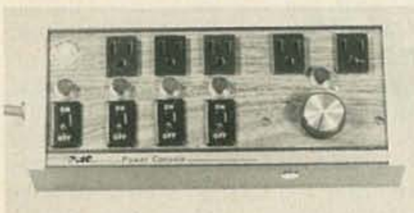
DIGITAL METER, *model LC53,* the "Z Meter", is a fully autoranged tester that checks capacitors and inductors for value and performance ability. Capacitor values are checked from 1 pF to

CIRCLE 151 ON FREE INFORMATION CARD

200,000 μF with 1% accuracy; inductor values are checked from 1.0 μH to 10 H with 2% accuracy.

A leakage test measures capacitor leakage to 10,000 μA in 12 voltage steps. Capacitors are automatically discharged after the test. The test also detects dielectric absorption and deformed capacitors, which can then be reformed by the power supply. Inductors are checked for quality by a test that detects faulty coils. The unit can also check rectifiers and detect breakage in transmission lines. Price is $695.—**Sencore, Inc.,** 3200 Sencore Dr., Sioux Falls, SD 57107.

MULTIPLE OUTLET BOXES, is a line of 8 Underwriters Laboratories' listed models, some with special features. These lightweight aluminum units all have 5 or 9 receptacles, 15-amp circuit breakers, AC on/off switches, and indicator



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lights. Two models feature surge suppressors that can absorb excess energy above 130 volts RMS, and one model has AC motor speed control for devices up to 6 amps. A fourth unit has a light dimmer that can control lamps up to 600 watts. All models include a 6-foot line cord and can be mounted anywhere. Prices range from $28.50 to $74.50.—**PMC Industries, Inc.,** 1043 Santa Florencia, Solana Beach, CA 92075.

DIGITAL RESISTANCE SUBSTITUTER, *model RS-200 R-Box,* provides fast, error-proof method of setting resistance from 0 ohm to 9 megohms. The unit uses 7 color-coded thumbwheel switches to dial in the desired resistance available across two banana-jack binding posts; the resistors used are 1% tolerance, ½-watt rated and

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serially tied. The *model RS-200* comes in a rugged high-impact plastic case and measures $3\frac{15}{64} \times 3\frac{3}{32} \times 2\frac{11}{64}$-inches. Suggested retail price: *model RS-200,* $89.95.—**IET Labs, Inc.,** 761 Old Country Rd., Westbury, NY 11590.

ANTI-STATIC SPRAY, *Stat-Free,* eliminates static, dust and dirt from electronic equipment without adverse effect on any substance. Can be used on computer equipment, workbenches and tools

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and is useful on panel meters and oscilloscope faces to prevent inaccurate readings. Available in 16 ounce cans. Price is $2.98—**Chemtronics, Inc.,** 681 Old Willets Path, Hauppauge, NY 11787.

R-E

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Input impedance:	1 megohm, 6 and 60 mHz ranges 50 ohms, 600 mHz range
Power:	4 'AA' cells, 12 V AC/DC
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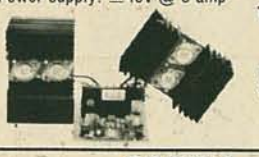

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AC Current: 6mA, 6A (2V and 55mV drop)
Resistance: 10kΩ 100kΩ
1MΩ 5MΩ (max. calbtn)
100Ω 1kΩ
10kΩ 50kΩ (mid scale)
10kΩ 100kΩ
Load Current: 30mA 3mA 300mA
Load Voltage: 3V 3V 3V
Decibels: −10 to +55dB
Batt Check: 0.9 to 1.5V (10Ω load)
LED Check: (Available)
Temperature: −50° to +100°C and 0° to +200°C
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DC Current: ±2.5% f.s.d.
Batt Check: ±2.5% f.s.d.
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AC Voltage/Power above 15V range: ±3.5% f.s.d.
AC Current: ±5% f.s.d.
Resistance/Temperature: ±3% of arc

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Weight: 240g
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9 Steps 4 Colors

LED VU

Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large, from −30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

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TY-18
$8.50 PER KIT

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

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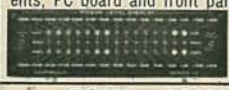
Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.



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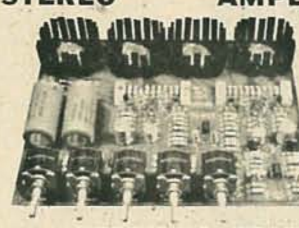
- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern.

$10.50 EA

STEREO AMPLIFIER



60 W + 60 W

COMPLETED UNIT — NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit. Assembled **$49.50 ea.**
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5W AUDIO AMP KIT

2 LM 380 with Volume Control
Power Suply 6 18V DC
ONLY $6.00 EACH

PROFESSIONAL PANEL METERS

Type MU-52E

A.	0-50UA	8.50 ea.
B.	0-30VDC	8.50 ea.
C.	0-50VDC	8.50 ea.
D.	0-3ADC	9.00 ea.
E.	0-100VDC	9.00 ea.

All meters white face with black scales. Plastic cover.

0.5" LED ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!

Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.

ONLY **$7.00 EACH**
SPECIAL TRANSFORMER FOR CLOCK **$1.50 EACH**

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4 DIGITS PERSONAL CODE!!

SPECIAL $19.95

- proximity triggered
- voltage triggered
- mechanically triggered

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm. **3-WAY PROTECTION!**

All units factory assembled and tested — Not a kit!

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

This series covers a wide range of level indication uses, output and input voltage, time related change, temperature, light measurement and sound level. The problem of uneven brilliance often encountered with LED arrangements as well as design problems caused by using several units of varying size are substantially reduced. 12 LEDs in one bar:

LED ARRAY

GL-112R3 Red, Red, Red	**$5.50**
GL-112N3 Green, Yellow, Red	**$6.50**
GL-112M2 Green, Green, Red	**$6.50**
GL-112G3 Green, Green, Green	**$6.50**

0.27"

2.28"

LED DRIVERS

1R 2406G is an I.C. specially designed to drive. 12 LED. The number of LED is lineally illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. **$5.35 EACH**

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6¼" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

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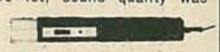

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Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor neded. Pulse rate 3Hz @ 5V 20mA.

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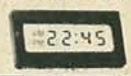

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Batteries and ear phones included.

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12V	SPDT	3 AMP	**1.60**
12V	DPDT	2 AMP	**2.50**
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500Ω SINGLE
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☐ 1-LASCR OPTO COUPLER, type H11C3, mini dip, (#5700)	1.29	2 for 1.30
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☐ 1-25 AMP BRIDGE RECTIFIER, 50 volts, 100% (#5948)	1.29	2 for 1.30
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☐ 25-DTL's, 100% prime, asst'd flip flops, etc., marked, (#3709)	1.29	50 for 1.30
☐ 10-MAN-3's, 7 segment, w/bubble magnifier, 100% material, (#3842)	1.29	20 for 1.30
☐ 4-PL-259 COAX PLUG, mates to SO-239, Amphenol, (#5221)	1.29	8 for 1.30
☐ 1-LITE SENSITIVE UNIJUNCTION TRANSISTOR, programmable, (#5719)	1.29	2 for 1.30
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☐ 30-FT. WIRE-WRAP WIRE, 30 gauge, insulated, continuous length, (#3803) ..	1.29	60 for 1.30
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☐ 6-MAGNETIC DISCS, shatter-resistant Plastalloy, 13/16" dia. (#6099)	1.29	12 for 1.30
☐ 5-PHOTO CELLS, Vactec 900, disc type, R: 2K ohm (dark) w/leads, (#6135)	1.29	10 for 1.30
☐ 1-12VDC SPDT RELAY, 180 ohm coil, 25 mA, 1x1x1½" sealed (#5937)......	1.29	2 for 1.30
☐ 10-VOLUME CONTROLS, asst. values, audio, and switch too! (#592)	1.29	20 for 1.30
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☐ 30-SUBMINI IF TRANSFORMERS, asst. slug tuned, shielded, (#35A9)	1.29	60 for 1.30
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☐ 10-PC TRIMPOTS, screwdriver adjust, assorted values, (#3346)	1.29	20 for 1.30
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☐ 3-MICRO SWITCHES, SPST, NO contacts, plunger style, solder tabs, (#5785)	1.29	6 for 1.30
☐ 65-MOLEX SOCKETS, "on-a-strip", for 8- 40 pin ICs (#1609)	1.29	130 for 1.30
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☐ 40-POLYSTYRENE CAPACITORS, asst'd values and voltages, (#1052)	1.29	80 for 1.30
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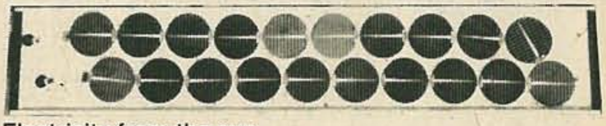

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LM 318H	1.10	LM 1820	2.50
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LM 320K-12	1.10	LM 1830	2.25
LM 324	1.10	LM 1841	2.50
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4 Digit .5"

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1 National - 5375AA Clock Chip
1 Bowmar Clock Stick Readout (L.E.D.) 4 digit - 1/2"
13 Transitors
2 Push Buttons for time set
2 Toggle Switches for alarm
1 Filter cap
4 1N4000 series diodes
1 1N4148
2 Disc caps
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1 LED Lamp for alarm indicator

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$9.99
ORDER KIT CK-100AC
P.C. Board **$2.25**
Plug In Transformer **$1.50**

D.C. MODEL

Same as above except it includes 60 Hz timebase.
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1 National 5375AA Clock Chip
1 Bowmar Clock Stick Readout - (L.E.D.) 4 digit - 1/2"
12 Transistors
2 Push Buttons for time set
2 Disc caps
27 Resistors
1 MOV
1 60 Hz time base

P.C. Board **$2.25**

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PRE PROGRAMMED ROM HAS SEVERAL RHYTHM PATTERNS STORED THAT ARE "WALKED OUT" WITH A COUNTER(ie, 555 & CD4024) CHANGE PATTERNS WITH A SWITCH. WITH DATA, FUN TO PLAY WITH!! D-6304

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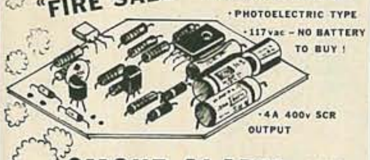

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Among world's smallest, solid state, self contained WIRELESS MIKE. Mercury Bat. furn. Picks up most sounds and transmits without wires up to 300 ft. thru FM Radio. Tuneable. Use as mike, ampf., alarm & alert system, baby sitter, hot line, etc. 2-1/4 x 3/4 x 1/2 **$24.95*** FCC Approved

Phone call Adapter $24.50*, VOX $24.95*, MIKE $24.95*. (* plus $1.00 ea. postage & handling), 10 hr. Recorder $155.00* (* plus $4.00 postage & handling). California residents add tax. Mail Order, VISA, M/C, cod's okay, quantity discounts available. Money back guar. Free data.

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TASA's Solid State Micro Proximity Keyboards

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55 micro proximity sensor positions three-color coded to function

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** FULLY STATIC OPERATION
** USES 2114 TYPE STATIC RAMSMS
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** PHANTOM LINE CAPABILITY
** ADDRESSABLE IN 4K BLOCKS IN 4K INCREMENTS
** 4K BLOCKS CAN BE LOCATED ANYWHERE WITHIN 64K BANK
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** LED INDICATORS FOR BOARD/BANK ACTIVE INDICATION
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7438	.28	74367	.75
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7454	.18	74LS03	.35
7474	.35	74LS09	.55
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Jumbo 6-Digit Clock Kit

* Four .630"ht. and two .300"ht. common anode displays
* Uses MM5314 clock chip
* Switches for hours, minutes and hold functions
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* 12 or 24 hour operation
* Includes all components, case and wall transformer
* Size: 6¾ x 3⅛ x 1¾

JE747.............. **$29.95**

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200....... **$14.95**

ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... **$12.95**

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$14.95
Z80A(780-1)	CPU	16.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.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
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49
UART'S		
A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
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
RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516	16K*	EPROM	49.95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT

FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin 1C connector
- Only +5VDC required for operations

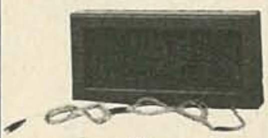
FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 .... **$59.95**

Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT



- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 .... **$39.95**

62-Key ASCII Encoded Keyboard Kit

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation.

JE610..... **$79.95**

62-Key Keyboard only . . $34.95

HICKOK LX303 Portable LCD Digital Multimeter

- Big ½ inch high, 3½ Digit Liquid Crystal Display • Over 200 Hours of operation with a 9V battery
- Automatic zero, polarity and overrange indication • 100mV DC F.S. sensitivity • 1% basic accuracy
- 19 ranges and functions • Rugged Cycolac® case and removable cover, stores test lead set.
- Full one year warranty.

SPECIFICATIONS: DC volts (5 ranges): [illegible] AC Volts (40Hz to 5kHz): [illegible] Resistance (6 Low Power Ranges): [illegible] DC Current (6 ranges): [illegible] Dimensions and Weight: [illegible] READ RATE: [illegible]

LX303 Digital Multimeter **$74.95**

PART NO.	DESCRIPTION	PRICE
RC-3	115V AC ADAPTER	7.50
CC-3	PADDED CARRYING CASE	7.50
VP-10	X10 DC PROBE ADAPTER (Up to 10K)	14.95
VP-40	40kV DC PROBE	35.00
CS-1	10 Amp DC Current Shunt	14.95

$10.00 Min. Order — U.S. Funds Only
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The Incredible "Pennywhistle 103"

$139.95 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. 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.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
* 8 each UPD416-1 (16K Dynamic Rams) 250NS
* Documentation for conversion

TRS-16K **$75.00**

JUST WRAP™

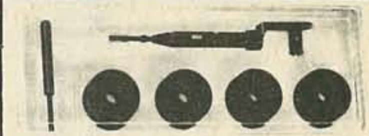
- 30 AWG wire
- .025" square posts
- Daisy chain or point-to-point
- Built-in cut off
- Includes 50 ft. wire
- No stripping or slitting required—just wrap

Part No.	Wire Color	Price
JW-1-B	Blue	$14.95
JW-1-W	White	14.95
JW-1-Y	Yellow	14.95
JW-1-R	Red	14.95

JUST WRAP™ Replacement Wire

Part No.	Color		Price
R-JW-B	Blue	50 ft. roll	$2.98
R-JW-W	White	50 ft. roll	2.98
R-JW-Y	Yellow	50 ft. roll	2.98
R-JW-R	Red	50 ft. roll	2.98

JUST WRAP™ Unwrap Tool $3.49



JUST WRAP™ Kit
- 50 ft. ea.: blue, white, red, yellow wire
- JUST WRAP Tool
- Unwrapping Tool

JWK-6 .... **$24.95**

Vacuum Vise

Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws, 1¼" travel. Can be permanently installed.

VV-1....... **$3.49**

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch
- Special conductive foam liner eliminates static build-up
- Built-in safety lock to prevent UV exposure
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips

UVS-11E........................ **$69.95**

JOYSTICK

- 2 each 100K pots (Linear Taper)
- Printed Circuit Board Mount
- Size: 1" x 1-3/16" x 1-3/16"

JOYSTICK **$4.95**

CIRCLE 18 ON FREE INFORMATION CARD

7400 TTL

SN7400N	.16	SN7470N	.29	SN74160N	.89
SN7401N	.18	SN7472N	.29	SN74161N	.89
SN7402N	.18	SN7473N	.35	SN74162N	1.95
SN7403N	.18	SN7474N	.35	SN74163N	.89
SN7404N	.18	SN7475N	.49	SN74164N	.89
SN7405N	.20	SN7476N	.35	SN74165N	.89
SN7406N	.29	SN7479N	5.00	SN74166N	1.25
SN7407N	.29	SN7480N	.50	SN74167N	1.95
SN7408N	.20	SN7482N	.99	SN74170N	1.59
SN7409N	.20	SN7483N	.59	SN74172N	6.00
SN7410N	.18	SN7485N	.79	SN74173N	1.25
SN7411N	.25	SN7486N	.35	SN74174N	.89
SN7412N	.25	SN7489N	1.75	SN74175N	.79
SN7413N	.40	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.59	SN74177N	.79
SN7416N	.25	SN7492N	.43	SN74179N	1.95
SN7417N	.25	SN7493N	.43	SN74180N	.79
SN7420N	.20	SN7494N	.65	SN74181N	1.95
SN7421N	.29	SN7495N	.65	SN74182N	.79
SN7422N	.39	SN7496N	.65	SN74184N	1.95
SN7423N	.25	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	.89	SN74186N	9.95
SN7426N	.29	SN74107N	.35	SN74188N	3.95
SN7427N	.25	SN74109N	.59	SN74190N	1.25
SN7429N	.39	SN74116N	1.95	SN74191N	1.25
SN7430N	.20	SN74121N	.35	SN74192N	.79
SN7432N	.25	SN74122N	.39	SN74193N	.79
SN7437N	.25	SN74123N	.49	SN74194N	.89
SN7438N	.25	SN74125N	.49	SN74195N	.69
SN7439N	.25	SN74126N	.49	SN74196N	.89
SN7440N	.20	SN74132N	.75	SN74197N	.89
SN7441N	.89	SN74136N	.75	SN74198N	1.49
SN7442N	.49	SN74141N	.79	SN74199N	1.49
SN7443N	.75	SN74142N	2.95	SN74S200	4.95
SN7444N	.75	SN74143N	2.95	SN74251N	.99
SN7445N	.75	SN74144N	2.95	SN74279N	.79
SN7446N	.69	SN74145N	.79	SN74283N	2.25
SN7447N	.59	SN74147N	1.95	SN74284N	3.95
SN7448N	.79	SN74148N	1.29	SN74285N	3.95
SN7450N	.20	SN74150N	.89	SN74365N	.69
SN7451N	.20	SN74151N	.59	SN74366N	.69
SN7453N	.20	SN74152N	.59	SN74367N	.69
SN7454N	.20	SN74153N	.59	SN74368N	.69
SN7459A	.25	SN74154N	.99	SN74390N	1.95
SN7460N	.20	SN74155N	.79	SN74393N	1.95
		SN74156N	.79		
		SN74157N	.65		

C/MOS

CD4000	.23	CD4028	.89	CD4070	.55
CD4001	.23	CD4029	1.19	CD4071	.23
CD4002	.23	CD4030	.49	CD4072	.49
CD4006	1.19	CD4035	.99	CD4076	1.39
CD4007	.25	CD4040	1.19	CD4081	.23
CD4009	.49	CD4041	1.25	CD4082	.23
CD4010	.49	CD4042	.99	CD4093	.99
CD4011	.23	CD4043	.89	CD4098	2.49
CD4012	.25	CD4044	.89	MC14409	14.95
CD4013	.39	CD4046	1.79	MC14410	14.95
CD4014	1.39	CD4047	2.50	MC14411	14.95
CD4015	1.19	CD4048	1.35	MC14419	4.95
CD4016	.49	CD4049	.49	MC14433	19.95
CD4017	1.19	CD4050	.49	MC14506	.75
CD4018	.99	CD4051	1.19	MC14507	.99
CD4019	.49	CD4053	1.19	MC14562	14.50
CD4020	1.19	CD4056	2.95	MC14583	3.50
CD4021	1.39	CD4059	9.95	CD4508	3.95
CD4022	1.19	CD4060	1.45	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	74C85	2.49	74C163	2.49
74C02	.39	74C90	1.95	74C164	2.49
74C04	.39	74C93	1.95	74C173	2.60
74C08	.49	74C95	1.95	74C192	2.49
74C10	.39	74C107	1.25	74C193	2.49
74C14	1.95	74C151	2.90	74C195	2.49
74C20	.39	74C154	3.00	74C922	7.95
74C30	.39	74C157	2.15	74C923	6.25
74C42	1.95	74C160	2.49	74C925	8.95
74C48	2.49	74C161	2.49	74C926	8.95
74C73	.89			80C95	1.50
74C74	.89			80C97	1.50

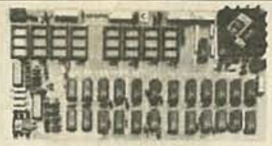
LINEAR

78MG	1.75	LM340K-18	1.35	LM710N	.79
LM106H	.99	LM340K-24	1.35	LM711N	.39
LM300H	.80	LM340T-5	1.25	LM723N/H	.55
LM301CN/H	.35	LM340T-6	1.25	LM733N	1.00
LM302H	.75	LM340T-8	1.25	LM739N	1.19
LM304H	1.00	LM340T-12	1.25	LM741CN/H	.35
LM305H	.60	LM340T-15	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-18	1.25	LM747N/H	.79
LM308CN/H	1.00	LM340T-24	1.25	LM748N/H	.39
LM309H	1.10	LM358N	1.00	LM1310N	1.95
LM309K	1.25	LM370N	1.95	LM1458CN/H	.59
LM310CN	1.15	LM373N	3.25	MC1488N	1.95
LM311N/H	.90	LM377N	4.00	MC1489N	1.95
LM312H	1.95	LM380N	1.25	LM1496N	.95
LM317K	6.50	LM380CN	.99	LM1556V	1.75
LM318CN/H	1.50	LM381N	1.79	MC1741SCP	3.00
LM319N	1.30	LM382N	1.79	LM2111N	1.95
LM320K-5	1.35	NE501N	8.00	LM2901N	2.95
LM320K-5.2	1.35	NE510A	6.00	LM3053N	1.50
LM320K-12	1.35	NE529A	4.95	LM3065N	1.49
LM320K-15	1.35	NE531H/V	3.95	LM3900N(3401)	.59
LM320K-18	1.35	NE536T	6.00	LM3905N	1.49
LM320K-24	1.35	NE540L	6.00	LM3909N	1.25
LM320T-5	1.25	NE544N	4.95	MC5558V	.59
LM320T-5.2	1.25	NE550N	1.30	8038B	4.95
LM320T-8	1.25	NE555V	.39	LM75450N	.49
LM320T-12	1.25	NE556N	.99	75451CN	.39
LM320T-15	1.25	NE560B	5.00	75452CN	.39
LM320T-18	1.25	NE562B	5.00	75453CN	.39
LM320T-24	1.25	NE565N/H	1.25	75454CN	.39
LM323K-5	5.95	NE566CN	1.75	75491CN	.79
LM324N	1.49	NE567V/H	.99	75492CN	.89
LM339N	.99	NE570N	4.95	75493N	.89
LM340K-5	1.35	LM703CN/H	.69	75494CN	.89
LM340K-6	1.35	LM709N/H	.29	RC4136	1.25
LM340K-8	1.35			RC4151	3.95
LM340K-12	1.35			RC4194	4.95
LM340K-15	1.35			RC4195	4.49

74LS00TTL

74LS00	.29	74LS47	.89	74LS138	.89
74LS01	.29	74LS51	.29	74LS139	.89
74LS02	.29	74LS54	.29	74LS151	.89
74LS03	.29	74LS55	.29	74LS155	.89
74LS04	.35	74LS73	.45	74LS157	.89
74LS05	.35	74LS74	.45	74LS160	1.15
74LS08	.29	74LS75	.59	74LS161	1.15
74LS09	.35	74LS76	.45	74LS162	1.25
74LS10	.29	74LS78	.49	74LS163	1.15
74LS11	.75	74LS83	.89	74LS164	1.25
74LS13	.59	74LS85	1.25	74LS175	.99
74LS14	1.25	74LS86	.45	74LS181	2.49
74LS15	.35	74LS90	.59	74LS190	1.15
74LS20	.29	74LS92	.75	74LS191	1.15
74LS21	.35	74LS93	.75	74LS192	1.15
74LS22	.35	74LS95	.99	74LS193	1.15
74LS26	.35	74LS96	1.15	74LS194	1.15
74LS27	.35	74LS107	.45	74LS195	1.15
74LS28	.35	74LS109	.45	74LS253	.99
74LS30	.29	74LS112	.45	74LS257	.89
74LS32	.35	74LS123	1.25	74LS258	1.75
74LS37	.45	74LS125	.89	74LS260	.69
74LS40	.35	74LS132	.99	74LS279	.75
74LS42	.89	74LS136	.49	74LS367	.75
				74LS368	.75
				74LS670	2.49

Cromemco incorporated



8K Bytesaver II

Cromemco's 8K BYTESAVER® card provides a built-in programmer for the popular 2708 PROM and has the capacity for a full 8K bytes of PROM memory storage. The BYTESAVER® II also offers a number of new features including convenient switch selection of board address and Cromemco's powerful memory bank selection. The BYTESAVER® II is assembled and tested (Model 8KBS-W) for $245.

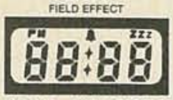
Memory Capacity: 8K bytes
Memory Type: 2708 PROM or equivalent
Memory Access Time: 450 nanoseconds
Wait States at 2MHz: none required
Wait States at 4MHz: one per machine cycle
Bus: S-100
Power Requirements: +8V @ 0.8A, +18V @ 0.4A, −18V @ 0.2A
Operating Environment: 0-55°C.

Assembled
8KBS-W....$245.00

DISCRETE LEDS

.200" dia.			.125" dia.		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			.185" dia.		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1	.190" dia.		
.085" dia.			XC111R	red	5/$1
MV50	red	6/$1	XC111G	green	4/$1
INFRA-RED LED 1/4"x1/4"x1/16" flat		5/$1	XC111Y	yellow	4/$1
			XC111C	clear	4/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY CLASS II
FIELD EFFECT



4 DIGIT – .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive $7.95
T1001A-Reflective 8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.75	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1.50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.59
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	1.50

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
CT7001	6.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

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	1.65	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	$.39	38	.31	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
20 pin WW	.85	.79	.72				

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ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

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TL494CN	Switching Regulator	4.49
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11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
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DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.95
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set
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XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55			XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4733	5.1	1w	28
1N965	15	400m	4/1.00	1N4734	5.6	1w	28
1N5232	5.6	500m	28	1N4735	6.2	1w	28
1N5234	6.2	500m	28	1N4736	6.8	1w	28
1N5235	6.8	500m	28	1N4738	8.2	1w	28
1N5236	7.5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 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
C36M	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
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
PN2907 Plastic	7/1.00	2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	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							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/35V	.35	.31	.27
.22/35V	.28	.23	.17	3.3/25V	.35	.31	.27
.33/35V	.28	.23	.17	4.7/25V	.33	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.49	.45	.35
.68/35V	.28	.23	.17	15/25V	.75	.68	.59
1.0/35V	.28	.23	.17	22/6V	.75	.60	.50
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.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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Assembled & tested circuit board.
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16K Econoram IV	S-100	$289	$339	$429
16K Econoram VIIA-16	S-100	$299	$349	$439
24K Econoram VIIA-24	S-100	$419	$499	$605
16K Econoram IX-16	Dig Grp	$319	$379	n/a
32K Econoram IX-32	Dig Grp	$559	$639	n/a
32K Econoram X	S-100	$549	$669	$789
32K Econoram XI	SBC/BLC	n/a	n/a	$1050
16K Econoram XIIIA-16	S-100 (1)	$349	$419	$519
24K Econoram XIIIA-24	S-100 (1)	$469	$539	$649
32K Econoram XIIIA-32	S-100 (1)	$579	$699	$849
16K Econoram XIV	S-100 (2)	$299	$359	$459
16K Econoram XV-16	H8 (3)	$329	$395	n/a
32K Econoram XV-32	H8 (3)	$599	$729	n/a

Econoram is a trademark of **Godbout Electronics
(1) Compatible with all bank select systems (Cromemco, Alpha Micro, etc.); addressable on 4K boundaries.
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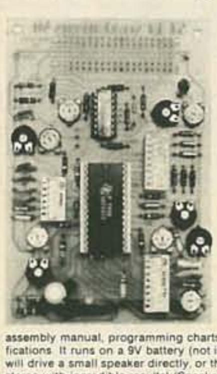
SE 01 Sound Effects Kit $16.95

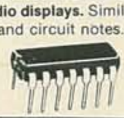


The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip,** the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of **other sounds.** The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included).

- **76477 CHIP IS INCLUDED.** EXTRA CHIPS **$2.95** EACH
- **$16.95** LESS SPEAKER & BATTERY

From T.I.: **TL490 BAR/DOT DRIVER IC.** Drives 10 LED's with adjustable analog steps. Units are cascadable up to 10 (100 steps). Drives LED's directly. Great for **voltage, current,** or **audio displays.** Similar in features to LM3914 with specs and circuit notes.

2.95 NEW!

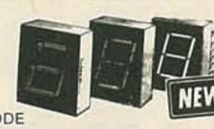


NEW ITEMS

LM3046	(CA3046) Transistor Array	.75
RCA 40430	400V 6A TRIAC TO-66	.75
CA3086	RCA Transistor Array	.80
MC1438R	Power Op Amp/Driver	.50
1N4148	Prime, Full Lead	100/2.50
LM3302	Quad Comparator	.89
2SC1849	High Freq NPN TO-92	6/1.00
MPS A20	NPN GEN PUR	8/1.00

XAN SUPER DIGITS

.6" JUMBO LED
7 SEGMENT
RED
99¢



6640 COMMON ANODE
6920 COMMON CATHODE

NOW A SUPER READOUT AT A SUPER BUY! These are **factory fresh prime** LED readouts, not seconds or rejects as sold by others. Compare our price and send for yours today, but hurry, the supply is limited!
SPECIFY: COMMON ANODE OR COMMON CATHODE

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A mix of new, panel mount 3/8" bushing pots in various values. Some dual, some with switches.
10/**2.00**

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A good mix of 5% and 10% values in both full lead and PC lead devices. All new, first quality.
(Asst.) 200 pieces/**2.00**

SLIDE SWITCH ASSORTMENT
An outstanding bargain. Includes miniature and standard sizes and multi-position units. All new first quality, name brand switches. Try one pack and you'll reorder more: *SPECIAL — 12 for $1.20* (Assortment)

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723 VOLT REG. 10 LEAD CAN	.50
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30,000 @ 15V COMPUTER GRADE	2.10
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2N4402 PNP COMPLIMENT	8/1.00
2N6028 P.U.T. W/SPECS	.50
LM380 2W AUDIO IC W/SPECS	1.09
LM377 DUAL LM380 W/SPECS	2.50
*7815 VOLT REG. 1A 15V	.69
IL-1 OPTO ISOLATOR MINI DIP	.60
*MEM 631 DUAL GATE MOSFET, DIODE PROTECTED, SIMILAR TO 40673	.50
MV1624 VARICAP DIODE 10 PFD	.49
1N4003 1A 200V DIODE	15/1.00
TIP30 TAB PNP POWER	3/1.00
*MC1351P FM IF, DISC IC	.50

*INDICATES ITEM IS "HOUSE NUMBERED"

LED'S

JUMBO GREEN	4/.89
JUMBO RED	5/.89
MEDIUM RED (⅛")	.15
MEDIUM GRN OR YELLOW	.16

7 WATT AUDIO AMP KIT
SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12 VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.
$5.95

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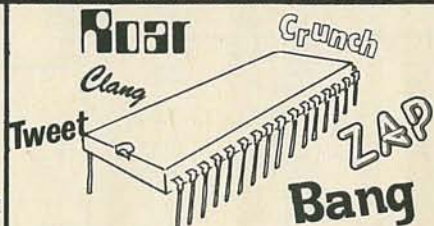

AY3-8910 PROGRAMMABLE SOUND GENERATOR
The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

$14.95 W/Basic Spec Sheet (4 pages)
60 page manual with S-100 interface instructions and several programming examples, **$3.00 extra**

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74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	276-1920	.99
74LS76	276-1921	.79
74LS85	276-1922	1.29
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74LS92	276-1924	.99
74LS93	276-1925	.99
74LS123	276-1926	1.19
74LS132	276-1927	.99
74LS151	276-1929	.99
74LS157	276-1930	1.19
74LS161	276-1931	1.49
74LS164	276-1932	1.49
74LS175	276-1934	1.19
74LS192	276-1935	1.49
74LS193	276-1936	1.49
74LS194	276-1937	1.49
74LS196	276-1938	1.59
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74LS368	276-1836	1.19
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4027	276-2427	.99
4028	276-2428	1.29
4046	276-2446	1.89
4511	276-2447	1.69
4049	276-2449	.79
4050	276-2450	.79
4051	276-2451	1.49
4066	276-2466	1.39
4070	276-2470	.79
4518	276-2490	1.49
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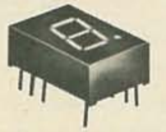
All Prime from Major Semiconductor Manufacturers. Specs and Pin Out Diagram Included with Each Device.

NEW! Rectangular LED Lamps

99¢ Pkg. of 2

High-brightness. Can be stacked vertically or horizontally. Max. forward current: 30 mA. Typical forward voltage: 2.5.
276-070. Red. .... 2/99¢
276-071. Green .... 2/99¢
276-072. Yellow. .... 2/99¢

NEW! Pair of LED Digits



1.98

These 10mm 7-segment, red displays are ideal low-cost readouts for any projects. For multiplexed or direct drive. Max. forward current: 45mA/segment.
Common Anode. 276-1643 ..... 2/1.98
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CMOS IC with 17 binary divider stages produces a highly stable 60 Hz square wave. Uses a TV 3.58 MHz crystal reference. Very low power operation over wide 3-15VDC range. 8-pin DIP.
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LM3914N. Features 10 adjustable analog steps, bar or dot display mode. Current-regulated LED ouputs. 8 to 25VDC supply. 18-pin DIP. **276-1707** 3.49

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Convert light to electrical power. All deliver 0.45V at rated current. Use several in series/parallel for higher voltages or current.
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Open-Collector Output

Detects magnetic fields electronically. 750 gauss "on" threshold. Constant amplitude independent of frequency. Similar to type ULN 3006. Ideal for tachs, position sensing, pulse counting. 5 to 16V supply. TO-92 case. With data.
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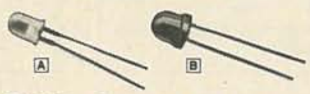
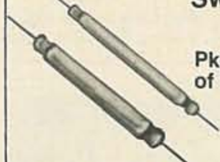
Unique LEDs



[A] **Tri-Color.** Displays red, green, yellow. Uniform light output of 0.6 mcd. Forward voltage: 2.2VDC. Max. current: 25mA. T1-¾ case style.
276-035 .... 1.39

[B] **Red Flasher.** Operates directly from 5VDC power source. Pulse rate: 3 Hz. Max. current: 20 mA at 5VDC.
276-036 .... 1.29

10 Assorted Mini Reed Switches



Pkg. of 10 **1.98**

Hermetically sealed. Gold-plated contacts close when magnetic field is present. Includes mini and micro types.
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Permanent Magnet Motors

99¢ Pkg. of 2

Up to 10,000 RPM at no load. Long leads for easy hook-up. Motor is 1½x⅞". Shaft, 5/64x¼".
273-206 .... 2/99¢

12/24-Hr. LCD Clock Module

19.95

Actual Size

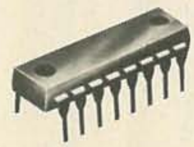
24-Hour Alarm
Shows Time/Day/Date

Complete clock module — just add switches and battery! 0.25" LCD display has built-in backlight, alarm set, PM and snooze indicators. Operates up to a year on single 1.5V battery. Accuracy: ±13 seconds per month. **277-1005** 19.95

Top Octave Synthesizer IC

NEW!

6.99



S50240. PMOS oscillator/frequency divider chip generates 13 equal-tempered notes from C_8 to C_8 to form the heart of any electronic keyboard instrument. CMOS compatible square wave outputs have 50% duty cycle for driving additional dividers or voice filters. Operates from single supply from 11 to 16 volts. 16-pin DIP.
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MC14553 3-Digit BCD Counter IC

2.99

CMOS chip replaces over 8 separate ICs in a digital display circuit. Input pulse shaping. Master reset pin. 16-pin DIP.
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Low As **2.49**

2102 1024 x 1 Array. Low-cost static memory chip. 16-pin DIP. Buy 8 and save!
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2114L 1024 x 4 Array. NMOS static RAM. 18-pin DIP. **276-2504** 10.99

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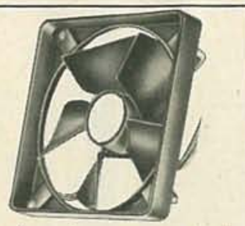
Super Quiet Operation



Ideal for cooling power supplies, microcomputers, hi-fi and Ham gear. Delivers up to 70 CFM. Diecast venturi. U.L. recognized motor. For 120VAC, 60 Hz.
273-241 .... 12.95

Dual Analog Delay IC

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Continuously Variable — Many Audio Applications

SAD1024A. "Bucket Brigade" device has 2 separate 512-stage shift registers which can be used independently or in combination. Provides continuously variable electronic delay for complex audio signals to create reverb, echo, phase shift, chorus and vibrato effects. Reliable NMOS design operates from single supply. With applications circuits and data. 16-pin DIP. **276-1761** 10.95

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Quest ELECTRONICS

NEW PRODUCTS!

Super Color S-100 Video Kit $99.95
Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Gremlin Color Video Kit $59.95
32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. Not expandable to high resolution Graphics.

Elf II Adapter Kit $24.50
Plugs into Elf II providing Super Elf 44 and 50 pin bus plus S-100 bus expansion (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

1802 16K Dynamic RAM Kit $149.00
1802/S-100 expandable to 32K, Hidden refresh w/clocks up to 4 MHz w/no wait states Addl. 16K RAM **$79.00.**

Quest Super Basic

Quest, the leader in inexpensive 1802 systems announces another first. Quest is the first company worldwide to ship a **full size Basic** for 1802 systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range ±.17E[38]), 32 bit integer ±2 billion; Multi dim arrays; String arrays; String manipulation; Cassette I/O, Save and load, Basic, Data and machine language programs; and over 75 Statements, Functions and Operators.

Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

Super Basic on Cassette **$40.00**

Tom Pittman's 1802 Tiny Basic Source listing now available. Find out how Tom Pittman wrote Tiny Basic and how to get the most out of it. Never offered before. **$19.00**

S-100 4-Slot Expansion **$ 9.95**

Super Monitor VI.I Source Listing **$15.00**

Coming Soon: Assembler, Editor, Disassembler, DA/AD, Super Sound/Music, EPROM programmer.

RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic Cassette **$10.00,** on ROM **$38.00,** original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface.** Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf.** The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $15.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

7400TTL	
7400N	.17
7402N	.18
7404N	.19
7409N	.23
7410N	.18
7414N	.70
7420N	.18
7422N	.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.18
7474N	.35
7475N	.49
7485N	.88
7489N	1.85
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.35
74121N	.34
74123N	.59
74125N	.45
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.69
74161N	.87
74162N	.87
74163N	.87
74174N	.96
74175N	.90
74190N	1.15
74192N	.87
74193N	.85
74221N	2.00
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL	
74LS00N	.35
74LS02N	.35
74LS04N	.35
74LS05N	.35
74LS08N	.35
74LS10N	.35
74LS13N	.55
74LS14N	1.10
74LS20N	.35
74LS22N	.35
74LS28N	.41
74LS30N	.35
74LS33N	.75
74LS38N	.55
74LS74N	1.25
74LS75N	1.00
74LS90N	.85
74LS93N	.70
74LS95N	1.10
74LS107N	.45
74LS112N	.45
74LS113N	.35
74LS132N	.89
74LS136N	.45
74LS151N	.85
74LS155N	.85
74LS157N	.85
74LS162N	1.15
74LS163N	1.15
74LS174N	2.00
74LS190N	1.06
74LS221N	1.95
74LS258N	.67
74LS367N	1.35

LINEAR	
CA3045	.90
CA3046	1.10
CA3081	1.80
CA3082	1.90
CA3089	2.95
LM301AN/AH	.35
LM305H	.87
LM307N	.35
LM308N	.89
LM309K	1.50
LM311H/N	.90
LM317T/K	3.75
LM318	1.35
LM320K-5	1.50
LM323K-5	5.95
LM320K-12	1.50
LM320K-15	1.50
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM343H	4.50
LM350	7.50
LM370	1.15
LM377	3.00
LM379	5.00
LM380N	1.00
LM381	1.60
LM382	1.60
LM703H	.40
LM709H	.28
LM723H/N	.50
LM733N	.67
LM741CH	.35
LM741N	.32
LM747H/N	.75
LM748N	.35
LM1303N	1.75
LM1304	1.10
LM1305	1.27
LM1307	2.00
LM1310	2.75
LM1458	.47
LM1800	1.75
LM1812	7.50
LM1889	3.00
LM2111	1.75
LM2902	1.50
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LM3905	1.75
LM3909N	.89
MC1458V	.50
NE540H	3.75
NE550N	1.00
NE555V	.39
NE556A	.85
NE565A	1.00
NE566V	1.50
NE567V	1.00
NE570B	5.00
78L05	.60
78L08	.60
78M05	.85
75108	1.75
75491CN	.50
75492CN	.55
75494CN	.89

A to D CONVERTER	
8038B	4.50
8700CJ	13.95
8701CN	22.00
8750CJ	13.95
LD130	9.95
9400CJV/F	7.40
ICL7103	9.50
ICL7107	14.25

CMOS	
CD34001 Fair.	.50
CD4000	.16
CD4001	.28
CD4002	.28
CD4006	1.10
CD4007	.28
CD4008	.28
CD4009	.45
CD4010	.45
CD4011	.28
CD4012	.28
CD4013	.39
CD4014	1.00
CD4015	1.00
CD4016	.45
CD4017	1.05
CD4018	.94
CD4019	.45
CD4020	1.02
CD4021	1.25
CD4022	1.10
CD4023	.28
CD4024	.75
CD4025	.28
CD4026	2.00
CD4027	.66
CD4028	.85
CD4029	1.02
CD4030	.45
CD4035	1.02
CD4040	1.02
CD4042	.85
CD4043	.85
CD4044	.85
CD4046	1.67
CD4049	.45
CD4050	.49
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	.40
CD4070	.50
CD4071	.28
CD4072	.28
CD4073	.28
CD4075	.28
CD4076	1.45
CD4078	.40
CD4081	.28
CD4082	.28
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74C04	.40
74C10	.28
74C14	2.10
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74C30	.28
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74C76	1.40
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74C93	1.40
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74C914	1.95
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8096	.65
8097	.65
8098	.65
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8T13	3.00
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8T24	3.50
8T25	3.20
8T26	1.69
8T28	2.75
8T97	1.69
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2102-1	.95
2102AL-4	1.25
2102AN-2L	1.60
21L02-1	1.18
21F02	1.25
2104A-4	4.95
2107B-4	3.75
2111-1	3.75
2112-2	3.95
2114L-1	7.40
2114L-3	7.90
4116	10.95
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MM5262	.40
MM5280	3.00
MM5320	9.95
MM5330	5.94
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P5101L	13.95
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82S25	2.90
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GIAY38500-1	9.95
MCM6571A	9.95
9368	3.50
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416	16.00

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MM5841	14.45
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CT7010	8.95
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2708	10.50
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2716 Intel	48.00
2732	115.00
2758	22.50
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8748	75.00
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8755A	65.00
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N82S129	3.75
N82S131	3.75
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N82S137	8.75
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100 pin edge	4.50
100 pin edge WW	5.25

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8	.15	22	.30
14	.14	24	.35
16	.16	28	.42
18	.27	36	.58
20	.29	40	.57

2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	.32	24	.88
16	.33	28	1.00
18	.57	40	1.23

CRYSTALS	
1 MHz	4.50
2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 MHz	4.00
1.8432 MHz	4.50
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2.4576 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
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5.7143 MHz	4.50
6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
22.1184 MHz	4.50

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AY5-3600	17.95
74C922	5.50
74C923	5.50
HD0165-5	6.95

D Connectors RS232	
DB25P	2.95
DB25S	3.95
Cover	1.50
RS232 Complete Set	6.50
DE9S	1.95
DA15P	2.10
DA15S	3.10

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Auto Clock Kit	17.95

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2N1893	.40
2N222A	.27
2N2369	.30
2N2904A	.20
2N2907A	.25
2N3053	.40
2N3638	.25
2N3643	.25
2N3904	.18
2N3906	.18
2N3055	.69
2N4400	.25
2N4401	.75
2N4402	.20
TIP31	.60
TIP33A	1.00

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25 per type .025	350 piece pack
100 per type .015	5 per type 6.75
½ watt 5% per type .05	

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Green, Yellow T018	.20
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DL727/728	CA/CC	.500	1.90
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DL750	CC	.600	1.95
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FND500/507	CC/CA	.500	1.35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2.20
3 digit Bubble			.60
4 digit Bubble			.80
DG8 Fluorescent			1.75
DG10 Fluorescent			1.75
5 digit 14 pin display			1.00
NSN69 9 digit display			.60
7520 Clairex photocells			.39
TIL311 Hex			9.50
MAN3640	CC	.30	1.10
MAN4610	CA	.40	1.20
MAN4640	CC	.40	1.20
MAN4710	CA	.40	.95
MAN4740	CC	.40	1.20
MAN6640	CC	.56	2.95
MAN6710	CA	.60	1.35
MAN6740	CC	.60	1.35
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MA1012A		**8.95**	
102P3 transformer		**2.25**	

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4013	.40	4042	.85	74C00	.27	74C173	1.30
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4016	.45	4046	1.95	74C10	.27	74C192	1.30
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4018	.90	4050	.45	74C20	.27	74C801	.50
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4020	1.10	4051	1.10	74C73	.75	74C914	1.90
4021	1.10	4053	1.10	74C74	.50		
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7409	.24	7485	.75	74170	1.60
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7432	.27	74123	.42	74195	.65
7437	.27	74125	.45	74196	.85
7438	.27	74126	.45	74197	.85
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