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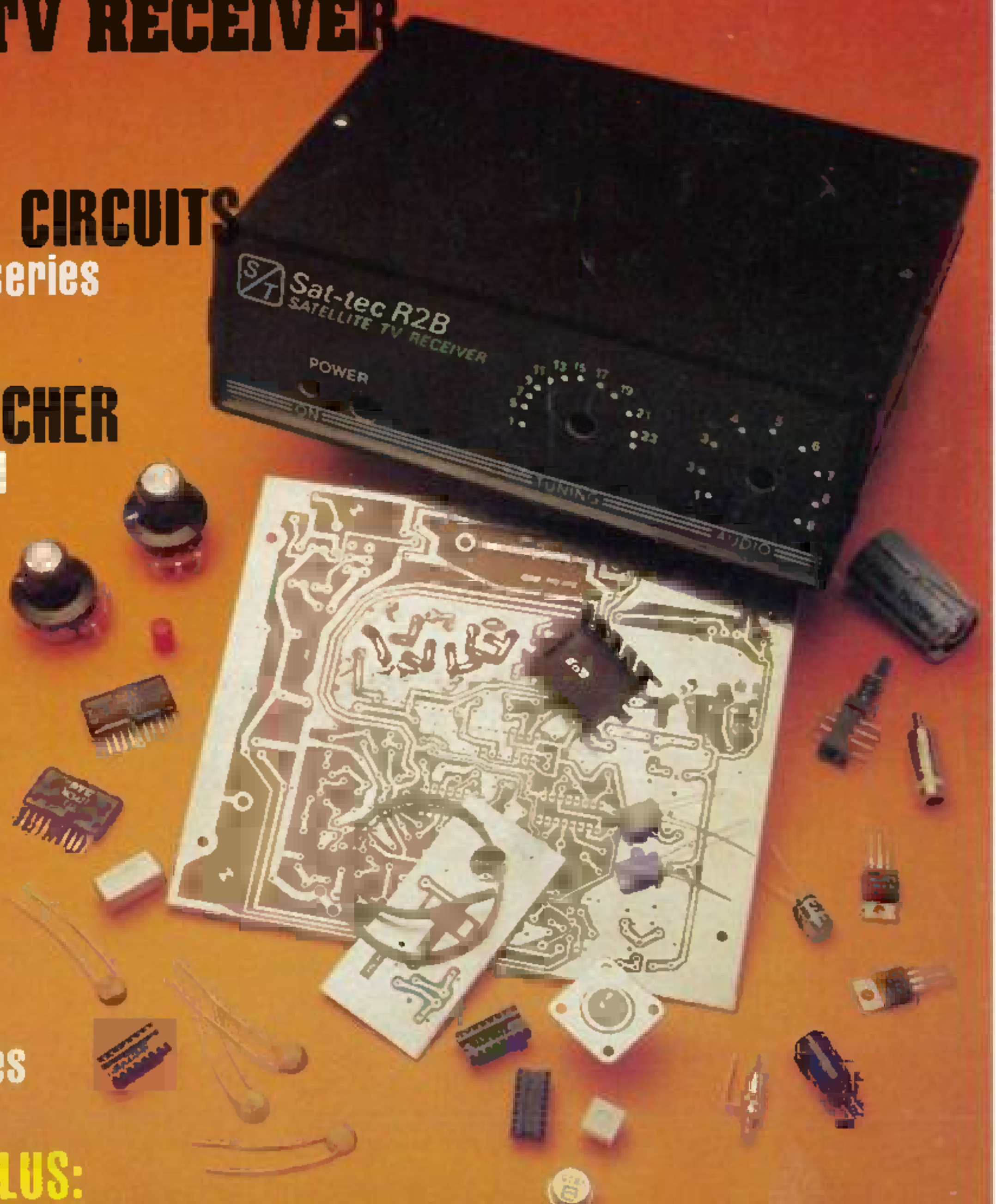

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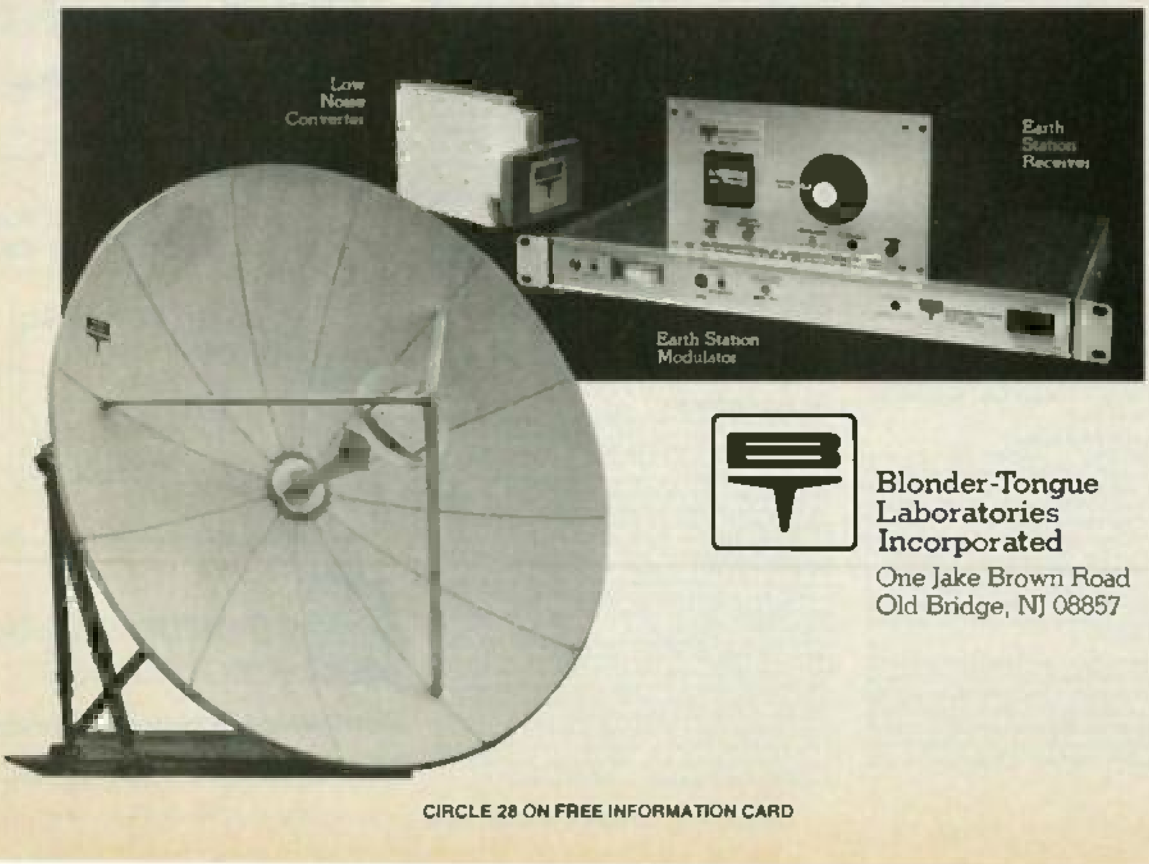

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Memorex Flexible Discs will be replaced free of charge by Memorex if they are found to be defective in materials or workmanship within one year of the date of purchase. Other than replacement, Memorex will not be responsible for any damages or losses (including consequential damages) caused by the use of Memorex Flexible Discs.

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To get the fastest delivery from CE of your Memorex Flexible Discs, send or phone your order directly to our Computer Products Division. Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. Written purchase orders are accepted from approved Government agencies and most well rated firms at a 30% surcharge for net 30 billing. All sales are subject to availability, acceptance and verification. All sales are final. Prices, terms and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless CE is instructed differently. Minimum order $50.00. International orders are invited with a $20.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Non-certified and foreign checks require bank clearance.

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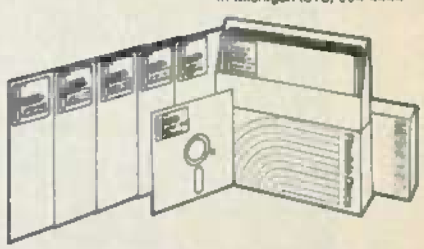

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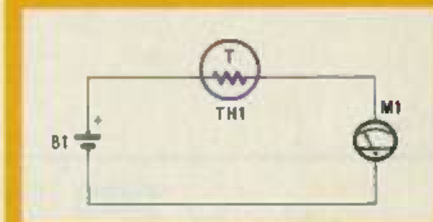
ON THE COVER

Build this high-quality satellite TV receiver for under $500. Add a satellite TV antenna and LNA for a complete TV earth station. The kit comes with a pre-aligned IF strip and LNA power supply. Get started building your satellite receiver today. Turn to page 49.



HOW TO DESIGN analog circuits is a new 11-part series on analog components and how to apply them. This month, thermistors and varistors are covered. The story starts on page 57.

AUTOMATIC POWER SWITCHER solves the problem of having to turn on multiple power switches in your hi-fi or computer system. Throw one switch and the power switcher does the rest automatically. Construction starts on page 54.

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

DISC REALIGNMENT

Growing pains and early problems have caught up with the infant videodisc industry, resulting in some major changes and realignments. In the optical LaserVision camp, the two early prime movers—IBM and MCA—now are out of the action so far as manufacturing is concerned, and Pioneer is in the driver's seat, along with Philips. Plagued by slow deliveries and a high reject rate, DiscoVision Associates, a jointly owned IBM-MCA venture, closed its Carson, CA plant, and now exists only as a patent-licensing company.

Pioneer Electronics (Japan) purchased DiscoVision's 50% interest in Universal-Pioneer, which masters and presses optical discs in Kofu, Japan. With the closing of the Carson plant, the only major source of optical videodiscs was Japan, where Pioneer is pressing consumer and industrial discs and Sony is pressing industrial discs only. However, a new U.S. facility for optical discs has just been opened by 3M in Menomonie, WI, and a new firm—Vidisco, headed by David Paul Gregg, an engineer who led the early development of the optical disc—at press time was bidding for the Carson facility. Another company, Quixote Corp., plans to press industrial optical discs using a new fast process. Philips expects to open a disc plant in Blackburn, England this year.

North American Philips isn't giving up on the disc. Its Magnavox Magnavision player, which has come in second to Pioneer's unit in features, will be replaced temporarily by one made in Japan by Pioneer around midyear. Probably it wil be sold under Philips' Magnavox, Sylvania, and Philco brand names, until a completely new Philips-developed model is ready in 1983.

RCA DISC PRICE SLASHED

Meanwhile, RCA's CED system has also been having its share of troubles. Player sales last year simply failed to meet projections, and competitive compatible players have been for sale at extremely low prices. However, RCA was surprised by the almost insatiable demand for discs from people who did buy its players; those who owned them for eight months or more purchased an average of 23 discs. As a result, RCA's marketing philosophy seems to have changed to one of wooing disc sales by offering players at low prices. RCA introduced a new model of its basic (monophonic) player with a suggested list price of $349.95, down $150 from its original model (which is virtually the same as the new one), and offered the older model to dealers at an even sharper discount. RCA plans to introduce a stereo-sound model during this spring and a wireless remote version in the fall.

LOOKMAN

Sony has introduced a sort of "video Walkman" in Japan, and probably will market it in the U.S. later this year. The 2-inch picture is provided by the first flat TV tube to be sold on the consumer market. The "FD" (Flat Display) tube resembles a small table-tennis paddle, its electron gun being parallel to the screen rather than perpendicular. The tube itself is about ⅝-inch thick, 2.17 inches wide, 5.24 inches deep; the TV set is smaller than a paperback book, and can be operated for 2½ hours on four AA alkaline cells. Another flat TV, using a 3-inch tube based on the same principle, has been developed by Sinclair Research of the U.K. and is to be built by Timex in Scotland for introduction here this year. Sony's Flat TV sells for about $240 in Japan. R-E

"No one else gives you as many functions in a handheld DMM.

Now you can move up to Fluke."

We've got great news for people who've been holding out for a high quality, high performance DMM at a moderate price: Fluke's new nine-function model D 801 is now available at select electronics supply stores.

With a suggested U.S. price of only $249 and features you won't find in any other handheld DMM, the D 801 is an exceptional value. Here's why.

Logic level and continuity testing: A real timesaver for troubleshooting passive circuits in pcb's, cables, relay panels and the like. The D 801 has a switch-selectable audible tone and visual symbols to indicate continuity or logic levels.

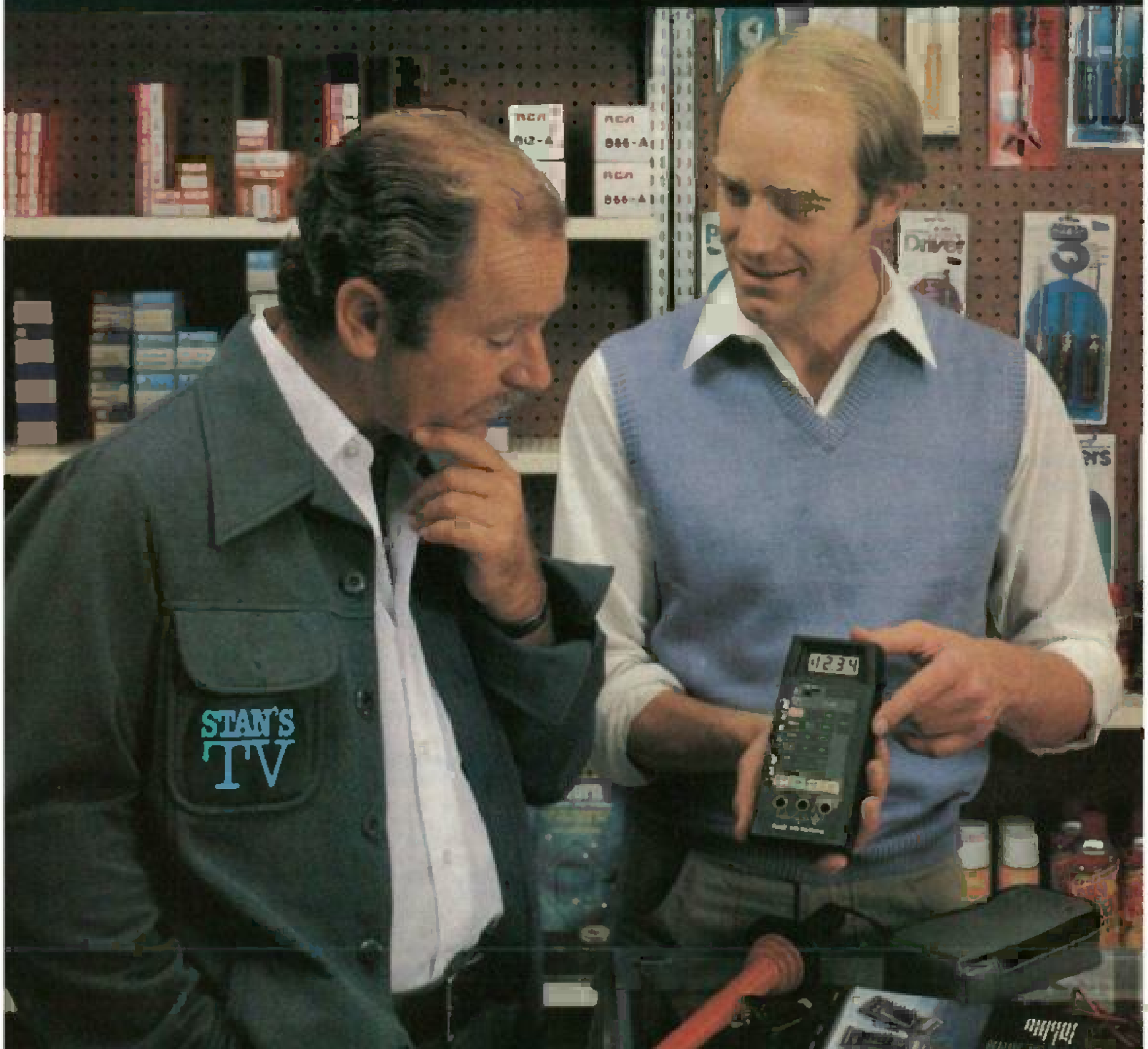
Direct temperature readings in °C: Used with any K-type thermocouple, the D 801 delivers fully-compensated readings in °C from -20°C to +1265°C, for checking heating and refrigeration systems.

Peak hold feature captures transients: A short-term memory in the D 801 captures and holds the peak reading of a motor starting current.

And more: 0.1% basic dc accuracy, conductance, 26 measurement ranges, battery, safety-designed test leads and a one year parts and labor warranty. A full line of accessories is also available to extend the measurement capabilities of your DMM.

Ask your dealer about the powerful, versatile D 801 and the rest of Fluke's new Series D line of low-cost digital multimeters.

From the world leader in DMM's. Now we've designed one for you.



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If your dealer doesn't carry Series D Multimeters yet, call this number. We'll be happy to tell you who does. 1-800-426-9182

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WHAT'S NEWS

U.S. semiconductors now equal Japan's

The quality of American 16K RAM semiconductors is now running neck-and-neck with that of their Japanese counterparts, reports Richard W. Anderson, general manager of the Hewlett-Packard Computer Systems division. "So far as 16K memory parts are concerned, the contest is now more nearly company-versus-company than country-versus-country, though we have yet to find a U.S. supplier who consistently matches the best of the Japanese," he says.

Failure rates among units from six suppliers—three of those Japanese and three were American—ran from 7 to 30 failures per 10,000 units, says Anderson. Both the highest and lowest failure rates were in semiconductors from Japanese suppliers, he said.

United States Mail goes electronic

Electronic Computer-Originated Mail (E-COM) became part of the postal technology last January. It offers large mailers considerable economy in distributing their computer-originated mail.

E-COM mail starts in a computer, as does much of the other mail today. It is transferred to magnetic tape and transmitted by telephone line (or other communications carrier) to one of the 25 "Serving Post Offices" of the system. From there it is transmitted electronically to any of the other 24 post offices in the net. The electronic message is then printed out, trimmed, folded, and placed in envelopes with the address showing through a window in the front. Delivery is by first-class mail.

Twenty-five post offices began the service. Others will be added as expedient.

E-COM EQUIPMENT UNDER TEST at the RCA Government Communications Systems, Camden, NJ. (RCA supplied the equipment for the new system, on a $31-million contract.) The system accepts inputs from a customer's computer-generated magnetic tape or from a computer via private telecommunications carriers and transmits it to the electronic center designated by the customer, where it is printed, trimmed, folded, placed in envelopes, and delivered by first-class mail.

Casio is now making a personal computer

THE CASIO FX-9000P personal computer. The basic unit comes with a 4K RAM, a 5.5-inch built-in CRT, very extensive high-resolution graphics, and powerful mathematical functions for scientific, engineering and statistical operations.

Casio Inc. has added to its line a new sophisticated personal desktop computer, which can be expanded up to 32K bytes of Random-Access Memory (RAM). A unique feature is the 4K CMOS (Complementary Metal Oxide Semiconductor) RAM cartridges, on which programs can be sotred for quick access for up to three years.

A high-resolution graphic function can express various tables, patterns, and graphs, thus simplifying analysis of experimental results or business data. Hard copies can be obtained with an optional graphic printer.

Powerful mathematical functions include standard deviation, regression analysis, and correlation coefficient.

The system uses a high-level, semi-compiled, problem-solving basic language, CBASIC. An easily understood grammer and versatile command group make it easy to master.

Suggested list price for the Casio *FX9000P* is $1,199. Numerous options are also available for the computer.

RCA videocassette now plays 8 hours

A new RCA long-play tape expands the recording capability of the "SelectaVision" video cassette recorder to a full eight hours. The new videotape permits packaging one-third more tape in a standard VHS cassette, resulting in an extension of playing time from six to eight hours in the SLP mode.

The deluxe 8-hour tape cassette, *VK330*, carries an optional retail price of $32.95. Two previous blank-tape cassettes, the *VK125* and *VK250*, with recording times of three and six hours respectively, will remain in the line.

Five new standards published by EIA

The Engineering Department of the Electronic Industries Association announces five new or updated standards.

RS-483, "Standard Method of Test for Effective Series Resistance (ESR) and Capacitance of Multilayer Ceramic Capacitors at High Frequencies," is the first of its kind for such measurements. A low-ESR transmission line has been constructed, and a mathematical system devised for using it in a resonant mode to determine capacitor parameters, particularly ESR, up to microwave frequencies. Copies of RS-483 are priced at $10.00.

RS-311-A, "Measurement of Transistor Noise Figure and Effective Noise Temperature at MF, HF and VHF" revises RS-311, adding information necessary for "effective input noise temperature" measurements. Copies of RS-311-A are priced at $6.00 each.

RS-381-A updates RS-381, clarifying the method used to measure "Q" of a voltage-variable-capacitance diode in the low VHF range, using an RF admittance bridge. It is available at $6.50 each.

RS-490, "Standard Test Methods of Measurement for Audio Amplifiers," replaces EIA

continued on page 12

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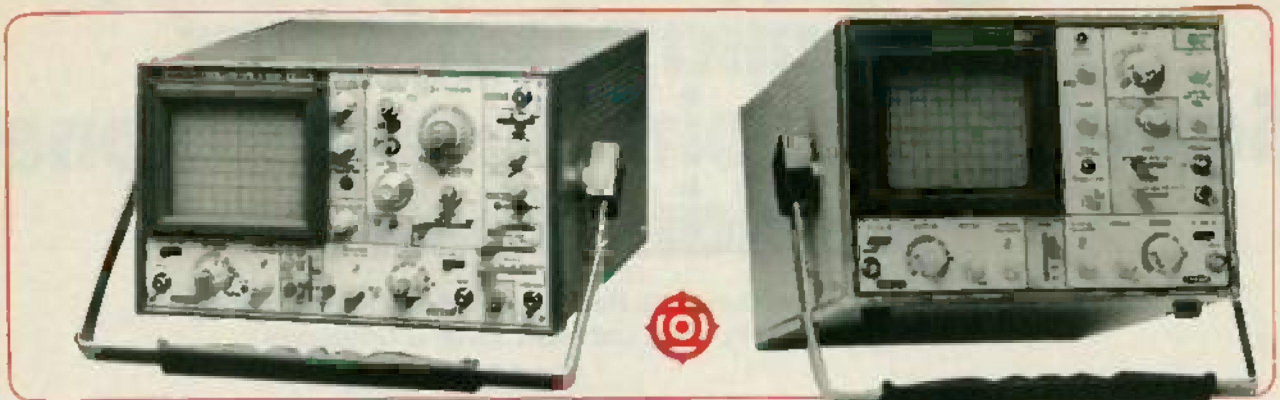

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*USING x10 PROBE
†USING x10 PROBE WITH MAGNIFIER
‡We had to obtain this specification by phone from Tektronics because it was not listed in the literature

Until now, if you wanted a 50MHz or 100MHz dual trace oscilloscope of uncompromising quality, there was only one choice. Now there is a second... outstanding new delay sweep with an established name — the Hitachi V550B and the V1050.

The HITACHI V550B (50MHz) and V1050 (100MHz) offer all the capabilities you might demand from a lab grade oscilloscope. Capabilities such as a max. sweep rate of 2ns/div (V1050) 5ns/div V550B). Also features you may not expect, like sensitivity of 1 mv/div (V550B) .5mv/div (V1050) @ 10MHz, automatic focus correction, and a built-in TV sync separator circuit.

The cost? Remarkably reasonable, expecially when you compare it to the other leading 50MHz or 100MHz Dual trace oscilloscopes. It's a price breakthrough made possible by using up-to-date production techniques and a design backed up by over 20 years of oscilloscope experience.

HITACHI Oscilloscopes are innovative oscilloscopes designed and manufactured by Hitachi Denshi Ltd. The wide experience gained by HITACHI electronic specialists in producing oscilloscopes has resulted in this line of modern oscilloscopes featuring wider band width, more compact design and light weight. Through adopting circuitry with linear IC's and logic IC's plus modern manufacturing techniques, including automatic component-insertion machines. These oscilloscopes offer increased stability, improved reliability, excellent performance and enhanced operating ease.

The panel layout is designed to create maximum operating ease by considering measuring processes and operation frequency. The layout is divided into three blocks according to respective functions identified by different colors. This convenience-oriented design for users improves daily controllability and drastically reduces operating errors.

Everybody's making money selling microcomputers. Somebody's going to make money servicing them.

New NRI Home-Study Course Shows You How to Make Money Servicing, Repairing, and Programming Personal and Small Business Computers

WHAT'S NEWS

continued from page 6

Interim Standard No. 2. which replaced IHF-A-202 published in 1978 by the Institute of High Fidelity. Copies are $8.00 each.

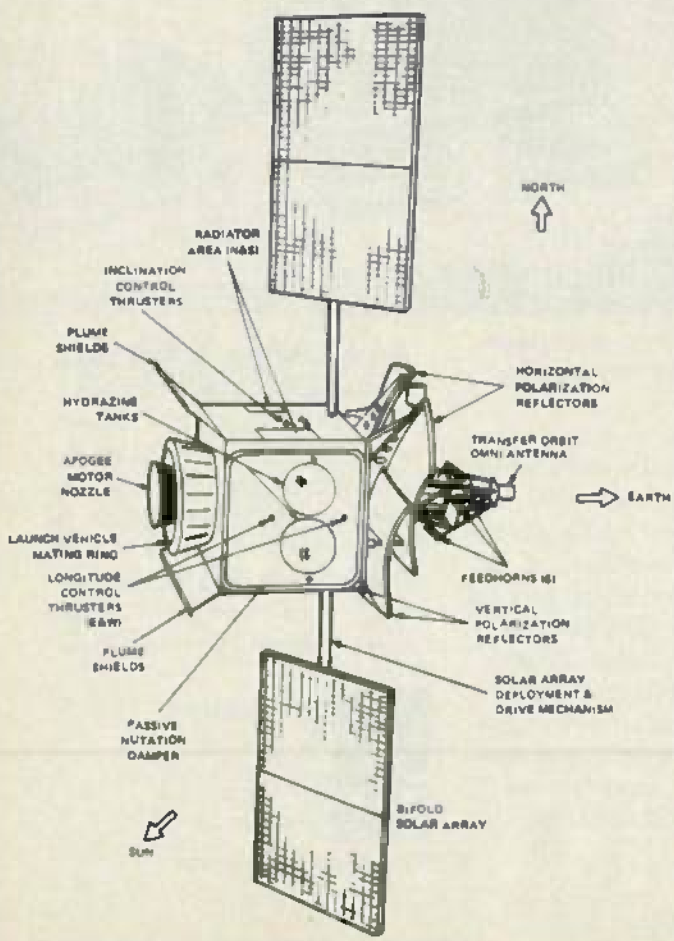
RS-475. "Generic Specifications for Fiber Optic Connectors," covers all fiber-optic connector types. Price is $7.00 each.

Copies of all the above are available from the Standard Sales Office, Electronic Industries Association, 2001 Eye St. N.W., Washington, DC 20006. A free catalog of EIA and JEDEC standards and engineering publications is also available.

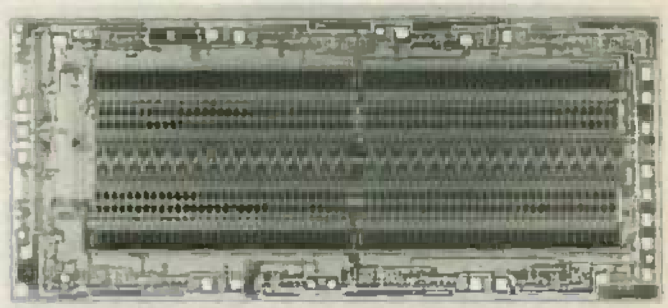
Domestic satellites now number fourteen

With the launching of RCA's Satcom IV on January 14, there were the equivalent of 14 U.S. domestic satellites in orbit. Like its predecessors, Satcoms, I, II, and III-R, Satcom IV has 24 channels, each of which can carry 1,400 voice circuits, one FM/color-TV transmission, or 64 megabits of computer data per second. The satellites cover all 50 states and Puerto Rico.

With Satcom IV, RCA Americom has two satellites dedicated to cable TV. They have a combined programming capacity of more than 1,000 hours per day. There are now 22 million U.S. homes served by cable TV, and nearly all of them receive at least one satellite-relayed channel of programs.



AN RCA SATCOM, with the various parts identified.



HEART OF GE'S NEW CIRCUIT for detecting radio signals through extreme interference is a pair of 128-point binary-analog computers in the central part of the chip. That chip was developed by scientists at the GE Research and Development Center at Schenectady, NY.

Interference cut by new GE device

At the recent International Solid State Circuits Conference of the IEEE in San Francisco, General Electric scientists described microelectronic device that improves radio communications where there's extreme noise or interference.

The device—called a surface-charge correlator—is intended for military applications. It will allow effective communication under combat conditions where the frequencies are jammed by the enemy.

The tiny (0.110 × 0.265 inch) circuit chip will recognize and amplify specially-coded signals containing voice communications, while discarding jamming noise. It does that by a series of multiplying and adding operations—at the rate of over a billion calculations a second. Through those calculations, the device can judge the degree of correlation between incoming signals and a special code programmed into its memory.

If the degree of correlation is high, the device concludes that the radio signal contains the desired voice data. Signals with a low degree of correlation are dismissed as noise. The desired data, containing the voice material, is amplified and passed on to a decoder, which reassembles them into recognizable words.

Ford moving toward semiautomatic travel?

This year selected car models in the Ford lineup will carry the company's second-generation Message Center that seems to some to be an approach toward the automatic road control system of the future. The Message Center is part of the standard instrument panel on the new Continental. Another version, the "Tripminder," is optional on the Mercury-Marquis, Cougar XR-7, and Ford LTD and Thunderbird. The optional "Trip Computer" will be available on the European Ford Granada.

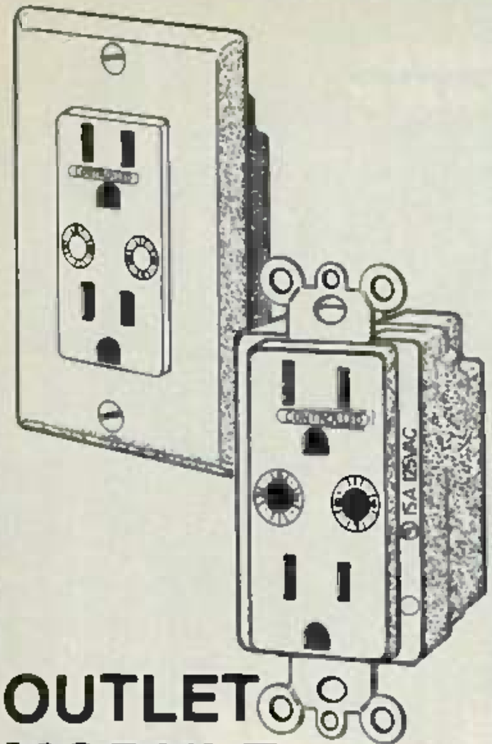
All three will show the day, date, elapsed trip time, distance travels, average speed, and instantaneous and average fuel consumption. The Continental's Message Center can also be programmed to show the estimated time of arrival and distance to destination. It also shows the distance that can be traveled on the fuel remaining in the tank, as does the Trip Computer.

The systems are produced by Philco-Ford of Canada Ltd., use National Semiconductor's 8050 microprocessors.

3M's videodisc plant is now in operation

3M has opened a complete videodisc mastering and replication facility in Menomonie, WI. (about 50 miles from the company's St. Paul headquarters.) The plant was in a modified start-up mode for several months before the opening, while testing the sophisticated equipment used in 3M's proprietary replication process.

The discs are compatible with Magnavox, Pioneer, Sony, and Discovision players. R-E



OUTLET MODULE

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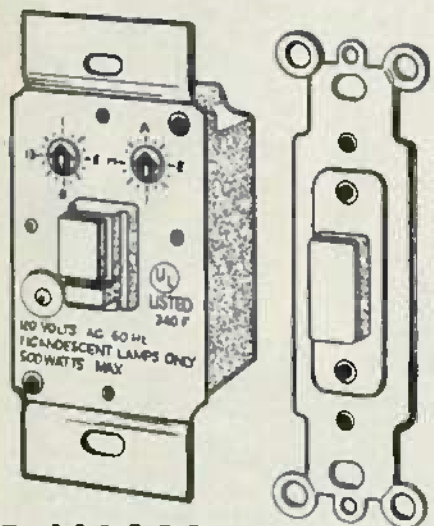

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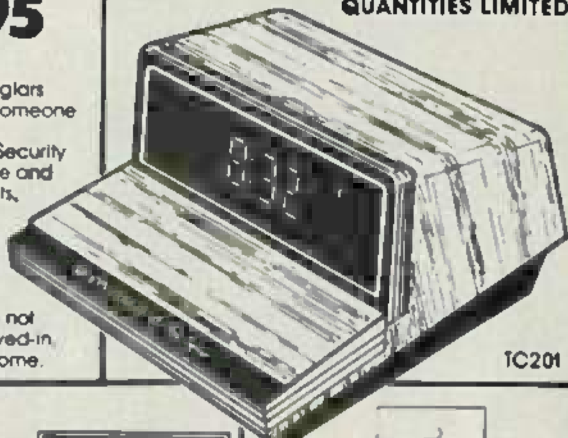

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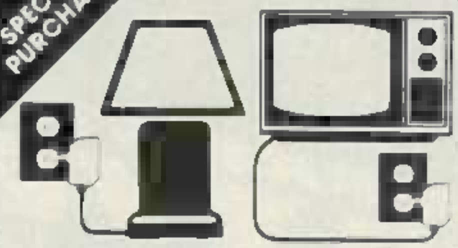

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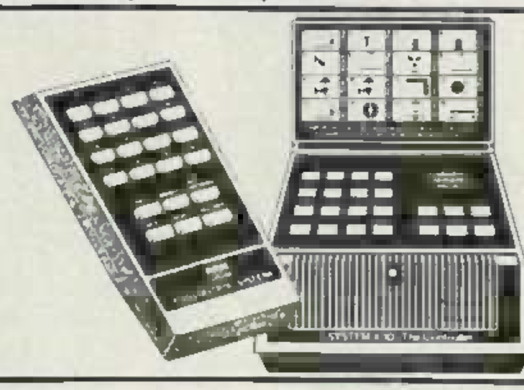

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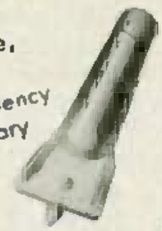

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CIRCLE 17 ON FREE INFORMATION CARD

EDITORIAL

Cable-TV Interference

You may feel that subscribing to a cable-TV service, will put an end to your TV reception and inteference programs. Unfortunately, that is not always true. As it turns out, midband cable-TV channels overlap VHF amateur radio bands and, among other sources, offending interference could be from your neighbor's ham rig. But before you decide to expand your junk box with parts from your neighbor's rig, let's take a closer look at the problem.

The cable-TV company transmits over shielded coaxial cable lines. A "leaky" cable will not only "receive" interference, but will also permit the cable signal to escape and be transmitted as interference. If your cable turns out to be leaky, it's unusually the result of poor installation.

If you should track the source of your cable interference to your neighbor's rig, remember that at the same time you are probably interfering with his amateur transmissions. To control that sticky situation, the FCC has restricted the maximum allowable leakage level from the cable to 20 μV-per-meter measured at a distance of 10 feet from the cable over a frequency range of 54 MHz to 216 MHz. Unfortunately, the FCC hasn't aggressively tracked down or taken action against offending cable companies. If you find interference in your cable-TV reception, report it to the cable company; they're responsible!

Recently, the FCC has proposed to increase the maximum allowable leakage level from 20 μV to 100 μV. In response, the ARRL (*A*merican *R*adio *R*elay *L*eague) has filed a petition against the proposed change. In its petition, the ARRL argues that "the Committee's recommendation constitutes acceptance of poor engineering practices of the cable industry and encourages expansion of an existing problem." We fully agree and support the ARRL in its petition. We hope that the FCC decides against this latest proposal and acts to enforce the existing regulation.

Art Kleiman

ART KLEIMAN
Editor

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

QUASI-TELETEXT SERVICES

A new hybrid teletext service that offers electronic listings of tonight's TV programs is now being delivered via the vertical blanking-interval of United Video's transponder 3 on Satcom III, the circuit that carries superstation WGN. "Electronic Program Guide"—EPG—carries hour-by-hour listings of shows appearing on cable-TV channels of cable systems that subscribe to the service. The EPG line-up is formatted specifically for each cable system, then beamed down the vertical interval, addressed so that each cable system picks up only the listings for its own programming. That makes it possible for systems to tailor the directories—and the ads—to their local needs since each system carries different pay TV channels and other services.

Another text service is available on the vertical interval of Satcom III Transponder 6, the circuit that carries superstation WTBS. Dow Jones Cable News, a continuous read-out of business and financial news, is the latest addition to the CableText package developed by Satellite Syndicated Systems.

NEW TVRO EQUIPMENT

New home-satellite reception equipment seems to be stabilizing in the price range under $3,000, according to indications at the latest Consumer Electronics Show where dozens of devices were on display. Sizable new companies are also getting into the business which could lead to more research, industry clout, and innovation.

For example, Boman Industries, a familiar name in the car-stereo market, has plunged into the home-satellite business, offering several packages of equipment that will retail for under $3,000. Its new 3.3-meter antennas can be put on several new mounts, including a 4-point AZ/EL mount that permits precision settings for azimuth and elevation positions. Bomar is offering three receivers, with its top-of-the-line model *SR-1000* including automatic frequency control, pushbutton controls for satellite-search antenna motor drive, plus a maximum noise of 12 dB. (Boman, 9300 Hall Road, Downey, CA 90241.)

Also at CES, the new Downlink *2001* home-satellite system made its debut. The system, being promoted by Interglobal Satellite Systems Inc. (ISSI), includes a motorized antenna, LNA, receiver, and remote control unit—with the package priced at nearly $5,000. (That is about half the price of other fully motorized systems.) ISSI is located at 30 Park Street, Putnam, CT 06260.

There's also an increasing market for satellite accessories. For example, Arunta Engineering Corp. has introduced its first receiver intended to pick up the increasing number of stereo-sound programs being distributed via satellite. The Arunta *DD-3000* stereo receiver and downconverter carries a $2995 list price, has a noise figure of about 9-dB maximum, plus several audio metering indicators. (Arunta, PO Box 15082, Phoenix, AZ 85060.)

AROUND THE SATELLITE CIRCUIT

Video News Conferences: A popular new use of satellite teleconferencing is the "video press conference," which permits reporters around the country to take part in coverage of an event even if they are in a distant city. One of the first such applications involved MGM/United Artists and their recent movie "Pennies from Heaven." Stars Steve Martin and Bernadette Peters, plus the film's director and screenwriter, were in New York answering questions from columnists and critics in 14 cities around the country. The feed, which was part of the new teleconferencing service of Hilton Hotels, may be the first of a number of similar satellite-fed press conferences run by movie studios.

RCA Americom has requested FCC permission to launch Satcom VI. The RCA proposal calls for its sixth bird to go up in January 1985; it will cost $80 million and be the most advanced satellite design, with 24 transponders capable of handling digital audio and video, packet switching, and other services.

Meanwhile the saga of Satcom IV, which was launched successfully in mid-January, continues. The FCC declared that RCA's auction to distribute Satcom IV transponders (R-E, March) was not permissible, thus forcing RCA into another plan to allocate the circuits. In other developments, RCA is planning to put up replacements for aging Satcoms I and II during the next 18 months; the FCC has approved one of those launches. R-E

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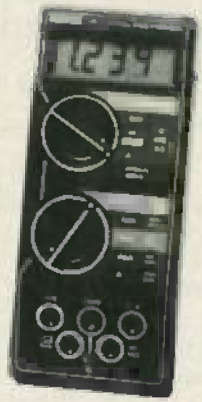

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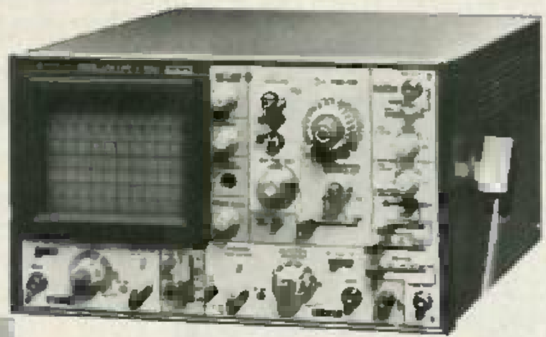

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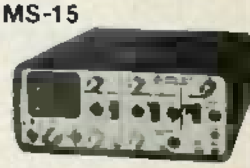

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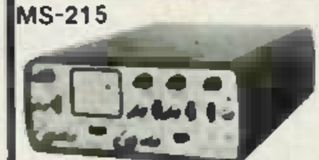

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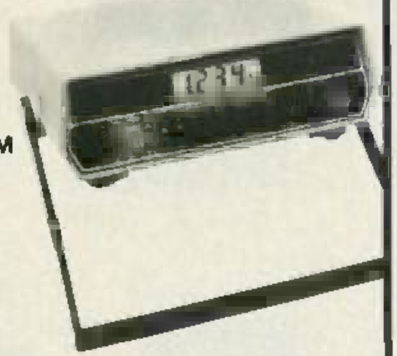

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LOOKING FORWARD

While looking through the February 1982 issue of **Radio-Electronics**, I found the "Computer Corner" department to have a very positive view of computer technology today.

Other people refer to the advances in computer science as a threat to workers. I thought that the advantages mentioned in that department show just how much we need those machines. I do not think that they could harm us very much, based on our economy.

Soon, I believe, people will be ready to accept computers as a part of their lives.
K. LYNN BELL,
Edwards, MS

THE *SINCLAIR ZX81*

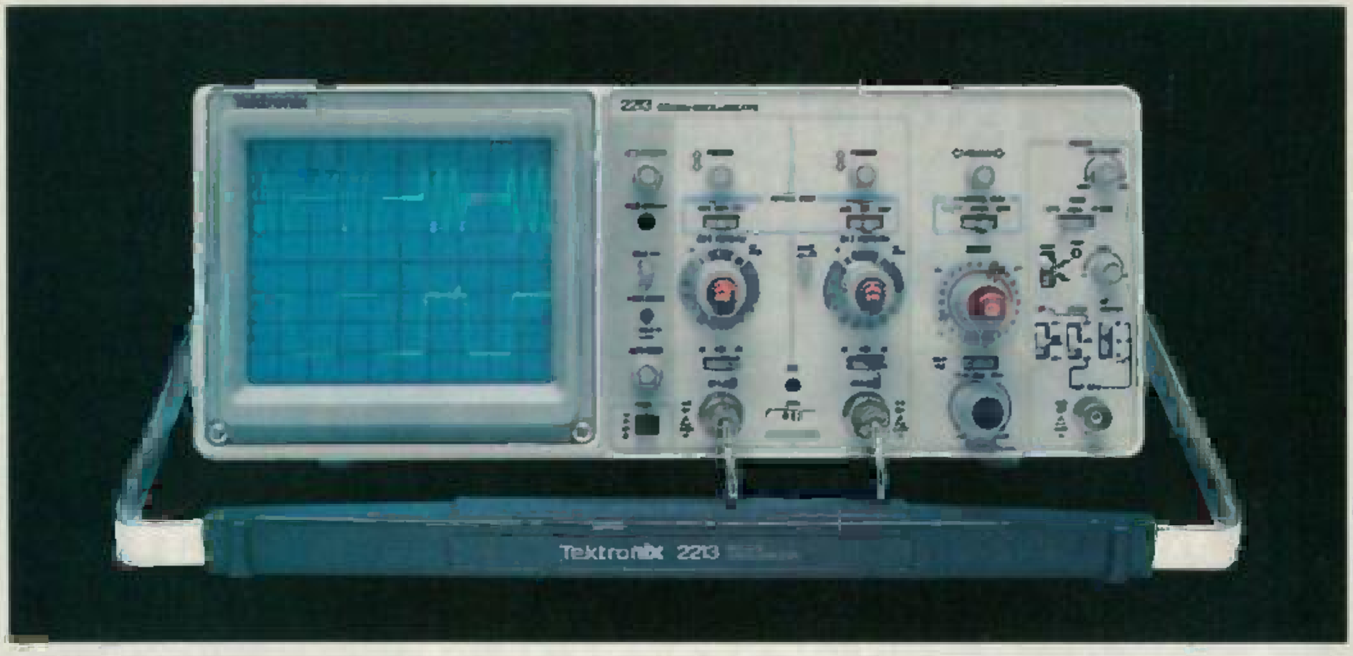
Recently, I purchased and assembled a *Sinclair ZX81* computer, but it wouldn't work when I had finished, and I had followed the instructions religiously, with certain exceptions. I am not a novice at soldering, or at reading diagrams, and accordingly must lay the blame on the kit designer—or the packer. Since what happened to me could happen to anyone else, I am writing this with the hope that you will make this information available to your subscribers.

I ordered the kit and received it within the 30-60 days purchasers were asked to allow. On reading the instructions, I saw references to variations in wiring for the UK, USA, and France, with the statement "not used, USA only" applying to the RF modulator. Apparently the instruction sheet was one for use in France and the UK. Nevertheless, I proceeded to the assembly.

The PC board differed from the diagram of parts locations, and that should have cautioned me immediately to be careful, but I proceeded and installed all components successfully, with the exceptions of those that were marked "not used, USA only" because they had not been supplied, nor were their values mentioned anywhere. As a result, one wire of the modulator was left adrift. Extra parts had been furnished, but there were no instructions concerning them.

I thought that a telephone call to Nashua, which is not far from me here, would clear things up in a jiffy. But when I asked the operator for the number of Sinclair Research, Ltd at their address there, she told me, without hesitation, that many people have asked for their number, but they do not have a telephone.

My point in writing to you is to inform any future buyers to examine their instruction sheets; and if they find that certain parts are listed as "not used, USA only"—specifically R32, R33, and D9—
continued on page 32



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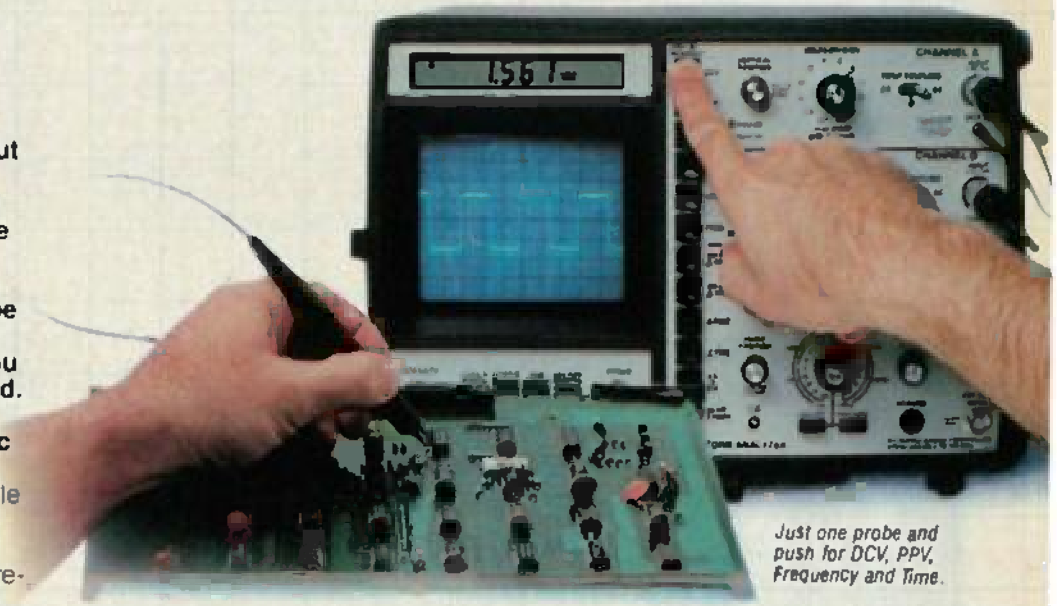

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LETTERS

continued from page 26

they will have little success in getting the computer to work, and they might as well send the whole package back.
JOHN K. MITCHELL.
Westwood, MA

The following is a reply to Mr. Mitchell's letter from Sinclair.

Dear Mr. Mitchell:

We regret any confusion that you may have been caused by the assembly instructions for our model ZX81 personal computer kit. However, we can assure you that the kit that you received will operate in the United States if properly assembled. If you will return it to us, we will be pleased to repair it free of charge.
NIGEL H. SEARLE,
Sinclair

THE *PROFEEL*

I enjoyed your articles on video entertainment, but I think that you have misinterpreted Sony's specs on the *Profeel*. According to Bell Laboratories. 340-350 lines of resolution is not that great—175/52.4 μsec => 3.3 MHz. Actually, that spec is for horizontal *lines*, not resolution; horizontal lines make up *vertical* resolution, and 340-350 is a typical picture.
C.C. WHITNEY,
Miami, FL

The article that you are referring to is entitled "The Home Entertainment Center" that appeared in the January 1982 issue. The 8-MHz bandwidth specification, as pointed out in the article, was based on the assumption that since the Profeel monitor is capable of displaying 80 characters-per-line as opposed to the 40 character-per-line capability of the standard TV set, the bandwidth capability of the Profeel monitor is twice that of a standard TV receiver—or 8 MHz. The 8-MHz bandwidth specification was confirmed in a conversation with a Sony engineer involved in the Profeel project.
ART KLEIMAN
Editor

OOOOOOPS!

There are several errors in the schematic (Fig. 1) that appeared with my article "Telephone In-Use Monitor" in the March 1982 issue of **Radio-Electronics**.

First, the values of resistors R1 and R3 should be 2.2 *megohms*, not kilohms (the values are correct in the parts list). Second, capacitor C1 should have its positive end connected to pin 2 of IC1 and its other end to the line joining pin 1 of the IC and the cathode of LED1. The way it is shown, the LED will not light.

Thank you for allowing me to bring those facts to the attention of your readers.
CHRISTOPHER M. DUNN

An error crept into the theory-of-operation section of the "chug-chug" toy described in our article entitled "4 Toys for the Holiday Season" in the December 1981 **Radio-Electronics**.

It should have stated that "...the op-amp noise current (bias noise-current), if any, would not be converted to a voltage due to the low impedances chosen to eliminate hum pickup. Thus, FET-input op-amp types *must* be used, because they exhibit voltage noise, whereas bipolar-transistor input op-amps exhibit more current than voltage noise...MOSFET op-amps have the highest input noise-voltages (higher than JFET's), but almost no input bias-current—hence, almost no input fluctuation current or 'current noise.' "

Thank you for printing this correction.
DAN & DIANE TALBOT

POOR PICTURES

I happen to be one of those misfortunate Americans who live next to the local power company's high-tension, distribution power-lines. After enjoying another evening of good *old American* AM-modulated television pictures, including car ignitions, arcing insulators, overhead aircraft, and the like, I have to ask an important question: *Why?*

Why in this day of fast-moving electronics technology are we still strapped to noisy, degraded TV pictures?

The satellite industry has already proven FM television far superior to AM, and I for one would like to see it a reality. With all of the new low-power UHF-AM stations to start springing up all over the country, it seems that, as times goes on,

continued on page 36

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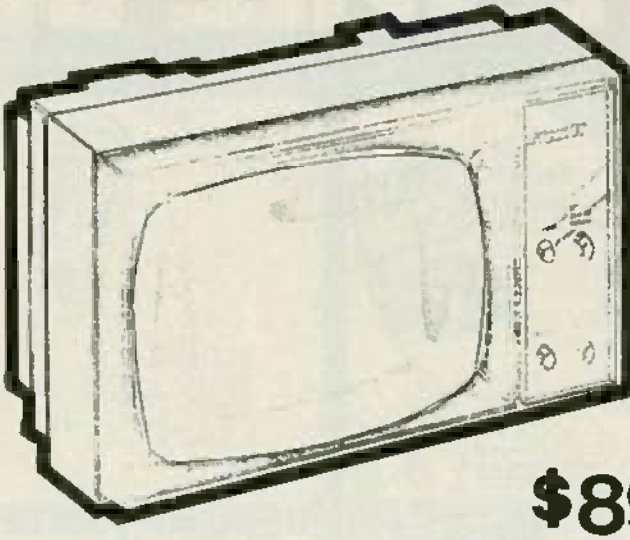

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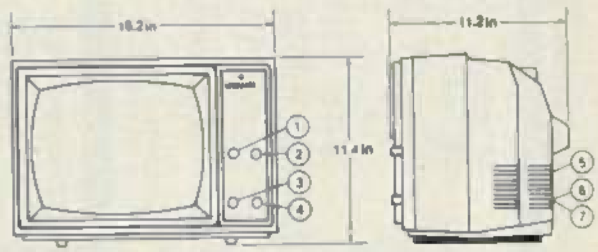
CRT Phosphor	P-4
Signal	Composite video input
Input Signal	1.0Vp-p, sync negative
Input Impedance	75 ohms
Scan Frequencies	Horizontal: 15600Hz Vertical: 50/60Hz
Display Size	210 (W) x 158 (H) mm
Deflection Linerity	Horizontal: 10% Max. (refer to EIA ball Chart and dot Pattern.) Vertical 8%
Video Response	12MHz (± 8dB)
Resolution	Center: 650 Corners: 550
Power Source	120V Ac, 50/60 Hz
Dimensions	11.375″ (H) x 16.25″ (W) x 11.25 (D)
Weight	8.5Kg (14.3 Lbs.) net



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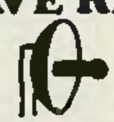

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Bright, 0.5%" LCD display. Single easy-to-use switch. Separate diode test function. Low power resistance range. 22 megohms input resistance. 12,000 hour battery life.
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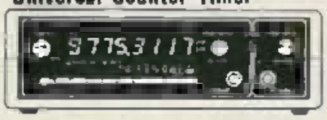

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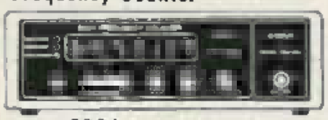

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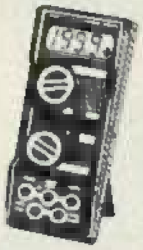

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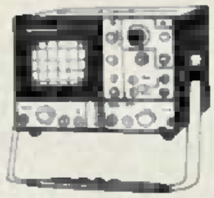

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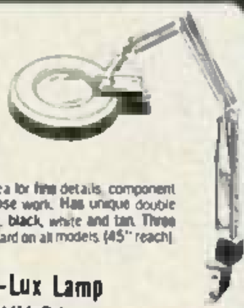

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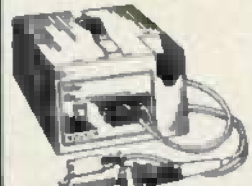

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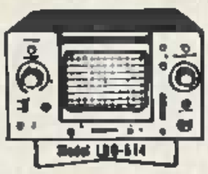

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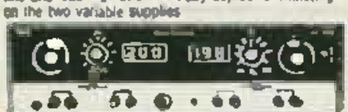

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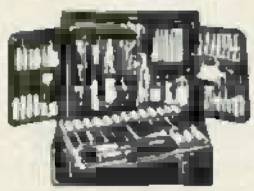

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LETTERS

continued from page 32

the harder the situation would be to change.

Let's see some of those "off-the-air Pay-TV" stations start experimenting with FM modulation. For those who choose not to subscribe, the distorted, out-of-sync pictures would prove just as unwatchable as those you get from present scrambling techniques. A simple FM-converter/AM-remodulator box could then be provided to subscribers. The only place AM interference could enter would be on the cable from the converter to the TV set. That could be a perfect way to test FM-TV in this country. Stations could forward their results to the FCC and, if successful, we could soon see FM-perfect stations popping up all over.

"Bandwidth too broad," you say? Well, how about some form of frequency-companding technique?

Come on, all you electronics engineers: Show us what you can do! Remember when FM radio was only a dream on the part of E.H. Armstrong? Just think: People could say, "I subscribed to that new pay-TV station, and the picture is so great that it's worth the $18 a month."

GARY N. SMITH,
Sinking Spring, PA

AUTOMOBILE IGNITION SUBSTITUTE

With respect to the "New Ideas" column in the February 1982 **Radio-Electronics**, I think that with a little close examination you will find that the author, Stan K. Stephenson II, knows very little about electronics, still less about gasoline engines, and needs to go back to school for his math.

The 2N6384 power darlington transistor has a collector-to-base breakdown voltage of 60 volts. The reason for the capacitor across the coil is to create a flywheel effect, causing a reverse emf of up to 450 volts; therefore, a power-transistor with a breakdown rating of at least 400-volts should be used, then a Zener diode of about 350 volts should be placed collector-to-base to clamp any spikes exceeding 350 volts. It is not good practice to use the voltage rating of a capacitor for a clamp, such as the .05/100 that he is using collector-to-emitter.

The frequency at which he is running his oscillator, 1-kHz, is equivalent to 15,000 rpm, not 650 rpm. I think that is a little too fast for a car engine to idle.

1 kHz × 60 = 60,000 sparks per minute. An eight-cylinder engine fires 4 times per revolution. Thus, 60,000 divided by 4 equals 15,000 rpm.

As for the neon lamp, who is going to hold a small NE2 neon lamp, with 30,000 volts across it, one eighth of an inch away from a pulley, fan, and a bunch of belts turning at 15,000 rpm?

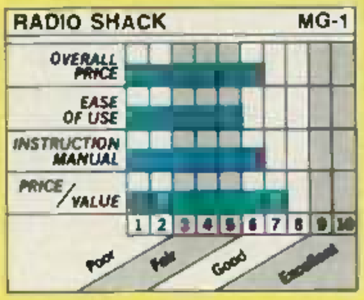
In conclusion, it is my hope that anybody who tries that gadget is lucky enough to have the .05/100-volt capacitor short the first time the coil fires, thereby eliminating all of the aforementioned problems.

GORDON HENDRIX   R-E

EQUIPMENT REPORTS

Radio Shack Model MG-1 Music

CIRCLE 101 ON FREE INFORMATION CARD



FOR YEARS, THE MOOG SYNTHESIZER HAS been synonomous with modern electronic music and rock bands. Early versions of that device, however, were very expensive and were regarded as status symbols for the rock musicians.

Now Radio Shack (One Tandy Center, Ft. Worth, TX 76102) has entered the market with their *model MG-1* from Moog.

The instruction manual that accompanies the instrument provides excellent graphic examples to acquaint the user with the wide variety of sounds available. Some of those sounds include musical instruments and sound effects. The manual also includes a section on basic music theory for those with little or no music background.

The 2½-octave full-chromatic keyboard is used in combination with a wide variety of tone-controlling features: a 2:1 sync selector, 3 position octave selector, square or triangular waveshape selector and even a mixer that will let you mix two tones, a noise source, bell tone, or polyphony (which allows you to play chords).

Modulation capabilities include vibrato, tremolo, random, and glide sequences. A separate filter permits cutoff and peak emphasis, while a contour section adjust rise and fall times.

continued on page 42

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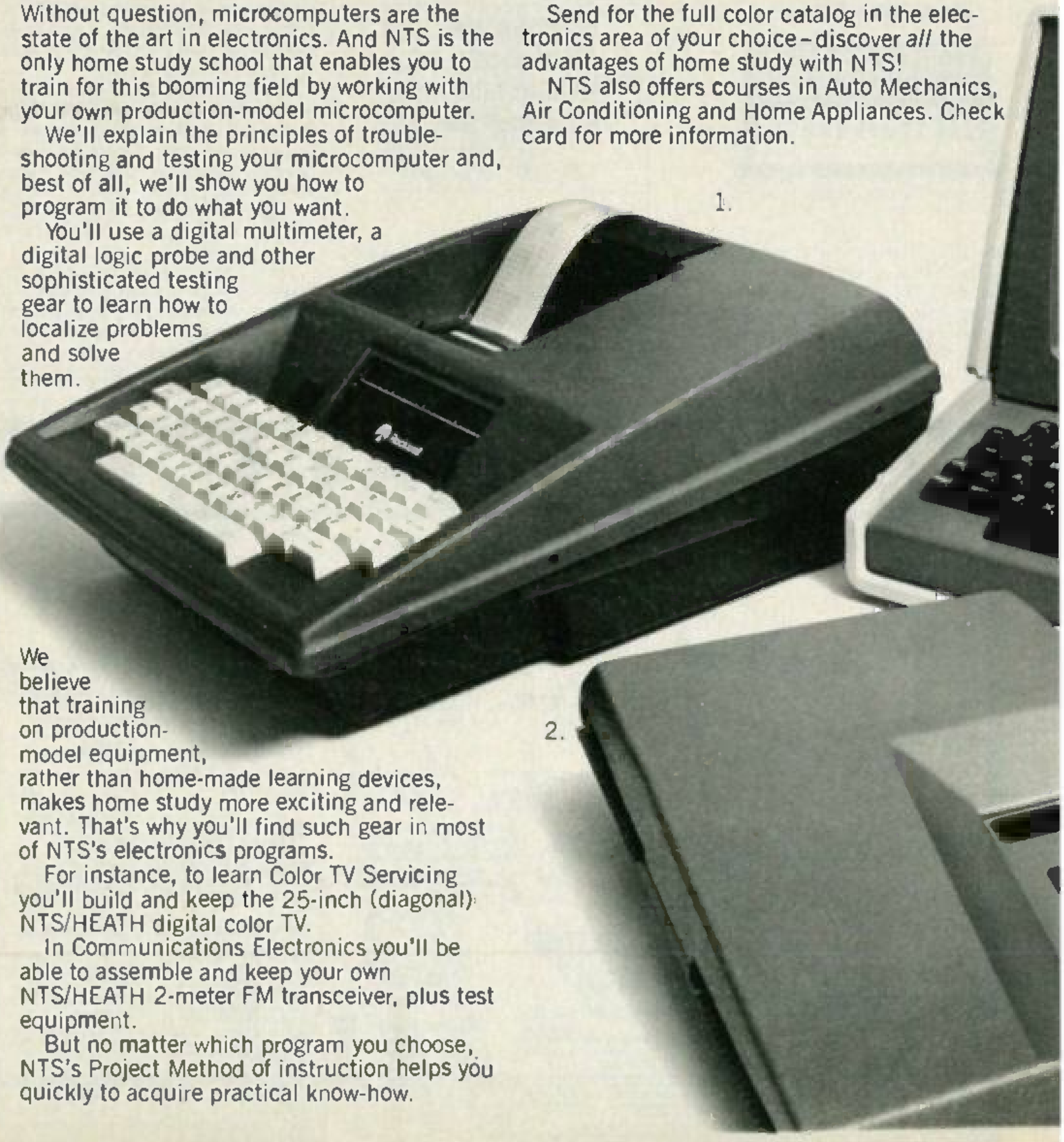

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EQUIPMENT REPORTS

continued from page 37

Above the keyboard is a cluster of switch controls that are used to "program" the synthesizer. Two waveform generators (sawtooth and square wave) provide the basic sound source: the modulation controls, filters, and mixers shape the final sound.

The synthesizer has a low-level, high-impedance output that is designed to be used with an existing amplifier, handy for home or "concert" use. In addition a headphone jack permits the unit to be used in a noisy environment, or without disturbing others. The unit also includes a built-in AC power supply.

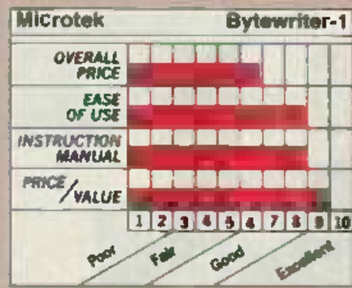
Rear-panel jacks provide pitch and trigger interface ports for computer control. Another rear-panel jack allows you to input an external sound source, such as a tape recorder.

The lightweight instrument has a professional look: basic black vinyl with color accents grouping the controls by common function. The "feel" of the keys is quite conventional and the spacing is standard.

The *model MG-1* provides an economical alternative to more expensive electronic sound generating equipment. It sells for $499.95, and is available from Radio Shack outlets. R-E

Microtek Bytewriter-1 Matrix Printer

CIRCLE 102 ON FREE INFORMATION CARD



THE *BYTEWRITER-1* MATRIX PRINTER, by Microtek Inc., is a 7 × 5 dot-matrix printer for the *TRS-80*, *Apple* and *Apple II*, and *Atari 400/800* computers that specifically answers the need for an inexpensive printer capable of accommodating standard letter-size sheets and paper rolls.

Priced at only $299, the *Bytewriter-1*

OOOOOOPS!

If you had trouble following our report on Microtek's Bytewriter-1 last month, there was a good reason. It seems gremlins played an April-Fool trick on us and moved around some type when we weren't looking. Here is how it should have appeared.

has three individual internal connectors for the three computer systems. It is almost impossible to mix up the connections if you move the printer from one computer system to another because the required interface cable from the computer to the printer will attach only to the appropriate connector.

The *Bytewriter-1* prints both upper and lower case—without lower-case descenders—at 10 characters-per-inch, 6 lines to the inch. It accepts 95 of the 96 standard ASCII printable character codes and three control codes.

In the ASCII "standard", the characters start at decimal code 33 and run through decimal 127. Code 127, however, is not really a character: it is the delete function. Some printers, on receiving a code 127 from the computer, will do nothing. The *Bytewriter-1*, however, translates code 127 into an open

Burglar Alarm

A computerized burglar alarm requires no installation and protects your home or business. It is the first real alternative to a thousand dollar or more professional system.

The Midex 55 alarm system measures only 4" x 10½" by 7" yet protects you like much larger and expensive security systems.

The concept is simple. Provide all electronic functions of a professional wired together system. Put sensing and control into one easy-to-use device. Use large scale integration of solid state components to achieve lower cost and greater reliability. Here are some of the exciting features:

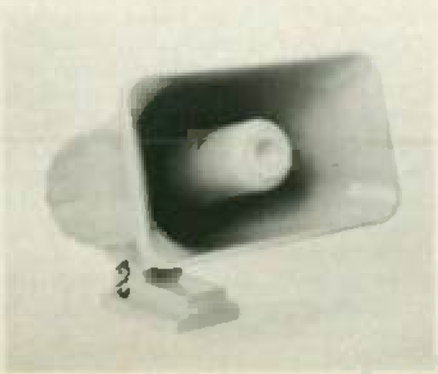
Invisible Protection. The Midex 55 protects your home using exactly the same technology that police radars use to catch speeding cars and trucks. When you are not at home, the Midex 55 generates a low energy radar field that detects anyone who moves in a designated area of your house. The protection pattern is an adjustable tear drop shape with maximum dimensions of 50 x 20 feet.

Loud Alarm. When the system detects an intruder, it turns on a loud police type electronic siren. The sound is loud enough to cause pain. It is loud enough to drive a burglar away before he can steal or damage your valuables. It is loud enough to alert your neighbors and, more important, loud enough to warn you not to enter your home before the police arrive.

Computerized Controls. To turn the system on, you punch in your personalized 4 digit access code. You now have 30 seconds to leave your home or office. When you return, you enter and disarm the system with your access code. You have 30 seconds to do that also.

When the Midex senses an intruder, it remains silent for 30 seconds. It then sounds the alarm until 8 minutes after the burglar leaves. The alarm then shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away.

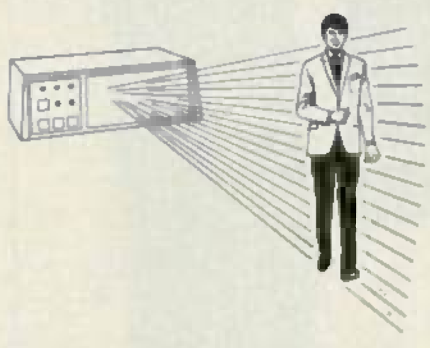
Standby Power. Should AC power fail or a smart burglar cut your AC power lines, the Midex 55 automatically switches to FAIL-SAFE operation using a built-in rechargeable battery pack. You are protected no matter what.



EXPANDABLE SYSTEM

You can set up the Midex in your own home in minutes. It looks like a stereo component. Just plug it into a wall socket, aim and adjust its protection pattern and connect two wires to the powerful alarm blast horn SP-30. If you wish, you can connect two alarm blast horns. If you connect 2 blast horns, we recommend one outside and one inside. A test light allows you to easily determine the area of coverage of the protection pattern. A thumb wheel lets you adjust it to your needs.

As an extra security measure, you can connect one or more panic buttons to the Midex. The panic buttons activate the alarm even with the radar protection pattern turned off. But even if you don't use the expansion features, the Midex is complete, ready to protect you, just as it arrives in its well-protected carton.



The adjustable pattern has a range up to 50 feet.

NO MORE FALSE ALARMS

Compared with other burglar alarms like ultrasonic systems, the Midex has almost no chance of false alarms, since it is not affected by traffic noise, plane noise, air conditioner turbulence, telephones or strong outside winds. Only the motion of the burglar walking through the radar field can set it off.

COMPARED AGAINST OTHERS

The Midex compares with much more expensive professionally installed systems. Yet it costs no more than do-it-yourself alarms purchased at retail. In a recent article, a leading consumer magazine rated the Midex tops in space protection, alarm siren power and immunity from false alarms. Don't be confused. There is no system under $1000 that provides you with the same protection.

The powerful blast horn has a 120dB output and makes a sound so loud it causes pain.

U.L. APPROVED SYSTEM

If you have owned a burglar alarm for more than a year, there's a good chance that it has required service. The Midex, however, is solid state and built with the same heavy duty components in industrial systems. The Midex is made by Solfan Systems, Inc., the leader in the production of radar detectors for commercial and industrial security systems. Solfan has made more than half a million industrial radar sensors and over 100,000 Midex 55. Will the Midex ever need service? No product is perfect. If you ever have a problem, call us on our toll free "help line" at (800) 227-8167. The product has a limited 1 year parts and labor warranty.

STANDING BEHIND A PRODUCT

The Midex protects more than 100,000 American homes. But the true test of how it performs is in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones. Decide after one month whether or not you want to keep it. If you decide to keep it, you'll own the best. If not, return your unit for a full and prompt refund. There is no risk.

Purchase the Midex 55 now for $199.95 and the SP-30 blast horn for $39.95. We recommend the purchase of two blast horns. To order, simply send your check to the address shown below. California residents add 6% sales tax. Credit card buyers may call our toll free number below. There are no postage or handling charges. The unit will be sent to you complete with all instructions.

Midex gives you everything you could possibly expect from a burglar alarm: 1) a professional grade system at a very reasonable price, 2) toll free telephone assistance, 3) the chance to buy a unit in complete confidence, knowing that you may return it if it's not exactly what you want. You can't lose.

Computer technology has produced the ultimate security system. Order your Midex 55 without obligation today.

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CIRCLE 23 ON FREE INFORMATION CARD

box of the type used on questionnaires. If you were printing something where you might want to check off each step with a pencil or pen, the open box would be an asset.

The *Bytewriter-1* responds to three ASCII control codes. Those are: CR (carriage return), SO (shift out), and SI (shift in). CR also provides an automatic linefeed. When the printer receives the CR code, all data stored in the print buffer is printed and the paper is advanced one line. If more than 80 characters have been received and stored in the printer's buffer before the CR is sent by the computer, the first 80 are printed on one line and the remainder are "wrapped around" on the next line.

When the printer receives the SO code, all data that follows is printed out in "bold" double-width characters. Reception of the SI code cancels the "bold" characters and all printing that follows the SI code is normal width. The SO and SI codes can be intermixed at will in the same line, permitting individual characters, words, and phrases to be printed "bold." The bold characters do not cancel at the end of a line, but will continue until the SI code is received.

Like some other printers, the *Bytewriter-1* ignores the Line-Feed (LF) code. A line feed is automatically accomplished as a result of the carriage return. If just a line feed is desired, it is necessary to send a CR code to the printer. While that provides a line feed, it also moves the printhead to the beginning of the next line: that makes it somewhat difficult, if not impossible, to line up columns.

Unlike earlier "budget" printers that used rolls of narrow, adding-machine type paper that permitted lines of perhaps 16 or 30 characters, or that used a somewhat difficult to obtain and expensive heat-sensitive or electrostatic paper, the *Bytewriter-1* uses standard sheets—letter or legal size—or standard paper rolls up to 8½-inches wide. The paper feed is friction only: there are no tractor or pin-feed devices. Single sheets are inserted from the rear. Permanent brackets and a removable spindle are provided for paper rolls. The bracket supports a standard 5-inch diameter teletype paper roll off the table—the user is not limited to one of the new mini-size rolls of approximately 3-inch diameter, which happen to cost more than the standard roll.

The characters are printed by a 7-wire printhead that plugs into a socket and is user-replaceable by simply loosening two screws and unplugging the connecting cable. Unlike most other printheads that are connected to their electronics by a flexible ribbon cable that "rolls" along with the printhead, the *Bytewriter-1* uses discrete, highly flexible wires to connect the printhead to the circuit. The wires flop and twist considerably as the printhead travels. While it does not appear to the eye that the twisting wires would have the life expectancy of "rolling ribbon", there is no previous experience on which to make a judgment as to life expectancy of the wires.

The printhead is driven by a grooved spindle, rather than a drive belt. Again, that is an arrangement we have not seen used in a matrix printer before; but it does work. Again, we have no idea what the life expectancy or reliability might be; but after several weeks of quite severe useage—likely more than done by the average hobbyist—we have had not a single instance of difficulty with any part of the printer's electrical or mechanical assembly.

The printhead's bi-directional drive is the "full line" system commonly found on many lower-cost printers: it is not logic-seeking. That is, the head sweeps from full left to full right, even if it prints just a single letter on the left side. It then sweeps back from full right to full left regardless how much it has to print. The printer speed is 80 characters-per-second (per line), 60 lines-per-minute.

There is no impression adjustment

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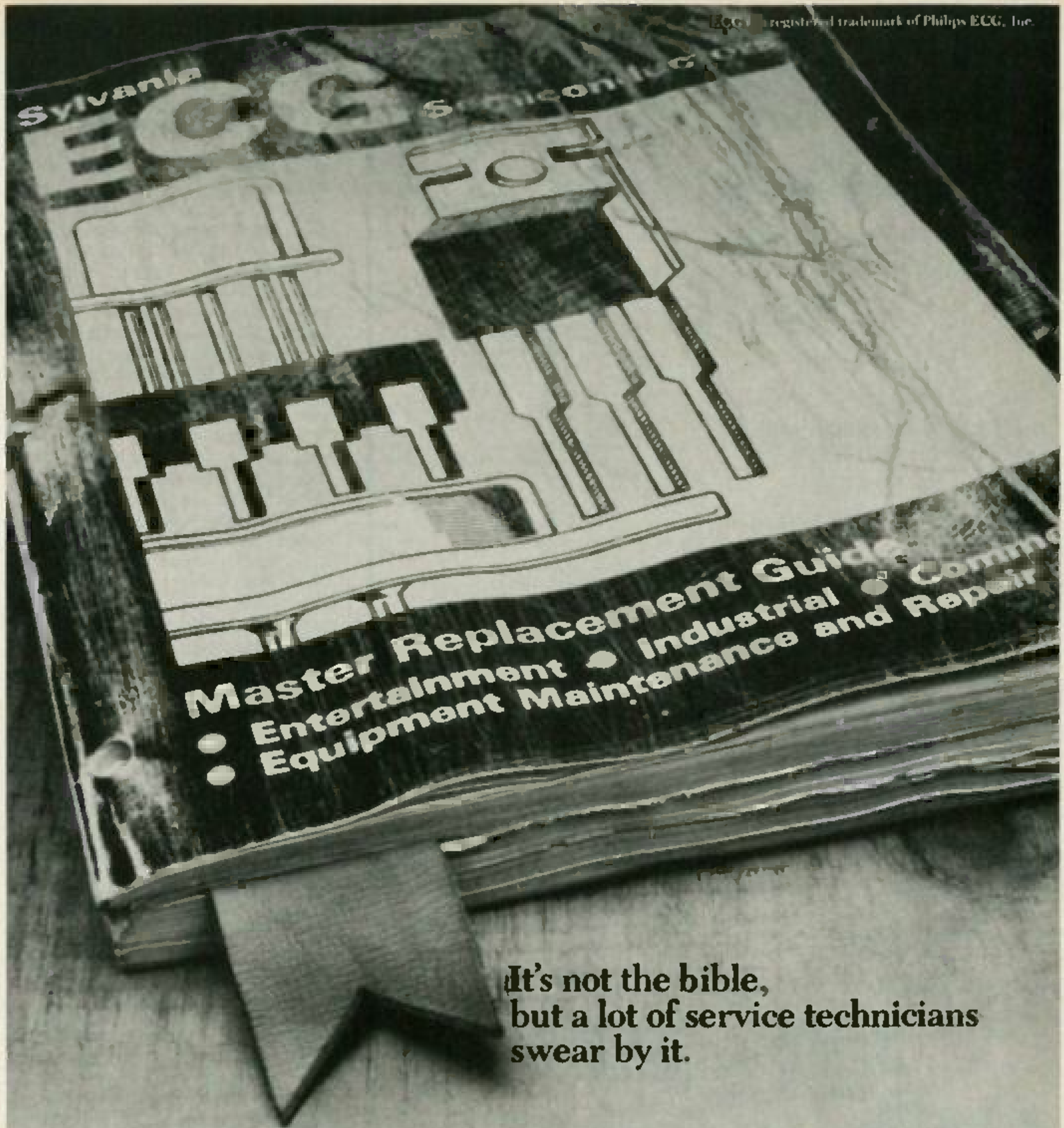

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for the printhead; it is set at the factory and will print up to the original and three copies. Our experience showed a somewhat irregular impression impact-density where a substantial part of the character was reproduced by a string of dots, such as the small letter "e", or the parenthesis symbols [(,)]. While the "top" (original) copy was legible, the copies—particularly the third—were somewhat difficult to read. Also, bear in mind that "copy does *not* mean carbon. Using sheets of letter-size paper, the original and two NCR (No Carbon Required) copies just barely slipped through. The original and three NCR's required considerable care to load. Unless a Mylar carbon film was used it was somewhat difficult to make "carbon copies" using single sheets because it was difficult to load single sheets interspersed with ordinary carbon paper. Paper rolls that consisted of factory interleaved original, carbon and "second sheet" (copy) were more convenient because they fed through smoothly and without any bother. Actually, roll paper proves the most convenient to use; and it's certainly inexpensive if you purchase the ordinary teletype-paper grade.

One nice feature is that the paper can be rolled backwards or forwards whether the power is on or off. Typical of matrix printers, the print line is low, out of sight. If you print one line you can roll the paper forward to check copy and then roll it back for additional printing; it's not necessary to turn off the printer to roll the paper backwards.

The ribbon is supplied in a cartridge that spans almost the full length of the printer. It simply drops into place; there is no threading or positioning. It is one of the easiest ribbons to install, even for someone who is all thumbs. Replacements are priced at $7.95.

The printer is rather small. Without the paper-roll adapter, it measures 15 × 9¼ × 3-inches. (You must allow some room at the rear for loading paper.) The power switch is located at the left rear outside the paper path. The interface cable comes out the right rear, also outside the paper path. (Even some of the best of other printers are known to get their cables tangled up with the paper because the cables are right in the feed path.) On the top right is a recessed, toothed knob for manual paper positioning.

While the *Bytewriter-1* has some obvious limitations, such as variable impact density and lack of direct line feed, it does quite a creditable job for its price. Certainly, at $299 (plus $19.95 for the interface cable and $15 for shipping) it is one of the least expensive "full size" printers around. For information, or to order a *Bytewriter-1*, write to Microtek Inc., 9514 Chesapeake Dr., San Diego, CA 92123. R-E

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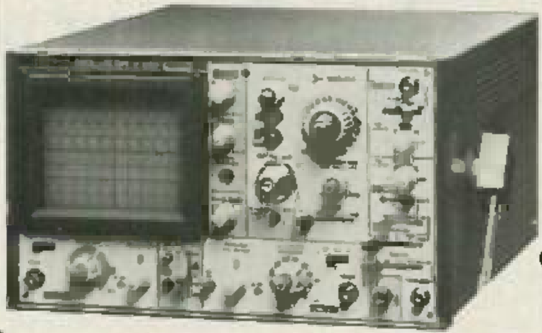

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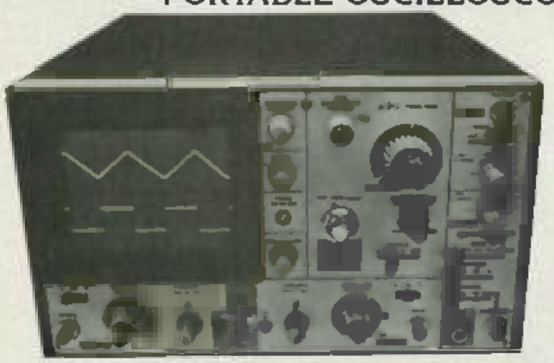

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SATELLITE TV RECEIVER

Here are the complete plans for a satellite-TV receiver to go with the 8-Ball antenna we presented in 1981. Add an LNA for a complete satellite-TV earth station.

DAVID BECKER

HOME SATELLITE TV RECEPTION, ONCE A dream, is now a reality. Thousands of enthusiasts have installed their own "backyard" earth stations and the simple, inexpensive receiver that will be described here will allow you to do the same. To understand how satellite TV works, let's look at why and how it developed.

In the early days of TV, transmissions were strictly local, using the standard VHF-frequencies. Later, as networks were formed, there came a need for nationwide video-distribution systems. Coaxial-cable lines and multiple copies of films or kinescopes (films taken from a video monitor) were used initially, but they were costly and were gradually replaced by microwave-relay links.

By 1980, satellite communications had progressed far enough to allow the use of a single satellite as a relay point, broadcasting to TVRO (*TV Receive-Only*) terminals across the U.S. Although TVRO terminals were expensive, the system was adopted quickly because its overall cost was less than that of a ground-link system.

Communications satellites have *geosynchronous* orbits. A geosynchronous (or *geostationary*) orbit is one in which the satellite orbits directly above the equator and has an orbital velocity that precisely matches that of Earth's rotation. An observer on Earth sees the satellite as a stationary point in the sky (see Fig. 1). A satellite-communications link has three points: the signal source on the ground, the satellite relay in orbit, and any number of ground-based TVRO terminals. We will examine each of those three points in a moment, but first let's see what type of programming the satellites carry.

Presently, as shown in Fig. 2, there are about a dozen U.S. and Canadian satellites within view from this country, with many more due to be launched in the near future. Each satellite carries 12 or 24 *transponders* (receiver/transmitters)—each one using a different frequency-pair—with programming that includes movies, sports, news, and almost anything else imaginable.

The domestic satellites can provide up to 228 separate TV channels, or over 200,000 telephone voice-channels, simultaneously. The most popular satellite is RCA's Satcom F1 (located at 135° west latitude) which is used by cable-TV companies to relay their programs. As an example of the diverse programming it carries, services available on Satcom F1 include: Home Box Office (HBO) and Cinemax, a 24-hour news channel, daily live coverage of the House of Representatives, a channel devoted entirely to sports, "superstations" WOR-TV in New York and WGN-TV in Chicago, and many others. And, if all of that programming isn't enough, there are plenty of other satellites to choose from.

The satellite link

We said earlier that a satellite-communications link is made up of three parts: the ground transmitting-station, the satellite, and the ground receiving-station. They are shown in Fig. 3. Let's first study the ground sending-station, or *uplink* transmitter.

The job of the uplink transmitter is to send a frequency-modulated video signal (as opposed to the amplitude-modulated video signals used in broadcasting) and an FM-audio signal to the satellite using a carrier in the 5.9–6.4-GHz range. Since the satellite is over 22,000 miles away, the signal must be aimed very accurately to insure that it reaches the "bird" with maximum strength. A signal of at least 500 watts is fed to a parabolic-dish antenna. That antenna provides gain by reflecting energy that would normally be radiated away from the satellite and focusing it into a concentrated beam toward it.

FIG. 1—THE ORBITAL VELOCITY of a geosynchronous satellite matches the rotational speed of Earth exactly, making it appear to be stationary in the sky.

An uplink station can beam up more than one video channel at a time by using special signal-combiners. The most recent development in uplinks is mobile transmitters; an antenna and transmitter mounted on a trailer and in a van are transported from place to place for on-location broadcasting. That allows live video-broadcasts to be beamed from and to virtually anywhere in the world.

The next part of the communications link is the satellite itself. It uses a parabolic dish to receive the 6-GHz uplink signal, and then retransmits it back to Earth on a lower 3.7–4.2-GHz carrier. Using two separate frequencies allows simultaneous reception and transmission. Both the uplink and the *downlink* (satellite-to-earth signal) paths have a 500-MHz wide frequency-range (5.9–6.4 GHz and 3.7–4.2 GHz) which means that there is room for 12 channels, each 40 MHz wide.

That's fine for a 12-transponder satellite, but how do you fit 24 channels in the same space? A combination of two systems is used. First, the channels are staggered so that the center of one channel is at the upper and lower edges of the adjacent ones, as shown in Fig. 4. The channels overlap, though, and normally would interfere with one another. To avoid that interference, the signals are cross-polarized. At microwave frequencies such as those used for satellite transmissions, signals polarized at right angles to one another are isolated by about 30 dB. Odd-numbered channels are vertically polarized; even-numbered ones horizontally polarized. In that way, the channel being received is 30-dB stronger than its oppositely polarized neighbors—more than enough to mask the undesired signals.

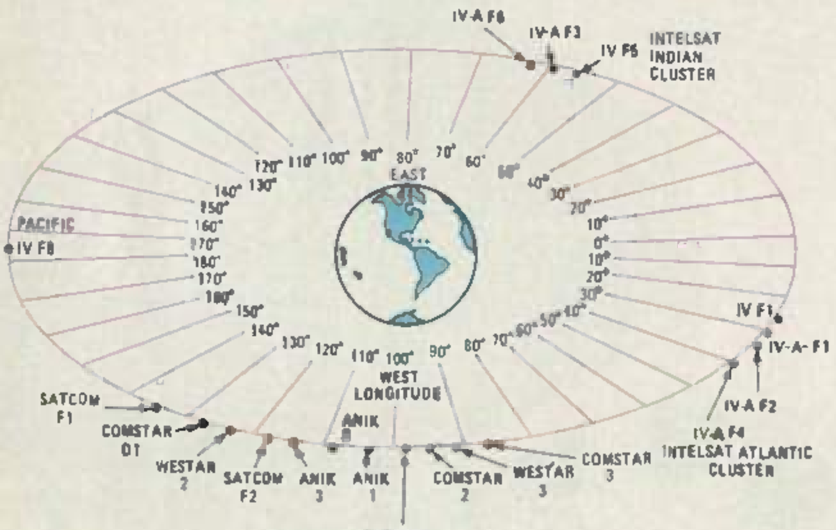


FIG. 2—U.S. AND CANADIAN communications satellites lie between 80° and 140° west longitude.

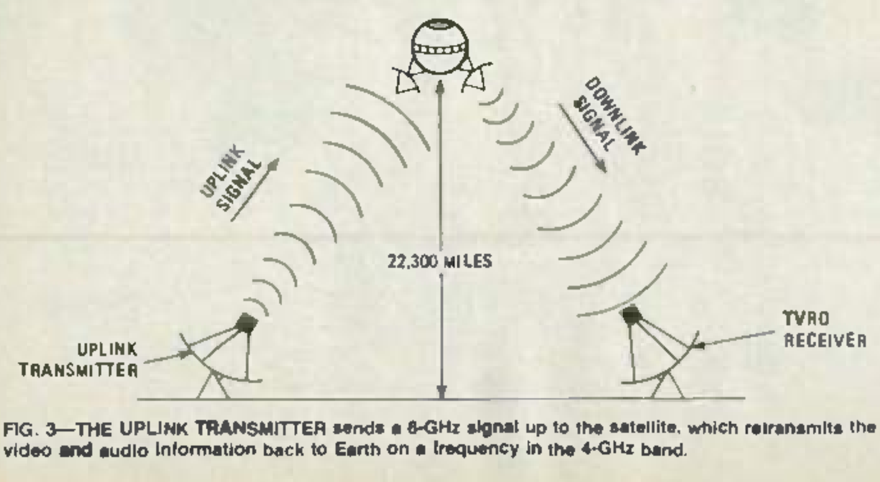


FIG. 3—THE UPLINK TRANSMITTER sends a 6-GHz signal up to the satellite, which retransmits the video and audio information back to Earth on a frequency in the 4-GHz band.

The biggest problem with the downlink signal transmitted by the satellite is that it is quite weak. Since the satellite is expected to perform without any maintenance during its expected life, it must be solar powered. Even with the most efficient solar panels, it can only produce about 5 watts of output power per transponder. That means that after the signal travels 22,000 miles to Earth, losing 196 dB of its initial strength (dropping to almost 5×10^{-20} watts), the ground receiving-station is not left with much to work with.

The first component of a TVRO terminal is a large parabolic or spherical-reflector antenna, typically 10 or 12 feet in diameter. (Construction of a spherical antenna, the "8-Ball," was described in the August, September, and October 1981 issues of Radio-Electronics.) The antenna gathers all the signal that falls on its surface area and reflects it to its focal point where an LNA (*L*ow *N*oise *A*mplifier) is positioned. Using cascaded GaAsFET and bipolar transistors, the LNA amplifies the 4-GHz signal by about 40 dB while adding only one or two dB of noise. It is important to introduce as little noise at this stage as possible, since any that does creep in will be carried and amplified through the rest of the system.

Once the signal leaves the LNA, it travels down a heavy coaxial cable to the receiver, the heart of the TVRO terminal.

Receivers

The receiver—the final part of the satellite-communications link—takes the 4-GHz RF signal from the LNA and transforms it into standard composite-video and audio. Receivers can be designed in a variety of ways and a discussion of some of the features desirable in a receiver will demonstrate what a quality unit should be capable of doing.

A receiver should be fully *frequency-*

agile; that is, it should be able to be tuned over the entire 3.5–4.5-GHz band. That will allow 24-channel use, as well as the reception of transmissions from foreign satellites. Its sound-subcarrier demodulator should be tunable over the full range of 5.5–7.5 MHz. The various transponders transmit their audio information on subcarrier frequencies located within that range and the receiver should, of course, be able to demodulate any of them.

Another important feature to consider is dual conversion, where the incoming signal is converted to a lower frequency in two steps rather than one. The advantage of dual-conversion receivers is that they do not interfere with one another, allowing multiple units to be operated in the same vicinity. A single-conversion receiver, on the other hand, can cause (and suffer from) interference problems because of an oscillator that would necessarily be operating within the 4-GHz band. A quality receiver should also incorporate an AFC (*A*utomatic *F*requency *C*ontrol) circuit, and, of course, be easy to assemble and align. The R2B receiver presented here uses a dual-conversion design and provides the features just described.

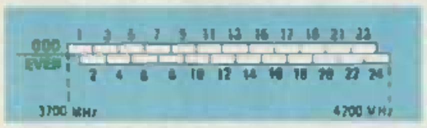


FIG. 4—HOW TO FIT 24 channels in a 12-channel bandwidth. Adjacent channels are overlapped, and odd-numbered channels vertically polarized; even-numbered ones horizontally polarized.

How it works

Figure 5 shows a block diagram of the R2B receiver. Figure 6 is a schematic of the mixer section of the receiver, and Fig. 7 is an overall schematic of the unit.

The input to the receiver is the amplified 4-GHz signal from the LNA. Circuits to handle signals in that frequency range are both critical and expensive, so the 4-GHz signal is immediately converted down to an 1100-MHz intermediate frequency (IF) by the first-mixer stage of the receiver.

First mixer

This stage is probably the most exotic part of the R2B receiver. Although it is simple in design, it is quite complex in the way it works.

A double-balanced design is used for impedance matching and to provide good local-oscillator rejection characteristics. The input signal from the LNA is split in phase by a quarter-wave transmission-line balun, L11, and coupled to the other side of the PC board through capacitors C72 and C73, which are actually formed by the PC-board material—the board itself acting as a dielectric between the two tinned-copper surfaces. The phase-split signal is then fed to a diode quad made up of D10-D13.

Similarly, the signal from the local oscillator is split using another transmission-line balun, L10, and then fed to the quad. The local-oscillator signal switches the diode quad on and off, thus producing the mixer products. (In superhetrodyne receivers, mixing two signals produces the sum and difference of the two. The R2B mixes signals in the 3.7–4.2-GHz range with 2.6–3.1-GHz signals from the local oscillator to produce a difference frequency of 1100 MHz.) Small wire loops, L12 and L13, act as chokes and couple the 1100-MHz signal-bearing intermediate frequency to the main receiver-board.

The tunable local oscillator, IC10, is a thin-film MIC (*M*icrowave *I*ntegrated *C*ircuit). It is difficult to build voltage-tuned oscillators from discrete components that will operate reliably at microwave frequencies and that IC does the job nicely.

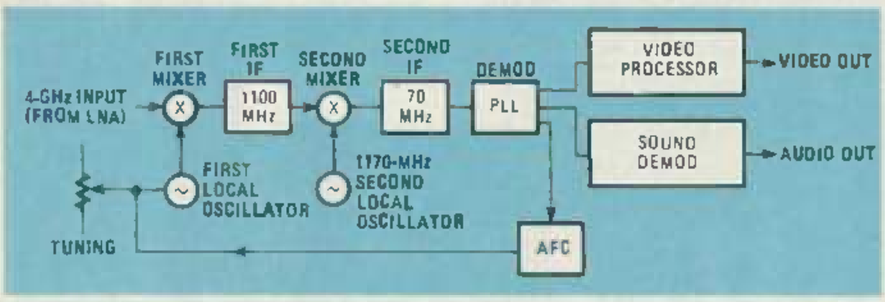


FIG. 5—BLOCK DIAGRAM of R2B satellite-TV receiver. Function of each block is discussed in text.

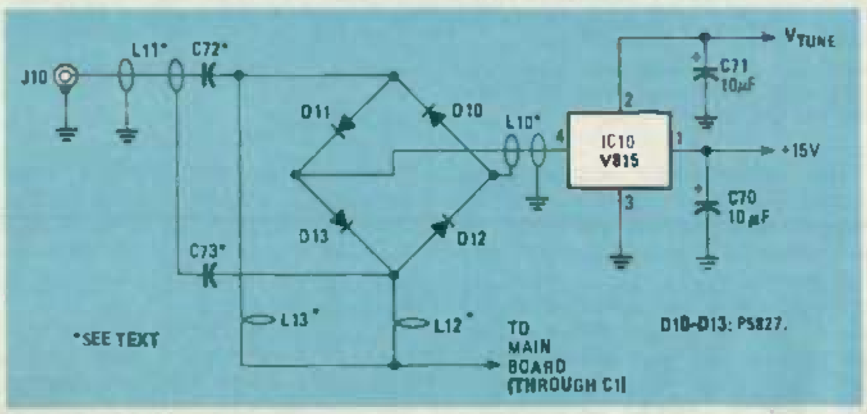


FIG. 6—FIRST-MIXER stage uses a thin-film MIC (*M*icrowave *I*ntegrated *C*ircuit), IC10, for a stable tunable local-oscillator. See text for explanation of L10–L13, and C72 and C73.

1100-MHz first IF

The first-IF stage, which follows the first mixer, uses three stripline transistors, Q1-Q3, to provide 5–10 dB of gain at 1100 MHz. The primary function of that stage, though, is not to provide gain, but to provide bandpass filtering. Properly tuned, the first-IF stage gives excellent image-rejection as well as limiting the total power (both signal and noise) of the signal for the second-IF stage.

Each stage is biased for class-A operation at about 5 mA of collector-current. Small (5 pF) capacitors couple the inputs and outputs of the stages. Miniature resonators are formed by piston capacitors. Proper impedance-matching is obtained by the placement of the coupling capacitors on the lead-straps of the piston trimmers. Carefully controlled spacing of the resonator sections makes possible a composite, double-tuned filter assembly. The 1100 MHz IF-stage is made up of two such assemblies; each one is isolated by a buffer/gain stage.

Second oscillator and mixer

The next stage encountered is the second mixer, which heterodynes the 1100-MHz signal with an 1170-MHz one, giving an output at 70 MHz. Since the R2B receiver has an excellent AFC range (greater than 20 MHz), a simple, fundamental-frequency, single-transistor (Q6) oscillator can be used to make a base-tuned 1170-MHz oscillator. Its output is buffered by Q5 before driving the second mixer, IC1. Once again, the piston capacitor/resonator arrangement is used. To provide a little more gain at the high end, resistor R51's lead inductance (that resistor's lead inductance is represented as L7 in the schematic) is used for peaking.

Transistor Q5 provides a signal having a level of about +7 dBm to mixer IC1's local-oscillator port; that level insures low conversion-loss as well as keeping the generation of spurious signals to a minimum. The mixer's output is filtered through a pi-network to provide a clean 70-MHz signal for processing by the second-IF stage.

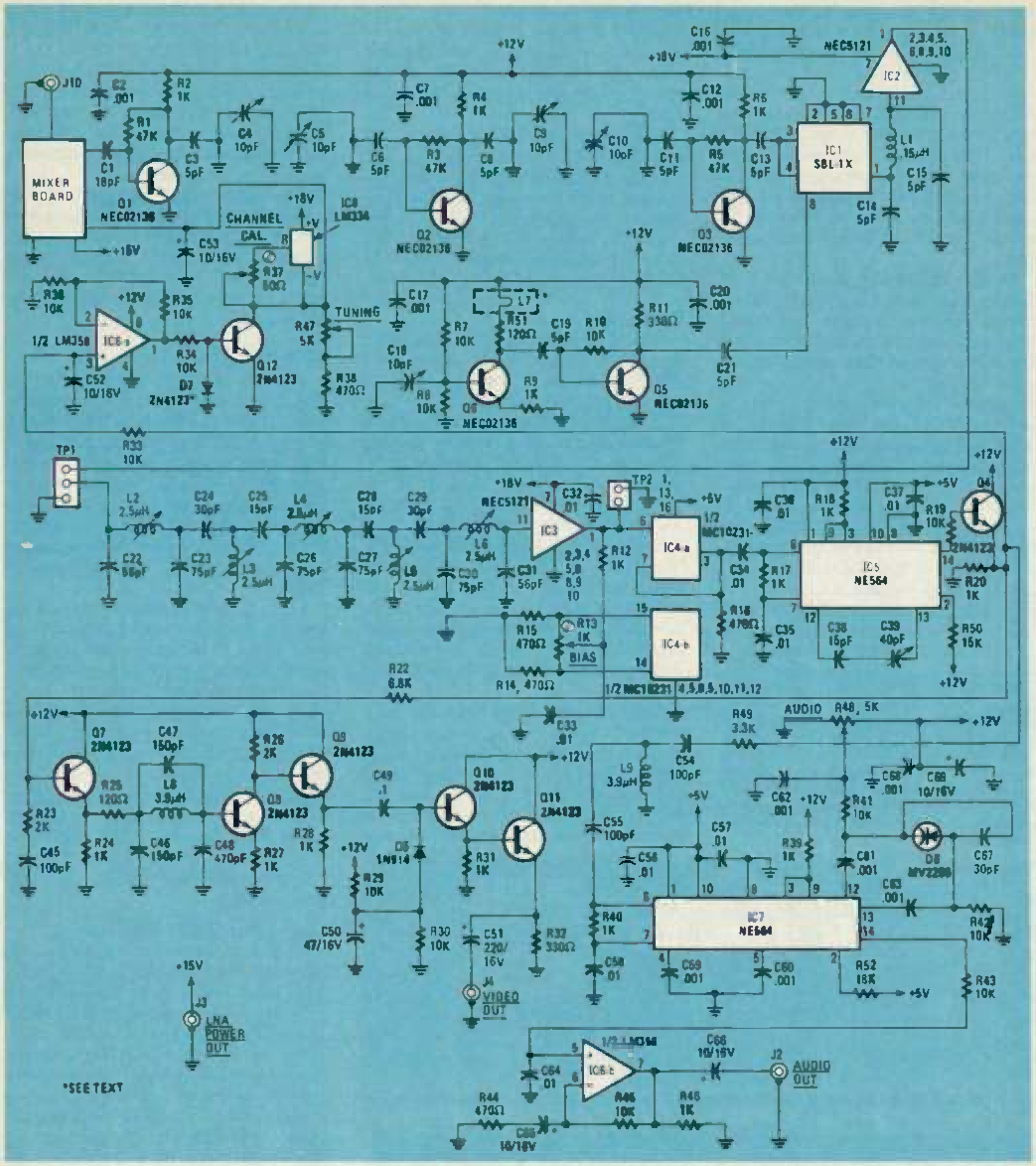


FIG. 7—RECEIVER uses two PLL's (*Phase-Locked Loops*), IC5 and IC7, to demodulate FM video and audio signals. Because those IC's can operate only up to about 50 MHz, IC4-a divides the 70-MHz second-IF frequency by two, generating a 35-MHz signal that they can handle.

Second-IF stage

The second-IF (or low IF) stage is responsible for most of the selectivity and gain of the receiver. Prepackaged gain-block modules, IC2 and IC3, provide about 60 dB of gain, and simplify the design and construction of the wideband (25 MHz) IF amplifier. The second-IF stage sets the noise bandwidth of the receiver and is optimized for low-threshold performance.

The bandpass-filter section of the second-IF stage is located between the two gain-block modules and is made up of a series of cascaded low-pass and high-pass networks. The 5-pole filter has input and output impedances of 75 ohms. Two test points, TP1 and TP2, are provided for use in sweep-alignment of the filter. Molded-plastic, slug-tuned inductors are used as tuning elements because they are temperature-stable and offer repeatable results.

Demodulator

After leaving the second-IF stage, the signal is at a low enough frequency to be demodulated. The demodulator is designed to extract as much video and audio information as possible from the weak satellite-signal.

The design uses a simple PLL (*P*hase-*L*ocked *L*oop), but in a rather unusual manner. Most PLL IC's have a difficult time tracking wide swings—especially at 70 MHz—and the satellite signal *is*

PARTS LIST

All resistors ¼-watt, 5% unless otherwise specified

R1, R3, R5—47,000 ohms
R2, R4, R6, R9, R12, R17, R20, R24, R27, R28, R31, R39, R40, R46, R50—1000 ohms
R7, R8, R10, R19, R29, R30, R33-R36, R41-R43, R45—10,000 ohms
R11, R32—330 ohms
R13—1000 ohms, trimmer potentiometer, PC-mount
R14-R16, R38, R44—470 ohms
R18—15,000 ohms
R21—1000 ohms, 1 watt
R22—6800 ohms
R23, R26—2000 ohms
R25, R51—120 ohms
R37—50 ohms, trimmer potentiometer, PC-mount
R47, R48—5000 ohms, potentiometer, linear taper
R49—3300 ohms
R52—18,000 ohms

Capacitors

C1—18 pF, ceramic disc
C2, C7, C12, C17, C20, C59, C60-C63, C68—.001 μF, ceramic disc
C3, C6, C8, C11, C13-C15, C19, C21—5 pF, ceramic disc
C4, C5, C9, C10, C18—10 pF, piston-type trimmer (Stettner 120-05—do not substitute!)
C16, C32-C37, C56-C58, C64—.01 μF, ceramic disc
C22, C31—56 pF, ceramic disc
C23, C26, C27, C30—75 pF, ceramic disc
C24, C29, C67—30 pF, ceramic disc
C25, C28, C38—15 pF, ceramic disc
C39—4-40 pF, trimmer
C40—not used
C41—2200 μF, 25 volts, electrolytic
C42-C44, C52, C53, C65, C66, C69-C71—10 μF, 25 volts, electrolytic
C45, C54, C55—100 pF, ceramic disc
C46, C47—150 pF, ceramic disc
C48—470 pF, ceramic disc
C49—.1 μF, Mylar
C50—47 μF, 16 volts, electrolytic
C51—220 μF, 16 volts, electrolytic
C72, C73—see text

Semiconductors

IC1—SBL-1X, 1-GHz double-balanced mixer
IC2, IC3—MC5121 broadband amplifier (NEC or other)
IC4—MC10231 dual flip-flop
IC5, IC7—NE564 phase-locked loop
IC6—LM358 dual op-amp
IC8—LM334 constant-current source
IC9—not used
IC10—V815 voltage-controlled oscillator (Watkins-Johnson or other)
IC11—7815 15-volt positive regulator
IC12—7812 12-volt positive regulator
IC13—7805 5-volt positive regulator
Q1-Q3, Q5, Q6—02136 microwave transistor (NEC—do not substitute!)
Q4, Q7-Q12—2N4123 NPN transistor or equivalent
LED1—Jumbo red LED
D1-D4—1N4004, 1 amp, 400 PIV
D5—1N914
D6—MV2209 20-80 pF varactor diode
D7—2N4123 or 2N2222, modified (see text)
L1—.33 μH choke
L2-L6—2.5 μH 4½-turn variable slug-tuned inductor with shield can (Coilcraft 104-1 ½T-⅛J-POS3 or equivalent)
L7—see text
L8, L9—3.9 μH choke
L10—1-inch length Teflon coaxial cable (see next part)
L11—1 inch length .141-inch diameter Teflon coaxial hardline (see next part)
L12, L13—single loop 28-gauge enameled wire
F1—⅜-amp slow-blow fuse
J1—RCA phono jack, panel-mount
J2-J4—RCA phono jack, PC-mount
J5—2-pin molex plug, PC-mount
J10—RG58U type "N," female
JU1—28-gauge wire with 1-inch insulating sleeving
JU2—Berg jumper clip (for TP1)
TP1—3-pin Berg mini jack, PC-mount
TP2—2-pin Berg mini jack, PC-mount
S1—DPDT push-on, push-off, PC-mount
T1—18 volts, 1 amp

Miscellaneous: PC boards (Mixer board to be made from .062-inch FR-4 material with 2/2-ounce copper and tin-lead plating not to exceed .0015-inches in thickness. Dielectric constant must be 4.83 ±.15.), IC sockets, TO-220 heat sink, wire, 28-gauge sheet metal, enclosures, knobs, line cord, fuseholder, hardware, etc.

The following are available from Ramsey Electronics, 2575 Baird Rd., Penfield, NY 14526: Complete Sat-tec R2B satellite-TV receiver kit with pre-aligned 70-MHz IF and 1170-MHz oscillator sections, $495.00; completely wired and tested Sat-tec R2B satellite-TV receiver, $749.95; RM3 RF modulator, $69.95; Watkins-Johnson V815 oscillator IC (IC10), $125.00; Avantek 120°K, 50-dB gain LNA, $595.00.

The above prices include shipping and insurance charges to points in the U.S. and Canada. Overseas orders please add 15% to cover shipping. MC and Visa accepted.

wideband. Since the PLL, IC5, has a typical maximum working frequency of only 50 MHz, a way has to be found around that limitation for 70-MHz operation.

The solution is to use an ECL (*E*mitter-*C*oupled *L*ogic) divider to divide the frequency of the input signal by two. That is done by IC4, a high-speed dual flip-flop. One half of that IC (IC4-a) is used as a divider, and the other half (IC4-b) as a bias source. Pins 14 and 15 of the IC are complementary logic-level outputs. Bias pot R13 is across those outputs and can be adjusted to provide any voltage between the logic-high and logic-low levels. When correctly adjusted, it biases the input to the flip-flop at a level that makes the 70-MHz signal cause the flip-flop to toggle, providing a 35-MHz output. Since both the bias source and the flip-flop are on the same chip, the bias source is temperature compensated.

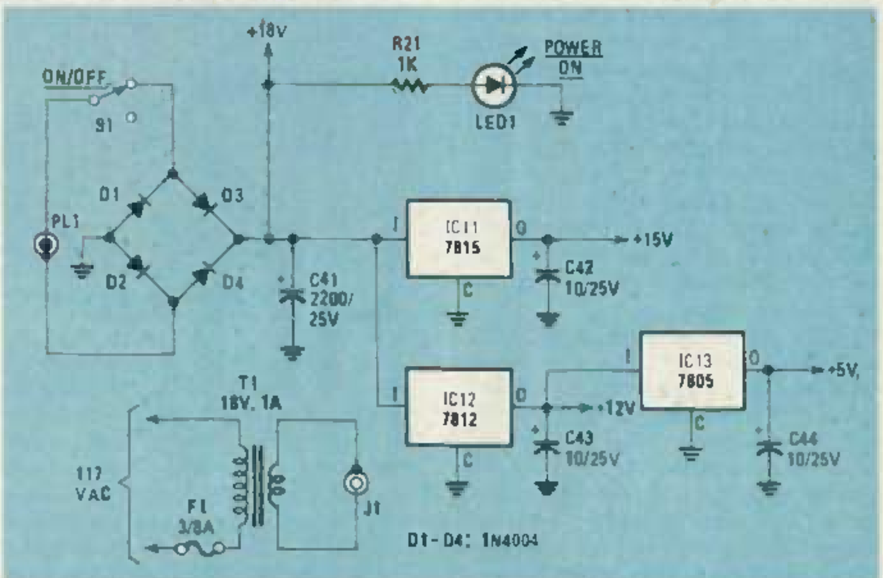


FIG. 8—POWER SUPPLY provides unregulated 18-volts DC, and regulated 5, 12, and 15-volts DC for receiver. Transformer is physically isolated from receiver to avoid drift due to component heating.

The 35-MHz output from IC4-a can be tracked easily by the PLL. The only penalty is that the demodulated signal has only half its original deviation, but that can be compensated for later. A simple FM demodulator with a center frequency of 35 MHz (determined by C38 and C39) is built around IC5. Transistor Q4, an emitter-follower stage, buffers the video and audio-subcarrier information from the PLL for the next stages of the receiver.

Video processor

The video output by the demodulator is "raw" video and must be processed before it can be viewed. The processing involves *de-emphasis* and *de-dithering*.

continued on page 104

BUILD THIS

AUTOMATIC Power Switcher

How many switches do you have to throw to get your computer or stereo system up and running? Build this power switcher and you'll need only one.

GARY McCLELLAN

ANY ELECTRONIC OR ELECTRICAL SYStem that uses a number of separately switched components can be a nuisance to power-up...all those switches to turn on, and then, having to remember to turn them all *off*! I had that problem with my Radio Shack *TRS-80* computer system.

As it grew, I quickly realized what a headache powering-up can be, and tried all sorts of solutions, such as extension cords and outlet strips. They did the job, but lacked what I like to call "elegance," for there is nothing elegant about plugging in an extension cord! The solution is a power switcher. It can be used with computers, on the test bench, and even with stereo equipment where there are many things to be powered up. Basically, the device is a current-operated switch: when current-flow through one of the computer devices is sensed, that turns on all the other equipment.

In my computer application, I plug the video monitor into the power switcher. Then I plug each of the accessories into the outlets on the unit. Now all I have to do to power-up my computer is to turn on the monitor and everything springs to life! Not only is the arrangement "elegant," but I no longer forget to turn off the computer after a late-night session. Other bonuses include the fact that no warranty-voiding modifications have to be made to the computer or accessories, and that the power switch on each accessory still works. For example, the printer isn't used all the time, so it is simply shut off until it's needed. That's great for saving wear and tear on expensive mechanical components.

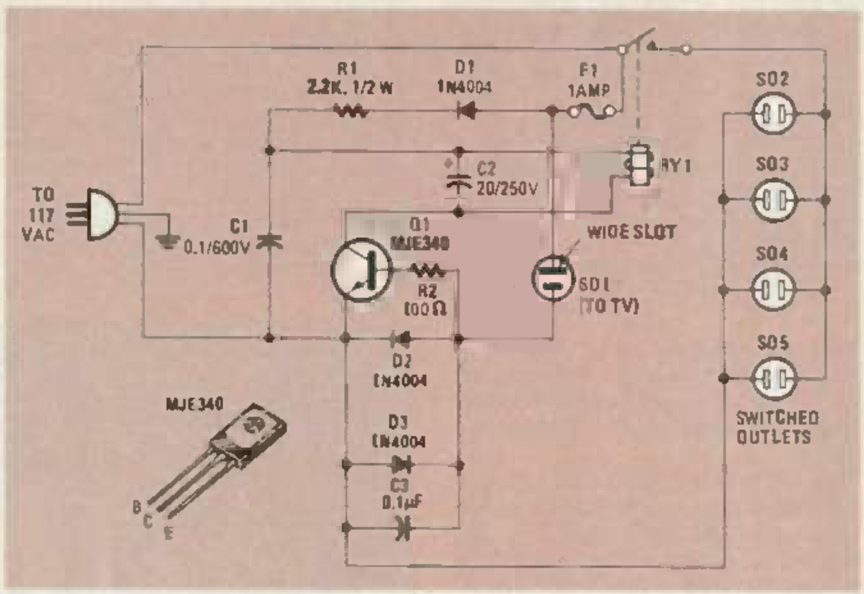


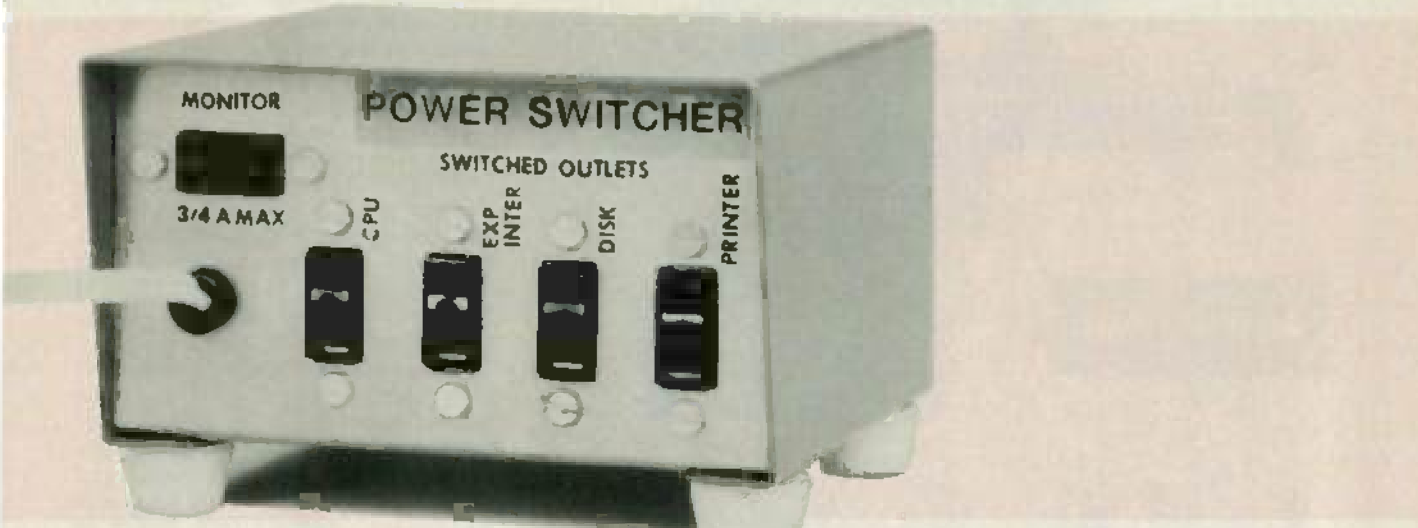
FIG. 1—IF POWER SWITCHER doesn't work with the Radio Shack video monitor, reverse the connections to SO1. See text for details.

The power switcher is inexpensive and easy to build. I built my version using junkbox parts, but I was careful to use readily available components. And, even if you have to go out and buy the parts, you should be able to keep the cost between $10 and $20 with reasonable effort and care in shopping. The switcher contains only a few parts, so construction should go quickly and easily. Building it should be a one-afternoon project.

How it works

Figure 1 shows a schematic of the power switcher. Note that diodes D2 and D3 are in series with the line to the monitor socket. That's because we want the monitor to do the power switching. When it is turned on, it draws current, causing the diodes to conduct. That applies a 0.7-volt P-P signal to the transistor, causing *it* to conduct, and close the relay. Don't be concerned about the 0.7-volt drop to the monitor—that value is negligible when compared to the full 117-volt line voltage.

The rest of the circuit is used to power the relay, and for glitch suppression. Diode D1 and resistor R1 make up the relay power-supply. Capacitor C2 across the relay coil filters the voltage, and prevents chatter. Capacitors C1 and C3 are included to keep power-line glitches from the transistor, and to pre-



vent damage to the device. Finally, fuse F1 was included as a protective device for the video monitor, even though the monitor already has its own fuse. A little extra protection never hurt anyone.

Parts substitutions

One of the nice things about this device is that parts values are not critical and a wide range of substitutions are possible. That can reduce your cost dramatically if you have a well-stocked junkbox. Of course, there are reasonable limits as to how far you can go; those are dictated mainly by safety and reliability, which are the most important factors. Let's look at some areas where you may make substitutions—and then a few where you shouldn't.

The first thing that most people will probably want to find a substitute for is relay RY1, a 117-volt-AC relay with contacts rated at five amps. The original part used was designed for vacuum-tube circuits, and is known as a "plate-circuit relay". Those devices are still in use, and are sometimes available at surplus-electronics stores or by mail order. If you can't find a relay with a 10,000-ohm coil, you may substitute one with a 5000, or even 2500-ohm coil. If you happen to have a 117-volt-*DC* relay, and the coil resistance is 2000 ohms or higher, it may also be used. In any case, adjust the value of R1 so that the relay closes any time a load is connected to SO1. One thing you should make sure of when you select a relay is that its contacts are heavy enough to switch at least five amps of current. Although it is doubtful that you will draw that much current with a *TRS-80* computer and its accessories, the extra capacity insures safety and longer component-life. Relays in the five- to ten-amp range are easy to find.

Another part that many people will want to use a substitute for is transistor Q1. The original part is an NPN, 250 mA, 350-volt-CE (*C*ollector-to-*E*mitter) breakdown-voltage devices, and is sometimes found in the audio output-stages of radios and TV's. Thus, you may be able to scrounge a usable transistor from such sources. Generally, the substitute transistor should have at least a 200-volt CE breakdown-rating, and be able to handle at least 100 mA of current. The gain really isn't important, since the device is used only as a switch. In fact, it might be possible to use an SCR, if you have one, in place of the transistor. Just be sure to replace C2 with a 1N4004 diode to suppress back-EMF, and make sure that the relay is an AC type. (Otherwise, the SCR will latch up when a load is applied to SO1, and you'll have to unplug the switcher to turn off the computer!) There are many substitutes for the MJE-340, though, if you don't have one.

There are other components for which substitutes are available. The diodes may be replaced by devices with a higher current-capacity or PIV rating. Diode D1 should have at least a 200-PIV rating though. The ratings of the other two diodes, D2 and D3, aren't as important because neither diode will see more than 0.7 volts.

Some substitutions are permissable for the capacitors, although it is suggested that C1 be a Mylar type; they handle line-voltage glitches better than ceramic discs. The other capacitors aren't critical.

If any of your equipment has three-prong plugs, you will want to change SO2-SO5 to 3-pin receptacles as required. That way you can avoid the headaches that adaptor plugs tend to cause, and still have your equipment grounded properly.

If you do make any substitutions, make sure that all parts you use are in good condition for maximum safety and reliability. If there's any doubt, spend the little extra cash necessary to get parts that you know you can trust!

Construction

Caution: The switcher is connected directly to the power line and can present a shock hazard if assembled incorrectly. It is suggested that you use extra care in assembling it. Also, it is recommended for safety reasons that you do not substitute for the three-wire power cord and metal cabinet.

Let's start construction. The layout, which is not critical, will depend to a large extent on the components you are using. The first step (after obtaining the parts) is to lay them out in the box to determine where they should be mounted. In the prototype, the line cord and sockets were mounted on one end of a box that measured 4½ × 4 × 2½-4 inches. The relay and fuse were attached to the bottom of the case. The rest of the circuit, mounted on a long terminal-strip, was then attached to the bottom of the box. Figures 2 and 3 show details of the layout.

Drill the holes for the power cord and sockets. Then turn to the installation of the relay and circuitry. Generally, those components can be mounted on the bottom of the box, unless you have a plug-in type relay; in that case, mount

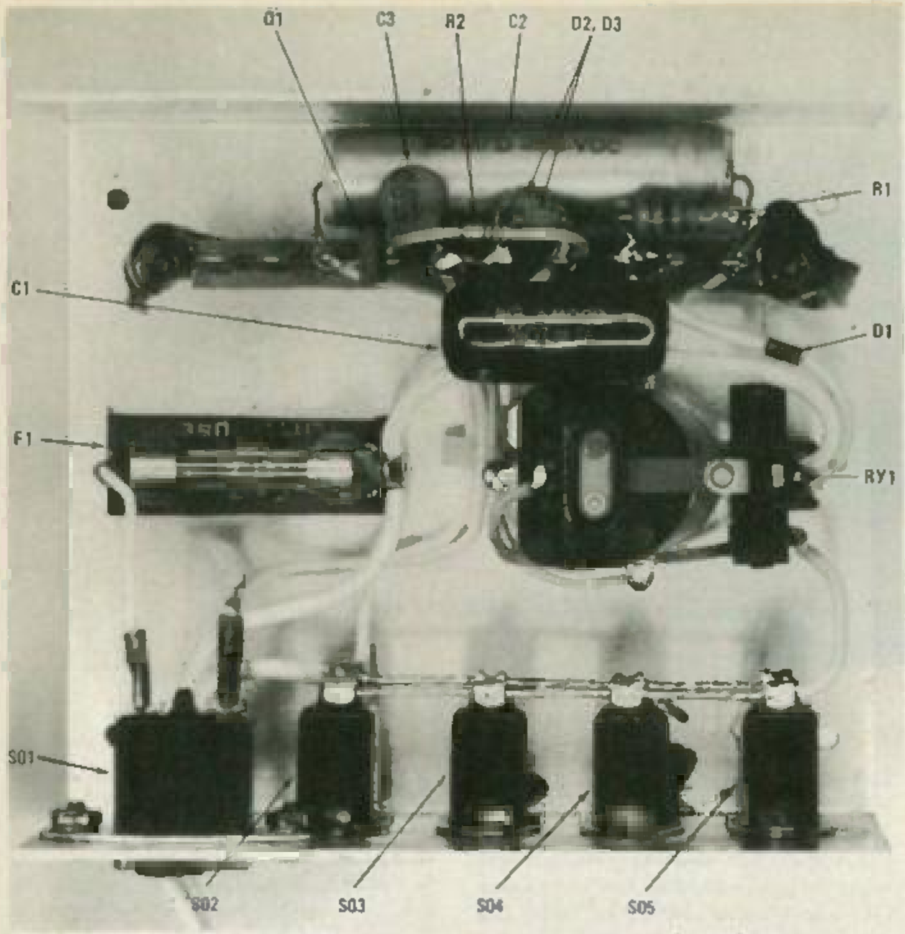


FIG. 2—MAJORITY OF COMPONENTS can be mounted on an 8-lug terminal strip. Be sure to use heavy-gauge wire to handle line voltage and current safely.

FIG. 3—THIS PARTICULAR VERSION of power switcher did not require 3-wire line cord, but yours probably will. Make sure that the ground wire makes good contact with case.

PARTS LIST

All resistors ¼-watt, 5% unless otherwise specified
R1—2200 ohms, ½-watt, 10%
R2—100 ohms
Capacitors
C1—0.1 µF, 600 volts, Mylar
C2—20 µF, 250 volts, electrolytic
C3—0.1 µF, 25 volts, ceramic disc
Semiconductors
Q1—MJE-340 or equivalent (see text)
D1-D3—1N4004 (1 amp, 400 PIV)
F1—1 amp fuse
SO1—polarized chassis-mount socket
SO2-SO5—nonpolarized chassis-mount socket
RY1—10,000-ohm plate-circuit type with SPST, 5-amp contacts (see text)
Miscellaneous: aluminum box, 3-wire power cord with plug, strain relief for cord, clip-type fuse holder, 8-lug terminal strip, relay socket and bracket (if required), wire, solder, etc.

the relay socket on an "L" bracket. Locate the terminal strip near the relay. The fuseholder should go near SO1, to which it will be connected. After component locations have been determined, drill the mounting holes for them. If you like, the outlets can be labelled with press-on letters, which will make them more convenient to use.

All the electronic components (resistors, capacitors, diodes, etc.) can be mounted on the terminal strip. Use "spaghetti" insulating tubing to keep component leads from shorting together. Be sure to observe polarities, especially in the case of the transistor (see the inset in Fig. 1). When the terminal strip is finished, mount it on the bottom of the enclosure.

The next step is the chassis wiring. Remember that it will be carrying fairly high voltages and currents, so be sure to do the best job that you can. Mount the line cord and strain-relief, sockets, relay, and fuseholder. Then start the wiring by busing together the lower terminals of SO2-SO5 with a piece of No. 18 solid wire (or tinned No. 18 stranded wire). Do the same with the upper terminals. Then connect the line cord as shown in the schematic. Finally make the appropriate connections to the terminal strip and relay. Finish up by checking over your wiring for errors and correcting any that you find.

Safety checks

Naturally, you are in a hurry to try this power switcher—but check it out first. Since it connects directly to the AC power-line, it is a good idea to take the time to be sure that the unit is safe for use. First, inspect the wiring to be sure that there are no shorts to ground (the case) or between adjacent wiring. Correct any shorts that you may find.

Then make sure that all connections are properly soldered; it's easy to miss a joint, especially on the terminal strip. While you're checking the wiring, make certain that the line-cord's ground wire (from the round prong on the plug) is in good contact with the case. Finish up by checking continuity between the case and the prongs of the line-cord plug. The resistance should be infinite on any ohmmeter range, except in the case of the round ground-prong, where you should see no resistance. If any of the readings are incorrect, recheck your solder connections, and look for any dirt or contamination between a connection and ground.

Operation

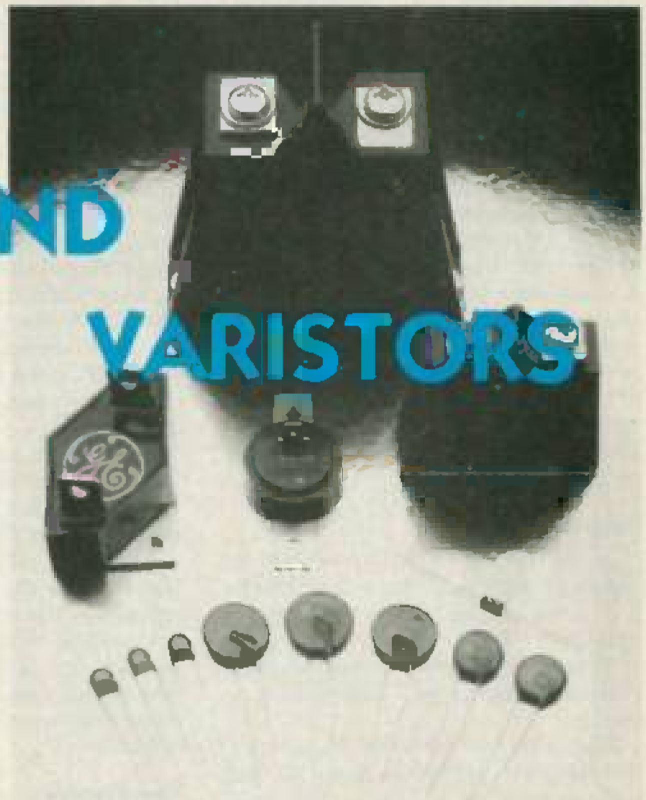
Assuming that you're using the power switcher with a computer, plug it and its accessories into SO2-SO5. Then plug the monitor into SO1 and the switcher's line cord into a wall outlet. Turn on the computer and accessory power switches, and then turn on the monitor. The entire system should spring to life, and you'll be all set to enjoy a computer system that's easier to use. To finish up, you may want to install the switcher under your operating table, as I did with the prototype, or conceal it some other way.

If you have trouble getting the switcher to turn on with the monitor, simply reverse the connections to SO1. The Radio Shack monitor has a half-wave rectifier in it that draws current on half cycles of the line-current, and reversing the connections causes the monitor to draw current on the same half cycle that is used to trigger the switcher. (That should not be a problem with the other accessories.)

You can also use the power switcher to operate other devices. One application that comes to mind is using a turntable to control an entire sound-system. Simply plug the turntable into SO1, and the other components of the system into the other sockets. That's all there is to it! Once you've built it, I'm sure you'll find many uses for this power switcher. **R-E**

HOW TO DESIGN ANALOG CIRCUITS

THERMISTORS AND VARISTORS



If a circuit is not designed properly, the likely result will be a device that does not work, or a pile of charred components. Learn the right way to design analog circuits that use semiconductor components in this new series.

MANNIE HOROWITZ

AT ONE TIME OR ANOTHER, ANYONE interested in electronics (either as a hobby or on a professional basis) has needed a circuit to perform some special function. Most of us have found, however, that it is almost impossible to design a circuit properly using haphazard techniques. That is especially true of circuits that use semiconductors. If proper techniques and procedures are not followed, the end result is likely to be either nothing or a bunch of charred components.

In this series of articles our goal will be to teach you how to design analog circuits that use semiconductors. Each article will cover one or more specific semiconductors. As we will be starting from scratch, some of the things we'll be talking about may seem ridiculously simple to some of you. That material will be presented for the sake of the novice, as well as for continuity. The only things we will assume is that you have a basic knowledge of such things as current and voltage, as well as some familiarity with components such as resistors, capacitors, and inductors. (If you do *not* have a background in those subjects, we suggest that you read a book on basic electronics first. Your local library is an excellent place to look for one.)

Only what you need to know to do actual designs will be covered here. Derivations of formulas will be avoided except where they help make the design procedure clear. When a formula is presented, an example showing you how to apply the formula will also be provided. Do not try to memorize any of the formulas or derivations; simply make a note of where they are so that you can refer to them when you need them.

Before we get much farther, let's speak briefly about some of the numbers we will be using. Many of the numbers used in electronics are either very large or very small. Writing numbers such as 100,000 or 0.000001 continuously can get tedious. It is a lot easier to write those numbers using scientific notation or *exponents*. In scientific notation, 1000 becomes 10^3 and 0.001 becomes 10^{-3}.

Special prefixes are also used to denote powers of 10. Some of the most common are kilo (10^3), mega (10^6), giga (10^9), milli (10^{-3}), micro (10^{-6}), nano (10^{-9}), and pico (10^{-12}). As an example, 0.001 volts would be written as 1 millivolt.

Conductors, insulators, and semiconductors

When the electrical characteristics of different materials are considered, they can be divided into three not-so-exacting groups. Those are conductors, semiconductors, and insulators. Most of us are familiar with conductors and insulators—but what about semiconductors? A semiconductor is defined as a material whose conductivity falls somewhere between that of an insulator and a conductor.

Most semiconductors use either germanium or silicon as the base element. Because those elements are good insulators in their pure form, they are mixed with another material to form the useful semiconductor; that mixing is called *doping*. Doping the base material has two consequences: The conductivity of the base material is increased and, depending on what is used for the doping, the base material picks up either an excess or shortage of negative charge. A semiconductor with an excess of negative charge is called *n-type*; a semiconductor with a shortage of negative charge is called *p-type*.

Semiconductor materials have a wide variety of properties. Their resistance varies with the voltage across them, with changes of temperature, and with the amount of light that strikes them. In addition, any device made up of a semiconductor material is to some extent sensitive to magnetic fields and can be considered to be a *Hall-effect* device. (We'll talk more about Hall-effect devices later.)

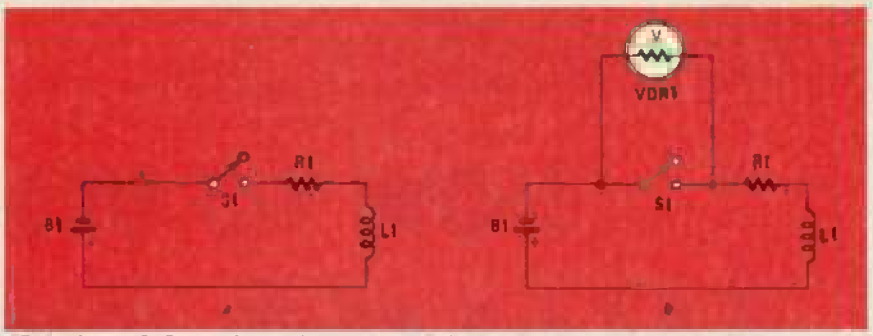


FIG. 1—A VARISTOR can be used as a current limiter. Opening the switch in the circuit shown in a would cause a current surge (due to the presence of the inductor) that could damage the switch contacts. Placing a varistor in the circuit as shown in b would protect the contacts.

Varistors

A semiconductor device whose resistance varies with the voltage across it is called a *varistor* or voltage-dependent resistor. Because of their structure, those devices are often called varistor diodes or current-limiting diodes.

The difference between an ordinary resistor and a varistor is that while the resistance of an ordinary resistor is constant, the resistance of a varistor changes with voltage. In that device, the resistance is very low at high voltages. As the voltage decreases, the resistance increases. Ohm's law, of course, applies here—just the resistance of the device changes. In most varistors, the polarity of the signal is unimportant, although there are some devices where it is. Just like a resistor, a varistor dissipates power and, as with any other device, the maximum ratings of a varistor should not be exceeded.

Let's see how we can make use of the characteristics of a varistor. The circuit shown in Fig. 1-a consists of a power source, switch, resistor, and inductor. When the switch is closed, current flows through the resistor and inductor. Steady-state current is limited to safe levels because of the presence of the resistor. When the circuit is broken by opening the switch, a high voltage is developed across the inductor because of the rapid change in current through that inductor. Since that high voltage is also across the switch, the switch contacts could be damaged if they are not protected. One way to protect the contacts would be to wire a varistor across the switch as shown in Fig. 1-b. In that circuit, the resistance of the varistor is very small when the switch is first opened, because the high-voltage developed by the inductor is applied across the device. That low resistance keeps the instantaneous voltage across the switch low, protecting the switch contacts. The varistor has no effect on the circuit with the switch closed, because the switch shorts out that device.

If you wish, the varistor could have been wired across the inductor instead. Despite the fact that it would be in the circuit even while the switch is closed, it would not affect the circuit's operation because the steady-state DC voltage across the inductor is low. As that low voltage would also be across the varistor, its resistance would be extremely high and thus negligible when compared to the resistance of the inductor.

Thermistors

A thermistor is a semiconductor device whose resistance changes with changes in temperature. A thermistor whose resistance increases with increasing temperature is called a positive-coefficient device; one whose resistance decreases with increasing temperature is called a negative-coefficient device. For the sake of simplicity, we will deal exclusively with negative-coefficient thermistors in this discussion, although most of what we will say can also be applied to positive coefficient devices.

How much the resistance decreases with temperature is a function of the particular device used. As a general rule, however, the resistance decreases by about 4% for each degree Celsius that the temperature rises (above 25°C). Once you know the resistance of 25°C, it is a fairly simple matter to calculate the resistance at any higher temperature—simply multiply the resistance by 96% for each degree over that temperature. For example, if the resistance is 250 ohms at 25°C, it is 250 × 0.96 = 240 ohms at 26°C, 240 × 0.96 = 230.4 ohms at 27°C, 230.4 × 0.96 = 221.2 ohms at 28°C, and so on. Another characteristic of a thermistor is that there is a time delay from when heat is first applied to the device until it reaches its final temperature, again assuming that all of the heat is supplied by an external source. That "thermal time constant" rating indicates the amount of time it takes for the temperature of the thermistor to rise to about ⅝ of its final value.

So far, we've assumed that all the heat is supplied by an outside source and none is developed by the thermistor itself. Of course, if you apply enough voltage to a thermistor, some heat will be generated. Assuming this time that there is no external source of heat, the resistance of a thermistor will remain constant up until the applied voltage exceeds a certain critical point. With no change in resistance, the current through the device increases linearly with increasing voltage. Once the critical point is reached, however, the device begins to heat up and the resistance begins to drop. When that happens, the current will increase at a faster rate than the voltage. That critical point is called the *self-heating voltage*.

The last characteristic that we'll look at is the thermistor's dissipation constant. That constant indicates how much power must be dissipated by the device to increase its temperature by 1°C. If, for example, the constant is 0.6 mW-per-°C, the thermistor must dissipate 0.6 × 20 = 12 mW if its body temperature ture is to rise by 20°C.

Sometimes you may find that you need to alter the thermal characteristics of a thermistor you have on hand to make it useful for some particular application. That would not be necessary if an infinite number of different types of thermistors were available, but that is rarely the case. The circuit in Fig. 2 is used for that. Just determine the minimum and maximum resistance that you require in your application and choose a device where the cold resistance is higher than the maximum resistance you require and the hot resistance is lower than the minimum resistance you

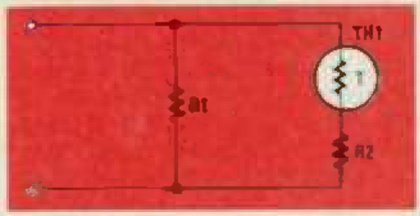


FIG. 2—THE RESISTANCE of a thermistor at different temperatures can be altered to fit the requirements of a particular application by properly choosing the values for R1 and R2.

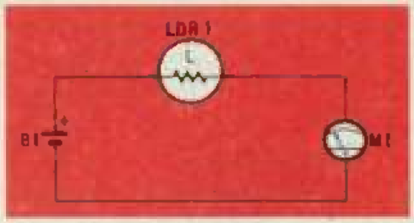


FIG. 4—A SIMPLE LIGHTMETER can be made using a photoresistor. For such an application, the photoresistor should be equally sensitive to all visible wavelengths of light.

need. Letting R_{TH} be the hot resistance of the thermistor and R_{TC} be its cold resistance, R1 and R2 in Fig. 2 can be determined from the following relationship:

$$R_H = \frac{(R_{TH} + R2)\,R1}{R_{TH} + R2 + R1}$$

$$R_C = \frac{(R_{TH} + R2)\,R1}{R_{TC} + R2 + R1}$$

Where R_H is the hot resistance required by the circuit and R_C is the cold resistance required.

As an example, let's assume that for a particular application you need a thermistor with a resistance that is 440 ohms at 25°C and 240 ohms at 50°C. You have a thermistor on hand with a resistance specified as 600 ohms at 25°C and 210 ohms at 50°C. Substituting into equations 1 and 2, you end up with:

$$240 = \frac{(210 + R2)\,R1}{210 + R2 + R1}$$

$$440 = \frac{(600 + R2)\,R1}{600 + R2 + R1}$$

Solving for R1 and R2 we get:

R1 = 1218 ohms
R2 = 89 ohms.

Because those values are not standard, they will be expensive to buy, if you can find them at all. But using standard, readily available values such as 1200 ohms for R1 and 91 ohms for R2 will be acceptable for most applications.

There are quite a number of practical applications for the thermistor. Among the more common is in a temperature-measuring circuit, as shown in Fig. 3. Here, the device is connected in series with a milliammeter and a voltage source. The current flowing through the meter is, by Ohm's law, equal to the voltage divided by the resistance of the thermistor. As heat is applied, however, the resistance of the thermistor changes. Thus the current flowing through the circuit and the meter changes with temperature. It is a simple matter to calibrate the meter's scale in order to indicate the temperature at the thermistor.

Another important application of the thermistor is in limiting current surges. The life of light bulbs, rectifiers, etc. would be shortened if a large current flowed through any of those devices at the instant power was applied. If a thermistor were placed in series with any device, its high cold resistance would limit that surge current. If the thermistor is properly chosen, its resistance will be large enough to limit the surge to reasonable and safe currents when it is cold, and be low enough not to affect the circuit when it is hot.

Photoresistors

As we noted earlier, not only is the resistance of semiconductor material dependent upon temperature and applied voltage, but it also varies with the amount of light that hits it. The photoresistor takes advantage of the fact that semiconductor materials are sensitive to light. The resistance of the device varies *inversely* with the intensity of the light striking it. (The more intense the light, the less resistance.)

The wavelengths of visible light vary from about 330 to 800 nanometers (3300 to 8000 angstroms). Different photoresistors respond to different wavelengths—the wavelength to which a particular device is most sensitive, depends upon the basic material used for the semiconductor, and upon the percentage of impurities added to the basic material. Because the device is made from semiconductor particles, the wavelength sensitivity also depends upon the size of those particles. Incidently, most photoresistors will respond to a wide variety of wavelengths, including wavelengths in the infrared and ultraviolet regions: those wavelengths are beyond the range of the human eye and are thus invisible.

Without getting into the physics involved, there are two units commonly used for light intensity: those are *foot-candles* and *lux*. The greater the number of foot-candles or lux hitting the photoresistor, the greater the intensity of the light source, and the lower the resistance of the photoresistor. You should also note that the intensity varies with the inverse square of the distance from the light source. For a fixed light source at 5 feet from a surface, let us assume that the intensity of light at the surface is 1. Now increase that distance to 10 feet. Because the distance from the source has doubled, the intensity is now $1/2^2 = 1/4$. If the distance were tripled to 15 feet, the relative intensity is $1/3^2 = 1/9$, and so on.

Photoresistors are used in many different types of devices. The obvious one is its application in measuring light intensity when taking photographs. Because color is an important factor in that application, semiconductor devices that respond to the entire visible spectrum should be used. A circuit for that application is shown in Fig. 4. In the absence of light, the resistance of the photoresistor is high; thus very little current from the battery will reach the meter. If the sensitivity of the meter is low, the pointer will not be noticeably deflected. With increasing light intensity, the resistance of the photoresistor drops. Now more current can flow in the circuit; that will be indicated by the meter. The higher the intensity, the greater the deflection of the pointer. Calibrating the meter is simple.

Another, more common use for the photoresistor is to control a relay, that in turn is used to control some device or appliance. A circuit that can be used to turn a lamp on at night is shown in Fig. 5. Here the photoresistor is across the relay. The photoresistor and R1 form a voltage divider. During daylight hours, the resistance of the photoresistor is low, and therefore most of voltage is across R1. The voltage across the relay coil is too low to establish the magnetic field necessary for the contacts to close. As night falls, the re-

FIG. 3—A THERMISTOR can be used to measure temperatures. This simple circuit shows one way to do that.

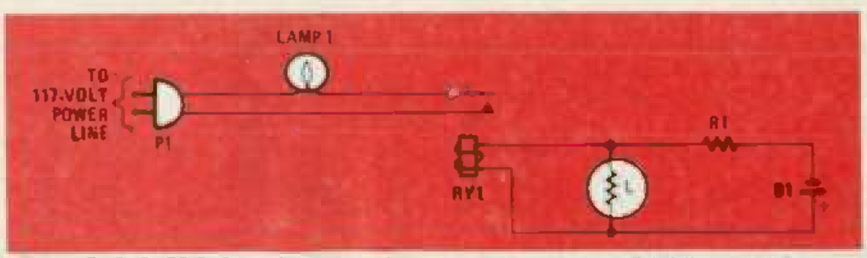
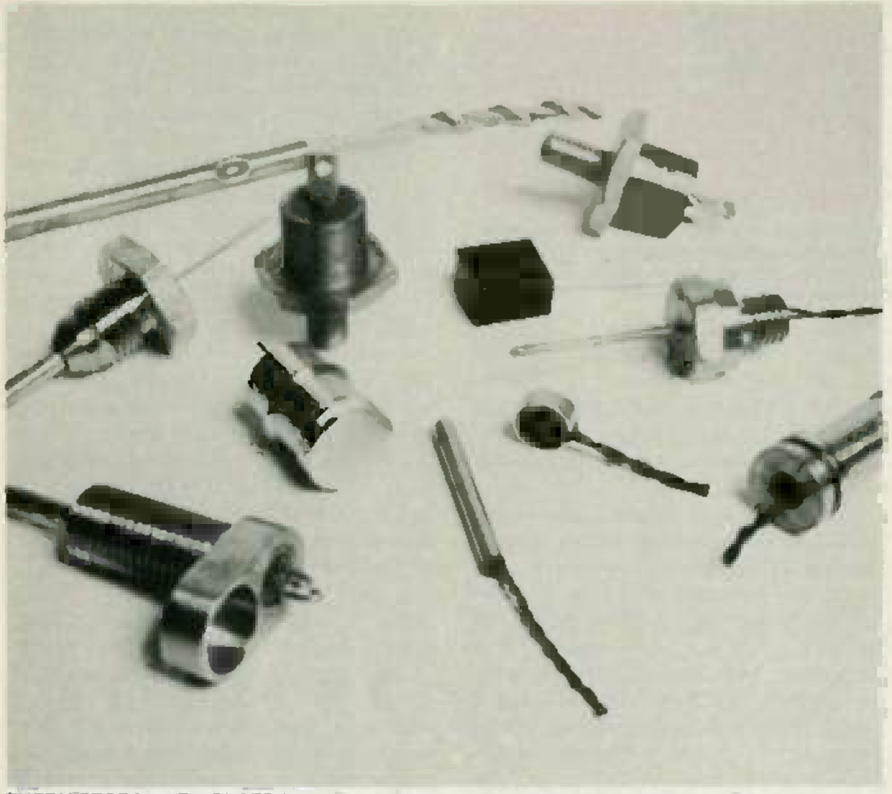


FIG. 5—A PHOTORESISTOR and a relay can be used to turn a lamp on at nightfall. The circuit will turn the lamp off at dawn.



THERMISTORS ARE HOUSED in a wide variety of enclosures for different applications. Among the enclosures shown here are ones for air, water, and surface temperature measurement.

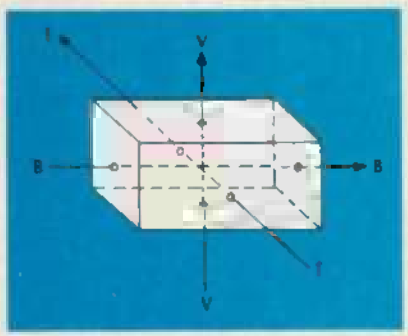


FIG. 6—THE HALL EFFECT is shown here. With a magnetic field B, and a current I as shown, a voltage V will be generated that is perpendicular to both B and I.

sistance of the photoresistor increases, as does the voltage across the relay's coil. Once the voltage across the coil is high enough, the contacts close, turning on the lamp. The procedure is reversed at dawn, turning the lamp off again. Of course, safety should be a prime concern when building that, or any other, circuit. Wires should be rated high enough to handle the currents that they will be carrying. The relay's contacts should be capable of handling the switching that will be required without pitting, and be rated high enough so that there will be no breakdown or arcing.

Just as with any other device, a photoresistor has certain ratings that should not be exceeded. Never exceed the specified limits of voltage, current, or power: doing so will destroy the device, at the very least.

The Hall effect

Perhaps the easiest way to describe the Hall effect is with an illustration, such as the one in Fig. 6. In that figure, the cube is a piece of semiconductor material. If the cube were placed in a magnetic field B, and a current I flowed through it, then a voltage V, perpendicular to I and B would be generated. The voltage that is generated is proportional to the product of I and the magnitude of B. If either the current or the magnetic field are missing, no voltage will be generated.

One of the most important applications of the Hall effect is to measure the field strength of a magnet. In that application, a voltmeter is connected so it can measure the voltage generated. If the current is held constant, the voltage will be *directly* proportional to the magnitude of the magnetic field. (The higher the voltage, the greater magnitude.) Again, it is relatively easy to calibrate the meter to give a direct readout of the magnitude of the magnetic field. That application may seem unimportant, but its principles can be extended to give you a way to measure a DC current flowing in a conductor. As the magnitude of a magnetic field is related to the DC current in the conductor, if the voltage across the conductor is known (measured from end to end), the Hall effect lets you determine the current through it—without breaking the wire—simply by measuring the magnetic field.

Note that the output voltage due to the Hall effect has a specific polarity. That polarity depends upon the directions of the magnetic field and the current. The polarity is also a function of the type of semiconductor material used. If it is n-type, the polarity will be opposite from the polarity when p-type material is used. Thus the Hall effect can be used to determine the type of semiconductor material. The easiest way to apply that is to note first the polarity of the voltage when a known type of material is used. Next substitute any unknown semiconductors. Compare the polarity of the voltage. If it is the same, the semiconductors are the same type: if it is different, the semiconductor is of the opposite type.

The devices we've looked at this month have been relatively simple, yet they are quite useful in analog circuits. Be sure to include those devices in your arsenal. When we continue this series, we'll look at a device that is used in a wide variety of applications—the diode. **R-E**

"These video war games sure are fun, Dad. ... I'll bet you didn't have this much fun in the real war!"

IMPROVE VIDEO SOUND

Dissatisfied with the sound quality of the videotapes you make? Here are several ways to improve it.

LEN FELDMAN
CONTRIBUTING HI-FI/VIDEO EDITOR

HOME VIDEOCASSETTE RECORDERS, LIKE TV receivers, tend to place more emphasis on the quality of the picture than on that of the sound. While the color pictures reproduced from videotape are often indistinguishable from those obtained from good, off-the-air TV reception. The sound portion of those recordings, however, seem almost to have been tailored for reproduction by the small speakers and minimal-power amplifiers found in most table-top TV receivers.

If, however, you have ever connected the audio-output jack from your home or portable VCR directly to your component stereo-system, you know that the frequency response of the sound-track on a videotape is not all that bad. When VCR's are operated at their fastest speeds (0.79 ips for Beta-format machines or 1.31 ips for VHS machines) the audio response often extends to beyond 10 kHz, while the signal-to-noise ratio may be as high as 45 dB or more if high-grade tape is used. While those specifications are not outstanding in high-fidelity terms, they would be more than adequate for general use were it not for some steps that makers of VCR's take to "simplify" the audio sections of their products.

Live-taping situations

Most VCR's are equipped with a single microphone-input and, in some cases, another high-level input. Home-video cameras usually have built-in omnidirectional microphones that are connected to a VCR by the multi-pin camera cable that has become fairly standard on this type of equipment. In any case, there is no means of controlling audio gain at the camera, nor is there a master level-control at the

VCR. The VCR is equipped with an ALC (Automatic Level Control) circuit that restricts the dynamic range of the audio severely.

The ALC can cause problems when the built-in camera microphone is used as the sole sound-pickup device in a home-videotaping setup. The reason is that, more often than not, the camera and microphone are several feet away from the subject being taped, and the resulting soundtrack has an echo-laden, reverberant quality that is incongruous when heard together with close-up views of the subject (taken with the aid of a zoom lens).

Background noise also increases, because the ALC circuit is doing what it was intended to do (maintaining a constant audio level—even if the only audio is irrelevant background-noise), and the effect is anything but natural-sounding. In addition, if the camera is hand-held or shoulder-supported (rather than being mounted on a tripod), one can often hear the sound of "heavy breathing" from the camera operator because of his proximity to the camera-mounted microphone and the "wide open" gain that is provided by the ALC circuitry.

The solution to the problem, obviously, is to use an off-the-camera microphone (or microphones), preferably of the directional or cardioid type. It can be kept just out of camera range, but still be positioned close enough to the subject or subjects being taped to give good solid audio.

Whether you choose a dynamic microphone or a condenser type, the plugs found on the higher quality, low-impedance microphones are not likely to fit directly into the miniature jacks found on most portable and home VCR's. However, adaptors that convert from one type of plug to another are readily available from electronics-parts stores.

FIG. 1—A MIXER, such as the Shure *M267*, allows you to use several microphones or other audio sources.

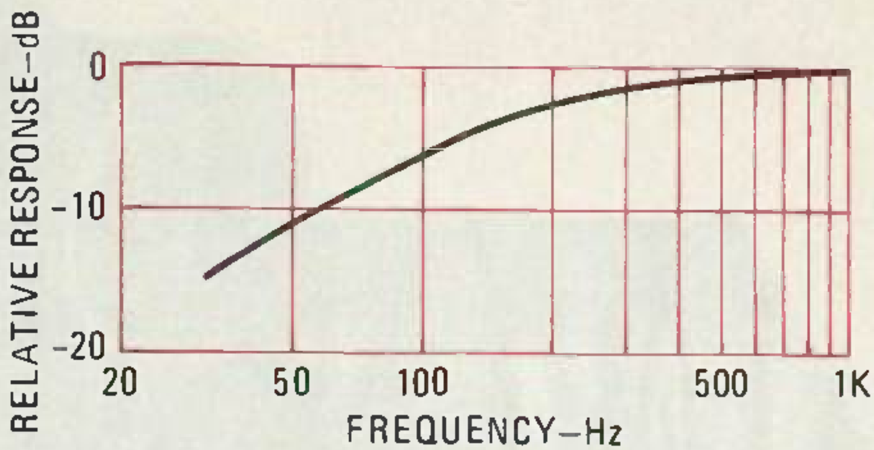


FIG. 2—LOW-CUT FILTERS can reduce the annoying effects of wind noise, turntable rumble, and other low-frequency sounds by decreasing low-frequency response.

Audio mixing

It's just one step from using a single external microphone to using several microphones and even some line-level program-sources (like music from records or tapes). Using multiple sources instead of the single-microphone approach is also preferable when dubbing a new audio-track onto your existing videotapes.

Shure Bros. (222 Hartrey Ave., Evanston, IL 60204), a well known manufacturer of phono pickups, microphones, and professional audio equipment and accessories, has introduced recently a small, 4-input audio mixer, the *model M267*. While it is intended for use primarily in audio-recording applications, the versatile, relatively inexpensive ($395.00) mixer can also solve a lot of problems for serious videophiles who want better-quality soundtracks on their tapes. (Shure also manufactures a *model M268* mixer that includes many of the features of the *model M267*, but sells for $250.00.)

The *model M267*, shown in Fig. 1, has wide frequency-response (30 Hz to 20 kHz, ±2 db) and low distortion up to +18-dBm output (less than 0.35% at +15 dBm at any frequency within its passband), extremely low noise, and very low susceptibility to RF interference—a problem that can often crop up in an untested "field" environment.

Four switchable microphone or line-level balanced inputs with individual gain controls and low-frequency rolloff switches are provided, and the output is switchable for either line or microphone levels. Thus, if your video camera is equipped with only an external-microphone input (and there is no line-level input on your VCR), you can still get the benefit of good signal-to-noise ratios.

There's a built-in peak limiter—together with an LED peak-indicator—that can cut distortion due to overload; it can be switched in or out. The sensitivity of a small VU meter can be set for +4 or +8 dBm with a VU RANGE switch (normally, 0 dB on the meter is equal to +4 dBm; the +8-dBm setting is used to reduce sensitivity). The meter is illuminated for easy reading when the mixer is AC-operated.

However, the *model M267* will operate either from AC or from an external battery pack. In case of an AC-line failure or power interruption, noiseless automatic switchover to the batteries takes place. Battery-charge condition can be checked at any time. A front-panel monitoring-jack will drive just about any mono or stereo headphones, and a separate level control is provided for the phones. Finally, a built-in 1000-Hz tone oscillator is incorporated for line tests and level checks.

The low-cut filters associated with each of the four LINE/MIC inputs provide a low frequency roll-off that follows the response curve shown in Fig. 2. The filters can be used individually with each input control to reduce wind noise or undesirable low-frequency signals, such as turntable rumble, or overly bassy voices caused by speakers or singers holding microphones too close to their mouths.

Better audio dubbing

Most of the owner's manuals supplied with VCR's suggest that the proper way to do audio dubbing (the process whereby a new soundtrack is substituted for the original one) on a videotape is

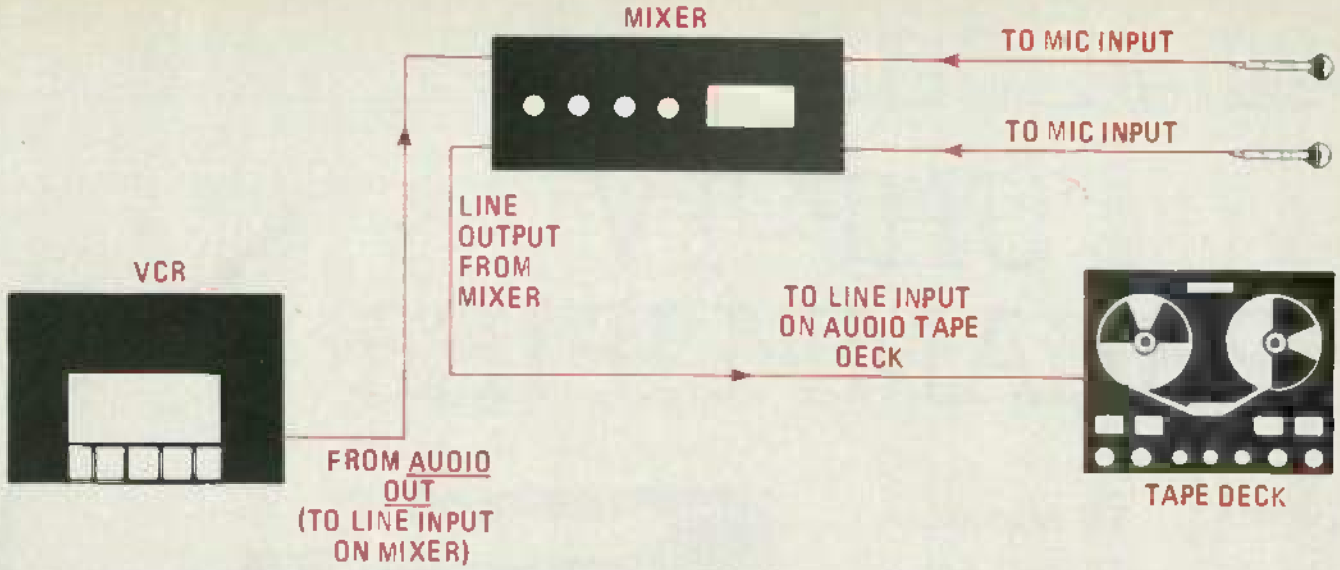


FIG. 3—A MASTER AUDIO TAPE is prepared by using a mixer to combine the orginal video soundtrack with new material.

FIG. 4—THE ORIGINAL SOUNDTRACK is replaced by the new one by transcribing the master audio tape to videotape using the VCR's "dub" function.

simply to plug a microphone (or a mixer such as the one we have been describing) into the external-microphone jack of the VCR, hit the AUDIO DUB button, and substitute new audio for the old.

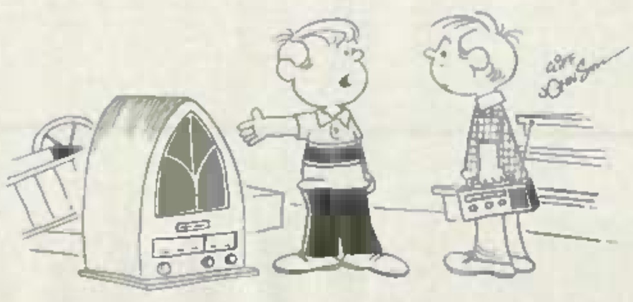
There are several disadvantages to that procedure. For one thing, it erases the original soundtrack, which you may want to include in the new sound mix. Secondly, working in "real time" and getting all the musical and voice portions to fit together, on cue, during the very first "take" is a rarity—if you've ever tried it, you know that the task can be extremely frustrating.

A much better technique involves transcribing the existing audio soundtrack from the videotape onto audio tape and, with the aid of a mixer, adding the additional microphone or line-level contributions, as shown in Fig. 3. If you don't get the "perfect" mix the first time, you have not destroyed the original videotape soundtrack and can try again—as many times as you need to get it right.

Figure 4 shows the hookup for the final audio-dubbing process. In that step, of course, it is necessary to synchronize the newly mixed audio master-tape with the VCR program using the audio-dubbing feature on your VCR. The synchronization process is not as difficult as you may think, at least for scenes of relatively short duration. After all, the final mixed tape contains the original "live" soundtrack, which is already perfectly synchronized with the video. Since the same audio-tape deck is used both to record and play back the final mix, tape speed—even if not perfectly accurate—will be consistent for the brief periods needed to transcribe the new audio mix back onto the videotape via the audio-input jack on the VCR.

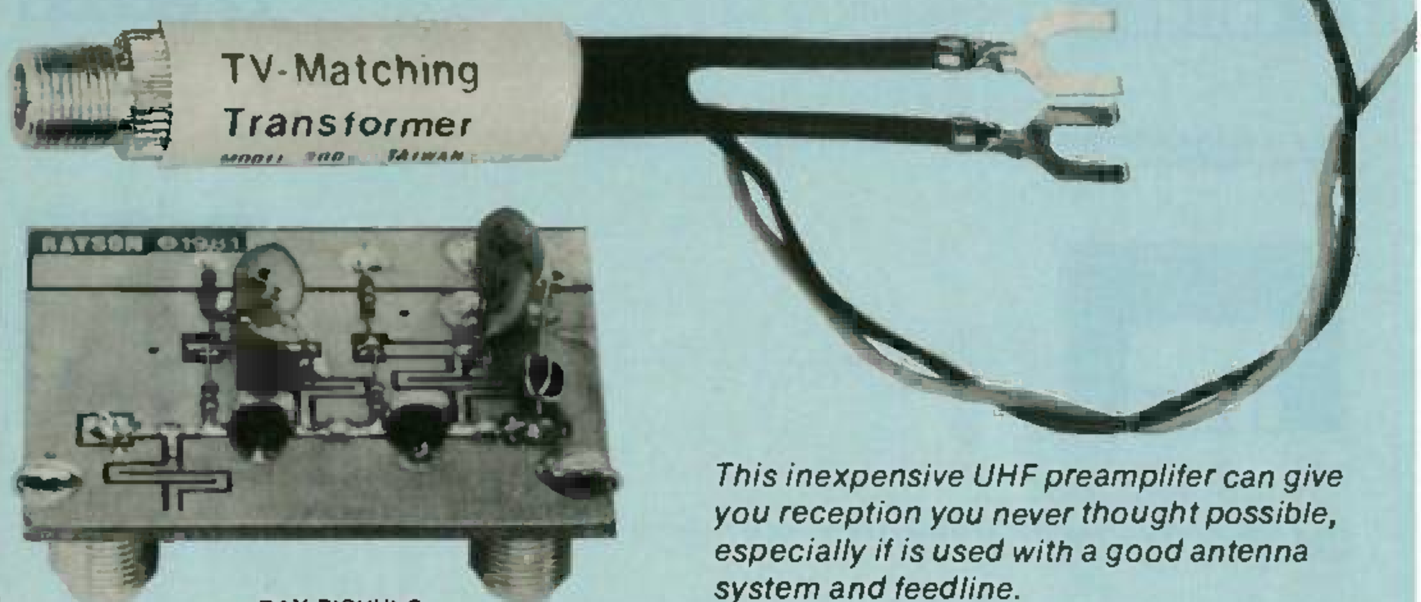
With practice, the PAUSE control on the VCR (which, in most cases, produces a still-frame picture on the screen), used in conjunction with the PAUSE button on your audio tape-deck, should permit a close-to-perfect audio-dubbing operation. (As for the VCR's speed stability, you don't have to worry because its tape-transport system is synchronized to the standard NTSC 30-frames-per-second picture rate.)

Imaginative use of a microphone/line mixer, together with playback through your sound system rather than through your TV set, can give your home-video productions near-professional audio quality. R-E



"My Mom says it's a radio. ... Boy, it must take a lot of batteries to run one that size!"

UHF-TV PREAMPLIFIER



This inexpensive UHF preamplifer can give you reception you never thought possible, especially if is used with a good antenna system and feedline.

RAY PICHULO

Part 2

LAST MONTH, WE looked at the preamplifier that could improve your UHF reception. We'll finish up by showing you a balun for use with coaxial cable, but first, let's look at other factors that can affect your reception.

Today we find that, in most urban areas, receiving antennas are disappearing from rooftops. Indeed, many viewers are getting satisfactory results on VHF channels 2 through 13 using just built-in "rabbit ears." There may be several reasons for that: better VHF tuners, higher transmitter powers, better-located transmitting antennas, and—regrettably—the fact that many people just don't recognize poor picture-quality or know how to correct it.

Many of those viewers usually use a simple loop antenna attached to their TV sets' antenna terminals for UHF and don't care whether or not they get more than one or two channels—or even if they get anything at all.

As you travel out through the suburbs and into the near-fringe areas where an external antenna is still a necessity, you will probably notice that most of the installations use a single "combination" VHF/UHF antenna. While that may seem at first to be a good solution, the results are little different from those obtained by city dwellers with their "rabbit ears" and loops—while the VHF quality may be good, that of the UHF is, generally, fair or poor. A look at combination-antenna specifications will usually show that the performance of the antenna at UHF frequencies is poor, with little or no gain.

Let's take a moment to consider TV design-practices. Until recently, UHF tuners never even had an RF-amplifier stage. Even with the addition of such a stage in most of the UHF varactor tuners, sensitivity is lower and the noise figure higher than with VHF tuners. In many parts of the world, most TV broadcasting takes place at UHF frequencies and the receivers sold must meet certain UHF sensitivity and noise-figure criteria. (In simple terms, "noise figure" is the decrease in apparent signal-to-noise ratio caused by inherent system-noise.) Such needs don't exist for TV sets sold in the U.S.

The reception problem is compounded by the higher transmission-line and propagation losses inherent in UHF transmission. Smaller antenna size, and therefore a smaller signal capture-area, is another factor contributing to poor UHF reception.

Improving the antenna system

Let's take the advice of the FCC and industry committee and see how an antenna system can be improved. The July 1981 issue of Radio-Electronics contains an excellent article with a comprehensive rating of many antennas with UHF capability that are now on the market. The first step is to get away from the ineffective ones, so we'll forget about loop antennas and take a close look at the UHF gain-specifications of the "combo" antennas. Unless the gain of those antennas is in the neighborhood of 7 dB or better on the UHF channels we are interested in, we should consider using separate UHF and VHF receiving antennas in areas where signal strength is not classified as "strong."

Probably the simplest effective UHF receiving antennas are the corner reflectors. Most of them will give at least 7 dB of gain. If more gain is required, either a combination corner reflector/

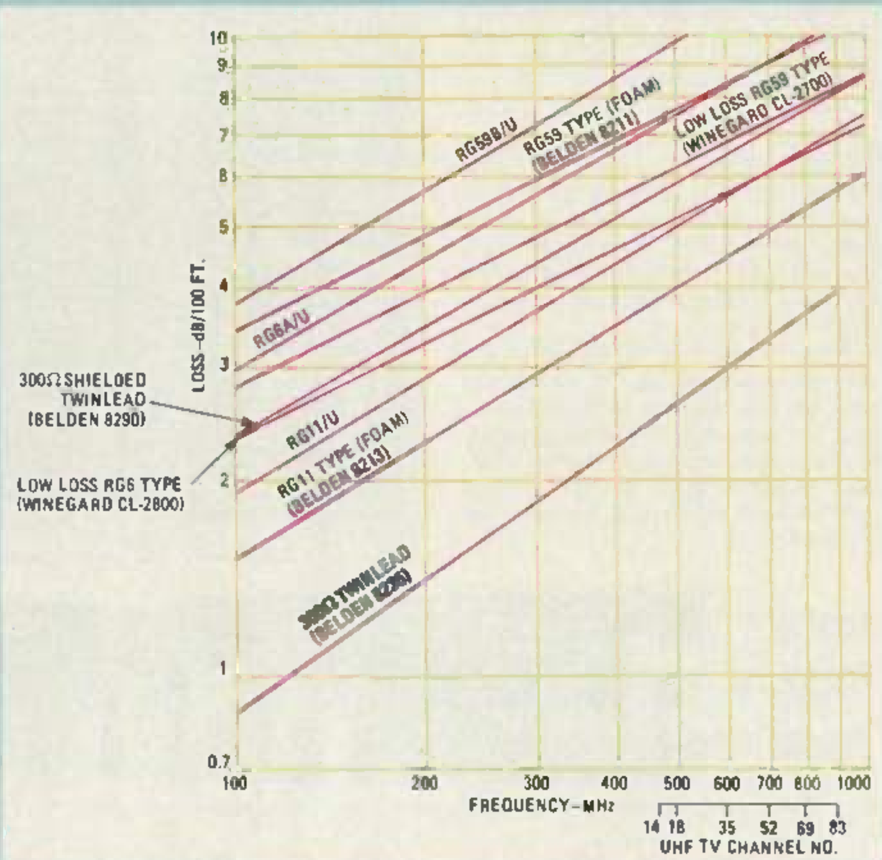


FIG. 12—LOSSES IN VARIOUS TYPES OF CABLE measured in dB/100 feet. Ordinary twinlead would seem to be best, but has serious shortcomings (see text).

yagi or a stacked 4-bay antenna can be used. Either can provide gains ranging from 8 to 15 dB, depending on their size and number of elements. Examples of corner reflector/yagi antennas are the Radio Shack *U-100* or the Winegard *CH-9085*. A good stacked 4-bay antenna that was recommended in the article is the Winegard *KU-420*. Antennas having even higher gains—on the order of 15 to 20 dB—are also available. They are of the parabolic-reflector type and are usually between 3 and 6 feet in diameter.

Before you buy any antenna, though, you should check the manufacturer's published gain-vs.-frequency data. Some of the curves may surprise you.

For example, most UHF antennas do not cover the full 70 channels (14 through 83). Instead, you will probably find that their best performance is in the range of channels 20 to 55, with a gradual dropoff above and below them. The reason is that channels 70 through 83 are allocated as translator-band channels, and channels 60 through 69 were originally reserved for subscription-TV use. At the low end of the band, channels 14 through 20, in many areas, are shared with the land mobile radio service. So, the design of most antennas was optimized for the best gain on the middle channels.

In many cases, that won't be a major problem, but if you're interested in receiving high-end channels, you may want to look further into the catalogs. You'll probably discover that there are antennas optimized for the high end as well. They are usually called "T-band" or "translator band" antennas, and should be suitable for high-end channels.

Installation

After you've chosen an antenna, the next step is its installation. There are several considerations unique to UHF. The line-of-sight principle is the main concern; if it is at all possible, try to select an antenna site where the antenna has a clear shot at the horizon. Ideally, the elevation angle to the horizon should be 0 degrees; however, satisfactory performance can still be obtained with an angle to the horizon of up to ten degrees. Close-by obstructions are to be avoided. Buildings, trees, hills, or similar obstructions will seriously degrade the received signal. In some cases a mast or tower can provide the necessary extra height to clear obstructions. While the effects of steel-frame structures and hills is pretty obvious, the effect of trees and foliage is not. Dense foliage can create a path loss of 20 dB or more.

Sometimes it may be impossible to get a clear line-of-sight shot to the transmitting antenna. Reception may still be possible using reflected or scattered signal. When that technique is used, though, the actual physical placement of the antenna becomes extremely critical because the signal is arriving via several different paths. Remember, we are dealing with wavelengths measured in *inches*, so a lateral or vertical move of only six inches can result in a change in signal quality.

Feedlines

The next item to consider is the feedline. Several types of feedline are available and most installers know that good quality, low-loss, feedline is important for UHF. Many, though, do not know what *makes* a feedline low-loss.

For example, many installers insist that you should never use coaxial cable at UHF frequencies because it is lossier than twinlead. Few people are aware, however, that the biggest contributor to coaxial cable's lossiness is its woven braid. UHF signals travel most efficiently in a straight line, something they can't do in a woven-braid conductor. However, low-loss coaxial cable using an aluminum foil or aluminized Mylar as a shield *does* permit the signal to travel in a straight line and has a significantly lower loss than the equivalent conventional coaxial cable (RG-59/U or RG-6/U).

The other major factor contributing to coaxial cable's loss figure is dielectric loss. That can be reduced by using

A kit of all parts for the UHF preamp, including power supply and balun (the balun will be discussed next month), is available for $34.50 plus $2.00 for shipping and handling. An assembled version is available for $57.50 plus $2.00 for shipping and handling. Both are available from:

RaySon Electronics Corp.
1010 12th St., Suite 5
Sparks, NV 89431

Micromart
508 Central Avenue
Westfield, NJ 07090
(201) 654-6008

Quest Electronics
P.O. Box 4430
Santa Clara, CA 95054
(800) 538-8196 (except CA)
(408) 988-1640

All suppliers accept MC and VISA. Please add sales tax where applicable.

foamed rather than solid dielectric-material in the cable. The effects of both factors can be seen in Fig. 12, which shows a comparison of the losses of various types of feedline used for UHF. At 470 MHz (channel 14) conventional RG-59 coaxial cable has a loss of 9 dB per 100 feet: the Belden *8211* foam-dielectric version of the same cable has a loss of 7 dB per 100 ft., while the Winegard *CL-2700* low-loss cable (foam dielectric and solid shield) has a loss of 5.8 dB per 100 feet. Since a 3-dB loss represents a 50% power loss, the low-loss cable has more than twice the power-transmission efficiency of RG-59 cable. Larger diameter cable such as RG-6 or RG-11 has even greater efficiency because of the greater conductor spacing and the resultant lower dielectric-loss. Low-loss RG-6 type cable (*CL-2800*) is more efficient than shielded twinlead (type *8290*).

So far, we've been talking about *dry* cable or twinlead. While moisture doesn't affect coaxial cable, because the dielectric is sealed in by the outer jacket, it *does* affect twinlead greatly. To see just how much, consider some figures supplied by Channel Master. At the low end of the UHF band (500 MHz) their best twinlead, type *9555* is twice as lossy wet as it is dry. The feedline has foam-clad conductors encased in a polyethylene jacket. As you go down the list, the feedlines listed have progressively less foam around the conductors, until you get to type *9561*, which is more or less conventional twinlead with just a solid polyethylene web. The wet attenuation-factor of that feedline is 100 times or more greater than the dry attenuation-factors. (Remember: −20 dB represents a power reduction of 99%!)

That data should convince you that wet twinlead is to be avoided if at all possible. You should also bear in mind that the figures are for *new* cable. Exposure to the elements causes polyethylene to become contaminated, increasing its dielectric loss and, therefore, the loss of the cable.

On the other hand, coaxial cable is protected by an outer jacket, and degradation of the cable occurs much more slowly. Before the dielectric can become contaminated, the protection provided by the outer jacket has to fail. So although, at first, the lower losses of twinlead would seem to favor it use over coaxial cable, when you consider the life of an installation, coaxial cable gives better results.

Installing feedline

Many an otherwise good installation is ruined by poor feedline-installation. No matter which type of feedline you use, care must be taken to keep it away from power and telephone cables. At least two inches separation should be maintained for coax; more in the case of twinlead. That precaution reduces the possibility of hum or noise pickup.

Where cables enter a building, feed-through bushings should be used—the cables should not be jammed under windows or doors!

If you are using twinlead, it is especially important to keep the cable at least four inches away from *all* metallic surfaces—gutters, downspouts, aluminum siding, the antenna mast, rotor cable, power cables, etc. In many cases that will prove to be a difficult or impossible task; that is when coax *should* be used.

Excess cable-lengths should be cut off, not wound into a coil or bunched up. That is particularly important in the case of twinlead, for you can end up unwittingly creating an RF choke. (Running twinlead down through a metal conduit, such as the mast, can have the same effect.)

OOOPS!

The parts placement diagram (Fig. 8) that appeared in Part 1 of this article (March 1982) was inadvertently reversed. The correct diagram appears below.

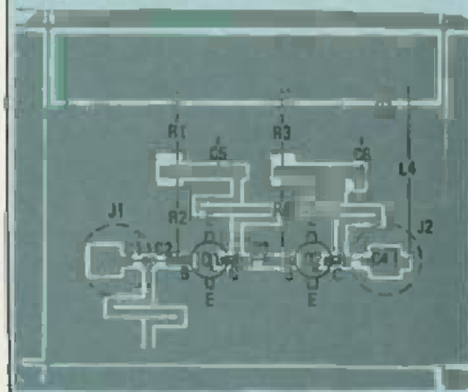


FIG. 8—TRANSISTORS ARE MOUNTED from etched side of board. "F" connectors are mounted from unetched side.

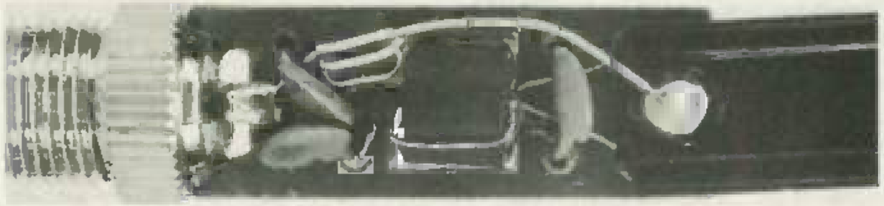


FIG. 13—BOARD FOUND INSIDE balun, showing addition of 10 µH choke and power leads.

Baluns

If you are using coaxial cable you will need two impedance-matching transformers, known as *baluns*. One must be of the outdoor type, because it is mounted between the outdoor preamp and the antenna. The other is used indoors, at the TV set. It must be modified slightly to form a "bias-T," which will permit both the TV signal and the current that powers the preamp to travel along the coax, while providing separate terminations for both at the set-end of the cable.

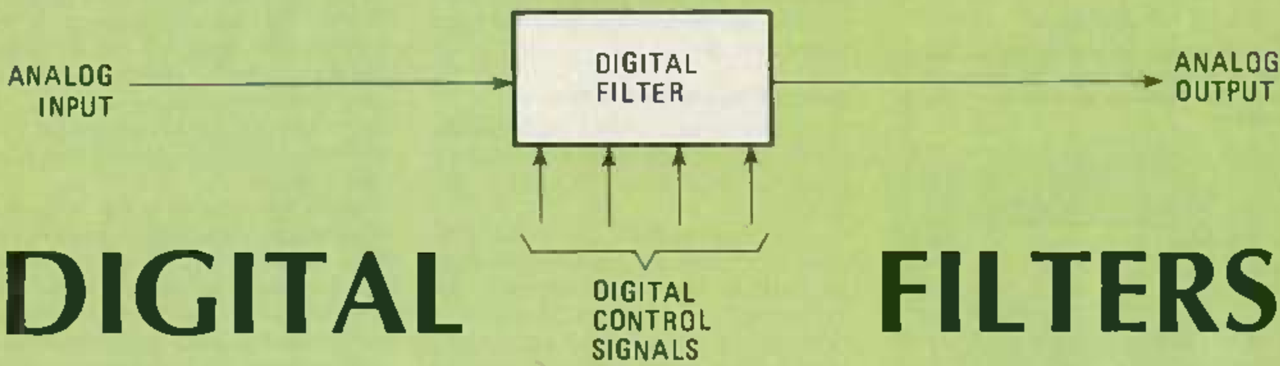
There are several baluns available that lend themselves very nicely to that application. Among the ones you might wish to use are the MCM Audio *TVT-1*, the RMS Electronics *MA 1000UV*, the Channel Master *0782* and the Arista *267A*.

All the baluns mentioned have an "F" connector pressed into a short length of aluminum tubing with a pigtail of 300-ohm twinlead sticking out the other end. The aluminum tubing is covered with shrink tubing. To open a balun for modification, cut away the shoulder of the shrink tubing at the base of the "F" connector and then remove the connector, and the board attached to it, by pulling it out of the aluminum tubing. It may be necessary to use pliers for that operation: if so, thread a male connector on temporarily and grasp *it* with the pliers. That will prevent any possible damage to the threads of the female "F" connector from taking place. (You may want to purchase a male-to-male connector for the purpose, since you will probably need it later when you connect the antenna balun to the preamp.)

All the baluns have three DC blocking-capacitors already built into them, so all that is necessary is to add a small choke. The choke, L1 in Fig. 11 (see last month's issue), is the same as choke L4 used in the preamp—3½ turns of No. 30 wire-wrap wire wound through a small ferrite bead. The bead is small enough to fit inside the transformer's housing. As shown in Fig. 13, one end of the No. 30 wire is soldered directly to the center pin of the "F" connector, while the other end is soldered to the rivet that secures the twinlead pigtail to the balun's circuit board. The rivet becomes the +V terminal and the positive lead from the power supply is soldered to it. The body of the "F" connector becomes the ground terminal and the ground lead from the power supply is connected to the connector by being soldered to the ground foil on the small circuit board.

The UHF preamp is easy to build and, when used with the type of antenna installation described, will do a lot to improve the quality of your UHF-TV reception. **R-E**

WHAT'S INSIDE DIGITAL FILTERS



Filtering an analog signal using digital techniques is becoming more and more commonplace. Here is a look at digital filters and how they work.

ARTHUR MAKOSINSKI

TRADITIONALLY, ACTIVE AUDIO-FILTER designs have used either L-C or R-C networks in combination with phase- or gain-compensating amplifiers. While such filters are relatively simple and economical when designed for one or two frequencies, they become complex and expensive if required in large numbers, as, for instance, in a ⅓ octave audio-spectrum analyzer. A device with a 20-Hz to 20-kHz range would require over 30 separate bandpass filters, or 360 precision capacitors and resistors for filter-tuning alone. That is in addition to the problems of achieving adequate temperature and amplitude stability, as well as maintaining acceptable reliability.

With the development of digital IC's in the late 60's, designing digitally controlled audio filters became possible. One of the first designs considered, was the digitization of the old mechanical commutating-filter; that filter is shown in Fig. 1.

Commutating filter

How the commutating filter works can best be understood by considering the simple low-pass section of Fig. 2 as an integrator with a time constant τ = RC. If n such sections are cascaded and sequentially switched at a rate of f times per second, the net time-constant increases by n, so that the new time-constant $\tau = n$RC. That will yield a 3 dB low-pass response at $f_{LOW\ PASS} = 1/(2\pi RC)$.

If a signal at the commutating frequency, f_C, is now applied to the filter, each individual capacitor sees a particular—and fixed—average voltage (the voltage is dependent on the phase of the input frequency) each time it is switched into the circuit. Each capacitor therefore charges to a fixed voltage, and as the individual capacitors are switched in, or commutated, the original signal is reproduced as a series of discrete values or steps.

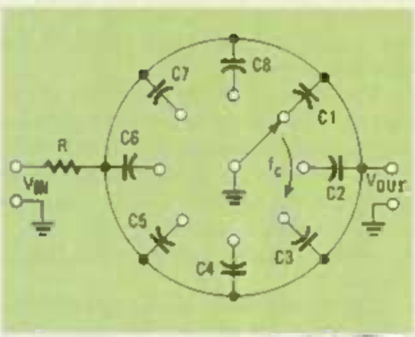


FIG. 1—A MECHANICAL commutating filter. If the input signal is equal to the switching frequency, the filter would reproduce the input signal at the output as a series of steps.

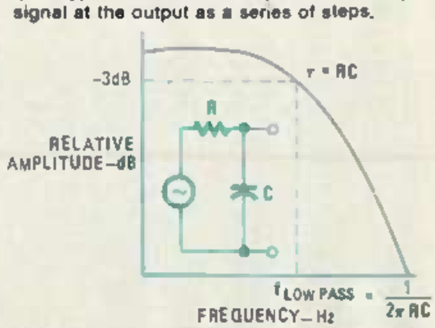


FIG. 2—THE RESPONSE of a simple low-pass filter is shown here. The time constant of the curve is determined by the values of R and C.

The commutating filter is often called a comb filter because it will only pass signals with a frequency of f_C—the resonant frequency of the filter—and its harmonics. That response is shown in the graph of Fig. 3. If, however, only the resonant frequency is desired, low-pass filters can precede or follow the commutating filter, attenuating the other "teeth" of the comb.

In modern commutating filters, the commutating is done by shift registers or counters. Standard transistors, or FET's, can be used to switch the capacitors. Figure 4 shows an eight-section commutating filter in which the necessary sequential switching is done by a combination of a CD4040 BCD ripple counter and a CD4051 BCD-to-decimal decoder. The CD4040 counter is triggered by a squarewave clock signal. As the counter advances, on the negative-going clock transitions, the first 3 bits of its 12-bit BCD output are connected to the BCD input lines of the CD4051 decoder. That IC translates the BCD code into sequential decimal steps that switch the internal CMOS transistors on and off: those transistors, in turn, switch the connected capacitors. In that circuit, the filter's frequency is a function of the clock rate, and the number of poles, or sections, in the filter. In

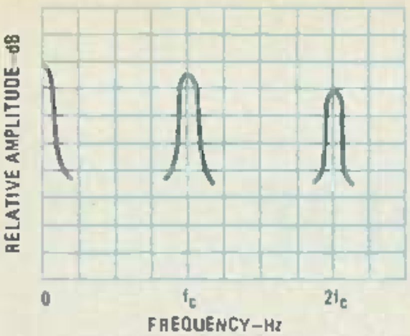


FIG. 3—A COMMUTATING FILTER can also be called a comb filter since, at resonance, it passes the fundamental frequency and its harmonics.

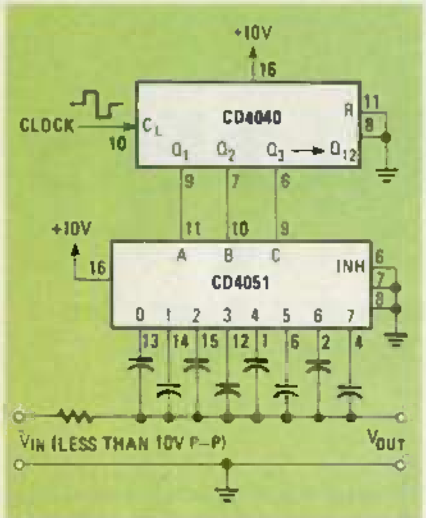


FIG. 4-USING A BCD COUNTER and 8-channel decoder IC's to control a commutating filter. The filter is tuned by changing the clocking frequency.

Fig. 4, since there are 8 poles, the filter's primary response frequency, in Hz, will be:

f_C = clock frequency ÷ number of poles

The filter will also pass the harmonics of f_C, and its bandwidth will be 2 divided by the number of poles, times the bandwidth of the single, original low-pass section. If the resistor's value is 10,000 ohms, and the capacitors are .01 µF each, the filter in Fig. 4 will have a practical, continuous turning range of from 10 kHz to over 1 MHz, and a Q of 80.

One problem is that the CD4051 is not exactly an ideal switch. Its typical "on" resistance, with a supply voltage of 10 volts, is 180 ohms, and it increases as the supply voltage is lowered. While that will rarely affect performance, since the other resistances in the filter are generally much greater (consider the 10,000-ohm resistor we just mentioned), in some cases individual transistors would be better.

If you wish, additional decoders can be added to the other BCD outputs of the CD4040 ripple counter—altogether the CD4040 can drive five decoders. As more decoders are added, the filter's output becomes smoother and its bandwidth becomes sharper. To minimize the filter's step non-linearity, the capacitors that are used should have a tolerance of less than 10%. An R-C low-pass filter at the output of the commutating filter can attenuate substantially any of the clock signal at the output and improve linearity. Precautions should also be taken so not to overload the input of the filter: that happens if the peak-to-peak input voltage exceeds the positive supply voltage to the decoder.

Switched-capacitor filters

Although this sounds suspiciously like the commutating filter, the switched-capacitor filter works in quite a different way.

In its simplest form, it is an R-C low-pass filter where the capacitve elements are fixed, and the resistive elements are substituted by "switched-capacitor" resistors. Later on, we will see how the switched-capacitor circuit can even simulate an L-C filter, but first, to understand this odd resistor substitution, let's take a look at Fig. 5. In Fig. 5-a, when the switch is in position *A*, the capacitor charges up to voltage V_1. When the switch is flipped to position *B*, the capacitor will discharge to voltage V_2. The amount of charge flowing into (or from) V_2 therefore equals $C(V_2 - V_1)$

Now, let's replace the analog switch with a pair of FET's, and drive the circuit with a clock pulse, as shown in Fig. 5-b. If the capacitors are switched at a clock rate, f_C, then the average current flow I from V_1 to V_2 will be $I = C(V_2 - V_1)f_C$. Since R = V/I, a resistor that woud give the same average current I as a switched capacitor could be calculated from $R = 1/Cf_C$.

Therefore, it would seem that any resistor in an R-C filter could be replaced by a switched-capacitor. That, however, turn out not to be a practical approach when working with IC's because of the internal cross-coupling that is caused by self- and parasitic-capacitances.

The most widely used type of IC low-pass filter is an op-amp integrator. If the switched-capacitor filter shown in Fig. 6 seems to resemble an integrator, there is a good reason: It *is*—but in that circuit the input resistor has been replaced by a switched capacitor. For those of you that are unfamiliar with integrators, and as a review for the others, let's take a brief look at how that circuit is used as a low-pass filter.

Due to the action of the capacitor in the feedback loop, if the input signal to the circuit has a relatively low frequency, the output will be the integral of the input—hence the name integrator. But if the input frequency is high enough, the feedback capacitor does not have time to charge, and the op-amp's output remains constant (i.e. DC). The filter's cut-off frequency is determined by the values of the resistor and capacitor.

Since the resistor in Fig. 6 has been replaced by switched capacitors, that filter can be tuned by simply altering the frequency at which the capacitors are switched (clocked). As an additional precaution against internal parasitic capacitances, the configuration shown in Fig. 7 is used. If that circuit is clocked properly, it can also be used to simulate the inductor currents and capacitor voltages of a passive L-C circuit. Here is what happens:

The ϕ clock signal is 180° out of phase with respect to the $\bar{\phi}$ clock signal. Let's feed the ϕ clock signal to Q1 and Q3, and the $\bar{\phi}$ signal to Q2 and Q4. During the first half cycle of the clock pulse, only Q1 and Q3 will be "on" and capacitor C1 will charge up to the value of V_{IN}. Assuming V_{IN} to be positive, C1 will charge up so that point *b* will be positive with respect to point *a*. During the second half cycle, only Q2 and Q4 will be "on" and the voltage across capacitor C1 is applied to the inverting input of the integrater. However, since point *a* is negative with respect to point *b*, the overall affect is that of a non-inverting integrator. The output will have some phase lag, in addition to the 90° phase lag of an ideal integrator, caused by internal delays.

Now, let's change the clock inputs to the filter. The ϕ clock signal is now fed to Q2 and Q3 and $\bar{\phi}$ is fed to Q1 and Q4. During one half of the clock cycle, only Q1 and Q4 will be "on" and capacitor C1 is shorted through ground and discharges to zero. During the other half of the clock cycle, Q2 and Q3

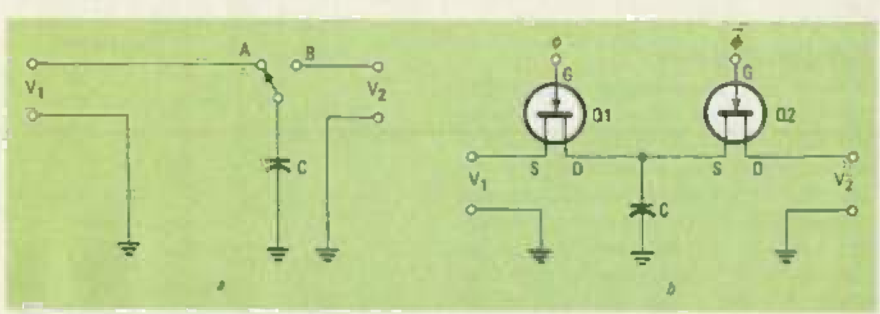


FIG. 5—THE SWITCHED-CAPACITOR technique shown in *a* is realized in an IC by using the circuit shown in *b*. In *b*, the two FET's replace the mechanical switch.

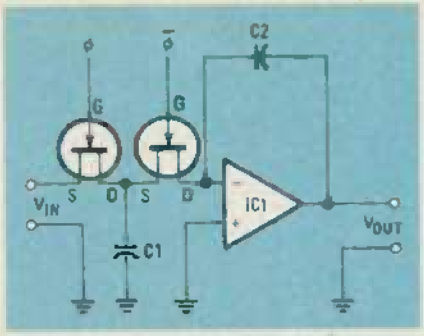


FIG. 6—AN INTEGRATOR is often used as a low-pass filter in IC's. In the circuit shown here, the input resistor has been replaced by a switched capacitor.

TABLE 1

Digital Filter Type	Commutating	Switched-Capacitor	Transversal
Filter response	comb	bandpass high pass low pass Notch	bandpass low pass chirp
Frequency range	< .5 Hz - 10 MHz higher with ECL	.5 Hz–25 kHz	1 kHz–1 MHz
Dynamic range	depending on types of switching elements, etc.	> 80 dB	> 40 dB
Distortion		< .1%	< .1%
Clock residue		≈6 mV	not specified
Input signal maximum		10 V p-p	3 V p-p
Input impedance	high	≥100 kilohms	≥ 200 kilohms
Output impedance	high	≤1 kilohms	≤ 1 kilohms
Stopband	depending on number of sections & switching elements	80 dB	> 40 dB
Skirt steepness		60 dB/octave	150 dB/octave
Insertion loss	≈ 20 dB	< ±.2 dB	≥15 dB
Center Frequency accuracy	absolute	better than .5%	better than .1%
Technology used	any: TTL, CMOS, ECL, transistors	MOS	MOS
Parts cost/filter (quantities of 1 - 9)	≈ $3.00	> $28.00	≈ $40.00

are "on" and since the capacitor is discharged, it appears as a short and V_{IN} is applied directly to the inverting input of the integrator. The circuit shown in Fig. 7 now behaves just like an inverting integrator whose output has slightly less lag than 90°.

It is a simple matter to connect the integrators in series and clock them so that every other integrator is of the same type. If that is done, the slight variations in phase angle will be cancelled. The resulting circuit will behave just like a low selectivity L-C network. As the differences in phase will be cancelled regardless of the clocking frequency, that switched-capacitor filter can be tuned by simply changing the clocking frequency.

By using the techniques we've discussed, it is possible to simulate complete networks of various types of single- and multi-pole filters. What's important from a manufacturing viewpoint is that switched-capacitor resistors require very little silicon area—in fact the area decreases as the value of the resistor increases. In practice, a 10-megohm resistor is needed if the filter's capacitor is to be kept to a reasonable 10 picofarads. A resistance of 10 megohms is obtained if a 1-picofarad capacitor is switched at a frequency of 100 kHz. If, in place of the switched capacitor, a 10-megohm resistor were actually used in the IC, it would require 100 times more space.

Though the switched-capacitor technique is still relatively new, several manufacturers are beginning to use it. Among the IC's using that technique are American Microsystem's (3800 Homestead Road, Santa Clara, CA 95051) S3505 and Mostek's (1215 W. Crosby Road, Carrollton, TX 75006) MK5912. Those IC's are telephone-system coder-decoders; both make extensive use of switched-capacitor filters.

EG&G Reticon (345 Potero Ave., Sunnyvale, CA 94086) uses switched-capacitors in three general purpose, digital-filter IC's—the R5604, R5605, and R5606. The R5604 contains three 6-pole Chebyshev ⅓-octave ANSI Class III filters that together cover an entire octave with one external input-clock trigger. The R5605 contains two 6-pole Chebyshev ½-octave ANSI class III filters that, like the R5604, cover a full octave with one external input-clock trigger. The R5606 contains one 6-pole Chebyshev full-octave ANSI class II filter. Each IC is housed in a 16 pin DIP and requires minimum of +5 volts for operation. Reticon is extending their high-end usable frequency to 20 kHz, and the low end to .5 Hz. The clock to center-frequency ratio of the R560x family is approximately 108:1, and the insertion loss is typically 0 dB. An on-chip flip-flop divides the clock frequency by two so that the switched-capacitor is switched at ½ the clock frequency.

One problem with most sampled data systems is that input frequencies at rates about ½ of the switching frequency may be mistaken for the filter's center frequency (aliased) and may appear at the filter's output. Reticon recommends using an external R-C network at the IC's input, if input signals greater than 27 times the center frequency are expected.

Another small drawback with those IC's—at least at present—is cost. Reticon sells the R560x series IC's at prices that range from $28.00 to $48.00 each, in small quantities.

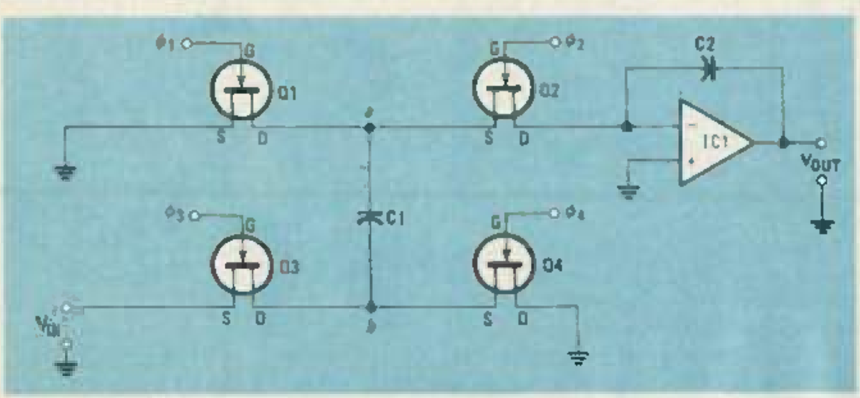
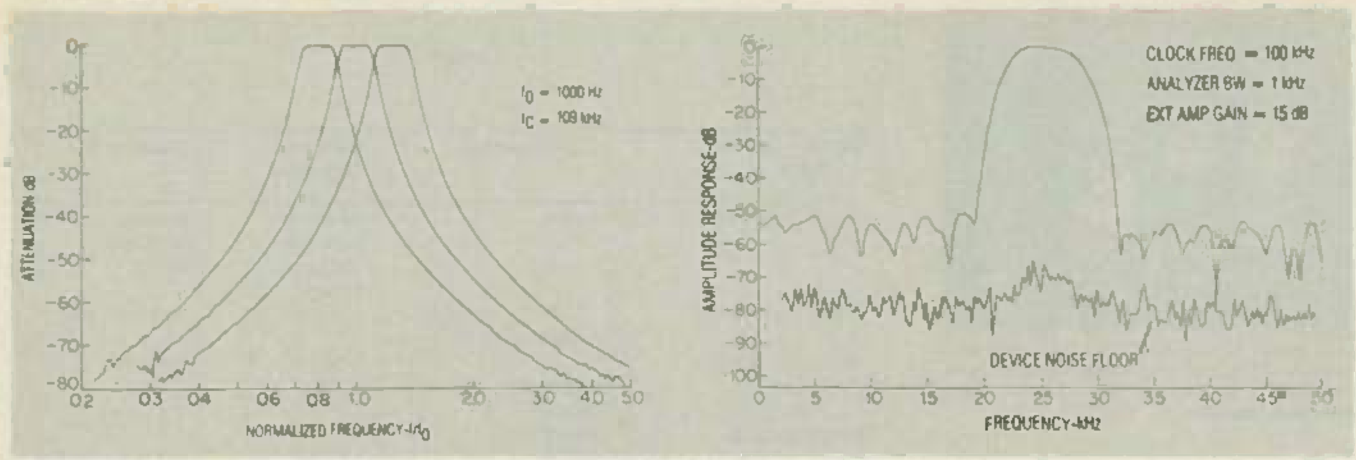


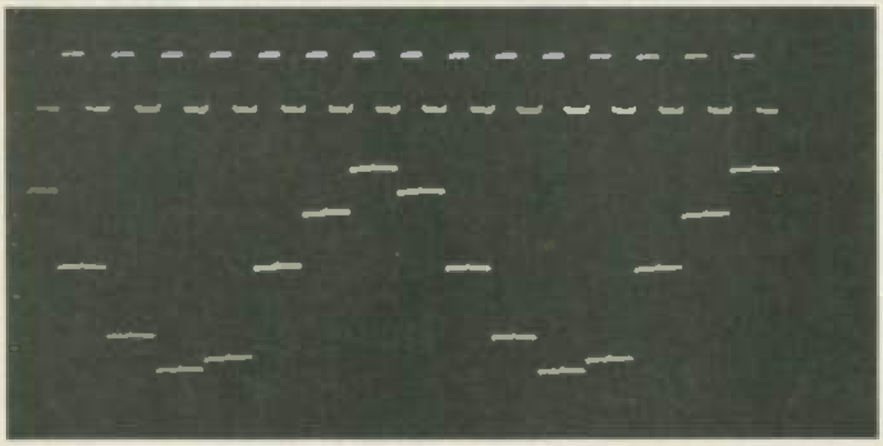
FIG. 7—PARASITIC CAPACITANCES can be reduced further by using this circuit. If clocked properly, several of them could also be combined to simulate a passive L-C filter.

Transversal filters

Another monolithic digital-filter that is beginning to be used in some applications uses a novel combination of a simulated multi-tap delay line and synchronized periodic sampling. Like the previously discussed filters, the transversal filter uses a trigger clock to "tune it" to the desired frequency. While its exact operation is quite complex, and beyond the scope of this article (if you are interested in a more complete discussion, see Reticon's



THE BANDPASS CHARACTERISTICS of a Reticon R5604 switched-capacitor filter is shown in a. Contrast that to the frequency response of the Reticon R5602-3 transversal filter, shown in b.



THE CLOCK INPUT to a commutating filter, and the resulting output is shown here. The signal input to the device is a sine wave.

R5602 Transversal Filter Family Data Sheet for details), let's take a brief look at how it works.

Basically, the IC uses a new MOS charge transfer technique to form a monolithic bucket brigade. The bucket brigade is a chain of N-channel MOS transistors connected to small monolithic storage capacitors. The input signal is sampled, and the sampled charge is transferred from one capacitor to the next by alternately switching the MOS transistors.

As the sampled charge is transferred, it is simultaneously summed with a fixed analog reference. Thus, at every clock transition an alternate pattern of signal samples and reference charges are shifted forward. By multiplying the sampled and reference values by preprogrammed weighting factors and combining them at the output, various responses can be simulated.

The Reticon transversal filters contain a 64-section bucket brigade, as well as timing and output circuitry. Like the switched-capacitor filters, transversal filters are available in several configurations including low-pass and bandpass filters.

The filters have linear phase response and skirts, with a 150 dB-per-octave roll-off rate. The same aliasing problems found in switched-capacitor filters can impair the transversal filter's performance if input circuitry is not carefully designed. The Reticon R5602 family requires more outboard circuitry than their switched-capacitor counterparts, as well as a +15-volt power source. They cost $40.00 each in quantities of less than 10.

Presently, a general limitation with the transversal filters is their poor low-frequency response, which, in turn, is a function of the minimum sampling (clock) frequency required to shift the capacitor voltage levels along the bucket brigade. That "refresh" rate must be fast enough not to allow loss of charge in the capacitors due to leakage. Currently, those filters can be used down to input frequencies of at least 1 kHz.

Recently, Reticon reported work on a transversal filter IC that uses double polysilicon low-loss capacitors, extending the low-frequency response down to 50 Hz: the high-frequency limit is 125 kHz. The IC has a dynamic range of over 65 dB and, what is perhaps most remarkable, it offers digitally programmed characteristics. Texas Instruments (PO Box 225474, Dallas, TX 75265) has also developed an advanced 1024-stage transversal filter with an 8-bit programmable response-characteristic and Q, in addition to a 60-dB dynamic range, 50-dB stopband attenuation, and a 1-MHz maximum filter frequency. No mention was made of the low-frequency capability. At the time of writing, neither the Reticon nor the Texas Instruments filters were commercially available.

Applications

With features like broad frequency-capability, digitally programmable center frequency, and, in the near future, programmable response characteristics, digital audio filters—and especially the switched-capacitor and transversal types—are a natural for use in computer-controlled networks. With those devices, a ⅓-octave spectrum analyzer could be built using only one filter IC to cover the whole range from 20 Hz to 20 kHz. If proper anti-aliasing measures are taken at the filter's input, switching the clock frequency will be all that's needed to sweep the filter through the entire range. Some other applications could include harmonic analyzers, programmable noise analyzers, modems, and any kind of audio or sub-audio filter. R-E

"Oh! You mean you wanted me to clean the videodiscs with the disc-washer?"

BUILD THIS

VIDEO TITLER FOR HOME VIDEO MOVIES

MICHEL CHAMPAGNE

Last month we showed you how to build and use a video titler for your VCR. Now we'll take a look at how it works.

Part 2 THE FIRST PART OF this article, in the April 1982 issue of **Radio-Electronics**, described the theory of operation and construction of a 6802 microprocessor-based video titler for your VCR. This part will discuss, in general terms, some of the programming techniques that are used to make the device operate.

The purpose of any computer program is to accept data, process it, and produce an output based on the results of processing that data.

In the case of the video titler, the input comes from the keypad. The processing consists of recognizing which keys have been pressed, and the output is a series of instructions to the VDG (*V*ideo *D*isplay *G*enerator) that results, ultimately, in a video signal.

Keypad

The program, located in an EPROM (*E*rasable *P*rogrammable *R*ead-*O*nly *M*emory), that controls the video titler has three sections that deal with the keypad: recognizing when a key has been depressed, recognizing *which* key has been depressed, and debouncing (turning into a clean pulse) the "key-pressed" signal.

The 40-key keypad is arranged as five rows of eight columns each. It uses two microprocessor ports—one for input to the microprocessor located at 1000 (hex) and one for output at 8000 (hex). Note that only five of the eight bits available at the output port are used for keypad control (one for each row of the keypad); the others are for VDG mode-selection.

Determining the status of a key (pressed or unpressed) is done by *scanning* the keypad. That is done in two steps. First, a bit-pattern is written to the output port to select a specific row. A logic-0 represents a selected row. A logic-1 a non-selected one. Then, the status of every key in the row selected is read through the input port. A logic-0 indicates that a key has been depressed.

Since there are eight columns in each row, and since each column is represented by a bit, a column with no keys depressed will be read as FF (hex), which represents a bit-pattern consisting entirely of logic-1's. Any column that has a value less than FF (hex) has a key depressed, and the position of the logic-0 within the bit pattern tells which key in the column it is.

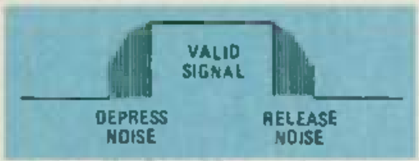


FIG. 12—KEY BOUNCE generates noise that can confuse the microprocessor when a key is pressed and released. The text explains how the valid signal is extracted.

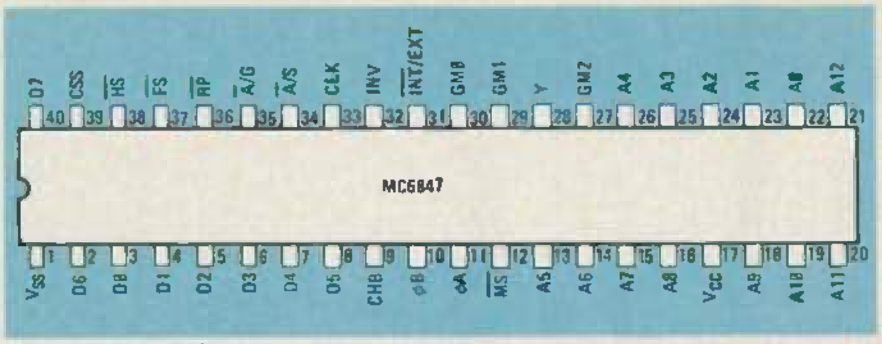


FIG. 13—MOTOROLA'S MC6847 video-display generator IC is the heart of the video titler.

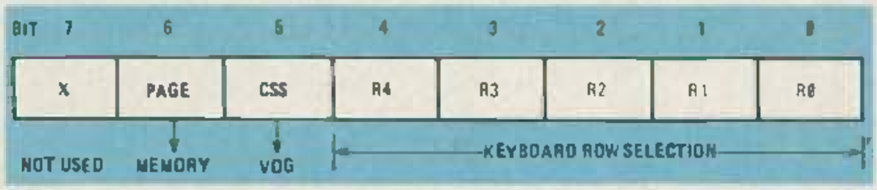


FIG. 14—A DATA BYTE contains information describing the character to be displayed, which page it is to be taken from, and what its background color (CSS) will be.

Mechanical switches, such as the keys of the keypad, present a problem for logic circuits. Even though *you* may have pressed the key only once, its contacts can continue to bounce against each other after you press it and after you release it (see Fig. 12). That bounce is confusing to the microprocessor, since it sees each one as a separate key closure—not what you intended at all. To "debounce" the keys, it is necessary to wait until the contacts are stable, and *then* read their status. That is done by making the assumption that typically a key will be depressed for about 300 milliseconds and that the maximum bounce duration is about 20 milliseconds. The sequence of instructions the microprocessor follows in debouncing and in determining which key has been pressed is as follows:

1. Select a row.
2. Read the input port.
3. If the value equals FF (hex) then read the value of the next row (and so on, until finished).
4. If the value is *not* FF (hex), then wait 100 milliseconds (that is a check for key bounce).
5. Select the same row.
6. Read the input port.
7. If the value equals FF (hex) then it *was* key bounce, so go back to step one and start again.
8. Check all the other rows to make certain that there is only one key depressed (value less than FF (hex)).
9. Read the input port.
10. If the value is not equal to FF (hex), then more than one key is depressed. Go back to step one and start over.
11. Execute the function determined by the value of the depressed key.
12. Wait for the key to be released. Check all lines until only FF (hex) is read.
13. Delay about 30 milliseconds.
14. Go back to step one and start again.

Display

The video display is generated by an MC6847 video-display generator IC. Its pinout is shown in Fig. 13. It can operate in 12 different modes, but the video titler uses only two of them—the "internal alphanumerics" mode and what's called the "semigraphics-4" mode. The alphanumeric mode is used to display characters, while the semigraphics mode is used to generate blocks of color (a full screen would consist of a 64 × 32 array of colored display elements, each one made up of an 8 × 12 array of dots).

The VDG receives its instructions from the display memory (located from 2000 (hex) to 23FF (hex)). Each memory address contains a byte representing the information to be displayed. If the most significant bit (bit 7) of the byte is a logic-0, then a graphics character will be displayed; if it is a logic-1, the result will be an alphanumeric character. The memory is divided into two sections (2000 (hex) through 21FF (hex) and 2200 (hex) through 23FF (hex)), to provide two separate "pages," or displays. Page selection is made by setting or clearing the page bit (bit 6), as shown in Fig. 14. The "CSS" bit (bit 5) is used to select the background color—red or green—for an alphanumeric character.

Note: Each byte presented to the VDG must contain the keypad-scan information, the page bit, and the CSS bit.

It is important to remember that the display memory is accessed by both the microprocessor for inputing data and by the VDG for retrieving data to create the display. If both sections try to access the memory simultaneously, the VDG will miss some data, and the display will be incomplete.

To keep that from happening, a synchronizing signal is provided through an input port located at 1800 (hex). Bit 6 of that port, when cleared, means that the microprocessor can access the memory: when it is set, the VDG is using it. A routine that guarantees a period of 2 milliseconds during which the microprocessor can access the memory is shown in Table 1.

Programming

This section will describe, in general terms, how the video titler is programmed.

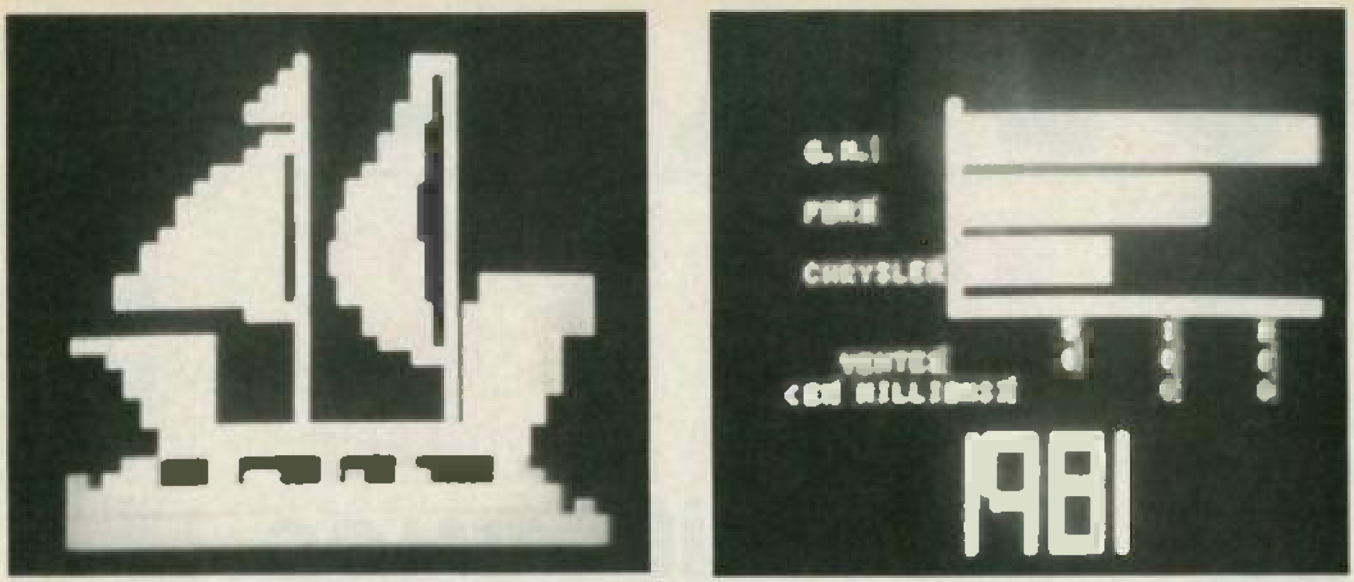
First, two tables relating specific keys to specific characters have to be created. One table is for the alphanumeric mode; the other for the graphics mode. The values for the tables are derived by multiplying the row number (0-4) by eight and adding it to a column number (0-7). Each value corresponds to a particular alphanumeric or graphic

continued on page 76

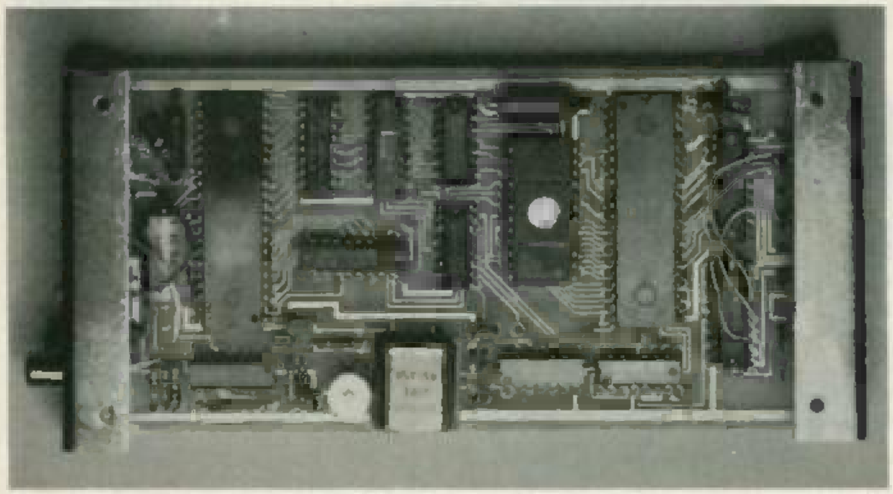
TABLE 1

```
;
; WAITS FOR THE END OF CURRENT "MEMORY ACCESSIBLE PERIOD"
;
WAITLO    LDA A    $1800     ; READS VDG FS SIGNAL
          AND A    $40       ; TEST BIT 6
          BNE      WAITLO
;
; WAITS FOR THE END OF VDG SCAN.
;
WAITHI    LDA A    $1800
          AND A    $40
          BEQ      WAITHI
;
; NOW YOU ARE SURE THAT YOU HAVE A MAXIMUM PERIOD FOR USING
; DISPLAY MEMORY.
;
```

CIRCLE 14 ON FREE INFORMATION CARD



HERE ARE TWO DIFFERENT DISPLAYS that can be created using the video titler. The one on the right uses both the graphic and alphanumeric modes.



THE PROGRAM that controls the video titler is located in an EPROM. That IC is easy to spot here—it is the one with a round quartz window.

continued from page 72

character and is written into memory when the appropriate key is depressed. (The correspondence between the keys and the values assigned them is stored in the EPROM.)

Second, two blocks of variables, each containing the current status of one of the two display pages, are required. Each block contains the following information:

- Cursor position (two bytes representing an address in the display memory).
- Contents of memory at the cursor position (one byte).
- Page number (one byte equal to 40 (hex) or 00 (hex)—see Fig. 14).
- CSS (one byte equal to 20 (hex) or 00 (hex)—see Fig. 14.)
- Row number (one byte).
- Column number.
- Flag indicating "cursor on" or "cursor off."
- Flag indicating alphanumeric or grahic mode.
- Flag indicating whether shift lock is on or off.
- Flag indicating direction of cursor movement (vertical or horizontal)

There are two types of keys on the video titler's keypad: those are the data keys and function keys. The data keys are used to select the characters that will be displayed; the function keys are used to move the cursor, erase, select modes, etc.

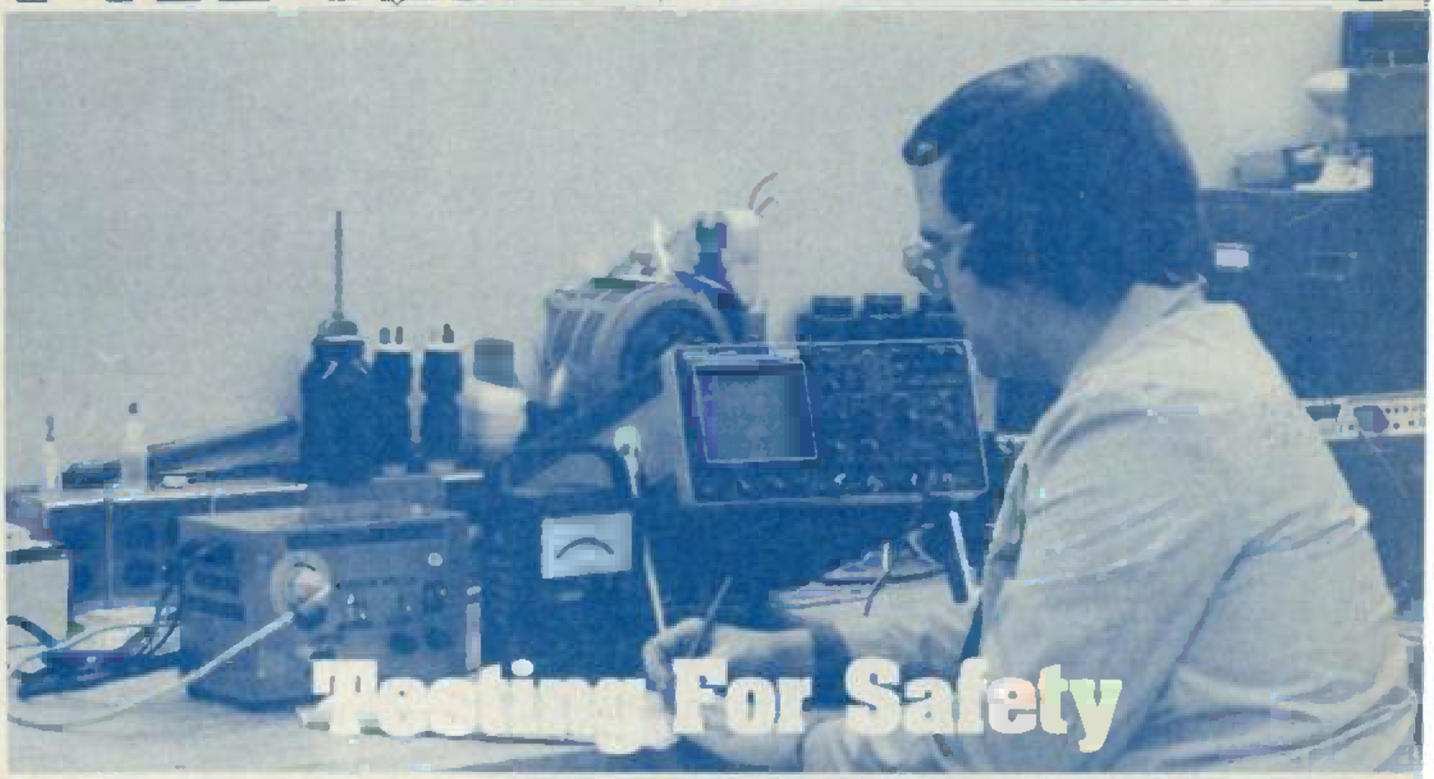
The cursor takes the form of a rectangular cyan picture-element. Every time a data key is depressed, the key number is computed and given a value between 0 and 39 if the shift lock is not set, and between 40 and 79 if it is. (The shift lock is used only in the CHARACTER mode.) That value represents a memory location in the character table or graphics table stored in the EPROM. The contents of that memory location are moved into the display memory at the cursor position after waiting for VDG synchronization. The cursor is then advanced one position (in the HORIZONTAL mode) or 64 positions (one entire line, so it is directly above or below the previous position) in the VERTICAL mode. If the cursor is to be displayed, the contents of the display memory at the new position are saved, but not seen until the cursor moves on.

If a function key is depressed, things get a bit more complicated. The program has to test the key number and, depending on the key, jump to the section of the program that contains instructions for performing its function. That portion of the program has to be executed before the keyboard scan can be resumed.

The video-titler program has a starting location of F800 (hex) and memory locations FFFE and FFFF, which are the reset interrupt-vector, must contain the address of the first instruction that the program will execute on reset.

One last thing, don't forget that the stack pointer has to be initialized, and the screen cleared (by writing 80 (hex)) into each address of the display memory.

That should give you some idea of what makes the video titler tick. Much more information can be found in Motorola's data sheet on the MC6847 video-display generator IC. R-E



Testing For Safety

Have you ever wondered how a manufacturer gets the right to use the Underwriters Laboratories' symbol, and what that symbol means to you? In this article we'll look at some of the provisions of UL's electronic test equipment standard, and see what they do to find out if a piece of equipment meets it.

JACK DARR
SERVICE EDITOR

MOST OF US KNOW ABOUT UNDERWRITERS Laboratories, and the product-testing that that non-profit organization does. They test all kinds of products that, if poorly designed, could cause injury. Among the kinds of products they look at is electronic test equipment. Recently, we received a copy of their Standard for Electrical and Electronic Measuring and Testing Equipment (UL-1244), and we thought you might like to know about some of its provisions.

The purpose of the Standard is to make sure that each unit is as safe as possible for the user. Samples of each instrument are tested, under operating conditions, in one of the four UL labs. They look for more than just shock hazard, and some of the tests may surprise you; they did surprise me!

Shock hazard

Of course, one of the things they *do* look for is potential shock hazards. For all AC-power instruments in metal cases, the AC line-cord must be of the 3-conductor type: black (hot), white (grounded side of the AC line) and green (earth ground). The green wire must be connected to the metal case of the instrument. All line cords must have a strain-relief clamp at the point where it enters the case. One of the tests UL performs is to apply a 35-pound pull to that cord: The case must not cut the cord, and the cord must not come loose or break.

Another provision is that the fuse device used must not break the "safety-ground" circuit. It should be placed so that it opens the black wire—the hot side of the line.

Testing for leakage current is also done. If you've done TV service work, the test should be familiar to you—we've had to use it on line-connected chassis for some time now. An AC-current meter is placed in series with a 1500-ohm resistor that is bypassed by a 0.15 μF capacitor as shown in Fig. 1. Using that setup, the leakage current between the case and the AC hot-line must not read more than 0.5 mA AC, or 3.5 mA for equipment with RFI filters in their AC inputs.

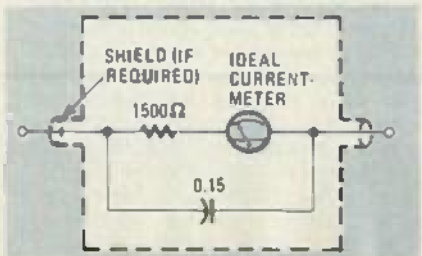


FIG. 1—SCHEMATIC DIAGRAM of the test setup used by the UL to test for leakage current.

Another thing they look for is whether any user-accessible parts could possibly give an electric shock. They define a "user-accessible part" as anything an operator might touch accidently while he is using or adjusting the device. Figure 2 shows a UL technician checking an oscilloscope for just such a hazard.

Drop tests

The "drop test" has long been an electronics joke—but that is a test that UL takes seriously. The equipment they test is "dropped" a few times to see if it can withstand "reasonable abuse." In fact, each of three samples of a piece of hand-held equipment is dropped three separate times from a distance of three feet. Each time, it is turned so that a different part of the in-

FIG. 2—**A PIECE OF EQUIPMENT** will not meet the UL Standard if any part that could give an electric shock is accessible to the user. Here, a UL technician is examining an oscilloscope for a potential shock hazard.

strument is faced down, and the result of each fall is examined.

For bench, portable, and floor-mounted equipment, each unit is tilted up until the bottom is 3^15^/16 inches from the floor/bench, then let go. It must fall back upright, and not fall over "on its next face." That is done for each of the four edges of the bottom.

Impact tests

Providing that the unit survives the drop test, an impact test is done on all equipment except hand-held units. The test involves hitting the instrument with a steel ball weighing 1.2 pounds. For the top, the ball is dropped from whatever height is needed to produce an impact of 2 newton-meters (1.5 foot-pounds). For the sides, the ball is suspended on a cable, and swung down like a pendulum to give the same impact-force on each side.

The meter-face doesn't get away, either. It must be subjected to an impact-force of 0.226 newton-meters. A special ball is used and it is dropped onto the meter face from whatever height is required to give the specified impact.

In addition to the drop and impact tests done on their cases, oscilloscope CRT's are also checked. For CRT's with a diameter of 6 inches or less, a special device called an impact-hammer is used. That has a spring-loaded cylinder with a ball-shaped end. The device is cocked, then tripped so that the end of the cylinder delivers an impact of 0.5 newton-meters (0.37 foot-pounds) to the CRT's screen. For larger scopes, the screen must withstand an impact of 2 newton-meters (1.5 foot-pounds). To perform the test, the scope is turned screen up, and a steel ball is dropped on it from the required height.

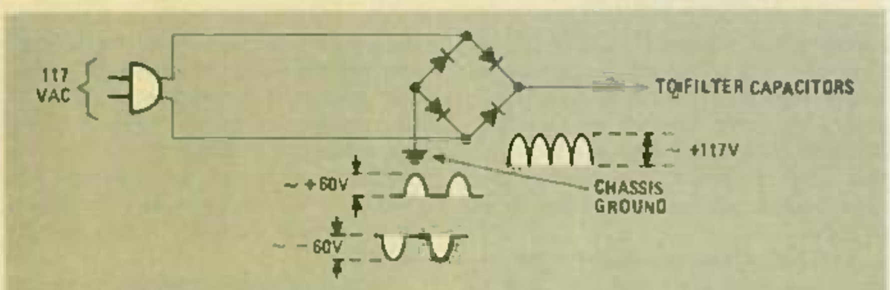
Implosion protection

CRT's, of course, should provide adequate protection from the effects of an implosion. To test that, UL breaks the CRT and looks closely at the results.

The implosion is caused in one of two ways. The "thermal-shock" method involves scratching the neck or funnel of the tube with a glass cutter in one of three prescribed patterns. The scratched areas are then either heated by applying repeatedly a glass rod that has been warmed almost to its melting point, or cooled by applying liquid nitrogen repeatedly.

The other way is called the "impact" method: A hole is made in the top of the case, and the end of a 1-inch metal rod is rested at the junction of the funnel and the screen. An 11-pound weight is then dropped through a five-foot guide tube and hits the top end of the rod. (If the CRT doesn't break, they add more weight!)

The scattering of glass from the im-



WITH A "HOT" CHASSIS, the chassis ground is always about 60 volts above or below true ground, depending on which side of the AC line is "hot."

SHOCK PREVENTION

HERE'S SOMETHING THAT THE UL STANDARD does *not* cover—and it's not intended to—but that I though I should mention because we are talking about safety. A great many of the newer TV sets use a full-wave bridge rectifier connected directly across the AC line (see above) for the primary DC supply. That means that the chassis ground is *ALWAYS* at least at 60 volts above or below true ground! If your test equipment uses the line ground as a common, you can cause damage just by hooking up the ground lead of the instrument. (You do not have to ask me how I found out!) Reversing the line plug does no good at all.

I recommend using a 1:1 isolation transformer at all times. The transformer should have a high enough rating to handle the highest load you might expect; usually something like 200 watts is ample. I've had one of those on my own bench for years; it feeds a separate AC receptable that I've labeled ISOLATED. (On my bench it also goes through a true wattmeter, which I've found helpful in dealing with power-supply problems, but such a set-up is not required.) R-E

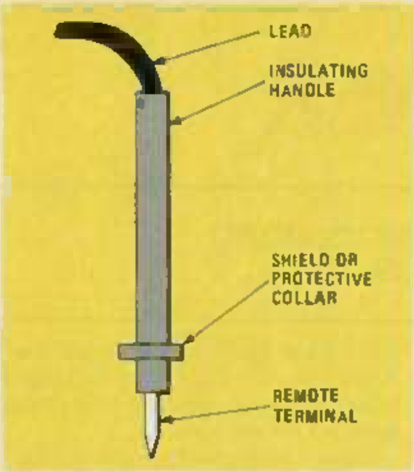


FIG. 3—TO PREVENT YOUR fingers from accidently slipping down to the uninsulated part of the probe, the handle should have a collar such as the one shown here.

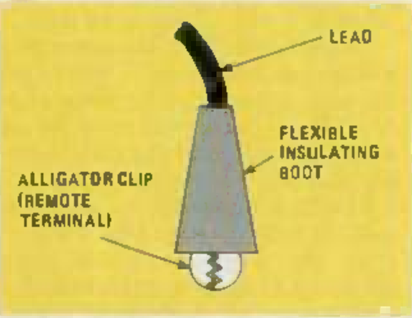


FIG. 4—A FLEXIBLE INSULATING BOOT located over an alligator clip will not make the clip any harder to use, but will protect against accidental shocks.

plosion is observed. The equipment under test is placed in its normal operating position, on a support that is about 30 inches high (equipment that normally stands on the floor is tested standing on the floor). Two barriers, each 9½ inches high, are placed on the floor at 1½ and 6 feet from the front of the CRT. The floor is covered with non-skid material. The Standard requires that no piece of glass heavier than 0.007 ounces pass the first barrier, and no glass at all pass the second. The total mass of all glass particles between the two barriers must not weigh more than 1.5 ounces. Two samples of each piece of equipment are tested.

X-ray emissions

All devices are tested for excessive X-ray emissions. That is done by setting up the equipment for normal use and adjusting the line voltage to the highest permissible value (for a device rated at 105-130 volts AC, the line-voltage is set at 130 volts AC). For the test, the unit is set up in such a way so that the maximum possible amount of X-rays are produced. In the case of oscilloscopes, the beam pattern must not exceed $1^{3}/_{16} \times 1^{3}/_{16}$ inches, or the smallest possible display, whichever is larger. In addition, for dual-track scopes, both beams must be on, and they must be positioned so that they generate the maximum amount of X-rays.

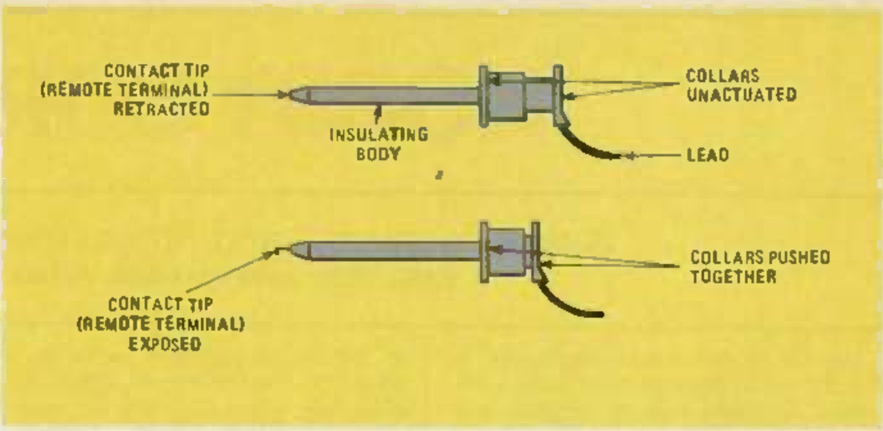


FIG. 5—THE REMOTE TERMINAL is completely insulated in the probe *(a)* until the handle's collars are pushed together as shown in *(b)*.

After the equipment is set up as described, X-ray levels are checked at a distance of 2 inches from the surface of the unit. The X-ray levels are averaged over an area of 1.55 square inches and must not exceed 0.5 milliroentgens-per-hour. The test is performed with any doors or covers that would be open during normal use open or removed; a second test is performed with any doors or covers that would be open or removed when servicing the instrument open or removed.

Test probes

One thing that is common to many types and brands of test equipment is test probes. The UL Standard calls for insulating all types of probes to minimize any possibility of shock. In addition, all connectors and terminals should be designed so that no area that could give an electrical shock is exposed when they are fully mated. That is one standard that has been met in most instruments for quite some time. Instead of the old-style banana jacks, most instruments use recessed jacks. The plugs on the test leads are insulated with soft rubber or plastic. (Remember the old banana plugs with a set-screw on the side to hold the wire? Those could, and did, "bite" you if you touched the end of the screw!) No metal is exposed when the leads are plugged into the device. One fringe-benefit from that setup is that the rubber or plastic acts as a strain-relief for the test leads, making it considerably harder to break them right at the plug.

The test-probes have always been insulated, at least to some extent. The Standard requires, however, that the construction of the probe minimize the possibility of accidently touching the remote terminal (the part of the probe that touches the circuit). That means using a protective "collar" at the lower end of a probe as shown in Fig. 3. The collar is there so that your fingers can't accidently slip down to the remote terminal, with rather nasty consequences. While, strictly speaking, the collar is required only on probes used to measure peak voltages of 1000 volts or more, it is a good thing to have on any probe—even a few hundred volts can smart! Alligator clips must also be properly insulated; one method for that is shown in Fig. 4.

Another type of probe that meets the UL Standard is the spring-loaded type shown in Fig. 5. In that type of probe, the remote terminal is not exposed until the two collars on the handle are pushed together. The remote terminal can either be bent, as shown, or straight.

All probes and test leads, of course, must be adequately insulated. The lead's insulation must have a rating at least as high as any voltage that it might be connected to. That is checked by inspection. In addition, a high voltage is applied to the probe assembly to see if the insulation might break down under those conditions.

The mechanical strength of the probes is also tested. That is done with a machine. The probe is hung by the end, and an arm on the machine pulls it up and then releases it. The probe hits a hardwood surface at the end of the drop, which simulates what happens when you drop a probe against a bench-leg or the floor. The test is repeated 50 times!

There you have some of the things that the UL does to make sure our test equipment is not just useful, but safe. Of course, there is a lot more to it (the Standard itself is a 60-page document), but that should give you some idea of what a piece of equipment must go through before the manufacturer has the right to use the UL label. Incidentally there is a difference between the statements "UL listed," and "meets UL specifications." Only equipment that has been tested by UL can be called UL listed. The statement "meets UL specifications" does not necessarily mean that UL has tested a piece of equipment. R-E

HOBBY CORNER

A new "contest," and notes from the mailbag

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THE OTHER DAY, I WAS ASKED HOW TO build the smallest possible audio oscillator. It seems that my neighbor was trying to squeeze an oscillator into a case that was already overcrowded.

My first thought was that a transistor is smaller than an IC, so the oscillator should use one. Well, the smallest circuit I could come up with is the simple device shown in Fig. 1. Of course, it turned out that the output transformer is larger than the rest of the components. Perhaps using an IC would not be such a bad idea after all.

That brought me to the circuit shown in Fig. 2. Excluding the speaker, the circuit still requires four components. In its favor, however, is the fact that no output transformer is required.

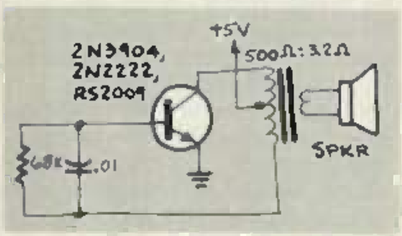


FIG. 1

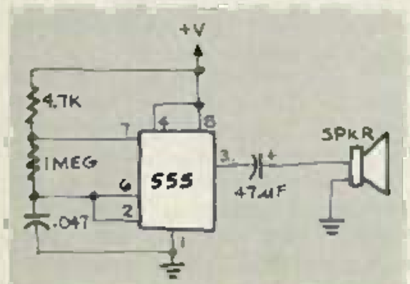


FIG. 2

I fooled around a bit with the design and managed to come up with a circuit that used just three parts, but the results were not satisfactory.

We have not given up. Sooner or later we'll stuff a tiny oscillator into that case. In the meantime, let's have a contest—we'll see who can come up with a design that takes up the least amount of space. In a later column, I'll publish the smallest that I receive (schematic only, please) before midnight June 1, 1982.

When writing

Certainly, I want to do nothing to make it more difficult for you to write to me about problems, answers, or whatever. Your letters are appreciated, especially when you come up with a solution to another reader's problem.

There are a couple of things, however, that will make things better for both of us. Send your letters to me at the New York office. Use this address:

Radio-Electronics
200 Park Avenue South
New York, NY 10003

If you mail anything except subscription information to the Subscription Department in Colorado, it is not only delayed but it may be misdirected. In addition, please take special care to identify each sheet of your correspondence. Perhaps the easiest way to do that is to stick a return address label on each page. Unless the pages are marked in some way, they may become separated, never to be rejoined. There are two reasons why that may happen:

First, your letter may go to/through several people before it gets to me. In spite of our best efforts, things sometimes get separated—especially envelopes from their contents. Second, and perhaps more important, is the fact that my filing system leaves a great deal to be desired. Well, the system itself is not so bad—it's just that I forget to use it until things begin to fall off the stacks that I toss them onto. Repeated New Years' resolutions have not resulted in any lasting improvement.

The little problem was brought to mind by a package I received recently—without envelope, of course. Someone named Bob sent me three issues of a magazine from the 1930's. The accompanying note thanked me for sending him something (What?), indicated that the unwanted magazines could be returned (Where?), and that those I kept would be deducted from the amount(????).

Well, I am completely in the dark. It's like starting to read a book in the middle. So, Bob, write again and let me know what to do with the magazines. They must have some special value, and it would be a shame for them to hang around here until they get lost.

Universal language

The most interesting things turn up in the mail. Noel Nyman of Seattle, WA works for a company that receives items from Thailand. Just as we do, the Thais use newspapers as packing material. Noel sent along a couple of pages from a Thai newspaper.

Now, I don't read a word of Thai. In fact, it might as well be written in Greek. To be accurate, Greek would be better—I might be able to recognize something. In this case, I could only read occasional things like "30K," "BACK E.M.F.," and some digits.

Nevertheless, I was fascinated by the Thai newspaper because when I turned the page, I found that I could read part of it! There at the bottom of the page was a schematic with the same symbols and numbers that we all know.

That Thai writer was communicating with me halfway around the world, and in his own language. As Noel pointed out, the schematic was unmistakably a capacitance-operated switch. Any of us could have built that circuit from the article.

Adjustable LED indicator

In the December Hobby Corner, Leonard Eisner asked for help in designing a circuit that would turn on an LED at selectable voltage levels.

Leonard Dennis of Atchison, KS sent a very good circuit that uses one-fourth of an LM3900. It can be adjusted over a very wide range and turns on an LED when the voltage exceeds the selected level.

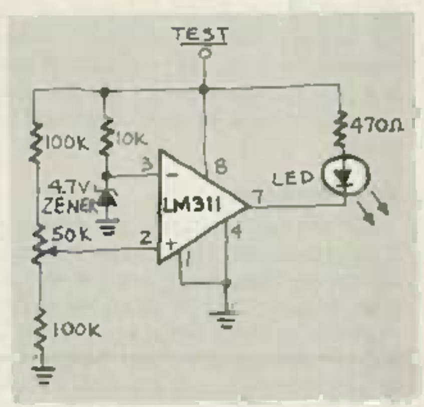


FIG. 3

I want to show you a circuit (Fig. 3) that was sent to me by Ronald Holder of Bridgman, MI. It is unusual because the voltage that is measured is also

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.† The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.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CIRCLE 21 ON FREE INFORMATION CARD

used to power the circuit.

The measured voltage (from 5 to 36 volts) is applied to the point marked TEST. The LED is turned on if the voltage exceeds the level set by adjusting the 50,000-ohm pot. Of course, the circuit will also drive a small relay or audio buzzer, if desired.

More on the rain gauge

Kent McSwain of Albemarle, NC, sent a great improvement on the rain gauge discussed in the November issue. He did not like the idea of having the weight of the water turn a potentiometer.

Kent suggests using a regular water-alarm circuit to measure the amount of rain in the gauge. Several sensors are attached to the inside of the gauge's tube, at appropriate levels, and the leads from them are run into the house using a multi-conductor telephone cable. Inside the house, each sensor (one at a time) is connected by a switch to the alarm circuit. Mark the switch so that you know which sensor is connected by each position: when the alarm sounds you will know the water level in the gauge. Thanks for sharing that idea with us, Kent.

It is "time" again

L.V. Clifford of New Port Richey, FL wrote in to say that he is tired of resetting his digital clocks. He wants a battery circuit that will take over, at least for a short period of time, when the AC power fails.

I agree that the situation is annoying, especially when the power is off for just a second or so. After all, even the old electric clocks had to be reset after they were off for a few minutes. But to have to reset it after a few flickers?—that is exasperating!

Let's help Clifford out. What kind of a battery circuit can you come up with to run your clock for short periods of time? Remember, that your circuit has to be small enough to fit into the clock's case. R-E

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CIRCLE 18 ON FREE INFORMATION CARD

COMMUNICATIONS CORNER

Shortwave listening on a budget

HERB FRIEDMAN, COMMUNICATIONS EDITOR

THE WAY IT LOOKS THESE DAYS, WE ARE living in the age of two computers in every garage and a microprocessor in everything else. Communications devices are not any different. Just browsing through any of the magazines devoted to our hobby would lead one to believe that nearly all communications receivers use at least some digital circuitry, if not a microprocessor.

In fact, that is just about right. But there are still some of us around that don't have the means, or the desire, to spend the equivalent of a couple of months salary for the latest "breakthrough." There are still some hams who haven't traded in their old gear just so they can listen to the new amateur bands. And there are many newcomers to our country who might like to listen to a shortwave broadcast from their old homeland, but can't afford even the least expensive non-digital receiver.

For those hobbyists, there's little value in the new—and expensive—"computerized" receivers. In fact, they would probably get more out of an old but reliable device called a crystal-controlled converter. To bring it up to date, we'll simply substitute solid-state technology for the old tube-design.

A crystal-controlled converter is a rather unsophisticated, low-cost device that converts SW signals to the tuning range of any available receiver. Figure 1 shows how it works. Assume that the desired signal is on 7.05 MHz, and all that's available to the listener is a broadcast-band radio with a tuning range of 550 to 1600 kHz. The signal from the antenna is fed into the mixer through a tank circuit that is resonant at 7.05 MHz. The output of an 8.05-MHz crystal oscillator is also fed into the mixer. The output of the mixer consists of the original 7.05-MHz signal, the sum of the signal and the output of the crystal oscillator (7.05 MHz + 8.05 MHz = 15.1 MHz), and the difference between the signal and output of the crystal oscillator (8.05 MHz - 7.05 MHz = 1 MHz); the output of the mixer is fed to the broadcast-band radio. If the radio is tuned to 1 MHz (1000 kHz) it will actually receive the 1-MHz component of the mixer's output—the 7.05-MHz signal. The other components of the mixer's output will be attenuated by the radio's tuned antenna-input circuit.

Unfortunately, frequency converters are subject to image-frequency interference. The best way to explain image-frequency interference is with an example. In Fig. 1, we beat the desired 7.05-MHz signal against an 8.05-MHz oscillator to get the desired 1-MHz output. But if there is a signal at 9.05 Mhz. (the image frequency), it will also beat against the oscillator, producing a 1-MHz output from the mixer. That is image-frequency interference. The only way to eliminate the problem is to select an oscillator frequency so that there is no signal on the image frequency. (Keep in mind that the output can be anywhere in the broadcast band.)

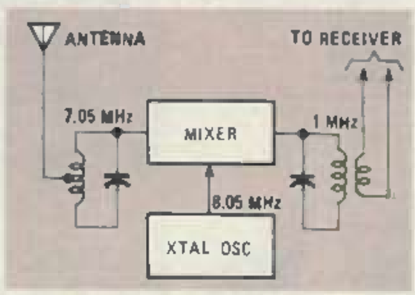

FIG. 1

Let's take a closer look at how a converter works. For this example, assume you've reworked a surplus Navy receiver that has a tuning range of 1.5-12 MHz, but you want to monitor 15 MHz with a minimum of image interference. We'll use a 25-MHz crystal oscillator in our converter. The 15-MHz signal is beat against the oscillator to produce a mixer output of 10 MHz. That output is fed into the receiver, letting you hear the 15-MHz signal when you tune to 10 MHz. As for the image, it's at 35 Mhz, a little-used frequency that's sharply attenuated by the converter's tuned input-circuit.

While this is essentially a fixed-frequency device that is tuned by changing the oscillator's frequency, depending on the "Q" of the converter's tuned circuits, you should be able to tune through a narrow range of approximately 500 kHz by simply adjusting the receiver's tuning control. For example, if the receiver is tuned to 10.0 MHz it will receive a 15-MHz signal; but if it were tuned to 10.1 MHz, it would receive a 14.9-MHz signal. Are you confused about why tuning the receiver to a higher frequency would let you receive signals that are lower in frequency? It is because the frequency of the converter's crystal oscillator is higher than the frequency of the desired signal. Thus, the output of the mixer is 25 MHz − 14.9 MHz, or 10.1 MHz. If the oscillator's frequency were below the SW-signal's frequency, tuning the receiver to a higher frequency would let you receive signals that were also higher in frequency.

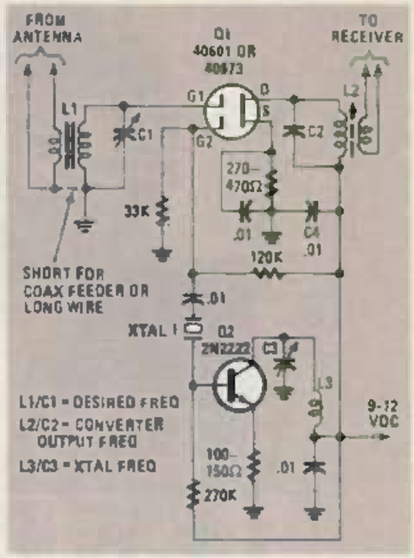

FIG. 2

The preceding examples are the primary uses for crystal-controlled converters. While it's difficult to locate a shortwave converter these day, if you have had any experience with winding your own coils, and you own or can borrow some form of dip meter (that device is used to determine the resonant frequency of a tuned circuit), you can probably use "junk-box" parts to throw together a converter for the frequencies below 30 MHz, such as the one shown in Fig. 2.

That circuit has not been optimized for performance; it's strictly an experimental project whose values have been selected to provide some level of operation using, within reason, almost any components. For instance, you can trim the performance for the specific transistors you use. Don't hesitate to make changes; it's almost impossible to


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"blow" anything.

Transistor Q1 is a diode-protected dual-gate FET. A 4060 is suggested because it's specifically intended for use in a mixer circuit. But if all you have around is an RF amplifier such as a 40673, give it a try. Transistor Q2 is a small-signal high-frequency NPN transistor. Any general-replacement type (such as a 2N2222, etc.) should work.

The tank circuit made up of C1 and L1 is tuned to be resonant at the desired frequency: C1 can be a variable unit as shown; or, if you wish, a slug-tuned unit can be used for L1. (As we said nothing is critical: that also holds true for the other tank circuits.) A second tank circuit, made up of C2 and L2, is tuned to be resonant at the converter's output frequency (for example, 1000 kHz). A third tank circuit, made up of C3 and L3, is tuned to be resonant at the crystal's frequency: tune that tank circuit so that the oscillator "starts" reliably each time power is applied to the converter. The adjustment of C3 (or L3, if you chose to make it adjustable) will have a slight affect on the crystal's operating frequency: you can "zero" the crystal frequency to within a few hundred Hz by fudging the adjustment of C3 (or L3).

The crystal can be either a fundamental or overtone type. If it is an overtone type, the output frequency will be slightly different from the marked or calculated value; again, you can compensate for that by adjusting either C3 or L3.

Please keep in mind that the converter we've described is intended as a "junk box" or "experimental" project. Even so, while it won't perform miracles, it will do a creditable job. R-E

"We're compatible on religion, love, and politics, but not on important issues—such as videotape versus videodisc!"

COMPUTER CORNER

Microcomputer memory devices

LES SPINDLE*

AN IMPORTANT CONSIDERATION IN planning your computer system is making sure that it has enough memory capacity to meet your needs—present and future. The amount of data that can be stored, and the speed with which it can be accessed, will play an important role in the efficiency of the system in handling your home or business applications. You should not only have enough memory to take care of your immediate requirements, but also have provision for expanding that memory as your use of the computer increases.

Memory comes in two basic forms. The first is *resident* memory—the memory that is usually located inside the computer and that is used to hold programs and variables when they are in use. The other form, *external* memory, is used for storing programs and data. Those programs and data, however, cannot be used by the computer until they are loaded into the resident (or *working*) memory.

Resident memory

Let's take a look at the memory options available to you, beginning with the internal memory capacities of your computer. All microcomputers have a certain amount of resident memory in the form of integrated circuits, classified either as ROM (*R*ead-*O*nly *M*emory) or RAM (*R*andom *A*ccess, or *R*ead-*A*nd-write, *M*emory). Both allow the microprocessor virtually instantaneous access to the data they contain.

ROM can be compared to a phonograph record—the data is fixed, and cannot be added to or subtracted from. It is used to store such things as the computer's operating system or a language (like BASIC) that will be used over and over, and which should be available to the user as soon as the computer is turned on.

The ROM's that are supplied with a computer are usually designed from the ground up to contain specific data: it is, literally, built in. There are several types of ROM, though, that a computer user—with the appropriate equipment—can program himself. The first is called PROM (*P*rogrammable *R*ead-*O*nly *M*emory). It can be programmed only one time and, if a programming error is made, a new PROM has to be "burned." An EPROM (*E*rasable *P*rogrammable *R*ead-*O*nly *M*emory), however, can be erased if an error is made, and the program reloaded. Even more valuable is the fact that, if the program contained by an EPROM is no longer needed, the IC can be erased and reused for a completely different purpose.

RAM, on the other hand, is designed for temporary data storage. Its contents can be changed or read at any time and without it a computer would be useless. RAM is used to hold programs and data.

It is important to know that there are two types of RAM—*static* and *dynamic*. Dynamic RAM's are easier to design and manufacture, and new large-capacity RAM IC's first appear in dynamic form; the static versions follow later. Among the advantages of dynamic RAM is its low power-consumption and lower price, when compared to static memory. The disadvantage of dynamic RAM is that it is "leaky," and quickly loses its contents unless it is frequently refreshed. In the early days, refresh circuitry was quite complicated, and dynamic-memory systems were regarded as somewhat unreliable. Current dynamic RAM's and the IC's used to refresh them have been considerably improved and simplified; those are now widely used.

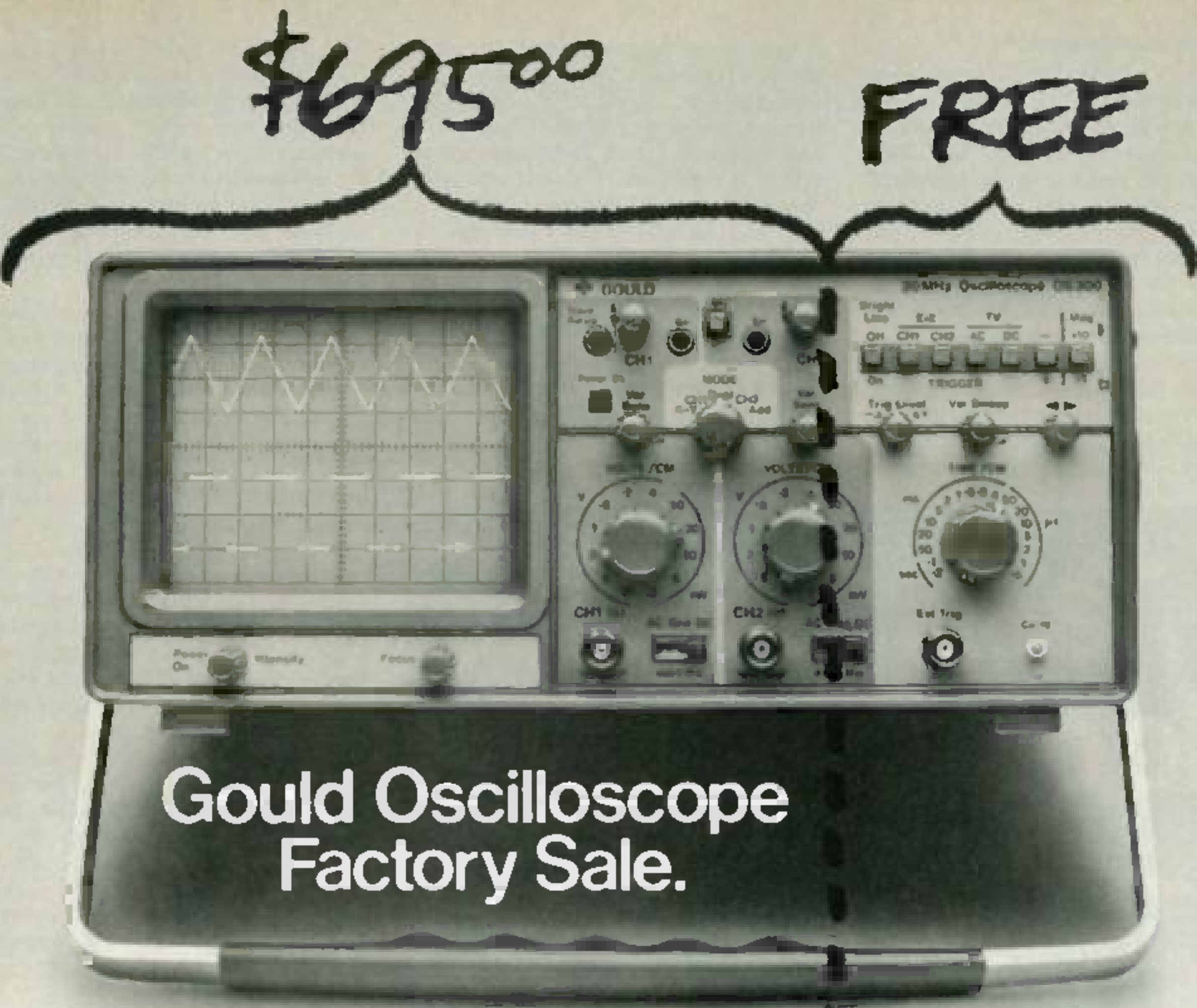
Static RAM's, on the other hand, require no refreshing. They will keep their contents intact until the computer is shut off. Static memories are more complex and expensive than their dynamic counterparts, and—generally—consume more power. Still, many computerists feel more comfortable with them than with dynamic memories.

Adding memory

There are several things to bear in mind when selecting add-on memory to extend your computer's capabilities. The first, of course, is whether it is compatible with the computer. If the computer uses memory boards or cartridges, they must fit. That sounds obvious, but is still something to watch. Also, if your memory is expandable simply by adding more RAM IC's, make sure that they are the proper type. Finally, make sure that the new memory does not take up physical space that may be needed for peripheral boards that may be added later, and that your computer's power supply can handle the memory *plus* whatever else it may be called upon to run.

FIG. 1

*Managing Editor, *Interface Age* magazine



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The Gould OS300 is a compact, portable 20 MHz dual trace oscilloscope weighing only 12 lbs. The scope is enclosed in a rugged metal housing that has a convenient carrying handle. The case size is only 5½"x 12"x 18", yet the display area is a large, bright 8 x 10 cm rectangular CRT.

This instrument offers features usually found in more expensive oscilloscopes including channel sum and difference, switched X-Y and 2mV/cm sensitivity across the full bandwidth. A 2-volt DC coupled Z-mod input facilitates use with logic analyzer outputs.

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External storage-devices

Once you've decided about memory, it's time to decide what external storage device you're going to use to hold your languages, programs, and data when they are not resident in the computer.

Audio-cassette type is the medium that seems to be most popular (and affordable) for home and hobby applications. Its storage capacity is high, and its cost is low. A reasonably priced ($50-$100) cassette recorder and several cassettes will start you on your way. Problems will quickly arise, however, when you start trying to use cassettes for larger-scale applications.

The major disadvantage of cassettes is that all the data on them is recorded serially. Just as one byte follows another onto the tape, so do whole files. Just trying to locate a particular file can be a time-consuming task, and updating it can be a nightmare. Cassettes are also slow—it can take several minutes to load in a file *after* you've managed to find it!

In a business environment, you can't afford to spend time searching through cassettes and waiting for them to load their contents into the computer's memory: you need something faster.

The answer is a disk system. There are two types of disk systems: *floppy* and *hard*. Let's look at the floppy disk first, since it is more widely used.

Floppy disks are a sort of cross between phonograph records and magnetic recording-tape. They come in two diameters: 5¼ inches and 8 inches and are enclosed in a square cardboard or plastic jacket to protect them (the disk surfaces are very delicate). Data is recorded as magnetic pulses on the surface of the disk.

The beautiful thing about disks, as compared to cassettes, is that it is possible to find and load anything that's on a disk in a matter of seconds. A directory is automatically maintained on each disk, indicating where everything is stored, and the disk drive's read/write head can position itself anywhere on the disk in milliseconds. The speed, plus the conveniences offered by the software—known as the DOS (*D*isk *O*perating *S*ystem)—that controls the comings and goings of data to and from the disk, make floppy disks ideal for the kind of situations encountered in small and medium-sized business—or even in serious personal computing.

It is possible to increase the storage capacity of a disk system. Initially, it will probably be "single-sided, single-density," which means that a 5¼-inch disk will be able to hold approximately 90 kilobytes (the figure will vary depending on the design of the circuit that

continued on page 99

STATE OF SOLID STATE

One IC voltage conversion

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

WHILE EXPERIMENTING WITH SOLID-state circuits, have you ever wished that you could power analog circuits from the supply you are using for digital circuits? Well, it's not impossible. In fact, it's simple when you use the Intersil CMOS ICL7660 voltage converter connected as shown in Fig. 1. Apply a positive voltage between pins 8 and 3 and you'll get a negative voltage of the same value between pins 5 and 3. Both voltages are measured with respect to pin 3, which is ground or the negative terminal of the battery or driving power supply.

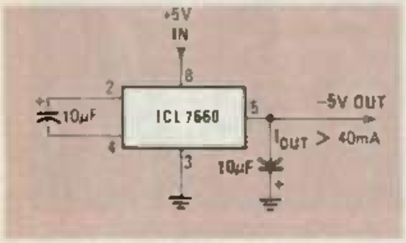

FIG. 1

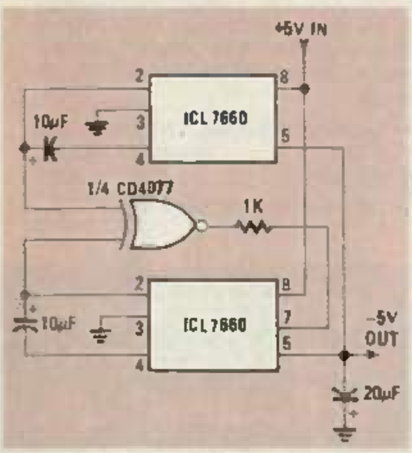

FIG. 2

Thus, in the 7660, we have a unique device that converts a positive-input voltage to a negative-output voltage with a conversion efficiency of 98% when $R_L = \infty$. Power-conversion efficiency is 98% when R_L is 5000 ohms. Output current is greater than 40 mA into a 55-ohm load.

If you need a higher supply voltage for a portion of your circuitry, simply cascade two or more 7660's. Need more current? Connect two 7660's in parallel as shown in Fig. 2. That circuit is useful when the load on a single 7660 causes an excessive voltage drop.

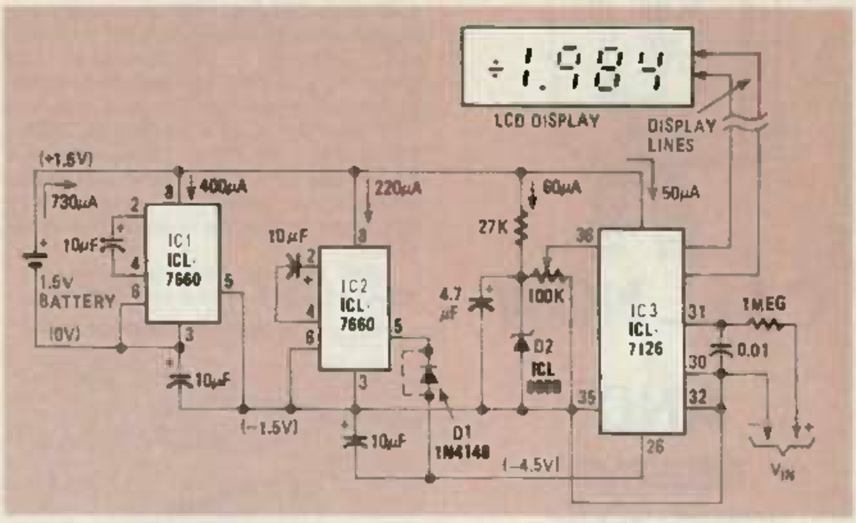

FIG. 3

Normally, simple power supplies cannot be paralleled with any degree of efficiency because the output voltages and internal impedances of the individual sources are never precisely equal. Thus, when two such supplies are paralleled, the one with the higher output will carry most of the load. In Fig. 2, each device sees the same input voltage and, since conversion efficiency is nearly ideal, the devices share the load equally.

Each device has a separate "pump" capacitor (10 µF in this application). The CD4077 exclusive NOR gate compares the device outputs at pin 2 and clocks one to maintain sync with the oscillator in the other. The scheme can be extended to deliver around 160 mA by paralleling four devices and using an extra logic gate.

In an interesting circuit innovation described by Intersil, a 1.5-volt cell and a pair of 7660's were used as cascaded voltage doublers to deliver 6-volts DC to a 7126 3½-digit micropower analog/digital converter driving a liquid-crystal display. The circuit is shown in Fig. 3.

With 1.5 volts applied to the input of IC1, the first voltage converter, a negative 1.5 volts is developed at pin 5. Converter IC2 sees a total of 3 volts at its input (1.5 volts from the battery and 1.5 volts from IC1) and produces −3 volts with respect to the output of IC1. The total voltage across IC2 pins 8 and 5 is four times the battery voltage, or 6 volts. That is high enough to supply the 7176 A/D converter and the 8069 voltage reference. The external voltage reference is needed because the A/D converter's internal reference works best with a power supply of over 6.5 volts. The 1.2-volt external reference insures that the A/D converter will work correctly even when the battery voltage is low.

Total battery drain is typically only 750 µA. Battery voltages up to 3.5 may be used. Diode D1 should be used whenever battery voltage can be expected to exceed 3 volts.

The ICL7660 is an inexpensive solution to many voltage-conversion problems. It's only $1.95 in lots of 100. Your Intersil distributor or favorite mail-order supply house should have it in stock.

VMOS power devices

Field-effect transistors (FET's) have been around as practical devices since about 1952. But for the next twenty years or so, they were strictly low-power devices capable of handling only loads of less than 1 watt. Thus, they were not able to compete with bipolar transistors and SCR's in power-handling applications. The reason for that is that in a typical FET, the current travels horizontally, just below the surface of the chip, and the maximum current density is much lower than that of

continued on page 97

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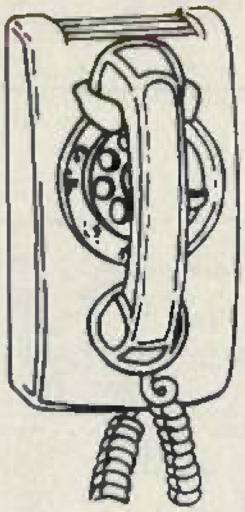

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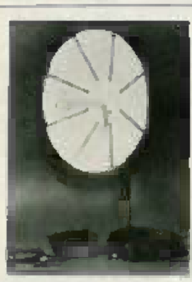

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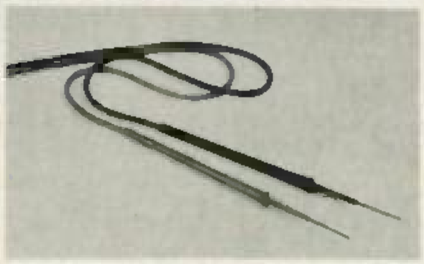

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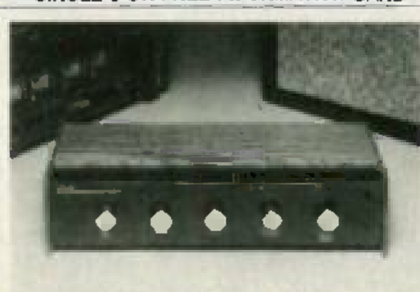

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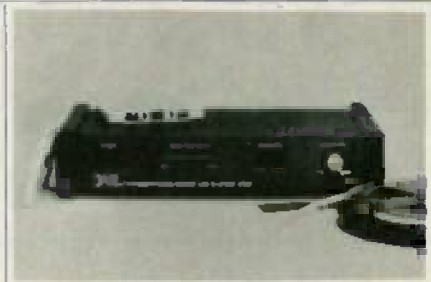

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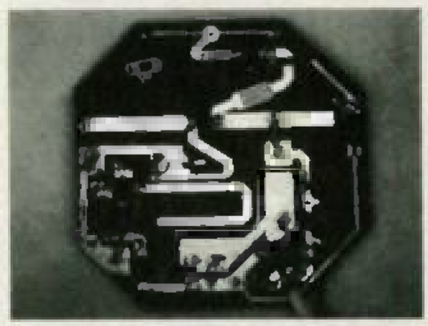

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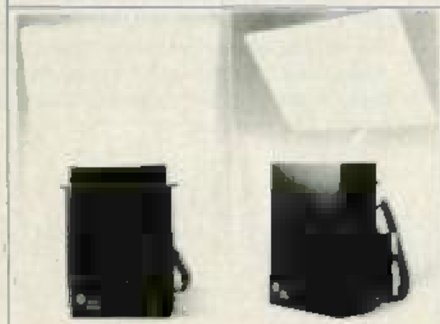

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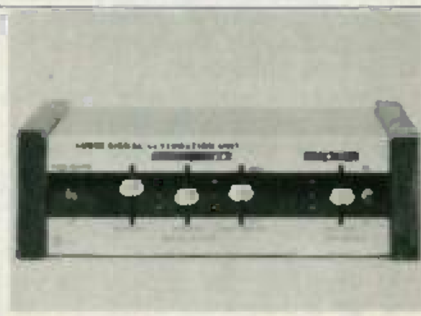

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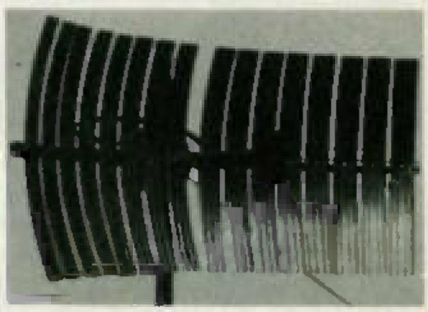

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SERVICE CLINIC

Troubleshooting IC circuits

JACK DARR, SERVICE EDITOR

INTEGRATED CIRCUITS ARE STRANGE and mysterious things to many of us. However, as times change, so must we; and because IC's appear to be with us to stay, we're going to have to learn to troubleshoot the circuits they appear in. The question is: *How* do you troubleshoot something that looks like a black bug with 24 legs?

The answer is to determine what the function of the IC is supposed to be, and then to see whether it is doing what it's supposed to. Check the inputs and the outputs. If it's a demodulator, is it demodulating? If it's an amplifier, is it amplifying? And so on...

Taking a comparatively simple device, an audio-preamp driver IC, we should see low-level audio signals at the input, and the same signals, at a much higher level, at the output. The output drives the base of the audio-output transistor. (Some IC's have the output transistor built in, in which case they drive the speaker directly.) To test the IC, feed a low-level—about one-volt peak-to-peak—audio signal to the input. Then, check for the normal signal-level at the output. That can be as simple as listening for it. If you don't hear anything, scope the output of the IC. If there's a signal there, the output transistor isn't working; check it. Input and output pins of an IC, as well as normal signal-levels, can usually be found on the schematic of the device giving you trouble.

If there's no output from the IC, check the DC voltages around it, starting with the DC-supply pin. It is connected to the DC power-supply, usually through a dropping resistor. If the voltage is off, check the resistor, and any bypass capacitors that may be connected to the power-supply pin. If the resistor shows signs of overheating, you may have found the problem. The chances are that the IC is internally shorted, or a bypass capacitor is bad. If the supply voltage is present but incorrect, check all the other pins of the IC. Some may have no connection, or go directly to another IC, but others may have small resistors to ground, or capacitors, on them; check them out, and make sure that the DC voltages are correct. They are produced by the IC and, if one or more is not there, the IC is probably bad. Be sure to check all the external components before condemning the IC, though! Some sets use the audio-preamp driver IC as a volume control—its output level is determined by a variable control-voltage. Make sure that the control voltage is normal, and varies as it should when the volume control is turned.

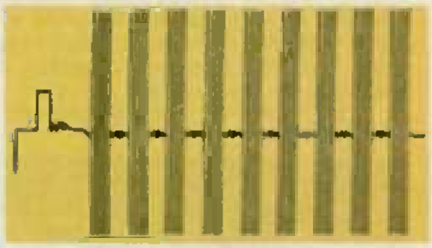

FIG. 1

We can still use the same basic tests with a much more complex but basically similar type of IC, such as a color demodulator. Feed a known input-signal to the IC and check its three outputs (in this case) to see whether or not there's a signal present at each. The input signal can be the video output of a color-bar generator, and will show a "comb" pattern (see Fig. 1). Use your scope to set the input level indicated on the schematic. The three outputs should bear the familiar "lazy-S", or "rocker" shape shown in Fig. 2. Each output feeds the input of one of the three color-amplifier transistors. Your schematic should indicate the correct peak-to-peak voltage for each IC output. Normally, the red and blue outputs will be stronger than the green one.

If you see an input but no output, read all of the DC voltages developed on the IC pins. If one pin is supposed to have +3.6-volts DC, for example, with a small resistor to ground, and the resistor is OK but the voltage is missing, the IC may be bad. Check DC voltages at other pins; you may find more of them off, and if that's the case, it's a good sign that the IC is bad.

If the DC-voltage tests don't produce results and the trouble is still present, look for pins with only a bypass capacitor, or something else, on them. If you see a signal on any pin with a bypass capacitor, the capacitor is very likely open. Also, the 3.58-MHz reference-oscillator signal is often brought out to an external tint-control; check all the components in that circuit, too. Open or leaky capacitors can cause feedback and some very strange symptoms!

Troubleshooting circuits containing IC's is really very simple: Any circuit has an input and an output. If signal is OK on the input, but not on the output, and all the external parts are good, then there's nothing left between those two points but the IC.

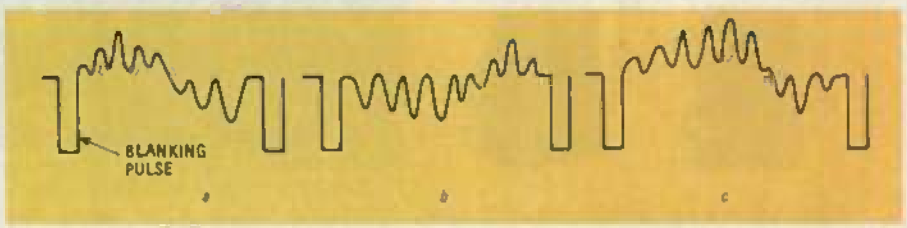

FIG. 2

If the problem is intermittent, don't ignore the IC's when you're hunting for it! IC's can develop thermal intermittents just like other components. In one situation that came up some time ago (and has cropped up several times since) the 3.58-MHz reference signal of a well-known make of receiver dropped out intermittently. The oscillator was made up of a simple op-amp and a crystal. The IC would get hot, and the signal would disappear. (By the way, the best cure we found for that was to use an IC of a different make from the original! Sylvania, GE, and RCA all had exact substitutes for it.)

Audio distortion showed up in a small black-and-white set that had an audio IC with a built-in output transistor. Cooling the IC cleared up the distortion, so the IC was replaced. Unfortunately, the same symptoms showed up with the new one! The final "fix" was to cement a small heat sink, made of a shallow U-shaped piece of thin aluminum, to the IC case. That kept it cool enough so that it didn't act up.

Replacements for some "unknown" IC's are hard to find, especially in the case of some of the imports. Sometimes we have been able to find a substitute

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part by determining the function of the IC and then looking through the list of IC drawings in the front pages of replacement part guides. They show functions, pinouts (a description of what each pin of the IC does) and so on. There's no guarantee that that method will work in all cases, but its a good place to start. If there are any numbers on the IC, check them against those in the guides, and also take into account the letters at the start of the number—they can be important. R-E

SERVICE QUESTIONS

HELPFUL HINTS

Douglas Hoff of Vacaville, CA sends these hints for the GE AC-B chassis:

The set was dead, with no voltage on horizontal driver Q551. I ran a jumper wire from the junction of C551/R551 to the cathode of Q980, the start-up SCR.

After that, vertical deflection was poor, with jagged edges on the raster. Resistor R650 was burning up. I added more jumpers through eyelets W41A and B and soldered them together, then did the same for eyelets W42A and B. (You'll find the eyelets clearly marked on the bottom of the board.) With the jumpers, normal operation was restored.

Thanks very much Douglas! That's the kind of field feedback a lot of us need.

NO HIGH-VOLTAGE

This RCA CTC-81 has no raster and noise in the sound. I've got DC voltage on T402 (the driver transformer for the trace switch) and there is a gate pulse on the retrace switch, but no waveforms on the transformer! Sometimes the set will kick on and play; when that happens, everything tests out normal! I need advice!—G.K., Massillion, OH

From the reaction when the fault is present, it sounds as if the retrace switch isn't doing anything—it could be open, and also apparently intermittent! Try checking it, or changing it. If it were shorting, it would blow the fuse; but if it's open, you'd get exactly what you see.

(Feedback: You were right—the retrace switch was open. Thanks.)

NO HORIZONTAL SWEEP

A Sony TV-740 came in with just a vertical line in the center of the screen. The solution seemed easy—find the break in the yoke circuit. It turns out that C810, 3.5 µF, was open. Since I didn't have an exact replacement, I used a 3.0 µF, 500-volt-DC capacitor and a 0.47 µF, 100-

continued on page 98

continued from page 91

a bipolar device that uses vertical current flow.

Around 5 years ago, a new FET technology was developed to increase the current density of the devices. That in turn, led to the development of high-power FET's that feature both high-voltage and high-current capability. The technological improvement on the basic MOSFET, Vertical MOS or VMOS (also called V-groove MOS) owes its greatly improved characteristics and high-power capability to a "V" groove channel that promotes vertical current flow.

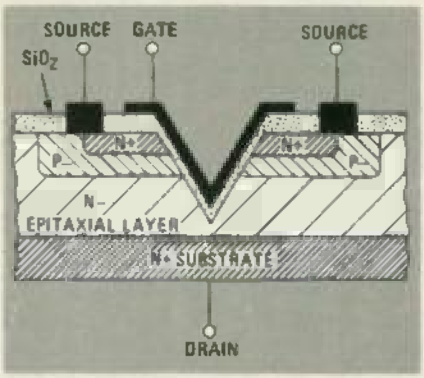


FIG. 4

Figure 4 shows a cross section of a VMOS channel. The device is fabricated on an n+ substrate that becomes the drain and provides a low-resistance current path. An n– epitaxial layer is added to increase the drain-to-source breakdown voltage and to reduce feedback capacitance.

Lightly doped p– bodies are diffused into the epitaxial layer to form channel regions. Smaller n+ regions are diffused into the p– island to form source regions. The n– epitaxial layer and substrate now become drain regions.

The V-shaped groove is etched through the source and channel regions into the epitaxial layer. A silicon oxide layer is then grown on the surface and in the groove and then aluminum metallization is added to form source and gate connections. Finally, the entire chip is passivated (coated with an inert protective material) to keep contaminants from entering the gate material.

The vertical design of the VMOS technology gives it the following advantages over the conventional MOS structure:

1. The length of the current channel is determined by the depth of the diffusion—a much more easily controlled factor than mask spacings used to define channel lengths in conventional MOS. That makes it possible to obtain a better width/length ratio and al-

lows higher current densities to be obtained.

2. Each groove creates two parallel channels so the current density is inherently doubled.
3. The substrate forms the drain contact so that there is no need to provide space for a metal drain contact on top of the chip. That reduces chip area and thus keeps saturation resistance low.
4. The high-current density results in low gate-to-drain (feedback) capacitance because the portion of the gate nearest the drain (called the overlap) is in the bottom of the V groove. In a conventional MOSFET, extra drain-gate overlap must be provided to allow for possible mask misalignment. Tht increases the gate-to-drain and gate-to-source capacitances.
5. The epitaxial layer of the VFET is lightly doped so it absorbs the depletion area from the reverse-biased drain-to-body PN diode. That greatly increases the breakdown voltage while having little or no effect on other device parameters.

Various designs of VMOS transistors have been developed by different manufacturers to increase such parameters as speed, power-handling capacity, and voltage and current ratings. Names given those technologies include DMOS, VDMOS, TMOS, ZMOS, HEXFET and SuperFet. We'll get to them in a future column. R-E

SERVICE QUESTIONS

continued from page 96

volt-DC one in parallel. That caused more problems! Now the sweep stops about 1½ inches from the right, with bad foldover. Everything around the yoke checks out OK. Any ideas?—G.H., Alplaus, NY

You had the right idea, but the wrong part! Since that capacitor is in the horizontal circuit, the original must have been a special type, with a special dielectric made to withstand the high-frequency pulses (like the familiar 4-legged capacitors).

You'll probably have to get an exact duplicate. Sony's address is Sony Corp. of America, 8281 N.W. 107th Terrace, Kansas City, MO 64195. Look up the New York State distributor and try him, too.

HIGH-VOLTAGE PROBLEM

I wrote you recently about a HV problem in an RCA CTC-68. One of the things you suggested was the HV-regulator transformer. That was it! The solder joints were bad. Thanks.

Thanks to Jim L. Webb, Fox, OK, for the feedback. R-E

COMPUTER CORNER

continued from page 90

controls the disk drive) and an eight-inch one about 250 kilobytes.

Changing the disk-controller board can allow you to have twice the capacity on the same disk and drive you have been using by going to a *double density* format. In that format, the amount of data that can be stored on one side of a single disk is doubled.

The latest in floppy-disk technology is *quad density*, or *double-sided, double-density*. There, two read/write heads are used, one for each side of the disk, and a single eight-inch disk can hold up to a megabyte of data.

Most disk systems can be expanded by adding extra drives. They usually come set for single-sided, single density operation, but many can be reconfigured to take advantage of the more advanced recording techniques.

Beyond floppy disks are hard disks. They are usually aluminum platters coated with a metallic oxide and they rotate at very high speeds. Because of the high speeds involved, the read/write head, unlike that of floppy-disk systems, does not touch the disk, but floats very close to its surface on a cushion of air. Hard-disk capacities start at 5 megabytes and go on from there. Hard disks are usually found in elaborate business systems.

A recent—and more affordable—hard-disk system appeared several years ago and is rapidly finding popularity in the microcomputer market. The *Winchester-technology* disk ("Winchester" was its code name when it was under development) typically uses 8- or 5¼-inch platters to give capacities starting with several megabytes and going up. Winchester drives are now available that can fit in the same space previously occupied by a standard 5¼-inch floppy-disk drive, but provide many times more storage capacity. (A representative Winchester-technology system with floppy-disk backup is shown to the left of the computer in Fig. 1.) Prices start out around $3000.00, but, when all the factors are considered, that is not a big price to pay if you are going to make extensive use of the system.

The memory market—both resident and external—offers a staggering variety of choices. Those choices involve not only the medium, but also the quality of the product. It's a good idea to consult other computer users and to search through the ads, catalogs, and computer stores before making a decision. A computer cannot perform efficiently if it doesn't have sufficient memory. What it doesn't need, though, is premature senility. R-E

NEW PRODUCTS

For more details use the free information card inside the back cover.

DESKTOP COMPUTER, the *Advantage*, is the first completely integrated desktop stand-alone system to offer minicomputer-grade graphics capabilities. It includes a 12-inch display, two 5¼-inch high-capacity floppy-disk drives, an 87-key *Selectric*-style keyboard, and a choice of optional broad-ranging operations and applications software.

CIRCLE 131 ON FREE INFORMATION CARD

The *Advantage* is built around a 4-MHz Z80A and includes 64 kilobytes of random-access memory (RAM). It features a 12-inch bit-mapped CRT display to produce bar charts, pie diagrams, plotted graphics, and 3-dimensional visuals, driven by an additional 20 kilobytes of RAM that support the bit-mapping feature. With the *Advantage*, small-business computer owners will be able to integrate graphics into their everyday business without paying a premium. The *Advantage* is priced at $3999.00.—**North Star Computers, Inc.**, 14440 Catalina Street, San Leandro, CA 94577.

PHONO CARTRIDGE, *model MV30HE*, is designed excusively for *model SME 3009 Series III* and *model SME 3009 Series IIIS* tone arms. It is a high-performance, miniature cartridge that is integrated with an SME carrier-arm. The integrated design results in significantly reduced effective mass; it virtually eliminates headshell resonances, and provides easy-to-mount convenience.

The *model MV30HE* features a distortion-reducing hyperelliptical stylus, the tip of which provides as much as a 25% reduction of distortion over a conventional bi-radial (elliptical) stylus. Its low mass allows the stylus assembly to follow the record groove not only up to, but beyond, the theoretical cutting velocities of today's recordings. The "HE" stylus assembly also incorporates a telescoped stylus-shank structure for reduced effective mass, without sacrificing stiffness.

CIRCLE 132 ON FREE INFORMATION CARD

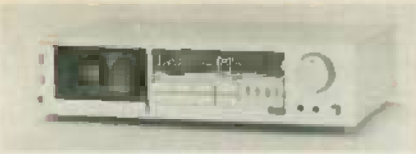
Installation of the *model MV30HE* simply requires plugging the carrier arm into the tone-arm pivot of a turntable. The integrated design eliminates the nuts, screws, and terminal-pin wires usually needed to mount phono cartridges. The *model MV30HE* has a suggested retail price of $230.00.—**Shure Brothers Incorporated**, 222 Hartrey Avenue, Evanston, IL 60624.

MICROPHONE, *model PL88*, is a dynamic cardioid vocal microphone, featuring voice-tailored frequency-response characteristics: It is resistant to handling-noise. Designed for the vocalist on a tight budget who is unwilling to compromise his or her standards of quality, the *model PL88* features an on/off switch and, for additional flexibility, is available in both high- and low-impedance models. The *model PL88* is priced at under $70.00.—**Electro-Voice, Inc.**, 600 Cecil Street, Buchanan, MI 49107.

CIRCLE 133 ON FREE INFORMATION CARD

STEREO CASSETTE DECK, *model KX-70*, uses metal tape and has an exclusive computerized memory that provides fast, automatic program access, as well as repeat operation.

Called the *Direct Program Search System* (DPSS), the microprocessor-controlled memory expands the deck's normal functions to include fast-forward and rewind search of up to 15 music selections on each side, as well as single-selec-



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tion and full-side repeat and re-record/standby. The DPSS is easy to operate and features a multicolored LED display and lighted arrows as mode indicators.

Electronic full-logic controls give instant response at the touch of a button, and allow the listener to change modes without an intervening "stop" action, and without tape stretch. Operation is simplified further by smooth-action pocket loading, and the pocket is removable for easy head-cleaning and demagnetizing. A dual-motor system insures minimal wow and flutter, and provides fast handling of the tape.

Other features include Dolby noise-reduction; a newly developed amorphous-alloy magnetic head for optimum metal-tape performance; three tape-selector positions with automatic equalization and bias-matching; seven-LED peak-level meters; a timer/standby switch; single-operation recording; MIC mixing; automatic jacks, and a headphone jack. The *model KX-70* has a suggested retail price of $349.00.—**Kenwood Electronics**, Dept. P., 1315 E. Watsoncenter Road, Carson, CA 90745.

SPEAKERS, *model Micro 10*, are 13½ × 9½ × 9½ inches, and have cabinets made from American black walnut. They feature

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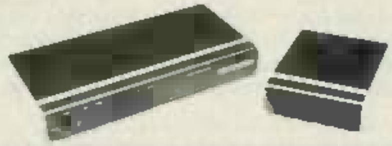
new 6½-inch modified polypropylene woofers with 1¼-inch high-temperature aluminum voice-coils; leaf tweeters, cases lined with lead, and hand-rubbed oiled walnut cabinets. The *model Micro 10* is priced at $500.00 a pair.—**Soundmates**, 796 29th Avenue S.E., Minneapolis, MN 55414.

AMBIENCE ACCESS SYSTEM, *model ARU*, offers a unique time-delay system that adds nothing of its own to sound reproduction. The listener receives the ambience that is present in the recording; there is no extra reverberation, and the effect is that of being in the concert hall. The original signal is transmitted without modification to the front speakers, while the same signal is fed to the side speakers, with a time delay of .03 seconds. In addition, a pair of rear speakers receives an uncorrelated signal that consists of the difference between left and right front channels, also delayed by .03 seconds.

In most recordings, the extreme low-frequency signals are cut in mono; thus the difference signal tends to be bass-shy. To fill in the missing bass, a mono signal made up of the sum of the left and right front channels is added to the rear speaker at frequencies below 60 Hz. High frequencies are contoured for the side and rear speakers as they would be in the concert hall. A remote-control unit with a 25-foot cord permits sound levels for the front, side, and rear speakers to be adjusted from a distance.



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The *model ARU* allows the user to take charge of his total music system far more easily than any other system of its kind because all key functions are available through the remote-control section. It will function with any stereo system the user now has, and with any kind of music, as well as interface with virtually anything the user might acquire in the future. The *model ARU* is priced at $829.00.—**Benchmark Acoustics**, 201 West 89th Street, New York, NY 10024.

CORDLESS TELEPHONE, *model FF-4000*, is microprocessor-based; the user can

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choose rotary pulse or pure tone-activated dialing, making this the first cordless telephone capable of full central-telephone-equipment interface. Features offered by the phone company such as call waiting, call forwarding, three-way calling, and speed calling can be used, via a special "hook" key.

The *model FF-4000* has automatic dialing capability, which means that the user can store up to three numbers in memory and dial any one of them by just pushing a button. The auto-dial feature is protected against power outages by an easily changeable 9-volt battery. There is also a security system, programmable by the owner, to prevent unauthorized use of the system.

Very low power-level operation allows

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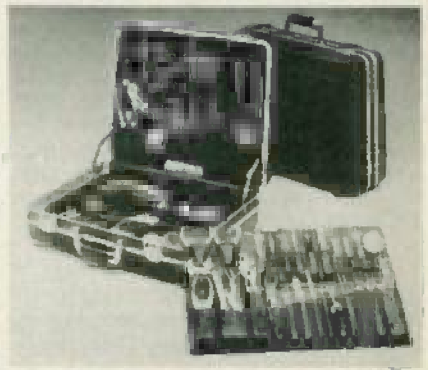
longer performance from a single charge than possible with any other cordless telephone. Special circuitry permits the handset to be recharged fully in under four hours. There is also a re-dial button, which permits one-button re-dialing of the last number called; a "battery-low" light, which indicates when the handset is in need of recharging; a "charge" light on the base, which indicates that the handset's batteries are being recharged, and a "power" light on the base to indicate that power to the base station is on. Other features include volume control on the handset and double modular external jacks on the base station (one for regular phone-line hookup, the other for any telephone accessories, such as phone-answering devices, etc.)

The *model FF-4000* has a suggested retail price of $349.95.—**Electra Company,** 300 E. Country Line Road, Cumberland, IN 46229.

TOOL CASES, *model 800T* and *model 805T*, are ruggedly constructed injection molded cases, made of high-impact polypropylene, combined with molded polyurethane pallets.



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Model 800T (shown) measures 18 × 13½ × 6 inches, and has two pallets; it is priced at $107.00. The slightly smaller *model 805T* measures 18 × 13½ × 5 inches, and has one pallet; its price is $87.00.—**Platt Luggage, Inc.**, 2301 S. Prairie Avenue, Chicago, IL 60616.

CONSOLE. The *P/C Desk Console*, has been introduced for the *Sharp PC-1211* and the Radio Shack *TRS-80* pocket computers with printer. Constructed of black plastic and measuring 8.5 × 16 × 2.75 inches, it has room for three cassette

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boxes, a full set of 3 × 5-inch cards, two paper rolls, a spare print ribbon, and the interface cable. The *P/C Desk Console* is priced at $19.95, plus $2.50 shipping, and 6% tax for CA residents.—**Fox/Walker,** 4650 Arrow Hwy., Bldg. G-17, Montclair, CA 91763. **R-E**

NEW IDEAS

Typewriter word counter

HERE'S A PROJECT THAT CAN SAVE YOU some time when you need a manuscript of a specific length, such as for a school project, a classified advertisement, etc. It will keep track of how many words you've typed, and display the total. The circuit uses Hall-effect switches (Sprague UGN-3020T, or equivalent) to detect keystrokes and spaces.

The Hall-effect switches are sensitive to the presence of a magnetic field. In this project, permanent magnets are used to turn the switches on and off. When the magnet is near the switch, the output from the switch is logic 0; when the magnet moves away, the switch opens and, because of the 10,000-ohm pull-up resistor, the output goes to logic 1.

The switches are connected to ¼ of a 4043 RS flip-flop. After the circuit has been reset, the output from that flip-flop is at logic 1. At the first keystroke, the output from the Hall-effect switch goes to logic 0, pulling the flip-flop's output to logic 0. The output from the flip-flop drives the MC14553 three-decade counter. That counter is negative-edge triggered, so the transition of the flip-flop's output from logic 1 to logic 0 increments the counter. The counter's BCD output is then fed to the 4511, a BCD-to-7-segment display decoder/driver, which in turn controls the 3½-digit LED display.

Each subsequent key stroke is ignored until the space bar is hit. Hitting the space bar opens the space-bar Hall-effect switch, which in turn resets the RS flip-flop. Subsequent spaces are ignored until the next keystroke is entered, and the entire cycle is repeated. If the space bar and a key are struck at the same time, the flip-flop's output is logic 1, and the next keystroke increments the counter.

When the count reaches 999, the next negative transition will clear the counter but set its overflow high. That overflow output is latched by a second flip-flop, ¼ of the 4043, driving the display's most significant digit (the 1 on the display) on. The procedure then repeats, for a maximum count of 1999 words.

For this circuit to work, the Hall-effect switches and the magnets must be mounted inside the typewriter itself. One switch and magnet should be mounted so that they are close together normally, but move apart when any key is struck. The second switch and magnet should be mounted so that they move apart when the space bar is hit. The switches and magnets are mounted using epoxy glue. Both sets of switches and magnets should be positioned so that the thick side of the switch (the side opposite the dot) is normally near the magnet's south pole.

You can power the circuit any way you wish. One good way would be to use a wall-plug transformer with a 9-volt output. You could also use a 9-volt battery. If you do that, you may want to devise a display blanking circuit to extend battery life.—*Larry Dighera*

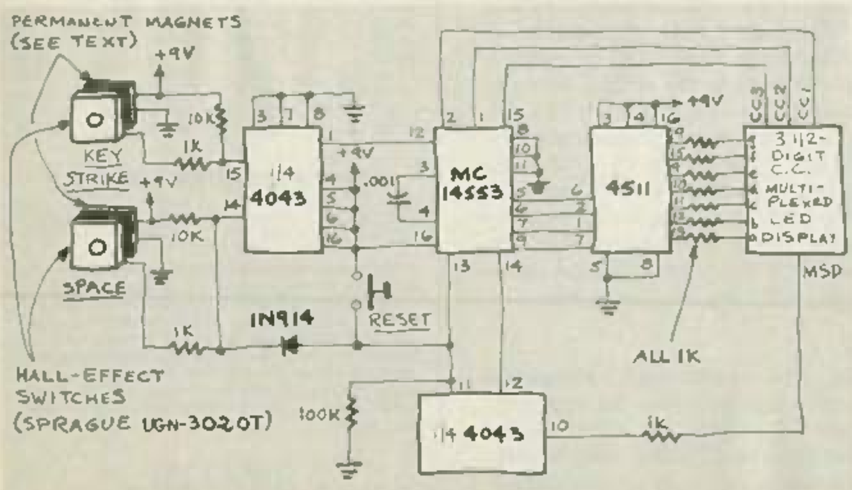

FIG. 1

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

All published entries, upon publication, will earn $25. In addition, Panavise will donate their *model* 333—The Rapid Assembly Circuit Board Holder, having a retail price of $39.95. It features an eight-position rotating adjustment, indexing at 45-degree increments, and six positive lock positions in the vertical plane, giving you a full ten-inch height adjustment for comfortable working. (See photo below.)

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SATELLITE TV RECEIVER

continued from page 53

(At the uplink transmitter, the video is pre-emphasized to reduce degradation in quality during transmission and is dithered—or dispersed—at a 30-Hz rate to prevent interference to ground-based microwave links. The two processes must be "undone" to recover the original video information.)

A de-emphasis network after Q4 made up of R22, R23 and C45 removes the pre-emphasis that was added at the uplink source. Transistor Q7 isolates the de-emphasis network from the video low-pass filter formed by C46-C48 and L8. That filter is needed to remove the audio-subcarrier components from the video; sometimes they can wreak havoc with devices like external RF-modulators. It should be noted that all stages so far have been direct-coupled to allow frequency response down to DC—an important factor for good video. Transistors Q8 and Q9 form a ×2-gain amplifier/buffer stage that drives C49 and D5, a simple clamp-stage that removes the 30-Hz dither that would otherwise cause the picture to flicker. Following the clamp stage, emitter-followers Q10 and Q11 provide enough gain to produce a one-volt peak-to-peak video signal into a 75-ohm load.

Audio demodulator

FM audio from the satellites is transmitted on subcarriers in the 5.5–7.5-MHz range (with 6.8 MHz being typical), making a tunable audio-demodulator a must. A high-pass filter consisting of C54, C55, and L9 couples the audio subcarrier to a second PLL stage, IC7, similar to that used in the video section with the exception that it operates only over a 5–8-MHz range. Its center frequency is determined by the capacitance across pins 12 and 13. That capacitance is formed by a varactor diode (D6) and C67. The bias on the varactor is adjusted by the front-panel AUDIO potentiometer; increasing the voltage increases the frequency of the PLL. The PLL follows the FM subcarrier and outputs demodulated audio at pin 14. That audio is low-pass filtered by R43 and C64, and applied to a ×20 gain stage made up of half of IC6, a dual op-amp. The output of IC6 is 1-volt peak-to-peak and is capable of driving a 600-ohm load.

AFC

The AFC (*A*utomatic *F*requency Control) stage performs the important function of keeping the 4-GHz signal centered in the 25-MHz wide 70-MHz IF. Although that task sounds complicated, the AFC circuit is really quite simple. Its heart is the TUNING potentiometer, R47, and a constant-current source, IC8. That IC provides a current to the potentiometer, where a voltage drop takes place. The output of the constant-current source is modified by a current mirror formed by D7 (a 2N4123 transistor with its base and collector leads tied together) and Q12. By varying the current applied to that current mirror, we can vary the current through the front-panel tuning potentiometer, and thus the voltage drop across it.

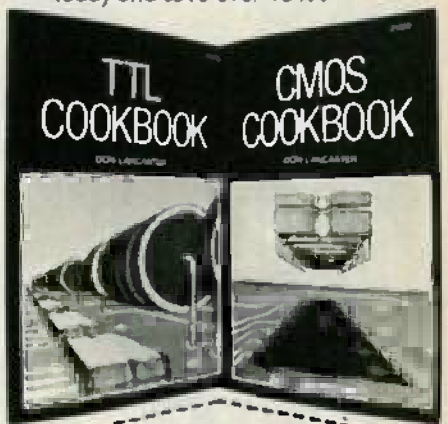
In effect, we "steal" some of IC8's constant current; that tends to linearize the tuning characteristics of the first local-oscillator. Integrated circuit IC6-a is used to drive the current mirror and the circuit performs a voltage-to-current translation.

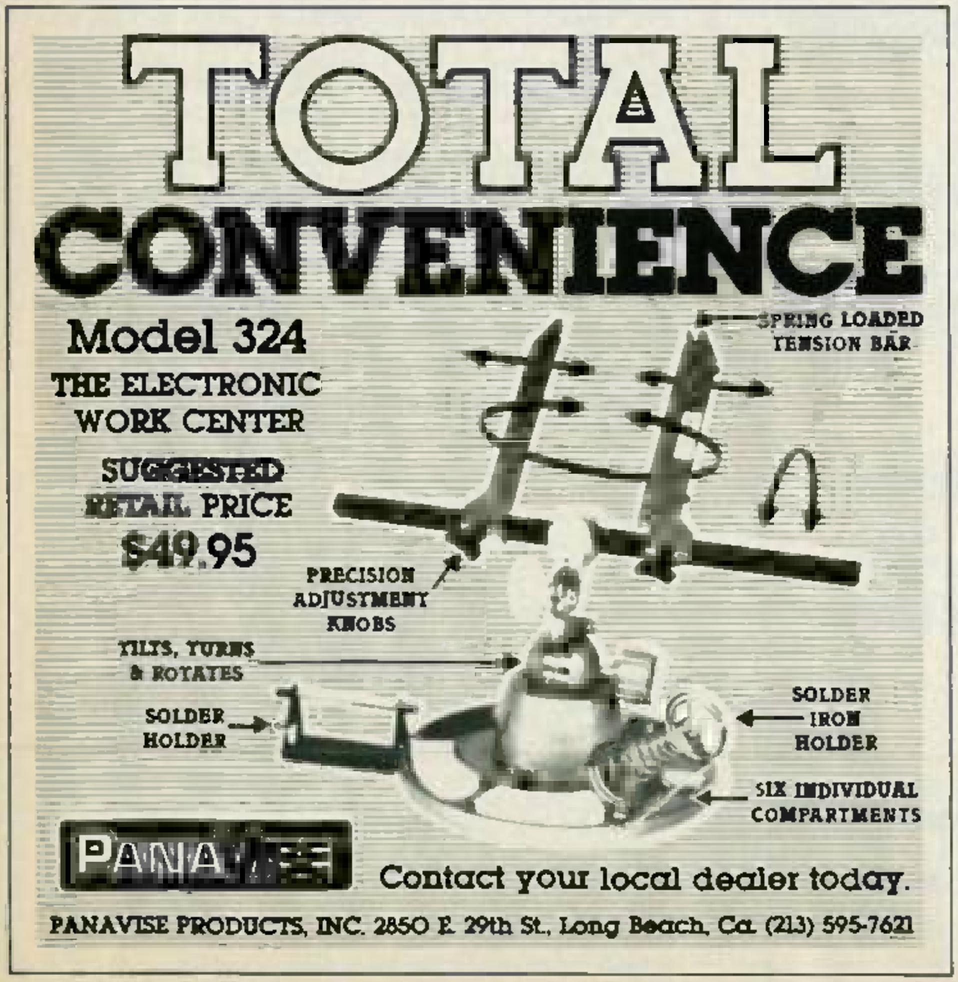
The output voltage from the demodulator (taken from the emitter of Q4) is filtered by R33 and C52 to remove any trace of video signal, so that all that's left is a control voltage representing a frequency. That voltage is applied to the non-inverting input of IC6-a and controls the voltage to the current translator, causing an AFC action to take place. If the signal drifts higher, the AFC circuit steals more current from IC8, causing the voltage drop across the tuning potentiometer to decrease and pulling the receiver back on frequency.

Power supply

A simple full-wave bridge rectifier-type power supply, shown in Fig. 8, provides unregulated 18-volts DC for the receiver, and IC11, IC12, and IC13 provide regulated 15, 12, and 5-volts, respectively. The 18-volt, 1-amp, power transformer is housed in a separate enclosure to reduce heat drift in the receiver.

In the next part of this article we'll present foil patterns and parts-placement diagrams for the receiver, along with assembly instructions. R-E





NEW BOOKS

For more details use free information card inside back cover.

INSIDE BASIC GAMES, by Richard Mateosian. Sybex, 2344 Sixth Street, Berkeley, CA 94710. 325 pp including appendix and index; 7 × 9 inches; softcover; $13.95.

Assuming that the reader has some knowledge of BASIC programming, this book teaches him or her how to design error-free interactive BASIC programs, including games and other "real time" situations. Eight different kinds of computer games (a total of 14 games) are described in detail, then completely analyzed to illustrate how the games were designed and developed in BASIC. All aspects of game-program design, including program structuring, cursor positioning, randomization, and other concepts are discussed. Programs for games such as Hangman, Ten-Key Flicker, and Taxman are coded in Microsoft BASIC, and versions are provided for the *PET/CBM*, *APPLE II*, and *TRS-80*.

CIRCLE 121 ON FREE INFORMATION CARD

EXPERIMENTS IN TELECOMMUNICATIONS, by Morris Tischler. Gregg Division, McGraw-Hill Book Company, 1221 Avenue of the Americas; New York, NY 10020; 186 pp; 8½ × 11 inches; softcover; $7.95. EXPERIMENTS IN GENERAL AND BIOMEDICAL INSTRUMENTATION, by Morris Tischler; same publisher and format; 201 pp; $8.95.

These two books are part of a series presenting linear IC's in a variety of circuit applications, and are written for use by electronics technicians who have a basic knowledge of transistors and test instruments. Each volume covers theory and application through laboratory experiments and tracks with standard electronics-course coverage. Step-by-step lab procedures reinforce learning with hands-on activities using common lab equipment and devices presently used in industry.

CIRCLE 122 ON FREE INFORMATION CARD

HANDBOOK OF OSCILLOSCOPES: Theory and Application, by John D. Lenk. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 340 pp including index; 6¼ × 9¼ inches; cloth; $19.95.

This new and revised edition carries through all the features of the first edition, bridging the gap between oscilloscope theory and practical applications. It is designed as a basic textbook for student technicians, hobbyists, and experimenters, and as a guidebook for experienced working technicians and engineers. Each chapter has been expanded to include new material, and existing information has been updated to reflect present-day trends, especially in the extensive use of curve tracers. The revision also simplifies much of the material in the first edition.

Assuming that readers are not familiar with the operating principles of oscilloscopes, the opening chapters present simplified details. Chapter one through four cover oscilloscope basics—typical operating controls and characteristics, specifications and performance—as well as a brief description of oscilloscope accessories. Throughout, the descriptions are kept to the block-diagram or simplified level; unnecessary and elaborate circuit descriptions are avoided.

CIRCLE 123 ON FREE INFORMATION CARD

HANDBOOK OF MICROPROCESSOR APPLICATIONS, by John A. Kuecken. TAB Books, Inc., Blue Ridge Summit, PA 17214. 308 pp including index; 5⅛ × 8⅛ inches; softcover; $8.95.

"What can a microprocessor *not* be used for? It will not mend a broken heart. It will not ensure justice among all men. It will not bring happiness to the lonely. It will not perform its functions instantaneously. Outside of those constraints, there is very little that it cannot do or assist in doing."...

So starts this book, whose object is to show the principles of microcomputers and to demonstrate some of the nearly infinite numbers of ways in which the microcompressor can be applied to measurement, process sequencing, "smart" instruments, and some of the more traditional computer applications.

The book is written with the assumption that the reader has no familiarity with binary arithmetic, BCD, hexadecimal or octal notation; because of that, those subjects are all treated early in the discussion.

Emphasis is placed upon the use of the microprocessor in the control, sequencing, and measurement functions and the manipulations of bits and bytes at the machine or assembly-language level in which most of the simple evaluation kits operate. It is not assumed that any of the extensive "development systems" are available to the reader.

The basic aim of the text is to render the use of microprocessors are simple as possible in the widest span of applications. The same subjects have been treated in different locations in the text from different viewpoints, so that a second and perhaps third encounter with the same topic will generate greater familiarity and understanding of the less-familiar concepts.

CIRCLE 124 ON FREE INFORMATION CARD

HANDBOOK OF SIMPLIFIED RADIO, PHONO, AND TAPE RECORDER REPAIRS, An Illustrated Troubleshooting Guide, by James Edward Keogh and Ben Suntag. Parker Publishing Company, Inc., West Nyack, New York 10994. 236 pp including appendices and index; 6 × 9 inches; softcover, spiral binding; $16.95.

The car radio keeps fading in and out...the tape-recorder playback is on the blink...the pickup arm on the stereo refuses to lift. For most people, repairs on three items like those would come to considerable expense at a repair shop.

This book is a simplified, time-saving guide that shows you how to troubleshoot radios, phonographs, and tape recorders quickly. Through step-by-step troubleshooting charts, you will find the source of the problem. Locate the symptom in the appropriate chapter and simply follow the troubleshooting chart. The malfunctions are listed according to the most likely occurrences. Not only are you told *what* component to check, but also *how* to make the necessary tests so that you can narrow the problem down to its primary cause. Succeeding steps are then outlined.

Once you know what the trouble is, it's a matter either of repairing or replacing the component. This book shows you how to make simple repairs, when that is possible, as well as indicating at what point a replacement is the only solution to the problem.

CIRCLE 125 ON FREE INFORMATION CARD

TELECOMMUNICATION TRANSMISSION HANDBOOK, 2nd Edition, by Roger L. Freeman. John Wiley & Sons, Inc., One Wiley Drive, Somerset, NJ 08873. 707 pp including appendices and index; 6½ × 9½ inches; hardcover; $49.50.

For practicing telecommunications engineers and advanced students, this standard handbook—now fully revised and updated—provides the practical and real-world information needed for telecommunication design for single links or for complete networks. It treats the technical expertise of 14 transmission disciplines with a unified telecommunications-system approach.

Because many engineers are unfamiliar with some aspects of transmission technology, each chapter begins with an examination of key concepts, which are then applied to the specific engineering situations. That integrative approach makes available a wealth of on-the-job techniques that can be used in any area of transmission-problem solving, whatever the engineer's specialty. Many tables, nomograms, and curves illustrate basic principles and suggest additional applications.

CIRCLE 126 ON FREE INFORMATION CARD

INTERFERENCE HANDBOOK, by William R. Nelson, WA6FQG. Radio Publications, Inc., Box 149, Wilton CT 06897. 247 pp including index and data on other recommended handbooks; 5½ × 8½ inches; softcover; $8.95 plus $1.00 for postage and handling.

This book tells how to locate and cure RFI (*R*adio *F*requency *I*nterference) relating to TV, stereo, radio, power lines, and telephones. Problems in all of those areas are analyzed and solved. There are many photos, diagrams, and charts. Suppression circuits for interfering devices are discussed in detail, as well as protection techniques for home-entertainment equipment.

Interference is a fast-growing problem, and there will be more tomorrow than there is today. This handbook is designed to be of service to those confronting that world-wide obstacle to clear, reliable electronic communication. **R-E**

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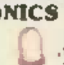

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[illegible]	.077	.066	.0012MF	.077	.066	.0068MF	.077	.066
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100/10	[illegible]	16/220	.30	25/2200	1.[illegible]
10/15	.14	40/220	.47	40/2200	1.45
25/22	.17	63/220	[illegible]	50/2200	2.[illegible]
100/22	[illegible]	160/220	1.[illegible]	10/4700	1.02
6/33	.15	200/220	1.[illegible]	16/4700	1.[illegible]
35/33	[illegible]	6/330	.18	25/4700	2.[illegible]
63/33	[illegible]	25/330	[illegible]		

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2N3906	.15

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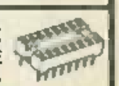

CONTACTS	PRICE	CONTACTS	PRICE
8 PIN	.13	22 PIN	.35
14 PIN	.22	24 PIN	.38
16 PIN	.25	28 PIN	.44
18 PIN	.28	40 PIN	.63
20 PIN	.31		

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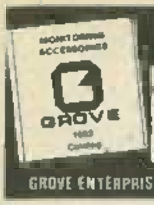

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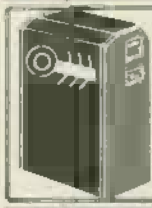

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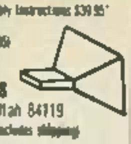

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ELECTRO SPACE PRINTED CIRCUIT CARD EJECTORS

For 1/16 thick card (.072 slot)

Stock No	Color	1-24	24-49	50-Up
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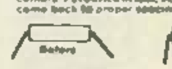
11451	Red	.25	.21	.19

ELECTRO SPACE PRINTED CIRCUIT CARD INJECTOR/EJECTORS FOR 1/16 THICK CARDS

11452	White	$.27	$.22	$.20
11453	Red	.27	.22	.20

Pin Straightening Tool puts devices on their true row to row spacing. One side is for 300 center devices, flip tool over for devices on 600 centers. Put device in tool, squeeze, bowed leads come back to proper spacing.



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- Cam actuated, true zero insertion force
- tin plated solder tail pins
- capable of being plugged into DIP sockets

Stock No	No Pins	1-24	25-49	50 Up
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11056	28	4.25	3.77	3.40
11057	40	4.90	4.34	3.91
11058	64	9.80	8.74	7.90

Texas Instruments Low Profile Sockets,

tin plated phospher bronze contact pins with gas tight seal

Stock No	No. Pins	1-24	25-99	100-Up
11201	8	$.15	$.13	$.12
11202	14	18	15	14
11203	16	21	18	16
11204	18	24	21	19
11205	20	27	24	21
11206	22	30	26	23
11207	24	33	30	29
11208	28	38	34	28
11209	40	53	45	40

ELPAC POWER SUPPLIES SOLV SERIES FULLY REGULATED

Stock No	Output Voltage	Output Current Rating	Dimensions (H×W×D) in Inches	Price
13802	5	3.0A	4-7 16x4x2	$38.00
13803	12	1.5A	4-7 16x4x2	38.00
13804	15	1.2A	4-7 16x4x2	38.00
13806	24	0.75A	4-7 16x4x2	38.00
13808	5	6.0A	5-5 8x4-7/8x3-3/16	57.00
13809	12	4.0A	5-5 8x4-7/8x3-3/16	57.00
13810	15	3.3A	5-5/8x4-7/8x3-3/16	57.00
13812	24	2.0A	5-5 8x4-7/8x3-3/16	57.00

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Stock No.	Braid Size	Ft. Spool	Price
50041	1/16	5	$2.10
50043	3/64	5	2.25

RCA C/MOS

Stock No	RCA No	1-24	25 Up
44001	CD4001BE	$.36	$.33
44002	CD4001UBE	36	33
44007	CD4007UBE	36	33
44011	CD4011BE	36	33
44012	CD4011UBE	36	33
44013	CD4013BE	56	52
44015	CD4015BE	1.07	1.01
44016	CD4016BE	59	55
44017	CD4017BE	1.07	1.01
44018	CD4018BE	59	55
44020	CD4020BE	1.18	1.12
44023	CD4023BE	36	33
44024	CD4024BE	92	87
44025	CD4025BE	36	33
44027	CD4027BE	64	64
44030	CD4030BE	59	55
44040	CD4040BE	1.18	1.12
44046	CD4046BE	1.56	1.46
44049	CD4049UBE	57	54
44050	CD4050BE	47	44
44051	CD4051BE	1.18	1.12
44052	CD4052BE	1.18	1.12
44053	CD4053BE	1.18	1.12
44054	CD4054BE	1.96	1.85
44056	CD4056BE	1.96	1.85
44060	CD4060BE	1.48	1.40
44066	CD4066BE	78	74
44069	CD4069UBE	36	33
44070	CD4070BE	44	41
44071	CD4071BE	36	33
44078	CD4078BE	1.26	1.20
44081	CD4081BE	36	33
44082	CD4082BE	78	74
44098	CD4098BE	1.56	1.44
44507	CD4507BE	1.72	1.64
44511	CD4511BE	1.26	1.20
44522	CD4520BE	1.18	1.12
44590	CD22100E	2.49	2.35
44591	CD40103BE	1.96	1.85
44593	CD40106BE	84	80

RCA POWER

SINTEC	RCA No	1-24	25-99
40122	C1220	$1.22	$1.16
42322	T2322D	1.40	1.30
42700	T2700D	2.07	1.96
42800-1	T2800B	1.58	1.50
42800-3	T2800D	1.88	1.79
43850	T2850D	3.08	1.85
40025-1	TIP29	.60	57
40029-2	TIP29A	.64	61
40031	TIP31A	.74	70
40121	TIP121	1.43	1.35
40125	TIP125	1.37	1.29
42955	MJ2955	1.16	1.10
43055	RCA3055	1.03	97
42102	2N2102	1.28	1.22
42270	2N2270	.82	78
43053	2N3053	61	58
43054	2N3054	1.37	1.29
43055-1	2N3055	1.03	97
43055-2	2N3055HOM	1.63	1.54
43439	2N3439	1.73	1.65
43440	2N3440	1.26	1.19
43771	2N3771	2.92	2.76
43772	2N3772	3.18	3.00
43773	2N3773	3.22	3.04
44036	2N4036	1.08	1.02

SINTEC	RCA No	1-24	25-49
44037	2N4037	$.86	$.82
45294	2N5294	80	76
45296	2N5296	80	76
45320	2N5320	1.25	1.16
45321	2N5321	1.03	94
45322	2N5322	1.61	1.53
45415	2N5415	1.60	1.52
45416	2N5416	3.17	2.08
45784	2N5784	1.37	1.29
46044	2N6044	2.04	1.93
46101	2N6101	1.25	1.19
46103	2N6103	1.29	1.18
46107	2N6107	82	.73
46108	2N6108	82	.78
46111	2N6111	80	.76
46254	2N6254	2.18	2.06
46290	2N6290	80	.76
46292	2N6292	80	.76
46386	2N6386	1.05	99
46387	2N6387	1.15	1.09
46388	2N6388	1.28	1.22
46474	2N6474	1.03	97
46667	2N6667	1.40	1.44
46668	2N6668	1.60	1.52
40347	40347	1.22	1.16

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47630	2516	16K E PROM	7.95
47632	2716	16K E PROM	7.95
47635	2532	32K E PROM	15.75
47637	2732	32K E PROM	15.75
47638	2764	64K E PROM	27.95
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47650	4116-3	16K DYNAMIC RAM	3.60

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13826	3.0-7.0	12±0.6	0-25	48x.51x3.05	7.00
13827	3.0-7.0	15±0.7	0-20	48x.51x3.05	7.00
13830	3.0-7.0	15±0.7	0-20	48x.51x3.05	7.00
13829	3.0-7.0	28±0.7	0-10	48x.51x3.05	7.00
13830	3.0-7.0	28±0.7	0-10	48x.51x3.05	7.00
1.5 W TYPE					
13831	4.0-7.0	12±0.6	125	.651x1.2x1.77	23.00
13832	4.0-7.0	12±0.6	125	.651x1.2x1.77	23.00
13833	4.0-7.0	15±0.7	100	.651x1.2x1.77	22.00
13834	4.0-7.0	15±0.7	100	.651x1.2x1.77	22.00
13835	4.0-7.0	28±1.4	50	.651x1.2x1.77	23.00
13836	4.0-7.0	28±1.4	50	.651x1.2x1.77	23.00

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50076	062	35	4	4.24
50077	062	50	8	6.02
50078	032	33	1.0	4.08
50079	032	69	4	6.18
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7414	.99	74154	1.95
7417	2/1.10	74157	.99
7420	2/.85	74161	1.19
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7474	.69	74174	1.59
7475	.79	74175	1.49
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7485	1.19	74193	1.19
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74LS30	.55	74LS161	1.29
74LS32	.69	74LS174	1.19
74LS38	.69	74LS175	1.19
74LS42	1.29	74LS192	1.49
74LS47	1.29	74LS193	1.49
74LS48	1.79	74LS221	1.49
74LS73	.75	74LS244	1.89
74LS74	.69	74LS245	3.49
74LS75	.75	74LS367	.89
74LS85	1.49	74LS374	1.95
74LS90	.89	81LS97	2.29

POTENTIOMETERS

2 Watt @ 70°C
7/8" Slotted Shaft
Linear Taper
1K, 5K, 10K, 25K, 50K, 100K, 1 Meg

CMU $2.96

3/4 Watt @ 70°C
15 Turn Pot.
Linear Taper
100 Ohm, 500 Ohm, 1K, 5K, 10K, 50K, 100K, 500K, 1Meg

830P $1.79

SOCKETS

Low Profile		Wire Wrap	
8 pin LP	2/.59	14 pin WW tin	.75
14 pin LP	2/.69	14 pin WW gold	1.09
16 pin LP	2/.79	16 pin WW tin	.79
18 pin LP	2/.89	16 pin WW gold	1.19
20 pin LP	2/.99	24 pin WW gold	1.69
22 pin LP	2/1.09	40 pin WW gold	2.75
24 pin LP	.79	14 p. plug/cover	1.29
28 pin LP	.82	16 p. plug/cover	1.39
36 pin LP	.99	24 p. plug/cover	1.95
40 pin LP	1.19	Also. The Molex Line	

NEW! JE215 Adjustable Dual Power Supply

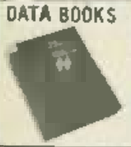
General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:

- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

DATA BOOKS



JPTTL	Jim-Pak7400/74LS TTL	$3.95
JPCML	Jim-Pak CMOS/Linear	4.49
JPMPD	Jim-Pak Micro/Display	3.95
30001	National CMOS	6.95
30003	National Linear	8.95
30005	National TTL Logic	8.95
30009	Intersil	7.95
10400	Intel Component	10.95

DIODES & TRANSISTORS

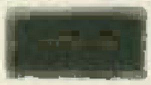
IN751	2/.59	2N2219A	2/1.19
IN757	2/.59	2N2222A	2/.89
IN1188	2.69	2N2907A	2/.89
IN3600	5/.99	2N3055	.99
IN4001	4/.59	2N3772	2.25
IN4004	4/.69	2N3904	2/.69
IN4007	4/.79	2N3906	2/.69
IN4148	10/.99	2N4401	2/.79
IN4733	2/.69	2N4403	2/.79
IN4734	2/.69	2N5129	2/.69
IN4735	2/.69	2N5139	2/.69
IN5401	3/1.19	TIP29A	.89
IN5408	3/1.99	TIP31A	.99

CMOS

4000	.55	4030	.75
4001	.55	4040	1.79
4002	.59	4044	1.39
4006	1.49	4046	1.95
4009	.79	4047	2.75
4010	.79	4049	.79
4011	.55	4050	.89
4013	.79	4051	1.59
4016	.79	4066	.95
4017	1.39	4069	.69
4018	1.39	4070	.75
4020	1.39	4071	.69
4023	.49	4081	.59
4024	1.19	4093	1.19
4027	.79	4511	1.95

JIM-PAK KITS

JE730



JE701

JE200	5V 1 Amp Regulated Power Supply Kit	$14.95
JE205	Multi-Voltage Board Kit (Adapts to JE200)	12.95
JE210	5-15V / .8-1.5 Amp Regulated Power Supply Kit	19.95
JE212	Neg. 12VDC Adapter Board Kit (for JE610)	5.95
JE215	Adjustable Power Supply Kit (Pictured above center)	24.95
JE300	Digital Thermometer Kit	39.95
JE305	Solar Cell Panel Kit	39.95
JE600	Hexadecimal Encoder Kit	59.95
JE610	ASCII Encoded Keyboard Kit	79.95
JE701	6-Digit (.300") Clock Kit (Pictured above right)	19.95
JE730	4-Digit (.357") Clock Kit (Pictured above left)	14.95
JE747	6-Digit (.630") Clock Kit	29.95
JE2206B	Function Generator Kit (Pictured below right)	19.95

CAPACITORS

Dipped Tantalum		ELECTROLYTIC	
.1mfd @ 35V	2/.89	1mfd @ 50V	3/.65
.47mfd @ 35V	2/.89	4.7mfd @ 50V	2/.59
1mfd @ 35V	2/.89	10mfd @ 50V	2/.69
2.2mfd @ 25V	2/1.09	22mfd @ 50V	2/.79
3.3mfd @ 25V	2/1.19	47mfd @ 50V	2/.89
4.7mfd @ 25V	2/1.39	100mfd @ 50V	.59
10mfd @ 25V	1.19	220mfd @ 50V	.69
33mfd @ 25V	3.95	1000mfd @ 25V	1.19
100V MYLAR		2200mfd @ 16V	1.39
.001-.01mfd	4/.79	**50V CERAMIC**	
.022mfd	4/.89	10pf-.022mfd	4/.59
.047mfd	4/.99	.047mfd	4/.69
.1mfd	4/1.19	.1mfd	4/.79
.22mfd	4/1.29		

CONNECTORS

DB25P	D-Subminiature Plug	3.95
DB25S	D-Subminiature Socket	4.95
DB51226	Cover for DB25P/S	2.25
22/44SE	P.C. Edge	2.95
UG88/U	BNC Plug	2.19
UG89/U	BNC Jack	3.95
UG175/U	UHF Adapter	.59
SO239	UHF Panel Recp.	1.49
PL258	UHF Adapter	1.95
PL259	UHF Plug	1.95
UG260/U	BNC Plug	2.39
UG1094/U	BNC Bulkhead Recp.	1.49

MICROPROCESSORS

Z80A	CPU (4MHz)	13.95
1173AN-1	30 Tune Musical MPU Chip	8.95
8080A	CPU	6.95
8212	8 Bit I/O Port	3.95
8216	Bi-Directional Bus Driver	4.49
2513/2140	Character Generator	12.95
8T97	Tri-State Hex Buffer	2.25
AY-5-1013	30K Baud UART	6.95
AY-5-2376	88-Key Keyboard Encoder	11.95
2114-2	4K Static RAM (200ns)	3.95
MK4116	16K Dynamic RAM (250ns)	3.95
2708	8K EPROM	5.95
2716	16K EPROM (+5V)	9.95

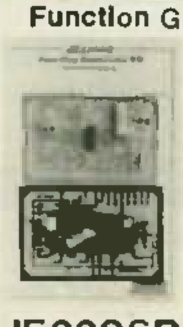
GRAB BAGS

GB100	Ceramic Disc Capacitors	(100)	$2.95
GB101	Mylar Capacitors	(50)	4.95
GB102	Electrolytic Capacitors	(50)	4.95
GB103	Tantalum Capacitors	(40)	4.95
GB107	Silicon Diodes (1N914/1N4148)	(100)	2.95
GB108	TTL Series Integrated Circuits	(50)	4.95
GB109	Linear Integrated Circuits	(30)	4.95
GB110	Assorted LEDs	(100)	5.95
GB113	Miniature Trimmer Pots	(30)	4.95
GB116	1/4 Watt Resistor Assortment	(200)	2.95
GB117	1/2 Watt Resistor Assortment	(200)	2.95
GB120	Miniature Slide Switches	(25)	3.95
GB123	Heat Sinks Assortment	(30)	3.95
GB127	Transistors Plastic/Power	(100)	3.95
GB137	Chokes, Coils and Inductors	(50)	3.95
GB139	3-8 Terminal Solder/Screw Type	(40)	3.95
GB140	Spacers, Standoffs, Insulators	(150)	2.95
GB141	Washers and Spacers	(200)	2.95
GB145	Lugs, Crimp On	(100)	2.95
GB147	Hardware Mix — Nuts, Screws, etc.	(500)	5.95
GB154	1 & 2 Watt Resistor Assortment	(100)	2.95
GB162	7-Segment Displays	(50)	5.95
GB165	Toggle, Rocker, Push Button Switches	(40)	10.95
GB173	U Test & Sort 3/8" Potentiometers	(100)	5.95
GB175	1 & 3 Amp Silicon Rectifiers (Diodes)	(100)	3.95
GB177	Shrink Tubing — Assorted 1" pieces	(200)	3.95

LINEAR

LM301N	.59	LM7805T	1.75
LM305H	1.39	LM7812T	1.75
LM307N	.75	LM7815T	1.75
LM308N	1.19	LM380N	1.49
LM309K	2.25	LM384N	2.49
LM310N	2.69	LM555N	.69
LM311N	1.49	LM556N	1.49
LM317T	2.29	LM565N	1.95
LM318N	2.95	LM566N	1.95
LM319N	2.95	LM567N	1.79
LM320K-5	2.25	LM723N	.79
LM7905T	1.75	LM741N	.65
LM7912T	1.75	LM1310N	2.95
LM7915T	1.75	LM1458N	.99
LM323K	5.95	LM1488N	1.59
LM324N	1.29	LM1489N	1.59
LM337T	2.29	LM1800N	4.49
LM339N	1.29	76477N	3.95

Function Generator Kit



Provides 3 basic waveforms: sine, triangle and square wave. Freq. 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

CIRCLE 71 ON FREE INFORMATION CARD

LONG-PLAY cassette recorder, 1½ pounds, with two slow speeds for recording up to 15 hours on a single standard C-180 tape! Unbelievable sensitivity and voice fidelity. Takes telephone recording and voice activator accessories. Perfect for professionals, students, security personnel. Excellent for radio and TV, security monitoring, home surveillance, lectures. Free brochure. **EXTENDO-TAPE SYSTEMS**, Box 16000LC, Temple Terrace, FL 33687

REVERBERATION for organs and keyboards — Simply connected to any electronic organ, even those with multiple outlet channels. Room size and reverberation time adjustable. Nothing comparable in this price range is offered on the market. Send for free brochure. **DEVTRONIX ORGANS, INC.**, Dept 60, 6101 Warehouse Way, Sacramento, CA 95826

SATELLITE Buffs: used 6, 10, and 16 ft parabolic antennas for sale. Muchmisc. Call days: (216) 871-5552; evenings (216) 779-8539

MICROWAVE and other TV equipment. Catalog 20c, manual $1. **TROJAN ENTERPRISES**, 2920 Shelby, Indianapolis, IN 46203

FREE Flyer! Electronic components, IC's, LED's, etc. Send SASE to **SYSTECH**, Box 18905, San Jose, CA 95158

MICROWAVE TV units complete—1 year warranty. $150.00. **MEC.** Box 3123, Tempe, AZ 85281. Dealers Wanted.

POLICE scanner owners attention: Police 10 code, fire department code. Send $4.00. **ROBERT TURRIN**, P.O. Box 1562, Clifton, NJ 07011

FOR sale—TV-VCR shop test equipment and inventory. RCA, Zenith, GE, Philco modules and parts. Bargain price. Send SASE for complete list. **DON DEMARCO** 5687 Billmyer, Tecumseh, MI 49286.

ADVANCED technological devices. Computer to human brain interfaces, talking watches, satellite home earth stations, lasers and many more **amazing** products. Send **$2.00** for catalog to: **TECHNOTRONICS, PO** Box 2643, Winter Park, FL 32790

CAR stereo graphic equalizer amplifier, 110 watt, 7-band equalizer, with LED power meters. Factory fresh and pretested. $45.00. Free acknowledgment of delivery. Send money order to **J. COOK**, 1381 North Sereno Circle, Bountiful, UT 84010. Plus $2.70 shipping.

BOB'S TV does it again! Six hour VHS taps only $130 for a box of ten. **BOB'S TV**, 93-15 86 Drive, Woodhaven, NY 11421

CIRCLE 73 ON FREE INFORMATION CARD

ramsey the first name in Counters!

9 DIGITS 600 MHz $129.95 WIRED

PRICES

CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC Adapter/Charger	12.95
OV-1, Micro power Oven time base	49.95
External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include: three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally: an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as, three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED

PRICES:

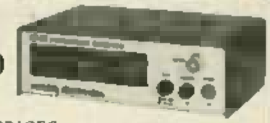
MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat. Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED



NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack + AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include: 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts	100uV to 1 KV, 5 ranges
DC/AC current	0.1uA to 2.0 Amps, 5 ranges
Resistance	0.1 ohms to 20 Megohms, 6 ranges
Input impedance	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

ramsey electronics, inc.
2575 BAIRD RD. • PENFIELD, NY 14526

PHONE ORDERS CALL 716-586-3950

TERMS: Satisfaction guaranteed ... examine for 10 days if not pleased return in original form for refund. Add 5% for shipping, insurance to a maximum of $10. Overseas add 15%. COD add $2. Orders under $10 add $1.50. NY residents add 7% tax.

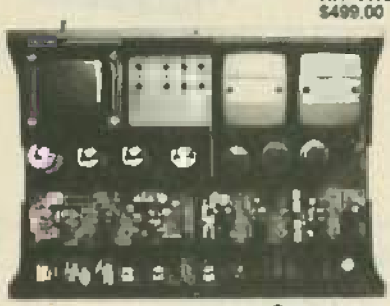
CIRCLE 69 ON FREE INFORMATION CARD

FUJITECH AUDIO KITS

LATEST AUDIO TECHNOLOGY FROM JAPAN

Model A1033 Integrated Tube Amplifier
- Latest Japanese Design
- Distortionless Output Transformer using special winding techniques
- Most circuitry on PCB for easy assembly and humfree performance
- Output 30W × 2 Ultra Linear (Switchable to Triode) 15W × 2 Triode Output (near class A performance)
- THD under 0.4%
- Frequency Response 30~30,000 Hz (-1dB)
- Separate Pre-Out and Main-In

KIT ONLY $499.00



$499.00

Model A501 Power Amp
- Pure Class A 25W + 25W
- Switchable to Class AB 100W + 100W
- Switchable to Bridge Class A 100W mono
- Switchable to Bridge Class AB 300W mono
- Frequency Response 5-200KHz (-1dB)
- Signal-to-Noise Ratio 120dB
- Non-magnetic Chassis
- "Out-board" comprehensive protection circuitry
- DC circuitry with limited use of NFB
- High Efficiency Fluid Convection Cooling
- THD under 0.007%

KIT ONLY $299.00

$299.00

Model A502 DC Stereo Control Center
- Direct DC coupling from Input to Output
- DC servo circuitry
- Cascade FET Input in all stages
- Separate Moving Coil RIAA amplifier
- Distortion below 0.005% (3V)
- Max Output 15V
- Frequency Response 20Hz-20KHz ±0.2 dB
- Maximum Phono Input
  MC = 16mv RMS (1KHz)
  MM = 270mv RMS (1KHz)
- Built-in Headphone amplifier
- Relay Output Muting

KIT ONLY $349.00

$349.00

Send $5.00 for each assembly manual, refundable with order.

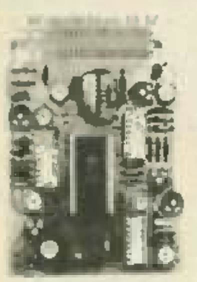
Monarchy Engineering, Inc.
380 Swift Avenue, Unit 21
South San Francisco, CA 94080

Visa or Mastercharge acceptable.

BULLET ELECTRONICS

P.O. BOX 401244R
GARLAND, TX. 75040
(214) 278-3553

Sound Effects Kit $18.50



7 Watt Audio Amp Kit $6.95

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" × 2" PC BOARD (INCLUDED) RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN ½% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.

Doomsday Alarm Kit $9.95

If you have trouble sleeping and you would like the rest of the neighborhood to share your misery then this little kit will be for you! There is no way to accurately describe the unearthly howls, screams and tones that come out of this kit. Four separate tone oscillators are mixed, cancelled and stepped at a varying rate. 10 Watts of crazy sounds. A great fun kit or a practical burgler alarm. Complete with PC board and all necessary components less speaker. For 6-12 VDC. ORDER DA-02

New! 3TZ Time Zone Clock Kit

Microprocessor/ROM clock kit keeps local time (12 hour format) and 2 world time zones (24 hour format). Large .6" ORANGE readouts. 10 min. ID timer for HAMS. Comes complete with attractive plastic case and wallplug XFMR.

$54.40

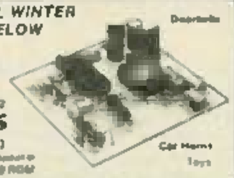
SEE SPECIAL WINTER PRICES BELOW

The Super Music Maker

REVISION 2

$24.95

(Basic Kit)



Now you can play hundreds of songs using the Bullet Super Music Maker. The unit features a single factory programmed microprocessor IC that comes with 20 pre-programmed short tunes. By adding the additional PROMS (2708's) the system can be expanded to play up to 1000 notes per PROM. Just think ... a compact electronic instrument that will play dozens, hundreds or even thousands of selections of music. The kit comes with all electronic components (less the PROM), and a drilled, plated and screened PC Board which measures 4" × 4½". The 7 watt amplifier section is on the same PC board and drives an 8 ohm speaker (not included) from a whisper to ear splitting volume. Since the unit works on 12 VDC or 12 VAC, vehicle or portable operation is possible. What do you get for $24.95? Everything but a speaker, transformer, case, switches, and PROM. Additional 2708 albums containing popular tunes are available for $5.95 each or you can program your own PROMS using information provided with the kit instructions. Lists of available PROM albums are available on request. (Note Unit plays electronic music one note at a time, it is not possible to play chords or a melody with harmony simultaneously.)
- Envelope control gives decay to notes
- On board inverter allows single voltage (+12) operation

OPTIONAL ACCESSORIES

DIP Switches (One 8 pos., One 5 pos.) (Can be directly soldered to PC Bd. to access tunes)	
Rotary Switches Two 5 position (For remote wiring to PC Bd. to access tunes)	2.50/set
Attractive Tan Plastic Case	6.00
Wallplug Transformer (For operation on 117VAC house voltage)	3.00

SPECIAL WINTER PRICES

1. Super Music Maker with case and two 5-position rotary switches	$33.00
2. Super Music with one 2716 2K × 8 PROM filled with over 50 selections of additional music (... 1500 notes)	$32.00
3. The Whole Ball of Wax #2 + case and switches	$37.95

A FEW THINGS ON THE SIDE

CA3000 TRANS COND AMP	DUAL PHOTO RESISTOR 3/8" DIA.	3/1.00
TLO-83 DUAL BI-FET AMP	2" 8 OHM SPKR. 25 W	2/1.00
CD4046 CMOS ÷ 50/60 CNTR	AY 3-8910 SOUND EFFECTS	11.00
MC3301 QUAD OP AMP (HSE #)	80 PAGE MANUAL FOR ABOVE	2.00
FPT500 PHOTO TRANSISTOR	JUMBO RED LED ASST STYLES	20/1.00
TIP 100 NPN DARL 2A IC	10103 SENSITIVE GATE SCR	3/1.00

SUPER SPECIAL DEAL!
STANDARD C-60 CASSETTE NEW IN PLASTIC CASE & TOP QUALITY
ORIG. USED IN DIGITAL APP
FREQ. RESPONSE 30Hz - 10KHz
3/3.50

ORDERING INFORMATION:
Call or Write For Free Catalog

- COD MINIMUM $20.00 • ADD $2.00 FOR COD's
- UPS DELIVERY ADDRESS MUST ACCOMPANY ALL COD ORDERS
- VISA, MC CARDS OR CHECK
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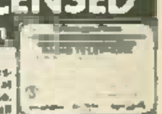

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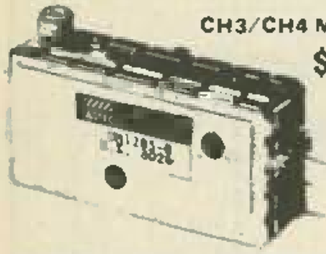

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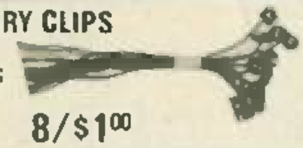

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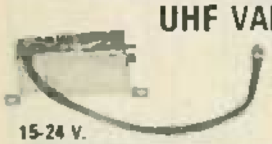

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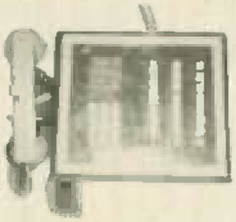

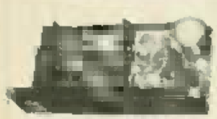

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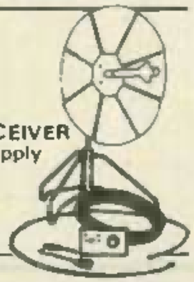

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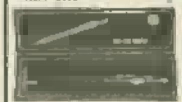

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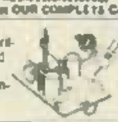

Complete variable rate strobe light kit produces brilliant flashes of light. Operates from standard 120VAC. Reliable design — thousands of these are in use throughout the world. Overall size of completed board 3"L x 2"W x 3"H

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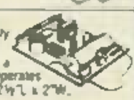
Push the start button and a bright red ball (LEDS) appear to spin around ten numbers. When you release the button the electronic ball appears to slow down and finally comes to a stop on one number. As the ball spins a small speaker emits a ticking sound in synchronization. Unit operates from 9V battery. Size of board 2.9" x 2.6". C3096 $9.99

3VDC ELECTRONIC WARNING FLASHER KIT



This portable battery operated device continuously emits bursts of intense light at a fixed repetition rate. Can be seen for great distances making it a great safety device. Features xenon flashtube. Operates on 3VDC (two 1.5V Batteries). Size of board 2½"L x 2"W.

C3207 $7.00

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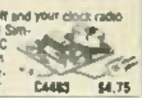

Have you ever been late because the AC went off and your clock radio didn't work? Well, that need not happen again! Simply plug this unit into the wall outlet and if the AC goes off the unit emits a tone. Features green ready light and piezoelectric tone device. Operates on 9V battery. Size of board 2.8" x 2.3"

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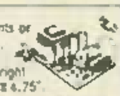

Reliable IC design kit for use in physics experiments or troubleshooting. Optically stops motion of fans, wheels, pullys, flywheels, etc. The stroboscope operates from standard 120VAC and features bright xenon flash tube and IC design. Size of board 3.5" x 4.75".

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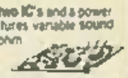

Kit provides a loud alternating tone output. Uses two IC's and a power transistor to provide a reliable performance. Features variable sound control and 6 to 12VDC operation. Requires 8 ohm speaker. Size of board 3.5" x 1.5"

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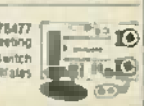

Exciting sound effects kit uses the popular TI76477 chip to develop phasor, locomotive, siren, tweeting bird, organ, Model T, etc. sounds. Uses dip switch for simple programming of the generator. Operates from 9V battery. Size of board 3.25" x 2"

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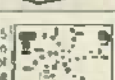
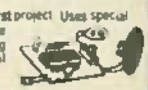


Produces an "exploding star" visual effect using 25 LEDS and IC circuitry. The center LED lights first then the next group of LEDS light and then another set of LEDS until the outer edge of the star lights up. The process then reverses itself. Operates from 9V battery. C4432 $16.95

PHASOR GUN SOUND AND LIGHT KIT



Here is a simple kit which makes an excellent first project. Uses special IC, darlington transistor and LED to produce "outer space phasor gun" sound and flashing red light. Operates from 9V battery. Size of board 1" x 1.2"

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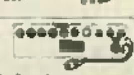
SEQUENTIAL LED FLASHER KIT



This kit combines IC circuitry and 10 jumbo red LEDS to produce a unique visual display. LEDS continuously light sequentially from right to left. Easy to build kit. Operates from 9V battery. Size of board 5.25" x 1.5".

C4431 $6.75

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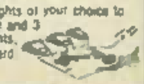

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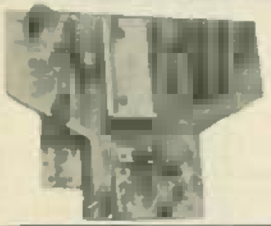

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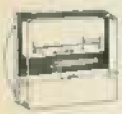

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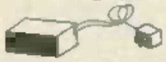

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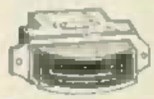

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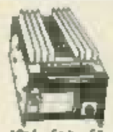


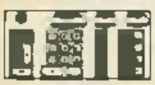
MFG by ACDC Electronics Inc. Model OEM 24N5.4-1

10" l x 5" h x 5" w

Input 105-125 vac 50/60 Hz. Has volt adj and O.L. adj. Output terminals contain + out, + sen, - sen, - out, ac neut, ac line and GND 13 LBS. **$45.00**

SAME AS ABOVE EXCEPT 24 VOLT 7 AMP **$65.00**

TEXAS INSTRUMENT KEYBOARD



$1.95 ea.
5/**$8.00**

Has 3 slide switches, 26 different keys, key pad removable by 4 screws

MUFFIN FANS

MFG By Rotron Inc.
3 Blades 4¾" Square
USED
110 VAC **$5.95 ea**
NEW
110 VAC Model MU2A1
$12.00 ea.

DB CONNECTORS

25 P **2.50**
25 S **3.50**

COVER FOR DB2 SP/S (PLASTIC) **1.25**

TRIMMER CAP

1.5-20pf

(ARCO PC-402) **50¢ ea**

REMOTE 40 CH. C.B. SPECIAL

NEW HYGAIN 16 MODEL 2716
HANDSET HAS DIGITAL CLOCK
PLASTIC CASE FOR REMOTE NOT INCLUDED. SOLD AS IS **$29.95**

MODEM CABLE ASSEMBLIES

$5.50 ea

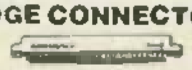
Conn & Hood	22 AWG # Cond	Length
25 P	14	15'
25 S	10	17'

C & K SWITCHES

Part #		Movement
J-60	7101	SPDT
L-3	7108	SPDT (momentary)
J-3	7201	DPDT (special large rocker)

$1.00 ea 6/$5.00

EDGE CONNECTORS



Double Row / Wire Wrap .100
22 pins $3.49 10/$30.00
30 pins $3.96 10/$32.00
50 pins $5.43 10/$45.00

Double Row / Solder Eyelet .156
6 pins $1.10 10/$ 9.00
15 pins $1.65 10/$12.50
22 pins $2.08 10/$17.00
43 pins $3.66 10/$30.00

DIP SOLDER IC SOCKETS

14 pin	$.14
16 pin	.16
18 pin	.18
20 pin	.20
24 pin	.24
40 pin	.40

DIP SWITCH

5 POSITION **$1.00 ea**
8 POSITION **$1.50 ea**
10 POSITION **$2.00 ea**
12 POSITION **$2.50 ea.**

7' POWER CORD

HEWLETT PACKARD TYPE

Molded 3 Prong Plug with molded receptacle Belden 16 AWG
$3.00 ea

IC SOCKETS GOLD-PLATED WIRE WRAP

14 pin **40c ea**
16 pin **45c ea**

TERMS: All material guaranteed unless otherwise stated. If you are not satisfied with our product, it may be returned within 10 days for a refund (less shipping). Please add $4.00 for shipping and handling on all orders. COD's accepted for orders totaling $50 or more. All orders shipped UPS unless otherwise specified. Florida residents please add 4% sales tax. Minimum order $15.00. Foreign orders - US funds only, add 20% for shipping and handling.

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UTC MINI STEREO FM RECEIVER WITH HEADPHONES

For Joggers, Cyclists, and Skaters!

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3½" x 4½" x 1". Wt. 6 oz.

Model 1810 List Price $89.95 ...... **$29.95**

SPEAKERS

	1	10
Part# A0201	1.25	.99

2¼" Round — 8 Ohm
.25 Watt (4" Leads)
Size: 2¼" x ¾"

	1	10
Part# SF-25016	1.39	1.25

2½" Square — 16 Ohm
.25 Watt (4 mount. holes)
Large Ceramic Magnet
Size: 2½" x 2½" x ¾"

National Semiconductor RAM SALE

STATIC RAMS

MM2114N-2 4K (200NS) .... $2.49 each
MM2114N-2L 4K (200NS) Low Power .... $2.95 each
MM2147H 4K (70NS) .... $4.95 each
MM6116P-4 16K (200NS) .... $14.95 each

DYNAMIC RAMS

MM4164N-20 64K (200NS) .... $14.95 each
MM5290N-2 16K (150NS) 4116 .... $2.95 each
MM5290N-4 16K (250NS) 4116 .... $1.95 each

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-11EL Replacement Bulb $16.95

UVS-11E $79.95

JOYSTICKS

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in [illegible]	$4.95

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- 105cfm free air delivery
- 4.68" sq. x 1.50" depth. Weight - 17 oz.
- [illegible] rating as low as NC-35
- more than 10 yrs. cont. duty at 15°C
- impedance protected
- for ambients to 70°C
- UL yellow card recognized & CSA approved

115V, 50/60Hz, 14 Watts, 105cfm — Ultrasonically cleaned & tested.

MU2A1 .... $9.95 ea.

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. ±2VDC to 15VDC.
- Power Output (each supply) 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 600mA, and 15VDC @ 175mA.
- Two, 3 terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3 1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) .. $24.95

(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) .. $14.95
JE205 Adapter Brd. (to JE200) ±5, +9 & ±12V. $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp. $18.95

MICROPROCESSOR COMPONENTS

8080A/8085A SUPPORT DEVICES — [illegible]

6800/6800 SUPPORT DEVICES — [illegible]

MICROPROCESSOR CHIPS — [illegible]

SHIFT REGISTERS — [illegible]

DATA ACQUISITION — [illegible]

DATA ACQUISITION (CONTINUED) — [illegible]

RAM'S — [illegible]

PROMS/EPROMS — [illegible]

ROM'S — [illegible]

NMOS READ ONLY MEMORIES — [illegible]

MICROPROCESSOR MANUALS — [illegible]

SPECIAL FUNCTION — [illegible]

TELEPHONE/KEYBOARD CHIPS — [illegible]

EECO Rocker DIP Switch — "Mini-Dipro" 2400 Series

THE MOST UNIQUE DIP SWITCH AVAILABLE! [illegible]

[illegible table]

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CAPACITORS — [illegible]

INTEGRATED CIRCUITS — [illegible]

LEDS — LAMPS — READOUTS — [illegible]

POTENTIOMETERS — [illegible]

DIODES — [illegible]

RESISTORS — [illegible]

SWITCHES — [illegible]

HARDWARE — [illegible]

MISCELLANEOUS — [illegible]

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[illegible]

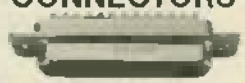
AC and DC Wall Transformers

With Universal Plug and 9V Battery Snap

Selective voltages 6,9,12VDC. Polarity selection (+ A), six-foot line from adapter to plugs — six inch line from adapter to battery snap. 120V/60Hz 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	8VAC 1.7 amp	$5.95
DC 800 (Ni-Cd charger)	120V/60Hz	9VDC 400mA (Ni-Cd charger)	$2.95
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	[illegible]
DV9300	117V/60Hz	9VDC 300mA	$3.25
DC900	120V/60Hz	9VDC 500mA	[illegible]
DC1200	120V/60Hz	12VDC 300mA	[illegible]

CONNECTORS



DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.75
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .40
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K
Kit comes complete with:

- 8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)
- Documentation for conversion

TRS-16K2 *150ns 19.95
TRS-16K3 *200ns 16.95
TRS-16K4 *250ns 14.95

KEYBOARDS

Datanectics 74-Key Keyboard

Uses EA 3013A Chip (Electronic Arrays). Size: 16¾"L x 5¾"W x 1-3/8"H. White, black, blue, grey key caps. (No Data Sheet) —

Part No. KB354 .... $29.95 ea.

Micro Switch 69-Key Keyboard

Uses AMI S9000. Chip. Size: 16-3/8"L x 5⅛"W x 1-5/8"H. Metal Frame. Light & dark grey key caps. (No Data Sheet)

Part No. KB69SD12-2 .... $19.95 ea.

Boschert Multi-Voltage Power Supply

5VDC, 12VDC and 24VDC

FEATURES: Voltages* 5VDC @ 25amps, 12VDC @ 4amps, & 24VDC @ 4amps. Reg. Load: +5V out ±1%, +12 & 24V out ±5% (20-100% load). Overvolt. & overcur. protection. 115 or 230VAC input. Wt. 4 lbs. Size: 4.5" x 2.8" x 11.5".
*Total average output shall not exceed 200 watts.

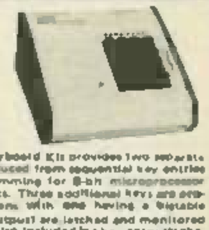
General Description: The "Boschert" Power Supply was originally designed for application with ITT Advance Terminal Corporation (ATC). This open frame switching power supply provides units with high current requirements common to use with computer systems. Its compact size provides versatility for mounting into electronic enclosures. Each supply has 8 threaded fasteners (mm) and types for mounting. Specification requirements to be used with ATC enclosed.

Part No. 200-3010 .... $69.95 each

— MANY OTHERS AVAILABLE • WRITE FOR INFORMATION —

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



"The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 2 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-definable keys with one being bistable operation. Debounce circuit provided for all 19 keys. 2 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 6¾"D

JE600/DTE-HK (After assembled as pictured above) $99.95
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. $59.95
K19 19-Key Keyboard (Keyboard only) $14.95
DTE-HK (case only — 3½"Hx8¼"Wx6¾"D) $44.95

CIRCLE 63 ON FREE INFORMATION CARD

PAT. # 4,259,705

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Low Power 95

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Low Power 2.75 8/17.95

HM6116P-4-2KX8 • 5v-200 n.s.
CMOS Low Power 2716
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TMM2016-2KX8 • 5v-NMOS
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MK4104J-4 250NS
4K x 1 STATIC 18 PIN CERAMIC
Computer Mfg Surplus PRIME. Fully Static. Easy to Use. Has Same Pin Out as TMS4044 but slightly different timing With Specs. (Mostek)

4 for 12.00 32 for 39.95
VERY LOW POWER!

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4KX1 22 Pin 1.59

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*2716 2KX8 +5v 450 n.s. 5.95
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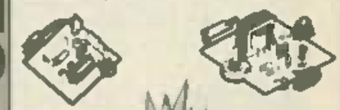
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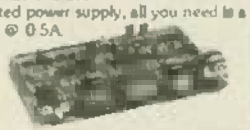
LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz-100KHz ± 0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation! Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ± 0.5dB • RIAA deviation: ± 0.2dB • S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level 1.3V • Max output: 15V • Tone control: bass ± 10dB @ 50Hz/treble ± 10dB @ 15Hz • Power supply: ± 24 D.C. @ 0.5A

Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A.



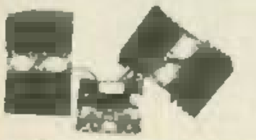
ONLY $44.50
Xformer
$4.50 ea.

100W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear. 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

- Output power: 100W RMS into 8-ohm 125W RMS into 4-ohm
- Frequency response: 10Hz-100KHz
- T.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: IV max.
- Power supply: ± 40V @ 5 amp
- One channel, needs two for stereo



TA-1000KIT
$51.95
Power transformer
$24.00 each

50 WATTS AUTO STEREO BOOSTER BY VERTRONIX

Specifications:

- 50 watts RMS total (25W + 25W)
- Frequency Response: ± 0.5dB, 20Hz ~ 20KHz
- T.H.D.: 0.2% at full rated output
- Input Impedance: 20K ohms
- Crosstalk: Better than 90dB
- Sensitivity: 1.5V for full rated output
- S/N Ratio: Greater than 95dB
- Speaker Load: 2 ~ 8 ohms
- Voltage Supply: 9 ~ 18V D.C.

Model V-Amp 500
REG. PRICE $119.00 EACH
OUR SPECIAL PRICE $55.00 EACH

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)

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

Super Buy Only $18.50

5W AUDIO AMP KIT

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

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9 ~ 15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

BUY 2 FOR $4.99

1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 ~ 9V D.C.

SPECIAL PRICE $1.95 ea.

NEW MARK III 9 Steps 4 Colors LED VU

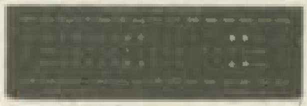
Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large from −30dB to +5dB. The Mark III indicator 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!

IN KIT FORM $18.50

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from −36dB – +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 – 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

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



MARK IV KIT
$31.50

MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

All functions same as Mark IV but this is with heavy duty aluminum front plate and case. Can be easily slot into the front panel of your auto, truck or boat. Operates on 12V DC.

$41.50 EACH KIT

SOLID STATE STEREO GRAPHIC EQUALIZER PRE AMP KIT TA-2500

Specifications:

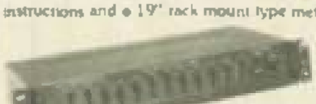
- Total Harmonic Distortion: Less than 0.05%
- Intermodulation Distortion: (70Hz 7KHz = 4:1 SMPTE Method) Less than 0.03%
- Frequency Response: Overall 10Hz ~ 100KHz +0.5dB, −1dB
- RIAA Curve Deviation: (Phono) +0.2dB, −0.2dB (30Hz ~ 15KHz)
- Channel separation (at rated output 1KHz)
- Phono, Tuner, Aux and Tape Monitor better than 70dB
- Input sensitivity and impedance (1KHz for rated output)

Phono: 2MV 47K ohms   Aux: 130MV 50K ohms
Tuner: 130MV 50K ohms   Tape: 130MV 50K ohms

Graphic Equalizer control: 10 Band Slide Control. Frequency Bands: 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz also with on panel selector for Phono, Tuner, Aux 1 and Aux 2.

Power Supply: 117 VAC

Kit comes with all electronic components, transformer, instructions and a 19" rack mount type metal cabinet.



MODEL TA-2500
$119.00 PER KIT

ELECTRONIC DUAL SPEAKER PROTECTOR

Cutt off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM **$8.75 EA.**

PROFESSIONAL REGULATED VARIABLE D.C. POWER SUPPLY KIT

All solid state circuitry with high efficiency power transistor 2SD388 and I.C. voltage regulator MC1733. Output voltage can be adjusted from 0-30V at 1 amp current limited or 0-15V at 2 amp current limited. Internal resistance is less than 0.005 ohm, ripple and noise less than 1 MV, dual on panel meter for voltage and amp reading, also with on board LED and audible over load indicator. Kit comes with predrilled P.C. board, instructions, all necessary electronic components, transformer and a professional look metal cabinet. The best project for school and the most useful instrument for repairman. Build one today!

MODEL TR 88A 0 ~ 15V D.C. 2 amp
MODEL TR 88B 0 ~ 30V D.C. 1 amp

$59.50 PER KIT

REGULATED DUAL VOLTAGE SUPPLY KIT

± 4 ~ 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

$12.50 PER KIT

POWER SUPPLY KIT

0-30V D.C. REGULATED

Uses UA723 and 2N3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts. Tranformer for Power Supply, 2 AMP 24V x 2 $9.50

0-30 Power Supply
$10.50 each

TA-323 6 WATTS TOTAL 30W + 30W STEREO AMP KIT

This is a solid state all transistor circuitry with on board stereo pre amp for most microphone or phone input. Power output employs 2 pairs matching Darlington Transistors. Driven by the popular 2N3053 Driver Transistors. Four built on board controls for, volume, balance, treble and bass. Power supplies requires 48 VET 2.5 amp transformer. T.H.D. of less than 0.1% between 100 Hz and 10KHz at full power. (30 Watts + 30 Watts loaded by 8Ω).

★ SPECIAL ★

EXCELLENT PRICE!

MODEL 001 0034
Transformer (Optional)
$29.50 PER KIT
$10.50 EACH

200 WATTS CLASS 'A' STEREO POWER AMP KIT TA-2600 (WITH LED POWER LEVEL DISPLAY AND RACK MOUNT TYPE CABINET)

TA-2600 is a kit that combines two sets of TA-1000 class A power amplifiers that can give you 100 watts of true power per channel. The kit also has the latest "V" shape LED power level display with memory Peak Hold on the front panel. For speaker protection it also has separate electronic speaker protection circuits. Kit comes with the 19" rack mount type metal cabinet with a professional quality black anodized front panel, all electronic parts and components, P.C. boards, filter capacitors and a heavy duty transformer.

Specifications:

- Power Level Display: Electronic LED type, 12 LED per channel from − 18 dB to 0 dB with Peak Hold memory
- Power Amplifier: Output power 100 Watts per channel into 8 Ohm load; 125 Watts into 4 Ohm load. Total Music power output 250 Watts Max
- Frequency Response: 10 Hz to 100 KHz
- Total Harmonic Distortion: Less than 0.008% at full power
- Signal/Noise Ratio: better than 80 dB
- Input Sensitivity: 1V Max

MODEL TA-2600
$225.00 KIT FORM
$285.00 FULLY ASSEMBLED

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MC 1358	$2.50	LM 7815	$1.20
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LM 380	$2.00	Matching Transformer	$1.40
Sanyo UHF Tuner	$35.00	Toinod Coils (Set of 4)	$3.00
Capacitors Set	$12.50		
Resistors Set	$2.00	Speaker Cabinet	$12.95
Trim Pots, Trim Caps Set	$13.50	Transformer 18V 800MA	$3.00
Pots and Knobs	$2.00		

We sell you all the above components in a package for **$125.00** and you will receive a free predrilled P.C. board and instructions at no charge!

SANYO UHF VARACTOR TUNER

For UHF CH 14 — 83

Tuning voltage +1V~+28V D.C. Input impedance 75 OHM. I.F. band width 7~16 MHz. Noise figure 11.5dB MAX. Size 2½" x 1¼" x ¾". Supply voltage 15V DC. Sound I.F. = 58.0 MHz. Video I.F. = 62.5 MHz.

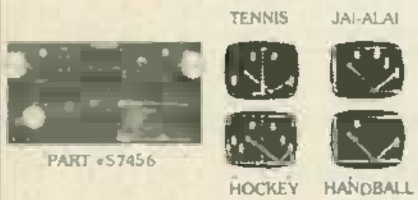
All units are brand new from Sanyo.
MODEL 115-B-405A
$35.00 EACH

Tuner is the most important part for the circuit. Don't let those $19.00 tuners fool you!

TV GAME BOARD

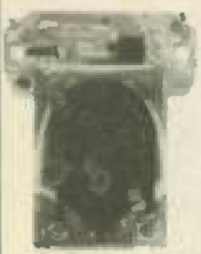
PLAYS 4 GAMES: TENNIS, HOCKEY, HANDBALL AND JAI-ALAI

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets. (Regular price for these games were $39.50 each.) **OUR PRICE ONLY $6.50 EACH**



PART #57456

ELECTRONIC PIN BALL MACHINE



That sounds and plays like the real thing. All units are brand new but without the case. Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.

SPECIAL **$8.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC MUSICAL TELEPHONE REST KIT

This telephone rest can be used as a door charm, an audible indicator and for many other sound projects. The special custom made I.C. is pre programmed with 4 musical tunes. Kit comes with a nice looking plastic case, pre-drilled P.C. board, volume control, special sound I.C. speakers and all electronic components and instructions. Ideal for home or school projects.

MODEL FIH-3000

BUY NOW!

SPECIAL PRICE! ONLY $15.50 PER KIT

DIGITAL TIMER/CLOCK

- 24 Hour preset time to turn on or off
- 12 Hour green 0.5" display for time
- operated on 12~16V A.C.

The whole timer is self contained in a compact plastic case (as seen in photo). Designed for VTR with push button switch for easy setting. Limited quantity available.

NOW ONLY $12.94 MODEL VEQ 0143

SANYO ANTENNA SIGNAL BOOSTER

This Booster is specially designed for UHF Channels (14-83). After installed this unit (between the antenna input cable and the UHF tuner) will have a minimum of 10dB gain, that is approximately 2 times better than what you are seeing now. Ideal for those who live in apartments that cannot put up an outdoor antenna. Size is so small, only 2" x 1½" x 1". Supply voltage is 15 VDC.

★ NEW ITEM ★

MODEL 001-0076

$12.50 EACH

13 FUNCTIONS LCD TIME MODULE

- Displays month, date and day of the week
- Displays hour, minute and second
- AM, PM Indicator
- Alarm 1 and Alarm 2 (Independent)
- 10 Hours Stop Watch
- 12 Hours presettable count down time
- Hour Charm Indicator
- Back light by touch of the switch

MODEL 001-0062
$7.94 EACH

These modules are brand new and made by LITRONIX. Designed for a man's watch. Can be used for many applications. Comes with 2 silver batteries and the ceramic round transducer.

MATCHED PAIR POWER TRANSISTORS BY MOTOROLA

MJ2955 PNP / 2N3055 NPN	150 Watts	BV=60 V	IC=15 A	$3.50 per pair
MJE2955 PNP / MJE3055 NPN	90 Watts	BV=60 V	IC=10 A	$3.00 per pair
MJ15003 NPN / MJ15004 PNP	250 Watts	BV=140 V	IC=20 A	$12.00 per pair

All above parts guaranteed to be prime and come with data sheets.

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These fans are pulled out from used computers. But carefully cleaned by ultrasonic cleaner. All in "like-new" condition. Size 4 11/16" x 1-1/2" x 4 11/16".
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FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

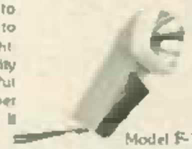
Lights up 8~15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

$6.50 Per Kit

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE! **$3.95 ea.**

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!



Model F-179

CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

No FCC license required.
OUR PRICE **$49.50**
ADDITIONAL MICROPHONE (TRANSMITTER) AVAILABLE AT $28.00 EACH

MURA WMS-49

Transmitter: FET mic for flat 30~18 KHz response extra controlled 49MHz AM Band for drift-free performance. 100 MW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included).
Receiver: Extra controlled locks on 49MHz transmitter signal. With on panel VU meter monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.

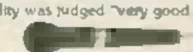
SUPER FM WIRELESS MIC KIT—MARK III

This new designed circuit uses high FEQ. FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condensor microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

FMC-105 **$11.50 PER KIT**

WEM-36 FM WIRELESS MICROPHONE

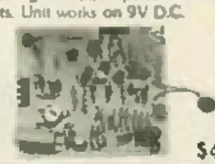
TEET MODEL WEM-36 is a factory assembled FM wireless microphone powered by two AA size batteries. Transmits in the range of 88-108 MHz with 3 transistor circuits to meet with F.C.C. part 15 regulations. Element is built in a plastic tube type case with an omni-directional electret condenser microphone unit. By using a standard FM radio, signal can be heard anywhere on a one-acre lot. Sound quality was judged "very good."



MODEL WEM-36 **$16.50 EACH**

WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted) will turn the switch on, then match your whistle to it again, then it turns off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9V D.C.



MODEL 968
$4.50 EACH

ULTRASONIC SWITCH KIT

Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver, All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC.

$15.50

ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off
uses 7473 I.C. and
12V relay

$5.50 each

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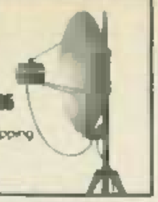

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2716	2048 x 8	(5V) (450ns)	5.50	4.95
2716-1	2048 x 8	(5V) (350ns)	9.00	8.50
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TMS2532	4096 x 8	(5V) (450ns)	12.95	11.95
2732	4096 x 8	(5V) (450ns) (200ns)		CALL
2764	8192 x 8	(5V) (450ns)		CALL

DYNAMIC RAMS

DYNAMIC RAMS				100 pcs
4027	4096 x 1	(250ns)	2.50	2.00
4116-120	16.384 x 1	(120ns)	8/29.95	CALL
4116-150	16.384 x 1	(150ns)	8/18.95	1.95
4116-200	16.384 x 1	(200ns)	8/15.95	1.80
4116-300	16.384 x 1	(300ns)	8/14.95	1.75
4164	64.536 x 1	(200ns)		CALL

STATIC RAMS

STATIC RAMS				100 pcs
2101	256 x 4	(450ns)	1.95	1.85
2102.1	1024 x 1	(450ns)	.89	.85
21L02-4	1024 x 1	(LP) (450ns)	1.29	1.15
21L02-2	1024 x 1	(LP) (250ns)	1.69	1.55
2111	256 x 4	(450ns)	2.99	2.49
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LP = LOW POWER

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74LS03	.25	74LS91	.89	74LS173	.80	74LS352	1.56
74LS04	.25	74LS92	.70	74LS174	.95	74LS353	1.55
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74LS13	.45	74LS112	.45	74LS192	.85	74LS368	.70
74LS14	1.00	74LS113	.45	74LS193	.95	74LS373	99
74LS15	.35	74LS114	.50	74LS194	1.00	74LS374	1.75
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74LS48	.75	74LS153	.75	74LS253	85	74LS670	2.20
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74LS54	35	74LS156	.95	74LS259	2.85	74LS683	2.30
74LS55	35	74LS157	.75	74LS260	65	74LS684	2.40
74LS63	1.25	74LS158	.75	74LS266	.55	74LS685	2.40
74LS73	.40	74LS160	.90	74LS273	1.65	74LS688	2.40
74LS74	45	74LS161	.95	74LS275	3.35	74LS689	2.40
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74LS78	50	74LS164	95	74LS283	1.00	81LS97	1.69
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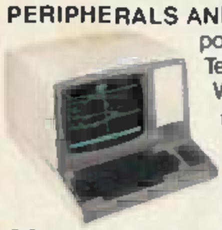

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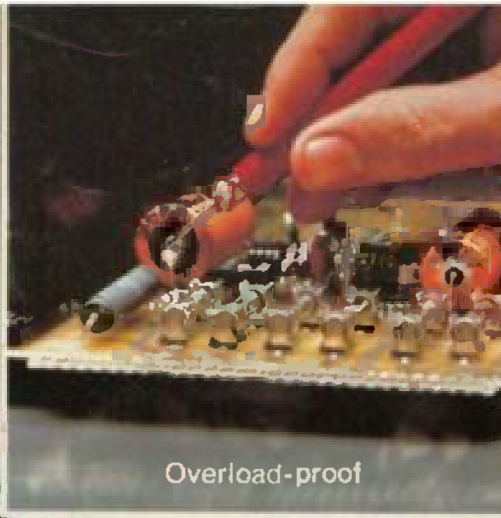

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