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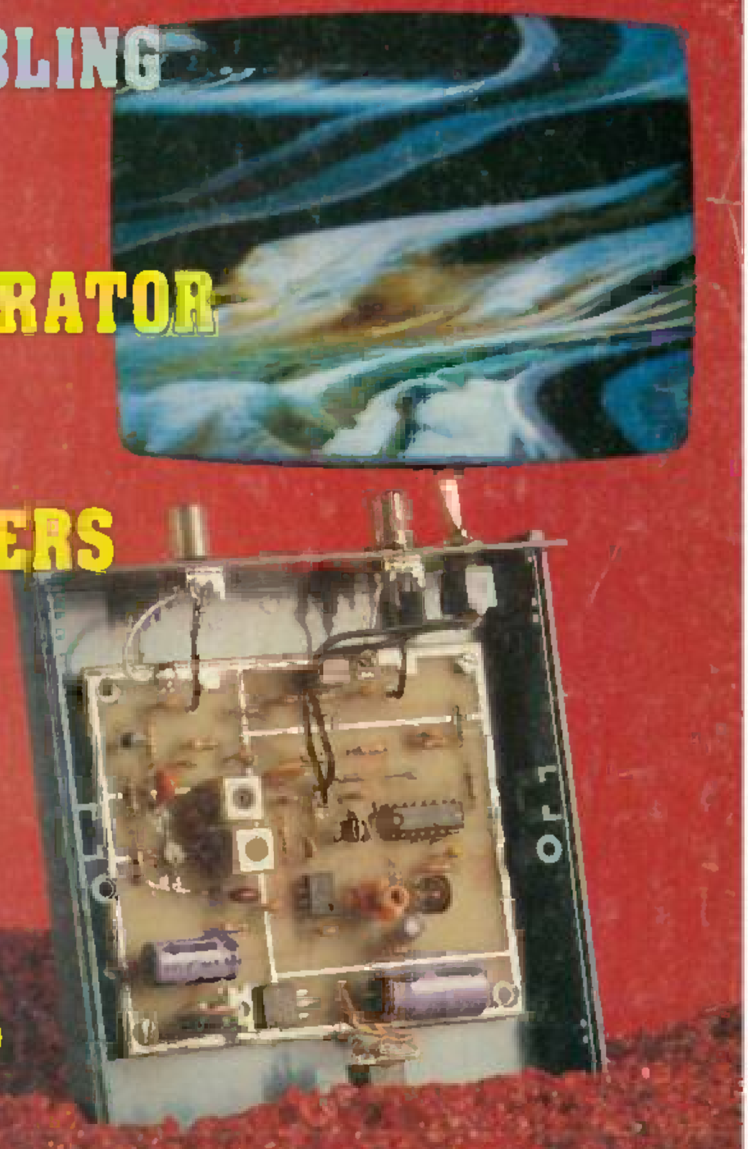

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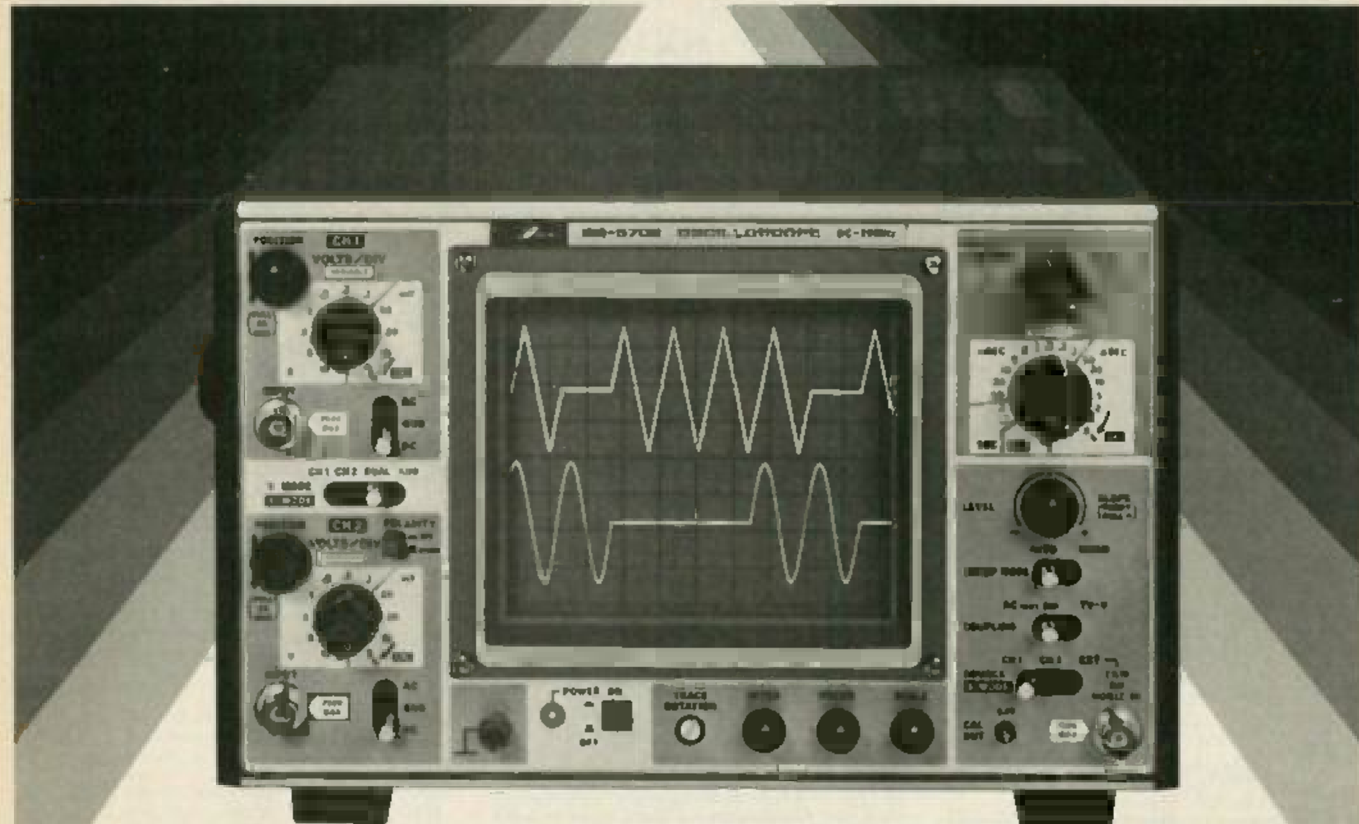

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FEBRUARY 1984 Vol. 55 No. 2

ON THE COVER

To say that cable-TV has undergone tremendous growth over the past few years would be an understatement. One of the biggest reasons for that growth is the presence on cable of first-run movies and live sporting events. Of course, that programming is most often offered as a premium service, which means that the viewer must pay a charge to receive it. To prevent unauthorized reception, the material is scrambled. This month, we'll use an experimental descrambling circuit to illustrate the theory behind the techniques used to encode video signals. The story begins on page 47.

ELECTRIC POWER GENERATION is among the most important areas of electronics. One method of power generation that has received quite a bit of attention is MHD. This month, we'll show you the theory behind that technique and build a working model of an MHD generator. The story starts on page 51.

COMING NEXT MONTH
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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

DIGITAL TV

The digital TV age has arrived. ITT announced at the Berlin show that it would start marketing color sets whose signal-processing was completely digital in October, producing some 30,000 for the rest of 1983 and 400,000 in 1984, converting its entire production to digital in three years. Also in Europe, Grundig, and Blaupunkt plan to start production in 1984 using the same VLSI IC's, made by ITT.

In the U.S., General Electric and Zenith are buying the ITT IC sets and are expected to introduce digital TV sets some time in 1984. Panasonic says it will have digital sets in 1984 as well. It, Sony, and Sharp are also buying the IC's from ITT.

ITT's TV design uses five basic VLSI IC's and two peripheral ones. However, early digital sets won't do much more, if anything, than conventional analog sets. Their main attraction is in their ability to accommodate new features easily, either by means of additional IC's or by programming. Peripheral features will include teletext, ghost-eliminators, "picture-in-picture" (permitting the insertion of a second picture from VCR or videodisc in the corner of the screen), higher resolution through increasing the number of displayed lines, still picture, zoom, picture-improving dynamic comb filtering, multi-standard (PAL-SECAM-NTSC) sets, and so forth.

SELF-PROGRAMMING VCR

Here's another thing you can do with a digital TV set: ITT displayed a simple VCR programming system—still developmental—for use with teletext-equipped digital TV's. The user dials up the teletext page that lists future TV programs and feeds it into the TV set's memory. Then he calls up the page and by means of the set's remote control manipulates a cursor to the program he wishes to record, and pushes the "enter" button.

After he is finished entering all the programs he wishes to record, he can call up a display listing his program recording schedule, in sequence, and the screen will warn him of any impossible situations—such as overlapping programs. Another push of a button and the VCR is programmed.

TV STUDY

A major research project, initially funded at $3,000,000, has been established at MIT to look at the entire American TV system to determine how it can be improved. The study will concentrate on basic research, including such aspects as how people perceive television, developing an ideal display system, and identifying and analyzing changes that will be required in the present TV system to achieve that ideal.

What is particularly unusual about the research is its auspices—a new consortium called the Center for Advanced Television Studies, financed jointly by 10 American companies involved in broadcasting, cable TV, and equipment manufacture, including all four networks. The new combine received an OK from the Department of Justice's Antitrust Division. One of the new group's bylaws limits membership to government agencies and private companies whose ultimate ownership is American. The avowed purpose of the research venture is to head off domination of the American TV industry by foreign companies that get technical research support from their governments. The new group is expected to fund other studies that could lead to a complete rethinking and redesign of the American television system.

VCR UPDATE

Quite possibly the reason that Philips is so interested in the 8-mm video format is the failure of its late-arriving Video-2000 format to achieve notable penetration in Europe. Video 2000 uses a cassette with ½-inch tape, about the size of a VHS cassette, but records on a ¼-inch track, using only one half the width of the tape as it does. Then it can be turned over and played in the other direction, like an audio cassette. The longest tape originally available was eight hours, playing four hours in each direction. Now Philips and Grundig (which also makes Video-2000 recorders) have introduced new VCR's with a second, half-time, tape speed, bringing total recording time to 16 hours per cassette—by far the longest of any consumer VCR.

Both Philips and Grundig, however, are now planning to manufacture VHS recorders as well as the Video-2000 type—the VHS units for sale in markets where Video 2000 is not used. In Japan, Funai, which originated the ill-fated CVC ¼-inch cassette format used by Technicolor in its unsuccessful effort to market home VCR's in the U.S., is changing over to VHS. R-E

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WHAT'S NEWS

Color oscilloscope uses liquid-crystal shutter

Tektronix has placed on the market the *5116* Color Display Oscilloscope, the first commercial application of its Liquid-Crystal Color Shutter. Color, says the company, results in increased productivity due to faster analysis, ease of use, and reduced operator error.

Color traces act as coding devices for separating information, emphasizing important features, enhancing pattern recognition, and, perhaps most important, improving the user interface.

Coupled with the *5D10* Waveform Digitizer (a plug-in for all 5000-series oscilloscopes) Tektronix calls it "the world's first liquid-crystal color-shutter display digital storage-oscilloscope," with the ability to store transient events with frequency components up to 1,000 kHz for single-channel acquisition and up to 50 kHz for dual-channel acquisition.

Digital X-ray system may change diagnostics

A new digital X-ray imaging system unveiled by Raytheon at the recent Chicago meeting of the Radiological Society of North America may "dramatically change the way physicians and radiologists are able to perform diagnostic angiography."

Angiography is a speciality that allows doctors to use advanced X-ray techniques to diagnose problems in the body's vascular system. It is done by introducing a chemical into the patient's bloodstream with a catheter inserted in a main artery, then taking a series of X-rays in rapid succession.

The new system uses a specially designed high-speed computer to produce five times as many images a second as can be taken with the best equipment now available. The new equipment can take 30 X-ray pictures-per-second, as compared to six with present-day equipment. That can capture the motion of fast-moving material in the arteries, which was not previously visible in digital studies.

The injection can now be made in a vein, rather than in an artery as previously required. That makes for shorter hospital stays and far less risk. In many cases the procedure can be handled on an outpatient basis, making it much less costly to the patient.

The new system consists of a high-resolution X-ray camera, a dual-console video monitor, and Raytheon's new RDL-3000 digital computer. That computer uses two central processors in tandem to process and store X-ray images at 30 frames per second, with an image resolution of 512 × 512 pixels. At a lower speed—7.5 frames per second—the RDI-3000 will produce super-high resolution of 1024 × 1024 pixels. That added capability will be available by mid-1984.

COMSAT and NBC join in satellite broadcasting

Comsat General Corp. and the NBC Television Network have signed an agreement to begin an advanced satellite-distribution system, using a K-band satellite to deliver programs to NBC affiliates. Programming is expected to begin early this year and will become fully operational by January 1985.

The national distribution system will begin operating with transponders on a Satellite Business Systems satellite. The agreement calls for NBC and Comsat General to use RCA Americom K-band satellites when they become available in early 1986.

Unlike C-band transmission, K-band frequencies permit broadcasters to put earth stations right at their studio locations—anywhere within sight of the satellite. By adding transmitters, downlinks can be converted into uplinks, and the affiliate can then be an interactive participant in uses other than normal reception of network programs.

Newspaper sees blur in videotex future

The future of videotex is blurred, pessimistically reports the Chicago publication *Electronic Media*. "Once heralded as a mass medium of the future with volume by 1990 estimated at $10 billion, a sober realism has settled over industry as providers begin to confront the problems of selling their services to the public."

Knight-Ridder newspapers launched a videotex system—Viewtron—in southern Florida, the paper says. The company hopes to sign up 5,000 homes by the end of the year. With Viewtron, customers must buy or rent equipment to convert their TV sets to videotex receivers and having to make such a purchase is the biggest criticism of the system, says *Electronic Media*.

"Other information services that can be received on a home computer are seen as having the edge," the article concludes.

New directory to help users of facsimile equipment

A new directory is intended to make it easy for facsimile machine users to reach each other. It will list the corporate firm names, exact locations of the facsimile machines, backup telephone numbers, hours in use, and contact names.

The directory is being prepared with the cooperation of major facsimile companies, including Canon, Exxon, NEC America, Panafax, Pitney Bowes, Sharp, Telautograph, 3M, and Xerox, and is published by Greenfield Information Service of New York City.

The first edition of the new directory is expected to be on the market early in 1984.

Single-mode fiber-optic transmission service is announced by ITT

The first commercial fiber-optic transmission system in the western world was inaugurated last September, by ITT Telecom Network Systems and Continental Telephone Co. of New York. ITT announced. The system is claimed to be the first capable of carrying enormous amounts of telephone traffic without intermediate amplifiers (repeaters).

That first-of-a-kind fiber-optic system links Continental's digital central offices in Norwich and Sidney, New York, about 23 miles apart. The system can carry 1344 telephone channels. A similar 23-mile (37 km) linkup is planned between the Sidney central office and one in Greene, NY.

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

FIRST DBS SERVICE

USCI Home Satillite Television, a division of United Satellite Communicatins, Inc., has begun this nation's first direct-broadcast satellite service. The service, which was available in the 26-county area surrounding Indianapolis beginning this past November, is beamed from Canada's Anik C III ku-band bird.

Five channels of programming are being offered, with two of those being movie channels (named Movietime and Showcase). Other channels feature Entertainment and Sports Programming Network (ESPN), children's programming, music video and entertainment specials, and UPI news. The subscription rate to the service is $39.95 a month, and there is a $300 installation charge.

MORE SATELLITES GOING UP

The race to put more satellites in orbit continues, with replacement birds going up and a series of new higher-powered satellites planned. The third advanced RCA Satcom domestic satellite, called Satcom IIR (replacing the original Satcom II bird), went into orbit last fall; the replacement satellite sits at 66° west longitude, a considerable distance from the original Satcom II, which has operated for nearly eight years at 119°.

Meanwhile, RCA Astro Electronics is building a three-satellite system of dual-band (C and Ku Band) birds for American Satellite Co. The first is due to be launched in September 1985, and the birds are designed for 10 years' life in orbit.

And Ford Aerospace has announced plans for two large-scale satellites to be launched in 1987. The Ford birds will also be dual-band satellites, and Ford plans to lease transponders to individual programmers. Each of the Ford satellites will have 54 transponders that provide interconnected C-and Ku-band service, with bandwidth of 36 MHz on each transponder—a total of 1944 MHz. The footprint for the satellite signal on each band will cover all 50 states, and spot-beam coverage for eastern and west coast sites will be available with higher power.

HOME COMPUTERS TO TAP INTO TELETEXT

KSL-TV, the Salt Lake City television station that pioneered teletext in the U.S., is making its teletext database directly available to personal-computer users. The same data that is transmitted as Teletext 5, the experimental KSL service on vertical blanking interval lines 15 and 16, can be accessed by calling a Salt Lake City phone number and, through a modem, hooking a home computer into the KSL teletext host computer. TV station executives hope that the system will help area residents keep in touch with teletext until true teletext decoders can be built and sold in sufficient quantity in the Salt Lake City area. Meanwhile, that alternative delivery method allows KSL to build a new research tool. It can keep track of what teletext database categories are accessed most often, including time of use and type of information sought by users.

AROUND THE SATELLITE CIRCUIT

International Satellite Inc. has become the second contender to go into competition with Intelsat in the bid to deliver video and data between the U.S. and Western Europe. ISI's bid comes on the heels of a similar plan by Orion Satellite. Like Orion, ISI wants to handle business communications plus cable-TV video programming, especially transatlantic sports shows. The company wants to be up and running by the time European cable-TV services go into operation. Among the owners of ISI are Satellite Syndicated Systems (the U.S. cable programming carrier) and United Brands.

Hospital Satellite Network has started its programming service, sending medical information to hospital personnel and entertainment to patients. About 50 hospitals have signed up for the service, which is uplinked from Banneville Satellite Corp.

EQUIPMENT HIGHLIGHTS

The Luxor satellite receiver (model *190-9530)*) is a high-performance model that can access all 24 transponder signals directly through the hand-held infrared remote controller. It features vertical and horizontal polarization, and fine tuning on each channel can be stored in memory. (Precision Satellite Systems, Route 2, PO Box 117A, Oakley, KN 67748.)

Hanover's *Linear Actuator* lets users steer satellite dishes through a Commodore *VIC 20* home computer. Up to 18 satellite locations over a range of 250 stops can be programmed into the *VIC*. (Hanover Systems, 1217 Washington, Waterloo, IA 50702.) **R-E**

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ANTIQUE RADIOS

I was pleased to read of Mr. David B. Ward's (**Radio-Electronics**, July 1983) interest in my article, "Antique Radios." His hint about the electrolytics is well taken.

Unlike the tubes, resistors, and transformers in the old sets, the electrolytic "condensers" (the old term) are almost always bad. However, removing them—whether they're tube type, can, etc.—can leave a gaping hole in the chassis. That will be noticed quickly by admirers of your antique; they always have to stick their heads in the back to see what an old chassis looks like.

Solution: Leave the old "condensers" in place, disconnected from the chassis, of course. The much smaller replacements can then be wired in and hidden under the massive chassis. Then the admirers who just have to inspect the inside of the cabinet to see the old chassis will never be the wiser. To be safe from ruining other parts, as Mr. Ward suggests, replace *all* the electrolytics when restoring an old radio.

RICHARD D. FITCH
Baltimore, MD

ON NIKOLA TESLA

The historical article in the August 1983 issue of **Radio-Electronics**, "The Life and Times of Nikola Tesla," is a welcome piece of literature in what I have always considered as one of the best magazines in electronics publishing.

Insofar as that article was a reprint from another publication, my comments are addressed only to the text as it appeared in your magazine.

In the early 1900's, Hugo Gernsback published many articles in his magazines. *Practical Electrics, The Electrical Experimenter, Modern Electrics, The Experimenter*, and *Science and Invention* all carried feature articles about Nikola Tesla's pioneering work. Mr. Gernsback was one of Tesla's most ardent fans of the time, and all of those publications were destined to become the forefathers of your present-day **Radio-Electronics**. Extensive reading among those articles, as well as Tesla's Colorado Springs notebook and the published patent wrappers, reveal key discrepancies in E.J. Quinby's article.

The paragraph under the heading "World's Most Powerful Transmitter," on page 53, and the drawing in Figure 2 on page 54, are misleading—and are, in fact, not what Tesla actually constructed at Colorado Springs. The Tesla Coil at the experimental station actually consisted of a three-coil or helix air-core transformer. The primary consisted of two

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New Zenith push-button VIDEO ORGANIZER permits switching from one program source to another without changing cable connectors. Lets you select up to six different program sources for viewing. Up to three different sources for recording. Even lets you view one program source while simultaneously recording another. All this without changing cable connections!

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Zenith Radio Corporation/Service, Parts & Accessories Division/11000 Seymour Avenue/Franklin Park, Illinois 60131 turns of 1.250-inch diameter copper wire. Mostly, Tesla used that coil as two one-turn primaries hooked in parallel (bifilar), which doubled the coil's capacity and reduced its self-inductance to one fourth. Loosely coupled to that coil was the main secondary coil or helix, which contained in its final configuration twenty-five turns of number-8 wire on a wooden coil form that was fifty-one feet in diameter and approximately eight feet high. In the large center of that secondary, Tesla constructed a first-order harmonically resonant helix, which was mostly reliant on its own self-inductance to give an additional boost from the secondary's output of approximately 1.8 million to 12.5 million volts. That third coil or "extra coil," as Tesla referred to it, gives a point-to-point discharge-length yield of approximately seventy-five feet under certain conditions. Coupled to the output of the extra coil was a vertical monopole radiator consisting of concentric steel telescoping pipes, which formed a structure approximately 124 feet high. That was surmounted by a wooden hollow sphere 30 inches in diameter and coated with metal foil on its outside surface.

Tesla speculated in his diary notes that with what he felt to be reasonable modifications to that scheme, it would be practicable to achieve discharge lengths greater than four-hundred feet! However, that was never accomplished. The descriptions given in Quinby's article appear in several other examples of the available literature and have needed correction for many years.

Here's something your readers may be interested to know. It concerns the U.S. twenty-cent commemorative stamp that appeared last September, honoring Tesla and three of his contemporaries. (See "What's News" in the October 1983 issue of **Radio-Electronics.**) Perhaps history is repeating itself yet again. Just as Tesla himself has been largely forgotten today, so it seems that the person probably most responsible for initiating the arduous process through which a commemorative stamp like that one comes into existence has been overlooked. The person is Nick Basura.

Also not to be overlooked is your editorial staff, for providing space for the article on Tesla in the pages of **Radio-Electronics.**

WILLIAM C. WYSOCK
President Professional Sound Systems, Ultra High Voltage Division, Monrovia, CA

MINI PLAYER PIANO

A liked the "Mini Player Piano" article in the September 1983 issue of **Radio-Electronics.** I would like to point out that some electrolytic capacitors were mislabeled in Fig. 4. (The Parts List is correct.)

I suggest some changes: Combine R30 and R40 for 1.2K ohms; eliminate R26, 27, 28 and the jumper there; eliminate ground connection to CC of center 7 segment display.

I have three of the 50240's and might try to use more than one octave. The clock oscillator for the 50240 will probably be variable in case of tuning with other instruments. I will do a lot of experimenting with that—maybe time it with clock of rhythm beat generators MM5871 or the 76477—if Spike Jones doesn't object.

DAVID H. DUNCAN
Huntington, TN

THANKS, FELLOW READERS

You published my "Help Needed" letter in the September 1983 issue of **Radio-Electronics.** As of this date (August 17, 1983), I have had 80 replies relating to my need for a schematic on a GE preamp from a GE transistor manual circa 1969. The response to that request has overwhelmed me. I have received copies and originals from all over the US, from big companies, universities, and private individuals.

To all of those generous people, I wish to extend wholehearted thanks. It is people like that who keep the hobby of electronics going on and on. If the people of the world as a whole would give others a helping hand, such as this, then the world would be in much better shape.

B.E. BROSKI
Cleveland, OH

SOFTTOUCH 83

We were surprised and delighted to read your review on our SoftTouch *83* in the September 1983 **Radio-Electronic** "Communications Corner." Your presentation of the problems we all face of spewing out digits to get some machine to do our bidding hit the nail on the head.

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LEO CORBALIS
Technical Director,
Buscom Systems, Inc.

SUGGESTIONS NEEDED

With the millions of monthly readers of **Radio-Electronics** like myself out there, I'm sure that at least *one* can help me with a problem that will ultimately save the rest of my hair being pulled out by the roots.

Living in a rural area has made my dreams of getting cable TV just that—dreams! So, being very electronically inclined, I decided to take the plunge into satellite-TV reception. To say that I'm a do-it-yourself freak would be an understatement, but I'm in the process of building my own system from A to Z. Problem: Even though I have the necessary front-end components (assembled and tested), I can't seem to find a schematic diagram of a 70-MHz IF amplifier and detector using discrete components.

Although using IC's could simplify construction markedly, I'm attempting to do the whole thing (receiver unit) from discrete parts, because I have a junkbox full of active and passive devices that have frequency tolerances far beyond 500 MHz.

So, how about it, fellow readers? Here's a chance to put your ideas to good use, not to mention the gratitude I'll have for the response.

What I'm asking for is a workable circuit of a 70-MHz IF amplifier with a 20-MHz bandwidth and a 70-MHz phase detector capable of handling the wide swing of the IF bandwidth. The catch is that they have to be designed using discrete components.

LeROY SMITH
Rt. 3, Box 479,
Wetumpka, AL 36092

APPRECIATION

Thanks for a normally good-to-very-good magazine. And thanks especially for the reprint of Mr. Quinby's article on Nikola Tesla! How about comparable coverage of Charles Proteus Steinmetz?

One more suggestion: How about some in-depth coverage of EMP (*E*lectro*M*agnetic *P*ulse)? I don't read widely, or pay any attention to the commercial electronics media (AM & FM radio and TV), but have never seen really good coverage of the phenomenon.

JAMES C. CAVE
Princeton, TX

COMMON ERROR

I enjoyed reading about Nikola Tesla, in the August 1983 **Radio-Electronics**, very much. As stated in the article, he is an almost forgotten genius. For those who would like to learn more about him, I suggest the book, *Tesla: Man Out of Time*, by Margaret Cheney.

Incidentally, Mr. Quinby made a very common error in his article. He said that one of the giant radio-frequency alternators has been preserved at the Smithsonian Institute. Not so: the proper name is the Smithsonian Institution.

ROBERT J. RUPLENAS
Dorchester, MA

EXTRACTING COMPONENTS

Once I tried pulling components from old PC boards. But, unfortunately, I found that retrieving the components wasn't quite that simple. The desoldering tool never "gobbled up" all the solder, and the remaining traces held the component as firmly as before. Then I tried this simple technique; and, believe me, the results were astounding.

The PC board is placed on a tripod, with the components down. Two soft springs are attached, one end to the component to be extracted, and the other end stretched to the

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lower end of the tripod. The solder is then softened with a soldering iron. As the solder softens and becomes liquid, the component is hurled from the PC board by the now-relaxing spring. The method takes a fraction of the time required by other techniques, and using two soldering irons and both hands, extracting components from old PC boards can be quite some fun.

If, on the other hand, you are extracting IC's, remember that all terminals must be heated at the same time, for which you will need a special soldering iron. Note, too, that in this method, a desoldering tool is not required. And that no "gobbling up" of solder before or during the extraction process is necessary.

KRISHNA BALDEO
Bronx, NY

PREFERRED CHOICE

Since I've received my bachelor's degree in June, I've had more time to read some of the smaller articles and departments in **Radio-Electronics**. The "Letters" section is one that I've caught up on, and I would like to make a comment.

I receive both **Radio-Electronics** and a computer magazine, and I agree with Stephen F. Willey (August 1983 "Letters") on keeping **Radio-Electronics**. I feel, as many others do, that the variety, quality, practicality, and feasibility of the articles and projects especially make **Radio-Electronics** what it is.

Stephens' comment: "The occasional overview of computer technology and markets in your magazine is welcome as general information, but I would not like to see heavy emphasis on computer circuitry and accessories." My question is: How heavy is heavy emphasis? Computer circuitry and accessories is one of the leading and largest markets today! Projects of that nature which show practical and feasible ideas that help many readers with their projects should not be emphasized any less. I don't think that computer-circuitry articles have been emphasized too heavily.

I feel that **Radio-Electronics** is doing a fantastic job on determining which projects to publish, and when.

EDWARD W. LOXTERKAMP
New York, NY

ROBOTIC ARMS

Recently I walked into a Radio Shack store to pick up their 1983-1984 catalog, and was astounded by what I saw. There, lying on the front counter of the store, was a real, live, and fully operational robotic arm.

I have always been interested in computers, but below that is a craving to build electronic peripherals for them; and one of my goals has been to assemble and run a computer-controlled robotic arm.

Robotic arms are now heavily used in the auto industry in Japan, and have been introduced to North American auto manufacturers. All are used to execute a series of preprogrammed movements to build a specific part of an automobile.

The robotic arm now on sale at Radio Shack, as a Christmas toy, caught my eye because of its price: $44.95. (It's probably cheaper in the United States than in Canada.) I was wondering if you at **Radio-Electronics** could publish a project that uses the immense capabilities of the Apple *II+* (or *IIe*) computer to operate such a robotic arm. It would be great for a Christmas edition of the magazine, or a major feature in a forthcoming issue of **Special Projects**. A project of that sort would be for the electronics, computer, or robotics hobbyist.

DEANE VENEMA
Ontario, Canada

We agree! However, there may be better approaches than attaching the arm to an RS-232 port. Perhaps a dedicated controller board would be the way to go. I, for one, think that an inexpensive chess game built around the arm would be terrific.

If any of our readers develop a construction project based around the robotic arm, please drop us a line.—Editor.

ULTRASONIC PEST REPELLER

A few words about the ultrasonic pest repeller in the August 1983 issue of **Radio-Electronics** ("New Ideas"). Although the circuit works—it doesn't work. By that, I mean that it fails to repel bees, ants, or flies. I believe that the project is grossly underpowered. But if anyone still wants to build it, the resistor in the Q1 emitter circuit should be R7 (not R6), and though its value is not critical, a value of at least 560 ohms will keep the LED current to a safe value, assuming a 12-volt supply.

C.B. OHMAN
San Diego, CA

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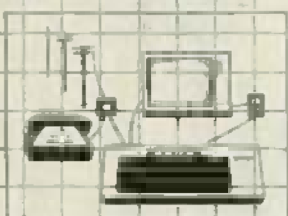

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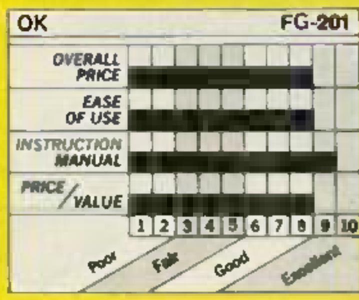

CIRCLE 101 ON FREE INFORMATION CARD

ONE OF THE MAINSTAYS OF A WELL-equipped electronics workbench is a function generator. Those devices are useful in a wide variety of applications, most notably in the troubleshooting of linear circuits such as audio amplifiers. Other applications include finding the impedance of a resistor, capacitor, or inductor, and finding the operating parameters of an op-amp. We recently had a chance to review a popularly-priced function generator, capable of outputing sine, triangular, and square waveforms, that would be a valuable addition to any test bench. The unit is the *FG-201* from OK Industries Inc. (3455 Conner Street, Bronx, NY 10475) and we would like to tell you about it.

One glance will tell you that the *FG-201* is a quality instrument. That's because, rather than the plastic we've become so used to, the 2.5 × 8 × 6-inch

case is made of steel. Aside from adding to the unit's durability, that also affords excellent RFI shielding. In addition, the unit uses BNC connectors instead of phono plugs or banana jacks.

The BNC connectors, as well as all of the unit's controls, are located on the front panel. The layout of that control panel is well thought out, with all connectors and controls grouped by function.

Starting at the far left (as you look head on at the unit) are two BNC connectors. Through those connectors you can input a signal either to amplitude- or frequency-modulate the unit's output. The output can be amplitude-modulated from 0 to 100% and the input can handle signals from 0 to −2.5-volts DC. For FM, the sweep can be varied from 0 to 100:1, and input voltages from −3 to −9-volts DC can be accommodated. Both inputs are overvoltage protected to ±25-volts DC.

Moving to the right, there are two controls used to select the frequency of the output waveform. The control labeled RANGE is used to select one of the unit's six frequency ranges (1–10 Hz to 100 kHz–1 MHz). The control labeled FREQUENCY is continuously variable and is used to select the actual frequency within the chosen range.

The next set of controls deal with the sinewave and triangular-wave outputs. A slide switch is used to select which waveform (sine or triangle) will be generated. The control labeled GAIN is used to set the amplitude of the waveform. That amplitude can be varied from 0 to ±10-volts AC P-P into a 50-ohm load. The DC-offset control is used to adjust the positive or negative offset of the output. The maximum offset is ±10-volts DC, but the sum of the offset and the amplitude of the waveform may not exceed ±10-volts DC +AC without clipping. A push-pull switch that's part of the offset control allows you to select either a 50-ohm or less-than-5-ohm output impedance.

The sinewave/triangular-wave output is taken from a front-panel BNC connector. As mentioned, the output impedance is switch selectable and maximum output voltage is ±10 volts DC. The maximum current is dynamically limited to 250 mA.

Squarewave outputs are taken from a separate front-panel BNC connector. The level of the squarewave is adjusted by its own LEVEL control. That control lets you vary the level from a logic low of less than 0.8-volts DC to a logic high of between +3 to greater than +12-volts DC. The level is continuously variable.

The true test of a device such as this is its accuracy. The accuracy of the frequency-selector control is claimed to be ±5% of the maximum selector setting. After warm-up (20 minutes) the frequency stability is good, with variations limited to ±0.05%. Sinewave distortion is claimed as less than 1% from 1 Hz to 100 kHz, and

less than 3% from 100 kHz to 1 Mhz. The triangular-wave linearity error is less than 1% from the best straight line on all ranges. The squarewave symmetry error is also less than 1% on all ranges. The AM-modulation error is less than 2% for 0 to 95% modulation. The FM-sweep linearity error is less than 2% for a 10:1 sweep and less than 5% for a 100:1 sweep.

Before each unit is shipped, it is tested and all important specifications are verified. The results of those tests are included with the unit and are listed on a "performance test card." The date of the test and the initials of the inspector are also listed.

If you want to verify those results, either upon receipt of the device or later on, to make sure everything is working as it should, complete details of the test set-ups (including clear illustrations) are provided in the manual. A blank copy of the performance test card is provided to help you keep track of the readings and easily compare the results.

Turning our attention more directly to the manual, it's not much to look at—no fancy binding or glossy paper, just loose-leaf pages held together with clips—but it packs a ton of important and useful information. It covers such things as specifications, installation and operation notes, warranty information, theory of operation, and performance verification. It also includes a complete schematic, parts-placement diagrams, and a parts list, including manufacturer's parts numbers where available. All replacement parts are available directly from OK.

Two sections of the manual bear particular note. The sample applications section is excellent. It includes descriptions of the test setups, schematic and hookup diagrams, all needed formulas, and sample waveforms. Everything is clearly illustrated and explained. The troubleshooting section is interesting because of its approach. If you are familiar with computer programming, you are likely to have encountered logic trees. If not, those are used to help you successfully tackle a problem by breaking it down to a series of questions, the answers to which eventually steer you to a solution. The manual takes the same tack—the troubleshooting section uses logic trees to help steer you from a general description of a problem to the component or section most likely to be at fault. It is an interesting approach and one that should work well.

If you are in the market for a function generator, we suggest you investigate the model *FG-201*. It boasts an impressive selection of features and excellent specifications for its price. The suggested list price of the unit is $250.00. **R-E**

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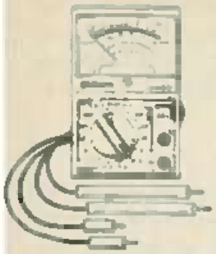

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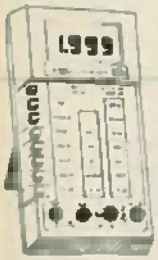

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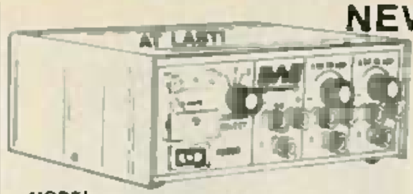

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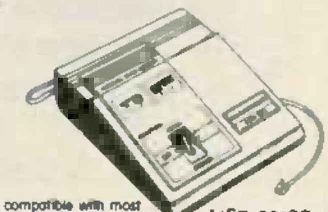

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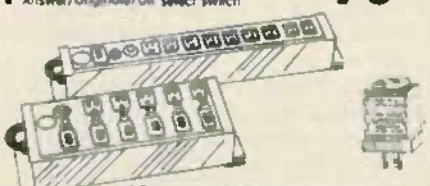

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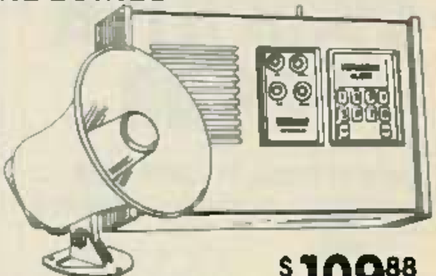

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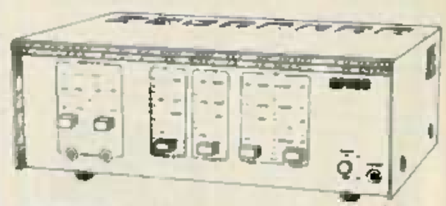

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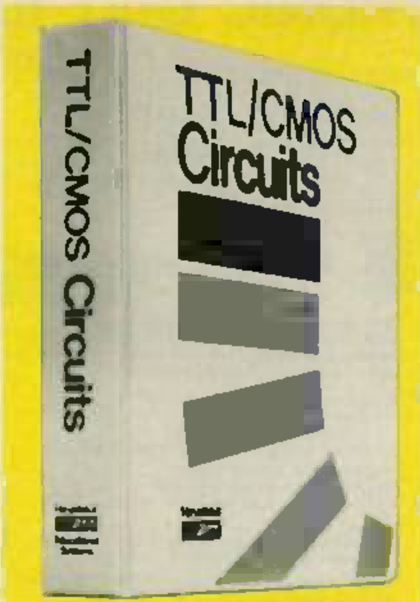

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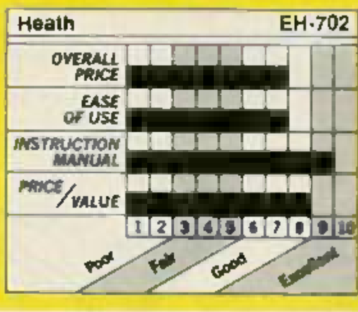

verter, you progress through two-input AND/OR logic, NAND/NOR logic, and two-input EXCLUSIVE-OR logic. From there you move on to experiments using a seven-segment common-anode digital display.

Once you have handled those tasks, the accumulated experience you have gained is applied to a demonstration of the operation of a 7447 BCD-to-seven-segment-display decoder/driver. At that time, you will be identifying the input codes required to light any digit from 0 to 9.

Once you have completed those experiments, you will learn about truth tables, and use them to help understand the operation of a basic R-S flip-flop and clocked R-S flip-flop.

Other topics in the unit include a look at the three basic types of multivibrators, J-K flip-flops, D-type edge-triggered flip-flops, and the 7475 latch and how it is used in a display circuit.

All of that is building toward the final series of experiments in the TTL module. Those final experiments deal with the 7483 four-bit adder and the 7485 four-bit comparator.

The first unit concludes with an examination that tests your accumulated knowledge to that point. That exam should be viewed as not only review for the final examination that accompanies the course, but also as a chance to review your knowledge. To further that aim, the exam answers are provided so that you immediately know how you've done and have the opportunity to review any areas in which you are weak.

CMOS circuits

Once you have mastered the material in the first chapter, it's time to move on to the 22-experiment CMOS segment of the course. In that part of the course, you'll be dealing with essentially the same types of circuits you dealt with in the first unit, but with particular emphasis on the special requirements and characteristics of CMOS devices.

Getting to the experiments, you will find yourself again dealing with AND/OR, NAND/NOR, and EXCLUSIVE-OR logic. From there, you move on to a look at the CMOS 4017 preset counter. The next set of experiments deal with conuters and BCD-to-seven-segment decoder/drivers. From there you move on to CMOS R-S, J-K, and D-type flip flops.

The final series of experiments covers topics such as finding the output frequency of a 12-stage ripple counter divider, how to use a dual D-type flip-flop as a divide-by-four-counter, and how to use a CMOS 4016 bilateral switch as a data selector and a data distributor.

Once again, a unit exam is provided (again, complete with answers) so that you can assess your progress and pinpoint any areas that need extra work or review. There is also a final exam that covers all of the material presented in the course. If you wish, that final exam can be mailed back to Heath for grading. Overall, the Heath TTL/CMOS Practical Circuits Course is a good effort. It is presented in a highly readable style and all the materials are first rate. Like all other Heath courses, the company supplies all the components that you will need for the experiments.

You should be aware, however, that you will need to have, or purchase, a few additional items in order to get the maximum benefit from the course; that is also true of the other offerings in the series. For one thing, you will need Heath's *ET-3300B* breadboard/trainer (or a similar device) to build the experimental circuits. That trainer costs $99.95 as a kit ($179.95 fully assembled) and is used in many of Heath's courses. You also should have access to an oscilloscope as well as to a good digital multimeter.

Considering the fact that the additional items needed are things that should be on any reasonably equipped workbench, the Heath TTL/CMOS Practical Circuits Course, which sells for $59.95, has to be rated as a worthwhile investment. It is not only appropriate for the professional who may need a refresher course, but also the novice who is just getting his feet wet in electronics. **R-E**

continued on page 30

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Coin Controls Model 5000 Pro Joystick

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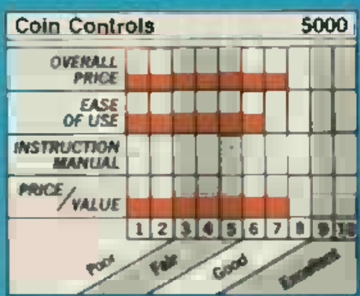

JUST AS MANY THINK OF XEROX WHEN they think of copying machines and kleenex when they think of tissues, ask most people about home videogames and the name that comes to mind is Atari. For a couple of years (and that's a long time in the volatile videogame industry) the *VCS* was the runaway sales leader, and for good reason—it offered good game play, a wide selection of titles, and was popularly priced.

Of course, the system has a few well-known problems. For one thing, the graphics, never really outstanding to begin with, cannot be compared to what is available on most recent models. And then there's the joystick. That joystick has created more than its share of sore wrists, sore thumbs, missed scoring opportunities, blown games, and frazzled nerves. It has also given rise to a whole new group of products specifically aimed at relieving the gameplayer from many of those miseries.

Needless to say, we're talking about replacement joysticks for the *VCS*. In just a short time a multitude of joysticks and joystick enhancers have appeared on the market. Those products range from hand shock absorbers to wireless remote-control devices.

We've recently had a chance to try out a new joystick that definitely merits your consideration. It is the model *5000* joystick from Coin Controls (2609 Greenleaf Ave., Elk Grove, IL 60007), and we would like to tell you more about it.

Advantages

As is obvious at first glance, that joystick addresses directly some of the most often heard complaints concerning the standard Atari joystick. For starters, at the top of the nylon-covered steel shaft is a large 1¼-inch control knob: that gives the joystick an arcade look and feel, and the gameplayer something to "hold on to." With that knob, quick moves and turns, so critical for successful play in games such as *Pac-Man*, become much easier to execute.

Turning to the fire button, it appears as if all of Atari's design engineers were right-handed. That's because the positioning of the lone fire button is such that the joystick cannot be conveniently used by most left-handers. In the model *5000*, that problem has been solved by simply adding a second fire button in the upper right-hand corner.

Finally, the model *5000* features a five-foot cord that really lets you "sit back" and enjoy your game. The extra couple of feet may not sound like much, but it can make quite a difference.

Drawbacks

Even with all it has going for it there are two things you should be aware of before purchasing this joystick. First of all, it does not play the same as the Atari. That's


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because the throw distance of the shaft is much shorter, and the arcade-like leaf switches are much more sensitive than what you might be used to. As a result, you'll be able to change directions much more quickly, but a light touch is required to prevent "overcontrolling."

The other problem is the one that this reviewer found the most disconcerting. The twin red fire buttons are over-sized and hair-trigger sensitive for sure action and quick response. The problem is that both of them are always active. It is very easy to accidentally brush the one you are not using during the heat of battle. Because of the button's sensitivity, more often than not that results in a shot, or what have you, being fired.

Thus, you should expect that your scores will decline at first. Rest assured that this is only temporary. Once you're acclimated to the joystick, you'll be easily passing your previous bests.

One thing is certain: Coin Controls has done its best to produce a product that will stand up to the rigors of even the heaviest use. That is evident by such things as the decision to use a steel rather than plastic shaft. And then there's the two-year warranty—if the joystick or its components prove to be defective due to workmanship or materials, the company will repair the joystick free of charge.

All-in-all, the model *5000* grades out as a good buy. Once you're used to its sensitivity, it will help maximize your scores. In addition, it is well made and backed by its manufacturer. The device is compatible with the Atari *VCS*, *400*, and *800*; Sears *Arcade Game*; Commodore *VIC*, and any other videogame or computer that uses the Atari joystick. It carries a suggested retail price of $19.95. R-E

Global Specialties Corporation Model 5000 Counter-Timer

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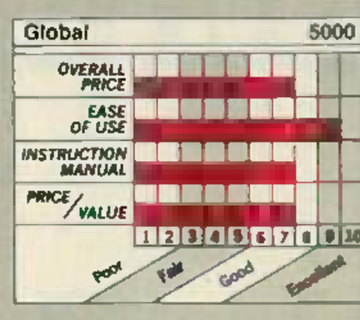
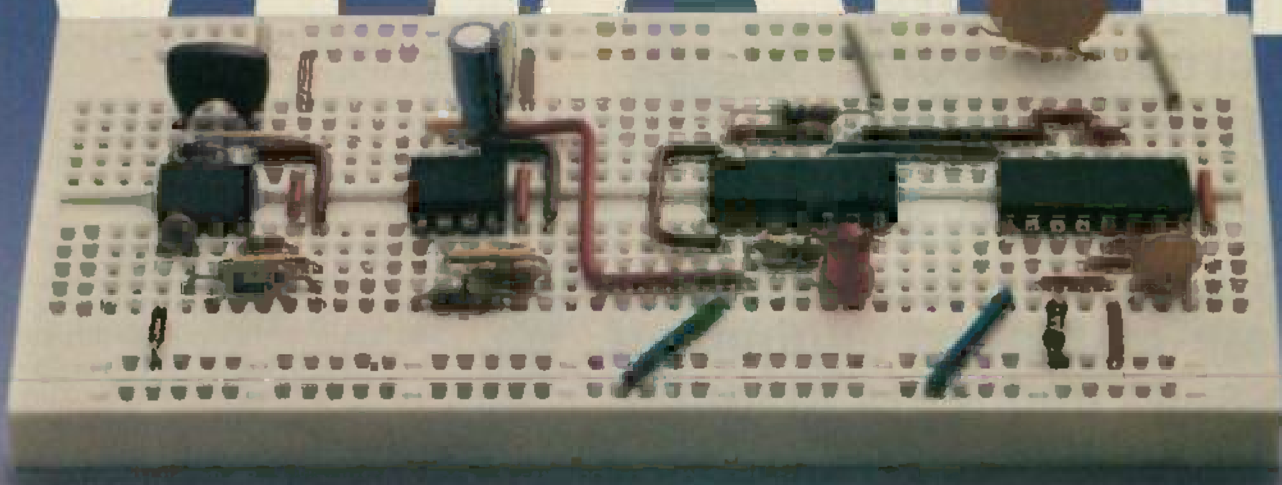


THE GLOBAL SPECIALTIES CORP. (70 Fulton Terrace, New Haven, CT 06509) has introduced a novel instrument, their model *5000* Counter-Timer. It will measure frequency, period, and pulse width of any signal up to 50 MHz. What makes this device so novel is not what it does; there many instruments on the market that perform the same functions. Instead, this

continued on page 113

WHAT IF



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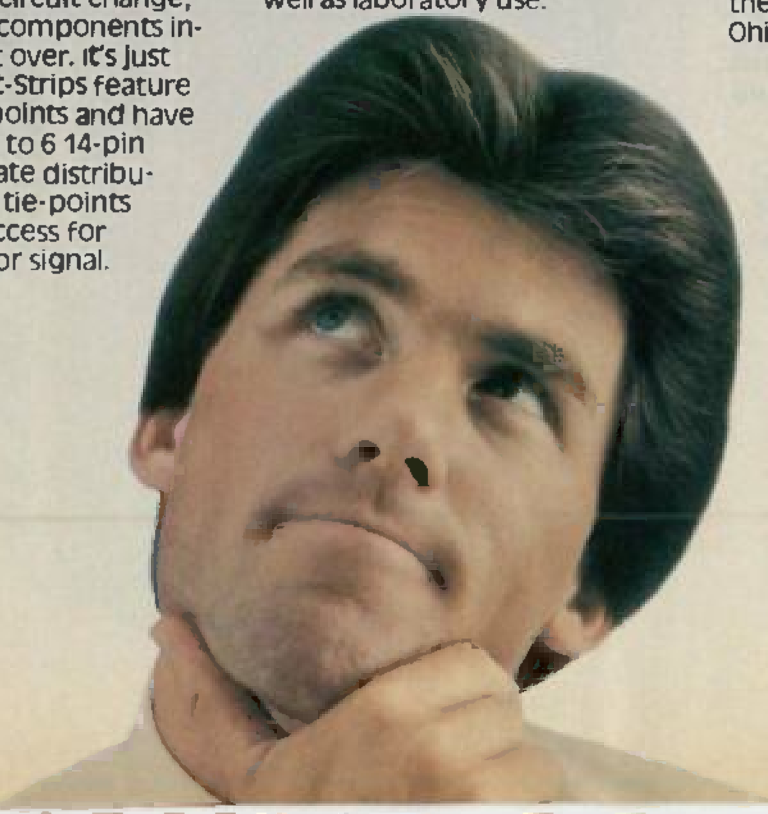

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debris reservoir. The *PA 1707* is priced at $26.95.—**Paladin Corporation**, 31332 Via Colinas, Suite 106, Westlake Village, CA 91361.

MICRO-OHMMETER, model *3205A*, is a 3½-digit instrument using the 4-wire measurement method to cancel lead-resistance errors inherent in 2-wire systems. Precise measurements can be made without the need for time-consuming adjustments.

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The model *3205A* is priced at $725.00. An optional BCD output, Option 01, permits logging of data and go/no-go checks to be made; the BCD Option 01 adds $125.00 to the price.—**Ballantine Laboratories, Inc.**, PO Box 97, Boonton, NJ 07005.

PERSONAL COMPUTER, model *HP 150*, featuring a touchscreen display, allows business professionals to run computer programs with the touch of a finger or a pen. Instead of memorizing commands, typing in menu-selection numbers, or using a mouse, the user simply touches the display screen to operate this personal computer and its application programs.

The model *HP 150* uses an Intel *8088* 16-bit microprocessor to run Microsoft's MS-DOS 2.0 operating system. That allows many popular programs to run on this personal computer.

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The system includes a keyboard; system-processor unit; bit-mapped graphics-display monitor; 256K of internal memory expandable to 640K; a dual microfloppy 3½-inch disk drive; built-in terminal features, and built-in data-communication ports. The terminal features and data-communication ports accommodate a full range of peripherals without using either of the two accessory slots included in the unit.

The model *HP 150* is priced at $3995.00.—**Hewlett Packard**, 3000 Hanover Street, Palo Alto, CA 94304.

650-MHz FREQUENCY COUNTERS, model *6000* (shown) and model *6500*, feature two front-panel BNC input connectors to allow flexibility in frequency measurement. The A input accepts signals from 5 Hz to 1 MHz with an input impedance of 1 megohm at 25 picofarads. A switchable lowpass filter, with an LED indicator light, provides a 3-dB-per-octave rolloff at 60 kHz to facilitate audio and

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Introducing the all new Regency MX5000, a 20 channel, no-crystal scanner that receives continuously from 25 MHz to 550 MHz. That's right! Continuous coverage that includes CB, VHF and UHF television audio, FM Broadcast, and civil and military aircraft bands. Plus a host of other features like keyboard entry, a multifunction liquid crystal display that's sidelit for night use, selectable search frequency increments, and a digital clock.

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Another new addition to the Regency line is the 30 channel MX3000. It's digitally synthesized so no crystals are necessary, and the pressure sensitive keyboard makes programming simple. What's more, it has a full function digital readout, priority, search and scan delay, dual scan speed, and a brightness switch for day or night operation.

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With the compact design, slanted front panel, and mounting bracket the MX3000 and MX5000 are ideal for mobile* use. But we also supply each radio with a plug-in transformer and a telescoping antenna so you can stay in touch at home.

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MX5000

MX3000

*Mobile use subject to restriction in certain localities.

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ultrasonic measurements. The B input is used for signals from less than 40 MHz to over 650 MHz, with an input impedance of 50 ohms at 10 picofarads. Selection of A or B input is through a pushbutton control with LED indicators.

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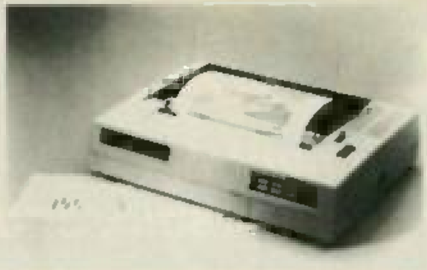
Both models also feature three-switch selectable gate times, with pushbutton operation and LED indicators. That enables the user to choose gate times of 0.1 second with 10-MHz resolution, 1 second with 1-Hz resolution, or 10 seconds with 1/10-Hz resolution. LED indicators for "gate open" and "overflow" provide additional convenience.

The model *6000* has a trimline front panel with easily-accessible controls, pushbutton operation, and accurate frequency measurement from 5 Hz to more than 650 MHz. It is priced at $399.95.

The model *6500* has an oven-oscillator time base, and is priced at $449.95.—**Global Specialties Corporation**, 70 Fulton Terrace, PO Box 1942, New Haven, CT 06509.

PRINTER, the *TRS-80 CGP-220*, ink-jet printer, is a drop-on-demand printer that quietly prints text and graphics. It prints in seven non-smearing colors: black, red, green, yellow, blue, magenta, and violet. It prints 2600 dots per second in graphics mode, with a resolution of 640 dots per line. The text mode offers 12 cpi at 37 (7 by 5) characters per second.



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Parallel and *Color-Computer*-compatible serial interfaces (600/2400 baud) allow use with any *TRS-80* computer. A screen-print utility for the *Color Computer* will allow the model *CGP-220* to create multi-color printouts of color graphics screens produced from any graphics program.

The *CGP-220* is priced at $699.00.—**Tandy Corporation/Radio Shack**, 1800 One Tandy Center, Fort Worth, TX 76102.

DIGITAL SWITCHES—five new series of miniature pushwheel switches featuring safety-lock actuators to prevent accidental actuation and insure data security. They include a special pushbutton that is set with a pointed instrument such as a ballpoint pen, and a flip up pushbutton that folds flush with the switch surface when not in use. Also offered are standard pushwheel and thumbwheel actuators. (All actuation styles are not available in each series.)

There is a variety of sizes. The *Series 1000* have a width of .236 inches and a height of .551 inches, with rear mounting. The *Series 1100* have a width of .236 inches and a height of .709 inches, with front mounting. The *Series 1200* have a width of .300 inches and a height of .709 inches, with front mounting.

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The *Series 1300* have a width of .300 inches and a height of .945 inches, with front mounting, and the *Series 1400* have a width of .315 inches and a height of .945 inches, with front mounting. The prices for the switches range between $2.00 and $4.66, depending on series and configuration.—**EECO Incorporated**, 1601 Chestnut Avenue, PO Box 659, Santa Ana, CA 92702-0659.

VOLT-OHMMETER, model *3525 Digi-Probe* is battery-operated, and shirt-pocket size. It uses a 5mm easy-reading 3.5-digit LCD display with a "data hold" feature to facilitate

continued on page 43

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fits in the palm of your hand

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NEW PRODUCTS

continued from page 40

measurements in low ambient light or in confined areas. It also enables the user to "hold" the reading for later review. An instant-tone

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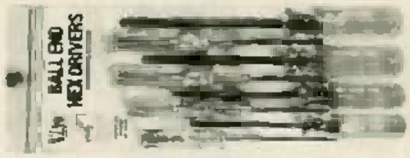
continuity test permits rapid testing of diodes, shorts, and circuit continuity. Volts, ohms, and continuity are selected with a function switch. AC and DC volts are selected by pushbutton, with AC shown on the LCD display.

The model *3525* has 13 ranges, and range selection in all functions is fully automatic. Blinking-digit overrange indication and low-battery visual indication are provided. Internal overload protection is to 750-volts AC/DC in voltage ranges and 250-volts AC/DC in ohms and continuity ranges. The *Digi-Probe* is priced at $65.00.—**Triplett Corporation,** One Triplett Drive, Bluffton, OH 45817.

HEX KEYS AND DRIVERS are now available in five new popularly-sized pouched assortment sets. There are three "L" style hex key sets: No. *BLMK6* is a 6-piece metric set containing sizes from 1.5mm to 5mm, and is priced at $11.46. No. *BLMK9* is a 9-piece



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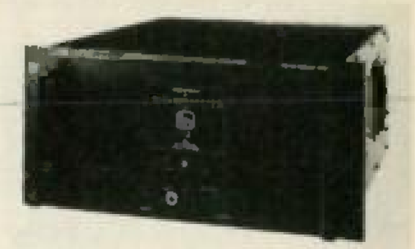
metric set with sizes from 1.5mm to 10mm, and is priced at $19.90. No. *BLK9* is a 9-piece inch set with sizes from 1/16th inch to 3/8ths inch, and is priced at $19.90.

There are two driver-style hex key sets: No. *HBLKM7* is a 7-piece metric set with sizes from 1.5mm to 8mm, and is priced at $22.60. No. *HBLK8* (shown in photo) is an 8-piece inch set with sizes from 7/64ths inch to 5/16ths inch, and is priced at $24.60.

The keys allow easy access in restricted or hard-to-reach areas. They set or remove Allen-type screws at angles up to 30 degrees.—**Vaco Products Company,** 1510 Skokie Blvd., Northbrook, IL 60062.

POWER AMPLIFIER, the Delta/Omega *TM2000*, actively controls the voice coil to develop precision in your sound system. It reduces ERD (Effective Radiation Distortion) and selects compensation needed to reproduce the realities of the original music being played.

The *TM2000* can deliver 600 watts continuous average output power into 8 ohms from DC to 45 kHz with no more than .05% THD. Power at clip point (less than .01% THD) is 2000 watts RMS into 2.2 ohms, 10 to 500 Hz; 50 Hz, 50% duty cycle tone burst. The slew rate is 32 volts per microsecond; IM distortion (60 Hz-7KHz 4:1) is less than .05% from .1 watt to 600 watts into 8 ohms; and less than



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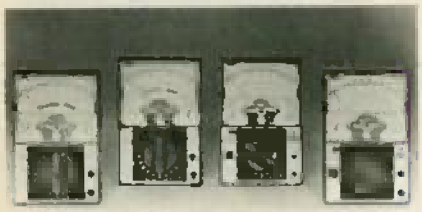
.01% at 600 watts into 8 ohms, and 1200 watts into 4 ohms. The harmonic distortion (true RMS) is less than .05% from DC–45kHz at

600 watts into 8 ohms; less than .001% from 20Hz–400Hz, increasing linearly to .05 at 20 kHz, 600 watts into 8 ohms.

Output impedance varies from +8 ohms to −8 ohms; input impedance is 25K ±5% with standard balanced bridging input; 44.76K ±5% at unbalanced remote-protect connector input. Hum and noise (20Hz-20KHz) is 120 dB below 600 watts into 8 ohms; typically 128 dB. The turn-on is switch-selectable for instantaneous or 4-second delay.

The Delta/Omega *TM2000* is priced at $2,995.00.—**Crown International**, 1718 W. Mishawaka Rd., Elkhart, IN, 46517.

ANALOG MULTIMETERS, model *DP-300*, model *DP-306*, model *DP-310*, and model *DP-316* all feature shock-absorbing PCB mounting; taut-band meter; low 25-ohm and 30-ohm mid-scales. They measure up to 1200 volts AC and DC, and feature a 0.3-volt DC scale. They will withstand a 5-foot drop.



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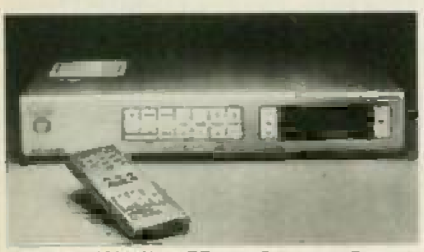
The model *DP-300* and *DP-306* also feature a −60°F to +482°F temperature range, while the model *DP-310* and the model *DP-316* feature a continuity buzzer for test up to 500 ohms, a built-in h_{fe} tester (0-1200), and a dB range of −10 to +23/31/43/51/63.

The model *DP-300* is priced at $40.00; the model *DP-306* is priced at $45.00; the model *DP-310* is priced at $47.50, and the model *DP-316* costs $52.50.—**A.W. Sperry Instruments, Inc.**, 245 Marcus Boulevard, Hauppauge, NY 11788.

VIDEO TUNER, model *AVS-2100*, combines an electronically tuned, digitally synthesized, 133/134 channel, cable-ready tuner; a preamplifier with special signal-processing capabilities, and a microprocessor-controlled input/output switcher.



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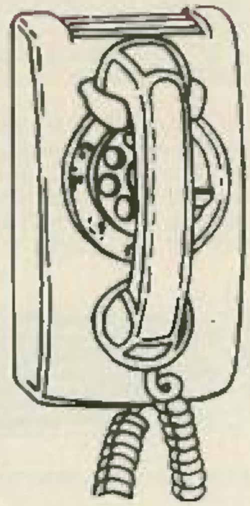
The model *AVS-2100* also features random-access tuning via the remote-control unit. The direct-access remote-control unit allows the user to select one of two video-input sources, in addition to a home computer or videogame. The user may also select synthetic stereo via remote control.

The model *AVS-2100* is priced at $590.00.—**Jensen Sound Laboratories**, 4136 North United Parkway, Schiller Park, IL 60176. R-E

Radio-Electronics mini-ADS



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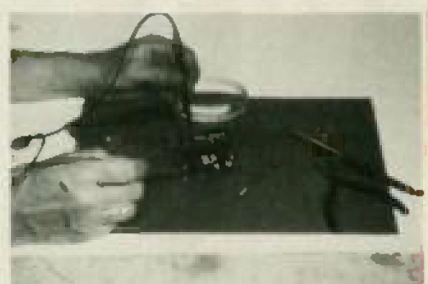

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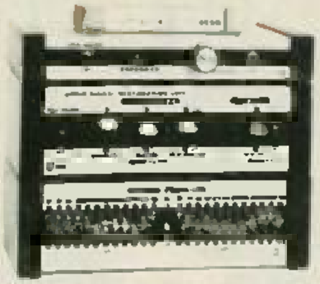

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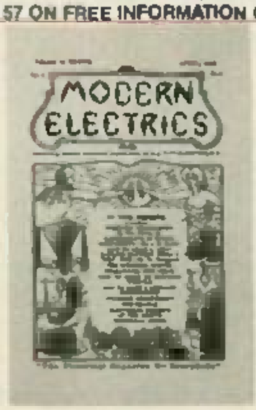

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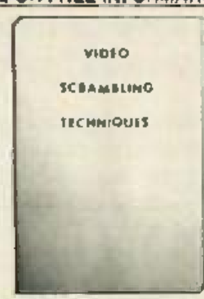

SUBSCRIPTION TV MANUAL. This information packed book details the methods used by subscription TV companies to scramble and descramble video signals. Covers the sinewave, gated pulse, SSAVI system, and the methods used by most cable companies. Includes circuit schematics, theory, waveforms and trouble shooting hints. **Only $12.95 puls $1.50 first class shipping and handling. RANDOM ACCESS, Box 41770R, Phoenix, AZ 85080.**

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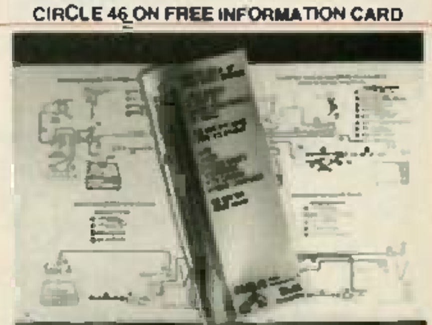

RCA Manual Details Video Systems Installations. New 52-page manual, including 36 simplified connection diagrams, guides layman and professional in hook-up of all makes of VCR, Video Disc, TV games, home computers, video cameras and TV sets. Get the handbook (1J7193) from your RCA Distributor/Dealer, or send **$1.95** postage/handling to **RCA Distributor and Special Products Division, P.O. Box 597, Woodbury, NJ 08096.**

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ALL ABOUT

CABLE-TV DESCRAMBLING

Learn the theory behind cable-TV signal-scrambling techniques by investigating a descrambling circuit.

FRED MEANS

IT IS ESTIMATED THAT BY THE END OF THIS decade, almost ninety percent of all households will be wired for cable television. One reason for cable TV's popularity is the excellent reception of local television broadcasts that it provides. Another reason is that several premium (pay) channels—that cannot be received without cable service—are offered. To prevent unauthorized persons (or non-subscribers) from viewing those premium channels, the signals are often *scrambled*. That is, the video signals are processed so that they can't be viewed on a normal TV—even one that is wired for cable—unless some device is used to decode or descramble them.

There are several techniques that cable-TV companies are now using to scramble their signals. In this article, we'll take a look at one of the more popular methods used today: the *inband gated-sync* method. We will explain the theory behind inband gated-sync scrambling/descrambling; and to further help you to understand and become familiar with the theory, we'll discuss a descrambling circuit that you can experiment with.

WARNING

The legality of the use of privately owned or built devices to receive or decode cable TV broadcasts is currently a subject of much controversy, debate, and litigation.

In certain instances, the TV cable companies and the FCC have taken the position that receiving and decoding cable-TV broadcasts without paying for them is "theft of service."

This article merely explains how one decoding device functions and is constructed. Prior to your using such a device, however, you are advised to obtain independent advice as to the propriety of such use based upon your individual circumstances and jurisdiction.

How is a signal scrambled?

Before we can understand what a scrambled signal is, we have to take a look at a normal signal. Such a normal signal contains horizontal- and vertical-synchronizing pulses that are sent during the horizontal- and vertical-blanking intervals respectively. (During those blanking intervals, the picture tube's electron beam is cut off as it retraces horizontally or vertically.) Those synchronizing pulses are among the most important parts of a standard TV signal. They are picked up by synchronizing circuits in the television set and are used to stablize the picture.

Figure 1-a shows part of a normal, demodulated, television signal that you would see, for example, after the TV's video-detector stage. The horizontal-blanking pulse can be seen in its proper place in the signal. (The vertical-blanking interval—when the electron beam snaps back to the top left corner of the screen to begin a new picture field—is not shown.)

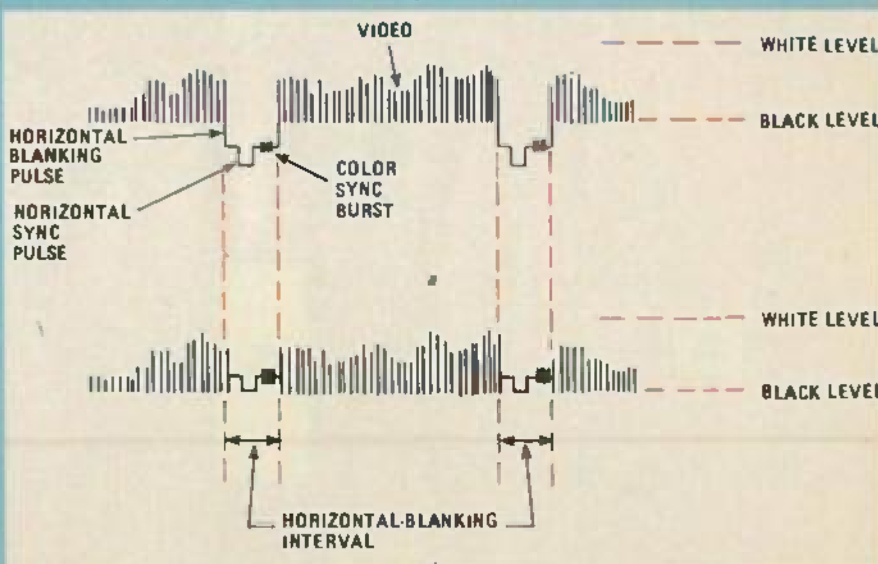


FIG. 1—THE INBAND GATED-SYNC scrambling method moves the horizontal-blanking pulse of a normal signal (*a*) into the video portion of the signal (*b*).

Now we can explain how the inband gated-sync scrambling method works. In that scrambling method, the level of the horizontal-sync and colorburst information is changed so that it is the same as that of the video information, as shown in Fig. 1-b. (The suppressed information is still within the signal's 6-MHz bandwidth, thus the word "inband." The "gated-sync" portion of the term means that during the horizontal-blanking interval, a gating signal is used to change the level of the signal.)

Because of the change (about 6 dB) in the level of the horizontal-blanking pulse, the TV's horizontal- and color-synchronization circuits do not pick up the pulses they need for synchronization. Therefore, the picture that you see is not stable—it is out of horizontal sync and the picture's color is also poor. The audio is not affected, though. Unlike many of the over-the-air scrambling schemes, the audio is not scrambled in the inband gated-sync method; it is simply passed through.

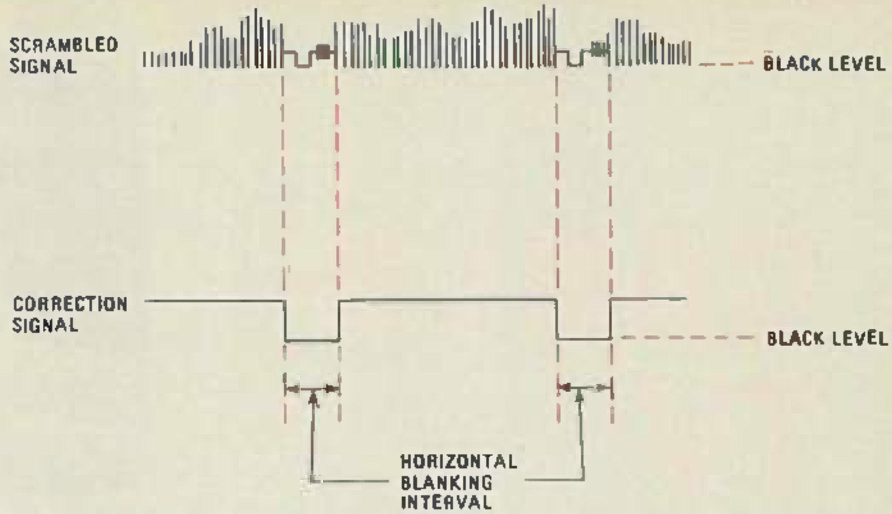


FIG. 2—WE CAN DECODE A SCRAMBLED SIGNAL by adding a correction signal to it, thus restoring the horizontal-blanking pulse to its proper location.

Descrambling the signal

We can see that to descramble the signal, it will be necessary to place the horizontal-blanking and -sync pulses back into their proper location. But first we must locate the hidden pulses. In the inband gated-sync signal, the horizontal-sync pulses are modulated on the sound carrier of the video signal. And because the sound carrier is 4.5 MHz above the picture carrier, we know where to look for the hidden sync pulses. For example, channel 3, whose picture carrier is at 61.25 MHz, has its sound carrier at 65.50 MHz. Therefore, if you wanted to decode signals from a cable system that used channel 3 as its output, you would have to look for the horizontal-sync pulses at 65.50 MHz. However, for a cable system that has its output on channel 2 (55.25 MHz), the horizontal-sync pulses are on 59.75 MHz, and so on.

Once we extract the horizontal-sync pulses, they can be used, along with the aid of some time-delaying circuits, to create a correction signal. The correction signal can then be added to the input signal to put the horizontal-blanking and -sync pulses back where they are supposed to be. What we want to do is to add a small DC voltage to the input signal *but only during its video portion*, not during

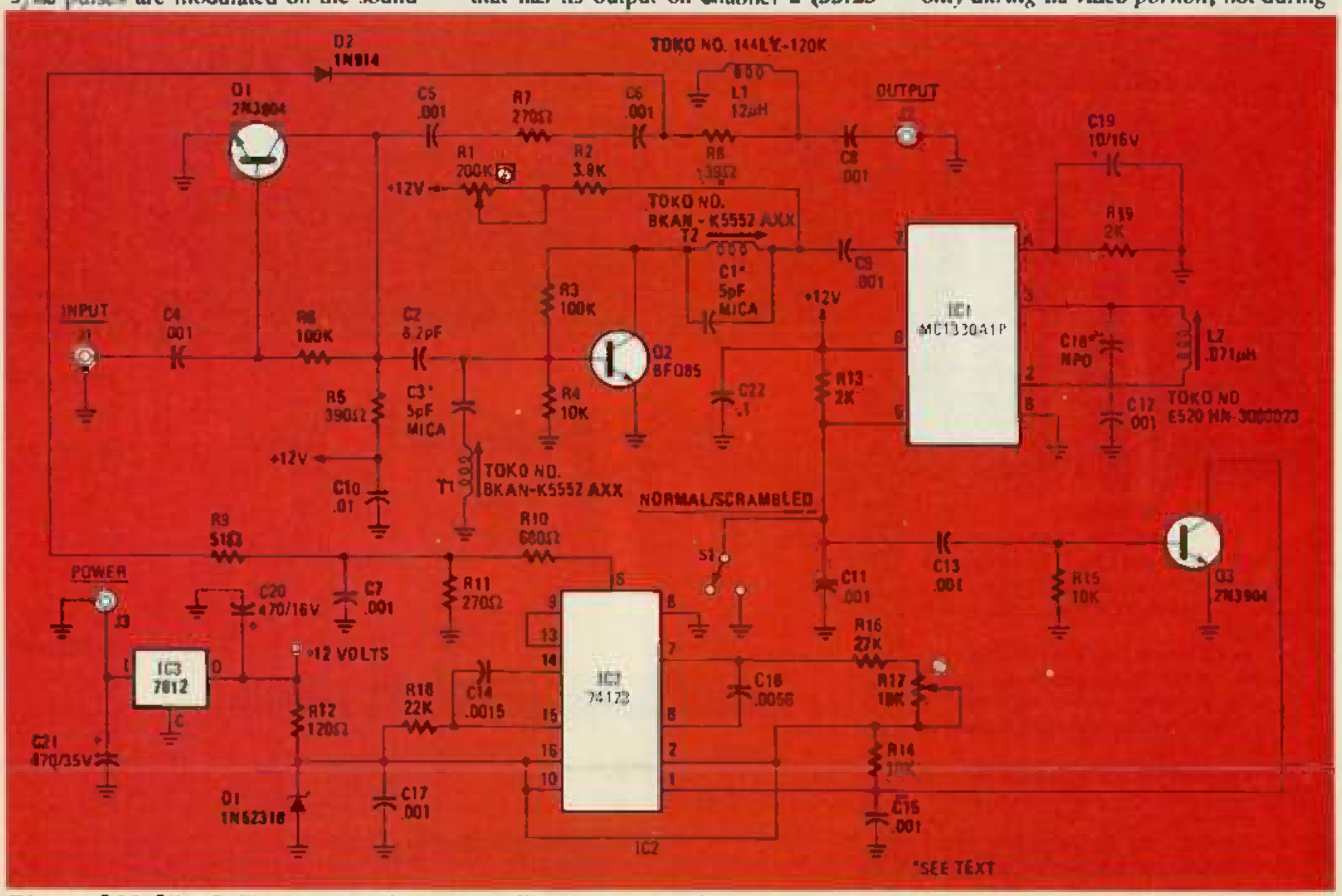


FIG. 3—THE SCHEMATIC of the descrambler is shown here. Note that the values of some components should be changed for operation at different frequencies. The descrambler can be used even with cable-ready sets. See the text for information.

FIG. 4—THE OUTPUT OF IC1 (pin 5) should have a minimum amount of video between the sync pulses.

the blanking interval. That process is shown in Fig. 2. The result of the descrambling process should be the original waveform shown in Fig. 1-a.

Circuit description

The schematic of a circuit that will do what we want is shown in Fig. 3. First we'll look at the power supply. The circuit can be powered by an AC adapter that has an output from 14 to 18 volts DC at 100 mA. The 7812 regulator, IC3, provides 12 volts DC to the rest of the circuit. The input and output of the regulator are filtered by capacitors C20 and C21. Zener diode D1 is used to provide +5 volts for IC2, a 74123 dual retriggerable monostable multivibrator.

Transistor Q1 provides a small amount of gain to the input signal—that compensates for any losses caused by the descrambling circuit. Transistor Q2, a BFQ85, is also used as an amplifier. But it will amplify only signals of a certain frequency. That frequency is determined by the setting of two tuned circuits. The first tuned circuit is made up of T1 and C3. Its resonant frequency will be set to shunt the video portion of the input signal to ground, while letting the audio portion of the signal through. The other tuned circuit is made up of T2 and C1. That is set to pass only the audio portion of the input signal. Potentiometer R1 can be used to vary the level of the signal at the output of the tuned circuit. Adjustment may be necessary because the inputs to the decoder from different cable-TV systems often are at different voltage levels.

After being amplified by Q2 and passed through the C1-T2 filter, the signal is fed into IC1, an MC1330A1P low-level video detector. (That signal contains the audio information of the input signal—where the sync pulses are hidden.) The tuned circuit (L2 and C18) associated with IC1 is also tuned to the frequency of the audio carrier of the input signal. That is, 65.50 MHz for channel-3 operation, 59.75 MHz for channel-2 operation. So, if operation on channel 3 is required, the value of C18 must be 68 pF. Operation on channel-2 requires C18's value to be 82 pF.

By changing the resonant frequency of the tuned circuits, the descrambler can be used at other frequencies than those of channel 2 or 3. For example, if your TV is "cable-ready" you would want to descramble the output of the tuner section. The output of the tuner is usually at 45.75 MHz (video carrier). The audio carrier is therefore located at 50.25 MHz. The tuned circuits could be adjusted for those frequencies by changing capacitors C1 and C3 to 10 pF, and changing the value of C18 to 130 pF.

The output of IC1 (pin 5) is the demodulated horizontal-sync pulses, as shown in Fig. 4. Most of the video on pin 5 of IC1 should be filtered by C13 and the input of Q3 (provided that the video is below the level that is needed to turn Q3 on). However, there will still be a small amount of video present between the horizontal-sync pulses. That video has to be reduced—which can be done by fine-tuning L2. (The result of too much video at pin 5 is false triggering of IC2. That shows up as streaking horizontal lines across the picture.)

When watching non-scrambled signals, we do not need the sync pulses from pin 5 of IC1. Therefore switch S1 is provided to shunt the sync pulses to ground. When the switch is open, however, the sync signals are sent to transistor Q3, which is used as a buffer. From there, the horizontal-sync signals are sent to IC2, a 74123 dual monostable multivibrator.

We use IC2 to form the horizontal-blanking interval from the demodulated sync signals. (The horizontal-sync pulses from IC1 are not the proper pulse width that we need.) The two R-C timing circuits associated with IC2 (at pins 6 and 7 and at pins 14 and 15) determine the pulse width of the output. Potentiometer R17 can be adjusted to "fine tune" the output for the pulse width that is needed—11 microseconds.

Once the proper pulse width is obtained for horizontal blanking, the signal from pin 5 of IC2 is fed to a voltage divider made up of R10 and R11. (The value shown for R11 works well when the input signal's level is between 50 to 70 millivolts. However, because different cable systems have different signal levels, it may be necessary to increase or decrease the value of R11.) From the voltage divider, the signal is fed to diode D2, where it is used to raise the DC level of the input signal—but as we mentioned before, only during the video portion of the signal.

During vertical blanking and horizontal blanking, no DC level is added to the signal. In effect, by increasing the DC level on the video—and only during the video—we are returning (with the help of the DC-restoration circuit in the TV) the horizontal-blanking pulse and colorburst information to their proper location on the composite-video signal.

Building the circuit

For those of you who want to experiment with the circuit we have been describing, we have included foil patterns for a double-sided board in Figs. 5 and 6. Although a double-sided printed-circuit board is used, plated-through holes are not necessary. That's because there are only seven connections that need to be

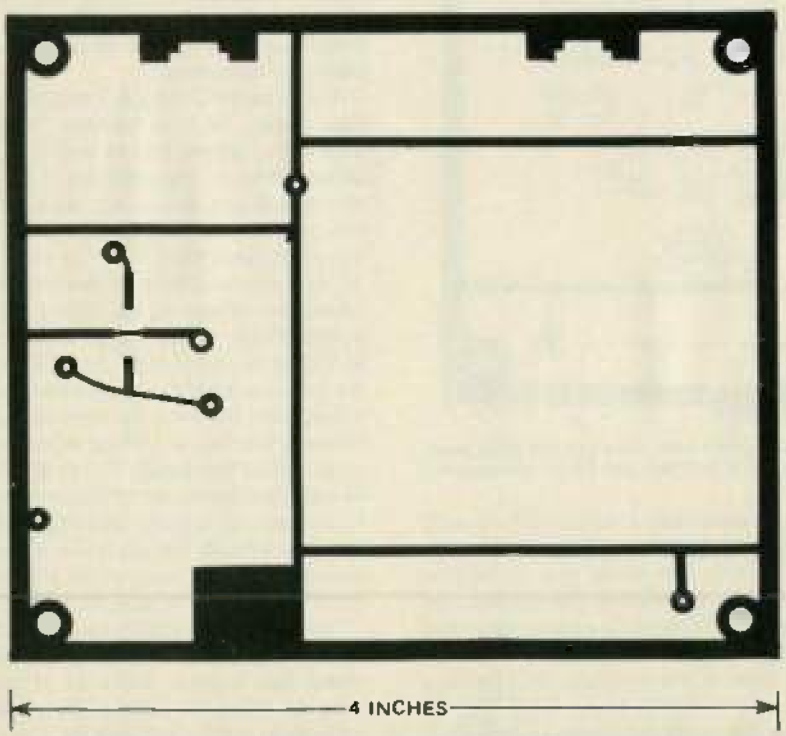


FIG. 5—THE COMPONENT SIDE of the decoder board. Note that there are only 7 connections to be made on this side of the double-sided board, so plated-through holes are not necessary.

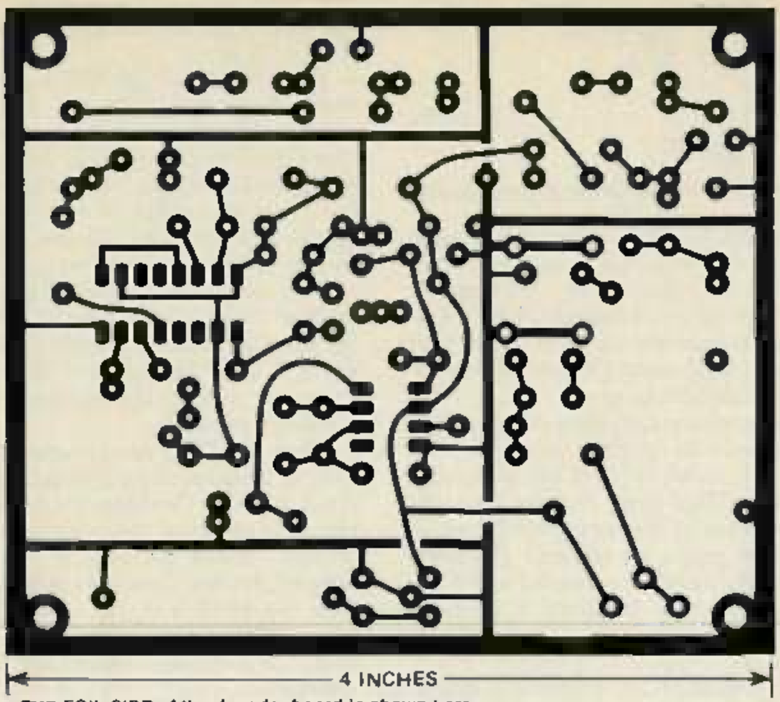


FIG. 6—THE FOIL SIDE of the decoder board is shown here.

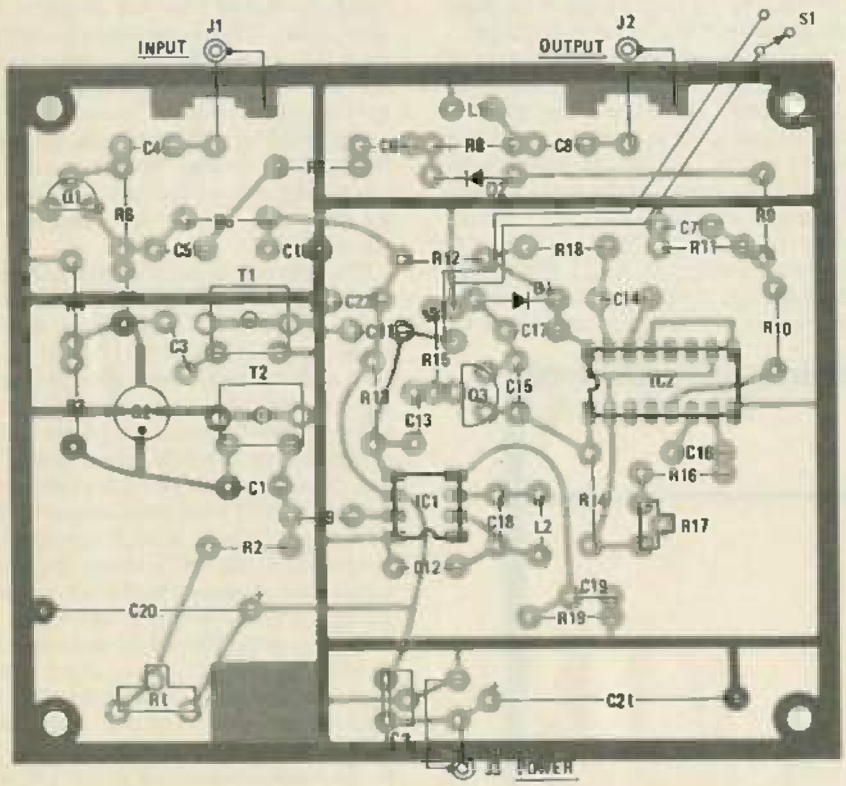


FIG. 7—PARTS-PLACEMENT and off-board connections are shown here. Note that the jacks used depend on your power source and RF connections. (We used a ⅛-inch jack and F-type connectors.)

soldered on both sides. Figure 7 is a parts-placement diagram for the board. Mount the components as close to the PC board as possible. When installing the electrolytic capacitors (C19, C20, and C21), be careful to check for proper polarity. The same holds true for the two diodes.

Transformers T1 and T2 must be modified so that they will fit into the holes on the PC board. That is, one of the pins—the one on the side of the transformer with the part number— on each has to be cut off. Be sure that when you install the transformer, the pin that you cut does not contact the PC-board's ground trace that runs under it.

To provide the regulator (IC3) with a heat sink, it should be mounted with its flat portion soldered to the board's foil. The leads of transistor Q2 (BFQ85) do not need to be placed through holes in the board. You can simply place it flat on the PC board and solder the leads to the foil (tack solder). Note that the dot on the parts-placement diagram indicates the collector lead. (Note that there is a dot on the transistor's package, too.) When we assembled our prototype, we mounted it in a plastic box and used an ⅛-inch jack for the input from the AC adapter, and F-type connectors for the signal input and output. The connectors that you use in your setup depend on what type of plug your AC adapter has, and what type of RF connectors you need to connect to your TV and cable converter.

Checkout and alignment

Do not hook up this device unless you are properly authorized to do so. As we continue, we will presume that you have received the proper authorization.

The first step is to plug the output from the AC adapter into J3. Using a voltmeter, check for +12 volts at the positive side of C20. Then check that you have +5 volts at pin 16 of IC2.

The next step is to tune to a scrambled station and connect the circuit between a cable-TV converter and your television. (Jack J1 is the input jack, and J2 is the jack for output to your TV.) Make sure that switch S1 is in the open position (not shorting the output of IC1 to ground). Then adjust potentiometers R1 and R17 to approximately the "12 o'clock" position. To set the coils in their approximate location, turn the slugs counterclockwise until the top of the slug is even with the top of the coil. Then turn the slugs clockwise as follows: T1, 2½ turns; T2 and L2, 3 turns. With those adjustments in their approximate locations, you can go on to the fine tuning of the circuit.

Using an oscilloscope, check the input signal level. If it is between 50 to 70 millivolts, adjust R1 so that you have about 4 volts on the collector of Q2. (As mentioned previously, the value of R11 may also have to be changed.) If the input signal is higher than 70 mV or lower than 50 mV, you will have to increase or decrease the voltage on the collector of Q2 proportionally. Next use an oscilloscope to look at the signal at pin 5 of IC1. Adjust the 3 coils to keep the level of the video to a minimum between the horizontal-sync pulses. (See Fig. 4.) When adjusting the coils, adjust them only ¼ turn at a time. Those adjustments are critical and have to be accurate. If you see streaking horizontal lines through the television picture at this point, it's because you are getting too much video and are false firing IC2.

Now, using an oscilloscope, look at the signal at pin 5 of IC2. Adjust R17 until the signal has a pulse width of 11 microseconds. When the pulse width is correct, you will be correctly gating the video sig-

continued on page 103

BUILD THIS

MHD GENERATOR

Learn the basic theory behind magnetohydrodynamic generators by building your own working model.

JOHN IOVINE

THIS ARTICLE WILL SHOW YOU HOW TO BUILD A WORKING MODEL of an MHD (*M*agneto*H*ydro*D*ynamic) generator for under $30.00. You're probably thinking, "Great! What's that?"

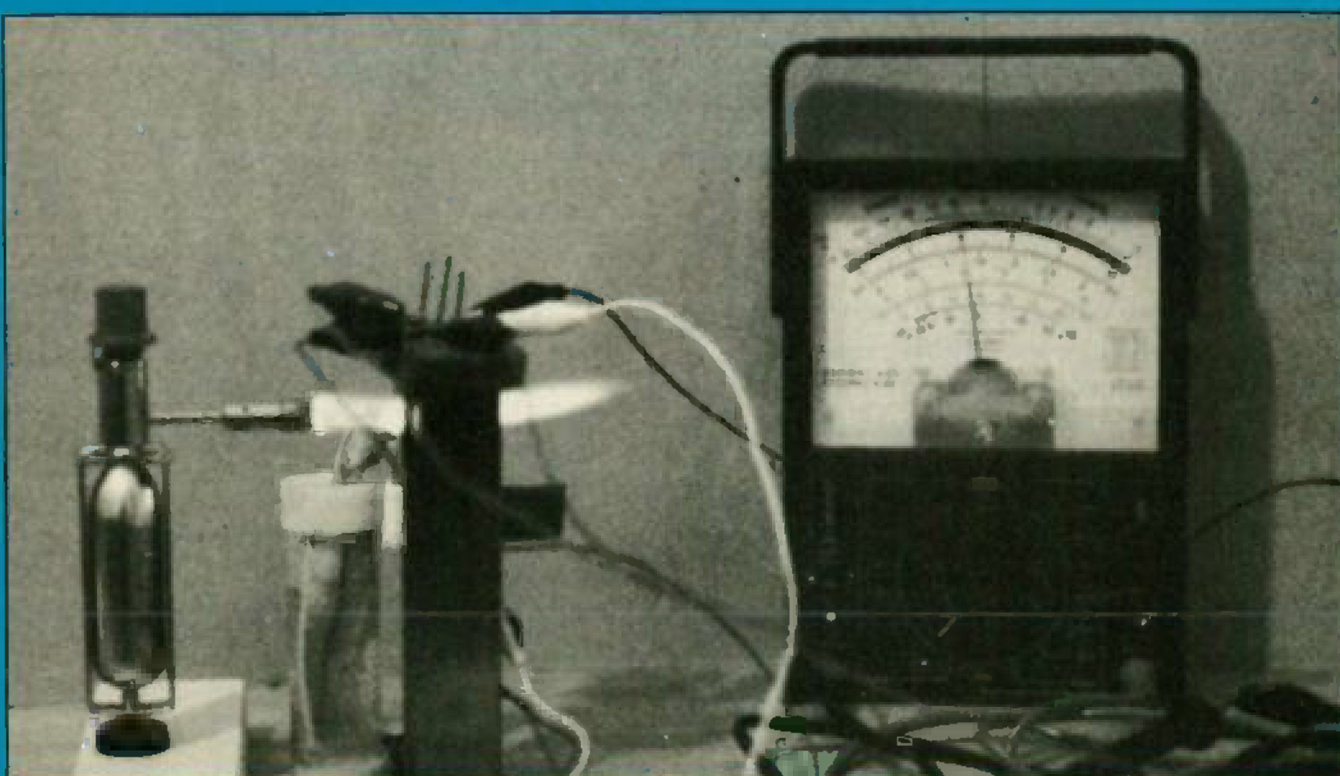
Before we can answer that question, we have to give a brief definition of what magnetohydrodynamics is: it's the study of the effects of magnetic fields on ionized gases or fluids. (It is often also called magnetogasdynamics or hydromagnetics.) An MHD generator uses an ionized gas and a magnetic field to generate an electric current. And it does it more efficiently than conventional power plants do. We don't expect to see commercial MHD power plants until the end of this century. But you can learn about MHD technology now as we discuss the basic theory and even build a working model of an MHD generator.

The power output of the model we will experiment with is on the order of one milliwatt. That certainly is not a lot of power, but it is enough to demonstrate some of the principles of MHD power generation—the same principles that will be used in full scale MHD power plants. We will give you some pointers on how to improve on the basic design. But we encourage you to have the simple model working properly before you try to make improvements.

It is beyond the scope of this article to deal with all of the mathematical formulas that can determine performance of MHD generators. But you will be working empirically with the factors that are involved. They include magnetic field strength, gas velocity, ion-seed concentrations and the Hall effect.

MHD basics

The basis of the magnetohydrodynamic generator is the same as conventional generators: A voltage is induced across a conductor that is moving in a magnetic field. Unlike conventional generators, however, the moving conductor in a MHD generator is not wire. Instead it is a high-velocity electrically-conductive gas (or fluid) stream. As shown in Fig. 1, the gas travels through a duct or *channel* in which a transverse magnetic field is present. An electric field is generated perpendicular to both the magnetic field and the direction of motion of the gas: $\boldsymbol{E} = \boldsymbol{u} \times \boldsymbol{B}$; where $\boldsymbol{E}$ is the electric field strength, $\boldsymbol{B}$ is the magnetic flux density, and $\boldsymbol{u}$ is the velocity of the gas. (Note that bold, italic letters indicate vector quantities.) If electrodes are placed in contact with the gas



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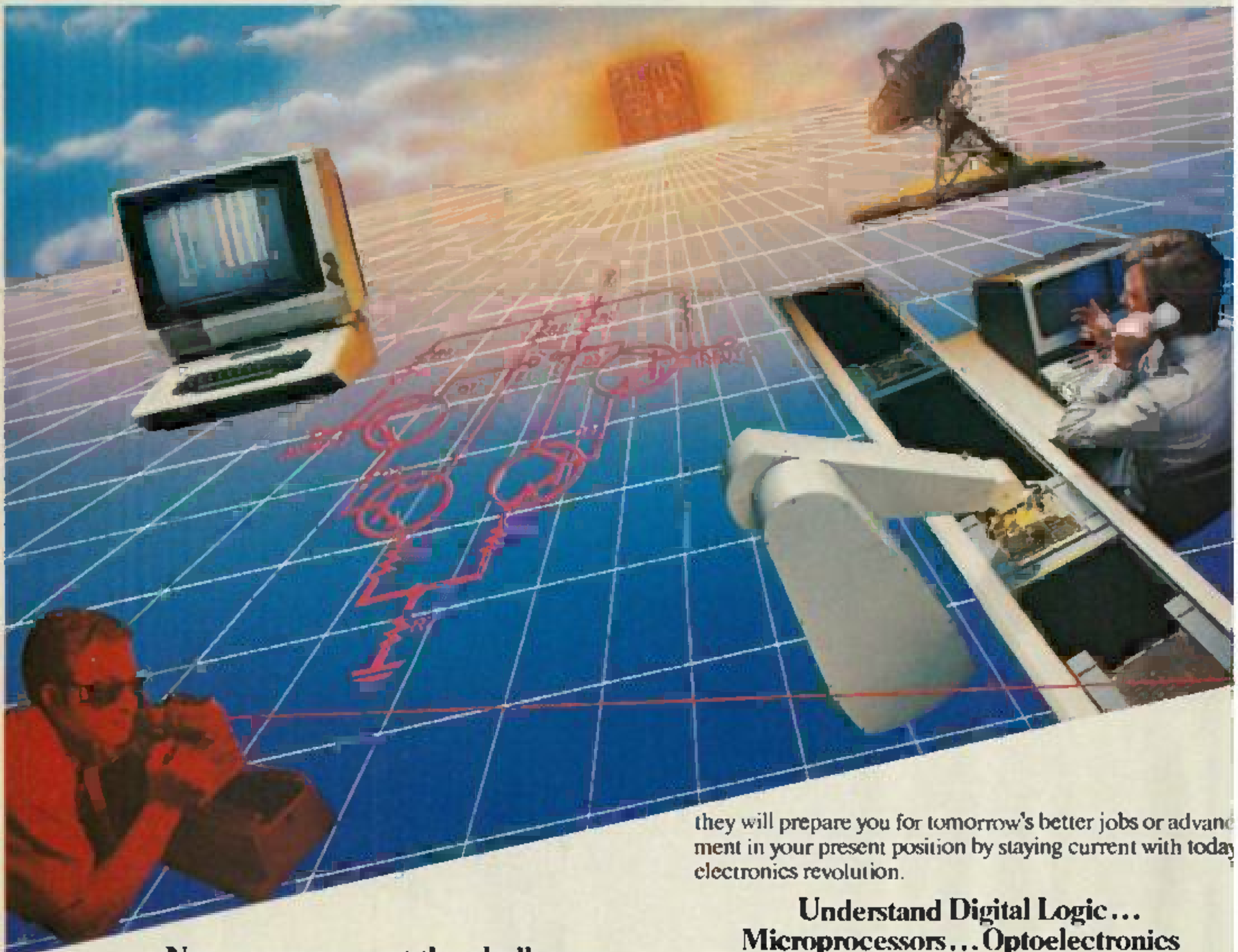

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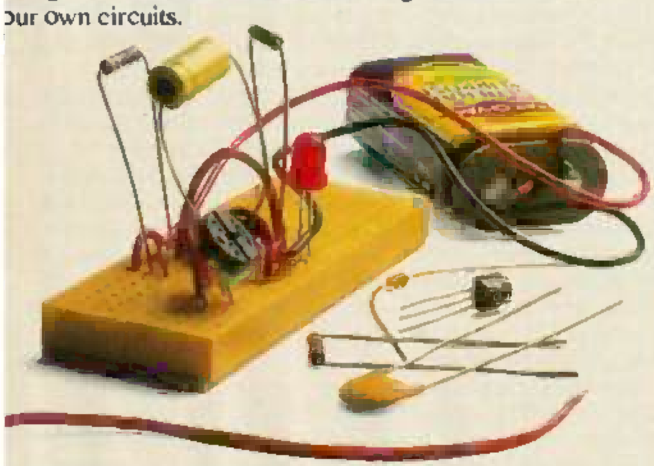

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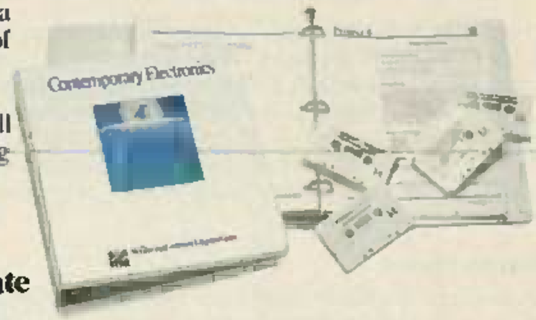

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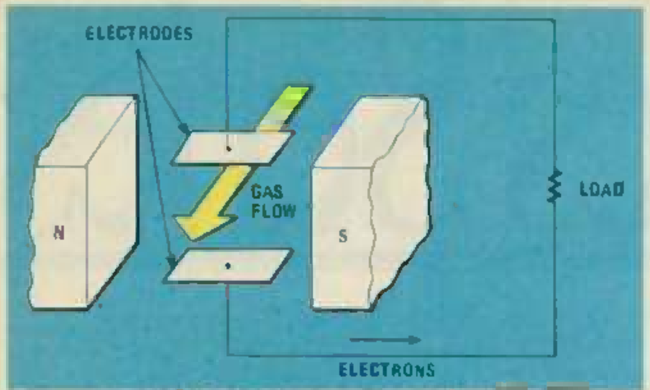


FIG. 1—A SIMPLIFIED DIAGRAM showing the basics of the MHD power generator is shown. As discussed in the text, the model that we'll build is different in several respects.

ject, energy can be extracted and delivered to an external load.

We see that some of the major factors that govern the voltage and current generated include the gas velocity and the magnetic field strength. Also important are the electrical conductivity of the gas, and the design and placement of the electrodes. Once you build the basic model and have it working properly, those are the factors that you should vary if you want to try to improve the performance.

Minimizing losses

The design of an efficient MHD generator is not a easy task. The study of electromagnetics, fluid mechanics, and heat transfer are involved. However, let's look at some of the ways to design a generator to keep losses to a minimum.

One of the most important loss factors is that of the Hall effect. When electrons move through the magnetic field, they are subject to a force, F (called a *Lorentz* force), that is perpendicular to both the direction of electron flow, u_e, and to the magnetic field: $F = eu_e \times B$, where e is the charge of an electron. As a result of that force, the electrons do not move in a straight path between the electrodes. Instead, they tend to flow to one end of the collecting electrode; thus, an electric field is generated. However, the electrode simply shorts the electric field, and so short-circuit currents flow in the electrodes and dissipate power. Those Hall-effect losses can be reduced by using a *segmented electrode*, as we will do in our model. That is, instead of using one pair of plate-like electrodes as shown in Fig. 1, we will use three smaller, independent sets of electrodes.

End loss is another factor that can reduce the effeciency of an MHD generator. End loss occurs because a shunt path between the electrodes is provided by the gas at the entrance and exit points of the generator channel. If the conductivity of the gas is high, the shunt currents at each end can introduce significant losses. End losses are reduced as the length of the channel increases with respect to its width. They can also be reduced by extending the magnetic field past the electrodes.

There are also *electrode losses* due to the fact that the gas at the electrodes is cooler than that of the rest of the chamber, and thus its conductivity is low. Those losses can be reduced in our model by keeping the flame as large and as hot as possible.

There are losses due to to skin friction (fluid dynamic loss). And there are also losses due to heat transfer (which can be reduced by increasing the ratio of channel volume to surface area). Because we are using permanent magnets in our model, we will not concern ourselves with losses due to producing the magnetic field. However, in a commercial MHD plant, those losses would be an important consideration.

How does a gas conduct?

The gases used in the MHD generator become conductive through a process known as *thermal ionization*. As the temperature of the gas is increased, the kinetic energy of the bound electrons increases until it reaches a point where the electrons are no longer bound to the atoms of gas. At that point, because of the free electrons, the gas becomes electrically conductive. That high-temperature, electrically conductive gas is called a *plasma*. In the plasma, along with the free electrons, there are also positive ions of gas (the atoms from where the electrons were originally bound). It is those free electrons and positive ions that are captured by the electrodes in the plasma, thus inducing the load voltage.

The temperature required to ionize a gas is usually extremely high, about 4500°C. We can reduce the ionization temperature by *seeding* the gas with an alkali metal that readily ionizes at much lower temperature. (An alkali metal is *univalent*—it has only one outer-shell electron, thus it ionizes at a relatively low temperature.) Potassium nitrate (which we'll use) and cesium nitrate are two alkali-metal salts that are commonly used for that purpose. We will use a small butane torch (with an output of about 1370°C) to achieve the temperature needed to ionize the seeded gas.

Why MHD?

New research is being conducted on the MHD generator for several reasons. First, the MHD generator promises to use fuel more efficiently than conventional generators do, especially when it is used as a *topping cycle* in a generating plant. In other words, MHD generators will not be stand-alone plants. Let's see how they'll be set up.

After the hot gas passes through MHD the channel, it is too cold to be sent to another MHD generator. However, that gas *is* hot enough to operate a conventional steam turbine, thus producing additional electricity. A commercial power plant using an MHD generator as a topping cycle is expected to be able to work with an efficiency of over 45%. Present-day coal-fired plants that use scrubbers obtain an effeciency of about 34%.

Another reason for renewed interest is that the MHD generator can use all conventional fuels, and it can use high-sulfur coal in an ecologically safe manner. (The particular fuel choice for an MHD power plant would depend on where the plant was located. For example, to make use of its large coal reserves, coal-fired generators would probably prevail in the United States.) Scrubbers, which remove sulfur from the smokestack emmisions of coal plants, are not needed for MHD generators because the sulfur combines chemically with the ion seed and can then then be separated and sold. In a coal plant, the sulfur is left in a useless limestone sludge.

There are some problems that have yet to be overcome. First the cost of MHD generating plants has to become economically competitive with other types of electric plants. And the reliability and life expectancy of MHD generators has to be increased. The major problem is that the electrodes deteriorate quickly because of the extremely high temperature of the gas in the generator. However, work has been done (at Avco Everett Research Laboratory) to suggest that water-cooled copper electrodes with stainless-steel and platinum cladding could have a lifetime of up to 8000 hours.

But, a question that remains unanswered is: How close is MHD power generation to being commercially viable? The goal of the National MHD Program (sponsored by the U.S. Department of Energy) is to have commercial MHD power stations in the early 1990's. Technologically, that is a fair timetable. But because of a lack of available funding, it is doubtful that commercial plants will appear that soon. However, the USSR is currently constructing their *U500*. That 500-megawatt, natural-gas-fired MHD generator is expected to be completed before the end of this decade.

Building the MHD generator

All of the materials that you'll need to build an MHD generator model are shown in Fig. 2. We'll begin construction with the *segmented-electrode* assemblies. First mold and cut a block of

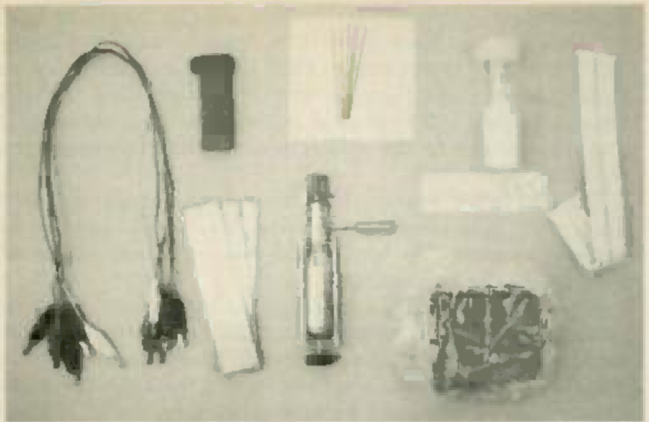
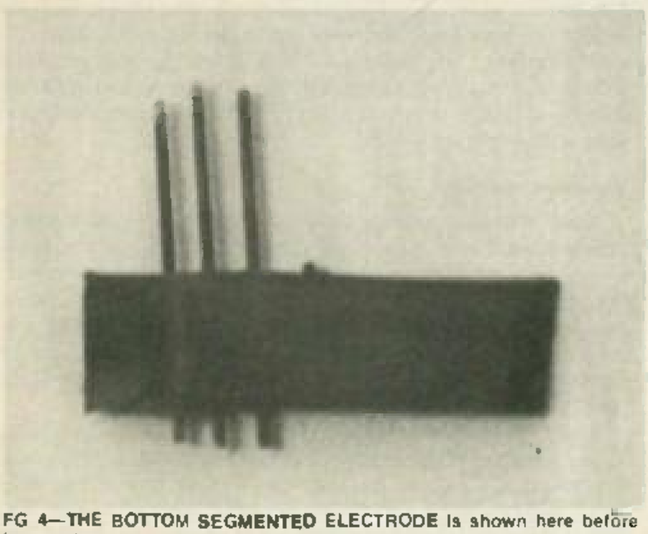


FIG. 2—ALL OF THE MATERIALS that you need to make a working MHD generator model are shown here.

FIG. 3—YOU NEED A PIECE of perforated construction board, about one inch square, to use as a template for electrode spacing.



FG 4—THE BOTTOM SEGMENTED ELECTRODE is shown here before installation.

clay approximately ⅜ inch thick by 1¼ inches wide by 2½ inches long. Then center a piece of perforated construction-board (about 1 inch square) on the clay block. That perforated board, whose holes are spaced on 1/10-inch centers, is used merely as a template for spacing and inserting the graphite electrodes. You'll want to make sure that the top and bottom electrode sets are spaced similarly. Although the actual spacing is not important, start by leaving 3/10 inch between each electrode segment.

Next gently insert the electrodes through the board and clay as shown in Fig 3. Use three electrodes to begin with. You want about ¼-inch of the graphite to be sticking out on top (for connecting to clip leads), and about ½-inch into the channel. If an electrode is too long, simply pinch and snap it at the desired length.

To make the second (bottom) segmented electrode, form some clay into a rectangular shape, 3/16 × ¼ × 2 inches. (The thickness of the clay should match the thickness of the center magnet that you'll be using.) Now insert three graphite electrodes. Use the perforated board to help set the spacing between electrodes the same as in the top electrode set. The bottom segemented electrode should be similar to that shown in Fig. 4.

When you have completed making the segmented-electrode assemblies, remove the perf-board template. Wrap the units loosely in aluminum foil and bake them in an oven at 375°F for an hour and a half, leaving the door of oven open approximately 2 inches. After baking, remove the assembly and allow to cool. Connect an alligator-clip lead to each of the electrodes. If you want, you can connect all of the top segments together and all of the bottom segments together, although in a commercial MHD generator, each set of electrodes is connected to its own load (or its own inverter to be converted to AC) as we show in Fig. 5. If an electrode breaks when you're connecting the test leads, use a straightened paper clip to push the electrode out of the clay, and replace it with a new one. You can also use that technique when the electrodes wear out from use.

The next unit to construct is the seeder, which is used to feed the alkali-metal salt solution into the flame. Almost any small

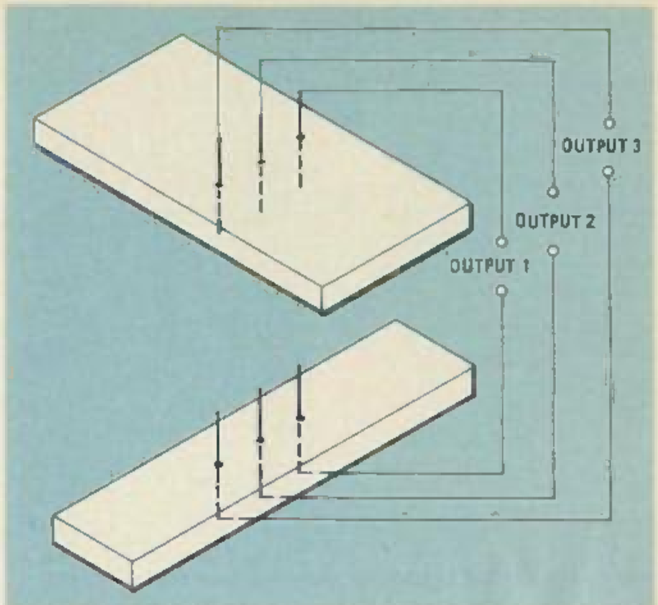


FIG. 5—THE "PINOUT" of the electrode assemblies. In a commercial MHD generator, each set of electrodes would feed its own inverter to be converted to AC.

PARTS LIST

½ pound modeling clay, oven baking
6 0.036-inch diameter carbon pencil leads
1 square inch perforated construction board
ounce potassium nitrate (KNO_3)
Alcohol-lamp wick
3 Ceramic magnets 3/16 × ¾ × 1 inch
3 Steel (pole and support) pieces 0.095 × 1 × 3 inches
1 container with cover (about 1 × 3 inches) for alkali-salt solution
1 butane torch (Radio Shack 64-2164 or similar)
Miscellaneous—alligator-clip leads, ceramic paper

A kit of all parts is available from Images Co., South Richmond Hill Station, Jamaica, NY 11419. The price of the kit is $30 including the torch, $20 without the torch. Please add $2.50 to cover postage and handling.

FIG. 6—THE SEEDER USED in our model was made from a coin tube.

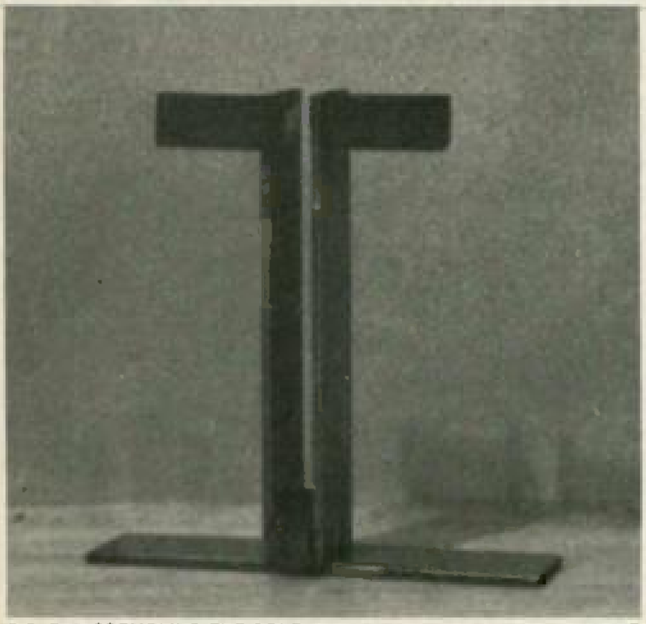


FIG. 7—ASSEMBLING THE POLE pieces and magnets to form the MHD chamber couldn't be easier.

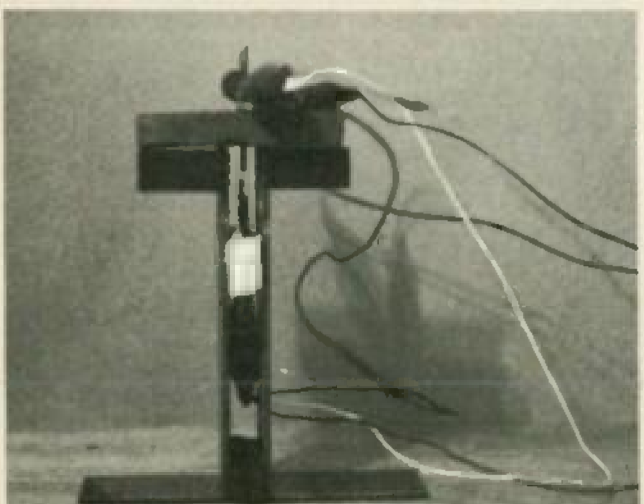


FIG. 8—THE ELECTRODE ASSEMBLIES should be placed between and on top of the support pieces as shown.

container with a tight-fitting lid can be used for the seeder. (The one shown in Fig. 6 was made from a plastic, tubular coin case that was used to store nickels.) Drill a hole near the edge of the lid large enough for the wick to pass through. Feed the wick through the hole and replace the lid back onto the container. To make the solution for the seeder, mix one part potassium nitrate with three parts water.

The next step is to arrange the three ceramic magnets and the three metal *pole pieces* as shown in Fig. 7. (Be sure to use ceramic magnets. We have found that very poor results are obtained if other magnet types are used.)

When that is done, we can install the electrode sets. Place the bottom segmented electrode in first. Make sure that the clip leads are attached before inserting it between the magnets. To ensure that the bottom electrode will fit snugly between the metal support pieces, you may want to wrap some ceramic paper around it.

The top set of electrodes just has to be placed on top of the assembly. Make sure that that set is directly on top of the bottom set. Leave about ¼ inch between the tips of the top and bottom segmented electrodes. When you attach clip leads to each of the top electrode segments, your assembly should look like that shown in Fig. 8.

Operation

Caution: Before you even turn the unit on, keep in mind that the generator can get *very* hot, so be careful.

To operate the generator, fill the seeder unit with the alkali-salt solution. Make sure that the electrodes are between the two pole pieces and not touching either side. Place the seeder unit at the entrance of the channel with the wick facing into the channel. You want the wick to feed into the flame just ahead of the nozzle of the torch.

Connect one set of output leads to your voltmeter. Start on a scale that reads about one volt. Following the manufacturer's instructions, start the torch and position it so that the base of the flame is just touching the wick, with the main flame projecting straight into the channel. Allow 20 seconds for the unit to heat up, and try to obtain as large and as hot a flame as you can. You should then observe a voltage reading on your meter. With the generator operating, cautiously move the torch one degree in each direction. You will hit a point where the voltage-output peaks. Don't forget this rule of thumb: The larger and hotter the flame you're able to maintain in the MHD generator, the higher your voltage output will be.

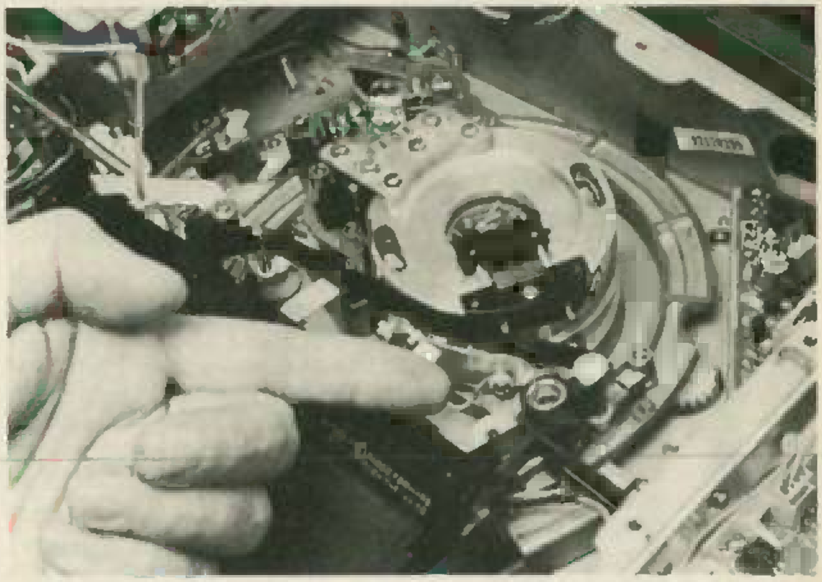
Troubleshooting

Using your voltmeter, measure the potential between the electrodes in each piece of clay. If a voltage is present, it is due to moisture in the clay. (The voltage is coming from some electrochemical reaction.) Either bake the clay again or wait 12 hours for the moisture to evaporate. A simple check for moisture is to set your meter to read resistance. If you get a reading between electrode segments of anything other than infinity, there is some moisture left in the clay.

If you fail to show any voltage when the unit is operating, use an ohmmeter to check that none of the electrodes are broken in the clay; also check all the test leads to be sure that they're in good working condition. Check the seeder unit to be sure that part of the wick is touching the flame. Otherwise it cannot feed the salt solution to the generator. Also, double check the dimensions of unit against the parts list and the photos.

Now that you have your MHD generator working, why not experiment? For instance, try using more electrodes for better coupling to the gas, or changing the electrode spacing. A different torch with a hotter output could be used. You could also try using metals other than steel for the support pieces, or using larger magnets to obtain a stronger magnetic field. After you've experimented with changing all of the variables, why not let us know what you come up with! **R-E**

VCR REPAIRS AND ADJUSTMENTS THAT YOU CAN DO



JOHN D. LENK

Repairing and aligning VCR's isn't easy, but it is possible to do some of the work yourself if you know how! In this article we'll tell you what repairs and adjustments you can make using standard test equipment.

Part 3 IN THIS MONTH'S ARTICLE we'll be looking at some VCR symptoms, and their likely causes. We'll also look at the steps that should be followed to be sure that your VCR is properly aligned.

Precautions when installing a VCR

In addition to all precautions described in the service or operating literature for the VCR, keep the following points in mind. Avoid placing the VCR in areas of high temperature or high humidity. Exposure to those environmental factors can harm the VCR and (especially) the cassette tape. The rear of the VCR should be at least 4 inches from the wall to maintain adequate heat dissipation. Make certain that the TV fine-tuning has been properly adjusted for either channel 3 or 4. The VCR output is displayed on the selected channel, but since that channel is not ordinarily used the fine tuning may not be precisely adjusted. Play back a tape that you know to be good, and adjust the TV fine tuning to get the best picture. Also make sure that the VCR fine tuning is properly adjusted.

If you have the job of demonstrating use of the VCR to someone, go over the operating instructions of the instruction manual in boring detail. Although operation of a VCR is simple to those familiar with electronic equipment, it may not be so to the general public, especially since a VCR has many more capabilities, and controls, than a TV. As a minimum, describe how to do the following: watch the TV, record a TV program, record one program on the VCR while watching another on the TV set, use the automatic recording timer to record while away from home, play back a recorded tape. If you can not do any of those yourself, do not attempt to service that VCR until you have studied the instructions, please!

One point often confused by those familiar with Beta or VHS, but not both, is in loading and unloading the cassette. With Beta, when the cassette compartment lid is closed, the tape is automatically loaded. For VHS, tape loading occurs after the lid is closed and the PLAY button is pressed.

To remove a Beta cassette, make sure that the power is turned on, and that the VCR is in the STOP mode. Press EJECT, remove the cassette, and close the lid. When a Beta compartment lid is raised by pressing the EJECT button, the tape is automatically unloaded, and the cassette supply and take-up reels disengage from the tape drive motors. (On some Beta VCR's, the EJECT button cannot be pressed except in the STOP mode. In other Beta VCR's, the EJECT button can be pressed, but does not actuate the circuit unless the VCR is in STOP.)

For VHS, when the STOP button is pressed, the tape is unloaded. The cassette can then be removed by pressing the EJECT button to release the cassette holder.

Checkout procedures for a VCR

Before we get into the detailed service notes where we discuss specific problems related to the major functional sections of a VCR, let us go over some simple, obvious steps to be performed before you start any service (and long before you tear into the VCR).

If the video playback or the TV picture is bad, set the program select switch to TV and check picture quality for each TV channel (using the TV channel selector). If the picture quality is still bad, check for defective antenna connections (or a faulty TV). Also check the TV fine tuning.

If the TV picture is good when the program select switch is set to TV, but the video playback is not good, set the program select switch to VCR, turn the TV to the inactive channel (3 or 4), and check reception on each channel by changing the setting on the VCR channel selector. If picture quality is bad, or there is no picture on all channels, it is possible that the TV fine tuning is not properly adjusted. If the problem appears only on certain channels, the VCR fine tuning is suspect (as is the VCR tuner).

If picture quality is good when viewing a TV broadcast through the VCR, try recording and playing back the program.

If noise is apparent (resulting in poor picture quality on playback but not when viewing through the VCR) it is possible that the video heads are dirty (head gaps are slightly clogged). If there is sound but no picture, the video head gaps may be badly clogged. If the playback picture is unstable with a new TV set (never previously used with the VCR), it is possible that the TV's AFC circuits are not compatible with the VCR. (We'll discuss that problem latter on.) If there is color beat (rainbow-like stripes on the screen) the problem may be interference rather than a failure in the VCR or TV.

Let's now go over specific symptoms and possible causes for some basic VCR troubles.

Record button cannot be pressed

Check that there is a cassette installed and that the safety tab has not been removed from the cassette. If necessary, cover the safety tab hole with tape. (The safety tab engages a plunger rod or switch when the cassette is inserted and the lid closed.) In most Beta systems, the RECORD button cannot be pressed unless the rod is pushed down by the tape. In VHS, the tab prevents a switch from closing. Closing the switch disables the record operation. If you want to keep a recorded program from being accidentally erased, you break off the tab so that the plunger is not pushed down, for Beta, or the switch can close, for VHS, and the record function is disabled. If you want to record on a cassette with the tab removed, cover the tab hole with vinyl tape.

No E-E picture.

If there is no E-E picture, check that the VCR program select switch is in the correct position. Also check the fine tuning on the TV. (The term E-E, or *E*lectric-to-*E*lectric, can be explained as follows. When the VCR is in the record mode, the record output circuit is also connected to the playback input circuit so that the video signal to be recorded can be monitored on the TV. Since the magnetic components (head, tape, etc.) have nothing to do with that signal, and the signal is passed directly from one electrical circuit to another, the function is called the E-E mode. When the heads and tape are involved in the normal record/playback cycle, the term V-V, or *V*ideo-to-*V*ideo is sometimes used.)

No color, or very poor color

If there is no color on playback, check the fine tuning on the TV. If the VCR fine tuning is misadjusted during record, color may appear while recording, but may not appear during playback. Always check the fine tuning of both the VCR and TV as a first step when there are color problems.

Playback picture is unstable

If you have periodic problems of picture instability, check the following: Has the VCR been operated in an area having a different AC line frequency? While recording, it is possible that a fringe-area signal was weak (intermittently) so that the video sync signal was not properly recorded? During recording, could there have been some interference or large fluctuations in the power supply voltage? Could the cassette tape be defective. Could the tracking control be improperly adjusted.

Both Beta and VHS machines have some form of tracking control that adjusts for minor variations between tapes recorded on one machine and played back on another machine. If the physical distance between the control head and video heads is different for the two machines, the playback signals are not synchronized, even though the servo is locked to the CTL signal. That condition can be corrected by physically moving the control/audio head stack in relation to the scanner. (That is one of the recommended service adjustment procedures for some VCR's.) But it is more practical to use the front panel tracking control, which shifts the relationship of CTL signal to the video tracks electrically.

Snow or noise during playback only

Check the tracking control!

Sound but no picture

Check for very dirty video heads. The same holds true for excessive black-and-white snow.

Tape stops during rewind

If the VCR has a memory counter, is the counter switch on? If the memory switch is on, the tape stops automatically at 999 during rewind (on most VCR's).

Rewind and fast-forward problems

If the rewind and fast-forward buttons can not be locked or operated, check to see if the cassette tape is at either end of its travel If the tape is at the beginning, rewind does not function. Fast forward does not function if the tape is at the end.

Cassette will not eject

Is the power on?

Feedback when using a microphone

Keep the microphone away from the TV. Turn down the TV volume.

Tape-speed-related problems

Those include such things as a noise band in the playback picture and picture instability with too high or too low pitched sound.

In some VCR's, the tape is automatically locked to the correct speed by the servo. However, many VCR's also require some manual switching. For example, certain Beta VCR's have a front-panel switch to select between Beta II and Beta III, as well as a rear panel switch for Beta I.

Some VCR service suggestions

The following points summarize some practical suggestions for servicing any VCR.

Initial setup

When a VCR is first connected to a TV, it is likely that the unused channel (3 or 4) of the TV is not properly fine tuned. When fine tuning the TV, operate the VCR in the playback mode using a known good cassette, preferably with a color program. If you try to fine tune the TV in the record or E-E mode, both the VCR and TV tuners are connected in the circuit, and the picture is affected by either or both tuners. With playback, the picture depends only on the TV tuner. Once the normally unused channel of the TV is fine tuned for best picture, the VCR tuner can be fine tuned as necessary.

Replacing a tuner

In many VCR's, the entire tuner is replaced as a unit in the event of failure, although some manufacturers supply replacement parts for their tuners, and include adjustment procedures for the tuner in the service literature. As a point of reference, a typical VCR tuner (including the IF) produces 1 volt P-P of video into a 75-ohm load. Typically, the audio output from the tuner is in the −10- to −20-dB range.

Replacing an RF modulator

In most VCR's, the RF modulator must be replaced as a package in the event of failure. No adjustments or parts replacement are possible. If you have proper audio and video inputs (and power) to the modulator, but there is no output (or low output), the modulator is most likely defective. As a point of reference, a typical RF modulator produces 1000 microvolts into a 75-ohm load (or 2000 microvolts into a 300-ohm load) on the selected channel.

Black-and-white picture circuits

Although the black-and-white (or luminance) circuits of any VCR are very complex, they are not the major cause of trouble. Mechanical problems are on top of the list, closely followed by servo and system control troubles. Also, although many circuits are involved, all of the circuits are found in three or four IC's. If all else fails, you can replace the few IC's, one at a time, until the problem is solved. (If only mechanical problems were that simple!)

The first step in servicing luminance circuits is to play back a known good tape, or an alignment tape. That will pinpoint the problem to playback or record circuits, or both. Then run through the electrical adjustments that apply to luminance, or picture, using the manufacturer's procedures.

If playback from a known good tape has poor resolution (picture lacks sharpness) look for an improperly adjusted noise canceler circuit, and for bad response in the video-head preamps. When making the manufacturer's adjustments, study the stairstep or color-bar signals for any transients at the leading edges of the white bars.

If the playback has excessive snow, try adjusting the tracking control, since mistracking can cause snow. Then try cleaning the video heads before making any extensive adjustments. (Cleaning the video heads clears up about 50% of all noise or snow problems.) If neither of those do the trick, then try electrical and mechanical adjustments. Make mechanical adjustments only as a last resort (even though snow and mistracking can be caused by mechanical problems).

If playback of a known good tape produces smudges on the leading edge of the white parts of a test pattern (from an alignment tape) or a picture, the problem is usually in the preamps, or in adjustments that match the heads to the preamps. The head/preamp combination is not reproducing the high end (5 MHz) of the video signals. The adjustment procedures usually show the head/preamp response characteristics.

If you see a herringbone (beat) pattern in the playback of a known good tape, look for carrier leak. There is probably some unbalance condition in the FM demodulators or limiters, allowing the original carrier to pass through the demodulation process. If very excessive carrier passes through the demodulator, you may get a negative picture. Recheck all carrier lead adjustments.

Most adjustment procedures include a check of the video output level (typically 1 volt P-P). If the VCR produces the correct output level when playing back an alignment tape, but not from a tape recorded on the VCR, you probably have a problem in the record circuits. The record current may be low (one symptom of low record current is snow), or the white-clip adjustment may be off. Look for details of those two adjustments in the manufacturer's literature.

Servicing color circuits

As in the case of black-and-white, the color (or chroma) circuits of a VCR are very complex, but not necessarily difficult to service (nor do they fail as frequently as the mechanical section). Again, the first step in color-circuit service is to play back an alignment tape, followed by a check of all adjustments pertaining to color. As in the black-and-white circuits, when performing adjustments, you are tracing the signal through the color circuits. (At least that is the case in most well-written VCR service literature.)

There are two main points to remember in regard to VCR color circuits. First, most color circuits are contained within IC's, possibly the same IC's as the black-and-white circuits. Also, both circuits are interrelated. If you find correct inputs and power to an IC, but an absent or abnormal output, you must replace the IC. A possible exception in the color circuits are the various filters and traps located outside the IC.

Second, in most VCR's, the reference signal input to the color converters comes from the same source for both playback and record (from crystal-controlled oscillators). If you get good color on playback, but not on record, the problem is definitely in the record circuits. However, if you get no color on playback of a known good tape, the problem can be in the color playback circuits or in the common reference signal. A good place to start color circuit signal tracing is to check any common source reference signals. Then check the AFC signals. If any of those signals are missing (or abnormal), the color will be absent or abnormal.

The following describes a few VCR color circuit failure symptoms, together with some possible causes.

If you get a "barber pole" effect, indicating a loss of color lock, the AFC circuits are probably at fault. Check that the AFC circuit is receiving the horizontal-sync pulses, and that the AFC voltage-controlled oscillator (VCO) is nearly on-frequency, even without the correction circuit. (Most electrical adjustments include such a procedure.)

If the hue control of the TV must be reset when playing back a tape that has just been recorded, check the color subcarrier frequency using a frequency counter.

If you get bands of color several lines wide on saturated colors (such as alternate blue and magenta bands on the magenta bar of a color-bar signal), check the automatic phase-control circuits, as well as the 3.58-MHz oscillator frequency.

If you get the herringbone (beat) pattern during a color playback, try turning the color control of the TV down to produce a black-and-white picture. If the herringbone is removed on black and white, but reappears when the color control is turned back up, look for leakage in both the color and luminance circuits.

If you get flickering of the color during playback, look for failure of the automatic color-control system. It is also possible that one video head is bad (or that the preamps are not balanced), but such conditions show up as a problem in black-and-white operation.

If you have what appears to be very severe color flicker on a Beta VCR, you may be losing color on every other field. That can occur if the phase of signal is not shifted 180° at the horizontal-sync rate when one head is making its pass. The opposite head works normally, making the picture appear at a 30-Hz rate.

If you lose color after a noticeable dropout, look for problems in the dropout-compensation circuit. Most VCR's have some form of dropout compensation circuit to sense any dropout of recorded signal. Those circuits compensate for dropout by using the preceding horizontal line signal. It is possible that the phase reversal circuits have locked up on the wrong mode after a dropout. In that case, the color signals have the wrong phase relation from line to line, and the comb filter is canceling all color signals.

It's usually easy to spot total failures in the servo system. If a servo motor fails to operate, check that the power is applied to the motor at the appropriate time. If power is there, but the motor does not operate, the motor is at fault (burned out, open windings, etc.). If the power is absent, trace the power-supply line back to its source. See if the system control circuits (usually a microprocessor) are delivering the necessary control signals.

The problem is not so easy to locate when the servo fails to lock on either (or both) record and playback. If the control signal is not recorded (or is improperly recorded) on the control track during record, the servo cannot lock properly during playback. So your first step is to see if the servo can play back a properly recorded tape.

There are usually some obvious symptoms when the servo is not locking properly. Often there is a horizontal band of noise that moves vertically through the picture if the servo is out of sync during playback. The picture may appear normal at times, possibly leading you to think that it is an intermittent condition. With a true out-of-sync condition, the noise band appears regularly (even though moving) and may cover the entire screen at times.

The symptoms for failure of the servo to lock during record are about the same as during playback, with one major difference. During record, the head-switching point (the point where head A is switched off and head B switched on, usually appearing as a break in the horizontal noise band) appears to move vertically through the picture in a random fashion.

Another way to check if the servo is locking on either record or playback involves looking at some point in the rotating scanner or video-head assembly under fluorescent light. When the servo is locked, the fluorescent light produces a blurred pattern on the scanner that appears almost stationary. When the servo is not locked, the pattern appears to spin. Try observing the scanner of a known-good VCR under fluorescent light. Stop and start the VCR in the record mode. Note that the blurred pattern spins when the scanner first starts, but settles down to almost stationary when the servo locks.

Once you have studied the symptoms and checked the servo playback with a known good tape, you can use the results to localize the trouble in the servo. For example, if the servo remains locked during playback of a good tape, you can assume that the circuits between the control head and servo motors are good.

Keep in mind that servo troubles may be either mechanical or electrical, and may be the result of either improper adjustment or component failure (or both). As a general guideline, if you suspect a servo problem, start by making the electrical adjustments that apply to the servo. That may cure the servo problem. If not, you will at least see if all of the servo-control signals are available. A block diagram of a servo-control system is shown in Fig. 16. That diagram shows where in the servo system the control signals are found. If one or more of the signals are missing or abnormal, you have a good starting point for servo troubleshooting.

If the VCR has rubber belts to drive servo motors, the belts may stretch (or be otherwise damaged) and cause servo problems. If you have replacement belts available, compare the used VCR belts for size. Hold a new and used belt on your finger under no strain. If the used belt is larger, or does not conform to the new belt, install the new belt and recheck the servo for proper locking.

Keep in mind that the servo adjustments may be so far from normal that the

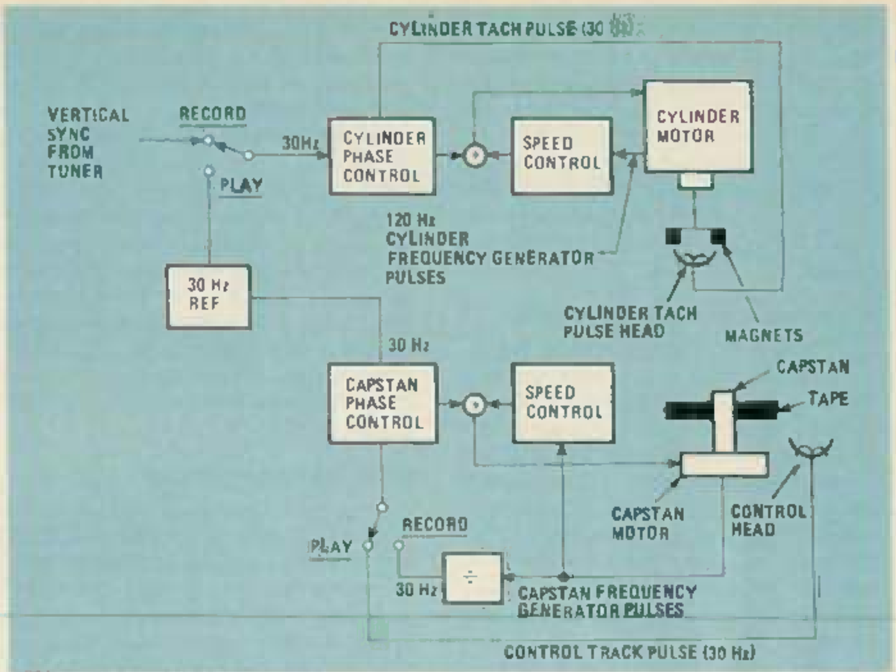


FIG. 16—BLOCK DIAGRAM of a VHS servo system. This diagram shows the location of all of the typical servo control signals.

servo simply cannot lock up. The only sure way to check that is to run through the servo adjustments.

Interchange operation

When a VCR plays back its own recordings with good quality, but the playback of tapes recorded on other machines is poor, the VCR is said to have *interchange* problems. Such problems are almost always located in the mechanical section of the VCR (usually in the tape path) and are often the result of improper adjustment. The simplest way to make interchange adjustments is to monitor the RF output from the video heads during playback and adjust elements of the tape path to produce a maximum, uniform RF output from a factory alignment-tape. Generally, the output is measured at a point after head switching so that both heads are monitored. But always follow the manufacturer's alignment procedures.

Wow and flutter

As is the case with audio recorders, wow and flutter are almost always present in all VCR's. To find out how much wow and flutter are present, use the low-frequency tone recorded on the alignment tape and a frequency counter connected to the audio line at some convenient point. Typically, the low-frequency tone is on the order of 333 Hz, and an acceptable tolerance is ±0.03%. You will probably use the period mode of the frequency counter to make that measurement. You can also use the special wow-and-flutter test equipment found in audio and hi-fi shops, but it is not really necessary. Any wow and flutter that does not show up when using the alignment tape and frequency counter is most probably not objectionable. The cause of wow and flutter can be either electrical or mechanical in origin.

Servicing systems-control circuits

Each VCR has its own system-control functions, and you must learn those functions to properly service any VCR. However, all system-control circuits have elements in common. In most VCR's, microprocessors accept logic-level control-signals from the VCR operating controls, and from various tape sensors. In turn, the microprocessor sends control signals to the various circuits, as well as drive signals to solenoids and motors. We will concentrate on the stop control-functions here, since those stop (or failure) functions are most likely to confuse those not familiar with VCR's.

Figure 17 shows the basic circuits of a VHS-system stop control. The VCR is stopped when the STOP button is pressed, when the tape runs to either end (forward and reverse), or when there is mechanical trouble.

Both ends of a VHS tape are transparent. The tape passes between an end-sensor lamp and two end-sensor phototransistors. When the tape reaches either end (supply or take-up), the light passes through the transparent portion of the tape onto one of the phototransistors. When either phototransistor receives light, it applies a signal to the IC, which stops and unloads the VCR. The VCR also stops should the end-sensor lamp fail. Without that feature, the tape could break at either end. If the lamp burns out, the cathode voltage of the Zener diode increases, and the increase is applied to

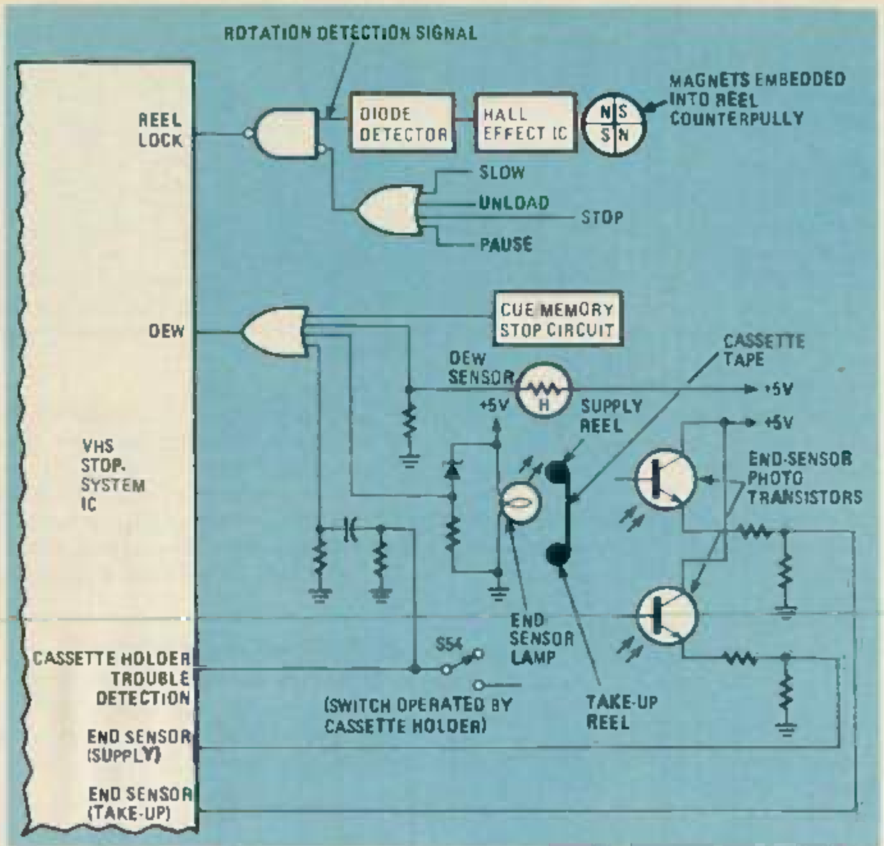


FIG. 17—THE STOP SYSTEM used in a typical VHS recorder. Its functions include sensing end-of-tape and excess humidity conditions.

the stop-system IC through the OR gate. The end-of-tape condition can be simulated by exposing the phototransistors to light; that should result in an immediate stop and unload. The end-of-tape function can be disabled (for service) by covering the phototransistor with opaque tape or a cap. Do not remove the light source for the end-of-tape sensor on a VHS machine! That is sensed as a lamp-failure condition by most VHS units.

When changes of temperature and humidity cause condensation of dew on the surface of the video scanner, that is detected by the dew sensor; and the stop mode is produced to prevent damage to the tape and mechanism. In Fig. 17, the dew-sensor output is applied to the IC through the OR gate. When relative humidity is less than about 80%, the resistance of the dew sensor is about 100 megohms. When humidity increases above about 80% the resistance drops to about 3 megohms, and the voltage at the junction of the sensor and the resistor increases. That increase is applied to the IC through the OR gate, and stops the VCR.

The reel-lock circuit detects when the reel motor has stopped rotating, except when the tape should not be running at the normal speed (unloading, loading, pause, step slow, etc.). The NAND-gate output is high when the reel disk is rotating, or when operating mode signals are applied to the OR gate. When reel rotation stops, the NAND-gate output goes low, and the IC causes the VCR to unload and stop. That can be prevented by applying an override signal to the OR gate. The rotation-detection signal is developed by diode detectors, a Hall-effect element, and magnets (usually embedded into the reel counterpully). When the reel is rotating, the magnetic field also rotates, and causes the Hall element to produce a current. That current is rectified and doubled by the detector to become the rotation-detection signal. If rotation stops, the alternating current stops, as does the detection signal, and the IC removes power to the tape-drive motor, preventing damage to the tape. The detector can be checked by holding the take-up reel. That causes the take-up clutch to slip (to prevent damage) but the detector senses that the reel is not turning, and produces an automatic stop.

The cassette-holder trouble-detection circuit detects if the cassette holder is in the eject condition (by sensing a switch that is operated by the holder). If the eject button has been pushed, the VCR is placed in the stop mode by the switch. To disable the cassette-holder-trouble function (that is often necessary to do during service), locate the mechanism that actuates the switch and hold the mechanism in place with cellophane tape. In many cases, it is possible to operate the VCR through all its modes without a cassette installed if the switch can be actuated manually. Always check that all automatic-stop functions work, and that all bypasses and simulations (covers on lamps, tape on switches, etc.) are removed after service!

Beta VCR's have similar stop functions (in the event of trouble) but the circuits are different. The two major differences are in the end-of-tape and reel sensors. Both ends of Beta tape are covered with foil. When the foil at the start of the tape approaches a forward sensor coil (the coil of an oscillator), the Q of the sensor coil decreases, as does the oscillator output (indicating that the tape is at the start position). The rewind sensor operates the same way, except that the rewind-circuit oscillator-signal output drops when the foil at the end of the tape passes the oscillator coil (placing the VCR in the stop mode, and indicating that the tape must be rewound). For Beta, the end-of-tape foil can be simulated by placing a piece of foil near the coil of either sensor.

The reel-sensor circuit of a Beta VCR usually consists of a phototransistor and an LED, arranged around the base of a take-up reel as shown in Fig. 18. The phototransistor receives light from the LED; the light passes through the slots at the bottom rim of the take-up reel base while the reel is in motion. When the take-up reel stops rotating, the light is blocked off from the phototransistor. When that happens, the sensor circuit produces a signal that places the VCR in its automatic-stop mode to prevent the damage to the tape.

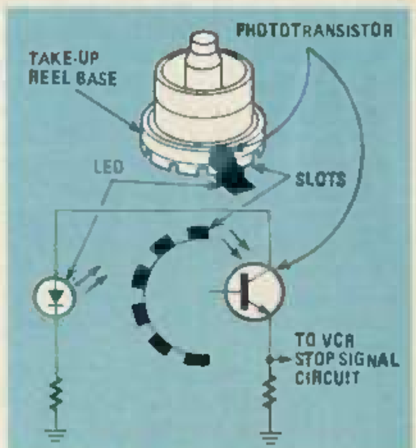


FIG. 18—THIS REEL-MOTION sensor circuit is used in Beta VCR's.

Most VCR's have some form of tape-slack sensor. Slack tape can cause damage (as can condensation, belt rupture, a sudden stop of the reel motor, etc.). Tape-slack sensors can be checked by visual inspection and by pressing on the switch with your fingers to simulate slack tape. If the tape-slack sensors include a microswitch (as is the case with most Beta VCR's), the sensor circuit can be disabled by forcing something like a match against the sensor to keep the switch from triggering. (That is useful if you want to run the VCR without a tape.)

Video-camera sync

If you have trouble using a video camera (perhaps one not designed for the VCR, possibly an inexpensive surveillance camera) you may have an interlace problem. Most cameras designed for use with VCR's—even those from different manufacturers—are compatible with any VCR. That's because such cameras have a 2:1 interlace. Some inexpensive cameras have a random-interlace, where the horizontal and vertical sync are not locked together. The playback of a recording made with a random interlace camera usually has a strong beat pattern (herringbone effect). One way to confirm a random-interlace condition is to watch the playback while observing the last horizontal line above the vertical-blanking bar. Operate the TV's vertical-hold control as necessary to roll the picture so that the blanking bar is visible. If the end of the last horizontal line is stationary, the camera has a 2:1 interlace and should be compatible. If the end of the last horizontal line is moving on a camera playback, the camera is not providing the necessary sync and probably has random interlace.

TV AFC compatibility

If the AFC circuits of a TV are not compatible with a VCR, skewing may result. In most VCR literature, the term "skew" or "skewing" is used to indicate that the upper part of the reproduced picture is being bent or distorted by incorrect back-tension on the tape (caused by improper mechanical adjustment). However, you can get that same effect if the TV's AFC circuits can not follow the VCR playback output. That condition is very rare in newer TV sets (designed for VCR's and videodiscs), and appears only in about 1% of older TV sets (and almost never when the TV and VCR are made by the same manufacturer). So do not go into the TV's AFC unless you are absolutely certain that there is a problem. First try the VCR with a different TV, then try the TV with a different VCR.

Once you are convinced that there is a compatibility problem, the easiest cure is to reduce the time constant of the integrating circuit of the TV's AFC (see Fig. 19): that's done by changing the circuit values.

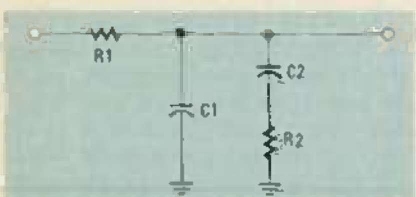


FIG. 19—COMPATIBILITY PROBLEMS can sometimes be solved by making changes in the TV AFC's integrating circuit.

To reduce the time constant, reduce the values of either or both capacitors C1 and C2, reduce the value of R1, or increase the value of R2. It is generally not necessary to change all four values. Be sure to check the stability of the TV's horizontal sync after changing any of the values in the AFC circuit.

Maintenance

We'll end this article by describing some typical maintenance procedures for VCR's. Keep in mind that those procedures do not necessarily apply to your specific VCR. When servicing VCR's, *be sure that you follow the manufacturer's instructions exactly*. Also, the procedures here are only the highlights, and only cover those areas common to most VCR's. All VCR's have many special-purpose adjustments that apply to their particular circuits. However, by studying the examples here, you should be able to relate the procedures to a similar set of adjustment points on any VCR, and to identify typical signals found in most VCR's (even though the signals may appear at different points in your particular unit).

Cleaning and lubrication

Table 1 shows the recommended maintenance intervals for most VCR's. However, never lubricate or clean any part not recommended by the manufacturer. Most VCR's use sealed bearings that do not require lubrication. A drop or two of oil in the wrong places can cause damage!

TABLE 1—SUGGESTED MAINTENANCE

Component	Operation
Video Heads	Clean every 500 hours
Audio/Control Heads	Clean every 500 hours
Pinch Head	Clean every 500 hours
Erase Head	Clean every 500 hours
Supply Head	Clean and lubricate every 2000 hours
Take-up Reel	Clean and lubricate every 2000 hours
Fast-Forward Roller	Clean and lubricate every 1000 hours
Clutch Pully	Lubricate at 2000 hours, then every 1000 hours
Rewind Idler	Lubricate at 1000 hours, then clean and lubricate every 1000 hours
Capstan Assembly	Clean every 1000 hours
Loading Gear	Clean and lubricate every 1000 hours

Clean off any excess, or spilled, oil. In the absence of a specific recommendation, use a light machine oil, such as sewing-machine oil. Although there are spray cans of head cleaner, most manufacturers recommend alcohol and cleaning sticks or wands for all cleaning. Methyl alcohol does the best cleaning job but can be a health hazard. Isotropyl alcohol is usually satisfactory for most cleaning.

Video-head cleaning

Turn the power switch off, and pull out the power cord. Rotate the video-head disk by hand to a position convenient for cleaning the video heads, as shown in Fig. 20. Moisten a cleaner stick with alcohol, lightly press the buckskin portion of the stick against the head drum, and move the head disk by turning the motor back and forth. Clean both heads (on opposite sides of the drum) following the same procedure. **CAUTION:** Do *not* move the cleaner stick vertically while in contact with the heads. Always clean the heads in the same direction as the tape path. Cleaning across the tape path can damage the heads.

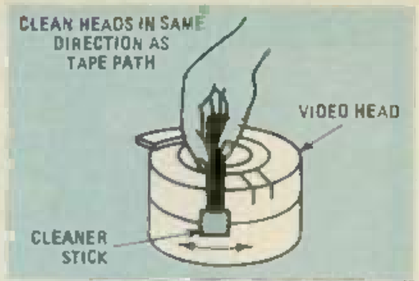


FIG. 20—CLEANING THE VIDEO HEADS. Be sure to always clean in the same direction as the tape path.

Audio control and erase-head

Moisten the cleaner stick with alcohol, press the stick against each head surface, and clean the heads by moving the stick horizontally, as shown in Fig. 21.

Tape-path cleaning

Figure 22 shows the tape path for a typical Beta VCR. Clean the drum surface and each tape-guide surface with a soft cloth moistened with alcohol. When cleaning the drum surface, be careful not to touch the video heads with the cleaning cloth. Rotate the video-head disk by hand

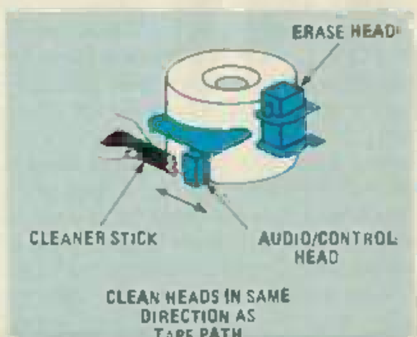


FIG. 21—WHEN CLEANING the audio/control and erase heads, move the cleaning stick horizontally as shown.

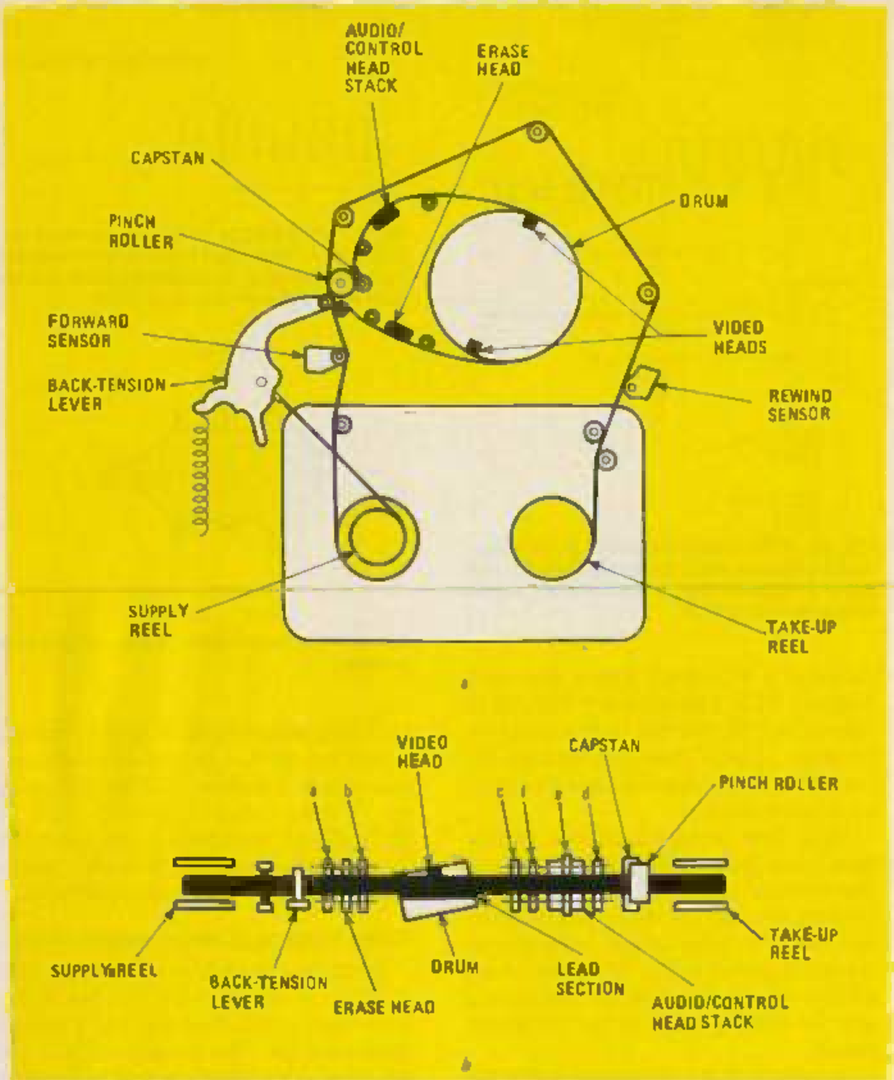


FIG. 22—TAPE PATH for a Beta VCR. Note that the location of the screw adjustments mentioned in the text are shown in *b*.

to move the head away from the spot to be cleaned.

Tape-path adjustments

The tape path for most VCR's is critical to proper operation. For that reason, the position and height of the tape guides and heads are precisely adjusted at the factory. Since those components greatly affect normal tape running, never touch the them unless necessary. First check operation of the VCR using an alignment tape and a known good monitor or TV. If the playback is good, quit while you are ahead. If you have playback problems, then (and only then) make the following adjustments (which are typical for VCR's with a tape path similar to that shown in Fig. 22).

1. **Connect a good monitor** or TV to the VCR, and an oscilloscope to a test point that monitors the video-color signal output of the playback amplifier circuits.

2. **Play back an alignment tape** (video portion) and observe the waveform (envelope) on the scope. Figures 23 and 24 show some typical envelopes.

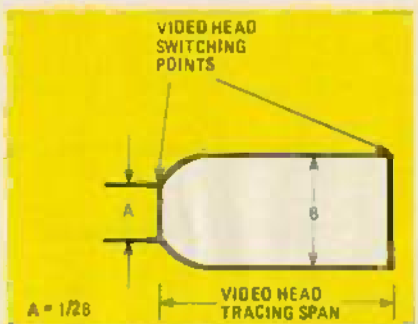


FIG. 23—ADJUST THE WAVEFORM so that the amplitude at A is equal to one half that at B. Note that only one period of the waveform is shown here for simplicity.

3. **Adjust the VCR tracking control** for the maximum waveform amplitude on the scope.

4. **Observe the running state** of the tape around the back-tension lever (Fig. 22). If you see any slack at the top or bottom edges, slightly bend the back-tension lever (with the appropriate tool) to eliminate the slack.

5. **Adjust** screw B (see Fig. 22-b) so that the top edge of the tape does not hit against the guide at the side below the screw.

6. **Observe the waveform** on the oscilloscope, and adjust screws A and B so that the amplitude at A is equal to one-half of the amplitude at B, as shown in Fig. 23. Note that A is measured at the video-head-switching point, and B is measured at 40% of the video-head-tracing span. Check that slack does not develop along screw A, screw B, or the lead section during those or any other adjustments.

7. **Adjust** screw C so that the tape top edge does not hit against the guide below. Then adjust screw C and D to make the waveform amplitude at C equal to one-half that at B, as shown in Fig. 24. While doing that adjustment, check that the tape-bottom edge is steadily in contact with the flange shoulder below screw D. Also, use an inspection mirror to check for slack along screws C, D and the lead section. The type of mirror used by dentists is very handy for checking tape slack at inaccessible points. The proper adjustment of screw C will give you the optimum waveform as described with no slack.

8. **Ideally, the center** portion of the video-head waveform should be flat after all the adjustments are complete. For acceptable performance, the minimum amplitude should be no less than 60% of the maximam amplitude at the center portion of the waveform.

9. **Switch the scope** from the video-head test point to the audio-output test point.

10. **Play back** the alignment tape (audio portion) and monitor the audio-signal output waveform. Adjust screw E for maximum amplitude.

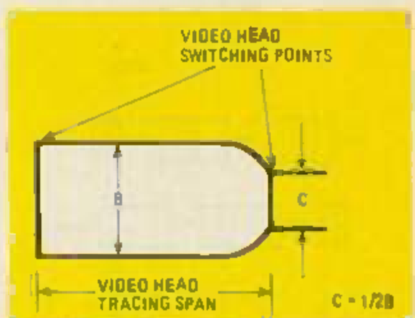


FIG. 24—WHEN THE NEXT SET of adjustments is completed, the amplitude at C should be one half that at B.

11. **Switch the scope** back to the video-head test point. Set the tracking control at the center position (at the click stop).

12. **Adjust screw** F for maximum video-signal amplitude.

13. **Turn the tracking control** to the right and left, and make sure that the waveform changes symmetrically.

14. Check operation of the VCR by recording and playing back a program. If the playback is good, you have made all of the adjustments correctly. Either that or you have fantastic luck!

Video-head-switching adjustments

Most VCR's have some form of video-head-switching adjustments. Before we get into some typical adjustments, let us consider how the switching circuits operate. The playback signals from the video heads are amplified and mixed to produce a continuous noise-free signal as shown in Fig. 25. Note that the overlap of the signals from channel 1 (head A) and channel 2 (head B) at the heads is eliminated by pulses that switch the channel 1 and 2 outputs so that channel 1 is off at the instant channel 2 is on (and vice versa). The switching pulses are called by various names (RF switching pulses, drum FF pulses, etc.) and originate in the servo system.

The video-head-switching adjustments for Beta and VHS are essentially the same, but with minor variations. In both cases you connect a scope to the video output of the VCR, and trigger the scope with pulses from the servo. Then you insert an alignment tape, and play back a color-bar signal. For VHS, the display is something like that shown in Fig. 26 on both channels, except that the switching pulse is inverted on one channel. (Generally, it is necessary to set the scope's trigger slope to "+" for one channel, and to "–" for the other channel.) With VHS, you set the switching adjustment so that head switching occurs 6.5 horizontal lines (6.5 H) before the start of the vertical sync pulse, as shown in Fig. 26. (If you don't know the difference between the vertical-sync pulse and the equalizing

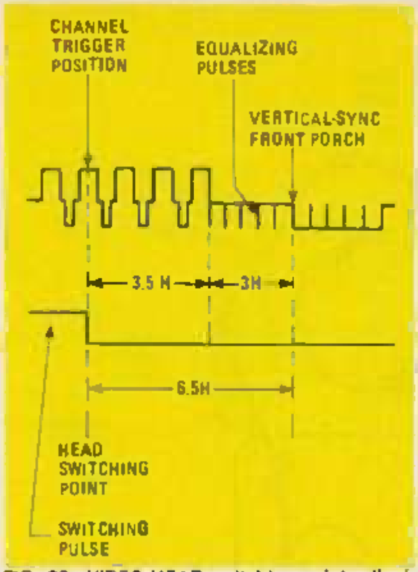


FIG. 26—VIDEO-HEAD-switching-point adjustments are made while observing the video output of a recorder. The output waveform shown here is for a VHS VCR.

pulses of a TV signal, please stay away from my VCR!) Because it is difficult to measure 6.5 H, you may want to measure for about 220 microseconds between the start of the scope triggering and the equalizing pulses instead.

Most Beta service literature recommends that the switching pulse occurs so that there is a 7-H (±0.5 H) difference between the edge of the switching pulse and the front edge of the vertical-sync signal, as shown in Fig. 27. Often, there are two adjustments (one for trailing and one for leading edge of the switching pulse).

No matter what is recommended by the VCR service literature, keep the following in mind when you make the head-

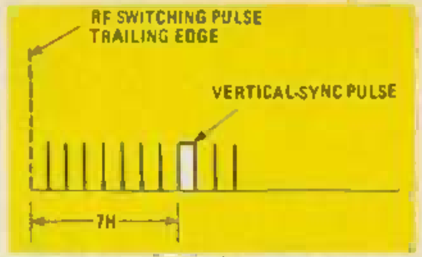


FIG. 27—FOR A BETA VCR, most literature recommends a 7 horizontal-line difference between the trailing edge of the switching pulse and the front edge of the vertical-sync pulse.

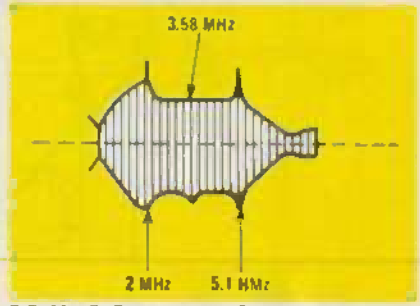


FIG. 28—THE RESPONSE OF a typical playback preamp.

switching adjustments: If head switching occurs too soon, a narrow band of noise may appear at the bottom of the picture on the TV being used to monitor the VCR. If the head-switching pulse is late, noise can be introduced during vertical sync, possibly resulting in vertical-sync problems.

Video-head resonance adjustments

Since the playback signal from the video heads is on the order of a few millivolts, their output is amplified by one or more preamps. The preamp circuits are provided with controls that make it possible to adjust video-head resonance and Q to produce an overall flat response (or some particular response). Figure 28 shows the response of a typical preamp. It was obtained by playing back the RF-sweep portion of an alignment tape. Typically, you set the adjustments so that the response is flat between about 2 and 5 MHz, and so that the signal levels on channels 1 and 2 (heads A and B) are equal. In some VCR's, you need to set the controls to get a peak response at one frequency.

Other adjustments

Although we have been through the major adjustments found on all VCR's, you will find many more adjustments in VCR literature. We will not cover those since they are unique to each model of VCR, or are similar to adjustments in other equipment. For example, all VCR's have power-supply adjustments where you set the various outputs to given voltage levels, and all VCR's have tuner/IF adjustments that are usually quite similar to those of a TV set. Both Beta and VHF

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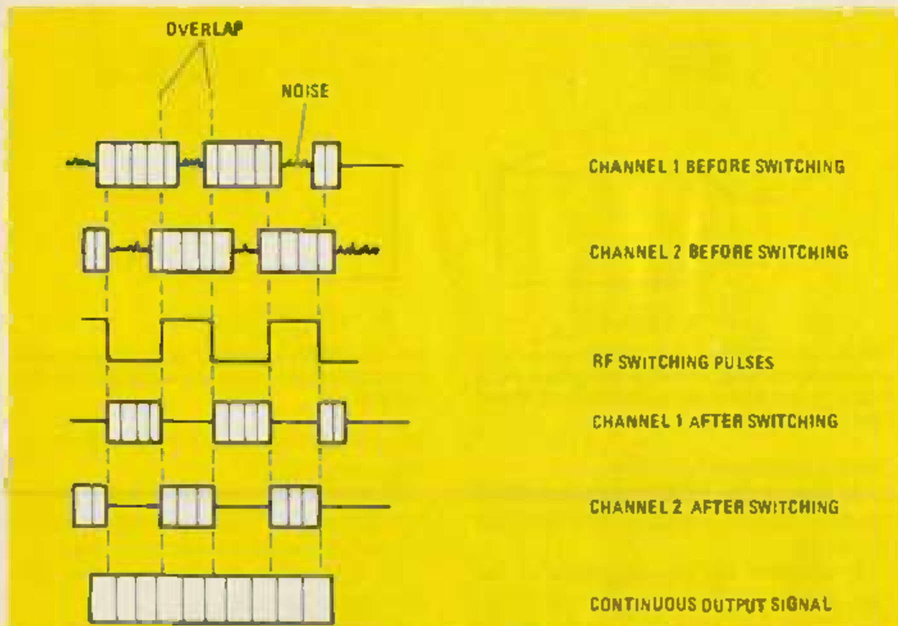
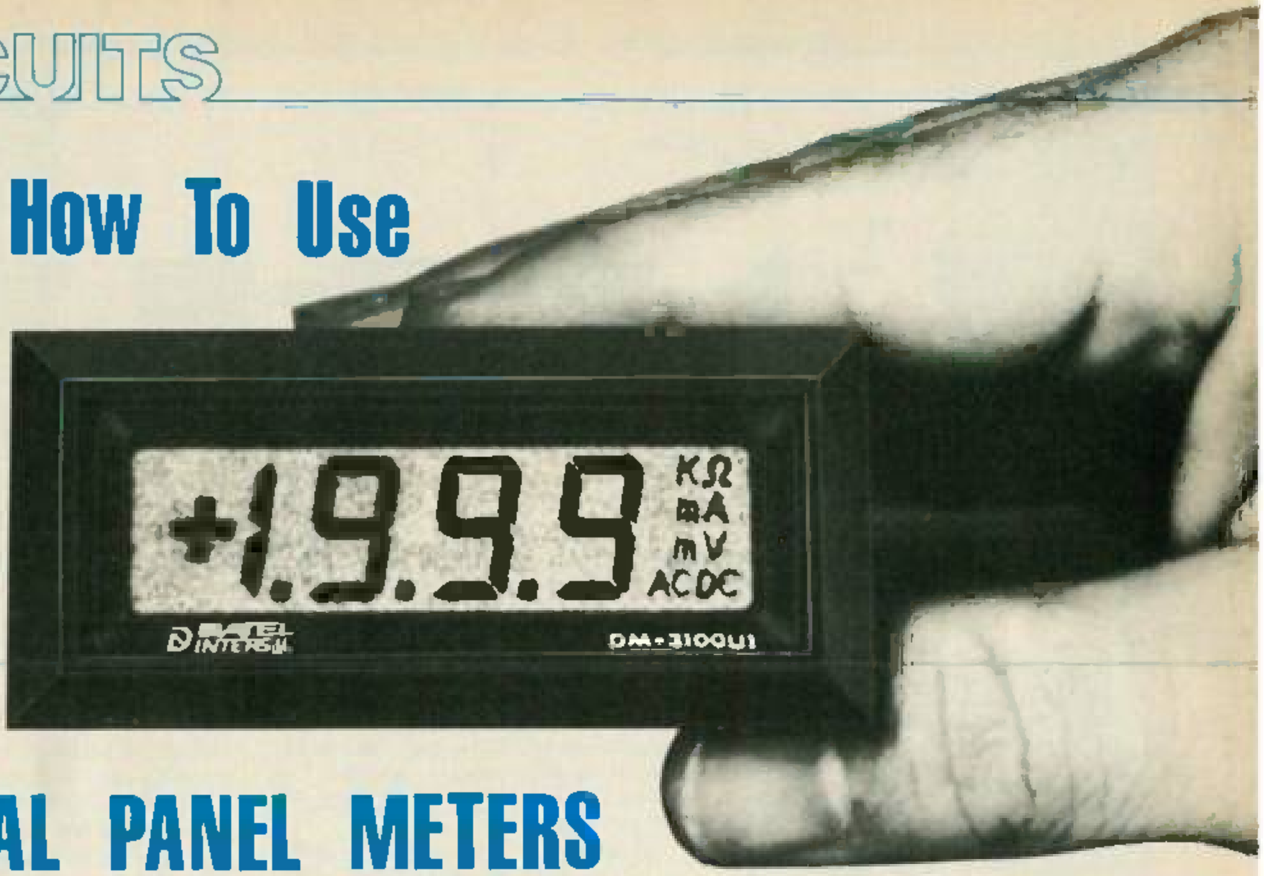


FIG. 25—THE SWITCHING PROCESS shown here produces a continuous output signal from the two video heads.

How To Use DIGITAL PANEL METERS



Modern digital panel meters can easily be used to measure voltage, current, resistance, capacitance, frequency, temperature—and a whole lot more.

RAY MARSTON

TAKE A LOOK AT THE TEST-EQUIPMENT market these days and you're sure to notice one thing—just about every VOM, or any other type of meter for that matter, uses a digital display. It's really not all that surprising considering the advantages that digital displays offer in the way of easy readability and better resolution.

But what about your own projects? There's really no reason not to use a digital display in any application that requires measuring an analog quantity such as voltage, resistance, current, temperature, or what have you. That's especially true now that easy-to-use digital panel meters are available from a number of manufacturers. In this article, we are going to take a look at those devices, and how to use them in a variety of applications.

Most digital panel meters combine an analog-to-digital (A/D) converter IC, a 3½ digit LCD or LED readout, a voltage reference, and a few other components, into a compact module that costs little more than a good-quality moving-coil meter. As supplied, the meters typically have an input range of +1.999-to −1.999-volts DC, 1-mV resolution, and a typical calibrated accuracy of 0.1% ±1 digit. They can easily be used to read any desired voltage, current, or resistance range, however, by connecting the appropriate external circuitry.

Several companies manufacture digital panel meters. The meter we'll be looking at here is the DM-3100U1 from Datel-Intersil (11 Cabot Boulevard, Mansfield, MA 02048). Generally, however, digital panel meters differ only in details of their internal circuitry and displays, and in the number and notations of their user-available terminals. As such, our discussion, and the circuits we'll present, can be easily generalized and applied to almost any of the other units on the market.

The DM-3100U1

Figure 1 shows a block diagram of our device. The pinout of its rear card-edge connector is shown in Fig. 2. The device normally operates on +5 volts DC and typically draws just 12 mA; power can be provided by either alkaline batteries or an inexpensive 5-volt regulated DC supply. Also, if an external reference (more on that later) is not required for a particular application, the meter can be simply powered from a 9-volt alkaline battery.

The heart of this particular meter is an LSI circuit that includes a dual-slope A/D converter and the necessary 7-segment-display drivers all in one unit. In essence, that IC automatically compares the relative values of an input voltage and a reference voltage, and uses the ratio of the two to generate the readout.

To ensure maximum versatility, provision has been made to allow for the use of an external reference when the meter is in the +5-volt mode. That reference is connected between pins B1, REFERENCE IN, and A15, EXT. REF. LOW. The panel meter also has a built-in internal reference available at pin A1, REFERENCE OUT. That reference is approximately +1 volt above the ANALOG RETURN input, pin B2. To use the internal reference, pins A1 and B1 are simply jumpered together. When we look at some sample applications for the device, we will show examples using both the internal and an external reference.

Before you use any digital panel meter in a project it is a good idea to know a bit about it. While we have already touched upon several important points, there are a few more that bear mentioning.

As supplied, and when configured as shown in Fig. 3, the meter has a full-scale input range of −1.999- to +1.99-volts DC. Claimed accuracy at 25°C is ± 0.1% of reading, ± 1 count. The resolution is 1 mV. The calibration can be adjusted using a multiturn screwdriver potentiometer.

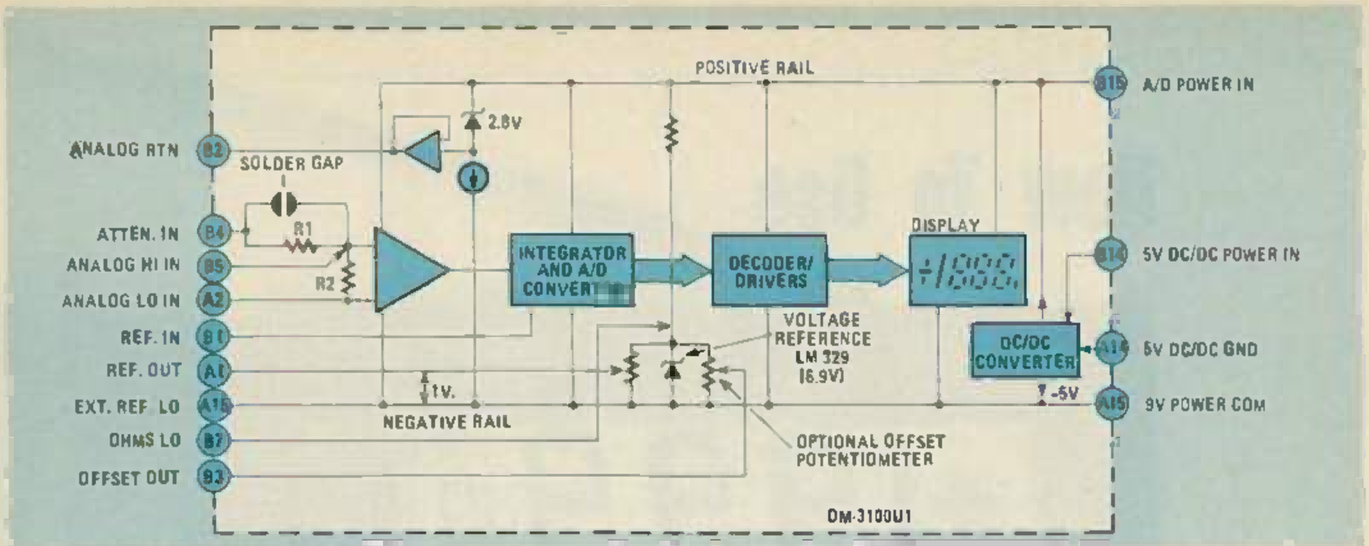


FIG. 1—SIMPLIFIED BLOCK DIAGRAM of the DM-3100U1 digital panel meter from Datel-Intersil.

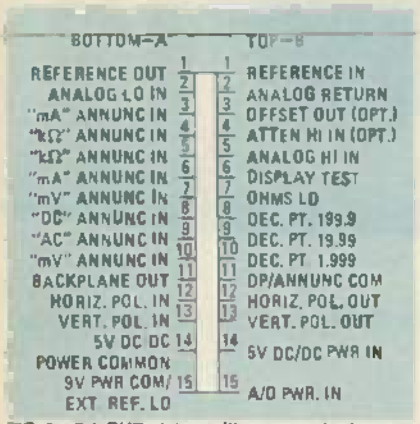


FIG. 2—PINOUT of the unit's rear card-edge connector. The pinout is shown here with the unit tilted on its side.

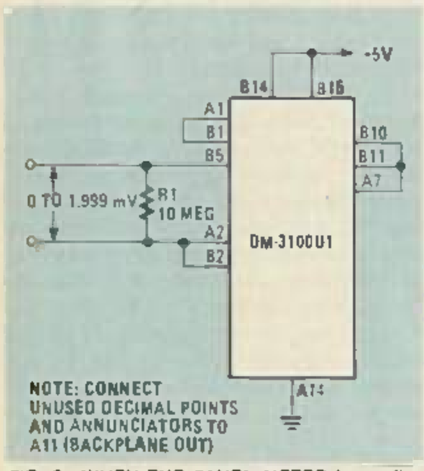


FIG. 3—WHEN THE PANEL METER is configured as shown, it will measure DC voltages from +1.999 to −1.999. The 10-megohm resistor across the meter's input is included to ensure proper auto-zeroing. It is otherwise optional and need not be included.

and the recommended recalibration-period is 90 days.

Differential input signals are applied to ANALOG HI and ANALOG LO, pins B5 and A2 respectively. To prevent the voltages at those inputs from exceeding the common-mode voltage range—$+V_S$ − 0.5 volts to $-V_S$ + 1 volt, where $+V_S$ is the positive rail (pin B15) and $-V_S$ is the negative rail (pin A15)—they must be externally tied to ANALOG RETURN, or POWER COMMON (A14) if the device is +5-volt powered.

Three decimal points (pins B8–B10), the vertical and horizontal portions of the polarity indicator (pins A13, B13, A12, and B12), and a variety of function annunciators (pins A3-A10) are available to the user. To select a decimal point or a function annunciator, simply connect it to DECIMAL POINT COMMON, pin B11. All unused decimal points and function annunciators should be connected to BACKPLANE OUT, pin A11.

There are two points we should mention concerning the function annunciators. First of all, they are only display labels. The meter cannot measure resistance, current, or AC without the appropriate user-added circuitry. We'll be looking at some of that circuitry shortly. Second, you'll notice in Fig. 2 that some of the annunciators are identified with one of the letters underlined. When those annunciators are selected, only the underlined portion is displayed.

Turning to the polarity indicator, for normal auto-polarity operation, pins A12 and B12, as well as pins A13 and B13, are jumpered together. For reverse-polarity sensing, pins A12 and B13 are jumpered together (no other connections). If the polarity sign is not wanted, the unused pins are again connected to BACKPLANE OUT, pin A11.

The meter uses a 3½-digit LCD readout. The readout is not backlighted, so sufficient room light is required. The digits themselves are ½-inch high. Overrange is indicated by a blanked display with the exception of the leftmost digit (1) and the polarity indicator. The sampling rate as supplied is 3 conversions-per-second, but that can be changed by the user to up to 20 conversions-per-second.

The DM-3100U1's input impedance is rated at 100 megohms minimum, and its input bias current is rated at 5-pA typical, 50-pA maximum. Those last two factors are significant because they mean that the meter will not load down any sensitive circuitry that is connected to its inputs.

Physically, the panel meter measures a compact 2.53×3.25×0.94 inches and weighs 5 ounces. It can be mounted in any

DIGITAL PANEL METER, this DM-3100U1 from Datel-Intersil features selectable function annunciators and decimal points, as well as auto-polarity and auto-zeroing.

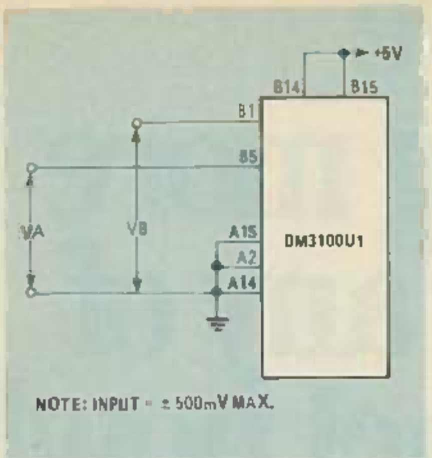
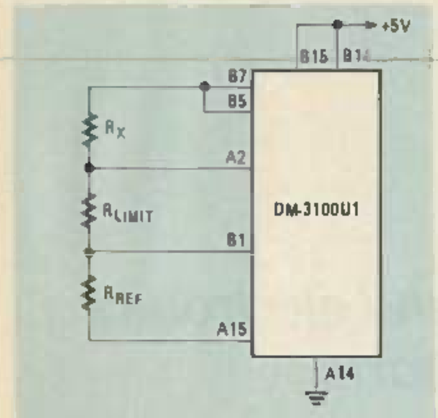


FIG. 4—A SIMPLE RATIOMETRIC VOLTMETER. When the inputs are identical, the meter will read 1000.



RANGE (FULL SCALE)	R_{LIMIT}	R_{REF}
19.99 MEG	22 MEG	10 MEG
1.999 MEG	3.6 MEG	1 MEG
199.9 K	360 K	100 K
19.99 K	36 K	10 K
1.999 K	8.2 K	1 K

FIG. 5—A RATIOMETRIC ohmmeter. The limiting resistor is included to constrain the voltage through the resistor series to 100 mV maximum.

position and has a claimed operating temperature range of 0°C to 50°C.

Applications

Figure 3 shows how to configure the meter to act as a simple voltmeter. As shown in the figure, the meter can handle inputs from −1.999-volts DC to +1.999-volts DC. For simplicity, we've kept the interconnections to a minimum. In this, as well as the remaining examples we'll look at, it is assumed that the polarity sign has been set up for auto-polarity readings as described earlier. Note that the v annunciator and the appropriate decimal point have been connected to pin B11; although not shown, all other annunciators and decimal points should be connected to BACKPLANE OUT, pin A11. In the remaining examples the annunciator and decimal- point connections will be eliminated for clarity. The 10-megohm resistor connected across the input terminals is

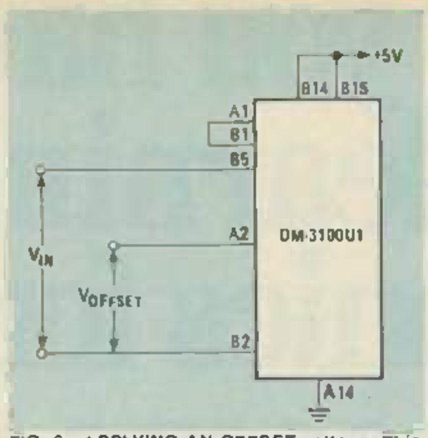


FIG. 6—APPLYING AN OFFSET voltage. This configuration is useful in applications where scaling is required.

included to insure proper auto-zeroing. It is optional and can be omitted if you desire.

Figure 4 shows how to set up the panel meter so that it acts as a simple ratiometric voltmeter. In that configuration, when two input voltages (V_A and V_B) are identical, the meter will read 1000.

It's relatively simple to configure the DM-3100U1 to act as a precision ohmmeter. Such a circuit is shown in Fig. 5.

The circuit takes advantage of the meter's ratiometric measuring capabilities. An external reference resistor—whose resistance, accuracy, and drift with temperature is known—is connected in series with the unknown resistance and a current limiting resistor. You'll recognize the fact that the series resistors form a voltage divider. The voltage to the three, a regulated 6.9 volts, is supplied via the OHMS LO output, pin B7; note that that pin is used only in resistance-measuring applications. The voltage drop across R_X and R_{REF} is compared by the meter and the result is used to calculate the resistance of the unknown. The current-limiting resistor is selected to keep the current though the series combination to a maximum of 1 mA; it serves no other function in the circuit. The values for R_{REF} and R_{LIMIT} for different ranges of R_X are also shown in Fig. 5.

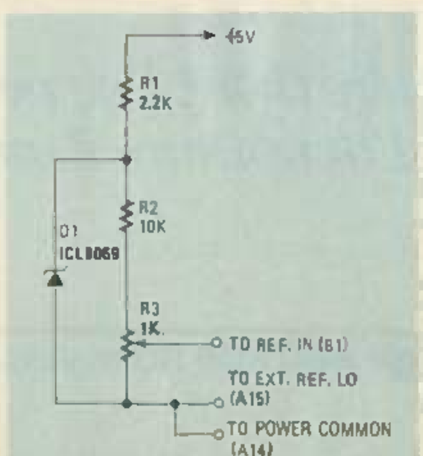


FIG. 7—A 100 MV external standard. The heart of this circuit is a 1.2-volt band-gap reference.

TABLE 1—SUPPLIERS

In addition to the manufacturer mentioned in the article, digital panel meters are available from a wide variety of sources. Some of those sources are listed below.

Ametek
2 Station Square
Paoli, PA 19301

Analog Devices
PO Box 280
Norwood, MA 02062

Analogic Corporation
Audubon Rd.
Wakefield, MA 01880

API Instruments
1601 Trapelo Rd.
Waltham, MA 02254

Ballantine Labs
90 Fanny Rd.
Boonton, NJ 07005

Data Precision Corporation
Electronics Ave.
Danvers, MA 01923

Fluke Manufacturing Company
Box C9090
Everett, WA 98206

Non-Linear Systems
533 Stevens Ave.
Solana Beach, CA 92075

Sigma Instruments
170 Pearl St.
Braintree, MA 02184

Simpson Electric Company
853 Dundee Ave.
Elgin, IL 60120

Weston Instruments
614 Frelinghuysen Ave.
Newark, NJ 07114

Finally, Fig. 6 shows how an offset voltage can be applied to the basic "DVM" circuit so that the display reads zero when the input voltage and the offset voltage are identical. That can be useful in a number of applications. Consider, for instance, a temperature-sensing application in which the sensor is scaled to produce an output of 1mV/°K. In other words, that sensor will produce an output of 273.2 mV at 0°C and 373.2 mV at 100°C. By feeding the output of the sensor between pins B5 and B2, and applying a 273.2 mV offset voltage between A2 and B2, the meter can be made to give a direct reading of temperature in degrees Centigrade.

DC voltage and current meters

As was mentioned earlier, provision has been made in the panel meter we are

If you have put off learning more electronics for any of these reasons, act now!

☐ *I don't have the time.*

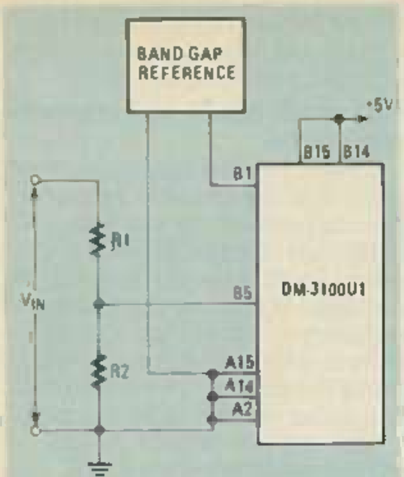
☐ *High school was hard for me and electronics sounds like it may be hard to learn.*

☐ *I can't afford any more education.*

☐ *I have a family now.*

☐ *I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.*

Read the opposite page and see how you can get started today!



R1	R2	$V_{FULL\ SCALE}$
0	10 MEG	199.9mV
9 MEG*	1 MEG	1.999mV
9.9 MEG*	100K	19.99V
10 MEG	10K	199.9V
10 MEG	1K	1.999kV

*SEE TEXT.

FIG. 8—THE VOLTMETER'S input range can be expanded easily using a simple voltage divider.

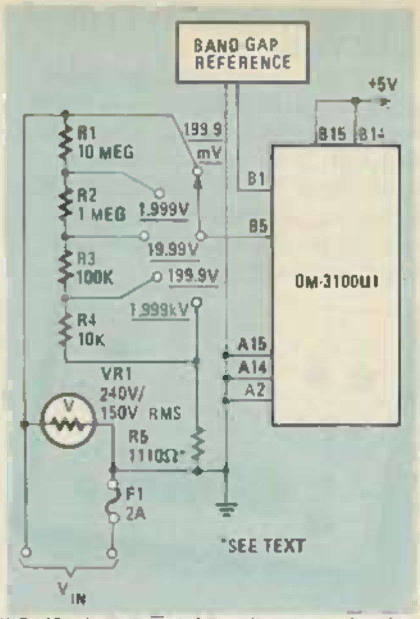


FIG. 10—A FIVE-RANGE switchable voltmeter. The varistor is included to prevent damage to the panel meter from excessive input voltages.

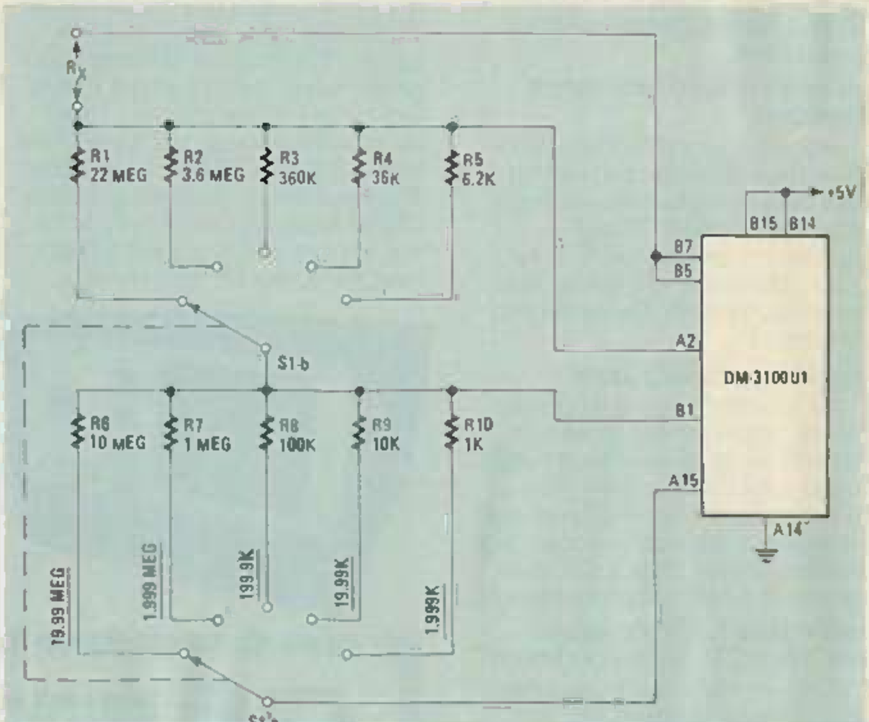


FIG. 11—THE RATIOMETRIC OHMMETER from Fig. 5 is expanded here to a five-range switch-selectable circuit.

using to allow the use of an external reference of from +100 mV to +2 volts, referred to $-V_S$. In several of the following examples we will make use of that feature. The external reference that we've chosen to use is shown in Fig. 7. The output of that circuit, which is built around a 1.2-volt band-gap reference (an Intersil ICL8069 is used here, although any similar device may be substituted), is a stable 100 mV.

The DVM module is supplied ready-calibrated to give a full-scale reading of ±1.999-volts DC. It is relatively simple, however, to add external circuitry that will extend that range. Consider, for example, the circuit shown in Fig. 8. It uses a simple voltage divider and an external 100-mV reference to allow the meter to measure voltages from 199.9 mV to 1.999 kilovolts full-scale over five ranges. Appropriate values for R1 and R2 are given for each range in the table in Fig. 8.

One note about the resistors before we go on. Some of the values may be difficult to obtain. If you can not find the appropriate resistances, simply combine two standard-valued units in series.

The DM-3100U1 can also be made to act as a DC current meter by wiring a suitable shunt resistor across the input terminals, as shown in Figure 9. Once again, the values for R1, the shunt resistor, are given in the table in the figure.

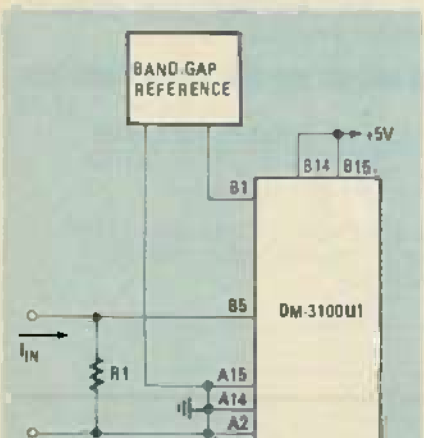
It is a simple matter at this point to take one of the circuits we've discussed and add the appropriate switching for range selection. That's what we've done in Fig. 10, a five-range voltmeter. Note that in multi-range applications the circuit should be provided with some form of overload protection. That has been taken care of in this circuit by fuse F1 and by a placing a voltage-dependent resistor (varistor) across the divider. That varistor ensures that the voltage to the meter does not exceed the meter's rating (250 volts DC, 175 volts rms continuous). Also note that on the 1.999-kV range the maximum input is therefore limited to 240.

Ohmmeter

The easiest way to use a digital panel meter as an ohmmeter is to use it in the ratiometric configuration shown in Fig. 5. That technique has two major advantages. First, it is very stable and inherently self-calibrating, the meter reading being equal to R_X/R_{REF}. Secondly, very low test voltages are generated across R_X, the maximum voltage being constrained to 100 mV by the presence of R_{LIMIT}.

As with the voltmeter and ammeter, it's relatively easy to set up a multi-range ohmmeter by expanding upon the basic circuit. Such a multi-range circuit is shown in Fig. 11.

There is still much more that can be done with a digital panel meter. We will look at some of those applications next time when we continue this article. **R-E**



R1	I_{IN} (FULL SCALE)
100Ω	1.999mA
10Ω	19.99mA
1Ω	199.9mA

FIG. 9—MEASURING CURRENT with the DM-3100U1.

Typewriter -to- Computer Interface

BILL GREEN

Build this interface/buffer and use your IBM typewriter as a low-cost letter-quality computer printer. The 30K buffer can be used with the typewriter or any parallel printer.

Part 3 WE'VE NEARLY COMpleted our look at the typewriter-to-computer interface. All that remains for us to do is to see how it's installed into a Selectric.

Selectric Installation

Adapting the *Selectric* for use as a printer is more difficult than adapting the *Electronic;* that is because the typewriter must be adapted mechanically as well as electrically.

The first thing to check if you're going to be using a *Selectric* is the the voltage at jumper JU1. If it's not between 17 and 18 volts or if the fuse blows when you turn the interface on, double check all your work. Check especially carefully for solder bridges and incorrectly installed components, (diodes, voltage regulator, etc.).

If that voltage is correct, we're ready to connect the interface to your typewriter. The first thing you have to do to is to remove the *Selectric*'s cover. To do that, you must position the carriage near the center and move the margin stops clear of the carriage. Then unplug the typewriter. Pull the paper bail forward, raise the cover, and pivot the paper table (with the various scales printed on it) to the rear. At each end of the platen is a latch, as shown in Fig. 16. Press down on both latches and simultaneously pull up on the platen. Pull the cover-release levers forward. They are located on either side of the inside of the case, about 3 inches forward of the platen. Lift the carriage pointer and both of the margin levers up. Now lift the cover straight up and reinstall the platen. Pull the assembly-release lever, located under the bell, forward. Lift the typewriter assembly by the shafts protruding from the TAB and POWER switches and pull forward

FIG. 16—TO REMOVE THE COVER of the *Selectric* model *II* or *III*, you first must remove the platen.

about 3 inches. Tilt the assembly back and let it rest on the support brackets. Your typewriter should look something like what's shown in Fig. 17, except that the solenoids and their printed-circuit boards should not be installed yet. With a 1/4-inch nutdriver or socket, loosen the two screws holding the right hold-down bracket and pull it all the way forward. Tighten the screws. Then remove the left hold-down bracket.

Now we have to prepare three adapter boards by installing ten 12-volt DC solenoids on them. Figures 18, 19, and 20 show the foil diagrams for the CODE, SHIFT, and the SPACE/RETURN boards. Figures 21, 22, and 23 show the placement of the solenoids on those boards.

Install and solder the ten solenoids on the three boards as indicated in Figs. 21, 22, and 23. Then cut 9 three-inch lengths of the plastic covered steel cable. (You can get that cable, often called leader cable, at a fishing-supply store, where you can also get the crimp sleeves that we'll use next.) Prepare six of those cables as follows. Slip one end through a crimp sleeve and loop it back through a small amount. (See Fig. 24.) Pull the long end until there is a loop about 5/32 inch diameter, and crimp the sleeve with pliers. Install a sleeve in the clevis of each of the nine solenoids (except the shift solenoid) and crimp each sleeve very slightly to keep it in place.

Loop one of the remaining 3-inch cables around the silver key-pressed bail (Fig 25) and crimp the sleeve. Install the remaining two cables on the space and carriage-return latches (Fig 26) and crimp. Referring back to Fig. 25, remove one of the screws in the latch guide bracket and replace with one of the threaded spacers. Tighten it and repeat with the other screw. Then mount the CODE board on those spacers and secure with 2 flathead screws as shown in Fig. 27.

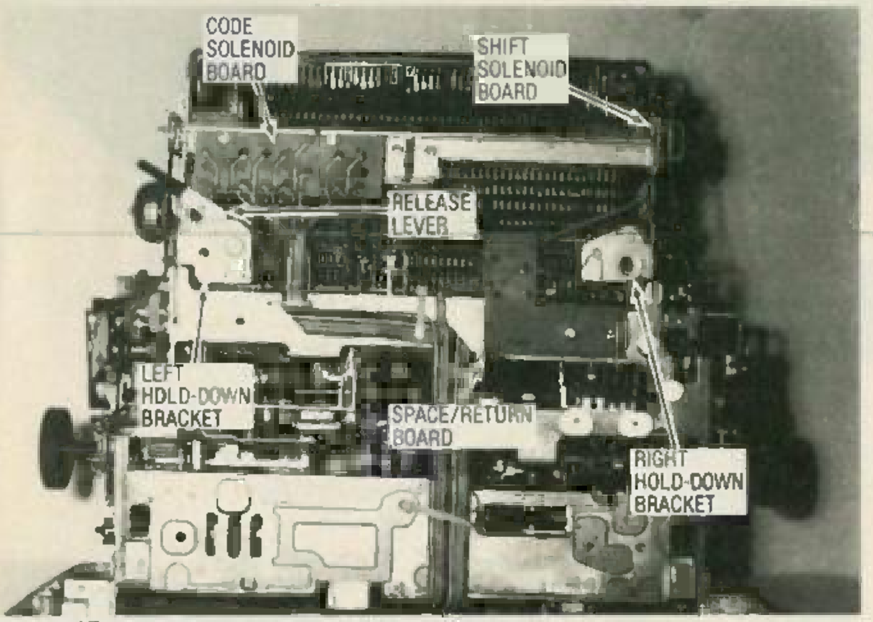


FIG. 17—TILT THE ASSEMBLY back so that it rests as shown.

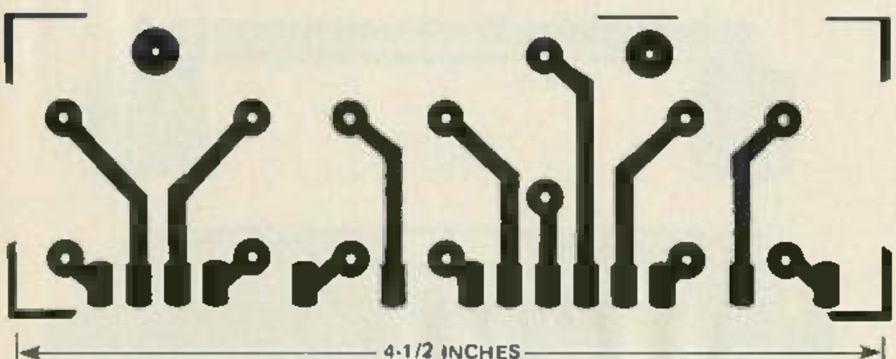


FIG. 18—THE FOIL PATTERN for the CODE board is shown here full size.

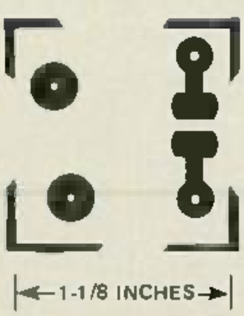


FIG. 19—THE FOIL PATTERN for the SHIFT board is shown here full size.

Using needle-nose pliers, open the clevis on the left-most adjusting link (Fig. 27) and slip one of the cables that you prepared with a loop over the clevis pin. Allow the clevis to close. Repeat with the other 5 adjusting links. Slip the free end of the cable on the left-most link into the sleeve that you installed in the clevis of the left-most solenoid and pull up the slack. Repeat with the other 5 adjusting-link cables. Slip the free end of the cable that you mounted on the key-pressed bail into the key-pressed solenoid. Be sure that this cable goes below the power-lockout bail (the bail that moves with the power switch).

Now we have to adjust the length of those cables. Follow each of the 6 adjusting links down to the interposer latches they are attached to. Pull on the cable attached to the left-most solenoid until the left-most latch just starts to move up. Allow the latch to just seat and then crimp the sleeve on the solenoid clevis. Pull up on the clevis. The latch should raise about 0.15 inch. That is the correct adjustment—it will allow the link to clear the ridge just behind it. Repeat with the remaining five solenoids.

Now plug the power cord in and turn the power on. Pull up the slack in the cable to the key-pressed bail until printing starts. Slack the cable until it just stops. Crimp the sleeve. Briefly push up the key-pressed clevis. Several print cycles should occur and printing should stop when the clevis is released.

Unplug the power cord again for safety's sake. Install the SPACE/RETURN board as shown in Fig. 28 Use two 1/8-inch screws—but do not tighten them yet. Form some 0.031-inch music or piano wire as shown in Fig. 29—it will be used as a guide for the cables—and cut off and save the excess. Install this wire under the screws and tighten. Install the 6-32 hex nut as shown and tighten. Route the cable from the space interposer over the left piece of music wire and slip it into the sleeve in the clevis of the bottom solenoid. Do the same with the other cable, slipping it into the top solenoid. Turn the power on. Pull up the slack in the bottom cable until spacing starts and release until spacing just stops. Crimp the sleeve at that point. Adjust the carriage-return interposer cable in the same way.

Now we have only one solenoid, the shift solenoid—to install. Remove the two large screws from the typewriter frame and install the shift solenoid using them. (See Fig. 30). Bend the remaining music wire as shown in Fig. 31. Install it under

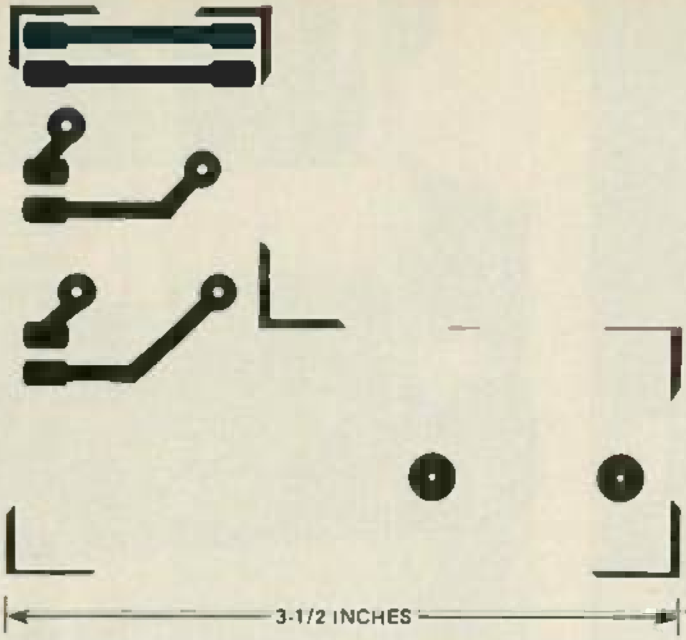


FIG. 20—THE FOIL PATTERN for the SPACE/RETURN board is shown here full size.

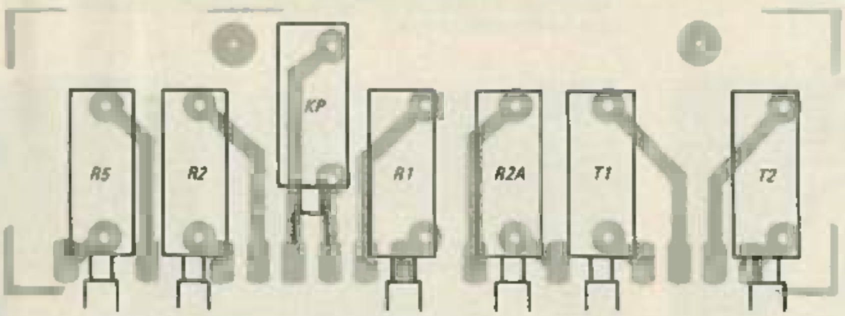


FIG. 21—PARTS-PLACEMENT diagram for the CODE board.

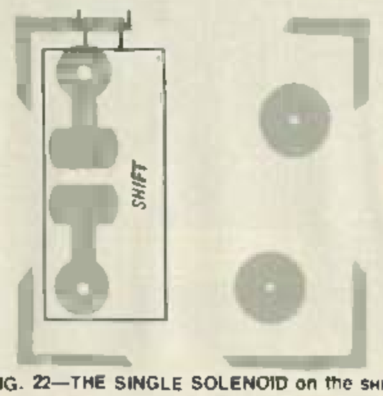


FIG. 22—THE SINGLE SOLENOID on the SHIFT board mounts as shown.

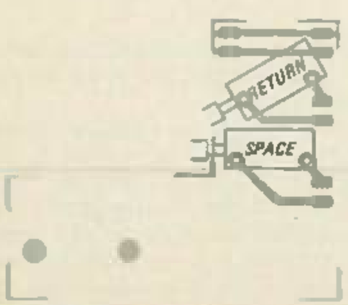


FIG. 23—THE *SPACE* and *RETURN* solenoids mount as shown.

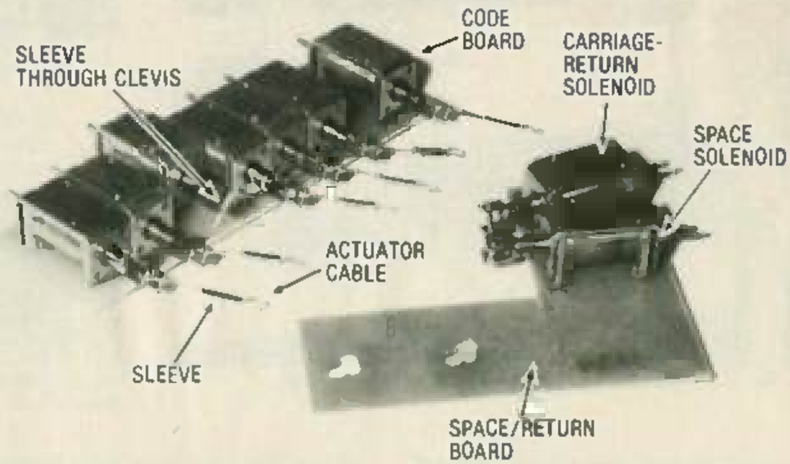


FIG. 24—YOUR ASSEMBLED SOLENOID BOARDS should look something like **this.**

the head of the screw that retains the shift-rod clip. Note the position of that clip on the end of the shift rod and retighten it in the same position. Push the plunger of the shift solenoid up and bend the shift link (that you made from music wire) down until it touches the top of the shift clevis. Bend the music wire at a 90 degree angle so that it will slip through the holes in the clevis. Insert it in the clevis. With power on, test the shift solenoid by pushing down on the clevis and releasing. Shift up and down should occur as appropriate. Check the shift key on the keyboard to make sure that it operates properly and bend the wire, if necessary, for proper solenoid and keyboard response. Trim the excess leader cable from all solenoids.

Now we're ready to hook the interface up to the boards you have installed in your typewriter. Referring to the schematic in Fig. 1, note the pinout of the header you installed at SO1. Prepare a cable (with a socket that will mate with the header at SO1) to go from the interface to the *Selectric*. The odd-numbered pins are the outputs to the solenoids and the even pins are the returns. That is, pins 1 and 2 connect to solenoid *R1*, pins 3 and 4 connect to solenoid *R2*, etc. (Those "*R*'s" and "*T*'s" are IBM designations that stand for *R*otate and *T*ilt—the direction that the ball element is moved in.) Split the ribbon cable as was shown in Fig. 17 and connect to the boards. Attach the cable to the typewriter frame with wire ties. Be sure the wires or the ties do not interfere with any moving part of the machine. Lower the machine into its normal position.

Now we're ready for the test. Connect the interface to your computer and plug the cable from the typewriter into SO1. Apply power to the interface, the typewriter, and then your computer. Press the RESET switch and then enter some text into your computer and dump it to the interface. Be sure the PAUSE switch is off. If you are not using buffer memory, the text will be printed at once. If you are using buffer memory, press the PRINT button. Examine the characters on the paper. If they are not as they should be, try typing all the characters with the keyboard (with the interface turned off). That should indicate which solenoid is not operating properly. Make adjustments as needed to the clevises. After all is working well, re-

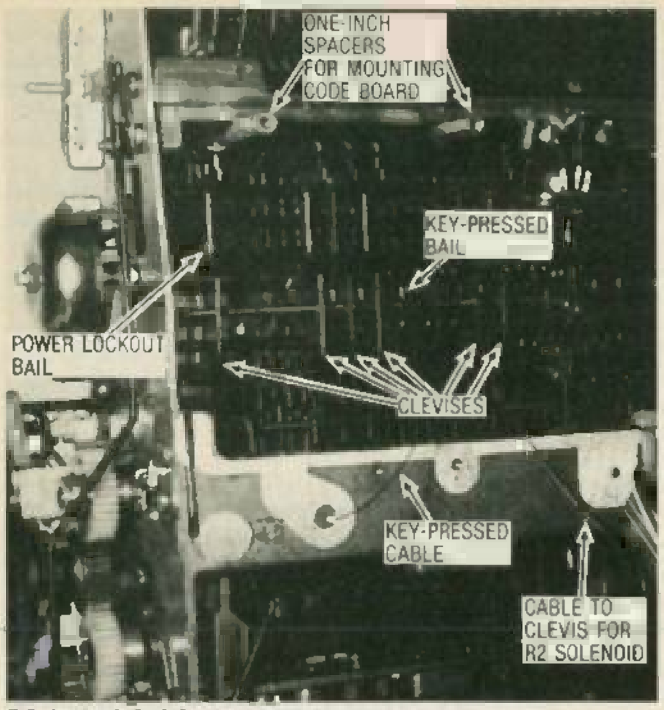


FIG. 25—VARIOUS CABLE-MOUNTING areas are shown here.

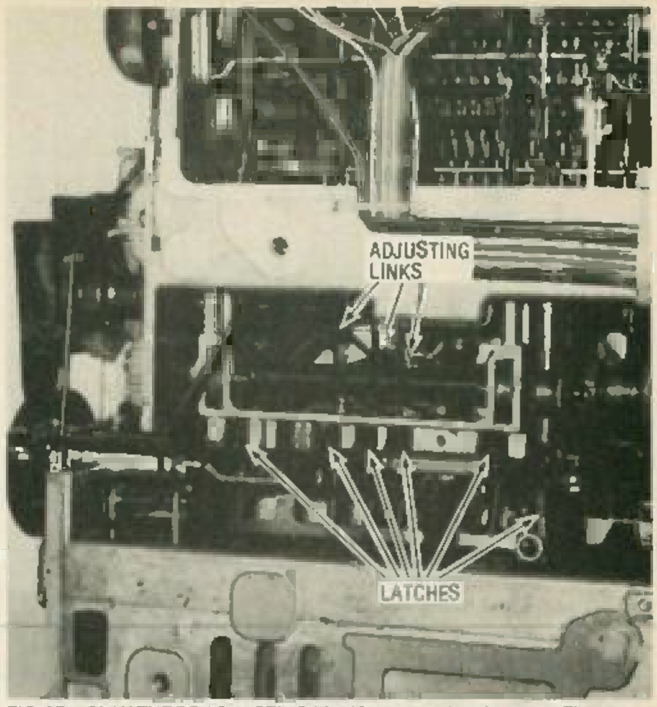


FIG. 27—ONLY THREE ADJUSTING LINKS are seen in this photo. The other three are hidden from view.

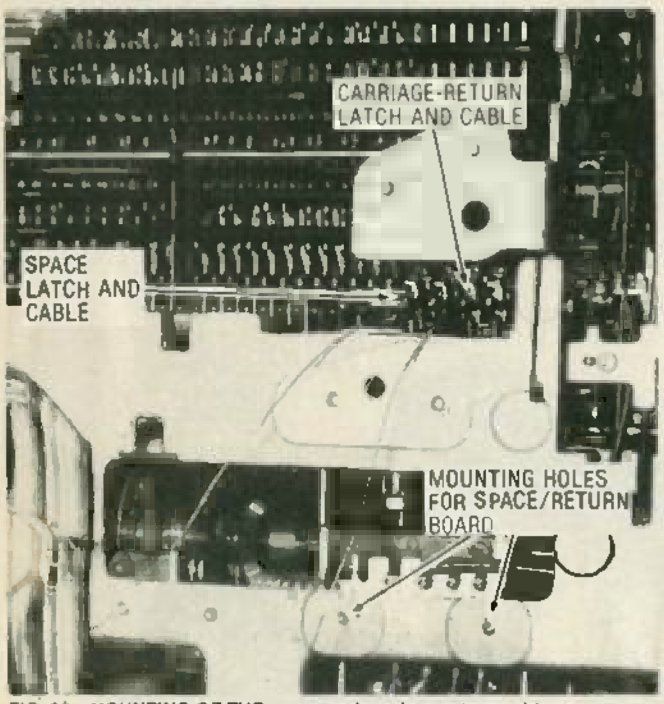


FIG. 26—MOUNTING OF THE space and carriage-return cables.

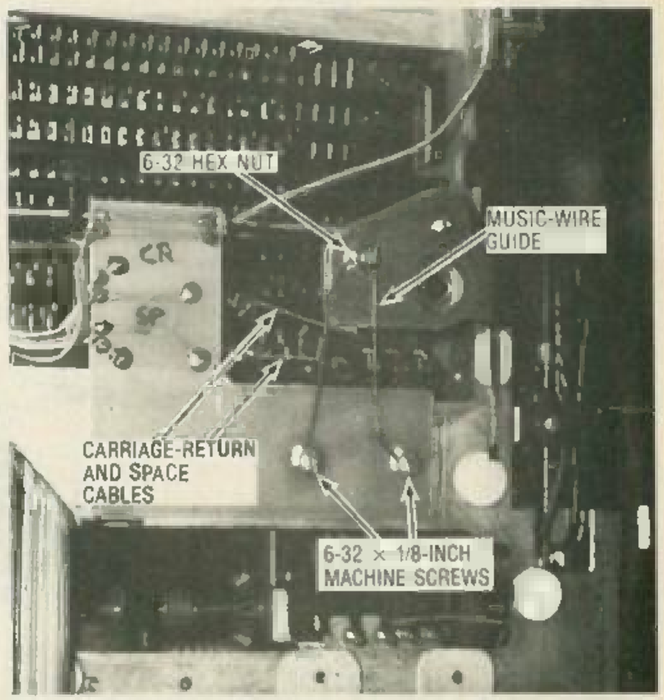


FIG. 28—HERE'S HOW TO fashion a guide for the carriage-return and space cables.

install the left hold-down bracket and pull it all the way out before tightening. Lower the typewriter down in the case and slide back until the holes in the two hold-down brackets drop onto the pins on the bottom cover. Run the adapter cable out through the hole in the vent cover beside the power cord. Push the assembly-release lever back to lock the frame down. Remove the platen and reinstall the cover and lock it in place. Reinstall the platen, flip the margin levers forward and the carriage pointer down. Pivot the paper table forward and down, and of course, lower the top cover.

When printing with a *Selectric*, it is good practice to press RESET after printing is completed if the shift solenoid is energized. You'll avoid trouble if you press the PAUSE switch only during a carriage return. (You can lose some characters otherwise.)

The buffer memory

Now that we've discussed how to use the interface with the different machines, it's time to look at how to use the printer buffer option.

The interface has a maximum capacity of fifteen 2K×8 memory IC'S. When memory is used, the first four bytes of IC13 are used by the microprocessor for a scratchpad. This leaves us with room for 30,716 bytes. If the data from the computer does not exceed the amount of available memory, the interface will not send data

continued on page 92

What you need to know about CP/M

YOUR OWN Software

What You Need To Know About CP/M

CP/M confuses a lot of people. It doesn't have to—read on and ease your fear of it.

ABE ISAACS

IF YOU HAVE RECENTLY PURCHASED—OR ARE CONTEMPLATING purchasing—a "serious" computer system, you have no doubt come into contact with the term "CP/M." And, unless you've had some previous exposure to computers, you are almost certainly wondering just what CP/M is, how you use it, and whether you really *do* have to use it.

Fortunately, with most of today's high-end computers coming with bundled software (programs included as part of the computer system and ready to run with it), it is not necessary to have a deep knowledge of how CP/M works, or of how to use it. Some of the software that comes with today's computers will even *auto-load*—that is, you put the disk into the drive, close the drive door, and the program will start to run by itself—and more or less isolate you from CP/M.

On the other hand, when you read the manuals that come with your computer, you'll undoubtedly find numerous references to CP/M, and, on occasion, despite the efforts of the computer and software suppliers, may find yourself face-to-face with it. For the uninitiated, panic often sets in at that point, and the computer, the programs, and everybody you ever dealt with in purchasing your system are—at least in thought—condemned to a fate worse than death.

In the hands of an experienced (or adventurous) programmer, CP/M can be a powerful tool; but to someone who just wants to get his correspondence out on time, a confrontation with it can be traumatic. In the pages that follow, we'll try to explain a bit about what CP/M is, and how to cope with it.

What Is CP/M?

CP/M stands for *C*ontrol *P*rogram for *M*icrocomputers. (Its original meaning was *C*ontrol *P*rogram/*M*onitor—which explains where the slash came from—but somewhere along the line the name got changed.) While it is primarily a DOS (*D*isk *O*perating *S*ystem) that coordinates the workings of the computer and the disk drive(s), it also takes care of communications between the computer and other peripherals like the terminal you use to talk to the computer, and other input/output devices like printers and modems.

CP/M works on any computer that uses an 8080, 8085, or Z80 microprocessor. It is considered a universal operating system because programs written on one computer to run under CP/M will run on *any other* computer using CP/M. That means that—within limits, of course—CP/M software doesn't care what computer you're using, as long as its operating system is CP/M. For that reason, CP/M software is considered "portable"—it can be created on one system, and run on another. (Such portable software is also called "machine-independent.")

Because of its universal nature, CP/M has been responsible for the creation of a large number of programs.

Consequently, you may find yourself staring at a hefty volume of CP/M manuals and wondering, "How did I ever let myself in for this?" but things aren't as bad as they may seem.

Introduction to CP/M

The first thing you'll see on your display when you "bring up" (load into memory and run) CP/M is the "A" prompt on your screen. That tells you that you are now using CP/M from disk drive "A." If you type "B:", you will find yourself on drive "B," and the prompt will change to "B."

When you see the "A" prompt (or the prompt for another drive), you can run a program that's on a disk mounted on that drive just by typing the name of the program and hitting the RETURN key. Programs that work that way can be identified by their ".COM" extension (the last three letters of the file name). The names of the files on a disk can be seen by typing "DIR", for "directory."

CP/M has a number of commands that allow it to perform a variety of functions. Unfortunately, many of those commands are somewhat obscure, and can intimidate the first-time user. For example, the command that allows you to copy files or programs, is "PIP" (which stands for *P*eripheral *I*nterchange *P*rogram). Not only does it have a strange name, but its language appears cryptic and awkward: PIP B:EASY.COM = A:AWKWARD.COM tells CP/M to copy a .COM-type file named "AWKWARD" on drive "A" to drive "B," and to rename it to "EASY.COM" in the process.

That's probably enough to scare people off by itself, but CP/M has other commands like "STAT" and "REN" that can be equally confusing. Actually, CP/M is fairly easy to work with after you get to know it; but if you're interested only in using your word processor or spreadsheet program, you may not want to get to know it that well. You *should*, but, happily, that doesn't mean that you have to.

Friendly utilities

A number of recent programs for word processing and other tasks are now menu-driven. That is, they display for you a menu of the things they can do, and all you have to do is indicate your choice. Usually included are options for such things as copying, renaming, and deleting files—functions that previously had to be performed directly from CP/M. Having them available from a menu, along with helpful prompts if they are needed along the way, isolates you from CP/M and can make your system much less intimidating.

There are several programs that make CP/M easy to use by acting as a "translator" between you and the operating system. One such program is *Power!* (Computing!, 2519 Greenwich, San Francisco, CA 94123). It has features for the neophyte, and also for the experienced computer user who just wants to make his life easier.

Power! is menu-driven, and when you instruct it to "COPY" (for instance), it presents a list of all the material on the disk on your display screen. Each file shown has a corresponding number, and all you have to do is indicate the numbers of the files you want to copy from one disk to another.

That's a lot easier than something like CP/M's awesome "PIP B:INFO.TXT = A:INFO.TXT'V'." It's faster too—once you start it doing something, *Power!* keeps on going until it's finished; CP/M's PIP utility requires you to type a whole command line for each file you want to copy. (The same comparison can be made between other *Power!* and CP/M utilities, like those for erasing and renaming files.) Working "by the numbers" is much easier, faster, and less likely to result in errors.

The program is smart, too. If it sees that a file with a particular name already exists on the disk you are copying to, it stops and asks you what you want to do with it. Answer the question with a single keystroke, and *Power!* is on its way again.

What do you do if you accidentally erase a file from a disk? That's something that happens more frequently than we would like to admit. Under CP/M there's nothing you can do to get that file back. *Power!*, though, offers a RECLAIM utility that makes it possible to bring back files from the dead. You simply type "RECLAIM," and as the name of each recoverable file is found and displayed, you indicate whether you want it reclaimed.

Power! is deceptively simple in appearance, but is worth a lot more than its $169.00 selling price.

Crashes

One of the most frightening experiences you can have is to have a program "crash" or "lock up" on you—the keyboard goes dead and no matter what you do, there's no way to communicate with the computer. That usually finds you with several hours' work inside the computer with no apparent way to get it out. Is it lost to you forever? It appears that the only thing you can do is push the RESET button and start all over again.

That's not necessarily the case. Although it's commonly believed that pushing the RESET button clears out the contents of the computer's memory, that material is frequently still there, and can be salvaged. Again, *Power!* comes to the rescue. It allows you to examine the computer's memory to see what's in it (and where it is), and to write the contents of that memory to a disk file that can be treated like any other file.

Crashes, at least the ones caused by things like giving the computer an unwanted jolt of static electricity (there's no way to recover your data if the power fails and the lights and everything else go dead), need no longer be fatal.

Control keys

Over at the left-hand edge of your keyboard is the CONTROL key. That key isn't found on ordinary typewriter keyboards and, for some reason, fills most newcomers to computers with a kind of fear. They just don't know what to make of it.

In actuality, the CONTROL key works just like a SHIFT key. As long as you hold the SHIFT key down, every key that you press generates a character different from the one that you would get if it were not used. For instance, instead of a "g," you get a "G." Similarly, if you hold the CONTROL key down and press another key, you get a third character—usually invisible. A CONTROL-g (or CONTROL-G—it doesn't matter whether the character is shifted or not) generates an audible signal.

Control characters, as they are called, are usually invisible, although some computers or terminals can display special symbols to represent them. Each CONTROL key has a specific function though. The original control functions were defined back in the days when Teletype terminals were in widespread use (hence the use of a CONTROL-G to sound a bell). Frequently, the purpose a control key serves will be determined by the software that's being used.

In program listings and in computer documentation, a control function, such as a CONTROL-S, is often shown as "^S." The caret (^) simply indicates that the CONTROL is to be pressed at the same time as the "S" key.

The most important control key is CONTROL-C. Its meaning is almost universal—in CP/M, in CP/M-based programs, and even in a lot of programs that don't require CP/M. Its meaning is simple—STOP! If you ever want to stop a program—almost any program—all you have to do is hit CONTROL-C.

As soon as you hit CONTROL-C, the computer will stop what it's doing and return you to a command level of some sort—to CP/M, to BASIC, or to a menu within a program. About the only time CONTROL-C won't help is when something (like a "zap" from static electricity) has caused the contents of the computer's memory to be scrambled so it no longer recognizes any input at all from the keyboard. There's a way to escape from that situation, too, as we'll show you shortly.

Consider CONTROL-C to be a kind of panic button. If you ever want to halt the execution of a program, or get out of it for any reason, use it. Even if the program doesn't mention it, CONTROL-C will probably bring it to a screeching halt. Remember, CONTROL-C is your friend.

Other keys

While we're on the subject of keys, another one that you may be wondering about is the ESCAPE key. That one isn't found on typewriters, either.

The ESCAPE is used to generate what are called escape sequences—that is, the ESCAPE key being pressed, followed by another key, or series of keys, being pressed.

Escape sequences are not normally entered from the keyboard, but are generated in software. They are widely used to control the operations of computer peripherals like terminals and printers. A word-processing program, for example, may send an escape sequence to a terminal to clear the screen, or to a printer to tell it to print bold-face or expanded characters.

The last key whose function you may be questioning is the BREAK key. Don't worry too much about it; it usually doesn't do anything. Its purpose was to cause about a 250-millisecond gap in data transmission, and it has little bearing on computer operations. It's a vestige of the Teletype days.

Error messages

CP/M is not known for the clarity of its error messages. Probably the one that occurs most frequently is "BDOS ERROR ON *n*." What CP/M is trying to tell you is that it's having a disk problem. The most likely cause of that is your having changed disks without having informed CP/M of the fact. The way out of that is CONTROL-C. That will cause the system to reboot, and the new disk will be recognized.

More help

After you've overcome your initial fears over using CP/M, you may even find that you like it and want to learn more about it. The best thing you can do is to read about it, and experiment with the things you study. Set aside a disk that you will use only for practice, and, when you want to take a break from processing words or juggling numbers, use it to "play around" with CP/M. That's the only way you'll learn. If you don't practice what you learn, it will go to waste. It's like trying to learn to speak French without moving your lips.

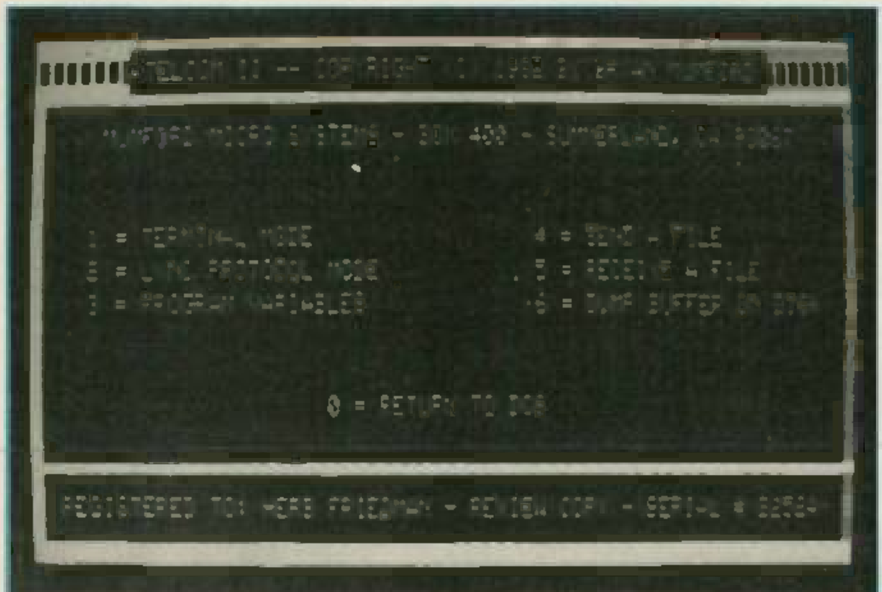
The CP/M manuals, while they are comprehensive, are not really intended for the beginner. The current version of the manuals is a lot clearer than the original one, but it still assumes that you know a lot more about computers than you probably do.

There are, however, several books that explain most of the CP/M commands and functions, and explain how to use them. Two such books are *Osborne CP/M User Guide* by Thom Hogan (OSBORNE/McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710) and *The CP/M Handbook* by Rodney Zaks (SYBEX, Inc., 2344 Sixth St., Berkeley, CA 94710).

Once you get involved with your computer and CP/M, you'll discover that there really wasn't so much to be worried about, after all. R-E

Radio-Electronics YOUR OWN Software

Telecommunications



To communicate with other computers and databases, you not only need hardware such as a modem. You need communications software, too. We'll take a look at what you can expect to find.

Telecommunications

HERB FRIEDMAN

A COMMUNICATIONS SOFTWARE PACKAGE IS A PROGRAM THAT allows a computer to exchange data, programs, and information with other computers—either a personal computer or the mainframe of a database/information service such as The Source or Dow Jones. Essentially, communications software converts a computer into an intelligent terminal, a device that can exchange disk or tape files with other computers, as well as information entered directly on the keyboard. An intelligent terminal is also often called a smart terminal. A terminal that isn't smart is dumb, meaning it can only receive and send in real time. It cannot store incoming data for later viewing or use, nor can it send a data file or program that was previously stored on disk or tape.

Getting started

There are many different levels of communications software. You can get simple programs intended for the so-called "home computers," that do little more than allow the user to converse with one of the information services such as The Source. Or you can get communications packages for mainframes that, even when completely unattended, will establish communications with another computer, swap data back and forth, automatically check for errors, and then shut down both computers.

We will limit ourselves to the less expensive, high-performance communications software available for personal computers—the type of software you might use in your own home or business. To start off, personal-computer communications software is almost universally intended for two types of circuits; either a telephone-system modem that connects computers through the dial-up telephone system (which accommodates voice-grade frequencies), or a direct connection between two computers through a multi-wire cable which we call a *null-modem*.

Communications software is the program that converts your computer's electrical signals into a format that can be passed on to the outside world; that is, to other computers, printers, and peripherals that aren't part of your personal-computer system. Somehow, we must take the formatted electrical signals and get them to another computer. The way we normally exchange computer signals with other computers that aren't in the same general location is through the dial-up telephone system. Since the telephone system handles only a selected range of voice frequencies, the computer's electrical input and output signals must be converted to audio tones. The device that does the conversion from electrical to audio, and vice versa, is called a modem (*MOD*ulator/*DEM*odulator).

To communicate with another computer there must be a modem at each end, one called an originate modem, the other an answer modem. In addition, in many instances the software must be configured for answer or originate operation that is usually independent of the modem; we can have answer software with an originate modem, and originate software with an answer modem.

Within the range of acceptable overall costs, for personal computers it is the dial-up telephone system's limitations that determines the maximum rate at which we can exchange information between computers. The unit we use to express the rate of information exchange is the baud, which happens to work out to the number of bits transmitted per second. For example, a 300 baud rate is the rate at 300 bits-per-second, 1200 baud is 1200 bits-per-second. By pure luck and mathematical relationships, 300 baud represents an exchange of 300 words per minute of text, while 1200 baud represents 1200 words per minute of text (assuming an average of six characters per word of text—the defacto American standard).

The typical low-cost (around $100) modem for personal computers will accommodate rates from 0 to 300 baud. More sophisticated modems (about $500) will accommodate 300 or 1200 baud. Because of cost and complexity, 1200 baud is presently the upper limit for the voice-grade dial-up telephone system.

On the other hand, if we wish to exchange data between computers in the same general location we can do it easily enough by passing the computer's electrical signals (without conversion to audio) through a multi-wire cable connected between the computers' RS-232 input/output connectors. That kind of multi-wire circuit is called null-modem. Within reason, there is virtually no limit to the character rate we can pass through the wires. The transmission rate from computer to computer can easily be 9600 baud or even 19,200 baud. As far as the communications software is concerned, it is working into a modem (the "null-modem"). The only limitation on how fast data can be transferred from one computer to another through a null-modem is the communications package and the computer itself: Will they support a higher transmission rate? For example, Heath computers easily support 9600 baud, while Osborne computers are limited to 1200 baud unless modified with non-factory hardware.

The degree of complexity of the program—its "sophistication"—depends on the particular computer and the application for which it's intended. Obviously, the software that automatically runs a high-speed data exchange or a dump between the mainframe computers of two international banks isn't exactly the kind of thing you would use for your *KayPro II* or Radio Shack's *Color Computer*.

Getting the message through.

The basic, least expensive form of communications software is intended primarily for sending or receiving ASCII-encoded messages or data. ASCII is an acronym derived from American Standard Code for Information Interchange. A complete ASCII set consists of 128 codes (0-127) that represent upper and lower case alphanumerics, 32 control codes such as the carriage return and linefeed, standard keyboard symbols, etc.

Simply typing on the computer's keyboard will send the message—text or data—in ASCII characters, which is received at the other end of the communications circuit. The difficulty with ASCII is that it can only handle text or data such as BASIC program listings, or anything else that's best converted to ASCII, though that is all you need for many applications. For example, if you are into using The Source or the Dow Jones information networks, or a local community or users' group bulletin board—which are accessed through the dial-up telephone system—the communication is usually done in ASCII. If you get a "terminal program" specifically prepared for your computer, such as those advertised at rock-bottom prices in the computer hobbyist magazines, it will probably be tailored specifically for your computer's screen. The words will wrap at the end of the line, or each line will be precisely the length sent by the information service...and that's about it, except for setting the baud rate. Budget, moderate, or gold-plated software—virtually all allow the user to easily change the baud rate to handle almost any communications situation. Most will cover from 300 to 9600 baud. Others go as low as 110 baud (for older teletypewriters), while some go as high as 19,200 baud for high-speed null-modem communications.

Virtually all intelligent-terminal software allows the user to either save the incoming ASCII message in a portion of free RAM, called a buffer, and then transfer it to disk (or tape), or to have the incoming data written directly to disk (or tape). The direct write is preferred because, as a general rule, if the RAM buffer fills, the incoming data writes over the beginning of the text and a save to disk (or tape) will not contain the complete file—the overwritten part no longer exists. Similarly, the software can either send an ASCII file directly from disk (the usual way), or transfer it from disk to RAM and then send it.

But what if you're interested in, or have need for, sending or receiving binary files such as machine language programs, which use 8-bits? That is quite another thing. Many communications programs can only transmit or receive 7-bit ASCII characters, so they have special routines for converting binary information into the ASCII character codes, and then back from ASCII to binary. It works but it's not the most dependable method of binary data exchange. Why? Because one single incorrect byte out of thousands can crash a program.

Protocols

Look at it this way. Assume you're taking an ASCII transmission of a BASIC program from a friend and you get a glitch on a character. The program kicks out on a RUN with a "SYNTAX ERROR on LINE 140." You list line 140 and the statement reads: "140 PRI/T A$." You know you've got trouble, but it's easy to correct "PRI/T" to "PRINT." Or suppose you are getting the latest news from UPI on The Source and your screen shows: "Inflaxxon is a 4.8& for August." You know it should read: "Inflation is 4.8% for August."

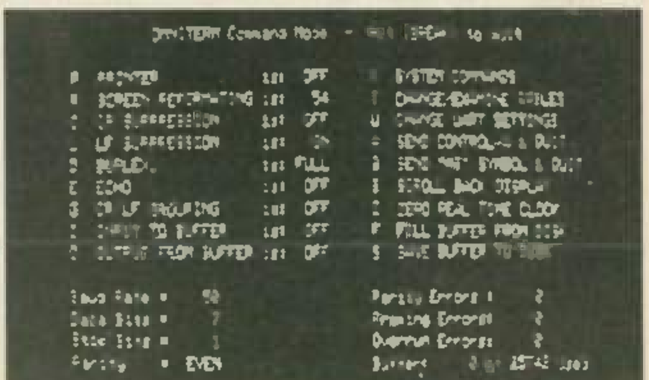
But what if you're receiving a command file? One glitch on one byte and the program crashes and you'll never know what's wrong, or why. To overcome that, all decent modern communications software has some form of protocol exchange.

Protocol means that the sending terminal transmits some kind of testing signal such as a checksum or CRC after transmitting a block of information. It then waits for a response from the receiving terminal that indicates the "test" was received correctly. If so, the sending terminal transmits the next block. If the sending terminal receives an incorrect answerback "test" from the receiving terminal, it re-transmits the block, and will keep doing so until it receives an "OK" from the receiving terminal. In that way, it sharply reduces the possibility a binary file will be garbled at the receiving terminal.

The problem with a protocol exchange is that the terminal protocols must match; that is, the software at each terminal must recognize the protocols of the software at the other terminal. As a general rule of thumb, except for the "free" communications software available from CP/M bulletin boards such as *Modem X* and *Modem 7* (and all its derivatives)—which use something called a "Christensen protocol"—there is no protocol standard. That means that both the sending and receiving terminals must use the same software (a cute way to insure extra sales).

While each communications package that can exchange binary files recognizes its own protocol, there are several communications packages that will match—or mate—with other protocols. For example, *M.I.T.E.*, from Mycroft Labs, Inc. (Box 6045, Tallahassee, FL 32301), will match the protocols of *MODEM X*, *Crosstalk*, *D.C. Hayes*, *IBMPC* (for text files), and *Text* (for mainframes). The relatively inexpensive but powerful *Telcom II*, from Mumford Micro Systems (Box 400-E, Summerland, CA 93067), for the Radio Shack computers, will also accommodate the *LINK* protocol. Matching protocols, however, is somewhat rare. Except for the "Christensen-based" software, most communications packages match only their own protocols.

Though many claims are made for each kind and brand of



THE COMMAND SCREEN you see when configuring *Omniterm* is shown here.

communications software, except for auto-dialing, within a given type they all do more or less the same thing as far as communications are concerned.

Auto-dialing means the software in conjunction with a special modem is capable of dialing the telephone number of another computer from a telephone number or telephone index file in the computer. Sometimes it's as uncomplex as dialing whatever telephone number has been typed on the computer's keyboard. Other times, the user simply types the user's name and the computer searches the correct number from a telephone file that's been stored in a disk file. Auto-dial modems, such as the D.C. Hayes, can pulse-dial a local telephone number and then automatically switch to touch-tones for an information service.

When running straight ASCII text or data communications, all packages will capture incoming data in RAM, all will dump, somehow, to tape or disk—either as the signal comes in or at the user's command—and all will transmit text or data from tape or disk, either directly or by first loading it into RAM and then sending it to the modem. The program can be an inexpensive plug-in module for the Radio Shack *Color Computer* such as the *Colorcom/E* by Eigen Systems (Box 180006, Austin, TX 78718), or a moderately priced package such as *Super 'Color' Terminal*, by Nelson Systems, Inc., (Box 19096, Minneapolis, MN 55419) that will even change the display format to 32x26, or 51-64-85 × 21 or 24. (Interestingly, the Nelson software, which has the same or more features than communications software for CP/M, IBM, and CP/M-86 computers, costs about half their price. That makes one wonder whether software is priced at all the traffic can bear.)

The Nelson software is more or less representative of what most software packages for the "higher cost" computers offer. The precise feature will depend on the particular program, and depending on your particular interests one might prove of more value than another. For example, some, such as the CP/M-based *M.I.T.E.*, or *Omniterm*, for the TRS-80 *Models I/III/4*, by Lindberg Systems, Inc. (41 Fairhill Road, Holden, MA 01520), allows specific versions to be configured for The Source, CompuServe, or anything else if you would like the program to directly load with all the correct parameters and *macros*.

A macro is a complete set of commands, instructions, or whatever that is transmitted by touching a single key. It's as if the key itself was a separate memory—which it really is. For example, assume you have an auto-dialing modem—that is, a modem such as the D.C. Hayes (5923 Peachtree Industrial Blvd., Norcross, GA 30092) *Smartmodem*, that will automatically dial a telephone number. You might program your communications software in such a way that pressing the CONTROL key and the numeral 1 will send the telephone access number of The Source to the modem. When the screen shows The Source has connected and asks for your ID (identification), pressing CONTROL-2 will transmit your Source ID (identification number) and password. Similarly, you might have programmed CONTROL-3 as a macro to dial Compuserve's telephone access, and CONTROL-4 to transmit your CompuServe ID and password. Macros can also be created for accessing particular areas of The Source, Dow Jones, or any other dial-up database or information service. The amount of information stored in each macro varies. It might be 25 characters, it might be 48 characters, or more.

If the software provides macros there are usually at least 8 or 10, corresponding to the numbered keys; or every alphabetic (A-Z) key might have the capacity for macro programming, as is available in the Hayes *Smartcom II* for the IBM personal computer. The Smartcom's macro definition is even carried to the point where there are individual sets (menus) of 26 pre-defined macros for The Source, for CompuServe, and for Dow Jones that allow direct access to different areas of the information services at the touch of a key.

Some of the newer software, such as *Smartcom* and *M.I.T.E.*, provide for the recognition of prompts by the host computer of The Source, Dow Jones, community bulletin boards, etc. A macro can be defined, say, to dial The Source through Tymnet; upon receiving Tymnet's recognition to dial the Tymnet password; then when The Source "comes up" with its prompt, to answer with the user's ID and password, etc. It's actually possible to connect with and get into a selected area (service) of an information network by just a single entry on the keyboard. Exactly how the macros perform varies widely and depends on price, and, unfortunately, the imagination of the person writing the advertisement. So, if macros are an important function for your use of communications software, doublecheck every feature before you purchase the software.

Particularly for infrequent users of a communications software package, the overall complexity of operation is an important consideration. The most sophisticated software is worthless if you can't remember how to use it, or you forget a function and twenty minutes into an upload you discover you forgot to name the file. The receiving terminal is going to have a copy of your file but its disk directory will have no usable indication it exists. (A common problem when exchanging binary data.) Some software, such as Crosstalk, from Microstuff, Inc. (1845 The Exchange, suite 205, Atlanta, GA 30339), avoids the whole problem by automatically transmitting the name of the file: The receiving computer always knows what it got. It should not be necessary to spend any time mucking through an instruction manual to figure out how to do things. Unfortunately, price and sophistication have nothing to do with ease-of-operation. Actually, some of the earlier superior communications software is virtually unknown today because simple procedures required reference to the documentation, and the documentation was a disaster.

Another desired feature for infrequent users of communications software is menu-driven function selection. The main functions are always displayed on the screen, or can be called up at the touch of a key. Similarly, the functions are also selected by the touch of a key. *Telcom*, *Omniterm*, and *Crosstalk* are examples of almost total menu-driven control.

There is probably no end to the functions that can be provided in a communications package. As fast as one package appears in the marketplace there is another with even more "sophisticated" functions. Actually, most do the same as the others, but in different ways and with different degrees of difficulty. Sometimes it's easier to use different kinds of software for different tasks simply to make communications more convenient. For example, for videotext-type communications and use of The Source, *Telcom I* is preferable; for binary data and program file exchange, *Crosstalk* does it with the least amount of hassle. But what works best for you and your computer may be other kinds of software. But regardless of the software's functions and features, for many users the most important consideration should be how often they will have to search through the documentation in order to use the software. **R-E**

How to Design Semiconductor Switching Circuits

MANNIE HOROWITZ

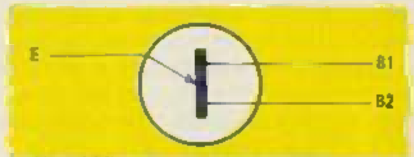


FIG. 1—SCHEMATIC SYMBOL for an n-base UJT.

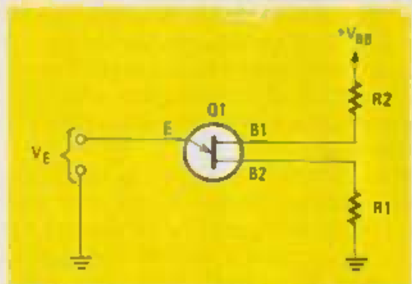


FIG. 2—A SIMPLE CIRCUIT using a UJT.

Here's a look at UJT's, PUT's, SCR's, triacs, and a host of other semiconductor switching devices.

Part 2 IN THE LAST PART OF this series, we saw how transistors are used in switching applications. Transistors, of course, are not the only solid-state devices that can be used in that way. Indeed, devices such as UJT's, PUT's, and SCR's can all be used in switching circuits. This month, we'll take a look at those devices, and others, and see what they are, how they work, and how you can use them in your own designs.

The UJT

The UJT (*Uni*/*unction Transistor*) is a one-junction device that consists of a slab of n-type and a slab of p-type semiconductor material. In an n-type UJT, the two base terminals are connected to the n-type material. An emitter terminal is connected to the p-type material. The schematic symbol for the n-base UJT is shown in Fig. 1.

The n-type material connecting base terminal B1 to base terminal B2 has a resistance of between 5,000 and 10,000 ohms. It is convenient to think of that resistance as actually being made up of two resistances. One, RB1, is between the junction and B1; the second, RB2, is between the junction and B2. With that out of the way, we can now talk about an important characteristic of the UJT, the *intrinsic stand-off ratio*. That is defined as RB1/(RB1 + RB2) and denoted by the symbol η. The voltage at the junction, due to V_{BB}, is equal to ηV_{BB}.

Circuits

The UJT can be used in a simple circuit such as the one shown in Fig. 2. Pulses of sufficient voltage, V_E, must be applied between the emitter and ground for the UJT to conduct current from $+V_{BB}$ to ground through the n-type slab. When it conducts, output pulses that are in step with the input pulses are developed across R1 and R2, although R2's main purpose is to keep the circuit operating properly despite variations in temperature.

We will show you how to choose the values of R1 and R2 shortly. In any event, the values of R1 and R2 are usually much less than RB1 and RB2. Because of that, the external resistors used around the UJT can be ignored when analyzing the action of the transistor.

Getting back to the performance of the circuit in Fig. 2, we want the UJT to conduct when the voltage at the emitter reaches V_E. The device itself conducts when V_E is about ½ volt higher than the voltage at the junction. That occurs when V_E is greater than $0.5 + \eta V_{BB}$. That is why the intrinsic stand-off ratio is a critical factor in determining the behavior of the UJT.

Using that information, a relaxation oscillator can be designed. To do that, only an R-C network need be added to the circuit shown in Fig. 2. The resulting circuit is shown in Fig. 3.

Let's see how that circuit works. When the supply voltage is initially applied, 0 volts is across C1; that voltage increases with time. The time it takes for the voltage to increase to the level required to turn on the UJT is determined by R3, C1, and η, and is just about equal to the product of

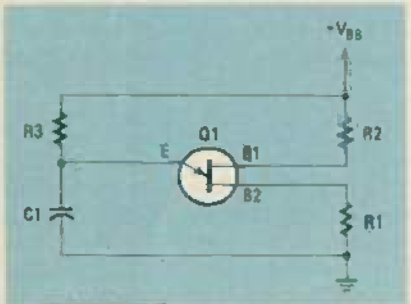


FIG. 3—ADDING AN R-C network to the circuit shown in Fig. 2 turns it into a relaxation oscillator.

R3 and C1. The oscillator frequency is about equal to the reciprocal of R3×C1, or about 1/(R3×C1).

The ideal value for resistor R3 is somewhere between:

$$\frac{V_{BB}(1-\eta)-0.5}{2I_P}$$

and

$$\frac{2(V_{BB}-V_V)}{I_V}$$

Where I_P is the maximum current flow between the emitter and B1; V_V is the *valley voltage*, the voltage between the emitter and B1 just after the device has begun to conduct, and I_V is the *valley current*, the current between the emitter and B1 when the voltage between those points is V_V. In the equations, η and I_P are the maximum values specified by the manufacturer of the particular UJT being used, while V_B and I_V are the minimum specified values. The current reaches I_P when V_E reaches a peak; that peak voltage is called V_P. Voltage V_P is significantly higher than V_V.

The voltage and current between the emitter and B1 continue to increase beyond V_V and I_V respectively because RB1 decreases as the quantity of current flowing through it increases. When C1 has discharged through the emitter-RB1 circuit, conduction ceases. The capacitor then recharges and the sequence repeats.

Capacitor C1 is selected to obtain the desired oscillator frequency, after R3 has been determined. Because the value you select for C1 depends upon the η (as well as on other factors) of the specific UJT being used, that capacitor may have to be "tweeked" to get the exact desired time delay.

If the UJT is to operate properly, R2 should be about equal to $(RB1 + RB2)/2\eta V_{BB}$. The value of R1 should be less than $(RB1 + RB2 + R2)V_{OUT}/(V_{BB} - V_{OUT})$. In the equation for R1, the values of RB1 and RB2 are the minimum resistances for this particular device as specified by the manufacturer. Voltage V_{OUT} is the peak-to-peak output voltage across R1. The value of R1 is usually about 50 ohms and R2 around 500 ohms, although at times the values chosen may radically differ from those. An ordinary bipolar transistor may be wired across the resistor used to deliver the output from the UJT; its purpose would be to provide sufficient push for the circuit to be driven by the pulse(s).

Because the UJT keeps on oscillating, repetitive voltages are developed across C1, R1, and R2. The voltage across C1 is a rising ramp while C1 charges and is a relatively fast-dropping slope when it discharges. If that ramp is to be used to drive another circuit, a high impedance must be connected between the R-C network and the circuit that is being fed by the ramp, so that the driven circuit will not load the R-C network (and affect the frequency of oscillation).

The UJT can be used in a switching circuit because it does not conduct until the capacitor is charged to a specific level. If a mechanical switch is placed across the capacitor and shorts it, the capacitor remains discharged. Under those conditions, the UJT does not conduct. The capacitor begins to charge at the instant the switch is opened. But the UJT does not conduct until the capacitor is charged to a voltage that exceeds $0.5 + \eta V_{BB}$ volts; in other words, it behaves as a time-delay switch. Conduction ceases at the instant the switch is closed and the capacitor is discharged.

Designing a UJT circuit

Let's see how we can calculate the values for the circuit shown in Fig. 3. As an example, assume that for the UJT being used, η is specified as 0.55, but can vary from 0.5 to 0.6. Similarly, V_V is specified as 2 volts, but can vary from 1 to 3.5; I_V is specified as 20 mA, but can vary from 10 to 30 mA, and I_P is specified as 8 µA, but can vary from 4 to 12. The internal resistance of the UJT, RB1 + RB2, is equal to 9000 ohms. What we are looking for is a 2-volt output across R1 at a frequency of 500 Hz. For this circuit V_{BB} will be 10 volts.

Start by determining the value of R3, the resistor in the timing circuit. Substituting into the equations for R3 noted above, we find that the value of that resistor should be between 146,000 ohms and 1,800 ohms. A good choice for R3 is 50,000 ohms. Since $f = 1/R3C1$, C1 should be equal to about $1/Rf = 1/(50{,}000 \times 500)$, or about 0.04 µF. Finally, substituting into our equations for R1 and R2 we find that they should be 2400 ohms and 820 ohms, respectively.

An interesting variation in the circuit shown in Fig. 3 would be to replace C1 with a phototransistor. The resistance of the phototransistor increases as the amount of light reaching it decreases. Thus, when there is very little light, the resistance of the phototransistor is high. Under those conditions, the UJT conducts and current flows. That current can be used to trigger a relay and turn on a light as night falls.

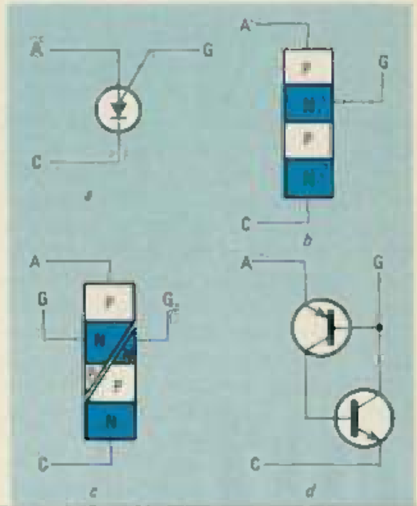


FIG 4—THE PUT. Its schematic symbol is shown in a, while its internal structure is shown in b and c. The equivalent circuit for that device is shown in d.

The PUT

The *P*rogrammable *U*nijunction *T*ransistor, or PUT, performs much like an ordinary UJT. The big advantage with the PUT is that η is not predetermined by the internal characteristics of the device. Instead, it can be set to a value between 0 and 1 using external resistors.

The PUT is a thyristor. It has three terminals, as shown in Fig. 4-a. A positive voltage is placed between the A (anode) and C (cathode) terminals. No current flows between the A and C terminals until a pulse that is negative with respect to the anode is applied to the G (gate) terminal.

Structure of the PUT

The device consists of four semiconductor slabs as shown in Fig. 4-b. To see how the PUT works, it is easiest to think of it as being split into two bipolar transistors—one NPN and the other PNP. The internal structure then would be as shown in Fig. 4-c. A schematic diagram of the two-transistor equivalent circuit is shown in Fig. 4-d.

Neither transistor is turned on when voltage is initially applied between A and C because current does not flow through either base-emitter junction. When G is made negative with respect to A, the base-emitter junction of the PNP transistor is turned on. Current can then flow through the collector lead of that transistor to the base of the NPN device. Because the voltage at the base of the NPN transistor is now positive with respect to the voltage at its emitter, current will also flow through the base-emitter junction of that device. The NPN transistor is therefore also turned on. Current from its collector flows through the base-emitter junction of the PNP device because its base voltage (and the collector voltage of the NPN section) is now negative with respect to its emitter voltage. Because of that, the PNP transistor stays on even after negative voltage has been removed from the gate terminal. Consequently, the NPN device also remains on. Because the paths between A and C have been completed, current flows from A to C. It ceases to flow when the anode current drops below I_V.

We can make a PUT act like a UJT by placing it in the circuit shown in Fig. 5. The maximum gate current, $I_{G(MAX)}$, allowed for turning on the PUT is specified by the manufacturer of the device and may be in the vicinity of 50 mA. Just what I_G actually is in a particular circuit, depends upon V_{BB}, R1, and R2, and can be determined from

$$I_G = \frac{V_G}{R1R2(R1+R2)}$$

where

$$V_G = V_{BB}\left(\frac{R_1}{R1+R2}\right)$$

The equations for calculating the time delay and the value of the resistor in the R-C circuit (in this case R4), are the same as the ones we used when we discussed the UJT. To determine R4, set η equal to $R1/(R1+R2)$, use the values of I_P and I_V provided on the device's data sheet, and let V_V be equal to about ¼ of V_F (the value of V_F, the forward voltage, can also be found on the data sheet). The value of V_V usually ranges somewhere between 0.6 and 1.2 volts so that 0.6 may be used for V_V in those equations without causing any unacceptable error.

Once the voltage across C1 is greater than that at the gate, the PUT conducts and current flows through R3. The output voltage that the current develops across R3 is called V_{OUT}. That voltage depends upon the voltage required to turn on the PUT, which, in turn, is about 1 volt higher than the voltage at the gate. That, in turn, is related to η, which is determined by the values chosen for resistors R1 and R2.

After the capacitor has been discharged and anode current has dropped below I_V, current ceases to flow through the junctions between A and C. The capacitor then gets recharged so that the current pulses through the PUT keep repeating. As was the case with the UJT, a switch can be placed across the capacitor to make this arrangement perform as a time-delay switching circuit.

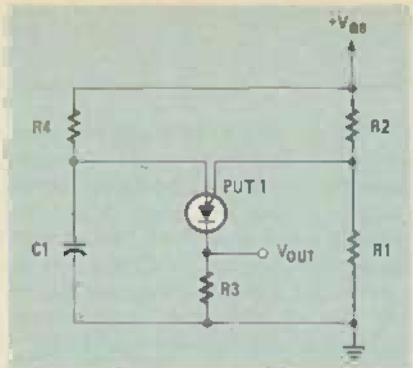


FIG. 5—THE PUT is used here in an oscillator circuit.

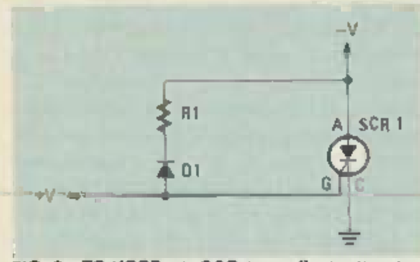


FIG. 6—TO KEEP AN SCR from dissipating too much power when the polarities of the voltages at its anode and gate are as shown, a series resistor-diode combination should be connected between those terminals.

The SCR

The structure of the silicon-controlled rectifier (SCR) looks like that of the PUT, except that the SCR gate is near its cathode rather than its anode. The SCR is composed of four semiconductor slabs arranged as shown in Fig. 4-b. The gate is connected to the second p-slab (the one located between two n-slabs) rather than at the first n-slab (the one nearest the anode). The equivalent transistor arrangement shown in Fig. 4-d still applies, except that the gate terminal is now at the base of the NPN device. A positive pulse at the gate with respect to C will turn on the SCR and let current flow from A to C when the anode is positive with respect to the cathode. The SCR will keep on conducting even after the trigger pulse has been removed. Conduction stops after the anode-cathode current drops below a particular current level specified by the manufacturer of the SCR. That current is identified as I_H, the holding current.

Triggering methods and precautions

Although gate triggering is the best method of turning on the SCR, it is possible to do it using other methods. For example, the SCR will be turned on if it is placed in a very hot environment. It will also be turned on if a specified maximum voltage that may be applied between the anode and cathode is exceeded. It will also be triggered if a sharp-rising voltage pulse is applied between A and C. As for the last case, it is frequently desired that the SCR not trigger under those conditions. Manufacturers therefore supply a dV/dT specification that indicates the maximum voltage change in a specific period of time that may be applied to the SCR without triggering it. Thus, if dV/dT is specified as 150 volts-per-microsecond, the SCR will probably be turned on by a pulse that changes at the rate of 175 volts-per-microsecond. To reduce the dV/dT factor of the pulse and avoid triggering the SCR, a 50,000-pF capacitor may be wired between the C and G terminals of the device.

If a voltage pulse that's applied between the A and C terminals triggers the SCR no damage will be done to the device. But it is also possible to apply a fast current pulse between the A and C terminals. That pulse may be used to trigger the SCR or may simply be present after the SCR has been turned on. But if that current pulse is faster than the dI/dT limit specified by the manufacturer of the SCR, the device can be destroyed. You must be sure that such current pulses do not occur at any time. To insure against such pulses a series R-C network can be connected between the anode and cathode of the SCR.

Some problems arise even when normal gate-triggering methods are used. If the leakage current is high, the SCR may be triggered inadvertently. To avoid that, a resistor should be wired between the cathode and gate of the device. The value of that resistor is normally specified by the manufacturer and can be found on a data sheet.

Precautions must also be taken so that the gate does not dissipate more power, P_{GM}, than is allowed by the manufacturer, or pass more current, I_{GFM}, than it was designed to do. Care must be taken so that the reverse voltage limit, V_{GRM}, between the gate and cathode is not exceeded.

Avoid applying a positive gate-cathode triggering voltage while a large negative voltage is at the anode of the SCR with respect to its cathode. Otherwise, the SCR will dissipate an excessive amount of power. To prevent failure, if that condition should occur, be sure to connect the diode-resistor circuit shown in Fig. 6 between the gate and anode. That circuit clamps the gate to the anode thereby reducing the conduction between the gate and the cathode.

Circuits using SCR's

A simple circuit involving an SCR and using an AC supply is shown in Fig. 7. Voltage is applied between the anode and cathode of the SCR. During the positive half of the cycle, a positive pulse is fed through R1 and diode D1 to the gate of the SCR and the device is turned on. Current flows through R_L, the load. Current stops flowing when the current passing through the SCR and R_L drops below I_H. During

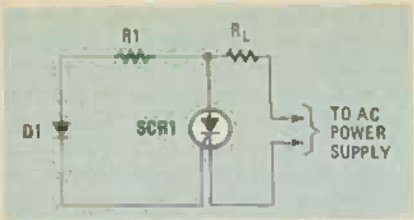


FIG. 7—A SIMPLE SCR circuit.

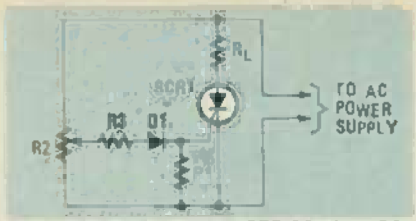


FIG. 8—THE CONDUCTION PERIOD of the SCR can be varied by changing the setting of R2.

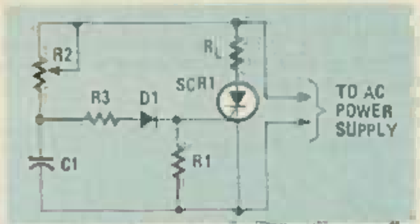


FIG 9—BY USING A PHASE-SHIFT NETWORK, the range of triggering points of the SCR can be extended.

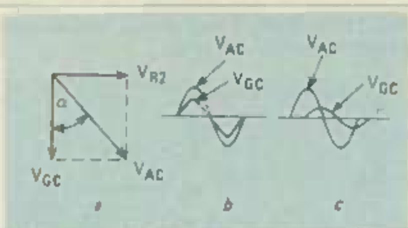


FIG. 10—PHASE RELATIONSHIPS. The graph in *a* shows that the magnitudes of V_{GC} and V_{R2} = V_{AC} only if their phases are taken into account. The relative phases and magnitudes of V_{AC} and V_{GC} in the case of a purely resistive load are shown in *a*, and in the case of a purely capacitive load in *b*.

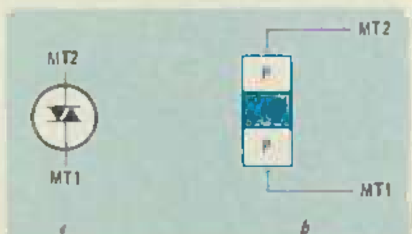


FIG. 11—THE SCHEMATIC SYMBOL for a diac is shown in *a*; its internal structure is shown in *b*.

the negative half of the cycle—when the anode is negative with respect to the cathode—the diode prevents any current from passing to the gate, and the SCR remains turned off.

In the circuit shown, current flows for just about the full positive half of the cycle. Conduction starts when just enough current is available at the gate to turn on the SCR. The flow stops when the anode-cathode current falls below I_H, the holding current. But the circuit can be changed so that the conduction through the anode-cathode circuit can be made to start at any point during the rising 90° portion of the AC cycle and end when the current flow drops below I_H. Thus, the conduction of the SCR can be varied between a 180° period (when the SCR starts to conduct at the beginning of the positive half-cycle) and a 90° period (when it starts to conduct at the peak of the positive half-cycle).

The circuit in Fig. 8 can be used to set the conduction period. Variable resistor R2 sets the voltage applied to the R3-D1 series circuit. The voltage at the wiper of the potentiometer, in conjunction with R3, D1, and R1, determines the amount of current that flows into the gate of the SCR. When R2 is set so that sufficient gate current flows to turn on the device, the SCR conducts. That setting can be adjusted for conduction to start at any specific instant in the rising portion of the positive half-cycle.

The voltage being applied to the gate in the circuit in Fig. 8 is AC. In a similar fashion, a DC voltage can be used to determine the turn-on point of the SCR.

The turn-on points of the SCR do not have to be limited to between 0° and 90°. That range can be extended by adding a phase-shift network consisting of a resistor and capacitor to the original circuit. Doing so allows you to extend the range to from just above 0° to somewhat below 180°. Such a circuit is shown in Fig. 9.

Figure 10-a shows the phase relationship of the voltage across C1 (between the gate and cathode), V_{GC}, with the voltage at the input to the R2-C1 circuit. The current in a capacitor leads the voltage across that component by 180°. The voltage across a resistor is in phase with the current flowing through it. Because of that, when an AC voltage is applied to a circuit consisting of a resistor connected in series with a capacitor, the voltage across the capacitor lags the voltage across the resistor by 90°. The sum of the voltages across the two components must be equal to the voltage applied to the R-C combination, or V_{AC}. But that is the case only if the addition takes the relative phases of the two voltages into account.

That is all shown in Fig. 10-a. The voltage across C1, V_{GC}, lags the applied voltage, V_{AC}, by an angle α. When R2 is set equal to 0 ohms, the entire applied voltage is across the capacitor and α is equal to 0°. Thus, the voltage across C1 and at the gate-cathode junction of the SCR is in phase with V_{AC}. That relationship is shown in Fig. 10-b. Also, because R2 is 0 ohms, the magnitude of V_{GC} is just about identical to V_{AC}.

When the value of R2 is made very large, the applied voltage is primarily across the resistor and there's just about no voltage across the capacitor. In that situation, α is equal to nearly 90°. The relationship between V_{AC} and V_{GC} is shown in Fig. 10-c.

Assume that the SCR will just trigger when a voltage equal to that at the peak of the V_{GC} curve in Fig. 10-c is applied between the gate and cathode. Turning to Fig. 10-b, with that small voltage requirement, and noting the slope of the curves in Fig 10-b, it's clear that the SCR turns on soon after the applied voltage passes 0° because V_{GC} reaches the trigger point near 0°. In Fig. 10-c, the peak of the trigger curve must be reached, before the SCR turns on because of that curve's low amplitude. Triggering therefore does not occur until V_{AC} is near 180°. Trigger points are made to vary between 0° and 180° by changing the setting of R2. In all cases conduction stops when the anode-cathode current drops to I_H. That is close to the 180° point on the V_{AC} curve. Thus, the trigger-point setting is used to determine just how long the SCR will stay turned on.

Diacs

In a diac, whose schematic symbol is shown in Fig. 11-a, the arrangement of semiconductor slabs appears quite similar to that of an ordinary PNP transistor (see Fig. 11-b). But there are two big differences between the diac and bipolar transistor. First, there is no lead to the center slab of the diac. Second, the same amount of impurities due to doping are at both junctions of the diac, while quantities differ at the two junctions of an ordinary transistor.

If a very small voltage is applied between the two terminals of the diac, MT1 (*M*ain *T*erminal 1) and MT2, the diac does not conduct. The applied voltage must exceed a specified value before the device will conduct. After the diac is turned on, current flowing through the device increases rapidly as the voltage across the diac decreases. Regardless of which terminal is made positive with respect to the other, the diac will turn on at the same breakdown voltage. Should an AC voltage be placed across the device (through a resistor, of course, so that the diac will not dissipate excess power), it will conduct during each half-cycle after the breakdown voltages have been exceeded.

Triac

As you can see in Fig. 12-a, the schematic symbol for a triac is very similar to that of a diac. The difference, of course, is that a gate has been added. The true differences between the devices can be seen, however, in the structural diagram shown in Fig. 12-b.

If you just consider the connections that are made to the right halves of the MT1, MT2 and gate terminals, and ignore anything that's connected to the left half of those terminals, what you have is a PNPN SCR, with the gate connected to the lowest p-slab. Consider next the connections made to left side of those terminals, this time ignoring the connections to the right. What you have now is an NPNP SCR. Converting that into its equivalent circuit gives you the two-SCR combination shown in Fig 12-c.

When MT2 is positive with respect to MT1 and a pulse is applied to the gate, SCR 1 in the equivalent circuit turns on. If MT2 is negative with respect to MT1, SCR 2 turns on. Thus, each SCR conducts on alternate halves of a cycle. Unlike the individual SCR, the triac conducts current in both directions. But the SCR has one important advantage over the triac: The SCR can operate over a range of from 0- to several-hundred-Hertz while the triac is useful only to somewhat above 60 Hz.

A triac can be used instead of an SCR in a circuit like the one shown in Fig. 7. Simply substitute MT2 for the anode and MT1 for the cathode. The diode is no longer necessary for the circuit to operate properly. The altered circuit is shown in Fig. 13.

The waveform output by the AC power supply is, of course, a sinewave. If a high-resistance potentiometer is used for R2, it can be adjusted so that the gate current will just barely turn on the triac when the applied signal is at its positive 90° point. It will stay on for the portion of the cycle from 90° to close to 180°. Near the 180° point, the positive voltage across the triac is just about zero, so that the current drops below I_H, the holding current and conduction ceases.

With the marginal turn-on signal available during the positive half-cycle, the triac will not turn on between 180° and 270°, the portion of the cycle when MT2 is negative with respect to MT1. That's because it requires a larger signal to turn the triac on during the negative half-cycle than it does during the positive half-cycle. If sufficient current should be applied to just-about turn the triac on during that negative half-cycle, it will conduct for the negative portion of the cycle between 270° and 360°. As was the case in the positive half-cycle, conduction will cease when the negative current drops below, $-I_H$, the holding current.

Should resistor R2 be set for a low value, sufficient current will be applied to the gate before the 90° point in the cycle is reached and the triac will be turned on at some point between 0° and 90°. Then current would flow for more than one half of each half-cycle.

There are four triggering modes used for turning on the triac. In two of those, MT2 is positive with respect to MT1. If the gate is positive with respect to MT1, relatively little gate current, I_{GT}, is

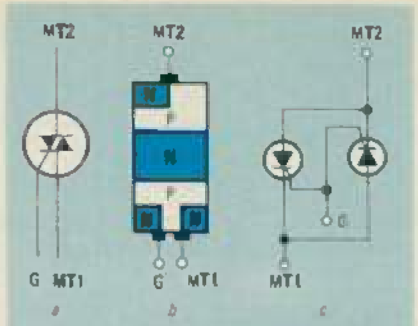


FIG 12—THE TRIAC. Its schematic symbol is shown in *a*, its internal structure in *b*, and its equivalent circuit in *c*.

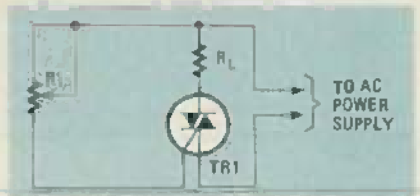


FIG. 13—A SIMPLE triac circuit. The device's triggering point is set by R2.

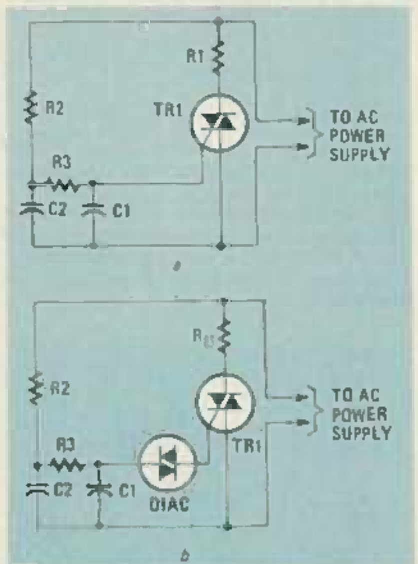


FIG. 14—AS WITH THE SCR, the range of triggering points of the triac can be extended by using the circuit in *a*. The conduction periods during the positive and negative half-cycles can be made symmetric by adding a diac as shown in *b*.

needed to turn on the triac. If it is negative with respect to MT1, at least five time that current is required to turn on the triac. Should MT2 be negative with respect to MT1, at least $2I_{GT}$ is needed to turn on the triac regardless of whether the gate current is positive or negative with respect to MT1. Considering that, it is obvious why when R2 is adjusted so that the triac will turn on just at the positive 90° point it is very unlikely that it will also turn on at the negative 270° point. That will be true unless a considerable amount of drive is added to the gate when the voltage goes negative.

In the case of the SCR, the 0°- to- 90° range of triggering points was extended to a 0°- to- 180° range through use of the R2-C1 network in the circuit in Fig. 9. In that example, we only needed triggering during the positive half of the cycle because an SCR does not conduct during the negative half-cycle. But the triac conducts during both the positive and negative half-cycles although that conduction can start at different points in the negative half-cycle due to the device's changing sensitivity to the gate signal. So, until R2 is set so that there will be sufficient voltage to trigger the triac in the negative half-cycle, it will conduct only up to 180°. When R2 is set so that the triac triggers on both half-cycles, conduction will take place during a longer interval during the first half of the cycle than in the second half.

The range of triggering points can be increased through the use of the circuit shown in Fig. 14-a. That arrangement uses two R-C phase-shift networks. With it, triggering can take place between 0° and 180° during positive half-cycle and between 180° and 360° during the second half-cycle.

The arrangement shown is similar to the one used for the SCR and shown in Fig. 9. But the circuit shown in Fig 14-a will not do anything to offset the differences in gate sensitivity and the device will trigger over different intervals during the positive and negative half-cycles. That situation changes when we add a diac to the circuit as shown in 14-b.

In that circuit, both the gate and MT2 are either positive or negative with respect to MT1. When the triac is operated in that manner, a diac can be used to compensate for the differences in the triac turn-on currents. That is, if the characteristics of the diac matches those of the triac gating circuit, the triac will turn on at relatively equal points during both halves of the cycle and the periods of conduction will be more or less equal during either half-cycle.

Other switches

The switching devices described above are the ones most commonly used, but there are many other types of semiconductor switching devices.

The schematic symbol for a CSCR (Complementary *SCR*) is the same as that used for the PUT, but the two are quite different devices. The CSCR turns on when a negative voltage is applied to its gate with respect to its anode.

One big objection to use of the SCR, is that no means is provided to turn it off. The GSC (*G*ate Controlled *S*witch) is a device that overcomes that drawback. It behaves as an ordinary SCR when a positive pulse is applied to its gate. The difference lies in the fact that it turns off when a negative pulse is applied to the same gate.

The SCS (*S*ilicon Controlled *S*witch) is

continued on page 114

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INTERFACE

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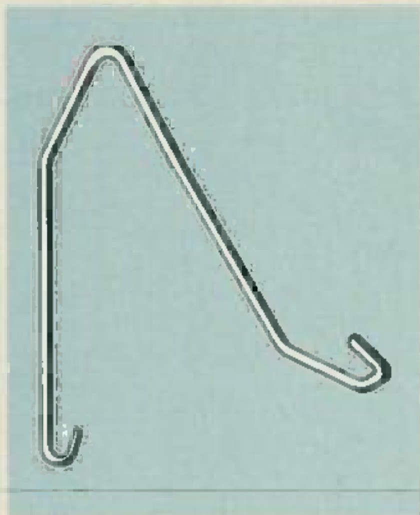

FIG. 29—THE WIRE GUIDE is shown here full size.

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The following are available from Alpha *Electronics*, PO Box 1005, Merritt Is., FL. 32952 (305-453-3534). A complete kit of parts—including main PC board, memory PC board, cable, case—for printer conversion (does not include memory IC's): $129 plus $6 postage; complete kit for *Electronic* conversion (does not include memory PC board or memory IC's): $119 plus $6 postage; 2K × 8 static RAM IC's, $6.50 each postpaid; 13941 PROM, $25; memory PC board (PC1832) $13 postpaid; main PC board, (PC1831), $18 postpaid; ABS plastic case, $12. A complete kit of all parts for *Selectric* conversion, (not including memory board or memory IC's): $169 plus $6 postage. The mechanical adapter alone is $90 plus $5 postage. The ULN2813A or ULN2803A IC's are $3 each postpaid. Florida residents please add 5% sales tax. Canadian orders please add $2 additional to US postage; other foreign orders, please add $6 additional to US postage.

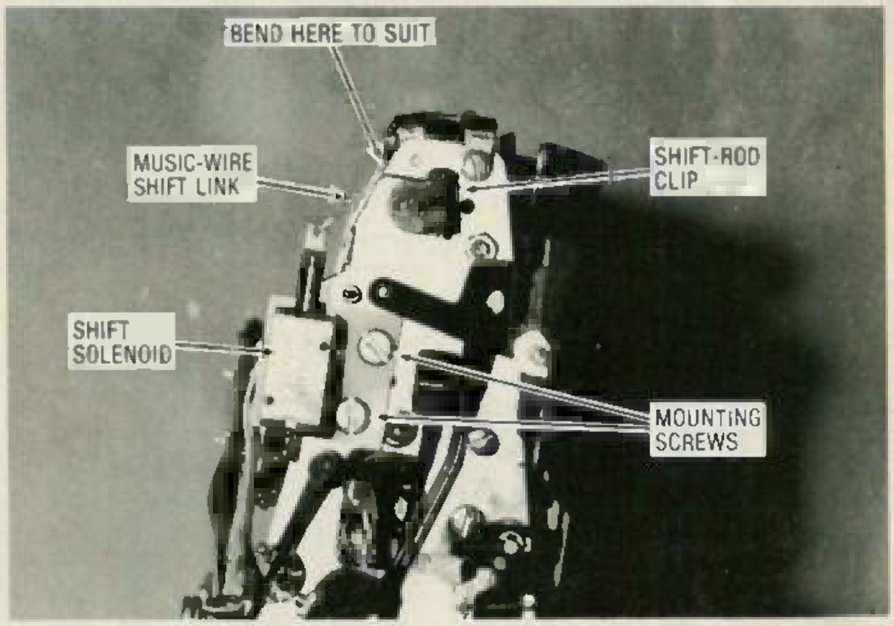

FIG. 30—THE MOUNTING OF the SHIFT board and solenoid and link is shown in this photo.

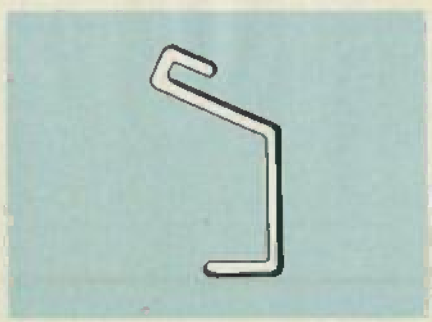

FIG. 31—THE SHIFT LINK is shown here full size.

to the printer until the PRINT button has been pressed.

After the buffer contents have been printed, you can print extra copies of the document(s) simply by pressing the PRINT button.

If there is not enough memory to hold the data from the computer, the interface will, when the buffer is full, halt the data load and print the buffer contents. Then it will resume the data load until the buffer is full again or until the PRINT button is pressed. If copies of the data are not required, press RESET before dumping new data to the interface.

Although we haven't had the opportunity to examine it, an option that allows this interface to be used with a serial computer port can also be added. Contact Alpha for further information. R-E

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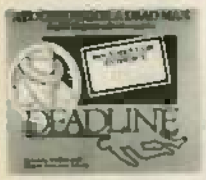

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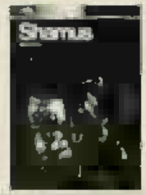

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Realistic battery-voltage measurements

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

BEFORE GETTING TO THE BUSINESS OF THE day, we want to thank each of you who has taken the time to write—and don't hesitate to write again. Your questions, comments, and suggestions have been quite interesting. We only regret that there isn't enough time to respond to each of you. For those of you who haven't written yet, why not get out the old pen and paper and let us know what you're doing.

Testing dry-cell batteries

David Patterson has raised the very practical question of testing batteries under "loaded" conditions (when current is being drawn). We're sure that you, too,

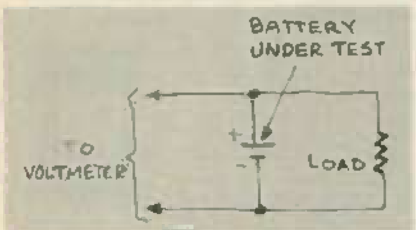


FIG. 1

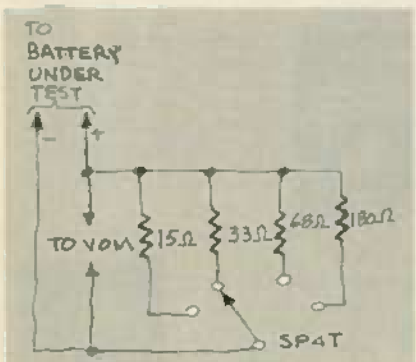


FIG. 2

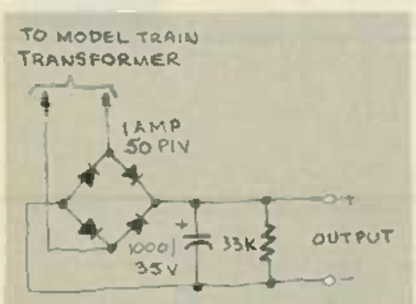


FIG. 3

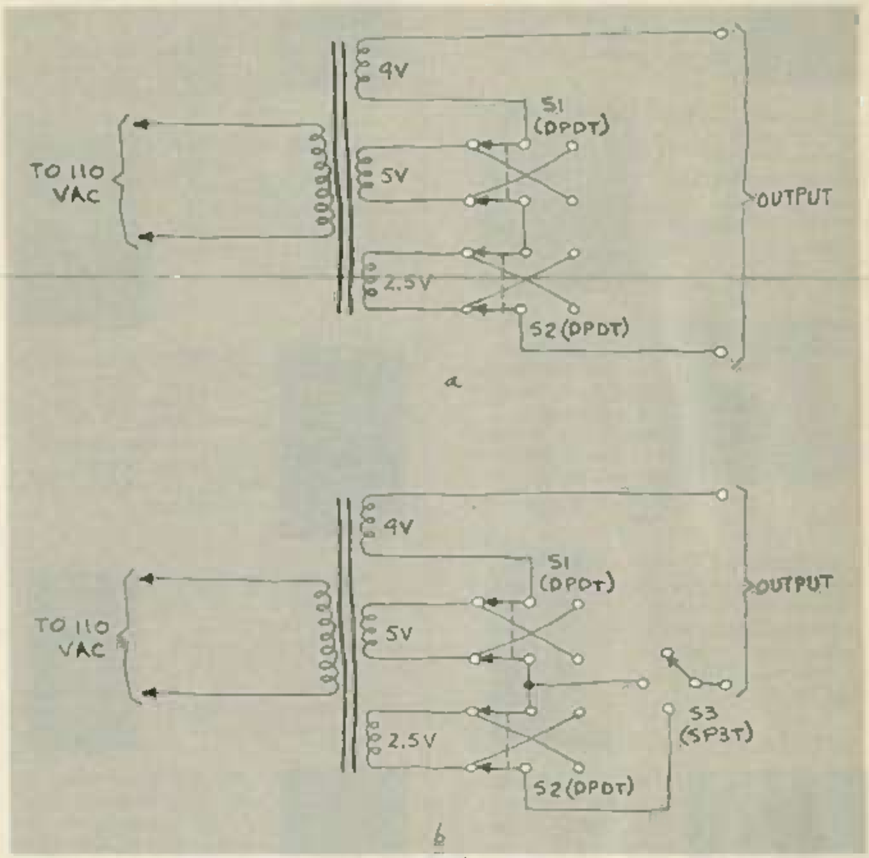


FIG. 4

have had the experience of having a battery die just a few minutes after it tested all right with a voltmeter. The reason for that is that a voltmeter has a high input impedance. As such, it draws no appreciable current from the device or circuit being tested.

In many situations that's a desirable characteristic, but not in this case. When measuring battery voltage using a meter (VOM, VTVM, etc.), the amount of current drawn is insignificant. In other words, the meter doesn't load the battery. Using a meter in that manner can produce very deceptive results. Without getting technical about battery chemistry, let's see what happens and why.

Within limits, carbon-zinc batteries have the ability to rejuvenate. Thus, after several hours, a nearly exhausted battery can muster up the strength to show a potential of 1.3 or 1.4 volts when measured with a VOM. That's great, but the battery has no stamina and soon quits when large currents are drawn from it. Since the VOM requires the battery to do little work, the measured voltage can stay high for a long time thus giving a false indication of battery status.

David's question shows us how we can get a meaningful voltage measurement. That is, to see how a battery will stand up under normal conditions, measure the voltage when the battery is "under load" and some current is being drawn.

There's no trick to loading a battery—all that you need to do is connect a resistor and a meter in parallel across the battery terminals as shown in Fig. 1. The resistor draws current from the battery so that a realistic battery-voltage measurement may be obtained. You've probably noticed that one small detail has been omitted; the load-resistor's value hasn't been specified. The "trick" of the procedure is determining that value. Fortunately, it's not difficult to do.

A wide range of resistor values will suffice but we want to avoid the extremes. The idea is to draw enough current to simulate a real situation. Too great a value, and the resistor might as well be omitted—too small a value and you can drain the battery.

Let's suppose that we want to measure the voltage of a D-size cell. The first thing we have to determine is how much current is normally drawn from such a cell. That, of course, depends on the device that is to be powered. For example a battery-operated toy will draw several times more current than a flashlight. For our purposes, let's use a rate of about 40 or 50 mA.

With that information and our old friend, Ohm's Law (R = E/I), we can easily determine the needed resistor value. Dividing the battery voltage, 1.5 (E), by the current, 0.050 (I), we get a resistor value of 30 ohms. A standard 33-ohm resistor will perform admirably, drawing about 0.045 A. Now, we have just one more calculation to make: the resistor wattage. Using the formula P = IE, we have 0.045 A × 1.5 V = 0.0675 watts. A ¼-watt resistor will handle the job with plenty to spare.

Obviously, the amount of loading on the battery can be set to any desired level simply by choosing the proper resistor value. If a non-standard value is needed, a combination of standard values in series and/or parallel will do the job. Now that we have all this information at our fingertips—why not design a circuit for a battery-test jig? In doing so, first consider the fact that 45 mA is a pretty heavy current for a little AAA-size cell to deliver. The smaller the battery, the less current it should be required to produce (that's why they make several sizes). So, let's make the loading variable by including several loading resistors.

Battery-test jig

Figure 2 shows a schematic for a battery- test jig consisting of four resistors and an SP4T switch. Reading from the smallest to the largest resistor specified there, the switch positions can be labeled 100, 45, 22, and 8 mA. You are now ready to realistically evaluate any standard-size dry-cell battery with that setup.

There's one other battery size that's frequently used—the familiar rectangular 9-volt battery. As long as you're making a test jig, you might as well include provisions to measure it, too. A typical small transistor radio draws about 3 or 4 mA from a 9-volt battery.

Following the previous calculations, a standard 680-ohm resistor pulls 13 mA and a 1000-ohm resistor will pull 9 mA. Either value will work fine. It can be substituted for one of the original four resistors, or you can use a five-position switch and add it to the others. Just don't forget to change the meter range when measuring a 9-volt battery. Well, there you have it. Now you can test your batteries under operating conditions.

Variable power supply

Glenn Anderson asks about building a variable power supply. Every experimenter should have a variable voltage source and you can build one without great expense. My first variable supply was homebrew and it's still used occasionally when just one more "odd-ball" voltage is needed. That supply is nothing more than a small box and an old model-train transformer. The transformer has an output that's variable from 0 to 18 volts in two ranges.

The box has a pair of terminal posts on each end and contains a full-wave bridge rectifier (similar to Radio Shack 276-1161), a filter capacitor, and a small bleeder resistor. The components are connected as shown in Fig. 3. When an odd voltage is needed, the transformer is connected to the input terminals on the box. The output terminals of the box are connected to a VOM and the circuit to be powered. The transformer is then adjusted to provide the desired voltage. That's all there is to it.

Of course, you can fancy it up with a

built-in meter for voltage and another for current, but that won't make it perform any better. You can build in more filtering for the rectified voltage, but that's seldom needed. When additional filtering is necessary, you can just connect the parts to the output side of the supply.

That's well and good, you say, but what if you don't have an old train transformer? There are a couple of reasonable alternatives—one, of course, is a Variac. The other substitute is a multi-secondary low-voltage transformer (or several small transformers).

Take a look at Fig. 4-a, it shows a transformer with three low-voltage secondary-windings (there could be more). There, double-pole double-throw (DPDT) switches are wired so that the leads from two of the windings can be reversed. By the setting of the switches, you can make the individual windings add or subtract their voltages from the total output.

For example, suppose you have three secondary windings for 9, 5, and 2.5 volts. With the addition of those switches, you now have a choice of 16.5, 11.5, 6.5, and 1.5 volts. If you add a SP3T switch, as shown in Fig 4-b, you'll have three more choices: 4, 7.5, and 14 volts. Of course, the specific voltages available will depend on the particular transformers used and the way in which the switches are wired. If you use the multiple-winding approach to build a variable power supply, we suggest that you put the transformers, rectifier, and filter in a box.

Well, that's it Glenn. Now, there's no reason why you and every other experimenter can't have a variable power supply on your workbench. R-E

VCR REPAIRS

continued from page 66

units have servo, video, audio, and system-control adjustments that must be performed according to the manufacturer's recommendations. However, keep the following points in mind no matter what the literature says:

If you get good performance on record and playback, leave the VCR alone!

If you make the adjustments for the three basic functions described here (tape path, switching, and head resonance/Q) with an alignment tape (using the video, audio, and RF-sweep portions of the tape), and get good performance after adjustment, all of the other adjustments are probably OK, and need not be made.

If you cannot get good response by adjusting the three basic functions, you have other problems (possibly terrible problems), and you must consult the manufacturer's literature. R-E

NEW IDEAS

Plant-water monitor

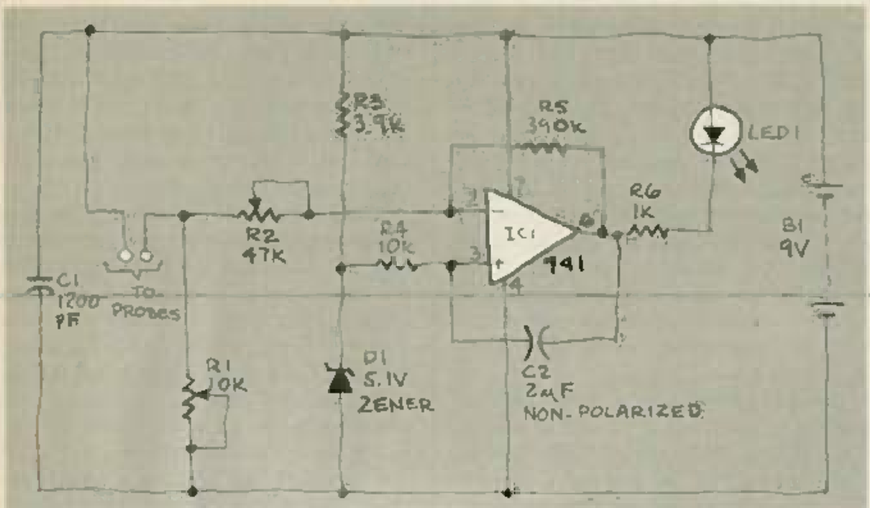


FIG. 1

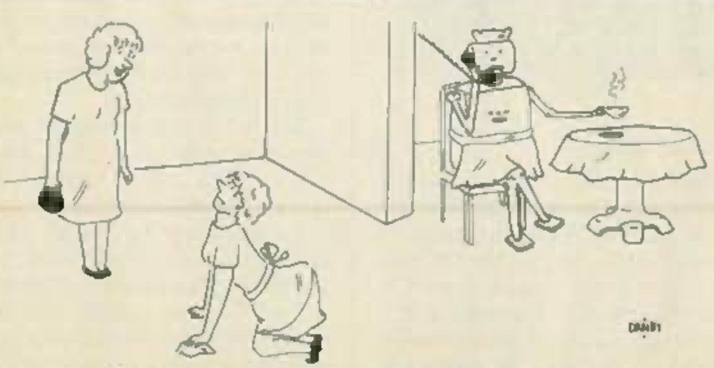
ONE OF THE MOST CRITICAL FACTORS IN A plant's well-being is the amount of water it receives. A plant that receives too little, or, for that matter, too much water will soon be in poor condition. As for house plants, you, their owner, determines how much or how little water to give them, but how do you know when to water them? Just looking at the soil can be misleading because it's the moisture at the root level that's critical. Thus, soil that's dry at the top of the pot could be quite moist at the root level and adding more water could put the plant in jeopardy.

That's where this project idea comes in. It's a plant-water monitor and is used to test the moisture of the soil at root level. When the soil is moist, an LED glows. If the moisture falls below a certain predetermined level, the LED begins to flash. If there is still less moisture, the LED turns off.

The schematic diagram of the device is shown in Fig. 1. It can be built on a small piece of perforated construction-board and housed in a small plastic case or experimenter's box. The probes are two slender metal rods. They should be tinned to prevent corrosion. For convenience, you can mount the probes on the case.

Calibrating the monitor is easy. Just connect the battery and insert the probe into a container of dry soil. Set R1 to its maximum value then reduce that resistance until the LED begins to flash. The range over which the LED flashes before going out is adjusted using R2.

If you wish, you can reverse the operation of the circuit. That is, you can have the LED off when there is enough water, and on when more water is needed. That's done by simply switching the positions of R1 and the probes in the circuit.—*Sreekumar. J.*



"How's your new robot maid working out?"

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.

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STATE OF SOLID STATE

IC metal-sensing devices

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

RECENT DEVELOPMENTS IN THE FIELD OF electronics technology have given us some interesting semiconductors. This month we'll take a look at some of those devices and their applications.

First let's look at two bipolar IC's from Cherry Semiconductor—the CS191 and CS209. Those IC's are metal-sensing devices and can be used in a wide variety of applications—including electronic ignitions and metal detectors. Figure 1 is a block diagram of the CS191 and Fig. 2 is the block diagram of the CS209.

Each IC contains a voltage regulator, oscillator, demodulator, and a level detector. The CS209, which we will look at, has only two high-level outputs (pins 4 and 5) for external loads. The output of pin 4 is normally open and pin 5 is normally closed (high). (The CS191 also has two low-level outputs with internal loads.) The saturation voltage for the high-level outputs is 0.2 volt at 124 mA (0.03 volt at 2 mA for low-level outputs). Both IC's require a supply voltage between 4 and 24 volts, and draw about 4.5 mA when operating from a 4-volt supply.

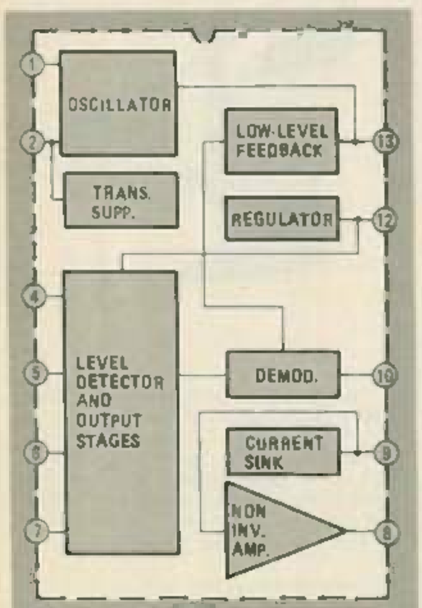


FIG. 1

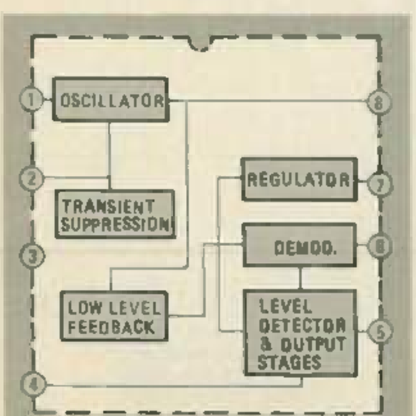


FIG. 2

The internal oscillator, together with an external L-C network, provides an output signal whose amplitude is highly dependent on the Q of the external L-C tank circuit. To sustain the oscillations when the Q is very low, a variable low-level feedback signal is developed. Both IC's have transient suppressors to protect their internal circuitry against transients (spikes) that might develop in the tank circuit.

The demodulator rectifies the oscillator's output and the resulting DC voltage is fed to the level detector, where it's compared to an internal reference to produce an output signal.

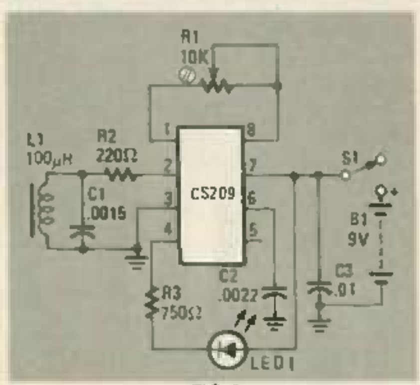


FIG. 3

Build a stud detector

The diagram in Fig. 3 shows how the CS209 can be used to build a pocket-size device for locating studs and joists in building walls and ceilings. The L-C network consists of coil L1 and capacitor C1. The "search" coil (L1) is passed over a wall or ceiling surface to locate a beam by pinpointing nails or screws. When the coil comes close to a nail or screw the Q of the tank circuit drops. Whenever that change in Q is detected, the LED lights showing the location of the screw or nail. A pencil line drawn through several nail positions shows the approximate center line of the beam you are looking for.

The sensitivity of the device is adjusted using potentiometer R1. To accomplish that, set R1 so that the LED lights when the search coil is well clear of any metal-objects. Then slowly adjust the trimmer in the other direction until the LED just goes out. The LED should light when the device is brought close to a nail and go out immediately as it's pulled away. If not, repeat adjustment procedure.

The search coil (L1) is a 100μH RF choke (Radio Shack 273-102 or equal), C1 is a silvered mica or polystyrene capacitor. The resistors are ¼-watt, 5% types. Potentiometer R1 should be a multi-turn trimmer of about 6K but since that value isn't readily available, we suggest that a 10K multi-turn potentiometer be used as a maximum.

You may want to try building an electronic ignition system for your car or a smaller engine, such as found on a snow blower or lawn mower. If so, try the circuit on the CS191/CS209 data sheet available upon request from Cherry Semiconductor Corp., 2000 South County Trail, East Greenwich, RI 02818.

Solid-state temperature sensor

The TD1A is the first in the Micro Switch line of temperature sensors using a nickel-iron alloy and thin film technology. The TD1A is a linear device with a positive temperature coefficient (sensor resistance increases with temperature). Its applications include room, duct and refrigerant monitoring, motor-overload protection, electronic-equipment overheat warning, and cooking-temperature settings for appliances.

The IC is constructed of nickel-iron alloy deposited on a 0.040-inch square silicon chip and is laser-trimmed to provide a stable room temperature resistance accurate to 0.4°C. It is then mounted on a 0.2-inch ceramic substrate and epoxy encapsulated for protection.

The TD1A has a higher resistance than that of platinum sensors—thus, making it well suited for use in low-power circuitry and for minimizing errors caused by voltage drops between the sensor and control circuitry.

It's operating range is from −40°C to +150°C and its resistance at 20°C is 2000 ohms. Its tolerance at 20°C is ±0.4° and ±1.0°C over the entire range. Its recommended excitation is 1 mA and it has a thermal time constant of 4 seconds maximum.—**Micro Switch**, a Honeywell Division, 11 West Spring St., Freeport, IL 61032.

Low-current LED's

Hewlett-Packard has announced the latest in its series of low-current LED's. Those LED's use only 2 mA and are five times brighter than standard ones that draw 10 mA. Typical CMOS and low-power TTL circuitry provides enough current to maintain high brightness without external drivers. The HLMP-4700, HLMP-1700, and HLMP-7000 are red LED's. The HLMP-4719, HLMP-1719 and HLMP-7019 are yellow. The HLMP-4700 series come in T-1¾ (5mm) packages and the -1700's in T-1 (3 mm) packages, and the -7000's are subminiature devices.**Hewlett-Packard Corp.**, 640 Page Mill Rd., Palo Alto, CA 94304.

Transistor replacement guides

A four-page booklet, *Direct Replacement for Texas Instruments Transistors*, lists STI direct equivalents for 540 metal-can small-signal and power transistors discontinued by Texas Instruments.

Also available from STI are cross-references and data sheets of pertinent characteristics of replacement high-voltage power transistors in the DTS series of devices that was discontinued by Delco.—**Semiconductor Technology, Inc.**, 3131 S.E. Jay St., Stuart, FL 33494.

Isolated-feedback generator

The UC1901 series IC's from Unitrode features an AM-carrier system that replaces the visible or infrared light path in optocoupler/isolators. An internal RF oscillator and amplitude modulator develop the signal that's coupled across the voltage-isolation boundary by a small RF transformer. The oscillator is usable up to 5 MHz. An external clock can be substituted for the oscillator to syncronize the device to a system clock or to the frequency of a switching power supply.

As an added feature—a status monitor that provides an active-low output when the sensed error voltage is within ±10% of the 1.5-volt precision internal reference. The UC1901 operates on voltages between 4.5 and 40-volts. It's available in 14 pin plastic and ceramic DIP's—in military, commercial, and industrial versions. Price at $1.98 to $6.00 each in 100 lots.—**Unitrode Corp.**, 5 Forbes Rd., Lexington, MA 02173. R-E

THE DRAWING BOARD

More on the 4018

ROBERT GROSSBLATT

ANYONE WHO SPENDS A LOT OF TIME hacking around with hardware soon finds out that there are certain kinds of circuit requirements that pop up over and over again. Forget the old axiom that there is nothing new under the sun—it's only half right. There may only be a few new questions, but there are always lots of new answers. One of the words to keep your eyes peeled for when you're browsing through data books is "programmable." Whenever you see that word, pay special attention to what follows because there's a good chance that the information there can save you all sorts of trouble.

The 4018 is billed as a "programmable" counter, meaning that it can be preset to perform division by any number up to ten. And, like the 4017, it can be cascaded to increase the range of division; that is, two IC's will divide by 100, three by 1000, and so on. Now, those of you out there who have been following along for the last few months on our little trip through the "suburbs of counterland" will probably be wondering why the 4017 was called a "decade counter" while the 4018 enjoys the added adjective of "programmable." Well, the answer is really simple.

When we used the 4017 for frequency division, there were lots of problems we had to overcome. Some of them, like fix-

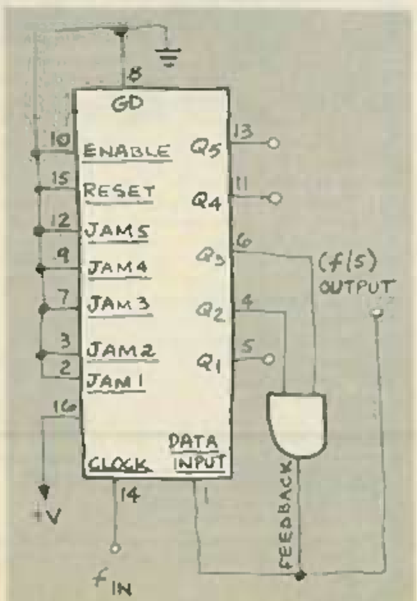


FIG. 1

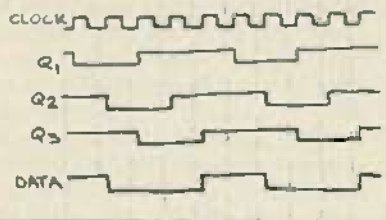


FIG. 2

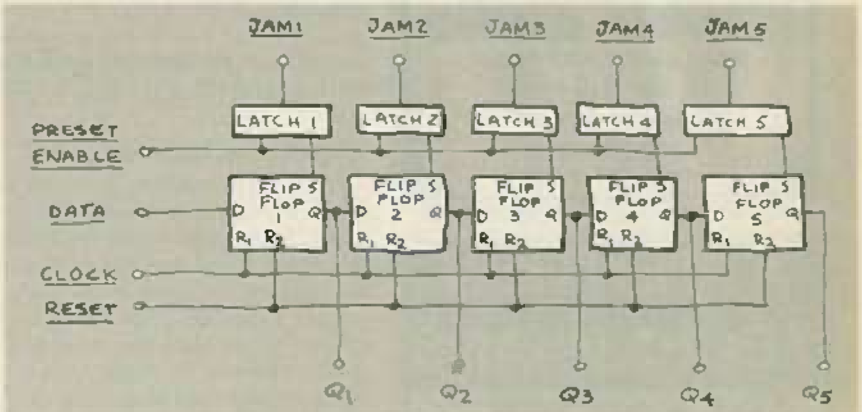


FIG. 3

ing the reset, could be handled by adding a bunch of extra parts to the circuit. Other problems, like the duty cycle of the output, weren't quite that simple to handle. Squaring up the output of the 4017 for any kind of division would have required the kind of hardware design that went out the window with 200-watt soldering irons and 12-gauge wire. What we mean is that the 4017 wasn't really designed to handle the job of frequency division. Sure, if all you care about is knowing "how many" over a period of time, the IC will do the job. But if your application is finicky about the output waveform, you'll have to turn to the 4018. The 4018 is a real "divide-by-n counter" while the 4017 is simply called a "counter."

In order to explore that a bit further, let's make the 4018 do something and see how it differs from the 4017.

First of all, there are two ways we can use the 4018—let's call them the "fixed" and "preset" modes; let's talk about the fixed mode first. In that mode, the IC can do pretty much what the 4017 did—divide by any number from 2 to 10. The device requires a feedback loop to operate and the output is picked off the feedback path at pin 1, the data input.

Figure 1 shows a typical circuit using 4018. In that figure, the IC is set up in the fixed mode to perform frequency division by five. (In our last column we gave you a table showing which pins to use to divide by a particular number.) Since we're not using the preset features of the IC, we have to ground the JAM inputs as well as the RESET and ENABLE pins. That is standard practice for all unused CMOS inputs. Although the ENABLE pin really controls the preset functions of the IC you can think of it as somewhat similar to the ENABLE pin of the 4017.

In any event, the proper feedback signal is provided by AND-ing the Q2 and Q3 outputs together and tying them back to the DATA input of the IC. Once we do that the incoming frequency is fed into the clock input and, as we said, we can pick off the divided output from the feedback path.

In order to appreciate that unique IC take a look at Fig. 2. Those are the waveforms you would see if you looked at various points in the circuit using an oscilloscope. Take a really good look at them because there's more here than is readily apparent—a little imagination will open up all sorts of wild possibilities.

Just as with the 4017, each of the outputs is phase-shifted from the previous one by exactly one (incoming) clock pulse. The difference lies in the fact that the unused outputs of the 4017 only stayed high for one clock pulse, causing the out put waveforms to be really spike-filled and irregular. As you can see from the figure, the 4018 has an output frequency equal to the incoming clock frequency divided by whatever number we selected to divide by. The duty cycle is always "just about" fifty percent. We say "just about" because division by odd numbers is going to throw the output duty cycle "out of square" by exactly one period of the clock frequency. That is really only a minor annoyance and easy to live with—especially if you remember what the output waveforms of the 4017 looked like.

If we look at the output waveform in Fig. 2, we can see that things turned out as we could have predicted. Since we're AND-ing outputs Q2 and Q3 together, the output is high only when both Q2 and Q3 are high.

If you're dividing by ten, you can get the same output symmetry from the 4017 by taking the output from pin 12, the CARRY OUT pin. What's so special about the 4018 is that division by any number from two to ten will produce the same symmetry at the output. All that you have to do is feed the required Q outputs back to the DATA input. At most, the whole thing is going to cost you one AND gate, and that's a pretty cheap price to pay. If you don't have a spare gate on the board you can always accomplish the same things with a pair of diodes and a resistor, or some other similar arrangement.

Preset mode

Now let's see what happens in the preset mode—so we can use the programmable features of the 4018. The JAM and ENABLE pins allow us to preset the 4018 to divide by any number we want. What's happening inside the IC is really very straightforward. Remember that what we are dealing with is nothing more than a series of interconnected flip-flops. The 4017 is a "serial-input-only" type of shift register while the 4018 has both serial and parallel inputs. When we use the 4018's JAM inputs, what we're really doing is presenting the appropriate information to the SET inputs of the internal flip-flops and then strobing that information into internal latches by taking pin 10, the ENABLE pin, briefly high.

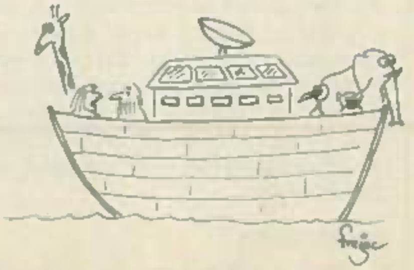
If you remember the design of the keyboard encoder we did some time ago, you'll realize that we used the same sort of strobing technique to latch the selected keyboard entry onto the data bus. What's happening here with the 4018 is exactly the same sort of thing. The designer of the IC was kind enough to put the latches on the substrate for us, so we don't have to go through the brain damage of hardwiring it ourselves. The code that we have to use to preset a number in the 4018 is, however, not a standard sort of code. That makes sense when we look at Fig. 3, a block diagram of the 4018's guts.

As you can see, what we have is a series of five flip-flops daisy-chained together. The incoming frequency of the clock line controls the speed at which the data is going to be routed through the flip-flops. The actual data is just various combinations of the Q outputs of the flip-flops that are fed back to the start of the daisy chain. If you think of that whole arrangement as a shift register, which is what it really is, you should have no trouble understanding exactly what's going on. Parallel loading with the JAM inputs is exactly the same as loading a shift register with parallel inputs. As a matter of fact, you should be able to see that the code that has to be used to load a number into the IC is the same code that the Q outputs present for any particular number.

When you reset the IC using the JAM inputs, all you're really doing is forcing the IC to start its count as if that number had already been reached by means of feeding the serial input. In other words, parallel loading a number is going to make the IC start its count at that number. Frequency division will have to be rethought a bit, since the IC is going to start out at a particular number and then reset to that same number when the count in the IC reaches 10. If you want to divide by four for instance, you'll have to load a six into the IC. That way the IC will reset after 10 − 6 = 4 counts. That may sound confusing but five minutes of actually playing with the IC will make it clear.

Parallel loading should make you think about what you have to do to make the operation switch-selectable. A simple rotary switch (if you're lazy) or a keyboard select (if you're ambitious) should allow you to divide by any number you choose, and the IC will provide glitch-free, highly symmetrical outputs. The added advantage of using that IC over the 4017 is that the output will be square, (or nearly square), regardless of the shape of the incoming wave. Think about that for a while.

Next month we'll discuss trying out that IC in a "real-world" application. We'll see how it can serve as the bridge for us to cross from the somewhat restrictive digital world to the occasionally flaky and always unpredictable world of analog circuitry. R-E



"Noah, I don't think that solar heating was a good choice for the Ark."

COMMUNICATIONS CORNER

Communications noise

HERB FRIEDMAN COMMUNICATIONS EDITOR

NO MATTER WHERE YOU TURN TODAY, YOU are sure to find that digital technology will play an ever-increasing role. Consider, for instance, noise-free sound reproduction. Audiophiles look to digital systems for wow-free and noise-free discs and tapes, while the communications industry looks to digital advances to remove noise from signals.

Noise has always plagued AM broadcasts. That's because noise itself can amplitude-modulate a transmitted signal. So when the receiver detects the transmitted signal, it also detects noise. That noise can be either atmospheric or man-made, continuous or impulse. (The constant "grind" one hears from a mobile CB is impulse noise.)

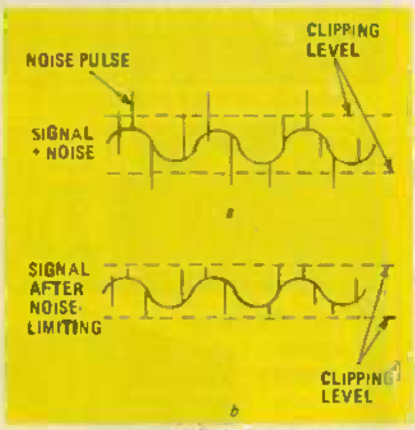


FIG. 1

Figure 1 is a simplified illustration of how noise might be added to a transmitted signal. Note that the noise can be in-phase or out-of-phase with the desired signal. That makes it hard to eliminate—though the phase relationship makes no difference to the ear.

Until the CB era, most noise filters were simple clippers. The clipping level was set at or near the average maximum detector output as shown in Fig. 1-a. Any impulse that exceeded the set clipping level was eliminated. The resultant output appeared similar to that shown in Fig. 1-b. (Notice that the noise pulses are still present but those above the clipping level are sharply attenuated.) Even those attenuated pulses were extremely annoying to the operator. Because of that, the clipping level was often set so that it actually clipped the signal. While that produced even greater noise attenuation, it distorted the desired signal (which can be clipped about 10 dB before becoming "muddy").

You've probably already figured out that a fixed clipping level has many problems associated with it. For instance, if the incoming signal is weak, its noise will be under the clipping level. On the other hand, if the clipping level is set low enough to affect weak signals, strong signals will be clipped excessively.

Eventually, the communications industry came up with the floating or self-adjusting clipper. Its clipping level is controlled by the average DC level of the detector. Say for example, the incoming signal is weak. The floating clipper automatically lowers the clipping level. In contrast, if the received signal is strong, the clipping level is raised. In that way the clipper won't cut too deeply into the desired signal. The fuss over clipping levels eventually reached a point where only better-quality and/or higher-cost receivers provided an adjustable noise-limiter. That allowed the clipping level to be user-selected for a given signal.

It was CB that introduced really effective noise limiting into consumer equipment. That's because most CB gear was installed in some kind of vehicle (since it was originally intended for mobile use) and motor vehicles are among the worst noise generators around. The AM clippers simply couldn't handle the noise created by the ignition system—primarily impulse noise. (Though the vehicle's generator whine was just as annoying—it could be easily corrected using a few simple filter components.)

A much more effective noise-reduction system was needed. Engineers had developed one, called a *noise blanker*, but it was too expensive for consumer equipment that used vacuum-tubes. But with the introduction of transistors it became possible to build a noise blanker into moderate-cost receivers. The cost of noise blankers plunged even farther because of the mass-marketing of CB equipment. In fact, by the end of the CB boom, virtually all CB transceivers were equipped with noise blankers.

How it works

Figure 2-a shows how an early noise blanker worked. The basic receiver used a

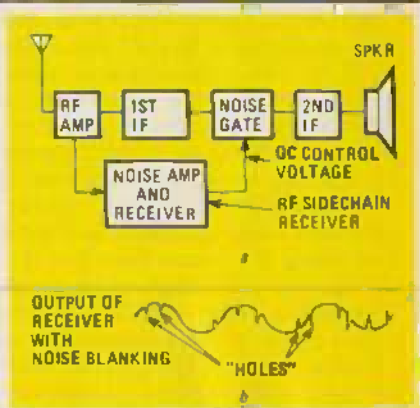


FIG. 2

double-conversion system—with the first conversion at a frequency of about 2.5 to 4 MHz. A noise gate—essentially a normally open electronic switch that is controlled by a DC voltage—is inserted between the first and second IF's. Some of the RF is split off at the amplifier's output and sent to a simple *sidechain* receiver. A sidechain receiver is one that is tuned to an unused frequency that's slightly different than the desired frequency. Say, for instance, that the desired signal frequency was 27 MHz, then the sidechain receiver would be tuned to 25–26 MHz.

The sidechain receiver is used to detect noise pulses. (That makes the reasonable assumption that the noise at 25 MHz is essentially identical to the noise at 27 MHz.) The output of the sidechain receiver is detected, and a DC voltage corresponding to each received noise pulse is generated. That DC voltage is used to control the gate in the main receiver. Whenever a noise pulse is received, the resulting DC is used to turn off the noise gate, thereby punching holes in the signal as it passes from the first IF to the second. The resulting audio signal is shown in Fig. 2-b. The signal is noise-free with "holes" where there would normally be noise pulses. The holes are shown in the conventional manner using little notches in the output signal. The notches are just for clarity—they represent discontinuities in the output.

The sidechain noise blanker performed superbly, but was limited in frequency range and used too many additional components. (To a manufacturer, if 10,001 components are used when 10,000 will

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CABLE DESCRAMBLING

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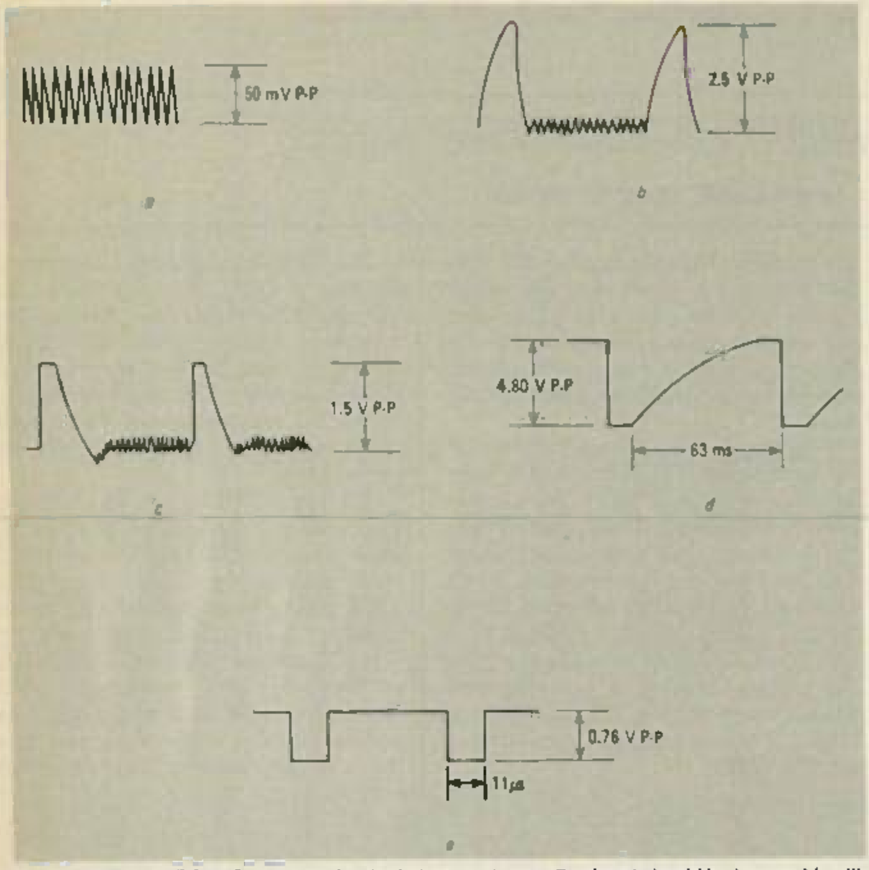

WHEN TESTING THE DECODER, look for the following signals: The input should look something like what's shown in *a*. The signal in *b* should be seen on pin 5 of IC1. The signals in *c* and *d* should be seen at the base and collector of Q3 respectively. The waveform shown in *e* should be seen at the junction of R10 and R11.

nal to return the horizontal-blanking pulse (which contains the horizontal sync and colorburst information) back into its proper location. The scrambled video should be clear.

Once the circuit is working properly on one scrambled channel, you will have to switch to other scrambled channels to see if the circuit is tracking properly. If it isn't (and some channels are not being properly descrambled), some minor, final touch-up adjustments will have to be made.

Remember that switch S1 has to be open to view a scrambled channel, and must be closed to view a non-scrambled channel. Unless you modify the circuit with a bypass-switch arrangement, it will be necessary to leave this circuit on whenever you watch TV. **R-E**

SERVICE CLINIC

A pulse-width-modulated power supply

JACK DARR, SERVICE EDITOR

WE'VE TALKED ABOUT PULSE-MODULATED power supplies in the past—well, here's another one for you. This time we'll take a look at Sylvania's C3 color-TV chassis. Because of the increased use of pulse-modulated supplies, we thought it would be an interesting topic to discuss in this month's "Clinic."

The power supply found in the C3 chassis is a bit more complex than some but a lot less than others. It does the same job as all the rest—that is, it controls the amplitude of the B+ voltage by varying the pulse-width of the driving signal.

How it works

The schematic shown in Fig. 1 is taken from the manufacturer's service notes on the C3 chassis. The power supply contains a half-wave doubler circuit. The half-wave doubler circuit outputs +310 volts that is needed to power the high-voltage circuits in the set. If that voltage is missing, check the 220-µF input capacitor to the voltage-doubler circuit (C402) and the doubler diodes (D400 and D402) for defects.

Referring to the schematic, note that the input signal is applied to Q400. That signal comes from IC500—the sync processor (not shown), which contains both the horizontal and vertical oscillators. The IC produces a positive-going 6-volt peak-to-peak sawtooth waveform at the horizontal frequency. It's powered by a 10-volt start-up voltage taken from a tap in the primary circuit of an integrated flyback-transformer or IFT (not shown). If that start-up voltage is missing—nothing works.

The sawtooth waveform is applied to the base of Q400, the pulse shaper. The duration of the pulses from Q400 is controlled by the pulse-width regulator (Q404) by using the B+ adjustment potentiometer R426. The output of Q400 is a controlled negative-going 4-volt spike and is applied to the base of the horizontal driver, Q402.

Transistor Q402 squares-up and inverts the signal and applies it to the switched-mode regulator, Q410. The switched-mode regulator has a 310-volt supply voltage applied to its collector. It steps-up the input signal and outputs a 310-volt square-wave. That output is applied to the switched-mode-regulator transformer, T402. The 130 volts DC that powers the high-voltage circuitry is developed here from the switching waveform. That signal volt-

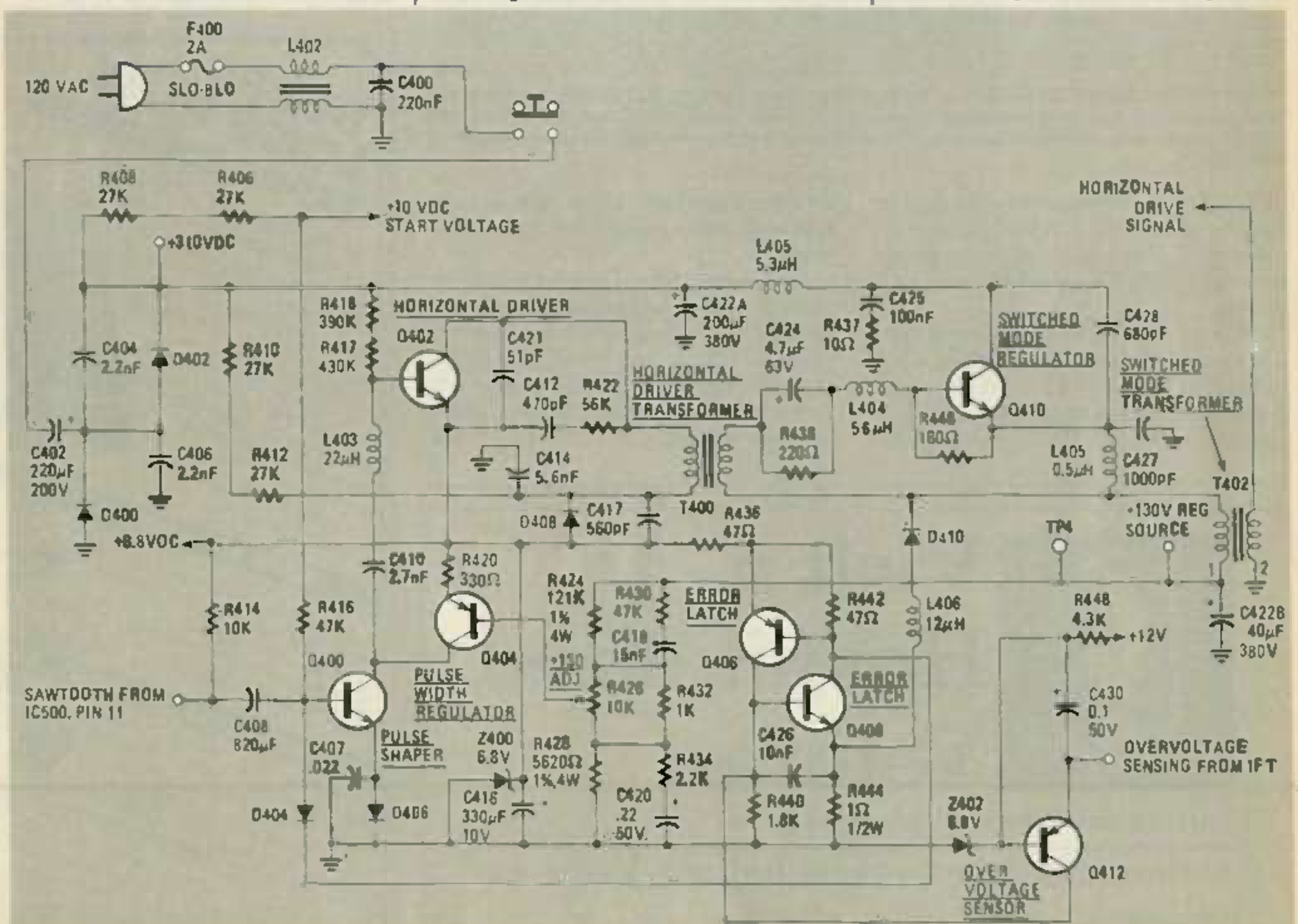

FIG. 1

age also drives the horizontal output transistor and that in turn drives the integrated flyback transformer (IFT). Note that the horizontal output transistor is not shown. The flyback transformer develops all the low-voltage DC supplies for the set's circuitry, except the audio stages. The audio circuitry is fed from a separate +20-volt DC supply.

Protective circuitry

The customary overvoltage/current protection is provided. We'll look at the overvoltage protection first. Overvoltage conditions are detected by transistor Q412, which receives its source voltage from an IFT-derived +12-volt supply. That voltage is regulated at +6.8 volts by Z402 at the base of Q412. The IFT's secondary provides approximately 6 volts to the emitter of transistor Q412. If that voltage rises, the error latch Q408 is turned on—producing an overvoltage condition that turns off the set.

An overcurrent condition is detected by diode D410. When that occurs the diode is forward biased causing current flow. That, in turn, causes the error latch Q406 to turn on and clamp the 6.8-volt bus to ground—turning off power to the set. Anytime Q408 is turned on, Q406 will be on because of the low signal level that's applied to its base.

Service tips

When servicing the C3 chassis, several points should be checked as indicated by the manufacturer. First, make sure that the 6-volt peak-to-peak sawtooth is present at the base of Q400. If it's not there, check the output of IC500; also check the 10-volt start-up voltage that powers the IC.

Verify the presence of the +310 volts that feeds the switch-mode-regulator. If that voltage is missing or incorrect, check the 220-μF input capacitor to the voltage-doubler circuit C402 and doubler diodes D400 and D402.

The source voltage for Q402 should be about 60 volts DC during normal operation. If the above is true and Q402 is working, 6.8 volts will be developed from the switching waveform and diode Z400. (The presence of the switching waveform can be verified with a scope.) If Z400 is shorted, a constant overvoltage will occur and cause transistors Q400 and Q404 to be cut off.

If Q410 is shorted, the 310-volt supply will be shorted to ground through T402, R424, R426, and R428. Those three resistors form a voltage divider from the 310-volt source to ground. If the set is left on too long with Q410 shorted, those resistors could increase in value and cause B+ to be incorrect. So, be sure to check those resistors before powering the set again.

The circuit appears complex, but after a closer look you'll see many easily accessible test points and some significant voltages that can help you to locate the problem. Good Luck! R-E

SERVICE QUESTIONS

BRIGHTNESS PROBLEMS

I've got an RCA CTC-40 with a dark raster; adjusting the brightness control has no effect. Looking around, I found that the control grids are a +50 volts instead of the normal +105 volts. The voltage to those is applied through three 2.2-megohm resistors, one to each grid, so any problem there must be common to all three. The B+ voltage is OK, as is the CRT bias control and voltage.—F.K., Port Hope, MI

As you said, the problem must be common to all three resistors. The first thing I see are the three blanking diodes (X26, X33, X40). Since their anodes are connected directly to the grid circuits, they would normally be forward biased by the +105 volts at the grids. However, those diodes also have their cathodes connected to +180 volts at the slider of the bias potentiometer. Normally, that +180 volts

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SERVICE QUESTIONS

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would reverse bias the diodes and they would not conduct. But what happens if that +180 volts is low? Why the diodes would conduct, pulling the grid voltage down.

Even though your note said that the bias control and voltage are OK, I would recheck both with the above in mind. In the past, similar situations have been caused by a shorted blanking transistor that has pulled the +180 volts down to a much lower level. The effect is exactly as you described.

Then again, something could be causing the blanking transistor to conduct heavily, which would also cause the same symptoms.

REMOTE APPLIANCE CONTROLLERS

I would like to get some more information on those appliance remote-control modules. Those are the ones that work on a carrier frequency over your house wires.—J.P.K., Grand Rapids, MI

There's nothing too unusual about those little modules. You already know how the signal is distributed to each outlet—by carrier current. That technique is anything but new, having been used even back in the 1930's. Today, utility companies make use of that technique for communications between various substations, etc.

As far as the handheld remote control goes, that uses the same principles as your TV remote control, except that the communications medium is ultrasonic rather than infrared.

Incidently, if you want an excellent, in-depth treatment of how the entire system works, including schematics, take a look at the September 1980 issue of **Radio-Electronics.**

SNEAKY PROBLEM

I've been working on an RCA CTC-55XZ with problems in the vertical-sweep section. To make the bottom correct, the top oversweeps and compresses the bottom. I have changed the components on the vertical-sweep board and the vertical-output transformer and still can not find the problem.—R.C., Vernon, B.C., Canada

From the voltage readings that you supplied with your letter, it would appear that the grid of the vertical output section of your 13GF7 is too positive. That would cause the cathode to become too positive as well. That matter is also verified by your readings.

I'll bet that what you are dealing with is a somewhat sneaky problem that comes up in many sets. Most likely there is leakage between the sections of the service switch. That can cause the grid to become too positive and create the symptom you have described. To check, disconnect the lead from the center terminal of S1-b to the grid of the 13GF7. If that returns the sweep to normal, than you can be sure that you've found your problem.

CB COIL

I've looked everywhere I can think of to find a replacement for T7, the 27-MHz transmitter driver coil in a Royce 1-648 CB radio. The company is no longer in business, and no one I've tried can identify the part, or tell me who, if anyone has taken over their line. Can you?—S.W., Ottawa Lake, MI

If memory serves us right, Royce was taken over, at least for a time, by Newcom Electronic Services, 1805 Macon St., North Kansas City, MO 64116.

Just out of curiosity, what happened to the original coil? It would seem that a 27-MHz coil would have little wire on it and thus cause little trouble. If you are just guessing that that coil is the cause of your problems try using a grid dip meter to check it out for sure.

Also, if you cannot get the coil from any other source, it should be a relatively simple matter to rewind it. Information on how to do that can be found in a number of sources, including the ARRL's *The Radio Amateur's Handbook*. That book and others with similar information should be available from your local library.

DOTTED RETRACE LINES

In the past you have always been able to help me when I've run into problems. This time I've got one that's so confusing that I don't even know where to begin.

The set I'm looking at works fine, except that on three or four of the twelve channels we receive there are six or seven horizontal lines that occupy the upper six to eight inches of the picture. The lines vary in spacing from channel to channel, and sometimes are accompanied by color dots. My question is: What is it that I am seeing, and how to I go about correcting it.—R.G., Copperas Grove, TX

There may not be anything wrong with the set, at least as far as defective or malfunctioning parts go. The symptom you described has been seen many times in the past, with several common factors in each occurence. First of all, most sets are not bothered by the problem, which seems to indicate that the ones that are suffer from a design flaw. Second, I've never seen the problem on a tube-type set. Third, the stations that the effects are observed on usually fall into one of two types. They are either "premium" stations on which the programming is usually scrambled (the lines and dots would appear on some sets whenever a free glimpse at the programming was provided) or stations that are experimenting with teletext. **R-E**

COMPUTER CORNER

Computer security

LES SPINDLE*

COMPUTER SECURITY HAS BECOME A POPular issue. One of the reasons for that has been the popularity of the movie *War-Games*. In that film, a bright, teenage computer buff accidentally accesses the computer system of the U.S. Defense Department—and almost launches World War III. (A scene from the movie is shown in Fig. 1.) Although *WarGames* exaggerated the problem a bit, it did bring into focus an issue that becomes more important every day: computer security.

But computer security is not only one issue. For example, from a user's point of view, it involves protecting proprietary data from outside parties (who may decide to log into the data bank to steal or change the secret information—as the hero of *WarGames* did to change his high-school grades.) From a manufacturer's point of view, security concerns the protecting against the copying of copyrighted software (for data backup or any other purpose). Let's now look at each of the issues in more depth.

FIG. 1

Unauthorized access

Of the two problems, securing data from undesirable third-party access is probably the easier to control—*War-Games* notwithstanding. Sophisticated encryption schemes (that make the data appear to be garbled unintelligibly) can be used. The most commonly used encryption algorithm—the Federal Information Processing Encryption Standard—alters 64-bit text words via a user-specified key. The result is a collection of 64-bit cipher words. Decryption works the opposite way—the encoded word is translated back into the original piece of data. Banks, government agencies, and other high-security institutions commonly use this scheme to prevent the disasters that could occur as a result of the wrong person entering the system (even accidently).

When the security problem is not one of remote on-line access (for example, an on-premises computer used by several people), another protection scheme is possible. Passwords can be assigned to individuals so that someone who needs to access certain data can do so by entering the password. If you have a group that mutually needs access to a set of data, you can assign one password to the group, or an individual password to each member, so that the information can be accessed only by the proper people.

Still another security method is to store the data on separate disks and then to keep all disks under lock and key. Then a check-in/check-out system can be used.

No method is 100% foolproof, of course. Code breakers have pulled off an alarming number of computer-data thefts. And "lock-and-key" secured disks are subject to break-in.

Copy protection

The more controversial security issue seems to be the matter of copy-protected software. Much like the debates currently raging in the videocassette industry, the question becomes an ethical matter. When is copying OK? Is it *ever* OK?

To protect their copyrighted software from bootleg sales, many software manufacturers have used a technique that causes data on the disk to be scrambled if an attempt is made to copy it. It's understandable that a software company wants to protect its profits from being siphoned off (by sales of pirated copies of its software). But selling a disk that cannot be copied can present problems even for users that have no intention of stealing the manufacturer's profits—users who simply want efficient, problem-free operation from their investment.

First and foremost is the problem of backup disks. Because the user's copy can not be backed up, the company will sometimes provide one backup disk of the program (and sometimes not even that). Many users, however, do not feel satisfied with just one backup copy. They rightfully fear that data can be lost on more than one occasion. The choices are to pay for a complete new copy as a backup (sometimes as much as $500 or upwards), or resort to some copy-unlocking scheme.

A related problem is the matter of multiple copies in use by various people on the same premises. Say you have 20 employees at various workstations all using one word-processing program for the same basic project. Is it reasonable for the software company to expect for you to pay $10,000 for one application? That example is admittedly extreme, but it does illustrate the problem. Some companies offer a discount on multiple copies, but there is an equal—or greater—number of companies that don't.

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*Managing Editor, *Interface Age* magazine

NEW BOOKS

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DATA BASE MANAGEMENT SYSTEMS—A Guide to Microcomputer Software, by David Kruglinski; Osborne McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710; 260 pages, including index; 9¼ × 7¼ inches; softcover, $16.95.

The author explains what a data base is through two examples. You could buy a mailing-list program for your computer, to help you at Christmas time, but that program wouldn't include many things you really need to know, such as clothing sizes, childrens' names, and various personal preferences. That would require you to write your own program—which might take four days' work. Once you have the program, however, you can manipulate it, adding new material and deleting old material whenever convenient.

Then, suppose you wanted to keep track of your phonograph record collection. You could write a program to do that by following the structure of the mailing-list program—making such changes as were necessary. That would take much less time than it took to do the first program.

Computer experts recognized the need, some time ago, to solve problems like the two noted above, *without* involving days of programming; thus they invented the data base. It was originally designed to help professional programmers; from that point it was developed for computer users. What a data base does is to identify a set of data that a computer can access and operate on—a tool for handling problems that involve information stored on disk.

This book defines the capabilities of three categories of data base management systems: file, relational, and network/hierarchical. It gives you standards whereby you can evaulate data base software, and examines several available packages, as well as discussing future products and trends in data base management. There are many charts and examples of menus.

CIRCLE 131 ON FREE INFORMATION CARD

IC TIMER HANDBOOK with 100 projects and experiments, by Joseph J. Carr; TAB Books, Inc., Blue Ridge Summit, PA 17214; 308 pages, including index; 8¼ × 5½ inches; softcover, $8.95.

This fully illustrated manual examines the world of IC timers and gives the reader all the theory and practical use-it-now information needed to tackle a wide range of applications—from ordinary bipolar integrated circuits to the XR-2240, CMOS timer circuits, TTL timer units, and even a 12-volt power-supply unit.

The section on bipolar IC's and operational amplifiers covers inverting followers, noninverting followers, and differential amplifiers, as well as troubleshooting techniques for op-amps. The reader is then introduced to the 555 timer—the most popular IC timer available—and given a thorough explanation of its monostable operation, astable operation, and specific applications. With the wealth of circuits, projects, and experiments included in this book, the reader will be able to take just the nucleus of an idea and develop it into a complete working circuit.

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THE COMPLETE BOOK OF WORD PROCESSING AND BUSINESS GRAPHICS, by Walter Sikonowiz; Micro Text Publications, Inc., Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 9 × 6 inches; 212 pages, including appendices and index; $14.95.

There are three principal sections in this book; Basic Concepts, Word-Processing, and Business Graphics. The first section introduces the reader to computers and how they are used in word processing and business graphics. Chapter one explains word processing and business graphics; chapter two examines the insides of a computer, while chapter three discusses mass storage of information, and chapter four deals with local networks.

The second section examines the equipment and software that is needed to process text. Chapter five shows how to select the right printer, chapter six deals with special word-processing hardware, and editing procedures are discussed in chapter seven. Chapter eight covers the printing and formatting of the text.

The final section concentrates on those aspects of computer graphics that are most useful in business. Chapter nine covers some of the special devices that enter graphical information into a computer, and chapter ten deals with the various electronic displays and recording instruments that are used in graphics. Those two chapters are concerned with hardware; the final two chapters focus on software: the general features of graphics software (chapter eleven) and various applications for graphics in business (chapter twelve).

The appendices consist of a bibliography, a directory of manufacturers, and a glossary.

CIRCLE 133 ON FREE INFORMATION CARD

CIRCUIT DESIGN USING PERSONAL COMPUTERS, by Thomas R. Cuthbert, Jr.; John Wiley & Sons, Inc., One Wiley Drive, Somerset, NJ 08873; 494 pages, including appendices and index; 9½ × 6½ inches; hardcover, $39.95.

This book is intended for practicing electrical engineers and for university students with at least senior-class standing. Its topics will also interest electronics engineers who design circuits derived in terms of complex variables and functions to provide impedance matching, filtering, and linear amplification. Circuits operating from very low frequencies all the way through millimeter waves can be designed using these techniques. The necessary numerical methods will also be of interest to readers who do not have specific applications.

A guide to designing electronic circuits using small computers and programmable calculators, the book makes it easy to implement both classical and sophisticated design techniques. It is filled with clearly-presented diagrams and equations.

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THE VIDEO TAPING HANDBOOK, by Peter Lanzendorf; Harmony Books, a Division of Crown Publishers, Inc., One Park Avenue, New York, NY 10016; 240 pages, including glossary, a list of video magazines, and index; 7½ × 8¼ inches; $16.95 (hardcover); $7.95 (softcover).

This is a practical guide to making effective, high-quality video programs. It includes instruction on selecting the right video camera, special lenses, tripods, and optical accessories; preparing the script for shooting and taping people, places, and events; setting up for effective lighting and manipulating sound, and ensuring quality editing. There is also a guide on how one should take the proper care of the equipment.

The book is generously illustrated with the latest equipment photos and numerous helpful diagrams.

CIRCLE 135 ON FREE INFORMATION CARD

DON LANCASTER'S MICRO COOKBOOK: Volume II: Machine-Language Programming; Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268; 450 pages including appendix and index; 5¼ × 8½ inches; softcover; $15.95.

This is the second of three volumes on the fundamentals of microprocessors and microcomputers; and since the pagination is continuous throughout the set, it starts with chapter six. (Volume one covered the fundamentals of microprocessors that are needed to start understanding machine-language programming.)

Machine language was chosen because nearly all the most efficient and popular microcomputer programs run *only* in machine language. The present volume will show the reader the basics of machine-language programming through a series of *discovery modules* that he or she can apply to the microprocessor family and the microcomputer of his or her choice. Once the elements are mastered, the reader can advance to *assembly language*, which is automated machine-language progamming that is made much faster, is more convenient, and more fun.

The ideas that the reader can draw from this book can be put at once to creative and profitable use, from the collection of 63 new microcomputer applications that are presented here.

CIRCLE 136 ON FREE INFORMATION CARD

RADIO ANTENNAS, by Stephen Gibson; Reston Publishing Company, Inc., A Prentice-Hall Company, Reston VA; 165 pages including appendix and index; 6 × 9 inches; softcover; $13.95.

This book thoroughly explains antenna systems for the beginning amateur radio operator. The various types of antennas are described with illustrations and photographs, and the advantages and disadvantages of each are noted. The reader is told how to design, construct, and erect antennas for use in the amateur bands.

The reader is given the basics of radio-wave propagation, and the effects of the sun and ionosphere are described. There is also information about antenna testing, measuring instruments and techniques, and possible sources of supply for the components needed.

CIRCLE 137 ON FREE INFORMATION CARD

BEGINNER'S GUIDE TO READING SCHEMATICS, By Robert J. Traister; TAB Books, Inc. Blue Ridge Summit, PA 17214; 134 pages including index; 5⅛th × 8¼ inches; softcover; $8.95.

This is a guide to electronics schematic diagrams that will make even the most complex circuit or system as easy to decipher as an ordinary road map. The reader is taken step-by-step through every phase of understanding *and* using electronics-circuit diagrams or schematics. He or she will learn how and why schematics are used; how each symbol is derived, used, and drawn; and how individual symbols are combined to represent electronics circuits. Clearly shown is which symbols stand for capacitors, resistors, inductors, transformers, switches, conductors, cables, solid-state components, batteries, vacuum tubes, and every other basic electronics element.

CIRCLE 138 ON FREE INFORMATION CARD

PRACTICAL ELECTRONIC BUILDING BLOCKS Book 1, by R. A. Penfold; Electronic Technology Today, Inc., PO Box 240, Massapequa Park, NY 11762; 109 pages 4⅛ × 7 inches; softcover; $5.75.

Nearly any electronic circuit will be found to consist of a number of stages, or building blocks, if it is analyzed carefully. Rather than gates, shift registers, and the like, linear circuits are usually composed of filters, amplifiers, oscillators, monostables, etc.

This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects instead of simply following project designs published in books or magazines.

The circuits for a number of useful building blocks are included here. Where relevant, details of how to change the parameters of each circuit are given, so that they can be modified easily to suit individual requirements. **R-E**

CIRCLE 139 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 32

unit is the only one we've seen that is completely self contained and hand-held. It is compact, about the size of an older VOM, and powered by 6 nickel-cadmium batteries. For bench use, it can be powered by an optional AC adapter, which also serves to charge the batteries.

It's intended to measure frequencies up to 50 MHz, periods from 26 nanoseconds to 10 seconds, and can read a single cycle, or up to 10 cycles. Time duration of the waveform (period) is read out in microseconds. It will also read the pulse-width of any signal in its range, measuring from either the positive or negative going portion. Like all equipment of its type, it really "counts edges," and can be triggered on either the positive- or negative-going edge.

On the outside, the design is very simple. An 8-digit LCD readout with nice large digits is at the top of the front panel. Also on the readout are overflow (OFL) and low-battery (BATT) annunciators.

Moving to the center of the panel, a GATE TIME switch allows selection of .01-, .1-, 1-, or 10-second gating of the counter. The TRIGGER LEVEL is a variable slide control; it is used to make the unit trigger at a specific level on either the negative- or positive-going edge and works exactly like the similar control on a triggered scope. The MODE switch selects either frequency, period, or pulse-width measuring modes.

At the bottom of the panel, the ON-OFF switch has a TEST position. That is used to initiate the device's self-diagnostic tests. If everything is working, the display will read 1000.

Next, going right, is a NORM-HOLD switch. Placing that switch in the HOLD position lets you "hold" the last reading on the display until the switch is returned to the NORM position. Other controls include a POLARITY switch for triggering on either positive- or negative-going edges (again, just like a scope), an AC/DC input coupling selector, and a three-position (×1, ×10, and ×100) attenuator. The attenuator prevents overload of the input and possible false counting on the 2nd harmonic, etc.

The unit's input is also conditioned internally for the same reason. That input is brought out to a BNC connector at the top of the case (the unit is supplied with a test cable that's terminated with a BNC connector at one end and two spring loaded mini-clips at the other). The counter's input impedance is specified as 1 megohm and its input capacitance is 5 pF.

Looking at the circuitry, the device uses a 10-MHz crystal-controlled clock for generating the clock pulses that "run" the counter circuitry. Also of interest is special circuitry referred to as "automatic master reset logic;" that clears the display and starts the new counting cycle, eliminating errors that could result due to starting the count in the middle of a count period.

The instruction manual that comes with the instrument is well written and completely understandable. It includes a full schematic and a circuit description that is quite interesting.

The model *5000*'s portability is one of its most outstanding features. For instance, the cockpits of small aircraft are not noted for roominess. When the unit was shown to someone who works in avionics, he almost took it away from us on the spot.

In all, the unit should prove to do a good job anywhere that pulse-width measurement or frequency determination is important. These days, that includes just about everything from radio and TV servicing to computers. The *5000* is priced at $349.95. **R-E**

SWITCHING CIRCUITS

continued from page 88

an SCR that can be turned on by either applying the usual positive pulse at the cathode-gate terminal with respect to the cathode or by applying a negative pulse to the anode-gate terminal with respect to the anode. By reversing the polarity of either pulse, the SCS can be turned off. The device then is a sort of combination of SCR and CSCR.

The four-layer diode has no gate. Its forward breakdown characteristics are similar to those of the SCR, as a specific voltage must be exceeded before it conducts any current. Once it conducts current, the voltage across the diode drops to a low value. Conduction increases at a rapid rate, while the voltage across it rises slowly. When the anode is negative with respect to the cathode, it does not conduct until a high voltage has been exceeded. While conducting in the reverse direction, the voltage across the device remains relatively constant, as if it were a zener diode.

There is also the LASCR (*L*ight *A*ctivated *SCR*). In the dark, the LASCR behaves as if it were an ordinary SCR with gate triggering. If light reaches the device, it will be triggered on even if no pulse is applied to its gate.

Finally, there's the SUS (*S*ilicon *U*nilateral *S*witch) and the SBS (*S*ilicon *B*ilateral *S*witch). The breakdown voltage of both devices is low—about 8 volts. That's much lower than the breakdown voltage for the SCR or the triac. While the SUS conducts in only one direction after breakdown, the SBS performs more like the triac, in that it conducts in both directions when gated with an AC voltage.

Applications

The circuits discussed can be used to control motor speed, used as light dimmers, and so on. Circuits can also be arranged to apply power through a load after different factors or conditions are used to turn on the gated device. It may be triggered by a thermistor in the gate circuit to sense and report a rise or drop in ambient temperature, by a circuit sensing if a battery supply voltage has dropped below a reasonable level, by a sick patient's excessively high or low blood pressure when the device is used in medical equipment, by an excessively high current flowing in a circuit, by excessive leakage current flowing between the power lines and ground, and so on.

Power supplies

Whatever the nature of a circuit, it's sure to have one requirement—a source of power from which to operate. We'll turn our attention to power supplies when we continue this series. **R-E**

COMPUTER CORNER

continued from page 111

Even if copying were possible in that case, there is yet another hitch that might throw a damper on multiple usage. Many manufacturers require the signing of a licensing agreement that guarantees the software will only be run on one computer. Under such an arrangement, you couldn't, legally, even pass the disk from one employee to the next (as cumbersome as that might be) so that each could use it at his own workstation.

To address the problems encountered by users, a number of commercial products exist that actually enable the "uncopyable" disks to be copied. The ethical questions involved in producing—or buying—such a product are undoubtedly problematical.

The plight of the software manufacturer who wishes to protect his rightful profits, weighed against the plight of the user who needs efficient operation at a reasonable price, doesn't allow for easy answers. Unless the issue goes to court—as it has in the videocassette industry—you can only weigh the various factors involved, and make your own choice. **R-E**

COMMUNICATION CORNER

continued from page 102

suffice, that's too many parts.) Blanking for a CB receiver with its limited frequency-coverage was easily provided, but imagine what would happen if the same trick were tried with a 3–30 MHz communications receiver. How could we be certain that the sidechain was receiving on an unused frequency? Can you just imagine finding an "unused" frequency at 7 MHz, 10 MHz, 12 MHz, or any other frequency that you are interested in? To say the least, it's not very likely—especially with the way things are these days.

The modern all-band receiver uses the same gating idea but eliminates sidechains by placing the noise-pulse detector in the signal path between the first IF and the noise gate. As with the sidechain system, the pulse-derived control voltage turns the gate on and off.

Generally, the pulse detector requires a relatively high IF to reduce spreading of the noise pulse. (The signal interruption caused by a spread pulse would be considerably wider than the noise pulse itself. That would make the perceived distortion intolerable.)

Generally speaking, putting a pulse detector in the signal path is not as effective as using a sidechain, but it is far less expensive. It's also the best system available for today's multiband communications receivers. **R-E**

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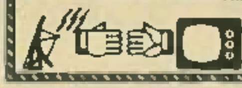

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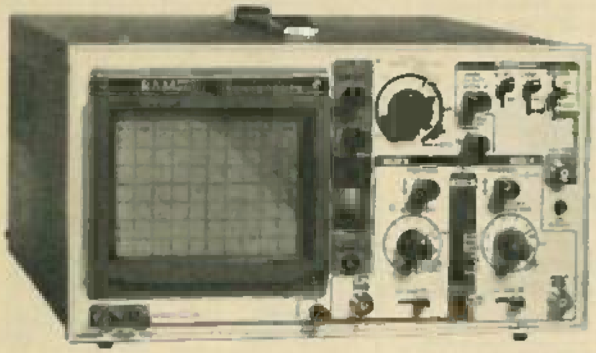

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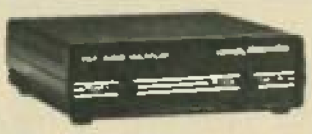

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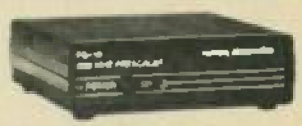

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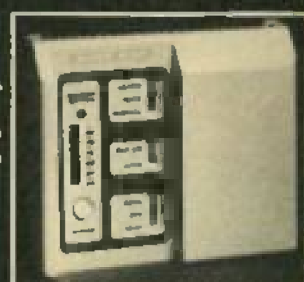

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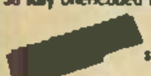

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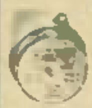

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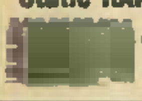
IEEE
Compatible
Uses Low Power 6116 IC's
5V Single Supply
Assm and Tested

$299.00

32K S-100 Static RAM Kit



8 MHz
Uses 2114L
ACP Price
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"Surgeonics" Power Sentry
15 Amps 250 Volts transient suppression
ACP Low Price $39.95

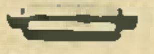
CORCOM FILTER

Popular CORCOM Filter

6 amps $4.95

Compatible Line Cord Add $3.50

CONNECTORS



DB25P (RS232)	$3.25
DB25S Female	3.75
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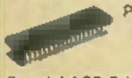
AMD MODEM IC



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1200 Baud
5 Volts

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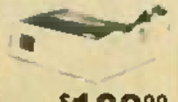

$199.00

MICROPROCESSORS

[illegible]	$44.95	8008-1	$14.95	6800P	$7.95
[illegible]	21.95	7601	[illegible]	[illegible]	[illegible]
[illegible]	3.95	7601A	[illegible]	[illegible]	[illegible]
Z80A	4.95	9600A	[illegible]	[illegible]	[illegible]
F-8 (3850)	16.95	6802	4.95	6750	[illegible]
[illegible]	16.95	6802A	6.95	6748	[illegible]
[illegible]	9.75	[illegible]	[illegible]	6809	[illegible]
8080A	5.95	[illegible]	[illegible]	[illegible]	[illegible]
8086	5.95	[illegible]	[illegible]	[illegible]	[illegible]
				[illegible]	[illegible]

RAMS

6116/2016	$7.95	2147	$4.95	8200	$1.90
8264-64K	5.95	411	[illegible]	5280	[illegible]
4116-2	1.90	414	4.90	[illegible]	4.50
4116-2	[illegible]	1101	[illegible]	[illegible]	6.50
2101	[illegible]	1103	[illegible]	[illegible]	3.75
2102	79	4027	4.00	6604	3.95
21L02-2	1.49	4044	3.95	[illegible]	7.95
21L02-4	[illegible]	4050	4.00	8130	[illegible]
2111	2.45	4060	[illegible]	8140	[illegible]
2112	2.75	4096	3.95	93415	6.95
2114	1.49	4513	1.49	93425	6.95
2114-L-2	2.29	4200	7.95	5101	3.75
2114L-4	1.49	4402	1.99	ZB132	24.95
2125	4.95	5280	4.90		

SUPPORT

8155	$7.95	8202	$9.95	6875	$5.75
8156	[illegible]	8203	[illegible]	6880	2.10
8202	24.95	8284	5.95	68047	22.95
8205	2.90	8286	[illegible]	68488	19.95
8212	2.10	8287	5.95	46505	14.95
8214	4.95	8288	24.00	6520	4.50
8216	1.75	3242	19.00	6522	7.95
8224	2.70	6810	2.95	6530-X	20.50
8226	2.95	6820	4.50	6532	[illegible]
8228	3.95	6821	3.50	6551	11.75
8243	5.95	6828	10.50	Z80-PIO	4.95
8250	14.95	[illegible]	14.95	Z80A-PIO	5.50
8251	4.25	6845	14.95	Z80-CTC	4.40
8253	[illegible]	6847	14.95	Z80A-CTC	5.50
8255	4.95	[illegible]	4.90	Z80-DMA	11.95
8257	7.95	6852	4.90	Z80A-DMA	16.95
8259	4.95	[illegible]	10.95	Z80-SIO	14.95
8275	29.95	[illegible]	10.95	Z80A-SIO	16.95
8279	9.95				

MOS PROMS

2704 (8Kx8) TS	$5.95	2708 (450nS)	$3.95
2732 (4Kx8) TS	8.95	68764 (8x8)	39.95
2532 (4Kx8)	8.95	27128 (16Kx8)	19.95
2716 2516 5V (2Kx8) TS	4.95	1702A	4.90
TMS2716 5V 12V	17.95	MM5203AQ	14.50
2758 5V (450nS)	3.50	MM5204Q	8.95

HI-TECH

2513-001 (5V) Upper	11.95	DAC08	[illegible]
2513 002 (5V) Lower	16.95	[illegible]	5.95
2513 ADM3 (5V) Lower	14.95	8038 Function Generator	4.95
MC6846-10 MCU System	17.95	MC4024 VCO	[illegible]
MC6846-10 Math System	13.95	LM566 VCO	1.95
MC6846-10 Aero Control	13.95	XR2206 Function Generator	[illegible]
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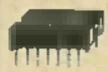
1791-01 Dual Floppy	39.95	AY3-1014A, 1013 (5V 12V)	5.95
1797 02 Dual Floppy	44.95	AY5-1013A, 1013 (5V)	6.95
1793 (10) [illegible] Floppy	44.95	[illegible]	7.95
1797 [illegible]	54.95	[illegible]	5.95
1691 Data Separator	[illegible]	7350 UDM	8.95
2143 Clock Generator	[illegible]	10716 Active	24.95
8700 8 bit Binary	13.95	MC14411	11.95
8701 10 bit Binary	[illegible]	4702	14.95
8750 8 bit [illegible]	[illegible]	[illegible]	9.95
[illegible] Volt & Freq Conv	7.95	[illegible]	[illegible]
7742 3½ Digit BCD	[illegible]	[illegible]	19.95
11C90 8 B [illegible]	9.95	675 2376	19.75
1408L 8 [illegible]	1.95	475-3000	13.75
DAC01 2.0 A	5.95	[illegible]	5.95

SOCKETS



LOW PROFILE SOCKETS (TIN)

	1-24	25-49	50-100
8 pin LP	16	15	14
14 pin LP	20	19	18
16 pin LP	22	21	20
18 pin LP	29	28	27
20 pin LP	34	32	30
22 pin LP	29	27	24
24 pin LP	38	37	36
28 pin LP	45	44	43
40 pin LP	60	59	58

3L WIREWRAP SOCKETS (GOLD)

	1-24	25-49	50-100
8 pin WW	59	54	49
10 pin WW (Tin)	65	63	58
14 pin WW	75	73	67
16 pin WW	80	77	70
18 pin WW	95	90	81
20 pin WW	1.15	1.08	99
22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
28 pin WW	1.60	1.50	1.38
40 pin WW	2.20	2.00	1.80

LINEAR

78H05K	$5.95	LM1414N	$1.90
78M05	1.00	LM1458CN/N	49
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LM304H	1.98	LM1820N	95
LM305H	1.09	LM1850N	95
LM308H	3.25	LM1889N	3.10
LM307CN	45	LM2111N	1.75
LM308CN	98	LM2900N	99
LM309K	1.49	LM2901N	2.90
LM310CN	1.25	LM2917N	2.95
LM311D CN	88	CA3013T	2.10
LM317H	1.75	CA3018T	1.60
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.80
LM319N H	1.25	CA3035T	2.75
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LM339N	99	CA3080T	1.29
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LM348N	1.20	CA3089N	2.99
LM350K	5.60	CA3096N	3.49
LM358CN	98	CA3097N	1.99
LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
LM380CN N	1.25	CA3190N	1.95
LM381N	1.79	CA3410N	49
LM383T	1.95	MC3423N	6.49
LM386N	1.25	MC3460N	3.95
LM387N	1.40	SG3524N	3.95
LM390N	1.95	CA3600N	3.39
NE531V/T	3.75	LM3900N	59
NE555V	39	LM3905N	1.19
NE556N	89	LM3909N	98
NE561T	19.95	LM3914N	3.75
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LM711N H	39	ULN2001	1.25
LM715N	1.95	ULN2003	1.50
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LM733N H	98	SN75451N	39
LM739N	1.15	SN75452N	39
LM741CN H	33	SN75453N	39
LM741CN-14	19	SN75454N	39
LM747N H	79	SN75491N	89
LM748N H	39	SN75492N	89
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LM1310N	1.90	SN75494N	89
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MC1358	1.75		

74S00

74S00	$ .39	74S124	$3.00	74S244	$2.49
74S02	49	74S133	54	74S251	1.35
74S03	45	74S134	89	74S253	1.35
74S04	49	74S135	1.15	74S257	1.29
74S05	52	74S138	1.00	74S258	1.29
74S08	49	74S139	1.99	74S260	75
74S09	49	74S139	1.29	74S280	2.70
74S10	42	74S140	73	74S287	2.90
74S11	42	74S151	1.29	74S288	2.55
74S15	42	74S153	1.29	74S373	3.10
74S20	42	74S157	1.29	74S374	3.10
74S22	42	74S158	1.29	74S387	2.75
74S30	42	74S160	2.79	74S471	7.95
74S32	49	74S174	1.49	74S472	7.95
74S38	1.19	74S175	1.49	74S473	7.95
74S40	49	74S188	2.90	74S474	9.95
74S51	42	74S194	1.00	74S475	8.95
74S64	49	74S195	1.00	74S570	6.75
74S65	44	74S196	1.00	74S571	5.75
74S74	59	74S240	2.75	74S572	8.95
74S85	72	74S241	2.75	74S573	8.95
74S112	72	74S242	2.90	74S940	2.90
74S113	72	74S243	2.90	74S941	2.90
74S114	72				

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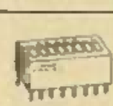

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7400	$ .19	7475	$ .38	74161	$ .69
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7404	19	7482	95	74165	89
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7406	Call	7485	59	74167	2.95
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7408	24	7489	1.75	74172	4.75
7409	19	7490	35	74173	89
7410	19	7491	45	74174	89
7411	24	7492	45	74175	69
7412	24	7493	35	74176	89
7413	29	7494	69	74177	89
7414	49	7495	50	74179	1.34
7416	Call	7496	69	74180	75
7417	Call	7497	3.00	74181	1.75
7420	19	74100	2.10	74182	75
7421	35	74107	24	74184	2.25
7422	38	74109	37	74185	2.25
7423	1.10	74116	1.25		
7425	29	74121	29		
7426	29	74122	39	74190	1.15
7427	25	74123	45	74191	1.15
7428	45	74125	39	74192	75
7430	19	74126	44	74193	75
7432	29	74128	39	74194	75
7437	39	74132	45	74195	69
7438	29	74136	75	74196	79
7439	1.19			74197	75
7440	19	74141	65	74198	1.29
7441	79	74142	2.95	74199	1.29
7442	45	74143	2.95	74221	1.19
7443	95	74144	2.95	74251	89
7444	89	74145	59	74273	1.05
7445	79	74147	1.69	74276	1.89
7446	79	74148	1.10	74279	79
7447	65	74150	1.09	74283	1.49
7448	79	74151	45	74284	2.99
7450	19	74152	67	74285	1.89
7451	19	74153	49	74290	89
7453	19	74154	1.19	74293	89
7454	19	74155	69	74298	89
7459	25	74156	79	74365	69
7460	23	74157	49	74367	95
7470	39	74158	1.65	74368	65
7472	29	74159	2.49	74390	1.49
7473	29	74160	79	74393	1.10
7474	34			74490	1.80

74LS00

74LS00	$ .29	74LS113	$ .39	74LS240	$2.99
74LS01	29	74LS114	39	74LS247	1.10
74LS02	25	74LS122	49	74LS248	1.10
74LS03	25	74LS123	1.19	74LS249	1.19
74LS04	29	74LS124	2.75	74LS251	1.40
74LS05	25	74LS125	89	74LS253	1.40
74LS08	25	74LS126	49	74LS257	69
74LS09	25	74LS132	59	74LS258	99
74LS10	25	74LS136	49	74LS259	2.95
74LS11	39	74LS138	59	74LS260	69
74LS12	29	74LS139	59	74LS261	2.49
74LS13	39	74LS145	1.25	74LS266	59
74LS14	59	74LS148	1.49	74LS273	1.75
74LS15	39	74LS151	59	74LS275	4.40
74LS20	29	74LS153	59	74LS279	59
74LS21	29	74LS154	1.70	74LS283	69
74LS22	29	74LS156	1.10	74LS290	89
74LS26	29	74LS157	1.49	74LS293	89
74LS27	29	74LS158	1.49	74LS295	1.10
74LS28	39	74LS160	1.49	74LS298	1.19
74LS30	25	74LS161	1.00	74LS324	1.75
74LS32	33	74LS162	1.49	74LS347	1.95
74LS33	55	74LS163	1.49	74LS348	1.95
74LS37	35	74LS164	1.49	74LS352	1.19
74LS38	39	74LS165	1.49	74LS353	1.19
74LS40	25	74LS166	1.49	74LS363	1.49
74LS42	59	74LS168	2.48	74LS365	39
74LS47	79	74LS169	1.75	74LS366	69
74LS48	79	74LS170	1.75	74LS367	69
74LS51	25	74LS173	1.99	74LS368	69
74LS54	29	74LS174	89	74LS373	2.00
74LS55	29	74LS175	89	74LS374	2.99
74LS73	39	74LS181	89	74LS375	69
74LS74	49	74LS189	2.20	74LS377	1.85
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74LS76	39	74LS191	1.10	74LS386	65
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74LS83	59	74LS193	89	74LS393	1.95
74LS85	89	74LS194	1.15	74LS395	1.70
74LS86	39	74LS195	95	74LS399	2.35
74LS90	57	74LS196	89	74LS424	2.95
74LS92	49	74LS197	89	74LS640	1.75
74LS93	59	74LS221	1.15	74LS670	2.20
74LS95	79	74LS240	1.00	81LS95	1.00
74LS96	89	74LS242	1.00	81LS96	1.00
74LS107	39	74LS243	1.95	81LS97	1.00
74LS109	39	74LS244	1.90	81LS98	1.00
74LS112	39	25LS2521	2.85	25LS2569	4.95

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4000	$ .29	4037	$1.95	4082	$2.95
4001	24	4040	75	4083	59
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4007	25	4043	85	4099	1.89
4008	95	4044	89	14409	12.95
4009	39	4046	89	14408	12.95
4010	39	4047	89	14410	12.95
4011	24	4048	99	14412	12.95
4012	24	4049	35	14413	8.95
4013	38	4050	39	14419	4.95
4014	89	4051	79	4501	39
4015	39	4052	75	4502	95
4016	36	4053	75	4503	69
4017	65	4056	3.95	4505	8.95
4018	79	4060	3.95	4506	79
4019	39	4066	0.25	4507	95
4020	89	4069	35	4508	3.75
4021	89	4066	39	4510	79
4022	69	4068	39	4511	79
4023	25	4070	35	4512	79
4024	59	4071	39	4514	1.29
4025	25	4072	39	4515	1.89
4027	45	4073	39	4518	1.45
4028	66	4075	39	4519	89
4029	79	4076	79	4520	79
4030	45	4077	35	4528	89
4031	3.25	4078	39	4566	89
4032	2.15	4081	39	4568	2.29
4034	3.25	4082	35	80C95	1.89
4035	79	4085	95	80C97	1.25

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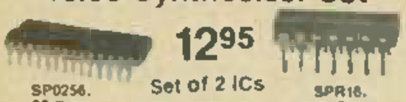

SP0256, 28-Pin 12⁹⁵ Set of 2 ICs SPR16, 14-Pin

SP0256 Speech Processor. The easy, low-cost way to get into "solid-state" talk! NMOS LSI device uses a stored program to synthesize speech or complex sounds. It operates with a few simple support parts, or use the **SPR16 Serial Speech ROM**, included, for microcomputer interfacing. SPR16 contains 32 "talking clock" statements, three melodies. With data, circuit examples. Requires 3.12 MHz clock crystal—order through your local Shack. **276-1783** .... Set 12.95

Dual Switched Filter

7⁹⁵

20-Pin

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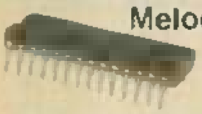

5⁹⁹ 28-Pin With Data

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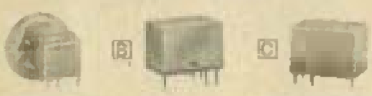
A B C



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C	5 VDC	3A, 125 VAC	275-246	2.99
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Semiconductor Reference Guide

3⁴⁹

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2.2	35	272-1435	.59
10	16	272-1436	.69
22	16	272-1437	.79

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Mini	24.0	300 mA	273-1386	2.99
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Mini	24.0 CT	450 mA	273-1366	3.99
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Std.	25.2	1.2A	273-1480	4.39
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220	271-1313	27k	271-1340
270	271-1314	33k	271-1341
330	271-1315	47k	271-1342
470	271-1317	68k	271-1345
1k	271-1321	100k	271-1347
1.8k	271-1324	220k	271-1350
2.2k	271-1325	470k	271-1354
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5⁹⁵

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22 pin LP	[illegible]	[illegible]	[illegible]
24 pin LP	[illegible]	[illegible]	[illegible]
28 pin LP	[illegible]	[illegible]	[illegible]
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28 pin SG	[illegible]	[illegible]	[illegible]
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ST

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18 pin WW	[illegible]	[illegible]	[illegible]
20 pin WW	[illegible]	[illegible]	[illegible]
22 pin WW	[illegible]	[illegible]	[illegible]
24 pin WW	[illegible]	[illegible]	[illegible]
28 pin WW	[illegible]	[illegible]	[illegible]
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4006	.90	4030	.40	4082	.40	74C32	.80
4007	.40	4034	1.75	4093	.80	74C42	1.00
4008	[illegible]	4035	1.00	4099	1.75	74C76	1.00
4009	[illegible]	4040	1.00	4481	.95	74C83	1.25
4010	[illegible]	4042	.80	4503	1.00	74C85	1.60
4011	.40	4043	.80	4510	1.00	74C86	.70
4012	.40	4044	.80	4511	1.00	74C89	.70
4013	.40	4046	1.20	4514	1.75	74C154	3.00
4014	.80	4047	1.00	4515	1.80	74C157	1.75
4015	.80	4049	.40	4516	1.00	74C160	1.10
4016	.40	4050	.40	4518	1.00	74C161	1.15
4017	1.00	4051	1.00	4520	1.30	74C163	1.15
4018	.70	4052	1.00	4528	1.00	74C173	.75
4019	.40	4053	1.00	4538	1.20	74C174	1.10
4020	.80	4060	1.00	4581	.90	74C175	1.10
4021	.80	4066	.50	4584	.75	74C192	1.30
4022	1.00	4068	.50	14500B	.40	74C193	1.15
4023	.40	4069	.50	74C02	.40	74C901	.60
4024	.75	4070	.50	74C04	.40	74C902	1.00
4025	.40	4071	.40	74C08	.50	74C914	1.75
4026	.95	4072	.50	74C10	.40	74C921	3.15
4027	.60	4073	.40				

74S SERIES

74S00	.40	74S85	1.10	74S174	1.40
74S02	.40	74S86	.90	74S175	1.40
74S03	.40	74S89	2.20	74S181	2.20
74S04	.30	74S112	.60	74S182	1.75
74S05	.60	74S133	.60	74S194	1.10
74S08	.50	74S136	1.10	74S196	1.50
74S10	.40	74S138	1.25	74S240	1.00
74S11	.45	74S139	1.10	74S241	1.50
74S15	.50	74S140	1.70	74S257	1.30
74S20	.45	74S151	1.25	74S280	1.50
74S30	.40	74S153	1.10	74S280	1.75
74S32	.60	74S157	1.25	74S373	2.25
74S43	.60	74S158	1.25	74S374	1.75
74S51	.70	74S161	1.75		
74S74	1.10	74S163	1.40		

4164-2 — $6.25
4164-15— 100/$660.00
4116-3 — 100/$100.00
2114-3 — 100/$100.00

2N3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG. UJT	$ .65

DISC CAPACITORS

1UF 16V	10/$1.00	100/$6.00
.01UF 35V	16/$1.00	100/$5.00

PRINTED CIRCUIT BOARD
4" x 6" DOUBLE SIDED EPOXY BOARDED 1/16" THICK 1.40ea ... $12.00

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.60	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12V DC RELAYS TTL SIZE
S.P. 1200 ohm coil .75
D.P. 400 ohm coil .95

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.05	.14	.35	.90	5.00	5.00
200	.06	.17	.50	1.30	7.00	9.00
400	.09	.25	.65	1.50	10.00	12.00
600	.11	.30	.80	2.00	15.00	15.00
800	.13	.35	1.00	2.50	16.00	18.00
1000	.20	.45	1.25	3.00	20.00	24.00

REGULATORS

LM338K	$5.75	323K (LA1408)	$1.75
LM317T	$1.25	LM309G	$ .75
78L05, 78L12	$ .40	340T 5, 6, 8, 9, 12, 15, 18 or 24V	1.75
723	$ .50	LAS1412 - 12V 3A	$3.95
320T 5, 12, 15 or 24	$ .85		
LM 337T	$1.95		

TANTALUM CAPACITORS

22UF 35V	5/$1.00	15UF 16V	3/$1.00
47UF 35V	5/$1.00	30UF 6V	5/$1.00
.68UF 35V	5/$1.00	33UF 15V	$ .50
1UF 20V	5/$1.00	47UF 20V	$ .85
2.2UF 20V	5/$1.00	68UF 16V	$1.00
3.3UF 20V	4/$1.00	120UF 6V	$ .75
4.7UF 35V	4/$1.00	200UF 20V	$1.75
6.8UF 20V	4/$1.00	150UF 16V	$1.30
10UF 20V	$ .40	330UF 10V	$1.75
22UF 10V	$ .30		

50 PIN EDGEBOARD CONN	3.95
40 PIN EDGEBOARD CONN	3.00
34 PIN EDGEBOARD CONN	3.00
30 PIN EDGEBOARD CONN	2.50
40 PIN RIBBON CABLE CONN	4.00
50 PIN RIBBON CABLE CONN	3.90
40 PIN RIBBON CABLE CONN	3.00
34 PIN RIBBON CABLE CONN	2.75
20 PIN RIBBON CABLE CONN	2.80
20 PIN RIBBON CABLE CONN	2.00

TRANSISTOR SPECIALS

2N1307 PNP GE TO-5	[illegible]
2N404A PNP GE TO-5	[illegible]
HEP G6014 — PNP GE TO-3	[illegible]
TIP 111	[illegible]
2N6233 NPN SWITCHING POWER	[illegible]
MRF 8004 CM RF TRANSISTOR NPN	[illegible]
2N4908 PNP Si TO-3	[illegible]
TIP 2955 PNP Si	[illegible]
2N3772 NPN Si TO-3	[illegible]
2N3867 PNP Si TO-5	[illegible]
2N3906 NPN Si TO-3	[illegible]
2N3904 NPN Si TO-92	[illegible]
2N3906 PNP Si TO-92	[illegible]
2N4161 PNP Si TO-92	[illegible]
TIP 31B NPN Si TO-220	[illegible]
TIP 32B PNP Si TO-220	[illegible]
TIP 34 PNP Si	[illegible]
TIP 121 PNP Si LDS	[illegible]
TIP 141 NPN Si LDS	[illegible]
BU208	[illegible]
DPS3000 — DUAL POWER DARL.	[illegible]
MJE3055T	[illegible]

TTL IC SERIES

7400	[illegible]	7474	.50	74164	.80
7401	[illegible]	7475	.50	74165	.80
7402	[illegible]	7476	.45	74166	.90
7403	[illegible]	7480	[illegible]	74170	1.60
7404	[illegible]	7483	.50	74173	.75
7405	[illegible]	7485	.70	74174	.80
7406	[illegible]	7486	.55	74175	.70
7409	[illegible]	7490	.30	74176	.75
7410	.30	7491	[illegible]	74180	1.90
7411	[illegible]	7492	[illegible]	74181	1.80
7412	[illegible]	7493	[illegible]	74182	.80
7413	[illegible]	7494	[illegible]	74190	.80
7414	.75	7495	.56	74191	.80
7416	1.10	7496	.80	74192	.80
7417	1.10	74107	.30	74193	.79
7420	.30	74118	[illegible]	74194	.85
7425	.30	74121	.40	74195	.45
7426	.30	74122	.50	74196	.75
7427	.30	74123	.56	74198	1.25
7430	[illegible]	74125	.60	74221	1.00
7432	[illegible]	74126	.40	74273	[illegible]
7437	[illegible]	74145	.60	74278	.80
7438	1.10	74148	1.10	74298	.65
7440	[illegible]	74150	1.10	74365	.60
7442	[illegible]	74151	[illegible]	74367	.80
7445	1.00	74153	[illegible]	74368	.80
7446	.80	74154	1.00	75325	1.50
7448	[illegible]	74156	[illegible]	75492	1.00
7450	.30	74157	[illegible]	9601	.75
7472	.40	74160	.85	9602	.75
7473	.44	74161	[illegible]	8T26	1.40
		74162	.70	8T28	1.40
		74163	.70	8T98	1.10

74LS SERIES

74LS00	.40	74LS109	.70	74LS241	1.90
74LS01	.40	74LS112	.60	74LS242	1.80
74LS02	.40	74LS113	.60	74LS243	1.80
74LS03	.40	74LS114	.60	74LS244	2.25
74LS04	.70	74LS122	1.10	74LS245	2.75
74LS05	.70	74LS125	.60	74LS248	[illegible]
74LS08	.70	74LS132	.80	74LS247	1.00
74LS09	[illegible]	74LS136	.75	74LS248	1.50
74LS10	.40	74LS137	.60	74LS251	.70
74LS11	.40	74LS138	1.25	74LS253	.70
74LS12	.40	74LS139	1.40	74LS257	.70
74LS13	[illegible]	74LS147	1.95	74LS258	.80
74LS14	.90	74LS151	.70	74LS259	2.00
74LS15	.60	74LS153	.70	74LS260	1.75
74LS20	.40	74LS155	.80	74LS266	.70
74LS21	[illegible]	74LS156	.80	74LS273	1.80
74LS22	[illegible]	74LS157	.80	74LS279	.80
74LS26	[illegible]	74LS158	.80	74LS280	1.80
74LS27	[illegible]	74LS160	.90	74LS283	.80
74LS28	.40	74LS161	.90	74LS290	1.20
74LS30	.40	74LS162	.90	74LS293	.80
74LS32	1.10	74LS163	.90	74LS298	1.00
74LS33	[illegible]	74LS164	.90	74LS299	2.00
74LS38	[illegible]	74LS165	.90	74LS321	3.00
74LS40	.40	74LS166	1.80	74LS348	.90
74LS42	.70	74LS168	2.10	74LS365	.80
74LS47	.80	74LS170	1.80	74LS367	1.25
74LS51	.40	74LS173	.80	74LS368	.80
74LS54	.40	74LS174	.80	74LS373	3.00
74LS73	[illegible]	74LS175	.80	74LS374	2.50
74LS76	1.25	74LS181	1.95	74LS377	2.00
74LS78	.60	74LS190	.80	74LS385	.80
74LS83	.80	74LS191	.80	74LS390	1.10
74LS85	[illegible]	74LS192	.80	74LS393	1.10
74LS86	.60	74LS193	.80	74LS395	2.50
74LS90	.80	74LS194	1.00	74LS670	1.75
74LS92	.70	74LS195	.80	74LS668	1.50
74LS93	.70	74LS196	.80	74LS670	1.20
74LS95	.80	74LS197	.80	81LS97	1.80
74LS96	.80	74LS221	1.50	81LS98	1.50
74LS107	.56	74LS240	1.80		

MULTI TURN TRIM POTS
50 OHM, 100 OHM, 1000 OHM, 5K, 10K, 50K — 3/$2.00

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4164 64K DYNAMIC 200 NS $5.95   TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/8.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
TC5514	1024 x 4	(650ns) (cmos)	2.49
TC5516	2048 x 8	(250ns) (cmos)	9.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95
HM6264	8192 x 8	(150ns) (cmos)	49.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/7.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	8.95

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2732A-4	4096 x 8	(450ns) (5v) (21vPGM)	8.95
2732A	4096 x 8	(250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8	(200ns) (5v) (21vPGM)	13.95
2764	8192 x 8	(450ns) (5v)	6.95
2764-250	8192 x 8	(250ns) (5v)	7.95
2764-200	8192 x 8	(200ns) (5v)	18.95
TMS2564	8192 x 8	(450ns) (5v)	14.95
MCM68764	8192 x 8	(450ns) (5v) (24 pin)	38.95
MCM68766	8192 x 8	(350ns) (5v) (24 pin)(per dia)	42.95
27128	16384 x 8	(300ns) (5v)	28.95

5v = Single 5 Volt Supply   21vPGM = Program at 21 Volts

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

- Computer managed inventory — virtually no back orders!
- Very competitive prices!
- Friendly staff!
- Fast service — most orders shipped within 24 hours!

CRYSTALS

32.768 khz	1.95
1.0 mhz	3.95
1.8432	3.95
2.0	2.95
2.097152	2.95
2.4576	2.95
3.2768	2.95
3.579545	2.95
4.0	2.95
5.0	2.95
5.0688	2.95
5.165	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
18.0	2.95
18.432	2.95
20.0	2.95
22.1184	2.95
32.0	2.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

FUNCTION

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

CMOS

4000	.29	4528	1.19
4001	.25	4531	.95
4002	.25	4532	1.95
4006	.89	4538	1.95
4007	.29	4539	1.95
4008	.95	4541	2.64
4009	.39	4543	1.19
4010	.45	4553	5.79
4011	.25	4555	.95
4012	.25	4556	.95
4013	.38	4581	1.95
4014	.79	4582	1.95
4015	.39	4584	.75
4016	.39	4585	.75
4017	.69	4702	12.95
4018	.79	74C00	.35
4019	.39	74C02	.35
4020	.75	74C04	.35
4021	.79	74C08	.35
4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	14.95	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
4527	1.95	74C929	19.95

6800

68000	49.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809E	14.95
6809	11.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.95

2 MHZ

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8202	24.95
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8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
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8271	79.95
8272	39.95
8275	29.95
8279	8.95
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8282	6.50
8283	6.50
8284	5.50
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74LS28	.35	74LS245	1.49
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74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
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74LS54	.29	74LS275	3.35
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74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
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74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
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74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS375	.95
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74LS123	.79	74LS378	1.18
74LS124	2.90	74LS379	1.35
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74LS163	.65	74LS689	3.20
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
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7815T	.75	7924T	.85
7824T	.75	7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69	LM323K	4.95
78H05K	9.95	UA78S40	1.95
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C, T = TO-220 K = TO-3
L = TO-92

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7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	4.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
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7432	.29	74166	1.00
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7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
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7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

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14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call

ST = SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
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8T28	1.89
8T95	.89
8T96	.89
8T97	.89
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DP8304	2.29
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DS8835	1.99
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ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

9000

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

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LM301H	.79	LM348	.99	LM566	1.49	LM1800	2.37
LM307	.45	LM350K	4.95	LM567	.89	LM1812	8.25
LM308	.69	LM350T	4.60	NE570	3.95	LM1830	3.50
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LM309H	1.95	LM359	1.79	NE590	2.50	LM1872	5.49
LM309K	1.25	LM376	3.75	NE592	2.75	LM1877	3.25
LM310	1.75	LM377	1.95	LM709	.59	LM1889	1.95
LM311	.64	LM378	2.50	LM710	.75	LM1896	1.75
LM311H	.89	LM379	4.50	LM711	.79	ULN2003	2.49
LM312H	1.75	LM380	.89	LM723	.49	LM2877	2.05
LM317K	3.95	LM380N-8	1.10	LM723H	.55	LM2878	2.25
LM317T	1.19	LM381	1.60	LM733	.98	LM2900	.85
LM318	1.49	LM382	1.60	LM741	.35	LM2901	1.00
LM318H	1.59	LM383	1.95	LM741N-14	.35	LM3900	.59
LM319H	1.90	LM384	1.95	LM741H	.40	LM3905	1.25
LM319	1.25	LM386	.89	LM747	.69	LM3909	.98
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LM334	1.19	LM399H	5.00	MC1350	1.19	RC4136	1.25
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H = TO-5 CAN T = TO-220 K = TO-3

RCA

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CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3180	1.19		

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TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

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TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

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MAN 72		.3"	CA	.99
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72 pin WW	7.95
50 pin ST	4.95
44 pin ST	2.95
44 pin WW	4.95

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* COLOR MATCHES APPLE
* FITS STANDARD 5¼" DRIVES, INCL. SHUGART
* INCLUDES MOUNTING HARDWARE AND FEET

NOTE: Please include sufficient amount for shipping on above items.

CABINET #2 $79.00

* COMPLETE WITH POWER SUPPLY, SWITCH, LINE CORD, FUSE & STANDARD POWER CONNECTOR
* DIMENSIONS: 11½ x 5¾ x 3¹⁵⁄₁₆"
* +5V @ 1 AMP, +12V @ 1.5 AMP
* FITS STANDARD 5¼" DRIVES
* PLEASE SPECIFY GRAY OR TAN

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1N759	12.0 volt zener	.25
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KBP02	200PIV 1.5amp bridge	.45
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2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.75	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4248	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS. SAME VALUE	.025
100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

LED LAMPS

	1-99	100-up
JUMBO RED	.10	.09
JUMBO GREEN	.18	.15
JUMBO YELLOW	.18	.15
LED Mounting Hardware	.10	.09

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

BYPASS CAPS

.01 UF DISC	100/6.00
.01 UF MONOLITHIC	100/12.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.50	4.40	.83	7.30
16	.55	4.80	1.00	8.80
20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP MALE	SOLDER CUP FEMALE	RIGHT ANGLE PC SOLDER MALE	RIGHT ANGLE PC SOLDER FEMALE	IDC RIBBON CABLE MALE	IDC RIBBON CABLE FEMALE	HOODS BLACK	HOODS GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	—	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

MOUNTING HARDWARE 1.00

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "xx" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH10SR.

JDR Microdevices

1224 S. Bascom Avenue, San Jose, CA 95128
800-538-5000 • 800-662-6279 (CA)
(408) 995-5430 • Telex 171-110

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PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING

TERMS: Minimum order $10. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges — please contact our sales department for the amount. CA residents must include 6% sales tax. Bay Area and LA residents include 6½%. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.

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(CALIFORNIA RESIDENTS)

(800) 848-8008

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Santa Clara, CA 95050
(408) 988-0697

DoKay

STATIC RAMS

2101	256 x 4 (450ns)	1.95
5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	.99
2102L-2	1024 x 1 (250ns) (LP)	1.45
2111	256 x 4 (450ns)	2.45
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/9.95
2114-25	1024 x 4 (250ns)	8/8.95
2114L-4	1024 x 4 (450ns) (LP)	8/11.95
2114L-3	1024 x 4 (300ns) (LP)	8/12.45
2114L-2	1024 x 4 (200ns) (LP)	8/12.95
2147	4096 x 1 (55ns)	4.95
TMS4044-4	4096 x 1 (450ns)	3.45
TMS4044-3	4096 x 1 (300ns)	3.95
TMS4044-2	4096 x 1 (200ns)	4.45
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	4.10
TMM2016-150	2048 x 8 (150ns)	4.95
TMM2016-100	2048 x 8 (100ns)	6.15
HM6116-4	2048 x 8 (200ns) (cmos)	4.70
HM6116-3	2048 x 8 (150ns) (cmos)	4.95
HM6116-2	2048 x 8 (120ns) (cmos)	5.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	8.95
Z-6132	4096 x 8 (300ns) (Qstat)	33.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.95
UPD411	4096 x 1 (300ns)	2.95
MM5280	4096 x 1 (300ns)	2.95
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.95
4116-300	16384 x 1 (300ns)	8/10.75
4116-250	16384 x 1 (250ns)	8/10.95
4116-200	16384 x 1 (200ns)	8/11.95
4116-150	16384 x 1 (150ns)	8/13.95
4116-120	16384 x 1 (120ns)	8/28.95
2118	16384 x 1 (150ns) (5v)	4.95
4164-200	65536 x 1 (200ns) (5v)	8.95
4164-150	65536 x 1 (150ns) (5v)	9.95

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.45
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.90
2716-1	2048 x 8 (350ns) (5v)	5.95
TMS2516	2048 x 8 (450ns) (5v)	5.45
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	5.90
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	8.95
2732-200	4096 x 8 (200ns) (5v)	10.95
2764	8192 x 8 (450ns) (5v)	8.95
2764-250	8192 x 8 (250ns) (5v)	13.85
2764-200	8192 x 8 (200ns) (5v)	23.95
TMS2564	8192 x 8 (450ns) (5v)	14.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	38.95
27128	16384 x 8	Call

5v = Single 5 Volt Supply

74LS00

74LS00	.23	74LS173	.68
74LS01	.24	74LS174	.54
74LS02	.24	74LS175	.54
74LS03	.24	74LS181	2.10
74LS04	.23	74LS189	8.90
74LS05	.24	74LS190	.68
74LS08	.27	74LS191	.68
74LS09	.28	74LS192	.78
74LS10	.24	74LS193	.78
74LS11	.34	74LS194	.68
74LS12	.34	74LS195	.68
74LS13	.44	74LS196	.78
74LS14	.58	74LS197	.78
74LS15	.34	74LS221	.88
74LS20	.24	74LS240	.94
74LS21	.28	74LS241	.98
74LS22	.24	74LS242	.98
74LS26	.28	74LS243	.98
74LS27	.28	74LS244	1.25
74LS28	.34	74LS245	1.45
74LS30	.24	74LS247	.74
74LS32	.28	74LS248	.98
74LS33	.54	74LS249	.98
74LS37	.34	74LS251	.58
74LS38	.34	74LS253	.68
74LS40	.24	74LS257	.58
74LS42	.48	74LS258	.68
74LS47	.74	74LS259	2.70
74LS48	.74	74LS260	.68
74LS49	.74	74LS266	.54
74LS51	.24	74LS273	1.45
74LS54	.28	74LS275	3.30
74LS55	.28	74LS279	.48
74LS63	1.20	74LS280	1.95
74LS73	.38	74LS283	.68
74LS74	.34	74LS290	.68
74LS75	.38	74LS293	.68
74LS76	.38	74LS295	.98
74LS78	.48	74LS298	.88
74LS83	.58	74LS299	1.70
74LS85	.68	74LS323	3.85
74LS86	.38	74LS324	1.70
74LS90	.54	74LS352	1.28
74LS91	.88	74LS353	1.25

74LS92	.54	74LS363	1.30
74LS93	.54	74LS364	1.90
74LS95	.74	74LS365	.48
74LS96	.88	74LS366	.48
74LS107	.38	74LS367	.44
74LS109	.38	74LS368	.44
74LS112	.38	74LS373	1.35
74LS113	.38	74LS374	1.35
74LS114	.38	74LS377	1.35
74LS122	.44	74LS378	1.13
74LS123	.78	74LS379	1.30
74LS124	2.85	74LS385	1.85
74LS125	.48	74LS386	.44
74LS126	.48	74LS390	1.15
74LS132	.58	74LS393	1.15
74LS133	.58	74LS395	1.15
74LS136	.38	74LS399	1.45
74LS137	.98	74LS424	2.90
74LS138	.54	74LS447	.36
74LS139	.54	74LS490	1.90
74LS145	1.15	74LS624	3.95
74LS147	2.45	74LS640	2.15
74LS148	1.30	74LS645	2.15
74LS151	.54	74LS668	1.65
74LS153	.54	74LS669	1.85
74LS154	1.85	74LS670	1.45
74LS155	.68	74LS674	9.60
74LS156	.68	74LS682	3.15
74LS157	.64	74LS683	3.15
74LS158	.58	74LS684	3.15
74LS160	.68	74LS685	3.15
74LS161	.64	74LS688	2.35
74LS162	.68	74LS689	3.15
74LS163	.64	74LS783	23.95
74LS164	.68	81LS95	1.45
74LS165	.94	81LS96	1.45
74LS166	1.90	81LS97	1.45
74LS168	1.70	81LS98	1.45
74LS169	1.70	25LS2521	2.75
74LS170	1.45	25LS2569	4.20

6500

1MHZ

6502	4.90
6504	6.90
6505	8.90
6507	9.90
6520	4.30
6522	7.90
6532	9.90
6545	21.90
6551	10.85

2 MHZ

6502A	6.90
6522A	9.90
6532A	10.95
6545A	28.95
6551A	10.95

3 MHZ

6502B	13.95

6800

68000	58.95
6800	3.90
6802	7.90
6808	12.90
6809E	18.85
6809	10.95
6810	2.90
6820	4.30
6821	3.20
6828	13.95
6840	11.95
6843	33.95
6844	24.95
6845	13.95
6847	10.95
6850	3.20
6852	15.70
6860	8.90
6862	10.95
6875	6.90
6880	2.20
6883	21.95
68047	23.95
68488	18.95

6800   1MHZ

68B00	9.85
68B07	21.25
68B09E	28.95
68B09	28.95
68B10	6.90
68B21	8.90
68B45	18.95
68B50	5.90

8000

8035	5.90
8039	6.90
INS-8060	16.95
INS-8073	23.95
8080	3.90
8085	5.90
8085A-2	10.95
8086	28.95
8087	CALL
8088	38.95
8089	88.95
8155	6.90
8155-2	7.90
8156	6.90
8185	28.95
8185-2	38.95
8741	38.95
8748	23.95
8755	23.95

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8200

8202	23.95
8203	38.95
8205	3.45
8212	1.75
8214	3.80
8216	1.70
8224	2.20
8226	1.75
8228	3.45
8237	18.95
8237-5	20.95
8238	4.45
8243	8.40
8250	9.95
8251	4.80
8253	6.80
8253-5	7.90
8255	4.45
8255-5	5.20
8257	7.90
8257-5	8.90
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
8275	28.95
8279	8.90
8279-5	9.00
8272	8.48
8283	6.45
8284	5.45
8286	6.45
8287	6.45
8288	24.00
8289	48.95

Z-80

2.5 Mhz

Z80-CPU	3.90
Z80-CTC	4.45
Z80-DART	9.95
Z80-DMA	13.95
Z80-PIO	4.45
Z80-SIO/0	15.95
Z80-SIO/1	15.95
Z80-SIO/2	15.95
Z80-SIO/9	15.95

4.0 Mhz

Z80A-CPU	4.90
Z80A-CTC	4.90
Z80A-DART	10.95
Z80A-DMA	16.95
Z80A-PIO	4.90
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	15.95
Z80A-SIO/9	15.95

6.0 Mhz

Z80B-CPU	12.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	18.95

ZILOG

Z8132	33.95
Z8671	38.95

DISC CONTROLLERS

1771	15.95
1791	23.95
1793	25.95
1795	48.95
1797	48.95
2791	53.95
2793	53.95
2795	58.95
2797	58.95
6843	33.95
8272	38.95
UPD765	38.95
MB8876	28.95
MB8877	33.95
1691	16.95
2143	17.95

UARTS

AY3-1014	6.90
AY5-1013	3.90
AY3-1015	6.90
PT-1472	8.90
TR1602	3.90
2350	8.90
2651	8.90
TMS6011	5.90
IM6402	7.90
IM6403	8.90
INS8250	9.95

INTERFACE

8T26	1.84
8T28	1.84
8T95	.88
8T96	.88
8T97	.88
8T98	.88
DM8131	2.90
DP8304	2.24
DS8835	1.94
DS8836	.88

VOLTAGE REGULATORS

7805T	.74	7905T	.84
78M05C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.79
78L05	.68	79L12	.79
78L12	.64	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	8.90		

C,T = TO-220 K = TO-3 L = TO-92

DIP SWITCHES

4 POSITION	.84
5 POSITION	.89
6 POSITION	.89
7 POSITION	.94
8 POSITION	.94

IC SOCKETS

	1-99	100
8 pin ST	.12	.10
14 pin ST	.14	.11
16 pin ST	.16	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call

ST = SOLDERTAIL

8 pin WW	.58	.48
14 pin WW	.68	.61
16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.94	1.68
40 pin WW	1.94	1.75

WW = WIREWRAP

16 pin ZIF	6.70	call
24 pin ZIF	9.90	call
28 pin ZIF	9.95	call

ZIF = TEXTOOL (Zero Insertion Force)

CRYSTALS

32.768khz	1.90
1.0 mhz	4.95
1.8432	4.90
2.0	3.90
2.097152	3.90
2.4576	3.90
3.2768	3.90
3.579535	3.90
4.0	3.90
5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
18.0	3.90
18.432	3.90
20.0	3.90
22.1184	3.90
32.0	3.90

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS.	1.25
100 PCS.	2.00
1000 PCS.	15.00

APPLE ACCESSORIES

80 Column Card	129.95
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Fan	38.95
Power Supply	64.95
RF Mod	24.95
Joy Stick (Apple II)	29.95
Paddles Apple	9.95
Z80 Card	129.95
SCRG Switch-A-Slot	19.95
Paddle Adapple	24.95
Extend-A Slot	19.95
Disk Drive	224.95
Controller Card	69.95

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SSSD	18.95
SSDD	22.95
DSDD	27.95

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- Simple to use — No configuring required
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- Includes Cable & Manual

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MESSENGER

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- Includes Cable & Manual

$98⁰⁰

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REAL TIME CLOCK

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- Expandable from 16K to 64K

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The new Flip Sort™ has all the fine qualities of the original Flip Sort™, with some added benefits. Along with a new design, capacity has increased 50%, to hold 75 diskettes and the price is more reasonable than ever. $19.95 ea.

The Flip Sort Plus™

The Flip Sort Plus™ adds new dimensions to storage. Designed with similar elegant lines as the original Flip Sort™, in a transparent smoked acrylic. The Flip Sort Plus™ has a storage capacity of over 100 diskettes and has all the outstanding features you have come to expect from the flip sort Family. 24.95 each

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