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The new 60 MHz Tek 2221 (above) offers such features as CRT readout and measurement cursors for just $3995.

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CRT readout and cursors distinguish the new 2221. For even higher performance, there's the 100 MHz, dual time base 2230 with optional battery-backed memory for saving up to 26 waveform sets. And if it's economy you want, choose the 60 MHz 2220 with many of the same features at an even lower cost.

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Features	**2230**	**● NEW! 2221**	**2220**
Analog/Digital Storage BW	100 MHz	60 MHz	60 MHz
Maximum Sampling Speed	20 MS/s	20 MS/s	20 MS/s
Record Length	4K/1K (selectable)	4K	4K
Peak Detect	100 ns	100 ns	100 ns
Save Reference Memory	One, 4K Three, 1K	One, 4K	One, 4K
Vertical Resolution	8 bits 10 bits (AVG mode) 12 bits (AVG mode over the bus)	8 bits 10 bits (AVG mode)	8 bits
CRT Readout/Cursors	Yes	Yes	No
GPIB/RS-232-C Options	Yes ($750)	Yes ($500)	Yes ($500)
Battery-Backed Memory (save 26 waveform sets)	Yes (inc with GPIB/ RS-232-C)	No	No
Warranty	3 year on labor and parts, including the CRT		
Price	$4995	$3995	$2995

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Vol. 59 No. 4

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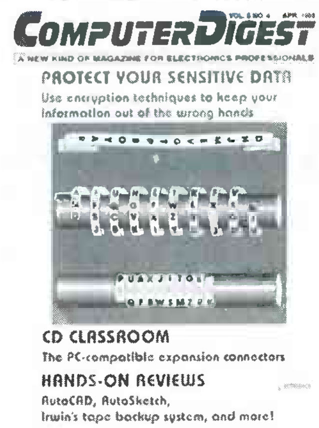
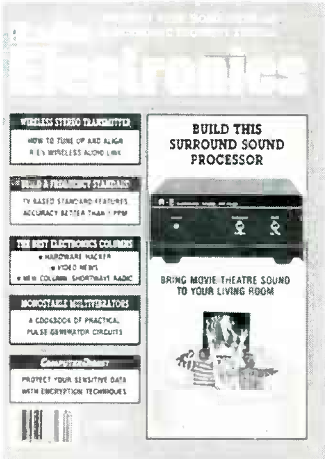


PAGE 85

PAGE 55

AND MORE

ON THE COVER



You have the latest video release playing on a wide-screen set, with stereo sound, and even fresh-popped popcorn—but it's still not quite like being in the movie theatre? Our Surround Sound Decoder can change that by bringing three-dimensional sound to your living room! The rear channel needed to create the surround-sound effect is concealed within the stereo tracks on modern home videos, and on TV movies broadcast in MTS stereo. Turn to page 45 to learn how to build a decoder to extract these hidden rear tracks, and how to position your speakers for optimal effect. Then dim the lights—you'll swear you're in a theatre!

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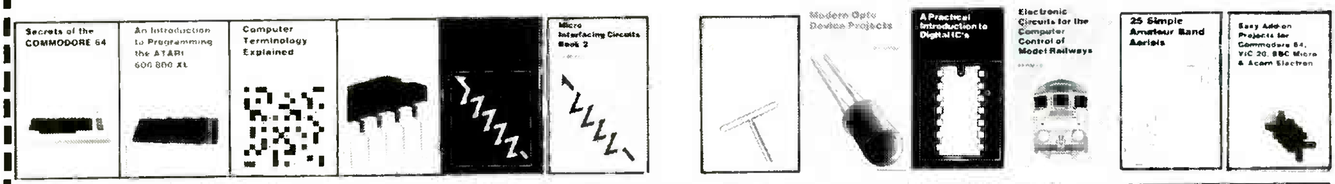

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EDITORIAL

The potential of CD-I

Are you ready for the next hi-tech wonder? Well, get ready for CD-I or *C*ompact *D*isc-*I*nteractive technology. It promises to be to the 1990's what the VCR was to the 1980's. That is, the hottest consumer electronics product of the decade.

CD-I combines the digital audio quality that we've come to expect from compact discs with high quality graphic images, a limited amount of full-motion video, and text. It can merge written and spoken words, music, pictures, and more to create entertaining, informational, or educational experiences. CD-I players will be stand-alone devices with audio and video outputs for your stereo and TV, and an RS-232 output, if you so desire, for your printer.

CD-I is not CD-V, which combines 5 minutes of video with 20 minutes of digital audio. CD-I is not CD-ROM, which is a computer peripheral that is powerful, but limited essentially to textual information. CD-I is not DVI, which is similar in many ways to CD-I, but is a CD-ROM peripheral. So what is CD-I?

CD-I *is* a truly interactive multi-media system that promises to open up a new world of applications in entertainment, edcuation, and information. But will it live up to its promise?

That's all up to the applications developers. The right application could create a demand for CD-I. For example, imagine that you are planning a trip to San Fransisco. Instead of watching a travel video to get an overall view of the popular attractions, you could pop a CD-I disc into your CD-I player, and get the same overall view. However, if you saw something that interested you specifically—such as Coit Tower—you could "click" yourself inside, and take a look around, and climb the steps to see what the view from the top is like. When you had seen enough, you could continue the tour until you came up to the next attraction that excited you—a ferry ride to the island of Alcatraz, for example.

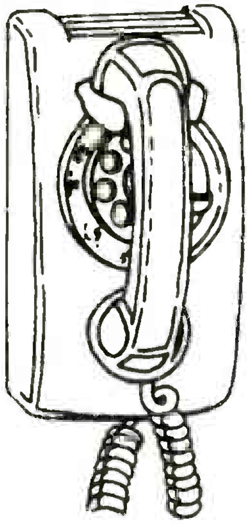
The educational impact could be enormous because of the interactive nature of CD-I. Imagine, for example, an electronics-teaching disc. The display could show a schematic of a video detector circuit. By pointing to a given spot on the schematic, you could see what a signal at that point was. You could change the input signal and immediately see the effect at different parts of the circuit.

Imagine watching a music concert video. Instead of being limited to watching the band play, you could have control over what you watched. You could change the camera angles to see what you were interested in, whether it's the crowd, or the fingering method that the guitarist is using. You could, perhaps, call up the sheet music on part of the screen.

Those examples only scratch the surface. The technology behind CD-I is exciting, and we'll be covering all the details in a future issue. But the applications of CD-I could prove to be even more exiciting. What would *you* do if you could be a CD- I author and could create an application that combined audio, video, graphics, and text?

BRIAN C. FENTON
Managing Editor

Radio-Electronics mini-ADS



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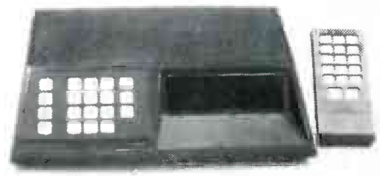

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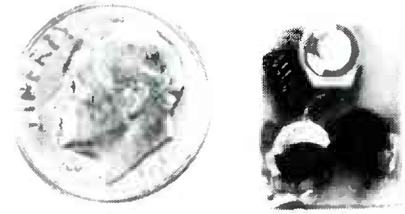

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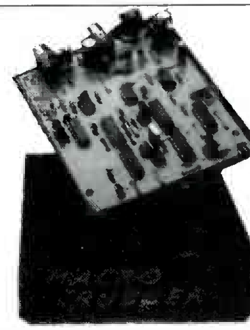

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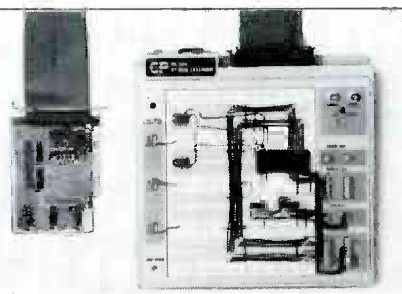

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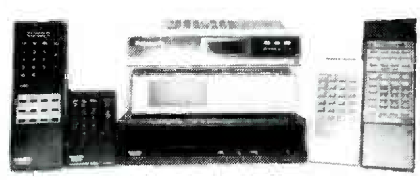

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WHAT'S NEWS

New solid electrolyte is absolutely dry

The world's first solid electrolyte, in the form of a kind of paper, has been announced jointly by Matsushita Electric Industrial Co. and Japan Synthetic Rubber Co. The new electrolyte can be used in a large number of solid-state devices, including primary or secondary batteries, electrolytic capacitors, and chemical sensors.

The current carrier can be chosen from a variety of ions, including silver, copper, lithium, etc. The present electrolyte is composed of $RbCu_4I_{1.75}Cl_{3.25}$, with the current being carried by copper ions. Temperature range is from -60 to $+100°C$.

The paper-form electrolyte is made by dissolving powdered solid electrolyte in an organic solvent with an insulating polymer that gives it the correct electrochemical and mechanical characteristics. The resulting slurry is coated on a sheet and dried. It can be made paper-thin or up to several millimeters thick. Increased thickness, of course, decreases flexibility. The "paper" is then sandwiched between electrodes to make a cell of any desired area.

Its freedom from leakage and the reliable stability of the electrolyte are expected to make construction and handling of certain devices much easier. Conceivable applications include semiconductor devices with built-in batteries and semi-permanently embedded heart pacemakers. Its dry nature makes it especially suited for applications in the high vacuums and wide temperature fluctuations of outer space.

THE WORLD'S FIRST SOLID ELECTROLYTE.

Microwaves at megavolts from new pulse generator

A new machine for generating megavolt microwave pulses of 100-nanosecond duration at repetition rates of 1 to 10 times a second has been designed by scientists of Sandia National Laboratories (Albuquerque, NM). Designed for burst-mode operation, the new machine is called Tempo, for *T*ransformer *E*nergized *M*egavolt *P*ulsed *O*utput generator.

Designed for defense and medical uses, three of the instruments have been built. One is at the Walter Reed Medical Center, Washington, DC, where it is being used for research into the effects of high-powered microwaves on organs and organisms. The other two, located at the Harry Diamond Laboratory in Maryland and at the Air Force Weapons Lab in Albuquerque, New Mexico, are used for testing the vulnerability of electronic and weapons systems to microwaves, and for microwave systems development.

The heart of the instrument is a voltage-doubling, pulse-forming transmission line called a *Blumlein*. A transformer and a 30-kilovolt capacitor bank at the rear charges the two parallel strip-line Blumleins, at the front is a microwave converter that transforms the high-voltage electrical pulses into high-power microwaves that are transmitted through a waveguide to an antenna.

Interactive TV, land mobile, pushing for spectrum space

Land-mobile radio operators have been pushing for frequencies in the 220-MHz range, to the extent that the FCC now has before it a docket proposing to reallocate the amateur 220–222 MHz band for mobile frequencies. Now a company known as TV Answer has petitioned the FCC for a 500-kHz slice of the same band for interactive TV systems (systems in which the receiving party can "talk back" to the transmitter, for merchandise ordering, polls, etc.).

The amateurs are contesting such moves vigorously, and thousands of letters in opposition have been received by the FCC. **R-E**

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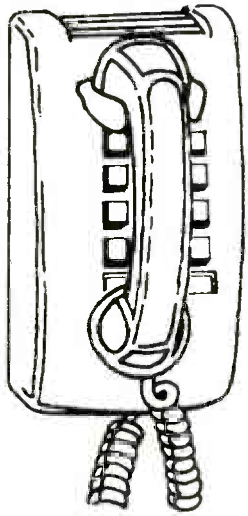

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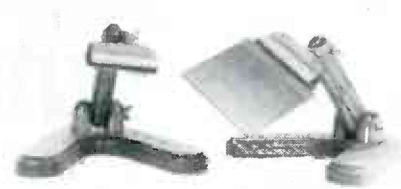

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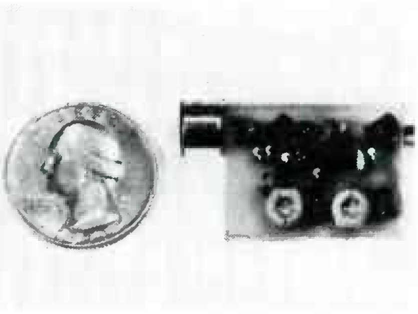

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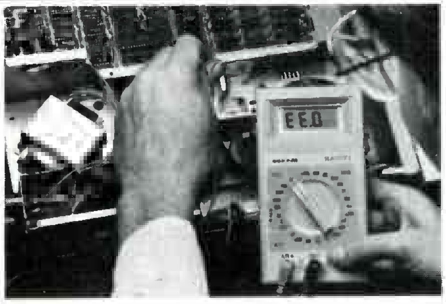

The power supply is assembled in the main unit of the computer. You check out keyboard connections and circuits with the digital multimeter included for training and field use.

Next, you install the 5¼" floppy disk drive, learning disk drive operation and adjustment. Later, you increase your data storage capacity dramatically by installing a 20 meg hard disk drive.

Using the monitor, you focus on machine language programming, an indispensable troubleshooting tool for the technician. You continue by learning BASIC language programming.

VIDEO NEWS

DAVID LACHENBRUCH,
CONTRIBUTING EDITOR

• **Sony goes VHS.** Sony, the inventor of the *Betamax*, the first successful consumer videocassette recorder, has announced that it will add VHS products to its line after 13 years of fighting its chief competitor. Although videophiles have always preferred the Beta format, the JVC-developed VHS format jumped to the lead among consumers in the United States in 1979, largely due to its longer recording time. Beta steadily declined in popularity, to the point where it is believed to have represented less than one percent of VCR sales in 1987. Other Japanese companies in the Beta camp—NEC, Sanyo, and Toshiba—switched over to VHS in 1985, after such American brands as Sears and Zenith changed sides.

Sony won't abandon Beta, and will continue to manufacture decks in the standard Beta format and the new high-resolution ED (*E*xtended *D*efinition) Beta. According to the company's announcement, Sony initially will buy VHS decks from Hitachi, but will start up its own production line around midyear. The Hitachi-made decks will go to Europe, while Japan and the United States will get the Sony-made version, with American sales probably starting late next fall.

• **3D camcorder on the way.** Long before stereo*phonic* sound, "stereo" stood for stereo *scopic*, or three-dimensional vision. Now, Toshiba promises to bring a 3D video camera-recorder combination to the United States this summer for $2,850. *3D CAM* has two half-inch CCD pickups, two lens systems, and records on a VHS-C cassette. Left and right images are carried on alternate frames. The version to be sold here uses a standard TV set, although a flickerless model is coming. That model requires a special TV set with a frame-doubling system.

• **Laservision revival.** For years, Pioneer was the only US supplier of laser optical videodisc players—but now the medium is suddenly making a comeback. It's all presumably keyed to the new *C*ompact *D*isc-*V*ideo (CD-V) system, which puts five minutes of video and 20 minutes of audio on a five-inch CD. The new laserdisc players are capable of playing the standard 8- and 12-inch videodiscs, the 5-inch CD-V discs, standard 5-inch audio CD's, and the new 3-inch CD singles.

While the CD-V discs haven't yet fulfilled their promise of becoming a new medium aimed at younger listeners and viewers, their very existence seems to have encouraged the spread of all-purpose laserdisc players—to the point where the number of brands available on the American market has increased from one to eight in a single year. Already on the market or announced for availability this year, in addition to two models from Pioneer, are players under the brand names of Yamaha, Sony, Devon, Hitachi, Image Entertainment, Magnavox, and Toshiba.

• **CD + graphics.** When Philips and Sony agreed on what were to be industry-wide standards for audio Compact Discs, they included eight inaudible subcodes in addition to the digital audio tracks. Two of those codes are used to control the player—programming the order of selections, and so forth. The rest are available for text and graphics. In Japan, special CD's are designed for "karaoke," or sing-along jukeboxes, which display lyrics on a video screen.

In the United States, Warner New Media, an affiliate of Warner Communications and Warner Records, has proposed to add graphics to compact discs, and has demonstrated such uses as reproduction of album covers, liner notes, guitar chords, and even elaborate color photographs, paintings, and pseudo-automation in time to the music. The graphics are viewed in the form of changing still pictures on a TV screen, with changes possible every two seconds for simple graphics, and about seven seconds for more complex art. JVC plans to make CD-players with the graphics feature, and says it can market them at about $399 after it completes design of an LSI IC. Warner says it will release about 50 CD's this year with encoded graphics. **R-E**

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Of course, there's a whole range of Circuitmate DMMs and service test instruments, including the DM78 autoranger that fits in a shirt pocket, yet gives you a full size 3 ½ digit, ⅜" readout. Not to mention a complete line of accessories like test leads, current clamps, even probes that can extend your DMMs range and sensitivity. All designed to work flawlessly with your Beckman Industrial Circuitmate DMM.

EMERSON

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- hFE (NPN or PNP): 1 range (1000)
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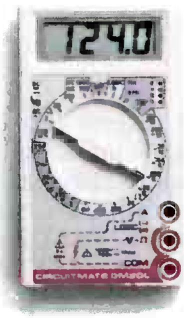
- Ohms-8 ranges (200 ohms to 2000 Megohms)
- Continuity beeper



DM850 True RMS

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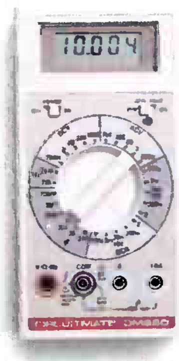
- True RMS
- Frequency counter to 200KHz
- Data Hold display capability
- Continuity beeper
- Built-in bail
- Anti-skid pads
- Price: DM850 (True RMS) . . . . $219.95* DM800 (Average) $195.00*



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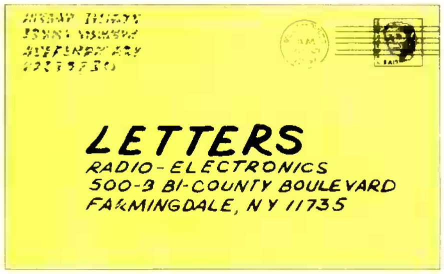
LETTERS



NEW ADDRESS

Just after the February 1988 issue of **Radio-Electronics** *hit the stands, we were notified of a change of address for one of the suppliers that was listed in "Making Your Own PC Boards."*

The correct address for The Datak Corporation is: 3117 Paterson Plank Road, North Bergen, NJ 07047. Their new phone number is (201) 863-7667.—Editor

CORRECTION

Don Lancaster's "Hardware Hacker" in the February issue of **Radio-Electronics** *contained an error. In the Names and Numbers box on page 77, the correct phone number of Sprague is (617) 853-5000.*—Editor

SORRY!

In our article "Build This Audio/Video Switcher" in the February 1988 issue, there are a couple of corrections to be made concerning the parts-placement diagram of Fig. 5. The first one, although it won't affect the operation of the switcher whatsoever, is that diodes D1–D8 are numbered incorrectly. From left to right they should read: D1, D3, D4, D2, D5, D8, D6, and D7. The second correction is that voltage-regulator IC7 is shown backwards. When correctly oriented, the flat side should be on the right with pin 3 at the top and pin 1 at the bottom.—Editor

ADDRESS CHANGE

I was glad to read MSgt. Flick's letter in the February 1988 issue, and to learn that my article on electronic technician certification (**Radio-Electronics**, August 1987) was helpful to members of the armed forces who are preparing for second careers. As he noted, The National Association of Business and Educational Radio has relocated. The current address is NABER, 1501 Duke St., Suite 200, Alexandria, VA 22314.
W. CLEM SMALL, CET

HDTV UPDATE

There are two flaws in the description of Advanced Compatible TeleVision (*ACTV*) in "HDTV Update" (**Radio-Electronics**, January 1988). First, the NTSC-compatible "center panel" is not enough to make a watchable picture. Currently, wide-screen films are adjusted for the narrower screen—usually by squeezing the picture during the credits, then panning the film to keep the relevant action on-screen. ACTV will eliminate such compensation.

Second, once NTSC receivers have been phased out, we'll be stuck with an unnecessarily convoluted system. Better to decide on a global television standard *once and for all*, and design converters for NTSC receivers—even if it means some loss in the picture's resolution to make a 16:9 picture fit in a 4:3 screen.
JOE MESZAROS
Danvers, MA

U-MATIC FORMAT

As a technical support specialist for a television systems and equipment dealer, I must take exception with several comments made by David Lachenbruch (*Video News*, **Radio-Electronics** January 1988) on the fate of the ¾" U-matic videotape system. While I agree that this format is on its way out, its demise is not as imminent as he or Panasonic may believe.

On the broadcast end, Sony's *Betacam* (now *Betacam SP*) and, to a much lesser extent, Panasonic's *MII*, have already started to replace U-matic for Electronic News Gathering (ENG). However, the real pressure from those ½" machines is on the 1" market, where the few remaining manufacturers are scrambling to adopt one format or the other.

With industrial and small-market broadcast users, U-matic is still a viable alternative to the high-priced formats and lower quality VHS. The new U-matic SP is a significant improvement over conventional U-matic, and should extend the life of the format. Contrary to Mr. Lachenbruch's statement, U-matic SP is fully compatible with standard U-matic, and it does not use a true metal tape.

There are several factors being downplayed in the current marketing of Super VHS. First, SVHS is "upward compatible" only. Tapes recorded in SVHS format cannot be played back on standard machines. Second, SVHS quality requires a monitor with a special Y/C input and circuitry; connectors for those inputs have not been standardized. Third, there is very little compatible support equipment available at this time, resulting in limited production capabilities.

A few years ago, true component systems were being touted as the next generation in video production. To date, there have been problems bringing those systems on line, and they have not been as well-received as was hoped. What about SVHS, where the quality depends on a component signal?

I'm not trying to bash Super VHS—it is an improvement. I just think Mr. Lachenbruch should have told the whole story.
PETER MECABE
Climax, NY

FAN MAIL

I just received the November issue of **Radio-Electronics** and I was thrilled to see Forrest Mims' name on the cover. I wasn't let down—his series on SMT was as easy to read and appropriate to the hobbyist as ever.

Getting Started in Electronics was the first book by Mr. Mims that I read. Wonderfully easy to read, it forms a basis of intuitive notions on which one can learn more about electronics. I love the book, and constantly recommend it to anyone just getting started.

I searched out his two-volume *Engineer's Notebook* in used-book shops, and by the time I finished *Circuit Scrapbook* I felt happy and confident putting together my own projects. Last year I read Mims' *Siliconnections* because I was curious about the man who was responsible for so much of my practical knowledge of electronics, the stuff which was so difficult to pick up from other sources. I was also pleased to read about my own company, Rising Star Industries, in that book.

I discovered **Radio-Electronics** about two years ago, and found articles for the beginning and experienced hobbyist alike. Most important to me was that each project was accompanied with explanations of circuit operation, which allowed for education and growth. I studied all the issues like text books, and felt I'd "graduated" from the school of **Radio-Electronics** by earning my FCC General Radiotelephone Operator License last month.

Now I'm enrolled in a masters program in computer engineering. I earned a B.A. in physics in 1982, but I gained a distinct distaste for formal education in the process. Reading *Siliconnections* gave me great hope for the success of sticking with just tinkering, but I have decided to give school another chance.

In any case, Forrest M. Mims III has been an inspiration as well as a wonderful teacher, and I have the utmost respect for wonderful teachers.

RICK SANGER
Monterey, CA

CROWBAR CIRCUIT

I was disappointed when I read "Ask R-E" in the January 1988 issue of **Radio-Electronics**. The design of the "Crowbar" circuit was drawn incorrectly.

The Zener diode (D1), as shown in Fig. 2 of the column, is used in its forward-bias mode of operation. Therefore, the voltage drop across D1 will be 0.7 volts and its resistance is negligibly small. Consequently, the D1/R1 series combination across the output of the voltage regulator will be seen as a virtual "short" to ground through resistor R1.

That will cause R1 to load down the power supply, assuming that D1 and R1 can handle the current that the power supply will deliver under that condition.

Surely that was not intentional. For the crowbar circuit to function properly, the Zener diode should be used in its reverse bias mode of operation, as shown in Fig. 1.

Now D1 will try to maintain a certain zener breakdown voltage V_Z by shunting current to ground through R1. This time, the current will be much smaller than before, since the resistance of D1 is nominally high now. If the output voltage of the power supply falls

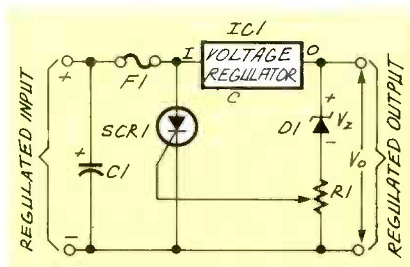


FIG. 1

below its rated output V_O, the diode will act as an open circuit. If the output voltage is at or above V_O, D1 will begin shunting current to ground through R1.

TREEFON J. SIAMPOS
Scott AFB, IL

MACRO-SCRUBBER

It seems that Mr. Dupre had not done his homework when he presented his article, "Macro-Scrubber", in the December issue of **Radio-Electronics**.

The 14 μsec delay after the beginning of each horizontal-sync pulse that precedes a Macrovision

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"noise-burst" is entirely too long to effectively eliminate all portions of the Macrovision signal. After checking several copy-protected tapes, it appears that at approximately 9 µsec after the beginning of the sync pulse, the Macrovision is added. (Perhaps the author designed his system around an older version of Macrovision?)

The result is that several pulses during each Macrovision-encoded line are allowed to pass to the output. While that may not appear to cause a problem, I noticed some brightness changes on my VCR system. I purchased the kit and confirmed the above.

Being curious, I decided to reprogram IC4, the binary counter, to decimal 9 (9 µsec). The result of that was to entirely eliminate the video signal.

It appears that the counter is being preset by sync pulses on Pin 13 of IC4 that have a duration of greater than 9 µsec. That occurs because IC2 is generating 11 µsec pulses corresponding to *all* horizontal sync pulses. The end result is the placing of "burst-locating pulses" throughout the entire video field.

R. FALCONE
Cincinnati, OH

CALIBRATING VCR COUNTERS

I read the article "Calibrating VCR Counters" (**Radio-Electronics**, January 1988) with interest. I had considered the same problem—for audio recorders—many years ago with the idea of solving the problem mathematically rather than empirically.

At first glance, the problem appeared difficult because the pack radius is a non-linear function of tape length and the effective tape thickness in the tape pack is hard to determine. The solution became much easier when I realized that the length of tape on the take-up pack is proportional to the pack *area*, while the tape counter (usually on the take-up reel) is linearly related to the pack radius.

In particular, where n = counter count; l = tape length on take-up

continued on page 76

ETTERS

H ome of the more "interesting" letters
w ived since April 1st.

THI E CONSTRUCTION OJECT

As er, I have enjoyed readi cles and building some ects presented in **Radio-I**

Howe uld like to see more so projects, such as a hand imental band, precision- d, clocked, microproce olled, random code sc voice-activated, freque ulated, spread-spectrum tranceiver with on-boa t keyboard for random seed number entry.

I'm sure every hobbyist would love to have at least two.

H.D.
Guthrie, OK

FLOATING DISH

We are on a ship operating in Southeast Asia, and we are interested in purchasing a satellite dish for our vessel so that we can receive a larger number of TV channels. Could you refer us to a company that sells them? Any information you can provide will be greatly appreciated.

THE RECREATIONAL COMMITTEE
FPO San Francisco

Do you also need a high-speed dish actuator with ocean-wave compensation?—Editor

IBM-INCOMPATIBLE

I was happy to see "Build This IBM Incompatible" in the April 1987 issue of **Radio-Electronics**. I always wanted to build a computer. Thanks to you, now I can.

I'm a carpenter, and I got a bunch of my friends together and built a whole bunch of those "NAND gates." We built the positron catcher to fill up the NAND gates. It didn't work but, being a carpenter, I figured it out.

Figure 1-*a* of the article shows that the positrons are mostly square-shaped. So, we heated the funnel and sort of squared it up. Then we filed the hole in the thimble square (you know about round pegs in square holes?). We put a straight straw on it after we found positrons jamming in the round bend of the straw. Figure 1 here shows the positron catcher for the Northern hemisphere. We got all of the NAND gates filled up, but, after a while, everything leaked out and we couldn't measure any positive electricity.

Now we've got two questions: 1. Is there some way of closing the gates a little tighter, or did we do something wrong? 2. How do you work those W's? I need a whole lot more information on how to manipulate those W's!

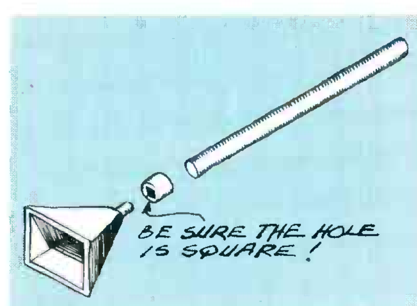


FIG. 1

You're my favorite magazine—keep 'em rolling!
WALT HENRY
Madera, CA

WHEN WILL IT END?

In his story, "Build This IBM Incompatible," Jeff Holtzman states that the series will extend to 463 parts. By my calculations, if you run one part in each issue of **Radio-Electronics**, it will take 38½ years to reach the end. Am I right?

How can this be? Will you include two or three parts in each issue to reduce the time-span?
A BEGINNER IN ELECTRONICS
Aguada, PR

You didn't read the article carefully enough. The series is supposed to appear in each April issue only; thus, it will take 463 years to reach its conclusion. (Unfortunately, we ran out of room in this issue....464 years?)—Editor

HELP!

I hope there is, among my high-tech fellow readers, somebody who can help me design an electronic trap for small insects. I've been bothered by an insect that entered my home on a contaminated house plant, and none of the chemically-toxic buy sprays have succeeded in eliminating it.

It is a flying insect that crawls into the hairy areas of my body. It doesn't bite—it just seeks out the warmest and most humid areas and walks around. The insect is too small to see with the naked eye, and local doctors don't believe me simply because they can't see it. They tell me to capture and identify it, but I can't trap or kill it.

I've tried the ultrasonic pest repeller described in the July 1985 issue of **Radio-Electronics**, but that only succeeded in annoying my neighbors. I had no success using an ultraviolet light bulb to lure it into a high-voltage zapper. All the toxic room fumigators do is poison me temporarily. Yet this little bug is still bugging me. Does anyone on your staff have any electronic suggestions?
GETTING DESPERATE
New York, NY

COMPACT DISC PROGRAMMER

We have a Sony CDP-C10 compact disc player which can be programmed to play 20 songs from any of 10 compact discs. We entertain frequently, using the compact disc as the source of music. Since most of the songs popular for parties are about 3 minutes long, we have only one hour of music before it is interrupted for reprogramming. This is an inconvenience—particularly if we are in the pool or jacuzzi, or on the tennis courts.

Is there a schematic available which will allow the programming of additional songs to be stored in a memory, and then send the signal to the compact disc player?
L.C.F.
Canoga Park, CA

Have you considered buying several more CD-players or, perhaps, teaching the butler to reprogram it for you?—Editor

PORTABLE LASER

I'm thinking of building my own helium-neon laser from scratch.

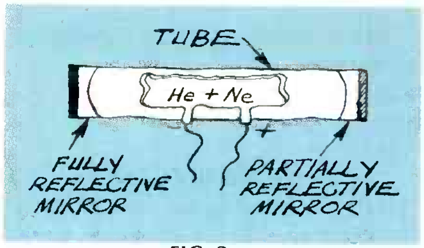


FIG. 2

Figure 2 shows what the "tube" will look like. I have some questions I hope you can answer.

What amounts of helium and neon can safely be put in the tube? Do you need a lot of gas for the tube to be effective? When you throw the switch, the atoms become excited and give off photons that bounce back and forth until a beam breaks through. How do you know where the beam would come through the mirror?

Finally, what volume of gas and what amount of current is needed to produce an effect like punching a hole through a **Radio-Electronics** at 50 yards.

I plan on making this laser portable. I was thinking about making a fuel cell (Fig. 3) which could be carried on my back.

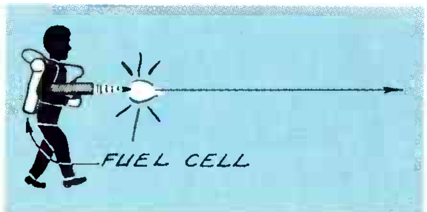


FIG. 3

If this is not a practical method of making a HeNe laser, please send a diagram of one.
R.B.
Stillwater, OK

AMERICA'S ILLITERACY PROBLEM

It might be an individual's own business on whether or not he/she can read or write,and I am certainly the latter would agree, but the circumstances that brings about the causes is what I would like to comment on. The 1986 U.S. Census Bureau report of 17 million to 21 million adults that are illiterate is partly due to the fact that the Humanities are neglected in secondary educational schools.
B. M.
Atlanta, GA

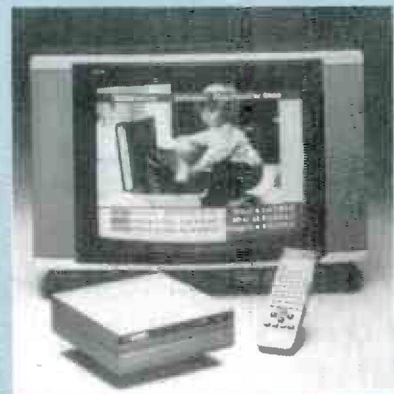
Yes, we do seem to have an illiteracy problem.—Editor

EQUIPMENT REPORTS

Videonics DirectED Video Editing System

Turn your home videos into professional-looking productions.

CIRCLE 49 ON FREE INFORMATION CARD



THE VIDEO CAMCORDER IS ONE OF THE hottest consumer electronics products of the last five years. But despite the continuing improvement in the capabilities of camcorders, shooting an interesting video continues to be extremely difficult. Making a good, interesting video requires that you do more then simply point and shoot. If you've ever been forced to watch a 45-minute video of a baby learning how to walk, you're sure to agree that the point could have been gotten across better—and faster—in 5 minutes of well-edited scenes. But editing videocassettes at home has never been an easy proposition.

All that will change with *DirectED*, from Videonics (1129 Dell Avenue, Campbell, CA 95008, 408-866-8300). *DirectED*, which Videonics calls a personal movie maker, is an advanced, microprocessor-controlled system that gives you the ability to turn your choppy, boring, home videos into

professional-looking video productions. It's compatible with most remote-controlled VCR's on the market, regardless of format, and despite its power, *DirectED* is surprisingly easy to use.

The *DirectED* system consists of three parts: the handheld remote unit, the control unit, and the control wand. To use *DirectED*, you must have two VCR's or a VCR and a camcorder. The main VCR must be an infrared-remote controlled unit; the second VCR only has to be able to play back a tape. Of course, you'll also need a monitor or a TV. Before we get into the details of the equipment and how it's set up, let's step back and look at the editing process.

Editing your own movie

DirectED's editing process starts with an original tape or tapes, from which duplicates or dubs are made (so that the originals can be stored away safely). Then good scenes are found and marked on the dubs, and they are named and numbered. A *rough-cut master* is assembled from those scenes so that you can check your work before you go back to the original tapes to assemble your movie. While you do all of your editing work with the dubs, the final movie production is made from the original tapes, not second-generation copies.

DirectED remembers the name of each scene, where each scene is, and how long it is. It even remembers what tape a given scene is on—you can assemble your movie production from many different tapes. The scene list can be displayed on screen and, if you wish, you can preview all of the scenes in order before making your final movie.

DirectED can do more than assemble scenes in sequence, however. It allows you to rearrange the order of scenes, add graphics, add titles, add fades or wipes between scenes, and more. When you're satisfied with your choices, you simply tell *DirectED* to make the production. It prompts you to insert the appropriate tapes into your VCR's, and does all the rest of the work by itself.

Using the movie maker

The power of *DirectED* shows itself in how easy the system is to use. Every step of the way is guided by menu screens that are arranged logically. And a help key is available to call up more information about a particular function. *DirectED* also keeps track of all your tapes! All your dubs and finished productions reside on library tapes. If you label your tapes when prompted by *DirectED*, you'll always be able to find not only a particular movie, but a particular scene as well. *DirectED* will tell you which tape to insert into the VCR, and it will forward the tape to the beginning of the scene you want.

Now that we know how *DirectED* is used, let's go back and take a closer look at the equipment and how it is hooked up.

You must start with two VCR's. One, which we'll call the main VCR, must be infrared-remote controlled. The other can be any deck, from a playback-only VCR to a camcorder. The two decks can be different formats.

The two decks are connected to the *DirectED* video control unit, which is an unobtrusive grayish box that measures about 8½×9½×2½ inches. It accepts video and stereo-audio inputs from both VCR's, and it outputs stereo audio and video to a monitor and the main VCR. A modulated RF output is not available, so if your TV does not have video inputs, you will have to purchase an RF modulator separately.

One final connection must be made to the video control unit: The control wand, which outputs the infrared signals to control your main VCR, is plugged into the rear panel of the control unit and is placed so that it can be seen by the main VCR's infrared sensor.

Making all those connections takes about 5 minutes. When you're done, you really never have to touch the video control unit again. It can simply be placed on a shelf, out of the way, where it can see the handheld controller, which is the user interface to *DirectED*. The controller has a 50-key keypad that contains the alphabet (in an "ABC" sequence), numerals, cursor controls, and a few special-function keys, including the all-important HELP key.

CONSUMER CORNER

New solid-state and digital TV sets, stereos, and videorecorders are tougher to repair than old-fashioned tube type sets and require special training for the service technician who works on them.

Only a few states have laws requiring competency tests for licensing technicians who repair consumer electronics, but fifteen years ago the International Society of Certified Electronic Technicians (CET) began its own certification program to qualify these technicians and those in industry. To carry the CET designation, technicians must have four years experience and pass a rigid examination on general electronics and a specific area of expertise such as audio or radio-TV.

Many consumers look for a Certified Electronic Technician in the shop when they need any electronic item repaired.

Free Consumer Checklist

A consumer checklist for selecting a service shop is av-

Modern electronic equipment such as digital TVs or stereos should be repaired by specially trained people.

ailable free by sending a stamped, self-addressed envelope to: Checklist, ISCET, 2708 West Berry, Fort Worth, TX 76109. The list reminds consumers to check such items as "Does the business have the parts for your particular brand?", "Did you get an estimated price?", and "Did you check this company with the Better Business Bureau?"

Teaching *DirectED*

Although everything is properly hooked up, you're not ready to use *DirectED* until you teach it about your setup, or more accurately, until *DirectED* learns about your system for itself. First you must choose names for each of your VCR's, such as "Play Only" and "Main", and tell *DirectED* their formats. Then you simply tell *DirectED* to "learn VCR remote control" by making the appropriate choice from the menu.

The screen display instructs you what to do next. Basically, you insert Videonics' "Getting Started" tape into the main VCR. That tape, which is included with the system, instructs *DirectED* to send various manufacturers' STOP commands to the main VCR while watching the video output. When the video stops, *DirectED* knows which stop command works, and it can deduce the rest of the codes from that. In our tests, we used the VR-HF800 from Canon, who we would like to thank for their cooperation. The process took only a few seconds, and we could then proceed to the menu choice "Checking the VCR control." *DirectED* then puts your VCR through its paces. All you have to do is to sit back and make sure that your VCR is doing what *DirectED* tells you it should be doing.

In the last setup step, *DirectED* must learn your VCR's motion characteristics, such as fast-forward and rewind speed, etc. That helps *DirectED* to be able to find scenes as quickly as possible, and to edit as accurately as possible. Once the menu choice is made, *DirectED* does all the work. When it's finished, you're ready to make your first movie.

Inside *DirectED*

The heart of *DirectED* is an NEC V40 microprocessor running at 8 MHz. (The V40 is a superset of Intel's 80188 microprocessor, which, as we saw in the R-E Robot series, is well suited for control applications.) The system program is contained in 8K of non-volatile RAM.

DirectED contains 256K of RAM for storage of such information as scene location, name, time, graphics, etc. To keep track of all that, timing codes are written in the vertical blanking interval of each video frame. When a scene is marked, the time code is written to RAM along with the scene's name. When your editing session is over, the contents of RAM can be written to videotape for permanent storage.

The graphics capabilities of *DirectED* are provided, in part, by Motorola's 1378 processor. Digital graphics are available with a resolution of 768 × 480, and 64 video levels are available. The circuitry provides the capability of switching between external and internal video sources pixel-by-pixel.

DirectED is not only a sophisticated consumer electronics products, it is one of the most innovative products we've seen in recent years. We congratulate Videonics for finding answers to a real problem while creating none of its own. *DirectED* is priced at $499, and it's worth it. **R-E**

ELECTRONIC KNIGHTHOOD

A guardian for your junkbox, from your junkbox!

VICKY di ZEREGO

IF KING ARTHUR HAD HAD THIS ELECTRONIC knight to guard the kingdom, we'd still be living in Camelot, for the knight's alternately blinking red eyes would strike fear into the hearts of any invader.

Body parts

The electronic knight's body consists of the components that make up a simple 555 free-running multivibrator that drives the LED's used for the eyes (Fig. 1), with a few "extras" added for show. The torso is a 14- or 16-pin wire-wrap DIP socket that also holds the 555. The 8-pin 555 uses only half the socket; the remaining socket pins are used to support the other components.

The arm holding the staff is an old plate choke; the staff is a length of coathanger that also serves as the battery's ground connection through the choke to IC1 pin 1. The other arm is two series-connected 1-watt resistors. (The resistors' wattage ratings are selected so the components are in proportion to the rest of the body.) The resistor closest to the torso is R3, with it's connection looped behind the resistor so that it can't be seen. The resistor connected to the chain is a dummy.

The knight's thigh's are 0.47-ohm, 5-watt wirewound resistors (effectively a short-circuit). One leg is electrolytic capacitor C1, the other leg is a 0.2-ohm, 1-watt resistor (also effectively a short-circuit) that provides B1's positive connection to the circuit. The feet are flat-sided transistors that are simply soldered in the proper location.

The knight's helmet is a black alligator-clip insulator that has been punched out for the miniature red LED's (LED1 and LED2) used for the eyes. The mace is a small ball of conductive foam with small pieces of wire stuck into it. The chain is made from small loops of No. 22 solid wire.

The electronic knight is mounted on a small plastic box containing a three D-cell battery holder. No power switch is provided because the current drain is so low that a set of batteries can blink continuously for several months before they run down. **R-E**

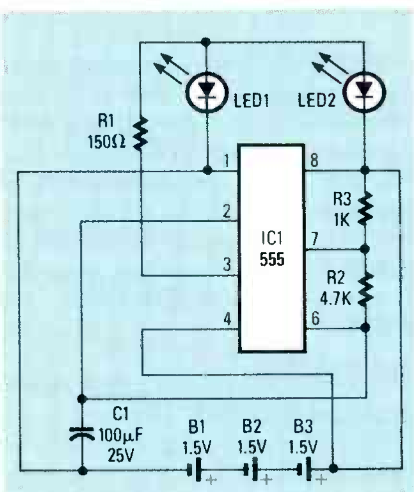


FIG. 1—THE SCHEMATIC for the electronic knight.

PARTS LIST

R1—150 ohms, ¼ watt, 10%
R2—4700 ohms, ¼ watt, 10%
R3—1000 ohms, 1 watt, 10%
C1—100-µF, 25 volts, electrolytic
IC1—555 timer
LED1, LED1—Miniature red LED
B1-B3—1.5 volt D-battery
Miscellaneous: IC socket, parts used for body, battery holder, stand, wire, solder, etc.

New Products

CIRCLE 10 ON FREE INFORMATION CARD

DMM. The Simpson model *464-4* DMM is a bench digital multimeter designed to meet UL 1244 requirements. It provides true rms voltage and current readings with frequency response to 100 kHz for accurate measurements of power, control, and audio circuits. The 0.56-inch orange 3½-digit LED display makes for easy reading by the user under a wide range of ambient light conditions.

The model *464-4* is priced at $325.00.—**Simpson Electric Company**, 853 Dundee Ave., Elgin, IL 60120.

COMMERCIAL CONNECTOR KIT. Jensen Tools' 273-piece RS-232 commercial connector kit is designed for easy fabrication and maintenance of RS-232 cable connectors. The kit includes 16 25-pin plug (male), and 6 25-pin receptacle (female) connectors; 100 each stamped and formed pins and sockets; 50 cable ties; and one insertion/extraction tool. All are contained in a sturdy, compact plastic case. Connector hoods are available separately. The kit is priced at $69.50.—**Jensen Tools, Inc.**, 7815 S. 46th Street, Phoenix, AZ 85044.

CIRCLE 11 ON FREE INFORMATION CARD

SPEAKER/MIC. The MFJ Enterprises model *MFJ-284* is designed for handheld radios. With it, you can comfortably carry your radio on your belt without ever having to remove it to monitor calls or talk. You will never have to turn up the audio annoyingly loud to monitor calls because the model *MFJ-184's* lapel/pocket clip lets it be placed close to your ear for easy listening. Nor will it be necessary to remove your radio from the belt because you can conveniently take the speaker/mic in one hand, press its push-to-talk button, and simply talk.

CIRCLE 12 ON FREE INFORMATION CARD

The model *MFJ-284* comes with a lightweight retractable cord that eliminates the "dangling cord" problem and has a connector that fits both Icom and Yaesu units; it features clean audio on both transmit and receive. It is priced at $24.95.—**MFJ Enterprises, Inc.**, 921 Louisville Road, Starkville, MI 39759.

UV EPROM ERASER. The *Palm-Erase* from Logical Devices is extremely fast and can erase EPROM's in less than three minutes. Measuring 4 inches long, 2 inches wide, and 2 inches high, the *Palm Erase* is particularly suit-

ION CARD

on and with old ire of

..d ..t AC ..s inten- ..d average ..00 hours. It is –**Logical Devices,** ..v. 65th Place, Fort , FL 33309.

..ATIC CLEANER. Chem- .. offers *Plast-N-Glas,* an ..ol agent that dissipates elec- ..tatic charges on all glass and ..astic surfaces while removing ..dirt, ink, grease, fingerprints, and nicotine stains.

The cleaner itself will not stain, smear, streak, scratch, or abrade, and offers long-lasting protection from electrostatic build-up. It is nonflammable, clear, odorless, and fast-drying.

Plast-N-Glas is available in 8 oz. and 16 oz. cans. The price of an 8 oz. can is $3.25; a 16 oz. can costs $4.70.—**Chemtronics,** 681 Old Willets Path, Hauppauge, NY 11788.

CIRCLE 14 ON FREE INFORMATION CARD

MOUNTED ANTENNA. Electron Processing, Inc., announces the *VAK-TENNA*, which mounts to glass or any other smooth surface with suction cups; it is designed to provide a means of mounting an antenna where drilling holes is not possible. The antenna can be installed or removed in minutes without leaving any marks, and no tools are required for either operation. Vertical or horizontal configurations can be used as desired.

The *VAK-TENNA* covers 30–500

CIRCLE 15 ON FREE INFORMATION CARD

MHz for receive and from 50–250 MHz for transmission and is rated to 50 watts. Two telescoping elements extend to a full 79 inches, yet collapse to 20 inches, and can be folded to 12 inches for storage or transport. A 15-foot 50-ohm RG-58 cable is provided for connection to the radio equipment. Standard connectors are either PL-259, BNC, Motorola, or F; other connectors are available on special order. Pricing of the *VAK-TENNA* starts at $29.95.—**Electron Processing, Inc.,** P.O. Box 708, Medford, NY 11763.

TOOL KIT. HMC offers the Gemini Series model *71A316*, tool kit, which contains a complete complement of tools required for the repair and maintenance of computers, office machines, telecom and datacom electronics, aerospace navigation, and radar equipment. Quality, name-brand tools are placed inside a 6½-inch aluminum case in a way that allows

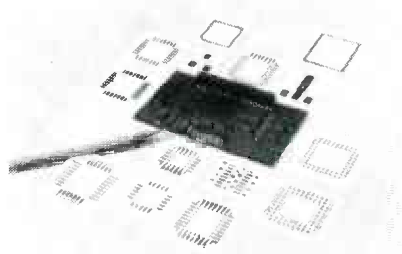
CIRCLE 16 ON FREE INFORMA

quick and easy identificati access.

The case comes complete two removable pallets that h tools securely in place. A literatu pocket is attached to the back the lid pallet.

The model *71A316* is priced a $540.00.—**Hub Material Company,** 33 Springdale Avenue, Canton MA 02021.

ARTWORK SYSTEM. Bishop Graphics has introduced a new surface-mount technology (SMT) artwork system to help circuit designers lay out and create artwork for that new, rapidly growing technology.



CIRCLE 17 ON FREE INFORMATION CARD

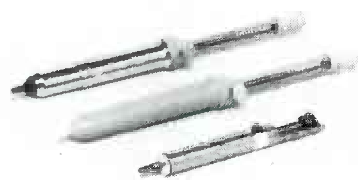
The new artwork system includes 30 lines/inch resolution layout grids, component land patterns that conform to IPC-SM-72 design guidelines, corresponding silkscreen symbols that also serve as component-placement aids, special-size artwork tapes, and SMT design layout templates in both 2× and 4× scale.

continued on page 42

The new surface-mount component land patterns have via pads connected to each land area to simplify integrating designs into a through-hole environment. The patterns are designed to fit on a .050-inch grid to facilitate PCB bare-board testing, and allow maximum component density and trace routing.

Pricing for Bishop's SMT artwork products range from $2.05 for SMT tapes to $76.00 for a 36" by 48-inch grid pattern.—**Bishop Graphics, Inc.,** 5388 Sterling Center Drive, Westlake Village, CA 91359.

DESOLDERING HAND PUMPS. A.P.E. Corporation offers two manual desoldering hand pumps, the model *DP-4* and the model *DP-5*. Both models come with conductive tips to protect even the most delicate components from static damage. The pump system has been designed to minimize recoil, thus protecting circuitry from mechanical damage.

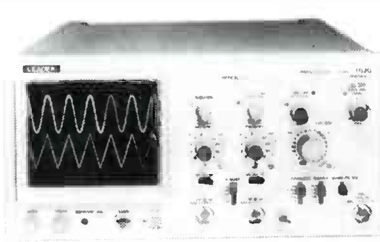


CIRCLE 18 ON FREE INFORMATION CARD

Those pumps are self-cleaning in each operation, have a bayonet twist for quick disassembly, and a fully enclosed plunger shaft for operator safety.

The model *DP-4* is priced at $13.95. The model *DP-5* is the same as the *DP-4*, but is completely conductive and antistatic; it is priced at $14.25.—**A. P. E. Corporation,** 142 Peconic Ave., Medford, NY 11763.

20-MHZ OSCILLOSCOPE. Leader Instruments' model *1020* has an ergonomic front panel that makes operation simple and straightforward, while offering comprehensive triggering controls, which include channel triggering, variable trigger hold-off, TV-sync separators, and line triggering.



CIRCLE 19 ON FREE INFORMATION CARD

With 0.5-mV sensitivity, very low-level signals can be observed on the unit's 8 × 10-cm rectangular CRT. An internal graticule, auto focus, and scale illumination are also standard features. The model *1020* is priced at $595.00.—**Leader Instruments Corporation,** 380 Oser Avenue, Hauppauge, NY 11788.

SOLDERING IRON. Weller offers the *Pyropen*, a cordless LP-gas catalytic soldering iron, torch, and hot-air gun. It is designed for field and service jobs, and in the electrical and communications industries, when electricity is not available. The multi-purpose tool can be used as a heat gun to shrink tubing, connect vinyl-chloride pipes and dry glues; as a soldering iron; and as a torch to braze copper and other metals.

CIRCLE 20 ON FREE INFORMATION CARD

The handle of the 9⅝-inch long tool serves as the gas container, and holds enough LP gas for about a three-hour operation. It only takes a few seconds to refill the container.

A control lever that regulates the gas volume changes the tip temperature when soldering, and flame length when being used as a torch. When it's used as a heat gun, the gas-catalyst reaction system converts the flame to hot air. Fingertip action operates the gas open/close lever and controls the volume of gas. By regulating the setting of the main valve, temperature control of the iron has a range of 392°F to 932°F.

The Weller *Pyropen* is priced at $59.95.—**The Cooper Group,** P. O. Box 728, Apex, NC 27502.

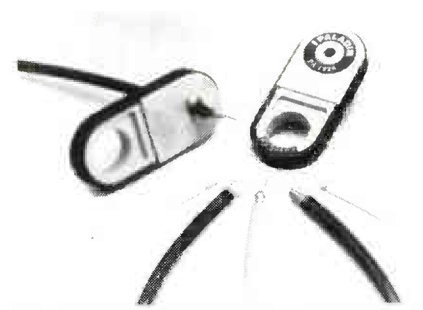
RF POWER METER. The model *4421* RF power meter, from Bird Electronic Corporation, is a programmable, microprocessor-based instrument that measures forward and reflected RF power, VSWR, and return loss in watts or dBm to 1 GHz and 1 kW. Its accuracy is plus or minus 3%-of-reading. There is also a *4020*-series remote sensor head based on Bird's "Thruline" principles for in-line unterminated measurement to 1 kW without the need for directional couplers or attenuators.

CIRCLE 21 ON FREE INFORMATION CARD

The model *4421* display unit features a backlit 3½-digit LCD display with annunciators for function and input trends; arrow indicators facilitate peak or null adjustments by showing at a glance whether a reading is increasing or decreasing. It also includes an audible alarm to warn of overloads in excess of 120% of the selected range.

The model *4421* is priced in the $2,000–$3,000 range, depending on accessories.—**Bird Electronic Corporation,** 30303 Aurora Road, Cleveland (Solon), OH 44139.

COAXIAL WIRE STRIPPER. Paladin Corporation's *Toggle* uses a new blade system whereby the field technician, service person, or in-



CIRCLE 22 ON FREE INFORMATION CARD

staller can quickly, accurately, and repeatedly strip braid and dielectric off coax cable in any number of strip configurations for any type of coax connectors.

Toggle is available in sizes suited for cables up to and including RG8/11. That includes the most popular cable groups of RG59, RA62AU, RG6, and 8281 video cable. Custom sizes can be accommodated upon request. *Toggle* is priced at $24.95 each.—**Paladin Corporation,** 3543 Old Conejo Road, Suite 102, Newbury Park, CA 91320. **R-E**

$75 DMM MEASURES CAPACITANCE, TRANSISTOR HFE, MORE...

B&K-PRECISION'S new 2905 is a more-than-full-f
3½ digit DMM, at a surprisingly low price. F
clude 0.5% VDC accuracy; 100 µV 0.1µA
tion. Measures capacitance to 20mF w
tion. Audible continuity and diode
For field survivability, it fea
verse polarity and ove
fusing. Contact: B
Street, Chicago, I
B&K-PRECISION
3½ digit DMM, at a
clude 0.5% VDC accu

RT Check out these features + prices. WOW! FL

B&K-PRECISION'S new 2905 is a more-than-full-feature 3½ digit DMM, at a surprisingly low price. Features include 0.5% VDC accuracy; 100 µV, 0.1µA, 0.1Ω, resolution. Measures capacitance to 20mF with up to 1pF resolution. Audible continuity and diode junction tests are built in. For field survivability, it features a drop resistant case, reverse polarity and overload protection and high-energy fusing. Contact: B&K-PRECISION, 6470 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.

FREQUENCY COUNTER AND DATA HOLD HIGHLIGHT NEW 4½ DIGIT DMM

For engineers in need of a high-accuracy 4½ digit DMM and a low range frequency counter the 2940 is made to order. DC voltage accuracy is 0.05%. Resolution is 10µV, 10nA, and 0.01Ω. Frequency measurements span from 20Hz to 200kHz with up to 1Hz resolution. The 2940 features a drop resistant case with full internal circuitry protection. $155.00 Contact: B&K-PRECISION, 6470 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.

HAND-HELD TEST BENCH READS VOLTAGE, RESISTANCE, CURRENT, HFE TEMPERATURE AND LOGIC.

The new 2906 3½ digit DMM from B&K-PRECISION is virtually a hand-held test bench, with a remarkable range of functions. °C and °F temperature measurements cover from −20C to 1000°C. The logic capability is ready for TTL and CMOS circuits. Other features include drop resistant case, reverse polarity and overload protection; plus high-energy fusing. DC accuracy, 0.25% VDC. $95.00 Contact: B&K-PRECISION, 6470 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.

TRUE RMS DMM OFFERS PEAK HOLD, CAPACITANCE, AND LOGIC

3½ digit true RMS handheld DMM featuring 0.1% DC accuracy. Housed in an ergonomic, drop-resistant case, the 2907 offers many functions and a low price. Resolution is 100µV, 0.1µA and 0.1Ω. Capacitance to 20µF with 1pF resolution. Peak hold feature freezes transient readings. Fully protected. Also checks logic, continuity and diodes. $190. Contact: B&K-PRECISION, 6470 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.

CIRCLE 77 ON FREE INFORMATION CARD

4½ DIGIT TRMS DMM READS FREQUENCY AND TEMPERATURE

The new 2945 is well suited for both the analog and digital worlds. DCV accuracy is 0.05%, with 10µV, 10nA, 0.01Ω resolution. Data hold freezes voltage and current readings. °C and °F temperature readings are from −20° to +1000°C; frequency from 20 Hz to 200kHz. AC voltage and current are read in true RMS. Also checks continuity and diodes. $250.00 Contact: B&K-PRECISION, 6470 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.

Radio-Electronics

Surround Sound Decoder

Add some excitement to your TV viewing! Our easy-to-build surround-sound decoder brings movie-theatre sound to your living room.

NORMAN M. HILL

AS STARFLEET COMMANDER, YOUR STARFIGHTER HAS the latest in weaponry. From above and behind you hear the dull *thwup-thwup* of the laser pom-poms as the ball-turret tracks the incoming enemy spacefighters, whose energy bolts *zing* past your ship into the void behind. From your ship's right and left energy pods the phasor cannons fire a staccato stream whose roar fades off into a darkness that can be seen only by your ship's time-transporter.

But turn off the sound effects and once more the indefatigable starfleet commander is just another viewer in a movie theater. Without the imagery created by multi-directional sound —what we call *surround-sound*—even the most thrilling sci-fi adventure flick is not much better than an "olde-tyme" silent movie.

Just try to imagine *Star Wars* or *Top Gun* without surround-sound: They would be deadly dull. In fact, the lack of video-movie surround-sound is what turns many of the great action movies into a dull night at home on TV.

Surround-sound brings scenes to life by wrapping you in a sound environment that's as good as being there. If the picture is a forest, you become surrounded by wind and wildlife. In auto chases, cars roar out of the back of the room and onto the screen. In crowd scenes, you actually sense yourself in the center of the crowd. Surround-sound creates such a sensation of being there, that once you hear it, you'll lose interest in video and movies without it.

This month, we'll show you how to build a low-cost surround decoder. Next time, we'll show you how to add even more excitement to your TV sound with a subwoofer simulator.

Concealed sounds

Every modern home video-movie now contains high-fidelity stereo tracks, which are output on the back panel of a modern VCR as left and right channels. When connected to a stereo system, they provide a *wide-screen* (semi-stereo) sound rather than the mono heard from a conventional TV or video monitor.

But *wide screen*, even genuine stereo, isn't surround-sound because it's still two-dimensional. The three-dimensional effect of surround-sound requires, at the very least, a rear channel, which might be provided by one or more additional sound tracks in the original theatrical release print; or, the rear sounds can be encoded within the stereo tracks. As far as home videos are concerned, there is only the stereo tracks, so the rear channel that creates the illusion of surround-sound is concealed by a special encoding within the left and right sound tracks. The encoded signals either blend into the front stereo channels or cancel each other; either way, they are not heard as distinct sounds when the sound you hear is played through a conventional stereo system.

It takes a special kind of decoder, such as our surround-sound decoder, to extract the rear sounds from the stereo signal, and it is the decoded rear sounds that cause the home viewer to be enveloped by a surround-sound that is very similar to what is heard in a movie theater.

Broadcast movies

What happens if the movie is broadcast by a TV station? The same thing, but only if the station is broadcasting MTS stereo. If you decode the MTS stereo signal you will again derive the rear audio channel. If you record the TV signal on a VCR, you can either decode the station's MTS stereo, or have the VCR do the stereo decoding (if it is so equipped).

Dolby

Surround-sound is brought to you by Dolby Laboratories, the same people that developed Dolby tape-noise reduction. A form of Dolby noise reduction is part of their surround-sound record/play system, and Dolby owns the rights to the surround-sound technique. Our decoder however does not include Dolby noise reduction yet it still produces good results.

How it began

The early 1970's saw the development of a patented technique of encoding four channels into two stereo tracks. When decoded, the stereo signal produced four distinct outputs. By adjusting the phasing and relative levels of the signals blended into the stereo tracks, it was possible, by using the speaker placement shown in Fig. 1, to create the illusion of sound coming from the front, the sides, or the rear. Effectively, the sound could be located anywhere within a 360° field.

The technique was later modified so that a conventional stereo-front/stereo-rear speaker placement could be used; that is, left and right speakers in front of the listener and left and right speakers behind the listener. Unfortunately, the stereo-type technique eliminated wide stereo separation. In fact, left-to-right and front-to-rear separation was often reduced to as little as 3 dB. Since 3 dB is the *minimum* change in *program material* that can be sensed by the human ear, electronic enhancement of 4-channel sound was necessary in order to create the spectacular effects expected by the listener. Basically, it was done by electronic gain-riding. A monitor circuit determined which sound position (location) was dominant and adjusted the gain of the various channels so that the listener would perceive a stronger signal at that position. As a general rule, the electronic enhancement added 3 dB to the already existing 3-dB separation. The total of 6-dB separation was sufficient to trick the brain into believing it was sensing a precise sound location.

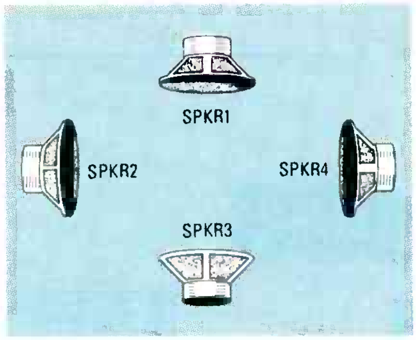


FIG. 1—THE EARLIEST OF MULTI-DIRECTIONAL sound systems used this unusual speaker arrangement, which foreclosed true stereo listening.

For various reasons, among them being the extra cost of the rear amplifiers and speakers, and the eventual deployment of several kinds of encode/decode circuits, 4-channel sound, usually referred to as *quadraphonic* or *quadriphonic* sound, met with little success in the marketplace. But it did establish that a multi-directional sound could be encoded within conventional stereo tracks.

About that time, the movie industry was searching for a blockbuster technology that would bring in more patrons; something more attractive than just another form of wide-screen projection. The blockbuster was to be Dolby Stereo.

Dolby Stereo

The Dolby Stereo system was introduced for movie theaters in 1975. Under that system, 35-mm film carries two stereo tracks, and uses quadraphonic weighting to encode/decode the stereo signal into four outputs.

However, the need in a theater is not for 360° quadraphonic coverage. A theater needs only a single rear track to generate spectacular effects. There is no need for side sound because the primary sound placement is almost always on the screen, which is in front of the viewer. The needed speaker arrangement is shown in Fig. 2.

Unfortunately, that's far from a complete solution because the limited 3-dB channel separation of movie surround-sound is a real problem for all but the good seats at the center. Seats close to the rear will be swamped by the 3-dB leakage from front left and front right. Up front, better separation is also desired so that audio sources track with the image on screen.

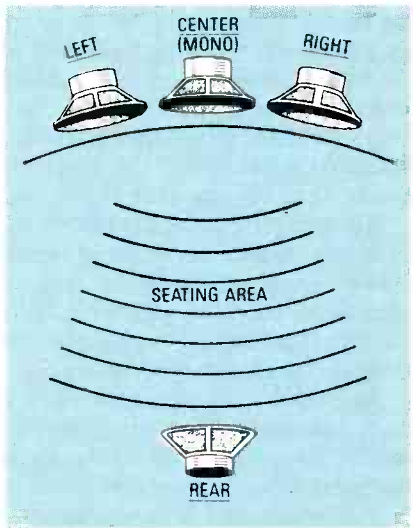


FIG. 2—THIS IS THE SPEAKER ARRANGEMENT for movie-theater surround-sound. Notice that a center speaker provides direct mono, rather than a mono image that's derived from left and right speakers.

For those reasons, the quadraphonic concept of gain-control positioning of the dominant audio direction was incorporated into Dolby Stereo, and the smashing 1977 success of the Dolby-Stereo encoded *Star Wars* entrenched the system as the industry standard.

The gain-control circuitry is a serious complication, necessary to make all the seats in the house good ones. Home decoders loaded with such circuitry, such as the Shure *HTS5000* are available for around $750. Units that incorporate gain control are identified by the *Dolby Surround Pro Logic* logo.

The Dolby home decoder

In 1981, Dolby Labs acknowledged a need for a low-cost, no-gain-control decoder for home video and recommended an appropriate circuit. Decoders without gain-control carry the *Dolby Surround* logo.

Those lower-cost units are available from various licensed manufacturers for $200-$400, and to carry the *Dolby Surround* logo they must process audio according to the block diagram shown in Fig. 3.

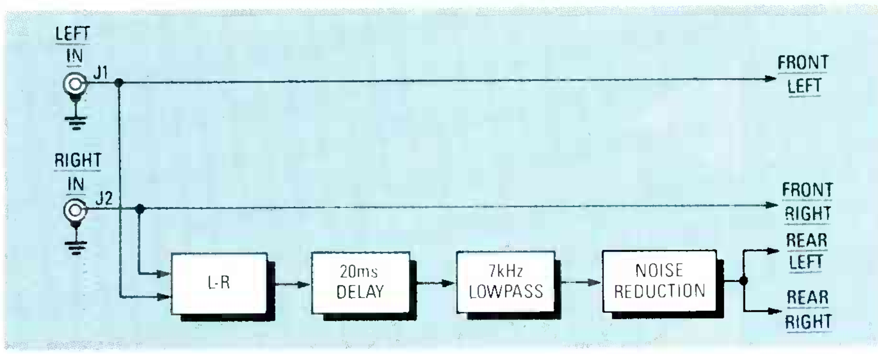


FIG. 3—DOLBY'S RECOMMENDED HOME DECODER includes a 20-ms delay and a noise-reduction system.

Dolby's decoder.

All processing is performed on the (L – R) difference signal, which is concealed within the left and right stereo tracks. While only a single rear-channel is decoded, it is intended that two speakers will be positioned at the rear of the room, hence, the rear output is shown as REAR LEFT and REAR RIGHT, even though they both carry the same signal. Two traditional stereo speakers provide the front sound.

As shown in Fig. 3, Dolby restricts the rear channel's high-end frequency response to 7 kHz. When the standard was being developed, the high-frequency coherence between the two channels of home-video equipment wasn't consistent. Directional placement could become random if high-frequency phase-coherence were to be lost on a wide-band signal; for example, an actor's voice might be reproduced with the lower frequencies from the front and the sibilants from the rear. However, the likelihood of that happening depends on the equipment used for recording and playback. While some tapes sound better with a rear filter, many tapes and the equipment they are played on have cohered high-frequency phase performance, and they sound better—at least more natural—without the filter. If you're finicky about sound quality, the 7-kHz cut-off should be switch selectable so that you can enjoy the best in sound when the tape and equipment make it possible.

Notice that Fig. 3 indicates a 20-ms time delay. The delay serves two purposes. First, since 20 ms represents the time it takes the sound to travel about 20 feet, it allows the rear speakers to be positioned close to the seating, yet the sound appears to originate from farther back, more closely simulating theater sound, where the rear speakers are located considerably behind the viewer. The time delay also proves useful when there is accidental leakage of the front-left or front-right sound to the rear. Since the 20-ms delay causes the sound to arrive after the front sound, it reinforces the perception that the sound is up front.

Fortunately, the positioning of home rear speakers can usually be juggled so that the delay isn't really necessary, which simplifies construction of a home decoder, reduces its cost, and also eliminates the noise and distortion that might be caused by a delay unit.

Noise reduction

In the Dolby system shown in Fig. 3, the rear-channel information is supposed to be encoded with a noise-reduction that is similar to the *Dolby B* processor used for cassette recorders. Listening tests and inspection of a frequency/gain table indicate that we could probably do without it as far as surround-sound is concerned, so we left it out of the prototype.

Note, in particular, that Fig. 3 does not show signal processing to the front speakers: Differential signals driving the rear speakers pass to the front unchecked. If we add some of each front channel to the other, we attenuate to the leakage of the rear signals while reducing the front stereo separation. The reduction in separation is desirable because it helps viewers in off-center seats hear a stereo spread without resorting to a center channel. (Note the center mono speaker used in the movie system shown in Fig. 2.)

WHICH IS WHICH?

The type of circuits used in a home *Dolby Surround* decoder is identified by the kind of *Dolby* logo used. If the decoder contains both 20-ms time delay and noise reduction circuits it is called a *PRO LOGIC* model and has this logo shown.

DOLBY SURROUND
PRO · LOGIC

If the decoder is the less expensive design that does not contain time delay and noise reduction circuits, it is identified by this Dolby logo.

DOLBY SURROUND

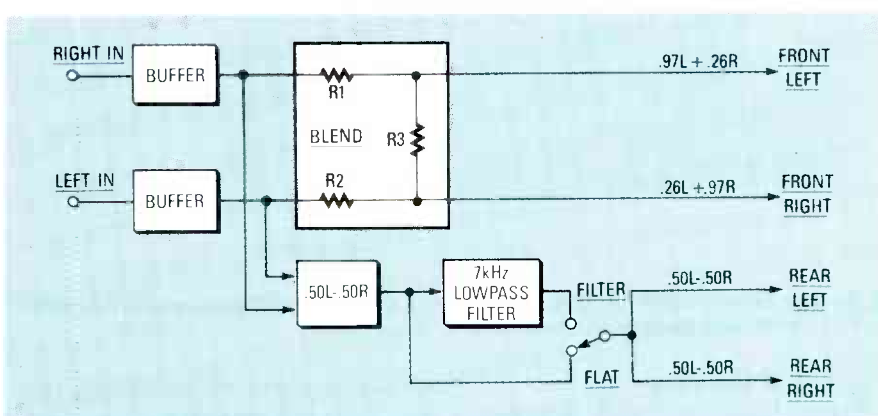


FIG. 4—OUR SURROUND-SOUND DECODER ELIMINATES both the time delay and the noise reduction, which doesn't seem to degrade how the three-dimensional effect sounds in the home.

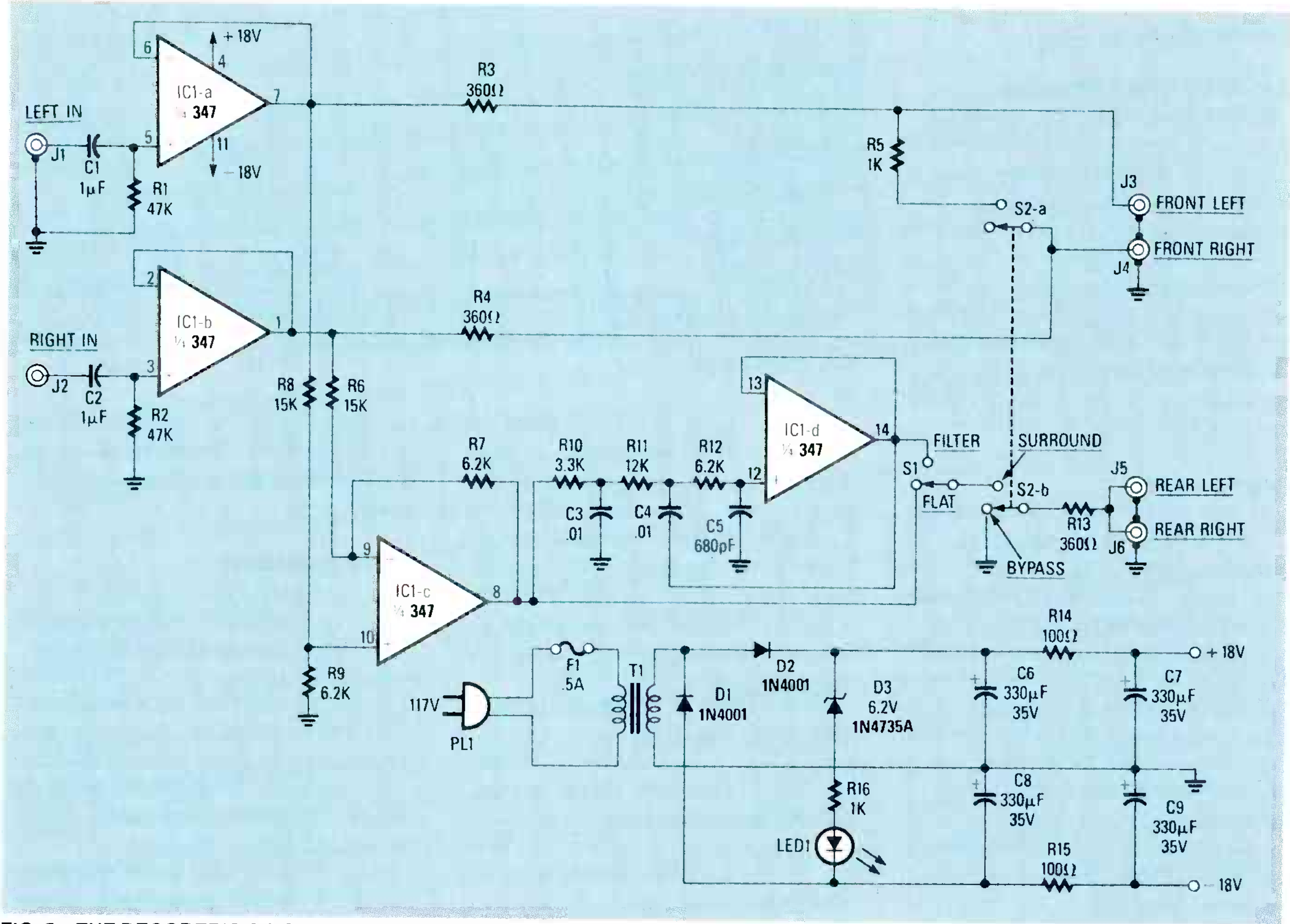


FIG. 5—THE DECODER'S CIRCUIT. Virtually nothing is critical because R3 and R4 isolate the buffer amplifiers from the capacitance of the shielded cables connected to J3 and J4.

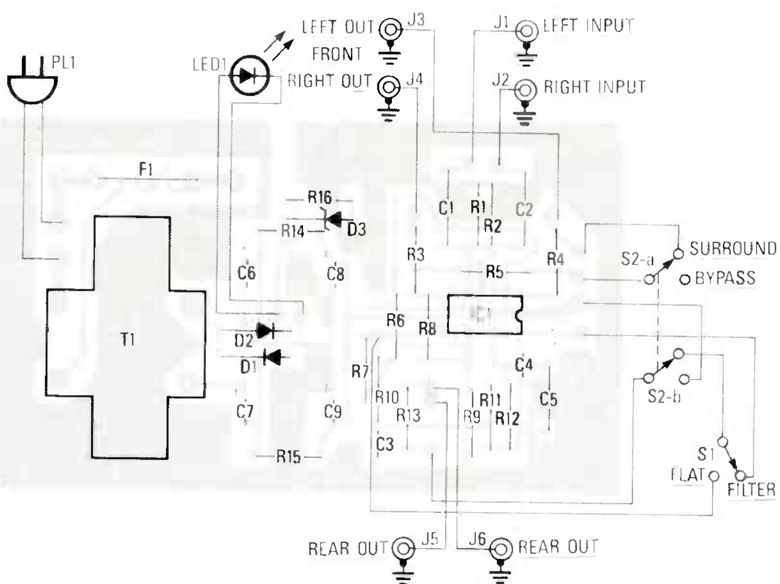


FIG. 6—THE COMPONENT LAYOUT for the printed circuit board. Double-check the polarity of all diodes and electrolytic capacitors.

A surround decoder

Figure 4 shows the block diagram for our surround-sound decoder. It consists of input buffers, a front blender, a rear difference decoder, and a switchable low-pass filter. The rear levels are such that, if all four speakers are identical, and the driving amps have identical gain, the system would be balanced for proper level with no need for level adjustments. In practice, however, the rear speakers are different and the level is adjusted on the rear amplifier.

If any one speaker sounds at full volume, the other two sound half as loud (-6 dB), ¼-power. A separation of 6 dB is a lot better than the 3-dB separation of a four-channel system, and such a decoder is easier to build than a "true" Dolby type, yet it sounds as good or better when it is fed from a Dolby surround-sound signal source.

Notice that the system actually puts out only three sound channels (the rear-right and rear-left are the same); it does not use a 20-ms delay, nor noise reduction, and although it lacks any form of gain control, the separation between channels is maximized.

In a typical home environment, the front speakers should just about flank the screen, because we want the sound to appear to originate up front, at the screen, just as it does in a theater. The rear speakers should be located behind and flanking the seating location of the viewer.

PARTS LIST

All resistors are 1/4-watt, 5%.
R1, R2—47,000 ohms
R3, R4, R13—360 ohms
R5, R16—1000 ohms
R6, R8—15,000 ohms
R7, R9, R12—6200 ohms
R10—3300 ohms
R11—12,000 ohms
R14, R15—100 ohms

Capacitors
C1, C2—1 μF, 100 volts, polyester
C3, C4—.01 μF, 50 volts, polyester
C5—680 pF, polyester
C6–C9—330 μF, 35 volts, electrolytic

Semiconductors
IC1—LF347N, quad op-amp
D1, D2—1N4001 silicon rectifier
D3—1N4735A, Zener, 6.2 volts
LED1—Light-emitting diode

Other components
F1—Fuse, slo-blo, 0.5 ampere
J1–J6—Phono jack
PL1—Power plug
S1—SPDT switch
S2—DPDT switch
T1—Power transformer: 120-volt primary; 12.6-volt, 300-mA secondary

Miscellaneous: Printed-circuit materials, fuse clips, enclosure, etc.

Note. The *Kwik-Kal* tape is available for $16 VHS, $19 BETA, plus $2 shipping and handling from Zero Ohm Enterprises, 15214 NE 8th, Suite G-10, Bellevue, WA 98007. WA residents must add appropriate sales tax.

An etched and drilled circuit board is available for $10.25 postpaid from Fen-Tek, P.O. Box 5012, Babylon, NY 11707-0012. NY residents must add appropriate sales tax.

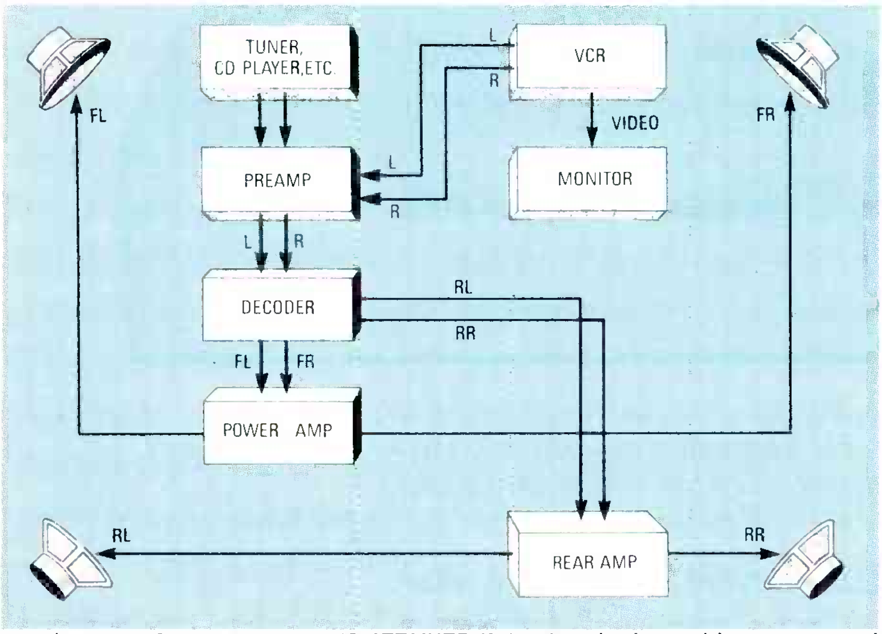


FIG. 7—THE MOST FLEXIBILITY IS ATTAINED if the decoder is used in a component system. This kind of arrangement also allows tuner and CD-player signals to be decoded.

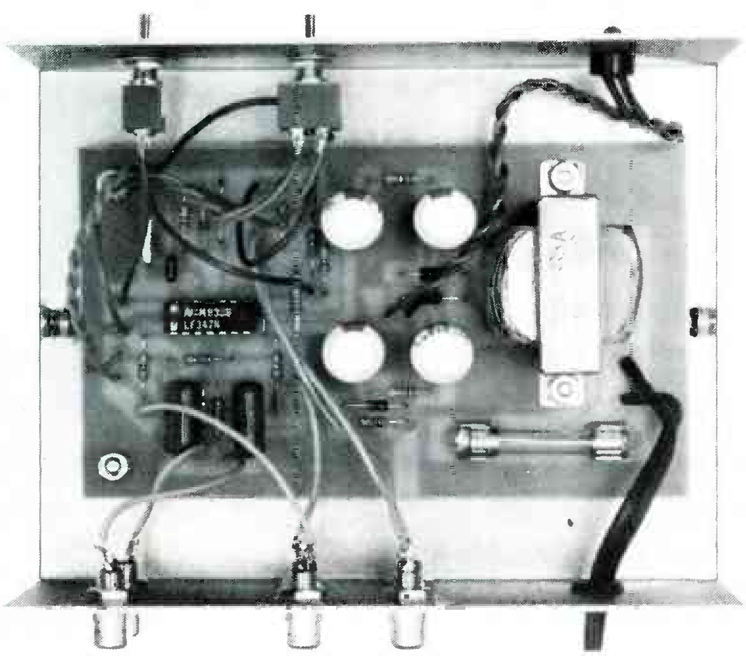


FIG. 8—THE PROTOTYPE USES PHONO JACKS for all input and output connections. Grouping them on the rear apron allows the decoder to be easily connected into any kind of component arrangement.

The circuit

The complete circuit is shown in Fig. 5. Components R1, R2, C1, C2, IC1-a, and IC1-b buffer the left and right channels at unity gain over the audio band. The front channel blending described earlier is attained when switch S2-a connects R5 across R3 and R4. When S2 is set to the BYPASS mode, R3 and R4 isolate IC1-a and IC1-b from the capacitance of the shielded cables that are connected to J3 and J4.

Resistors R6–R9, and integrated circuit IC1-c, make the L − R difference signal the correct level if all speaker/amplifiers are equal. Resistors R10–R12, along with capacitors C3–C5, and amplifier IC1-d, form a 3-pole Chebychev 7-kHz active filter. When the filter is selected, R13 isolates the capacitive cable loading from IC1-d.

The power supply is not regulated because precise voltage values are not critical. Diode D3 is used to slow the power-off loss of the positive-voltage output, reducing "turn-off" pops.

Our prototype decoder is assembled on a printed-circuit board; the template for the board is provided in PC service. There are no unusual assembly considerations other than insuring that there is isolation between T1's ground lead and C6–C8 (there should be only one power-supply ground, as shown). Also, ceramic capacitors should not be used because their tolerance varies with temperature and the applied voltage, thereby possibly creating distortion. Polyester capacitors are recommended.

The PC-board's component layout is shown in Fig. 6. Nothing is unusual or critical as long as the polarity of all diodes and electrolytic capacitors is

continued on page 54

WIRELESS STEREO LINK

This great little stereo FM transmitter lets you listen to whatever you want, whenever you want, wherever you want.

WILLIAM SHEETS and RUDOLF F. GRAF

Part 2 LAST TIME WE showed you how to build the wireless link. Now it's time to get it up and running.

After you are sure that everything is okay, connect your chosen power supply to the B+ connection on the PC board. Now, you must quickly make the following voltage checks using a VTVM or FET VOM having a 10-megohm input.

- IC4 pin 8: 12 volts
- IC1 pins 1 & 7: 5–7 volts
- IC4 pins 1 & 7: 5–7 volts
- IC2 pin 16: 11 volts
- IC3 pin 12: 8–10 volts
- IC3 pin 8: 4–6 volts
- IC3 pin 4: 3–4 volts
- IC3 pin 5: 0.5–1.5 volts
- Q1 collector: 8–9 volts
- Q1 emitter: 1.5–3 volts
- Q2 collector: 6–10 volts
- Q3 collector: 8–9 volts
- Q3 emitter: 1.5–3 volts
- Q4 emitter: 1.5–2.5 volts
- Junction of R54 & D2: 6–9 volts if using a VTVM or a FET VOM; or 3–9 volts if using 20 kilohm/volt VOM.

If all those voltages are present, and nothing is hot to the touch, everything is probably okay.

For the next tests, use a steady tone of approximately 1,000 Hz. Suitable sources for that are an audio oscillator, a recording made from an on-air tone, such as a TV-test pattern, or a test-LP record.

The following procedures must be carried out. Do not go on to the next step until the previous one is satisfactorily completed.

1—Connect a 1-kHz audio signal of about 0.5 volt p-p, to J1. Set R7, R9, R3, and R10 to their mid-positions, and set R31 to its minimum position. Connect a scope or the audio-level meter (shown in Fig. 8) or some other indicating device to the junction of C4 and R7, and note the audio level. It should be nearly equal to the input. Then connect the audio signal to J2. The level should be equal to that obtained when the left input was used. If not, adjust R3 until the both inputs yield *exactly* the same level, which should occur near the middle of the adjustment range of R3.

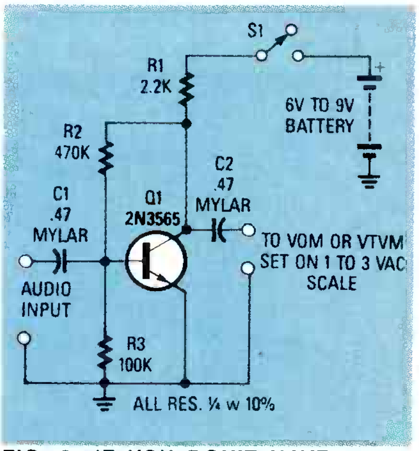


FIG. 8—IF YOU DON'T HAVE an oscilloscope, this amplifier circuit will provide sufficient gain to detect millivolt-level audio signals on a high-impedance VTVM or FET-VOM.

2—Connect the scope or audio-level

meter to the junction of C5 and R9, and connect the audio signal to the J1 (left) input. The output level should be approximately the same as the input level. Now connect the audio signal to the right channel, and the output-level should still be about equal to the input. Connect a jumper between the left and right inputs so that the audio-signal is on both inputs. The output should now drop to zero or nearly zero. Adjust R10 for lowest output: ideally zero. If you have any problems, check the IC1 audio-matrixing circuit.

3—Connect a frequency counter to the collector of Q2 and adjust L1 for a reading of 76.000 kHz. If you don't have access to a frequency counter you can use an AM radio tuned to a station at 760 kHz. If you have trouble doing that, try it at night when more stations can be heard. Otherwise, you need an accurate signal generator. Run a wire from the collector of Q2 to the antenna of the receiver, or simply lay the wire near the radio. Now adjust L1 so that a whistle is heard on the radio, and then adjust L1 for lowest audio tone (pitch). Now tune the radio to a station at 1140 kHz, and that station should also be experiencing the audio interference. Rock the slug of L1 back and forth slightly to verify that. If not, go back to 760 kHz and readjust L1.

4—Adjust R31 at halfway and connect the scope or audio-level meter to the junction of R31 and C19. Adjust the slug of L3 for a maximum output (19 kHz). That should occur with the slug well into the coil. If you must back out the slug almost all the way, you are probably not tuned to 19 kHz but to 57 kHz (the 3rd harmonic). Check your wiring, and C17 and C18. Return R31 to its minimum setting after this step.

5—Connect the scope or audio-level meter to the junction of C26 and R50. Set R35 temporarily all the way to either side. The audio input should be zero. Set R9 to minimum and adjust L2 for maximum output; then *very slowly* adjust R35 for a null. That should occur somewhere near midpoint and should be deep and definite. If there's no null, check IC3 and its associated components.

6—Reset R9 to midpoint and apply the audio signal to the left and right inputs. You should get an indication on the scope of a signal at the junction of R50 and C26. If the left and right inputs are connected together, and audio is simultaneously applied, no output should be obtained. Adjust R35 again if necessary and then return R9 to zero.

7—Set R7 to about ⅓ of maximum, set R9 to about ¼ maximum, set R31 about halfway, and set R64 to about ⅓ maximum. Then, tune a stereo FM receiver to an unused channel near 88 MHz, and set it for mono. Connect a stereo-audio source to the left and right inputs of the transmitter. Turn C32 until the FM receiver picks up the program fed into the transmitter's inputs. A 12" wire can be connected to the junction of C40 and C41 to serve as an antenna. If the program is not heard, check the setting of R64, the Q3 and Q4 circuitry, and that L4 and L5 are correctly made.

8—Adjust R64 until the volume on the FM receiver is about the same as when a commercial FM station is tuned in. Switch the FM receiver to stereo. Adjust R31, the pilot-level pot, until the receiver's stereo indicator lights, and then advance it about 50% further. If there's no stereo light, check to see if the Q1 stage is producing 76 kHz, and then try readjusting R31. You should now hear stereo-audio on the receiver.

9—Adjust R9 for the best stereo separation, and then adjust L3 for the best separation. If you used a scope, little adjustment will be required. If you did not use a scope, adjust R9, L3, R7, and R3 a little bit at a time. It takes some patience, but it's not too difficult. A pair of stereo headphones and a tone on one channel at a time is a great help.

10—Adjust L5 so that the signal-strength meter on your FM receiver is at a maximum. This step is not critical, and if your receiver does not have a signal-strength indicator, forget this step unless the range of your transmitter is inadequate.

The alignment is now complete. You can mount the transmitter board and its power supply in any suitable cabinet, such as shown in Fig. 9. All you have to add is a power switch, and an LED and a 1K resistor for a pilot light. **R-E**

ORDERING INFORMATION

The following items are available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, NY 10804: PC board and all components that mount on it including all resistors, capacitors, semiconductors, L1–L3, cores and wire for L4 and L5 (LED and 1K resistor, power-supply components, cabinet, on/off switch, and phono jacks NOT included) $57.50 + $2.50 S/H. PC board only $14.00 + $2.50 S/H. NY residents must include sales tax.

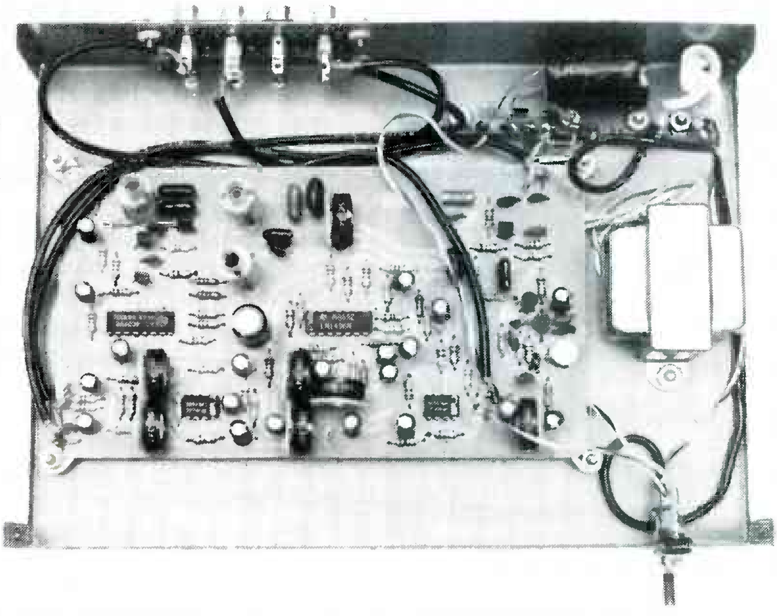


FIG. 9—YOU CAN MOUNT your transmitter in a cabinet similar to this one.

Build REACTS:

THE RADIO-ELECTRONICS ADVANCED CONTROL SYSTEM

This month we get to work and build the CPU module.

H. EDWARD ROBERTS, M.D.

Part 3 LAST TIME we looked at the theory behind the REACTS CPU module. Now, its time to put our theory to practice and build the CPU module.

Construction

Construction is straightforward. The PC board, which is shown in PC Service, is double-sided; a plated-through board with silk screen and solder mask applied is available from the supplier listed in the Sources box.

Components are mounted on the board following the parts-placement diagram shown in Fig. 1. Figure 2 is a photograph of the author's prototype. Although there are some minor differences, your finished board will closely resemble that one.

Note that, as shown in Fig. 2, we used sockets for all IC's; despite the fact that only IC16, the EPROM disk, strictly requires the use of a socket, we strongly recommend that you too use them for all IC's.

Care should be taken in handling the CMOS parts since they are very sensitive to static-discharge damage. Grounding the workbench and soldering iron is highly desirable, especially if you don't use sockets. Placing the IC's, PC board, and tools on a single sheet of grounded aluminum foil will prevent static damage to any components.

You should be careful when installing the Molex connectors (SO3 and SO4). The connector comes in two pieces, one with pins and one without pins. To install the connector, the piece with the pins is mounted flush with the top (component) side of the board and the pins are soldered on the bottom of the board. When soldering the connector to the board, use a minimum amount of solder and make sure no solder bridges occur. Furthermore, don't "drag" solder up the pins. That's because those pins must slide down over the other half of the connector, and any excess solder could damage the friction fit. The connectors are designed to be assembled once only; it is a bad idea to push the two halves together and then to pull them apart. But if assembled following the preceding recommendations, they are extremely reliable and durable, and may be plugged and unplugged into other connectors literally hundreds of times.

Note, however, that when separating modules **it is important that the connectors be carefully pulled apart by pure vertical force. Prying the boards apart may cause serious damage to the connectors.** The connectors are the most expensive single item on the board, and they are time consuming to remove and replace if damaged. That doesn't mean that they are fragile, but with careless handling they can be broken.

Other than the connectors, installation of all other parts is straightforward, although care should be taken to be sure that all polarized components (IC's, diodes, electrolytic capacitors, etc.) are installed correctly. After all components are installed, a careful inspection for proper compo-

Sources

The following items are available from DataBlocks, Inc., 579 Snowhill Road, Glenwood, GA 30428. Or call (800) 652-1336; in Georgia call (912) 568-7101: DP-CPU—design package of schematics and instructions, $10.00; PC-CPU—PC board for CPU module (includes DP-CPU design package,$37.00; PC-CLK—PC Board for clock, $18.00; SYS-PROM—the REACTS operating system (enhanced SB-80) installed on a 32K UV-erasable PROM (includes operating system documentation), $44.00; REC-CPU—complete kit of parts, PC boards, IC's, connectors, for CPU module (does not include clock or system PROM), $147.00; REC-CLK—complete clock subsystem including all parts, PC boards, NiCd battery, and connectors, $43.00; and REC-SYS—All of the above, $218.00. An Elpac power supply is also available for $49.00. Please add $10.00 postage and handling per order. GA residents must add appropriate sales tax.

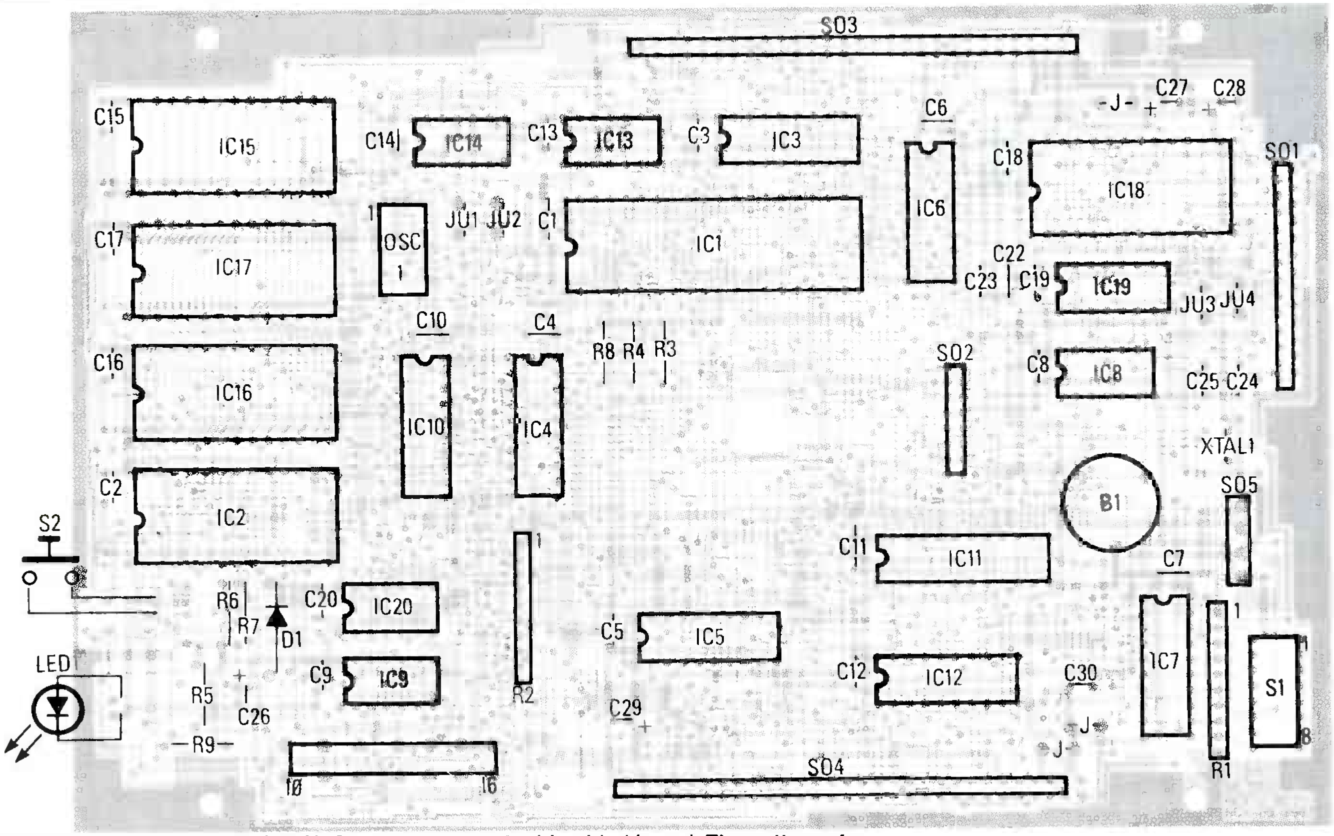


FIG. 1—ALL OF THE COMPONENTS mount on one double-sided board. The patterns for the board can be found in PC Service.

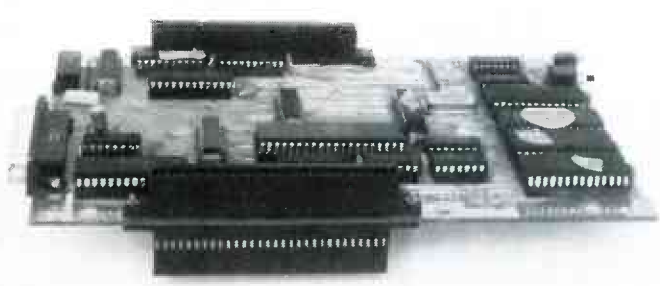


FIG. 2—THE COMPLETED AUTHOR'S PROTOTYPE. While the prototype differs slightly from the project described in the article, your board and this one will appear similar

nent location should be made. Also, the board should be carefully searched for solder bridges or other construction defects; a magnifying glass will be useful for that.

The operating system

REACTS uses an enhanced version of Lifeboat Associates SP-80. SP-80 was designed to be an improved version of CP/M. We have added enhancements to the package in order to produce the REACTS DOS. If you are familiar with CP/M, MS-DOS, or SB-80, you will feel right at home with the operating system. REACTS DOS is available on a PROM from the vendor listed in the Sources box elsewhere in this article. Once the CPU module is assembled, that PROM is installed, a terminal is connected via the serial port, and power is applied, the CPU is ready for checkout and use.

Checkout

Power can be applied to the CPU via the power jack (SO5) using an Elpac power supply (available from the source listed in the Sources box found elsewhere in this article). Other supplies can also be used, as long as they provide the appropriate voltages and currents and are well regulated and current limited. The Elco power supply produces +5 volts DC at 860 mA, +12 volts DC at 300 mA, and −12 volts DC at 300 mA.

The checkout itself is actually quite simple. Just connect a standard terminal to the serial port and apply power to the system after setting switch S1 as shown in Fig. 3. If everything is working correctly, in less than a second (about 250 milliseconds to be more exact) you will see the opening screen. If that happens, you are ready to use your system to control the world!

TABLE 1

Parameter	Setting
EMULATION	QVT101C
PARITY	OFF
DATA BITS	8
STOP BIT	1
BIT8	0
FDX/HDX (Full or Half Duplex)	FDX
CHAR/LINE/BLCK	CHAR
ON LINE/LOCAL	ON LINE
BAUD RATE	9600

Adding a terminal

Before we wrap up, let's spend a couple of moments discussing exactly

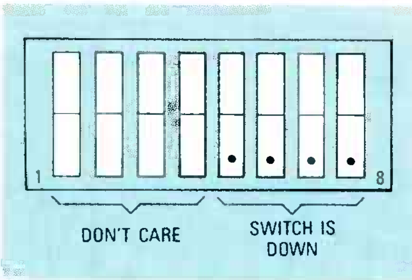


FIG. 3—SET THE EIGHT DIP SWITCHES of S1 as shown here. The settings of the don't-care switches will not affect the checkout.

what we mean by a "standard terminal." Over the past decade computer terminals have gotten "smarter" and at the same time less expensive. For example, a quality "dumb" terminal sells in single quantities for less than $400. Ten years ago, a terminal with less capability would have sold for 4 to 5 times that price.

While developing the REACTS system, we have made extensive use of both the Qume 101 and the ADDS VPT/A2 terminal. Also, we have tested a number of different terminals and all operate in a satisfactory manner.

Another alternative is to purchase a used terminal. At the present time there are a number of used terminals on the market (e.g. ADM-7, etc.) that can be purchased for next to nothing. Be sure that any terminal you consider is compatible with a standard RS-232 interface before buying. In addition, it is probably a good idea not to purchase any used terminal if its technical manual is not available.

The settings we use on the Qume 101 terminal are shown in Table 1. They will give you a starting place even if you use a different machine.

In addition, the REACTS system allows you to use two other devices for the terminal. One is to use an IBM PC or compatible as a terminal. If you have a computer and a modem, the software needed to convert your PC into a terminal is available on the RE-BBS (516-293-2283, 8 data bits, no parity, 1 stop bit). It is also available on disk from the supplier mentioned in the Sources box for $18.00 plus postage. That disk also includes a routine that allows you to use your hard or floppy disk as a storage device for the REACTS system.

Finally, you can choose to build your own terminal. The last alternative has several advantages; we will go into those in detail and provide construction plans for the REACTS

PARTS LIST

All resistors ¼-watt, 5%, unless otherwise noted
R1, R2—10,000 ohms, 9-into-1 resistor network, SIP package
R3–R6, R8—10,000 ohms
R7—10 ohms
R9—470 ohms
Capacitors
C1–C20, C22, C23—0.47 µF, 25 volts, ceramic disc
C21—not used
C24, C25—22 pF, 25 volts, ceramic disc
C26—10 µF, 16 volts, electrolytic
C27, C28—47 µF, 16 volts, electrolytic
C29—47 µF, 10 volts, electrolytic
C30—6–36 µF, trimmer
Semiconductors
IC1—Z80 microprocessor
IC2—82C59 programmable interrupt controller
IC3–IC7—74HC245 octal three-state transciever
IC8—74HC02 quad 2-input NOR gate
IC9, IC20—74HC14 hex inverting Schmitt trigger
IC10, IC12—16L8 custom PAL, see text
IC11—EP600 custom PAL, see text
IC13, IC14—74HC73 dual JK flip-flop with clear
IC15, IC17—55257 32K static RAM
IC16—27C256 32K UV-erasable EPROM
IC18—82C52 programmable UART
IC19—MC145406 RS-232 driver/receiver
D1—1N914 switching diode
LED1—Red LED, right-angle PC mount
Other components
OSC1—8-MHz crystal oscillator
XTAL1—2.4576-MHz crystal
B1—3.6-volt rechargeable NiCd battery (Panasonic MMB 3.6C)
S1—8-position DIP switch
S2—SPDT, momentary pushbutton switch
SO1—25-pin female connector, DB-25 type
SO2—16-pin double-row header, PC mount
SO3, SO4—60-pin male/female feedthrough bus connector assembly (Molex 70090/70088), see text
SO5—4-pin jack
Miscellaneous: PC board, extruded aluminum case (see Part 1), IC sockets, hardware, wire, solder, etc.

terminal in a future installment. Note that the REACTS terminal also features a parallel printer port.

Next, we will show you how to build a battery back-up system. **R-E**

SURROUND SOUND

continued from page 49

correct. Note that there is no power switch between power plug PL1 and T1's primary winding. That was done because the power to the prototype is switched with the rest of the system to avoid turn-on pops.

Setting up

Figure 7 shows how the surround-sound decoder can be set-up in a component video-sound system. Notice that by having the decoder connected between the preamplifier and the power amplifier it can also be used to decode signals that originate in a conventional tuner, a CD player, or whatever. Also note the use of left-rear and right-rear speaker signals even though the left and right decoder outputs, as previously discussed, are the same. Obviously, your particular video-audio system will be different, but Fig. 7 will give you a good idea of the various ways in which signal sources and amplifiers can be combined with the surround-sound decoder. As shown in Fig. 8, all of the decoder's inputs and outputs are made through phono jacks that match the conventional phono-plug patch cords that are used for all home video-sound connections.

If your system doesn't use components, and the stereo outputs of your your VCR or TV normally drive an integrated amplifier or a receiver, simply connect the decoder between the VCR or TV and the amplifier's or receiver's AUX or VIDEO-SOUND inputs.

If all four speakers were identical, and if their driving amplifiers had identical gain, and if the front and rear speakers were equidistant from the viewer, no level balancing or adjustment would be necessary. But that's a lot of ifs. More than likely, you'll spend some time fiddling with the amplifier controls. A better way to calibrate Hi-Fi surround-sound system is to use a 7-minute video calibration tape called *Kwik-Kal: A Seven Minute Surround Test*, which features on-screen indication of speaker placement, the channel being encoded, and its weighting. The tape is available in the Beta and VHS formats and contains a Hi-Fi track. (See Parts List.) Once the system is optimized by using the tape, there's no need to fiddle with any adjustments. Simply sit back, relax, and enjoy the show. **R-E**

TV Derived Frequency Standard

LUTHER M. STROUD, CET

You can use almost any TV as an accurate frequency reference.

REGARDLESS OF THE KIND OF MEASUREment being made, you must always consider the accuracy or tolerance of the tool you're using. Sometimes, overall accuracy isn't important because all that's needed is an approximation of a circuit's voltage, current, frequency, or whatever. But in most cases, simply using an approximation isn't good enough when the technology becomes more complex; in thoseinstances, a more precise degree of accuracy is necessary. The general rule regarding measurement-accuracy is for the test equipment to be at least ten times more accurate than the parameter being measured.

Measurement standards, to which all other standards of measurement are compared, are set for the United States by the *N*ational *B*ureau of *S*tandards (NBS), a branch of the U.S. Department of Commerce. Calibrated measurement devices having documented proof of being compared to the primary standards at NBS are referred to as *secondary standards*. (A system of secondary standards have been worked out world-wide for use by anyone who has a need for such accuracy.)

NBS distributes time and frequency reference standards through a radio system known as WWV, which operates on numerous shortwave frequencies. The system allows your time and frequency standards to be calibrated by comparison to the WWV signals, a somewhat painstaking process. A simpler and more convenient way for the hobbyist and professional to calibrate time and frequency measurement devices, with greater accuracy than most applications require, is by using a television-derived frequency standard.

Color-TV precision

When television broadcasting converted to color, in order to ensure uniformity of color reproduction throughout the broadcast system, the three major networks agreed to carefully control the accuracy of the color-subcarrier frequency. The subcarrier frequency of 3579545.454 Hz (3.58 MHz) is derived from a precision 5-MHz oscillator controlled by a rubidium atomic-standard that is directly traceable to NBS. Since the synchronization pulses for locking the TV receiver's sweep circuits are derived from the 3.58-MHz color subcarrier, the TV's horizontal-sync (H-sync) pulses are directly traceable to NBS when viewing a network-originated broadcast. It is the NBS-referenced H-sync pulse that is used by the television-derived frequency standard to provide more useful reference frequencies for the electronic hobbyists and professional.

How it works

The television-derived frequency standard has three primary functions. First, the 3.58-MHz subcarrier is re-created by frequency-multiplying the H-sync pulse picked up by the standard's antenna (which is a resonant circuit tuned to 3.58 MHz that is placed near a TV set). Second, a submultiple of the 3.58-MHz signal is used to tune and hold a phase-locked oscillator precisely on 1-MHz. Third, the 1-MHz signal is step-divided in 10:1 steps to provide the user with output signals down to 1 Hz.

The schematic is shown in Fig. 1. Ferrite-rod antenna L1 is tuned by C2 to parallel resonance near the TV horizontal-sweep frequency of 15734.265 kHz. The voltage induced in the antenna is amplified by IC11-d —a logic-inverter that is biased for linear operation. It's output triggers IC1, a 555 timer operating as a monostable oscillator having a time delay (set by R1 and C1) of about 90 microseconds. The timer triggers on every other H-sync pulse, creating a 50% duty-cycle square-wave output of one-half the H-sync rate, or 7867.1325 Hz. That signal is applied to one input (pin 14) of phase detector IC5.

Meanwhile, IC2-a functions as a crystal-controlled oscillator whose output frequency can be "rubbered" (changed slightly) by capacitor C10

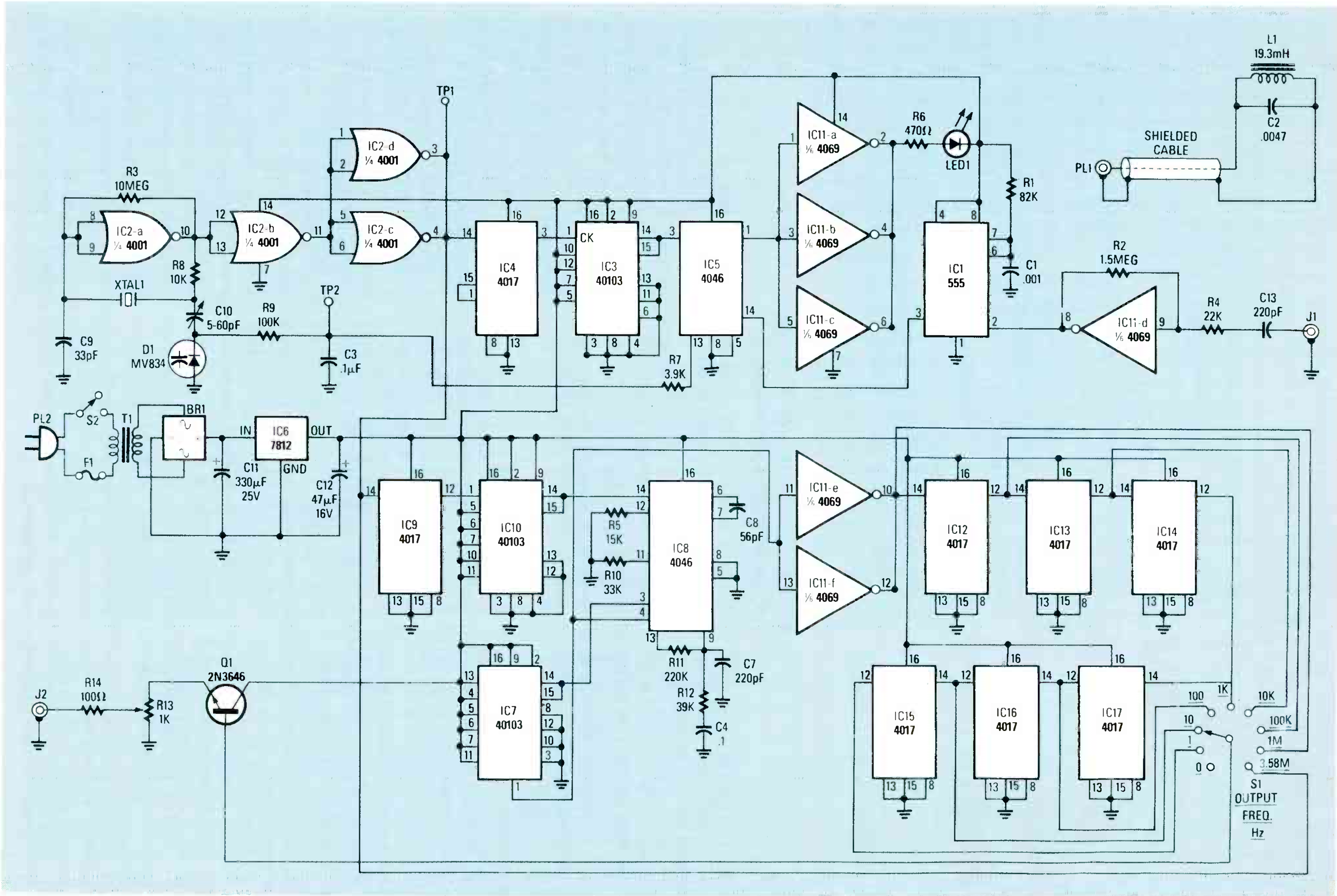


FIG. 1—ALL FOUR SECTIONS OF IC2 are used for the crystal oscillator, while three parallel-connected sections of IC11 are used as the LED driver

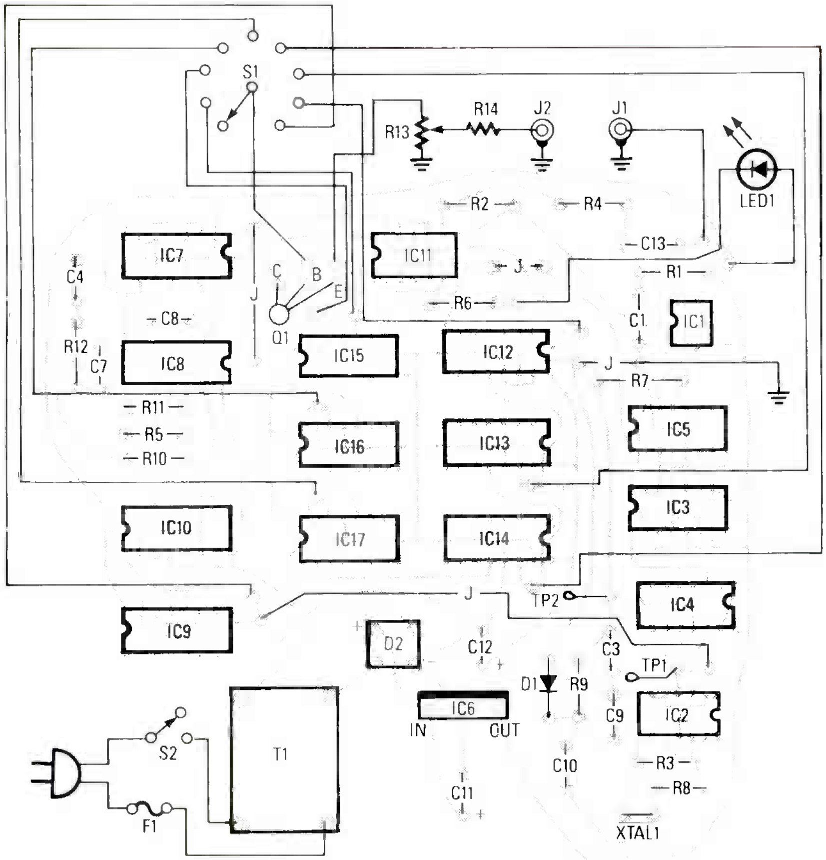


FIG. 2—TAKE EXTRA CARE THAT VARACTOR DIODE D1 is installed with the correct polarity, and double-check the connections to output selector switch S1 before applying power to the circuit.

and varactor diode D1; thus, the crystal-controlled oscillator becomes voltage-tunable. Capacitor C10 adjusts the crystal close to the correct operating frequency, while the capacitance determined by the voltage applied to D1 through R9 determines the oscillator's precise output frequency.

The remaining sections of IC2 are used as buffers to prevent loading the crystal. The output of the buffers, at test point TP1, is divided by IC4 ($\div 5$) and IC3 ($\div 91$) to 7867.1325 Hz, which is applied to the other input (pin 3) of phase detector IC5. The output voltage at IC5 pin 13 varies between zero and 12 volts, depending on the phase difference between the input signals on pins 3 and 14. The voltage at pin 13 is filtered by R7 and C3 and is used to correct the 3.58-MHz oscillator for a zero phase difference at pins 3 and 14. IC5's output voltage (pin 1) is inverted and buffered by three paralleled sections of IC11, which drive lock-indicator LED1.

Something useful

So far, we have multiplied one-half of the horizontal-sweep frequency by 455 to the color sub-carrier frequency of 3579545.454 Hz. Now let's see how we take such an odd frequency and convert it to something that is more useful.

A common sub-multiple of both 3.5 MHz and 1 MHz is used for phase comparison to lock IC8 to exactly 1.000 MHz. The 3.58-MHz reference signal is divided by IC9 ($\div 10$) and IC10 ($\div 63$) to 5681.818 Hz. The frequency of 1 MHz divided by 176 is also 5681.818 Hz, so IC7 is connected as a divide-by-176 counter in the feedback path of IC8, a phase-locked loop oscillator. IC8's free-running VCO frequency is set near 1 MHz by C8 and R5. Resistor R10 creates an offset so that the VCO is restricted to 1 MHz ± 100 kHz. Restricting the operating range in that manner minimizes the jitter in the output signal caused by system noise when the device is in phaselock.

The output at IC8 pin 13 is a voltage proportional to the difference in the frequency applied to pins 3 and 14. That voltage is filtered by R11, R12, C4, and C7 and is used as the VCO's control voltage input at pin 9. The voltage at pin 9 tunes the VCO frequency until the signals applied to pins 3 and 14 are equal or phase-locked. At phase-lock the VCO's output is a stable, high-accuracy square wave wave of 1.0000 MHz. To review, we have divided 3.58 MHz by 630 and then multiplied the result (5681.818 Hz) by 176 to yield 1.0000 MHz. The original accuracy of the color subcarrier (3.58 MHz) is transferred to the 1-MHz signal.

A series of decade counters, IC12–IC17, divide the 1-MHz signal in decade steps to 1 Hz. Switch S1 selects the desired output frequency signal and feeds it to emitter-follower Q1, whose output level is determined by potentiometer R13. Resistor R14 ensures that the minimum output impedance will be 100 ohms.

Getting it together

While the device can be assembled on perforated wiring board if you're careful to keep lead lengths short, the best method is to use a printed-circuit board. A suitable pattern is shown in PC Service; alternately, the PC board can be ordered from the source given in the Parts List.

The PC board's parts-placement diagram is shown in Fig. 2. Begin stuffing the board by first installing the four jumpers, then the resistors and capacitors—taking particular care that the polarity of the electrolytic capacitors is correct. Next, install XTAL1, using a drop of silicone-rubber adhesive to cement the crystal to the PC board to prevent damage.

Finally, install the IC's, but take note that not all are oriented in the same direction; double-check the location of pin 1 when installing all IC's on the board. And just to be on the safe side, we suggest testing the power-supply section (including IC6) before installing the IC's.

Clean the board with a solvent wash to remove the soldering flux, and then check the board closely for solder bridges, especiallly where the traces pass between the IC pins.

The main circuit can be housed in a metal or plastic cabinet, and just about any kind of layout can be used for the components that are not mounted on the PC board. Figure 3 shows the author's protoype.

The antenna

Antenna-coil L1 should be 19.3 millihenries ±20%. The coil used for

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1—82,000 ohms
R2—1.5 megohm
R3—10 megohms
R4—22,000 ohms
R5—15,000 ohms
R6—470 ohms
R7—3900 ohms
R8—10,000 ohms
R9—100,000 ohms
R10—33,000 ohms
R11—220,000 ohms
R12—39,000 ohms
R13—1000-ohm potentiometer
R14—100 ohms

Capacitors
C1—0.001 µF, 50 volts, ceramic disk or Mylar
C2—0.0047 µF, 50 volts, Mylar
C3,C4—0.1 µF, 50 volts, ceramic disk or monolithic axial
C5,C6—not used
C7, C13—220 pF, 50 volts, ceramic disk or monolithic axial
C8—56 pF, 50 volts, ceramic disk
C9—33 pF, ceramic disk
C10—5–60 pF, trimmer
C11—330 µF, 35 volts, electrolytic
C12—47 µF, 16 volts, electrolytic

Semiconductors
IC1—NE555 timer
IC2—CD4001B quad NOR gate
IC3, IC7, IC10—CD40103B divide by N counter
IC4, IC9, IC12-IC17—CD4017B decade counter
IC5, IC8—CD4046B phase-lock loop
IC6—7812 12-volt regultor
IC11—CD4069B hex inverter
Q1—2N3646 NPN transistor
D1—MV834 varactor diode
D2—Bridge rectifier, 50 volt, 1 amp
LED1—light-emitting diode

Other components
F1—¼-amp fuse and holder
J1—phono jack
J2—BNC jack
L1—19.3 mH, see text
PL1—Phono plug
PL2—Power plug
S1—10-position non-shorting rotary switch
S2—SPST toggle switch
T1—12-volt PC-mounting power transformer
XTAl1—3.58-MHz, type HC-18 color-burst crystal
Miscellaneous: PC board, 70-feet No. 30 enameled wire, ⅜- × 4-inch ferrite rod, enclosure.

Note. The following are available from Pershing Technical Services, P.O. Box 1951, Fort Worth, TX 76101: A drilled and plated-printed circuit board for $20.00. A kit of all board-mounted parts and the printed-circuit board for $65.00. The board is also available assembled, tested, and calibrated for $95.00. Prices are postpaid in the U.S. Allow from 4 to 6 weeks for delivery. Texas residents must add appropriate sales tax.

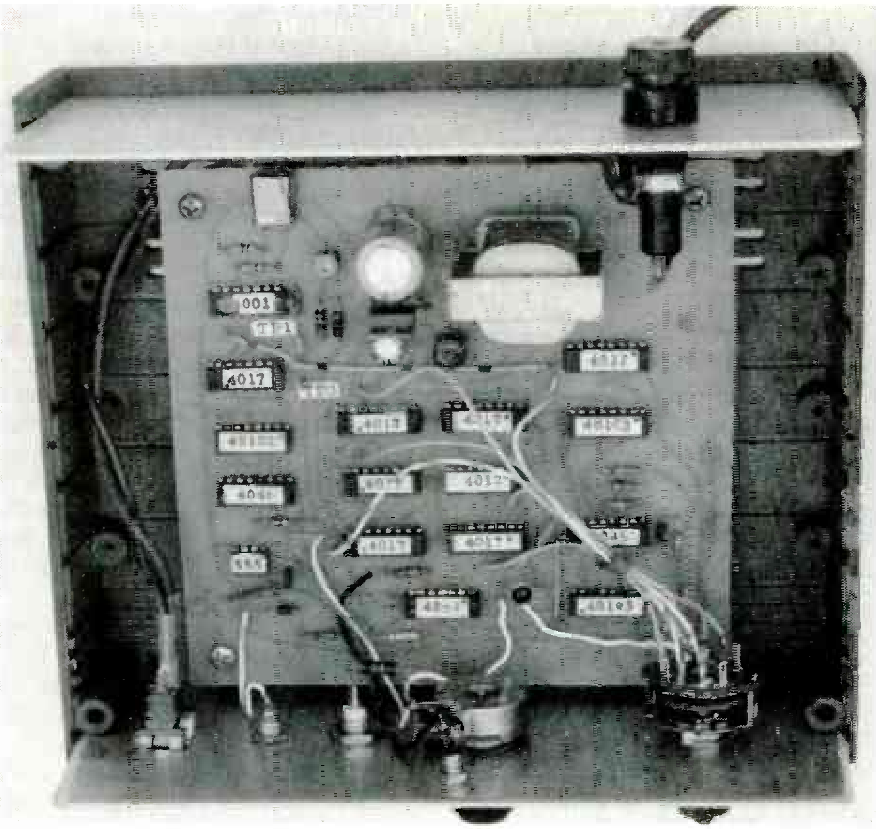


FIG. 3—ANY KIND OF CABINET can be used for the main circuit. Even the layout of the cabinet-mounted components isn't critical. If you wish to use a PC board, the pattern is shown in PC Service.

the prototype is made from 70-feet of No. 30 magnet wire wound on a ⅜- × 4-inch ferrite rod salvaged from a discarded AM radio. (Because reception of the 15,734 Hz pulse from a TV set requires a rather large inductance having many turns of wire, rather than counting turns we are specifying the length of the wire to be wound on the ferrite core.)

The winding is spread evenly along the length of the rod to within ½-inch of either end. (The rod can be inserted in a variable-speed drill because it yields a coil much neater and faster than hand winding.) Secure the wire with tape when finished, but leave three inches free for connection to a length of shielded cable. Tin both free ends and solder C2 and the shielded cable in parallel with the leads. Secure the shielded cable to the coil with tape and set the assembly aside.

The antenna assembly is shown in Fig. 4. The enclosure for the antenna is made from a 5-inch length of ½-in. I.D. plastic water pipe and two end caps. Drill a hole slightly larger than the shielded cable in one of the plastic caps and pass the shielded cable through the hole. Install an RCA-type phono plug on the free end of the cable. Then install a rubber grommet on each end of the ferrite rod and slide the antenna assembly into the plastic pipe. Do not cement the caps in place, just slide them on the pipe.

Connect the antenna to the main circuit via J1.

Adjustment

Place the antenna near an operating TV set and adjust C10 with a plastic

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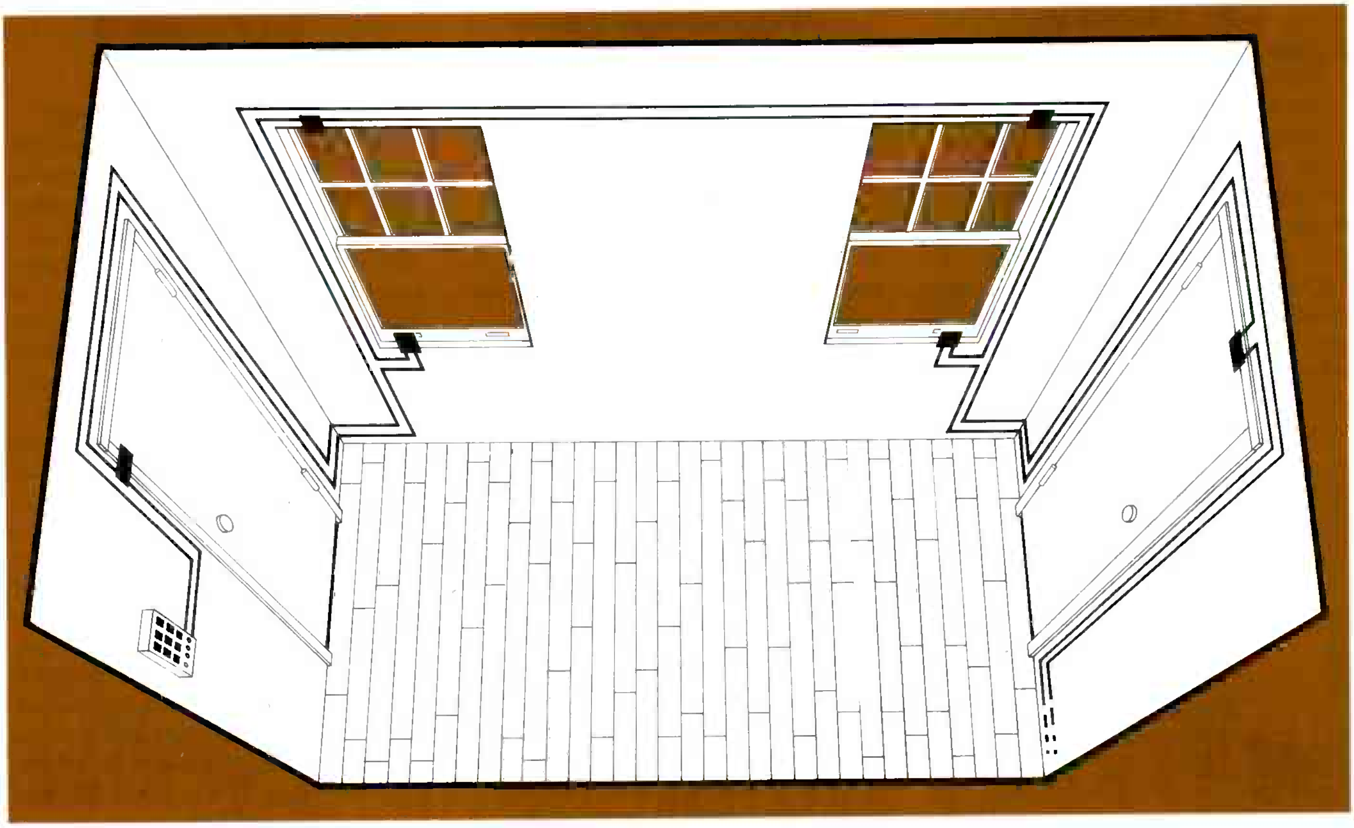

ELECTRONIC SECURITY SYSTEMS

Seize the advantage from would-be burglars with an electronic security system.

ALAN GLASSER

ACCORDING TO THE MOST RECENT REPORT released by the Federal Bureau of Investigation, one out of every four households will be burglarized over a ten year period with your odds of being burglarized increasing to one out of two in a thirty year period. It is no longer a question of *whether* you will become a victim of crime, but only a matter of *when*!

Worse, according to the Director of the National Crime Prevention Institute, residential break-ins have reached a point where traditional law-enforcement methods cannot contain the problem. Since there are not enough police officers to control crime, a self-help approach to protecting your home is required.

Electronic security systems

Probably the first burglar alarm ever developed was by Ugh the caveman, who used a large rock propped up by a trip-stick. When an intruder entered Ugh's cave, he would inadvertently activate the trip-stick and be struck on the head with the rock. Upon hearing the racket, Ugh would awaken and finish off the intruder with his club.

Not too many improvements in Ugh's system took place until the late 1800's (although many civilizations used animals, or geese, to sound an "alarm" if strangers approached). In 1853, Augustus R. Pope patented the first electromechanical alarm. It consisted of electromagnetic contacts, which were mounted on doors and windows and wired to a battery and a bell. It met with minor success in the Boston area. In 1858, Pope sold the patent to Edwin Holmes.

Holmes, a true pioneer in the alarm industry, opened a business for selling alarm systems in New York City. By 1872, Holmes opened *central-station* offices in New York City and Boston to monitor alarms from a remote location. (By the way, the Boston location was to become the first telephone exchange in the country.) In 1882, Chauncy McCulloh was awarded a patent for a method of alarm transmission still in use today, known as the *McCulloh loop*. It is interesting to note that the electromechanical burglar alarm was invented in 1853, prior to the invention of the telephone (1876) and the electric light (1879).

Alarm-system basics

All electronic security systems consist of three basic parts: the *control panel* (the brains), the *detection devices* (the eyes, ears, nose and sense of touch), and the means to notify a third party (the voice). Pope's patent consisted of detection devices (electromagnetic contacts), third-party notification (the bell), and the control (a battery housed in a box, along with a switch to turn it on and off), as shown in Fig. 1. Follow along as we explain how all the parts work to form a modern electronic security system.

As we said, an electronic security system needs eyes, ears, a nose and a sense of touch. All of those functions are accomplished by the use of different sensors or detectors designed for a specialized application. The first "sensor" ever used was a simple switch. It was used in a basic circuit that you learned about in grade-school science class: a battery, in series with a normally open switch (doorbell button), and a doorbell as

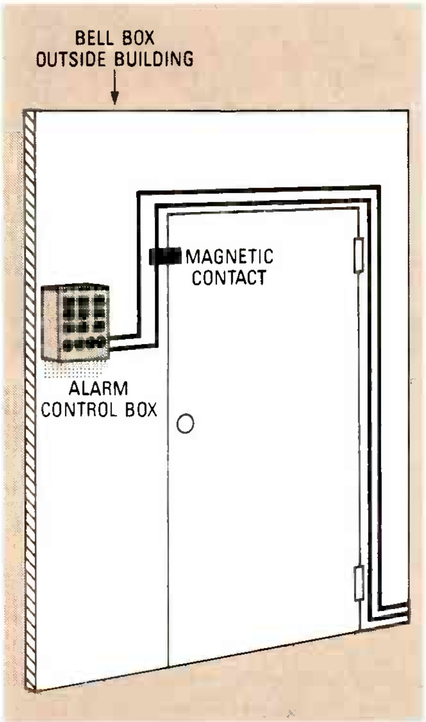

FIG. 1—A SECURITY SYSTEM consists of a detection device (electromagnetic switch), a control box, and an alarm to alert others.

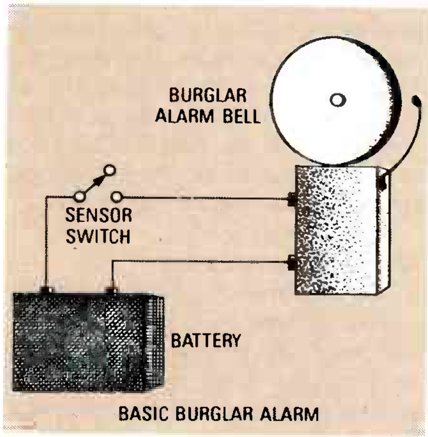

FIG. 2—THE FIRST SENSOR was a normally open switch. Putting that switch in a science-class doorbell circuit yields a basic burglar alarm.

shown in Fig. 2. In your science class you pressed on the switch and the bell rang. In an alarm circuit, the closed window or door presses on a normally closed switch, holding it open. If it were a normally open switch, the bell would ring all the time that the window or door was closed and pressing on the switch—not very effective. By using a normally closed switch, the bell rings only when the pressure is taken off the switch (allowing the switch contacts to close). Of course, a complete burglar-alarm system would contain the circuitry to keep the bell ringing even if the window or door were closed again.

But switches alone are not enough, so alarm-equipment manufacturers have developed literally hundreds of alarm switches to meet virtually every application imaginable.

Other sensors

Did you ever put a bucket of water over a door and attach a string to the door knob? When someone came into the room, they were greeted by a rude surprise! Sounds almost like Ugh's alarm. What would happen if you attached a very fine string to an alarm-system switch and stretched the string across the room at just about knee height? No bucket of water, but your alarm system would ring when someone tripped on the string and triggered the pull trap!

Now, what would happen if we were able to put the string under the carpet so that no one could see it? Just a little impractical. So how about developing a long flat switch? Such a switch is called a *mat switch*. Step on it and the alarm will sound.

A *vibration detector* is a variation of the basic switch. It works on the principle that the vibrations set up when an intruder is breaking through a wall, roof, or plate glass window will activate the switch. The switch contains a heavy weight (relative to its size) that cause the switch to bounce open and closed each time a vibration is sensed.

Another type of sensor is a *glass breakage detector*. Did you ever notice the silver stripe on the edge of the plate glass on most store-front windows and doors? That's part of the alarm system. Although that stuff is commonly called foil, it's actually extremely thin lead tape that carries a small amount of electrical current supplied by the burglar-alarm system. The foil is applied in a special manner that causes it to break with the slightest crack in the glass. When the foil breaks, the alarm sounds.

Electronic intrusion detectors

The *photoelectric beam* was the earliest electronic intrusion detector. The earliest version used an incandescent visible-light beam aimed at a photocell across the room. Interruption of the continuous beam by an intruder triggered the alarm. The only trouble was that at night the beam shined like a flashlight and actually helped to light the intruder's path.

Adding an infrared lens to filter out visible light took care of that problem. Other improvements to the photoelectric beam were the addition of pulse modulation to the beam to prevent circumvention by a different light source, and the use of solid-state electronics such as LED's and integrated circuits, which contributed to the miniaturization of the equipment. Modern photoelectric beams can span a length varying from across a three-foot doorway to across a warehouse of up to a thousand feet.

Ultrasonic motion detectors

Next in the development of electronic detectors was the *ultrasonic motion detector*. That was the first truly electronic motion detector, incorporating tubes, power supplies, piezoelectric elements used as transducers, and a host of other electronic components. The ultrasonic motion detector was also the first detector to use the *Doppler effect*. The Doppler effect is the change in received frequency of a vibration (ultrasonic energy between 19 to 30 kHz in this case) caused by any motion of an object within the energy field. In sound, the effect is most readily recognized as the change in pitch of a train whistle or in an automobile's roar as it approaches, passes in front of, and then travels away from you. In an ultrasonic motion detector, the Doppler effect occurs when the ultrasonic energy is reflected off a moving object, such as a moving person.

Most ultrasonic motion detectors are transceivers: the transmitter and the receiver are located in the same housing. The received frequency is compared to the transmitted frequency. If both are the same, then there is no motion and no alarm. If the received frequency is different (due to

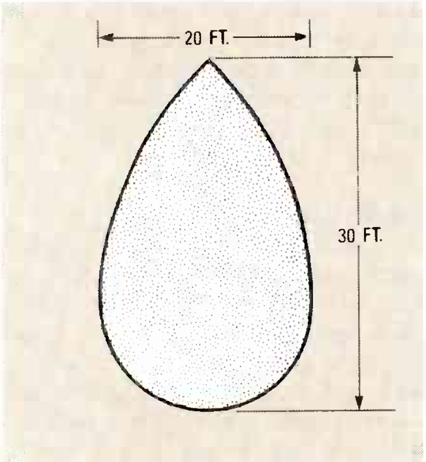

FIG. 3—COMMON ULTRASONIC DETECTORS have a teardrop shaped coverage pattern. That pattern can be altered for special applications.

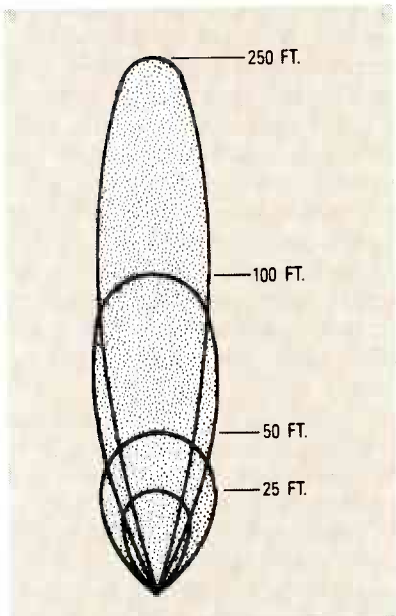

FIG. 4—MICROWAVE MOTION DETECTORS are available with many different coverage ranges.

the Doppler effect), then the unit will go into the alarm condition. Special filters and logic circuits are built into the ultrasonic motion detectors to allow them to respond only to human-sized objects moving within a certain speed range peculiar to, and indicative of, human motion.

The most common detection pattern of an ultrasonic motion detector is teardrop in shape and covers an area approximately 30 feet by 20 feet, as shown in Fig. 3. Patterns and distances can vary due to the protection needs. Since ultrasonic energy cannot penetrate solid objects such as walls, doors, or glass, their detection pattern is confined to the enclosed area in which they operate.

Microwave motion detectors

Microwave motion detectors are much like ultrasonic motion detectors in that they use the Doppler-effect principle. However, microwave motion detectors use microwave energy around 10.5 GHz while ultrasonic motion detectors use ultrasonic energy in the 19- to 30-kHz range.

Unlike an ultrasonic motion detector, a microwave motion detector's microwave energy can penetrate walls, doors, glass and almost any non-metallic substance. Therefore, a microwave motion detector can detect outside its enclosed area. The advantage is that the detection pattern (which is much the same as that of an ultrasonic motion detector) can extend beyond the enclosed area, such as to a second room or even outside the building into a parking lot. The disadvantage is that the detection pattern may extend out even when you don't want it to. Preplanning and careful placement of microwave motion detectors is a must. Microwave motion detectors are available with short- to long-range detection patterns, as shown in Fig. 4.

Passive IR motion detectors

The passive infrared motion detector is one of the newest of all of the detection devices. It is based on the fact that all objects having a temperature above absolute zero emit infrared radiation. Infrared radiation is also a form of electromagnetic radiation and it falls just below the visible light spectrum.

Just as your eye can see visible light and your brain can then detect a moving object, a passive infrared motion detector can "see" radiated infrared energy by use of a highly specialized pyroelectric sensor and a segmented lens arrangement. In addition, its electronic "brain" can detect movement by comparing the background radiated infrared energy to the moving person's radiated infrared energy. It can then activate a relay.

The passive infrared motion detector is different from the photo beam, ultrasonic motion detector, and the microwave motion detector in that it does not emit any energy in order to do its job. A typical passive IR motion detector is shown in Fig. 5.

Dual-technology detectors

The dual-technology motion detector uses a hybrid motion-detection

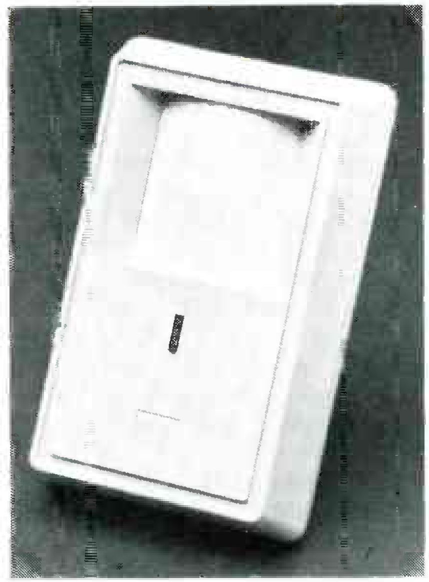

FIG. 5—A PASSIVE INFRARED DETECTOR does its job without emitting energy.

FIG. 6—THIS DUAL-TECHNOLOGY DETECTOR combines passive-infrared and microwave sensors. Other technology combinations can also be used.

system that incorporates two different motion-detection technologies in one unit. For example, the dual-technology motion detector shown in Fig. 6 has passive infrared detection capabilities (radiated infrared energy) and microwave detection capabilities (Doppler effect). Another acceptable combination is passive infrared and ultrasonic. The reasoning behind the dual technology is that both technologies must sense the presence of the intruder before the unit will go into the alarm condition, thereby eliminating many of the false alarms due to background and/or environmental disturbances.

Detecting intrusion sounds

The *audio switch* or *sound discriminator* is an electronic device that responds to the sounds that are associated with an intrusion. Those sounds can range from infrasonic (which is below the range of human hearing) to ultrasonic (which is above the range of human hearing).

Infrasonic-sound detection takes place between 0.5 hertz and 2.0 hertz and is based on the principle that when an abrupt intrusion is made—such as the opening of a door, a window, or by any kind of forced entry through a wall, floor, window, or ceiling—infrasound waves are generated. Those waves are generated primarily in two ways.

First, when an abrupt opening is made, the difference between the outside environment and the inside environment of a tightly enclosed area creates a pressure wave. As that low-frequency pressure wave propagates, it reflects off various surfaces and is detected by the infrasonic detector. Second, the acceleration of a hinged door or window surface in or out starts a low-frequency wave in motion toward the infrasonic detector.

Mid-range-sound detection takes place when the actual sounds of an intrusion taking place (the same sounds that you and I can hear, i.e. pounding on surfaces, splintering wood, breaking glass, etc.) are "heard" by the detector's microphone, which then activates a relay. Ultrasonic-sound detection is mainly used to detect breaking glass. The vibrations of glass breaking or splintering fall high within the ultrasonic range. Those detectors are designed to detect only those frequencies associated with breaking glass.

But detection devices can't function on their own. They need something to which to report, something that can serve as the brains of the system and make the decision to sound an alarm.

The control panel

Now that we know how to detect the intruder, we need some way to turn the system on and off and to notify a third party that an intrusion is taking place. The control panel fulfills that function.

All control panels consist of an on/off switch, a power source (battery), and a latching relay that keeps the bell ringing even after the detection device has reset. Within the last ten years, security equipment manufacturers have developed modern micro-

FIG. 7—A MODERN, SOPHISTICATED control panel allows the user to zone the protection. It also allows the user to arm and disarm the system using a digital control.

processor-based control panels that provide a variety of enhancements. They allow the user to arm and disarm the security system by entering a "secret" digital code through a numeric key pad similar to the kind found on a telephone. See Fig. 7. Some control panels allow for multiple users to have different levels of security through different user codes. Most control panels will allow the "zoning" of the security system, whereby the user can turn on or off different areas of protection or different detection devices as the need arises. Zoning also allows the pinpointing of where an intrusion is taking place so the police department can be sent directly to the point of entry.

While most control panels require wires to be run between the detection devices and the panel, there are some control panels that establish the link through low-power radio-frequency transmitters. Those wireless control panels allow a system to be installed with a minimum of wires being run throughout the premises and make it easier for systems to be installed in areas where wire can't be run.

All control panels have one thing in common, however. They all will notify a third party that an intrusion has taken place. However, how that notification takes place differs from system to system. Most people are familiar with the sound of the burglar-alarm bell that is used in many commercial as well as residential security systems. Now, the electronic siren is gaining in the popularity race. Many of them can be programmed for different sounds and one manufacturer even has one that has a prerecorded, voice-synthesized message!

An intruder is sure to run when either a bell or siren is activated by the security system. However, there are times when a silent alarm system is preferable or even necessary, or when a third party such as the police department or a responsible party *must* be notified.

Off-premises monitoring

A properly designed home burglar-alarm system will feature a distinct alarm signal (be it bell or siren), both inside and outside the premises. That alerts the occupants and the neighbors, and warns the intruder that an alarm has been set off. Those audible alarm signals, along with window stickers that make it clear that your home or business is protected, will deter a high percentage of break-ins.

A higher degree of protection can be achieved with an alarm system that causes the police to be notified by a central-station alarm-monitoring service. That can be particularly important if you are away from home, such as while on vacation, or when the alarm has been tripped by a fire. Many insurance companies recognize the extra protection provided by off-premises monitoring, and offer larger discounts on homeowner or business insurance, some as high as 20% annually, where such systems are installed.

A central station is a place where alarm-signal transmissions (transmitted in various ways) are received so a third party can be notified of a burglary or other emergency condition. See Fig. 8. Besides central stations, alarm signals can be transmitted directly to police departments or directly to the owners or other concerned parties.

There are a number of methods used to transmit an alarm signal from the protected premises to the receiving party. We'll start with the oldest and work our way to the most recent.

In the late 1800's, cotton-covered wire was run over roof tops from the protected premises to the central station. As the central station gained more customers, burglar-alarm poles (remember, the burglar alarm was invented before the telephone) were used to get the wires from one place to another. The use of wires running directly from the protected premises to the central station was known as a *direct-wire* circuit. Those direct-wire circuits are still in use today but now use the telephone company's existing telephone poles or underground conduits and existing wiring. Unlike the

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FIG. 8—A MODERN COMPUTERIZED central station. Information from a tripped alarm system is displayed on a CRT and help is sent within moments.

direct-wire circuits of the 1800's, today's direct-wire circuits are protected against tampering and circumvention by very elaborate electronic encoding processes, some unbeatable by even the most sophisticated computer.

A variation of the direct-wire circuit is the *McCulloh* loop, which we mentioned earlier; that circuit can best be described as a party line. Another arrangement is the *multiplex* circuit, where highly sophisticated digitally-encoded signals allow many customers to be serviced using one telephone line.

The important thing to remember is that all of those circuits make use of a dedicated pair of telephone-company wires leased for the sole purpose of alarm transmission. In the mid 1960's, an electro-mechanical device was developed that used the telephone company's existing switched telephone network. That device was known as the *tape dialer*. It consisted of a tape-playback mechanism and associated electronic circuitry that, when activated, would electronically dial a telephone number and play a voice-recorded message indicating that a burglary or some other emergency was taking place. Some modern versions of the tape dialer are completely solid-state, voice-synthesized, units. Some of those units allow for remote confirmation of the received message.

By the early 1970's, a new device was developed to take advantage of the switched-telephone network and thereby alleviate the high cost of leased, dedicated, telephone lines. The *digital-alarm communicator* revolutionized the central-station alarm business. Digital-alarm communicators are sophisticated dedicated microcomputers that, when activated, use a built-in modem to conduct complex two-way communications with a remote central station. Within seconds, the information can be displayed on a CRT and help sent.

The newest development in alarm transmission uses the switched-telephone network. Spread-spectrum transmission is used, permitting the overlay of alarm and data signals onto already existing telephone-subscriber services. A supervisory signal is constantly transmitted (which is outside the range of human hearing) from a terminal unit located at the customer's premises to the telephone company's exchange office. Those transmissions are constantly monitored by a telephone-company computer that monitors each terminal unit's status. Any indication of tampering or of an alarm condition results in the telephone company's computer notifying the appropriate central station, which sends help.

The cable-television industry has in some instances provided the necessary link between the alarm company's central station and the customer's protected premises. Modern two-way interactive cable-TV plants have the ability to transmit and receive alarm signals over existing coaxial cable. Alarm signals received by the cable operator are retransmitted to the appropriate central station, which in turn sends help.

Long-range radio-alarm monitoring should not be confused with the wireless alarm systems that were discussed earlier in this article. Long-range radio-alarm monitoring provides a very reliable method of monitoring an alarm system without the use of wires.

Developed in the early 1970's, long-range radio systems can be found working on frequencies ranging from 27 to 900 MHz. Different manufacturers use different transmission methods, from double-sided narrow-band AM to high-speed FM packet switching. Typical line-of-sight coverage for long-range radio is about 25 miles, with repeaters extending the range as needed.

Installing security systems

By this point, you should have a good working knowledge of the many reasons why you should consider the installation of an electronic security system, the component parts of the system, and how they work. Now you have to make the decision as to whether you want to install one yourself or hire a professional security contractor. The decision is a hard one. However, it is important to note that some of the more sophisticated detection devices and control panels mentioned in this article are only available to professional security contractors on a wholesale basis. If your particular situation requires the features of those more sophisticated systems, then the decision has pretty much been made for you.

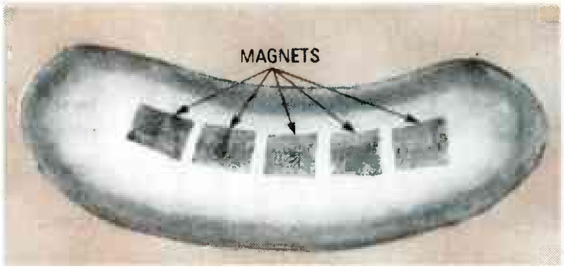
However, do-it-yourself installation may be appropriate for many simpler situations. Many electronics hobby stores, electrical supply houses, and mail-order houses do sell some limited security system equipment. Most of those devices consist of an all-in-one tabletop control console with a built-in detection device such as an IR or ultrasonic motion detector. They will also have a built-in sounding device and/or the capacity to add an external sounding device. Separate components, such as a simple control panel, different types of switches, motion detectors, sirens, bells, wire, batteries, foil, as well as how-to books, can be obtained through those sources as well.

Professional installations

For those that choose to go the professional-installation route, here are a few guidelines that may save you some headaches:

A security system is often a once-in-a-lifetime purchase and is simply too important to trust to the lowest bidder or a friend's expertise. Shop around, but not for price. Look for a well-established company that will be there if and when your alarm requires service. Look for a professional company, one that will explain to you clearly the services they provide. Recommendations from friends and neighbors are also valuable in selecting an alarm company.

Almost every state, and many local regions, have burglar- and fire-alarm associations. A call to a local association for a list of dealers would surely help in the selection process. Also, while police departments generally are not supposed to give out individual recommendations, a phone call to them might net two or three names on a non-official basis. Another source of information or recommendations is the National Burglar and Fire Alarm Association (1120 Nineteenth Street, N.W., Suite LL-20, Washington D.C. 20036). **R-E**



NEW MAGNETIC MEMORIES

GLYNN G. GILLETTE

A new breakthrough, announced April 1st, makes tiny magnetic memories possible.

SCIENTISTS AND ENGINEERS ARE CONstantly seeking ways to make computer memories smaller and more reliable. Now, a new breakthrough has allowed scientists to fabricate magnetic memories that are far smaller than was ever possible using any other technology.

The key is the discovery of a type of creature that regularly creates magnetic structures that are as small as 300 angstroms (an angstrom is 1/10,000 of a micron)! Called *magnetoactic* bacteria, they use the magnets for navigation. A mature specimen measures about 2000 angstroms long and contains about five of the tiny magnets.

Those microscopic creatures are far from rare; a small sample of muddy pond water may contain millions. When the creatures die and decompose, they leave behind large aggregates of the tiny magnets, which are known as *loadstones*. (Those natural magnets are not to be confused with the more well known lodestones, which, of course, have a completely different origin.)

Now, computer scientists and engineers at Foolem Laboratory, working hand-in-hand with a team of top microbiologists, have found a way to incorporate the magnets generated by the bacteria into a promising new magnetic read-only memory.

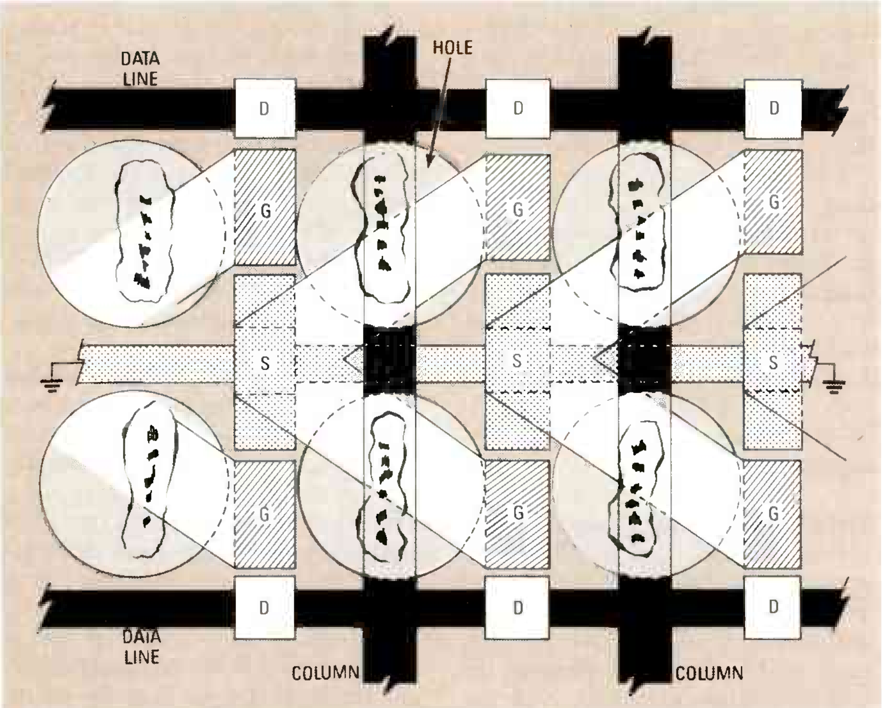


FIG. 1—NORTH-SEEKING BACTERIA are washed onto a semiconductor wafer and are trapped in the holes. The bacteria are then manipulated by an external magnetic field and then zapped by a low-power precision laser.

First of all, it was discovered that certain types of magnetoactic bacteria are north seeking, while others are south seeking. If a uniform north-seeking bacteria culture is placed in a magnetic field, all of the bacteria will face and swim in the same direction. If the polarity of the field is reversed, all of the bacteria will turn around and swim in the opposite direction.

To create a uniform north-seeking culture, a sample of pond water is passed through a north magnetic field to draw out any north-seeking bacteria. After the bacteria are removed from the sample, the balance is then discarded.

To make a memory, or any one-or-zero switch, the north seeking bacteria are washed over a specially prepared semiconductor wafer. On that wafer, holes that measure 1000 angstroms deep by 2500 angstroms in diameter that have been etched wherever a one-or-zero switch is to be placed. Each hole traps one and only one bacterium. See Fig. 1.

Using an external magnetic field, the bacteria are manipulated into the appropriate position for a one. A low powered laser then zaps the cells where ones are desired. After all of the ones have been programmed (zapped), the field is reversed. The remaining live bacteria turn around and face the opposite way. Then the remainder are zapped as zeros. The wafer is then finished along with the rest of the circuitry.

To detect a one or zero from the extremely small magnets, a slow rise-time pulse is applied to the column line. When the level of voltage is at maximum, a magnetic field will appear 90° from the bacterium magnets;

continued on page 108

WORKING WITH MONOSTABLE MULTIVIBRATORS

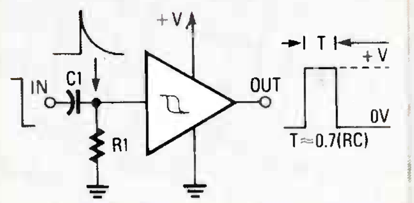


FIG. 1—THIS LEADING-EDGE DETECTOR circuit has a positive output pulse.

RAY MARSTON

Learn how to design and build pulse generators and monostable multivibrators, and how to use them in your projects.

CIRCUIT DESIGNERS often need to come up with a circuit to generate a pulse when triggered by the leading or trailing edge of a waveform. When the pulse width is not critical, they usually turn to a circuit element that's known as a *half-monostable* or *edge-detector*. When the pulse width is critical, they usually use a circuit element known as a *full-monostable multivibrator*.

There are two types of monostables, standard and retriggerable. In a standard monostable circuit, the arrival of the trigger signal initiates an internal timing cycle that causes the output of the monostable to change state at the start of the timing cycle, and then revert back to the original state on completion of the cycle. Note that once a timing cycle has been initiated, the standard monostable is immune to the effects of subsequent trigger signals until the timing period ends. That type of circuit can be modified by adding a RESET control, so that the output pulse can be terminated or aborted at any time.

In a retriggerable monostable circuit, the trigger signal actually resets the monostable and initiates a new timing cycle even if the trigger signal arrives in the midst of an existing cycle. Thus, the retriggerable monostable's output will stay in its active state as long as new trigger pulses are introduced before the timing cycle ends.

The choice of an IC to implement a pulse generator is usually dictated by economics and convenience, rather than by the actual design requirements. So, if the designer needs a standard CMOS monostable of only modest precision, he can build it very inexpensively using IC's such as a 4001B or 4011B. Otherwise, it can be done at a greater expense using a 555 timer or a dedicated monostable IC such as 4047B.

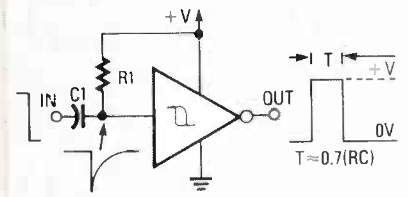


FIG. 2—THIS TRAILING-EDGE DETECTOR circuit also has a positive output pulse.

Edge-detector circuits

Edge-detector circuits are used to generate an output pulse on the arrival of either the leading or trailing edge of a rectangular input waveform. In most applications, the precise width of the output pulse is not critical. The basic method of making an edge-detector is to feed the input waveform to a short-time-constant RC network, which produces an output waveform with a sharp leading edge and an exponential trailing edge upon the arrival of each input edge. The unwanted edge waveform is then eliminated with a discriminator diode, and the remaining spike or sawtooth waveform is then converted into a clean pulse by feeding it through a Schmitt-trigger.

CMOS Schmitt IC's incorporate built-in protection diodes on all input terminals, which can be used as discriminator diodes as was previously described. The 4093B quad 2-input NOR Schmitt can be used as a normal Schmitt inverter by wiring one input terminal to the positive supply and using the other terminal as the input. Also, a non-inverting Schmitt trigger can be made by wiring two inverting Schmitts in series.

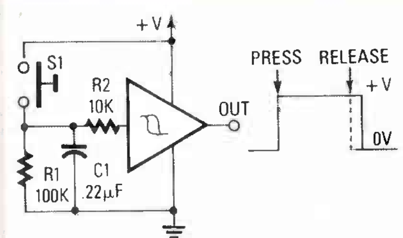


FIG. 3—IF YOU NEED A NOISELESS push-button switch, this circuit can be used to de-bounce a switch.

Figure 1 shows a leading-edge detector circuit. The input of the Schmitt is tied to ground via R1, and the RC time constant is relatively short compared to the period of the input waveform. As shown, the leading edge of the input signal is converted to the spike waveform, and the spike is then converted into a pulse waveform by the Schmitt. The circuit will generate a positive-going output pulse if a non-inverting Schmitt is used, or a negative-going output pulse with an inverting Schmitt. In either case, the output has a period (T) of roughly 0.7(RC). Figure 2 is a similar circuit that is set up as a trailing-edge detector.

An edge-detector circuit can be used to make a "noiseless" push-button switch as shown in Fig. 3. The input of the non-inverting Schmitt is tied to ground via timing-resistor R1 and by input-protection-resistor R2, so the output of the circuit is normally low. When S1 is closed, C1 charges almost immediately to the positive supply voltage, and the Schmitt output goes high. When S1 is released, C1 discharges relatively slowly via R1, and the Schmitt output does not return low until roughly 20 ms later. Therefore, the circuit provides a clean output waveform.

The reset-pulse generator circuit in Fig. 4 generates a reset pulse when power is first applied to the circuit. The circuit produces a 700-ms output pulse for resetting external circuitry. When power is first applied, C1 is discharged, pulling the Schmitt input low and driving the output high. Capacitor C1 then charges via R1 until, after about 700 ms, the C1 voltage rises to such a level that the Schmitt output switches low.

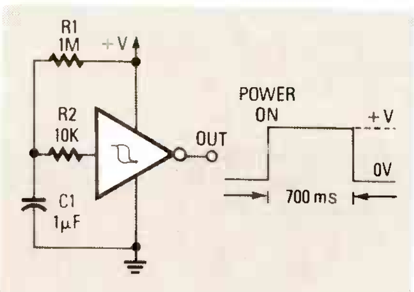


FIG. 4—A RESET-PULSE generator circuit will generate a reset pulse upon power up.

Monostable IC's

The cheapest possible way of building a standard or resettable monostable circuit is to use a 4001B quad 2-input NOR gate or a 4011B quad 2-input NAND gate; circuits using those IC's are shown in Figs. 5–8. Note, however, that the output pulse widths of those circuits are subject to variations between individual IC's and variations in the supply voltage, so they are not suitable for use in high-precision applications.

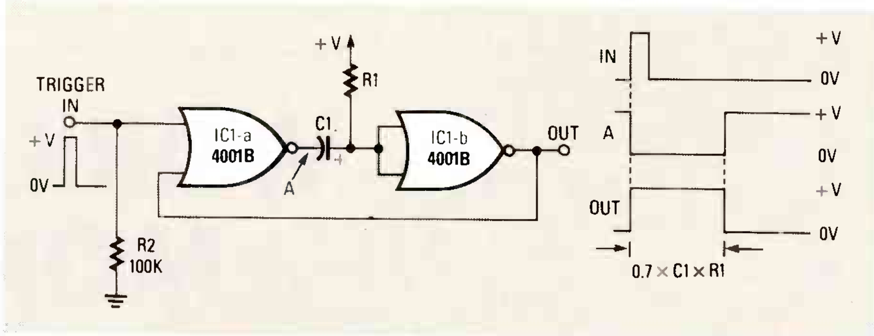


FIG. 5—THIS 2-GATE NOR monostable is triggered by a positive-going signal and generates a positive-going output pulse.

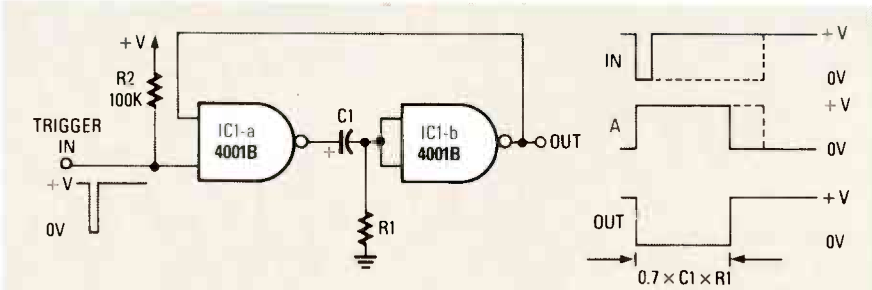


FIG. 6—THIS 2-GATE NAND monostable is triggered by a negative-going signal and generates a negative-going output pulse.

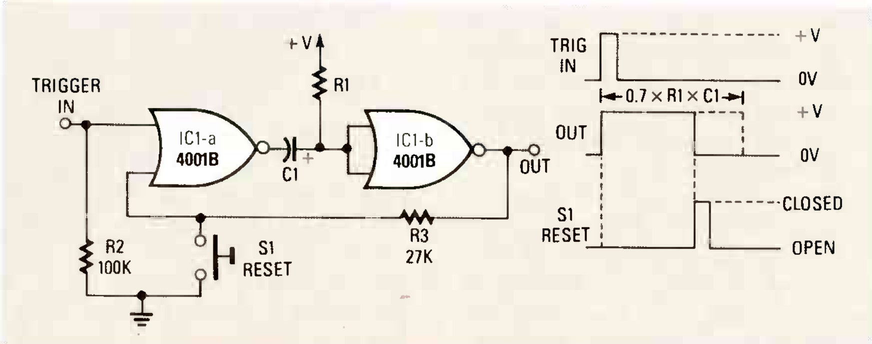


FIG. 7—A RESETTABLE NOR monostable can be reset by pressing S1. It is triggered by a positive-going signal and produces a positive-going pulse.

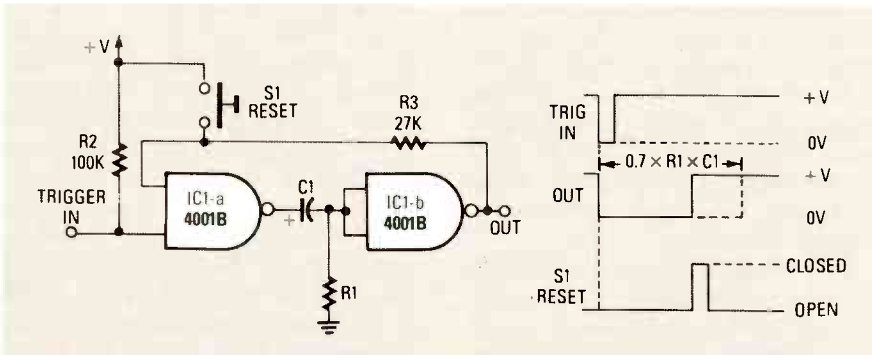


FIG. 8—THE CIRCUIT SHOWN HERE is a NAND monostable. Unlike the NOR-type, it is triggered by a negative-going signal and produces a negative-going pulse.

Figures 5 and 6 show two versions of the standard monostable circuit, each using only two of the four gates that are available in the CMOS package. The duration of the output pulse is determined by the values of R1 and C1, and is approximately 0.7 × C1 × R1. When R1 has a value of 1.5 megohms, the period of the pulse is approximately one-second-per-μF of C1's value. In practice, C1 can have any value from about 100 pF up to a few thousand μF, and R1 can have any value from 4.7K to 10 megohms. The NOR version of the circuit (Fig. 5) has a normally-low output, and is triggered by the edge of a positive-going input signal, while the NAND version (Fig. 6) has a normally-high output and is triggered by the edge of a negative-going input signal.

One good feature of those circuits is that the input trigger pulse can be direct coupled, and the duration of the trigger pulse has little effect on the length of the generated output pulse. Another useful feature is that the signal appearing at point A has a period equal to that of either the output pulse or the input trigger pulse, whichever is greater. That feature is valuable when making pulse-length comparators and over-speed alarms.

The operating principles of those two circuits are fairly simple. Let's look first at the circuit in Fig. 5, where IC1-a is wired as a NOR gate and IC1-b is wired as an inverter. When the circuit is in the quiescent stage, the trigger-input terminal is held low by R2, and the output of IC1-b is also low. Both inputs of IC1-a are low, so the output of IC1-a is forced high and C1 is discharged. When a positive trigger signal is applied to the circuit, the output of IC1-a is immediately forced low and, since C1 is now discharged, it pulls the input of IC1-b low and drives its output high. The output of IC1-b is coupled back to the input of IC1-a, and forces the output of IC1-a to remain low, irrespective of the prevailing state of the input trigger signal. As soon as the output of IC1-a switches low, C1 starts to charge up via R1, and after a delay determined by the values of those components, C1's voltage rises to such a level that the output of IC1-b starts to swing low, terminating the output pulse. The circuit will not return to its quiescent state if the trigger signal is high when the output pulse is terminated.

The circuit in Fig. 6 operates like the one in Fig. 5, except that IC1-a is wired as a NAND gate, with its trigger input tied to the positive supply via R2, and the timing-resistor R1 is connected to ground.

The circuits in Figs. 5 and 6 have their outputs coupled directly to one input of IC1-a to effectively maintain a trigger input once the original trigger signal is removed, thereby providing semi-latching operation.

The circuits in Figs. 5 and 6 can be made resettable by providing them with a means of breaking the feedback path, as shown in Figs. 7 and 8. The feedback connection from the output of IC1-b to the input of IC1-a is made via R3. Consequently, once the circuit has been triggered, and the original trigger signal has been removed, the circuit can be reset by forcing the feedback input of IC1-a to its normal quiescent state by pressing S1. In practice, S1 can be replaced with a transistor, enabling the circuit to be reset electronically.

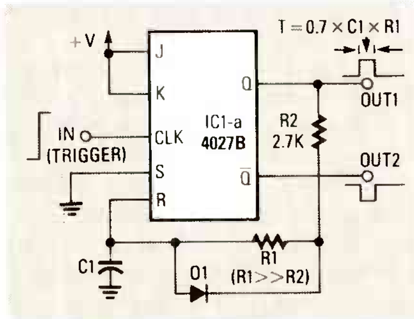


FIG. 10—A JK-TYPE FLIP-FLOP can also be used as a monostable. Its operation is similar to the D-type in Fig. 9.

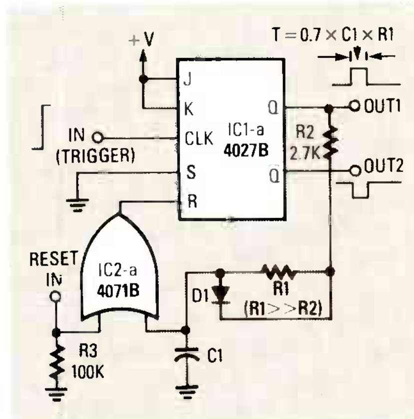


FIG. 11—THIS JK-TYPE monostable is electronically resettable.

Flip-flop monostables

Medium-accuracy monostable circuits can be built using standard edge-triggered CMOS flip-flop IC's, such as the 4013B dual D-type or the 4027B dual JK-type, in the configurations shown in Figs. 9 and 10. Both circuits operate in the same basic manner, with the IC wired in the divider mode by proper connection of their control terminals (DATA and SET in the 4013B, and J, K and SET in the 4027B), but with the Q terminal connected to RESET by an RC time-delay network. The operating sequence of both circuits is as follows:

When the circuit is in its quiescent state, the Q output terminal is low and discharges timing capacitor C1 via R2 and the parallel combination of R1 and D1. Upon the arrival of a sharply rising leading edge on the CLK terminal, the Q output flips high, and C1 starts to charge up via the series combination of R1 and R2. Eventually, after a delay determined mainly by values of C1 and R1, the C1 voltage rises to such a value that the flip-flop is forced to reset, driving the Q terminal low again. Capacitor C1 then discharges rapidly via R2 and the D1/R1 network, and the circuit is ready to generate another output pulse when the next trigger signal arrives.

The timing period of the circuits in Figs. 9 and 10 is roughly equal to 0.7 × C1 × R1, and the reset period (the

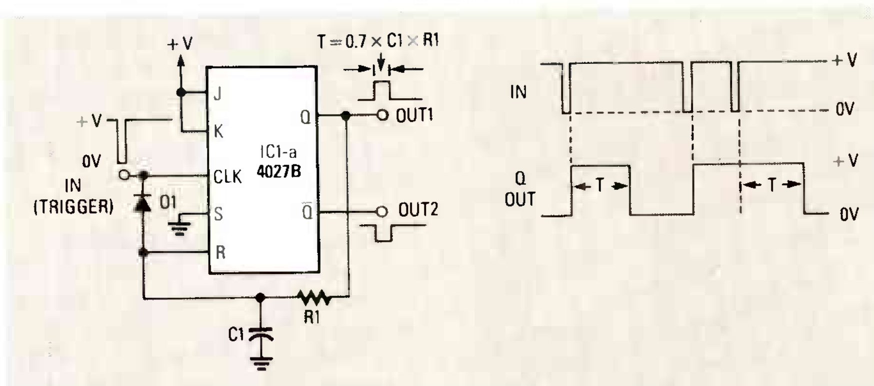


FIG. 12—A RETRIGGERABLE JK-type monostable has an output pulse that can be prolonged by an additional trigger pulse before the timing cycle ends.

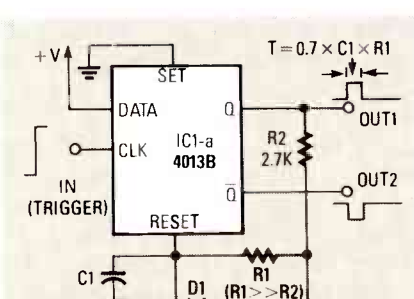


FIG. 9—A D-TYPE FLIP-FLOP can be used as a monostable. It produces both negative- and positive-going pulses.

time for C1 to discharge after each pulse) is roughly equal to C1 × R2. In practice, R2 is used mainly to prevent degradation of the trailing edge of the pulse waveform as C1 discharges; R2 can be replaced by a jumper if degradation is acceptable. Note that the circuit generates a positive-going output pulse at Q, and a negative-going pulse at $\overline{Q}$.

The circuit in Fig. 10 can be made resettable as shown in Fig. 11. That is done by connecting capacitor C1 to the RESET terminal of the circuit via one input of an OR gate, and using the other input of the OR gate to accept the external reset signal.

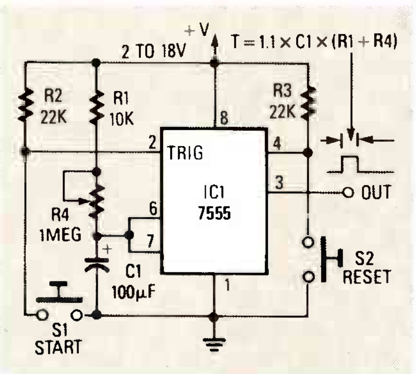


FIG. 13—THIS MONOSTABLE can be manually-triggered and has a variable pulse width from 1.1 to 100 seconds.

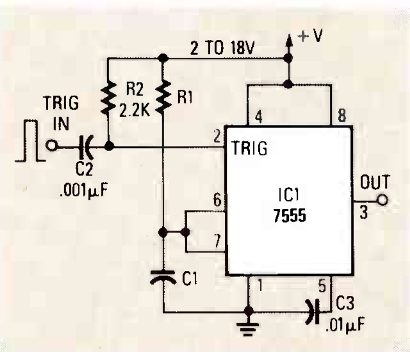


FIG. 14—THIS 7555 MONOSTABLE is similar to the one in Fig. 13, with the exception that it can be electronically triggered.

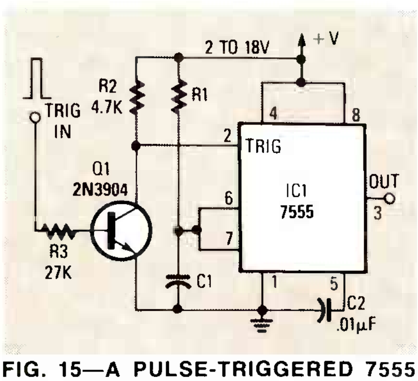


FIG. 15—A PULSE-TRIGGERED 7555 monostable can produce an accurate output pulse from a medium-accuracy input signal.

Finally, Fig. 12 shows how the 4027B can be used to make a retriggerable monostable, in which the pulse period restarts each time a new trigger signal arrives. Note that the input of that circuit is normally high, and that the circuit is actually triggered on the trailing (rising) edge of a negative-going input pulse. The circuit operates as follows:

At the start of each timing cycle, the input trigger pulse switches low and rapidly discharges capacitor C1 via D1 and shortly afterwards, the trigger pulse switches high again, releasing C1 and simultaneously flipping the Q output high. The timing cycle then starts in the normal way, with C1 charging via R1 until the C1 voltage rises to such a level that the flip-flop resets. That drives the Q output low again and C1 slowly discharges via R1. If a new trigger pulse arrives in the midst of a timing period (when Q is high and charging C1 via R1), C1 rapidly discharges via D1 on the low part of the trigger, and commences a new timing cycle as the input waveform switches high again. In practice, the input trigger pulse must be wide enough to fully discharge C1, but should be narrow relative to the output pulse. The timing period of the output pulse equals 0.7 × C1 × R1, and for best results, R1 should have as large a value as possible.

High accuracy monostables

In all of the circuits that we've looked at so far, the width of the output pulse depends on the switching threshold of the IC, which is subject to considerable variation between individual IC's, and variations in supply voltage and temperature. Therefore, the circuits have only moderate accuracy. If precise pulse widths are needed, the best way of generating them it is to use a 7555 IC, which is the CMOS version of the ubiquitous 555 timer. It has a built-in precision voltage comparator that activates internal flip-flops and precisely controls the output pulse width, irrespective of wide variations in supply voltage and temperature. The 7555 can operate from supplies that range from 2 volts to 18 volts.

Figure 13 shows the basic way of using the 7555 as a manually triggered variable-pulse generator. The IC is triggered by briefly pulling pin 2

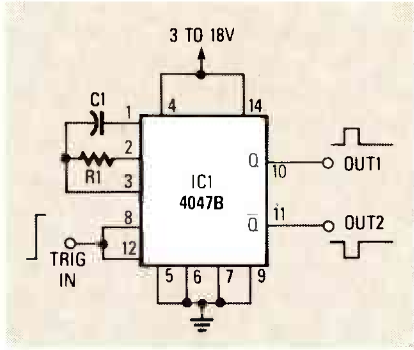


FIG. 16—THE 4047B can be used as a retriggerable monostable, with positive-edge triggering.

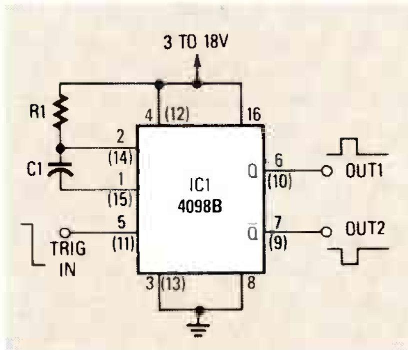


FIG. 17—THE 4098B is used here as a retriggerable monostable with negative-edge-triggering.

low (less than ⅓V) via S1. At that time, the output (pin 3) switches high and the IC enters its timing cycle, with C1 charging up via the R1/R4 circuit. Eventually, after a delay of 1.1 × C1 × (R1 + R4), C1's voltage rises to the upper switching threshold (⅔ V), and the output abruptly switches low, ending the timing cycle. The timing cycle can be terminated prematurely by briefly pulling RESET (pin 4) low via S2. The circuit can produce a pulse from 1.1 to 100 seconds; the duration is controlled by R4.

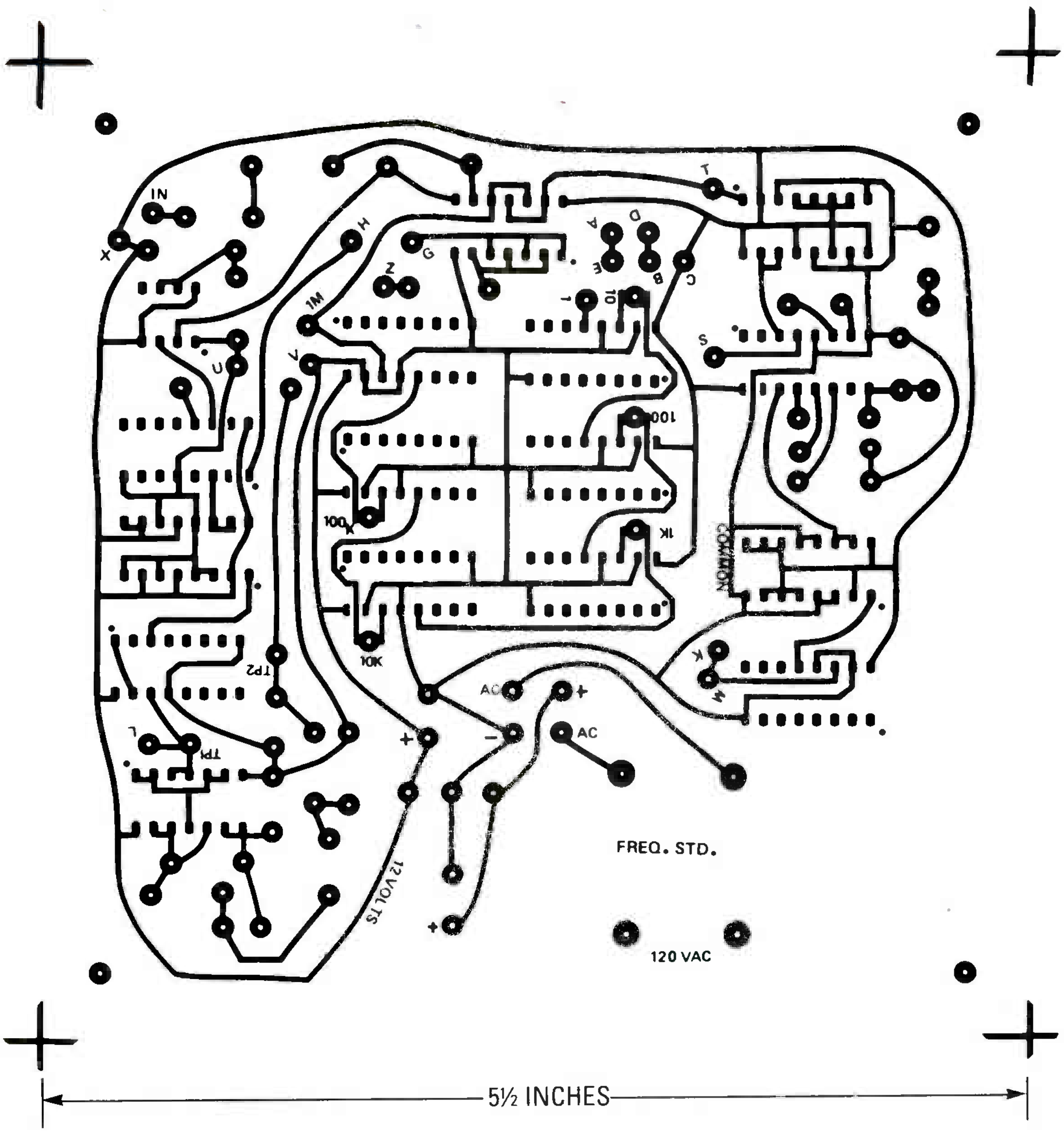
In most practical applications using the 7555 the designer will want to trigger the IC electronically, rather than manually (by pressing a button). If that's the case, the trigger signal must switch from an off value greater than ⅔V to an on value less than ⅓V (triggering actually occurs as pin 2 drops through the ⅓V value). The pulse width must be greater than 100 ns, but less than the desired output pulse, so that the trigger pulse is removed before the timing period ends.

One way of generating a trigger signal from a rectangular input is to connect the signal to pin 2 of the 7555 via a short-time-constant RC dif-

continued on page 71

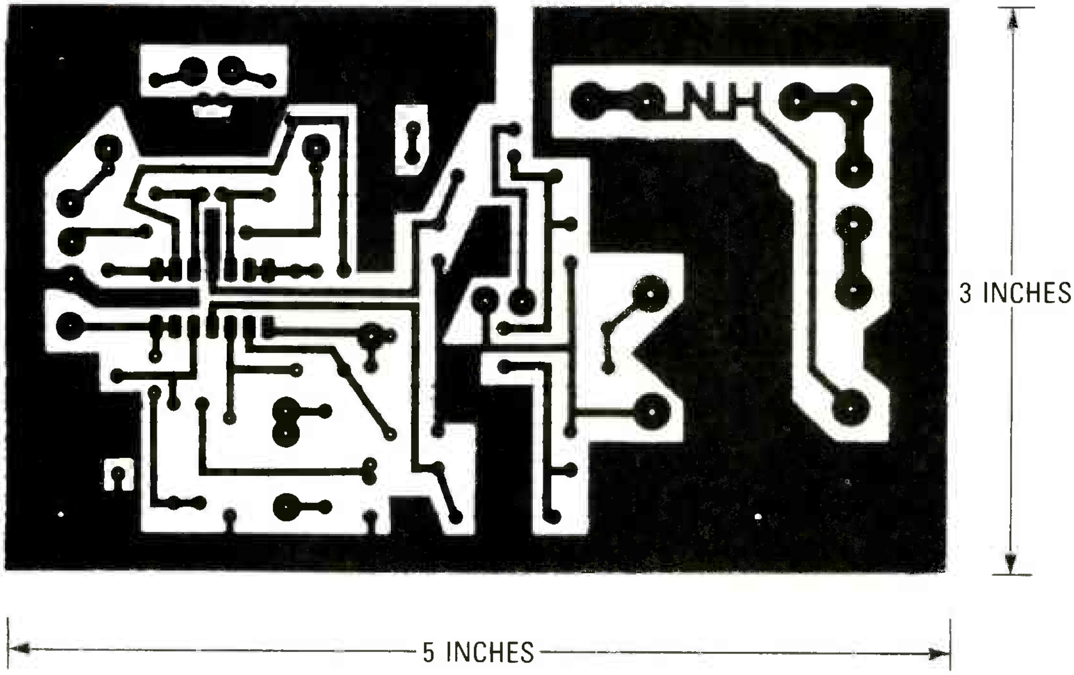
PC SERVICE

Here are the PC patterns for the construction projects in this month's issue. All patterns are right reading and full sized, unless otherwise noted.

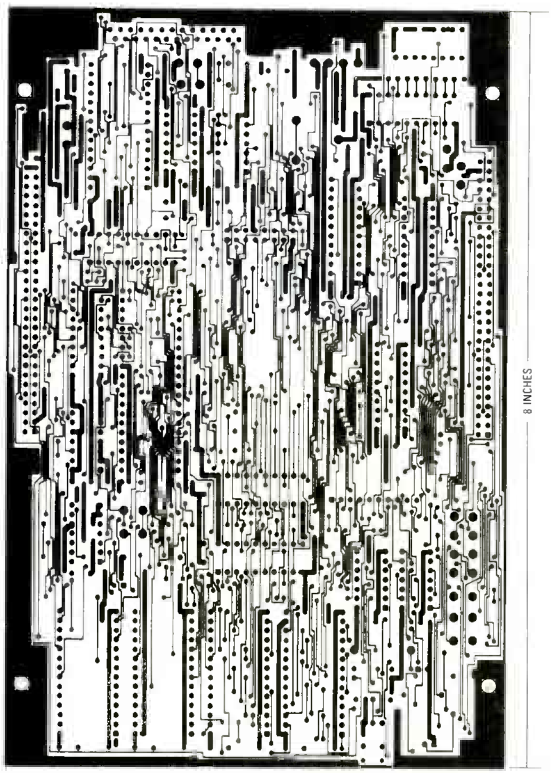


BUILD THE FREQUENCY STANDARD using this PC pattern.

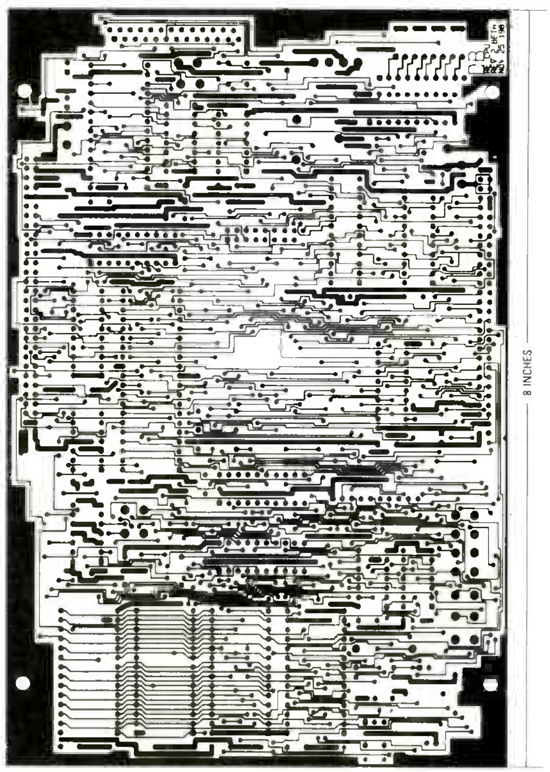
PC SERVICE



HERE'S THE PATTERN for the Surround-Sound decoder.



SOLDER SIDE for the REACT's board. It is shown half size.



COMPONENT SIDE of the REACT's board. It is shown half size.

FREQUENCY STANDARD

continued from page 58

alignment-tool or a non-conducting screwdriver until the LED glows brightly without flicker, and the voltage at test point TP2 is between 6 and 10 volts. If you have problems with the above procedure, perform the following tests:

- Using an oscilloscope, observe the square-wave output at IC1 pin 3; it should be *clean* with no jitter, as shown in Fig. 5. Overcoupling of the antenna to the TV will cause too much signal on IC1 pin 2, which will result in an unstable output.
- Check the operation of IC8 by temporarily jumping pin 9 to pin 16. The VCO output at IC8 pin 4 should be greater than 1 MHz but not greater than 1.1 MHz. Reducing the value of resistor R5 will increase the operating frequency.
- Remove the jumper and check IC8 pin 1 for a narrow negative pulse that indicates the PLL is locked. Connect a frequency counter through a ×10 probe at test point TP1 and adjust C10 for a reading of 3579545 Hz when 6 volts is applied to TP2 from an external power supply. In some cases, the value of C9 will need to be changed slightly to allow a proper adjustment range for C10.
- Connect a frequency counter or a scope to output jack J2 and verify proper operation of the decade counters and wiring of the frequency output select switch. The output level of the standard is adjustable between 0 and 12 volts.

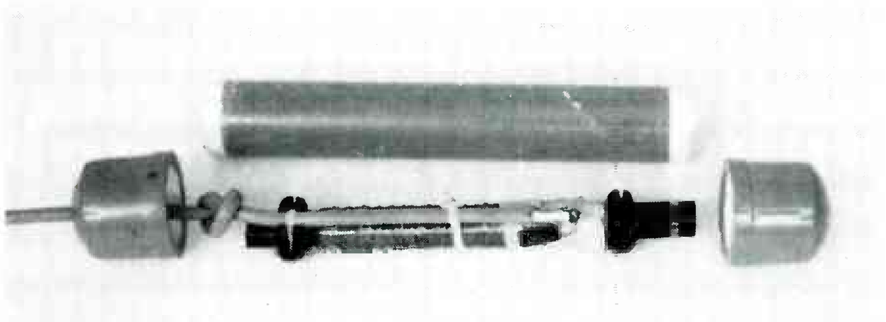


FIG. 4—THE ANTENNA IS HOUSED in a section of PVC pipe. Note that one end cap must be pre-installed on the antenna's connecting cable.

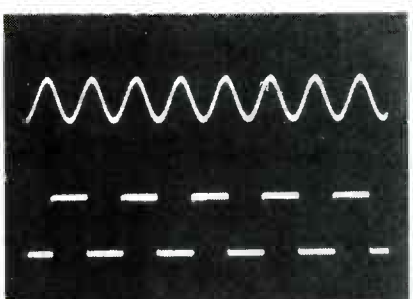


FIG. 5—THE FREQUENCY-STANDARD OUTPUT (bottom trace) should be jitter free. The top trace is the input from the antenna.

Accuracy

You may have noticed that the readings on your frequency counter may not be exactly 1.000 MHz when the output selector is set for 1 MHz. The worst-case error measured when the TV was tuned to a locally-originated TV program was 1-ppm (*p*art *p*er *m*illion), or 1 Hz at 1 MHz. When the TV is tuned to a network-originated program the error is less than 1 part in 10^{-7}, or 0.1 Hz at 1 MHz. (The local broadcasts are not always on the network atomic standard. Local news and local live productions use their own master oscillator.)

Set S1 for a 3.58-MHz output and select a network-originated broadcast. Then change the channel to a different network broadcast and note that the reading on the frequency counter is the same—you are thereby assured that the atomic standard is in use. Adjust the counter's timebase to exactly 3579545.45 Hz. If your frequency counter has an external timebase input you can use the 1-second (1-Hz) or the 1/10-second (10-Hz) output from the standard to gate the counter for good accuracy without having to calibrate the counter or warm up its crystal oven (if it has an oven).

The internal decade counters can be reprogrammed to divide by any number between 2 and 10, which makes a myriad of other output frequencies available to those wanting to customize the standard. **R-E**

MULTIVIBRATORS

continued from page 68

ferentiating network. It converts the leading or trailing edge of the input waveform into suitable trigger pulses, as shown in Fig 14.

The best way of triggering the 7555 is to use one of the previously described medium-accuracy monostables to generate a narrow (about 100 ns) positive-going trigger pulse, and transistor-couple it to pin 2 of the 7555, as shown in Fig. 15. Note in that circuit, and also the previous one, C2 is used to decouple the trigger circuitry from supply transients.

CMOS monostables

A number of dedicated CMOS monostable IC's are available. The best of those devices are the 4047B monostable/astable IC and the 4098B dual monostable. It should be noted that both devices have rather poor pulse-width accuracy and stability. They are, however, quite versatile, and can be triggered by either the positive or the negative edge of an input signal, and can be used in the standard or the retriggerable mode.

When the 4047B is used in the monostable mode, the trigger signal actually starts the astable and resets the counter, driving its Q output high. After a number of astable cycles, the counter flips over and simultaneously switches the Q output low. Consequently, the circuit will produce relatively long output pulses; the period is approximately 2.5 × R1 × C1.

In practice, R1 can have any value from 10K to 10 megohms, and C1 must be non-polarized with a value greater than 1000 pF. Figure 16 shows how to connect the 4047B in the retriggerable mode. It can be reset at any time by pulling pin 9 high.

The 4098B dual monostable has two sections that share common supply connections, but can otherwise be used independently. The timing period of both monostables is controlled by a single resistor (R1) and capacitor (C1), and is approximately 0.5 × R1 × C1. Resistor R1 can have any value from 5K to 10 megohms, and C1 can have any value from 20 pF to 100 µF. Figure 17 shows the 4098B used as a retriggerable monostable that is triggered by a negative input edge. **R-E**

HARDWARE HACKER

Bar code information
Pressure transducer data
Low pressure pneumatics
Battery powered regulators
New video imaging devices

Surplus EGR valves for the hacker, and more!

DON LANCASTER

OUR BIG NEWS THIS MONTH IS THE brand new *Optoelectronics and Image Sensor Data Book* you can get from Texas Instruments. Inside it you will find the details on two remarkable chips called the TC240 and the TC241.

They're both solid-state image sensors intended for use in video cameras and such, with a total of 367,952 photo elements, arranged in a 754 × 488 format.

Incredibly, the TC240 also includes a set of three built-in color filters so that one single device and one simple lens is all you need to obtain full resolution red, blue, and green "RGB" color outputs. That is done by actually placing all of the individual filters precisely above each light sensing element of the IC.

If you aren't into using color, the TC241 is the same device intended for monochrome use, sans filters.

And, yes, they are available. So much for the good news. The bad news is that they are not yet hacker priced. The sensors list at $375 in monochrome and $405 for full color. And five other custom chips are needed to convert the sensor into a "real" camera.

But the devices are available today, and the prices are certain to drop in the future. So now is a good time to at least start studying high-resolution CCD sensors.

Let's move on to one of my all time favorites.

What is your favorite surplus component?

It's been on the surplus market for at least ten years now, and virtually no one has picked up on this incredible hacker opportunity. It's called an automotive EGR valve, and they are available for as little as thirty cents(!) from Jerryco, besides being available in singles for $1 to $3 each from just about any other surplus house.

Not to mention the fact that they are available by the barrel full at your local junk yard. The original manufacturer seems to be Carter Carburetor.

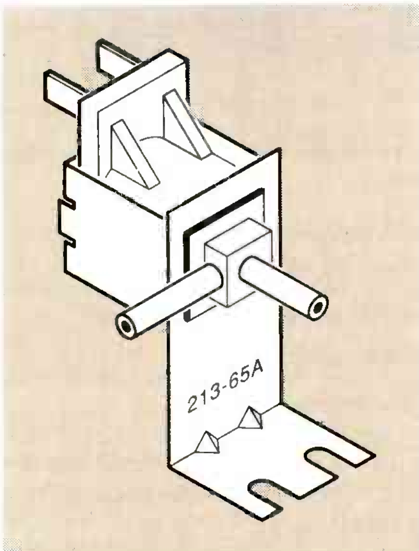


FIG. 1—3-WAY AUTOMOTIVE EGR VALVES are available for as little as thirty cents each! They are ideal for robotics and for low-pressure pneumatic hacking.

NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:
Don Lancaster
Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073.

Figure 1 shows you a typical EGR valve. What you have here is a three-way pneumatic control valve that can interface beautifully with almost any microcomputer or other controller circuit. Do nothing, and the side pipe exhausts to ambient air via a filter at the rear. Apply +12 volts at 200 mA and the front pipe gets connected to the side pipe.

While it was intended for use as a vacuum valve, you can use it "backwards" with air pressures as high as 10 psi. You can even run water through it, if you plug up the exhaust vent with epoxy.

Low-pressure air in the 4- to 6-psi range has all sorts of robotic and hacker opportunities. You can use a large aquarium pump with a simple accumulator made up from a toilet-bowl float, and a surplus regulator as a power source. Then you use the valves to activate various actuators under computer or manual control.

Unlike a solenoid, most any air actuator is cheap, tough, powerful, and offers a very linear force. It also "amplifies", since most of the muscle comes from the air pump, rather than from the electrical input. And unlike mechanisms, air lines can easily go around corners, particularly robotic elbows.

What about the actuators? Figure 2 should give you some ideas. One thing I have found out about using low-pressure air is that you absolutely, positively must never have a seal that moves! If the seal is a good one, then all your force is spent overcoming friction. If the seal is not a good one, then all your air goes bye bye around the seal and is gone forever.

So, your best bet in actuators is

NAMES AND NUMBERS

A.I.M.
1326 Freeport Rd.
Pittsburgh, PA 15238
(412) 782-1624.

Automatic ID News
7500 Old Oak Blvd.
Cleveland, OH 44130
(216) 243-8100

C & H Sales
2716 E. Colorado Blvd.
Pasadena, CA 91107
(213) 681-4925

Carter Carburetor
9666 Olive Rd.
St. Louis, MO 63132
(314) 997-7400

Clippard Minimatic
7390 Colerain Rd.
Cincinatti, OH 45239
(513) 521-4261

Computer Shopper
Box F
Titusville, FL 32781
305) 269-3211

Ferranti
87 Modular Ave.
Commack, NY 11725
(516) 543-0200

Hygenic Manufacturing
1245 Home Ave.
Akron, OH 44310
(216) 633-8460

Identification Journal
2640 N. Halsted St.
Chicago, IL 60614
(312) 528-6600

Jerryco
601 Linden Pl.
Evanston, IL 60202
(312) 475-8440

Maxim
510 Pastoria Ave.
Sunnyvale, CA 94086
(408) 737-7600.

Melles Groit
435 S. Pacific St.
San Marcos, CA 92069
(619) 744-7060

Meredith Instruments
6403 N. 59th Ave.
Glendale, AZ 85301
(602) 934-9387

Nova Sensor
1055 Mission Court
Fremont, CA 94539
(415) 490-9100

Player Piano Company
704 E. Douglas
Wichita, KS 67202
(316) 263-3241

SenSym
1255 Reamwood Ave.
Sunnyvale, CA 94089
(408) 744-1500

Siemens
2191 Laurelwood Rd.
Santa Clara, CA 95054
(408) 980-4500

Texas Instruments
Box 5012
Dallas, TX 75265
(214) 995-3821

UPC Council
7075 Corporate Way S-106
Dayton, OH 45459
(513) 435-3870

Value Plastics
626 W. 66th St.
Loveland, CO 80357
(303) 669-4351

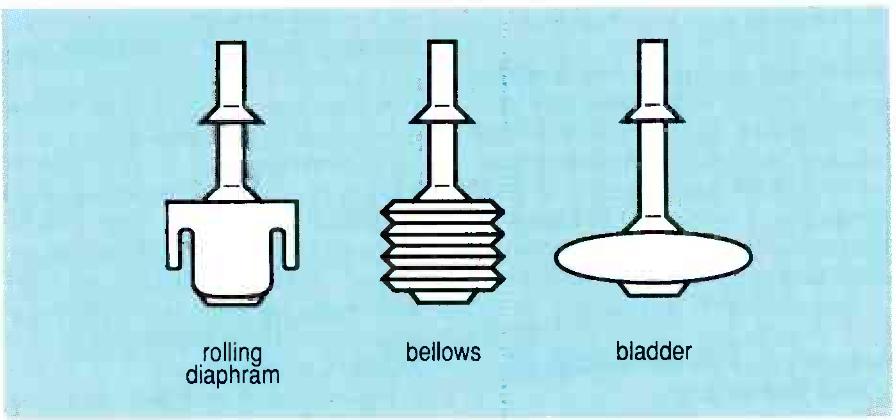


FIG. 2—THE FORMOST RULE of low-pressure hacker pneumatics is this: NEVER have any seal that moves! Here are some actuator ideas to get you started.

to use balloon, rolling-diaphragm, or elbow actuators of one type or another, since none of them have seals that move. Old toys at a yard sale are often an excellent source of actuator ideas.

By the way, if you ever need a static seal, a plain old "O" ring is the only way to go. Those "O" rings nearly always work like a champ. Unless you freeze one up on a poorly designed rocket seal, of course.

Some other sources I have found handy when hacking low-pressure pneumatics: Check out Hygenic for low-cost tubing and rubber sheeting, Value Plastics for connectors, and C & H Sales for regulators. You might also check out the Clippard people for some real miniature air components, but they often are rather overpriced.

Another "must have" reference for low-pressure pneumatics work is the superb catalog from the Player Piano Company.

You'll get the best results in the 4- to 6-psi range. Less than that and you don't get enough power. More than that and you get into seal and leakage problems.

Figure 3 shows you a typical low-pressure pneumatic system.

The accumulator is just a fairly large air tank that will hold the pressure constant during the pump cycles. Adjustable regulators, such as the one shown, typically go for around $5 at surplus prices.

The manifold is simply any way to distribute air to several valves and actuators. A quantity of "T" connectors could also be used. I once made a manifold by taking a foot length of heavy-wall rubber tubing, ¾-inch o.d. by ½-inch i.d. and then putting a pinhole every

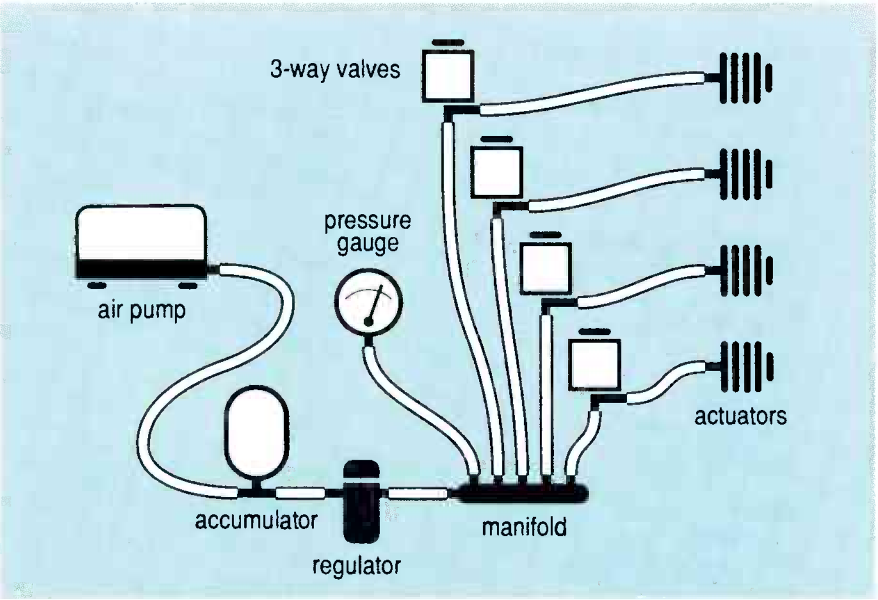


FIG. 3—A TYPICAL LOW-PRESSURE air system. Note that three-way valves MUST be used; otherwise, the air will stay stuck in the tubing and all of the actuators will remain extended.

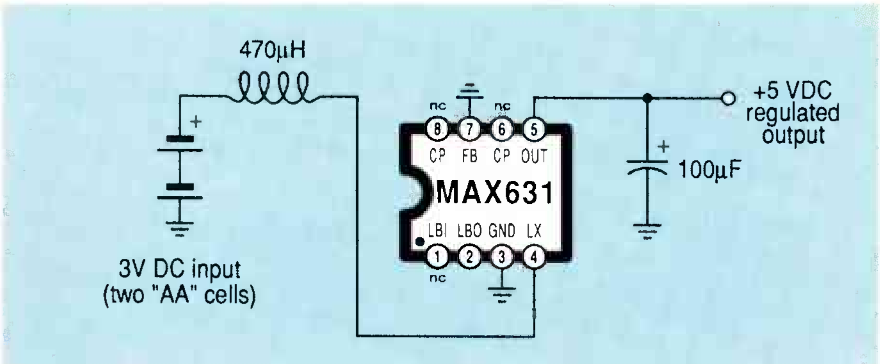


FIG. 4—THIS SIMPLE SWITCHING REGULATOR steps up two AA cells to give you a fixed +5-volt output at 10 mA. A pass transistor can be added for more output current.

place I wanted an EGR valve to go. Each valve snout was simply pushed through the tubing wall, giving an adequate seal.

One thing that beginners in pneumatics often miss—three-way valves are usually essential. If you connect an air source directly to an actuator through a two-way (or "SPST") valve, when you turn the valve off, the air stays stuck in the actuator and the actuator will stay extended. Instead, the three-way valve action either lets you "fill" the actuator from the accumulator or else "empty" it to ambient.

Tellyawhatweregonnado. For this month's contest, just come up with a paper design that uses the valves for economical low-pressure control of gases or liquids. To start you thinking, how about an automatic bartending/drink-mixing machine? Or some sort of aide for the handicapped? Or a device to convert any piano into a player piano? At any rate, there will be a free copy of my Incredible Secret Money Machine to the top twenty entries, and an all expense paid *tinaja* quest for two (FOB Thatcher, AZ) to the person who submits the best entry of all.

Fair enough?

Where can I go to find out all about bar codes?

Bar codes, of course, are now popping up just about everywhere, and there are all sorts of nickels to be made reading and entering codes, printing labels, or offering label software for sale to others.

While there are many different "standard" bar codes, far and away the most popular one is called the Uniform Product Code (UPC). An outfit named the UPC Council will be glad to sell you a complete set of UPC standards for $30.

If enough of you are interested, we might go further into what those standards are and how to use them in a future column. I always like to work directly from a copy of an actual standard, rather than using any third-party information. There are fewer rude surprises that way.

Meanwhile, there are several other bar-code resources you might like to pick up on. One group is called the AIM, which is shorthand for the Association of Identification Manufacturers. Their membership list is particularly useful for pinning down bar-code sources.

Two free trade journals are also now available for all you bar-code enthusiasts. One of them is called *Automatic I.D. News*, while the other one is the new *Identification Journal*. The latter people also publish *Marking Industry*.

How do I build a battery-powered regulator?

There's often a real dilemma in any portable electronic equipment, particularly the ultra-low-power hacker stuff. Many of the integrated circuits require a finely regulated supply that is very close to +5 volts DC. On the other hand, you often would like to run off a penlight cell or two, or possibly off a nine-volt "transistor" radio battery.

A very innovative Silicon Valley integrated circuit house has come to the rescue. The Maxim people have some outstanding low-power regulator circuits at very cheap prices. They also have a *Power Supply Circuits Handbook* that you might like to get, as well as a new monthly mailing called the *Maxim Design News*.

Figures 4 and 5 are two examples of what you can do with their components. Figure 4 is a switching mode regulator that steps two AA cells up to a solid and regulated five volts. The intended output power is 10 mA or less, for which you can get 80 hours or so of operation. The integrated circuit itself needs 100 microamperes off the battery.

Figure 5 shows you a classic linear regulator that drops 9 volts down to the needed 5. Linear regulators are normally much less efficient than switching ones. At a 10-mA load, you'll get around 55 hours of operation.

But the linear regulator has one exceptional feature—it only needs a mere 5 microamperes to operate. Thus, for very low load currents, the MAX 666 might actually give you a longer battery life.

Let's think about where we could go with ultra-efficient, ultra-low-voltage regulators. One quite obvious use is solar power, where a few series connected 0.6-volt cells could be up-converted to useful voltage levels.

And, how about this: A super-efficient, three volt output switching and up-converting regulator that can be powered from a ridiculously low input voltage, say 0.4 volt or so. Just snap one of them onto the top cell of your flashlight, and you can utterly and completely flatten your flashlight cells clear down to zilch, all the while maintaining a constant lamp output brightness.

What's new in pressure transducers?

The price of silicon pressure transducers does continue to drop ridiculously, and I'm now working up some sample circuits for you. But, to get you started, the Nova Sensor people recently had a sale on their new NPS-100 pressure sensors, for $11 each. That beauty is packaged completely in a six pin mini-DIP. It is rated 0–15 psi, but it will need an external op-amp for most serious hacker uses.

You might also like to get a copy of the new SenSym *Pressure Sensor Handbook*. There is a wealth of design information on what pressure sensing is all about and how to go about doing it. A series of application notes is also included.

What's new this month?

There's a new and informative free *HeNe Laser Guide 2* available from the folks at Melles Griot. Besides the usual red color, they also offer helium-neon lasers in green and infrared. They are a tad pricey though; for the best in surplus and other low-cost lasers, look into Meredith Instruments instead.

Also, be sure to check out the *Standard IC Product Guide* from Ferranti Semiconductors. In-

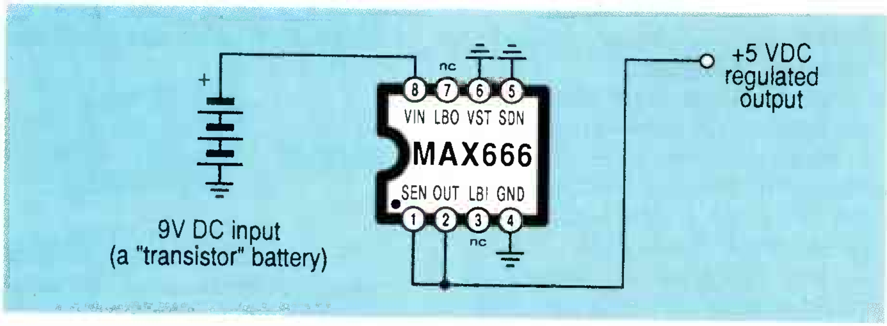


FIG. 5—THIS LINEAR REGULATOR drops down a 9-volt battery to give you a fixed +5-volt output at up to 40 mA. The standby current is a mere 5 μA.

cluded here are details on such hacker IC oddments as special television-pattern chips, low-noise preamps, telephone circuits, A/D and D/A stuff including video, some digital thermometers, and lots more.

A new *Integrated Circuits and Microcomputers* short form catalog is available from Seimens. Included there are remote-control chips and infrared receivers.

Turning to my own product, for any of you interested in Apple computing, there's my *AppleWriter Cookbook, Apple Assembly Cookbook, Enhancing your Apple IIe*, volumes I and II, and my *Ask the Guru* reprints from one of my other columns over in the *Computer Shopper*. I do stock autographed copies on hand here for you.

Once again, this is your column, so be sure to write or call. I'll be most happy to send you more info on all my hacker goodies. **R-E**

LETTERS

continued from page 22

reel; r_o = radius of empty take-up reel; r = radius of tape pack:

$n = K_1(r - r_2)$ (1)

$I = K(\pi r^2 - \pi r_o^2)$

or $I = K_2(r^2 - r_o^2)$ (2)

These equations may be solved for I as a function of n, or for n as a function of I. By solving (1) for r and substituting into (2) we get:

$$I = \frac{K_2}{K_1^2} n^2 + \frac{2K_2 r_o}{K_1} n \qquad (3)$$

Using the quadratic formula to solve (3) we get:

$$n = K_1 \left(\sqrt{r_o^2 + I/K_2} - r_o\right) \qquad (4)$$

To find values for K_1 and K_2, all that is needed is a ruler and the number of counts at the end of a tape. To get this, simply record for 2 hours at SP and look at the counter. My "typical" T-120 tape had about 126 minutes of tape on it. For my typical T-120:

r_{end} = 39.1 mm

r_o = 12.8 mm

I must confess that I do not use that method with my home VCR. Instead, I use a tabular listing of 30 minute (EP) readings. This is easier, and accurate enough for my purposes.

P.S. Congratulations on signing up Don Lancaster; he's a great addition to **Radio-Electronics**!

CHARLES KEITH
Poway, CA **R-E**

NEW IDEAS

Simple sine-wave generator

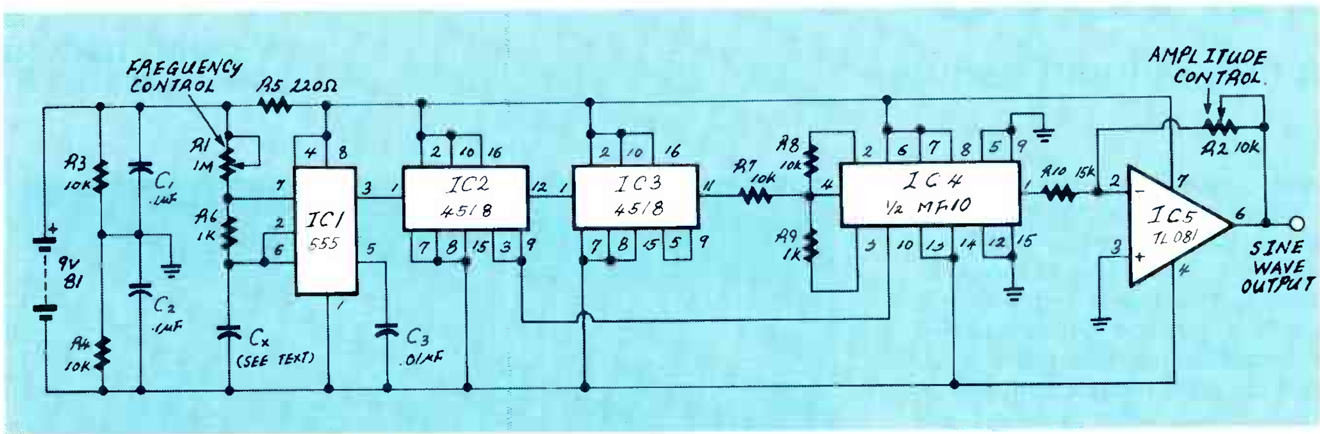


FIG. 1

FOR PEOPLE WHOSE NEEDS DON'T WARrant buying an expensive feature-filled sine-wave generator, a simple, low-cost one might often be useful. The circuit shown here is just that. It features amplitude and frequency controls, is made from low-cost components that are easy to obtain, and is powered from a 9-volt battery.

At the heart of the sine-wave generator circuit shown in Fig. 1 is an MF-10 IC made by National Semiconductor. It is part of a new generation of switched-capacitor filters that use an ingenious technique of switching internal capacitors to determine the cutoff frequency. The output frequency of the MF-10 follows the frequency of an external clock. A square-wave input signal is fed into the device, and only the frequency of the clock signal is allowed to pass through. All other components of the input signal are filtered out. Because both the clock signal and the input signal must be square waves, a dual-output square-wave oscillator is used to simultaneously drive the clock and signal inputs. Therefore, the clock signal and the input signal are correspondingly shifted so that the MF-10 always filters out all but the fundamental frequency of the input signal. The result is a nice clean sine wave at the output.

A 555 timer operating in the astable mode generates the driving pulses and two 4518 dual BCD (*B*inary *C*oded *D*ecimal) counters provide the square waves. A TL081 op-amp serves as an output buffer-amplifier, and potentiometers R1 and R2 are used in order to control the pulse's frequency and amplitude respectively.

The output-frequency range can be varied by changing C_x. For example, a value of 0.1 µF gives a range from about 0.1–30 Hz, and a value of 470 pF gives a range from about 10 Hz to 1.5 kHz. The maximum output frequency is 30 kHz.

The circuit can be built on a piece of perforated construction board using point-to-point wiring techniques. Further, it is inexpensive to build, and therefore practical for use in dedicated applications where the sine-wave generator is permanently incorporated into another circuit or device.

For more information on the MF-10 switched capacitor filter IC, write to National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051.—*Dale Nassar.* **R-E**

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, for U.S. residents only, 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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SHORTWAVE RADIO

A new column debuts

STANLEY LEINWOLL, CONTRIBUTING EDITOR

DURING EACH WEEK, MORE THAN HALF a billion people on this planet listen to their shortwave radios at least once. For many of those listeners, shortwave radio represents a source of news and information not otherwise available because many countries on Earth censor what is heard and seen on their media.

For many millions of other listeners, the excitement of shortwave radio comes from seeking broadcasts that originate as far as half a world away, in remote, and sometimes unlikely, corners of the world. The miracle of shortwave radio makes it possible, at virtually any time of day or night, to seek out those distant stations and, sometimes as an end in itself, obtain verification that they were heard on a given frequency at a particular time of day. The hobby of verifying broadcasts—DX'ing—has grown rapidly in the United States in recent years.

Whether you listen to shortwave radio to obtain another viewpoint, because you are a DX'er, or for the sheer joy of listening to the world, this column is for you.

I do not plan to inundate you with numbers unless they are of particular significance. There are more than enough shortwave publications available that provide numbers by the ton, and the *World Radio and TV Handbook* has more numbers in it than you can shake a whip antenna at.

What I hope to accomplish is to inform you about the general conditions you can expect during the next two months to facilitate your listening. You will be told which frequency bands will be best during the listening period, as well as any unusual conditions.

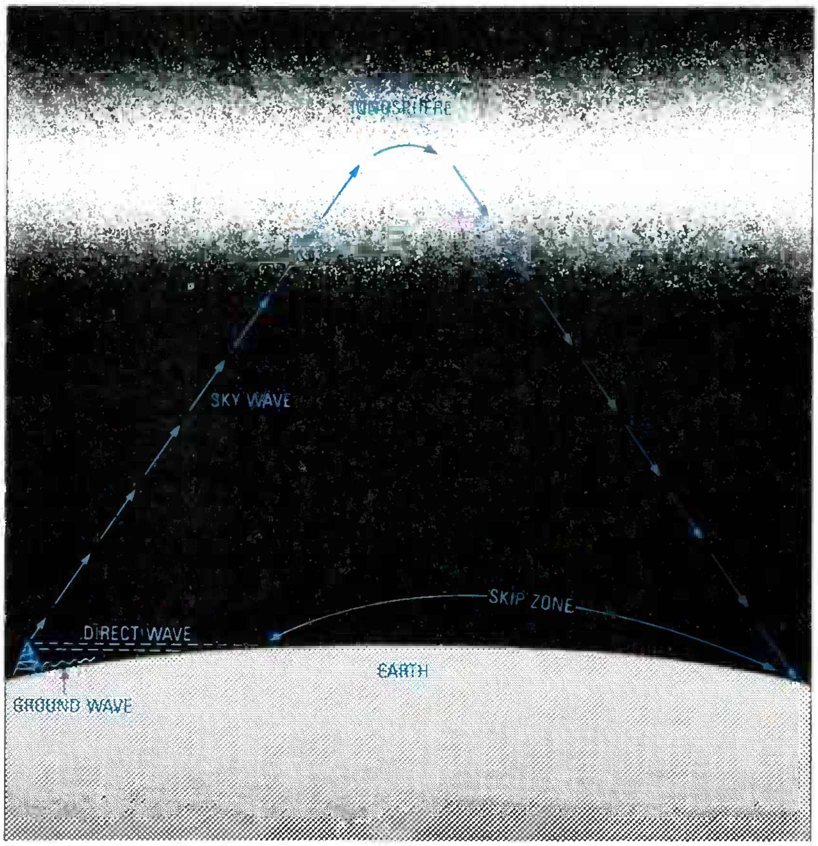

FIG. 1

There will also be a bi-monthly feature on a subject of special interest to listeners and DX'ers. Among the topics to be covered in future columns are sunspots, jamming, out-of-band broadcasting, radio storms, etc. In addition, other topics of more than passing interest will be covered, even though they don't relate directly to shortwave. For example, within a few years we will be seeing regular CB, TV, and possibly FM and amateur 6-meter DX. We hope to tell you about it just before it starts happening. I also hope to devote a future column to medium wave (broadcast band) DX.

I will have a chit-chat section that will periodically provide you with insider information: What new transmitter sites are under construction? What broadcasters are exchanging facilities, and where? What new clandestine stations are being heard, and where are they located?

Finally, and this will depend on you, there will be a mail-bag section. I will try to answer all your questions, and those of special interest will be reprinted here.

So, without further delay, let's begin. And what could be more appropriate for a shortwave column than to describe the medium itself, and how it works?

Shortwave propagation

When a radio wave leaves a transmitting antenna, it travels outward in all directions, as shown in Fig. 1. Part of the signal travels along the ground, and is called the *ground* or *surface wave*. Part of the signal travels through the lower atmosphere in a direction nearly parallel to the surface of Earth, in a line of sight trajectory. That component of the signal is called the *direct* or *space wave*. Still another part of the signal travels upward at an angle to Earth. That component is generally referred to as the *sky* or the *ionospheric wave*.

In the shortwave (high-frequency) portion of the spectrum (3–30 MHz), the ground- and space-wave components travel relatively short distances that rarely exceed 25 or 30 miles. The sky-wave component, however, often propagates to great distances, making long-distance shortwave communication possible. The medium that makes that possible is the ionosphere, a region of electrified gases in Earth's upper atmosphere that has the unique property of being able to bend, or refract, certain radio frequencies and return them to Earth at considerable distances.

Rocket, satellite, and other measurements have shown that the ionosphere extends from about 60 miles to several hundred miles above the surface of Earth. It is formed primarily by ultraviolet and X-rays from the sun. That solar radiation interacts with the gases in Earth's upper atmosphere and ionizes them—separates them into positively charged gas molecules and free electrons. The process is called ionization and the region is collectively called the ionosphere.

The ionosphere is not a single region. It actually consists of several distinct layers. Those layers, whose characteristics vary, are formed by different wavelengths of solar radiation. The most important layer of the ionosphere, insofar as shortwave radio is concerned, is the F-layer, which starts at an altitude of about 150 miles and extends to about 300 miles above the surface of the earth.

Radio signals that are refracted by the F-layer may be returned to Earth at distances as great as 2,000 miles from the transmitter. At the point where a signal returns to Earth, it may be reflected by the ground and returned once again to the ionosphere, where the process of refraction is repeated. That process may take place several times, and, although the signal weakens with each "hop," signals are often transmitted to remotely distant points by means of that multiple-hop method of propagating radio waves.

The skip zone

Close to the transmitting antenna, the ground and direct wave components are strongly received. The signal strength drops off very rapidly as the distance from the antenna increases, and within 25 or 30 miles or so is too weak to be received. Beyond the limit of ground and direct-wave reception there generally lies a zone of silence in which the signal cannot be heard. Then, at a still greater distance, a strong signal is received again. That is where the sky wave component first returns to Earth after being refracted by the ionosphere. The region between the end of the direct wave and the beginning of the sky wave is called the *skip zone*, and the distance between the two is called the *skip distance*. Both are functions of the frequency, time of day, and many other factors, which we will discuss in future columns.

There is rarely any skip zone after the first hop—that is the region where the sky wave first returns to Earth. That is so because the radio energy is widely dispersed by the planet, Earth, and by the ionosphere, as well.

Frequency dependence

When a shortwave radio signal enters the ionosphere it will either

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AUDIO UPDATE

History of hi-fi

LARRY KLEIN
AUDIO EDITOR

HI-FI AUDIO COMPONENTS AND THE baby boom were both post-World War-II phenomena. It has been suggested that the interest in high-quality audio equipment may have resulted from the technical training acquired during military service; the baby boom was self-explanatory. In any case, during the late 1940's and early 1950's, returned veterans began to acquire—through different means—both babies and audio equipment.

In June 1948, when Columbia Records announced the 33-⅓ rpm microgroove LP record, the "premature" audiophiles of the day were essentially limited to public-address, recording-studio, and broadcast equipment. If you were truly dedicated to operating at the leading edge of audio reproduction, you might own a 250-pound broadcast-console two-speed turntable with a 16-inch transcription arm bearing a very expensive European magnetic cartridge. All of that was to change in only a few short years.

FIG. 1

Early components (circa 1950)

A Sun Radio pamphlet entitled *Audio Equipment Handbook for Music Lovers* that was published in the early 1950's listed 15 phono-equipment manufacturers, 17 tuner and amplifier manufacturers, and 14 speaker manufacturers. And I suspect that there were at least a dozen more companies whose products weren't represented. A page spread from that pamphlet is shown in Fig. 1 where some of the accessories that were available can be seen. Some of the listed brand names still exist as audio companies—Pickering, Altec Lansing, Scott, Jensen, Jim Lansing (JBL), Electro-Voice—but most have long since faded away. Perhaps it's worth mentioning that everything was tube-operated in those good old days, and stereo was something that you looked through funny glasses to see.

Tuners

In 1950, Browning, Radio Craftsman, and Meissner were important brand names, and FM/AM-tuner prices ran from a low of about $45 to almost $200 for a state-of-the-art-model that included a full complement of switched inputs and tone controls; however, stereo FM broadcasting was still about 10 years away. The higher-priced quasi-preamp tuners were meant to directly feed a power amplifier.

Amplifiers

The amplifiers in those days were mostly single-chassis integrated models with powers ranging from 8 watts to a high of about 30 watts. Prices ranged from about $40 to over $200 for an H.H. Scott "remote control" amplifier with a "Dynaural" noise-suppressor circuit. The remote-control feature refered to a separate full-featured preamp that derived its power-supply voltages through a thick multiconductor cable plugged into the power-amp's chassis.

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order to be a successful audio sales manager in the U.S. it was necessary to "Look British—and speak Yiddish."

The Williamson power-amplifier circuit appeared in England in 1947 and its simplicity and superior performance made it a popular build-it-yourself project for advanced audiophiles on both sides of the Atlantic. It required a carefully wound output transformer, and the original article in *Wireless World* provided precise instructions on how to wind your own. Several companies came up with versions of the transformer, and commercial versions of the Williamson amplifier subsequently appeared under a variety of U.S. and British brand names.

Record players

Changers of reasonable quality were available from Webster-Chicago, Garrard, and V-M, but anyone who was really serious owned a manual turntable from Red-O-Kut, Presto, or later, Thorens. Tone arms and cartridges were available from Audax, Clarkstan, Fairchild, Pickering, General Electric, and Weathers. The last two deserve special discussion: The GE was a high-quality, reliable "variable-reluctance" magnetic cartridge that was only slightly more expensive than the crystal cartridges of the day. However, it did require a "preamplifier" to boost its 6-8 millivolt output up to the 0.5-volt level of the usual "xstal" phono-cartridge input. It was a tribute to the success of the GE cartridge that in the next year or so all new integrated amplifiers—even those at the lower-price levels—came with "mag" inputs. A 6SC7 tube usually provided the extra gain.

The Weathers FM cartridge and tone arm were exceptional products very much ahead of their time. For example, the Weathers cartridge would track reliably at 1 gram, while most other brands were grinding away at 6 to 8 grams. The Weathers low-mass basswood tone arm not only ignored warps, but was so designed that it was untroubled by the critical leveling requirements that troubled most other arms. In fact, I found that the Weathers tone arm could play reliably with the turntable tilted at a 45-degree angle.

All cartridges offered a choice of sapphire or diamond stylus and tip radii intended for microgroove (LP) or standard (78 rpm) recordings. Of course, everything was monophonic since stereo discs were not due to appear until mid-1958.

Tape

In the early 1950's there were a few open-reel home tape recorders, most of which offered single- or two-track heads, and 3-¾, 7-½, and 15 ips (inches per second) speed options. The best of the units, which cost between $350 and $500 in 1954 dollars, had a performance at their 15-ips speed roughly equivalent to that of a cassette deck selling for $350 to $500 in inflated 1986 dollars. Some of the two-track machines that were available could be hooked up to play stereo, but there wasn't any real interest in stereo tape until Shure's 1958 introduction of the first four-track tape head.

Stereo growing pains

1958 was a very good year for stereo. The conflict among the various stereo-disc formats was finally resolved in favor of the Westrex system still in use today. The audio industry geared up for the change, and the 1959 hi-fi directories listed about thirty models of stereo preamps, power amps, and integrated amplifiers. (The directories from the previous year had

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ANTIQUE RADIOS

Our readers write

RICHARD L

THIS MONTH, WE'LL TURN OUR ATTENtion to some of the many questions I've received from budding antique-radio hobbyists. Not surprisingly, many of those questions have involved the prices of some old radios.

Assigning a monetary value to an old radio is a very subjective task. Technically, no radio can truly be an antique; in the antique field, that term is generally reserved for items that are at least 100 years old. Instead, a radio is a "collectible." As with all collectibles, or antiques for that matter, the value is set by the marketplace and hinges on several factors. Of course, the condition of both the electronics and the cabinet are critical, but regional demand and the "fad" factor can also play significant roles. There are several price guides available, but their accuracy can vary widely.

Further, there's no guarantee that market conditions will stay the same or improve. An antique or collectible that's "hot" today could easily be "cold" tomorrow, leaving those who invested in that type of item with large losses.

Therefore, the best guide to value is common sense. Collect for the pleasure of it, not for future rewards. When sizing up a new acquisition ask yourself: What am I willing to pay to add this particular radio to my collection? The answer will tell you whether or not a radio is a "good buy."

What is it?

Many readers are sending in photos or descriptions of radio sets for me to identify. I always

FIG. 1

enjoy receiving such photos because early sets are fascinating. But, would you believe that during the first decade of broadcast radio (the 1920's), there were over 1000 manufacturers! Some made many different models during that time, others made but a few.

What's more, during the same period there were many hobbyists that built their own sets from plans published in the electronics magazines of the day. Those sets often used top-quality parts and featured construction that was superior to anything available in a store. The radios they built make up a large pool of unidentified and unidentifiable units.

Despite all of those handicaps, if you send in your photos, I'll do my best to identify a set for you, or at least match it up with a similar one. However, if you want any of those photos returned, *please enclose a self-addressed, stamped envelope*. Otherwise those photos will remain in my files.

Radio restoration

Don't get the idea that none of the questions I get are technical; many are. But the most popular question is how faithful to the original must a restoration project be?

The answer is that it should be as faithful to the original as is practical. If you are going to restore only one or two radios, then it's possible and enjoyable to take the time to search out the part or parts that you need. But if you are someone like myself that may have some 30 or 40 sets on hand at a time, some allowances must be made to keep from being overwhelmed. It's a lot more rewarding to get your sets operating and on display (see Fig. 1) then to have them all on your workbench waiting for original parts.

There is a difference, however, between making a substitution or modification and stripping an antique radio of any semblance of its original design. Some readers have asked that I cover using solid-state components as substitutes for vacuum tubes. I won't do that because it goes against the spirit of what most antique-radio hobbyists are trying to achieve. Even if the changes were made under the chassis and the original components were left in place for show, it would be little better than installing a transistor radio in an old cabinet. Old tubes, etc., may be hard to find, but there seems to be sufficient supply still around to make doing that type of modification unnecessary.

On the other hand, however, if you need to replace a capacitor or resistor, there's no reason not to use a modern component. Further, capacitors often deteriorate over time. That's particularly true of the old paper types. In fact, some hobbyists practice a little bit of preventive medicine by replacing all of the capacitors in their sets with new units.

On-off switches can be a headache. That's because they sometimes are combined with other components, such as a potentiometer. For safety, **never try to repair a broken power switch.** Instead, find a suitable replacement. Sometimes, an electronic wholesaler can fabricate a suitable switch, however there are few who will take the time to search their stocks for the suitable parts. A long-established TV or radio repair shop may be more helpful, or try sending an SASE to some of the names on the Haves list that we publish on occasion.

To operate the set in the meantime, you can use a simple toggle switch. Mount the switch on a bracket at the rear of the chassis rather than on the front of the cabinet. Then you won't have a hole to patch later.

Working with cabinets

That brings us to our last popular question for this month: How do I restore my cabinet? Unfortunately, the time to ask that question is when you are buying the set. The condition of the cabinet should play an important role in determining whether the radio is worth having, especially if you are not experienced in woodworking. Further, the condition of the cabinet will often reflect the condition of the chassis.

Even if you are comfortable working with wood, you should remember that refinishing radio cabinets is more difficult than refinishing many other pieces of furniture because you are working with thin veneers cemented to a lower-quality wood.

The reading list

On occasion I mention something in my column that results in a stack of mail. Recently, that happened with my request for reading material on antique radios. As soon as I can confirm the availability of the various publications, I will pass the information along. My thanks to everyone who took the time to respond. **R-E**

SHORTWAVE RADIO

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be reflected back to Earth, penetrate the ionosphere and be lost in outer space, or be absorbed by the ionosphere and so weakened that it dies out entirely. The effect of the ionosphere on the radio wave depends primarily on its frequency, the angle at which it leaves the transmitting antenna, and the variable condition of the ionosphere.

With few exceptions, the ionosphere will reflect a fairly wide range of frequencies. Frequencies above that range will penetrate the ionosphere, and frequencies below it will be absorbed. The highest frequency that the ionosphere will reflect over a particular circuit is called the *M*aximum *U*sable *F*requency, or MUF. The *L*owest *U*sable *F*requency is called the LUF.

That's all for now. Next time we'll continue with a discussion of the layers of the ionosphere.

Condition report

Many of the world's shortwave broadcasters will make major schedule changes on March 6, in accordance with international radio regulations, which stipulate schedule changes be made on the first Sunday in March, May, September, and November.

During recent years, however, there has been a tendency on the part of some major broadcasters, such as the Voice of America and the BBC, to make major schedule changes only twice yearly—in March and September, to coincide with the changes in European clock time.

On March 27, therefore, when Europe shifts to summer time, the VOA and the BBC will, among others, inaugurate their summer schedules, which will continue until September 25.

During the spring, with increasing hours of daylight in the northern hemisphere, the higher bands—15, 17, and 21 MHz—will be open longer. At night, frequencies from 6 to 11 MHz will be open for DX, with 11 MHz especially strong from Latin America, Africa, and Australia. **R-E**

AUDIO UPDATE

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none.) Of the twenty or so phono cartridges listed, about half were stereo, and those were equally divided between ceramic and magnetic types. A number of stereo adapters were also available; they provided the master volume control and the switching facilities needed to combine two separate mono systems into one clumsy stereo system.

Several tuners labeled AM-FM stereo were also on the dealer's shelves—despite the fact that there were no stereo FM broadcasts. The tuners were stereo in the sense that they had independently-tuned AM and FM sections whose outputs were available separately and simultaneously. A station with AM and FM affiliates would occasionally broadcast stereo material with one channel mostly on AM and the other mostly on FM. (It had to be a "mostly" arrangement to prevent AM- or FM-only listeners from losing half the audio material.) But despite the limited separation provided by AM-FM stereo, I remember how thrilling it sounded—particularly with headphones. (Incidentally, there were no commercial stereo headphones at the time; I had to rewire a pair of military-surplus mono phones.) Also in 1958, the first Japanese audio product arrived; it was an unhoused $25 8-inch full range driver made by Panasonic. I'm sure that at the time no one in the U.S. could guess what it ultimately presaged.

Next time, we'll continue our look back and then peer into the crystal ball for a look into the future.

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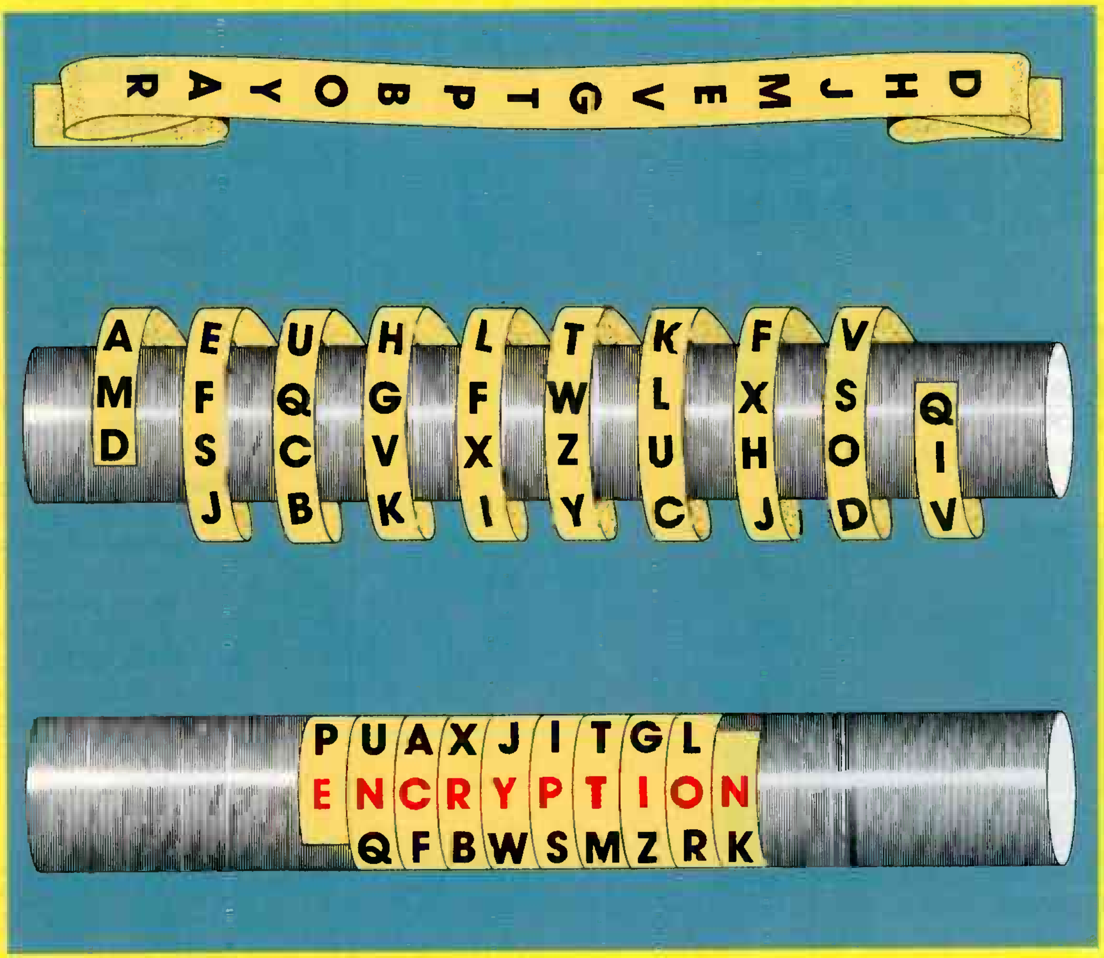

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The PC-compatible expansion connectors

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Irwin's tape backup system, and more!

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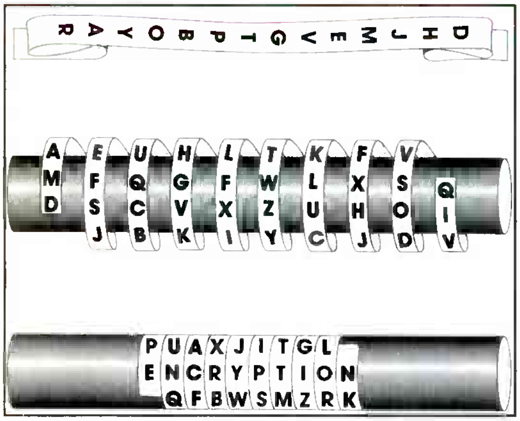

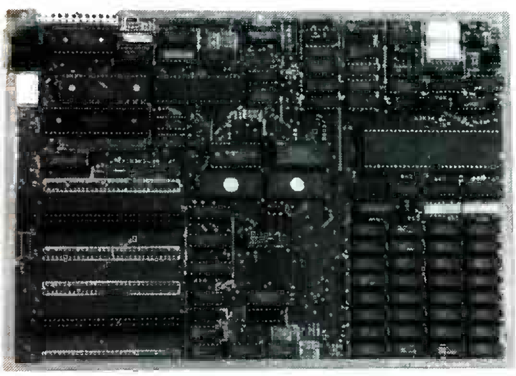

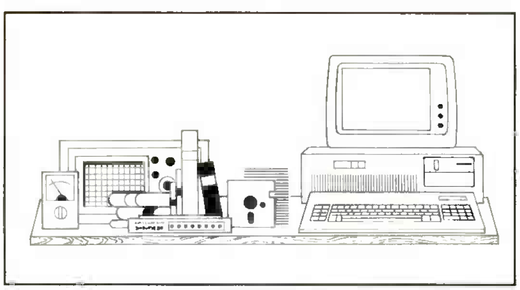

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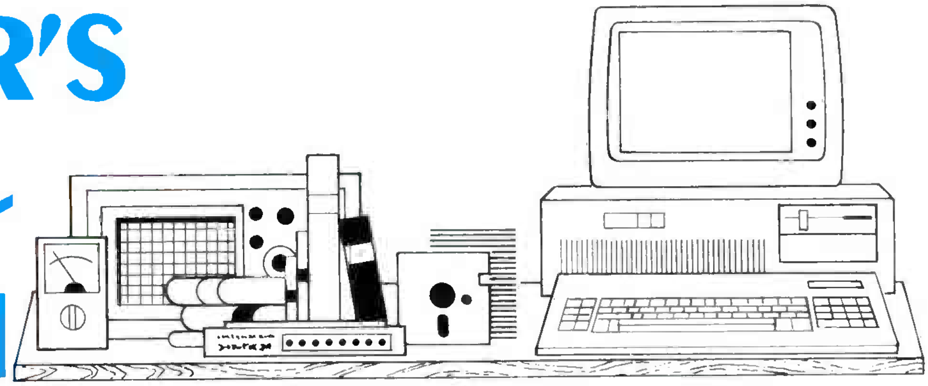

Irwin Model 310 Backup Tape Subsystem

Because a hard disk holds a relatively huge amount of data, making floppy disk backups is often so time-consuming and expensive that many users prefer to play Russian-roulette with their data, hoping that the hard disk won't fail, and that someone doesn't accidentally key in the command DEL *.* and erase an entire directory. But we all know what must eventually happen, because even with the best of luck and care, hard disk drives quite often have a rated lifetime of only five years.

The best way to guard against both a *.* delete and a hard-disk failure is to back up the hard disk with magnetic tape, because next to punched paper

tape—which is no longer in general use—magnetic tape is the most reliable storage media for personal computers, and it can do its job while unattended.

Low-cost system

One of the lowest cost and easiest-to-use tape backup systems that we've come across is the Irwin Backup Tape Subsystem, which is available as the model *310* for PC and XT compatibles and clones. See Fig. 1. (A somewhat different model, the *325* is available for use with the AT.)

The Irwin tape subsystem copies files from a hard disk to a magnetic-tape cartridge, and restores the files in the event the originals are damaged. Most important, the subsystem can restore files either to the hard disk or to a floppy; so if the hard-disk unit actually dies you can continue using your files from floppies until you get the hard-disk unit repaired or otherwise replaced.

The system consists of an integral tape drive and power supply unit measuring approximately 11.5"D × 4.5"H × 6.75"W, and controlling software that is compatible with DOS 2.0 or higher. The tape mechanism uses the Irwin-type *TC200* and 3M-type *DC1000* mini data cartridges, which can store up to 10 megabytes. If the hard disk contains more than 10 meg, or if the tape's 10-meg capacity will be exceeded, operations automatically cease and the user is prompted to install another cartridge.

Just one connection

The backup subsystem has only one signal cable, whose connector matches the 37-pin D-connector on the back of a PC/XT's disk controller. The D-connector is there because IBM originally made provision for four floppy drives: two internal, two external. The Irwin tape subsystem uses one of the two external floppy connections. If your PC/XT-compatible is one of the models having a multi-function disk controller, and therefore doesn't have the 37-pin connector, you must purchase an optional interface adapter for the tape backup, or substitute an IBM-type disk controller.

The Irwin system requires that the tape be specially formatted. One formatted tape is supplied with the system. Others are formatted using the supplied TFORMAT software. The two-part formatting records a servo pattern that identifies eight specific tracks on the tape, and the block structure used for storing the data. The formatting verifies the tape as it writes the block structure, and if the tape contains a spot that cannot be recorded or read reliably its block is listed at the beginning of the tape in a "bad-block" table, and that block is skipped over each time during subsequent save and restore operations.

Backup and restore

To backup or restore files, the user simply calls up the appropriate menu-driven IMAGE or FIPS (file oriented) software. In an image backup, all the parts of the hard disk known to DOS are transferred to tape, except for empty sectors. During an image restore, the data is put back on the hard disk exactly from where it originated. The user has no control over what gets restored—it all gets restored. If, in the interim, a bad spot has developed on the hard disk, the restore won't know about it and will simply write the data back over the bad spot, and the data will be unusable.

In a file backup, directories that represent the groups of files the user has selected for backup are written on the tape. The groups, called *savesets*, can be keyed to a specific date and time, to selected files, to specific directories, or to files that were modified since they were last backed up. The files can be restored to the hard disk as a unit directory, by saveset name, or even individually. Since a FIPS restore is file oriented, it will not write over a defective spot on a hard disk (because it will fail the verify). Alternately, if the hard disk is reformatted to lock out bad spots, the FIPS software will simply restore the files using the good sectors. Unlike an image restore, a FIPS restore represents only the files themselves, not the precise location of those files on the hard disk.

Command driven

Although the three supplied programs—TFORMAT, IMAGE, and FIPS—are menu driven, a command structure is also available through the FIPS program. The advantage to the command mode is that it has more flexibility and allows more sophisticated save and restore operations. For example, the user can take a directory listing of a saveset and create a customized saveset having a selected group of files. Files from other disk directories can also be included in the custom saveset. The command mode also allows individual files to be unselected from a saveset.

In the restore mode, the command structure allows the usual directory listings, can restore or copy selected files or groups of files to the hard disk or floppy disks, can unselect files from groups to be restored, and can even restore new versions of files in place of older versions having the same file name. If it's necessary to preserve both old and new versions of a file, DOS can be used to rename either the old or new files.

Reusing tapes

The tapes can be reused any number of times, but the data must be erased first. The FIPS program provides a RESET function that erases the tape—actually, only the data is erased. If the tape is erased by using a bulk tape eraser it must be reformatted, because unlike the RESET software, bulk erasure destroys the tape's formatting. On the other hand, if you want to reformat a tape because you believe the tape is defective or that new "bad spots" have developed, the tape must be bulk erased because servo writing on a formatted tape can create conflicting servo signals.

The Irwin *310* tape subsystem is available from computer dealers for about $450, or less, depending on the particular source. The exact same tape mechanism and software (no housing or power supply) is also available for internal mounting within the computer for a price that's about $100 less. For further information on the system it's best to write directly to the manufacturer, Irwin Magnetics, 2311 Green Road, Ann Arbor, MI 48105.

AutoCAD and AutoSketch, by Autodesk

AutoCAD is the standard by which all other personal-computer based CAD systems are judged. The program has become an institution in itself; is it used not only for its intended purpose of computer-aided drafting and design, but also as a speed benchmark and as a compatibility-testing program for new hardware designs. Subsidiary industries have arisen that supply AutoCAD add-ons, add-ins, and educational materials.

Until a few years ago, AutoCAD was the only product of its type, but as the market has expanded, competition has increased. To meet that competition, Autodesk has not rested on its laurels. New versions have been introduced at the rate of several per year, and each version has greatly improved on the capabilities of its predecessor.

Those improved capabilities have brought concomitant increases in the hardware required to run the program. It was possible, if impractical, to run previous versions on an XT (or compatible), but an 80286 microprocessor running at 8 MHz really is the minimum hardware for acceptable performance. In addition, the current version (called Release 9) simply will not run without a math coprocessor (8087, 80287, or 80387), which can cost anything from $100 to $500, depending on the type of IC and its speed.

AutoCAD is not cheap; the list price of Release 9 is $2850. If that sounds like a lot of money, it is. Counting the cost of the hardware (computer, mouse or digitizing tablet, printer, plotter), you can easily double or triple that figure. Counting the cost of user training, you can easily add several hundred or thousand more.

If that makes you weak in the knees, either you don't need the facilities AutoCAD provides, or you're being unrealistic about the investment that's required to attain them.

At the other end of the spectrum is a program Autodesk released this past summer. AutoSketch is an easy-to-use drawing program that sells for under $100. (Weak-kneed types take note.) You cannot do with AutoSketch what you can with AutoCAD, but you can do a great deal. In fact, you can do a rough draft of a drawing in AutoSketch, and then transfer it to AutoCAD for final polishing.

Actually, there are two versions of AutoSketch: The standard version ($79.95) will use a math coprocessor, if one is present; the enhanced version ($99.95) requires one. The enhanced version runs three to nine times faster than the standard version.

What is it like to use AutoCAD? What is it like to use AutoSketch? How are the two similar? How are they different? In what follows, we'll try to answer those questions. Keep in mind, however, that thick books have been written that describe use of AutoCAD, so we'll only be able to hint at some of its advanced features. Both programs will work with just the keyboard, but using a mouse or digitizing tablet is much more convenient and productive.

Installation and documentation

The AutoCAD package weighs about ten pounds; the box contains a hardbound Reference manual, a supplement to it, an Installation Guide, a Programmer's Reference, a quick-start guide, and other materials. The Reference manuals are highly technical, and not suitable for use in learning the program; if you're new to CAD you'll almost certainly want third-party training, or at least one of the many books on learning how to use AutoCAD.

The software itself is contained on ten DSDD floppy disks. Installation takes about ten minutes, and is not automatic, so you must have basic understanding of DOS commands, subdirectories, etc. You'll need more than a megabyte of disk space for the required files.

AutoCAD requires a graphics adapter of some sort; the program supports all common display adapters, including CGA, EGA, PGC, and Hercules, as well as many specialized adapters, for a total of about 40 in all.

Similarly, some 30 digitizing instruments are supported, including most popular mice (Microsoft, Logitech, Mouse Systems) and digitizing pads (Houston Instruments, Pencept, Summagraphics). Seventeen types of plotters and fourteen types of printers are also supported. Device drivers are updated fairly often, as new hardware is released.

As for RAM, the program will run in 512K, but some functions will be unavailable. AutoCAD really needs 640K, with few RAM-resident programs occupying any of it. In addition, AutoCAD can be configured to use extended (AT) or expanded (EMS) memory.

The first time you run AutoCAD, you must configure the program for your hardware. Thereafter you can do so at will. You needn't clutter your hard disk with unnecessary software drivers; they can be called in from the installation disks if you change hardware.

AutoSketch, by contrast, comes in a slender package weighing less than a pound; software is contained on a single disk. (A second disk containing sample drawings is included.) The program supports only the most popular display adapters, digitizers, printers, and plotters. All installation information is maintained in the program itself, so you needn't worry with extra files containing hardware drivers. You can only set the program up to drive a single printer or a single plotter (AutoCAD supports one of each); to create draft prints on a dot-matrix printer and final copy on a plotter, you must re-configure the program, or maintain two separate copies of it. AutoSketch will run on an XT with 512K of RAM and two floppies. However, more RAM, an accelerator card, a math coprocessor, and a hard disk make it much more pleasant. The program does not utilize extended or expanded memory.

A 58-page paperback book contains the program's documentation. The book is a model of clarity and conciseness. It contains a quick-start tutorial and a reference section. The book is well indexed. You won't need third-party documentation in order to become proficient with the program.

Off and running

At this point, we'll describe how you work with AutoSketch. AutoCAD has most of the facilities we'll discuss; we'll point out those it doesn't, as well as differences in how those it does have are accessed. Then we'll go on to discuss some of the many facilities that are exclusive to AutoCAD.

AutoSketch first presents you with a drawing screen like that shown in Fig. 1. The central portion is for drawing; the top line contains menu titles, the current time, and a memory-usage indicator; the bottom line contains the current file name, and is also used for prompts.

A menu is accessed by moving the pointer to its title and pressing a mouse button (to Macintosh and Windows users, a process known as *clicking*). A menu "drops down," revealing several options. The Draw menu (shown in Fig. 1), for example, allows you to pick the type of figure you'd like to draw: line, circle, arc, box, text, etc. The Change menu allows you to modify drawing entries; you can erase, copy, and move items, as well as rotate them, create mirror images of them, stretch them, etc. The View menu allows you to magnify a portion of your drawing, in one of several ways. The Assist menu sets up operational characteristics that help you align drawing elements. The Settings menu lets you pick line type, drawing color, drawing layer, size and orientation of text, etc. Measure allows you to determine lengths and angles of drawing elements; the menu also allows you to add automatic dimension lines and values to horizontal and vertical objects. If you use the Stretch item in the Change menu, those dimensions will automatically change accordingly. Last, the File menu allows you to save the current file, clear the screen for a new drawing, load a previously saved drawing, play a game, etc.

Working with AutoSketch is easy, intuitive, and fun. And, because of two special features (Undo and Redo), you feel free to experiment. If you make a mistake—even erase the whole drawing—just choose Undo, and the drawing will be restored to its previous state. In fact, AutoSketch maintains a file listing each change to the current drawing; successive Undo's can be counteracted by successive Redo's. Undo/Redo is one of the few features that actually works better in AutoSketch than in AutoCAD.

Getting your drawing on paper may take some experimentation the first time around, but once you understand the system, it works well. From the File menu you create a plot box, which appears on-screen as a box labeled "Plot box", along with the plot size (in inches) of the box. If you find that part of your drawing is cut off, or the plot box is wider than your printer, just change the draw/plot ratio and view the new plot box.

AutoCAD

AutoSketch is so intuitive that you can become proficient with it in just a few hours. AutoCAD, on the other hand, requires much time and study before you can even begin to talk about proficiency. And because the program has a built-in programming language, as well as the ability to be thoroughly customized, proficiency means more than just deep familiarity with the program; it means customizing it for your hardware and for the type of work you do. In fact, numerous companies are in the business of customizing AutoCAD for specific applications—electronics, for one.

For example, the Great Softwestern Company markets a product called AutoBoard that turns AutoCAD into a system that helps you create schematic diagrams. With the information provided, AutoBoard can then automatically generate a PC board. (See page 71 of the August 1987 issue for a discussion of AutoBoard.)

The classic AutoCAD screen is shown in Fig. 2. The top line shows status information; the bottom line shows the most recently entered commands; and along the right is the program's main menu. The main menu leads to subsidiary menus, which in some cases lead to yet other menus. For example, choosing *Display* from the main menu leads you to a menu that gives you several ways to vary your view of the current drawing. The most common are *Pan* and *Zoom*. Choosing the latter brings up yet another menu that allows you to look at the previous view, the entire drawing, an area you define by drawing a box, etc.

That's classic AutoCAD. The new version beefs up the graphics appeal of the program. For one, colors are used more effectively than in previous versions. But the biggest change is in the drop-down menus. In Release 9, when you move the pointer into the status line, it changes into a series of menu titles. Click on one and a menu drops down. Then click on the desired function, and get to work. Figure 2 shows AutoCAD's drop-down menu of drawing tools.

The drop-down menus in and of themselves don't add any new drawing or design capabilities. In fact, they present a limited subset of AutoCAD's plethora of functions. But they do provide a more intuitive way to get at those functions. And you can customize the menus, removing functions you don't like to use, and adding others that you do.

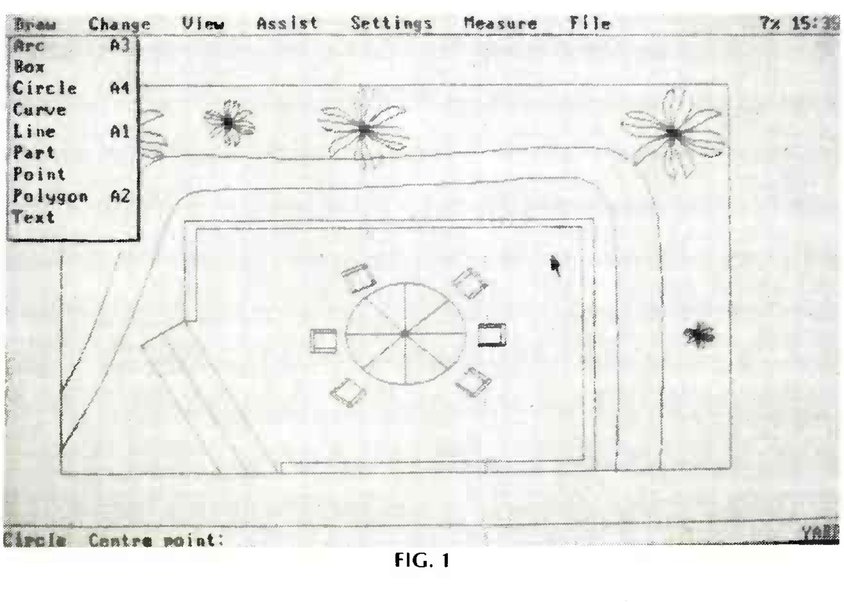

FIG. 1

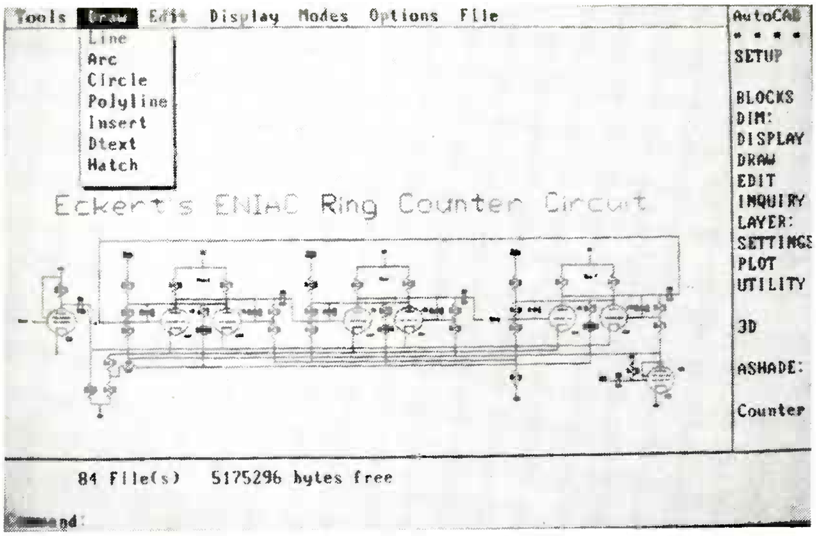

FIG. 2

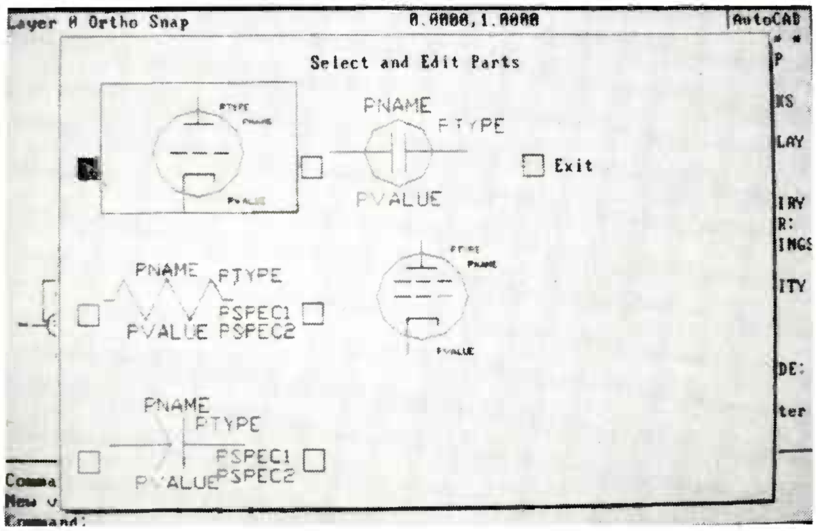

FIG. 3

Graphics are put to good use in other places, too. For example, older versions of AutoCAD required you to select hatch patterns by name; now a Dialog Box presents samples on-screen; you choose the desired one by clicking on it. For inserting "parts" into drawings, you can create your own menus, as shown in Fig. 3.

To help you differentiate between AutoCAD and AutoSketch, let's discuss several commands that AutoCAD shares with AutoSketch, pointing out how they differ in the two programs. In addition, we'll show the enhanced versions of many commands that AutoCAD provides; those commands can greatly simplify some kinds of work. Our discussion will be representative, not exhaustive.

Both programs allow you to copy drawing entities by selecting them one-by-one or in groups. In addition, AutoCAD provides an Array command that allows you to create a circular or rectangular array of objects. Laying out an array of memory IC's on a PC board would be child's play with that command.

Both programs provide a Break command that allows you to delete part of an entity—the end of a line that is too long, for example. AutoCAD improves on Break with the Trim and Extend commands. Essentially, Trim performs a Break on multiple objects simultaneously. Extend, on the other hand, allows you to patch up an object that has been Trimmed or Broken too much (or that for any other reason needs to be extended).

Two areas in which AutoSketch is sorely lacking are hatching and text fonts. The program provides no hatching at all, and only a single, rather ugly text font. AutoCAD, however, provides almost four dozen hatch patterns and almost two dozen text fonts. You can create your own hatch patterns and text fonts if you like, and several companies market such products independently.

AutoCAD has no true three-dimensional capabilities, but it has a number of commands that allow construction of three-dimensional objects. More commands are added to each release of the program; we expect a full 3-D version in the not-too-distant future. AutoSketch has nothing comparable.

Third-party support is one area in which AutoCAD really shines. AutoDesk itself occasionally publishes a book listing products for enhancing or customizing AutoCAD. The *AutoCAD Applications Catalog* runs more than 300 pages, and contains products that support disciplines ranging from electronics to theatrical lighting.

Because it is so new, we have seen few support products for AutoSketch, but just as we were going to press, libraries of electronics and other symbols was announced by CAD Easy.

Disk Technician

Reliability is the most important characteristic of a hard disk. In fact, an unreliable hard disk is worse than no disk at all. Hard disks are inexpensive these days, but not so inexpensive that you can afford simply to throw an unreliable one away. But what can you do with it? You can perform a low-level format, hoping that marginal sectors will be recognized and marked, so that DOS will not try to use them. The problem is that most low-level format routines are not sensitive enough to pick up intermittent errors.

A company called Prime Solutions learned about unreliable hard disks the hard way (no pun intended). Prime Solutions came into existence building CP/M machines that were very powerful for their day (1980). The machines never came to market because of—you guessed it, intermittent hard-disk troubles.

Attempting to locate and remedy the problem, the company switched direction. Rather than build computer systems, Prime Solutions focused on writing software that would both find and fix intermittent disk errors. Early last year the fruit of their effort finally came to market in a product named Disk Technician.

Actually, there are two versions of the program; Disk Technician and Disk Technician Plus. The former ($99.95) can handle standard (MFM) hard disks of up to 32 megabytes; the latter ($129.95) can handle RLL disks, partitioned disks, and disks larger than 32 megabytes. We evaluated Disk Technician Plus.

Before installing the program, we had been having some trouble running several disk-speed benchmarks in conjunction with some equipment we were testing. Occasionally we'd receive a value ranging from two to four times the usual value. We figured our disk was suffering from "soft" errors (bits on the hard disk that sometimes showed up as a 1, and at other times as a Ø), and those errors caused DOS to retry—in some cases many times—reading some sectors. The problem was that we had no idea which sectors were causing the problem. So we backed up the disk, did a low-level format (using our Xebec controller's built-in format routine), restored our files—and still suffered the same problems.

We were considering junking the drive when we learned of Disk Technician. We obtained a copy in short order, and let it run its paces on our disk—a process that took about seven hours. When finished, it had noted *and repaired* 101 soft errors of various types, and it had simply marked several sectors as bad, so that DOS would not try to use them. The program also took note of about 140K of "suspect" areas, which it would specially monitor in future runs.

After running Disk Technician that first time, our benchmarks ran consistently. But we'll be watching that drive very carefully from now on.

Preventative maintenance

For maximum reliability Prime Solutions recommends running Disk Technician on a daily basis. The program comes with daily, weekly, and monthly tests, which take progressively longer periods of time, but which do progressively more comprehensive testing and repair. On our machine, the daily test runs in six minutes, the weekly test in about two hours, and the monthly test in about seven hours. Those times will vary, depending on the type of disk and on its quality. You can run each test automatically, in which case the entire disk is tested, or manually, in which case you can then test individual tracks and sectors.

Disk Technician maintains a database of several classes of errors; it processes the database using what the company calls AI (Artificial Intelligence) techniques. It thereby monitors all of the occasional soft errors, upgrading their status as they become more frequent, and finally marking a sector as bad if the errors become too frequent.

The program allows you to perform a non-destructive low-level format (on an AT), a destructive low-level format (on an XT), and it comes with a small RAM-resident utility that automatically parks your disk's read/write head after a user-specified period of inactivity.

The manual shows you how to run Disk Technician without getting involved in the details, but if you're so inclined, it also has a lot of information.

The only problem with Disk Technician is that it's copy protected; you must run the program from the distribution disk. You can make a backup copy of the disk, but you'll still only be able to run it on the same hard disk. Considering the benefits, however this, may be one case where it is worthwhile tolerating the inconvenience of copy protection.

Correction

An apparent installation error caused erroneous timings of PC Technologies' Rainbow Plus to be reported in the article "Turbocharge Your PC," which appeared in the November 1987 issue. The board is actually much faster than reported; in fact its speed in most tasks is roughly equivalent to that of the BreakThru 286. Our apologies to PC Technologies for the error.

GrafPlus

Print-screen utilities—at least good ones—are hard to come by. Here's one that sells for only $49.95, and can print just about any IBM screen on just about any printer. In fact, GrafPlus can print screens from all common IBM video adapters (Hercules, CGA, EGA, PGC, VGA), and several you probably never heard of. Likewise with printers—the present incarnation of the program can drive literally hundreds of printers (including laser printers).

Printing color screens on a black-and-white printer? No problem; GrafPlus does a reasonable job of translating colors into different shades of gray. You can set the program up to print in landscape (horizontal) or portrait (vertical) orientation. You can also set it up for reverse printing. All those capabilities cost you only about 13K of RAM.

Installing the program is simple; you can specify the desired video adapter, printer, and the print parameters (reverse, etc.) on the command line. If you don't specify the desired set-up on the command line, the program presents you with a series of menus that allow you to choose your set-up by number.

In the unlikely event your printer isn't on the GrafPlus list, you can add it yourself (assuming you can dig a few control codes out of your manual).

Linkable binary forms of the program are included, so a Fortran, BASIC, or Pascal programmer can link the appropriate file in his program, and cause a screen to be printed at will. Another special feature is the ability to "clip" portions of the screen image. That allows AutoCAD users to avoid printing the menu and command-line areas of the screen.

As much as we like GrafPlus, we have a few suggestions that would make it even easier to use. First, you cannot change any of the program's operating parameters without rebooting and reloading the program. For example, in order to obtain the best printout you might want to print a screen in both normal and reversed modes. The only way to do so is to reboot, re-install GrafPlus, run your application again, and then press the print screen key.

Second, you can only clip the right and bottom edges of the screen. The ability to clip all four edges could be useful, depending on the application.

Third, printing Hercules monochrome graphics screens can be a little tricky, because some programs use the first page, and others use the second. Because you can't change operating parameters on the fly, you may have to experiment (i.e., re-install the program) to find which page your application uses. A way of toggling between the two pages after pressing the print-screen key, perhaps by pressing the space bar, would be very useful.

However, those wish-list items don't detract from the real usefulness of GrafPlus. If you need to print the screen of anything but a standard CGA, you need GrafPlus.

PRODUCTS REVIEWED

- Model 310 Backup Tape Subsystem (prices vary), Irwin Magnetics, 2311 Green Road, Ann Arbor, MI 48105.
  CIRCLE 50 ON FREE INFORMATION CARD
- Disk Technician ($99.95, $129.95), Prime Solutions, Inc., 1940 Garnet Avenue, San Diego, CA 92109. (619) 274-5000.
  CIRCLE 51 ON FREE INFORMATION CARD
- GrafPlus ($49.95), Jewell Technologies, Inc., 4740 44th Ave. SW, Seattle, WA 98116. (800) 628-2828 ext. 527, (206) 937-1081.
  CIRCLE 52 ON FREE INFORMATION CARD
- Rainbow Plus ($945), PC Technologies, 704 Airport Road, Ann Arbor, MI 48106. (313) 996-9690.
  CIRCLE 53 ON FREE INFORMATION CARD
- AutoCAD ($2850), Autosketch ($79.95, $99.95), Autodesk, Inc., 2320 Marinship Way, Sausalito, CA 94965, (415) 332-2344.
  CIRCLE 54 ON FREE INFORMATION CARD
- The AutoBoard System ($2500), The Great Softwestern Company, Inc., 207 W. Hickory St., Suite 309, Denton, TX 76201.
  CIRCLE 55 ON FREE INFORMATION CARD
- AutoSketch Symbol Libraries (prices vary), CAD Easy, 15125-D S. W. Koll Parkway, Beaverton, OR 97006, (503) 649-0966.
  CIRCLE 56 ON FREE INFORMATION CARD
- For information on learning AutoCAD, we recommend *Inside AutoCAD*, New Riders Publishing, P.O. Box 4846, Thousand Oaks, CA 91360, (818) 991-5392.
  CIRCLE 57 ON FREE INFORMATION CARD
- *CADalyst, The Journal for AutoCAD Users* is published bimonthly by CADalyst Publications, Ltd., 282-810 W. Broadway, Vancouver, BC, Canada, V5Z 4C9, (604) 873-0811. The magazine contains update information, hints on using AutoCAD more effectively, new product announcements, and advertisements from third-party vendors of AutoCAD add-ons.
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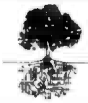

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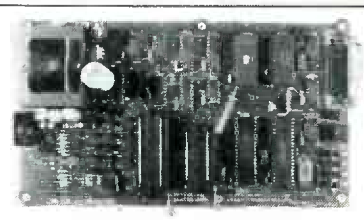

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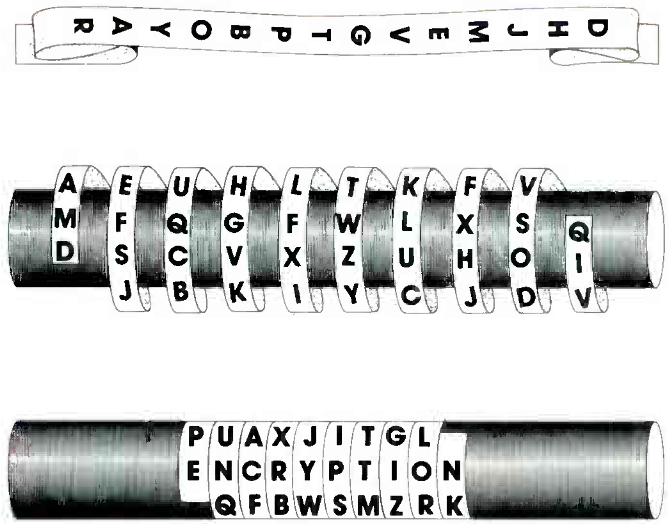
DATA ENCRYPTION

The ultimate data-encryption algorithm. Encrypt your data and gain peace of mind.



MARIO J. MANISCALCO

Lock it or lose it! For sensitive data, it's that simple. If it's more than just an annoyance if someone obtains a sensitive file, encrypting that file can provide security as well as peace of mind. Encryption does not prevent file theft, but it does render a stolen file useless to anyone who does not possess the encryption key.

In this article, we will present a highly secure data-encryption algorithm (called Crypt) that combines the best features of several other algorithms. We'll discuss its implementation in the C programming language, and we'll also present a challenge offering a reward to any reader who can decrypt an encoded message that is published herein. The full source code in C, an executable version of Crypt, and the encoded message are available from the R-E BBS and on IBM PC format diskette from the author; see the "Ordering Information" box for more information.

Background

A number of simple yet powerful encryption algorithms exist, including what is probably the most widely known: the National Bureau of Standards Data Encryption Standard (DES) algorithm. The problem with most standard algorithms is that the keyspace provided is seldom large enough for the desired security (more about keyspace later).

In addition, it's best not to use a standard simply because it is a standard. However, although there is an abundance of non-standard algorithms, seldom can one find conclusive proof of the security provided by any of those algorithms.

The final design consideration is that the author wanted an encryption system that was portable between several computer systems (especially PC and VAX systems).

The algorithm presented here is simple to implement on any micro or minicomputer, and it is unbreakable in any practical sense of the word.

How to use it

To use Crypt (on a PC system), make sure the executable file is located in your path. CRYPT.EXE performs both the encryption and decryption functions. Invoke it as follows,

CRYPT INFILE.TYP OUTFILE.TYP E

where the first parameter is the file to be encrypted, the second is the file that will contain the encrypted data, and the third specifies encryption. To decrypt a file, specify the two file names followed by "D." The file must consist only of the printable ASCII characters (with values ranging from 32 to 125) carriage return (13), line feed (10), form feed (12), and tab (9). A tilde (~) will be substituted for any other character.

Whether encrypting or decrypting a file, the program will then ask you for the key, which may be as long as 64 characters. Like the data file itself, the key may contain any of the printable ASCII characters, in the form of a sentence or phrase that can be remembered easily. To avoid wasting time processing a file with an incorrect key, the program requires that you type the key in twice.

How it works

For this discussion, refer to Fig. 1, which shows pictorially the operations performed by the algorithm. Also refer to the sidebars entitled "Basic Terms," "Cipher Types," and "Key Types" for definitions of unfamiliar terms.

The power of Crypt comes from three main features that are as follows: 1) it has an extremely (and arbitrarily) large functional keyspace, 2) it is a product cipher, and 3) the key is only used once.

Crypt has an effective key space of 95^{64}; compare that to a key space on the order of 10^{17} for DES. The key is used only once, for encrypting the first 32 characters of the plaintext. Thereafter, Crypt groups the plaintext into a series of 32-character blocks and encrypts each block one at a time. Blocking provides a useful benefit: the codebreaker cannot tell anything about the format of the plaintext file from the ciphertext file. He cannot determine the number of paragraphs, etc., since all that appears are blocks of 32 seemingly unintelligible characters.

The first 32 characters of the key are used as the transposition key (TK). Those characters determine a permutation of the plaintext block. The next 32 characters are used as a substitution key (SK). That key is added byte by byte to the permuted plaintext, and determines the substitution characters.

Things are a little more complicated than that, however.

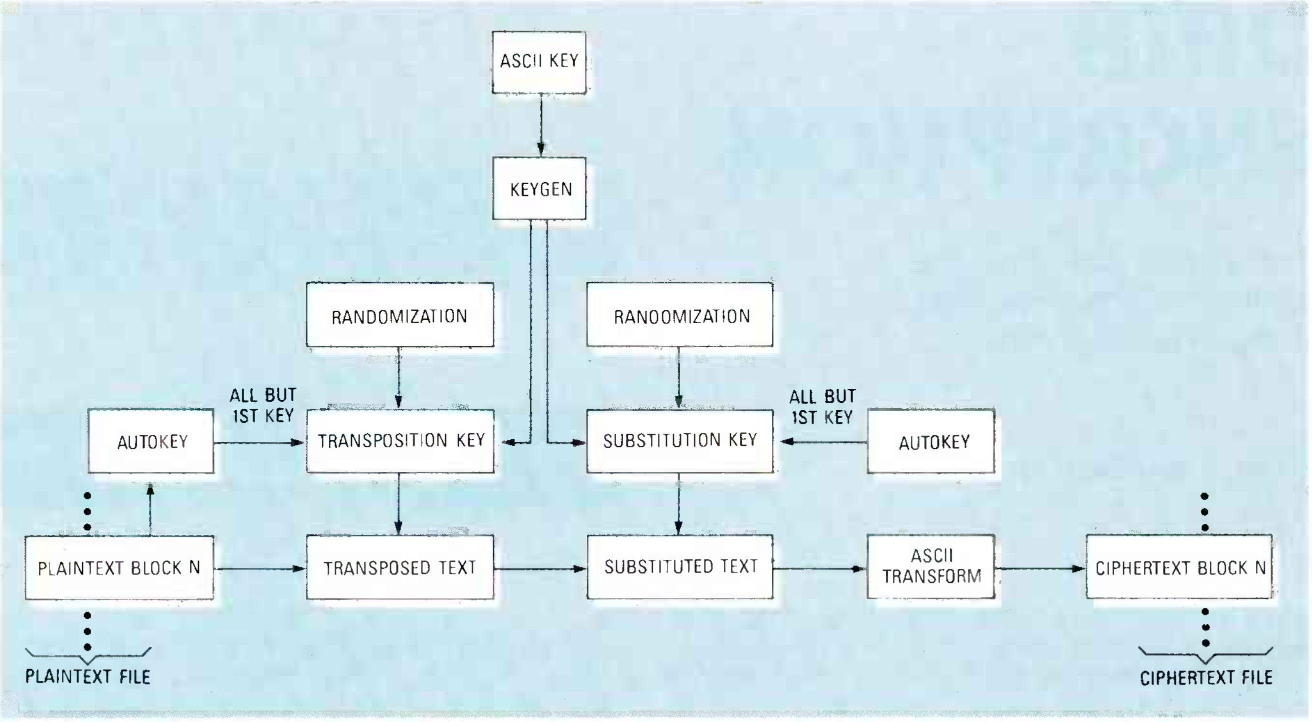


FIG. 1—THE ENCRYPTION/DECRYPTION ALGORITHM works on 32-byte blocks, performing both substitution and transposition ciphers.

The first key used is not the raw key entered by the user, but one that has been randomized prior to use by adding two pseudo-random number sequences to it. That may seem unnecessary, but it is essential to protect against a plaintext attack. Each successive key is also randomized, as well as having the running sum of plaintext added to it (modulo addition), forming what I call a randomized autokey.

The new permuted and substituted block will in general have integer values that are not printable ASCII characters. Before writing to the ciphertext file, each character is transformed into a printable character by a special routine (xform). The inverse transformation is performed when decrypting the ciphertext file.

In summary, the plaintext is chopped into blocks of 32 characters. A unique randomized autokey is used to permute and then substitute the characters in each block. The block is then transformed into printable ASCII, and written to the ciphertext file. The inverse is performed on decryption.

Security

The security of the algorithm is determined by the keyspace, or the length of the effective (or usable) key. Crypt's keyspace is 95^{64}, because each of the 64 key characters may be one of the 95 printable ASCII characters. Also, it is a true functional keyspace. Changing even one character in the key will yield a totally new mapping function by changing both pseudo-random number sequences. The result is that decrypting a file with a key that is off by only one ASCII value will result in a file of total garbage.

The key length is determined by a constant in the program (KEYLEN). In fact, KEYLEN is the separate length of the transposition and substitution keys, which makes it

BASIC TERMS

The following are basic terms and definitions that are necessary to understand how the encryption algorithm works. Interested readers will also find additional information in the sidebar entitled "References," which can be found elsewhere in this article.

The *plaintext* is the message to be put into a secret form. The *ciphertext* is the encrypted message. The *encryption algorithm* is the function that maps plaintext into ciphertext, or vice versa. Mapping is determined by a *key;* mapping is often called a *cipher.*

The *keyspace* describes the size of the domain (set of all possible keys). For example, a 16-bit key has a keyspace of 65,536. The *functional* keyspace is the number of keys that result in a unique mapping function, and may not be as large as the *apparent* keyspace. For example, suppose a 64-character key (composed of the 95 printable ASCII characters) is used. If the program were to use a shift-and-add process to generate a 16-bit number which is used to determine the mapping function, then the apparent keyspace is 95^{64}, but the functional keyspace is still only 16 bits, or 65,536.

In order for the functional keyspace to be equal to the apparent keyspace, each unique key must have a one-to-one correspondence to a unique mapping function, i.e., each unique key must yield a unique ciphertext for the given plaintext.

The reason the distinction between apparent and functional keyspaces is important is that it is easy to be fooled into believing that a long key in and of itself yields more security. In fact, that is only true if the long key results in a large functional keyspace. That is the case in the Crypt algorithm, where changing one character of the key (by only one ASCII value) results in an entirely new ciphertext.

CIPHER TYPES

Ciphers can be grouped into three major types: substitution, transformation, and product ciphers. As the name suggests, a *substitution* cipher simply substitutes each character in the plaintext by another character, as determined by the key. The substitution cipher is a weak cipher, and it falls apart under a *plaintext attack*, wherein the codebreaker has a portion of the plaintext, either by guessing or stealing it. Any serious encryption algorithm must account for the possibility of a plaintext attack, because in many cases message content can be guessed from the name of a file, or, if the plaintext is in the form of a letter, return address and salutation could probably be guessed.

A *transposition* cipher, by contrast, performs a permutation of the characters in the plaintext message (i.e., it rearranges their order), as determined by the key. The transposition cipher is also weak, because even though their order has been changed, all of the original characters are present.

Something amazing happens, however, when the two types of weak ciphers are combined. When both substitution and permutation are performed on a message, it is called a *product* cipher, and is considered the most difficult type of cipher to break. Even if a portion of the plaintext is known, the permutation is not known, and that creates many problems for the codebreaker. Although it contains other features (such as a randomized autokey, described below) Crypt can be classified as a product cipher.

KEY TYPES

It is commonly accepted that the only unbreakable cipher is a one-time key or one-time pad system. In that type of system, the key is only used once, so it must therefore be as long as the plaintext. For example, if the message is 1000 characters long, the key must also be 1000 characters long. If the key is random in nature, then the message can never be broken, since any and every 1000-character message can be formed from an appropriate key. Although the one-time key cipher is unbreakable, it is not very useful.

There are other, more practical ways of generating a key that are almost as effective and much more practical than the one-time key method. For example, if a key that is shorter than the plaintext message is used, one method of using the key only once is the *autokey* approach. An autokey is simply a key that is used only once, and then is transformed (using the plaintext) into a new key. The problem is that autokey becomes useless under a plaintext attack, because if the codebreaker has the first block of the plaintext, he can then generate successive autokeys.

However, the autokey can be made effective if it is also randomized, with the randomization determined by the initial key. That is what is done in Crypt. In fact, the algorithm uses a *randomized* autokey, which means that pseudo-random number sequences are also added to the autokey. So even if the codebreaker has the plaintext, he must still deal with the randomization, in addition to the autokey!

half the length of the user-entered key. So, for a 64-character key, KEYLEN must be 32. As will be discussed later in this article, a 64-character key provides sufficient security for any need. However, if desired, the keyspace can be increased (or decreased) by changing the value of KEYLEN. The limiting factor is that the computation time (due to the permutation) is a square law function, and program efficiency drops off rapidly with increasing key length.

The program

Crypt uses only standard C constructs and library functions, so the program should be easily portable to any C system. The program (in both source and executable forms) is available as mentioned in the sidebar "Ordering Information." The source code includes the complete design language (consisting of narrative and pseudocode), so that programmers can implement the algorithm in another language.

Items that may require change on different machines or compilers are found in the #define statements. Also, in order for the algorithm to be portable between systems (and for the pseudo-random sequences to be the longest), it is necessary that long integers are used in several places in the Crypt program. Those *longint*'s should be 32 bits long, so that the maximum integer is 07FFFFFFFh. All C compilers provide 32-bit long integers, but on some machines longint may be even longer. If that is the case, change the longint definitions to obtain 32-bit integers, or change MAXINT to match the size of integer used. Remember, however, that for portability between different machines, the integer sizes (for those integers defined as longint) must be the same.

Most C compilers generate relatively efficient codes, but the execution time of course will vary from machine to machine. To give the reader an idea of execution speed, encrypting the 53K C source file required about 90 seconds on an IBM PC AT.

Portability

An encrypted file is portable between systems because the ciphertext is composed only of printable ASCII characters (plus CR, LF, TAB, and FF). Note that if the ciphertext file was a binary file, the results might be unpredictable for different systems. However, it is possible that those few control characters might not be transmitted correctly between systems. It is important to note that although Crypt will function correctly on any system, transmitting the ciphertext file though communications lines may cause the control characters to be handled incorrectly.

For that reason, I have created a tool called Chat (Ciphertext Hex-ASCII Translator), which can be used to convert ciphertext to hex ASCII and vice versa. This hex ASCII code can then be transmitted between any two systems as an ordinary ASCII file. The program, which is also written in C, is available as discussed in the sidebar "Ordering Information," which can be found elsewhere in this article. Chat creates a printable version of the ciphertext file, so the program can also be used to print an an encrypted file for sending through the mail or other purposes. Hex ASCII is a hexadecimal representation of a byte, wherein two ASCII digits are used by the program to represent each byte. For example, a space has the ASCII value of 20 hex. Therefore, the ASCII characters "20" are used to represent a space.

CHALLENGE

The author will offer a reward of $100 to the first person to break Crypt by decrypting the ciphertext shown in Listing 1, and who meets the requirements specified below. (First person is defined as the first letter or communication which I receive.) In the event of a tie, the reward will be split among the tying parties. A time limit of one year from the publication of the second part of this article will be allowed. (One year is defined as being from the last day of the month of this publication to the last day of the same month of the following year.)

To aid you in breaking Crypt, Listing 2 contains a portion of the ciphertext in plaintext form, hence allowing you to launch the most feared type of attackthere is: a plaintext attack.

In order to collect the reward, the codebreaker must provide the author with the method used to break the cipher (including source code for any program or programs used). The codebreaker must also provide the author with the fully decrypted message as proof that Crypt was broken. The key need not be provided, because it is given in the plaintext message. That's right, the key is encrypted along with the message!

ORDERING INFORMATION

For $10, the author will provide an IBM PC format disk containing: source and executable code for both Crypt and Chat, the encrypted message, and ciphertext and plaintext shown in Listings 1 and 2. Write to Mario J. Maniscalco, 11413 St. Mark Ve., Cleveland, OH 44111.

A photocopy of the encrypted message is also available from **Radio-Electronics** by sending an SASE to our editorial offices. Or you can obtain all the files from our BBS (516-293-2283, 300/1200 baud, 1 start, 1 stop, and 8 data bits); download the file CRYPT.ARC. Also, after the one year period has elapsed, the author will send the plaintext message and key to any reader who sends in an SASE.

Testing

In order to verify that Crypt has been implemented properly on a particular system, I have provided a test procedure, shown in the sidebar "Test Procedure." The reader should execute the test procedure to determine whether the implementation produces ciphertext that is compatible with the author's version. That compatibility is especially important if the reader wishes to accept the decryption challenge (described elsewhere).

Limitations

The plaintext file must contain only printable ASCII characters, with the exception of the "newline" character or characters (i.e., CR, LF, or both), formfeeds and tabs. If the plaintext file contains illegal characters, they will be substituted with the SUBCHAR character, a tilde (-) in this implementation. However the rest of the file will be encrypted and decrypted correctly.

Warning: Double or multiple encryption will not work. The reason is that Crypt requires 4 control codes for its own use, and if those codes are found in a "plaintext" file, they are replaced by SUBCHAR. Besides, Crypt is strong enough that multiple encryption is not necessary.

Modifications

If necessary for a particular application, the program can be modified for special purposes easily. For example, if the user can refrain from using the last four ASCII characters in his plaintext, Crypt can be modified to produce printable ciphertext. That is done by changing the values of MIN—ASCII, MAX—ASCII, MIN—LEGAL and MAX—LEGAL. Of course, there is really no need to produce printable ciphertext, because Chat can convert ciphertext to printable form.

Crypt can also be modified by increasing or decreas-

LISTING 1


```
24297A24692F3D50574D632071693C393A4B4F2632701F234A4C2E32413A6039
376679351D1E274149602833412962293E495F7275254D69262A307C3473464C
4151435A56751F49393B32634A583823692A41555C4F356C54782A251D554859
406E39286C385C292A4F2550242F2A2E3C5D6F547E5C614275464A1F47353C6A
315240334D274B3E61475542561C53522B6C3D52626D35507922327D6C39531D
1C433D4C1D514B66523A63504B6C2E4C7A3730436A624B52563B294747313976
403E3A65274E624B3F5036666A725A21615B362B54721E675C7E565E5D5A5C2E
3E24754842C5D23215529447B23523E5148657B257C602D1D3E4D682F4A663564
51342C44601F7C674E50442C552838307 43A2B3C5366493B695533404F7C2F42
76471C42292345682C4667263F58624E5B2A714B2060224F65606B2E793B752D
527054245 43E325B4D275E4A6E49407E33541D4131392B584B577D396237454 7
57637B224836695344332F40534339336C396167533954 6D661F6D55755B384D
712D353977795E29323547 2D427246205125653C563B3246742F653579663D65
701C735B546E1F6A6B34684830267A316460346055 7E5D2C45421D566C217447
4B6677591E56623C57347D456C4F76464728354453 3D4D6A515538336249 3D1E
66273E2623511C3D2434715C441C2A3B1E584E43475E676474394239 5E4A7335
434E6E2B784F4247307A3B425F43741D5A2E4F4C204A333B63254128565 71D28
5B3A5D78646D69525777633 0241F7C7B352060554A497E4E2E537C1F62576A35
221E602E5A3D6245331E5645416C46547C7A4E4121444A50413F443A5B32514C
5A39363144206043642531485 93E5C423A5C316F2D2C772D6B56436F2022633D
35692F405B7E6B772E6225425A4C312B31546C207E752948582C4127566F7A2D
1E1D264A5A752C5E485A3849764A5664474940517C49527B242A71746359 3D57
773D3C5935356664727749 3F252F337D67396A3D34351E636050656F2D30487B
3F736570466B66375342322 22F2A207B2C44587D54364B4F252F5C366A7E4A6B
4C301C58734 34D51327035 3C4560664B485834537543445D5D2D3E6045513630
2C62493B2A3B301F24393C366C616F7729484858774A4957296C4551222F4A42
523937565A36211E1D2834423F461F3D4E4E4F3B70533C50583C543733773C67
42483F564863344030305125743A6A54574D263E536149244723 2F2C4B795152
2E3569645E2B7D1F557E7748734F70536640774B6E34653C5E7B3C4B1F435B37
4D514C417A4D546E2C4552746E7067263B78616D5E4E462556385A552A55555C
3C51414733722D1C4B6C6773724E5A7644224934573727372649753D4D5E6B39
29345D305077287976266841234676284C2F4675294F3C7A317A48385B285345
4E6A496F755D5F43673F5E34425D704F746647451C6E2B6052552B4B4E67721D
461E3A4E765B2E5C521C795B256151381E65293A675B5132373 17D614942495 1
28604033 6E543156366D5967575362362 77A632623617A5E346D783942724753
33595B365C6345764E6C69757 04D34755F24344754522D6B5E64427E4B48521F
466653423D674749537D6E2A7E766C6659225E2D766554703C374B495B37584B
7425213B3336285C322E56555B4D675432307B40485B4C274953316057364540
252B385E6168493F383D49245F405734537 35C456A4C3A45674158654172344 4
575C1C674053543C405B57264B4D222E4A724036471C483D42335523732954 22
1F366B5D511C4E464C4C62304E314C5462484A3345417E266B211D4F2B7E355A
687844466E492B622547521F2D4D577B344D4C44217138414A6F5F553A4F753B
7A63233C2F6F422A305E241E445C444E70486246202 73D4D2E5B63411D2E7468
33643135674D376E607A75377E1D286D5A3C4D2C54376B2C4E271F2062672370
1C564A407D33285B7A3851302F3B485C31786B6F31425D447B6E791F536F4B3F
773B1F5B4154751D51545C475B617E3E715D4552414C455A51456250446E5758
3B266C6A56707D2C7E4F65335B382E3E7B471F787E4E5B686B5D4A563C734E3D
5A5D5B28633E2656523042514 04C4827297E2A555F2C257E5F616F32697A422C
52707E586B6F727D3C467C437C24692C233C7B7D2A316C32233F73376F1F6873
457C6E2B5B70315F2657627A4C5A1F553F2F752F487E3D675E22587A77343A75
7C343E7325322959314 45C662D7358314F754C3339322B50403C434877393759
6D444465227 04D5A7957254B2D3E34455A3B6C50433559323760225224623 87C
202166307 44F5B305D6B53255F1D41626D2825471D5F573C603B7B327D524254
763E603E24391E4B5C305E5F4A72342027374431 3C5154205 31C421D641F7142
663E372B5D44591E1C667943486C473E237A3C6F745E2D3139475E4E6A676D43
34307B485F61416161213E307D4F55393E65334E603A4E5D64302F351E636A72
396E2F7B3C4C5632775B444A5234451E487D392E4726555827566441 3F666D30
3B3E72485340365934 3D283C1F225D624C5E43472D4D3C2139752961432 2613B
612659444C715D26371D414F66567443342B5F264E4C562B7C2D426345492C2E
4448267A49315E667674634A622649721F702E723D793A432E1E664D7C3B4C51
7E1E707520785771463 22F5C47482E7B68675A23312662355162607C773D302F
58414D725E386D483C1F45477E443952402A416869552B646B25301D283E5C6C
5056664B3A3D59205D227B7752464153553 42F236B465D226D573B3B28464D65
49452C302554232C545255417042 2B305D4466351E48466020527A58523D5544
70786E40637548454A4E505629692E5B68666E35783D66603875 1C4766485C40
2D3B4E447D4C55215C2C3378374A5864752 67C6D63797869654D5E7A2E66452D
```


LISTING 2

```
     In this challenge, I have given the codebreaker everything he
needs to break this ciphertext: the algorithm, the program itself
that was used to encrypt the plaintext, and even this portion of
the plaintext!  The only information which I have kept from the
codebreaker is the key itself.  I will not give any clues about the
key, except I will state that it is a full 64 character key (obviously
I would not want to use an abbreviated short key).

     I should also mention that there are no hidden spaces in this
plaintext.  (An example of a hidden space is one or more spaces
which trails at the end of a line.)  The only spaces which exist
are those between words, or the five spaces in the indentation of a
new paragraph.  Also, note that there are two spaces between
sentences.  The blank lines between paragraphs are composed only of
a newline character, and do not contain any spaces.  Also, the very
first character of this message is the first of 5 spaces in the
indentation of the first paragraph.
```

ing the key length (KEYLEN). A shorter KEYLEN will of course provide less security, but faster execution. A longer KEYLEN has the opposite effect. A KEYLEN of 32 (resulting in an ASCII key length of 64) was found to be a good compromise.

It is possible to make other modifications to the program. For instances, you might want to change the default seeds and starting points for the pseudo-random number sequences. Doing so would produce a unique version of Crypt, one that would be incompatible with all of the other versions of the program.

Last, if Crypt is used on a system where it can be invoked by a batch file or a command procedure, it is possible to create procedures to make Crypt easier to use, and to accomplish many of the necessary operations (such as deleting plaintext files from the disk after encryption) automatically.

Conclusions

When I leave work at night, I have no worries. If I forget to remove my floppy disk (which contains sensitive information), or if the system manager leaves his terminal logged on with SYSTEM privileges—so what! My private files are encrypted. Even if someone cracks the computer system's security, he can't crack Crypt.

Likewise, if a burglar breaks into my home and steals my computer equipment, at least he hasn't stolen my *information!*

In short, I can sleep at night, and, with Crypt, so can you!

TEST PROCEDURE

To determine whether Crypt has been implemented correctly on a particular system, the following test message should be encrypted with both a null key and the given key. The following is the test message:

This is just a test message to see if Crypt has been
implemented properly.

In that message, the "newline" character after the word *been* is part of the message. (On your system, press Return after the word *been.*) There is no newline at the end of the second line.

First try to encrypt the message using a null key. A null key simply means answering the key prompt with a carriage return. You should get the ciphertext shown below. However, note that several unprintable characters are not shown. Therefore the Chat hex ASCII form of the ciphertext is also given. From the hex ASCII, you can verify that each character of the ciphertext is correct.

CIPHERTEXT FOR THE NULL KEY

```
.oScH8LE1EiMA5 CCD%5(j6-qX7oY2da
?hYHLZd-UYQtEKP%b<Le × CMPJXKM
i-:/JV9,7R6]G = = #V-0'NM33a!mOg&
```

HEX-ASCII CIPHERTEXT FOR THE NULL KEY:

```
2E6F536348384C453145694D41352043
43442535286A362D7158376F59326461
3F681F59484C5A641D2D55595174454B
507C25623C4C652B58434D504A584B4D
692D3A2F4A56392C3752365D473D3D23
562D30274E4D333361211E6D4F7E6726
```

Now try encrypting the given test message with the following key (which is a statement of Gauss's law):

The flux crossing a closed surface is equal to the charge enclosed.

Note that the key is longer than 64 characters, so Crypt will only use the first 64 characters. Again, here are the ciphertext and hex-ASCII forms of the test message. CIPHERTEXT FOR THE GAUSS'S LAW KEY:

```
d#Q8ow;U%S%6 tP<ZPB#e
```

HEX-ASCII CIPHERTEXT FOR GAUSS'S LAW KEY:

```
642351386F773B55251D532536207450
3C333F774B4D527C7C7D394D1D236330
604E252F7E5A1E42455C3655404D763B
57643474543B51374B58512466585365
5A7A4A492A465E5D2E232F4B226A6B50
346D6D461C275A6B2A3C5A504223651D
```

Now you should decrypt the encoded versions of the test message, and use the DOS COMP command to compare the decrypted files to the original one. They should all be identical.

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BUILD THE PT-68K

68000 addressing, and more.

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Part 6 Before we get to this month's topic, let's finish up the connector discussion from February.

Most of the pins on the right side of the connector are simply buffered address and data lines. Figure 5 shows how we buffer the address lines, Fig. 6 shows how we generate the PC control signals, and Fig. 7 shows how we buffer the data bus and generate additional control signals.

To begin with the latter, the lower eight bits of the 68000's data bus drive the expansion connector's eight-bit data bus (BD0–BD7). Therefore, each expansion bus address is an odd 68000 address. Moreover, the 68000's A1 line becomes BA0 on the expansion bus, A2 becomes BA1, and so on, up to A20 which becomes BA19. That is necessary because the expansion connectors need a BA0 line, but the 68000 does not have an A0 output; hence, everything is shifted by one bit.

Intel memory decoding

To understand how expansion slot addresses equate to 68000 addresses, we have to understand the decoding circuit in Fig. 6. In a 68000 (and, in fact, most Motorola microprocessors) there is only one set of addresses, which are used for both memory and I/O. The 8088 (and most Intel processors) have two sets of addresses: one for memory, and another for I/O. Typically, memory addresses are accessed by MOV instructions, and I/O addresses are accessed by IN and OUT instructions. A typical Intel processor manipulates memory and I/O locations with four control lines: $\overline{\text{MEMW}}$, to write to memory; $\overline{\text{MEMR}}$, to read from memory; $\overline{\text{IOW}}$, to write to an I/O device; and $\overline{\text{IOR}}$, to read from an I/O device.

In a typical PC, those four signals are brought to the bus connectors, and all four are used by many I/O cards. For example, on a monochrome or color video board, $\overline{\text{IOW}}$ and $\overline{\text{IOR}}$ are used to control the card, but $\overline{\text{MEMW}}$ and $\overline{\text{MEMR}}$

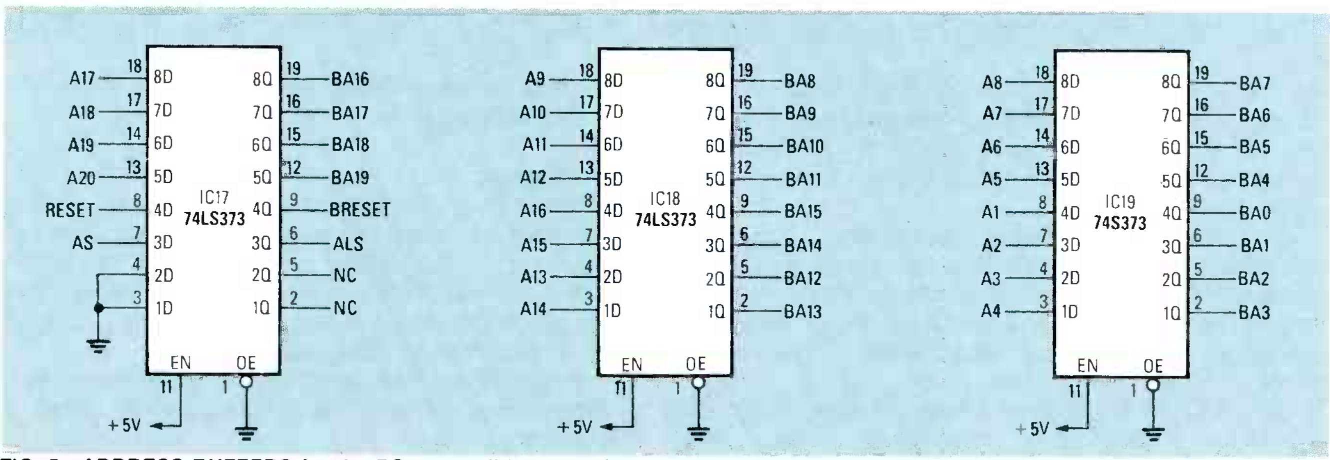

FIG. 5—ADDRESS BUFFERS for the PC-compatible expansion slots are shown here. Note that only IC19 is a 74S373; IC17 and IC18 are LS parts.

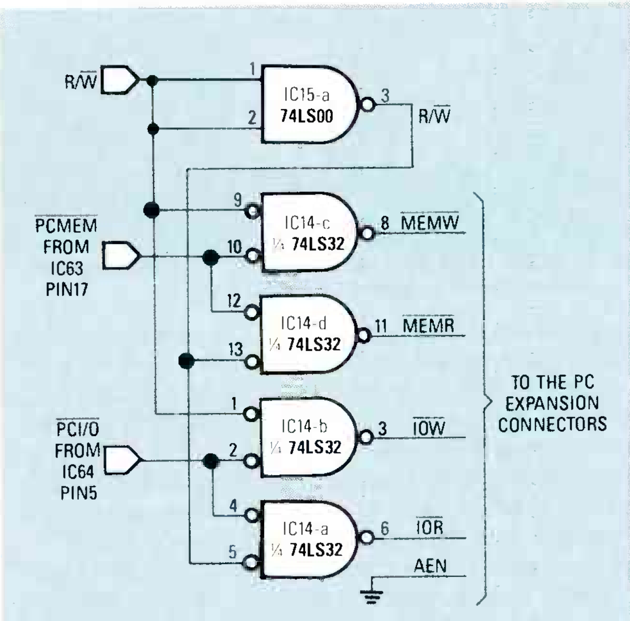

FIG. 6—I/O AND MEMORY CONTROL SIGNALS for the PC-compatible expansion slots are decoded as shown here.

Although most PC's have a maximum of 640K of RAM, the microprocessor can actually address one megabyte of memory, and 64K of I/O addresses, using 20 address bits for memory and 16 bits for I/O. Memory above the first 640K (i.e., above \$9FFFF) is reserved for video (128K), hard disk (32K), BIOS and BASIC ROM's (64K), and the remaining 128K may be used for different purposes (expanded memory boards, for example).

As we saw in Fig. 3 in the January 1988 issue, the address decoder generates a PCMEM signal for 68000 addresses \$C00000 through \$DFFFFF, and a PCI/O signal for addresses \$FA0000 through \$FBFFFF. Those two enable signals are used by the circuit shown in Fig. 6 here as follows:

1. If PCMEM is low and R/W is low, then IC14-c generates a low MEMW signal.

2. If PCMEM is low and R/W is high, then IC14-d generates a low MEMR signal.

3. If PCI/O is low and R/W is low, then IC14-a generates a low IOW signal.

4. If PCI/O is low and R/W is high, then IC14-b generates a low IOR signal.

So when the 68000 reads or writes memory addresses

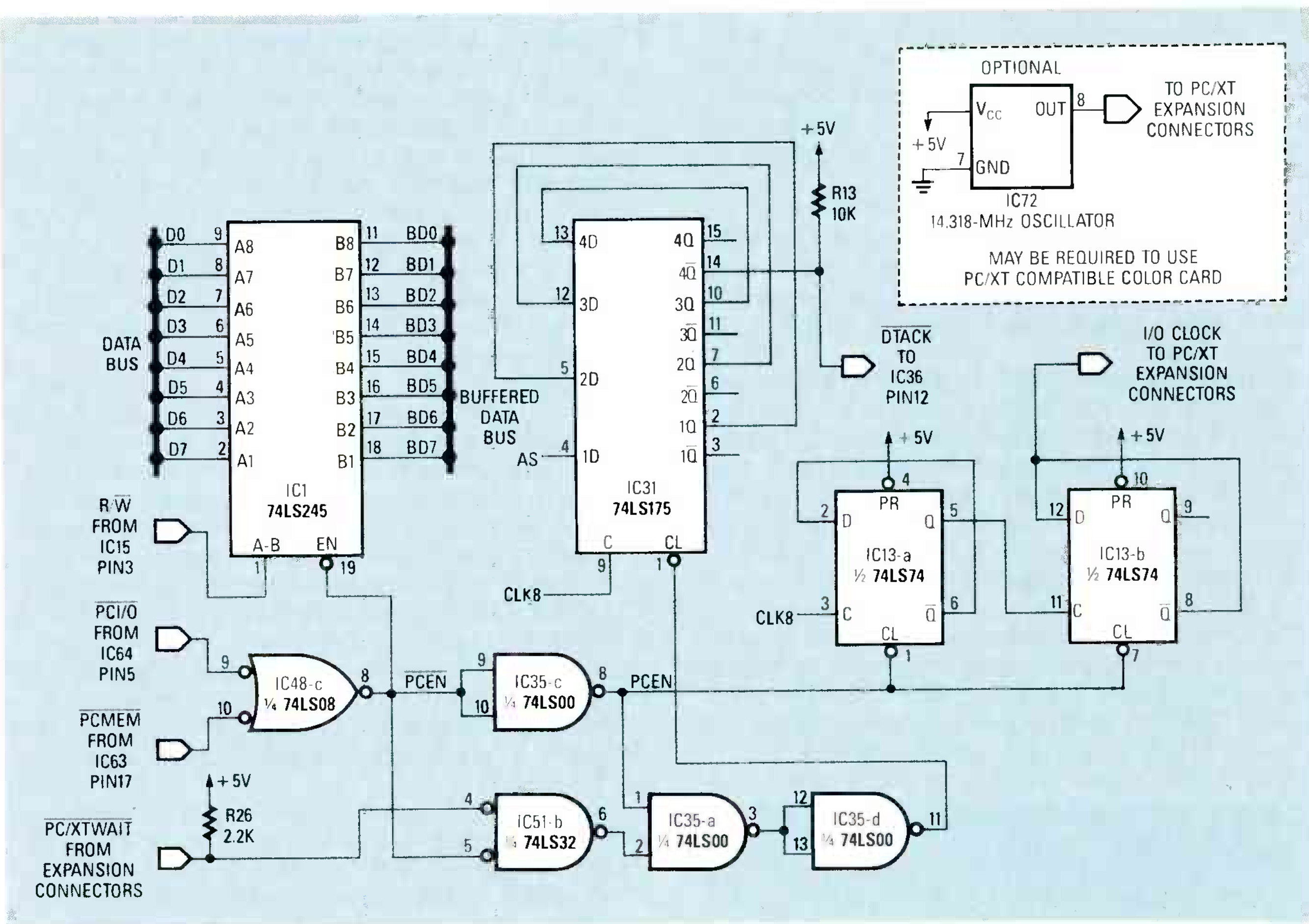

FIG. 7—THE EXAPNSION-SLOT DATA-BUS BUFFER (IC1) and miscellaneous control signals are shown here.

are used to access the video RAM where display data is stored. On a hard-disk controller, IOR and IOW again control the hardware, but MEMR is needed to read the ROM on the board. All of those addresses must be squeezed into the 68000's single memory-address space.

\$C00000 through \$DFFFFF, cards plugged into the expansion slots get a memory-read or a memory-write signal; when the 68000 accesses memory addresses \$FA0000 through \$FBFFFF, the cards get an I/O-read or an I/O-write signal.

The result is that cards in the expansion connectors can be written to and read from, but the addresses accessed are not simply translated from the 68000's address space. For PC memory addresses, the relationship is given by the following formula:

68000 address = \$C00001 + 2 × PC address

For example, the character in the upper left corner of the screen in a monochrome PC is stored at address \$B0000, which translates to address \$D60001 in the PT-68K. That character's attribute byte is located at \$B0001 on the PC, and at \$D6003 on the PT-68K.

For PC I/O addresses, the relationship is indicated by the following formula:

68000 address = \$FA0001 + 2 × PC address

For example, the control port of a monochrome video board is at PC I/O address \$03B8, which translates to address \$FA0771 in the PT-68K.

The result is that the PC's one-megabyte address space occupies two megabytes in the PT-68K, ranging from \$C00000 through \$DFFFFF, and the 64K of PC I/O addresses translates to 128K of 68000 addresses, from \$FA0000 through \$FBFFFF. One consequence of our design is that it is not practical to connect a PC memory board to the PT-68K.

Now let's examine the circuit in Fig. 7. Whenever either PCI/O or PCMEM goes low, indicating that the 68000 is trying to access the expansion connectors, IC48-c outputs a low PCEN signal, which enables IC1, the bi-directional transceiver that buffers the data bus for use by the expansion connectors. The direction of data flow is determined by the signal at pin 1 of IC1.

PCEN also drives IC35-c, which inverts it to produce PCEN; that signal allows IC13-a and IC13-b to divide the 8-MHz CLK8 signal by four and send the resulting 2-MHz I/O CLOCK signal to the expansion connectors. That signal is used by some PC video adapters as a clock for the 6845 CRT controller chip.

PCEN is also buffered by IC35-a and IC35-d to drive the CLEAR input (pin 1) of IC31, which is wired as a shift register to produce a time delay. In normal operation, IC31 is held in the cleared state, so it does nothing. But when PCEN goes high, IC31's CLEAR input also goes high and it starts to shift a high (from AS) through the register, one flip-flop for every pulse of CLK8. After four clock pulses, or about 500 nanoseconds, the 4Q output from IC31 goes low and sends DTACK to IC36.

That provides PC-compatible cards 500 nsec to work. However, some cards need additional time, so they return a WAIT signal, which is fed through IC51-b. The WAIT signal prevents IC31 from timing out until WAIT goes high. At that point IC31 gives the card an additional 500 nsec.

Figure 7 also shows an optional 14.31818-MHz oscillator, which is needed by some CGA adapters. (That signal is four times the 3.579545 MHz color-burst frequency). Some color boards have their own oscillator; others need one on the motherboard. The easiest way to determine whether your color board needs that signal is to examine the OSC contact on the board connector (the next-to-last on the left side). If the board has a connection to that pin, then the external oscillator is needed.

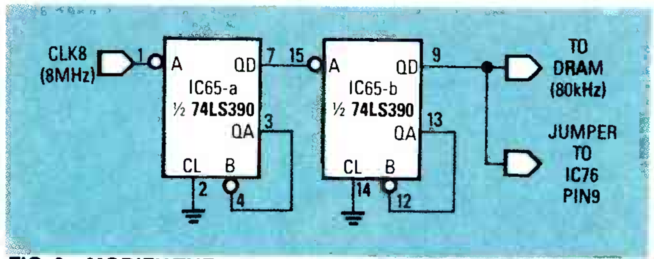

FIG. 8—MODIFY THE BUS-ERROR CIRCUIT as shown here ONLY if you intend to use a modern CGA adapter.

If you intend to use a modern CGA video board—the type with surface-mounted IC's and components—you may need to do a bit of surgery on the PT-68K motherboard at this time. Since designing the PT-68K, we found that some boards generate a very long WAIT signal so that they can prevent access to the video memory while the CRT controller is displaying characters. That is done to minimize on-screen snow and hash, but, unfortunately, it also causes the bus-error timer in the PT-68K to time out.

There is a way around the problem, however; the fix involves installing an IC, cutting one trace, and installing a jumper, all on the PT-68K. As shown in Fig. 2 last month, the bus error circuit counts four pulses of the E clock (which runs at one tenth of the CPU clock, or 800 kHz) and generates a BERR signal if no DTACK has been received by then. That provides a delay of about four or five microseconds, which is not enough for the new CGA boards. The solution is shown in Fig. 8.

In that circuit, IC65, a 74LS390 dual decade counter divides the 8-MHz CLK8 signal by 100 to produce an 80-kHz signal. That IC is really part of the DRAM refresh circuit, but we can install it now and use its output instead of the E clock to lengthen the bus error time-out from about 5 to about 50 μs. To do so, install the following components:

62-pin card edge connectors at J1 through J6 (if you install fewer than six, then space them apart); sockets for IC18 (74LS373), IC15 and IC35 (74LS00), IC14 and IC51 (74LS32), IC1 (74LS245), IC48 (74LS08), IC31 (74LS135), and IC13 (74LS74). Install the IC's, and then install R13 (10K) R26 (2.2K), and C1 (0.1 μF disk). Also, if needed for your CGA board, solder IC92 (14.31818-MHz oscillator) directly to the board, with the pointed corner identifying pin 1 closest to J4.

If you're going to use a modern CGA adapter, also install IC65, cut the trace between IC76 pin 9, and IC47 pin 20, and install a jumper from IC65 pin 9 to IC76 pin 9.

Now install a short wire jumper from pin 12 to pin 7 of IC15. The reason is that part of IC15 is generating a false DTACK, which is upsetting everything else. For now, the jumper disables the circuit; we'll remove it later.

If you have a PC-compatible video board and matching monitor, plug it in now and turn on the power. If all is well, you should now see the message "Please press enter" on the screen. If not—well, we're running a bit short of space this month, so we'll discuss debugging next time.

Ordering Information

Complete details were given in part one (in the October issue). To summarize: The basic kit (PT1, \$200) contains all parts except power supply, case, and video terminal or personal computer to get a small system (ROM monitor, 2K RAM) up and running. The full basic system (PT68K, \$460) includes 512K of dynamic RAM, floppy-disk controller, parallel port, battery-backed clock/calendar, and three PC-compatible expansion slots. To order, or for more information, contact Peripheral Technology, 1480 Terrell Mill Road #870, Marietta, GA 30067, (404) 984-0742.

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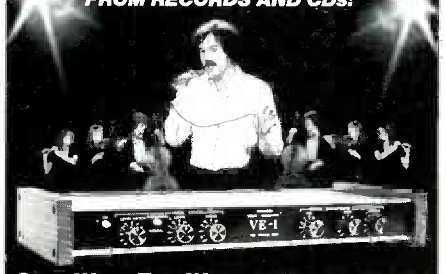

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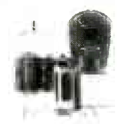

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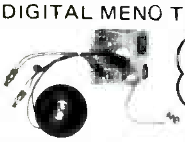

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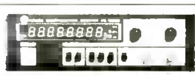
8 Digit 1GHz Multifunctional Counter SM/FC—1000A ☆



A versatile laboratory bench digital counter with FIVE FUNCTION performance. FREQUENCY, PERIOD, UNIT (TOTALIZE), DATA HOLD & SELF CHECK. The period function makes the instrument outstanding for video tape recorder service applications. 0.5" Bright LED display assure easy readability of values. High stabilized dual crystal oscillators are used to ensure the accuracy in measurement. Durable alloy cabinet with a fancy looking panel. Comes complete with test lead and owners manual.

FEATURES:
Frequency range 10Hz—1GHz GUARANTEED, 5Hz—1.2GHz typically.
Input sensitivity: 10Hz—100MHz (10mV—32mV)
100MHz—1,2GHz (5mV—20mV)
Period range 0.5uS—10S.
Unit counting capacity 99999999.
Accuracy ±1 count, ±time base accuracy.
Hold function Hold the last input signal (Max. 8 digits).
Power source 117V AC ±10% 50—60Hz
Dimensions 9.69"(W) X7.87"(D) X3"(H)
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SPECIFICATIONS:
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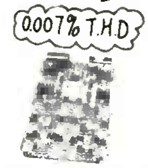
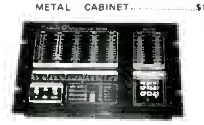
- The power supply is based on by pass coupling DC stabilizer which uses class A design to obtain low internal impedance at high frequency and to greatly reduce transient distortion.
- Professional ralay delay circuit prevents noise which may occur during power on and off.
- All FETs were tested and paired in the factory so no problem is likely to occured during building.
- It can be directly connected to any power amplifier. The best partner is TA-477 120W MOS FET power amplifier.



KIT/ASS. WITH TESTED .... $55/[illegible]
METAL CABINET $18

PROFESSIONAL COLOR LIGHT CONTROLLER SM—328 ☆



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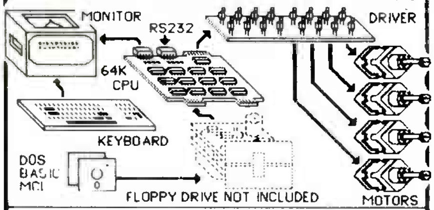

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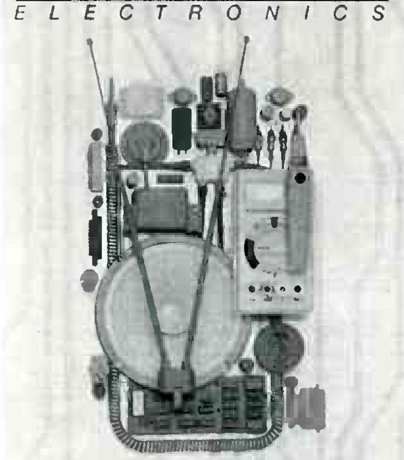

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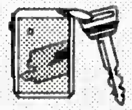

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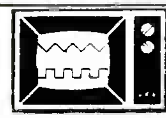

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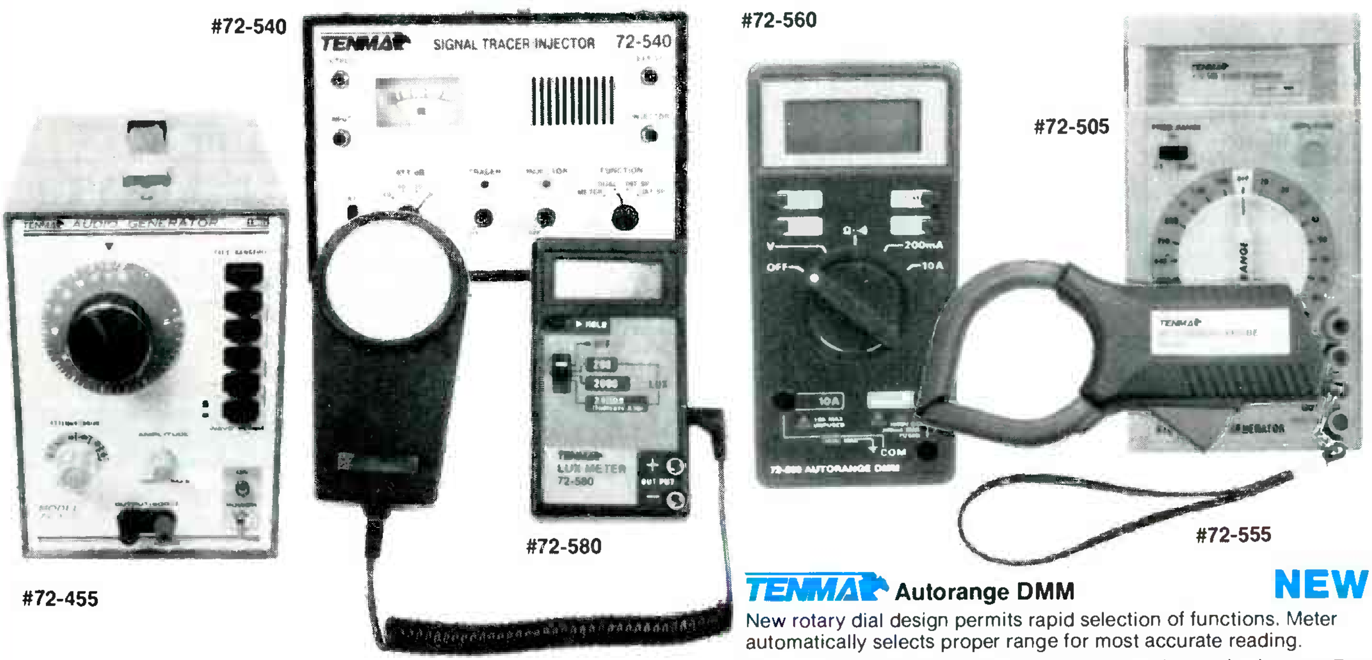

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7403	25	75324	20	74LS174	30	4016	25
7404	25	75452	55	74LS191	45	4019	30
7406	30	75454	55	74LS192	60	4022	60
7407	25	N8T22	25	74LS194	60	4023	20
7408	30	N8T24	20	74LS195	60	4024	45
7409	30	N8T26	75	74LS221	55	4025	20
7410	25	**74LS SERIES**		74LS240	65	4035	60
7411	25	74LS00	20	74LS241	60	4040	60
7416	25	74LS01	20	74LS242	60	4041	70
7420	25	74LS02	20	74LS244	65	4042	50
7425	25	74LS03	20	74LS245	70	4046	80
7426	30	74LS04	25	74LS247	1.90	4047	65
7427	25	74LS05	20	74LS251	40	4049	25
7429	25	74LS08	25	74LS253	40	4050	25
7430	25	74LS09	20	74LS257	35	4051	35
7432	25	74LS10	20	74LS258	40	4052	60
7437	25	74LS11	25	74LS259	85	4060	60
7438	25	74LS12	25	74LS260	40	4066	30
7439	25	74LS13	25	74LS262	40	4068	30
7440	30	74LS14	35	74LS266	40	4069	20
7442	25	74LS15	25	74LS273	45	4070	25
7445	50	74LS20	20	74LS290	75	4071	20
7447	75	74LS21	20	74LS293	75	4072	20
7450	60	74LS22	20	74LS295	75	4073	35
7451	25	74LS26	20	74LS298	60	4076	50
7454	30	74LS27	25	74LS299	1.35	4077	25
7474	30	74LS28	25	74LS356	75	4078	35
7475	45	74LS29	50	74LS365	35	4081	20
7476	45	74LS30	20	74LS366	35	4082	20
7482	85	74LS32	20	74LS367	40	4085	35
7483	50	74LS33	25	74LS368	35	4086	45
7485	55	74LS37	25	74LS373	65	4093	45
7486	40	74LS38	25	74LS374	75	4160	45
7490	45	74LS40	30	74LS375	85	4163	45
7491	65	74LS42	30	74LS377	70	4416	45
7492	45	74LS47	90	74LS378	1.10	4428	45
7493	35	74LS51	20	74LS393	70	4449	45
7495	45	74LS54	25	74LS620	1.50	4497	45
7496	55	74LS55	30	74LS670	85	4502	65
74107	35	74LS73	25	**74SC SERIES**		4511	70
74109	40	74LS74	25	74SC137	50	4516	70
74116	1.00	74LS75	30	74SC138	35	4517	75
74121	35	74LS76	25	74SC139	35	4518	85
74123	40	74LS78	40	74SC237	60	4519	60
74125	45	74LS83	40	74SC239	60	4528	75
74126	40	74LS85	40	74SC240	50	4532	75
74128	55	74LS86	25	74SC241	50	4538	75
74145	45	74LS90	40	74SC244	65	4555	75
74148	1.00	74LS93	35	74SC245	50	4556	35
74151	50	74LS107	30	74SC373	50	4573	45
74153	50	74LS112	25	74SC374	60	4574	45
74156	70	74LS113	30	74SC533	50	4581	70
74157	50	74LS114	30	74SC534	50	4585	70
74161	60	74LS123	45	74SC540	50	40098	45
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74173	70	74LS132	35	74SC573	2.00	**EPROM/MISC**	
74174	50	74LS136	30	74SC574	2.00	2716	2.95
74175	50	74LS138	40	DATA BOOK FOR ABOVE #'s	2.50	2732-2	3.95
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74192	70	74LS157	30	4001	20	8035	1.95
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74194	70	74LS160	25	4006	60	Z80A CTC	1.25
74195	75	74LS161	45	4011	20	UDN6118A	50
74298	55	74LS162	45			UDN6128A	55
74365	60	74LS163	45			UDN6184A	60
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LM307H	40	UA741	25	PN2222A	10/1
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LM311H	50	MC1330	50	PN2907A	10/1
LM311N	40	MC1350	1.40	2N2904A	5/1
MC3177	75	MC1398	50	2N3055	55
LM318H	90	UA1458	25	PN3643	10/1
CA324	35	ULN2283	1.50	PN3904	10/1
LM325N	95	LM2903	50	PN3906	10/1
LM339N	35	LM2904	50	2SD898	2.50
LM380N	75	MC7805	45	2SC1172B	2.25
LM386N	80	MC7806	45	HOUSE #216 TO 92 NPN	25/1
LM393N	35	MC7812	45	1N914A	40/1
NE555	25	MC7824	45	1N4148	40/1
		MC7905	45	1N4001	30/1
		MC7912	45	1N4004	25/1
				1N4007	15/1
				1N5231B	5/1

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Diode Test	forward voltage testing
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(As featured in Radio Electronics March/May articles, 1982)

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Electronics technicians, and the members of the International Society of Certified Electronics Technicians (ISCET), will be honored nationally on March 8, 1988, with the celebration of National Electronics Technicians Day. This special day recognizes their high standards of performance, and the vital part that they play in helping to assure our country's continued technological and economic leadership in international competition.

ISCET maintains the certification program for professional electronics technicians. March 8, 1988 will be set aside as a national testing day for certification of electronics technicians, and ISCET test administrators encourage technicians all over the nation to demonstrate their own professionalism by taking the CET exam.

ISCET
2708 West Berry
Fort Worth, TX 76109
(817) 921-9101.

NEW MAGNETIC MEMORIES

continued from page 64

when the voltage is pulled low fast the magnetic field will collapse, inducing a voltage on the gate which gives a one on the data line. For a zero, the gate will be low, disrupting the channel and giving a zero on the data line.

While the memory is designed to be read-only, reprogramming is possible. The procedure involves placing opposite but equal voltages on the data and ground line.

One problem in reprogramming is that the memory must be completely shielded from any external magnetic fields. Otherwise, the effects of the reprogramming procedure can be unpredictable. In fact, because of the tiny size of the magnets, even the Earth's magnetic field can effect the procedure. Further, studies have detected a tiny but noticeable seasonal variation in the Earth's field. As a result, it has been concluded that the best time for reprogramming is in the early spring, with the optimum date being April 1. **R-E**

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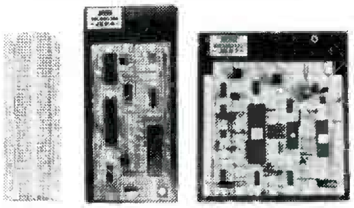
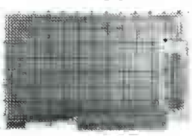


JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE20	6½ x ¾	200	0	$ 2.29
JE21	3¼ x 2⅛	400	0	$ 4.49
JE22	6½ x 1⅜	630	0	$ 5.95
JE23	6½ x 2⅛	830	0	$ 7.49
JE24	6½ x 3⅛	1,360	2	$14.95
JE25	6½ x 4¼	1,660	3	$22.95
JE26	6⅞ x 5¾	2,390	4	$27.95
JE27	7¼ x 7½	3,220	4	$37.95

Jameco General Purpose Prototype PC Boards



- Wire Wrap
- Component Testing
- Point-to-Point Wiring
- 31/62 Connection

JE417 (Pictured)

JE415 (6½", No Pads, PC/XT). . . . $14.95
JE417 (6½", Plated w/Pads, PC/XT). . . . $19.95

Extender Board

JE421 (4¾" Extender, 31/62 Connector) . . $19.95

DATA BOOKS

30003	National Linear Data Book (82)	$19.95
30005	Logic Data Book - Vol. II (84)	$19.95
30009	Intersil Data Book (87)	$14.95
21398	CMOS Cookbook (86)	$14.95
210830	Intel Memory Handbook (87)	$17.95
230843	Intel Microsystem Hndbk. Set (87)	$24.95

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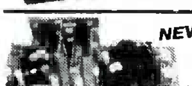
TA450S. $11.95
Torin Industries (4.68" sq., 50 cfm)

SU2A1. . . . . $11.95
EG&G Rotron (3.125" square, 34 cfm)



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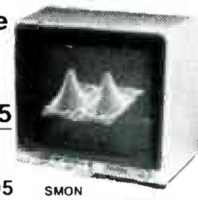

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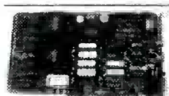

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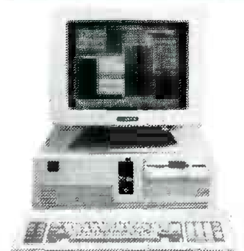

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SAVE $68.85!

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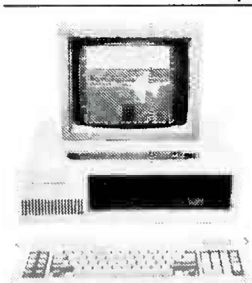

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JE1015	XT/AT Style Keyboard	$ 59.95
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JE1001	4.77/8MHz Turbo Motherboard (Zero-K RAM – Includes Award BIOS ROM)	$ 99.95
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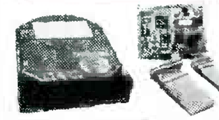
COMPUTER PERIPHERALS



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Jameco PC/XT & AT Compatible Disk Drives

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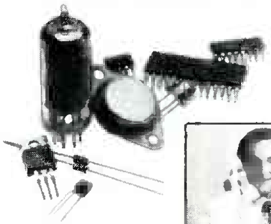

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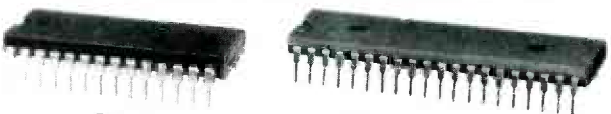

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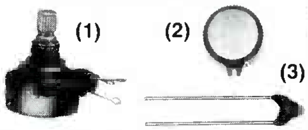

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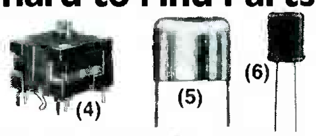

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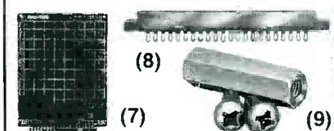
6	72"	270-1408	3.99
6*	17¾"	270-1409	2.49

*#270-1409 has L-mounting bracket.

Builders' Helpers



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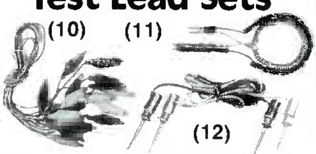

(10) Set of Ten Color-Coded Test Cables. Gator clips. #278-1156, **3.99**

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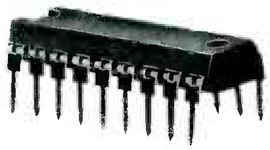

Combines RF, mixer, IF and demodulator in a single IC. Makes receiver projects a cinch to build; and with 70KHz IF, no coils are required. Built-in mute circuit reduces spurious reception. With application notes. #276-1304 .... **5.95**

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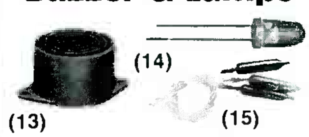

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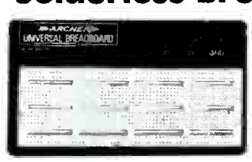

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7445	.69
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7475	.45
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7486	.35
7489	2.15
7490	.39
7493	.35
74121	.29
74123	.49
74125	.45
74150	1.35
74151	.55
74153	.55
74154	1.49
74157	.55
74159	1.65
74161	.69
74164	.85
74166	1.00
74175	.89
74367	.65

LINEAR

TL071	.69	LM567	.79
TL072	1.09	NE570	2.95
TL074	1.95	NE592	.98
TL082	.99	LM723	.49
TL084	1.49	LM733	.98
LM301	.34	LM741	.29
LM309K	1.25	LM747	.69
LM311	.59	MC1330	1.69
LM311H	.89	MC1350	1.19
LM317K	3.49	LM1458	.35
LM317T	.69	LM1488	.49
LM318	1.49	LM1489	.49
LM319	1.25	LM1496	.85
LM320	see7900	ULN2003	.79
LM323K	3.49	XR2206	3.95
LM324	.34	XR2211	2.95
LM331	3.95	LM2917	1.95
LM334	1.19	CA3046	.89
LM335	1.79	CA3146	1.29
LM336	1.75	MC3373	1.29
LM338K	4.49	MC3470	1.95
LM339	.59	MC3480	8.95
LM340	see7800	MC3487	2.95
LF353	.59	LM3900	.49
LF356	.99	LM3911	2.25
LF357	.99	LM3909	.98
LM358	.59	LM3914	1.89
LM380	.89	MC4024	3.49
LM383	1.95	MC4044	3.99
LM386	.89	RC4136	1.25
LM393	.45	RC4558	.69
LM394H	5.95	LM13600	1.49
TL494	4.20	75107	1.49
TL497	3.25	75110	1.95
NE555	.29	75150	1.95
NE556	.49	75154	1.95
NE558	.79	75188	1.25
NE564	1.95	75189	1.25
LM565	.95	75451	.39
LM566	1.49	75452	.39
NE590	2.50	75477	1.29

H=TO-5 CAN, K=TO-3, T=TO-220

6500

1.0 MHz

6502	2.25
65C02 (CMOS)	7.95
6520	1.65
6522	2.95
6526	13.95
6532	5.95
6545	2.95
6551	2.95

2.0 MHz

6502A	2.69
6520A	2.95
6522A	5.95
6532A	11.95
6545A	3.95
6551A	6.95

3.0 MHz

6502B	4.25

6800

1.0 MHz

6800	1.95
6802	2.95
6803	3.95
6809	2.95
6809E	2.95
6810	1.95
6820	2.95
6821	1.25
6840	3.95
6843	4.95
6844	6.95
6845	2.75
6847	4.75
6850	1.95
6883	22.95

2.0 MHz

68B00	2.95
68B02	3.95
68B09E	5.49
68B09	5.99
68B21	1.85
68B45	4.95
68B50	1.75
68000	9.95

Z-80

2.5 MHz

Z80-CPU	1.25

4.0 MHz

Z80A-CPU	1.29
Z80A-CTC	1.69
Z80A-DART	5.95
Z80A-DMA	5.95
Z80A-PIO	1.89
Z80A-SIO/0	5.95
Z80A-SIO/1	5.95
Z80A-SIO/2	5.95

6.0 MHz

Z80B-CPU	2.75
Z80B-CTC	4.25
Z80B-PIO	4.25
Z80B-DART	6.95
Z80B-SIO/0	12.95
Z80B-SIO/2	12.95
Z8671 ZILOG	9.95

CLOCK CIRCUITS

MM58167	9.95
MM58174	9.95
MSM5832	2.95

BIT RATE GENERATORS

MC14411	9.95
BR1941	4.95
4702	9.95
COM8116	8.95

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ICL7106	9.95
ICL7107	10.95
ICL7660	1.99
ICL8038	3.85
ICM7207A	5.95
ICM7208	15.95

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1791	9.95
1793	9.95
1795	12.95
1797	12.95
2791	19.95
2793	19.95
2797	29.95
8272	4.39
UPD765	4.39
MB8876	12.95
MB8877	12.95
1691	6.95
2143	6.95
9216	6.29

UARTS

AY5-1013	3.95
AY3-1015	4.95
TR1602	3.95
2651	4.95
IM6402	3.95
IM6403	9.95
INS8250	6.95
NS16450	10.95

MISC.

ADC0804	2.99
ADC0809	3.85
DAC0800	3.29
DAC0808	1.95
DAC1022	5.95
MC1408L8	1.95
8T28	1.29
8T97	.59
DP8304	2.29
9334	1.75
9368	2.85
9602	.69
ULN2003	.79
MAX232	7.95
MC3470	1.95
MC3487	2.95
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V20* 8 MHz	10.95
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32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.4576	1.95
3.579545	1.95
4.0	1.95
5.0	1.95
5.0688	1.95
6.0	1.95
6.144	1.95
8.0	1.95
10.0	1.95
10.738635	1.95
12.0	1.95
14.31818	1.95
16.0	1.95
18.0	1.95
18.432	1.95
20.0	1.95
22.1184	1.95
24.0	1.95
32.0	1.95

OSCILLATORS

1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
2.5	5.95
4.0	4.95
5.0688	4.95
6.0	4.95
6.144	4.95
8.0	4.95
10.0	4.95
12.0	4.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

PALS

16L8	$2.95
16R8	$2.95
16R6	$2.95
16R4	$2.95

74F/74S

74F00	.35
74F02	.35
74F04	.35
74F08	.35
74F10	.35
74F32	.35
74F64	.55
74F74	.39
74F86	.55
74F138	.79
74F139	.79
74F253	.89
74F157	.89
74F240	1.29
74S00	.29
74S02	.29
74S04	.29
74S08	.35
74S10	.29
74S32	.35
74S74	.49
74S86	.35
74S112	.50
74S124	2.75
74S138	.79
74S153	.79
74S157	.79
74S158	.95
74S163	1.29
74S175	.79
74S195	1.49
74S240	1.49
74S241	1.49
74S244	1.49
74S280	1.95
74S287	1.69
74S288	1.69
74S299	2.95
74S373	1.69
74S374	1.69
74S471	4.95
74S571	2.95

CMOS/HIGH SPEED CMOS

4001	.19	4066	.29	74HC154	1.09
4011	.19	4069	.19	74HC157	.55
4012	.25	4070	.29	74HC244	.85
4013	.35	4081	.22	74HC245	.85
4015	.29	4093	.49	74HC273	.69
4016	.29	14411	9.95	74HC373	.69
4017	.49	14433	14.95	74HC374	.69
4018	.69	14497	6.95	74HCT00	.25
4020	.59	4503	.49	74HCT02	.25
4021	.69	4511	.69	74HCT04	.27
4023	.25	4518	.85	74HCT08	.25
4024	.49	4528	.79	74HCT32	.27
4025	.25	4538	.95	74HCT74	.45
4027	.39	4702	9.95	74HCT138	.55
4028	.65	74HC00	.21	74HCT139	.55
4040	.69	74HC02	.21	74HCT161	.79
4042	.59	74HC04	.25	74HCT240	.89
4044	.69	74HC08	.25	74HCT244	.89
4046	.69	74HC10	.25	74HCT245	.99
4047	.69	74HC14	.35	74HCT273	.99
4049	.29	74HC32	.35	74HCT373	.99
4050	.29	74HC74	.35	74HCT374	.99
4051	.69	74HC86	.45	74HCT393	.99
4052	.69	74HC138	.45	74HCT4017	1.19
4053	.69	74HC139	.45	74HCT4040	.99
4060	.69	74HC151	.59	74HCT4060	1.49

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CAPACITORS

TANTALUM

1.0µf	15V	.12	1.0µf	35V	.45
6.8	15V	.42	2.2	35V	.19
10	15V	.45	4.7	35V	.39
22	15V	.99	10	35V	.69

DISC

10pf	50V	.05	.001µf	50V	.05
22	50V	.05	.005	50V	.05
33	50V	.05	.01	50V	.07
47	50V	.05	.05	50V	.07
100	50V	.05	.1	12V	.10
220	50V	.05	.1	50V	.12

MONOLITHIC

.01µf	50V	.14	.1µf	50V	.18
.047µf	50V	.15	.47µf	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1µf	25V	.14	1µf	50V	.14
4.7	50V	.11	10	50V	.16
10	50V	.11	22	16V	.14
47	35V	.13	47	50V	.19
100	16V	.15	100	35V	.19
220	35V	.20	470	50V	.29
470	25V	.30	1000	16V	.29
2200	16V	.70	2200	16V	.70
4700	25V	1.45	4700	16V	1.25

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UL APPROVED

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- QUICK HEATING & RECOVERY
- RANGE: 200°—900°F

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FR-4 EPOXY GLASS LAMINATE
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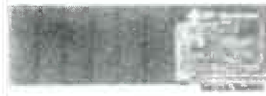

XT

BOTH CARDS HAVE SILK SCREENED LEGENDS & MOUNTING BRACKET

IBM-PR1 $27.95
WITH +5V AND GROUND PLANE

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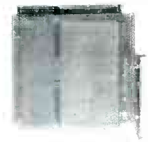
AS ABOVE WITH DECODING LAYOUT

AT

IBM-PRAT $29.95
LARGE +5V & GROUND PLANES

EXTENDER CARDS FOR IBM

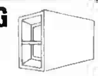
EXT-8088 $29.95
EXT-80286 $39.95



BYPASS CAPACITORS

.01 µf	CERAMIC DISC	100/$5.00
.01 µf	MONOLITHIC	100/$10.00
.1 µf	CERAMIC DISC	100/$6.50
.1 µf	MONOLITHIC	100/$12.50

SHORTING BLOCKS



5/$1.00

SOLDERLESS BREADBOARDS

WBU-D	100	TIE POINTS	2.95
WBU-T	630	TIE POINTS	6.95
WBU-204-3	1360	TIE POINTS	17.95
WBU-204	1660	TIE POINTS	24.95
WBU-206	4390	TIE POINTS	29.95
WBU-208	3220	TIE POINTS	39.95

RESISTOR NETWORKS

SIP	10 PIN	9 RESISTOR	.69
SIP	8 PIN	7 RESISTOR	.59
DIP	16 PIN	8 RESISTOR	1.09
DIP	16 PIN	15 RESISTOR	1.09
DIP	14 PIN	7 RESISTOR	.99
DIP	14 PIN	13 RESISTOR	.99

VOLTAGE REGULATORS

7805T	.49	7812K	1.39
7808T	.49	7905K	1.69
7812T	.49	7912K	1.49
7815T	.49	78L05	.49
7905T	.59	78L12	.49
7908T	.59	79L05	.69
7912T	.59	79L12	1.49
7915T	.59	LM323K	4.79
7805K	1.59	LM338K	6.95

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IDCEN36	RIBBON CABLE	3.95
CEN36	SOLDER CUP	1.85
IDCEN36/F	RIBBON CABLE	4.95
CEN36PC	Rt Angle PC Mount	1.85

DISCRETE

1N751	.15	4N28	.69
1N4148	25/$1.00	4N33	.89
1N4004	10/$1.00	4N37	1.19
1N5402	.25	MCT-2	.59
KBP02	.55	MCT-6	1.29
2N2222	.25	TIL-111	.99
PN2222	.10	2N3906	.10
2N2907	.25	2N4401	.25
2N3055	.79	2N4402	.25
2N3904	.10	2N4403	.25
4N26	.69	2N6045	1.75
4N27	.69	TIP31	.49

EDGECARD CONNECTORS

100 Pin	ST	S-100	.125	3.95
100 Pin	WW	S-100	.125	4.95
62 Pin	ST	IBM PC	.100	1.95
50 Pin	ST	APPLE	.100	2.95
44 Pin	ST	STD	.156	1.95
44 Pin	WW	STD	.156	4.95

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- ERASES 2 EPROMS IN 10 MINUTES
- VERY COMPACT, NO DRAWER
- THIN METAL SHUTTER PREVENTS UV LIGHT FROM ESCAPING

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SOCKET-WRAP I.D.™

- SLIPS OVER WIRE WRAP PINS
- IDENTIFIES PIN NUMBERS ON WRAP SIDE OF BOARD
- CAN WRITE ON THE PLASTIC; SUCH AS AN IC #

PINS	PART #	PCK. OF	PRICE
8	IDWRAP 08	10	1.95
14	IDWRAP 14	10	1.95
16	IDWRAP 16	10	1.95
18	IDWRAP 18	5	1.95
20	IDWRAP 20	5	1.95
22	IDWRAP 22	5	1.95
24	IDWRAP 24	5	1.95
28	IDWRAP 28	5	1.95
40	IDWRAP 40	5	1.95

PLEASE ORDER BY NUMBER OF PACKAGES (PCK. OF)

IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	---	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' GREY RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS. SEE D-SUBMINIATURE CONNECTORS, BELOW

SPECTRONICS CORPORATION EPROM ERASERS

Model	Timer	Chip Capacity	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189

SWITCHES

SPDT	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39

DIP SWITCHES

4 position	.85	7 position	.95
5 position	.90	8 position	.95
6 position	.90	10 position	1.29

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	---	.79	2.27	---
	FEMALE	DBxxSR	.55	.75	---	.85	2.49	---
WIREWRAP	MALE	DBxxPWW	1.69	2.56	---	3.89	5.60	---
	FEMALE	DBxxSWW	2.76	4.27	---	6.84	9.95	---
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	---	2.25	4.25	---
	FEMALE	IDBxxS	1.45	2.05	---	2.35	4.49	---
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	---	---
	GREY	HOODxx	.39	.39	---	.39	.69	.75

ORDERING INSTRUCTIONS:
INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.

MOUNTING HARDWARE 59¢

LIGHT EMITTING DIODES

LED DISPLAYS

FND-357(359)	COM CATHODE	.362"	1.25
FND-500(503)	COM CATHODE	.5"	1.49
FND-507(510)	COM ANODE	.5"	1.49
MAN-72	COM ANODE	.3"	.99
MAN-74	COM CATHODE	.3"	.99
TIL-313	COM CATHODE	.3"	.45
TIL-311	4x7 HEX W/LOGIC	.270"	10.95

DIFFUSED LEDs

		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

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CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

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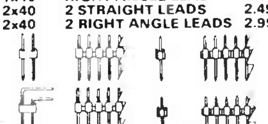
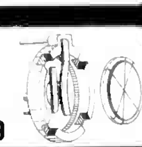
2x40	2 STRAIGHT LEADS	2.49
2x40	2 RIGHT ANGLE LEADS	2.99



3 VOLT LITHIUM BATTERY

$1.95

HOLDER $1.49



IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	---	4.95	4.95	---	5.95	---	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	---	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS, ABOVE

Dear Mr. Rose,

I am writing to compliment the service I received yesterday on a phone call to JDR. I spoke to a salesperson named Helen. She went out of her way to assist...it is service like this that keeps us coming back to JDR.

Thanks!
Jim Mikeworth

25 PIN D-SUB GENDER CHANGERS

$7.95

EMI FILTER $4.95

LINE CORDS

2 conductor 39¢ 3 conductor 99¢
3 conductor w/female socket $1.49

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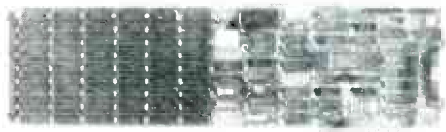
ALL MCT PRODUCTS CARRY A 1 YEAR WARRANTY

INTERFACE CARDS

FROM MODULAR CIRCUIT TECHNOLOGY



MCT-MF

DISPLAY CARDS

MCT-MGP MONOCHROME GRAPHICS **$59.95**
TRUE HERCULES COMPATIBILITY. SUPPORTS LOTUS 123
- SOFTWARE DRIVER ALLOWS COLOR GRAPHICS PROGRAMS TO RUN ON A MONOCHROME MONITOR
- PARALLEL PRINTER PORT

MCT-EGA ENHANCED GRAPHICS ADAPTOR **$149.95**
100% IBM COMPATIBLE, PASSES IBM EGA DIAGNOSTICS
- 256K OF VIDEO RAM ALLOWS 640 x 350 IN 16 OF 64 COLORS
- COMPATIBLE WITH COLOR AND MONOCHROME ADAPTORS

MCT-CG COLOR GRAPHICS ADAPTOR **$49.95**
COMPATIBLE WITH IBM COLOR GRAPHICS STANDARDS
- SHORT SLOT SUPPORTS RGB, COLOR & COMPOSITE MONOCHROME
- 640/320 x 200 RESOLUTION, LIGHT PEN INTERFACE

MULTIFUNCTION CARDS

MCT-MF MULTIFUNCTION **$79.95**
ALL THE FEATURES OF 6 PACK - AT HALF THE PRICE
- 0-384K DYNAMIC RAM USING 4164s
- SERIAL, PARALLEL, GAME PORTS, CLOCK/CALENDAR

MCT-MGMIO MONOGRAPHICS I/O **$119.95**
TOTAL SYSTEM CONTROL FROM A SINGLE SLOT
- 2 FLOPPY CONT, SERIAL, PARALLEL, GAME PORT, CLOCK/CAL
- RUN COLOR GRAPHICS SOFTWARE ON A MONOCHROME MONITOR

MCT-MIO MULTI I/O FLOPPY **$79.95**
A PERFECT COMPANION FOR OUR MOTHERBOARDS
- SERIAL, PARALLEL, GAME PORT, CLOCK/CALENDAR
- SUPPORTS UP TO 2 360K FLOPPIES, 720K WITH DOS 3.2

MIO-SERIAL 2nd SERIAL PORT $15.95

MCT-IO MULTI I/O CARD **$59.95**
USE WITH MCT-FH FOR A MINIMUM OF SLOTS USED
- SERIAL PORT, CLOCK/CALENDAR WITH A BATTERY BACK-UP
- PARALLEL PRINTER PORT ADDRESSABLE AS LPT1 OR LPT2

IO-SERIAL 2nd SERIAL PORT $15.95

MCT-ATMF AT MULTIFUNCTION **$139.95**
ADDS UP TO 3 MEGABYTES OF RAM TO THE AT
- USER EXPANDABLE TO 1.5 MB OF MEMORY (ZERO K INSTALLED)
- INCLUDES SERIAL PORT AND PARALLEL PORT

ATMF-SERIAL 2nd SERIAL PORT $24.95
MCT-ATMF-MC PIGGYBACK BOARD (NO MEMORY) $29.95

MCT-ATIO AT MULTI I/O **$59.95**
USE WITH MCT-ATFH FOR A MINIMUM OF SLOTS USED
- SERIAL, PARALLEL AND GAME PORTS
- USES 16450 SERIAL SUPPORT CHIPS FOR HIGH SPEED OPERATION

ATIO-SERIAL 2nd SERIAL PORT $24.95

MEMORY CARDS

MCT-RAM 576K RAM CARD **$59.95**
A CONTIGUOUS MEMORY SOLUTION IN A SHORT SLOT
- USER SELECTABLE CONFIGURATION AMOUNTS UP TO 576K USING 64K & 256K RAM CHIPS (ZERO K INSTALLED)

MCT-EMS EXPANDED MEMORY CARD **$129.95**
2 MB OF LOTUS/INTEL/MICROSOFT COMPATIBLE MEMORY FOR XT
- CONFORMS TO LOTUS/INTEL EMS
- USER EXPANDABLE TO 2 MB
- EXPANDED/CONVENTIONAL MEMORY, RAMDISK AND SPOOLER

MCT-ATEMS AT VERSION $139.95

DRIVE CONTROLLERS

MCT-FDC FLOPPY DISK CONTROLLER **$29.95**
QUALITY DESIGN OFFERS 4 FLOPPY CONTROL IN A SINGLE SLOT
- INTERFACES UP TO 4 FDDs TO AN IBM PC OR COMPATIBLE
- SUPPORTS BOTH DS/DD AND DS/QD WITH DOS 3.2

MCT-HDC HARD DISK CONTROLLER **$79.95**
HD CONTROL FOR WHAT OTHERS CHARGE FOR FLOPPY CONTROL
- SUPPORTS 16 DRIVE SIZES INCLUDING 5, 10, 20, 30 & 40 MB
- DIVIDE 1 LARGE DRIVE INTO 2 SMALLER, LOGICAL DRIVES

MCT-FDC-1.2 1.2MB FLOPPY CONTROLLER **$69.95**
ADD VERSATILITY & CAPACITY TO YOUR XT
- SUPPORTS 2 DRIVES, BOTH MAY BE 360K OR 1.2 MFG
- ALLOWS DATA TO FLOW FREELY FROM XTs TO ATs

MCT-FH FLOPPY/HARD CONTROLLER **$139.95**
SYSTEM STARVED FOR SLOTS? SATISFY IT WITH THIS TIMELY DESIGN
- INTERFACES UP TO 2 FDDs & 2 HDDs, CABLING FOR 2 FDDs & 1 HDD
- SUPPORTS BOTH DS/DD & DS/QD WITH DOS 3.2

MCT-ATFH AT FLOPPY/HARD CONTROLLER **$149.95**
FLOPPY/HARD DISK CONTROL IN A TRUE AT DESIGN
- SUPPORTS UP TO 2 360K/720K/1.2MB FDDs AS WELL AS 2 HDDs USING STANDARD CONTROL TABLES

Seagate

1/2 HEIGHT HARD DISK DRIVES

40 MB $469
60 MB $649

Drives are Seagate models ST-251 (40 MB) & ST-277 (60 MB RLL) 5¼" half heights FAST 40ms access time!

1/2 HT HARD DISK SYSTEMS

20 MB $289
30 MB $329

Systems include Seagate ½ height hard drive, drive controller, cables & instructions. All drives are pre-tested & warranted for 1 year.

IBM COMPATIBLE MOTHERBOARDS

FROM MODULAR CIRCUIT TECHNOLOGY

MCT-TURBO TURBO 4.77/8 MHz **$99.95**
- 4.77 OR 8 MHz OPERATION WITH 8088-2 & OPTIONAL 8087-2 CO-PROCESSOR
- FRONT PANEL LED SPEED INDICATOR AND RESET SWITCH SET SUPPORTED
- CHOICE OF NORMAL/TURBO MODE OR SOFTWARE SELECT PROCESSOR SPEED

MCT-XTMB STANDARD MOTHERBOARD $87.95

MCT-ATMB 80286 6/8 MHz **$379.95**
- 8 SLOT (2 EIGHT BIT, 6 SIXTEEN BIT) AT MOTHERBOARD
- HARDWARE SELECTION OF 6 OR 8 MHz
- 1 WAIT STATE
- KEYLOCK SUPPORTED, RESET SWITCH, FRONT PANEL LED INDICATOR
- SOCKETS FOR 1 MB OF RAM AND 80287
- BATTERY BACKED CLOCK

MCT-BATMB MINI 80286 **$389.95**
- REPLACEMENT BOARD FOR XT STYLE CHASSIS
- OPERATE AT 6/10 MHz WITH UP TO 1MB ON-BOARD MEMORY (ZERO K INSTALLED)
- SOCKET FOR 80287 MATH CO-PORCESSOR
- BATTERY BACKED CLOCK
- 8 SLOTS: 2 EIGHT BIT, 6 SIXTEEN BIT
- USES CHIPS & TECHNOLOGY CHIP SET FOR RELIABILITY AND SMALL SIZE

IBM COMPATIBLE KEYBOARDS

FULL ONE YEAR WARRANTY

MCT-5339 **$79.95**
- IBM ENHANCED STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- LED INDICATORS
- AUTO REPEAT FEATURE
- SEPARATE CURSOR PAD

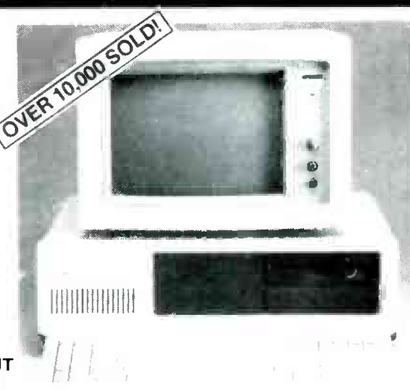
MCT-5060 **$59.95**
- IBM AT STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- LED INDICATORS
- AUTO REPEAT FEATURE

MCT-5150 XT STYLE LAYOUT **$49.95**
MCT-5151 KB5151™ EQUIV. **$69.95**

WHY BUY A SYSTEM FROM JDR?

- BUILD IT YOURSELF AND SAVE!
- MONEY BACK GUARANTEE (ASK FOR DETAILS)
- LEARN ABOUT THE INNER WORKINGS OF A COMPUTER
- MOST ORDERS SHIPPED IN 24 HOURS
- QUALITY COMPONENTS AND COMPETITIVE PRICES
- TOLL FREE TECH SUPPORT IN THE U.S. AND CANADA
- YOU CAN ASSEMBLE A SYSTEM IN ABOUT 2 HOURS WITH A SCREWDRIVER & OUR EASY-TO-FOLLOW INSTRUCTIONS

BUILD YOUR OWN 256K XT COMPATIBLE



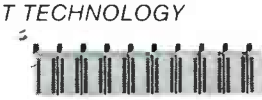
- MOTHERBOARD
- 256K OF MEMORY
- 135 WATT POWER SUPPLY
- FLIP-TOP CASE
- XT STYLE KEYBOARD
- 360K FLOPPY DRIVE
- DRIVE CONTROLLER
- MONOCHROME MONITOR
- GRAPHICS ADAPTOR

FOR ONLY $498.15

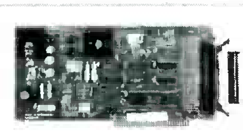
ANYONE CAN BUILD A SYSTEM IN ABOUT 2 HOURS USING A SCREWDRIVER AND OUR EASY-TO-FOLLOW INSTRUCTIONS!

DEVELOPMENT TOOLS

FROM MODULAR CIRCUIT TECHNOLOGY



MCT-EPROM PROGRAMMER **$129.95**
PROGRAMS 27xx & 27xxx EPROMS UP TO 27512
- SUPPORTS VARIOUS PROGRAMMING FORMATS AND VOLTAGES
- SPLIT OR COMBINE CONTENTS OF SEVERAL EPROMS OF DIFFERENT SIZES
- READ, WRITE, COPY, ERASE CHECK AND VERIFY
- SOFTWARE FOR HEX AND INTEL HEX FORMATS



MCT-EPROM-4 4 GANG PROGRAMMER $189.95
MCT-EPROM-10 10 GANG PROGRAMMER $299.95
MCT-PAL PAL PROGRAMMER **$269.95**
MCT-MP PROCESSOR PROG. **$199.95**

PARTIAL LISTING ONLY-CALL FOR A FREE CATALOG!

CIRCLE 179 ON FREE INFORMATION CARD

What's New at
AMERICAN DESIGN COMPONENTS?

We warehouse 60,000 items at American Design Components – expensive, often hard-to-find components for sale at a fraction of their original cost!

You'll find every part you need – either brand new or removed from equipment (RFE) in excellent condition. But quantities are limited. Order from this ad, or visit our retail showroom and find exactly what you need from the thousands of items on display.

OPEN MON. – SAT., 9–5

THERE'S NO RISK.
With our full 90-day warranty, any purchase can be returned for any reason for full credit or refund.

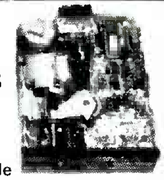
3½", 20 Mb, HALF HT. HARD DISK DRIVE

Fits standard 5¼" spacing. High speed, low power. Comes w/both full ht. and half ht. face plates. Mfr – Lapine #LT200/2000
Item #15853 **$199.00** New

15 Mb, 5¼" FULL HT. HARD DISK DRIVE

(IBM® PC/XT Compatible)
Removed from working equipment. Tested & formatted. Mfr – CMI model CM5619
Item #14511 **$199.00**

5¼" 1/2 HT. DISK DRIVES



IBM® AT Compatible 48/96 TPI, 1.2 Mb
Double side, high density; 160 tracks. Mfr – Panasonic #JU-475
Item #10005 **$109.95** New

96 TPI, DOS 3.2 Compat.
Double side, quad density. Mfr – Tandon TM55-4
Item #1904 **$79.00**
2 for **$150.00**

5¼" FULL HEIGHT DISK DRIVES –

48 TPI (IBM® Compatible) DS/DD, 80 Track
Tandon #TM100-2 or equiv.
Item #7928 **$79.00** New
2 for **$150.00** New

48 TPI (TRS80/Zenith/Xerox 800 Compat.) DS/DD, 40 Track
Shugart #450. Item #1892.
$79.00; 2 for **$150.00**

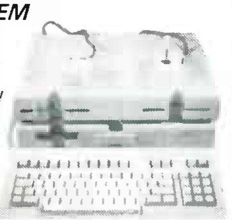
48 TPI, SS/DD, 40 Track
Shugart #SA400. Item #1895.
$39.50; 2 for **$75.00**

96 TPI, DS/Quad Density
CDC #9409T
Item #1893 **$89.00**

Mindset® Color Graphics *PERSONAL COMPUTER SYSTEM*

(Does not incl. monitor)

Runs all the same programs as an IBM® PC!



Fast graphics capabilities allow you to draw/animate & color objects instantly. 265K, w/360K floppy disk drive. Includes built-in RGB/monochrome card & TV adapter. Also incl. Mouse & Joystick, & is supplied w/GW Basic & MS DOS 2.1.
Item #16077 **$299.00** New

Accessories Available (limited supply):

★ **NV RAM 8K Cartridge**
Provides 8K non-volatile RAM.
Item #16078 **$29.95** New

★ **RS-232 Module w/Power Option**
Provides EIA standard RS-232-C serial interface.
Item #16080 **$39.95** New

★ **Modem Module**
Item #16081 **$39.95** New

ADAM 5¼" DISK DRIVE

Gives your Adam fast, reliable data storage and retrieval. Can hold up to 160K bytes of information. Uses industry-standard SS/DD disks. Connects directly to your Adam memory console. Comes w/disk drive power supply, Disk Manager disk & owner's manual. Mfr – Coleco, model 7817.
Item #12830
Like New – **$199.00**

Fans . . .

115 CFM MUFFIN® FANS

115 VAC, 60 Hz.; 21W.; 28A.; 3100 RPM; 5-blade model; aluminum housing. Can be mtd. for blowing or exhaust. Dim.: 4$^{11}/_{16}$" sq. x 1½" deep

NEW – Mfr: IMC
Item #1864 **$9.95**

USED – Mfr: Centaur/Howard
Item #5345 **$5.95**

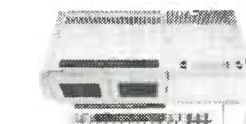
ANALOG to DIGITAL CONVERTER

Binary output: 12 bit; Conversion time: 8 microseconds; Linearity: 8 ms. ± 1/2 lbs. Parallel and series outputs; internal reference. Mfr – Datel ADC-HZ-12BGC
Item #7052 (RFE – tested good!)
Originally $ ~~130.00~~
Special – **$39.95**

5¼" FLOPPY DISKETTES

Single side/single density; 16 hard sectors. Mfr – Xerox #11R61630
Item #14537
Pack of 10 **$9.95** New

ADAM COMPUTER



(Less printer)
No wiring nec. (just plugs together). Hook-up diagram incl. Incl.: keyboard, 1 cassette digital data drive, 2 game controllers, power supply & 1 cassette. Cap. of running CP/M, has built-in word processor. Item #7410
Complete – **$99.00**

27 CFM MINI FANS

115VAC; 50/60Hz.; 12W. Low noise level fans, can be mounted for blowing or exhaust.

1" Thin –
Contains 9 plastic blades. Dim.: 3⅛" sq. x 1" deep
Mfr – Tobishi #U9201B
Item #10960 **$7.95** New

1½" Standard –
Contains 7 metal blades. Mfr – Rotron #SU2A1
Item #5970 **$7.95** New

150 CFM SUPER VENTURI FAN

Ball bearing; 115 VAC, 60 Hz.; .195/.178 amps. Has 2 sets of mtg. holes (fits standard rack or larger). Can be mtd. for blowing or exhaust. Dim.: 5" sq. x 1½" deep. Mfr – Rotron
Item #1866 **$19.95** New

Protect your Printer/Typewriter with our DIABLO CLEANING KIT

For printers & typewriters w/print wheel, spindle, & metal ball type print elements. Good for 5 cleanings. Incl.: platen cleaner, type/print element cleaner, sound shield cleaner, plus buffers & cloths. Mfr – Diablo Supplies #9R87106
Item #15419
3 sets/**$14.95** New

14" EGA COLOR MONITOR (25 Khz.)

PC, XT, & AT Compatible

Perfect for text, CAD & other graphics applications. Requires a 25Khz EGA card ('Wonder' or compatible). Resolution: 752 x 410 max. Input: 110/220V, 50/60Hz, 80W. Hook-up diagram included. Mounted in metal housing. Mfr. #14-GZF2
Item #14864 **$179.00** New

Adam & *ColecoVision* Accessories . . .

Data Drive –
Item #6641 **$19.95**

Printer Power Supply –
Item #6642 **$14.95**

ASCII Keyboard –
Item #6643 **$19.95**

Controllers (Set of 4) –
Item #7013 **$9.95** RFE

***Adam* Cassettes** –
(Incl. Smart Basic, Buck Rogers & blank cassette.) Item #7786
BAKER'S DOZEN – **$19.95**

***Adam* Link Modem** –
(Software included.)
Item #12358 **$29.95**

Auto-Dialer Address Book –
Item #12365 **$19.95**

***Adam* Daisy Print Wheel** –
Item #13305 **$3.95**

***Adam* Ribbon Cartridge** –
Item #13306 **$3.95**

***ColecoVision* to *Adam* Expansion Kit** –
This expansion module just plugs into your *ColecoVision*. With printer power supply & data drive (both included), you will have a working *Adam* computer. *Adam* keyboard, 1 Smart Basic cassette & hook-up diagram also included.
Item #9918 **$59.50**

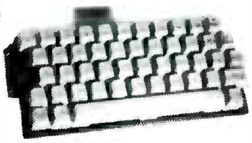
Expansion Module #2 –
Includes *Turbo* cartridge.
Item #13146 **$39.95** New

Roller Controller –
Includes *Slither* cartridge.
Item #13147 **$39.95** New

Super Action Controller Set –
Includes ***Baseball*** cartridge.
Item #13148 **$39.95** New

Call or Write with Your Requirements

MECHANICAL KEYBOARDS . . .



48-KEY – Timex Z81/1000
Item #6712 **$5.95** New

75-KEY – Timex or Adam
For computer upgrade . . .
Item #7429 **$5.95** New

66-KEY – Commodore C-16
Item #9394 **$5.95** New

STEPPING MOTORS for ROBOTICS . . .

Precision steppers with increments from 1 to 7.5 degrees. Speeds up to 5,000 steps.

Fig. 1

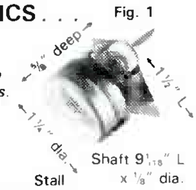
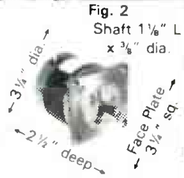


Fig. 2



Item No.	Step Angle	Volts DC	Stall Torque oz/in	Type	Mfr. & Part No.	Fig	Price
5431	1	5	17	PM	N.A. Phillips A82310-M2	1	$9.95 ea. 2/$14.95
5275	1.8	1.8	72	PM	Superior Electric MO61-FF-6201B	2	$19.95 ea. 2/$37.50
6671	3.7	1.2	18	–	Mitsubishi 42SH-32KOA	2	$9.95 ea. 2/$14.95
7630	1.8	3.0	200	PM	Superior Electric M092-FT-402	2	$34.50 ea. 2/$59.50

PLUG-IN POWER SUPPLIES

COMPUTER/GAME ADAPTOR

Output: +5 VDC, .9A
–5 VDC, .1A
+12 VDC, .3A
Input: 120 VAC/60 Hz., .25A
Mfr – Coleco #55416
Item #1882 **$4.95** New

9 VDC ADAPTOR

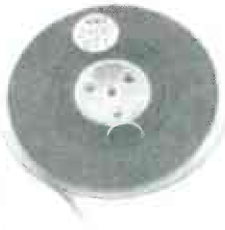
Input: 115 VAC, 50/60 Hz.
Output: 9.5V @ 1A
Dimensions: 2⅜"W x 3⅛"H x 2" deep
Mfr – Commodore #251539-01 02
Item #9393 **$5.95** New

12 VDC ADAPTOR

DC Output: 14V @ 200ma.
Input: 110VAC/60Hz., 2.8W
Mfr – Spirit Ind. #CS-451
Item #12872 **$2.95** New

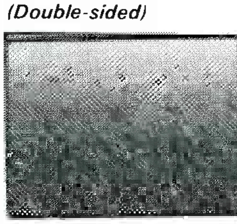
RECORDING TAPE

7½" Reel, 2400 ft.



Bulk erased. Major mfrs.: Ampex, Scotch, etc.
Item #6711 – ¼ Mil.
15 reels for **$9.95**

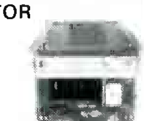
COPPER-CLAD PRINTED CIRCUIT BOARD *(Double-sided)*



Glass coated, epoxy laminated, 1 oz. Double sided, .022" thick. Dimensions: 24"L x 18.5"H
Item #13606
3 sheets/**$9.95**

MINI MICRO-COMPUTER REGULATOR

140 VA



Provides voltage regulation & ultra-isolation for microprocessor-based equipment. Contains less than 3% harmonic distortion, better than 60 dB traverse noise rejection. Contains dual outlet for CPU & monitor, & 6 ft. line cord.
Input: 95 – 130V, 60Hz.
Output: 120V @ 1.17A
Dimen.: 11⅝"L x 4⅜"H x 5⅝"W
Mtd on metal base w/rubber ft
Mfr – Sola #63-13-114
Item #9999 **$89.00** New

CIRCLE 106 ON FREE INFORMATION CARD

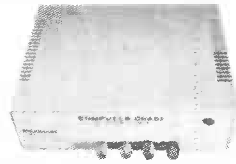
"The First Source"— for electromechanical & electronic equipment and components — AMERICAN DESIGN COMPONENTS!

TTL MONITORS . . . *(Open Frame)*

12" High-Res.
12VDC, green phosphor. Subassemblies, CRT, board & transformer incl. Comes w/ hook-up diagram.
Item #6811 **$19.95** New

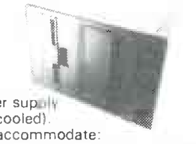
15" Data Display/Monitor Kit
Alphanumeric & graphics display. Green phosphor. Input power reg 24 VDC. Band-width: 22-72Khz. Consists of 2 subassemblies (monitor & board). Hook-up diagram incl. Mfr — Wells Gardner #15V7025.
Item #16171 **$24.95** New

COMPUTER GRADE POWER SUPPLY



Other uses–runs CB & car radios. Comes ready to plug in!
DC Output: −5V @ .5 amp. +5V @ 3 amp +12V @ 6 amp.
Input: 115V/60Hz. Dimens ons: 9¼"W x 3¾"H. (Rubber ft. incl.)
Item #9501 **$24.95** New

EXTERNAL DISK DRIVE CHASSIS

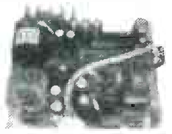


With 60W power supply (fan cooled).
Can accommodate:
2 full ht. drives our item #7928
2 floppy drives #1904
1 hard drive & 1 floppy #13250
Input: 115/230V, 50/60 Hz.
Originally for Burroughs computer.
Dim.: 11"W x 8"H x 12" deep
Item #14541 **$59.50**

★ ★ ★ ★ ★ ★ ★ *TIMEX-SINCLAIR* . . . 2040 PRINTER

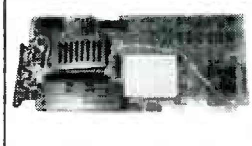
32 column — compatible w/any of the Timex Sinclair computers, as well as our PC 8300 Computer. Uses standard 4½" thermal paper.
Item #15851 **$39.95** New

SWITCHING POWER SUPPLY



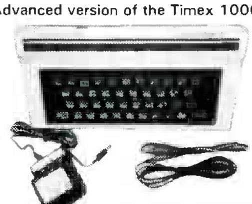
DC Output: −5V @ .5A +24V @ 1.0A +5V @ 8.6A
Input: 115/230 VAC, 50/60 Hz.
Dim.: 7⅜"W x 1¾"H x 6⅛"D
Mfr — Xerox #105S80441
Item #15756 **$19.95** New

COMMODORE VIC 20 CPU BOARD



Insides of the Commodore VIC 20. For parts only — guaranteed not to work!
Item #12144 **$14.95**

PC 8300 HOME COMPUTER
(Advanced version of the Timex 1000)



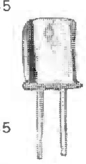
42-key mech. keybd. 2K RAM. Rev. video, Z80A, 6.5MHz processor, ROM 8K BASIC. Graphics cap./sound-music, TV or monitor. Joystick input. 115 VAC. AC adapt, TV cable & cass. cables. Runs tapes for Sinclair/Timex 1000-ZX85. Mfr – Power 3000. (In orig. boxes.)
Item #10336 **$29.95** New
★ **16K RAMPACK upgrade**
Item #10337 **$9.95** New

MAGNIFYING LAMP

Multi position, 30", completely adjustable swing arm w/3-way metal C-clamp. Has 4" diopter magnifying lens w/ruler. Porcelain lamp socket, & on/off switch; uses up to a 60W bulb. Color: Beige. UL listed.
Item #13136 **$24.95** New

— BATTERIES — FANS — BLOWERS

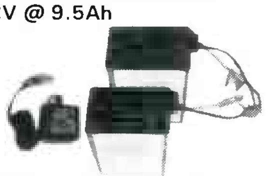
CRYSTALS
(Microprocessor) HC-18U



Mhz.	Item #
1.8432	7915
3.2768	13911
3.579545	12361
4.0	7045
4.032	13041
5.0	13043
5.0688	6786
6.0	12362
6.144	13226
10.736835	1953
12.0	7920
13.7931	7362
14.31818	7359
16.0	13425
18.432	13227
20.0	12360
48.0	7389
122.666	7037

$1.75 ea.

12V BATTERY PACK & MATING CHARGER
12V @ 9.5Ah



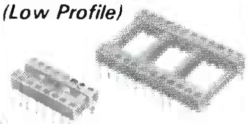
Consists of: 2 solid gell cell batteries, 6V @ 9.5Ah ea. Connected in series by a fusable harness. Mating battery charger: 12VDC @ 800Ma. Perfect for battery-operated toys, robotics, solar storage, burglar & fire alarms, etc.
OA Dim.: 4¼"W x 5½"H x 5½"D
Item #14619 **$29.95** New

GELL CELL/LEAD ACID BATTERIES . . .
RECHARGEABLE — Used for solar energy storage, alarm systems, model boats, planes, cars, trains, etc.

6V @ 9.5AH
Dim.: 5½"H x 4⅛"W x 2⅝"D
Mfr — Elpower
Item #7039 **$14.95**

6V @ 4.0AH
Dim.: 4"H x 2⅝"W x 1¾"D
Major Mfrs.
Item #15757 **$7.95**

IC SOCKETS . . . *(Low Profile)*



No. of Pins	Item #	Price
8	13518	$ .11
14	7350	.12
16	7354	.13
18	13649	.15
20	7353	.18
24	1230	.20
28	12865	.22
40	7351	.30
64	16169	1.75

INTEGRATED CIRCUITS . . .

Static Rams

2114-45	1024 × 4 (450ns)	$ .99	HM6116LP-3	2048 × 8 (150ns)	$1.89
2148 55		3.49	HM6116LP-4	2048 × 8 (200ns)	1.85
2149	1024 × 4 (45ns)	2.49	6147P		2.95
2167S-45		3.95	6167P 6		4.50

Dynamic Rams

4116-200	16,384 × 1 (200ns)	$.69	MS4416	16,384 × 4 (150ns)	$3.75
4116-250	16,384 × 1 (250ns)	.49	4464 150	65,536 × 4 (150ns)	4.95
4164-150	65,536 × 1 (150ns)	1.25	8118	16,384 × 1 (120ns)	.49
TMS4164	65,536 × 1 (150ns)	1.95	41256 150	262,144 × 1 (150ns)	2.95

Eproms

2708	1024 × 8 (450ns)	$4.95	2764-250	8192 × 8 (250ns)	$3.55
2716	2048 × 8 (450ns)	3.49	MCM68766	8192 × 8 (350ns)	15.95
TMS2532	4096 × 8 (450ns)	5.95	27128A 25	16,384 × 8 (250ns)	5.00
2732	4096 × 8 (450ns)	3.95	27128-250	16,384 × 8 (250ns)	4.25
2732A-25	4096 × 8 (250ns)	3.95	27C256	32,768 × 8 (250ns)	7.95
27C64	8192 × 8 (250ns)	4.95	27256	32,768 × 8 (250ns)	5.95
2764	8192 × 8 (450ns)	2.95	27512	65,536 × 8 (250ns)	11.55
2764A-25	8192 × 8 (250ns)	3.55			

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8088	5.75
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8755	13.95

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6800	1.90
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6821	1.25
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LH0070-0H	3.55
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TL072CP	.71
LM301N	.32
LM307N	.41
LM310N	1.16
LM311N	.41
LM317K	2.65
LM317LZ	.62
LM317MP	.80
LM317T	.90
LM318N	1.07
LM319N	1.07
LM324N	.35
LM334Z	1.07
LM336Z	.98
LM337MP	1.03
LM337T	1.34
LM338K	3.55
LM339N	.44
LF347N	.90
LM348N	.62
LM350K	3.55
LF353N	.53

Linear Devices *(continued)*

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LM380N	.80	RC4151NB	.90
LM380N-8	.98	RC4193NB(DE)	2.65
LM381N	1.16	7805K	1.21
LM383T	1.34	7812K	1.21
LM385Z	1.70	7815K	1.21
LM386N-4	.80	7818K	1.21
LM389N	.90	7824K	1.21
LM393N	.41	7805T	.44
LF398N	2.15	7812T	.44
LF411CN	.71	7815T	.44
TL494CN	1.75	7818T	.44
TL496CP	1.34	7824T	.44
TL497ACN	1.97	78S40	1.75
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NE558N	1.07	7915K	1.21
NE564N	1.75	7918K	1.21
LM565N	.90	7924K	1.21
LM566CN	1.25	7905T	.53
LM567V	.80	7912T	.53
NE570N	2.24	7915T	.53
NE571N	1.75	7918T	.53
NE592N	.80	7924T	.53
LM748CN	.53	79L12AC	.53
DS8T28N	1.57	79L15AC	.53
LM1456V	1.75	LF13201N	2.33
LM1458N	.44	LM13600N	1.07
LM1488N	.62	LM1889	1.85
LM1496N	.90	75107N	.90
LM1899N	1.43	75108N	.90
ULN2003A	.90	75110A	1.34
DS26LS31CN	1.34	75115	1.07
DS26LS32CN	1.34	75123N	1.34
LM2901N	.53	75124N	1.34
LM2903N	.53	75138N	2.65
LM2907N	1.75	75154N	1.25
LM2917N	1.39	75450N	.53
LM2917-14N	1.34	75451CN	.44
LM2931CT	1.07	75452CN	.44
MC3346P	.90	75453CN	.44
MC3486	1.34	75463N	.53
MC3487	1.34	75472	.80
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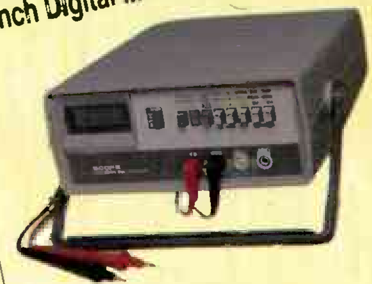

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