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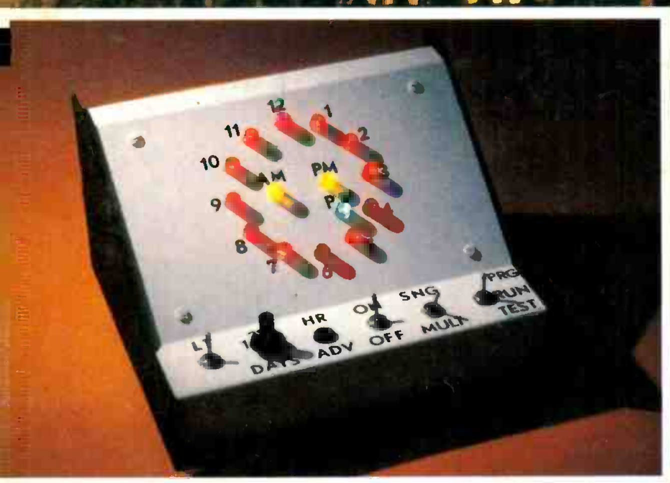
Car Electronic Ignition Systems
TRS-80 Color Computer Review

Protect Your Home with the Burglar Baffler



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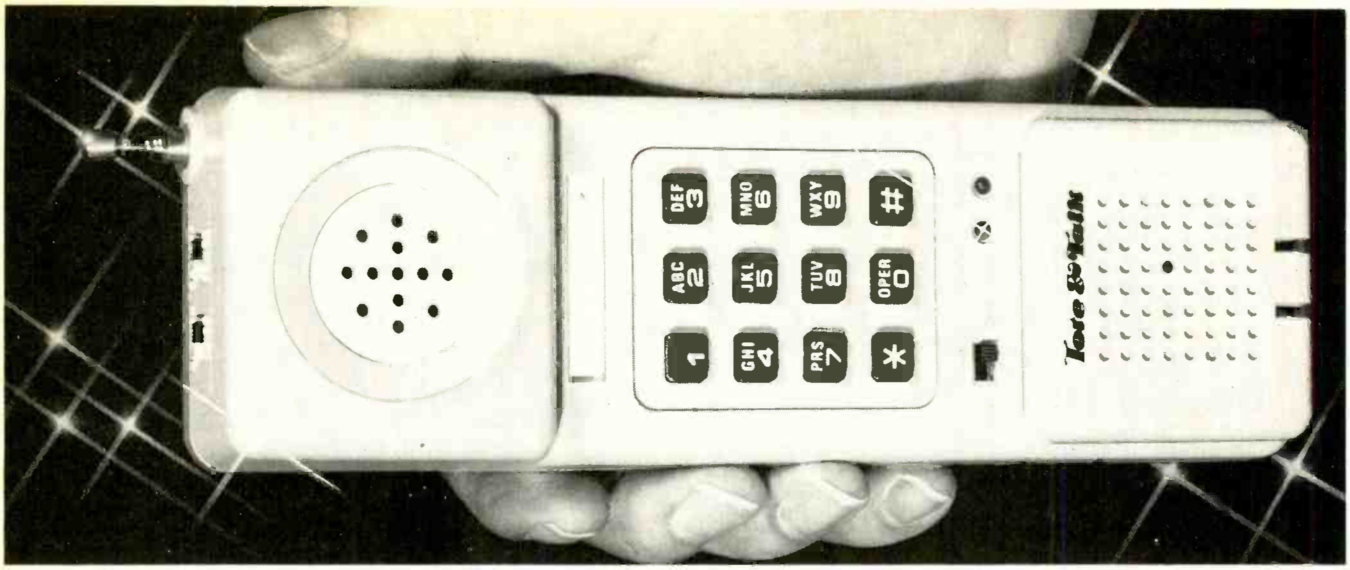

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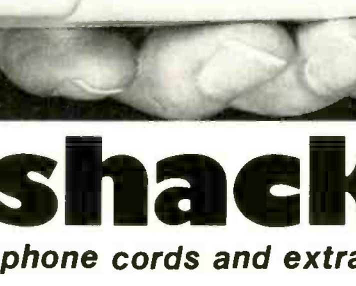

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JULY 1981 VOLUME 19, NUMBER 7

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Feature Articles

Construction Articles

Equipment Reviews

Columns

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COVER PHOTO BY FRED BURRELL

Radio Shack Made the TRS-80® Color Computer Even Better!

At $399*, it's no wonder the 4K TRS-80 Color Computer is ideal for beginners. Now there's a TRS-80 Color Computer designed for more advanced applications, too.

TRS-80 Extended Color BASIC Computer. This high-performance computer includes a 16K ROM Extended BASIC with advanced graphics, eight brilliant colors, and sound for an unprecedented low price! You can draw fine lines, circles, rectangles, boxes and more with *easy-to-use one-line commands.* Four graphic modes with two color sets allow up to 49,152 programmable screen points (pixels). There's 225 separate tones for music or sound effects, too. All this on a 16K RAM machine (including video memory) loaded with the dynamic features a serious programmer demands. You get a 32-cpl x 16-line screen, multi-character variable names (two significant), editing, tracing, user-definable keys, 255-character string arrays, floating point 9-digit accuracy, and even machine language routines.

Priced at Only $599, the TRS-80 Extended Color BASIC Computer is useful, entertaining and educational. Yet using it can be as simple as plugging in one of Radio Shack's instant-loading Program Paks. The computer attaches to your TV, or our own $399 TRS-80 Color Video Receiver. For just $24.95, you can add a pair of joysticks which add flexibility to games and video displays. A built-in serial interface lets you attach a printer or a modem. A pair of tutorial, Extended Color BASIC instruction manuals are included, as well.

More Good News. Extended Color BASIC is also available as an upgrade kit ($99) for your 4K Color Computer (16K RAM required — $119). There's a modest installation charge for each kit.

New TRS-80 VIDEOTEX Software (with the modem shown below) offers quick, affordable access to various information and data services. The CompuServe® Information Service gets you local, national and international news, weather and sports from major newspapers, like The New York Times and The Washington Post, plus the Associated Press News Service; info on stocks and bonds; educational reference service; nationwide Electronic Mail and much more! The Dow Jones® Information Services provides stock exchange quotes — as recent as 15 minutes — plus feature selections from The Wall Street Journal and Barron's.

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EDITORIAL

The Amplified Mind

Doomsayers in the field of audio have been flagellating themselves and others with the idea that technological developments have gone about as far as they can. Amplifiers are better than they need to be; speakers are nearly as good as they can be; FM tuners are pushing the theoretical limits of sensitivity; and so forth. To those of this persuasion, digital audio, while it promises sound of unparalled quality, is tinged with the menace of stagnation to come. What will there be to develop? What will manufacturers offer in new models except more "bells and whistles" and flashier cosmetics? (What these folk have against convenient, attractive equipment is not clear.)

At the opposite pole, though still on the sphere of pessimism, are the so-called "tweaks," the audio fans and manufacturers who will apparently spare no expense to own or bring forth the latest improvement in exotic componentry. Many of these seem to regard digital audio as a kind of latter-day heresy, leading believers away from the true faith and the true quest for better sound. From my view, both camps are sadly lacking in imagination.

Looking more deeply at the phenomenon of digital audio, one can see that its foundation depends on 16-bit D/A and A/D converters able to handle samples at a rate of about 50,000 per second. For these to be widely used in consumer products, they will have to be cheap; and once they are, the door is open to the digital computer as a signal processor. Imagine a preamp that realized all its functions in software rather than hardware, or a "black box" that could synthesize forms of artificial imaging yet undreamed of. In addition, experimental digital loudspeakers, however crude, have been successfully demonstrated.

Pundits now speak of the "marriage of audio and video." But, viewed in terms of technological fecundity, this, I think, will prove a temporary alliance of convenience. The truly fruitful marriage (scandalous though the image may be) will be between the evolving microcomputer and practically everything else electronic. Even now, artists are discovering a new medium in computer-generated video. And although electronic music is still considered somewhat of an oddity and is just now beginning to enter the mainstream, it will soon be possible to make computer-operated synthesizers perfect enough to tempt the most conventional-minded musician, if only as a compositional aid.

My purpose here is not to recount the virtues of cheap computing power. That has been done. Instead, it is to seek a lesson or watchword for dealing with technological impasses. If there is one, it might be this: the important amplification is not that applied to signals, but rather that applied to our minds.

Hal Rodgers

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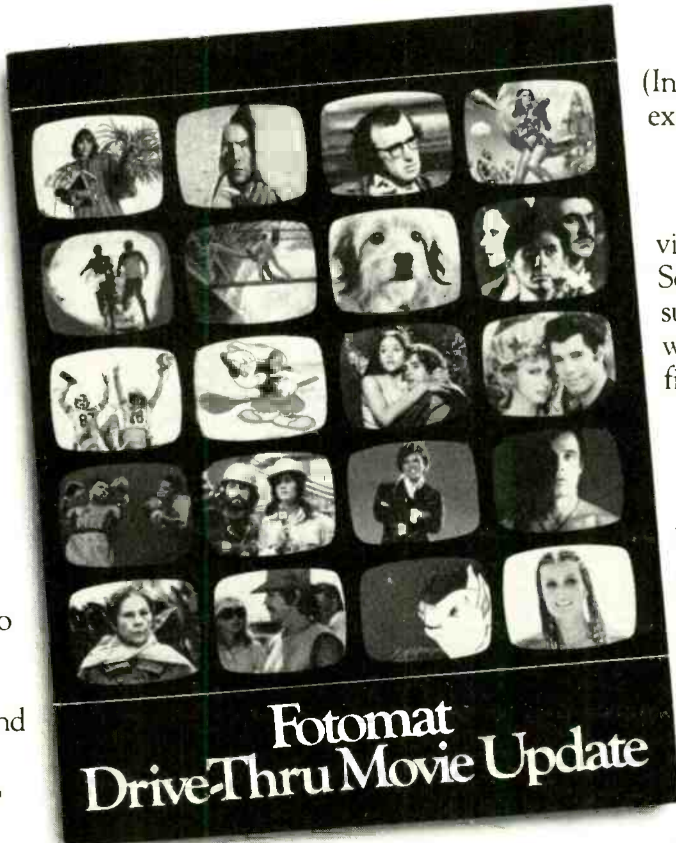

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LETTERS

From the VOA

In the "DX Listening" column for March 1981, there are two references to the *Voice of America* that require some clarification.

The first is the implication that *VOA* broadcasts only official policy. In fact, the Voice—as America's largest international broadcaster, with an estimated regular weekly audience of 80-million people—is a respected source of world news and information. Its newscasts are prepared by professional journalists and are separate from the clearly labelled commentaries explaining U.S. foreign policy.

Second, the *VOA* relay station on the Caribbean island of Antigua is hardly redundant. It is, in fact, essential if *VOA* is to provide the type of mediumwave service the majority of Caribbean listeners want and deserve.

Finally, the implication, from whatever source, that *VOA* mediumwave broadcasts would ever "be part of a CIA plot against the eastern Caribbean" is simply absurd. Such a connection does not exist, whatever critics of a more audible *VOA* in the region might wish to believe.—*M. William Haratunian, Acting Director, Voice of America.*

No Soft Errors

Mr. Mims' "Solid-State Detective Story" (Sept. 80) was rather interesting. However, if he hoped to find soft errors in his RAMs with alpha radiation, he would be disappointed if the chips were sealed, as alpha particles simply cannot penetrate more than a sheet of paper.

My chemistry teacher and I repeated Mr. Mims' experiment with a few variations. We used a video game that has 4K of RAM for our RAM scanning circuit. Then we used a *beta*-emitting device, because beta particles penetrate considerably deeper than alpha particles. Finally, placing the beta source directly over the powered RAMs, we bombarded the latter at several thousand counts per second (instead of the few counts per second used by Mr. Mims). We detected no soft errors during 10 hours of continuous beta bombardment.—*Edward Ramsden, Quincy, MA.*

New Computer *Is* Important

In the "Computer Bits" column of May 1981, Carl Warren states that Commodore's new Video Interface Computer 20 is little more than a repackaging concept, with color- and sound-generation capabilities thrown in. In my view, the point is not that the VIC-20 represents anything remarkably new in technology (although many would argue that the new video interface chip is *quite* remarkable), but that it is being introduced for under $300. If that isn't remarkable, I don't know what is!—*Dennis Globus, Panorama City, CA.*

Variable Speed for Film Editors

I have read the article "Vary the Speed of Synchronous Motors with this Programmable Control" (April 1981), and it occurs to me that this control might be very useful for film editors who require accurate variable speed. Perhaps it could be used in projectors and professional cameras where speed is important to give fidelity in sound.—*J.V. John, Chicago.*

Oscilloscope Specifications

In your article "Oscilloscope: 1981" (April 1981), you covered the subject of bandwidth very well, but the reader who may not have a strong electronics background or is unfamiliar with scope specifications may be misled by the numbers given by manufacturers. In a strict engineering sense, bandwidth for voltage amplifiers is defined as f(upper) − f(lower), where f(upper) is the high-frequency point at which the gain has dropped by approximately 30%. The point f(lower) is defined similarly except it refers to the low-frequency point. Since most oscilloscopes have an f(upper) that is much larger than f(lower), which is usually dc, the bandwidth is normally listed as f(upper) only. Some manufacturers prefer to use some other (incorrect) definition of bandwidth. A prospective oscilloscope purchaser should be aware of this "specmanship" played by the manufacturers, and consult with someone who is familiar with the game before purchasing.—*S.D. Swift, Albany, GA.*

I'd strongly suggest that a scope buyer see the instrument he is going to buy before doing so. Take the covers off and visualize trying to change a panel light. He may be surprised at what is necessary in some models. To save money, he should be able to service his own instrument and if changing a panel light looks impossible, consider another purchase. Also, he should read the owner's manual before he buys, studying especially the calibration and maintenance sections. You get what you pay for and a less expensive scope might not be as well documented as it should.—*David Whitfield, Santa Fe, NM.*

I was particularly pleased with "Oscilloscope 1981" in the April issue. However, I must point out the table is in error in stating that the Heath Model IO-4555 does not have a sweep magnifier. I am the satisfied builder-owner of a Heath IO-4555, and I can assure you that in the center of the TIME/CM switch is a dual-function switch/potentiometer labeled VARIABLE-PULL FOR X5. It performs both functions reliably.—*Robert Hornberg, Lombard, IL.*

Popular Electronics Tests

The Radio Shack TRS-80 Color Computer

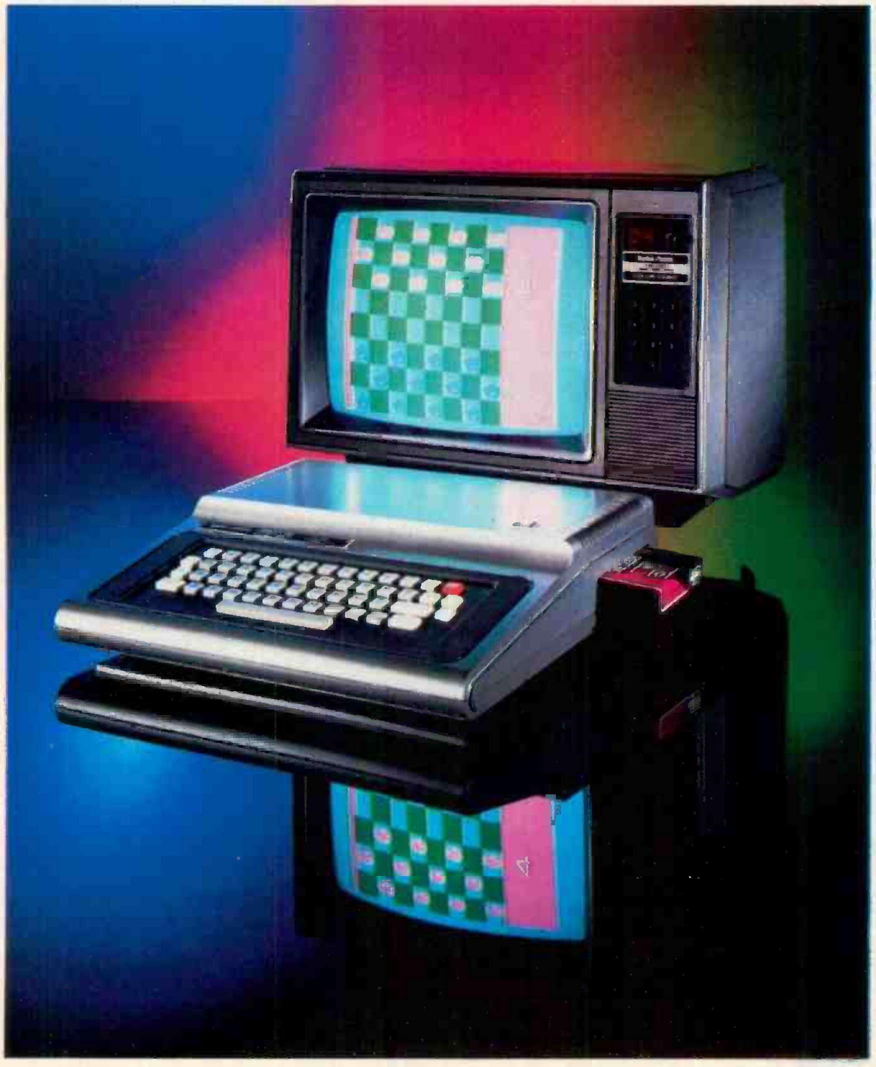
DESIGNED around a 6809E microprocessor, the Radio Shack TRS-80 Color Computer is meant for the home enthusiast. It offers sound generation and color graphics, of which the maximum resolution (256 x 192 pixels) permits excellent displays. Like many units in its class, the color computer comes equipped with a TV/Game 60-dB isolation switch that permits its use with any TV receiver through the set's antenna terminals.

The computer is housed in a gunmetal silver plastic case that covers the single-board computer and provides RFI shielding. The 53-key, short-stroke keyboard is laid out in a typewriter-like format. Although the keys have flat tops and are not really geared for fast typing they have an excellent "touch," and positive closure. Two joystick interfaces, a high-speed cassette interface, and an RS232 serial interface, a channel select switch for channels 3 or 4, and a 15-ft video connector cable for attaching to the isolation switch are available on the rear apron along with the RESET and POWER ON/OFF switches. All interface connections are made via a DIN connector. A small spring-loaded door in the right side allows plugging in the ROM-based Program Paks.

In its basic configuration, the TRS-80C is supplied with 4K bytes of RAM (expandable to 16K) and 8K of ROM that contains BASIC and other system firmware (expandable to 16K). The basic price of the TRS-80C is $399. Options include: 16K memory conversion (26-3015), $119, extended BASIC add-on (26-3018), $99, Model CTR-80A Cassette Recorder with cable, $59.95, and Dual Gyrating Joysticks (26-3008), $24.95. A fully configured Color Computer, including extended BASIC and 16K RAM (26-3002), is priced at $599.

The currently available software comes in what Radio Shack terms Program Paks and include: Chess $39.95, Quasar $39.95, Pinball $29.95, Football $39.95, Checkers $29.95, Personal Finance $39.95, Math Bingo $29.95, and Music $29.95. The only cassette-based package available is Videotex for $29.95, which includes a free hour on Compuserve's information system network. A number of other packages are reportedly under development either by Radio Shack or outside vendors and will supposedly include an editor/assembler, Pascal, and Pilot. Micro Works of Delmar, CA has developed a Monitor available in cassette for $29.95 or ROM for $39.95 that permits the changing of memory, communicating with a host, and development of high-level graphics.

General Description. The Motorola 6809E microprocessor works in tandem with a Motorola 6847Y Video Display Generator that reads data from memory and produces a composite video signal, and a 6883 synchronous address multiplexer. Interface to the television is accomplished via the 1372 modulator, as



shown in the block diagram. In operation, the computer is tied into the television receiver via the isolation switch and a 15-ft cable. The fully interfaced composite video signal permits the creation of a 31 character by 16 line display. Line wrap is automatic.

On power up, the computer defaults either into color BASIC, or, if a Program Pak is installed, to the program contained in the Pak.

Initial familiarization with the unit is facilitated by a 31-page Operation Manual. This covers every aspect of getting the computer into operation. It also provides helpful short programs to check the video-monitor color purity, horizontal and vertical positioning, and the sound on the TV set's speaker.

Compensating somewhat for the lack of software available for the TRS-80C is an extremely powerful BASIC interpreter. The version for the 4K machine is designed for the beginner and offers the functions that allow color selection, creation of a variety of sounds, and text string manipulation. The BASIC provides full string operators, LEFT, RIGHT, MID, PEEK, POKE, EDIT, and RENUMBER. Operators are provided to allow access to joysticks and the other peripheral ports. Use of the language is explained in a well-written, highly illustrated 152-page manual, "Getting Started with Color BASIC."

Once you have mastered this entry-level BASIC, you will more than likely want to migrate up to "extended color" BASIC, described in a very complete 215-page manual, "Going Ahead with Extended Color BASIC." We recommend that, even if you purchase the fully configured system, you start with the first manual and work up to the second.

GRAPHICS SCREEN RESOLUTION

PMODE #	Grid Size	Color Mode	Pages Used	Point Size
4	256x192	2	4	
3	128x192	4	4	
2	128x192	2	2	
1	128x96	4	2	
0	128x96	2	1	

The extended BASIC is one of the most powerful we have seen and provides a full spectrum of graphics primitives including DRAW, CIRCLE, PAINT, and COLOR. In extended BASIC, up to 9 pages of memory (one page equaling 1536 memory locations) are available. One page is the normal mode and can be thought of as the entire available working video. The other 8 pages are for graphics. In other systems, these pages are called planes and are used to create depth or three-dimensional effects on the CRT screen.

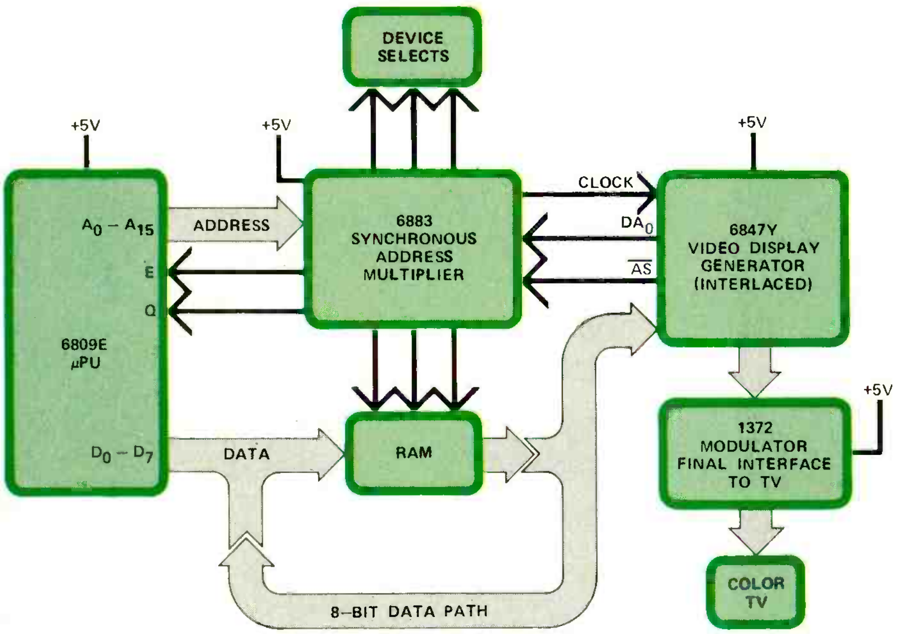
In the graphics mode, two operators are required: PCLEAR defines the number of pages desired (4 pages is the default if PCLEAR is not used), and PMODE. The latter tells the TRS-80C the resolution (see table), and which graphics page to start on. Both can be variables in a program. Because more memory is required to generate the viewed screen, at highest resolution, only two colors are provided.

Working in concert with the basic graphic operators are functions such as PCLS, which clears the screen and sets the background to the specified color. The SCREEN function tells the computer what you will be using the screen display for—graphics or characters. As a consequence, this permits the creation of programs that combine characters and graphics. To further enhance the graphics capability of the machine, the BASIC has a PCOPY function that allows copying one page of graphics to another. Furthermore, you can draw a circle by using CIRCLE and specifying where its center is and its radius. The circle can be shrunk or stretched and even rotated by entering height and width parameters. If you desire, the PAINT operator allows a specified color to be used as a "fill in".

Boxes of all sizes and shapes are easily created using the DRAW functions and setting the parameters. A neat trick is to create a box on the screen and then fold and unfold it. Then if you're really inventive, create a ball that you drop into the box. All of this is possible by mixing the various BASIC functions and without running out of memory!

Powerful as they are, graphics functions represent only a portion of the interactive functions available in extended BASIC. Using the PLAY function, the tones of a chromatic scale (A-G#) can be generated and made to sound in any of five octaves; duration, tone-color, and loudness can be specified as well. One interesting program that can be created involves using the graphics functions to create various musical instruments on the screen and using PLAY to make the associated sounds.

And there is still more to the BASIC. Operators that query the joysticks are provided to enable moving things around the screen. Two really interesting functions are GET and PUT. GET allows reading the graphic contents of a rectangle into an array, while PUT allows reading the array back on the screen. And, of course, should you want to create some interesting designs, or develop a mechanical design, extended BASIC includes all the trigonometry functions.



Block diagram of the TRS-80 Color Computer. The 6883 multiplexes available RAM and peripheral devices

Evaluation. The TRS-80 color computer that we evaluated was a 16K version with extended BASIC and without any of the Program Paks or cassette software mentioned earlier. Setting up the system is extremely simple, involving only connecting the computer to the isolation switch and the switch to the color-TV vhf antenna terminals, then tuning the TV receiver. Before using the computer, we spent some time reading the operation manual and both BASIC manuals, a move we strongly recommend for all users.

Before connecting the color computer to the TV receiver, we heard a rattle inside the case. Upon opening the case (we suggest you don't do this—it voids the warranty), we found that one of the two bolts holding down a transformer had worked its way loose and the other was about to follow suit. While we had the cover off we checked the clock and found it well within spec. We were unable to measure any significant RFI.

On power up, the TV receiver screen immediately turns green and the color BASIC sign-on message is displayed in the upper left-hand corner. There was no screen interference to disturb the display.

We did notice a slight pincushioning that we determined to be the fault of the receiver rather than the computer. By adjusting our TV receiver to create a slight ballooning, we created a more desirable display.

Although in general everything worked well, we found many discrepancies in the BASIC manuals. For example, when entering a SETCOLOR command to achieve a certain color, we got a different one. When we tried to emulate the suggested trig function formulas, we discovered that the math functions, as created in BASIC, were incorrect. Additionally, several of the sample programs contain errors that either caused incorrect operation or a syntax error.

We checked with Dave Lunsford of Compusoft Publishing, who has been working with the TRS-80C for several months. He identified the same problems and provided Radio Shack with corrections. Radio Shack's Jonathan Erickson, the author of the manuals, verified the problems and indicated that corrections had been made for these and others that neither Lunsford nor we had found. Current owners will receive an updated manual in short order. Meanwhile, an errata sheet is provided with each set of manuals. Otherwise, the manuals are for the most part well-written and illustrated.

After several hours of using the machine, we found it difficult to use the keyboard. This is primarily due to the use of very flat short-stroke keys. Radio Shack says that the expected use of the machine would not normally extend past a few hours. We would have preferred to see the keyboard used on the Model III, or at least a derivation of it. We also would have liked to have had dedicated keys for functions such as BREAK, ESCAPE, and CTRL, rather than trying to remember which combination to use. A possible alternative might be a labeling system on the keyboard or keys that quickly identifies these functions.

We also had difficulty holding the background color we had set when entering data. Each time we did, the computer defaulted to green. We were unable to find a satisfactory answer to this, but it was suggested that it might indicate the need to use the SCREEN function to set the parameters.

Truly a peccadillo is that the joystick ports don't match the manual in the way they are labeled. So when you think you are accessing the right joystick, you may be working with the left. Rather than relabel the computers, Radio Shack has altered the manuals to match the machine as it stands.

More disturbing is the use of reverse video and upper-case letters to indicate lower-case characters on the screen, in lieu of a full ASCII set. Similarly, we are disappointed to find that both versions of BASIC fail to understand common lower-case inputs.

Comments. To evaluate microcomputer systems priced under $500, one must take a number of variables into account. Chief among these is functional capabilities, which abound in this particular model.

Additionally, one must consider support. Like the other Radio Shack computers, this one should soon be backed up by a copious supply of software. Also, Radio Shack has some 7000 stores to provide service and supplies. Moreover, there is a rapidly expanding network of "cottage industry" companies providing software and peripherals for the new machine.

The color computer represents what we consider the top-of-the-line, low-cost system. Anyone seeking a machine that will serve well as a teacher and a base for a home communication and entertainment center will find the TRS-80 color computer a strong contender. Although we found some problems, Radio Shack has assured us that it is carefully monitoring the color computer and working to improve its weak points.
—Carl Warren.

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THE ELECTRONIC WORLD

VIDEO 81

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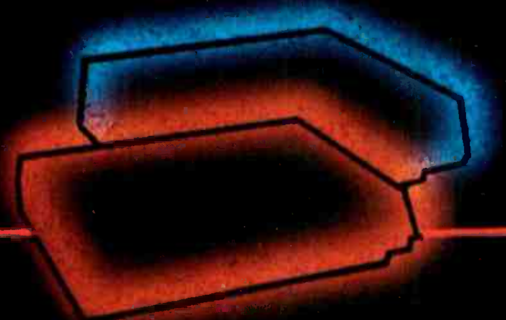
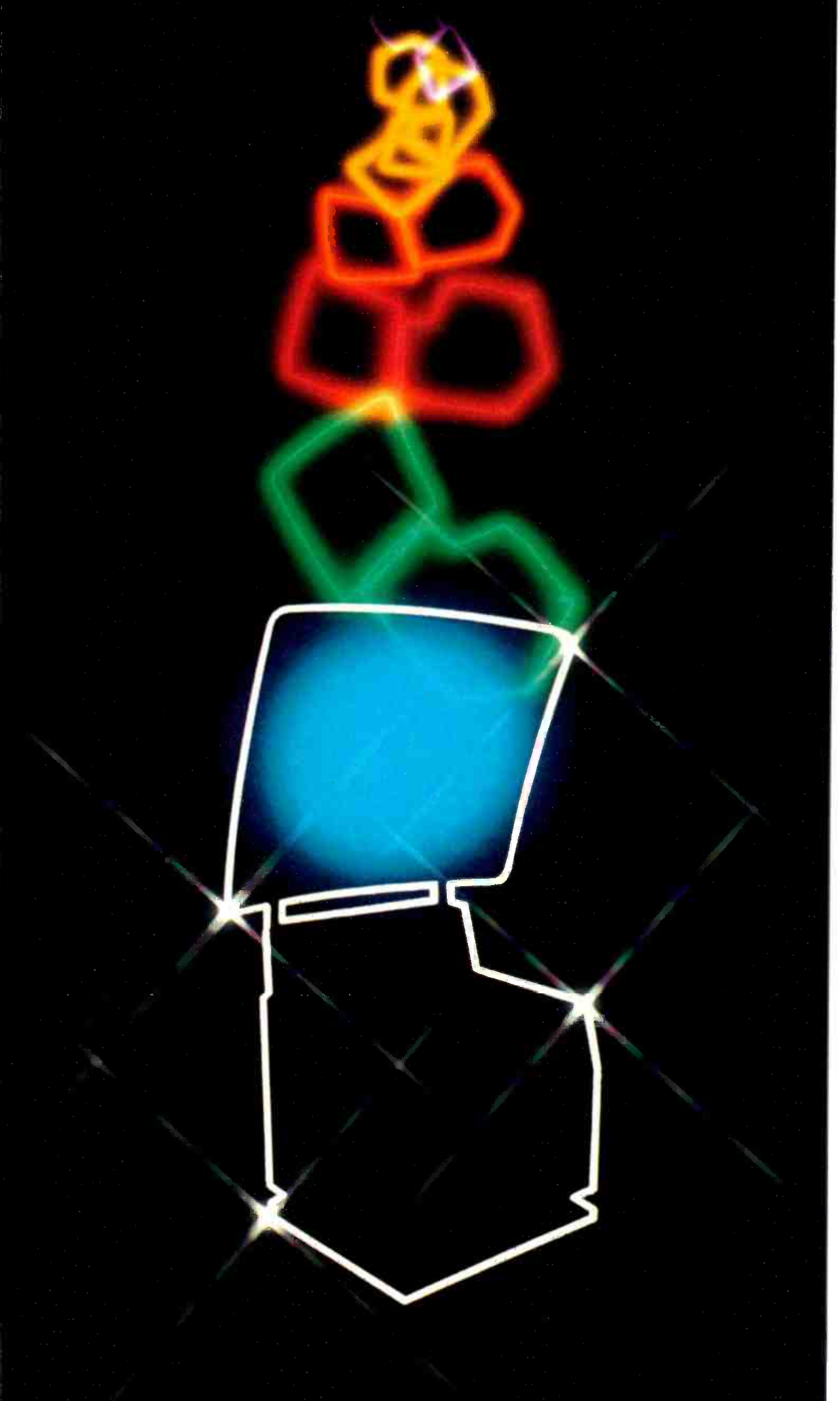


BY PETER MITCHELL

VIDEO 81



IS

PROJECTION TV, an idea that was born in the 1940s, when lenses and mirrors were used to enlarge the image from a five-inch cathode-ray tube for easier family viewing, is back, and this time the world may be ready at last. The experience projection TV gives is not merely one of greater size. Its more detailed and involving image creates a far richer viewing sensation than can a glass tube in a box.

Often considered an eccentric extravagance, much as hi-fi components were in the '50s, projection TV has been confined to taverns and seldom found in living rooms. High price and unfamiliar brand names, such as Advent and Mitsubishi, have also slowed popular acceptance. But the times, they are a-changin'.

In recent months, projection sets have been advertised by such mass-marketing heavyweights as RCA and Sears, evidently reflecting a belief that projection TV is about to make the transition from the exotic to the mass market. As of now, full-size projection sets are offered by Advent, Kloss, RCA, Sears, General Electric, Mitsubishi, Panasonic, Quasar, Sony, Heath, Curtes Mathes, Hitachi, and Sanyo, while models from Magnavox, Zenith, Pioneer, Tatung, Sylvania, and Fisher are expected soon. Still, projection TV isn't for everyone, and if you are contemplating a purchase (or are being asked for advice), it's worth knowing what to expect. We'll consider disadvantages, benefits, design tradeoffs, and installation hints, in that order.

WHAT'S WRONG WITH PROJECTION TV? High cost is one thing. Prices for three-tube sets range from \$2000 to \$5000. Of course, when this is amortized over a useful life of 10 years, the annual ownership cost is less than many people spend for cable service.

A fuzzy picture is another thing that's wrong. A projection-TV picture seldom looks completely sharp with crisp edges around objects in the scene. Video signal bandwidths are limited to about 4 MHz at the transmitter and are often down to about 3 MHz by the time they reach the screen, and the big picture reveals this. Smaller screens often seem sharper, but this is an illusion caused by sitting far away. If you look at the very best 19-inch TV from just a few inches away, it too seems quite fuzzy. With typical video bandwidths, a good rule of thumb is that you must sit about three screen diameters away to see a sharp picture, for example, 6 feet from a 25-inch console TV. A 7-foot screen can look just fine at 20 feet, but in a 12-foot room you probably will find a 4- or 5-foot screen more satisfying.

Typically, projection models are not as bright as ordinary TVs, so much so that most function best in a darkened environ-

PROJECTION TV FOR YOU?

ment—in effect, a home video theater. You can watch with full room lighting, or with daylight streaming in the windows, but ambient light reflecting off the screen will dilute the contrast, making the highlights look pale.

Owners of high-quality stereo systems are often dissatisfied with the technical quality of records, because they show up flaws that cheaper record-playing systems don't. A high-detail television system is similarly unforgiving of program-material faults. You may discover that your antenna and lead-in cable aren't good enough, that camera operators often are careless about focus and color registration, that many commercials are photographed on grainy film, and that closeups that look OK on a 12-inch monitor are ludicrous on the big screen. You will also find TV signals highly variable in quality, and that video cassette recorders produce pictures inferior in detail, texture, and color shading. (A video disc player, with its clean ghost-free images, is ideal for use with projection television.)

Another drawback is that projection TV is demanding. You can't put the big screen just anywhere in the living room. The set's requirements will dictate what the layout of your room must be. In two-piece sets, the positioning of the projector is critical. Bump it by as little as an inch or two, and picture resolution suffers. With three-tube sets you must periodically adjust the convergence of the three colored images on the screen, using the built-in test pattern. If you are fussy, you may want to do this daily.

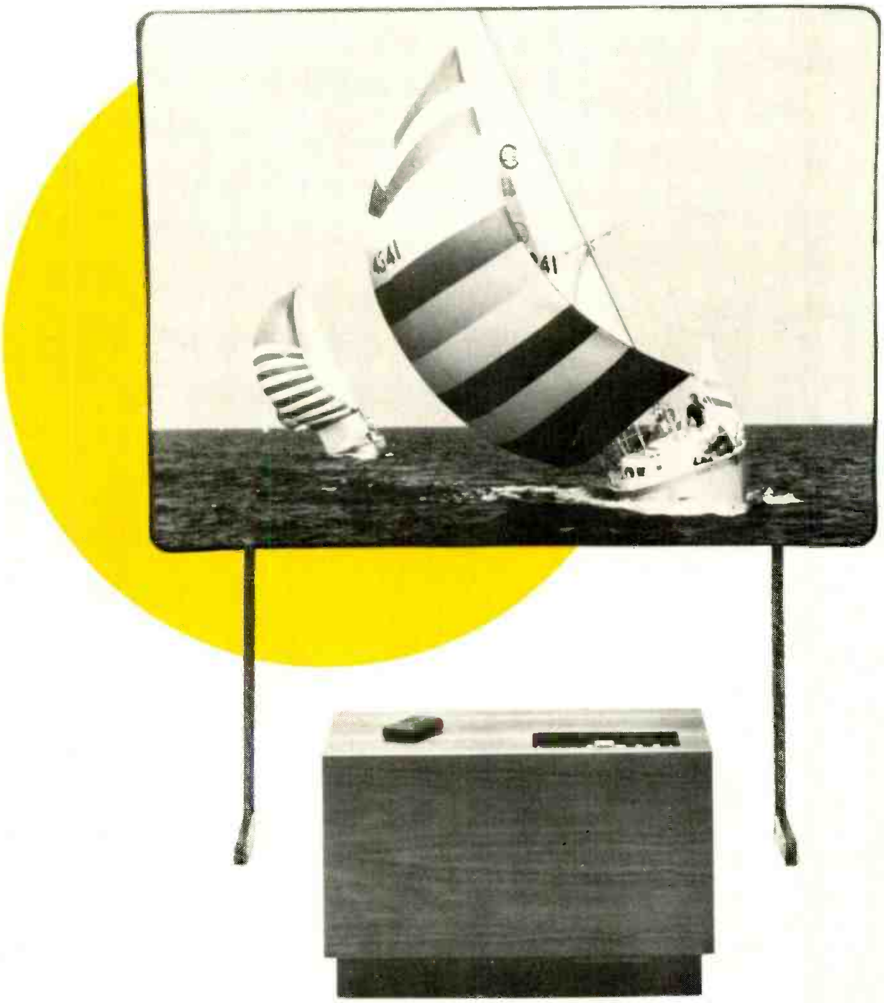
A manufacturer may claim that his screen is washable and not prone to damage, but take this with a grain of salt. All screens except the rear-projection type are vulnerable to some damage. The screen has a finely-textured aluminum-foil surface that aims the picture's light toward the prime viewing area rather than reflecting it randomly. If the screen surface is struck or scraped, replacement may be necessary, at a cost of $200 or more. Fortunately, most of the circuitry of a projection set is the same as that in a conventional TV, so repairs are no more frequent or costly (except for the problem of transporting the big set into the shop). The picture tube in any TV can fail; with a three-tube projection set, the odds of failure are three times greater.

WHY YOU MIGHT WANT ONE ANYWAY. The attractive side of good projection TV is hard to describe on paper. But you'll know it when you see it—properly demonstrated, with a good live broadcast, satellite relay, or video disc playback, on an accurately focused and aligned set, with appropriately muted room lighting. And don't be turned off by one bad demo. In many stores, projection systems are shown with maladjusted controls, bad antennas, and mediocre video tapes.

Good, large-screen TV is much more like a movie in a theater than like ordinary TV. It involves you in a way that a tiny picture in a box cannot. Viewing a Cousteau special, you don't merely watch scuba divers; you virtually swim with them, immersed in blue water as multicolored fishes float by. When you watch a football game, your perspective is that of someone on the field—not quite a participant, but much closer than you would be if you were in the stands. In ice hockey, you can see the puck in flight and almost feel the bone-jarring impact when players collide.

Small-screen TV—which includes even 25-inch consoles—leaves you a casual spectactor, able to split your attention between the TV and a book, a meal, or conversation. But high-resolution large-screen TV is a contact medium. The people are full-size. In a dramatic show you see every detail of facial expression and body language, and the characters seem three-dimensional. Conversation becomes annoying, commercial interruptions even more so (except for the really well-crafted ones, which become a delight to watch). If you also pipe the sound through a good hi-fi system, the total experience can make you more of a television addict than you ever wanted to be. Of course, there is another aspect to this. Bad acting, cheap production values, and manipulative screenplays are even worse when they are presented full-size.

All this comes not just as a result of the intimacy and visual impact the big picture



Kloss Model One Projection TV

brings. It's also because there is more to see. No longer segmented into dots or stripes, the picture can offer finer details and present a more realistically textured panorama. You become a more active viewer, scanning each scene for details that illuminate the context and enrich the sense of place, putting the action into truer perspective.

Big-screen video is distinguished by the stronger emotional reaction you have when watching. Its potential for pleasure (or annoyance) is greater; but otherwise, it's still TV. The controls are the same as those on a small TV, except for a couple of extra knobs to correct color alignment. Once a projection system is installed and aligned, even small children can operate it as easily as they can a 12-inch set. They won't hurt the projection set, and it won't hurt them. The tubes project harmless colored light at the screen, so the only special precautions are those needed to protect the screen.

SHOPPING AT LAST. Basically there are two classes of projection TV: one-tube and three-tube. Each is available in two formats: one-piece or two-piece.

Let's look at the formats first. Basically a projection TV uses a lens to project the image of a small TV picture tube onto a large screen. In a two-piece system, the TV circuitry and projection optics are in a console that sits in the middle of the room, throwing an image onto a separate free-standing screen. In a one-piece set, the screen is mounted directly on top of the console and a large, flat mirror (often mounted in a drawer) is used to fold the light path, reflecting the image up to the screen. Because of its more elaborate cabinetry and reflecting mirror, a one-piece set is likely to cost more than a two-piece set of equivalent performance. The choice between the formats is essentially a matter of cosmetics, convenience, and economics. Neither is necessarily superior where performance is concerned.

But the choice between one-tube and three-tube design involves performance as well as cost. A one-tube set is just a standard 12- or 13-inch TV set mounted in a cabinet, together with a lens to project an enlarged image of its face onto a bigger screen. The advantage of such sets is their price, typically under $1500. For rock-bottom cost (about $560) you can buy lens-and-screen kits for use with your existing TV set. (Since the lens projects an inverted image, usually the TV must be modified to flip its image.)

The disadvantage of one-tube sets is their relative lack of brightness and detail. When you take a 12-inch picture and blow it up to fill a 48-inch screen, you are spreading a fixed amount of light over a 16-times larger area. Loss of brightness is thus inevitable, even if you compensate by turning up the set's brightness and contrast controls unusually high (and risk shortening the picture tube's life). Moreover, enlarging a 12-inch picture cannot increase its inherently limited resolution, so there's no more detail in the projected picture than you would see if you simply sat close to the 12-inch set. While one-tube sets can provide a big picture and lots of viewing enjoyment, they cannot equal a three-tube system in performance.

Fundamentally, the segmentation of a color CRT into thousands of groups of phosphor dots or vertical phosphor stripes limits brightness and resolution. This is because only about one-fifth of the screen area can glow in any one color. The remainder of the tube face is occupied by the phosphors for the other two primary colors and the border areas separating them.

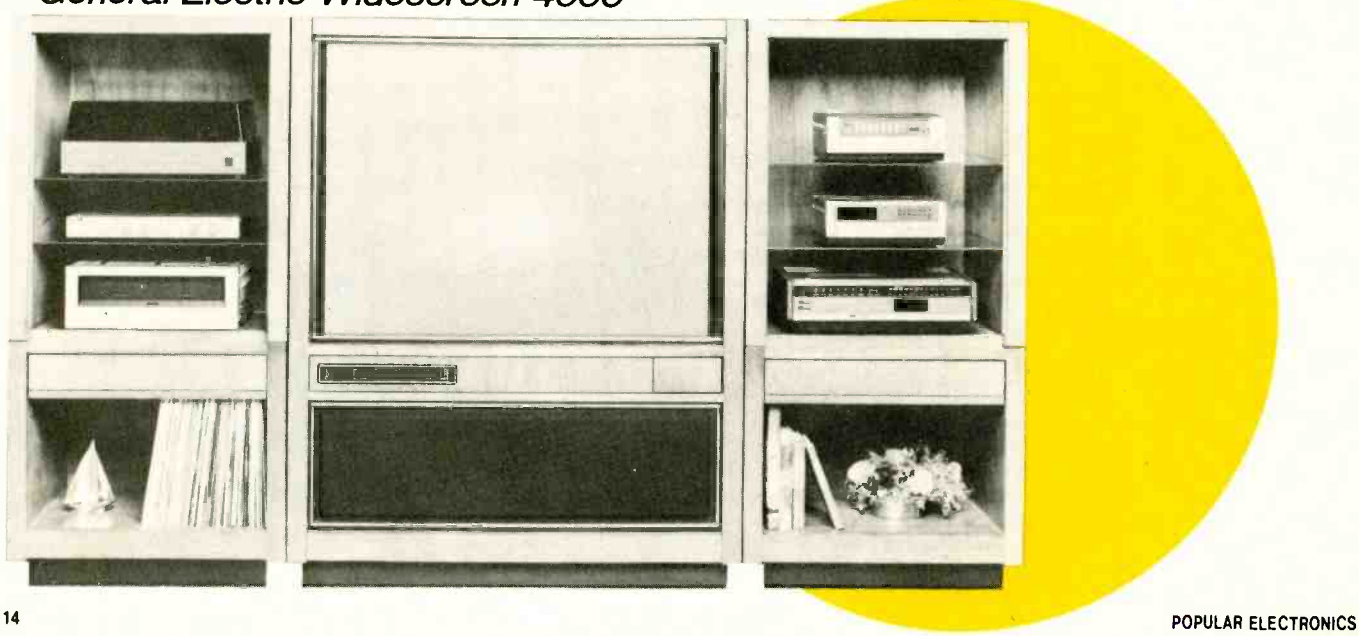
In a three-tube system, on the other hand, a separate CRT is used for each color. As each CRT face is fully and uniformly coated with just one phosphor, resolution is limited only by the fineness of the electron beam and the bandwidth of the video signal. Since each tube is fully coated with phosphor the image can be *very* bright.

WHAT TO LOOK FOR. In the absence of widely available test reports and standardized specifications for projection TV, it may be difficult to sort out claims made by competing manufacturers and retailers. Here are some of the factors you may want to consider.

Brightness. Every manufacturer claims to deliver a bright image, but some are substantially brighter than others. Still, most projection sets don't have the brilliance of today's direct-view sets. Some manufacturers rate their image brightness in *foot-lamberts.* If such measurements were made by a standardized technique, they could provide a valid comparison; but, in fact, manufacturers use differing procedures, and so, this is not the case. You'll have to make your own judgment, aided by the knowledge that screen brightness is affected by screen directivity and size, lens f-number, and CRT design.

Directivity. As with antennas, the brightness "gain" of a projection screen is derived from its directivity. If the screen reflects its light narrowly in one direction, the image will be bright there and dim everywhere else. If the screen scatters its light

General Electric Widescreen 4000



over a larger angle, the viewing area becomes larger and the image dimmer. High brightness and a very wide viewing angle are mutually incompatible, so beware of claims to the contrary.

Screen Size. Some manufacturers use virtually the same electronics and optics in several models with different screen sizes. All else being equal, the smaller the screen the brighter the image. This is one reason why so many new models feature 4-foot (50″) screens; at this size it is relatively easy to achieve adequate brightness.

Lens f-number. The lower the f-number of the projection lens, the more light it collects from the CRT to project onto the screen, and thus the brighter the image can be. An f/1.0 lens collects twice as much light as an f/1.4 lens, and an f/0.7 lens collects twice as much as an f/1.0. But low f-number lenses cost more to manufacture, and their focusing is more critical, requiring greater precision in projector assembly and in screen manufacturing. Below about f/1.0, lenses are impractical and a curved mirror is used to project the image, aided by a thin corrector lens at the front; this is the Schmidt optical system.

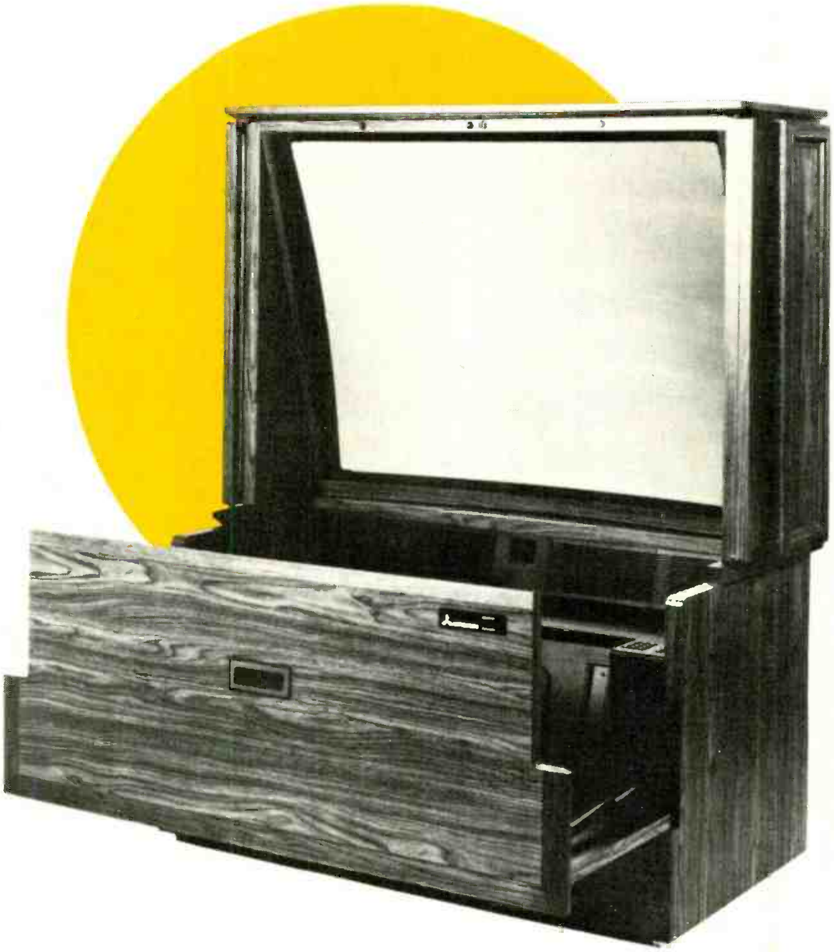
Resolution. It may be argued that, in view of its large size, the sharpness of a projection TV's picture is at least as important as its brightness, yet specifications of picture detail are remarkably rare. To reproduce all the detail in a broadcast, a TV set should have a video bandwidth of about 4.2 MHz. But as the test reports in POPULAR ELECTRONICS have shown, conventional models often have a bandwidth no greater than about 3.0 MHz at the screen. Regrettably this is also true of many projection sets. And while the difference between 3 and 4 MHz of video bandwidth may not be very obvious on a 19-inch screen, it is readily visible on a 6-foot screen. Right now, resolution is an eyeball judgment. When making it, be sure that apparent sharpness isn't being compromised by poor convergence, or by a low setting of the DETAIL or SHARPNESS control.

Comb Filter. In broadcast signals, the highest luminance frequencies (between 3 and 4 MHz, representing the finest picture details) straddle the chroma subcarrier at 3.58 MHz. Consequently, conventional video circuits don't completely succeed in separating the luminance and chroma. A common symptom of this is a false color shimmer superimposed on fine black-and-white stripes, such as a sport referee's shirt. A comb filter provides virtually complete separation of the two signals and makes it easier for the designer to exploit the full bandwidth of the video signal.

INSTALLATION. If a large-screen TV is just what you want, the first thing to check is the quality of the picture you receive now. Snow, static, or ghosting that seems innocuous on a 12-inch screen will be much more annoying enlarged. If you are investing $3000 in a projection system, it's false economy not to spend another $300 for a high-quality antenna, rotor, and lead-in system—preferably one without splitters and distribution amplifiers. Given an inadequate master antenna system in your apartment building, or sloppy engineering at your local cable franchise, you may want to explore the likelihood of improvements before you bring the big set home. Should you end up with a signal so strong that it overloads your set's tuner, a passive attenuator at the TV end of the cable will reduce it and, as a bonus, may improve the impedance match between the TV and the cable, minimizing closely spaced ghosts.

When planning to install a projection system in the living room, there are two major factors to consider. One is the desirability of locating the screen away from the primary traffic paths in the room, so that people won't collide with and damage it. The second is the location of windows and lights. The screen behaves a little like a mirror: light arriving at the screen head-on is reflected directly back (into the prime viewing area in front of the screen), while light striking the screen at an angle will be reflected off to the side. To fully enjoy projection TV you will have to darken the room. On the other hand, lamps located above or to either side of the screen, and light from windows on either side of the screen, will simply reflect off to the other side and not affect the prime viewing area much.

Life-size video, then, is a little more fussy about the quality of the signals it receives and about its installation in the living room than a conventional TV set is, but the effort is well worth it. Industry optimists hope to sell as many as 100,000 projection sets this year, or about one percent of all color TV sales. If you are lucky enough to be among that one percent of buyers, you will find your decision rewarding—especially if you pipe the video soundtrack through a good stereo system and experience the video and audio on an equally panoramic scale. ◇

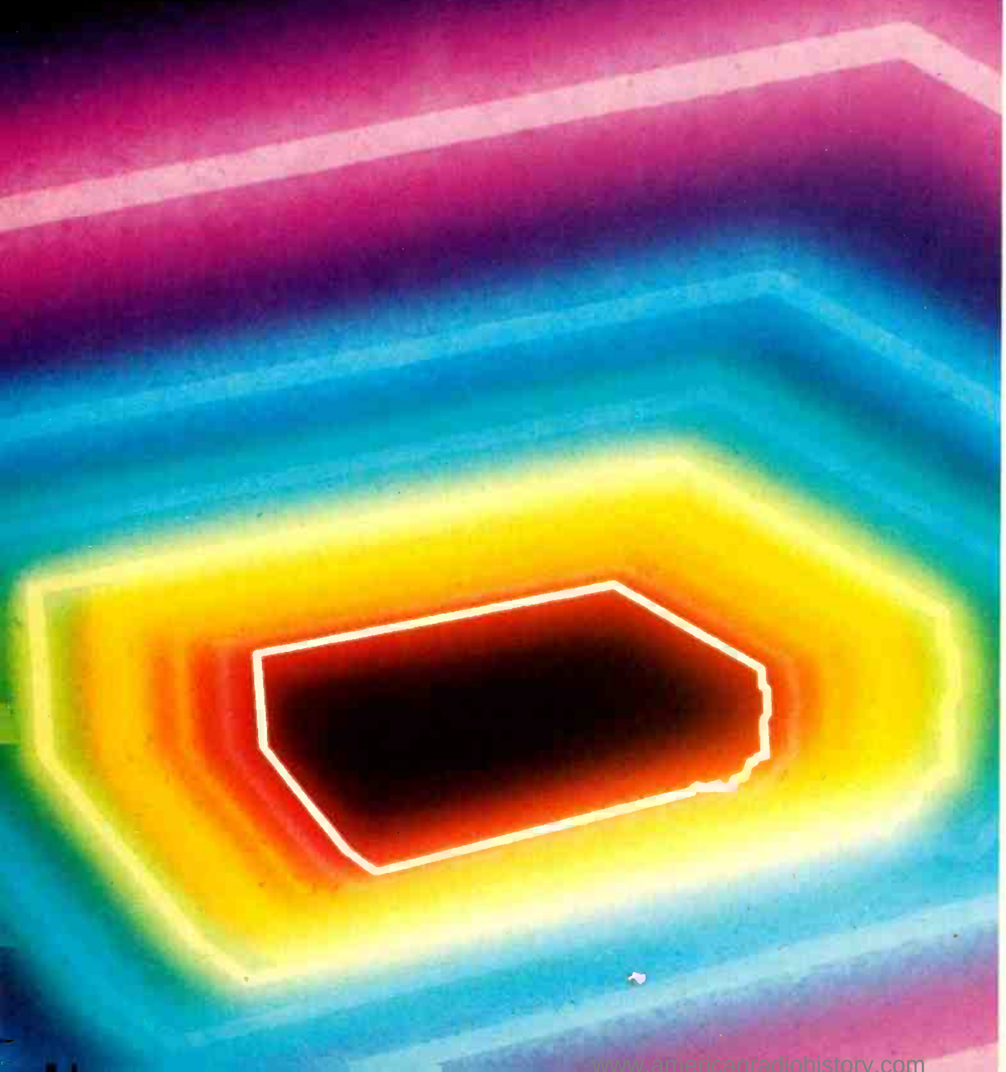


Mitsubishi Model VS-510UD Projection TV

VIDEO 81

BY STEPHEN ISAACS

A Buyer's Guide:



FREEDOM from network TV schedules, the ability to play back rental movies at your own convenience, and even the capability of making your own productions from scratch are all benefits that a video cassette recorder (VCR) bestows upon its owner. But in the past year or so, the number of available VCR models has proliferated to the point where choosing the one that best fits your needs is a challenging task. In addition to knowing just how the machine is to be used, a potential buyer needs basic information about the various models and their features. Fortunately, satisfying this requirement is easier than it seems, for what appears to be a myriad of machines can be distilled into a handful of models from just a few manufacturers. The material below describes each of the important models and indicates the brand names under which they are available.

VHS

MATSUSHITA. Model 1, is a no-frills machine with a Start Only Timer that always records to the end of tape. Its transport and mechanical tuner are the same as those used in the line two years ago, but it does have 6-hour capability and will play all VHS tapes recorded at any speed.

Moving up to Model 2 is a major jump, not in features—for all you gain is audio dub and an off time setting—but in technology. This machine uses a new transport developed to counter Beta's advantage of visual search (Betascan). The tension in the VHS M-Load tape path precluded high-speed search in both directions. This new transport can reduce tape tension during search modes. Ironically, however, this model doesn't offer search! That comes in the next model.

A backup assemble editor that cleanly joins recorded segments is included, as well as a varactor tuner instead of the dual-drum type used in the Model 1. Since the timer in this unit cannot change channels, the advantage to the varactor tuner is limited to channel change on the remote control and access to cable channels D-K. If the tuner is set to Hi-vhf and channels above and below 7 and 13 are explored, extra channels will be found.

Model 3 adds visual search, allowing scanning at nine times recorded speed. This only functions for long-play (LP) and super long-play (SLP) modes because this is a two-head machine. The 30-micron video heads are too narrow to scan SP tracks. As it is, the noise bars visible during LP scanning are worse than those in SLP. The function is inhibited at standard play, where the noise would be objectionable.

VIDEO CASSETTE RECORDERS

Next in the series is what we'll call Model 4, which adds 8-event/14-day programming to the simple 1-event/1-day timers in the lesser machines. This timer permits daily and weekly repeats. You are only limited by the 6-hour capacity of current VHS T-120 tapes.

Promises of a T-180 cassette with 9-hour capacity have not materialized so I will venture a prediction: a VHS T-150 that will extend record time to 7.5 hours will surface in about a year, but only on machines with scanning abilities will this cassette play safely. The reduced tape tension of these machines is the key. A T-150, incidentally, will hold a 2.5-hour movie at SP.

The top of the Matsushita home VCR line, Model 5, has all the previous features plus the four-head video scanner necessary for special effects at SP and SLP and visual search at all speeds. This machine makes the best SP recordings due to the full use of the 58-micron track allotted in the original VHS specs. Video heads on multispeed two head VCRs are always narrower than the video track width allowed at the highest speed. This not only wastes tape, it degrades the signal-to-noise ratio. The SP heads in the Model 5 are actually wider than the video track to permit scanning of adjacent tracks during freeze. A separate set of heads is necessary for these effects on SLP recordings because the dimensions of the head gaps must suit the tracks being read. This minimizes noise bars. No freeze frame or slow motion is possible for LP recordings.

Matsushita also makes a portable VHS model that is available in several forms. Model 6 is a 3-speed unit with one pair of special effects heads designed for SLP recordings. This configuration makes this unit one of the most versatile currently available. It plays and records at all speeds, is lightweight (13 lb), and can record for over two hours on one battery charge. This is reduced to 80 minutes while powering a camera. It offers freeze frame and frame advance at SLP and can be teamed with three different power-supply/tuner/timer accessories: a power supply alone, a 1-event on/off tuner/timer with power supply and an 8-event/14-day tuner/timer also with power supply.

If you can forego LP and SLP speeds and want the best quality possible, Model 7 may be for you. Really from Panasonic's industrial line, the NV8410 is identical to the Model 6 except that it uses a single pair of SP special effects heads.

Matsushita makes VCRs for Panasonic, Quasar, RCA, Curtis Mathes, Magnavox, Sylvania, Philco, and J.C. Penney, but not all brands have all models.

HITACHI. In the Hitachi line, even the lowest machines offer extended programming. Hitachi machines offer slightly better signal-to-noise specifications than the best of other brands: 46 dB compared to 45 dB. Strangely, this is achieved in all cases with only two video heads. The company credits this feat to a video enhancer circuit incorporated in an IC chip.

Model 1, at the bottom of the line, has 3 speeds and a 1-event/10-day timer. Recording time is set in 15-minute increments. Several buttons, each worth a different number of minutes, must be depressed to give the total time desired. The tuner is a varactor type with some cable channel coverage. No high-speed visual search is offered, although SLP recordings can play at triple speed.

Model 2 adds a 5-event/7-day timer that is very flexible, allowing daily and weekly repeats. This model also has the triple-speed-play feature for SLP.

Hitachi's latest, Model 3, features full special effects by remote control and visual search at 10 times normal speed. These features only work at SLP due to the two-head design. This machine has the editing feature that minimizes breakup during program assembly, and the amount of video enhancement is user adjustable. The latter permits increased detail when video noise isn't a problem or vice versa.

Hitachi offers one portable, Model 4, with three speeds and triple-speed play of SLP recordings. This recorder lacks freeze frame, but offers excellent video specs with an editing feature. Options include a power supply alone and a 5-event/7-day tuner/timer power supply. Also available in some stores is a 1-event/7-day timer that was offered with last year's two-speed (2/4-hour) portable. Both tuners are varactor type with some cable channel range.

Hitachi's machines are sold under its own name and General Electric's. RCA gets its portable from Hitachi instead of Matsushita, which supplies all its other VCRs.

Just introduced is a new home unit that is a slightly simplified Model 3 without the special effects and multievent timer. Also, a new 11-pound portable with full effects for SLP recordings.

JVC. Japan Victor Company, originator of the VHS format, takes pride in maintaining a video quality where some other companies compromise for tape economy and long recording times. JVC's lineup includes last year's 6700 and this year's HR2200 portable.

When introduced, the four-head HR6700 was state of the art. Its unique scanner design permitted 6-hour record time without compromising 2-hour quality. Its slow-

General Electric VHS Model IVCR2002X

Akai VHS Activideo Model VPS-7350

motion system was the first to suppress noise bars.

Model 6700 also offers "edit start control" for good assembly edits and a 6-event/7-day tuner/timer. This timer has three semipermanent events which repeat indefinitely as well as three one-time events. Record duration can be set in 5-minute increments. Unique to the 6700 is double-speed play with audio. A chopping technique is used to, in effect, throw away half of the audio and restore normal pitch. This permits viewing and comprehension of a 1-hour program in 30 minutes.

Unlike Matsushita and Hitachi, JVC does not offer LP (4-hour) mode. Rather than include the extra set of heads needed to offer full effects at that speed, JVC has omitted it entirely. This is unfortunate, since LP is very popular, and many second-time buyers have a library of such recordings. Also, JVC owners will not be able to trade tapes as readily as they might like.

The lack of high-speed visual search in the 6700 should be remedied in the next JVC model. In Europe, the single-speed JVC7700 is already available. A U.S. multi-speed version is being developed, no doubt. But will it have LP?

JVC's newest portable is the 11-lb HR2200 model, which is an SP machine with full special effects on a wired remote control. Besides variable-speed slow motion, it offers ten times normal speed visual search. A power supply is available that charges the internal battery as well as a second spare battery in under 90 minutes. (Most other portables take 6 to 8 hours to charge.) A tuner/timer/power supply is also offered. Because of the machine's 2-hour maximum record time, the timer only has one event, but it can be set up to 10 days in advance. In North America, only JVC itself sells JVC-built machines.

AKAI. Both models currently available, the VP7300 and this year's VP7350 are portables. Akai's thinking goes: Why offer a stationary model if a portable can do the job as well and permits on-location shooting as a bonus? The 7300, Akai's first North American VHS product, is an SP-only VCR with full special effects including four times normal speed play. (This was a VHS speed record until recent improvements in other brands.) Freeze frame is free of noise, but the slow motion is not. The tuner/timer for this machine offers 2 on/off events over a 7-day period, but both events must be from the same channel. As with the JVC portable, multiple events are of limited use due to the 2-hour maximum time available on the T-120 cassette.

Akai's newest, the VP7350, is the only consumer stereo VCR and it uses Dolby noise reduction to compensate for the loss in signal-to-noise ratio caused by halving the audio track width. It is an SP/SLP recorder with a special search mode that stops the tape during fast forward at each blank space. The 6-event/7-day tuner/timer has essentially the same capabilities as the JVC 6700.

SHARP. Sharp is one of the newest VCR manufacturers, but its sophisticated calculator technology carries over to its video products. A liquid-crystal display and microcomputer give Model VC6800 a 7-event/7-day tuner/timer and an elapsed timer meter unique in the industry. This 2-/6-hour machine has no special effects, but at present it is the only front-loading VCR. Sharp also offers a go-to-counter feature that permits entering a tape location into the microcomputer and having the tape cued to that spot automatically. This is more useful than the simple memory counters on other machines.

Pressure from the videodisc has Sharp offering the latest budget model, the 7400, for $895 or less. It is a bare-bones machine, but it retains the 6800's front-loading feature. It has only a 1-event timer.

MITSUBISHI (MGA). Mitsubishi's first VHS product was a JVC 3300 in disguise, but the VCR now offered in North America, Model HS300, is unusual in terms of design. The use of five motors is said to reduce the internal parts count and increase reliability. This is also the only VCR offering wireless remote control. It is an SP/SLP machine with one pair of video heads that give it full special effects at SLP. It also offers 15 times normal speed visual search of SLP recordings. The tuner/timer is similar to the JVC 6700 with 6 events over 7 days.

Beta

SONY. Sony is currently selling four models. Since the Zenith machines are also made by Sony, we will, as we did with Matsushita, characterize the line by arbitrary numbers. Sony's basic unit, Model 1, incorporates a 1-event/3-day timer. The record duration is programmed in steps of 30 minutes. Recordings can be made daily or every other day as well as on any one of the three days. This is a good compromise, since most of us will rarely be away for more than a weekend, and elaborate programming you don't use is clearly a waste of money. This machine offers limited effects with three times normal and freeze available, though the latter is marred by noise bars.

The major innovation that this machine offered at its introduction in 1979 was Betascan. Visible picture is possible at speeds of 13 to 17 times normal in forward or reverse. This machine also marked the beginning of Beta III, which helped to shrink the differences in operating costs between Beta and VHS. Four-hour VHS (4 hours on a $20 tape) had the edge over Beta (3 hours on a $20 tape). With Beta III that 3-hour tape could now hold 4.5 hours. Since then the VHS 6-hour SLP speed has regained the upper hand, but many users feel Beta III offers better quality at a modest cost penalty.

This machine also includes Beta I playback so as not to obsolete the tape libraries of early Betamax buyers. (Zenith equivalents lack Beta I playback.)

On the rear panels of all three Sony home VCRs is a switch marked PCM. Normally a vertical blanking pulse is inserted to eliminate the VIR signal from the VCR playback, and a dropout compensator is used to replace missing video with information from the previous line. With this switch on, these functions are disabled to allow pulse-code-modulation audio adapters to be used. These units, which at present cost several thousand dollars, can transform a home VCR into a digital audio recorder.

Model 2 is Sony's first fully programmable machine. It has all the features of the Model 1 plus a 4-event/14-day timer with daily and weekly repeat. Duration of recording is now adjustable to the minute. A jack on the rear panel takes the cable from the AG300 Betastack changer, which permits cassettes to be loaded and the VCR to use each one separately for each of the four events. Alternately, the end of tape can be the trigger signal to change tapes and if L830s are used, up to 20 hours of programs can be stored. Also included is an indexing feature to stop the tape at the start of each recording.

Model 3, Sony's most recent home VCR, has full special effects in addition to the functions of the Model 2. The Sony method of obtaining stop-action is in sharp contrast to that used in VHS. Normally, because each head gap is tilted 7 degrees from normal or 14 degrees from the other, it is not possible for both heads to read a single track. With Sony's double-azimuth design, one head has gaps in both directions, enabling it to read the track of the other head. One track is read twice in this way to produce freeze field instead of the freeze frame of VHS. Duplicating the same field for each TV frame produces an image with half the normal vertical resolution but absolutely no movement. Using consecutive fields produces an image of normal resolution, but there will be 60-Hz flicker in any area of the scene where movement has occurred in the 60th of a second that occurs between fields.

Sony Betamax Model SL-5800

Another refinement found in Model 3 is variable Betascan. Instead of the preset type of scan in the other models, the Model 3 allows the user to dial any speed from 5 to 20 times normal, using the remote control. Full fast forward or rewind is also possible.

The SL3000 portable is a Beta II unit with Beta I playback as well. An editing feature, similar to the recent VHS decks, joins segments with very little breakup. A 1-event/7-day tuner/timer is available for home use.

TOSHIBA. This company's Beta series consists of three machines, one brand new. Toshiba's first programmable machine offered a 3-event/7-day timer designed when L750 Beta II kept Beta limited to 3 hours of recording time. Model 5425 offers Beta II and III for up to 5 hours of recording, but retains that 3-event timer. It also offers freeze frame and Betascan.

The Model V8000 has a 1-event/7-day timer, freeze, and fast play, but its real claim to fame is Superscan. This permits visual scanning at the highest speed available, 40 times normal. Pressing cue during play causes the scenes to zip by at 17 times normal. Hold the button down and high gear is engaged. Toshiba has accomplished this by reducing head friction. Normal Beta head drums consist of a narrow disc with the heads attached between two stationary support cylinders. The V8000 heads protrude from a slot in the support cylinder. Since the disc no longer rubs against the tape, friction is cut to a minimum. The newer V8500 goes a step further and uses four heads for noiseless freeze frame.

Toshiba's 5535 is similar to the Sony SL3000 without Beta I playback. A Beta II/III version of this portable has also just been introduced.

SANYO. Sanyo, whose technical contribution to the Beta format was Beta III, now offers three models that are sold under the Sears name as well. Model 1 is a no-frills, Beta-II-only machine with a start-only timer. It is last year's model and clearly a price leader. Model 2 has Beta III, freeze, and four times normal speed play. Model 3 also has Beta II and Beta III and offers Betascan. But it functions properly only with Beta III. Freeze is also offered but it is marred by noise bars. A 1-event/1-day timer and all-solenoid controls are also included, and a full-function, remote-control system is available.

TECHNICOLOR. Most compact of the portables (7 lb) on the market now is the 7LB made by Funai Electric and sold by Technicolor. It only has a 30-minute record time, and, so far, no other tuners or timers to mate with it. The unit uses a unique 1/4" tape format, so don't expect it to play your VHS or Beta tapes. It will be interesting to see if this machine sets a new standard or pushes VHS and Beta portables to reduce size and weight yet further. ◇

VIDEO 81

BY STAN PRENTISS

HOME EARTH STATIONS

for Satellite Transmissions

IF YOU could see 22,300 miles or so and focus on spots 10 to 20 feet in diameter, you'd soon discover the skies are beginning to fill with satellites. Some of these are geosynchronous, meaning that their orbital periods are the same as the earth's rotation period, so that from the ground they appear to hang motionless. Designed as communications vehicles, these satellites relay an enormous amount of thoroughly interesting video, voice and facsimile traffic, some is scrambled, but most not.

Primarily products of Hughes Space and Communications and RCA, WESTAR and SATCOM satellites all work in the C-band (4 GHz/6 GHz). They are located strategically to service large portions of both the continental and territorial U.S. SATCOMs I, II, and IIIR (June launch), for instance, are at longitudes 135° W, 119° W, and 132° W, while WESTARs I, II, and III (already operating) are at 99° W, 123.5° W, and 91° W, with more WESTARs scheduled for launch in January and September 1982.

These two series of satellites pretty well divide most currently available work between them, although serving different clients. SATCOM concentrates on an estimated 3,000 TV cable head-end systems and also carries voice communications, as well as leased channels and traffic from several government agencies. HS-333 Hughes WESTAR types do some cable TV, but are primarily used for broadcast retransmissions from TV networks such as ABC, CBS, PBS, and broadcast distributors like Hughes, Westinghouse, and Wald. They also handle voice and data facsimile—a very important service since the *Wall Street Journal, Time Magazine, Sports Illustrated,* and *U.S. News* transmit their western and midwest editions by this fast and economical route.

SATCOM I, for example, accommodates 21 channels of video for cable, two channels for private business messages, and another channel that's not presently in use. SATCOM II handles telephone and data traffic for Alaska and Hawaii. When SATCOMs III and IV are sent into orbit, they will pick up more cable TV and relieve transponder leasing from AT&T's COMSTAR D-2, which has had to fill in temporarily due to the loss of a SATCOM entering orbit in December 1979.

Launched in 1974, WESTAR I is recorded as the first U.S. domestic communications satellite. It was followed by WESTARs II and III, forming a series of identical communications vehicles for voice, video, and data with 12 transponders each—which normally means 12 channels if there is only single polarity. Given all these satellites and their programs, how do we go about receiving them?

DELUXE DISHES ARE THE ROUTE! If you can't wait for COMSAT and other promised direct broadcast satellite (DBS) systems, $10 or $12 thousand plus shipping and installation (perhaps $1000 more) can let the good time gigahertz roll in the 3.7- and 5-meter bands. Consider the 3.7 to 4.2 and 11.7 to 12.2 GHz antennas recently announced by Third Wave Communications of Ann Arbor, Michigan, one of 30-odd companies supplying complete earth stations.

With this system, you get a TVRO-1 12-foot parabolic dish and mount with integrated electronics package located at the dish's focal point. It includes a low-noise amplifier, feed horn, down converter, modulator, demodulator, and synthesized tuner with 24 channels, plus a hand-held unit for the house. There's only RG-59-type cable running between installation and living/working quarters. The reflector is of high precision fiberglass, and the backup structure contains aluminum with copper feed. Net weight is 500 lb. Between 1 and 3 cu yd of reinforced concrete with anchor bolts are needed for installation and about a day's working time. Antenna delivery comes by special truck from Ocala, FL.

If $10,000 won't buy you enough reception, the TVRO-2 for $11,750 is certain to please. This is a 16-foot parabolic dish with all the goodies as before but with somewhat better gain for weaker signals, and a net weight of 1750 lb. Both types are said to withstand 125 mph winds with no ice, and 100 mph blows with 1-inch radial ice. This big one requires between 3 and 9 cubic yards of reinforced concrete and a bit more labor.

Larger dishes are necessary, of course, because of the relatively small 5-watt transponder power of these contemporary communications satellites. For instance, with 24 transponders and 24 or 48 channels of 20 watts each, we're told that a 6-

Downlink Skyview I Antenna Kit

FOR MORE INFORMATION

Channel One, Inc.
Willarch Road, Lincoln, MA 01773
(617)259-0333

Comtech Antenna Corp.
3100 Communications Blvd.,
St. Cloud, FL 32769
(305)892-6111

Downlink, Inc.
30 Park St., Putnam, CT 06260
(203)928-7731

Earthstar Corp.
Box 68, Steger, IL 60475
(312)755-5400

Gardiner Communications Corp.
1980 S. Post Oak Rd., Houston, TX 77056
(713)961-7348

H and R Comm./Star View Systems
Rte. 3, P.O. Box 103G,
Pocahontas, AR 72466
(800)643-0102 or (501)647-2291

Hamilton Satellite Systems, Inc.
1101 E. Chestnut, Ste. A.,
Santa Ana, CA 92701
(714)543-5217

Hero Communications
1783 W. 32nd Pl., Hialeah, FL 33012
(305)887-3203

Hi-Tek Satellite Systems
177 Webster St., Ste. A455,
Monterey, CA 93940
(408)372-4771

KLM Electronics, Inc.
Box 816, Morgan Hill, CA 95037
(408)779-7363

Robert A. Luly & Associates, Inc.
Box 2311, San Bernardino, CA 92406
(714)888-7525

Microdyne Corp.
Box 7213, Ocala, FL 32672
(904)687-4633

Microwave Associates Communications Co.—MA/COM
South Ave., Burlington, MA 01803
(617)272-3000

National Microtech
P.O. Box 417, Grenada, MS 38901
(800)647-6144 or (801)226-8432

Satelco, Div. of Thunder-Compute
5540 W. Pico Blvd.,
Los Angeles, CA 90019
(213)931-6274

Satfinder Systems
6541 E. 40th St., Tulsa, OK 74145

Satvision
Box 1490, Miami, OK 74354
(918)542-1616 or 542-1617

SED Systems, Ltd.
Box 1464, 2414 Koyl Ave.,
Saskatoon, Sask., CAN S7K 3P7
(306)664-1825

Starvision Satellite TV
Box 8624, Orlando, FL 32856
(305)851-8332

Alan Swan
614 Cimarron, Stockton, CA 95210
(209)948-5254

Third Wave Communications
2600 Gladstone, Ann Arbor, MI 48104
(313)996-1483

Tri-Star General
4810 Van Epps Rd.,
Brooklyn Heights, OH 44131
(216)459-8535

Vitalink Communications Corp.
1330 Charleston Rd.,
Mountain View, CA 94043

Western Satellite
1660 Lincoln St., Ste. 2918
Denver, CO 80203
(800)525-1636

foot receiving antenna would be adequate. And if you want to wait until 1985 or so until Satellite Television Corporation gets its birds aloft, there will be 185-W traveling-wave-tube transponders in orbit. Conveniently, the down-to-earth side of this link requires only 2.5-ft antennas that can be mounted almost anywhere by virtually anyone. But that decision is up to the FCC.

Downlink, Putnam, CT, is also very much in the race for both business and home buyers and has broken the $10,000 price barrier. Instead of a larger complex, Downlink is offering Skyview I and II units for $5,000 and $7,500 (installed) in knockdown kits for relatively easy assembly.

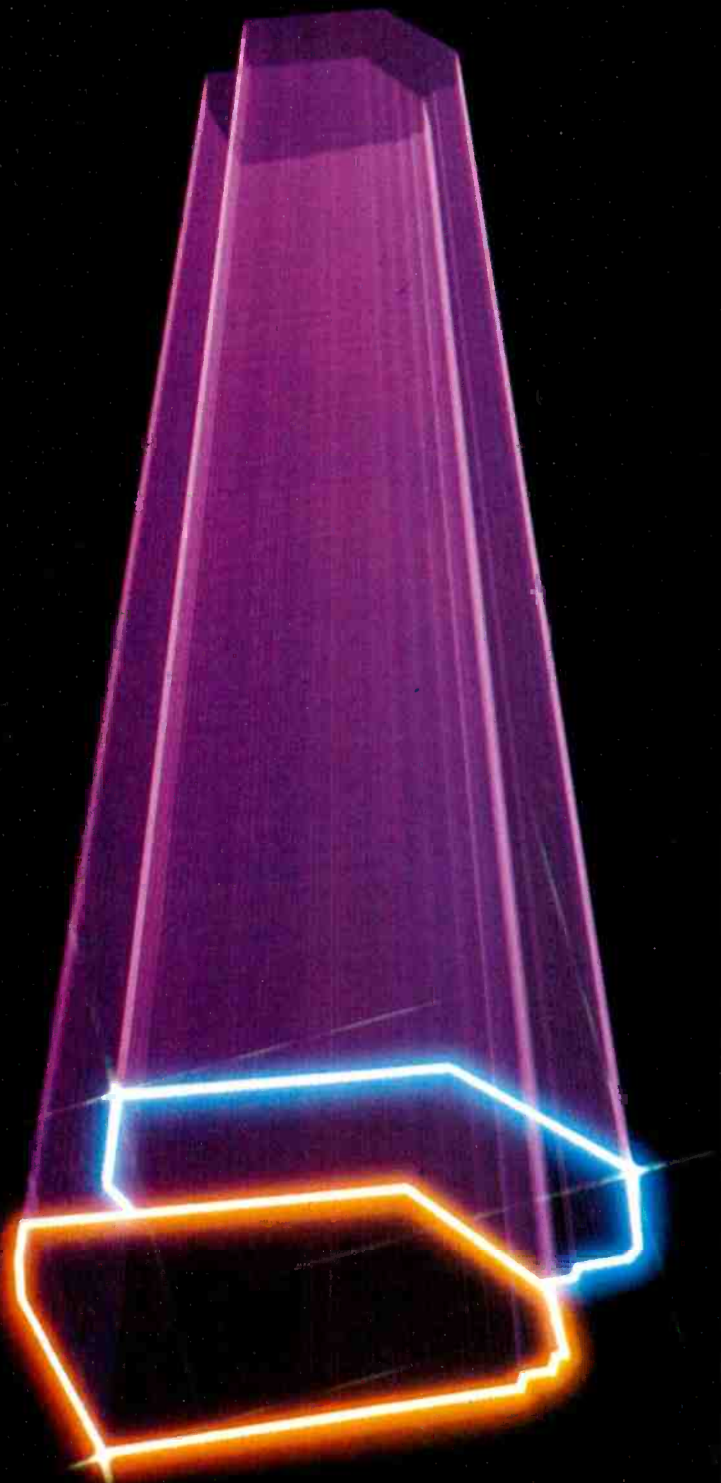
Skyview I comes as either an 8- or 12-foot spherical antenna made of aluminum screen reflector surface and a supporting frame of redwood strips, angle irons and galvanized tuning bolts. Reception of up to seven of the currently active satellites is possible by simply moving a small feed horn and low-noise amplifier assembly. The antenna itself can be left in a fixed position. The 12-foot version—the more expensive one—is needed for areas with weak signals, such as the southern U.S.

Downlink also has Skyview II, mass-produced 4 x 4 lightweight modular panels that form 8-, 12-, or 16-foot spherical antennas. All are injection molded with plastic aluminized surfaces, and the price, naturally, will be somewhat higher. Included is an all weatherproof down converter-receiver, with an enclosure that contains receiver electronics. Controls, of course, are mounted on the viewer's TV set while the down converter-receiver mounts on the antenna. Downlink's D2 receiver has continuous tuning for the C-band in the 3.7-to-4.2-GHz frequencies plus 5.8 to 7.4 MHz for audio subcarriers used in hi-fi music services. The D2 receiver offers video cable, audio cable, and r-f (but not the modulator) connections.

There is also a D3 state-of-the-art modular receiver available for connection to a conventional low-noise amplifier or a new Downlink integrated down converter that drops 4-GHz signals down to 70 MHz, eliminating considerable signal loss from the usual cables and couplers. Also included are a video polarization switch and other optional and extra features. Dealers (retailers) are now being franchised throughout the country and, according to Downlink, will be competent to install and service its products.

These manufacturers appear to be two of the main builders and innovators in the home terminal market antenna business at the moment, but there are others even now and probably dozens more to come as Joe Public becomes aware of what's up in the sky. If you're in the home terminal market, check carefully before you buy. Be sure that the electronics package has FCC approval, that dish diameter and amplifier gain are sufficient for your needs, and that a good gale won't topple the whole thing from its mounts. ◇

BY STAN PRENTISS



VIDEO

FOR OVER two years, Magnavox has introduced its laser-optical system video disc (Magnavision) to market after market with little competition, low yields in disc manufacturing, and relatively apathetic consumer response. But this summer and fall, video disc players will stream from every vendor imaginable, each hoping to excite consumer demand. As with video cassette recorders, this torrential flow will arise from just a few ultimate sources. Fortunately as yet, only three variations of the basic equipment exist, although they are all mutually incompatible. These originate with Philips-Magnavox, RCA, and Matsushita-JVC, the last using General Electric as one of two prime U.S. outlets.

March's blast-off for the RCA SelectaVision, which uses a capacitance electronic disc (CED) system with stylus pickup and spiral-grooved plastic records, preceded the launch of the Matsushita-JVC-General Electric system video high-density (VHD) player by just a few months. The VHD system also uses a plastic disc and capacitive pickup, but with a grooveless record that does not physically contact the pickup. This permits a two-frame stop mode that the RCA system lacks.

At this writing, the competing forces line up like this: RCA CED—RCA, Zenith, Sanyo, Sears, Hitachi, J.C. Penny, Sharp, Radio Shack, and Montgomery Ward; Magnavox/Philips optical-laser—Magnavox, Pioneer, Sylvania, Philco, Fisher, Gold Star, and perhaps two others; Matsushita VHD CED—JVC, Panasonic, General Electric, Quasar, Sansui, and perhaps two others. All told, more than 20 sources will offer video disc products to the home-entertainment market by next year.

So far, the leading competitors are Magnavox and Pioneer (laser-optical) vs. RCA and Zenith (CED). Prices are currently $750 and $500, respectively. How will the public react to a price differential of $499.95 for CED and VHD versus $749 for Magnavision? With discounts, the prices won't be that far apart. For those whose sharp eyes and even sharper ears demand, respectively, 4-MHz video bandpass and 20-kHz stereo reproduction the laser disc seems to be the system of choice. Those who are less visually and aurally acute—or who want to spend less—could well choose between CED and VHD. But available software titles (discs) and peripheral features such as the two-frame stop mode, frame and chapter indexing, stereo, etc., also must be put into the equation. Until VHD reaches the market, however, the disc contest will basically be Magnavox/Pioneer vs. RCA/Zenith.

CED. Although the RCA and Zenith products have minor cosmetic differences, what can be said of one will apply to the

DISC PLAYERS *Laser Disc vs. CED*

other, at least for the next year or so. The player measures 15½" D x 5¾" H x 17" W and weighs some 20 lb. Power consumption is 35 watts.

The cabinet has a removable top hatch for stylus/cartridge replacement. Operating controls are: a function lever for OFF/PLAY/LOAD/UNLOAD, and pushbuttons for forward and reverse rapid access, visual search and pause. These are on the front panel along with LED readouts for elapsed playing time (in minutes and seconds) side 1 or side 2. A slot is provided for insertion of the 12-inch disc in its protective caddy.

With the function lever in LOAD, the disc entry door opens. When a disc is inserted, metal fingers remove it from its caddy and a lift plate positions it for the turntable. Thereafter, the caddy is manually removed and the function lever moved to its PLAY position. This action automatically lowers the stylus to the outside groove of the disc, and sound and picture commence after a delay of about eight seconds. During the ensuing one-hour-per-side program, the rapid-access forward and reverse buttons can be used to locate desired program segments.

For each second that one of these buttons is depressed, about two minutes of the program is displayed, so that an entire side can be scanned in less than 30 seconds. When RAPID ACCESS is used, the stylus is automatically lifted from the record and video is blanked, removing all noise effects from the screen. Meanwhile, the LED shows the elapsed time, within a minute, to any recorded position on the disc. The time signal is developed by an optical switch about the pickup arm drive.

The PAUSE mode also raises the stylus and suppresses video noise on the screen, while the LED readout flashes the letter "P" once per second. In VISUAL SEARCH, the platter is scanned in forward or reverse at about 16 times normal speed, with the picture remaining on the screen and the audio muted to avoid garbling. Pressing the VISUAL SEARCH FORWARD and REVERSE buttons simultaneously produces a soundless pseudostop mode; but the image is jerky since one groove is tracked and then the stylus jumps to a previous groove.

The recorded disc, made of poly-vinyl-chloride (PVC) resin, and loaded with tiny, uniformly sized carbon particles for adequate conductivity, has a thin coating of lubricant added to extend its life and that of the stylus. The vinyl caddy protects the disc against dust, liquids, scratches, or fingerprints. Grooves in the disc are about 2.5 micrometers wide with a maximum depth of 0.5 micrometer, matching some of the recorded signal wavelengths. Designed to be played in an ambient temperature of 60° to 90° F, the discs are said (by the manufacturer) to survive temperatures from −20° to +130° F.

Video and audio information is stored on a CED disc as frequency modulation (FM). Using FM eliminates the need to detect precise amplitude-modulation (AM) variations. Having dimensions several times longer than recorded wavelengths, the stylus maintains a fixed vertical position during playback. A thin metallized electrode on the trailing surface of the stylus forms one plate of a capacitor, the disc the other.

Variations in capacitance caused by modulation sensed by the stylus change the parameters of a resonant line through which a 915-MHz carrier from an ultrastable oscillator passes, thereby modulating the carrier. The carrier is then envelope-detected to recover a signal corresponding to the disc modulation. Video signals vary between 4.3 and 6.3 MHz, and one audio channel has a subcarrier frequency of 716 kHz, with maximum deviation of ±50 kHz. A second audio subcarrier to be added next year for stereo will be placed at 905 kHz. Thus both audio subcarriers, as well as the "buried color" subcarrier at 1.53 MHz lie within the 3-MHz (at −6 dB) system bandpass and do not interfere.

After filtering, limiting, doubling, and conditioning, the FM signal passes to two demodulator stages, one for video, one for audio. Detected sound modulates the usual 4.5-MHz intercarrier for the r-f modulator stage. Video, simultaneously, passes through a nonlinear aperture correction circuit that inverts the modulation and adds it to the original signal to cancel any 716-kHz soundbeats in the video. Thereafter, video is detected and also compensated by a line dropout detector that replaces missing video with a portion of the previous horizontal line. The demodulated composite signal is then routed to a comb filter to separate chroma and luminance.

Chroma is next up-converted to the standard 3.58 MHz and recombined with luminance. Audio and video then modulate a video carrier for channel 3 or 4.

Control signals known as DAXI (digital auxiliary information) and "arm stretcher" are developed from digital and chroma information during vertical blanking intervals. DAXI is used to overcome a problem called "locked grooves" that occurs when static trash such as record dust will cause the system to replay a groove repeatedly. Since frame and field numbers are sequentially recorded along with the picture and sound information, a special microprocessor in the equipment refers to these numbers and verifies that each appears in proper order. Should a locked groove occur, the DAXI microprocessor generates a pulse that moves the stylus ahead two grooves correcting the condition.

Each field, we are told, contains 77 bits of digital auxiliary information. These in-

LABORATORY DATA

ZENITH CED

Parameter	Measurement
Video carrier:	−50 dBm + 5.72 dBm*
Audio carrier:	−63 dBm + 5.72 dBm*
Video S/N:	40 dB
Audio S/N:	26 dB
Video bandpass:	<3 MHz (at −3 dB)
Audio bandpass:	>30 kHz
Operating power consumption:	35 W

MAGNAVOX LASER DISC

Parameter	Measurement
Video carrier:	−51 dBm + 5.72 dBm*
Audio carrier:	−67 dBm + 5.72 dBm*
Video S/N:	39 dB
Audio S/N:	24 dB
Video bandpass:	>3.5 MHz (at −3 dB)
Audio bandpass:	>30 kHz
Operating power consumption:	75 W

*Positive 5.72 dBm added for impedance conversion from 50/75 ohms.
Test equipment used: Tektronix 7L12 spectrum analyzer; Telequipment D67A and Tektronix 465B oscilloscopes; and Sencore PR57 Power-rite.

clude a start code, error detection codes, 26 bits as yet unused, and field and band number codes. The number seen on the LED readout is derived from DAXI.

The arm stretcher is actually a time-base correction generated by comparing the frequency of chroma subcarrier developed in the video converter with a locally generated 3.579545-MHz reference. It compensates for disc eccentricity. When errors occur, a boom on the stylus moves it backward or forward to compensate. This prevents color variations and/or horizontal tearing in the picture.

The dc arm motor is controlled by a flyleaf on the stylus, which rests between two diodes connected out-of-phase and receiving a 260-kHz signal from a control oscillator. Their currents are synchronously detected to drive the dc motor as the difference signal requires.

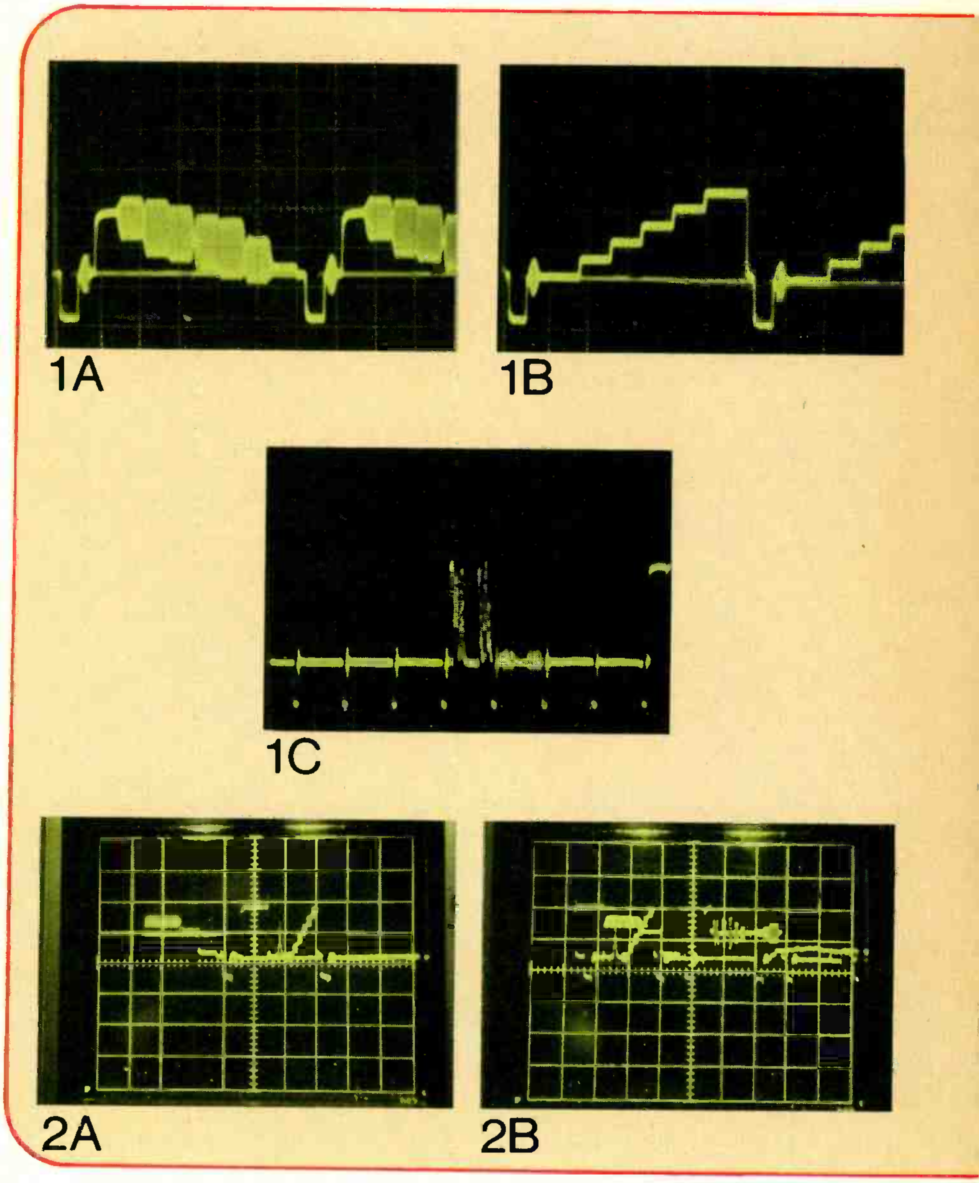
LASER DISC. The optical-laser disc player, introduced by N.V. Philips through its subsidiary, Magnavox, plays a grooveless disc that requires neither a caddy nor special handling. Audio and video information is encoded on the optical disc as a series of microscopic pits laid down in a spiral. The segment of the spiral scanned in one disc revolution is called a track and represents one video frame. Each 0.4-μm-wide track contains all the intelligence required for 8.1-MHz composite video and stereo sound. The discs have a surface of reflective aluminum and a transparent plastic outer casing. Minor scratches or dust on the casing do not impair reproduction.

Red laser light is used to read the program encoded on a disc. Laser light impinging on millions of disc pits reflected back through an optical system is directed onto a photodiode, where it is converted to an electrical signal.

The two-speed turntable motor operates at a constant 1800 rpm on standard play or 600 to 1800 rpm on extended play. Separate CAV (constant angular velocity) and CLV (constant linear velocity) LEDs indicate which type of disc is being played. Freeze-frame capability is available, but only with CAV discs. A fast-forward mode allows one track to be jumped at the end of each field to produce a still picture as the same track is repeated. Using the search mode, hundreds of tracks are skipped to permit quick location of any desired portion of the program.

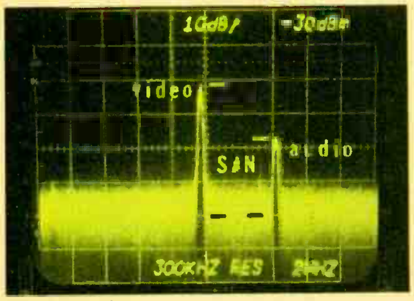
Audio signal transfer from player to TV receiver occurs after the 2.3-MHz left channel and 2.8-MHz right channel signals have been limited and detected, mixed, and applied to the output r-f modulator.

Included in the player are sync, color burst, and dropout protection. The last provides a means for countering dropouts caused by dust and scratches on the disc and appearing as gaps in the FM waveform. A seriously defective line of video is

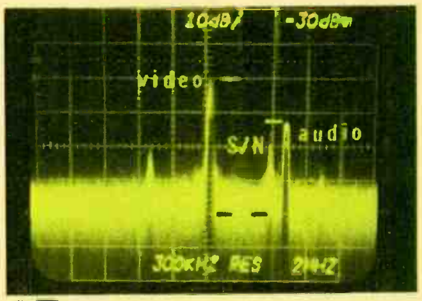


1A 1B 1C 2A 2B

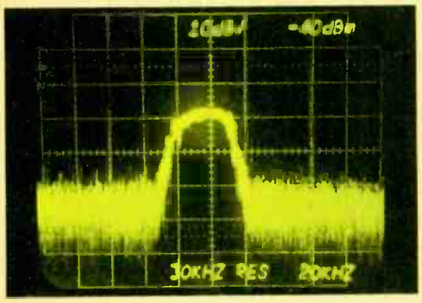
Magnavox Model VH8000 Laser Disc Player



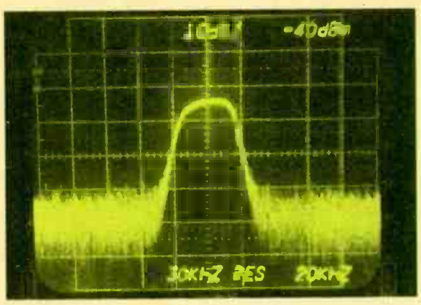
3A



3B



4A



4B

Fig. 1A, B, and C (opposite top) were made on a Zenith player using a preprogrammed test disc and show NTSC color bars (A), gray-scale staircase (B), and DAXI information (C).

Figs. 2A. and B (left) show information obtained from VIRS and VITS on the Magnevox player.

Figs. 3A and B (at top) are spectrum analyzer displays of video and audio S/N for Magnavox (A) and Zenith (B).

Fig. 4A and B (above) are spectrum analyzer displays of audio carriers for Magnavox (A) and Zenith (B).

Zenith CED Video Disc Player

replaced by a previous line so that any signal interruption is virtually unnoticeable.

The r-f modulator processes audio and video by combining them on a regulation TV channel 3 or 4 carrier (user selectable). The resulting composite r-f signal is then fed to the TV receiver. (More detailed information on the Pioneer Model VP-1000 optical-disc player, which is the same operationally as the Magnavox player, can be found in the March 1981 issue of POPULAR ELECTRONICS.)

Differences between the Magnavox and Pioneer players are more mechanical than electrical. The Magnavox player has 20 replaceable modules, versus the board assemblies used in the Pioneer player, for easy servicing. Helium-neon lasers are the same, electronics are virtually identical, and the method of encoding 8.1-MHz video and 2.3- and 2.8-MHz audio carrier information into the microscopic pits on the disc is the same. Mechanically, some laser disc machines are slightly noisier than others, and an ear test is worthwhile before you purchase. Pioneer and Magnavox, through selected dealers, do their own service.

ELECTRONIC ANALYSIS. Our laboratory analysis yielded two sets of waveforms for the competing CED and laser disc systems. The CED tests (Fig. 1) were made on a Zenith player using a preprogrammed test disc, since special signals to accommodate all player electronics are not yet available. For the laser disc system, however, both vertical interval test (VITS) and vertical interval (color) reference (VIRS) signals are available directly from regular 30-minute discs (Fig. 2).

The CED waveform in Fig. 1A reveals normal color bars and relative amplitudes, including the slight separation between green and magenta, which is to be expected. Burst has good formation, and there is little rounding of the horizontal sync pulse. Representing some five shades of gray scale out of a possible 10, the staircase is also very linear. (Fig. 1B). Illustrated in Fig. 1C is the DAXI information and its pulses.

Magnavox information for VITS and VIRS (Fig. 2) is considerably more revealing, since these are the signals used to set up broadcasting-station luminance and chroma and to search for nonlinearities in the transmitting system. The first signal (Fig. 2A) includes both VITS and VIRS information from lines 18 and 19, respectively, of the vertical blanking interval. Following the chroma envelope on the left is the 50% IRE level, black reference at 7.5% IRE, and horizontal-sync pulse. Next comes an 18-microsecond window, barely discernible 2T and 12.5T sine-squared pulses for luminance and chroma amplitude and phase-lag evaluation, and a six-level modulated staircase.

Some low-frequency tilt is discernible at the "toe" of the horizontal-sync pulse, and there is slight rounding of the window, de-noting possible loss of high frequencies. The 1-to-3-MHz 2T pulse is at full amplitude, and the 12.5T chroma information reveals neither lag nor phase distortion. The modulated staircase appears normal, indicating no differential phase errors.

The waveform in Fig. 2B contains portions of intelligence from lines 17, 18, and 19 of the vertical blanking pulse, which allowed us to present multiburst on line 17 a little better, shown here to right of the center vertical graticule line. It shows up as a fairly strong 3.58-MHz burst just before the remainder of the waveform and barely a suggestion of 4.1 MHz thereafter. That the trace is seemingly down in the "mud" across the entire bandwidth is more of a problem with the TV receiver's synchronous detector than with the disc.

Spectrum-analyzer displays for the Magnavox (Fig. 3A) and Zenith (Fig. 3B) players are quite close in signal-to-noise ratios and video/audio carrier levels, although the Zenith does beat the Magnavox by 2 dB in the audio S/N measurement. But carrier differences (video vs. audio) are virtually nonexistent. Apparent spurs near the audio carrier in Fig. 3B are 3.58-MHz chroma subcarrier voltages that are not apparent in either the picture or the sound.

As for audio, the Magnavox spectrum-analyzer display (Fig. 4A), apparently containing some spurious modulation, exhibits 30-kHz signal bandpass in a 40-kHz window. The Zenith display (Fig. 4B) shows about the same bandpass, but without evident modulation.

COMMENTS. As opposed to more than two years in the field for Magnavox, RCA/Zenith's video disc player is brand new. However, being some 15 years under development, the CED system should come to the market with most of the bugs ironed out, and you can expect an extremely simple and fairly accurate operating player.

Two motors, a turntable, a microprocessor, and some associated electronics for the CED system, compared to optical system's tangential and radial mirrors, precision servo systems, complex disc-tracking, and an 1800-rpm turntable motor, accounts for much of the price differential between the two machines. However, the ability of the optical system to produce pictures of better quality and good stereo sound could render the price difference relatively insignificant. Then, too, later this fall, we understand that optical systems with fewer frills may become available to virtually wipe out all price differences.

As of this writing, video disc titles for both the laser-optical and CED players are quite varied. Among the offerings available are old and current movies, sporting events, tutorials, children's shows, etc. Prices for recent full-length movies for both systems are $24.95. In lesser offerings, Magnavox, Pioneer, and DiscoVision will be selling single optical discs for as low as $5.95. RCA's best pricing schedule to date simply states that lower-priced discs should sell for $20 or less and account for at least 50% of available titles. ◇

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VIDEO 81

BY IVAN BERGER

CHOOSING A VIDEO CAMERA

JUST AS A microphone resembles a speaker working in reverse, a video camera tube is like a TV picture tube working backwards. In each case, an electron beam is swept across a target screen in the familiar TV raster pattern. In the picture tube, the beam illuminates phosphor dots, to turn electronic impulses back into light. The camera tube's reversal of this process is a bit more complicated.

In modern camera tubes (see p. 36), the beam's target is a photoconductor, whose resistance falls in proportion to the light striking it. Where light from an image focused on the target screen by a lens makes the target conductive, the beam current flows in proportion to the amount of light reaching that spot on the screen. The output signal developed by this current must be joined to a signal from a sync generator that controls the beam's sweep, so that the receiver will produce bright and dark spots on its phosphor screen exactly where the camera found them on its photosensitive one. This luminance signal, as it is called, is a record of the scene's brightness levels exactly as a black-and-white camera would sense them.

To sense colors, professional TV cameras use multiple tubes. Some have four tubes: one each for red, blue and green, and one for luminance. Filters ensure that each tube will "see" only its proper color. More commonly, today, one tube is used for each of the three colors, with the luminance signal derived as a weighted sum of their outputs—usually 59% green, 30% red, and 11% blue.

A few cameras use one tube for luminance and another for red and blue. A rotating filter wheel synchronized to the beam sweep alternates the colors "seen" by the red/blue tube: the green signal is obtained by matrixing the red/blue and luminance signals.

To avoid the complex, expensive hardware needed in multi-tube systems, home video cameras use single tubes. In its simplest form, the single tube camera has a grid of colored dichroic filter stripes on its faceplate (Fig. 1). In some designs, clear and red stripes run in one direction, clear and blue stripes crossing them in the other; in other cameras, the two primaries used are cyan and yellow (the complements of red and blue). Where the primary-colored filters cross, a third color is produced—green, in blue/yellow combinations, yellow in red/green ones.

As it sweeps across the screen, the electron beam alternately reads white and colored information. In line "n" of Fig. 1, for example, the beam scans white and green areas alternately, in line "n+1", yellow and cyan. With the exception of green, these colors are all composites of the video primaries (red, blue, green): white = R + B + G; yellow = B + G; cyan = R + G.

Thus, we can represent the tube's output when scanning the white-green-white line as alternating RBG and G information (line A in Fig. 2), and the output from a cyan-yellow-cyan line as alternating RG and BG information (line B). By phase-shifting line A by 90 or 270 degrees and subtracting it from line B, we get only red and blue components.

To perform the subtraction, we must have both lines A and B present at the same time. Since they're not produced simultaneously, one line must be delayed long enough to meet the other as it emerges from its phase-shift networks.

The red and blue signals produced this way are then mixed with the luminance signal (derived from the tube's output by passage through a low-pass filter) to produce an NTSC signal, comb-filtered to remove the scanning frequency.

Another approach, using the same type of tube, is to simply filter out the red and green information, with bandpass filters matched to the "spatial frequencies" generated by the beam's scanning of the striped tube face. Two newer tube designs do things a bit differently. The tri-electrode tube used by Hitachi, Akai, Sanyo and others has vertical red, green and blue filter stripes, and separate electrodes for each of the three primary colors.

Sony's Trinicon uses a similar RGB faceplate filter system, but with a comb-shaped "index electrode" between the filter and the photoconductor. The index electrode's bias polarity is alternated for each horizontal scanning line. With each line, the phase of the signal picked off the index electrode as the beam scans it is reversed. The chrominance information, however, has the same phase with every line. By adding and subtracting lines (again, using a delay line), either chrominance or index information can be derived. A phase detection circuit derives R−Y (Y is the luminance signal)

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VIDEO 81

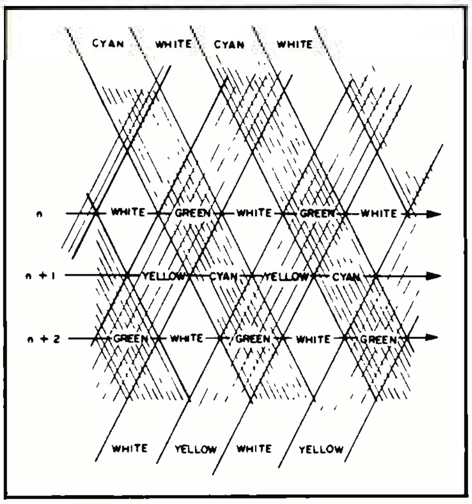


Fig. 1. In the JVC camera, filter stripes produce areas of alternating colors.

and B−Y, while the luminance signal itself is filtered out of the tube's output signal by a combination low-pass filter and trap, which eliminates the 4.5-MHz spatial modulation frequency.

Differences in the composition of their photoconductive targets is the main distinction between such tube types as the vidicon, Saticon and Plumbicon. Vidicons, with targets of selenium or antimony trisulphide, have comparatively high dark current (the current that flows when no light strikes the tube). This causes "lag", or perceptible image decay. Raising the dark current makes the Vidicon less sensitive, but decreases lag. Lag also decreases with face-plate size, making home cameras (with 2/3" tubes) slightly less subject to the problem than broadcast cameras (with 1" or 30-mm tubes). However, the smaller faceplate also limits resolution. And small tubes can still have color smearing.

Another tube type, the Saticon, is finding use in home cameras. Developed by NHK (the Japanese broadcasting network) and Hitachi, this tube uses an amorphous, glassy target of selenium, arsenic and tellurium. Saticon targets reflect very little light, which minimizes some flare problems. There's also very little light dispersion within the photoconductor, which helps resolution. The tube's main problem is lag, which can be minimized by a technique known as "light biasing". This uses a light aimed at the faceplate from the back of the tube, keeping it uniformly illuminated at all times. The uniform current caused by this bias is used as the reference black level.

BUYING A CAMERA. Color cameras should be selected as carefully as the VCRs they will be used with—after all, they cost about the same. But since the camera market is smaller, finding information and getting units demonstrated is harder. Stores specializing in video equipment are likely to be of most help. They will probably have more demonstration facilities and expertise. But they don't always offer the largest discounts.

Cameras differ in weight, cost, sensitivity, lenses, viewfinders, color-correction facilities, controls, indicators, connector plugs, power consumption, "feel", and so on. Of these, the most obvious difference is in viewfinders. Three types are available: the optical sight finder, the through-the-lens (TTL) optical finder, and the electronic finder (EVF)—a small, black-and-white monitor screen on the camera.

The optical sight is the least expensive and most limited. It tells you where the camera is aimed and what will be within the frame. But it can't be used with zoom lenses, tells you nothing about picture quality, and is prone to "parallax error" on extreme closeups. (This is the problem that leads photographers to cut off people's heads on closeups). Most cameras with optical finders and fixed-focal-length lenses can be upgraded by fitting electronic finders and zoom lenses.

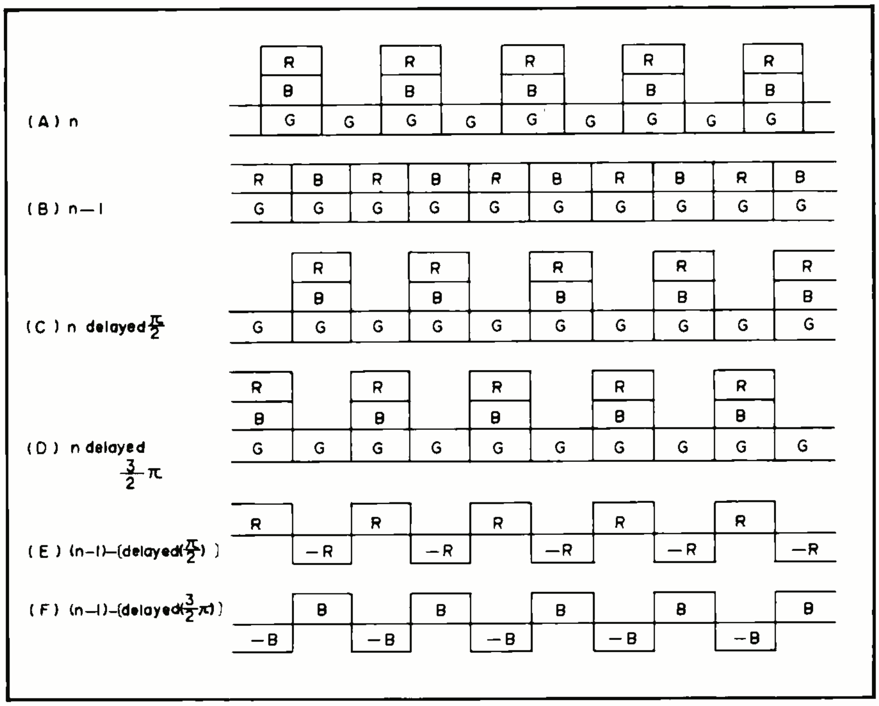
Through-the-lens finders look through the same lens as the camera tube does. That's vital with zoom lenses (and virtually every camera with a TTL finder has one) since the angle of view changes as you zoom. Many TTL finders also have built-in focusing aids, either grids of tiny "microprism" or split-image wedges. Both the shared viewpoint and the focusing aids are useful in closeup work. And although it's a minor point, a TTL finder ensures that you'll never try to shoot a scene with the lens cap on or the iris closed. Splitting the image between finder and pickup tube does steal some light from the latter, but not more than 10% to 25%. Camera bodies must be designed for TTL finders—you can't add one later.

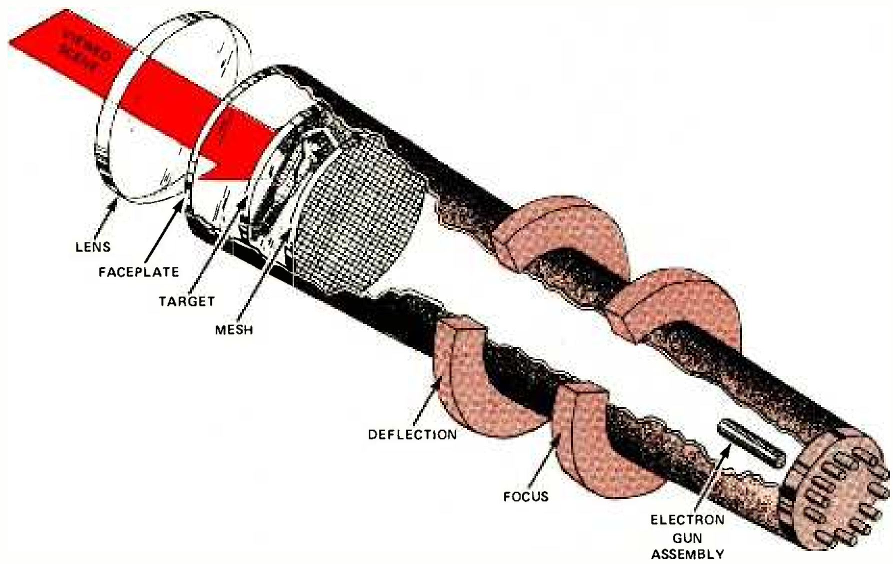
Electronic viewfinders tell you the most about what you're actually taping. While you're shooting, the finder shows you what the lens is seeing, what is and what is not in focus (TTL finders only show focus at the image center), and whether exposure, illumination, and contrast are within the camera's fairly tight limits. It will also tell you if you have such camera problems as burn-in (caused when the camera is focused on a single scene or object for too long) or lag. Most electronic finders can be used as playback monitors, for checking purposes.

One or two EVF cameras have audio playback connections, too, either for use with earphones (many cameras have earphone jacks so the camera operator can monitor the sound) or through a built-in speaker (as on Hitachi's GP-5). Some cameras have electronic finders built into the camera body, others have them mounted externally. Those with built-in finders tend to be more compact, lighter and less expensive, and their finders are a bit better protected against accidents. External finders are more flexible, though. You can usually tilt them up and down and, often, mount them on whichever side of the camera you find most comfortable.

There's no question that the EVF is the

Fig. 2. JVC camera shifts the output lines to produce an NTSC signal which is then comb-filtered.





Light, focused by a lens, strikes a target screen, making it conductive. Beam current flows in proportion to the amount of light reaching a spot on the screen.

most helpful finder type—one reason it's virtually universal in broadcast work. Its disadvantages are cost, bulk (especially when externally mounted), and weight. In portable applications, its slight additional power drain may be a minor problem, too.

In most finders, regardless of type, there are a variety of indicators. Virtually all cameras have a run/stop indicator LED; since not all VCRs are wired identically, though, the camera manual usually can't tell you whether the VCR is running when the LED is on or off. Low-light indicators are also common, over-exposure indicators less so. Both tell you to adjust your f-stop or the illumination, if either is possible, or be prepared for a reduction in picture quality. An EVF will show you most of this quality reduction, but will not show color shifts, which are especially likely in very low light.

Some cameras (such as Sony's HVC-2200) show light level or lens iris position (with auto-iris cameras, this amounts to much the same thing) on a continuous scale. The HVC-2200 also can display the camera's output waveform, a unique touch. The waveform's excursions show scene contrast, while the sharpness of its peaks is a guide to how well the camera is focused. Low-battery warning lights are also found on a few cameras.

Color-balance indicators, though useful, needn't be in the camera finder. Many cameras have meters on a side or rear panel. All video cameras must have some way of compensating for different colors of light. Otherwise, a white object will look red under incandescent illumination, blue on cloudy days, and green under fluorescent tubes. Our brains automatically compensate for what our eyes are seeing, but cameras can't.

At its simplest level, color compensation may consist of only a filter to be put over the lens. If the camera is balanced for outdoor light, the filter will be a bluish one to be used indoors; if the camera is balanced for indoor illumination, the filter will be somewhat orange to warm the light outdoors.

Most cameras use a more sophisticated system. In lower-priced models, this is often a switch that recalibrates the camera output for tungsten-bulb or daylight illumination or perhaps for tungsten, fluorescent, sunlight, or cloudy-day light. Some systems add a fine-tuning red/blue balance control to the basic switch, while a few have separate red and blue controls.

When shooting at home, you can use your color monitor to check and adjust the camera's color output—if the monitor is properly calibrated. But it's more convenient and consistent to have a white-balance indicator on the camera itself. This should be adjusted with the camera focused on a white object. Sony cameras frequently come with white, translucent lens caps that can be used as suitable white targets, too.

Several camera controls are concerned with illumination levels. To adjust the amount of light reaching the camera tube (which should be kept within fairly narrow limits), video cameras have either manual or automatic iris controls. An automatic iris is more convenient but, like any automatic exposure system, can be fooled by unusual subjects, such as dark subjects against light backgrounds, or vice versa. Usually, therefore, auto-iris systems have a manual override. For greater convenience, many cameras have "backlight switches," that increase exposure by a fixed amount when the subject is against a bright background, or switches and controls that can set exposure under high-contrast conditions. Some even allow agc to be switched off for relatively low-contrast scenes. Switches to raise sensitivity 6 dB in dim light are sometimes provided.

The iris control on the lens often includes a position marked "C" or "S," in addition to the normal f-stop markings. In this position, the diaphragm can be totally closed, to protect the tube from light exposure that could cause "burn-in." A small but growing number of models have fade buttons, that automatically fade the image to or from black.

Focus and zoom controls are usually found on the lens, though power-zoom control buttons are usually found on the camera head as well. A few cameras also have zoom speed switches.

At least three new cameras (Toshiba's IK-1850AF, Akai's VCX-1 and Hitachi's VK-C800) now offer auto-focus systems. These work on similar principles, comparing images from two mirrors, one fixed and one turning as the lens is focused. When the images from the two mirrors coincide, the camera is in focus. This works like a still-camera rangefinder, but with a comparator instead of the photographer's eye judging the image match. Auto-focus systems, too, should have override or defeat switches for special situations (such as shooting through cage bars or a nearby fence) where the autofocus is confused by, or may zero in on the wrong part of, the subject, and to prevent the system from "hunting" in and out of focus.

Some lenses have separate "macro" focusing ranges, for shooting closeups within a few inches of the lens surface. Auto focus will not work at these distances.

The microphones built into home video cameras are usually electret condenser types, with frequency response more than adequate for home VCR sound-tracks. But there are differences worth noting. Microphones mounted on telescoping booms, while more susceptible to damage, tend to do a better job because they're closer to the subject and farther from the sounds of the power-zoom motor and the camera operator's hands and breath. Microphones mounted at the front of a horizontal handgrip have similar advantages, though they're more prone to pick up camera-handling noises. Directional microphones help minimize ambient noise pick-up. Indoors, echoes can make them seem less directional. JVC is introducing a professional camera with a zoom microphone, that becomes more directional as the lens zooms toward telephoto.

Microphone input jacks extend the camera's versatility. Microphones can, of course, also be plugged into the VCR directly, but the camera operator will then be unable to monitor their pickup through the camera's earphone jack. Accessory shoes on some cameras can be used to hold boom microphones, lightweight movie lights, or other accessories.

The wider the range of focal lengths, the more versatile the lens. The faster its maximum aperture (that is, the lower its f-stop number), the lower the light in which it can be used. And, unfortunately, the wider its zoom range and the lower its f-number, the more it weighs and costs. Most home cameras come with either a 25-mm fixed lens, or a 6X zoom, usually with an aperture of f/1.8. In many cases, the lenses are interchangeable, usually using a standard "C" mount.

Not all zooms are 6X; 3X and 5X lenses are also seen, and at least one lens can be switched between either of two focal lengths. Nor do all 6X zooms cover the same angle of focal lengths. Models have appeared with ranges from 11.5 to 70 mm (Toshiba) to 17.5 to 105 mm (Sanyo, Sharp, Toshiba), with 12.5 to 75 mm (GTE Sylvania, JC Penney, JVC, Panasonic, Quasar, RCA, Sony and others) being the most common.

The shorter the minimum focal length, the wider the lens's maximum angle—very handy when shooting indoors. The longer the maximum focal length, the more useful the lens is outdoors, where distances are longer. A few camera manufacturers, such as JVC, are bringing out wide-angle and telephoto converters, which attach in front of the lens to extend its range. If none is made for your camera, those made for use with still and movie cameras may work.

Still photographers should note that in video (or cine) cameras, "wide angle" does not have exactly the meaning they're used to. An 11.5-mm "wide-angle" video zoom setting (about as wide as one can find) is only as wide as a 45-mm "normal" still-camera lens. Telephoto settings of video zooms are, however, much more generous than still photographers are used to. A 70-mm video zoom setting is equivalent to a 280-mm lens on a 35-mm still camera, and a 105-mm zoom setting would be equivalent to a 420-mm lens.

SPECIFICATIONS. The main specifications to check on a video camera are signal-to-noise ratio (usually around 42 to 46 dB) and horizontal resolution (usually around 240 to 250 lines, equivalent to a bandpass of 3 MHz, though trielectrode cameras claim up to 270 lines, and Sony's HVC-2200 Trinicon model claims 300).

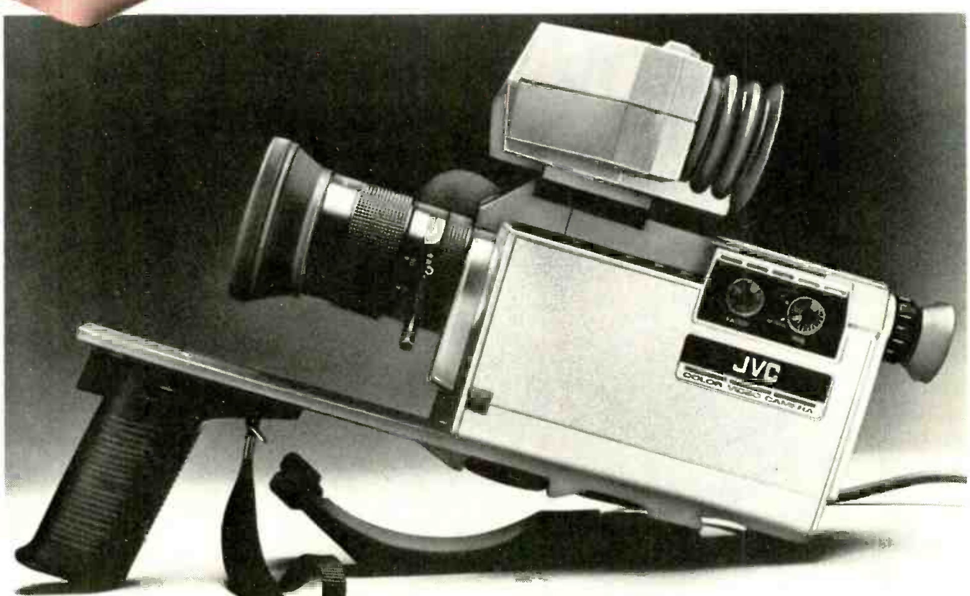
If dim-light operation is likely (most homes are dimly lit, by video standards), the minimum illumination figure will be significant. At this light level, the camera will produce a picture, but not necessarily a good one. Some spec sheets also list an "optimum illumination" range which shows the light levels at which noise goes down to normal levels and blacks become neutral-colored again.

For portable use, power consumption (make sure it includes the drain from the electronic viewfinder, if there is one) is important; and, for handheld use, so is weight.

The answers to some questions can't be found in the spec sheets. Weight alone won't tell how long you can hold a camera before fatigue sets in. Balance, dimensions, shape of the hand-grip or shoulder pad, and location of the finder and principal controls matter, too. There's no way to know without a showroom trial, which, unfortunately, is hard to get. Even test reports are of limited help, as human bodies differ. Do, however, look for information on how the camera can be adapted to fit you.

NOW THAT YOU'VE GOT ONE. Owning a video camera can turn you from a passive participant in video to an activist. Camera operation may seem highly technical at first, but if you remember the principles we've discussed here the fussy detail will become second nature and leave you thinking like an artist. And that can be rewarding indeed. ◇

Akai Activideo VC-X1 Camera

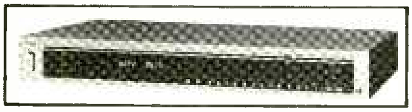


JVC Model GX-68U Camera

NEW PRODUCTS

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Alpha-Numeric Tuner



Toshiba's Model ST-S80 tuner enables a user to preprogram up to 30 channels (15 AM and 15 FM) for quick access. A fluorescent display will accept any of the 35,152 station call letters that can be issued by the U.S. government. Also, it can be programmed for any of the 456,976 possible combination/permutations with which one might identify one's own code, e.g., "Rock", "News", etc. Recall is accomplished in any of four ways: frequency, station call letters, individual code (as above), and via memory buttons. A station may be tuned in either by a manual or auto scan, or by direct access using a numerical frequency output. S/N is 74 dB; THD 0.12% at 400 Hz. $419.95.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Energy Management System

The Regulator 5700 from Regency Electronics is designed to control up to 100 different lights and home appliances. Its memory can store as many as 57 timed commands, and a battery backup will maintain memory in case of power failure. The unit is powered by ordinary house current. If high-current appliances are to be tied into the 5700, e.g., water heaters and clothes dryers that use 240 volts ac, an adaptor module is available. A coding key prevents commands from interfering with signals of similar units in the vicinity. An audible tone informs the user when a command is being transmitted. $299.95; modules for 120-V appliances, $22 to $40. 240-V module, $49.95.

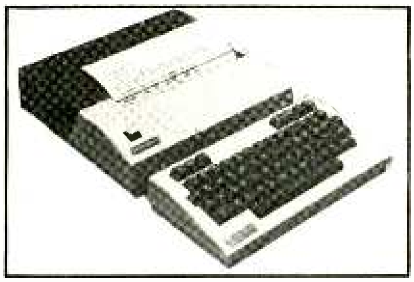
CIRCLE NO. 89 ON FREE INFORMATION CARD

Dynamic Cardioid Microphones

High- and low-impedance versions of a new microphone, the 671B, have been introduced by Electro-Voice. The basic microphone is said to be especially good for vocals due to its close-up bass boost and high-frequency characteristics. Features a built-in "pop" filter and a locking on/off switch. The 671BH (high Z), $97; 671BL, $95. Both versions come with a stand clamp and a 15′ cable.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Teleprinter with Intelligent Keyboard



The Trendcom 600 intelligent keyboard can be combined with the Trendcom 800 teleprinter to communicate with TWX and Telex terminals, as well as direct-dial terminals and computer systems. The teleprinter can accommodate 80 characters per line at 110, 200, or 300 baud. Messages can be transmitted as they are typed, or they can be prepared off-line, edited, and then transmitted. A 4000-character memory is available to store the message. Also included is an "answer back" feature, where the teleprinter automatically answers the phone with a programmable identification line of up to 40 characters. The teleprinter alone, $695; the intelligent keyboard (which gives the teleprinter a send/receive capability), $295.

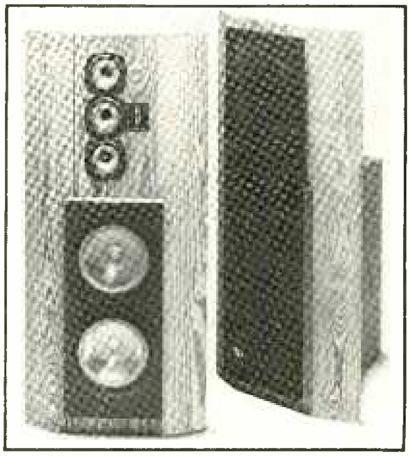
CIRCLE NO. 91 ON FREE INFORMATION CARD

Satellite Video Receiver

Hustler Inc. has introduced a 24-channel receiver, Model SVS-1000, for the earth-station component market. The satellite receiver is designed to pick up transmissions in the 3.7-4.2-GHz range, with an audio subcarrier of either 6.2 or 6.8 MHz. Controls include AUDIO LEVEL, SUBCARRIER FREQUENCY, FINE TUNING, and a 24-position channel selector. Features include a built-in regulated power supply and a switchable modulator with 75-ohm output on vhf channels 3 or 4 for feeding the signal to a TV receiver's antenna terminals.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Infinity Speaker System



Infinity's Reference Standard II speaker system features a curved solid oak "wing" said to minimize diffraction errors and virtually eliminate dead spots. It contains two 10″ woofers in separate subenclo-

(Continued on page 40)

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David D. Thornburg
Compute Magazine, November/December 1980

"The Atari machine is the most extraordinary computer graphics box ever made..."

Ted Nelson
Creative Computing Magazine, June 1980

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Russell Walter
"Underground Guide to Buying a Computer"
Published 1980,
SCELBI Publications

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Ken Skier, OnComputing, Inc. Summer 1980

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Desktop Computer

The S-100 computer from Micro-Expander Inc. is said to require only a video display and media storage for operation. It is built around a single circuit board that contains a Z-80A CPU, keyboard, video circuitry, real time clock, parallel printer interface, and an RS-232 serial interface. Features include standard 80x24 screen format, upper/lower case, 4K ROM monitor, 64K RAM expandable to 512K, video output and color graphics using 256 colors, and a complex tone generator with an internal speaker. The keyboard is outfitted with 2 programmable function keys, 4 cursor control keys and a calculator-like keypad cluster. The Expander will work without a video display for process control, data communications, and the like, although there is room for several S-100 boards for video or other desired applications. It will accept all CP/M and MP/M software written for the Z-80. The unit is sold with 24K Microsoft BASIC-80 (disk version) and 10K Microsoft BASIC-80 (cassette tape version). $2,200.

CIRCLE NO. 98 ON FREE INFORMATION CARD

sures, three 5" dipole midrange drivers, and two EMIT tweeters. One woofer crosses over at 60 Hz and operates only in the deepest bass registers, while the other crosses over at 125 Hz. However, each operates as a dual-drive Watkins woofer in the lowest bass registers. System frequency response is rated at 38 to 32,000 Hz ±2 dB. The Reference Standard II can be used with amplifiers rated at 35 to 250 watts continuous per channel. Finished in golden oak veneer and supplied with a dark brown grille cloth, the system measures 48" H x 22¾"W x 18"D. $650.

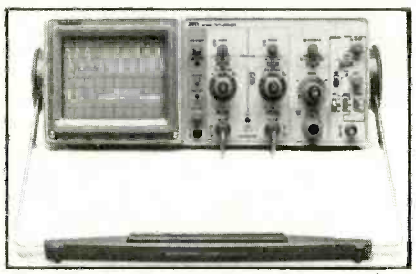
CIRCLE NO. 95 ON FREE INFORMATION CARD

B&O Computer-Controlled Stereo System

The programmable computer-controlled Beocenter 7000 hi-fi system from Bang & Olufsen contains a stereo-FM receiver, cassette recorder, and radial-arm turntable, all in an attractive rosewood-veneer-finished cabinet. It comes with two-speaker systems and a wireless remote-control module. The system can be programmed to start or stop automatically for unattended recording, to wake you up to music, and to shut off at bedtime. The turntable features B&O's new ultra-low-mass tonearm, MMC cartridge, and three-point pendulum suspension that isolates the turntable platter from the main chassis. A digital display panel keeps tabs on all selected music sources, tuner frequency, tape travel, etc.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Portable Oscilloscope



The 2213 oscilloscope from Tektronix is a portable (6.1-kg) dual-trace, screen-calibrated, delayed-sweep instrument, with a single time base providing an accuracy of 3%. It is said to achieve 60 MHz with inputs of 20 mV to 10 V, and 50 MHz at the 2-, 5-, and 10-mV settings. The maximum sweep speed is 5 ns/div. A vertical mode system triggers on asynchronous signals in dual-channel alternate operation, and enhanced auto triggering is reported to minimize the need for adjustments. TV line and field triggering is also provided. Features include Z-axis input, front-panel trace rotation, and beam finder controls. In addition, the probes have an IC grabber, permittting in-circuit measurements of pin voltages. $995.

ENTERTAINMENT ELECTRONICS

By Ivan Berger

Indoor FM Antennas

THE wire dipole antenna that comes free with FM tuners and receivers is better than nothing, but not much. In most homes, the only practical ways to install it are to lay it on the floor or tack it to a wall, neither being an optimum reception site. With floor mounting, you can orient the dipole to pick up the cleanest signal from at least one station (heaven help you if your stations lie in several different directions, as they usually do), but your walls are seldom oriented toward your favorite stations. I have one friend who gets good results with a wire dipole hung with a string catty-corner between two walls. When she's not listening, she takes it down—it's too ugly otherwise.

Ordinary TV rabbit ears do a much better job. This antenna too is a dipole, but its stiff rods can be angled to select the best available signal from the many that bounce around the average home. It's versatile and cheap. But, like the wire dipole, it is decidedly unattractive.

What would be ideal, of course, is a directional, rooftop antenna with a rotator. Such antennas can provide enough gain for fringe-area listeners and enough directionality to help city-dwellers cope with multipath. If you already have a good TV antenna on your roof, it may work for FM, but some TV antennas filter out the FM band to prevent possible interference. If it is desired to receive FM and TV simultaneously, there may be family conflicts when the two stations lie in different directions.

What's Available. If you can't have or don't want a rooftop antenna, there are still alternatives superior to rabbit ears. Probably the best-known indoor FM antenna is the B.I.C. Beam Box, now available in two models, at $90 and $50. I tried the top-of-the-line Model FM 10, which is also the original model.

The Beam Box is shaped and styled like a stereo component, so you can stack it with the rest of your system. It's aimed by switching antenna elements within the box and phasing them for maximum pickup along any of four lines: front-rear, side-side, or either diagonal. Like ordinary dipoles, the Beam Box has a bidirectional, figure-8 pick-up pattern.

Technics Model SH-F101 Indoor Wing Antenna

The Beam Box also has a passive tuning network to peak its response for the station you're listening to and help reject "garbage" on other frequencies. The network has a tuning knob (calibrated only at the 88 and 108 points, with seven dots between them) and a wide/narrow bandwidth switch (that worked best for me in the narrow position almost all the time).

Directionality isn't exceptional—a bit less than that of rabbit ears, I'd judge—and gain is below that of a standard dipole. But the Beam Box is more convenient and attractive; and, in the city, where signals are usually strong, it works pretty well. In fringe country, gain could become a problem—though not an incurable one, as we'll see.

The Technics SH-F101 Wing Antenna ($85) is another dipole variation—a printed circuit shaped like an airplane wing and swivel-mounted atop a neat, weighted metal base. The base contains an active tuning network, powered by two 9-volt batteries (Panasonic estimates their life at 18 months); and there's a battery checker built into the unit. In the back of the base is the 75-ohm output jack and a switch to allow manual tuning from the small knob on the front (calibrated at 88, 92, 96, 100, 104, 106 and 108 MHz) or automatic tuning by any of several Technics tuners and receivers, which also supply power to the antenna.

The Wing can be turned or tilted for the best possible reception. That's less advantageous in practice than it seems in theory. Since the signal pattern in the room is affected by your body, you're carefully orienting the antenna for a signal pattern that will cease to exist when you sit back to listen. But you can profitably tune for station frequencies. Since the Wing has an active tuning circuit, it's more selective than the Beam Box (nominally -6 dB at ± 3 MHz for the former compared to -3 dB for the latter). Rated gain is -2 dB re a standard dipole, while that of the Beam Box is -5 dB. The Wing's manual tuning knob has a very nice feel—and the automatic feature should appeal to owners of the appropriate Technics FM equipment.

Winegard's Stereo-Ceptor FM-4400 ($71.95) uses active circuitry to amplify, but not select, the signal. Its dipole is a gold-anodized aluminum bar with vertical plates at each end. At 19 inches, it's longer than the Wing's 16½-inch element. The Stereo-Ceptor's element doesn't tilt, but does turn 90 degrees, which for a bidirectional antenna is enough. The 4400 is ac-powered, and has an on-off switch and pilot light. It is available without amplification as the Model 2400 ($39.95).

Performance. There was no significant difference in the number of stations each antenna picked up. But there was a definite difference in signal strength. Not surprisingly, the amplified Winegard beat the other two. It was the only one to bring in any station strong enough to light all five LED's on my tuner.

For signal *quality*, however, the Technics Wing, with marginally less gain, on the average, than even the B.I.C., brought in more good and very good signals than either of the others. It is harder to adjust than the other two, but the results are worth it.

Signal Boosters. Since the Beam Box had the lowest gain, and since it alone had a 300-ohm output in addition to its 75-ohm one, I tried it with three different signal amplifiers: the Channel Master 0300 Amplitenna, the Breubeg Magnum, and the Winegard FM-3400. The Channel Master is designed for TV and FM, the other two for FM only.

The Breubeg is the most expensive ($150) of the three. It's also the most elaborate, with a thoroughly calibrated tuning dial. And it had the most gain. The other two amplifiers are just "black boxes"—literally, in the case of the $24.95 Channel Master, which consists of a small, black plastic case with a separate, calculator-style power supply. The $40.25 Winegard is an aluminum box with built-in power supply. Neither it nor the Channel Master has any external features except input and output terminals.

The Breubeg had the most gain, with the Winegard a close second, and the Channel Master right on its tail. On signal quality, the Winegard FM-3400 did just a hair better than the other two pulling in more stations with low noise and multipath. The differences, however, were not large.

These tests were all made in New York City, a difficult reception area due to multipath and noise. Just to make the test a little tougher, I had a computer (albeit the FCC-approved Radio Shack Model III) running in the next room, to give me a noise source of constant strength and known direction. Out in the country, though, my rankings of these antennas and amplifiers might well change. There, gain becomes far more important, while noise and multipath rejection are a bit less so. ◇

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

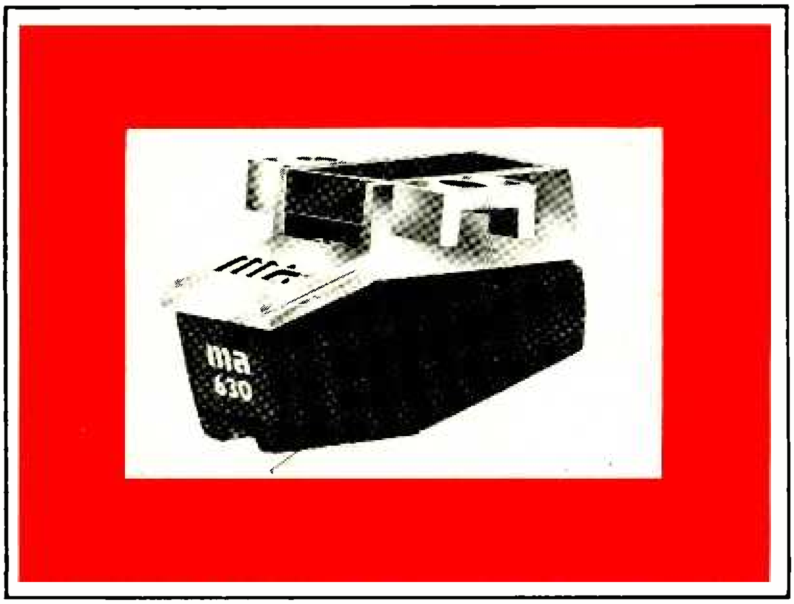
Micro-Acoustics Model 630 Phono Cartridge

THE Micro-Acoustics 630, though similar in operating principles to other Micro-Acoustics phono cartridges, embodies several refinements that distinguish it from its predecessors. Among them are a low-mass, molded-carbon fiber body and a beryllium cantilever fitted with a specially shaped diamond stylus. The mass of the 630, already low at 4 grams, can be further reduced in half-gram steps to 2.5 grams for use in tonearms having sufficiently light counterweights. Suggested retail price of the Micro-Acoustics 630, which carries a three-year full warranty, is $250.

General Description. Micro-Acoustics cartridges, including the 630, are electret transducers. The signal voltage is said to be generated by the flexing of a tiny electret element (a permanently polarized capacitor) that is mechanically coupled to the stylus cantilever through a pivoted yoke, or "resolver". Like other nonmagnetic transducers such as piezoelectric or strain gage elements, the electret is an amplitude-responding device that requires equalization to be compatible with an RIAA-equalized magnetic phono preamplifier. Also, to be compatible with such an input, its output voltage must be attenuated.

In the Micro-Acoustics 630 the equalization is done within the cartridge by small, passive "microcircuits". These R-C networks convert the output response of the cartridge to the equivalent of a velocity-responding magnetic cartridge, at a level of about 3.5 millivolts. However, the output impedance of the 630 is essentially a resistance of about 4,500 ohms. This makes the frequency response of the cartridge essentially independent of the external load.

The fine (0.01 inch diameter) beryllium cantilever is designed for very low mass and high stiffness. At the apex of the "resolver" is an iridium-platinum damper that flattens out the frequency response of the cartridge in the 10-to-30-kHz range. Unlike a moving-magnet cartridge, whose frequency response is influenced by the electrical as well as mechanical properties, the frequency response of a Micro-Acoustics cartridge is determined only by its mechanical properties. The design makes use of independent suspension and damping systems (usual practice combines both functions in a single elastomeric bearing). This makes possible optimization of both tracking ability and transient response.

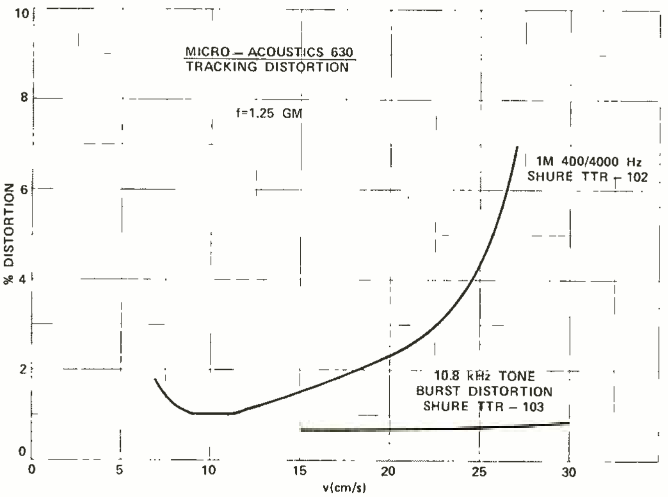


The shape of the diamond stylus, which is called the "Micro-Point II", is said to be an analog of the Micro-Point recording styli manufactured by Micro-Acoustics. Although no details are given, it appears to be a form of extended line contact stylus, comparable to the proprietary shapes used in the top models from most cartridge manufacturers.

The molded carbon fiber body of the cartridge contributes to its low mass (which is due largely to the absence of magnetic structures and coil windings). The actual cartridge mass is 2.5 grams, which is too low to be balanced in many tonearms. In the top of the body is a small storage space for up to 3 small weights of 0.5 gram each. A hinged cover secures the weights within the cartridge body. It is normally shipped with all weights installed to give 4 grams total mass, compatible with most arms.

In the event that 4 grams cannot be balanced, a separate 1-gram weight is supplied. It can be installed between the top of the cartridge and the headshell. In some tone arms (such as Dual and Philips) the rear of the cartridge body may contact the record surface. If this happens, an angled wedge is supplied, which can be installed between the cartridge and headshell. It tilts the front of the cartridge slightly downward to give the required clearance from the record surface. The stylus assembly is user-replaceable.

Each Micro-Acoustics 630 cartridge is supplied with its own individual frequency response calibration curve, made with the CBS STR 170 test record. The response is rated at 5 to 20,000 Hz ±1 dB. The tracking force range is 0.7 to 1.4 grams, with 1.25 grams being the recommended force. The rated channel separation is 30 dB at 1 kHz and 25 dB at 10 kHz. The noncritical nature of its load requirements is emphasized by the recommended range of 5 kΩ to 100 kΩ and 25 to 1,500 pF. The manufacturer also rates the rise time of the cartridge,



Tracking distortion using the Shure TTR-102 at velocities up to 27 cm/s and the TTR-103 with tone bursts.

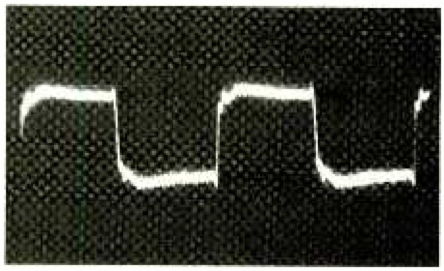
measured with a CBS STR 112 test record, at 4.5 microseconds, also independent of load conditions.

Laboratory Measurements. Testing was done in a typical "J-shaped" tonearm with an effective mass of about 20 grams. The cartridge compliance resonated with the arm mass at about 8 Hz, near the low end of the acceptable range. In more recent tonearms, whose mass is typically about 15 grams, the resonance should fall closer to the ideal 10-Hz point.

With the CBS STR 100 test record (similar to the STR 170 in general characteristics), frequency response was impressively flat, varying only ±1 dB from 40 to 20,000 Hz. Channel separation was about 25 dB in the midrange and 17 to 23 dB at 10 kHz. (The separation measured on any cartridge is very much a function of the test record used.) Because of its uniform high-frequency response, we also measured the cartridge up to 50 kHz with the JVC 1005 test record. There was little sign of any high-frequency resonance (evidently the dampers in the 630 were operating effectively), and the response sloped downward gently to about −4 dB at 40 kHz. The channel separation was still 7 to 10 dB at 50 kHz.

To check the claims of insensitivity to loading, we measured the cartridge response with the STR 100 record using loads from 10 kΩ to 1 MΩ and capacitances from less than 100 to 1,000 pF. There was absolutely no detectable effect on frequency response, although the output voltage was about 3 dB higher into 1 MΩ than into 10 kΩ. With the standard 47-kΩ cartridge load, the output was 3.4 millivolts, with a channel unbalance of 0.4 dB.

The vertical tracking angle was a relatively low 16 degrees. At the recommended 1.25 grams stylus force, the tracking ability of the 630 was outstanding. It played our high-level low and midfrequency test records easily and tracked the 70-micron level of the German Hi Fi #2 record. It was also one of the very few cartridges we have tested that could play every level of every section of both Shure "Audio Obstacle Course" records. The square-wave response with the CBS STR 112 record showed a trace of ringing on the leading edge (about 1 cycle) and a low-level 40-kHz signal riding on the square wave (this is cut into the record). Although we did not attempt to measure the rise time of the square wave in the cartridge output, it was obviously small.



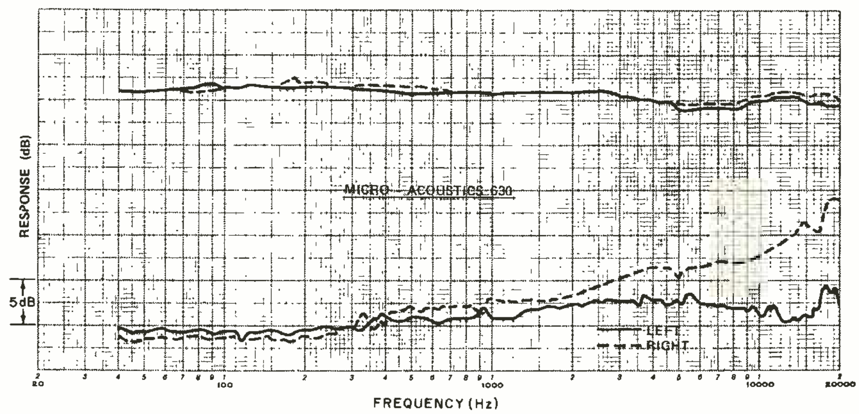
Scope photo of square-wave response.

Tracking distortion was measured with two Shure test records. The TTR-102 measures IM distortion, using 400- and 4,000-Hz test signals at various peak velocities up to 27 cm/s. The measured IM distortion was low (under 3%) up to about 22 cm/s, but increased to 7% at 27 cm/s. The TTR-103 measures high frequency tracking distortion, using shaped 10.8-kHz tone bursts at a 270-Hz repetition rate. There was almost no change in the level of 270-Hz product over the full range of the record, from 15 to 30 cm/s and the readings of 0.7 to 0.8% were about as low as we have measured, and may be the test residual.

User Comment. The flat frequency response, uniform crosstalk response, and excellent tracking ability of the Micro-Acoustics 630 translate into uncolored, silky smooth record reproduction, as one might expect. Not quite so predictable is the quiet background that comes from having a noninductive, fairly low-impedance source connected to one's phono inputs. This has been a characteristic of other Micro-Acoustics cartridges we have used, and it was just as obvious with the 630. With any reasonably good amplifier, it should be possible to turn up the volume fully without any audible hum. (The hiss level, though likely to be low, will depend on the amplifier itself.)

We discovered quite soon that the section of the cartridge instructions dealing with keeping the stylus clean must be taken very seriously. This is probably the result of its stylus shape (line contact styli seem to be more susceptible than conical or simple elliptical shapes to picking up dirt from the record grooves). A suitable stylus cleaning brush is provided with the cartridge, and our experience indicates that it should be used frequently.

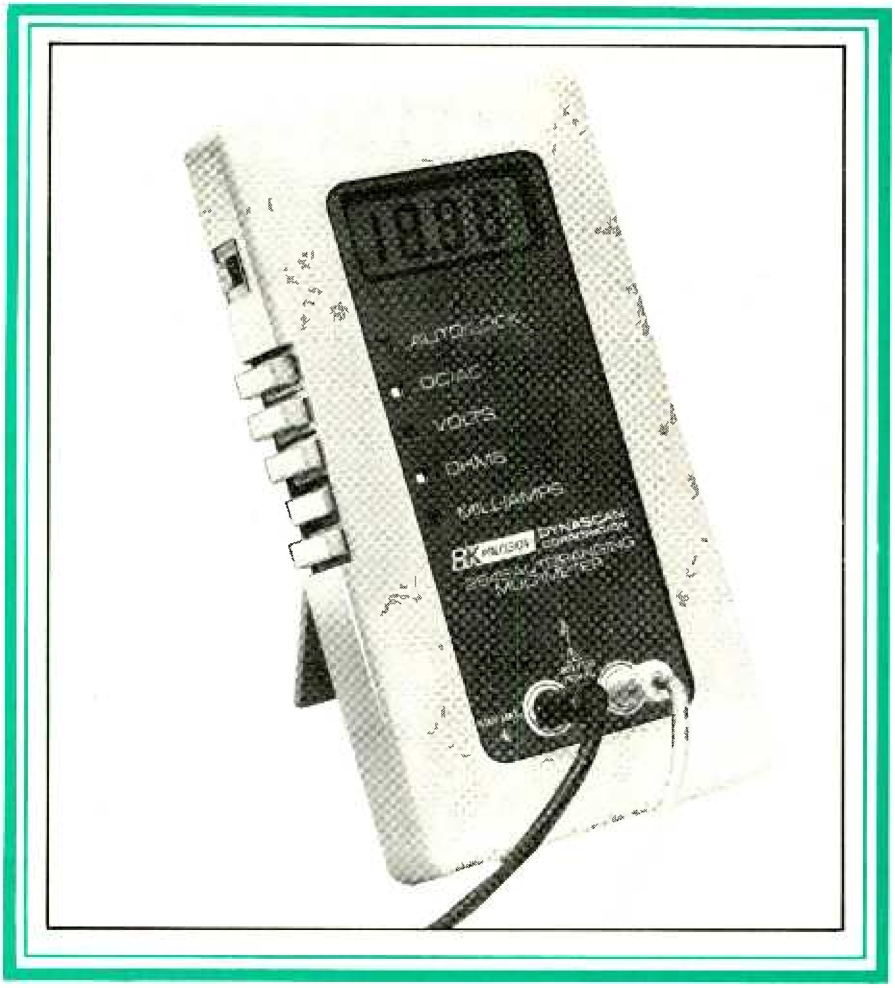
The Micro-Acoustics 630 is one of the very few cartridges we have used whose frequency response flatness is comparable to that of an amplifier, and better than any speaker. In combination with its superb tracking ability, low distortion, and ideal interface with a preamplifier input, this qualifies it as one of the best cartridges presently available to the critical audiophile. In addition, when used in a low mass tonearm, it should track severely warped records with relative ease.—*Julian Hirsch*



Frequency response of both channels using the CBS STR-100 test record.

Popular Electronics Tests

B&K Precision Model 2845 Autoranging Digital Multimeter



THE B&K Precision Model 2845 Autoranging Digital Multimeter has a "new look" among pocket-portable, state-of-the-art digital instruments. It features a 0.5-inch high 3½-digit LCD display, and 21 ranges of voltage, current, and resistance with autoranging, autopolarity, autozero, continuity buzzer, 0.1% accuracy and 1-mV/1-ohm/1-μA resolution. The automatic features are provided by a 4-bit microprocessor. There are no range switches; five function pushbuttons do all the work.

The unit will tolerate operating environment from 0 to 55°C (18 to 28°C for stated accuracy) and 0 to 80% humidity. Its internal 9-volt alkaline battery has an estimated life of 100 hours under normal operating conditions. The sleek plastic case is 3¾ inches wide, 1¼ inch thick, 6¾ inches long; and it weighs one pound (with battery). A built-in tilt stand/belt clip is provided, as are a pair of color-coded safety test leads, spare fuses, and a detailed instruction manual. Suggested retail price is $175.00

General Description. The most interesting feature of the Model 2845 is the 4-bit microcomputer. The 40-pin chip includes a processor, a 1K x 8-bit ROM that carries the selected function programs, and 48 x 4-bit RAM for holding variables. Automatic range selection is made via sealed reed relays driven by the processor. In resistance measurements, the processor also puts either a KΩ or MΩ symbol on the LCD display. All inputs are applied across a 10-megohm input voltage divider and eventually applied to a dual-slope A/D converter. Resistance is measured by a ratiometric technique.

The selected pushbutton determines which ROM program controls the system. In the autoranging mode, an uprange command is produced when the count is greater than 1999. This command changes both range and decimal-point placement. A count of 179 or less on a particular range produces a downrange command. There is a user selectable range lock that allows the instrument to stay in the current range, with an overrange indicator on the LCD display coming into operation. In the voltage function, an Auto Skip circuit senses the input level and, if it exceeds 25 volts of either polarity, it skips to the 200-volt range. To allow "eyes off" continuity tests, a defeatable internal audio tone comes on when the external resistance is 179 ohms or less.

As the selected function pushbutton is depressed, the color of and adjacent "window" changes to white to indicate the function in use. In the dual-function modes AUTO LOCK and DC/AC, the window display is either white or red.

Optional accessories include LC-45 Carrying Case, BE-16 Battery Eliminator, PR-21 Isolation/Direct Probe, PR-23 RF Detector Probe to permit making measurements to 250 MHz, PR-28 High Voltage Probe to extend the range to 40 kV dc and 20 kV ac at 60 Hz with an input impedance of 600 megohms, ES-28 10-Ampere Shunt, and TP-28

Temperature Probe for measurements from −50 to +150°C (−58 to +302°F) with a switch-selectable C or F scale.

The dc-voltage mode selects from 2, 20, 200, or 1000 volts of either polarity with an accuracy of 0.1% reading ±1 digit on all ranges. Polarity indication is automatic, and the input resistance is 10 megohms. Overload protection extends to 1000 volts dc or dc + peak ac.

The ac-voltage mode uses average responding circuitry calibrated to display rms value of a pure sine wave measuring 2, 20, 200, and 1000 volts. On the 2- and 20-volt ranges, accuracy is 0.5% ± 3 digits between 50 and 200 Hz, 2% ± 3 digits between 200 and 1000 Hz, and ±1 dB between 1 and 5 kHz. On the 200 and 1000 volt ranges, accuracy is 1% ±3 digits between 50 and 200 Hz. Input impedance is 10 megohms and the circuit is protected up to 750 volts ac rms or 1000 volts dc + peak ac.

For dc current, the ranges are 2, 20, 200, and 2000 mA with an accuracy of 0.75% reading ±1 digit on all ranges and automatic polarity indication. The voltage burden is 200 mV full scale on the three lower ranges and 600 mV typical full scale on the 2000-mA range. Circuit protection is provided by a 2-ampere fuse, and diodes.

Ac current is measured on the same four ranges as dc current with an accuracy of 1% reading ±3 digits between 50 and 1000 Hz. The voltage burden and protection are the same as for dc current.

Resistance is measured on ranges of 2K, 20K, 200K, 2000K, and 20-megohms with automatic KΩ or MΩ symbols on the display. Accuracy is 0.3% of reading ± 1 digit on the 2-to-2000k ranges, 0.6% reading ± 1 digit on the 20-megohm range with the read jack positive on all ranges. Protection against overload extends through +1000 to −450 volts dc or 300 volts ac.

Comments. The B&K Precision 2845 Autoranging Digital Multimeter was checked by the Lockhead Electronics Co., Instrumentation Measurements Laboratory against standards traceable to the National Bureau of Standards and was found to meet or exceed its advertised specifications in all respects.

Following our normal practice, we used the instrument on our workbench for several weeks to get the "feel" of it. It takes a little time to get used to the idea that range switches are not available. It seems a bit eerie to perform measurements of a volt or so, then measure a hundred or so volts, and watch the meter make its own adjustments.

The continuity buzzer mode works fine, except that it takes a second or two for the buzzer to sound. We felt that the buzzer volume was a little too low for the ambient noise level around our bench. However, we did use the function on several occasions and found it quite satisfactory.

Resolution on each function is very good and enabled us to make exacting measurements. We like the idea of the recessed test lead plugs, and the "finger stopper" rim on the red test lead. Both of these keep the user's fingers away from any potentially dangerous voltages during measurements.

We have some slight reservations about the mechanical construction. The instrument slides easily into a pocket for field work; but, unfortunately, the sleek plastic case is slippery enough to escape the grasp of slightly moist hands. Our inadvertent "drop test" did no harm, but we would like to see some kind of "anti-slip" agent on the case.

We found the Model 2845 excellent for both bench and field use. The automatic functions in particular make it very convenient to use. We would like for other manufacturers to use microprocessors in their test instruments to allow the user to concentrate more on testing and less on the instrument. We recommend the Model 2845 highly.—*Leslie Solomon*

CIRCLE NO. 103 ON FREE INFORMATION CARD

CIRCLE NO. 10 ON FREE INFORMATION CARD

COMPUTER BITS

By Carl Warren

Coming Attractions Plus a Tip

AS MANY of you would probably suspect, nothing in the realm of microcomputer systems or peripheral add-ons is really standing still. This past April at the West Coast Computer Faire in San Francisco, the crowd of over 20,000 was greeted by the introduction of a personal system dubbed Osborne-1. This Z-80 microprocessor-based system is from the Osborne Computer Corp., headed by Adam Osborne of microcomputer book fame. The unit, which is enclosed in a brushed aluminum weather-proof suitcase small enough to fit under an airline seat, is slated to sell for the surprisingly low price of $1795.

Even more startling is what this price includes. On the hardware side, there is a built-in 5-inch diagonal CRT monitor, two 5.25-inch single-density floppy drives, a full-sized keyboard with a 10-key numeric keypad, and an IEEE-488 and EIA RS232C interface. The software includes: Digital Research's CP/M operating system, Compiler Systems' CBASIC, Microsoft's MBASIC, Mi-

PROGRAM TO SET UP A BUFFER

```
10 CLEAR 1000:CLOSE                  'SAVE SOME STRING SPACE
20 GOTO 220                          'GOTO THE MENU
30 GOSUB 280                         'SET UP THE BUFFER
40 R=R+1                             'SET THE RECORD COUNTER
50 INPUT "LAST NAME";N$
60 INPUT "FIRST NAME";F$
70 INPUT "AGE";A$
80 LSET LN$=N$: LSET N1$=F$:@
 LSET AG$=A$                         'LEFT JUSTIFY BUFFER
90 PUT #1,R                          'WRITE IT TO DISK
100 I=I+1
110 IF I=4 THEN 130 ELSE 40          'THIS IS TO ALLOW 4 INPUTS FOR DEMO
120 END
130 CLOSE                            'CLOSE THE FILE TO MARK THE END
140 INPUT"ENTER TO RETRIEVE";CC$             'LETS BE FANCY
150 GOSUB 280                        'GOT TO OPEN AND REFIELD THE BUFFER
160 FOR R= 1 TO 4                    'THIS SET NO OF RECORDS WE CAN GET
170 GET #1,R                         'GET THE RECORD
180 PRINT N1$;LN$;AG$                'DISPLAY THE DATA
190 NEXT R                           'CIRCLE AROUND AND GET MORE
200 CLOSE                            'REMEMBER CLOSE THAT FILE
210 END
220 PRINT TAB(15);"(1) TO ENTER"
230 PRINT TAB(15);"(2) TO RETRIEVE"
240 INPUT C
250 IF C=1 THEN GOTO 30
260 IF C=2 THEN GOTO 140
270 IF C<1 OR C>2 THEN END
280 OPEN "R",1,"TREE.DAT"            'OPEN A RANDOM FILE NAMED TREE.DAT
290 FIELD 1, 15 AS LN$,@
 10 AS N1$, 4 AS AG$                 'ESTABLISH A BUFFER
300 RETURN
310 END
```

cropro's Wordstar word-processing package, with MailMerge option, and an electronic worksheet package from SORCIM called Supercalc that somewhat resembles Visicalc.

Attractive though the Osborne-1 may seem, don't get on the phone and try to order one. The company won't sell it direct (they plan to sell only through distributors) and production of the first units began only last month. Moreover, there is at least one peculiarity you should consider. The viewable display is 52 characters by 24 lines with a 128-character by 34-line expanded feature, which implies horizontal and vertical scrolling. A number of application software houses I spoke with view this unique display as a possible limiting factor, since numerous applications written originally for 80 x 24 full-view screens will have to be rewritten to include horizontal scrolling commands.

Furthermore, you might want to wait for other hardware options such as modem electronics, larger video monitors, and higher density disk drives, which, according to the company, are currently on the drawing boards. Expected introduction is late 1981 or early 1982.

Some Programming Help. A few months ago, Edward Craig, Blytheville, AK, wrote about some difficulties that he was having converting a genealogy program from DEC BASIC Plus 2 to TRS-80 BASIC. Specifically, he was unable to get the program to read and write data.

Well, Bob, here, finally, is some help for you in solving your problem. Since I don't have the space to show you the entire program, I can give you some troubleshooting tips.

The program shown opposite is an example of how to set up a buffer and get information into and out of it. The most important point to notice is that I have written the buffer statement only once in the form of a subroutine. This way I can set up a menu as I did in line 20 and do one of three things: ENTER, RETRIEVE, or QUIT.

Another important point to remember when using random files is that you have to tell the computer where in the buffer you want them in terms of right or left justification (see line 80). Then some sort of record counter is used to keep track of what record is next. This is a neat program to experiment with when learning about using files.

Here is an experiment you might want to try. Change line 160 to read INPUT "ENTER RECORD NO"; N and change line 190 to a GOTO 160. This way you can choose the exact record you want.

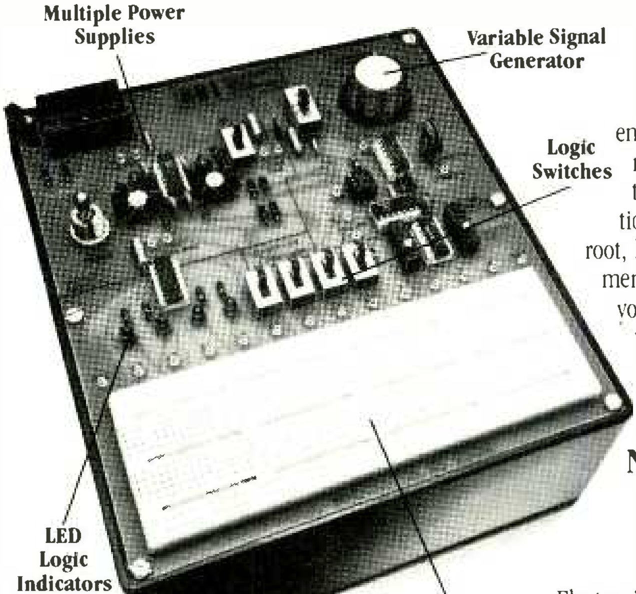
Incidentally, I only used 29 bytes of the available 256 in the field statement so you can expand this. Try this out; I think you will be surprised at how fast you catch on.

Let's Talk Disks. Over the next several months, you are likely to read a lot about a number of high-density flexible media drives coming on the scene. Some of these have been mentioned previously in this column, and were seen at the National Computer Conference (NCC) held in Chicago. Among the new offerings set to be available to systems designers later this year are Remex's (Irvine, CA) 5.25-inch 1M-byte drive called the Pico. This drive fits in two-thirds the space required for a standard 5.25-inch floppy and is double-sided, double-density with 96 tracks per inch. You can't buy this drive yet, but expect it to start showing up in a number of systems by late fall or early '82. According to one industry source, both Heath and Tandy are giving it serious consideration as an upgrade.

Taking a little more bullish approach to high-capacity disk drives is Persci (West Los Angeles, CA). This company is preparing to launch production models of a 6.4M-byte, 8-inch drive sometime this fall. The unit, which was shown at NCC, comprises two 8-inch drives housed in a single 8-inch drive form factor. It employs dual heads for

(Continued on page 54)

.ELECTRONIC
LOGY TRAINING



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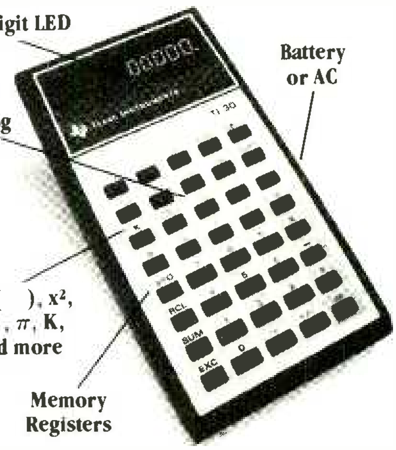

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each drive for double-sided, double-density recording. According to a company spokesman, the drive system is designed to directly replace previous Persci and other lower capacity drives without changing system mounting requirements. However, be aware that even if you can latch onto one of these drives, numerous software changes would be required to take advantage of the increased capacity.

The Persci drive, like the Remex, won't be directly available to the end user, but will be employed in various systems or as part of an upgrade package. Many industry watchers believe the Persci drive will find its way into a number of units such as those manufactured by Wang or Digital Equipment Corp.

Directly related to disk drive developments are controllers—the electronics that permit the computer to read and write data on the disk, format the medium and locate specific information. Since this is an important area of concern, many companies are vying for a piece of the pie. One such company is Magnolia Microsystems.

You are already familiar with this Seattle, WA manufacturer if you own a Heath system and have purchased their zero-based CP/M package or Winchester controller. What Magnolia is preparing to offer, by early fall, is an 8-inch disk controller for the H-89 that allows using a wide variety of drives including standard Shugart 8-inch units. The manufacturer says the idea is to open up other avenues for adding 8-inch floppies to Heath systems.

Functionally, the Magnolia controller will support CP/M and permit the use of the Heath 5.25-inch controller. It will not, however, support HDOS.

Answers to Your Questions. First I have to apologize. Since I'm not able to answer your letters directly, using this column seems to be the best way, especially since many of you are asking similar questions. One such question that has arisen is: "How do I get in touch with *Micro Media Magazine*?" Well, apparently a typographical error occurred when we last mentioned this magazine; but I can assure you that they are alive and well and issue No. 4 of their disk-based magazine is out and is chock full of useful information and software tools. The address is *Micro Media Magazine*, 1316 Elmhurst, Garland, TX 75041, or phone 214–840-1477 and ask for David Alford.

Regarding conversion software, there currently is no universal conversion package available. There is one that will convert from TRS-80 to Apple to Atari, and I can assure you that slowly but surely it's on the way. In fact, what I identified as the best way to perform this unique function was to write it to run on Micronet. Right now I'm not sure whether or not it will be a BASIC or Fortran program or a little of both; but expect to see it available sometime before year's end. ◇

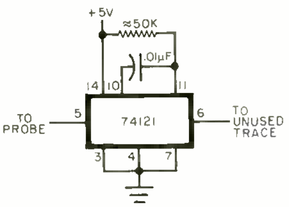
COMPUTER SOURCES

By Leslie Solomon
Senior Technical Editor

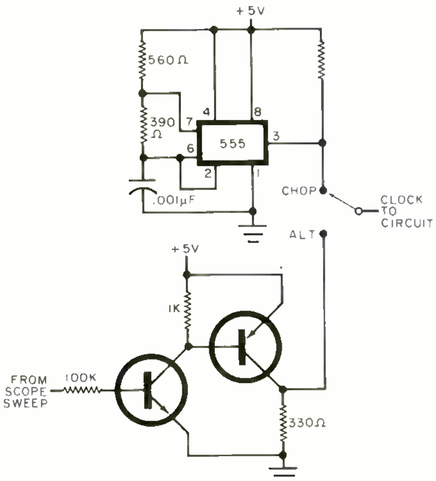
Hardware

Glitch Finder. We have been using the multi-trace logic display (February 1981, page 60) for quite a while now for troubleshooting logic displays. Recently however, a problem occurred. Some logic did not work properly even though the display showed that all the correct inputs were present. Changing the suspected IC did not cure the problem so we decided that a high-speed "glitch" was present, but our scope could not display it.

What was needed was a "glitch finder" that could signal the presence of such an invisible glitch by showing its presence on screen. The circuit shown at A does this.



(A)



(B)

The 74121 is wired as a one-shot that accepts a brief positive-going trigger and delivers an output pulse whose width is about 7 to 10 microseconds — a clearly visible pulse. The output of the glitch finder is applied to one of the unused traces, while the input at pin 5 is probed to the data line under test. In operation, you will see the glitch-finder pulse located under the positive-going edge of each pulse on the data line under test — including the "invisible" glitch. Since some one-shots are more "sensitive" than others, you may have to try several 74121s before you find one that will respond to a glitch that is only a few nanoseconds wide.

The circuit at B illustrates both a "chop" clock oscillator and a technique for using the scope sweep as the "alternate" trigger source. This modification allows using either clock source to trigger the multitrace display, contingent on the speed required to observe the multitraces on the scope.

Software

6800 Diagnostics. The programs in this package are designed to run under FLEX Operating System and include a versatile memory diagnostic utility and a disk repair utility that includes three diagnostics to report unreadable sectors and structural inconsistencies, plus two utilities for recovering data when the disk directory is not readable and one utility to remove bad or intermittent sectors from free space. It also includes a program to retrieve deleted files from the diskette free chain, a single sector read/write/modify routine, and a copy utility that ignores CRC errors. $75, 5- or 8-inch diskettes. Address: Technical Systems Consultants, Inc., Box 2570, West Lafayette, IN 47906 (Tel: 317-463-2502).

Apartment Management. The Landlord provides property owners with listings of apartments, residents, and past residents as well as vacancies, lease expirations, intents to vacate, and resident payments. Records of disbursements and other financial transactions, and monthly property analysis are provided. Up to 26 different account codes are available, and up to 400 units can be handled. The software is completely nontechnical for those having no prior experience in computers. Requires an Apple II, 48K RAM, two disk drives, and a printer. $795. Address: Min Microcomputer Software Inc., 5835-A Peachtree Corners, East Norcross, GA 30092 (Tel: 404-447-4322).

Fantasy Game. Lords of Karma is a fantasy game for the TRS-80 Level II, 48K; Apple II, 32K; and Pet 32K machines. The program is played solitaire, with the player making all decisions. The player explores forests, twisting trails, rugged mountains, labyrinth caverns, always watching for monsters, and trying to stay alive. $20. Address: The Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.

Nuclear Attack Game. ABM is based on an arcade game in which nuclear missiles must be stopped by your ABM (anti-ballistic missile) devices before they hit. Multiple warhead MIRVs are used, as are hi-res color graphics and sound. Requires Apple II, Applesoft ROM, DOS 3.2 (13 sector disk), 32K RAM. $24.95. Address: Muse Software, 330 North Charles St., Baltimore, MD 21201 (Tel: 301-659-7212).

Atari/PET Library. A number of programs including games, graphics, music, ham radio, astronomy, home use, and utilities are available from this catalog. Prices are from $2.50 for PET and from $3.50 for Atari. Address: Kinetic Designs, 401 Monument Rd., #171, Jacksonville, FL 32211 (Tel: 904-725-0435).

PET Educational. A software subscription for kindergarten through sixth-grade levels is carried on MALA (Microcomputer Assisted Learning Aids), a monthly cassette containing four programs on varied subjects. They will run in an 8K PET. Eight issues per school year are $40. Address: Comm-Data Systems, Inc., Box 325, Milford, MI 48042 (Tel: 313-685-0113). ◇

BY HERBERT COHEN

How to banish elusive problems that haunt your circuits

IN PURSUIT OF GLITCHES

BUILDING projects from schematic diagrams can be a hit-or-miss proposition. Working without benefit of wiring diagrams or written instructions, you may build a circuit that appears perfectly reasonable on paper and find that it breaks into oscillation, suffers from hum, or exhibits lower-than-designed gain or sensitivity for some unfathomable reason. In most cases, the fault doesn't lie in the design of the circuit; rather, it's how you wired and/or laid out the components. The solutions for such problems lie in using a little common sense and care in assembly.

A simple analysis of a schematic diagram won't always tell you what's supposed to happen in a circuit. Although schematics show all the components *intentionally* included in a circuit, additional "phantom" components and conductive paths often introduce "glitches" that can radically influence circuit operation, sometimes to the point where the circuit fails to operate at all. These phantom-component-induced glitches can all be eliminated *before* a circuit is translated from schematic to prototype. Once you're aware of where the problem situations can occur and how you can go about eliminating them, every soundly designed circuit can be made to work as well in fact as it does in theory.

Let's take a look at some of the most common problem areas you're likely to encounter and how to go about avoiding the pitfalls. In the process, you'll learn how to build glitch-free projects almost every time.

Phantom Resistors. Shown in Fig. 1A is a simple audio amplifier and power supply circuit. Each component that goes to ground in this schematic is shown with its own separate ground symbol, giving no specific information on how each ground is to be connected. If you were to assemble this circuit exactly as shown, without properly connecting the grounds, it would act more like an oscillator than an amplifier.

The same circuit, this time with a ground bus added and its resistance taken into account as *R1*, *R2*, *R3*, and *R4* is shown in Fig. 1B. Assume the speaker lead to ground to be a 2" length of No. 22 wire with a resistance, exclusive of soldered connections, of 2.5 milliohms. (Phantom resistors are almost always of very low ohmic value.) Applying power to this circuit causes current to flow through *R2* and the speaker to charge the output coupling capacitor, causing a voltage to be dropped across *R2*. Assume now that a short length of copper wire, represented by *R1*, connects the ground return (point A) of the input volume control to the same point used as the speaker ground. Under these conditions, the amplifier's input "sees" the unwanted voltage dropped across *R2* as an input signal.

Since the amplifier's input and output are in phase, a positive-feedback loop is created. Feedback in this circuit is pure ac, since the speaker coupling capacitor blocks dc. If the speaker were directly connected to the amplifier's output, both could be catastrophically damaged.

This situation can be avoided by connecting points A, B, and C together and then to point E, as shown in Fig. 1C, to keep all signal grounds at one common potential. Speaker line point D then independently connects to the filter capacitor's negative pole at point E. This done, the feedback path is removed from the circuit.

As a general rule, all ground returns should be made to the lowest-impedance point in the power supply, which is the negative side of the filter capacitor. Bear in mind that the filter capacitor absorbs large currents from the rectifiers, stores the dc charge, and then releases a flow of direct current to power the circuit. Current between the center tap of the transformer at point F and the negative side of the filter capacitor at point E consists of 120-Hz pulses with amplitude as high as five times the speaker current. This makes the current path from point E to F the noisiest part of the ground bus. It is best, therefore, to avoid using bare wire to make this connection or attaching any ground wires between these points.

Bipolar Power Supplies. A typical operational-amplifier audio circuit using a bipolar power supply is shown in Fig. 2. In this circuit, the $-V_{cc}$ (negative) dc line doesn't share the same line as the speaker return. This points up one of the great advantages of the bipolar power supply—isolation of the load from the power supply lines.

Audio input signals appear across *R1* and enter the op amp through the noninverting (+) input. In op amps, the feedback loop must supply at point C a voltage equal to that at point A to ensure that the differential sum of the voltages between these two points is zero. If a ground loop produces a voltage differential between points B and D, the op amp sees this voltage as part of the input signal and produces a voltage across *R2* equal to $V_{BD} + V_{AB}$. To remove any problem created by this differential, the grounds at points B and D must be combined into a single point.

Transformer Fields. Electromagnetic radiation from a power transformer or a tape-recorder or phono motor can also create problems with ground loops. Electromagnetic devices can produce large 60-Hz eddy currents whose associated magnetic fields can induce un-

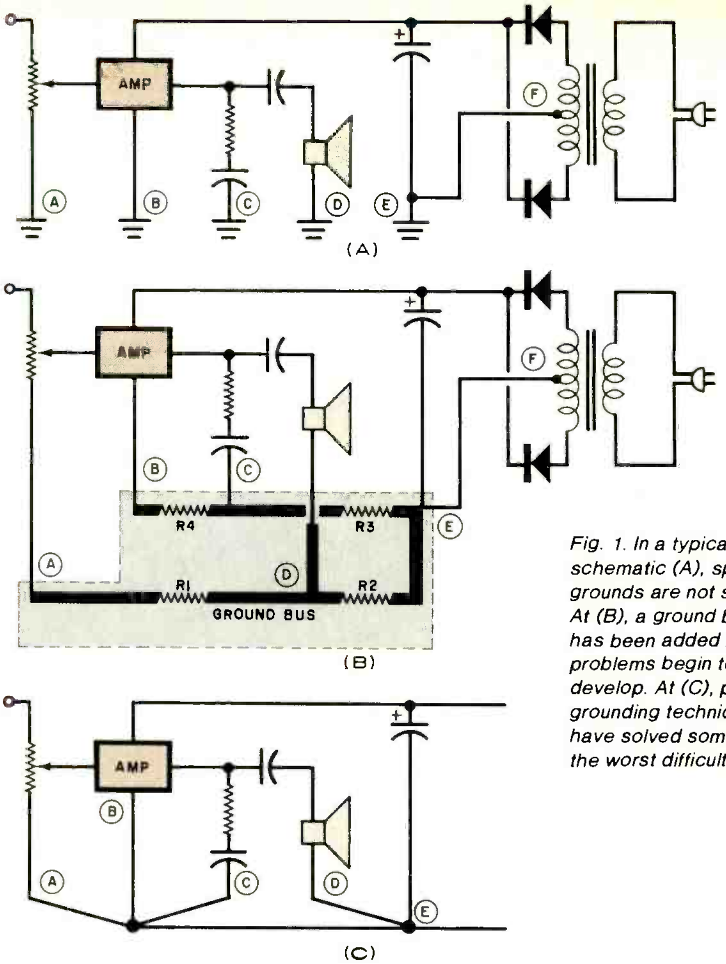


Fig. 1. In a typical schematic (A), specific grounds are not shown. At (B), a ground bus has been added but problems begin to develop. At (C), proper grounding techniques have solved some of the worst difficulties.

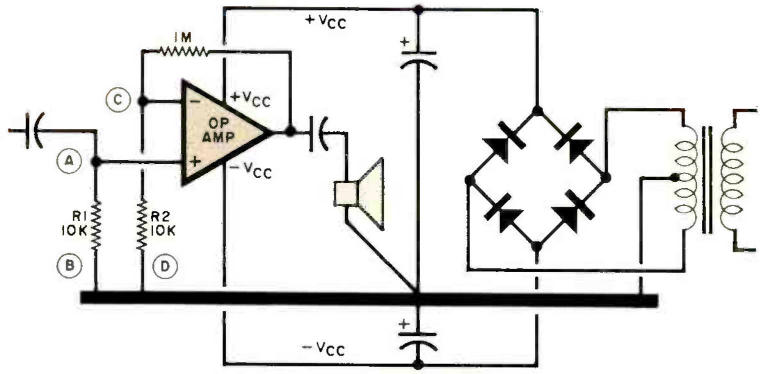


Fig. 2. An op-amp audio circuit using a bipolar power supply to isolate audio grounds from supply lines.

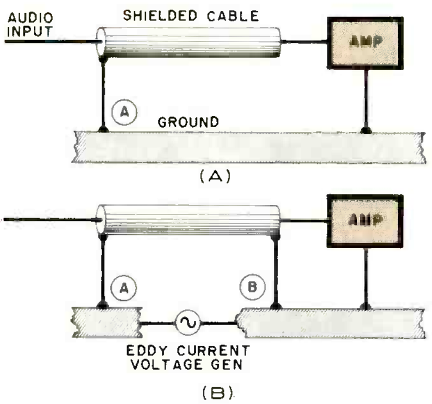


Fig. 3. Shielded cable should be grounded at only one point (A). Grounds at both ends of the cable (B) may result in hum due to an eddy-current loop.

wanted voltages in any nearby conductor. Being metal, a ground bus will pick up these eddy currents. Therefore, care must be taken to keep these induced currents from being combined with the signal. The obvious precaution is to locate electromagnetic devices as far as possible from sensitive circuits.

Shielded Cables. One of the most common causes of hum problems in audio amplifiers is shown in Fig. 3A. Here, a shielded cable feeds a signal from one point in the circuit to another. Good grounding practice calls for the shield to be grounded at only one place, point A. If hum appears in the signal, it more than likely is the result of the shield being grounded at both ends of the cable, as illustrated in Fig. 3B. In such a configuration, a few millivolts of 60-Hz signal can be induced into the ground path by eddy currents from a power transformer or coils of an ac motor. We assume in this circuit that both ends of the cable's shield are grounded at different points. Since the eddy-current loop has a very low source impedance, a rather large current can flow through the cable shield. As a consequence, the shield acts like the primary of a one-turn transformer and induces a 60-Hz voltage into the signal-carrying inner conductor of the shielded cable.

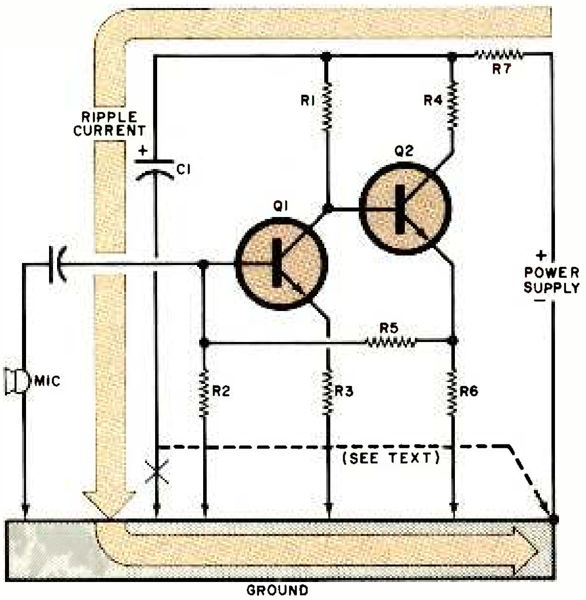


Fig. 4. To prevent hum caused by the ground loop through capacitor C1, the capacitor should be grounded as shown by the dotted line.

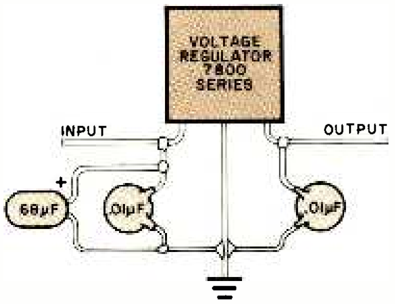


Fig. 5. Both input and output of a three-terminal voltage-regulator IC should be bypassed with capacitors connected as close to pins as possible.

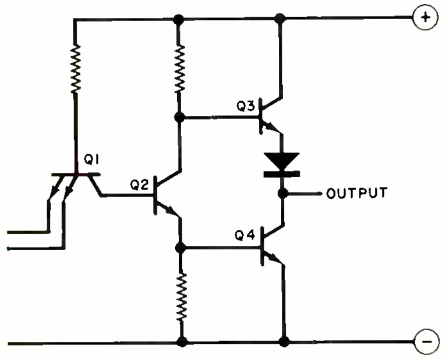


Fig. 6. In a standard TTL gate, both output transistors can be conducting briefly during switching, producing a high-current spike. Using a bypass capacitor is the solution.

Power Lines & Bypass. Op amps generally ignore ripple and low-frequency voltage variations in the power supply. However, IC amplifiers tend to oscillate if they see any appreciable inductance in their power-supply leads. Since even an inch or so of hook-up wire or pc-board trace may have enough inductance to cause problems, the best course is to bypass both the negative and the positive power-supply leads to ground through a 0.1-μF ceramic disc capacitor directly at the IC's power pins or the printed-circuit pads to which these pins are connected. In a bipolar supply, each power line must be independently bypassed to ground.

Motorboating. The "put-putting" sound that can sometimes be heard in an audio amplifier's speakers, called "motorboating," is a problem that results from poor power-supply regulation. When the amplifier connected to an inadequately regulated power supply draws current to charge its capacitors, a voltage drop appears across the power-supply lines. The result is that the amplifier turns itself off when the voltage drop occurs. Then, when the power supply recovers, the amplifier turns on again, immediately drawing current from the supply and causing a continuous repetition of the on/off cycle. It is this on/off cycle that produces the annoying put-put sound. The most efficacious cure for motorboating is heavy filtering of the amplifier at the power input to the output stage, or, if the amplifier is encapsulated, filtering directly at its power pins.

Keep in mind that ultrasonic or r-f oscillations can occur in an audio amplifier and cause it to draw large currents. Although large electrolytic capacitors with values of up to 50,000 μF may be effective against power supply ripple, power factor and internal inductance may make them inadequate bypasses at high frequencies. As a rule, then, all high-value electrolytic capacitors should be bypassed with a much lower value (say, 0.01-μF) capacitor to remove objectionable high-frequency signals. It isn't a case of how much capacitance to use here but of where to use it.

Don't be afraid to use capacitors liberally; you can't have too many of them. A single 1-μF capacitor, for example, will never be as effective as twenty 0.05-μF capacitors judiciously scattered about a circuit.

Decoupling. In the discrete-component microphone amplifier circuit shown in Fig. 4, *C1* and *R7* form a decoupling network that's supposed to prevent noise and ripple in the power supply from entering the amplifier. When the grounds are connected exactly as shown and power is applied to the circuit, however, the amplifier will be plagued by hum. If you were to disconnect *C1*, the hum would diminish considerably. The hum is the result of *C1*'s low reactance of about 25 ohms at the 120-Hz ripple frequency of a full-wave rectifier power supply. Although it holds the dc voltage constant, *C1* presents a low resistance to the ripple current through the ground bus and back to the power supply. Therefore, connecting *C1* back into the circuit as shown creates a classical ground-loop situation. Also, since *R4* and *R7* make up the collector load for *Q2*, a feedback path from the output of *Q2*, through *R2*, to the base of *Q1* is created via the ground loop, thus forming an oscillator. To remedy this situation, simply move the ground side of *C1* closer to the power supply, using a separate wire if necessary.

Voltage Regulators. Three-terminal IC voltage regulators can bring their own special problems to a circuit. The 7800 series regulator, in particular, is prone to oscillation and must be carefully bypassed. In addition, these devices tend to oscillate at the onset of current limiting. It's important, therefore, never to operate a 7800 series regulator near its maximum rated output current and to properly heat sink the device.

Shown in Fig. 5 is a circuit for a typical 7800 series voltage regulator. In the interest of good circuit design, capacitors are connected as close as possible to the IC pins and a 68-μF tantalum capacitor is connected across the device's input. In some cases, a 0.001-μF capacitor may have to be connected in parallel with a 0.1-μF capacitor to arrive at a bypass combination that really works.

Diode Oscillation. If you have a circuit that's plagued by high-frequency signals and can't find the cause in the obvious locations, look to the rectifiers in the power supply. Silicon rectifiers require approximately 0.6 volt to begin conduction. If a clean power-line sine wave is applied to a rectifier, an almost square "notch" would appear in the waveform on each side of the zero-crossing point as a result of the 0.6-volt effect. This squared-off waveform is rich in harmonics, some at audible frequencies, that may sneak into the output of an audio amplifier. Ultrasonic harmonics can also change biasing and produce other undesirable effects. Bypassing each rectifier diode in the power supply with a low-value capacitor (say, 0.001 to 0.1 μF) will smooth the edges of the waveform and alleviate the problem.

Digital Circuits. While any given TTL gate may be required to sink only 1.6 mA of current, rarely is a TTL project operating with only one gate on. A typical TTL device may contain 30 or more gates connected to a common ground bus. With all or a large portion of these gates enabled simultaneously, a large current can flow and possibly produce unwanted signals through the power/ground system.

In the typical TTL gate shown in Fig. 6, the *Q3*/*Q4* output circuit forms a "totem pole" such that when *Q3* is on, *Q4* is off, and vice-versa. However, during the switching transition, both transistors conduct for a few nanoseconds, producing a high-current spike that can exist all along the power/ground system. Any gate (or other TTL device) connected to the power-bus system can see this spike as a legitimate signal and falsely trigger. In asynchronous circuits in which the logic doesn't switch at the same time, such glitches can be disastrous to circuit operation.

Since these glitches are usually narrow-width, high-current pulses, ringing can be caused across a broad spectrum of frequencies, making bypassing difficult. The only effective way to deal with the problem is to connect a bypass capacitor directly between the voltage pins and ground of *each* IC in the system, keeping capacitor leads as short as possible. In multiple-board printed-circuit systems, each pc board assembly should be heavily bypassed at the points where power and ground enter as well, to prevent glitches generated in one assembly from travelling to the others.

When analog and digital circuits are combined on a single pc board, it's best to use separate ground traces for each type of device and connect both together at the board's main filter capacitor.

Other Kinds of Glitches. The 10 problems and solutions we've presented here by no means exhaust the glitch-producing possibilities you're likely to encounter. Doubtless, you'll run across, or have already encountered, some that aren't covered in this article. However, the great majority fall into the categories we've discussed here, and the solutions we've presented may suggest fruitful courses of action in other cases. ◇

UNDERSTANDING ELECTRONIC IGNITION SYSTEMS

Despite their seeming complexity, you can service and maintain them

BY DAVE BOWMAN*

DEVELOPED primarily to reduce engine pollution emissions, and improve performance, the electronic ignition (EI) systems found in most post-1975 American and post-1978 import vehicles, offer many additional advantages over the older breaker-point ignition systems. One of these is that the EI system, by handling a larger ignition-coil primary current, produces a higher secondary voltage throughout the engine's operating range. This voltage, 25 to 40 kV, depending on system manufacturer, assures a good spark at the plugs, resulting in improved combustion, cleaner emissions, and improved fuel economy. Moreover, since EI systems generally have fewer parts and adjustments, they are more reliable.

The Basic System. A typical electronic ignition system is shown in Fig. 1. The heart of the system is the control module, which, in addition to regulating dwell (the time during which primary current flows) determimes when to fire the coil. A triggering device contained in the module performs the latter function, replacing the breaker points and capacitor used in conventional ignitions.

Voltage step-up in EI systems is performed by an ignition coil, just as in a conventional system. Primary current flow, however, is controlled by a power transistor rather than by breaker points, which in a conventional system develop the necessary timing signals as well.

With the exception of Volkswagen, both domestic and import vehicles use a "magnetic pulse" generator as the triggering mechanism. Basically, this consists of a toothed wheel and a magnetic pickup coil, as shown in Fig. 2. The toothed wheel is called a reluctor (Chrysler), timing core (GM), or armature (Ford), while the pickup coil is called a stator (Ford), or pole piece (GM).

*Fram/Autolite

In operation, a magnetic field generated by a permanent magnet surrounds the pickup coil. As the engine turns over, the toothed wheel, driven by the engine, rotates as well. Each time a tooth passes across the end of the coil, the magnetic field collapses, generating a pulse across the coil. This, in turn, is passed to the control module and used to control the power transistor that handles coil primary current. As in conventional systems, the high voltage passes to the distributer and associated rotor, and from there to each spark plug. From the coil secondary on, the system is much like a conventional one.

Variations on a Theme. Most of the differences between EI systems are in the location and names of the parts, and troubleshooting procedures. Chrysler, Ford, Toyota, Datsun (except California 200 SX and 510 models), and Honda (except Civics and California models), have essentially the same layout—a distributor with internal pickup coil and toothed wheel, the ignition coil, an accompanying "black box" module. In General Motors cars, Honda Civics, and California Hondas, module, pickup coil and toothed wheel are housed in the distributor. Only GM 4- and in-line 6-cylinder engines have an external ignition coil. Also, GM and Honda use a "core" type ignition coil as opposed to the "can" type used by Chrysler, Ford, other imports, and conventional ignition systems. In Chrysler and some Toyota systems, an "adjustable air gap" is used between the toothed wheel and pickup coil to facilitate parts replacement.

The Datsun 200SX and 510 produced for California feature two sets of spark plugs and dual ignition coils, using two spark plugs per cylinder. Thus, the distributor of this four-cylinder model resembles that of a conventional eight-cylinder engine. This "doubling up" improves combustion so that the vehicle can meet the strict California emission standards.

Ford limits current flow through the ignition coil primary with a ballast resistor, while Chrysler uses a dual ballast—one to control current flow to the module, and the other to the ignition coil. Other manufacturers use more sophisticated limiting devices that regulate primary current as a function of engine speed. Chrysler, and some Toyota systems use an "adjustable air gap" between the toothed wheel and the pickup coil to make parts replacement and servicing easier.

Mazda's approach is similar to that of Chrysler, but is designed for faster warmup of the catalytic converter in order to reduce emissions. In this "dual timing ignition system", the ignitor (another name for the control module) advances and retards the ignition timing. When the engine is cold, a thermal switch senses the coolant temperature and turns on a timing mode that makes the engine produce more waste thus raising the coolant temperature. Once the engine reaches operating temperature, the thermal switch turns off, returning the ignition timing to normal. This also contributes to better driveability during warm-up.

Most unusual among EI systems is that used by Volkswagen. This one senses engine rotation by means of a Hall-effect device similar to that used by Chrysler in the 1978-1979 Omni and Horizon. This system contains a distributor, ignition coil, reluctor (toothed wheel), and a control module.

Inside the distributor is a Hall device (magnetically sensitive semiconductor) "biased" by a nearby permanent magnet. With the magnetic bias present, the Hall device develops an output voltage, and when the magnetic field is interrupted, the Hall output drops to zero.

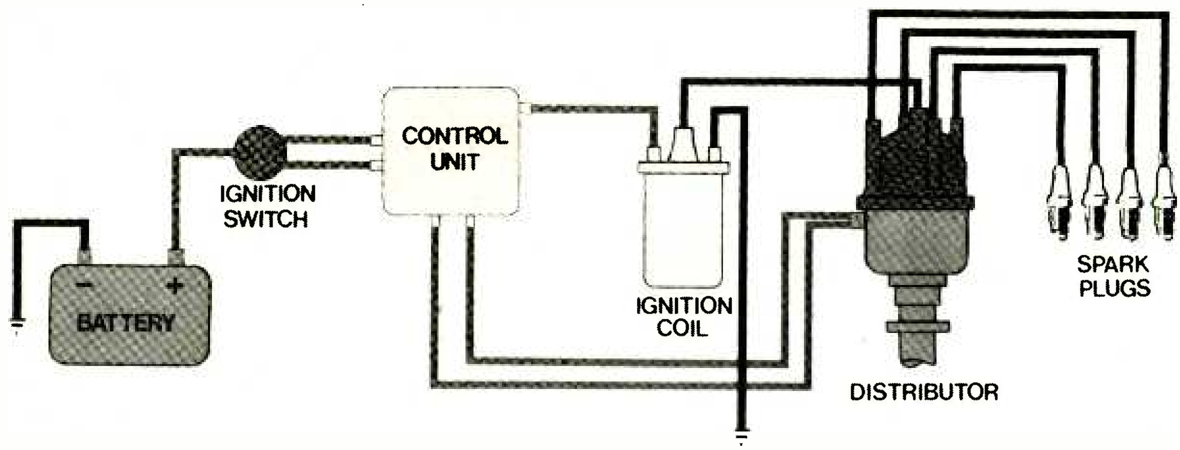


Fig. 1. Basic layout of a typical electronic ignition system. Included in the distributor are a pickup coil and reluctor.

(All artwork courtesy Fram / Autolite)

An engine-driven toothed wheel is arranged so that its teeth pass through the air gap between the permanent magnet and the Hall device. Thus, each time a tooth breaks the magnetic lines of force, the Hall device delivers a pulse that the control module uses to fire the coil.

Another interesting feature of the Volkswagen system is the Distributor Idle Stabilizer (DIS) shown in Fig. 3. This device electronically keeps engine idle speed between 600 and 940 rpm. This reduces emissions and leaves less for the catalytic converter to clean up. Periodic adjustment of idle speed and ignition timing are no longer required with the DIS.

Servicing. With the proper tools and the appropriate service manual, any experienced do-it-yourselfer can maintain and troubleshoot an electronic ignition. In fact, since these systems are not subject to physical wear, they require relatively little maintenance.

EI system service intervals vary with each auto manufacturer, therefore, it is best to consult your owner's manual for the proper maintenance schedule. However, to keep it operating efficiently, the system should be checked after each tune-up or filter change. If you are a "severe driver", or one who drives in dusty or hilly areas, travels on short stop-and-go trips, idles extensively, or tows heavy loads, your car should be serviced more frequently. Fram/Autolite surveys show that more than 84 percent of motorists fall into the severe-driving category. To check an EI system, you will need a volt-ohmmeter, timing light, nonmagnetic feeler gauge, spark plug, and service manual for your system. Tests should be made in the following order: spark (secondary circuit); current flow from the battery to the module (primary circuit); system ground; current flow through the ignition coil; and signal output from the signal generator (usually the pickup coil and reluctor).

With the exception of the first check (spark), the step-by-step procedures vary with the system. The best and safest way to perform these checks is listed in the service manual for your system. These manuals are published by car or spark-plug manufacturers and can be obtained from the manufacturers or from retail outlets.

The following procedure for checking the spark can be performed on almost all the EI systems:

1. Take a spark plug and either break the side electrode off or open the gap very wide. (Use of a spark plug prevents open-circuiting the system and possibly burning out other components.)

2. Plug the test spark plug into one of the spark-plug cable connectors.

3. (In the following procedure, use insulated spark-plug pliers, a dry rag, thick leather gloves, or anything that will act as an electrical insulator, otherwise you may get a violent shock.) Using the insulating medium, hold the spark

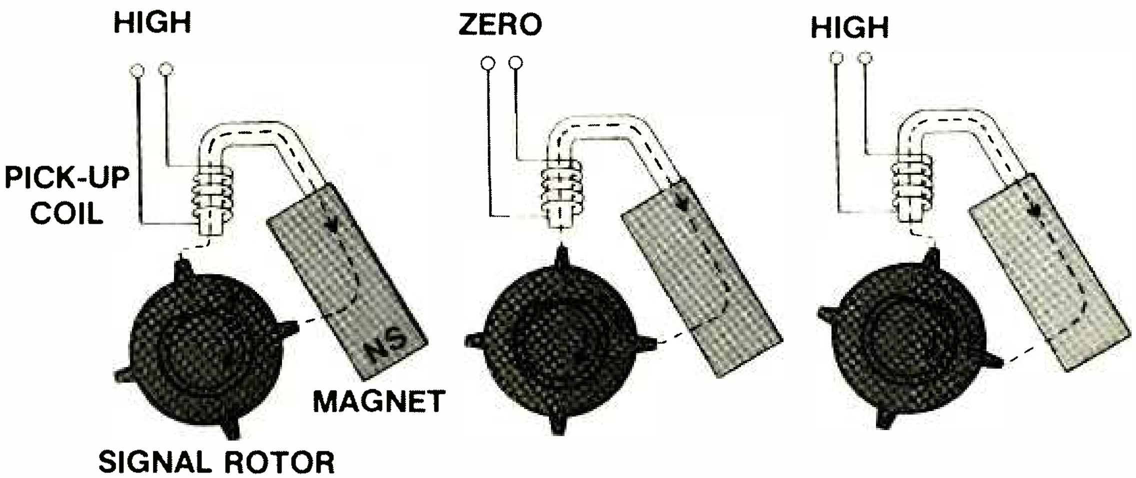


Fig. 2. The triggering mechanism in most systems consists of a magnetic pickup coil and a reluctor or toothed wheel.

plug shell (threaded end) to ground (that is, the engine block).

4. Have someone crank the engine, while you watch for a spark between the plug and ground. If you have a "healthy" spark, but the engine runs poorly, check the ignition timing and carburetion or search for vacuum leaks. If you do not see a spark, and your car is *not* a GM model with a V6 or V8 engine, perform the following test on the ignition coil:

a) Disconnect the coil wire from the center of the distributor cap.

b) Insert the test spark plug into the end of the wire just removed.

c) Using the insulating medium as before, hold the test spark plug shell (threaded end) to ground.

d) Crank the engine and watch for a spark. If a spark is observed, the problem is probably between the coil and spark plugs. Check the distributor cap, rotor, spark plugs, and spark-plug wires for cracks, corrosion, burn marks, and other signs of wear. If you see *no* spark, it is time to pull out the service manual and proceed with troubleshooting check number two—current flow from the battery to the module.

In GM cars with V6 or V8 engines, you cannot perform this ignition-coil spark check. The coils on these EI systems are housed in the distributor and cannot be checked this way. Therefore, if your GM system shows no spark after the first check, examine plug wires, distributor cap, and rotor for signs of wear.

General Checks. In addition to the trouble-shooting procedures just discussed, there are a number of other checks common to all EI systems. These include:

Spark-plug wires. The higher ignition-coil secondary voltage generated by the EI system can be hard on delicate silicone insulated wires. Check for cracks, torn boots, or brittle wires every 10,000-15,000 miles or once a year, whichever comes first. Check for intact spark-plug-wire insulation by running the engine at night or in a dark garage. If you see sparks jumping around the wires, they need to be replaced.

Battery. EI systems are more sensitive to battery condition than conventional ignition. If the battery voltage is low, or the terminals dirty, the engine may crank and fail to start. Check voltage and terminals monthly.

Wiring connections. Squeeze or rub these to be sure there are no broken wires in the connectors. Also check for corrosion in the connector terminal.

Rotor and distributor cap. Check and replace if they are burnt, cracked, corroded, or there are carbon tracks leading from the spark-plug wires to the distributor base.

Distributor advance weights. Make sure these are well lubricated and free to move. Use high-temperature lubrication sparingly.

Mechanical advance. Using a fingertip, twist the rotor on the distributor shaft. Release it and make sure the spring returns it to its original position.

Vacuum advance. Use a vacuum pump to apply vacuum to the advance unit, making sure it is not stuck, or the diaphragm ripped.

Reluctor. Make sure the reluctor (in systems using this assembly) has not become magnetized. This can be checked by contacting it with a ferrous metal object. If the reluctor attracts the object, the reluctor needs replacing.

Precautions. To avoid injury or system damage, before beginning any work on an EI system, there are a number of precautions to be taken.

Do not touch an exposed transistor while the engine is running. You could get a severe shock.

Do not work on any EI system under "wet" conditions. This includes working with wet or moist hands, standing on a wet or damp floor, or in rainy weather.

Do not unplug wiring harnesses with the ignition on. A high-voltage surge can burn out the control module.

Do not open-circuit spark plug wires (that is, don't pull off wires while the engine is running). Current is continually flowing through these wires and if the circuit is opened, the current may ground out elsewhere, usually in another, more expensive component.

There are additional precautions that are particularly applicable to each manufacturer's EI system. Be sure to read the appropriate service manuals before beginning any work. ◊

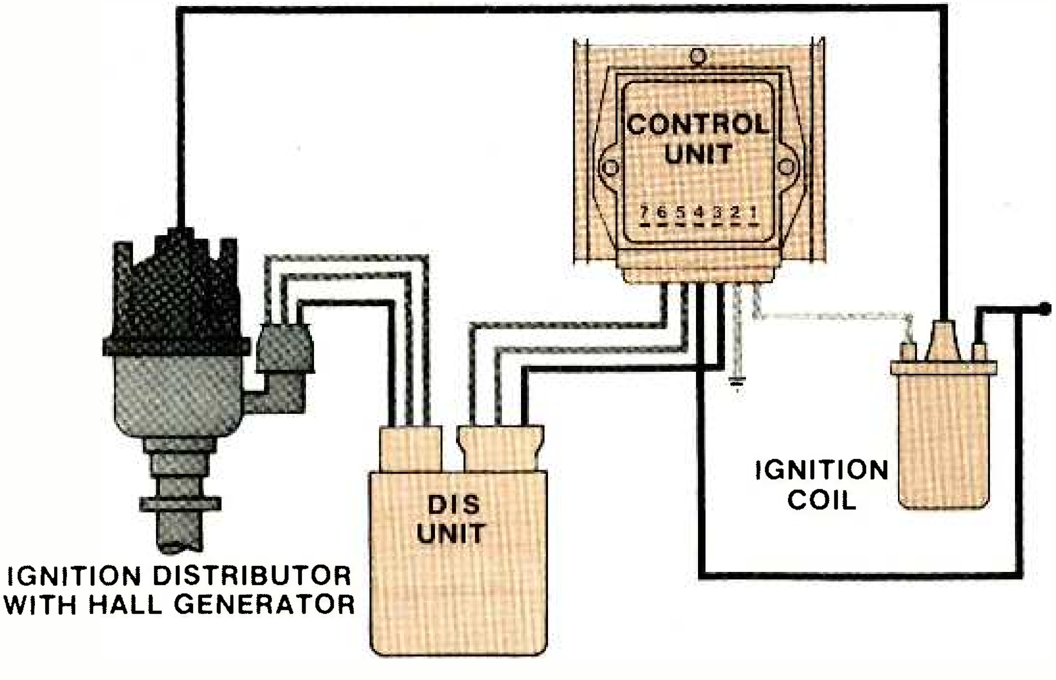


Fig. 3. Volkswagon's Hall Ignition System uses an unusual triggering mechanism and a distributor idle stabilizer.

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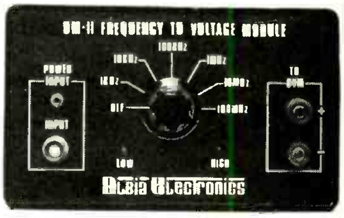

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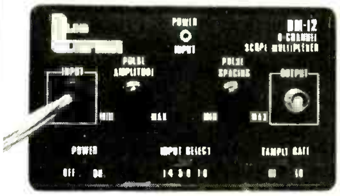

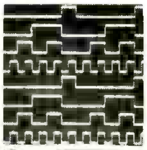

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PROTECT YOUR HOME WITH THE BURGLAR BAFFLER

Ultrareliable circuitry provides programmable, pseudorandom lighting

BY VAUGHN MARTIN

As A deterrent to burglars, turning lights on and off by means of a conventional timer has proved itself economical and practical despite some severe limitations. The first and most objectionable of these is that lights being repeatedly turned on and off at the same times daily in a predictable pattern may alert an astute, observant burglar to the unattended, mechanical switching. The "protective" system then becomes almost an invitation to drop in.

Secondly, the possible limited lifetime of a conventional light timer due to mechanical failure must be considered. Contacts, for example, may rapidly become pitted and ineffective. More subtle is the often overlooked problem of current surges that may reach the incandescent light-bulb filament and reduce its life. Should the light bulb fail while the home owner or apartment dweller is away, the protection conferred by the system evaporates entirely.

The Burglar Baffler expands upon the basically sound light-timer method and overcomes these objections. It is programmable over several days, and has provisions for pseudorandom actuations and 28-day cycling. Dependability, reliability, and longevity are enhanced by total solid-state design—even the light-controller section uses a LASCR (light-activated SCR) and triac.

Bulb life is extended by using a zero-crossing detector that prevents application of full voltage to a cold filament. Thus, the current surge and resultant thermal shock that would occur under this condition are avoided, and the likelihood of sudden filament failure is reduced.

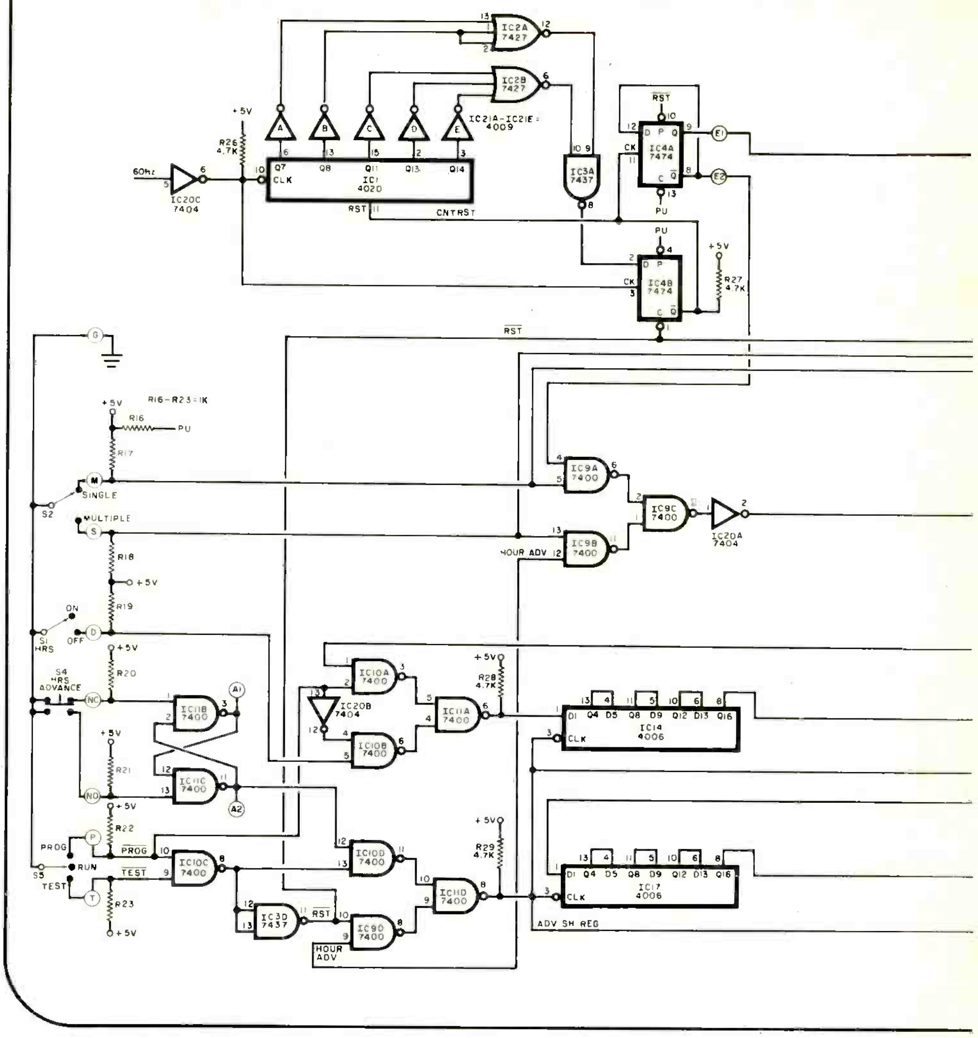
The problem of predictable switching sequences is overcome by using a pseudorandom number generator to control activation times. Shift registers, acting as simple memories, can store a program of up to four days of operator-programmable light activations, thus each day can then have a unique pattern. Likewise, the operator can program as many activations as desired.

The pseudorandom number generator (PNG), or linear sequence generator, is composed of serially connected flip-flops forming a shift register. The trick is to tap certain outputs of the shift register, apply these to an exclusive OR gate, and then feed this signal back around to the D input of the first flip-flop. When the right taps are made and the state of all binary zeros is suppressed, a sequence results that appears totally random.

This project uses three flip-flops, resulting in seven distinct states that correspond to light activation from 1/8 to 7/8 time period after the selected programmed "on" hour. Once the timer has gone through its unpredictable pattern, it recycles after 28 days.

Single or multiple activation of lights within the programmed "on" hour is also possible through a front-panel toggle switch. This adds more unpredictability to the switching sequence, since the number of activations, when in the MULTIPLE mode, is also controlled by a 3-bit PNG.

Circuit Operation. The overall block diagram is shown in Fig. 1. The 60-Hz driven counter is mainly composed of *IC1*, a CMOS binary counter consisting of 14 serially connected, negative-edge triggered flip-flops having a common reset. The reset provides a convenient means of recyling *IC1*. The *IC1* outputs are selected to produce a count of 13,504—which, in terms of the 60-Hz power-line fre-



quency, converts to 3 minutes and 45 seconds, or 1/16 hour. After 13,504 pulses have been counted, the counter will force outputs *Q7*, *Q8*, *Q11*, *Q13*, and *Q14* high.

These signals are buffered and inverted by *IC21A* through *IC21E*. The low outputs from the inverters are again inverted by *IC2A* and *IC2B*, while *IC3A* provides another inversion. The output of *IC3A* is applied to flip-flop *IC4B* then to flip-flop *IC4A* which acts as a divide-by-two toggle. At this point, the period of the square wave is 1/8 hour. This signal is applied to flip-flops *IC5A*, *IC5B* and *IC6A* which form a divide-by-eight ripple counter, called the hour subinterval counter. This circuit recycles every hour, is advanced by one count every 1/8 hour, and applies the three flip-flop's Q outputs to exclusive-OR gates *IC8A*, *IC8B*, and *IC8C*.

An exclusive OR gate is a digital comparator. That is, when both inputs are either simultaneously high or low, a logic low output results. Thus, during the hour, each time an eighth-hour passes a different binary number from 000 to 111 is represented by the outputs of *IC5A*, *IC5B*, and *IC6A*. This three-bit number is compared with the three-bit number representing the output of the PNG (*IC6B*, *IC7A*, and *IC7B*). The three exclusive-OR gates have all logic low outputs when the two 3-bit numbers match. No other combination will force three-input NOR gate (*IC2C*) high, so that it clocks flip-flop *IC12B*, which transfers what appears at its data (D) input to its Q output. During operation in the MULTIPLE mode—operation in the SINGLE (*S2*) mode was just described—the hour subinterval counter's output is inhibited, but it still advances each 1/8 hour. However, the hour subinterval counter's 3-bit word is not compared with that of the PNG, which is advanced every 7½ minutes (1/8 hour) from the $\overline{Q}$ output of flip-flop *IC4A*. Pull-up resistor *R17* causes a logic high to be applied to pin 1 of *IC13B*. The other two inputs to this IC are the MSB of the PNG and the output of the shift registers (IC's 14 to 19). When the MSB of the PNG is high, and if the hour represented in the shift registers is a programmed "ON" hour (indicating a desired light activation during that hour), the circuit will cause a light to come on.

Shift registers (*IC14* to *IC19*) represent a capability of storing a four-day, or 96-hour, period. Control of 1, 2, 3, or 4 days requires 2, 3, 5, and 6 shift registers respectively. Each shift register represents 16 hours through its 16 bits, and equating an exact hour per bit is derived by clocking these serial shift registers exactly once per hour by the hour subinterval counter. Note that the HOUR ADV line (pin 9 of *IC6A*) is also applied to *IC9D* which, in turn, gates this square wave to the clock inputs of shift registers *IC14*-*IC19*. Taps are provided via *S6*, at multiples of 24 bits each representing the exact duration of one day multiples, providing means of altering the number of days that can be programmed. If an exact nonvariable fixed duration is required, hardwire *S6* points 1 through 4 and F.

The shift register memory is loaded with highs and lows representing hours ON and OFF respectively by input gating, which operates as follows: The PROG or TEST position of *S3* drives *IC10C* which inhibits *IC10D*, which in turn causes the shift registers not to advance. While *S3* is in the PROG position, progamming occurs. Advancing the hour is accomplished by depressing HR ADV momentary contact push-button switch *S4*. If an hour is desired to be one during which the lights will come on, hours ON/OFF toggle switch *S1* is placed in the ON position, or conversely in the OFF position if the opposite is desired. Advancing causes gates *IC11C* and *IC11B* to apply a pulse to *IC10D* which, in turn, causes *IC11D* to toggle the shift register's clocks. This is accompanied by the ON/OFF switch applying a logic high through gates *IC10B* and *IC11A* to the data input of first shift register *IC14* while in the ON position. While in the OFF position, a logic low is applied to the shift register input.

SINGLE/MULTIPLE mode switch *S2* causes the AND-OR-INVERT combination of gates *IC9A*, *IC9B*, *IC9C*, and *IC20A* to either make the digital comparison with exclusive-OR gates *IC8A*, through *IC8C* in the single mode, or make no comparison in the MULTIPLE mode. In the MULTIPLE mode, the MSB of the PNG activates the light if the shift register's output through inverter *IC20D* is a logic high corresponding to an ON hour programmed in. If a logic low, corresponding to an OFF hour, has been en-

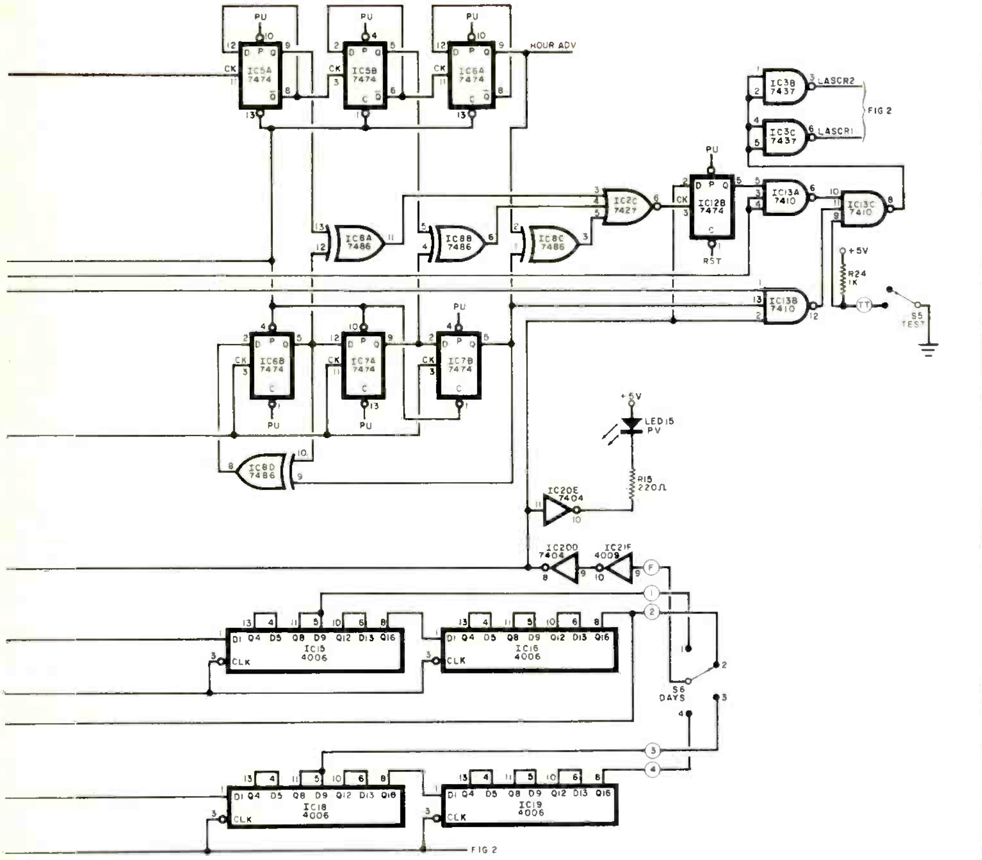


Fig. 1. Schematic diagram of the complete circuit for the Burglar Baffler.

tered, no activation will occur because one of the three inputs to gate *IC13B* will be low.

This randomness of the hour's starting time as well as the randomness of the number of multiple activations makes it unlikely that a lurking burglar will determine that the lights are automatically switched. Further randomness is added by a purposely induced error of approximately 2½ minutes per week because of the inexact division of the CMOS counter. That is, the counter recycles after 13,504 counts rather than the 13,500 counts which would be exactly one-sixteenth of an hour.

The timer requires regulated +5 V dc at 500 mA, and a 60-Hz (clock) source. In the power supply shown in Fig. 2, diodes *D1* through *D4* form a full-wave bridge rectifier, capacitor *C7* is the filter capacitor, and *IC24* is the +5-V voltage regulator. Capacitor *C6* bypasses any ripple that might appear at the +5-V output. The network of *R39* and *C6* across the *T1* primary keeps ac line transients out of the transformer.

The 60-Hz clock circuit that provides system timing is derived from transistor *Q1*, and components *R36*, *C5*, *D9*, and *R25*. The 17-volt peak voltage from the *T1* secondary is passed through *R36* and *C5*, which provide a low-pass filter rolling off at 60 Hz to reduce transients. The ac voltage applied to the base of *Q1* generates a square wave across *R25*.

The ADV SHREG line that drives shift registers *IC14* through *IC19* also drives divide-by-12 counter *IC22* (Fig. 2). In turn, this counter drives 4-to-16-line decoder *IC23*. The 12 outputs from this IC drive 12 LEDs to indicate 12 hours, while the overflow from *IC22* drives *IC12A* via an inverter. The Q and $\overline{Q}$ outputs of this IC drive either the AM or PM LED indicators. Each hour LED will glow as the operating time is selected. The AM or PM indication is automatic.

Ac Activation. When any of the three inputs to *IC13C* (Fig. 1) is low, the output is high. This high output is inverted by *IC3B* and *IC3C* which can sink twice as much current as a normal gate. The current that they are sinking is from two LEDs, one in *LS1* and the other in *LS3* (Fig. 2). These LEDs are contained within a six-pin package along with a light-sensitive SCR. As gates *IC3B* and *IC3C* go low, they cause their associated LEDs to glow. This triggers the light-sensitive SCRs. These two 200-volt SCRs are connected in series to improve system reliability. When activated, the SCRs gate triac *TR1* enabling it to permit ac power to flow to the electrical device plugged into the Burglar Baffler at *SO1*.

The circuit can control up to 500 watts mainly in the form of a resistive

PARTS LIST

C1 through C4 — 0.1-μF, 15-V ceramic/Mylar capacitor
C5 — 0.1-μF, 25-V ceramic/Mylar capacitor
C6 — 1.0-μF, 15-V ceramic/tantalum capacitor
C7 — 200-μF, 35-V electrolytic
C8, C9 — 0.1-μF, 400-V capacitor
D1 through D4, D9 — 1N4001
D5 through D8 — 1N4004
IC1 — 4020 14-stage binary ripple counter
IC2 — 7427 triple 3-input NOR
IC3 — 7437 quad 2-input NAND
IC4 through IC7, IC12 — Dual D flip-flop
IC8 — 7486 quad 2-input EXOR
IC9 through IC11 — 7400 quad 2-input NAND
IC13 — 7410 triple 3-input NAND
IC14 through IC19 — 4006 18-stage shift register
IC20 — 7404 hex inverter
IC21 — 4049 hex inverter
IC22 — 7492 divide-by-12 counter
IC23 — 74154 4-to-16-line decoder/demultiplexer
IC24 — LM340T-5.0 5-volt regulator
LED1 through LED14 — Red LED
LED15 — Green LED
LS1, LS2 — Light-activated SCR (H11C1, 2, or 3, GE)
Q1 — 2N2222 transistor
R1 through R15 — 220-Ω, ¼-W resistor
R16 through R25, R41 — 1-kΩ, ¼-W, 5% resistor
R26 through R29 — 4.7-kΩ, ¼-W resistor
R30, R31 — 270-Ω, ¼-W, 5% resistor
R32, R33 — 56-kΩ, ¼-W resistor
R34, R35 — 270-kΩ, ¼-W resistor
R36 — 27-kΩ, ¼-W resistor
R37 — 100-Ω, ½-W resistor
R38, R39 — 47-Ω, ½-W resistor
R40 — 1-Ω, 5-W, wirewound resistor
SO1, SO2—Ac chassis receptacle
S1, S2, S5 — Spdt switch
S3 — Spdt switch, center off
S4 — Spdt pushbutton switch
S6 — 4-pole rotary switch
T1 — 12-V, 1-A transformer
TR1 — 8-A triac

load. Small transistorized radios and tape recorders can still have their inductive (transformer) input powered effectively by the Burglar Baffler.

Construction. The Burglar Baffler can be built using any desired construction technique. The 12 LEDs (*LED1* through *LED12*) are arranged in a circle with a press-on type number identifier for each LED. The AM and PM LEDs (*LED13* and *LED14* respectively) are mounted within the circle as desired with *LED15* (PV), the green LED.

Light test switch *S5*, DAYS switch *S6*, HR ADV switch *S4*, hours ON/OFF switch *S1*, SNG/MULT (single-multiple) switch *S2*, and PRG/RUN/TEST (program/run/test) switch *S3* are also mounted in suitable position on the front panel.

The power supply, including the transformer, regulator, triac, and output sockets are chassis mounted.

Once assembled, the circuit can be tested using conventional digital techniques. If the 60-Hz circuit is working, there should be outputs at test points *E1* and *E2* at *IC4A* (Fig. 1) every 7½ minutes. Since this is a long time to wait for a test, remove the *IC4A* connections from *E1* and *E2*, and connect the two test points to *A1* and *A2* at *IC11B*. Operating HR ADV switch *S4* will now provide a faster timing signal. Switch *S5* can be operated to ground to test the power control circuits.

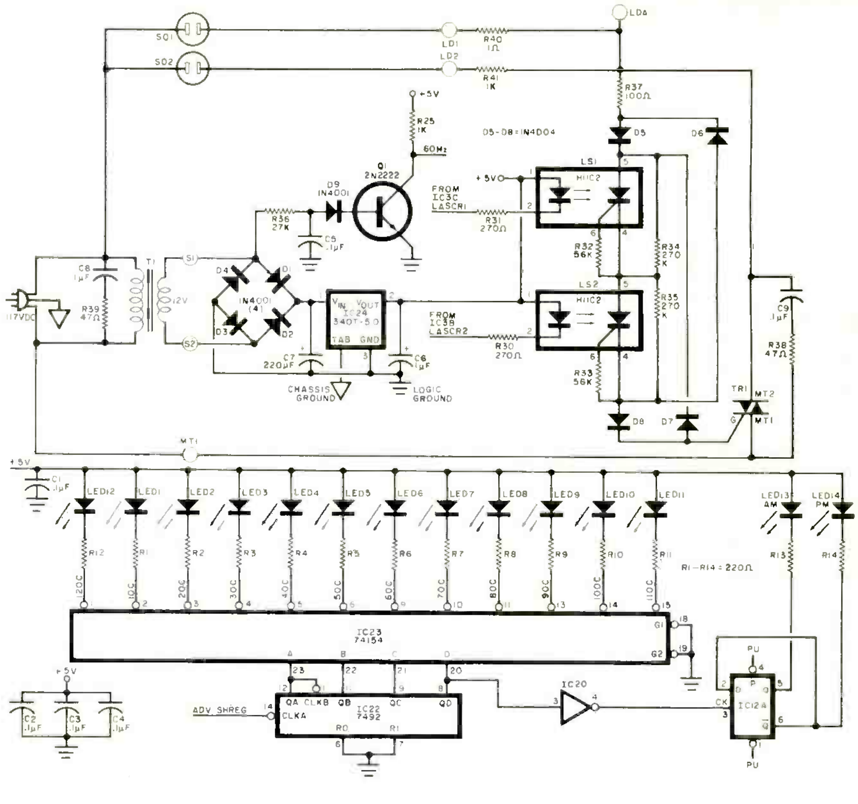


Fig. 2. Schematic diagram of the power supply circuit and the counter and LED driver circuits.

Operation. The hours are advanced by depressing the HR ADV switch and that particular hour LED will be lit if the hour ON/OFF switch is in the ON position. Conversely, if the OFF position is selected, the hour advanced to will have no light activation within that hour.

The TEST pushbutton switch is used to test the triac and the associated ac activation circuitry. Do not worry about damaging the light bulb in this mode, because, even in this mode, the timer is still protected by the zero-crossing detector.

The DAYS 1,2,3,4 switch selects how much memory is to be used. If one day is selected, 24 bits will be enabled, two days, 48 bits; etc., up to four days or 96 bits. This corresponds to one bit per hour.

When the PRG/RUN/TEST switch is set to the PRG position, the timer may be programmed to control light activations of each and every hour of the number of days selected. Programming consists of repeatedly depressing the HR ADV switch while setting the ON/OFF switch to the position you desire with respect to the light activations within that hour. For example, if you preset 11 AM and the ON/OFF switch is in the ON position, during this hour the light will come on. When in the PRG mode you need not worry about the program previously entered in the shift register memory. The new program "pushes" out the old data during this function.

Once programmed, the memory can be examined. This is accomplished by placing *S3* in the TEST position. If four days have been selected, you must have used all 96 hours. Using any fewer will cause a start at an incorrect time. In the TEST position, depress the HR ADV pushbutton 96 times, noting that the PV (program verification) LED comes on to indicate if a particular hour will experience a light activation. Once the program is entered and checked, *S3* is placed in the RUN mode to start the timer.

Programming Example. Assume it is 10 minutes before 5 PM. Depress the HR ADV pushbutton twice until the LED indicates 7 PM, and place the ON/OFF switch in the ON position. This means that at 7 PM or sometime during that hour, the light, will come on. Press the HR ADV pushbutton twice until 9 PM is indicated. That will cause the light to come on at 8 PM and then turn off sometime during the 9 PM hour if the ON/OFF switch is in the OFF position. Operating the HR ADV switch twice will cause the next two hours to be off. The system is now at 11 PM, and we wish the light to be on during the next two hours. Place the ON/OFF switch in the ON position, then press the HR ADV pushbutton twice. We wish the light to remain off between 1 AM and 7 PM. To do this, place the ON/OFF switch in the OFF position and then just operate the HR ADV pushbutton 18 times, so that the next 18 hours will remain off. This same pattern can be entered for the second day.

Since the timer uses a pseudorandom number generator to control the times during the selected hour the lights come on and off, as well as the number of times they come on within that hour, the second day-light pattern will be somewhat different. To verify the program, set the PROG/RUN/TEST switch to the TEST position and then depress the HR ADV pushbutton while watching the LEDs come on around the clock face. When these numbers, in conjunction with the PM or AM lights, coincide with a PV LED on, it indicates the hours in which the light will come on. ◊

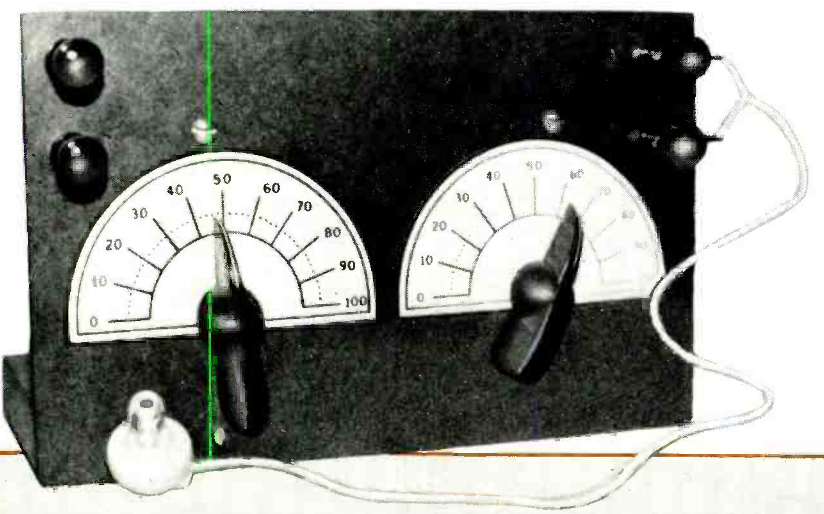
BUILD AN OCEAN-SPANNING CRYSTAL RECEIVER

DX reception with a totally passive circuit

BY HOWARD D. LASH

ALTHOUGH most people think of the crystal set as a simple radio suitable only for short-range reception, a properly designed crystal set can receive signals from thousands of miles away. The Ocean-Spanning Crystal Receiver covers the 49-, 41-, and 31-meter international broadcast bands and can be modified for other frequencies. It employs no means of signal amplification. The author's prototype, in use near Chicago with a 150-foot longwire antenna and an earth ground, regularly provides good reception of Radio South Africa, the BBC, Deutsche Welle, and other shortwave broadcasters. Although the project doesn't generate an ear-splitting audio output and lacks the microvolt-level sensitivity and sharp selectivity of today's communications receivers, it will perform well with a good antenna and earphones.

About the Circuit. The Ocean-Spanning Crystal Receiver is shown schematically in Fig. 1. Signals picked up by the external antenna are applied to binding post *BP1* and coupled to the receiver's tuned circuit, air-core inductor *L1* and the *A* portion of dual-section variable capacitor *C2*, by dual-section variable capacitor *C1*. Section *B* of this capacitor couples the bottom of the tuned circuit to binding post *BP2*, which is connected to a solid earth ground.



Tuned circuit *L1C2A*, which is adjusted for resonance at the frequency of interest, is inductively coupled to air-core inductor *L2*, forming an r-f transformer that has a tuned primary and variable coupling between its windings. Signals appearing across the secondary are demodulated by germanium detector *D1*, a 1N34A diode connected across binding posts *BP3* and *BP4*. Earphones *TR1*, connected across binding posts *BP5* and *BP6*, have high-impedance elements that transduce the demodulated waveform into an audio output.

Capacitor *C2B* isolates the tuned circuit somewhat from ground to make it more selective. Additionally, because the capacitive reactances of *C1A*, *C1B* and *C2B* are smaller at high frequencies, there is less likelihood of signals from medium-wave broadcasters reaching the detector. Variable capacitor *C1* and the variable coupling between *L1* and *L2* allow adjustment of selectivity. The main function of r-f transformer *L1L2*, however, is to minimize shunting of the tuned circuit by the detector circuit. Connecting the network *D1TR1* directly across *L1* would result in considerably lower volume of received signals.

Construction. The r-f transformer should be assembled first. Inductor *L1* should be wound on an electrically inert, thin-walled cylindrical form (preferably a celluloid or plastic tube) measuring 5 inches long and 2 inches O.D. An acceptable substitute form can be made as follows: Cut a sheet of thin poster board 5′ by $6\frac{3}{4}$″. Gently curl up the sheet into a cylinder 5 inches long with an outer diameter of 2 inches, allowing $\frac{1}{2}$ inch for overlap. With the glossy edge facing the outside, apply thin coats of rubber cement on the two edges that will touch. When the cement has dried, press the edges together, being careful not to crush the cylinder. Now squeeze the cylinder gently until it is completely round.

In constructing *L1*, refer to the photos, where *L1* is the coil wound using light-colored wire. Drill two $\frac{1}{8}$-inch mounting holes in the coil form $\frac{3}{8}$″ in from each edge. Make a tiny pinhole 1″ in from one edge of the form, noting its correct position in relation to the mounting holes. Push one end of a 83-inch length of coil wire through the hole from the outside of the form, and pull it out through the near end of the form. Number 22, double-cotton-covered (d.c.c.) wire is the best to use for *L1* and *L2*, but it might be difficult to obtain. Enameled wire of the same gauge can be used instead.

Allow at least 8″ of wire to extend out through the end of the coil form. Wind $10\frac{1}{2}$ turns of No. 22 d.c.c. wire or $9\frac{1}{2}$ turns of No. 22 enameled wire onto the form. Now cut the wire 8 inches beyond the end of the winding. Make another pinhole in the form at the end of the winding, insert the wire, and pull it out through the same end as before. Temporarily hold the winding in place with a few strips of celluloid tape, then apply a little household cement to the edges of the winding to secure it in place. When the cement has dried, remove the tape and set the completed *L1* aside.

The coil form for *L2* is similar to that for *L1*, but is $1\frac{1}{2}$″ long and has an *inside* diameter of $2\frac{1}{8}$″. A substitute coil form can be made in the

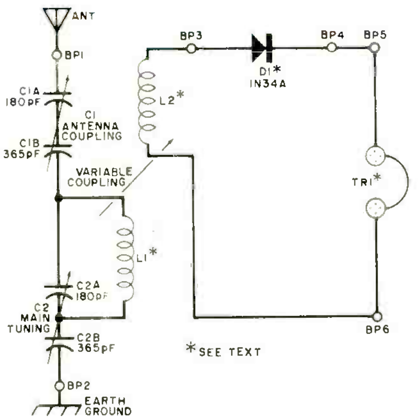


Fig. 1. Schematic diagram of the circuit for the Crystal Receiver.

same manner as for *L1*. Cut the poster board into a strip 7¼" by 1¼".

The relative sizes of the coil forms permit *L2* to slide freely on the form of *L1* and over its windings, thus providing variable coupling. If *L2* is a little large, tape can be applied to opposite sides of the form of *L1* to build it up until there is just a slight amount of friction between the two forms.

When the desired sliding action has been obtained, remove the form of *L2* from *L1*. Measuring ¼" back from one edge of the form, wind 30 turns of No. 22 d.c.c. or enameled wire. Make sure that the coil is wound in the same direction as *L1*. Having allowed 6" of loose wire on each end of the coil for connections, secure the coil with tape and cement the edges as was done for *L1*. When the cement has dried, slide the form of *L2* onto that of *L1*.

All receiver components mount on a 5" x 8" panel ⅛" or ¼" thick. Acceptable materials to use for the panel are fiberboard, plastic or bakelite. Do not use a metal panel, and do not enclose the receiver in a metal cabinet. It can be mounted in a wooden or plastic cabinet if desired, but easy access must be maintained so that the coupling between the windings of the r-f transformer can be adjusted. Perhaps the easiest method of construction is simply to fasten the panel to a 4-inch x 8-inch x ¾-inch wooden base to hold it upright. The wooden base can be finished according to your preference, but a fiberboard panel should not be painted because the proximity of carbon pigments can degrade the performance of the Crystal Receiver.

When drilling the front panel, follow the guide shown in Fig. 2 exactly. The exact positions of your variable capacitors' mounting holes may differ from those of the capacitors used by the author, so drill the holes to suit the capacitors you have. The holes for the shafts will be correct in any case.

Now mount all the parts except for the r-f transformer and detector diodes, using the photos of the prototype as guides. Note particularly how the binding posts and circuit tie-points are positioned. The prototype employs Fahnestock clips in place of binding posts *BP3* and *BP4* to secure diode *D1*. Part of the Fahnestock clips had to be filed away for adequate clearance of the mounting bolts. Fahnestock clips can also be used in place of *BP1*, *BP2*, *BP5* and *BP6*.

The use of Fahnestock clips to secure *D1* is to facilitate substitution of one diode for another. Not all diodes perform equally well, especially at high frequencies, even ones having the same part number. The capacitor tuning knobs can either be vernier types or pointer types, the latter requiring separate dial scales.

When all parts have been mounted, interconnect them with No. 14 copper wire, according to the schematic diagram. Keep each wire as far away from other wires and receiver components as possible.

Now mount the spacing nuts and the r-f transformer onto the bolts so that *L1* is close to the detector diode. Then put one more nut on each of the transformer's mounting bolts to hold it in place. Finally, solder the coil wires to the appropriate places, cutting off all excess wire. Don't cut the leads of *L2* too short or it won't be able to slide completely across the form of *L1*. Recheck all connections against the schematic diagram.

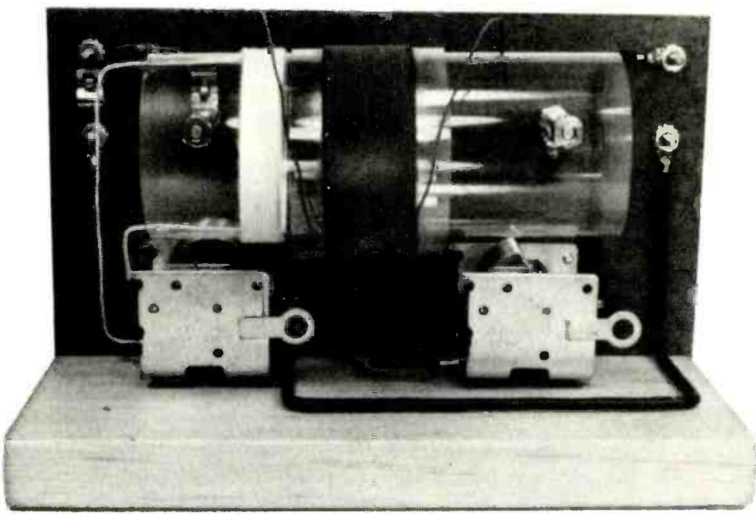
PARTS LIST

- BP1 through BP6—Binding posts
- C1,C2—Dual-section (365-pF and 180-pF), air-dielectric variable capacitor
- D1—1N34A germanium diode (see text for selection procedure)
- L1—10½ turns of No. 22 d.c.c. wire or 9½ turns of No. 22 enameled wire wound on a 5-inch long, 2-inch O.D., air-core cylindrical form.
- L2—30 turns of No. 22 d.c.c. or enameled wire wound on a 1½-inch, 2⅛-inch I.D., air-core cylindrical form.
- TR1—High-impedance crystal earphone or magnetic headphones (see text)
- Misc.—Antenna, earth ground, No. 14 solid copper wire, two vernier control knobs or pointer-type knobs and dial scales, solder lugs, suitable front panel and base or nonmetallic enclosure, suitable hardware, solder, cement, etc.

Note—Calibrated (0 to 100) tuning-capacitor dial scales for use with 1¼-inch pointer-type knobs are available for $1.00 for three dial scales from Howard D. Lash, 19 East 157th Street, South Holland, IL 60473.

Set-Up and Use. For best reception, an antenna mounted outdoors, in the clear, and as high as possible should be used. Good results have been obtained with a longwire antenna. Dimensions of the longwire are not critical; the longer the better, with integral multiples of a half-wavelength at the frequency of interest being the best. The usual precautions against lightning strikes and against contact with high-tension wires should be observed.

Except where shortwave reception is extremely poor, you should be able



Rear view of author's prototype shows construction of r-f transformer. L1 is light wire, L2 is dark.

to receive some shortwave stations with this radio. An indoor antenna should be as high and shielded by as little structural metal as possible. Connect the free end of the antenna lead-in wire to *BP1* and another wire from *BP2* to a good earth ground.

Garden-variety magnetic headphones are unsuitable for this receiver. The only magnetic headphones that work well with this circuit have extremely high input impedances, as, for instance, Trimm "Featherweights," whose impedance is rated at 24 megohms.

For several reasons, however, crystal earphones are the transducers of choice. They are cheaper, more readily available, and, above all, much more sensitive than magnetic headphones. Magnetic headphones, however, do attenuate background room noise—which can enhance the intelligibility of received signals.

If the crystal earphone or pair of magnetic headphones you obtain has a cable terminated with a two-conductor phone plug, cut off the plug and solder pin plugs to the conductors instead. Then attach the pin plugs to *BP5* and *BP6*.

Gather a number of germanium diodes and select one, connecting it between *BP3* and *BP4*. Use this as a detector in your first listening session, while experimenting with control settings to familiarize yourself with receiver operation. Shortwave reception in the 49-, 41- and 31-meter bands is generally best at night.

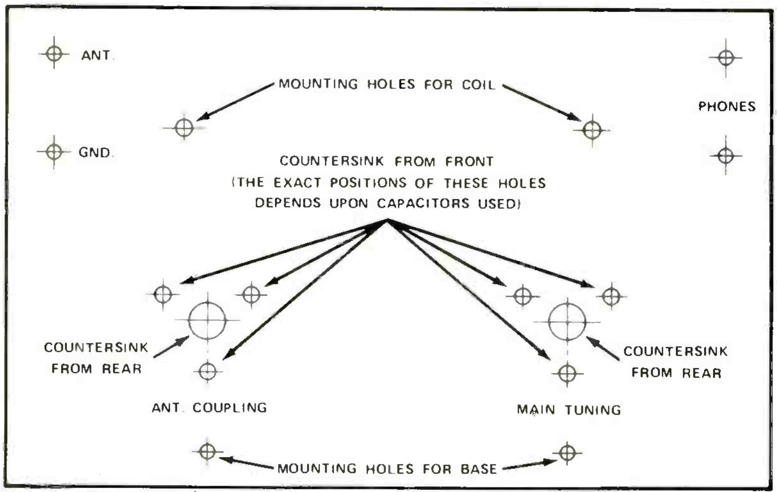
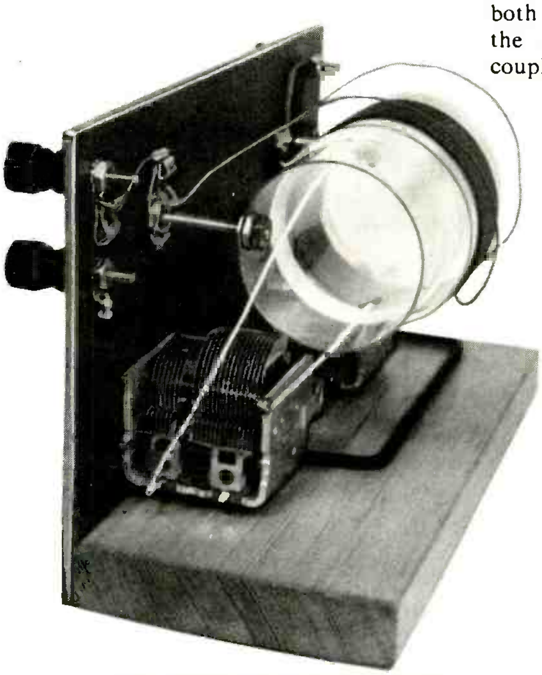


Fig. 2. Half-size drilling guide for front panel. All holes are 9/64 inch except two for capacitor shafts. These are 3/8 inch.

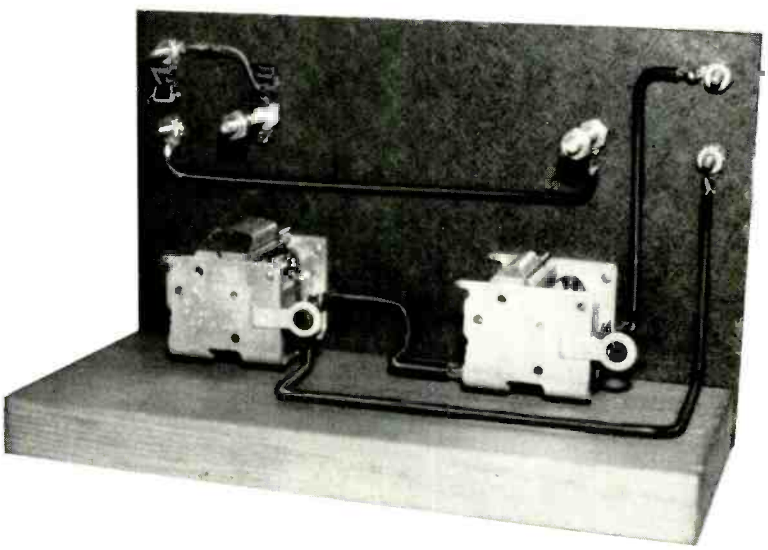
There is a certain amount of interaction between adjustments of the tuning capacitors and of the coupling between the windings of the r-f transformer. (The main tuning knob is the one that controls *C2*.) Decreasing the coupling between *L1* and *L2* (by moving *L2* away from *L1*) shifts the control range of *C2* upward in frequency. It also decreases signal volume and increases receiver selectivity. Reducing the effective capacitance of antenna coupling capacitor *C1* has similar effects. Appropriate adjustments of *C1* and the coupling between *L1* and *L2* will, thus, optimize tuning range, signal volume, and selectivity.

As a guide, employ minimum interwinding coupling and capacitance (of both *C1* and *C2*) for initial tuning of the 31-meter band and maximum coupling and capacitance for initial tuning of 49 meters. The settings for 41 meters will be between these extremes. The antenna employed, the effectiveness of the earth ground, and the wire used in winding the coils all affect these adjustments. Often, a number of different combinations will tune the same station; choose (and log) the combination that yields the best results. When you have developed a feel for tuning the receiver, try a number of germanium diodes and select the one that performs best. A station on the 31-meter band is best for this test, with one on the 41-meter band as second choice.

The Ocean-Spanning Crystal Receiver is now optimized for shortwave reception. Although it can't compete with a triple-conversion superhet, it can, in light of its simplicity, deliver amazing results. ◇



View showing how transformer and variable capacitors are mounted.



Back of receiver with r-f transformer removed. Connections between components are with No. 14 solid copper wire.

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

A Potpourri of Developments

SOLID-STATE developments in the United States and abroad are occurring at such a rapid pace that it's difficult to keep up with them. This month, we'll examine a potpourri of such events, some recent and others more dated but generally overlooked.

New Speech Synthesis. Machines, games and computers that speak are about to become commonplace. Many new speech-synthesis products are either available now or soon will be. One such development is Speech 1000, a single-board synthesizer containing 458K of on-board ROM and that is capable of generating 200 to 300 seconds of continuous male or female speech. The system is controlled by an Intel 8085A eight-bit microprocessor. At some $1,200 in single-unit quantities, the price is well above what typical experimenters and magazine columnists can afford. The cost breaks down to $4 to $6 per second of speech.

Most of us would never think of exchanging $1,200 for five minutes of speech, machine-generated or otherwise, but the trend in speech synthesis is clear. The quality of such speech will continue to improve, and hardware prices will continue to fall. You can obtain more information about Speech 1000 by writing to the manufacturer, Telesensory Systems, Inc., 2626 Hanover Street, Palo Alto, CA 94304.

On-Chip BASIC. National Semiconductor has made an important advance in microcomputer technology by loading its version of Tiny BASIC into 2500 bytes of on-chip ROM in the INS8073 eight-bit microcomputer chip. A complete computer can be assembled by connecting a terminal and at least 256 bytes of RAM to the chip.

In a typical application, a BASIC program specifically developed for the INS8073 is loaded into an external ROM in the form of ASCII characters. The microcomputer is then used as a dedicated controller or processor. Program execution time of the INS8073 is slower than microcomputers programmed in machine language, but the on-chip BASIC considerably speeds up software development. As you may know, the time and expertise required to develop software for most microcomputer applications usually costs far more than prototyping the hardware.

The INS8073 includes a variety of features which greatly simplify its use. For example, it includes on-chip firmware that allows simple serial interfacing with RS-232-compatible terminals. Also included is automatic program execution following power application or reset. Simplified program editing and debugging are an integral feature of the on-chip Tiny BASIC.

The INS8073 sells for $40 in single-unit quantities. You can obtain more information about this important new chip by writing to the National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051.

Digital Vector Generators. Analog Devices, Inc., has announced what it believes to be the first commercially available digital vector generators. These devices are actually trigonometric multipliers. In operation, an ac or dc analog reference signal is applied to the device's input terminal. Simultaneously, a 12- or 14-bit digital code signifying the magnitude of angle is applied to the device's digital inputs. The generator then synthesizes the product of the reference input and the sine of the digitally coded angle, and the product of the reference input and the cosine of the digital angle. These represent the *x* and *y* components of the reference input.

Two versions of these new vector generators are available: Models DTM1716 and DTM1717. Both devices can be considered to be dedicated analog computers which solve for $V_{IN} \sin \theta$ and $V_{IN} \cos \theta$. In addition to performing various analog-computer functions, they can be used to rotate the coordinates of an oscilloscope display. They can also convert an X-Y recorder into a polar plotter. Still another application is the production of novel oscilloscope displays and various forms of video art.

You can obtain additional information by writing to the company at Route One Industrial Park, P.O. Box 280, Norwood, MA 02062.

Microminiature DIPs. The November 1980 installment of this column included a photograph (Fig. 3, page 100) of a new microminiature IC package available from Signetics. The new package, which has been designated "SO" by Signetics, is only one-fourth the size of a standard 8-pin miniDIP.

It turns out that the SO package has

solid-state developments

been around a long time. Philips Corp. has used similar packages for discrete components since 1967. When Philips began manufacturing custom chips for the digital watch industry in 1971, the SO package was selected to house the watch chips.

What is new about the SO package is the wide range of analog chips now available in it. Many different op amps, timers, voltage comparators and other popular chips are now available in SO packages having from 8 to 16 pins. Prices for SO chips are higher than DIP versions, but they are certainly reasonable. Here, for example, are the single-quantity (1-24) prices for some of the most popular SO chips:

Type	Function	Cost ($)
LM301AD	High performance op amp	.86
LM311D	General-purpose comparator	1.02
NE555D	Timer	.86
NE556D	Dual timer	1.10
NE5534D	Low-noise op amp	1.74
NE5044D	Seven-channel RC encoder	2.02
NE5045D	Seven-channel RC decoder	1.72
μA741CD	General-purpose op amp	.84
NE565	Phase-locked loop	1.78
MC1408-8	D/A Converter	2.54

Recently, I spoke with Joe Resendes, SO Program Manager for Signetics' Linear Division. He informed me that Signetics will consider packaging in the SO DIP virtually any of its linear chips for which there is sufficient demand. Incidentally, Joe is now preparing an application note which will describe how to use reflow soldering to attach SO chips to pc boards.

Many of Signetics' digital chips have also been made available in the SO package. Approximately 80 to 90 percent of the U.S. Philips Corporation's line of LOC-MOS 4000 series is now available this way. These chips are manufactured in Europe. Many of Signetics' LS integrated circuits are also available in SO packages.

You can obtain small quantities of SO chips from local Signetics distributors. For more information about the entire SO line, write to the company at 811 E. Arques Ave., Sunnyvale, CA 94086.

Remote-Control Chips. In the March 1981 column, I described several new remote-control encoder and decoder chips available from Signetics. Among them are the NE5044 and NE5045, which are now available in miniature SO packages as described above.

You can buy these chips from Signetics distributors, but they are also available by mail order from Ace R/C, Inc., Box 511, 116 W. 19th Street, Higginsville, MO 64307. Ace publishes an interesting catalog filled with unusual and hard-to-find model-airplane R/C equipment and parts. The price of the catalog, which is refundable on your first order, is $2.00. ◇

HOBBY SCENE

By John McVeigh, Technical Editor

S-100 Bus Information

Q. ***I am a computer hobbyist who wants to build an S-100-bus-compatible computer. However, I have been unable to obtain a detailed diagram of the S-100 bus. Can you provide me with one or tell me where I can get one?—Mark Shepard, Salem, OR***

A. There isn't enough space allotted to this column to contain an S-100-bus diagram. However, I suggest you procure a copy of *The S-100 Bus Handbook* by Dave Bursky. This large-format, softcover book contains 280 pages of information about the S-100 bus and includes bus diagrams and schematics of microcomputer circuits that are compatible with that bus. It costs $12.95 and is published by the Hayden Book Company, 50 Essex Street, Rochelle Park, New Jersey 07662.

Feeding Multiple Scanners

Q. ***Is there a simple circuit I can build that will feed several scanners with the signal from my outdoor antenna? There are a number of signal splitters commercially available, but the ones that I have seen split the signal into several frequency bands. I want to split it so that each scanner receives all frequencies. Can a 75-ohm TV splitter be used, and will there be a great loss of signal?—Ted Wilson, Mount Laurel, NJ***

A. I recommend that you use a 75-ohm coaxial TV splitter. These resistive networks are designed to function over a wide range of frequencies and will ensure that each scanner receives a portion of the signal picked up by the antenna. The 75-ohm splitters that I have seen do not filter the r-f input into different frequency bands and do not introduce severe signal loss. Of course, each scanner will receive less signal than it would if it alone were connected directly to the antenna, but perfectly acceptable results will be obtained in most cases.

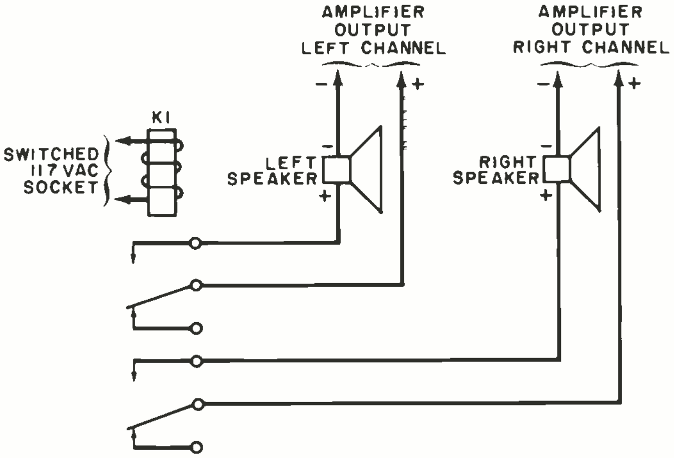
Have a problem or question in circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N Y 10016 Though all letters can't be answered individually, those with wide interest will be published

Speaker Transients

Q. ***I have a Cerwin-Vega A-3000I power amplifier. When I turn it off, its capacitors discharge through my speakers. Is there any way to avoid the surge of power through my speakers, and is it harmful to them?—John Strand, Madison, WI***

A. Turn-off transients can be harmful to speakers. It is difficult to be more definite because of the wide variations in the transient-handling capabilities of different loudspeakers and in the amplitudes of transients generated by different power amplifiers. However, a simple circuit can be used to keep turn-off transients away from loudspeakers. The circuit shown will perform this function and can be considered an inexpensive insurance policy for your loudspeakers. It consists of a relay with a 117-volt coil and two sets of contacts. Usually, an amplifier that generates turn-off transients will not do so until a few seconds after power has been removed.

This circuit takes advantage of this time delay. The relay coil receives line current from one of the control preamplifier's switched ac sockets. When the preamplifier is turned off, both the power amplifier and the relay are deprived of current. The relay deenergizes almost immediately and opens the signal paths between the amplifier output terminals and the loudspeakers. The transients, which occur some time later, cannot reach the loudspeakers once the relay contacts have opened.



If desired, the relay can be installed inside the power amplifier and its coil wired in parallel with the primary of the amplifier's power transformer. It will then be controlled by both the control preamplifier's power switch and the power amplifier's power switch, assuming that the power amplifier's line cord is plugged into one of the control preamplifier's switched outlets. This eliminates the need for a line cord for the relay, an enclosure, and connection terminals. It also avoids tying up one of the control preamplifier's switched outlets.

In-Situ Solar Cells

Q. ***In the April 1977 issue, you published an item in the Hobby Scene about do-it-yourself solar cells. I would like to know if you have any other information about procuring the required materials and building a 100-watt cell. I would like to use such a cell as part of my senior design project at the technical school I attend.—Michael Boussoni, Fort Wayne, IN***

A. The April 1977 issue of POPULAR ELECTRONICS did not contain a "Hobby Scene" column written by me. Rather, it contained an "April Hobby Scene" written by a fictitious Marcia Swampfelder. All of the items comprising that column were hoaxes—the entire thing was an April Fool's joke. Unfortunately, perhaps by wishful thinking, many readers were taken in by the description.

EXPERIMENTER'S CORNER

Remote Sensing—Part 1

ALL matter emits, absorbs, and reflects different wavelengths of electromagnetic radiation, each type in its own unique fashion. The combination of these properties provides an electromagnetic "signature" which permits various kinds of sensors to identify unknown matter from afar.

The study of electromagnetic signatures has given rise to the method of observation and measurement called *remote sensing*. In this two-part discussion, we will consider several types of remote sensing and describe the assembly of some circuits which can identify a portion of the electromagnetic signatures of various man-made and natural objects.

Elements of Remote Sensing. In its broadest sense, remote sensing is the perception of an object from a distance by means of a suitable sensing device. By this definition, observation devices ranging from the human eye to telescopes, cameras, and spectroradiometers are remote sensors.

Effective remote sensing usually requires that the sensor be capable of distinguishing a range of wavelengths emitted by, reflected from or transmitted through the object or matter being sensed. Photography, an early and still important remote-sensing method, provides a good illustration of the importance of spectral sensitivity.

A black-and-white aerial photograph, for example, displays as various shades of gray all the wavelengths to which the film is sensitive and which are emitted from or reflected by the matter within the camera's field of view. Such a black-and-white photograph can convey a considerable amount of information, but a *color* aerial photograph simplifies the location of man–made structures and can even permit the identification of various kinds of vegetation.

The use of black-and-white film in remote sensing can be made more productive by exposing the emulsion through a narrow-bandpass optical filter. Several such black-and-white photos of the same scene, each exposed through a different filter, can be superimposed to provide as much or even more information than a color photograph.

Another important form of remote sensing was developed in the last century when astronomers used glass prisms and diffraction gratings to break up the light from distant stars into its component parts. Hot gasses, whether on earth or in a star, emit characteristic wavelengths of radiation. Astronomers learned how to determine the composition of stars by analyzing the spectra of their emissions. *Spectrometry*, as this research tool is called, has become far more sophisticated in recent years due to the development of more sensitive equipment. The basic technique, however, remains unchanged.

Remote-Sensing Methods. Figure 1 illustrates four important remote-sensing methods. The *passive reflection* method is probably the most widespread. In this method, the object being observed, called the *target*, reflects ambient radiation emitted by the sun or a nearby source of artificial light. The *active reflection* method is more specialized, because in it the target is illuminated by a source of artificial light designed specifically for this purpose. In both of these methods, target characteristics can be determined by the way various wavelengths are reflected.

The *emission* method is totally passive and relies only upon radiation emitted by the target. So long as the detector is sufficiently sensitive, this method will detect *anything* from ice cubes to stars, for all matter at a temperature greater than absolute zero emits electromagnetic radiation. It permits the temperature of a target to be determined from afar. Also, if the target is heated to incandescence, the characteristic spectral lines it emits permit its constituents to be identified.

The *transmission* method, which is commonly used to detect dust, gases, precipitation and other matter in the earth's atmosphere, requires a separate source and detector. Sometimes, the source can be the sun or some other natural or artificial light source suitably placed with respect to the target. Generally, however, the source is designed specifically for the purpose. In any case, the target can often be identified by the way it absorbs and scatters different wavelengths of light.

Many variations on these basic methods are possible. For example, the active-reflection method may employ a wideband, "white" light source and a single detector, before which various narrow-bandpass filters are placed. While the detector is pointed at a fixed target (which is illuminated by the source), detector-output measurements are taken each time a different filter is moved into position.

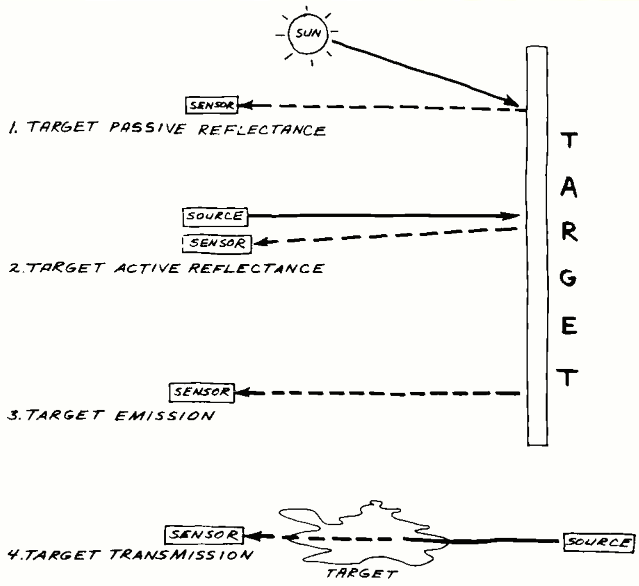


Fig. 1. The principal kinds of remote sensing.

Alternatively, the filters can be placed before the light source. Another variation is to eliminate the filters entirely and illuminate the target with a narrow-band source such as a laser. If necessary, sunlight or artificial ambient light can be blocked by a suitable narrow-bandpass filter placed in front of the detector.

As you can see, there are many ways to implement remote sensing. We will first consider active- and passive-reflection remote sensing, two methods which are also known as *reflection spectroscopy*.

Reflection Spectroscopy. I first became interested in reflection spectroscopy while evaluating the performance of various kinds of infrared travel aids for the blind. To predict the range of such a device, it is necessary to know the optical reflectance of many different materials at the wavelengths employed by the aid. The most common wavelengths are 880 and 940 nanometers in the near infrared. Very efficient, powerful LEDs which emit radiation at these wavelengths are readily available.

Figure 2, for example, shows the spectral reflectance of a typical green leaf. This plot nicely illustrates how well such leaves reflect incident radiation at near-infrared wavelengths. It also shows that a leaf has a distinctive *reflection signature*. Chlorophyll, the key chemical constituent of green plants, readily absorbs blue and red wavelengths. The small peak in reflectance at 550 nanometers produces the characteristic coloration of photosynthetic plant life.

The much larger peak beyond 700 nanometers is in the

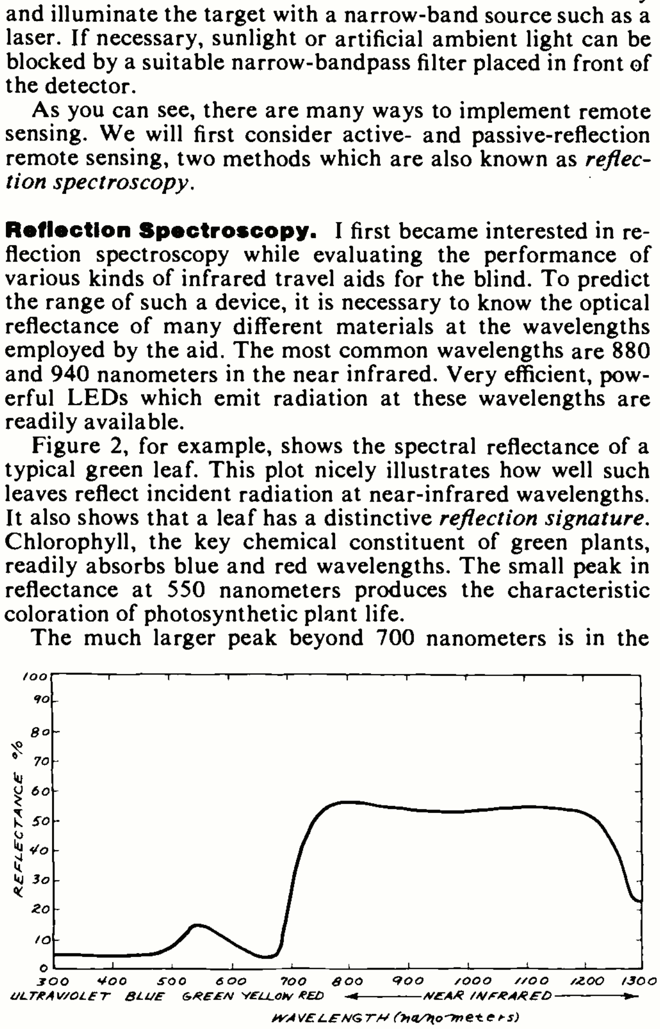


Fig. 2. Spectral reflectance of a typical green leaf.

near infrared, and is therefore invisible to the unaided eye. This spectral region, however, is readily detectable by means of infrared film or an infrared image converter such as a starlight scope. The peak explains why vegetation appears bright white on infrared film or when viewed through an infrared-to-visible-light image converter.

The large difference in reflectance values at 650 nanometers and in the 750-to-1200-nanometer band means that a GaAsP red LED and an (AlGa)As or GaAs:Si near-infrared emitter can be used in their light *detector* (either reverse-biased or photovoltaic) mode as the heart of a detector circuit which indicates the presence or absence of green vegetation. As you may recall from previous columns, LEDs make excellent narrow-band detectors.

The same result can be achieved with two silicon detectors, one covered with a 600-to-670-nanometer bandpass filter, the other covered with a near-infrared bandpass filter. This approach, however, is more expensive—suitable filters may cost as much as $50 or more.

Using LEDs to Detect Vegetation. To determine if a GaAsP LED could be teamed with a GaAs:Si LED to detect green vegetation, I tried an experiment that you might want to duplicate. In this experiment, I used the variable-gain operational amplifier shown in Fig. 3.

First, a GaAsP LED enclosed in a clear (*not* diffuse) red encapsulant was connected to the input of the amplifier. The diode was then pointed at the white side of a Kodak Neutral Test Card (available at most camera stores) which was illuminated by a single incandescent lamp. All other lights were extinguished.

The Kodak test card has a reflectance of 90 percent in the visible and near-infrared regions of the spectrum. Therefore, I adjusted *R1 and* the distance of the light from the card to achieve a meter reading of 0.9 milliamperes. I then removed the card and placed a fresh leaf from a Japanese ligustrum in its place. The meter indicated 0.05 milliamperes, which signifies a reflectance of 5 percent.

I then repeated this procedure with the GaAs:Si LED. This time, I measured a reflectance of 52 percent. Both reflectance measurements coincide well with published values. And though GaAsP LEDs are less sensitive than GaAs:Si LEDs, this simple experiment proved that *both* LEDs can be used in tandem to measure the reflectance of green leaves.

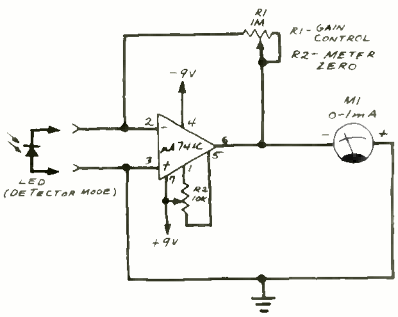


Fig. 3. Simple green detector circuit as described in text.

A Practical Green-Leaf Detector. The "truth table" for a dual-wavelength, leaf-signature detector is:

	Reflectance	
A 650 nm (red)	**B 940 nm (near infrared)**	**Leaf present?**
Low	Low	No
Low	High	Yes
High	Low	No
High	High	No

The Boolean function for this table for an active low output is

$$(\overline{A \cdot \overline{B}})$$

(Continued overleaf)

Figure 4 shows a practical green-leaf detector circuit. As in the previous experiment, two LEDs function as narrow-band wavelength detectors.

In operation, each LED is reverse-biased and connected to a series resistor (*R1* and *R5*) across which a voltage drop appears when light striking the LED generates a photocurrent. The series resistor for the GaAsP LED (*R1*) has a much larger resistance than that for the GaAs:Si LED (*R5*) because the GaAsP LED is not as sensitive to light.

The output voltages generated by the two LEDs are applied to the inverting inputs of two comparators (*IC1A* and *IC1B*). When the light level is sufficiently high, the outputs of the two comparators go low. Otherwise the outputs remain high.

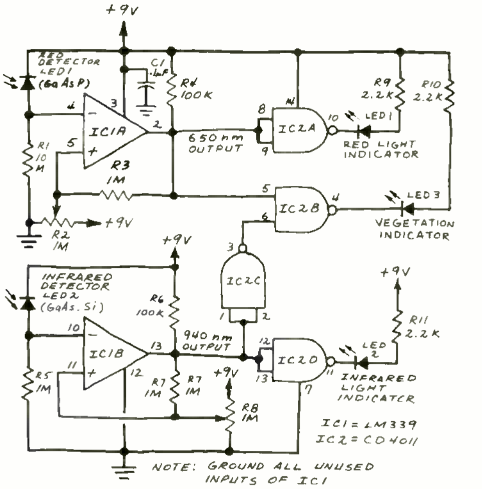


Fig. 4. Circuit for remote sensing of green vegetation.

The required Boolean function for the truth table is implemented by two of the four NAND gates in a 4011 (*IC2B* and *IC2C*). When both detectors receive reflected light from a leaf illuminated by sunlight or a bright incandescent lamp, the output of comparator *IC1A* stays high and that of *IC2B* goes low. This combination is decoded by NAND gates *IC2B* and *IC2C*, and VEGETATION INDICATOR *LED3* glows. The LED is dark for any other combination of inputs.

For preliminary work, assemble the circuit in Fig. 4 on a solderless breadboard. The two detector LEDs should be mounted next to one another and installed in an opaque housing such as a short length of heat-shrinkable tubing.

Before it can be used, the circuit must be calibrated. The calibration procedure is greatly simplified by the three LEDs. Begin by rotating the wiper of trimmer potentiometer *R2* until *LED1* just begins to glow. Then rotate the wiper of *R8* until *LED2* just begins to glow. Indicator *LED3* should now be dark.

Now place a white card a few centimeters from the two detector LEDs, and illuminate the card with a bright incandescent lamp or sunlight. Both *LED1* and *LED2* should darken, and *LED3* should remain dark. If either *LED1* or *LED2* remains on, adjust the appropriate potentiometer until the LED functions properly. If this fails to solve the problem, make sure the fields of view of the chips in each LED are not blocked by the edge of the opaque tube. Also, make sure light is not entering the rear of the opaque tube and illuminating the LEDs from behind.

The circuit is now ready for use. Leave the light source in place and remove the white card. Both *LED1* and *LED2* should glow. Then place a fresh green leaf where the card was located. Indicator *LED1* should continue to glow, and *LED2* should darken. Diode *LED3* will glow to indicate the presence of a leaf.

With careful adjustments, the circuit will detect a single leaf up to 10 centimeters away. Under the proper conditions, trees and shrubs illuminated by bright sunlight can be detected over much greater distance.

To Be Continued. Next month, we will look at a remote-sensing circuit designed by NASA to distinguish between green vegetation, bare ground, water, and clouds or snow. We will also experiment with a simple dual-LED method for detecting water vapor. ◇

DX LISTENING

By Glenn Hauser

Slow Scan Television on Shortwave Broadcast

FOR YEARS, hams have been sending each other slow-scan television(SSTV) pictures. Now, broadcasting stations are experimenting with SSTV transmission.

While ordinary (fast-scan) TV requires a bandwidth of several megahertz, that of SSTV is no more than an ordinary SSB signal so it can be sent on existing shortwave facilities, whether amateur or broadcast. The price paid for this narrow bandwidth is reduced definition (clarity) and a great increase in the time it takes to send one single frame. It takes eight seconds, in fact, which means that motion cannot be conveyed, so a more appropriate name might have been "fast scan facsimile".

Nevertheless, the prospect of being able to see still picutres from shortwave broadcast stations is intriguing. During certain programs (the news, for instance) stations with more than one frequency in use could send voice on one and accompanying slides on the other. A small investment in amateur SSTV equipment would be necessary, but transmitters would not need to be modified. However, SSB provides better results on SSTV than does AM.

The major obstacle at this point is the lack of SSTV equipment among shortwave listeners, which is not surprising since there are no regularly scheduled SSTV broadcasts! If some station took the plunge and began SSTV transmissions on a regular basis, people would be encouraged to buy the equipment. If the latter were receive-only, it would cost considerably less than amateurs pay for two-way capability.

Already there are some nonamateurs who have SSTV receiving capability. One spur to this was the rapid retransmission by SSTV of pictures just received from the Voyager mission, thanks to ham station *W6VIO* at Jet Propulsion Laboratory.

Within the past few months both *Israel Radio* and *Radio Sweden* have carried out experimental SSTV transmissions, and more are expected. The inventor of SSTV, Cop Macdonald, VE1BFL, prepared the test on Radio Sweden, and sent us the accompanying photo of one of the eleven pictures transmitted, as he received it in Prince Edward Island off the air from Radio Sweden. Thanks also to Dr. John H. Woodruff of Durham, New Hampshire,

who is not a ham but monitors SSTV, for sending us photos of the same tests. His receiver was a battery-operated Sony ICF-5900W, with a Robot 400 scan converter, and a 5-inch GBC video monitor.

In the field of fast-scan TV, we must note a remarkable achievement: Jerry Pulice in New York succeeded in viewing snow-free pictures from New Zealand television on 45 MHz, March 10.

Country by Country.

Brazil. If *Radio Nacional*, Brasília, has a youthful sound, there's good reason. Taking over last November as director of the external service was 22-year-old Antonio Augusto Silva, who went to high school in New Mexico, writes flawless English, and was profiled by Robert Horvitz in the April *Review of International Broadcasting.* Silva attributes his success to experience and being in the right place at the right time.

Costa Rica. Ever since its leftist orientation became apparent once it went on the air in 1979, *Radio Noticias del Continente* has been threatened by right-wing military dictatorships in South America. It is hard to imagine any shortwave station of any political stripe having such an impact on North America. The "southern cone" military dictatorships brought pressure to bear on the Costa Rican government to close the station down. Freedom of the press is more of a tradition in Costa Rica than most other Latin American countries, so it was necessary to get the station on some other grounds. Finally, in February *RNC* was ordered to close because an unauthorized cache of arms had been found at the station. It maintains they were planted, but complied with the order and closed March 7, after several days of broadcasts in its own defense, including statements of solidarity from many other international broadcasters, including *Radio Mexico*, *Radio Canada International*, and *Radio Sweden*.

Radio Noticias del Continente planned to continue functioning as a news agency rather than a broadcaster on 9615 kHz, and expected many of the stations expressing solidarity with it to broadcast programs it produces. Its equivalent is reported to have moved from Costa Rica and might turn up in Nicaragua.

Cuba/Florida. Anti-Castro elements continue regular broadcasts ranging from the mild to the rabid. Their favorite haunt is the 7000-7100-kHz range between 8:30 and 10:30 pm (ET). Among the names they go by, as reported by monitor Steve Reinstein, are: *Radio Trinchera*, *La Voz de Cuba Independiente y Democrática*, *La Voz Cristiana de Cuba*, *La Juventud Progresista Cubana*, *La Voz de Alpha 66*, *Radio Abdala*, *Radio Libertad Cubana*. A U.S. attorney has refused to prosecute one such operator, a ruling which is expected to encourage more anti-Castro stations.

Gabon. After a year of moldering in the jungle, *Africa Number One* returned to the air in February. Despite its obvious French connection, the station billed itself as "an African station for Africans", which could also be heard clearly in North America thanks to its 500-kilowatt power, on 4811 kHz, opening at 0500 GMT and before closing at 2300 GMT. On other frequencies, it relays *Radio France Internationale*.

Honduras. Also in February a new station appeared on 4910 kHz, called *La Voz de la Mosquitia* (named after the country's eastern coastal region). *HRXK*, Puerto Lempira, is operated by a family of southern Baptist missionaries who speak Spanish with a pronounced American accent. Jack Jones in Mississippi reports the schedule as 0000-0300 and 1200-1400 GMT, with an English segment around 0100.

Ireland. Since the Irish government is not interested in external broadcasting, it has fallen to an unofficial station, *Radio Dublin*, to represent this country to the world. The station has done surprisingly well with its 400-watt transmitter, last reported on 6908 kHz. Though a 24-hour operation, reception in North America peaked around 0600 in the winter. It is less likely to be heard in the summer. The station hoped to get a second-hand transmitter of somewhat higher power, and to use higher frequencies which would propagate much better—14400 or 28000 kHz.

Lebanon. Another unofficial station is the *Voice of Hope*, operated from "Free Lebanon" (the southern border area adjacent to Israel) by a California missionary organization called High Adventure. It began on mediumwave only, but in February added a shortwave outlet of 6215 kHz, which could be heard in North America around 2100 and 0400 GMT. The station bills itself as "WORD" and "KING" with pseudo-American call letters; also as "King of Hope", and more recently added a TV station called "Star of Hope". The radio station mixes country music with biblical passages, and gives the military leader of the area, Major Sa'ad Haddad, all the air time he wants. Although beyond its jurisdiction, the U.S. State Department is not at all happy with this station, which it says is an obstacle to peace in the area as Maj. Haddad uses it to promote his differences with the Beirut government.

Mexico. Two 49-meter stations are having a terrible time staying on their authorized frequencies. Our monitor in Monterrey, Horacio Hinojosa Arce, has been keeping track of their fluctuations. The new station *XEUJ*, Linares, Nuevo León, succeeded in landing on its proper frequency of 5980 kHz only once, and on other days varied all the way from 5865 to 6095 kHz. Mexico City's *Radio Mil* has reactivated its shortwave outlet, supposed to be on 6010 kHz, but appearing as far down as 5850.

Nicaragua. Turnabout is fair play. The Sandinista government was confronted by a "counter-revolutionary" clandestine station which came on the air in April, called *Radio Quince de Septiembre* (named after Nicaragua's original independence day). Sponsored by a group called the Nicaraguan Democratic Revolutionary Alliance, it has one-hour broadcasts at 0400 and 1100 GMT on 5565 kHz (variable ±5).

Paraguay. *Radio Nacional* has finally activated a high-power transmitter, on 11914.25 kHz, marking for many the first opportunity to hear this country clearly. Spanish broadcasts in the 2300-0200 GMT period appear to be simulcasts of domestic programming, including transcriptions from European and North American stations at 0030. Don't be fooled!

United Arab Emirates. *UAE Radio*, Dubai, is another station new to the international braodcasting scene, and also relying on simulcasting its domestic service which, fortunately, contains some English segments, best heard in North America at 0330-0400 on 15320 and 17775 and at 1615-1650 on 17710 and 21655 kHz. Frequencies change without notice and the station has caused considerable interference to others, but its newscasts in English followed by features on Arab history and culture have received good marks from several of our listeners.

English-Language Listings. The following changes and additions should be made to the listings that appeared in

the June issue. To make the corrections as concise as possible, only the GMT, station name, and frequency correction are given.
0900-1000, AFRTS, drop 11805 and 9700
1045-1100, R. Bucharest, 17870, 15250
1100-1300, R. Australia, add 17795
1200-1230, R. Kol Israel, add 21600
1200-1230, R. Finland, add 17800
1200-1255, R. Peking, add 11945
1230-1325, R. Finland, add 17800 (Sun.)
1300-1700, WYFR, 9535, ex-11830
1430-1520, R. Nederland, add 15560
1600-1615, R. Pakistan, 21757
1600-1800, AFRTS, 15345, ex-15430
1615-1650, UAE Radio Dubai, 21655, 17710+, ex-1630-1700
1645-1740, R. Pakistan, 11672, ex-9460
1700-1730, HCJB, 17835†, ex-17790
1700-1745, BBC, 17695, ex-18080
1900-2000, HCJB, 17835+, ex-17790 and 15295
2000-2030, Kol Israel, 21495, 21675, 15415, ex-12025 and 11637
2030-2130, V. of Turkey, 9725, ex-9615
2100-2155, R. RSA, 11900, 9585, ex-17780, 15155
2115-2245, R. Cairo, 9805
2130-2200, HCJB, 17835†, ex-17795, 15295
2200-2215, R. Japan (via Portugal), 15425, ex-11955
2200-2300, V. Turkey, add 11770
2200-0200, AFRTS, 17765, ex-25615
2230-2300, Kol Israel, 21710, 15415, ex-12025
2230-2300, R. Nacional Angola, add 11955
2300-2400, WYFR, 5985, not 9535
2300-2400, BBC, 9600, ex-9580
2300-2400, HCJB, 15180, ex-15350
0033-0230, HCJB, add 17885
0100-0130, R. Budapest, add 6025
0100-0500, R. Moscow, 9785, ex-9530
0200-0230, R. Budapest, 6025, ex-6000
0200-0255, R. RSA, delete 11900
0200-0255, R. Bucharest, 9510, ex-11735
0200-0330, R. Cairo, 12000, ex-12050
0230-0500, HCJB, 15360, ex-15155
0300-0330, R. Portugal, 6025(?)
0300-0426, R. RSA, 4990, ex-11900, 7270
0330-0357, UAE Radio, Dubai, 17775+, ex-11755
0400-0430, R. Bucharest, delete 11735
0400-0500, R. Sofia, 11735, 15285, 21495
0430-0457, Austrian R., add 17745
0430-0700, AFRTS, 17765, 15330, ex-9755
0500-0515, Kol Israel, 21710−, 21600, 11655, ex-17710, 15105
0500-0515, R. Japan, 15325, ex-15430
0530-0600, R. Portugal, 9575, 6155, ex-0500-0530
0530-0630, Spanish For. R., 11880, 9630, ex-0515-0615
0600-0615, R. Japan, 15325, ex-15430
0700-0715, R. Japan, 15325, ex-15430, (via Portugal) 15235, ex-15170 ◇

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ELECTRONICS LIBRARY

21 Custom Speaker Enclosure Projects You Can Build

by David B. Weems

If you'd like to build your own speaker systems and need a source of ideas and accurate information, this book probably has what you need. The author has assembled descriptions of 21 speaker projects, each with step-by-step details and fully supported with photos and illustrations, parts lists, and bills of materials. Among the projects are two- and three-way closed-box systems; vented systems; equalized systems; and omnidirectional systems.

Published by Tab Books, Blue Ridge Summit, PA 17214. Soft cover. 215 pages. $7.95.

Skarbeks Software Directory

If you don't know what software, accessories, and peripherals are available for your Apple II microcomputer or where to get what you want, this may be the book you need. This handy directory lists more than 800 programs, including games and graphics, education and business, engineering and medicine, etc. Entries are listed in alphabetical order by title, each followed by publisher or vendor, a brief description of the item, memory requirements, and suggested list price. Two indexes are provided: one alphabetical, the other by category.

Published by Skarbeks Software Directory, 11990 Dorsett Rd., Maryland Heights, MO 63043. Soft cover. 364 pages. $11.95.

(Continued overleaf)

(Continued from page 83)

Interrelated Integrated Electronics Circuits

by R.M. Mendelson

Here's a book for the project builder. It contains details for building a diversity of interesting electronic projects, including power supplies, amplifiers, passive circuits, test and measurement instruments, and electronic games. All told, there are 25 projects. Among the items you can build are an audio mixer, SSB detector, resistance boxes, portable DMM, battery-powered frequency counter, electronic dice, and a digital roulette "wheel." Each project is fully described, accompanied by circuit description, schematic diagram, parts list, component-layout diagram, hints on construction, and photo of the finished project. Etching-and-drilling guides for each project are contained in the appendix at the back of the book.

Published by Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. Soft cover. 128 pages. $6.95.

PROJECT OF THE MONTH

By Forrest M. Mims

A Simple, Low Cost Timer

FOR simple timer applications, transistor circuits are as good as more complicated and expensive IC designs. Figure 1, for example, shows a simple timer made from only three components—a field-effect transistor (FET), a timing capacitor and a discharge resistor. A LED, protected by a current-limiting resistor, indicates when a timing cycle is complete.

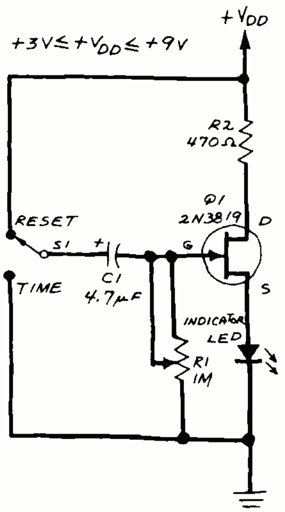

Fig. 1. Ultra-simple FET timer circuit.

The FET is responsible for the simplicity of this circuit. Its very high input impedance places a negligible load on *C1* during a timing cycle. By contrast, a bipolar transistor would quickly discharge the capacitor and prematurely end the timing cycle. In effect, the FET serves as a high-impedance buffer between timing capacitor *C1* and the output LED, which provides the timing indication.

When the circuit is connected to a single-ended positive supply, *C1* is charged to $+V_{DD}$ by momentarily placing *S1* in its RESET position. A timing cycle is initiated by placing the switch in its TIME position. This causes *Q1* to turn off and extinguish the LED. At the same time, *C1* begins to discharge through *R1*.

When the voltage across *C1* decreases to approximately 0.6 volt, the FET conducts, and the LED glows to indicate completion of the timing cycle. A new timing cycle can be initiated by momentarily toggling *S1* to its RESET position. Figure 2 is a plot of the voltage across *C1* during a typical timing cycle.

When I used a 4.7-μF miniature aluminum electrolytic capacitor as *C1*, I could obtain a maximum time delay of approximately 10 seconds. Shorter delays can be achieved by adjusting *R1* so that its effective resistance is decreased. Longer delays are available by using a component with more capacitance and less leakage for *C1*. Tantalum capacitors are well suited to such applications. Substituting a higher resistance potentiometer for *R1* can also give longer delays.

Adding a Relay. Figure 3 shows a more practical, expanded version of the basic timer of Fig. 1. Here each of three (or more) separate capacitors can be switched into the circuit to provide different time delays without any adjustment of *R1*. Of course, *R1* can also be adjusted if desired.

The most important addition to the circuit shown in Fig. 3 is *K1*, the output relay. Normally, *R2* keeps *Q2* conducting, which in turn energizes the relay coil. When a timing cycle is complete, however, *Q1* grounds the base of *Q2*, cutting off the bipolar transistor. This causes the relay to drop out. Diode *D1* absorbs any high-voltage inductive kick which might be generated during the keying of the relay coil.

With this circuit, delays of ten minutes or more are possible if quality capacitors are selected. Low-leakage capacitors are a *must* for time delays of this magnitude. ◇

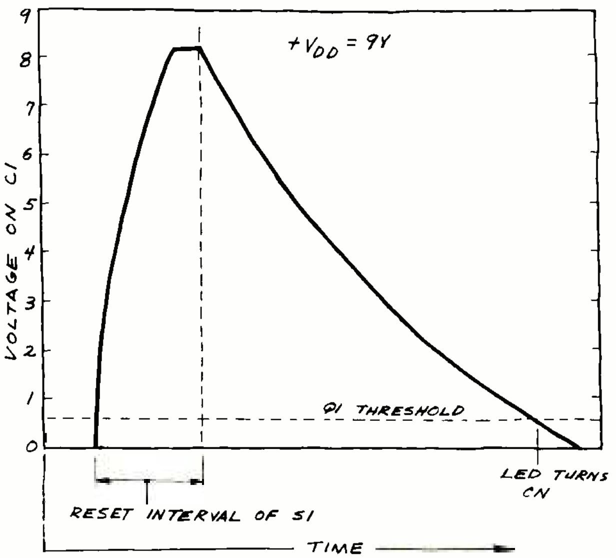

Fig. 2. Voltage on C1 during a timing cycle.

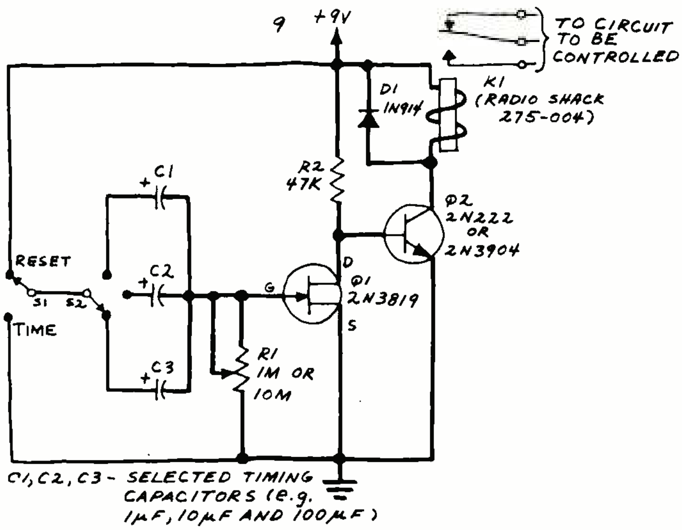

Fig. 3. A variable-delay FET timer.

OPERATION ASSIST

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, *1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)*

Concord model 104M tape recorder. Need drive belt and motor control knob. Michael Ardai, 350 East 52nd St., New York, NY 10022.

Hycon Manufacturing Co., OS-8A/U navy oscilloscope. Need schematic and manual. Everett C. Estep, 313 N.E. 99th St., Vancouver, WA 98665.

RCA model Victor R-3 radio. Need tube #UX245. John Ager, 1426 W. Farwell, Chicago, IL 60626.

Elco model 753 tri-band transceiver. Need schematic or service manual. Noel Evans, 87 Oldtown Road, Castledawson, Magherafelt, Londonderry, N. Ireland BT45 8BZ.

Dumont oscilloscope model 208B. Need instruction book and schematic. Allan Madsen, 4608-38th Ave., Salem, OR 97303.

Hickok model 6000A tube tester. Need operating manual and schematic. Guy Edwards, 104 Hancock, San Francisco, CA 94114.

Knight Kit model 83 YU144 scope. Need schematic. E. Upham, 81 Gray St., Portland, ME 04102.

Precision model 912 tube tester. Need schematic and operating manual. Truk Tidneb, 3919 19th St., San Francisco, CA 94114.

NRI model III professional resistor and capacitor bridge. Instruction manual needed. M. Match, 21B Thorney Ave., Huntington Sta., NY 11746.

Videobrain model 101 family computer. Need schematics, programming and interface information. Mel Hengen, 16312 Rainier St., Fountain Valley, CA 92708.

Instruments Design model A-100 modulation scope. Need schematic and parts list. Tom Witzgall, 345 Kearny Avenue, Apt. 3, Kearny, NJ 07032.

Electro Products model 947 stereo. Need photo fact for repair of unit. Mary Ann McGlamry, 33 Executive Park Drive NE, Atlanta, GA 30329.

Tektronix model 545 oscilloscope. Need schematic. Real Gautreau, 306 Oak St., Copperas Cove, TX 76522.

Electro Voice model 1278 receiver and Lloyd's model 9N18C-82A radio. Need schematics. Dave Overton, 1709 W. 30, Austin, TX 78703.

Dumont type 350 oscilloscope. Need schematic and operating manual. Elbert Orazy, 6 Amherst Rd., Andover, MA 01810.

Heathkit Laboratory model 0-12 oscilloscope. Need schematic diagram. James M. Toney, 207 Smythe Dr., Summerville, SC 29483.

Precision Apparatus Co., Inc., series E-200-C signal generator. Need operation and service manuals. John Pankow, Box 86, Chiefland, FL 32626.

B&K model 1070 circuit analyzer. Need schematic, operation and maintenance manual. Charles T. Altschul, 3911 Rhodes Ave., Charlotte, NC 28210.

Hallicrafters S-210 shortwave receiver. Need schematic, alignment information and operation manual. Roy Patterson, Box 2085, Spring Valley, CA 92077.

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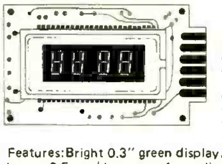

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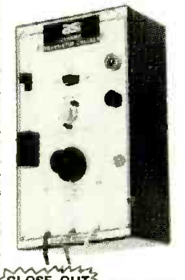

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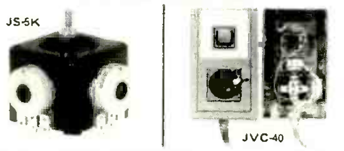

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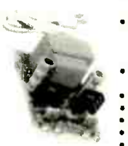

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.937 O.D. x 1.201 Length

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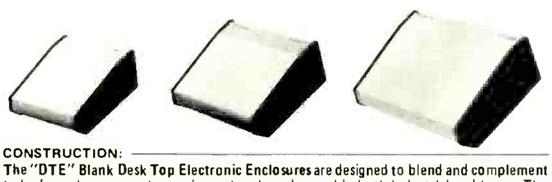
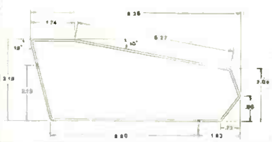
DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures



CONSTRUCTION:

The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



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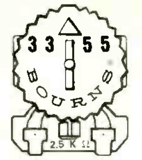

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AC1000	117V/60Hz	12 VAC 1 amp	$5.95
AC1700	117V/60Hz	9 VAC 1.7 amp	$6.95
DV 9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS

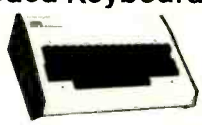
DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
★ Documentation for Conversion

TRS-16K2 *150 NS	$39.95
TRS-16K4 *250 NS	$29.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) ... **$124.95**

JE610 Kit 62-Key Keyboard, PC Board, & Components (no case)	$ 79.95
K62 62-Key Keyboard (Keyboard only)	$ 34.95
DTE-AK (case only — 3¼"Hx11"Wx8¾"D)	$ 49.95

NEW! JE212 – Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
Provides -12VDC from incoming 5VDC . . $9.95

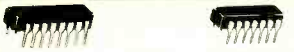
JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case)	$59.95
K19 19-Key Keyboard (Keyboard only)	$14.95
DTE-HK (case only — 3½"Hx8¼"Wx8¾"D)	$44.95



7400

SN7400N	.25	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.25	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74107N	.35	SN74184N	2.49
SN7426N	.29	SN74109N	.39	SN74185N	2.49
SN7427N	.25	SN74116N	1.95	SN74190N	1.25
SN7428N	.49	SN74121N	.39	SN74191N	1.25
SN7430N	.25	SN74122N	.55	SN74192N	.89
SN7432N	.29	SN74123N	.59	SN74193N	.89
SN7437N	.25	SN74125N	.49	SN74194N	.89
SN7438N	.40	SN74126N	.49	SN74195N	.69
SN7439N	.25	SN74132N	.75	SN74196N	.89
SN7440N	.20	SN74136N	.75	SN74197N	.89
SN7441N	.89	SN74141N	.99	SN74198N	1.49
SN7442N	.59	SN74142N	3.25	SN74199N	1.49
SN7443N	1.10	SN74143N	3.49	SN74221N	1.25
SN7444N	1.10	SN74144N	3.49	SN74251N	.99
SN7445N	.89	SN74145N	.79	SN74276N	1.95
SN7446N	.79	SN74147N	1.95	SN74279N	.79
SN7447N	.69	SN74148N	1.29	SN74283N	1.49
SN7448N	.79	SN74150N	1.25	SN74284N	3.95
SN7450N	.20	SN74151N	.69	SN74285N	3.95
SN7451N	.20	SN74152N	.69	SN74365N	.69
SN7453N	.20	SN74153N	.79	SN74366N	.69
SN7454N	.20	SN74154N	1.25	SN74367N	.69
SN7459A	.25	SN74155N	.79	SN74368N	.69
SN7460N	.20			SN74390N	1.49
SN7470N	.29			SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.29	74LS112	.45	74LS240	1.95
74LS09	.35	74LS113	.49	74LS241	1.95
74LS10	.29	74LS114	.49	74LS242	1.95
74LS11	.75	74LS122	.89	74LS243	1.95
74LS12	.35	74LS123	1.25	74LS244	1.95
74LS13	.59	74LS125	.89	74LS245	2.95
74LS14	.99	74LS126	.55	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.29	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	1.49
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.99
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.29	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	1.19	74LS273	1.95
74LS33	.59	74LS156	1.19	74LS279	.75
74LS37	.45	74LS157	.89	74LS283	1.09
74LS38	.49	74LS158	.99	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.25	74LS365	.75
74LS51	.29	74LS165	1.25	74LS366	.75
74LS54	.29	74LS168	1.19	74LS367	.75
74LS55	.29	74LS169	1.19	74LS368	.75
74LS73	.45	74LS170	2.49	74LS373	1.95
74LS74	.45	74LS173	1.39	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.45			81LS95	1.95
74LS90	.59			81LS97	1.95

74S

74S00	.50	74S124	2.49	74S243	3.25
74S02	.50	74S133	.55	74S244	3.25
74S03	.50	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.50	74S140	1.15	74S280	2.95
74S11	.50	74S151	1.35	74S287	4.95
74S15	.50	74S153	1.35	74S288	4.95
74S20	.50	74S157	1.35	74S373	3.49
74S22	.50	74S158	1.35	74S374	3.49
74S30	.50	74S160	1.95	74S387	5.95
74S32	.55	74S174	1.59	74S471	19.95
74S38	.69	74S175	1.59	74S472	19.95
74S40	.55	74S188	4.95	74S473	19.95
74S51	.50	74S194	1.95	74S474	21.95
74S64	.50	74S195	1.95	74S475	21.95
74S65	.50	74S196	3.95	74S570	7.95
74S74	.79	74S240	2.95	74S571	7.95
74S86	.79	74S241	2.95	74S572	19.95
74S112	.79	74S242	3.25	74S573	19.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

CA—LINEAR

CA3010H	1.07	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080N	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.48	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD—CMOS

CD4000	.39	CD4041	1.49	CD4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	14.95
CD4028	.89	CD4078	.55	MC14410	14.95
CD4029	1.49	CD4081	.39	MC14411	14.95
CD4030	.49	CD4082	.39	MC14412	11.95
CD4034	3.49	CD4093	.99	MC14419	4.95
CD4035	.99			MC14433	13.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

A P PRODUCTS

DIP JUMPERS

- Mate with Standard IC Sockets
- Fully Assembled and Tested
- Integral Molded On Strain Relief
- Line-By-Line Probeability

Dip Jumpers are used for jumpering within a PC Board; interconnecting between PC Boards, backplanes and mother boards; and interfacing input/output signals.

Part Number	No. of contacts	Description	Wire Length	Price
924102-12	14	single end	12"	$1.51
924102-24	14	single end	24"	1.82
924102-36	14	single end	36"	2.33
924106-12	14	double end	12"	2.61
924106-24	14	double end	24"	3.02
924106-36	14	double end	36"	3.43
924112-12	16	single end	12"	1.67
924112-24	16	single end	24"	2.13
924112-36	16	single end	36"	2.59
924116-12	16	double end	12"	2.88
924116-24	16	double end	24"	3.34
924116-36	16	double end	36"	3.80
924122-12	24	single end	12"	2.60
924122-24	24	single end	24"	3.30
924122-36	24	single end	36"	4.00
924126-12	24	double end	12"	4.50
924126-24	24	double end	24"	5.20
924128-36	24	double end	36"	5.90
924132-12	40	single end	12"	4.35
924132-24	40	single end	24"	5.53
924132-36	40	single end	36"	6.71

DISCRETE LEDS

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

XC556 RED LED, METAL MTG. HDW, 2-6" LEADS.
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode C.C. — Common Cathode

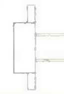
Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	1.25	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	1.25	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL746	C.A.—red ± 1	.630	1.49
MAN 72	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DL750	C.C.—red	.600	1.49
MAN 82	C.A.—yellow	.300	.49	DLO847	C.A.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DLO850	C.C.—orange	.800	1.49
MAN 3620	C.A.—orange	.300	.49	DL33B	C.C.—red	.110	.35
MAN 3630	C.A.—orange ± 1	.300	.99	FND358	C.C. ± 1	.357	.99
MAN 3640	C.C.—orange	.300	.99	FND359	C.C.	.357	.75
MAN 4610	C.A.—orange	.400	.99	FND503	C.C. (FND500)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	FND507	C.A. (FND510)	.500	.99
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.75
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 sgl. dig. RHD	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7302	4x7 sgl. dig. LHD	.600	22.00
MAN 6780	C.C.—red	.560	.99	5082-7304	Overnge. char. (±1)	.600	19.95
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.99
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

SOCKETS RECEPTACLES

Test TEXTOOL Sockets

ZERO INSERTION FORCE

- Nickel Boron Plating
- G.F. PSF Plastic Body
- For testing IC's



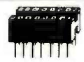
- Nickel Boron Plating
- G.F. PSF Plastic Body
- Wire Wrap Contacts

Part No.	Pins	Price	Part No.	Pins	Price
214-3339	14 pin	5.95	222-3343	22 pin	9.95
216-3340	16 pin	6.49	224-3344	24 pin	9.75
218-3341	18 pin	7.95	228-3345	28 pin	11.95
220-3342	20 pin	8.95	240-3346	40 pin	12.95

Part No.	Pins	Price	Part No.	Pins	Price
214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3595	20 pin	11.95	240-3599	40 pin	15.95

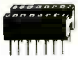
LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61



SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30



SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
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LM340K-12	1.35	LM567V	1.25	75451CN	.39
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47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

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.0022mf	.12	.10	.07	.047mf	.21	.17	.13
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.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
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4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

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Z80A-S10/0	22.50	4009	.49	4060	1.39	4581	1.99	74LS08	.39	74LS132	.79	74LS257	.98
Z80-S10/1	18.50	4010	.49	4066	.75	4582	1.01	74LS09	.39	74LS136	.59	74LS258	.98
Z80A-S10/1	22.50	4011	.35	4068	.35	4584	.55	74LS10	.28	74LS138	.89	74LS259	2.95
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Z80A-S10/2	22.50	4013	.49	4070	.49	4702	9.95	74LS12	.39	74LS145	1.25	74LS261	2.49
3205	3.95	4014	1.39	4071	.35	74C00	.39	74LS13	.47	74LS148	1.49	74LS266	.59
3242	10.00	4015	1.15	4072	.35	74C02	.39	74LS14	1.25	74LS151	.79	74LS273	1.75
8155	11.25	4016	.59	4073	.35	74C04	.39	74LS15	.39	74LS153	.79	74LS275	4.40
8185	29.95	4017	1.19	4075	.35	74C08	.49	74LS20	.26	74LS155	1.19	74LS279	.59
8185-2	39.95	4018	.99	4076	1.29	74C10	.49	74LS21	.38	74LS156	.99	74LS283	1.10
8202	45.00	4019	.49	4078	.35	74C14	1.65	74LS22	.38	74LS157	.99	74LS290	1.29
8205	3.95	4020	1.19	4081	.35	74C20	.39	74LS26	.39	74LS158	.75	74LS293	1.95
8212	2.00	4021	1.19	4082	.35	74C30	.39	74LS27	.39	74LS160	.98	74LS295	1.10
8214	3.95	4022	1.15	4085	1.95	74C32	.99	74LS28	.39	74LS161	1.15	74LS298	1.29
8216	1.85	4023	.38	4086	.79	74C42	1.85	74LS30	.26	74LS162	.98	74LS324	1.75
8224	2.65	4024	.79	4093	.99	74C48	2.39	74LS32	.39	74LS163	.98	74LS347	1.95
8226	1.85	4025	.38	4099	2.25	74C73	.85	74LS37	.79	74LS164	1.19	74LS348	1.95
8228	5.00	4026	2.50	4104	1.99	74C74	.85	74LS38	.39	74LS165	.89	74LS352	1.65
8238	5.45	4027	.65	4501	.39	74C85	2.49	74LS42	.79	74LS166	2.49	74LS353	1.65
8243	4.65	4028	.85	4502	1.65	74C89	4.95	74LS47	.79	74LS170	1.99	74LS363	1.49
8251A	5.55	4029	1.29	4503	.69	74C90	1.85	74LS48	.79	74LS173	.89	74LS365	.99
8253	9.85	4030	.45	4505	8.95	74C93	1.85	74LS51	.26	74LS174	.99	74LS366	.99
8255A	5.40	4031	3.25	4506	.75	74C95	1.85	74LS54	.35	74LS175	.99	74LS367	.73
8255A-5	5.40	4032	2.15	4507	.95	74C107	1.19	74LS55	.35	74LS181	2.20	74LS368	.73
8257	9.25	4033	2.15	4508	3.95	74C151	2.49	74LS73	.45	74LS190	1.15	74LS373	2.75
8257-5	9.25	4034	3.25	4510	1.39	74C154	3.50	74LS74	.59	74LS191	1.15	74LS374	2.75
8259A	7.30	4035	.95	4511	1.39	74C157	2.10	74LS75	.68	74LS192	.98	74LS375	.69
8271	60.00	4037	1.95	4512	1.39	74C160	2.39	74LS76	.45	74LS193	.98	74LS377	1.95
8275	32.95	4040	1.29	4514	3.95	74C161	2.30	74LS78	.65	74LS194	1.15	74LS385	1.95
8279	10.80	4041	1.25	4515	3.95	74C163	2.39	74LS83	.99	74LS195	.95	74LS386	.65
8279-5	10.80	4042	.95	4516	1.69	74C164	2.39	74LS85	1.19	74LS196	.89	74LS390	1.95
8282	6.70	4043	.85	4519	.99	74C173	2.59	74LS86	.45	74LS197	.89	74LS393	1.95
8283	6.70	4044	.85	4520	1.39	74C174	2.75	74LS90	.75	74LS221	1.49	74LS395	1.70
8284	5.85	4046	1.75	4522	.99	74C175	2.75	74LS92	.75	74LS240	1.95	74LS399	2.95
8286	6.70	4047	1.25	4526	1.15	74C192	2.39	74LS93	.75	74LS241	1.90	74LS424	2.95
8287	6.70	4048	.99	4527	1.75	74C193	2.39	74LS95	.88	74LS242	1.95	74LS668	1.75
8288	25.40	4049	.69	4528	.99	74C195	2.39	74LS96	.98	74LS243	1.95	74LS670	2.29
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	1N4749	24v	"	.25
	1N753A	6.2v	500 mW Zener	.25
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	1N759A	12v	"	.25
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	16-pin	pcb .30	ww	.70
	18-pin	pcb .35	ww	.95
	20-pin	pcb .45	ww	1.05
	22-pin	pcb .50	ww	1.15
	24-pin	pcb .55	ww	1.25
	28-pin	pcb .60	ww	1.45
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	25 Amp Bridge		200-prv	2.25

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	2N2907A	PNP	.35
	2N3906	PNP (Plastic)	.25
	2N3904	NPN (Plastic)	.25
	2N3054	NPN 4A 90v	.60
	2N3055	NPN 15A 60v	.75
	TIP125	PNP Darlington	.95
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	DL728B	doub 7 seg 5" com-cathode	2.50
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C MOS

QTY			QTY			QTY			QTY		
	4000	.40		4019	1.15		4041	1.15		4081	.55
	4001	.35		4020	1.25		4042	95		4082	.60
	4002	.35		4021	60		4043	.90		4093	.90
	4006	95		4022	1.25		4044	1.20		4098	2.25
	4007	30		4023	.45		4046	1.50		4507	1.15
	4008	.55		4024	.95		4047	1.50		4511	.90
	4009	.75		4025	.45		4048	2.50		4512	1.25
	4010	.75		4026	2.95		4049	.65		4515	2.50
	4011	.45		4027	.85		4050	.65		4518	1.50
	4012	.25		4028	.95		4052	.75		4519	.85
	4013	.65		4029	1.00		4053	1.50		4522	1.50
	4014	.95		4030	.95		4060	2.25		4526	1.50
	4015	.95		4033	2.50		4066	1.25		4528	1.50
	4016	.55		4034	3.75		4069/74C04	.45		4529	.95
	4017	.95		4035	1.75		4070	.60		MC14409	12.50
	4018	.75		4040	1.10		4071	.40		MC14419	4.85
							4072	.50		74C151	2.50

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1771 Disc Controller $22.50

8T13	1.50
8T23	2.50
8T24	2.50
8T97	1.50
74S188	4.50
1488	1.75
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TMS4044	5.95
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— TTL —

QTY			QTY			QTY			QTY		
	7400	.25		7493	.60		74H10	.35		74LS74	.65
	7401	.35		7494	.75		74H11	.45		74LS75	.95
	7402	.35		7495	.60		74H15	.45		74LS76	.75
	7403	.30		7496	.55		74H20	.45		74L86	.75
	7404	.35		74100	1.75		74H21	.35		74LS90	.95
	7405	.35		74107	.55		74H22	.40		74LS93	.70
	7406	.35		74111	3.00		74H30	.40		74LS107	.90
	7407	.65		74121	.55		74H40	.45		74LS109	1.00
	7408	.50		74122	.70		74H50	.40		74LS123	1.20
	7409	.35		74123	.70		74H51	.40		74LS138	1.00
	7410	.35		74125	.75		74H52	.40		74LS151	1.00
	7411	.35		74126	.75		74H53	.45		74LS153	1.15
	7412	.35		74132	.75		74H55	.45		74LS154	2.50
	7413	.45		74141	.90		74H72	.45		74LS157	1.15
	7414	.65		74145	1.35		74H74	1.50		74LS180	1.00
	7416	.35		74150	1.15		74H101	.95		74LS161	1.50
	7417	.40		74151	.95		74H103	.55		74LS164	.90
	7420	.45		74153	.95		74L00	.60		74LS193	1.00
	7426	.35		74154	1.40		74L02	.80		74LS195	2.00
	7427	.40		74156	.70		74L03	.35		74LS196	2.50
	7430	.40		74157	1.50		74L04	.90		74LS244	1.50
	7432	.65		74158	1.50		74L10	.30		74LS245	1.50
	7437	.45		74161	1.50		74L20	.75		74LS253	.95
	7438	.50		74163	1.50		74L30	.55		74LS298	1.50
	7440	.40		74164	1.50		74L47	1.95		74LS367	1.50
	7441	.65		74165	1.10		74L51	.65		74LS368	.95
	7442	.65		74166	1.10		74L55	.85		74LS373	.95
	7443	.75		74175	.75		74L72	.65		74S00	.50
	7444	.75		74176	1.15		74L73	.70		74S02	.60
	7445	.75		74177	1.10		74L74	1.95		74503	.45
	7446	.75		74180	1.10		74L75	1.05		74S04	.60
	7447	1.50		74181	2.25		74L85	3.00		74505	.65
	7448	1.50		74182	.75		74L93	2.95		74S08	.80
	7450	.35		74190	1.25		74L123	2.95		74S10	.65
	7451	.50		74191	1.25		74LS00	.30		74S11	.60
	7453	.25		74192	1.50		74LS01	.30		74S20	.60
	7454	.35		74193	1.50		74LS02	.30		74S22	.75
	7460	.40		74194	.95		74LS03	.30		74S40	.70
	7470	.35		74195	.95		74LS04	.40		74S50	.70
	7472	.40		74196	1.75		74LS05	.30		74S51	.75
	7473	.40		74197	.95		74LS08	.40		74S64	.35
	7474	.45		74198	1.50		74LS09	.60		74S74	.75
	7475	.45		74221	1.50		74LS10	.40		74S86	.75
	7476	.45		74298	1.50		74LS11	.40		74S112	.90
	7480	.60		74367	1.15		74LS20	.40		74S114	.85
	7481	.95		75107A	.95		74LS21	.50		74S133	.85
	7482	.95		75451	.85		74LS22	.45		74S140	.95
	7483	.75		75452	.85		74LS27	.40		74S151	.95
	7485	.75		75491	1.50		74LS32	.60		74S153	1.50
	7486	.55		75492	1.50		74LS37	.60		74S157	1.50
	7489	1.95		74H00	.40		74LS38	.65		74S158	1.50
	7490	.75		74H01	.40		74LS40	.70		74S194	1.75
	7491	.60		74H04	.90		74LS42	.75		74S196	2.00
	7492	.50		74H05	.55		74LS47	.95		74S257(8123)	1.95
				74H08	.90		74LS51	.95		74S287	3.95
										8131	2.75

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QTY			QTY			QTY		
	XR2206	3.95		LM320K15	1.65		LM340K24	1.50
	MCT2(E)	1.25		LM320K24	1.65		LM373	3.95
	8038	4.50		LM320T5(7905)	1.65		LM377	1.95
	LM201	2.00		LM320T12	1.65		78L05	.75
	LM301	.95		LM320T15	1.65		78L12	.75
	LM308	1.25		LM323K	4.95		78L15	.75
	LM309H	1.50		LM324	.85		78M05	1.95
	LM309(340K-5)	1.50		LM337T	2.25		LM380(8-14 Pin) 386N	1.19
	LM310	.85		LM339	.95		LM709(8-14 Pin)	.75
	LM311 (8-14 Pin)	1.50		7805(340T5)	1.50		LM711	.75
	LM317T	2.25		LM340T12	1.50		LM723	.75
	LM318N	1.60		LM340T15	1.50		LM725	2.95
	LM320H6	.89		LM340T18	1.50		LM739	1.95
	LM320H15	.89		LM340T24	1.50		LM741(8-14)	.55
	LM320H24	.89		LM340K12	1.50		LM747	1.25
	LM320K5	1.65		LM340K15	1.50		LM1307	1.75
	LM320K12	1.65		LM340K18	1.50		LM1458	.65
							LM3900	.95
							LM3909	1.50
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10 day trial: We recognize that "do it yourself" isn't for everybody. So, order the book and look it over; if the building process looks too complex, return the book in resaleable condition within 10 days for full refund.

"Home Recording for Musicians". This is the book that has shown thousands of musicians how to make quality recordings using common, inexpensive equipment. Covers mixing, miking, consoles, noise reduction, how to build a very high performance monaural mixer, and much more. 190 pages, softcover; **$9.95.**

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Project #31 - Preamp/Input Selector Module. Gain variable from X1 to X20; also includes input selector switch, and low pass rolloff filter to minimize microphone "Popping". **$19.25.**

Project #32 - Tone Control Module. Bass/Treble, Boost/Cut shelving type equalizer. **$19.25.**

Project #33 - Noise Gate Module. Suppresses tape hiss and also allows for special effects. **$33.35.**

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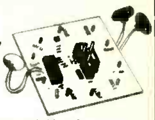
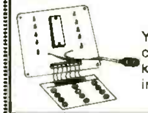
Computer Perfect



Has 10 LEDS and tone signals. You try to guess correct button sequence to light LEDS in order. Requires two 9V batteries. With instructions. C24404 **$4.50**

Computer Mind



You guess the secret number stored in computer chip memory. Has 10 LEDS and keyboard. Requires one 9V battery. With instructions. C24405 **$3.75**

Starsound Board

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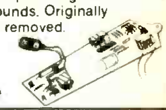

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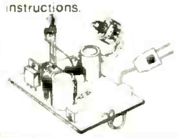

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74LS22N	35
74LS28N	35
74LS30N	35
74LS33N	60
74LS38N	50
74LS74N	45
74LS75N	65
74LS90N	.60
74LS93N	.75
74LS95N	1.00
74LS107N	45
74LS112N	45
74LS113N	45
74LS132N	89
74LS136N	50
74LS151N	.75
74LS155N	79
74LS157N	1.10
74LS162N	1.10
74LS163N	1.10
74LS174N	1.15
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8T24	3.50
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CDP1802D	35.00
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10 per type	03
25 per type	025
100 per type	015
1000 per type	012
350 piece pack 5 per type	6.75

½ watt 5% per type 05

IC SOCKETS

Solder Tin PIN	1 UP	Low Profile PIN	1UP
8	15	22	30
14	14	24	35
16	16	28	42
18	27	36	58
20	29	40	57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	46	24	93
16	49	28	1.00
18	67	40	1.23

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2.4576 MHz	4.50
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6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
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MAN3		CC	125	39
MAN72 74	CA	CA	300	1.00
DL704		CC	300	1.25
DL707 DL707R		CA	300	1.00
DL727 728	CA	CC	500	1.90
DL747 750	CA	CC	600	1.95
FND359		CC	357	70
FND500 507	CC	CA	500	1.35
FND503 510	CC	CA	500	90
FND800 807	CC	CA	800	2.20
3 digit Bubble				60
10 digit display				1.25
7520 Clairex photocells				39
TIL311 Hex				9.50
MAN3640		CC	30	1.10
MAN4610		CA	40	1.20
MAN4640		CC	40	1.20
MAN4710		CA	40	95
MAN4740		CC	40	1.20
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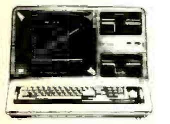

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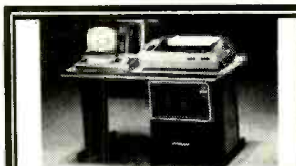

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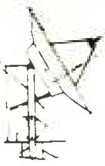

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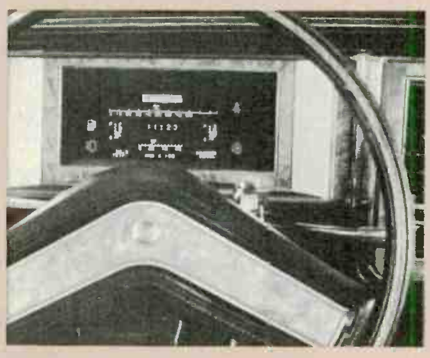
DOMESTIC BROADCASTING SHOULD USE THE NEW AM CHANNELS allocated by the 1979 World Administrative Radio Conference says the National Association of Broadcasters. In a filing with the FCC, the NAB said planning should consider the present and future operation of Travellers Information Service stations, the nonbroadcast uses of the 1605-1705-kHz band during the interim period and the post-implementation sharing of the 1625-1705-kHz band. Following the implementation, the 1605-1625-kHz band will be used exclusively for AM broadcasting. Plans for relocation of the interim frequency services should be made immediately, according to NAB.

A RECALL OF TEST LEAD KITS sold in Radio Shack stores as Cat. No. 270-332 from 1971 through June, 1980, has been announced by the company. Metal that remains exposed when the probe is fully inserted into lead wire tips presents users with a potential shock hazard. The units should be returned to the nearest Radio Shack store for a full refund.



A CATHODE RAY TUBE FOR VEHICLE DASHBOARD use has been developed by Zenith Radio Corp. to provide a compact, flexible instrument display. The CRTs present data and graphics in an easily readable format in indirect or direct sunlight. The 3" x 8" display is 7.7" deep and is designed to interface with many microprocessor-controlled automotive electrical systems. In six colors, it can display speed, fuel, coolant levels, temperature, and oil pressure, miles-to-empty, estimated times of arrival, and other related parameters.

CONGRESSMEN TALKED TO VOTERS BY SATELLITE recently when the House Subcommittee on Telecommunications participated in a "live" communications demonstration of the Warner Amex Cable two-way QUBE system. Six members of the House sat in a room in the Rayburn House Office Bldg. and engaged in a meeting with voters sitting in their homes in Columbus, OH. Warner-Amex is presently constructing QUBE two-way systems in Pittsburgh, Cincinnati, Houston, Dallas, and St. Louis.

A FREE INFORMATION NETWORK of over 100 small computers nationwide is now available to anyone with a computer terminal, a telephone, and a compatible modem, says Novation, Inc. (Tarzana, CA). Novation's staff has compiled a list of the computers and the telephone numbers that access them. They are located in 29 states and contain specialized information on medicine, photography, astronomy, education, and other fields, including geneology and commodity trading. In addition, callers can input data to the computers. Novation offers a free dial-up directory of the computers: dial 213-881-6880 and when the message LOGON PLEASE appears, type in the word cat.

ELECTRONIC CARS HAVE BEEN GIVEN A BOOST by an inverter for induction motors developed by Hitachi as an alternative to the dc motor driven by a thyristor chopper. Cars using induction motors controlled by variable-voltage/variable-frequency inverters are reported to be more compact, lighter, and easier to maintain. They are already in use in Europe. The 1500-volt inverter introduced by Hitachi is said to be capable of smooth control of motor torque and speed, as well as simple regenerative braking action.

AID TO REACT, the volunteer CB organization specializing in highway safety, is being provided by Antenna Specialists Co. in the form of a $1.00 contribution for every purchase of the new Model M-710 Formula-1 mobile CB antenna. The new Antenna Specialists model is 61 3/8 inches long, has hardware for trunk-lip or standard roof mounting and comes with 17 feet of connection cable.

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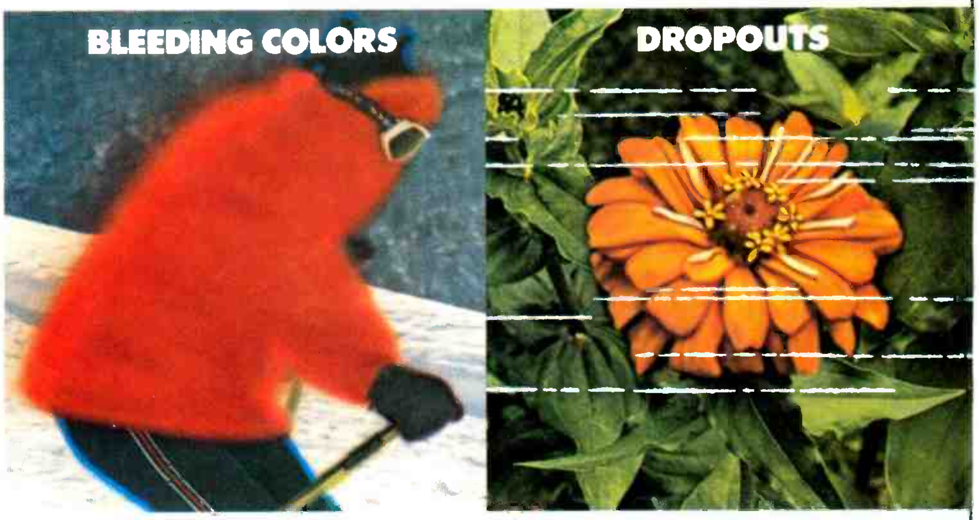

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