SPECIAL ISSUE: VIDEO ELECTRONICS

Radio-Electronics

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COMPUTERS - VIDEO - STEREO - TECHNOLOGY - SERVICE

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NEW! Regency®‡ MX3000

List price $299.95/**CE price $199.00**
6-Band, 30 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Bands: 30-50, 144-174, 440-512 MHz.
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5-Band, 6 Channel • Handheld crystal scanner
Bands: 30-50, 146-174, 450-512 MHz.
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Frequency range: 26-27, 30-108, 108-136 AM, 144-174, 440-512, 806-881 MHz., 1.0 GHz., 1.1 GHz.
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NEW! JIL SX-200

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8-Band, 16 Channel • No-crystal scanner
Quartz Clock • AM/FM • AC/DC
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NEW! JIL SX-100

CE price $134.00/***NEW LOW PRICE***
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Frequency range: 30-54, 140-174, 410-514 MHz.
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List price $329.95/**CE price $209.00**
6-Band, 20 Channel • No Crystal scanner
Search • Lockout • Priority • Scan delay
Sidelit liquid crystal display
Frequency range: 30-50, 144-174, 440-512 MHz.
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NEW! Regency® D810

List price $399.95/**CE price $259.00**
8-Band, 50 Channel • Crystalless • AC only
Bands: 30-50, 88-108, 118-136, 144-174, 440-512 MHz.
This scanner offers Public service bands, plus Aircraft and FM broadcast stations. You can listen to Bach or a Boeing 747, the Rolling Stones or the riot squad, or any of 50 channels. Plus special direct access keys let you listen to police, fire, emergency, or any of your favorite channels just by pushing a button.

Regency® R1040

List price $199.95/**CE price $129.00**
6-Band, 10 Channel • Crystalless • AC only
Frequency range: 30-50, 144-174, 440-512 MHz.
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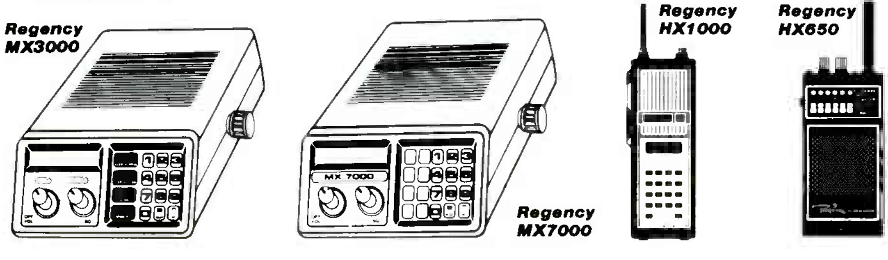

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CIRCLE 35 ON FREE INFORMATION CARD

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

DECEMBER 1983 Vol. 54 No. 12

SEASON'S GREETINGS

The editors and staff of Radio-Electronics join in sending holiday greetings and our best wishes for a happy new year

ON THE COVER

If you're like many home-video hobbyists, your videotapes leave something to be desired. Your colors may appear washed out, the picture is filled with noise, or, perhaps your edits are far from smooth. Well, there's a way around those problems, whether you're making new tapes or duplicating old ones. With the color processor you can create fade-ins and fade-outs, reduce background noise, and you can vary color saturation from black-and-white to full chrominance. The article describing its construction—which is only one of our special video features this month—begins on page 49.

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

VIDEOMOVIE

The surprise hit of Berlin's big Audio and Video Fair was *Videomovie,* a combination VCR and camera using the VHS-C cassette. Obviously introduced to compete with Sony's *Betamovie, Videomovie* weighs only 4.2 pounds without cassette and battery, 4.6 pounds with them —more than a pound lighter than Betamovie when empty, almost two pounds less when loaded. (See left-hand photo.)

But *Videomovie* is a complete self-contained system. It includes a 1/2-inch Saticon pickup tube, 6:1 motorized zoom, 1/2-inch electronic viewfinder, and all VCR controls. *Betamovie,* which has the same power zoom, is a record-only device with a through-the-lens optical viewfinder. *Betamovie* has the advantage in recording time, since it accommodates a full-size Beta cassette, while *Videomovie* uses the small version of the VHS cassette which will record only for 20 minutes (30 minutes in the European version). The VHS-C cassette can be played back on a standard VHS recorder using a cassette adaptor.

Videomovie, so far made only by JVC, but to be offered under a variety of brand names, is scheduled for marketing next year—announced first in Europe, but destined to come to the U.S. as well—while Betamovie is already in limited distribution. The introduction of *Videomovie* could cause some manufacturers to rethink their plans to market the new 8-mm video format next year. In fact, there is considerable sentiment in Japan to put 8-mm back on the drawing board and re-engineer it to use a more sophisticated recording technique known as Timeplex, which would make the same tapes playable on NTSC, PAL, or SECAM color sets and accommodate future developments such as digital TV and high-definition as well. The re-engineering of the 8-mm standard would make it probable that no new VCR format would emerge for three or four years.

5-INCH PROJECTION TV

"Giant screen" and "projection TV" are no longer synonymous—not since Panasonic displayed a prototype five-inch projection set. The little set is designed for use as a desktop monitor and folds into a compact size not more than three inches high. (See right-hand photo.) When opened, a translucent screen pops up and three tiny projection tubes two inches in diameter (one for each color) throw a well-defined color picture on the screen, over five foot-lamberts bright. The whole thing weighs less than seven pounds and operates from AC or battery. Panasonic declined to give out price or availability date.

NEW TUBE FAMILY

The most dramatic trend for 1984 is the new series of FS (for *F*lat *S*quare) picture tubes that is appearing in color sets for the first time. Pioneered by Toshiba, and destined eventually to spread to all other manufacturers, the new tubes have extremely rectangular corners and a virtually flat faceplate contour. They are specifically designed for better presentation of computer graphics, as well as more aesthetic set design and wider viewing angle. Because of the squarer corners, diagonal measurement is increased — the 20-inch FST replacing the existing 19-inch, 14-inch replacing 13-inch and eventually (probably next year) a 26-inch FST for applications that currently use 25-inch. The first sets using the new tube configuration are several 14- and 20-inch models from Toshiba and a 20-inch Toshiba-made monitor-receiver sold under the Sears brand, to be followed shortly by a 20-inch from Hitachi, with other brands to be phased in later in the year. **R-E**

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100 MHz scope, counter, timer, multimeter: All one integrated system.

100 MHz dual time base scope. 3.5 ns risetime; sweeps from 0.5 s to 5 ns/div; alternate sweep; ±2% vertical/horizontal accuracy; vertical sensitivity to 2 mV/div @ 90 MHz.

9-digit fluorescent display. Digitally accurate readouts accompany the CRT waveform. Error messages and prompts also appear on the display.

Dc volts and ac coupled true RMS volts. Measured through the Ch 1 scope input.

Gated measurements. Use the scope's intensified marker to measure frequency, period, width and to count events within specified portions of the signal.

Auto-ranged, auto-averaged counter/timer. Frequency, period, width, delay time, Δ-time, plus totalize to more than 8 million events —with 7 digits plus exponent displayed.

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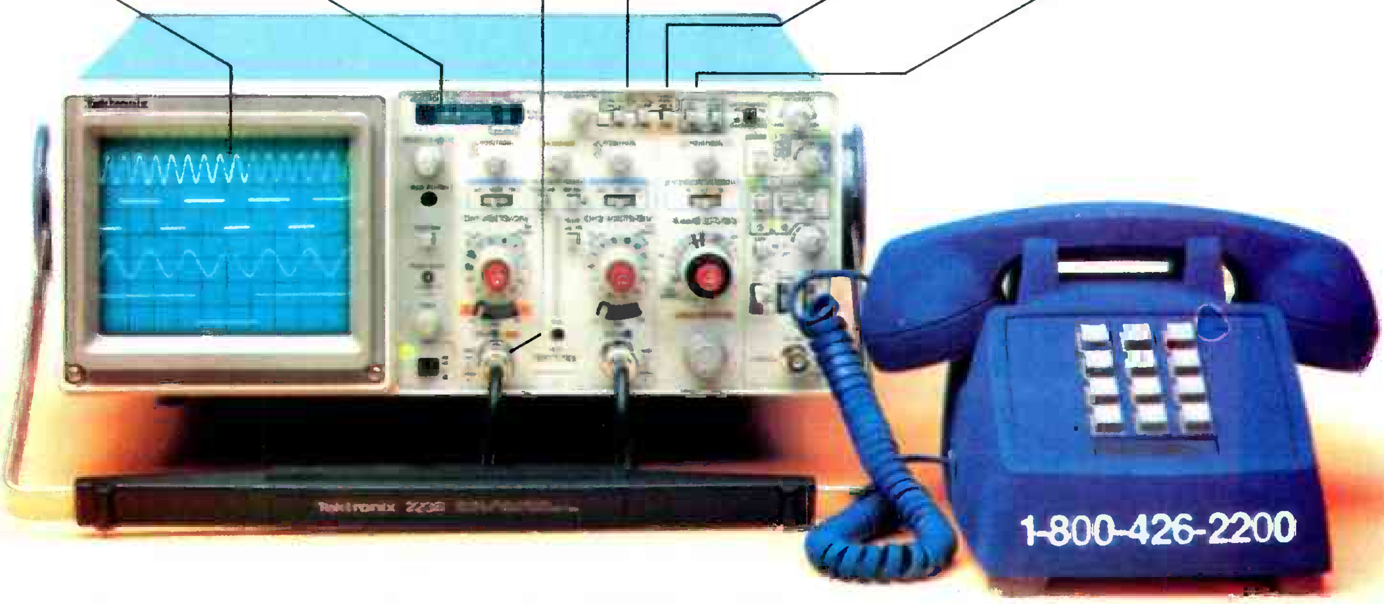

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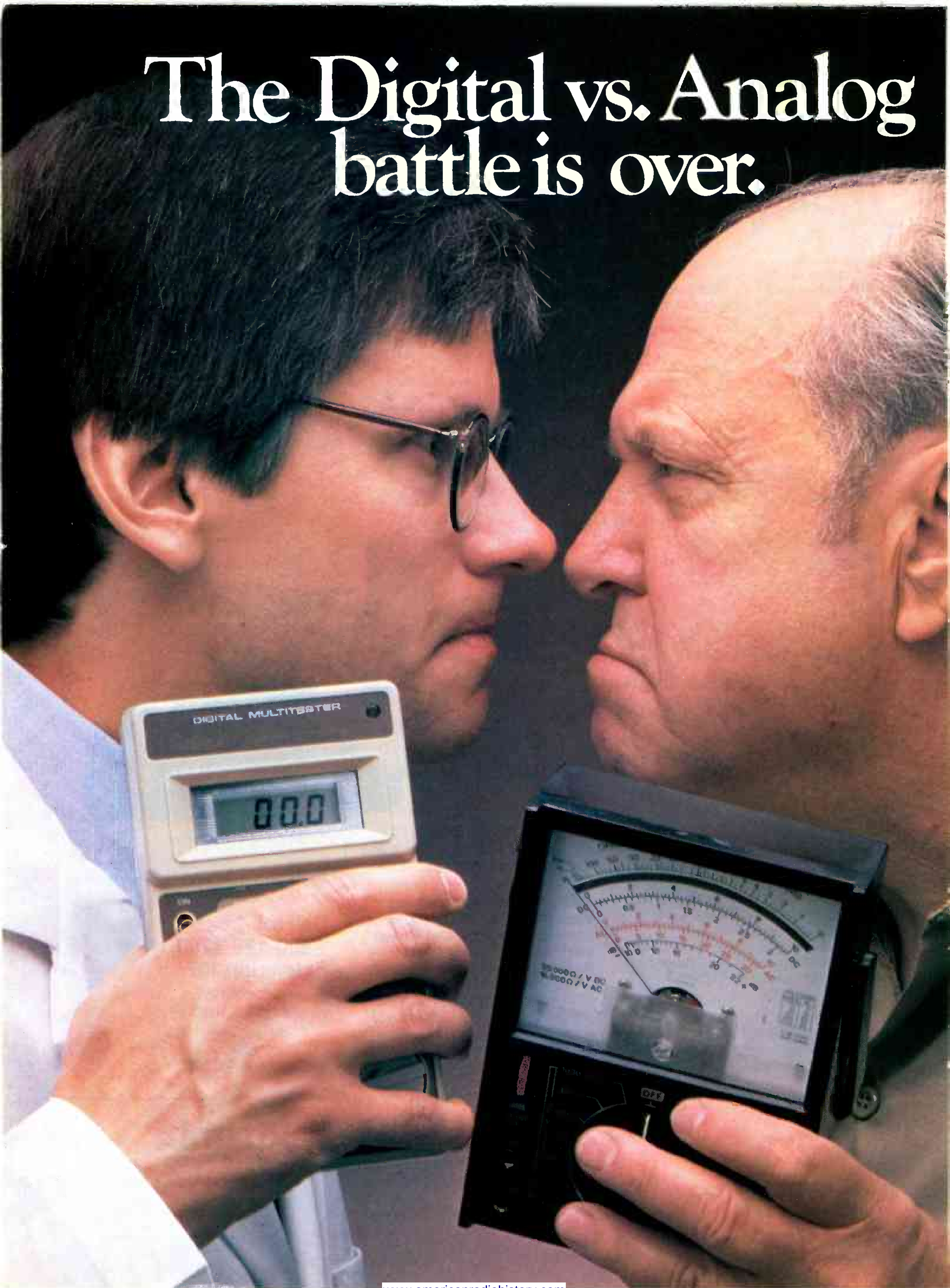
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The new Fluke 70 Series.

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Choose from three new models. The Fluke 73, the ultimate in simplicity. The feature-packed Fluke 75. Or the deluxe Fluke 77, with its own multipurpose protective holster and unique "Touch Hold" function (patent pending) that captures and holds readings, then beeps to alert you.

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Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, mA, diode test
Autorange	Audible continuity	Audible continuity
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3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
		3-year warranty
		Multipurpose holster

* Suggested U.S. list price, effective October 1, 1983.

FLUKE®

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WHAT'S NEWS

Computer now transforms mechanics into experts

A computerized troubleshooting system that promises to make an expert out of the most inexperienced mechanic has been demonstrated by scientists of the General Electric Co. to the annual meeting of the American Association for Artificial Intelligence, in Washington, DC.

The unit—a small computer and its associated hardware—combines recent advances in artificial intelligence with the accumulated expertise of a skilled engineer.

For the "body of knowledge" of the system, a team of computer specialists spent several months interviewing GE's top service engineer, David I. Smith, an expert with more than 40 years of experience in troubleshooting diesel-electric locomotives. The team then devised a custom-software program that made it possible for the computer to make the relevant portions of that information available to the repair mechanic on demand.

The system questions the repairman as to symptoms, displaying a list of possible malfunctions. When the mechanic selects one, the computer asks more detailed questions to pinpoint the problem. The system then operates along human thought lines, reasoning: "If this and this are true, then this..." and directs the mechanic toward the probable trouble. It can then lead him through the repair presenting detailed, computer-aided drawings of parts and sub-systems and specific "how-to" instructions.

CATS-1, GE'S NEW COMPUTERIZED TROUBLESHOOTER that makes the inexperienced locomotive mechanic into an expert. It can ask questions, diagnose problems, show detailed drawings of the locomotive's components (screen at right), and even demonstrate repair procedures on a video monitor (screen at left). Francis S. Lynch, head of the team that devised the software program, is seated before the instrument; David Smith, whose expertise was tapped to supply the computer with its body of knowledge, stands behind it.

The electronic troubleshooter is expected to have a major impact on the locomotive-service field, by slashing locomotive downtime as well as repair costs.

Personal computer sales to quadruple in Japan

By 1990, says the Japan Electronics Industry Association (JEIA), Japan's personal computer industry will have increased more than four times. Based on a survey of Japan's 12 leading computer manufacturers, shipments are expected to top five million units by the end of the decade, nearly seven times the 1982 figure of 762,000 units. Gross sales volume is expected to rise about 4.3 times, to more than $4.1 billion.

Navigation satellites are aiding science

Due to a development by time and frequency scientists at the National Bureau of Standards (NBS), the Global Positioning Satellites (GPS) of the Department of Defense will be able to perform a new and valuable function.

The GPS's give the United States a world-wide, state-of-the-art navigation system. In addition to that function, NBS scientists are using them to synchronize clocks at remote locations to less than 10 billionths of a second (10 nanoseconds). Precise synchronization is necessary for clocks that serve navigation, space probes, and power networks, and a great deal of energy and money is needed to keep them synchronized.

To use the GPS satellites, it was necessary to develop a satellite receiver with a billionth-of-a-second stability in the delay time of its receiver circuit. NBS scientists designed such a receiver, and the computer software to go with it.

With that equipment, they have compared the atomic clocks at NBS in Boulder, CO, with those of the U.S. National Observatory in Washington, DC, 1500 miles away, with an uncertainty of less than 10 nanoseconds.

The system is also being used for synchronizing (equalizing the frequency of) the Jet Propulsion Laboratory's deep-space tracking stations at Gladstone, CA; Madrid, Spain; and Canberra, Australia. Frequencies are now being equalized wth accuracy ten times that required by JPL, and at a fraction of the former cost.

All the components that make that high-accuracy comparison possible will soon be available for commercial use. Interested persons may obtain information from D. W. Allan, Time and Frequency Division, National Bureau of Standards, 325 Broadway, Boulder, CO, 80303.

New hole-making method for color display masks

Two RCA engineers have been issued a patent for an improved method of etching the tiny holes in shadow masks for the color CRT's used to display computer data.

Shadow masks for display or TV CRT's are normally made by moving a continuous strip of steel, or other material, through an etching chamber, where the sheet is sprayed with etching fluid on both sides. (The two sides of the sheet are covered with a photo-resist with openings that are registered with each other.)

Since the effects of the etch tend to spread out, as well as pierce through the material, various methods have been tried to keep the holes as small as possible to improve the resolution of the image. The commonest approach has been to do most of the etching on one side, then finish by etching in only a short distance from the other side that produces a tapered hole with a small, very clearly defined aperture.

The small-hole side has usually been protected during the earlier stages of etching by coating it temporarily with etch-resistant material, or by covering it with a plastic sheet during the first stages of the etching.

The new patent, No. 4,389,279, places a wall behind and spaced from the material being etched. End seals are placed between the wall and the edges of the strip. The pressure in the chamber behind the strip can be made higher than the pressure on the other side of the strip, keeping out all etching fluid.

When the process is nearly com-

continued on page 10

look closer at a DSM!

Here's a flat-panel scope, a transient recorder, and a 32-range DMM in a compact 4 lb. box.

Now you can use one instrument to capture 2 μs transients, evaluate their waveform characteristics on a flat-panel LCD, and simultaneously measure their true RMS values.

It's all made possible with the first in a new class of instruments from BBC, the Digital Scope Multimeter, Model M 2050 DSM. By applying precision European engineering to the measurement needs of design and service engineers, BBC is revolutionizing test and measurement.

Large Flat-Paneled Scope Display

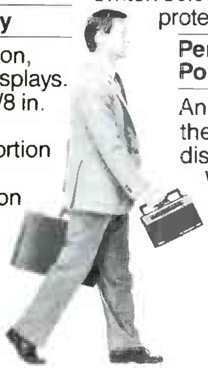
The LCD provides excellent resolution, 128 dots by 64 dots, for waveform displays. It measures 4-5/8 in. (118 mm) x 1-5/8 in. (42 mm). Simultaneous display capabilities let you use the scope portion of the LCD to evaluate signal characteristics while the DMM portion displays the true RMS signal value. Your measurement evaluations will be more accurate and consistent.

Transient Recording

Two independent memories of 512 words (horizontal dots) with 8-bit vertical resolution let users capture information about events ranging from 2 μs to 1-hr in duration. Five selectable trigger points (0, 25%, 30%, 75%, and 100%) give users options as to how much data is stored before and after the triggering event.

True RMS Multimeter Measurements

You get 15 voltage ranges (to 650V), 15 current ranges (to 10A), and two resistance ranges (200Ω and 20kΩ). True RMS and Averaging RMS modes are switch selectable. All ranges are overload-protected (Spikes to 6,000 V or 60A).



Performance Packed and Portable

An impact resistant case protects the M 2050 DSM. When open, the display angle is easily adjustable. When closed, the display and the controls are protected, the meter shuts itself off, and the tilt bail becomes a carrying handle.

Affordable and Available

The price of the M 2050 DSM is only $1,795.00 (for the optional analog output, add $200.00). Rechargeable batteries for 8 hours of portable operation are available for $35.00

BBC's M 2050 DSM and other innovative instruments are available via select distributors throughout the U.S. If your instrumentation supplier doesn't carry BBC yet, we'll gladly tell you who does. Call toll free:

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WHAT'S NEWS

continued from page 8

plete, etching is allowed to take place on both sides of the strip. Thus the holes on the wall side are etched only a small portion of the strip's total thickness, making for smaller and more precisely defined holes. Beside making for greater resolution in the display, the new method is not as expensive nor as difficult to operate as are the older methods.

New transpacific cable to use optical fibers

Japan's international communications company, KDD; American Telephone and Telegraph (AT&T), and 25 other companies have agreed on 1988 as the target-completion date for a new transpacific submarine cable. Work is expected to begin in mid-1984.

The new cable will make a break with all previous technology—it will use optical fibers and transmit at visible-light frequencies.

The new cable is called TPC 3. (There were two earlier cables to Japan. TPC 1 runs from Japan to Hawaii via Guam, Wake, and Midway islands, with 138 telephone circuits; TPC 2 from Okinawa to Hawaii via Guam, with 845 telephone circuits.) The number of circuits that TPC 3 will carry has not yet been set, but it is estimated that it will be more than 4,000.

The exact route of the new cable has not yet been decided. It has been proposed that it run direct from Japan to Hawaii, a distance of more than 4,000 miles, on its way to the west coast of the United States. Laying the cable will be a major engineering feat. Even if the shallowest route is selected, it will be necessary to lay the optical-fiber cable at depths of 16,500 to more than 19,000 feet.

Echo cancellers improve satellite transmissions

RCA Americom reports that echo cancellers are installed on all its satellite private lines to eliminate the annoying echo or clipping that has been characteristic of satellite transmissions in the past. It was the first satellite carrier to install echo cancellers on all retail circuits at no cost to the customer, says Americom president Dr. James A. Tietjen, and is the only carrier that continues to provide that service at no cost.

The Satcom satellite system now carries more than 10,000 dedicated voice lines, Dr. Tietjen stated. Those lines are being used by direct customers of RCA Americom, and by other common carriers marketing both private-line and metered services for business and residential long-distance telephone calls.

The superior quality of satellite service as compared to terrestrial links is credited for that growth. "Our leased channel availability is consistently over 99 percent," Dr. Tietjen reported. "To the extent that service interruptions do occur, in 75 percent of the cases they are related to the local loops connecting the customer's telephone to our central terminal office. In any event, RCA Americom assumes full responsibility. Our policy is to act on customers' complaints immediately, and to notify them every two hours of our progress in service restoration."

FCC approves pager for use with SCA's

The Federal Communications Commission has approved the first pager for use with the sub-carrier channels of FM radio stations. The decision opened the door to paging over sub-carrier channels, with its benefits of lower costs and greater range.

The tone-and-voice pager approved is the *TVC-1*, distributed by Reach, Inc., of Lincoln, NE.

TVC-1 has an audio output of 150 mW and runs up to 12 months without a battery change. Group-calling capability, a vibrator operated independently of the voice signal, and an ON/OFF switch are optional equipment.

Information on the *TVC-1* can be obtained from Reach, Inc., 301 S. 68th St., Lincoln, NE 68510.

Fiber optics has uses outside communications

Non-communication or short-haul communications uses for fiber optics may become a half-billion-dollar market in the near future, according to Frost & Sullivan, a market research organization based in New York and London.

Those applications, in computer systems, instrumentation, process control, local-area communications networks, and the military will generate $475 million in annual component sales by 1990, as compared to only $47 million last year, says Frost & Sullivan in a 255-page report, "The Non-Telecommunications Fiber Optic Component Market."

Components, says the report, usually need not be the same as needed for telecommunications. For short-haul uses, LED emitters may be used instead of laser diodes and PIN photo diodes instead of the costly avalanche types needed in telecommunications. But the short-haul transmission environment may be much more hostile than long distance, also affecting components needed to do the job.

First digital TV sets shown in Europe

The world's first production color-television sets using digital signal-processing techniques were shown in public at the International Radio and Television Show in West Berlin, last September.

Both picture and sound signals are processed digitally, with claimed advantages in long-term picture-quality stability, true high-fidelity stereo sound, simplified inclusion of videotext, easier and more accurate service adjustments, and increased reliability.

The new sets were demonstrated by Standard Electric Lorenz, an ITT company, and are being sold under the brand names of ITT and Graetz.

Seven very-large-scale integrated circuits (VLSI), designed and patented by ITT Semiconductors Worldwide (Freiburg, Federal Republic of Germany) are being used to replace some 300 conventional components. The space saved by reducing the number of parts has been used to incorporate an enhanced audio section, with improved sound reproduction from a new bass-response system.

The new VLSI circuits will be licensed to major television manufacturers in Europe, Japan and the United States.

For a detailed report on the ICs and the digital TV set, see page 58.

R-E

Radio-Electronics

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See here for the many ways to say

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ZENITH VIDEO/AUDIO ACCESSORIES

Now, with Christmas just around the corner, Zenith introduces a whole host of video/audio accessories. And every one of them about as sensible and rewarding a gift as you could wish on anyone...including yourself.

Chief among them, perhaps, in terms of TV convenience is the Zenith Video Organizer that lets you switch—with pushbutton ease!—from one program source to another without manually changing cable connections.

Individually packaged and clearly labeled, too, are such TV accessories as dust covers, video tape ID kits, cassette storage modules, signal splitters, attenuators, terminators, A-B switches, "F", mini and other types of plugs and jacks in virtually any combination ...plus cables in a variety of lengths, each with gold-electroplated connectors.

Also included in this, the biggest, broadest-ever Zenith line of video, audio and telephone accessories, are indoor and outdoor antennas...super lightweight stereophones ...and the Zenith Spike Suppressor to protect the TVs, home appliances, and solid-state electronics in your home from damaging high-voltage surges.

Now's the time to check on these new Zenith video/audio accessories for your Christmas shopping or hinting list. They're at your dealer's proudly bearing TV's leading name in performance and reliability. Go see. And remember, Zenith sends you!

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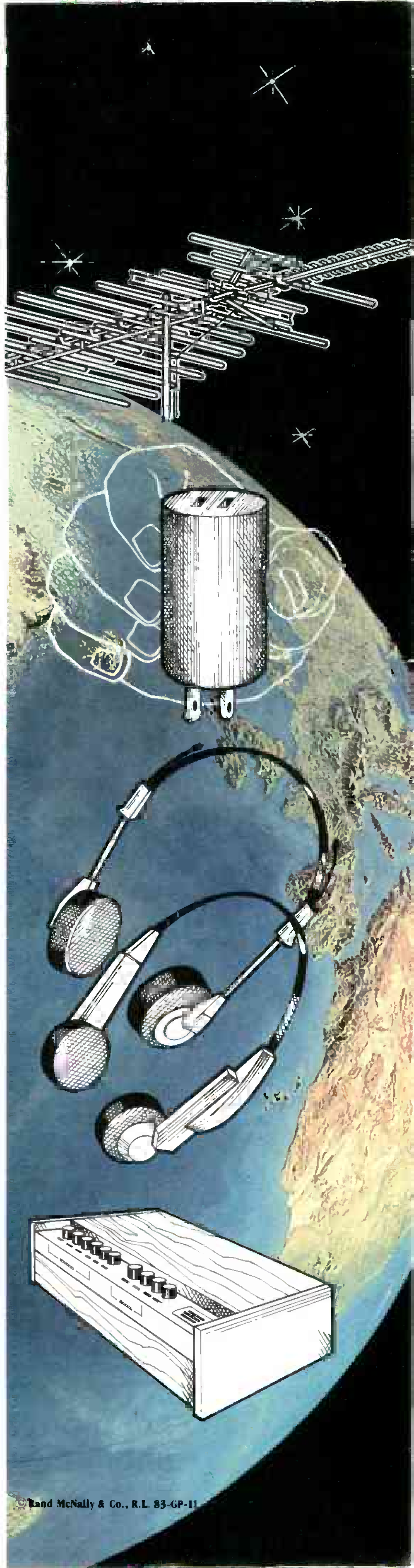
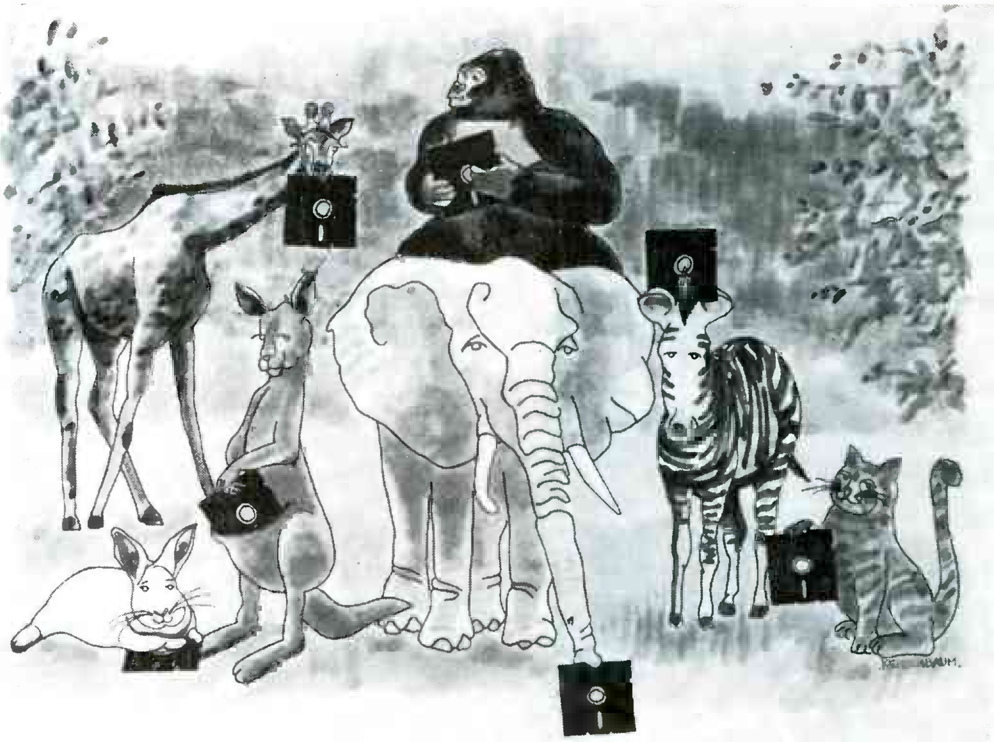


Diskette Users...

When you've heard from all the animals in the diskette zoo, but you need fast delivery and high quality diskettes...



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Choose your brand
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Wabash diskettes for as low as **$1.29 each**

Ultra diskettes for as low as **$1.39 each**

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8" SSSD IBM Compatible 128B/S, 26 Sector	F111	1.89	81726	1.99
8" SSSD Shugart Compatible, 32 Hard Sector	F31A	1.89	——	——
8" SSDD IBM Compatible (128 B/S, 26 Sectors)	F131	2.39	81701	2.49
8" DSDD Soft Sector (Unformated)	F14A	2.99	82701	3.19
8" DSDD Soft Sector (256 B/S, 26 Sectors)	F144	2.99	——	——
8" DSDD Soft Sector (512 B/S, 15 Sectors)	F145	2.99	——	——
8" DSDD Soft Sector (1024 B/S, 8 Sectors)	F147	2.99	82708	3.19
5¼" SSSD Soft Sector w/Hub Ring	M11A	1.49	50001	1.79
5¼" SSSD Same as above but bulk product	M11AB	1.29	00153	1.39
5¼" SSSD 10 Hard Sector w/Hub Ring	M41A	1.49	50010	1.79
5¼" SSSD 16 Hard Sector w/Hub Ring	M51A	1.49	50016	1.79
5¼" SSDD Soft Sector w/Hub Ring	M13A	1.79	51401	1.89
5¼" SSDD Same as above, but bulk product	M13AB	1.59	00096	1.59
5¼" SSDD Soft Sector Flippy (use both sides)	M18A	2.69	——	——
5¼" SSDD 10 Hard Sector w/Hub Ring	M43A	1.79	51410	1.89
5¼" SSDD 16 Hard Sector w/Hub Ring	M53A	1.79	51416	1.89
5¼" DSDD Soft Sector w/Hub Ring	M14A	2.69	52401	2.79
5¼" DSDD Same as above, but bulk product	M14AB	2.49	00140	2.49
5¼" DSDD 10 Hard Sector w/Hub Ring	M44A	2.69	52410	2.79
5¼" DSDD 16 Hard Sector w/Hub Ring	M54A	2.69	52416	2.79
5¼" SSDD Soft Sector w/Hub Ring (96 TPI)	M15A	2.59	51801	2.59
5¼" DSDD Soft Sector w/Hub Ring (96 TPI)	M16A	3.69	52801	3.69
5¼" Fileware Diskette for Apple® Lisa Computer	——	——	——	——

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CIRCLE 22 ON FREE INFORMATION CARD

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For you the diskette buyer, it's a jungle out there. There are so many different brands to choose from, you need to go on a safari to find a good brand at a reasonable cost. Fortunately, CE has already hunted for the best diskettes and offers you an excellent choice at a CE price. To save you even more, CE also offers bulk product where 100 diskettes are packed in the same box without envelopes or labels. Since we save packaging costs, these savings are passed on to you. Diskette envelopes are also available from CE.

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When the read/write heads on your computer are dirty, that can cause you a lot of grief. Now...with CE **Head Cleaning Diskettes**, you can clean the read/write heads on the diskette drives yourself in just 30 seconds. Each kit contains two head cleaning diskettes, and enough solution for 30 cleanings. Order # 5-CLE for 5¼" drives and order # 8-CLE is for 8" drives. Only $25.00 each. Also available from CE are **3M data cartridges**. The DC100A data cartridge is a small version of the DC300A data cartridge. The DC100A contains 140 feet of 0.150" tape in a package measuring 2.4 x 3.2 x 0.5 inches. Cost is $14.00 each. The DC300A is a pre-loaded tape cartridge containing 300 feet of one mil thick by ¼" computer tape. The DC300A costs $18.00 each. The DC300XL is an extra length data cartridge with 450 feet of tape. It is the same size and interchangeable with the DC300A. The DC300XL provides a total storage capacity of 34.5 million bits at 1600 BPI. The cost of the DC300XL is $22.00 each. If you need **extra mini-diskette envelopes**, CE sells super strong and tear resistant Tyvek® envelopes for $12.00 per 100 pack. Use order # TE-5 for a 100 pack of 5¼" diskette envelopes. **Smith-Corona TP-1 letter quality printers** are available in serial or parallel versions for only $529.00 each.

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Our diskettes are packed 10 disks to a carton and 5 or 10 cartons to a case. The economy bulk pack is packaged 100 disks to a case without envelopes or labels. Please order only in increments of 100 units for quantity 100 pricing. With the exception of bulk pack, we are also willing to accommodate your smaller orders. Quantities less than 100 units are available in increments of 10 units at a 20% surcharge above our 100 unit price. **Quantity discounts** are also available. Order 300 or more disks at the same time and deduct 1%; 500 or more saves you 2%; 1,000 or more saves 3%; 2,000 or more saves 4%; 5,000 or more saves 5%; 10,000 or more saves 6%; 50,000 or more saves 7%, 100,000 or more saves 8%, 500,000 or more saves 9% and 1,000,000 or more disks earns you a 10% discount off our super low quantity 100 price. Almost all our diskettes are immediately available from CE. Our efficient warehouse facilities are equipped to help us get you the quality product you need, when you need it. If you need further assistance to find the flexible diskette that's right for you, call the appropriate manufacturers compatibility hotline telephone number listed at the bottom of this ad. **Dealer inquiries invited.**

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To get the fastest delivery from CE of your computer products, we recommend you phone your order directly to our Computer Products Division and charge it to your credit card. Be sure to calculate your price using the CE prices in this ad. Written purchase orders are accepted from approved government agencies and most well rated firms at a 30% surcharge for net 30 billing. For maximum savings, your order should be prepaid. All sales are subject to availability, acceptance and verification. All sales are final. All prices are in U.S. dollars. Prices, terms and specifications are subject to change without notice. Out of stock items will be be placed on backorder automatically unless CE is instructed differently. Minimum *prepaid* order is $50.00. Minimum *purchase order* $200.00. All shipments are F.O.B. CE warehouse. No COD's. Non-certified and foreign checks require bank clearance.

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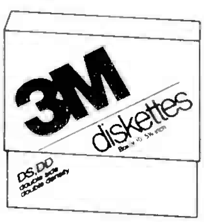

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8SSSD-32	1.94
8SSDD	2.49
8DSDD	3.14
—	—
—	—
8DSDD-1024	3.14
—	—
—	—
—	—
—	—
5SSDD-RH	1.94
—	—
—	—
5SSDD-10RH	1.94
5SSDD-16RH	1.94
5DSDD-RH	2.69
—	—
5DSDD-10RH	2.69
5DSDD-16RH	2.69
5SSDD-96RH	2.79
5DSDD-96RH	3.74
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Lifetime warranty
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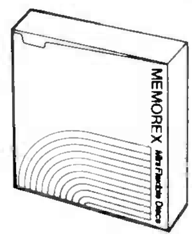

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3015	1.94
3090	2.49
3102	3.14
—	—
—	—
3104	3.14
—	—
—	—
—	—
—	—
3481	1.94
—	—
—	—
—	—
—	—
3491	2.69
—	—
—	—
—	—
—	—
3501	3.74
—	—

5 year warranty
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FD-105	2.09
FD-108	2.64
FD-109	3.29
FD-110	3.29
FD-111	3.29
FD-112	3.29
—	—
—	—
—	—
—	—
MFD-11	2.09
—	—
—	—
MFD-12	2.09
MFD-13	2.09
MFD-14	2.84
—	—
MFD-15	2.84
MFD-16	2.84
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800618	2.99
800605	3.89
800803	4.59
—	—
—	—
800839	4.59
801184	2.99
—	—
801186	2.99
801185	2.99
801187	3.19
—	—
—	—
801014	3.19
801188	3.19
802060	3.89
—	—
802062	3.89
802061	3.89
800439	3.89
802067	4.49
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CIRCLE 22 ON FREE INFORMATION CARD

SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

FCC VOTES ON BROADCAST TELETEXT

The Federal Communications Commission has adopted an "open environment" teletext policy, clearing the way for U.S. broadcasters to start commercial teletext services. NBC and CBS have already begun feeding national teletext databases down their networks—but it may be a year or more before decoders and circuit boards are available to permit widespread reception of the teletext signals.

The FCC ruling did not deal with technical standards for teletext. Among the controversial aspects of the FCC decision is the authorization to allow broadcasters to offer any type of teletext service they choose, including private, closed-user or pay-teletext transmission intended only for specific audiences, rather than for all TV-set owners. TV stations can sell or lease the teletext vertical-blanking-interval lines to outside organizations or they may set up separate subsidiaries to offer teletext.

Another aspect of the FCC's teletext ruling that is certain to generate further legal maneuvering is the decision not to require cable TV systems to retransmit broadcast teletext along with conventional TV programs on the same channel. The only exception comes if the teletext material is directly related to programming, such as back-up information or captions tied into the TV show.

The FCC ruling will allocate about 25% of the VBI to teletext: lines 14 to 18 and line 20; line 21 will remain dedicated to closed captioning. In 1988 the FCC will reexamine teletext, possibly opening lines 10 to 13 for teletext use.

HEADLINE NEWS

Keycom Electronic Publishing will package a news service as the information segment of Control Video Corp.'s online "Gameline" system. The Keycom feed will begin late this year. Control Video offers a roster of services (mostly downloaded videogames) through Atari videogame consoles equipped with CVC's "Master Module." Users can pick headlines and news stories by manipulating the videogame controller to pinpoint items they want to read on the quasi-videotex service.

TELETEXT SERVICE UPGRADED

Time Video Information Services' cable-teletext test will be upgraded late this year to include new telesoftware and an audio feature which will enhance videogames and other material by providing a synthesized voice to accompany on-screen actions. In addition, Time is adding software to allow scrolling of headlines in a 30-second cycle. Another new feature will allow users to program frames of specific interest so that information is automatically sequenced whenever a customer turns on the Time teletext service. During the next test phase (continuing in Orlando and San Diego) a printer will be provided to some users allowing them to get a paper copy of certain teletext data.

EQUIPMENT HIGHLIGHTS

The latest proliferation of satellite equipment continues the trend toward lighter, lower priced and special-application devices. Among recent items of special interest:

KLM Electronics' new **X-11** parabolic antenna and polar-trak mount features slide-in screen panels and aluminum support ribs. A motorized model with remote control console features a low-voltage DC motor. (KLM, PO Box 816, Morgan Hill, CA 95037.)

Winegard has two new earth-station packages: model *SC-5000* includes an eight-foot spun-aluminum antenna, polar mount with button-hook feed, and a 130° LNA. The *SC-5001* is upgraded with a 100° LNA and an azimuth adjustment jack with a turnbuckle adjustment. A new Winegard receiver (model *SC-7032*) features a digital channel-selector readout and fine-tune control and automatic polarity switching. (Winegard Co., 3000 Kirkwood St., PO Box 1007, Burlington IA 52601)

Regency Electronics has introduced a $595 Polaris *SA 9000* antenna, a deep-profile satellite dish with a 90-inch diameter and lightweight construction. The dish has a buttonhook feedhorn, Chapparal polarotor, polar mount, and a post mount option. (7707 Records St., Indianapolis, IN 46226).

Dexcel now offers a *DCR-4000* Low Noise Block Converter which can convert signals using a frequency synthesizer at the antenna. The receiver uses a 510 MHz PLL demodulator and a saw filter for better frequency response, phase response, linearity, and signal-to-noise ratio. (Dexcel, 2285 Martin Ave., Santa Clara, CA 95050.) **R-E**

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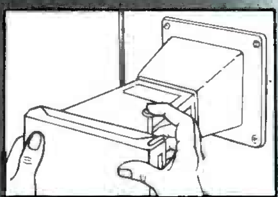
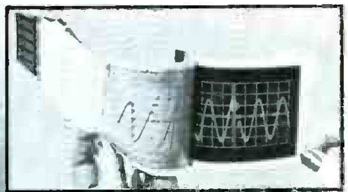


Available hand-held or bezel mount



OSCILLOSCOPE CAMERA
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- Fits all Oscilloscopes and most Logic Analyzers
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...converts any oscilloscope into a storage scope

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- Storage adapter for any oscilloscope with external trigger input
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CIRCLE 43 ON FREE INFORMATION CARD

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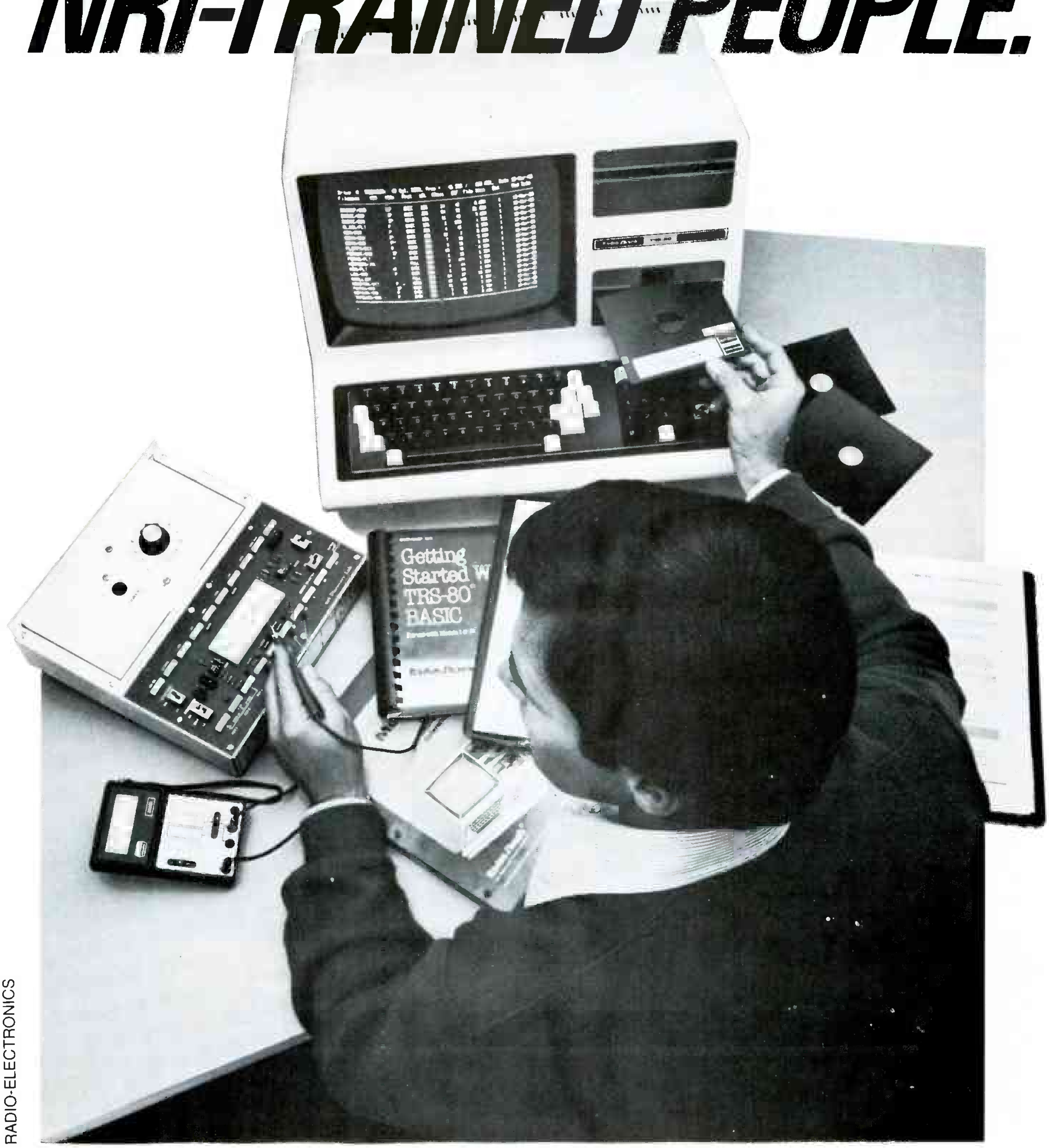


VIDEOGAMES

Holiday shopping

DANNY GOODMAN

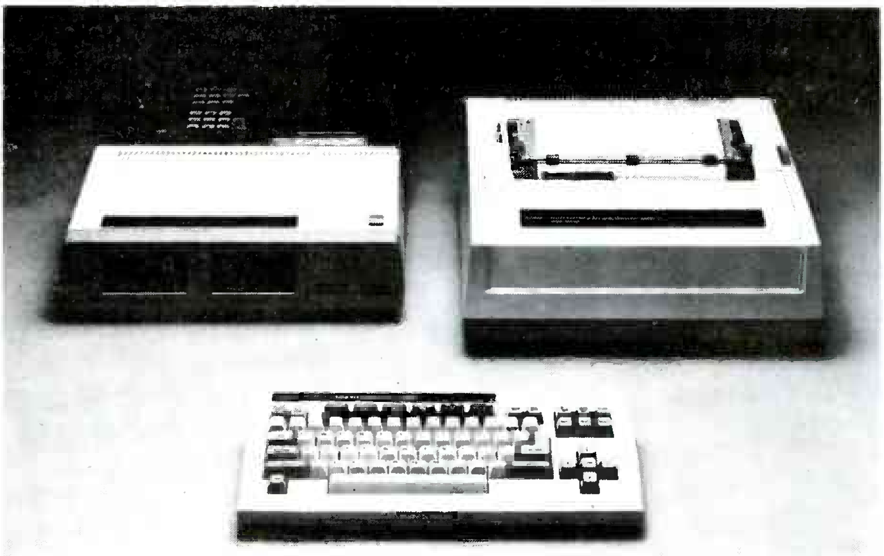


FIG. 1

IT'S TIME ONCE AGAIN TO PUT OUR Christmas wish lists in order. Fortunately, we videogame players are a pretty easy lot to shop for, what with all the cartridges and accessories that are available for just about every machine in captivity.

Probably at the top of every *2600*, *Intellivision*, and *ColecoVision* owner's list is the computer add-on for the respective system. After a lot of years and hot air about turning videogame systems into full-fledged computers, we finally are going to have the real thing for each of those systems.

The *Entertainment Computer System* is a unique addition to Mattel's (5150 Rosecrans Ave., Hawthorne, CA 90250) *Intellivision* game because its primary focus is on extending the entertainment possibilities of the console. Music afficianados will want the piano keyboard and music recording/playback software before the computer keyboard. Yet with the latter, you can learn some of the basics of programming game graphics and sound.

Coleco's (945 Asylum Ave., Hartford, CT 66105) computer add-on, shown in Fig. 1, is more substantial in the realm of personal computers. The value-packed system includes a very powerful computer module with mass tape storage, a letter-quality daisywheel printer, and a few excellent software programs thrown in for good measure. (Coleco's *Adam* is essentially the same machine). While $450 may seem like a lot of money, it buys a real computer system that won't need a bunch of further add-ons to become a serious machine. At the same time, the computer gives the games player the ability to play Coleco's line of Super Games, with more play screens than many original arcade games.

Owners of the *Vectrex* self-contained videogame from GCE (233 Wilshire Blvd., Santa Monica, CA 90401) will surely want to experiment with the new lightpen. It's only about $40 and comes with a special graphics cartridge that lets you draw on the screen with the pen and perform some elementary animation. Other light pen cartridges include music and geography learning tools plus a more sophisticated animation package.

Over at Atari, roller-ball controllers are new on the scene. Some may opt for Atari's unit, but the Zircon (475 Vanell Way, Campbell, CA 95008) *Trackball Controller* ($30) has two fire buttons for left and right-handed players as well as a built-in adjustable rapid-fire control. And for rapid firing on regular joystick controllers, the $13 *Blaster* from Questar Controls (670 NW Pennsylvania Ave., Chehalis, WA 98532) is a simple little module that plugs in right at the connector on the console. A variable control allows firing up to 20 shots per second. That'll save wear on the thumb.

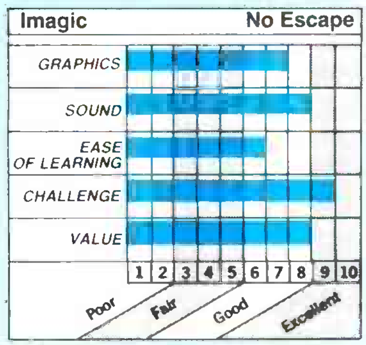
If you own a *2600* and don't have a Starpath *Supercharger* yet, let Santa know. That $45 plug-in addition to the *2600* will give you some of the best games playable on that system with graphics resolution that rivals that of the *5200* and *ColecoVision*. Games are loaded in from cassette tapes; and some games progress through three or more loads into several levels of play. You're missing half the fun if you don't have one.

Coleco is adding all kinds of accessories for its unit, but one of the most functional comes not from Coleco, but from Zircon. It's called the *Port Expander* and plugs into one of the controller jacks on the console. It allows you to keep the original *ColecoVision* controller attached while you also plug in any other Atari-compatible joystick controller that suits your fancy. That way you have the numeric keypad readily available for selecting game level and restarting. For only $10 each, the *Port Expander* makes an excellent stocking stuffer for the Coleco addict.

To all our readers, best wishes for the holiday season.

Imagic's No Escape for Atari 2600

CIRCLE 101 ON FREE INFORMATION CARD



continued on page 22

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VIDEOGAMES

continued from page 20

While there have been dozens of games for the *2600* in which the player controls a missile-generating object across the bottom of the screen to shoot objects hovering above, *No Escape* from Imagic (981 University Avenue, Los Gatos, CA 95030) is a refreshing, new approach to the old action.

In that game, which uses a theme based on Greek mythology, one or two players (alternately) control "Jason" across the screen bottom with the joystick. He is inside a temple, the roof of which consists of several layers of colored bricks supported by columns at each side of the screen.

Scooting between Jason and the temple roof are as many as six "Furies" at a time. Jason, fortunately, has an endless supply of stones—but, to make life difficult, he can't hit the Furies directly.

To kill off each wave of Furies, Jason must hurl a stone to the temple roof, loosening a brick from it. The gently falling brick must land on one of the Furies for the demon to disappear. A direct hit with a stone brings an extra Fury back to life. That kind of bank shot is no easy feat, especially on higher levels. That's because at those higher levels the Furies are significantly more erratic in their behavior. Plus, as the waves get more intense, the Furies start stoning Jason.

Jason has a limited number of lives, as shown by a relative lifeline on the screen. As he finishes each wave, his lifeline increases. But hits by the Furies or his own bricks subtract from his total.

Every two waves, the type of Fury changes. Our personal favorite is the griffon-looking one in waves 3 and 4. Building onto the intensity of each wave is a more ominous sound repetition until all Furies are gone.

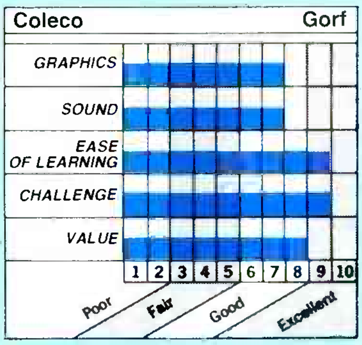
The skill involved in mastering *No Escape* is considerably more than simple hand-eye coordination. In some waves you must anticipate the moves of the Furies. In others, you have a modest amount of control over them because they rush toward your side of the temple after you hurl a stone. With careful planning, you can time a second shot so that you draw the Furies into a falling brick from the first shot.

Yet you must always be on the lookout for the stones the Furies are hurling. At higher levels, they come fast and from quite a long distance, not giving you much time to figure out a strategy while constantly in defensive motion, furiously avoiding the falling bricks.

No Escape is not a complex game to learn, but it is no pushover in the long run. The game play may not have the broad appeal of Imagic's legendary *Demon Attack*, but for something completely different in a shoot-'em-up game, this effort is worth a try.

Coleco's Gorf for ColecoVision

CIRCLE 102 ON FREE INFORMATION CARD



We'll be honest up front and say that we never cared much for *Gorf* when it was in the arcades: it just seemed like a rehash of the old Space Invader/Galaxian themes. But when it comes to the *ColecoVision* version, well that's another story.

For those of you who have not seen the very popular *Gorf* in the arcades, let's go over the fundamentals. The game is essentially four different games in one, each a different kind of outer space shoot-'em-up. The first one, "Astro Battle," is indeed very much like *Space Invaders*, but with only three rows and eight columns of aliens.

Moreover, your space fighter at the bottom of the screen has two advantages: a one-way shield that blocks the first enemy bomb at each spot, and vertical as well as horizontal movement inside the shield. Both allow experienced players to get a jump on the enemies while they're still frolicking back and forth at a slow speed.

The second game is "Laser Attack," a free-form version of *Galaxian*. One formation (at higher levels there are two) consisting of a laser ship and robot ships move rhythmically, but erratically across the sky. The laser ship occasionally lets fly a deadly blast. Again, your job is to eliminate all aliens.

In the third game, "Space Warp," robot ships come swirling out of the center of the screen (supposedly a tunnel) shooting off radiation bombs at you. It's not easy hitting a target going around in spirals. And the last game, called "Flag Ship," pits you against a mother ship and its missiles. Now, however, the shield is one-way in favor of the flag ship, so you must first blast your way through and then aim very carefully for the precise spot that destroys the ship's internal reactor, blowing the ship to smithereens in a very colorful video display.

Even with four games in one, experienced home game players might get bored with a repetition of the same four games. But two elements of the Coleco version keep us coming back for more. First of all, succeeding levels increase noticeably in difficulty. Anything that moves, moves faster; anything that shoots, shoots more accurately.

Secondly, at the successful completion of each level, you are promoted to a new rank. To us, the actual score is not as important as the rank you achieve and the number of missions (game screens) you complete. Unlike many other games of that type in which you shoot away for higher points, Coleco's *Gorf* gives you something more to hang onto than just a number.

Unfortunately with a game of such simple ancestry, the graphics execution on the Coleco edition is nothing very exciting, except perhaps the destruction of a flag ship. But unexciting graphics aside, it still beats any other version we've seen, including the original. **R-E**

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LETTERS

Address your comments to: Letters, **Radio-Electronics,** 200 Park Avenue South, New York, NY 10003

CAR BURGLAR ALARM

In your "Car Burglar Alarm," (**Radio-Electronics,** May 1983), you presented a very effective and yet relatively simple design. You did, however, make what I consider to be a mistake when you advised hooking up the device so that it would get power from the car's battery. I realize that that is what most alarm installers do, but it is very easy to disable the device when it is hooked up in that manner.

From personal experience (regrettable), I have found that when planning to steal merchandise from a car, the first thing that many burglars do is to cut the battery cables, to disable any alarm; and that can be done from underneath the car, so as not to trip off any sensors.

I recommend that, if at all possible, the alarm be powered by a separate battery kept inside the car (a gel-cell or equivalent) that is trickle-charged off the car's power system and isolated by way of a series diode so that it doesn't try to power the rest of the car's electrical system.

KENNETH C. FINNEY
Graham, WA

POCKET-SIZED SHORTWAVE RECEIVERS

In regard to the Danny Goodman article about pocket-sized shortwave receivers (**Radio-Electronics,** March, 1983), it should be pointed out that no special circuitry is required to obtain excellent SW reception. In fact, any of the modern pocket radios can be modified for that purpose. The modification can be accomplished in less than 30 minutes, at a cost of less than one dollar.

The only *basic* difference between a SW receiver and a regular broadcast-band AM radio is the tuned circuit. With a simple modification, one can receive all the popular SW stations, WWV, some of the ham frequencies, and nearby radio telephone transmissions. If you or your readers would like more details, write or call me. My address is 115 Manor Place, Santa Cruz, CA 85060; telephone: (408) 426-2149.

H. BAILEY

SMOKING POTENTIOMETERS

This letter is in response to the one written by Mr. Campbell (**Radio-Electronics**, February 1983) concerning his potentiometer smoking as a result of using a VOM to test it. That phenomenon is hardly unknown, and can be caused by the VOM delivering excessive wiper current—as much as 0.5 A, reportedly. (See *The Potentiometer Handbook*, by C.D. Todd, McGraw-Hill 1975.)

While that isn't likely to occur with a modern, sensitive VOM, it is possible. Please note that the effect generally decreases by an order of magnitude as the ohms range is in-

creased each step. Thus if a 1 megohm potentiometer is being tested with a VOM, it may not be wise to use the "X1" or "X10" ranges. Inexpensive DMM's, especially the imported variety, also can deliver enough current to damage a high-resistance potentiometer. (Values up to 10 megohms are reasonably common, as up to 50 megohm potentiometers are available from some manufacturers.)

Even if the pot is not destroyed in a dramatic fashion, leaving an open element, it is possible to burn a small hole in the element (since the area of contact is often very small) and that will result in a noiser pot of slightly higher resistance that will actually open up as the wiper passes the burned zone. The above problems can also affect meter movements and a few fussy semiconductors. Oldtimers will recall the point-contact transistor of the 1960's that could tolerate only a very tiny power dissipation of perhaps 40 mW, as compared with 360 mW or more for the modern planar epitaxial devices. Fortunately, few active devices today are as fragile electrically. Futher information on potentiometers can be found in the book I mentioned above.

SPEHRO PEFHANY,
Milton, Ontario, Canada

ON NIKOLA TESLA

As a well-satisfied subscriber to **Radio-Electronics**, let me add my compliments to you for your informative contributions to the memory of that forgotten genius, Nikola Tesla. The letters from other readers show that they are quite well informed, and the overview article by E.J. Quimby in your August 1983 issue was outstanding.

I have been associated with the electronics field for almost 30 years, 20 years of that in Naval Aviation electronics, and presently involved in computer-data communications. I am one of the very fortunate individuals in this world who enjoys working with my hobby: electronics.

Back during the 50's, I had the exciting experience of reading O'Neill's work, *The Prodigal Genius*. Since that time, the life and times of Nikola Tesla has been a continuing fascination to me. Over the years, my biggest question has been: How did it happen in America that the name "Nikola Tesla" is not a household word? He is a national hero to his fellow Serbians.

Thomas Edison was a semi-hero to America's young; however, the educators and history writers have surely missed their greatest opportunity in failing to promulgate the story of the greater genius inventor. But thanks to the increasing band of his admirers, and your magazine's cooperation, thousands more will have the thrill of learning about the exploits of Nikola Tesla.

Although O'Neill's book is out of print, Margaret Cheny's book, *A Man Out of Time* would make a great good introduction to those who would like to find out more about Tesla. Again my thanks to **Radio-Electronics** for helping to keep the memory of that great man alive.

ROBERT B. ESON, US Navt Ret.
Westminister, CO

AUTOMOBILE LOCATER

In reference to the automobile locator ("New Ideas," **Radio-Electronics**, April 1982), I would like to offer the following comments. I tried the above-mentioned circuit myself, and a few of my friends experimented with it, too. We all reached the same conclusion: When R1 is set to 10K, the frequency output is 12 kHz. With the 10K pot set at 0, although the IC timer 555 had a tendency to heat up, the operating frequency was 72 kHz. The tuning range of the output tank with a 20-pF to 400-pF capacitor and 500 µH to 1800 µH coil is between 188 kHz to 1.59 MHz. With an 1800 µH coil and 20-400-pF variable capacitor, the tuning range is 188 kHz – 839 kHz. Now there is a problem with the IC timer output of 12 kHz to 72 kHz, which falls below the tuning range of the author's circuit.

Also, I see a problem with the antenna-coupling capacitor of 47-pF with the IC timer output of 12 kHz. The capacitance reactance of the coupling capacitor is 282K ohms and with 72 kHz, X_C = 47K. Obviously, it will attenuate the signal transmission.

We found the following modifications appropriate: Capacitor C1 should be dropped to .001 µF, and that will give an operating range of 120 kHz to 481 kHz. The tuning range of the output tank with 13-pF to 365-pF variable capacitor and 1800 µH coil is from 196 kHz to 1.04 MHz; the capacitative reactance has also markedly decreased.

Please note the following manufacturer's data on the open-loop gain of the 741 operational amplifier:

1 KHz = 1000 or 60 db;
10 KHz = 100 or 40 db;
100 KHz = 10 or 20 db,
1000 KHz = 1 or 0 db.

As you see from the above data, there is a serious attenuation of the received signal as the transmitter frequency increases.

MOHINDER S. GOOMAR, M.D., F.R.C.S.
Saratoga Springs, NY **R-E**

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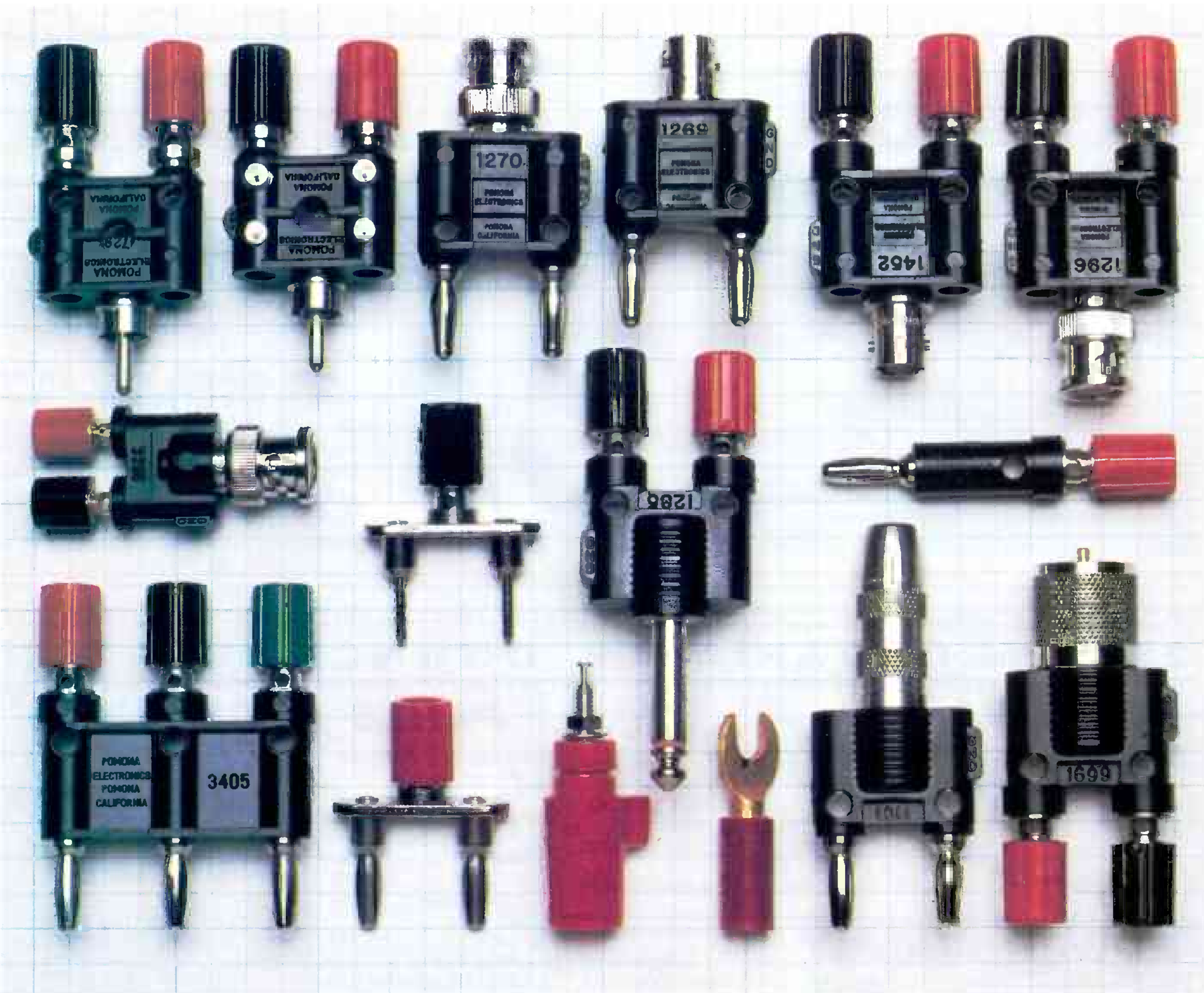

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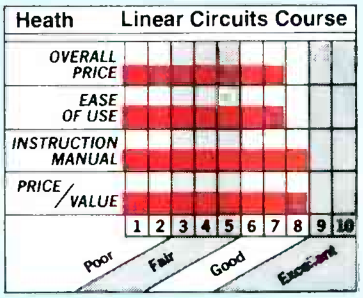

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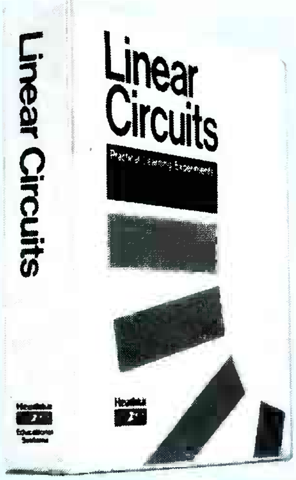

WHENEVER YOU BEGIN ONE OF HEATH'S (Benton Harbor, MI 49022) self-study courses, you can be sure of one thing—that by the time you are finished you will have a thorough knowledge of the material presented. Their *EH-701* linear circuits course is no exception. One of the modules in their hands-on educational series, it is an ideal follow-up to their DC and AC electronics courses, as well as the semiconductor devices course (*EE-3101A* through *3103A*).

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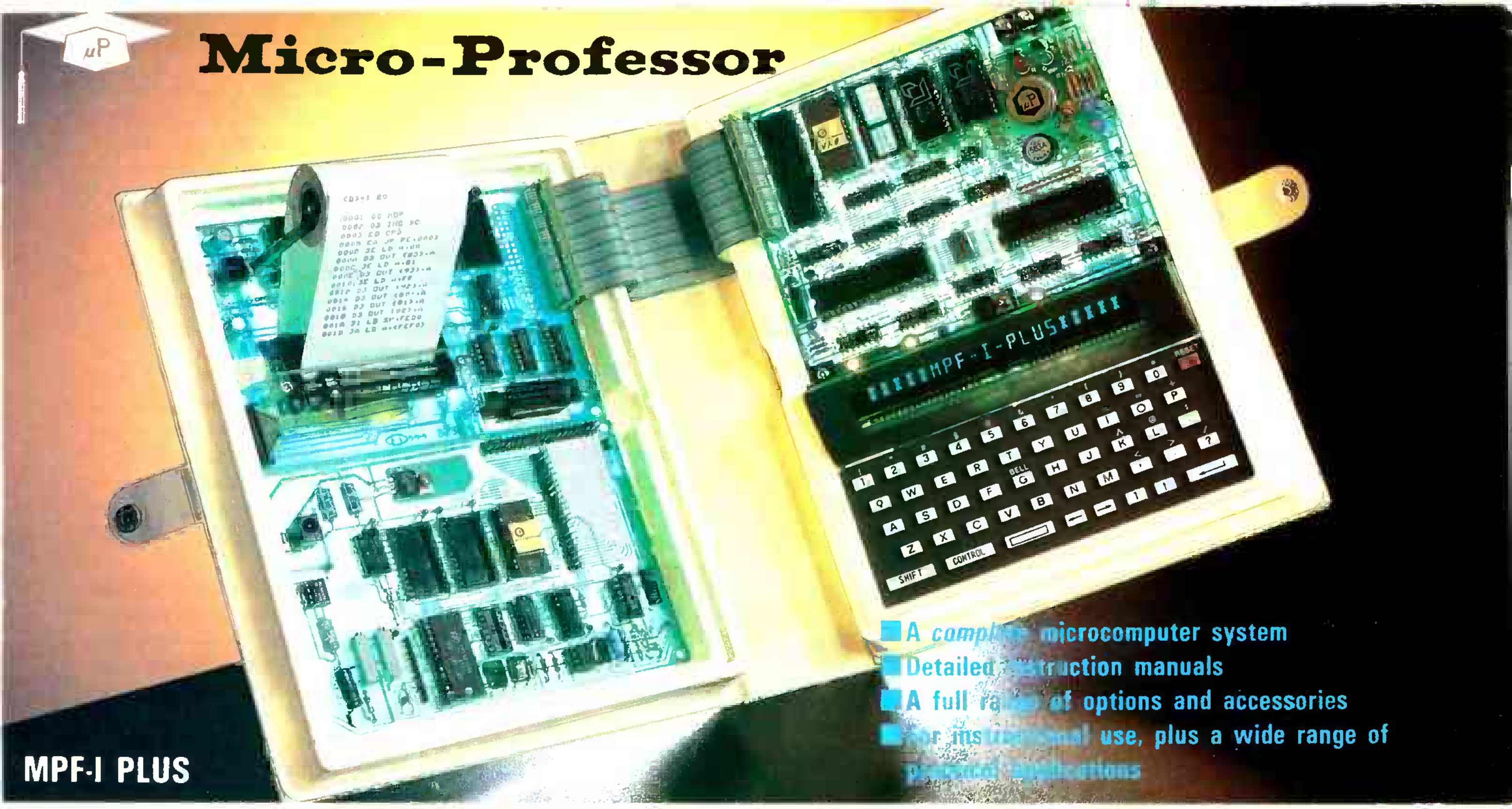

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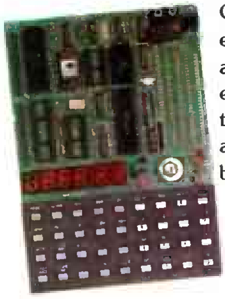

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CIRCLE 16 ON FREE INFORMATION CARD

practical with hands-on experience building circuits, using what you've learned in the previous modules. It covers three separate categories: bipolar transistors, field effect transistors, and linear integrated circuits. The course is intended to be used with Heath's *ET-3300B* trainer (available for $99.95 as a kit or $179.95, assembled); that trainer is also used with the other courses in the series.

Each lesson consists of a circuit and the theory upon which it is based. The material is arranged so that progressive self-study is encouraged. That assures not only an orderly progression through the material, but also that everything you learn will be reinforced.

What's covered

Looking at the course, the first segment explores one of the building blocks of solid state electronics, the bipolar transistor. By the time you are finished with the unit you will know all about that device, its applications, and how to correctly use it in a circuit.

Unit Two deals with the *F*ield *E*ffect *T*ransistor (FET). You'll study both *J*unction *F*ield *E*ffect *T*ransistors (JFET's) and *M*etal *O*xide *S*emiconductor *F*ield *E*ffect *T*ransistors (MOSFET's) and how they function. You'll also learn how FET's differ from a bipolar transistors and see how FET's can be used in a wide variety of applications.

Among the topics and circuits covered are various types of oscillators, phase splitters, function generators, and amplifiers. By the time you are done with the unit you will know how to use the circuits covered, and why they work the way they do.

Unit three deals with linear IC's. In it, you will learn about such devices as op-amps and timers. Among the topics covered are how the devices work, what factors influence their operation, and how they are used in circuits. The circuits discussed include highpass, lowpass, and bandpass active filters; voltage followers; oscillators, and function generators. Several frequently used linear devices are dealt with in detail, including the 555 timer IC.

As is true of other Heath educational products, each unit builds on the material presented in the earlier ones. And, like those earlier courses, there are exam modules to test what you have learned; those help to insure that the material covered will be retained. Those exams will also help you to pinpoint any areas that you are weak in, enabling you to go back and review the material.

What's included

Naturally, the course comes complete with every component you will need to build the circuits. Those parts include all the necessary transistors, capacitors, op-amps, and integrated circuits. Other components that are provided include speakers, potentiometers, and crystals; Heath even supplies such things as the jumper wires. To get the full benefit of the course some type of test equipment, such as a voltmeter and oscilloscope, is needed; you will have to provide that equipment as it is not included.

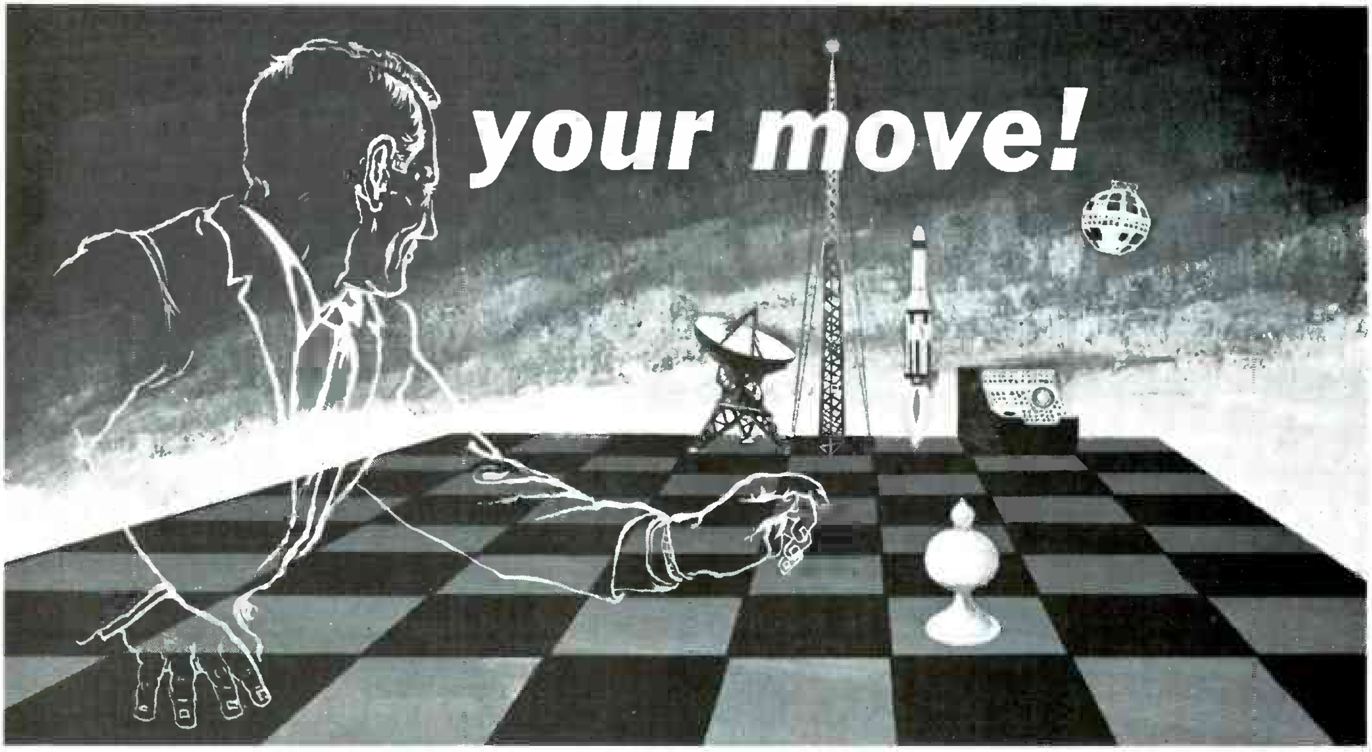
The course arrives well packaged and ready to use. It includes not only the components, but a plastic box in which to hold them—a nice touch—and a high-quality binder for the lessons. The material in the lessons is well-written and clearly illustrated. You really do get your money's worth.

One word of caution: Despite the obvious care that Heath takes in packaging the materials some errors do happen so it is wise to check your course against the parts list. In the course we received for this review, an electrolytic capacitor, crucial to one experiment, was left out. However, Heath's parts department came through and we received the missing part in short order.

Overall, the Heath *EH-701* linear circuits course is a good hands-on learning experience. It should be valuable to anyone from the novice hobbyist just dabbling with circuits to the advanced technician who needs a refresher course. It is an excellent addition to Heath's educational line. R-E

continued on page 32

Where's Your ELECTRONICS Career Headed?



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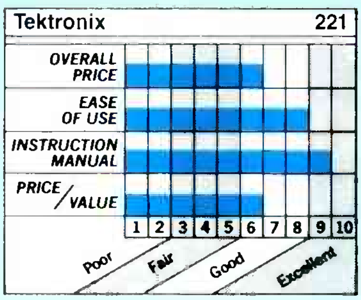
Tektronix 221 Portable Oscilloscope



CIRCLE 104 ON FREE INFORMATION CARD

YOU MIGHT WONDER WHY ANYONE would want an oscilloscope with a display that measures only about 2½ inches diagonally. But when you consider that the same scope weighs only 3½ pounds and measures 3 × 9 × 5¼ inches, the small display seems to be a limitation you might be willing to put up with.

The scope that fits those dimensions is the *221* from Tektronix (Box 500, Beaverton, OR 97077). The *221* is a portable, single-channel scope with a vertical bandwidth of five megahertz.

Although the *221* is a portable instrument, it can be run off line voltage as well as its 10 internal type "A" nickel-cadmium batteries. With a full charge, those batteries will power the scope for two to three hours (depending on the trace intensity used). A BATTERY meter on the side of the instrument indicates FULL, LOW, and RECHARGE. When the meter reads LOW, there is less than 10 minutes of operating time left. When it reads RECHARGE, it indicates that the battery charge has dropped to less than 10 volts and a battery discharge protection circuit has automatically interrupted the scope's operation to prevent excessive discharge.

Whenever the line cord is plugged in to the line voltage (greater than 90 volts), the batteries will be charged whether the scope is on or off. When the line cord is removed, however, we have a problem—a potential shock hazard. If you make voltage measurements with the common lead floated, it is possible—due to RFI circuitry connected between the AC power plug and the *221*'s common—that small amounts of current from the elevated reference will be present on the AC power plug.

The manuals clearly point that out (several times) and a caution is written on the oscilloscope over a storage compartment for the AC plug. (That's where they strongly recommend that you store the plug when you use the scope as a portable instrument.) We feel, though, that any test instrument should be fool-proof—safe even for those who refuse to read or follow safety warnings.

Controls and features

The controls are laid out on the right side of the instrument, about as neatly as you could hope for in such a small unit. The VOLTS/DIV and SEC/DIV controls are located on the right panel at the front of the *221* and can be read when looking straight on at the scope. All other controls are located in a recess on the side panel. Six rotary controls include vertical and horizontal POSITION controls, controls to continuously vary the volts/div and sec/div deflection factors, a trace-intensity control that includes the power switch, and a LEVEL/SLOPE control that selects both the amplitude and slope of the signal that will trigger the sweep. That control can be set to AUTO PRESET.

There are also three slide switches: the INPUT COUPLING switch chooses between AC or DC coupling and ground. The HORIZ-MAG switch can be used to increase the sweep time (or the horizontal sensitivity in the X-Y mode) by a factor of ten. The last switch chooses between an internal and external trigger.

There are six screwdriver-adjustable controls on the side panel. The STEP ATTEN BAL adjustment balances the vertical system so that the trace will not shift as you change deflection factors. There are also trace FOCUS and TRACE ROTATION as well as adjustments to calibrate the vertical gain and horizontal sweep. The final side-panel adjustment selects the preset trigger point for AUTO sweep operation.

As you can see, those controls don't differ too much from a standard (larger) scope. How about the input jacks? There are banana-plug jacks for COMMON and EXT TRIG (or HORIZ INPUT for the X-Y mode). There is no jack for the vertical channel—the probe is permanently connected to the scope and can be neatly stored when not in use.

Specifications

Now that we have a good idea of the general features of the *221*, let's look at it a bit closer. We'll start with the graticule, which is an internal, non-illuminated, 6- by 10-division grid. Because of its size, it's not something we would want to work with on a test bench, but we'd be willing to put up with it in the field. A non-illuminated graticule is an advantage because it helps reduce battery drain.

We'll move on to the vertical amplifier, which has a 1-megohm input impedance and a 30-pF input capacitance. The vertical deflection factor is controlled by the VOLTS/DIV that is arranged in a 1-2-5 sequence (from 5 millivolts to 100 volts-per-division). When the VAR is in its detent (CAL) position, the *221* is accurate to within 3 percent. When that control is moved off its detent position, it can continuously increase the vertical deflection factor by at least 3:1 on every scale. The maximum safe input voltage is 600 volts peak-to-peak AC or 600 volts DC + peak AC.

The horizontal deflection system can be used with the internal sweep generator or an external voltage input. The sweep generator's SEC/DIV control is arranged in a 1-2-5 sequence from 200 milliseconds to one microsecond-per-division. The VAR can be used to continuously decrease the sweep rate by a factor of about 2.5. Also, the HORIZ-MAG can be used to increase the sweep rate by a factor of ten.

When the horizontal deflection system is used to measure an external voltage, you have a choice of two deflection factors: 1 volt-per-division or 0.1 volts-per-division (when the HORIZ-MAG switch is in its 10x position). The bandwidth of the horizontal amplifier is 500 kHz, its input resistance is 500 kilohms, and its input capacitance is 30 pF. The same jack that is used for an external trigger input is used for a horizontal voltage input.

Aside from its battery operation, one feature of the *221* that makes it very portable is that it will operate over a large line-voltage range. Its AC range is from 90 to 250 volts (48 to 62 Hz). Its DC range is from 80 to 250 volts.

Now that we've discussed the scope, we can talk about the documentation that comes with it. Two manuals were supplied with our unit: a service instruction manual and an operator's instruction manual. The operator's manual is a small spiral-bound book that gives a quick overview of the *221*, its controls, and some basic test setups and procedures. The service manual is a much larger book. As we have come to expect from Tektronix, it is loaded with information including an overview of the scope, information on preventive and corrective maintenance, a detailed circuit description, calibration procedures, troubleshooting aids, complete electrical- and mechanical-parts lists, and complete schematics and parts-placement illustrations.

All in all, we liked the *221*. As with most of what we see, there are some things we'd like to change. For example, we'd like to see a front-panel power indicator to reduce the chance of leaving the scope's power on, and we'd like to see the tilt-bail double as a carrying handle. But we have no complaints about how the *221* operates. If you need a lightweight, small-sized, battery-operated scope, and the $1775 price doesn't scare you off, then the *221* might be just for you. **R-E**

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NEW IDEAS

Sound-activated AC switch

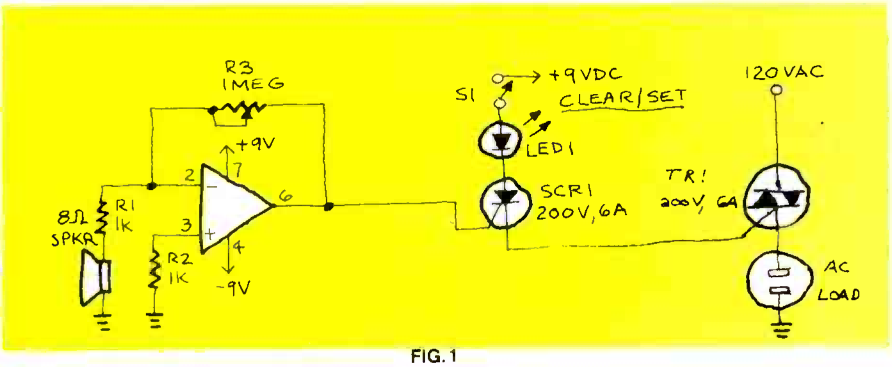


FIG. 1

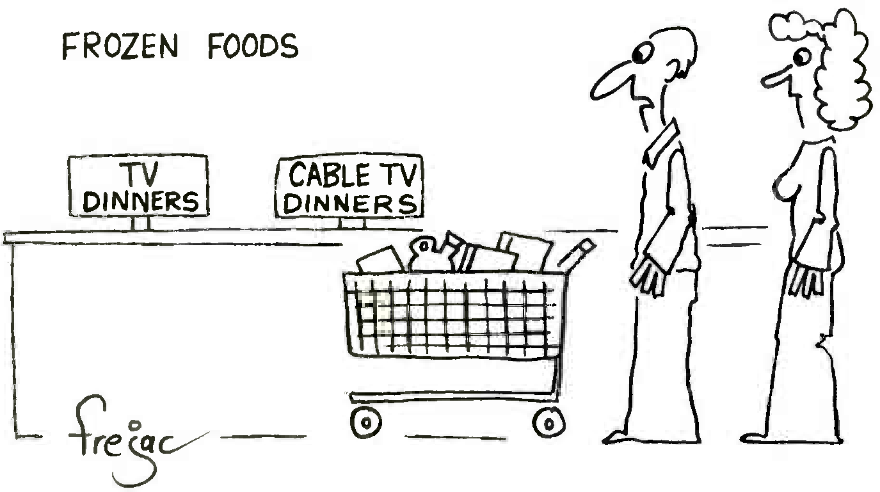
WHILE LOOKING THROUGH SEVERAL REFerence books and periodicals for various switching methods, I not only found very little concerning sound-activated switches in general, but there was almost a complete absence of sound-activated switches that would directly switch an AC load. Switching on such a load is a fairly easy problem that could be handled by a (mechanical) relay system. But I've found that it's just as easy to put together an inexpensive, reliable, non-mechanical sound-activated AC switch.

The circuit, shown in Fig. 1, uses a 741 op-amp operating as an inverting amplifier. It amplifies the voltage produced by an 8-ohm speaker. That speaker is used here to detect any sounds. The feedback resistor, R3, a 1-megohm potentiometer can be used to vary the gain of the amplifier—it determines the sensitivity of the circuit.

When S1 is closed in the (SET position) and a sound is applied to the speaker, the silicon-controlled rectifier (SCR1) is turned on. It will remain in conduction until the anode voltage is removed by opening S1—putting it in its RESET position. (Once an SCR is turned on, the gate or trigger has no control over the circuit.) As long as the SCR conducts, the Triac, TR1, will remain on and supply voltage to the load.

The ratings of the components shown in the schematic should be sufficient for most household uses, but you can change them if you want to control a larger load. The unit should be mounted in a case for safety, and a standard AC socket should be mounted in the front panel.

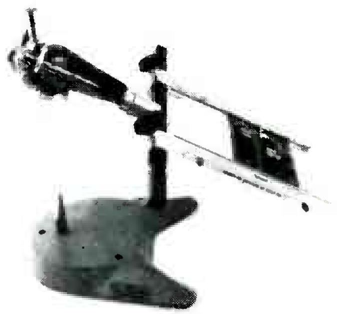
The circuit in Fig. 1 is fairly simple and it can be adapted for any number of uses. You can try a lowpass or highpass filter system at the input of the op-amp so that the switch will respond only to certain frequencies—a whistle, perhaps. The best thing about this circuit is that it can help you to understand better how to use the Triac and SCR in control applications.—*Jeffery N. Krumm*



NEW IDEAS

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

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



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CHORD COMPUTER, is palm-sized, and will help musicians to understand both music and keyboards. Selecting a chord letter instructs the *Chord Computer's* 31-key piano-keyboard LCD to display which notes are to be played for the selected chord. Pressing another button allows for sharp, flat, major, minor, augmented, diminished , 6th, 7th, or 9th chords—including inversions. The *Chord Computer* can also display complete scales for all keys and can transpose them at the touch of a button. It runs off a single 9-volt battery (not included) and is available assembled and tested for $59.95 (plus $2.50 postage/handling).—**PAIA Electronics,** 1020 W. Wilshire Blvd., Oklahoma City, OK 73116.

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BENCH-TOP REPAIR SYSTEM, the *PRC-151,* is a completely self-contained system for any rework, repair, or modification of printed-circuit boards. It can perform the following repair operations: temperature-controlled desoldering (removal of components); milling, drilling, and grinding for general PC-board repair; removal of conformal coatings, high-strength reflow soldering; thermal wire stripping, and resistance heating capacity.

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The *PRC-151* incorporates zero-power switching so that the complete system is safe for working on sensitive boards and components. It comes complete with a new power source featuring *Thermo-Drive* heat control, a "no clog" dual-path solder extractor, a precision miniature machining unit with deluxe tool set, a pad and track selector pack, a deluxe soldering iron, resistance tweezer, thermal wire stripper, probe for conformal coatings, a soldering-iron stand with wet and dry cleaning facilities, and a lead measuring and forming tool, cleaning brushes and experimental tip kit, and a universal power cord.

The manufacturer's suggested price for the *PRC-151* is $1175.00. Systems are available from all authorized Pace distributors. For information on your local Pace distributor, contact Pace, Incorporated (301) 490-9860.—**Pace Incorporated,** 9893 Brewers Court, Laurel, MD 20707.

AMPLIFIER, model *DDX410,* is a MOSFET stereo amplifier, producing 205 watts per channel continuous power, at its rated distortion, at any impedance from 2 ohms up to 8 ohms and in excess of 500 watts at 8 ohms in bridged mono mode. Full power is produced at any line voltage from less than 95 volts to over 135 volts. The slew rate is high, distortion rate low, and the unit weighs only 16 pounds with dimensions of 5 × 13½ × 8½ inches. The model *DDX410* is priced at $449.00.—**Soundcraftsman,** 2200 So. Ritchey, Santa Ana, CA 92705.

CIRCLE 113 ON FREE INFORMATION CARD

COMPACT DISC PLAYER, model *XL-V1,* features soft-touch controls and a multi-purpose digital display. It also incorporates an error-correction code to correct for dropouts or reading errors by means of interpolation. The frequency response is 5 Hz to 20 kHz, and it can play up to 75 minutes per compact disc. Random-track selection allows users to program up to 15 tracks for play in any order selected. A CLEAR button makes it easy to change or cancel programmed tracks, while a CALL button lets the user confirm the entered selections.

Other operations include pause, memory stop, analog location indicator (an LED display of approximate time elapsed since play began), headphone output with volume control, and both fixed and variable line outputs. The model *XL-V1* is priced at $1000.00.—**JVC Company of America,** 41 Slater Drive, Elmwood Park, NJ 07407.

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CORDLESS TELEPHONE, the *Freedom Phone 350,* can be used up to 500 feet from its control unit, and there is no external handset antenna to get in the way. It can dial up to 10 phone numbers automatically from its memory: By pushing just two buttons, any important number—emergency, office, doctor, or dentist, etc., can be dialed. The numbers can easily be changed by reprogramming the handset's touch-button pad.

The *Freedom Phone 350* is designed so that it can be either a wall or a table phone; when not in use, the handset fits into the control unit, which is designed to be compatible with standard phone company wall/bracket jacks. A light on the handset indicates when the batteries need to be recharged.

CIRCLE 115 ON FREE INFORMATION CARD

Also featured is automatic redialing of busy or unanswered numbers, and there is a special two-position volume control that allows the user to select louder than normal volume, as well as a "mute position" to disconnect the

continued on page 44

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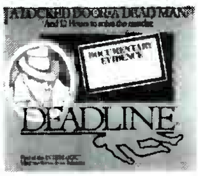

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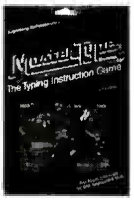

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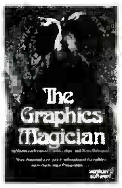

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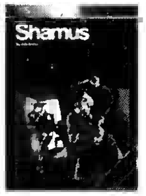

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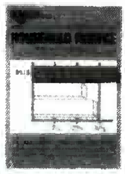

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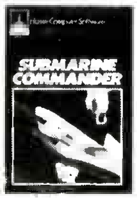

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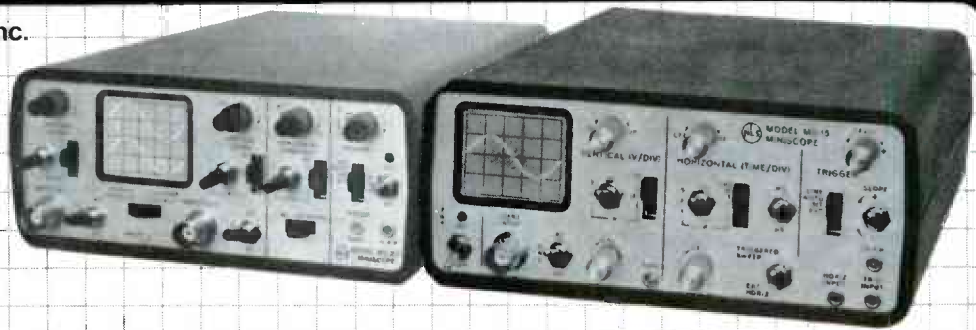

MS15 15 MHz Single Trace

MS215 15 MHz Dual Trace

MS230 30 MHz Dual Trace

Non-Linear Systems' trio of miniscopes are accurate, affordable, portable. And there's one to match nearly every budget and need. Standard features on all models include an input impedance of 1 megohm with 50 pF; maximum input voltage of 350 V; trigger modes in auto, internal, external and line; slope that's + or − selectable; graticule (4 × 5 division of 0.25″ each); dual power sources operating either internally from rechargable lead acid batteries or externally from 115 VAC or 230 VAC (50-60 Hz) via plug-in transformer; handy size (2.9″H × 6.4″W × 8.0″D) and weighs just 3 lbs.*

*(Exception: model MS-230 is slightly deeper, at 8.6″, and heavier, at 3.6 lbs.).

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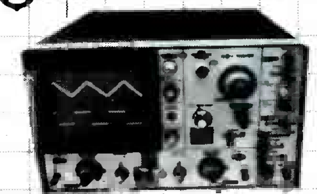

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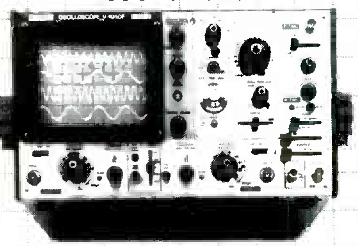

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MODEL 3010 $179.95 WAS $229.

MODEL 3020 $319.95 WAS $394.

MODEL 3010

- Sine, square and triangle output
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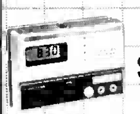
- 0.1 Hz to 1MHz in six ranges
- Push button range and function selection
- Typical sine wave distortion under 0.5% from 1 Hz to 100kHz

SWEEP FUNCTION MODEL 3020

- Four instruments in one package—sweep generator, function generator, pulse generator, tone-burst generator
- Covers 0.02Hz-2MHz
- 1000:1 tuning range
- Low-distortion high-accuracy outputs

B&K PRECISION CAPACITANCE METERS



$189.95

WAS $238.

MODEL 830

- Automatically measures capacitance from 0.1pF to 200mF
- 0.1pF resolution
- 0.2% basic accuracy
- 3½ digit LCD display

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WAS $192.

MODEL 820

- Resolves to 0.1pF
- 4 digit easy-to-read LED display
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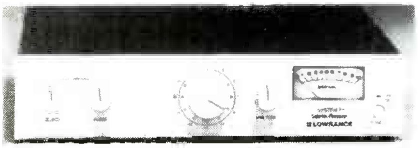
NEW PRODUCTS

continued from page 40

microphone when conversing with another person in the room.

The *Freedom Phone 350* is priced at $159.95.—**Electra Company,** 300 East County Line Road, Cumberland, IN 46229.

SATELLITE RECEIVER, the *System 7XL*, has the performance and operation of the earlier *System 7AR* receiver, with the exception of stereo and a standard remote control. The new unit features detent tuning, a signal-



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strength meter, built-in modulator, weatherproof downconverter, 125 feet cable, fixed and variable audio, and operational remote-control capability. It is priced at $850.00.—**Lowrance Electronics,** 12000 E. Skelly Drive, Tulsa, OK 74128.

RECORDER, is a modified, all solid-state Panasonic Slimline AD/DC type designed to provide seven hours of recording and play back on each side of the cassette for a total of 14 hours. Built-in features include voice-level control and digital counter; a TDK DC 180 cassette is furnished. The unit is priced at

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$159.00 plus $4.00 shipping and handling.

Also available is the AMC 10-hour model with the same features priced at $95.00 plus $4.00 shipping and handling.

Accessories include a phone recording adapter that, when connected to the user's phone and the recorder automatically starts the recording when the phone is lifted and stops when it is hung up; and a VOX (voice-activated control switch) that has adjustable sensitivity—voices or other sounds activate the recorder. The recording adapter is priced at $24.50, the VOX at $24.95, with a $1.50 shipping and handling charge for each.—**AMC Sales,** Box 928, Downey, CA 90241.

EXTRA BASS BOOSTER, is an amplifier/woofer combination designed for mobile hi-fi systems that may not have room for an extensive speaker system and equalizers to amplify low-frequency response. The amplifier delivers a maximum of 25 watts of low-frequency power, and four frequency switches allow the user to select the most effective cutoff point between bass and treble.

It is easy to install, and the instructions are printed on the box. The electronic control panel is small enough to fit almost anywhere

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under the dash, and the speaker setup may go under a seat or on the rear panel. The *Extra Bass Booster* is priced at $95.50.—**Tei Electronics,** 570 West 18th Street, Hialeah, FL 33010.

MULTI-FUNCTION COUNTER, model *WD-755*, is capable of frequency, period, totalize, ratio, and time-interval measurements. It is a combination of CMOS, TTL, low-power Schottky, and LSI technology. Features include an 8-digit LED display with leading zeroes blanked, automatic input-triggering level, switchable attenuator, selectable

lowpass filter, pushbutton reset switch, and rear-panel BNC clock input/output connector. All critical circuits are enclosed in shielded

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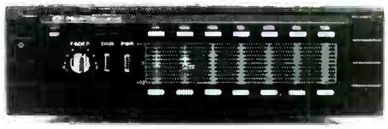
metal chassis to reduce EMI/RFI. The suggested retail price of the model *WD-755* is $299.00.—**VIZ Mfg. Co.,** 355 E. Price Street, Philadelphia, PA 19144.

EQUALIZER/AMPLIFIERS, model *EQ-355* and model *EQ-370* (shown) join the original *EQ-360* electronic pushbutton models that were introduced a year ago.

The model *EQ-355* is a five-band equalizer/amplifier. It offers 36W + 36W, RMS, along with five electronic-pushbutton equalizer controls, 10 LED power readout, preamp line with RCA jacks (high/low impedance), common and floating ground capability, fader balance front or rear, and IC power circuitry.

The model *EQ-370* is a seven-band equalizer/amplifier with built-in DNR and is supplied complete with in-dash mounting trimplate. Pushbuttons provide 12 dB of boost and cut indicated by floating digital readouts,



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adjustable sensitivity capacity, and preamp lines in with three-position variable impedance (100mV, 500mV, 3V) through RCA jacks (high/low impedance).

The suggested retail price of each model is $199.95.—**Metrosound,** 10615 Vanowne Street, North Hollywood, CA 91605.

MOBILE SCANNER, model *MX 7000,* has 30 programmable channels with range up to 1.25GHz. In addition, it offers CB, VHF, and UHF TV audio, FM broadcast, all aircraft bands (civil and military), 800MHz communications, cellular telephone, and, when connected to a printer or CRT, satellite weather pictures.

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The *MX 7000* computer-controlled keyboard allows the user to program up to 20 channels without a need for crystals. Special features include search, clock, dual scan, and scan or search delay. The unit is supplied with a telescoping antenna, mobile mounting bracket, and an AC adaptor/charger. It is priced at $599.00.—**Regency Electronics, Inc.,** 7707 Records St., Indianapolis, IN 56226.

SOUND SYSTEM, *The Sacramento,* features an AM/FM stereo radio with *ARI* capabilities and an auto-reverse stereo cassette deck. It has a two-channel integral amplifier with seven watts of output per channel, and also includes a low-level output jack for optional attachment of a high-power amplifier. Other features are electronic station-signal

CIRCLE 122 ON FREE INFORMATION CARD

search, pushbutton station selection, and a digital time display. The tape deck includes motorized cassette loading and power-off eject, which automatically ejects a playing cassette when the system is turned off. *The Sacramento* is priced at $399.95.—**Blaupunkt Division, Robert Bosch Sales Corporation,** 2800 South 25th Ave., Broadview, IL 60153. **R-E**

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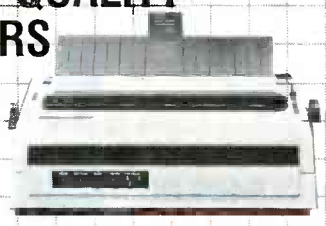

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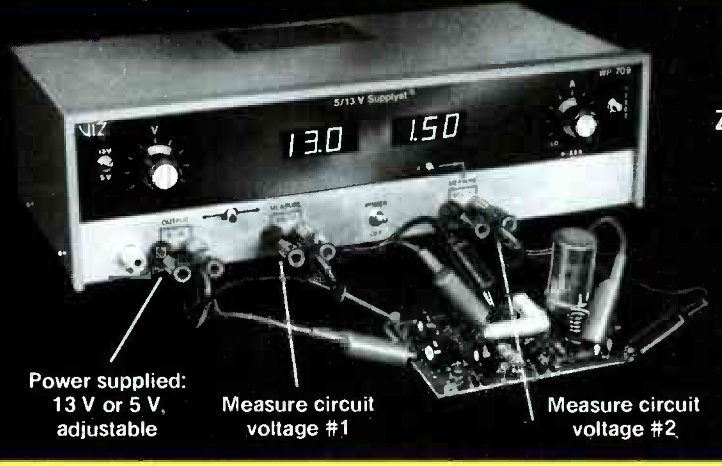

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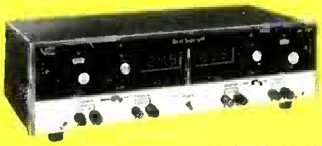

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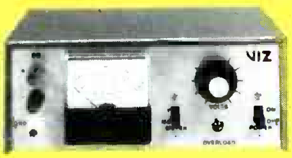
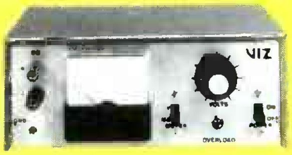


Single WP-703A
0-20VDC. 0-500mA **$119.00**



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Video Accessory

Color Processor/ Noise Filter

ROGER COTA and LLOYD ADDINGTON

Here's an inexpensive add-on device that you can use to create professional fades, reduce noise, and correct color errors in video recordings

IF YOU OWN A VIDEOCASSETTE RECORDER (VCR) then you are no doubt familiar with the problems of making high-quality recordings. No matter how hard you try, you end up with washed out colors, glaring reds, and other assorted problems. It gets even worse when you record from one tape to another. But those problems can be remedied easily and inexpensively with the video color processor we'll describe here. You'll find that tapes with their color properly restored, their video noise reduced, and with the look of professional editing will be much more enjoyable to view than those you're probably looking at now. And not only that—you can actually save money using the processor by using less tape. That's because you can use slower recording speeds and still obtain acceptable results.

While the color processor can be used for several applications, it's perhaps most useful when recording from one tape to another. You can correct some of the first tape's color distortion and insert fades-to-blacks, where appropriate, to get what looks like a professionally edited tape That's especially helpful for making home movies.

You can also use the processor when recording off-the-air programs. But the processor does not contain its own RF modulator and it has no audio input Therefore you'll need an enhancer, a second VCR, an RF modulator with an audio input, or a monitor with a composite-video input so that you can see the results of the processing.

Features

This color processor is designed to let you correct color and contrast errors, create professional quality fade-ins and fade-outs, and eliminate unwanted colors and video noise. You can do those things by using the front-panel TINT, FADER, LEVEL, and BACKGROUND controls—they let you manipulate the picture color and brightness in ways that you cannot with a TV set or monitor alone.

Proper restoration of skin tones and balance of color hues is the function of the TINT control. The FADER control allows adjustment of the picture level from black (0%) to full luminance (100%), and can be used in editing for fading to black or fading from black to full luminance. Color saturation of the picture can be reduced to black-and-white or increased to full color by adjusting the LEVEL control. Unwanted noise in the picture background can be virtually eliminated or background colors can be intensified by adjusting the BACKGROUND control.

Another control, FLASH FILTER, is provided so you can eliminate the problem of single-color dominance that is often present in bright pictures. A PROCESS/BYPASS switch is included so that you can bypass the processor while still leaving it in-line. Finally, a graduated PICTURE LEVEL LED meter lets you monitor the output level.

The processor is powered by 12 volts DC. We used a wall transformer with a 12-

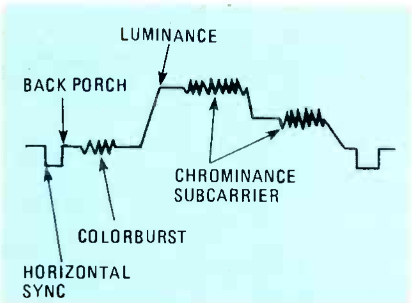

FIG. 1—A COMPOSITE COLOR-VIDEO SIGNAL contains luminance and chrominance information as well as horizontal sync pulses.

volt DC, 300-milliamp output to convert the line voltage to that level. If you want to use the processor for portable applications, such as when using a video camera, you can power it with a 12-volt battery pack.

About the circuit

Before we can talk about the circuit of the color processor, we have to introduce you to a composite video signal, as shown in Fig. 1. As you can see, it is composed of two unrelated signals: *luminance* and *chrominance*. Those signals are processed independently in the color processor and are mixed together again before they are output.

The luminance (or black-and-white) signal contains the picture (or brightness) information. The chrominance (color) signal contains the hue and saturation information. It is used to modulate a subcarrier frequency of 3.58 MHz. That subcarrier is then used to amplitude modulate the video carrier.

Also contained in the chrominance signal is a *colorburst* that is sent to synchronize the receiver's color circuits with the color that is being transmitted. The colorburst is sent during the horizontal blanking interval (when the electron beam snaps back across the screen). It can be thought of as a reference for interpretation of the color information.

We should take a closer look at the information contained in the chrominance signal: the hue and saturation. The hue is commonly called color, while saturation has to do with how pure a given hue is (how much white it contains). The hue that your set displays is determined by the phase relationship between the color subcarrier and the colorburst. The color processor's TINT control lets you adjust that phase and thus the hue. The saturation is determined by the amplitude of the chrominance carrier. That can be adjusted by the LEVEL control.

A block diagram of the color processor is shown in Fig. 2 and its schematic is shown in Fig. 3. Video input enters the chrominance/luminance separator and is broken up into a luminance-and-sync signal and a chroma-and-burst signal. Let's

PARTS LIST

All resistors ¼ watt, 5% unless otherwise specified.
R1, R25, R55, R89—100 ohms
R2, R39—75 ohms B
R3, R9, R32, R71, R75—150 ohms
R4—27,000 ohms
R5, R11, R36, R48, R101—22,000 ohms
R6, R12, R13, R20, R47, R63, R65, R73, R87, R96—1000 ohms
R7, R16, R17, R40, R41, R58, R59, R67, R68, R72, R74, R76, R77, R85, R99, R103, R106—470 ohms
R8, R26, R84, R91—1500 ohms
R10, R19, R54, R79, R80, R97, R98, R104—10,000 ohms
R14, R37, R38, R42, R78—220 ohms
R15, R21, R29, R34, R53, R64, R95, R100—2200 ohms
R18, R94—680 ohms
R22—6800 ohms
R23, R27, R93—4700 ohms
R24, R88—15,000 ohms
R28, R56, R57, R66, R83, R92, R102—3300 ohms
R30, R35, R105—22 ohms
R31, R82, R86—2,000 ohms, potentiometer, linear taper
R33, R49, R90—47,000 ohms
R43, R62, R107—330 ohms
R44—56 ohms
R45—1 megohm
R46—5600 ohms
R50—750 ohms
R51, R52—33,000 ohms
R60—560 ohms
R61—390 ohms
R69—20,000 ohms
R70—12,000 ohms
R81—10,000 ohms, potentiometer, linear taper

Capacitors
C1, C2, C6, C11—22 µF, 10 volts, electrolytic
C3, C40—470 µF, 10 volts, electrolytic
C4—5-55 pF trimmer capacitor
C5, C10, C17—22 pF, 50 volts, ceramic disc
C7, C18, C41, C42—0.1 µF, 50 volts, ceramic disc
C8—68 pF, 50 volts, ceramic disc
C9—100 pF, 50 volts, ceramic disc
C12, C20 through C24, C26, C29, C30, C32, C35 through C38—.05 µF, 50 volts, ceramic disc
C13—680 pF, 50 volts, ceramic disc
C14—.01 µF, 50 volts, mylar
C15, C31—130 pF, 50 volts, ceramic disc
C16—.001 µF, 50 volts, ceramic disc
C19—10 pF, 50 volts, ceramic disc
C25—56 pF, 50 volts, ceramic disc
C27, C28—180 pF, 50 volts, ceramic disc
C33—220 pF, 50 volts, ceramic disc
C34, C43—100 µF, 10 volts, electrolytic
C39—470 µF, 35 volts, electrolytic

Semiconductors
IC1—7808 8-volt positive regulator
Q1 – Q5, Q8, Q9, Q11, Q12, Q16 – Q19, Q21 – Q23, Q25, Q27, Q28, Q32, Q33, Q35 – Q39—2N3904
Q6, Q7, Q10, Q13 – Q15, Q20, Q24, Q26, Q29 – Q31, Q34—2N3906
D1 – D9, D11—1N914 or 1N4148 diode
D10—1N4004
LED1 – LED4—red LED's
J1, J2—RCA-type phono jack
J3—miniature phone jack
L1—33 µH, high-Q inductor
S1, S2, S3—SPDT toggle switch

Miscellaneous:—
117-volts AC to 12-volts DC, 300-mA wall transformer; printed circuit board.

The following are available from Video Control, 3314 H Street, Vancouver, WA 98663 (1-206-693-3834): Complete kit including PC board, wall transformer, case, and all parts for $139.00. Drilled and plated circuit board $28.50. Power adapter (wall transformer) $10.00. Please add $3.50 for postage and handling; WA residents add state and local taxes as applicable. Allow four (4) weeks for delivery.

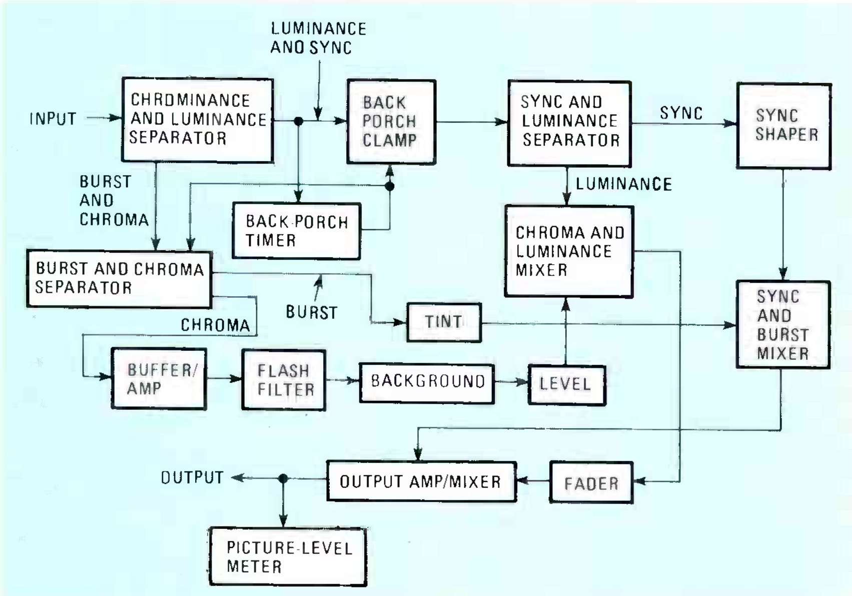

FIG. 2—BLOCK DIAGRAM OF THE COLOR PROCESSOR shows how the luminance and chrominance are processed separately.

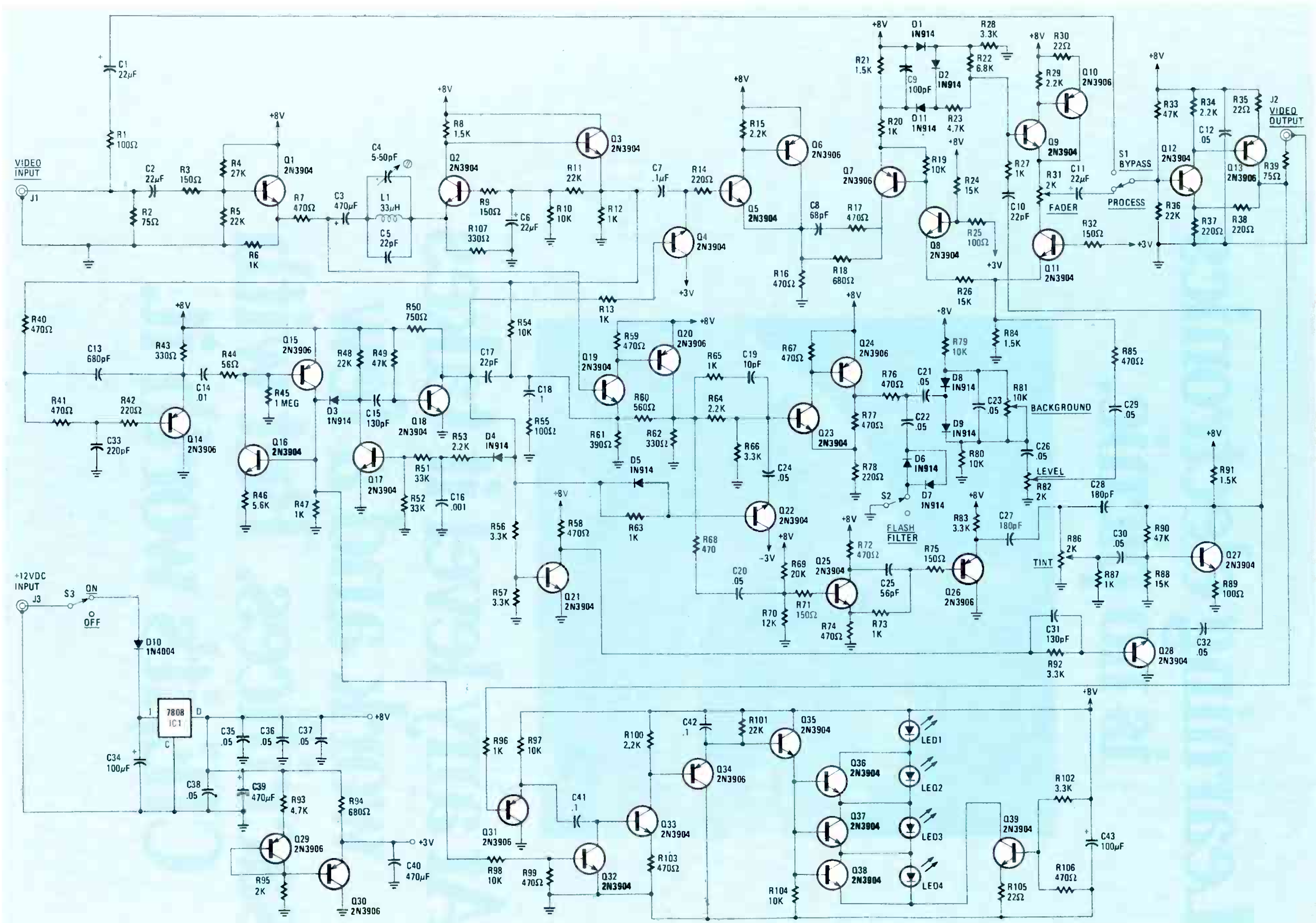

FIG. 3—SCHEMATIC OF THE COLOR PROCESSOR. You can substitute 1N4148 diodes for those marked 1N914.

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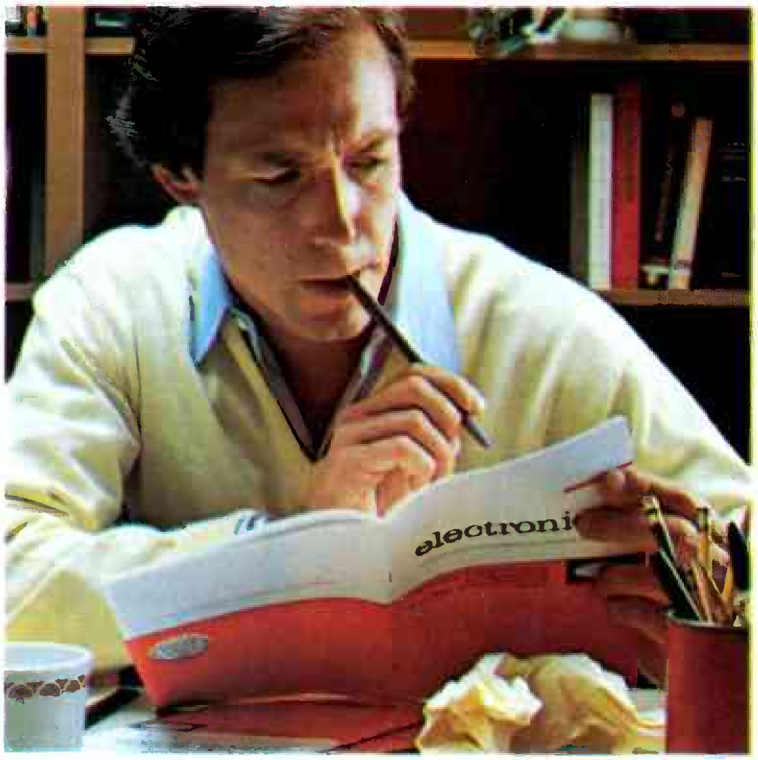

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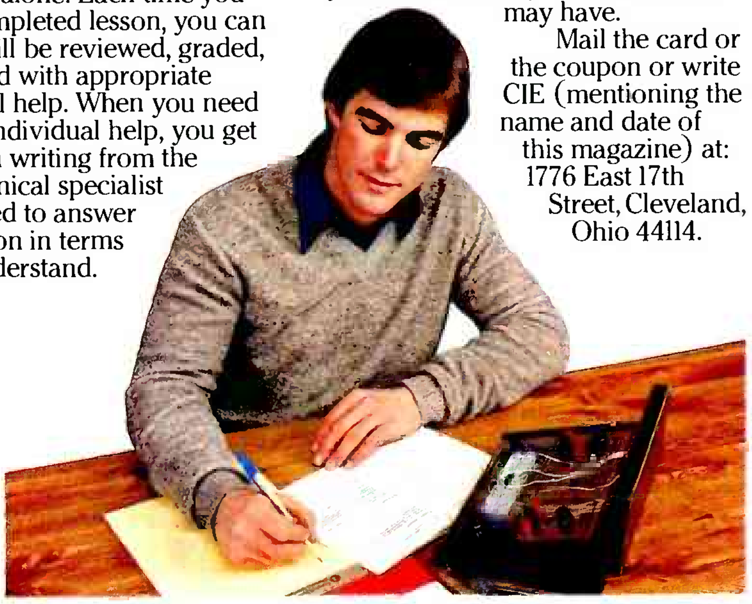

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first see what happens to the luminance-and-sync signal.

The luminance-and-sync signal goes to both the back-porch timer and the back-porch clamp. (The back-porch timer is a circuit that detects the sync pulse. It tells both the back-porch clamp and the burst-and-chroma separator when to begin their action.) From the back-porch clamp, the signal enters the sync-and-luminance separator. The luminance signal is sent to be mixed with the processed chroma signal in the chroma-and-luminance mixer. The sync pulses are properly restored in the sync shaper and are sent to be mixed with the processed burst signal in the sync-and-burst mixer.

Now we'll look at how the burst and chroma signals are processed. After the burst-and-chroma signal is separated from the luminance-and-sync signal, they are sent to the burst-and-chroma separator (Q22 and Q28). That separator acts like a switch that is controlled by the back-porch timer. The chroma subcarrier is sent through the buffer amplifier and then passes through the flash-filter, background-, and level-control sections. The processed chroma signal is then mixed with the luminance.

The burst passes through the tint-control section (phase shifter) and is mixed with the restored sync pulses in the sync-and-burst mixer.

The output signal from the chroma-and-luminance mixer passes through the fader and proceeds into the output amplifier/mixer, where it is mixed with the signal from the sync-and-burst mixer. The LED PICTURE LEVEL meter monitors the processed video output from the output amplifier/mixer.

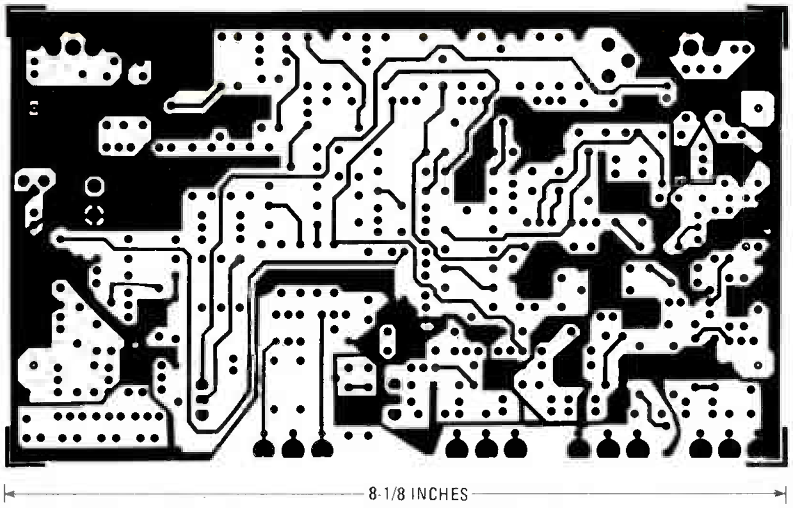


FIG. 4—The component side of the processor board is shown half size.

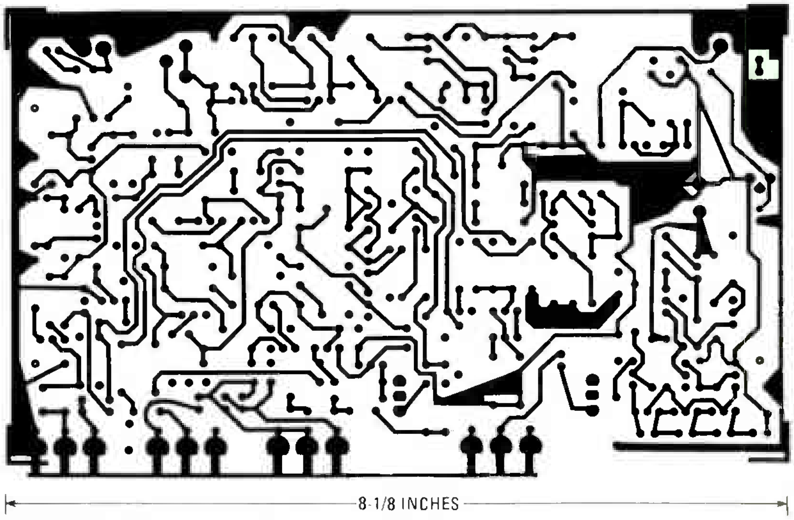


FIG. 5—THE FOIL SIDE of the board is shown here half size.

A look at the circuit

Now that we have an idea of the basic blocks of the color processor, let's take a closer look at the circuit. Its schematic is shown in Fig. 3. The video signal enters at J1 and is buffered by Q1. The color subcarrier, including the colorburst, is separated from the luminance and sync information by a filter made up of L1, C4 and C5. The luminance and sync are amplified through Q2 and Q3, and the DC level is restored by Q4, which clamps the video at the back-porch level. The back-porch timer (made up of Q14, Q15, Q16, Q17, Q18) generates a pulse during the back porch of the signal at Q3. That pulse tells the luminance-and-sync separator and the burst-and-chroma separator when to start their action.

The sync and luminance are separated by Q5, Q6, Q7, and Q8, and sent to the luminance-fader circuit and the sync-restoration circuit. The sync is amplified and shaped by Q7 and diodes D1, D2, and D11, and is then sent to Q9 and Q10, which feed the top of the FADER control. The luminance is amplified by Q11 and is fed to the other side of the FADER control. When the slider of R31 moves toward the collector of Q11, both sync and video are passed. But when the slider is moved away from Q11, the luminance will be attenuated.

The back-porch timer synchronizes the color-processing section by gating (Q22 and Q28) the color-sync burst independently from the color signal. The chrominance subcarrier is amplified by Q19 and Q20. The color burst is phase shifted by Q25, C25, and R73. The TINT control (part of a variable phase-shift network) composed of R86, C27, C28, and Q27 gives additional control over the phase shift. The color burst is then mixed back with the sync pulses through C10 and R27 and is fed to Q9. The remainder of the chrominance subcarrier is amplified by Q23 and Q24 and then limited by D6 and D7, the FLASH FILTER. After limiting, the background-noise gating diodes D8 and D9, whose bias is controlled by R81, set an amplitude that is adjusted to block out low-level noise. The LEVEL control, R82, adjusts the amount of color carrier. The chrominance signal is then mixed back in with the luminance at the emitter of Q11. The output of the FADER control feeds the output amplifier Q12, Q13, and then to the video output J2. From the output of Q13 the total signal is amplified by Q31 and goes to the meter-drive circuit. The signal is clamped at Q33 by Q32 (driven by a timing pulse from the sync separator, Q15). That gives a reference level for amplifier Q33. The signal is amplified and rectified through Q34, which drives the display circuit made up of Q35, Q36, Q37, Q38, and LED1 – LED4.

Construction

A double-sided printed-circuit board is definitely required for this project so that stray capacitance is kept to a minimum. Half-size foil diagrams are shown in Figs. 4 and 5. Figure 6 shows a parts-placement diagram.

A few construction tips are in order. When installing parts, it's important that all parts are inserted in their correct place. (That may seem too obvious to say, but *double check* your work!) Make sure you watch out for polarity, too, especially with transistors, diodes, and electrolytic capacitors. It is also important that all leads be kept as short as possible, because of the

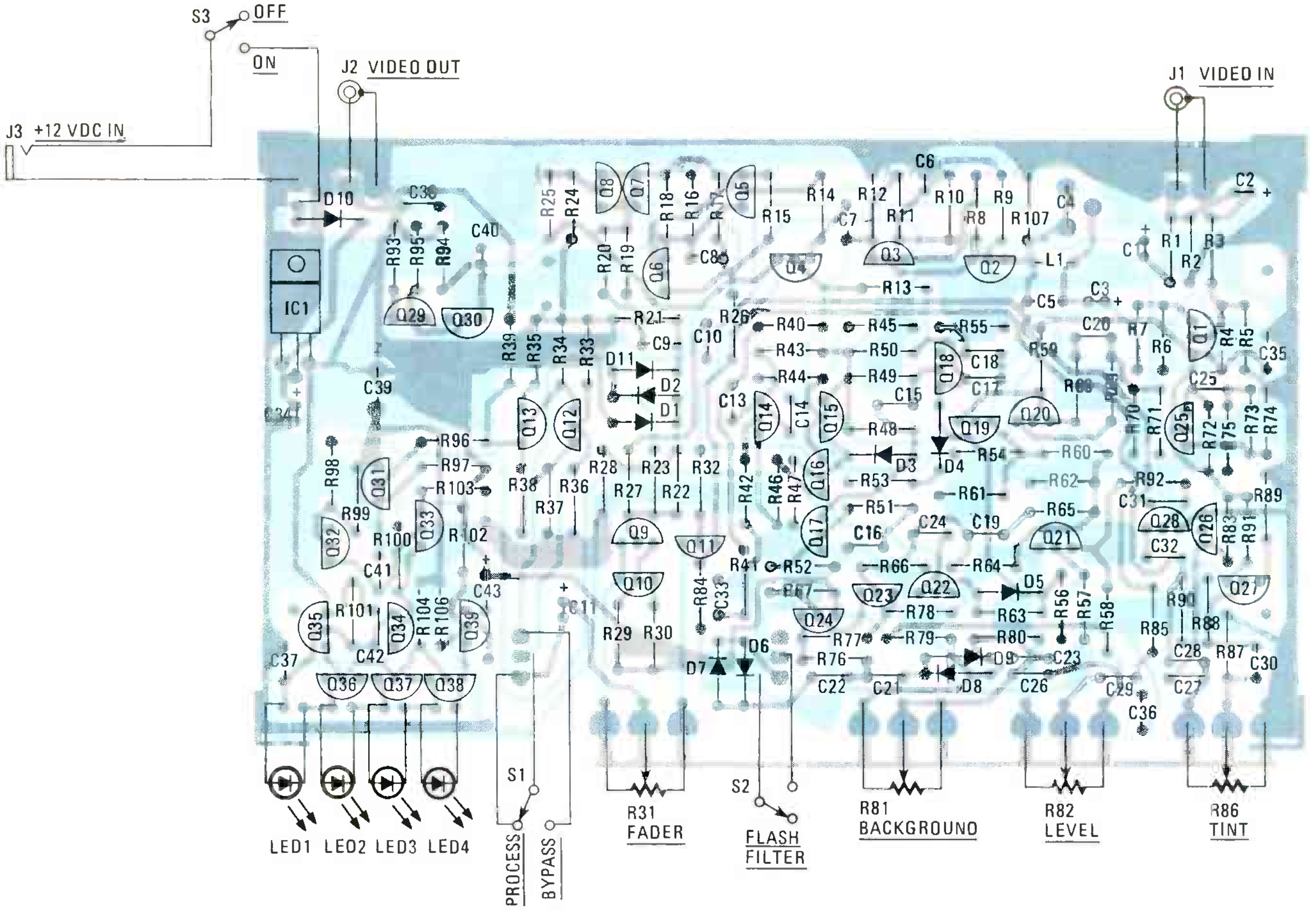


FIG. 6—PARTS-PLACEMENT DIAGRAM. Note that the voltage regulator, IC1, is mounted to the foil with a nut and bolt.

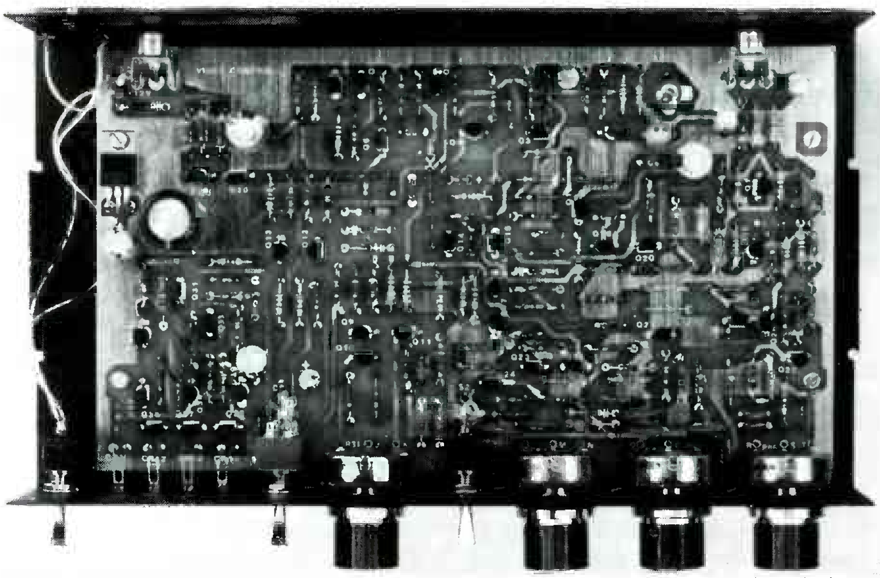


FIG. 7—A METAL CASE IS NECESSARY to ensure shielding. The potentiometers and phono jacks are mounted directly to the board without interconnecting wires.

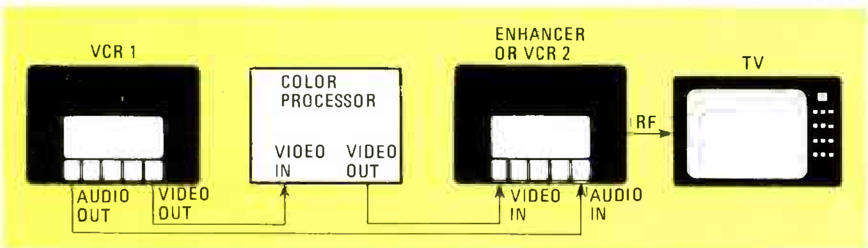


FIG. 8—ONE POSSIBLE HOOKUP for the color processor is shown here.

high frequencies involved. Be careful when you solder. Avoid cold solder joints and remove any flux residue with alcohol after soldering. Then you can inspect the board to make sure that there are no solder bridges between the traces.

The project should be mounted in a metal case to ensure shielding. One possible method is shown in Fig. 7. However, before you place the cover on the chassis, you have to calibrate C4. To do that, you'll have to hook up the unit as shown in Fig. 8. Connect the VIDEO IN jack of the unit to the VIDEO OUT jack of VCR1. Connect the VIDEO OUT jack of the processor to the VIDEO IN jack of VCR2. (If you do not have a second VCR, you can use an enhancer or an RF modulator.) Connect the enhancer's output or the RF output of VCR2 to the TV's antenna input. For calibration, the front-panel controls of the processor should be set as follows: Power switch in ON position, PROCESS/BYPASS switch in PROCESS position, FADER control at 12 o'clock (adjust for slight flickering of 100% PICTURE LEVEL LED), FLASH FILTER in OFF position, BACKGROUND control fully counter-clockwise, LEVEL control fully counter-clockwise, and TINT control at 12 o'clock. After completing the preliminary adjustments, C4 can now be calibrated. Adjust C4 until color disappears and only a black-and-white picture is on the TV screen. Now the processor is properly calibrated. **R-E**

NEW IC's FOR DIGITAL TV

A look at the technology behind the new generation of television receivers.

ROBERT GROSSBLATT

EVEN BEFORE THE FIRST TELEVISION SET was rolling off the production line more than thirty five years ago, engineers were hard at work looking for ways to reduce the parts count in the second set. When LSI (*L*arge *S*cale *I*ntegration) techniques made it possible to squeeze more than 70,000 transistors into an IC, television engineers were able to produce whole subsections of TV circuitry on a single silicon chip. This was, however, all analog circuitry. Digital electronics was only used for peripherals such as keyboard scanning, and bells and whistles such as time and channel displays.

VLSI (*V*ery *L*arge *S*cale *I*ntegration) has more than quadrupled the possible component density on a single chip and this state-of-the-art IC fabrication technology has resulted in a real breakthrough in consumer television design. ITT has invested more than two hundred man-years of highly specialized and expensive labor to produce a set of 5 VLSI IC's designed to be used as the processing heart of a digital television set. These new IC's are intended to replace more than 300,000 transistors and, together with some support circuitry, will mean the elimination of more than 25 IC's in conventional television circuits.

Now, digital TV in this case doesn't mean digital transmission or reception of some new type of signal. These IC's are meant to process the baseband audio and video signals in the television receiver—regular analog circuitry will still be needed to demodulate the off-the-air signals. The IC set works by doing A/D conversion, processing the signal digitally, and then restoring it to analog form for the picture tube and audio amplifier. If the IC's were designed to demodulate the off-the-air signals, then the A/D conversion would have to be performed on signals with a top end around one gigahertz, which is a tricky, expensive business. Using analog circuitry in the front-end reduces these frequencies down to a manageable size. This was a smart move on ITT's part because it vastly simplified the A/D conversion circuitry, reduced the amount of needed R&D time, and, more important, kept the cost of the IC set at manageable levels—presently about $40.00. (Unfortunately, these IC's are not presently available in low quantities.)

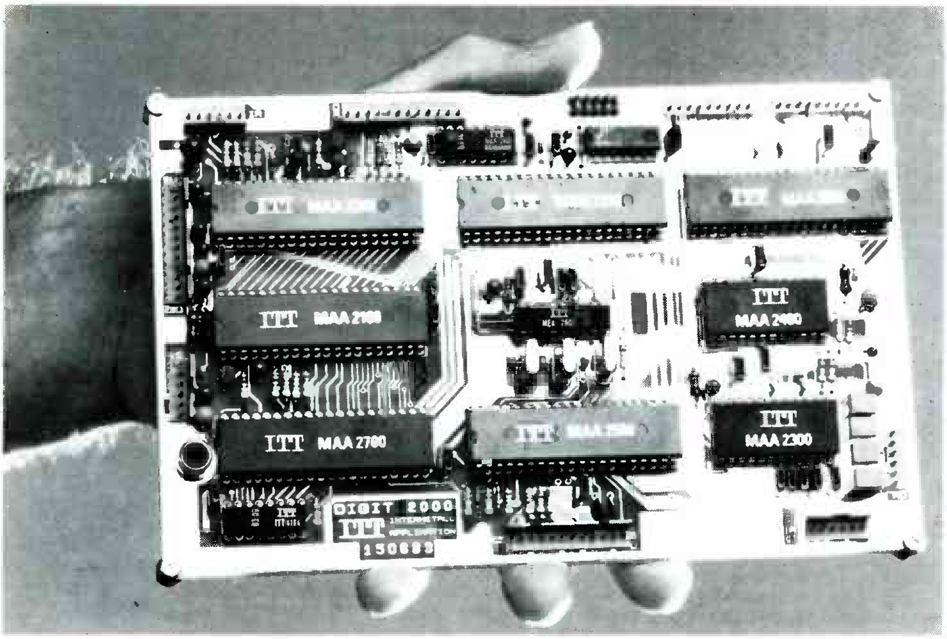
A block diagram of a typical TV receiver using the digital IC's is shown in Fig. 1. Once the incoming signal has been demodulated by the tuner, the composite video is fed to the VCU (*V*ideo *C*odec *U*nit). Figure 2 shows a block diagram of the VCU. The A/D conversion is the first step in the VCU. It's done by a flash converter and it's here that we see the first of a series of slick tricks used in the design of the IC's. The ITT engineers decided that eight bits of resolution were needed, but this can use up a healthy amount of silicon. This is because a flash converter is nothing more than a bunch of comparators in parallel, each being fed a reference voltage on one leg and the signal to be digitized on the other. Now, eight bits of resolution means that you'll need 2^8, or 256 comparators—and that takes up a lot of valuable room on the IC substrate. By using a clever bit of design, the people at ITT were able to get eight bits of resolution with only seven bits. This is accomplished by shifting the reference voltages for all the comparators. This bit of business is interesting enough to discuss in some detail.

The reference voltage for the string of comparators is shifted by an amount equal to one-half the value of the least significant bit. To determine whether this shift will occur or not, the composite video signal is sampled once each horizontal sweep. If this sample is halfway between two digital levels, then the reference level during the *next* horizontal line will be shifted up. The result will be that for the present horizontal line, the video signal will be converted to the lower digital level and during the next horizontal line, the video signal will be converted to the next higher digital level. When the digitized signals are converted back to analog, the D/A converter undergoes a similar shift in sync with the A/D converter. The human eye averages these two levels and provides an intermediate level as seen on the picture screen. This approach is valid since video information does not change very rapidly from one line to the next.

The number of bits isn't the only variable in this, or any other, A/D conversion. Not only do you have to decide how much you're going to sample, you also have to decide how often you're going to sample it. And this is where we start to see some of the real benefits of digital processing. The sampling clock for the A/D converter is phase-locked to the broadcast color-burst frequency. By changing the frequency of the clock, therefore, the system can accommodate NTSC (3.58 Mhz) or PAL (4.43 Mhz).

Once the signal is in digital form it is fed to both the VPU (*V*ideo *P*rocessing *U*nit) and the DPU (*D*eflection *P*rocessing *U*nit.

In the VPU the signal is split into the luminance (brightness) and the chrominance (color) signals. If you look closely at the block diagram of the VPU shown in Fig. 3, you'll recognize most of the stan-



dard signal-processing stages of a conventional TV receiver. In the luminance path, the signal goes through a chroma trap and peaking filter to improve the high-frequency response. This results in enhanced brightness and definition, and is controllable by the user in eight steps. The signal is passed on to a series of digital multipliers for the appropriate contrast setting, and a limiter that watches the voltage and clips the amplitude if the signal gets too strong. The seven-bit digital luminance signal is then fed back to the Y D/A converter in the VCU.

In the chrominance channel, the signal goes through the chroma bandpass filter for IF compensation. The amplitude of the signal is controlled by circuitry that keeps comparing the signal to an internally generated reference voltage. By doing this, the filter is perfectly phase linear and makes sure that the IF compensation is constantly being corrected. The circuitry that follows is a digital version of standard video-signal processing. The filter leads to an automatic color-control circuit, a color killer, and a color decoder. This is where things start to get interesting again. For NTSC and PAL, the blue and red signals are 90 degrees apart on the

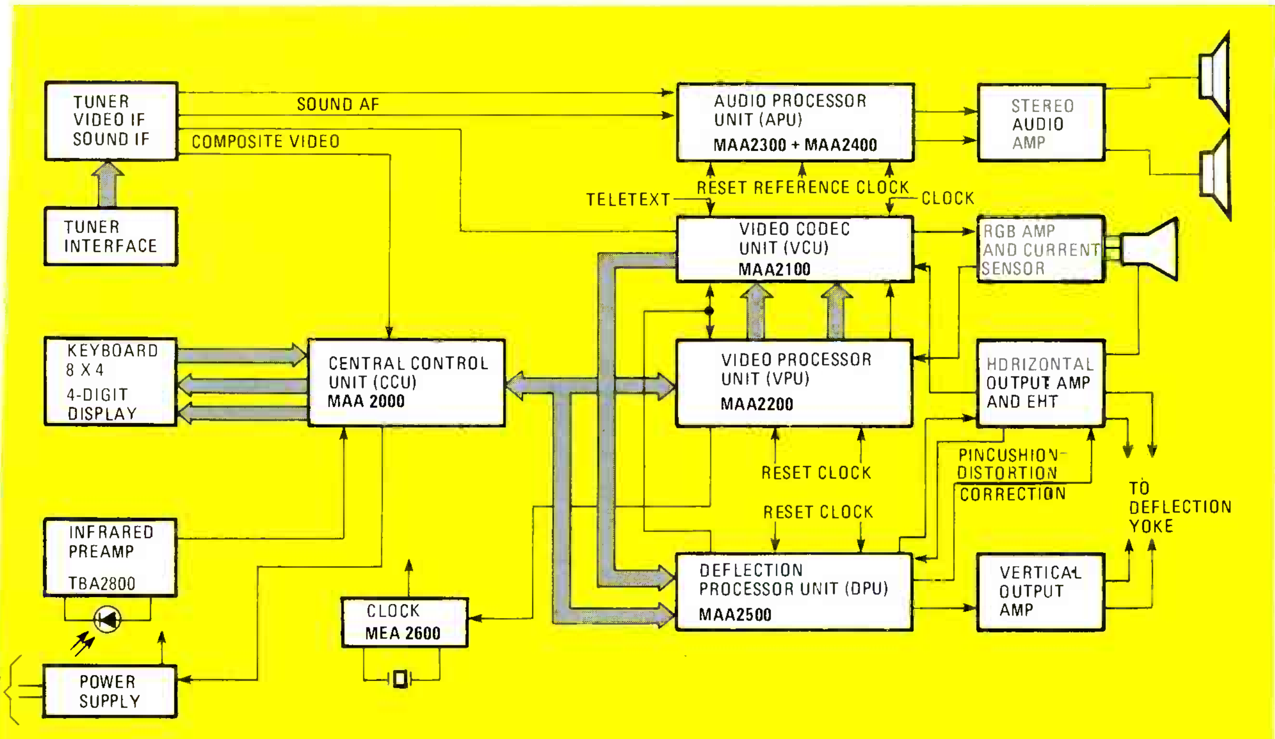


FIG. 1—ALTHOUGH ANALOG SIGNALS are fed in and analog signals come out, all the signal processing is done digitally in this new TV set. Note that the ADC is part of the APU block above.

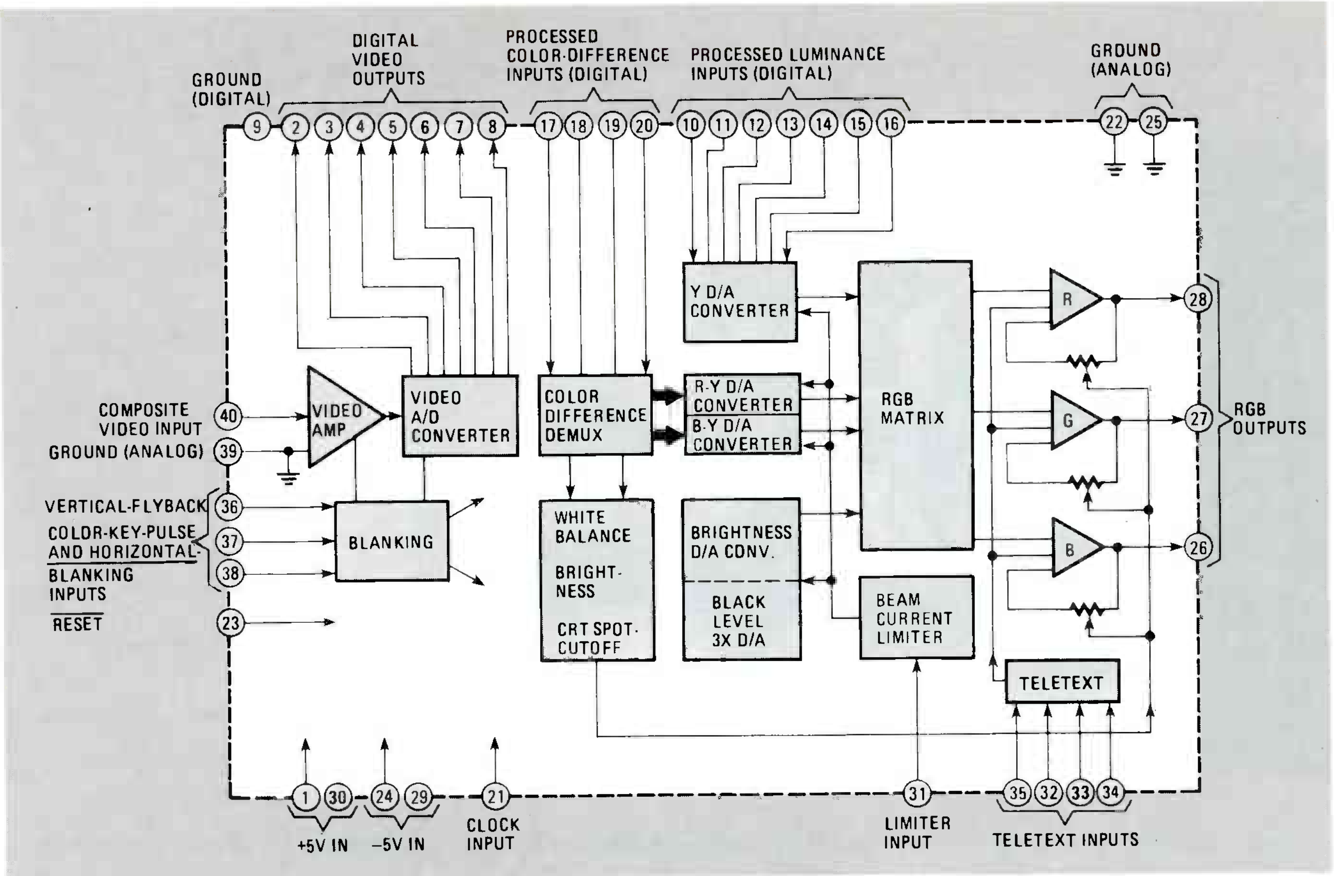


FIG. 2—THE VCU performs the analog-to-digital conversion of the video signal as well as the digital-to analog conversion. This IC also processes the video signal into separate R-G-B analog outputs.

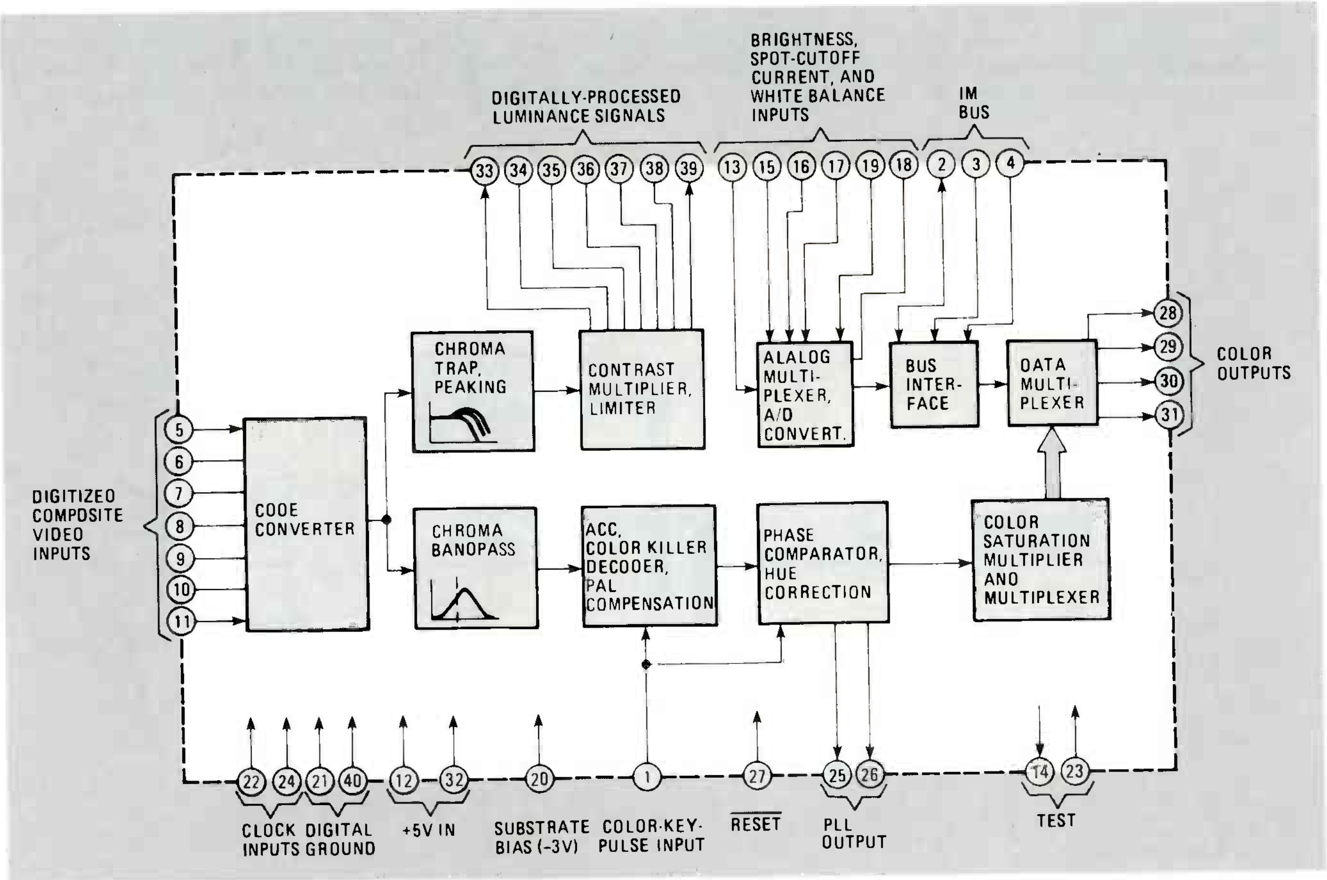


FIG. 3—COLOR AND LUMINANCE processing is done by the VPU IC. This IC can handle both PAL and NTSC signals.

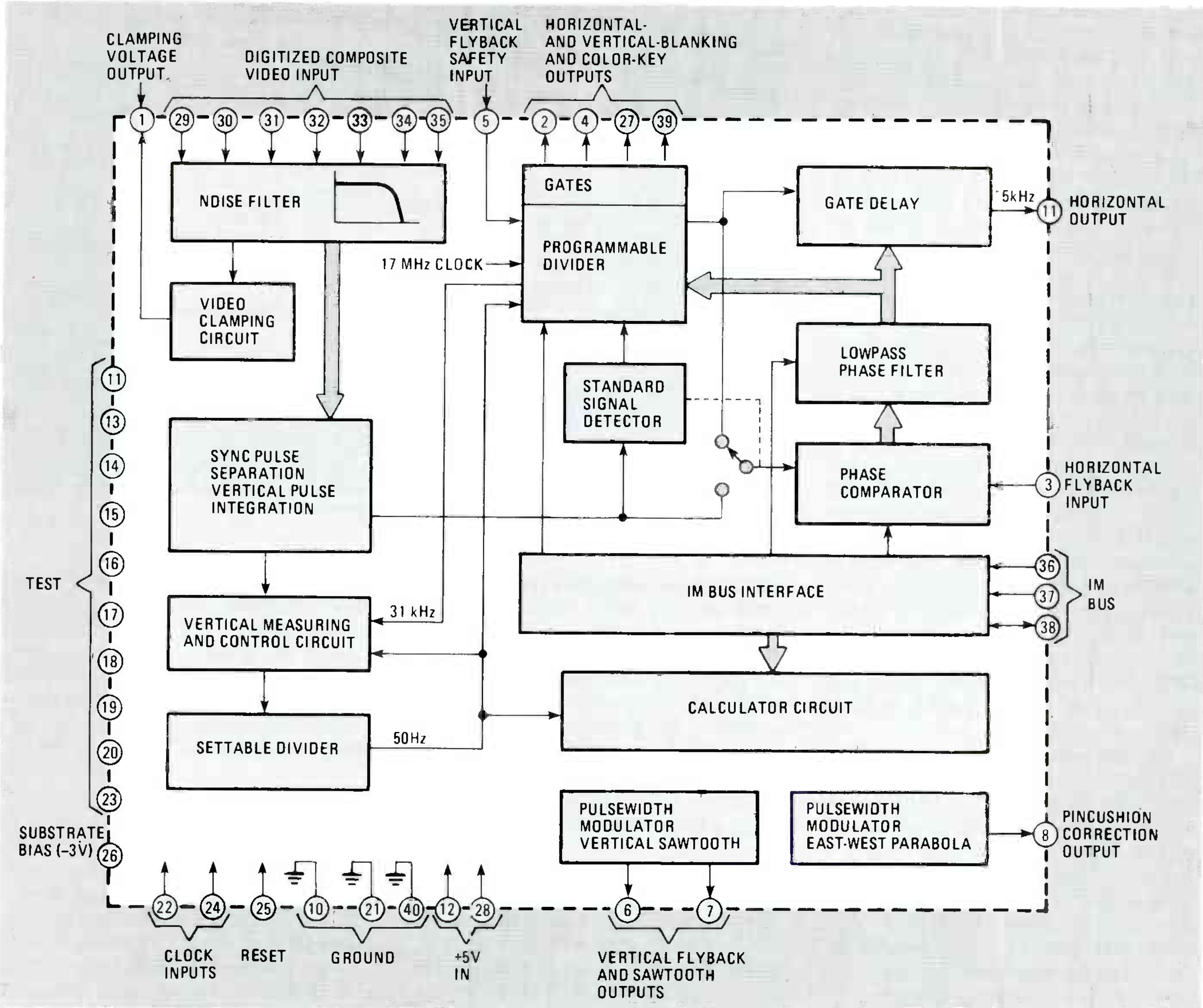


FIG. 4—THE DPU handles the deflection processing and has a unique way of coping with sync signals.

carrier and are amplitude modulated. SECAM, however, sends the blue and red signals separately on alternate horizontal sweeps and frequency modulates them on the carrier. The CCU (*C*entral *C*ontrol *U*nit) tells the color decoder what sort of TV signal it's looking at and decodes it into the proper blue and red components. The circuit that follows this is the compensation network for PAL signals. Since this phase compensation isn't needed for NTSC signals, the compensation circuit does double duty by using its delay lines as a comb filter when the circuitry is processing NTSC signals. Because the signal is in digital form, however, conventional analog delay lines aren't used. The VPU contains some RAM to emulate the delay by temporarily storing the signal for a number of clock pulses before passing it along to the next stage of video processing.

Since the red and blue information has been extracted from the signal, this is the point in the signal path where it's possible to check that the processor clock and the broadcast signal are in phase with each other. A digital phase-locked loop compares the blue signal in the decoded video with the red signal in the broadcast colorburst. Any phase difference found there is going to be proportional to the phase difference between the system clock and the colorburst. As in any phase-locked-loop system, an error voltage is generated. In this case, the error voltage is in digital form and is used to adjust the system clock so that TV sync is checked against broadcast sync on every horizontal line! Hue correction is done next by rotating the demodulation axis, using sine and cosine values in real time. The sine and cosine values are provided by the CCU in response to a user-adjusted front-panel HUE control. The corrected chroma signals are multiplied, multiplexed (to cut down the number of pins needed on the IC package), and put back on the bus to the VPU.

In the VCU, the signal is demultiplexed and fed to separate R – Y and B – Y D/A converters for restoration to analog form. These converters are resistive ladders of the R-2R type. An analog RGB matrix is used to convert these color and luminance signals into conventional RGB form and they are fed into individual RGB output amplifiers. One interesting point here is that the VCU has separate inputs for teletext featuring their own brightness and contrast settings. The VCU also monitors the beam current drawn by the picture tube. As the tube ages, the current is adjusted and kept at a constant level. The effects of picture tube aging are therefore cut way down and the useful life of the tube is greatly increased.

Deflection circuits

Things really start to get intriguing when we take a look at the deflection circuits. The DPU (*D*eflection *P*rocessor *U*nit) is the IC that takes the digitized video and produces all the sync and timing signals. A block diagram of the DPU is shown in Fig. 4. As we single-step our way through this amazing piece of silicon, you'll see why digital video processing can lead to some truly amazing things.

The first thing the incoming seven-bit signal sees is a video clamping circuit that holds the black level to a fixed voltage during flyback. Since we've already seen that there are limiters to cut excessive signal elsewhere in the circuitry, it's important to maintain a really rigid black level. This lets the incoming analog video swing across the full range of the video A/D converter in the VCU. The seven-bit video signal is fed in parallel to the DPU, has the noise filtered out by a digital lowpass filter, and sync is stripped out by separate horizontal- and vertical-sync separators. From here on in, things get fascinating. In theory, since the colorburst frequency is always in a fixed ratio to horizontal and vertical sync, it's possible to have the IC do some arithmetic and constantly check sync against colorburst. What this means is that sync can be derived by using some countdown circuitry that is keyed to the colorburst frequency. Remember that the system clock is set to exactly four times the colorburst and is checked and corrected on each horizontal sweep. The clock, then, contains all the information needed to produce all the necessary sync information, regardless of whether or not sync is accurately transmitted by the TV station. The ITT system uses the horizontal sync pulse to tell the DPU when to expect the sync pulse. The DPU can, however, tolerate one or two missing pulses and its stability in noisy signals is excellent.

By detecting colorburst and constantly locking the system clock to the broadcast colorburst frequency, the DPU knows where and when the sync pulses should appear. After all, horizontal sync is a function of the colorburst frequency and vertical sync is a function of horizontal sync. It's just a matter of arithmetic. As a result, the digital TV set isn't totally dependent on the broadcaster for sync—this is most definitely something new!

The DPU handles horizontal sync in two ways—locked and non-locked. If horizontal sync shows up where it's supposed to, the DPU operates in the locked mode and the broadcast sync pulse triggers an internally generated sync pulse that is passed on to the rest of the processing circuitry in the IC. The correct phase is guaranteed because the countdown circuitry lets the IC know when to expect the sync pulse. If the countdown is done and horizontal sync doesn't show up, the IC goes into the non-locked mode and generates horizontal sync all by itself. The switching between locked and non-locked operation is done on each horizontal line of video. The IC also does a check to see whether the phase of the horizontal sync pulse is correct by comparing it to the flyback. If a discrepancy is detected, the countdown timer, which is programmable, is corrected.

Vertical sync operates pretty much the same way. Horizontal sync is counted down and the IC knows when to expect the vertical sync pulse. If it shows up on time, all well and good—if it doesn't show up, the IC generates it. Strictly speaking, all sync pulses are generated by the IC. If the broadcast is standard, (ie, sync pulses are where they should be), the broadcast sync signal triggers the IC to produce a pulse. When things are non-standard or off-spec, the IC detects this and generates sync at the appropriate time all by itself. Since a fairly narrow window is used to catch sync, spurious signals such as those caused by airplanes or electric appliances won't have any affect on the picture. This goes a long way toward keeping the picture rock solid.

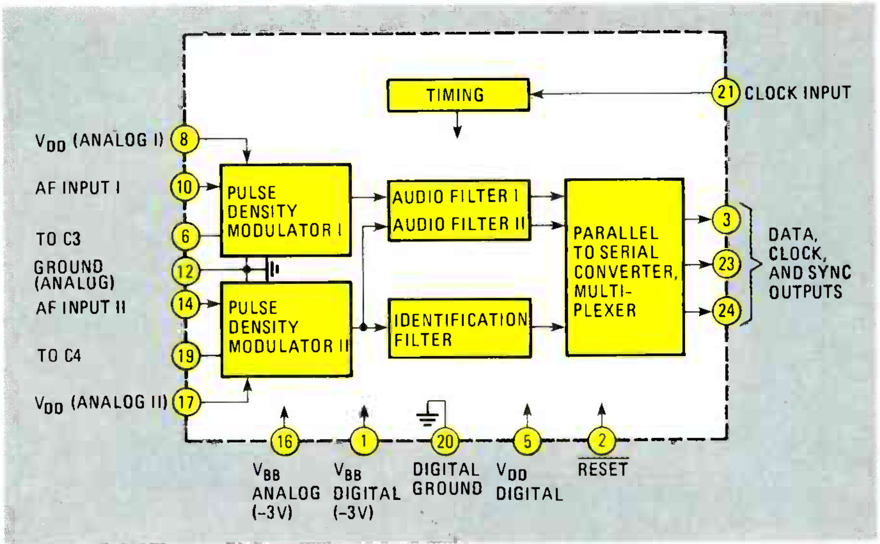


FIG. 5—THE AUDIO SIGNAL is converted into digital form by the ADC. This IC also has provisions for identifying whether the signal is broadcast in mono, stereo, or bilingual.

The audio signal

The audio is handled by two IC's—the ADC (*A*udio *D*igital *C*onverter) and the APU (*A*udio *P*rocessor *U*nit). A block diagram of the ADC is shown in Fig. 5. The ADC is basically an A/D converter that takes the audio signal from the tuner and converts it to a 16-bit digital signal at a 35-kHz conversion rate. The ADC identifies the signal that indicates whether sound is being broadcast in mono, stereo, or bilingual, and then multiplexes the parallel audio data into serial form to be passed to the second IC in the audio section—the APU.

A block diagram of the APU is shown in Fig. 6. The overall block diagram of the TV receiver in Fig. 1 shows the APU and ADC as a single block labelled APU. The APU has two paralleled, identical sections so to be able to handle either stereo or mono broadcasts. Processing in the IC is done in real time and the sequencing is done by a controlling algorithm in an onboard ROM. This means that changing the data in the ROM will enable the IC to economically handle different stereo standards. A tiny RAM is also onboard to store user settings such as loudness, tone, and so on. Although ITT doesn't mention it in their literature, these two audio IC's could easily be the heart of a separate digital audio system composed of just a handful of silicon. Since these IC's are designed to look at analog audio and output pulse-width-modulated signals, it wouldn't take much to produce a sound system featuring completely digital audio signal processing. Considering the quality of current sound transmission in broadcast television, the use of the digital-TV audio subsection for handling FM and other things seems a natural—but we'll have to wait and see.

System control

The brains behind the chip set is the CCU (*C*entral *C*ontrol *U*nit). This is basically an eight-bit single chip microcomputer—more specifically an 8049. A 96 × 8 EAROM is onboard and is used to store preprogrammed TV channels, (up to 30 are possible), preferred user settings for brightness, volume, etc.; and during manufacture of the TV set, all the alignment data can be written in. Every time the TV is turned on, the alignment data can be read out to the TV circuitry so factory-fresh alignment is always available. Component aging is just not the problem it is with conventional analog circuitry. It will be rare for alignment problems to show up. This arrangement becomes very important when the set has to be serviced. The technician will have a handheld unit with which he can check settings and make any adjustment to the data in the EAROM that is indicated. Performance upgrades could very well be simply a matter of altering the program in the EAROM. In theory this could be done without taking the back of the set off and should allow such currently impossible things as a ten-second conversion of the set from PAL to NTSC or vice versa.

The CCU also handles the TV controls from either an infra-red remote control or a front panel keyboard. Up to 32 keys can be decoded and that should be more than enough for even the most die-hard knob twiddler. Several output ports on the CCU can directly drive LED displays and handle additional features such as automatic station search and so on.

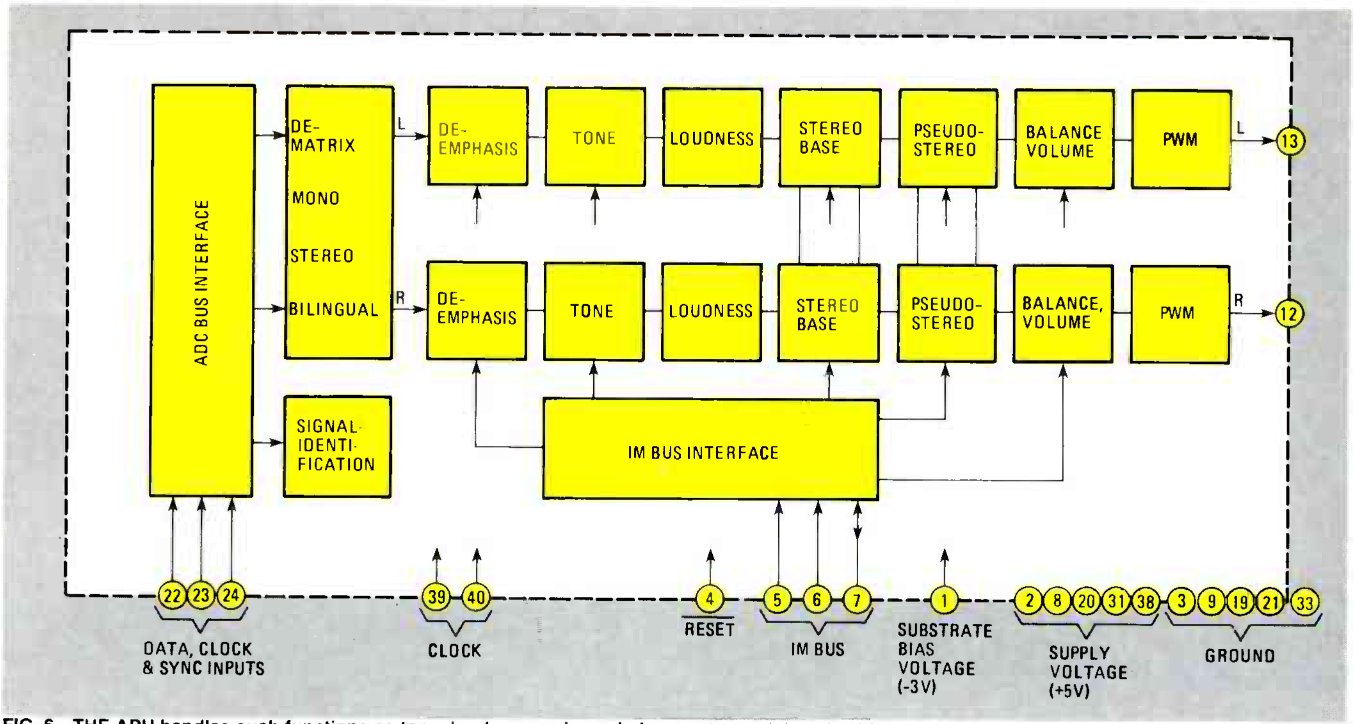


FIG. 6—THE APU handles such functions as tone, loudness, volume, balance, etc., and does it with two independant audio channels.

The clock-generator IC is crystal controlled and delivers the two phase, non-overlapping pulses used by the rest of the circuitry. As we've already seen the VCO (*V*oltage *C*ontrolled *O*scillator) in this IC is part of the digital phase-locked-loop contained in the VPU. This arrangement makes it possible to sync the system clock to the broadcast colorburst. It also means that the same clock IC can be used for either NTSC (14.32 MHz) or PAL (17.73 MHz). If these numbers look strange, remember that the clock is designed to run at four times colorburst. The basic clock frequency is fed to a pulse shaper to produce the two-phase clock signal and buffers are used to convert it to a low impedance output.

Advantages of digital TV

Now that we understand how digital TV works, let's talk a bit about some of the things it can do. To start off with, we've already seen that the same TV can receive either PAL or NTSC signals. Now, there may not be too many of you out there who are planning on a move to Europe but I'll bet there are a lot of you who are using earth stations. If this benefit seems a bit limited, there are other advantages. A bit of extra silicon will produce picture store. For those of you without VCR's it means that you can do a freeze frame during actual transmission. But picture store goes a lot farther than that. It includes such goodies as zooming, picture within picture (seeing a different channel in the corner of the screen), easy conversion between different standards, and so on.

We can take this last bit a little farther since, in theory, interpolation techniques could be used to create as many lines as you want. There is a breakeven point, but adjacent lines could be averaged to produce new "in-between" lines of video. Either averaging or real bit interpolation could be used. This would go a long way toward correcting one of the worst features of large-screen, projection TV. Some work has already been done on this by ITT but it was found that moving objects tend to blur. This doesn't rule out digital enhancement, however, but it does mean that some sort of processor-controlled motion-sensing circuitry is needed to change the interpolation algorithm for moving objects.

Picture store can also be used to reduce the flicker caused by current interlace methods and increase the apparent resolution of the picture. This is simply a matter of reading out the picture at a higher rate than the picture is produced. TV engineers have known for quite a while that the resolution seen in today's conventional sets is much lower than even a 525 line picture scan should be able to produce. A good part of the reason for this is that only half the total scan lines are on the screen for each field of video. Digital TV can eliminate the interlace by storing all 525 lines and then displaying the completed picture on the screen all at once. This picture would be continuously displayed until the next full picture was ready to be put on the screen. This would give you 30 images a second—movies get by with 24.

People plagued by poor reception in weak-signal areas would have their lives made a lot easier by easily added noise-reduction circuitry (remember, this is digital signal processing), and ghosting can be reduced by using echo cancelling.

TV manufacturers are constantly touting new features and calling them revolutionary. Well, they're often innovative and creative, but "revolutionary" is a strong word. Digital TV is, however, revolutionary—it's a brand new way to process video and, even as it stands now, it opens the door to features that are just not possible with conventional analog circuits. The current eight-IC set will undoubtably be reduced in number.

At the moment, ITT is alone in producing an IC set for Digital TV. Most of the other semiconductor manufacturers in the field seem to be taking a wait-and-see attitude—and this is understandable. The design and development of the IC set is only a part of the economic question of whether digital TV can compete with traditional circuitry. Producing VLSI IC's with their enormous component densities is a difficult and complicated process. Remember that VLSI techniques have only been around for a few years. Whether it can be done efficiently and economically in a high-volume operation is a question still looking for an answer. Product reliability in the field is another parameter that has yet to be determined. Mass production of an IC set as complicated as ITT's current design hasn't ever been done on the sort of scale needed for consumer applications. If everything works out, however, ITT will be way ahead of everybody else and will enjoy a well-deserved lead in the marketplace. **R-E**

VCR REPAIRS AND ADJUSTMENTS THAT YOU CAN DO

JOHN D. LENK

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

SO YOU WANT TO TRY SERVICING VCR'S? On the other hand, maybe you would just like to know how to make some simple adjustments to improve VCR performance or some sure-fire troubleshooting to quickly pinpoint VCR problems. Well, we'll start this article by saying there are no such tricks or simple adjustments! Servicing any VCR takes all the skill and knowledge required to service any TV set or tape recorder. More important, all VCR adjustments, particularly mechanical adjustments, are critical. An improper mechanical adjustment can not only put a VCR out of commission, but can result in permanent damage to the VCR or cassette.

Now that we have duly frightened you, let us go on to discuss what practical steps you can take in VCR servicing, without hassle, and with a minimum of danger. Before we start, however, let us set a few ground rules. First off, we will assume that you are thoroughly familiar with TV, both color and black-and-white, and with magnetic tape recorders. We also assume that you can use all forms of test equipment and tools associated with TV and tape-recorder service. If the above is not true, you probably have no business trying to service a VCR.

Now let us review how VCR's, both Beta and VHS, operate. We will not go into full circuit descriptions or mechanical details (to do so would fill a book, let alone a magazine article), but we will go through VCR functions so that you can understand the theory-of-operation sections found in VCR service literature.

The basic VCR circuit

Figure 1-a is a block diagram of a basic VCR circuit. Note that a VCR is a form of VTR, or videotape recorder. VTR's have been used in the television industry since about 1955 to record programs. Based on the same electromagnetic principles as an audio-tape recorder, a VTR has the ability to record on magnetic tape, and later play back, video signals coming from a video

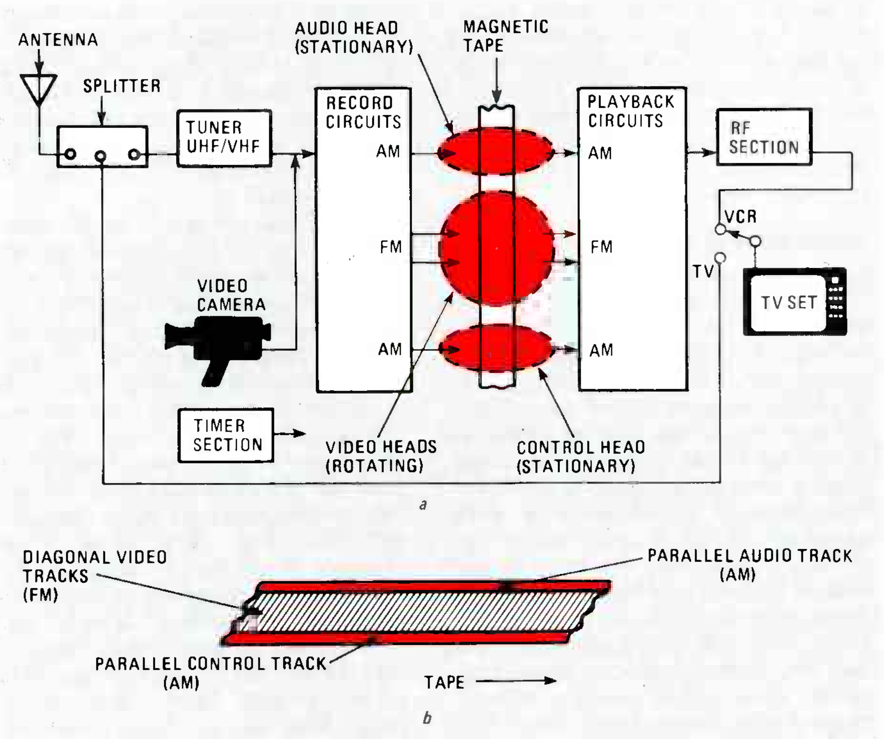
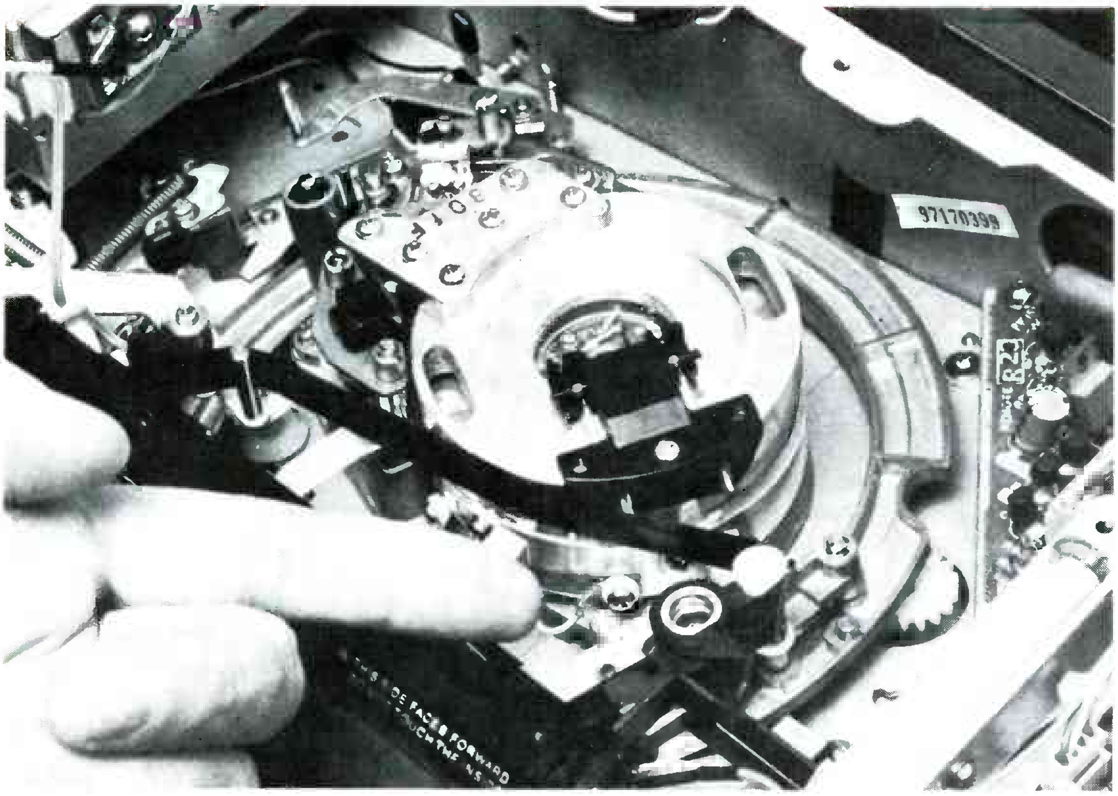


FIG. 1—SIMPLIFIED BLOCK DIAGRAM of a home VCR is shown in *a*. How that VCR records tracks on a tape is shown in *b*



camera or a TV station. That process is called video recording, and has many advantages over older TV recording processes and over motion-picture film. For example, both picture and sound can be recorded at the same time; there is no need for developing or processing the tape after recording; long-term preservation is possible; many recordings can be made using the same tape over again; continuous recording and playback are possible over relatively long periods of time, and a VTR or VCR is relatively compact and easy to use.

As shown in Fig. 1-a, a typical consumer VCR includes a tuner (VHF and UHF), an RF section, a timer section, and a mechanical section (including tape transport, stationary audio head, stationary control head, and rotating video heads). The same heads used for recording are also used for playback, and there are two rotating heads (typically) for video record/playback, whereas there is only one audio head and one control head.

The tuner section is similar to tuners found in TV sets, and functions to convert broadcast signals picked up by the antenna to frequencies and formats suitable for use by the VCR. All TV channels, 2 through 83, are covered by the tuner. Typically, tuner output to the recording circuit is 1 volt (P-P) for video, and 0 dB (0.775 volt) for audio.

The recording circuits function to convert the tuner output into electrical signals used by the heads to record the corresponding information on the magnetic tape along tracks. There are three tracks as shown Fig. 1-b (audio, video, and control or synchronization). Note that the audio and control tracks are parallel to the tape, whereas the video track is diagonal. As we will discuss later, the video track is recorded diagonally to increase tape-writing speed, and thus increase the bandwidth as is necessary to record video signals.

The playback circuits function to convert information, recorded on the tracks and picked up by the heads, into electrical signals used to modulate the RF section. In the simplest of terms, the RF section is a miniature TV broadcast station with its output on an unused TV channel (typically Channel 3 or 4, but possibly 5 or 6). The output of the RF section is applied to the TV set.

During operation, you select the channel you wish to record, using the VCR tuner controls. That need not be the channel watched on the TV set. (In fact, the TV set need not even be on while recording on the VCR.) You then turn on the timer and the program (or programs) are recorded.

When you are ready to play back the recorded program, you select the appropriate unused channel using the TV's channel-selector controls. Then you turn on the timer and play back the program using the TV set as a display device.

Many present-day VCR's also provide for recording directly from a video camera and microphone. Those are connected to the VCR's recording circuits at the same point that the tuner would be. Once the material is recorded, operation of the VCR during playback is the same, no matter what the recording source (off-air programming or video camera).

Why VCR circuits are so complex

The diagram shown in Fig. 1-a is, of course, greatly oversimplified. Although a VCR is essentially a tape recorder, there are two unique problems associated with them that are not found in audio tape recorders. Those two problems result in very complex circuits, as well as precision mechanical assemblies for both Beta and VHS VCR's.

One of the problems is the high video frequencies (4 to 5 MHz) used in TV. It is not practical to record those frequencies on tape using familiar audio-frequency techniques. The other problem is that there must be precise synchronization of video and audio during both record and playback.

Now let us see how these problems are solved in a present-day consumer VCR.

Recording the video signal

Recording the audio and control tracks is relatively simple when compared to recording the video signals. The control signals are typically 60 Hz, whereas the audio signals rarely go below about 20 Hz or above 20 kHz. The techniques used in audio-tape recorders are adequate for both of these signals. However, typical video signals can range from DC (0 Hz) up to about 4.2 MHz.

There are three methods used to increase the frequency range (or increase writing speed) that a VCR can handle—small head gaps, frequency modulation, and rotating heads.

Small video-head gaps

The recording heads in a VCR are a form of electromagnet made up of a core wrapped with a coil. Those electromagnets are made so that the north and south poles are placed physically close together. But no matter how close together they are, there is always a small space, or gap, between them. That space is referred to as the head gap.

Both record and playback frequency limits are inversely proportional to head gap (the frequency limit increases as the gap decreases). Thus, all other factors being equal, a smaller head gap means shorter-wavelength signals can be handled. A shorter wavelength, of course, means a higher frequency. The reason head gaps place that limit on high frequencies is that when the wavelength of the signal recorded on tape is the same as gap width, the playback output is zero. Thus the gap must always be narrower (or shorter) than the wavelength of the highest frequency to be recorded. Note, however, that although present-day video-head gaps are very small (typically 0.6-micrometer for Beta and 0.3-micrometer for VHS), there is an obvious physical limit on how small you can make a practical video head. Thus, other methods of increasing the frequency range must also be used.

FM recording and playback

The output voltage of any tape playback head varies in amplitude with changes in frequency; Fig. 2 shows that relationship. If only a narrow portion of the frequency range is used, as is the case with audio recording, you can ignore the amplitude variations. However, with video (where the highest frequency is about 200 times that of audio), the wide variation in amplitude produces a playback output (at the head) that is totally distorted compared to the recorded signal. An FM recording has no variation in amplitude (theoretically) and any amplitude variations that do occur in either record or playback can be virtually eliminated by limiters and amplifiers that are driven into saturation (just as they are in the audio portion of a TV set).

For those reasons, the video signal is converted to an FM signal by an FM modulator before recording on tape in a VCR. Upon playback, the FM signals coming from the video heads go to amplifiers and limiters where the amplitude variations are removed. Typically, the playback head signal is amplified so that the lowest output is beyond the amplitude limit (at saturation) of a limiter circuit, which then reduces all signals to the same amplitude level. Those constant-amplitude signals are then applied to an FM demodulator that converts the FM signal back into a replica of the original video signal.

Rotating video heads

Rotating video heads are used to increase the relative speed between the tape and head. If you are familiar with audio tape recording, you know that a slow tape speed is sufficient for recording conversation, but music requires a faster speed (typically 19 cm-per-second) for good sound quality. If you assume that the top frequency for recording music is 20 kHz, that the top frequency limit for video signals is 4 MHz (200 times that of audio), and that a 19-cm-per-second tape speed is sufficient for good quality for audio, the required tape speed is 3800 cm-per-second ($19 \times 200 = 3800$) or 38 meters-per-second. This works out to about 2280 meters-per-minute, and would require a video cassette the size of a truck tire (or very thin tape) for only one hour of playing time!

Instead of running the tape at a high speed, the video heads are rotated to produce a high relative speed between head and tape. Figure 3 shows how the heads and tape move in relation to each other. While the video heads rotate in a horizontal plane as shown in Fig 3-a (on a drum in Beta and on a cylinder in VHS), the tape passes the heads diagonally. That is known as a helical scan system, and produces slant tracks or diagonal tracks for the video recording.

Note that the audio head and control-track head (mounted one above the other on a stack as shown in Fig. 3-b) are stationary, and are separate from the video heads, as is the erase head. That arrangement is typical for both Beta and VHS. However, because of different drum or cylinder size, the relative speed of the Beta system is typically 6.9 meters-per-second (273.2 inches-per-second), whereas the typical VHS relative speed is 5.8 meters-per-second (228 inches-per-second), even though the actual tape speed is in the range of 2 cm-per-second. Also note that the drum or cylinder (often referred to as the scanner) rotates at a speed of 1800 rpm for both Beta and VHS.

FIG. 2—PLOT OF FREQUENCY versus output voltage for a typical playback head. Note that over a wide frequency range, as is the case with a video recording, the variations in amplitude can cause unacceptable distortion.

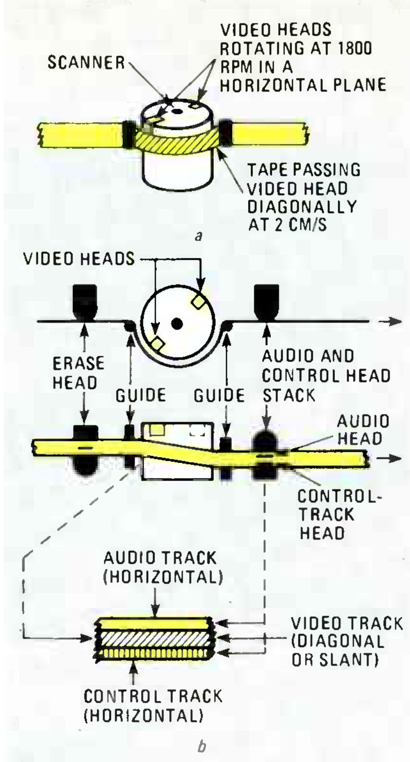


FIG. 3—HOW VIDEO HEADS and tape move with relation to each other.

Video signal recording sequence

Figure 4 shows the typical sequence in recording and playback of the luminance (black-and-white) signal on a VCR. During recording, the entire luminance signal (from sync tips to white peaks) is amplified and converted to an FM signal that varies in frequency from about 3.5 to 4.8 MHz (for Beta) or 3.4 to 4.4 MHz (for VHS). During playback, the FM signal is demodulated back to a replica of the original luminance signal. Note that this provides an FM luminance bandwidth on tape of about 1.3 MHz for Beta and 1 MHz for VHS.

TV color information is transmitted on the 3.58-MHz chrominance subcarrier. Color at any point on the TV screen depends on the instantaneous amplitude and phase of the 3.58-MHz signal. In VCR's, the 3.58-MHz subcarrier is hetrodyned or down-converted to a frequency of 688 kHz (Beta) or 629 kHz (VHS), and is then recorded directly (AM, not FM) on tape. That system is known as color-under, because the color signal frequency is always well below the luminance signal frequency.

Tracks, fields, frames

As shown in Fig. 5-a, video heads A and B are positioned 180° apart on the drum or cylinder, which rotates at 30 rps. The tape is wrapped around the drum or cylinder and passes diagonally across the surface to produce the helical scan. Since there are two heads, each head contacts the tape once each 1/60 of a second, so each head completes one rotation in 1/30 of a second, and one video track is recorded on the tape during half a rotation (1/60

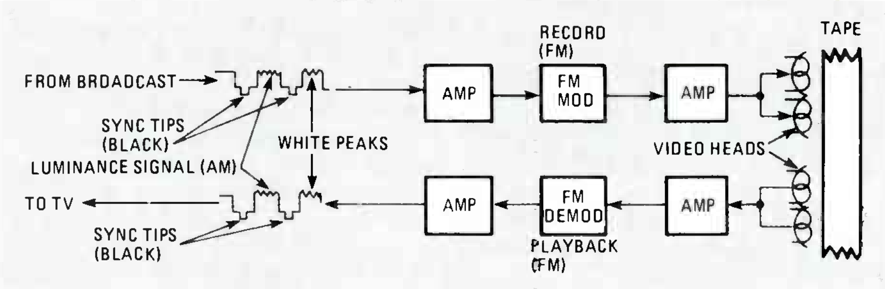


FIG 4—THE SEQUENCE FOLLOWED in recording and playing back a luminance signal in a typical VCR. Note that the same heads are used for recording and playback.

of a second).

Since the tape is moving, after the first head has completed one track the second head records another track immediately behind the first. If head A records during the first 1/60 second, head B records during the next 1/60 second. The recording continues in an A, B, A, etc. pattern as shown in Fig 5-b. During playback, the same sequence occurs—the heads trace the tracks recorded on tape and pick up the signal, producing an FM signal that corresponds to the recorded video signal.

Figure 6 shows the relationship between the video tracks and TV signals. Since there are two heads, 60 diagonal

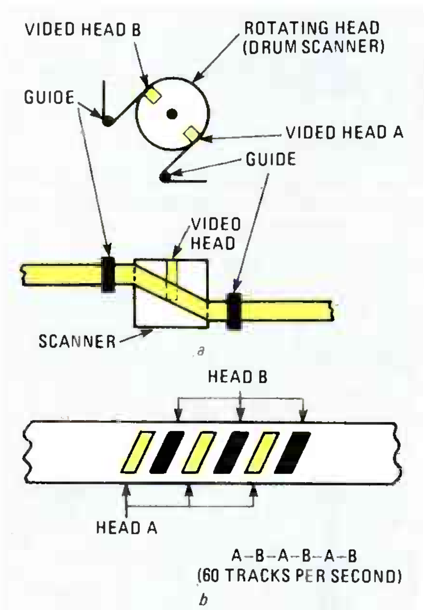


FIG. 5—THE RELATIONSHIP between the video heads and the video tracks recorded on a tape.

tracks are recorded every second as shown in Fig. 6-a. One field of the TV video signal is recorded as one track on the tape, and two fields (adjacent tracks A and B) make up one frame as shown in Fig. 6-b. In both Beta and VHS, there is some overlap between the two tracks. For example, the video signal recorded by head A (just leaving the tape) is simultaneously applied to head B (just starting its track). During playback, this overlap is eliminated by electronic switching so that the output from the two heads appears as a continuous signal.

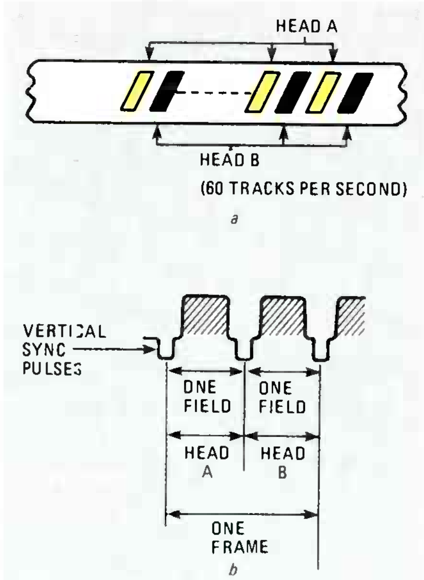


FIG. 6—HOW FIELDS, frames, and tracks are related.

Zero guard band recording

On studio-type VTR's, there is unrecorded vacant space between the video tracks. That blank area, or guard band, is necessary to eliminate crosstalk between tracks. Crosstalk occurs when the heads mistrack and play back a portion of two adjacent tracks. On consumer VCR's, there are no guard bands between the video tracks. Figure 7 shows a comparison of tapes with and without guard bands. Note that the tape without guard bands shown in Fig. 7-a (consumer VCR) contains much more information than the studio VTR tape shown in Fig. 7-b, and is often referred to as high-density recording tape. Although those high-density systems are called zero guard-band, there are guard bands that separate the audio and control tracks from the video tracks.

Without special precautions, crosstalk can occur in zero guard-band systems. In both Beta and VHS, the problem of crosstalk is eliminated by two techniques: azimuth recording and phase inversion.

Azimuth recording

If you are familiar with audio-tape recorders, you know that considerable high-frequency loss (known as azimuth loss) occurs when there is a difference in the angle of the head (in relation to the tape) between record and playback. One symp-

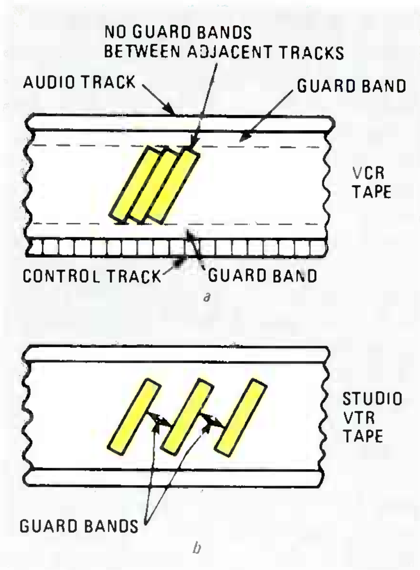


FIG. 7—THE DIFFERENCES between home VCR tape and studio VTR tape. Note that in the VCR tape there is no guard band between the tracks.

tom of an audio recorder with any misalignment (known as azimuth error) is that the recorder plays back its own recordings without high-frequency signal loss, but produces considerable loss when playing back tapes made on other machines (where the tapes are recorded with different azimuth adjustments).

In VCR's, that azimuth-loss principle is used to eliminate high-frequency luminance crosstalk. The two video heads are mounted so that one head is at a different angle from the other head, as shown in Fig. 8. In Beta, the angle for one head (arbitrarily called head A) is +7° from the reference point, whereas head B has an azimuth angle of −7° from the reference, producing a difference of 14° between the heads. VHS uses a ± 6° azimuth difference (resulting in a 12° difference between head A and head B). During playback, a strong signal is picked up only when head A traces track A. If head A runs over to track B, for any reason, the track B high-frequency signal is weak and does not produce interference or crosstalk.

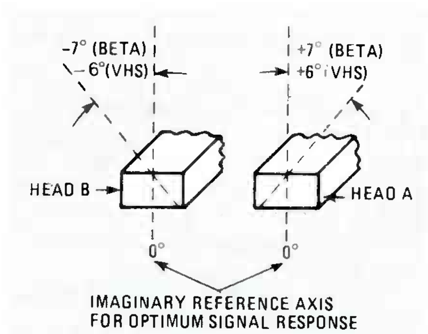


FIG. 8—TO ELIMINATE high-frequency luminance crosstalk, the heads in a VCR are mounted so that they are at opposite angles to an imaginary reference axis.

Phase-inversion color recording

In Beta, the color or chroma signal (at 688 kHz) to be recorded on track A is phase-inverted by 180° with every line period, while the color signal recorded on track B remains continuously in the same phase (see Fig 9-a). The term "line period" refers to the period of time required to produce one horizontal line on the TV screen, about 63.5 microseconds, and is referred to as "1H". Upon playback, both track A and B signals are restored to the same phase relationship. That is done by passing the chroma signal through a comb filter using a 1H delay line and a resistive matrix, as shown in Fig. 9-b. Both the delayed (head B) and non-delayed (head A) signals are added together in the resistive circuit, canceling the crosstalk component out, and doubling the normal color signal component amplitude.

The phase-inversion system used in VHS is entirely different from that in Beta. In VHS, the phase of the color signal being recorded on head A is advanced in phase in increments of 90° at each successive horizontal line. At the end of four lines, the signal is back to the original phase. When head B is recording, the signal is shifted in phase (retarded) in the opposite direction (0°, 270°, 180°, 90°). That operation results in the pattern shown in Table 1.

LINE	1	2	3	4	5	6
HEAD A	0°	90°	180°	270°	0°	90°
HEAD B	0°	270°	180°	90°	0°	270°

With that sequence, recorded phase shifts for odd-number lines (1,3,5) are the same, but are opposite for even-number lines (2,4,6). Upon playback, the phase of the color signal is shifted on every other line and, when such a signal is passed through a 1H delay line, the crosstalk component is canceled, and the normal color signal is doubled.

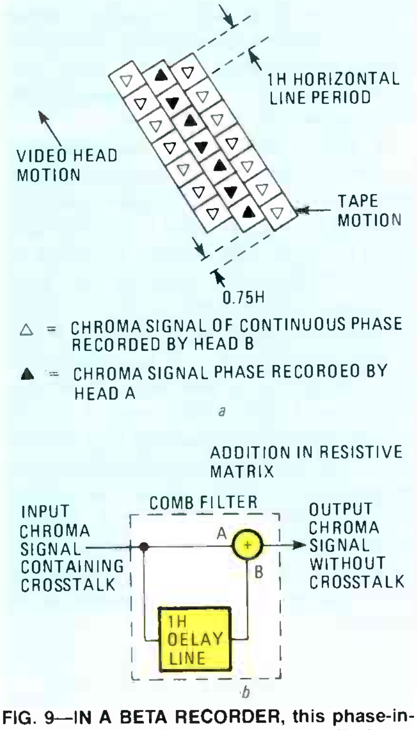


FIG. 9—IN A BETA RECORDER, this phase-inversion system is also used to eliminate crosstalk.

Synchronizing the picture

No matter how precisely the tracks are recorded, the picture can not be reproduced properly if these tracks are not accurately traced by the rotating heads during playback. In addition to a high degree of mechanical precision, both Beta and VHS systems use an automatic self-governing arrangement, generally known as the servo system. Figures 10 and 11 show the operation of a typical VCR servo system during record and playback.

As shown in Fig. 10, the vertical-sync pulses of the TV broadcast are used to synchronize the rotating heads with tape movement. The heads are driven (by the same motor used to drive the tape capstan) so that the heads turn just a little faster than 1800 rps (30 Hz). The 60-Hz vertical sync pulses are applied to a 2:1 divider circuit, producing 30-Hz control signals (often referred to as the "CTL" signal). That CTL signal is recorded on tape by the separate stationary control track head (which is on the same stack as the audio head).

A pulse signal (called the "30 PG" signal) is generated by detecting the actual rotational speed of the heads. The most common way to generate the 30 PG signal is to use a stationary pickup coil and a rotating magnet. The magnet is rotated together with the heads, and produces a pulse in the pickup coil each time the magnet passes the coil. The 30 PG signal is compared with the 30-Hz CTL signal, and any difference (or error signal) is amplified. The output of the amplifier is used to control the current of a magnetic brake that controls speed of the rotating heads.

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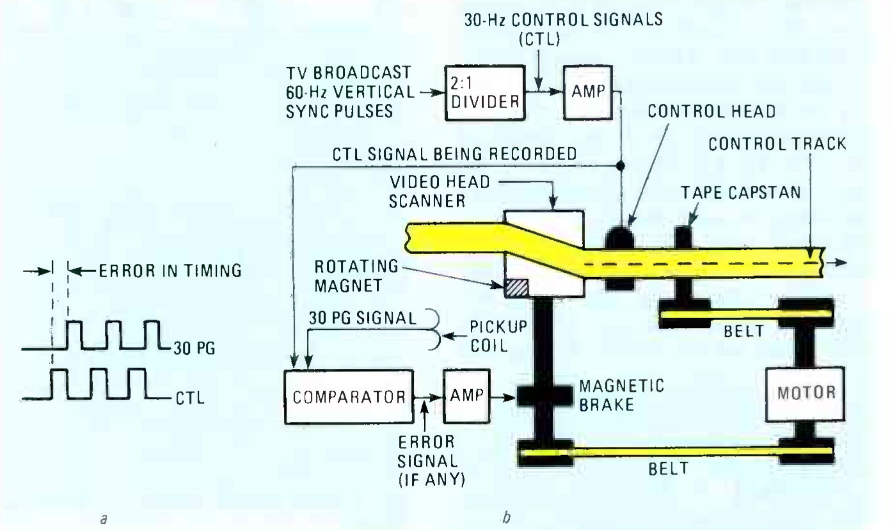

FIG. 10—DURING RECORDING, the CTL and 30 PG signals (shown in *a)* are generated by the servo system (shown in *b*. Any difference between those signals is detected by a comparator, whose output is amplified and used to control the speed of the video-head scanner.

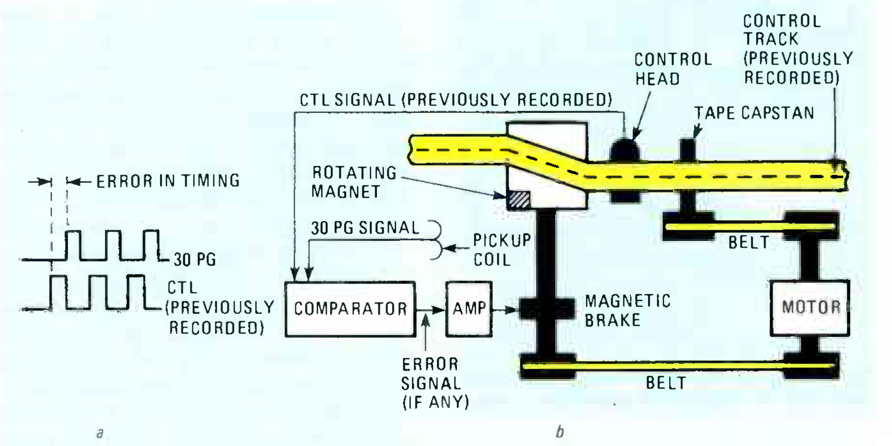

FIG. 11—THE OPERATION OF THE SERVO SYSTEM during playback is similar to that during recording. Here, however, the 30 PG signal is compared to a previously recorded CTL signal.

WHAT'S NEW IN PORTABLE VIDEO

CARL LARON
ASSOCIATE EDITOR

Here's a look at the state-of-the-art in portable video, as well as a look at the new 8-mm standard that could revolutionize the entire video industry.

THERE ARE A LOT OF ADVANTAGES TO owning a videocassette recorder. One of the biggest, however, is the ability of a VCR, when used with a video camera, to capture on tape those cherished moments in everyone's lives. And, while not all of those moments occur in your home, with a portable video recorder the world can become your living room.

In this article, we are going to take a look at portable video equipment. Specifically, we are going to look at the most advanced systems, at least as far as portability goes, available in the two major formats—VHS and Beta. We are also going to take a look ahead at an exciting new development—8-mm video—that potentially could become the single universal standard of portable video equipment in the future. Needless to say, then, if the 8-mm standard comes to pass it will revolutionize home as well as portable video.

VHS-C

JVC (41 Slater Drive, Elmwood Park, NJ 07407) has answered the public's call for more truly portable video with their VHS-C system. It consists of a compact, lightweight recorder, the model *HR-C3U* (see Fig. 1), an ultra small camera, the model *GZ-S3U* (see Fig. 2), and a full line of accessories.

The key to what makes this system different, however, is their VHS-C cassette. That cassette is just one third the size of a standard VHS cassette and allows up to 20 minutes of recording time. That tiny cassette can, of course, be used to record and play back with the compact recorder. Because it is true VHS, it can also be used to record or play back on any standard VHS recorder, although a special adapter (model *C-P1U/C-P2U*) is required.

The major advantage to using the small-sized cassette is that it allowed JVC to manufacture the smallest, lightest, full-capability VHS recorder currently on the market. The recorder measures just 7¼ × 3 × 8½ inches, and weighs only 5.3 pounds; both the measurement and the weight quoted here include the optional *NB-P3U* battery pack. According to JVC, it is 60% smaller than any other portable recorder that company has produced to date.

In addition to the nickel-cadmium battery pack, with the proper optional accessories the recorder can be powered from a car battery or, for home use, from any 117-volt AC source. Other features include automatic back-space editing for smooth edits, a running time display that shows how much time is left in minutes and seconds, a two-way speed-search mode, and a wired, full-function remote control.

The recorder lists for $850.

Of course a small recorder deserves an equally small camera. JVC's *GZ-S3U* fits that bill nicely—it roughly measures just 4 × 4½ × 8 inches and weighs 2.75 pounds. The camera uses a ½-inch Saticon pick-up tube and an *f*/1.2 lens that allows recording at light levels as low as 30 lux (2.8 foot-candles). The lens system

FIG. 1—THE SMALLEST VHS recorder yet, the *HR-C3U* from JVC uses the new VHS-C cassette.

FIG. 2—THE MODEL *GZ-S3U* compact camera.

also has a × 6 power zoom. A macro setting that allows for close focusing is also included.

As you would expect, the camera uses an electronic viewfinder. In-the-viewfinder displays include: pause, tape run, under-exposure warning, low-battery warning, tape-end warning, and sensitivity, white balance, and filter settings. As it is mounted on a flexible adapter, the viewfinder can be easily positioned however the operator wishes.

The camera lists for $895.

One of the more interesting accessories for the system is the model *SF-P3U* frame. That frame allows the recorder and the camera to be combined into a single unit for on-the-shoulder operation (see Fig. 3). To make operation even simpler, the frame relocates the recorder's major controls so that they can be accessed easily when using the camera.

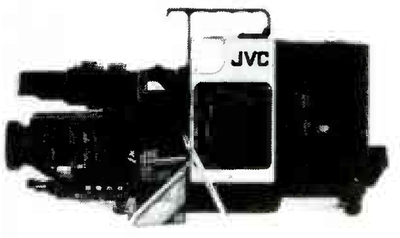

FIG. 3—PUTTING IT ALL TOGETHER. The *HR-C3U* and the *GZ-S3U* can be combined into a single unit for on-the-shoulder operation using the *SF-P3U* frame.

Betamovie

Camcorders, one-piece video recorder/camera combinations, have been promised now for a couple of years. Well, by the time you read this, the first of those units should have reached your store's shelves. That unit, the *Betamovie* (model *BMC-110*) from Sony (Sony Drive, Park Ridge, NJ 07656) is a record-only camera/recorder combination that uses standard Beta cassettes. Because of that, the cassettes can, of course, be played back on any standard Beta deck.

According to Sony, the unit's small size was achieved thanks to major changes in the head drum and tape-loading system, as well as the decision to eliminate playback and TV-recording capabilities.

Let's look at the differences between a standard Beta deck and the *Betamovie*. Figure 4 shows the head drum and Fig. 5 the loading system in a standard Beta deck. As those figures show, all such decks use a 74.5-mm drum, two or more heads, and a "U"-wrap loading system. Contrast that with the system used in the *Betamovie* as shown in Fig. 6 and 7. That system uses a 44.7-mm head drum, just one double-azimuth head, and a special μ-wrap loading system. Those changes allow a small recorder mechanism while retaining full compatibility with the Beta system.

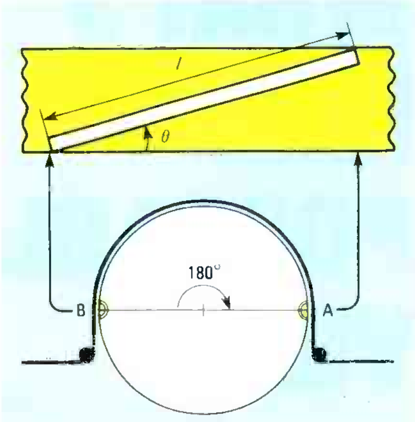

FIG. 4—IN THE STANDARD Beta system, a 74.5-mm head drum and two or more recording heads (located at A and B) are used.

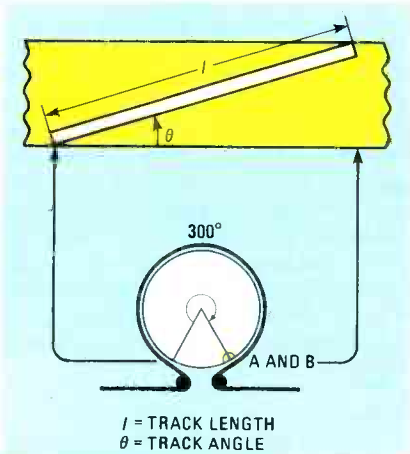

FIG. 6—THE SMALL SIZE of the *Betamovie* is partially made possible through the use of a smaller head drum, a single recording head (located at A AND B), and a special μ-wrap loading system.

Turning briefly to some specifications, the Betamovie unit weighs just 7 pounds, including the battery pack and a cassette. It measures 5 × 8¾ × 14 inches, including all projecting parts. The unit operates at the Beta II speed (2-cm-per-second) allowing up to 3 hours and 20 minutes of recording with an *L-830* cassette. The rechargeable battery pack will allow up to 60 minutes of continuous operation on a single charge. The battery pack fits into

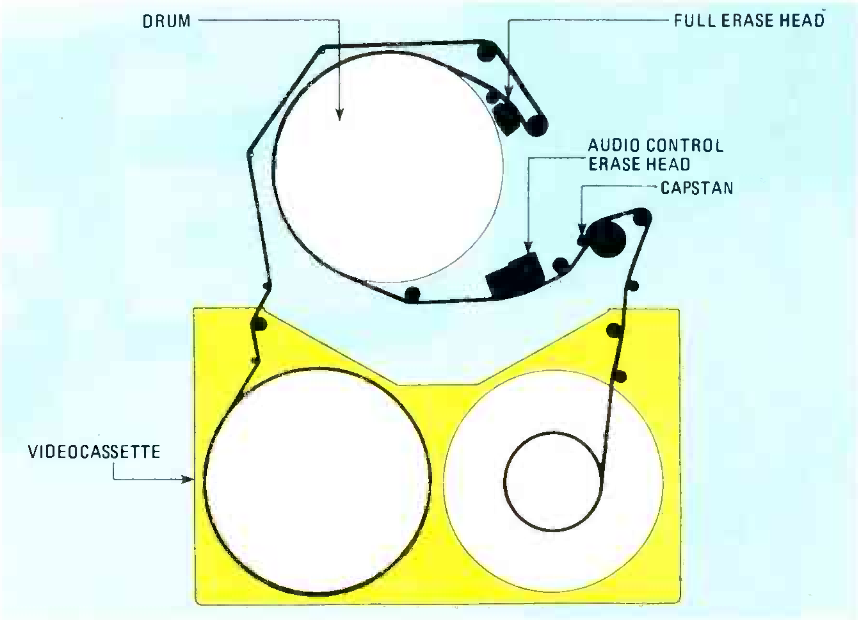

FIG. 5—THE U-WRAP LOADING SYSTEM used in a standard Beta deck.

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the camera's hand grip and can be recharged in just about an hour using an AC adapter.

Looking at the camera section, the *Betamovie* uses a ½-inch Saticon pickup tube. The minimum light level required for satisfactory operation is 28 lux. The *f*/1.2 lens features a ×6 zoom and macro focus. The camera features a TTL (*T*hrough *T*he *L*ens) optical viewfinder. LED's in the viewfinder are used to alert the operator to an insufficient light level, the white balance setting, the fact that the tape is running, and the fact that the record head requires cleaning.

The *Betamovie* is expected to sell for $1500, and will be supplied with the battery pack and AC adapter.

The new standard

The real excitement in portable video recently has been generated by the word out of Japan that agreement had been reached by 122 electronics companies from around the world on a new videotape standard for the home market. Using 8-mm tape, which is roughly half the width of the tape in either of the current popular formats, there's great hope that the new system will make even smaller portable systems possible. It's also believed that the new format could eventually replace both VHS and Beta. Therein lies the problem with the new system—many of its original proponents have since backed off, fearing that the new format could jeopardize the profitability of their existing video business. Others are promoting the development of a completely different standard than the one agreed upon, one that would allow compatibility with PAL, SECAM, and perhaps NTSC.

The new standard does not represent the first time that a narrow-width tape format has been explored. Indeed, most of us remember Funai Electric of Japan's CVC (*C*ompact *V*ideo *C*assette) system, the most recent of such efforts. Introduced here by Technicolor, that ¼-inch system never gained popular support, and last year Technicolor announced that is was pulling out of the consumer-video market. Two other proponents of the system—Germany's Grundig and Japan's Elbex—also shelved their plans to market CVC recorders in this country.

Specifications

The specifications covered in the agreement covered audio recording, tracking, cassette and tape, luminance signal, and the use of color-under conversion for NTSC and PAL video-signal recording. Let's take a closer look at them.

Like VHS and Beta, the new system uses a dual-head azimuth recording system. Such a system lays the video and audio information on the tape at an angle. The video-recording system itself, however, is the source of some controversy. In the agreed-upon standard, FM will

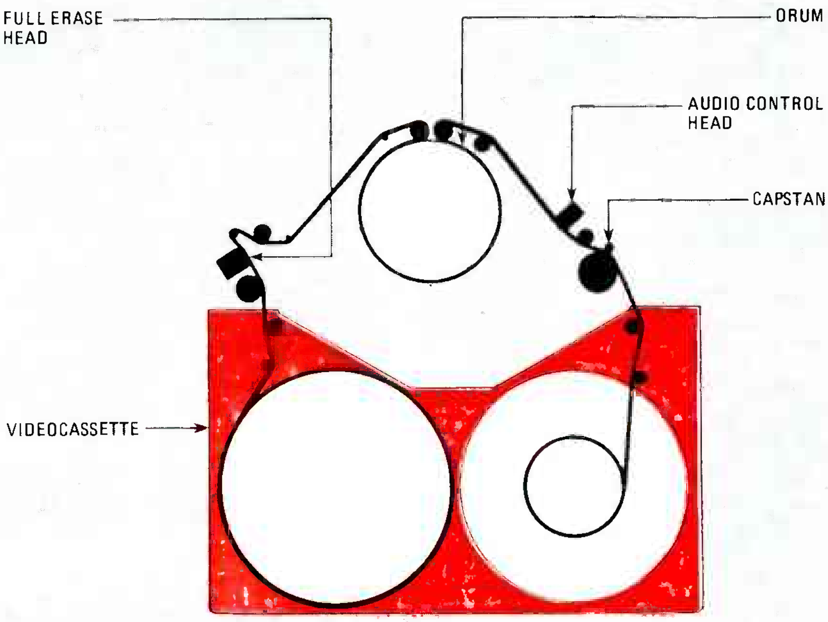

FIG. 7—THE SPECIAL μ-wrap loading system used in the *Betamovie* recorder.

be used to record the luminance signal, while converted-carrier-signal direct recording (*color-under* or *down* conversion) will be used for the color signal. In color-under conversion, the 3.58-MHz chrominance subcarrier, which contains the color information, is down converted to a lower frequency (629 kHz for VHS, 688 kHz for Beta) that can be handled more easily by the recording system. But, while that system is fine for NTSC and PAL recordings, it is incompatible with SECAM. As for SECAM, France's Thomson-Brandt has proposed a baseband recording system that they call "Timeplex." That system, which would be compatible with SECAM, PAL, and NTSC, was proposed only shortly before the agreement was reached, and thus is still under study.

Turning to the audio specifications, the standard calls for one mandatory and two optional recording methods. The mandatory system is one-channel, high-fidelity FM. The audio signal is laid down using one of the rotary video heads, with the audio signal multiplexed with the video signal. Some type of noise reduction, though not completely specified by the standard, is required.

The first of the two optional audio systems is PCM (*P*ulse *C*ode *M*odulation). The standard calls for two channels for that digital-audio system. Like FM, PCM audio is laid down using one of the rotary video heads. Unlike FM, however, no multiplexing is used; instead, the audio is placed on an auxiliary video track. Once again, some type of noise reduction is required.

The second optional audio system is simply called "Aux. Audio." Unlike the other systems, it is laid down on a 0.6-mm band at the bottom edge of the tape using a completely separate, stationary audio head. Its use is apparently left open as little beyond its existence is specified. There is no mandatory noise reduction for that system.

Let's touch just briefly on some of the other points of the standard. The head drum is specified as 40 mm. Recording time is to be 1.5 hours for NTSC and 1 hour for PAL. Recording speed is 14.3 mm-per-second for NTSC; 20 mm-per-second for PAL. Compatibility with both metal-powdered and metal-evaporated tape is required. The cassette size will be 95 × 62.5 × 15 mm. The width of the tape is, of course, 8 mm.

The cassette

The cassette for the system is designed to be as uncomplicated as possible, and thus inexpensive to produce. One thing that will go a long way to keeping production costs low is the elimination of tape guides. In their place, the cassette is to have a wide mouth that will accommodate as wide a variety of loading mechanisms as possible. There are also to be recognition holes that will allow the recorder to detect such things as the kind of tape and its thickness.

User convenience also seems to have been carefully considered. That is evidenced by such things as the inclusion of grips for use by an automatic tape changer, and the requirement of some type of restorable accidental-erasure prevention mechanism.

Clouds on the horizon

Despite the trumpeting that accompanied that agreement this past March, the future of 8-mm video now appears less sure. Although the manufacturers wanted to present a common front and introduce

continued on page 110

Typewriter to Computer Interface

BILL GREEN

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

THERE ARE MANY TYPES OF PRINTERS that you can use to obtain hard-copy output from your computer. You can pay about $400 for a dot-matrix printer with marginal print-quality or you can pay more than $2000 for a daisywheel (or other type) letter-quality printer.

But there's a less expensive way to get letter-quality hard-copy output. You can build the interface that we'll describe here and convert your IBM *Selectric* (models *II* or *III*) or *Electronic* (models *50*, *60*, or *75*) into a printer. The interface *may* work with models other than those just mentioned. But the installation is sure to require some changes to what we'll describe here.

A buffer option that we'll describe lets your computer rapidly dump more than 30,000 characters into RAM. Then you're free to use the computer, even while the document is printing. While that's especially important when using a relatively slow printer, such as a converted typewriter, the buffer can also be used with any parallel printer—we'll show you how. Another advantage of the buffer is that once a document is contained in its memory, you can print as many copies of it as you want—independent of the computer—simply by pressing the PRINT button.

What are the advantages of using the IBM typewriters? Well, the first advantage is low price and the second is high quality. When a used, reconditioned *Selectric*—which can be purchased for around $400—is combined with this interface, you have a complete, letter-quality printing system with readily changeable type fonts for not much more than the cost of a cheap dot-matrix printer. And you also still have a typewriter—the interface does not affect normal typewriter operation.

The interface circuit

The schematic of the interface appears in Fig. 1. As shown there, it is configured for operation with a *Selectric*. That's because we think the most popular application will be converting that typewriter. Shown in Figs. 2, 3, and 4 are the options available: Figure 2 shows the changes that have to be made to the interface so that it can be used with *Electronic* typewriter, and Fig. 3 shows the changes that have to be made to use the interface with a parallel printer. Figure 4 shows how to add up to a 30K printer buffer. We'll look closer at those options in just a little while. Let's first look at the circuit in general.

The "heart" of the interface is a Signetics 2650 microprocessor, IC1. That microprocessor, under control of the program ROM (IC2), determines how much, if any, buffer memory is installed and what type of printing device is being used. It controls all I/O data transfers and timing, and memory data transfers. It also handles all code conversions when a typewriter is connected. (Those are necessary to convert the ASCII from your computer into a code that the IBM typewriters can understand.)

On power up, or whenever S2 is closed, the microprocessor is reset by a short pulse that is provided from the combination of R2, C4, and hex-inverter IC3. After it is reset, the microprocessor begins execution of the program in IC2. The three-state output port (IC6) is set to its high-impedance mode and the latch output of IC7, pin 7—which tells the *Selectric* that the shift key is pressed—is cleared. Also the FLAG output (of IC1), which sends the *Selectric* an any-key-pressed signal, is cleared. A test is then performed to determine if RAM is installed and, if so, how much.

If no RAM is found, the computer performs a test to determine what type of printing device is being used. If the *Electronic* is connected, the level on SENSE will be high. If it is low and it remains low when FLAG is set, a *Selectric* is connected. If SENSE goes high with FLAG, diode D5 is installed, and a printer is therefore connected. After that test, the microprocessor runs the routine for the selected printing device and outputs the data from the external computer byte by byte.

However, if the memory test indicates that RAM *is* installed, the microprocessor initializes the buffer pointer and proceeds to store each byte from the external computer until the buffer is full or until all the data has been dumped. Then the routine to determine what printing device is being used is run as described earlier.

The driver routines for the *Selectric* and the *Electronic* typewriters are similar. In both routines the ASCII data from the external computer has to be converted to a

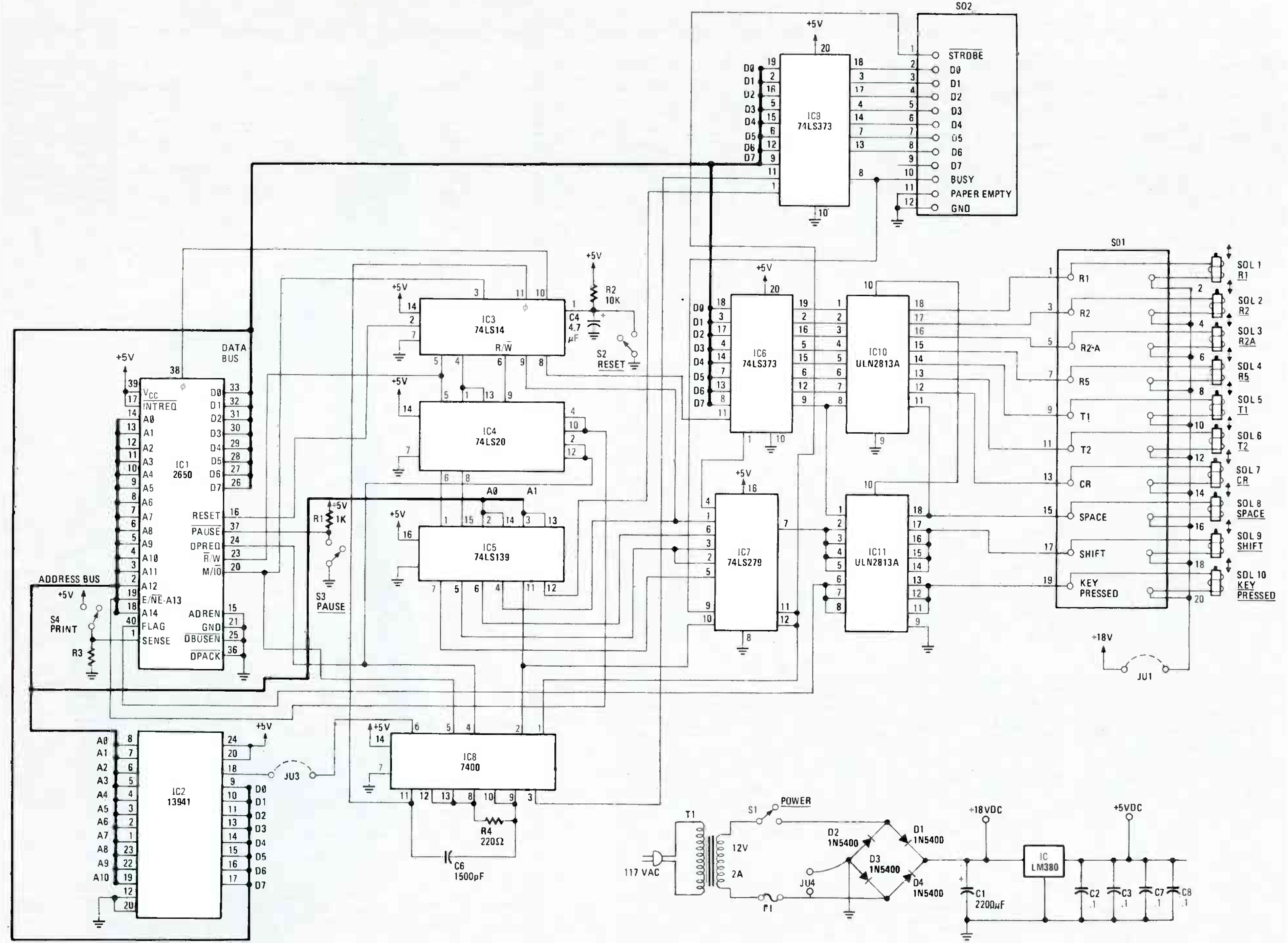

FIG. 1—THE SCHEMATIC FOR the interface is shown here configured for use with a *Selectric*.

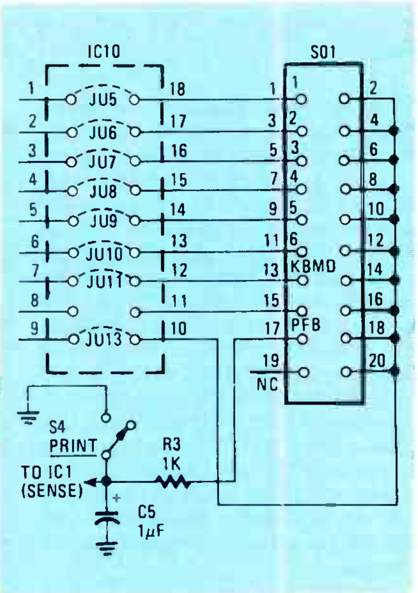

FIG. 2—THE CHANGES THAT ARE MADE to use the interface with the *Electronic* typewriter include removing IC11 and replacing IC10 with appropriate jumpers as shown here.

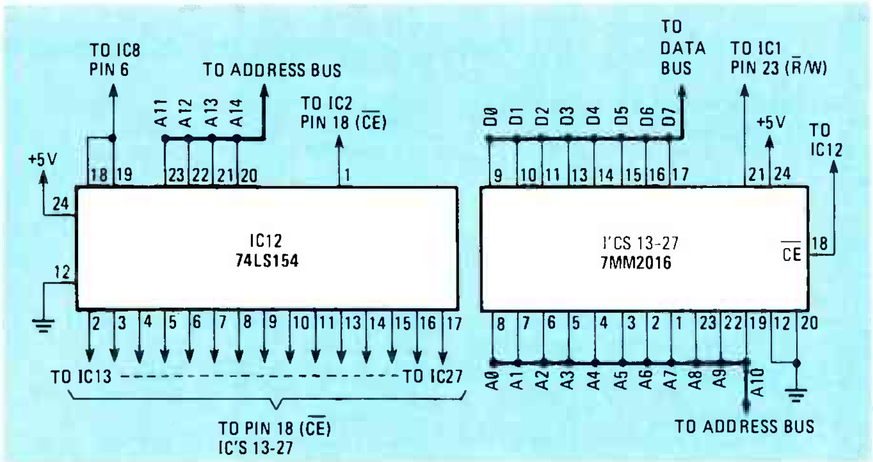

FIG. 4—BY ADDING IC12 and from one to fifteen TMM2016 static RAM'S, up to 30K bytes of buffer memory can be added to the interface.

code that the typewriter can understand—that's done using an internal lookup table—and then outputting the proper code to the typewriter.

When using a *Selectric*, the interface determines all delays that are needed to allow for the typewriter's print cycles, space cycles, carriage-return cycles, and shift cycles. Those delay routines are dependent on the frequency of a clock that is made up of R4, C6, and two of the 2-input NAND gates in IC7. (That free-running multivibrator gives us a system clock with an oscillation frequency of about 1.24 MHz.) On the other hand, all timing for the *Electronic* is done by the typewriter itself and is signaled by the *PFB* (*P*rint *F*eed*B*ack) line.

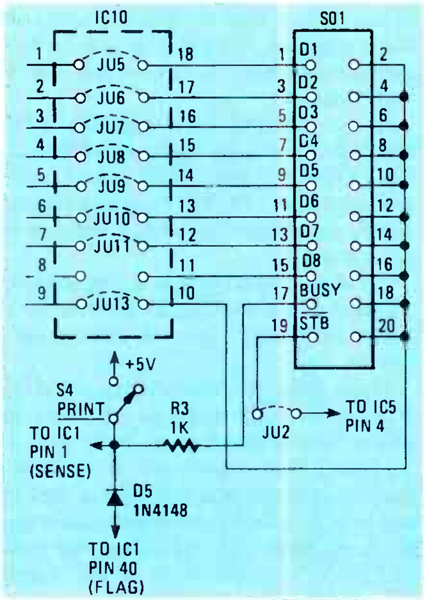

FIG. 3—THE CHANGES THAT ARE MADE to use the interface with a parallel printer also include removing IC11 and jumpering the pads for IC10.

When a printer is used with the interface, the enable signal for IC6 is conected to the printer's STROBE line and the interface reads the BUSY signal from the printer, allowing for synchronous operation. The ASCII code from the computer is stored in memory and is output unconverted—there is no need for conversion to a different code. Only the lower seven bits of the ASCII word are read however, so the printer will not respond properly to any special commands that use the eighth bit set.

Looking closer at the circuit, we see that IC4, a 74LS20 dual four-input NAND gate, controls IC5, a 74LS139 dual two-to-four line decoder. That IC in turn provides the enable signals for the 74LS373 8-bit three-state data latches (IC6 and IC9, which can be considered to be output and input ports respectively). Also, IC5 provides the set and clear pulses for IC7, a quad R-S latch.

We've already seen how two of IC8's NAND gates are used in a system clock. A third gate provides the chip-enable pulse for IC2 (the program ROM) when no RAM is used, or the enable pulse for IC12 (a four-of-sixteen decoder) when RAM is used. The fourth gate in IC8 provides the output-control signal for IC9 (the input port).

Different configurations

Although we have already discussed some of the various ways that the interface can be configured, we'll look at them in a bit more detail.

When a *Selectric* typewriter is to be driven, as shown in the schematic of Fig. 1, two ULN2813A (or 2803A) octal high-current Darlington transistor arrays (IC10 and IC11) must be installed. Those high-current drivers, manufactured by Sprague, are needed to interface between the low-level digital logic circuitry and the ten solenoids that we'll be adding to control various latches in the *Selectric*. The drivers will sink 600 mA, but they can be paralleled if higher load-current capability is needed.

When the interface is used with the *Electronic* typewriter, IC10 is replaced with 8 jumpers (as shown in Fig. 2) and IC11 is not used. Of course the solenoids are not used, either. Thus the output of IC6 is connected directly across the 7 reed switches on the *Electronic*'s keyboard-switch plate, and the appropriate signal lines are brought to ground. But we're getting ahead of ourselves—all that will be covered in the "*Electronic* Installation" section.

The interface does not use its system clock for print timing when it's used with the *Electronic*, as it does when it's used with the *Selectric*. Instead, the interface reads the state of the *PFB* (*P*rint *F*eed-*B*ack) reed switch for timing. That switch is debounced by R3 and C5.

When a standard printer is used, nine jumpers are used to replace IC10 and, again, IC11 and the solenoids are not used. The eight outputs of IC6 and the inverted enable pulse for that latch are connected to the printer as shown in Fig. 3. Note that S4 is wired differently here, also.

The system clock of the interface is not used for timing here, either. Operation is synchronous and the BUSY signal from the printer is used for timing.

The final configuration we'll discuss is the addition of a printer buffer. Of course, if you're going to be using a printer, it's not much of an option—the interface is not of much use with a standard printer if buffer memory is not added. But whether you're going to use a converted typewriter or a standard printer, the size of the buffer can be anywhere from zero to 30K. That is shown in Fig. 4. By installing IC12 along with from one to fifteen RAM's (IC's 12 – 27), you can determine the size of the buffer. You can start, say, with an 8K buffer, and then increase it to a full 30K when the need arises.

Assembly

It is strongly recommended that you use PC boards for this project. If you do not need more than 8K of memory, and if

PARTS LIST—PRINTER AND ELECTRONIC INTERFACE

All resistors ¼-watt, 5%, unless otherwise specified
R1,R3—1000 ohms
R2—10,000 ohms
R4—220 ohms
Capacitors
C1—2200 μF, 25 volts, electrolytic
C2,C3,C7,C8—0.1 μF, 6 volts, ceramic disc
C4—4.7 μF, 10 volts, electrolytic
C5—1 μF, 6 volts, electrolytic (used only with *Electronic*)
C6—1500 pF, 6 volts, ceramic disc
Semiconductors
IC1—2650 microprocessor, (Signetics)
IC2—13941 PROM, (Alpha)
IC3—74LS14 hex inverter
IC4—74LS20 dual 4-input NAND gate
IC5—74LS139 dual 2-to-4 line decoder/multiplexer
IC6,IC9—74LS373 octal D-type latch
IC7—74LS279 quad S-R latch
IC8—7400 quad 2-input NAND gate
IC12—74LS154 4-to-16 line decoder/demultiplexer (for buffer)
IC13-IC27—7MM2016P 2K × 8 static RAM (Toshiba) (for buffer)
IC28—LM340T five-volt regulator
D1—1N5400
D5—1N4148 (used only with printer)
F1—5-amp fuse
S1,S3—Switch, SPDT toggle
S2,S4—Switch, SPST momentary push button
T1—12-volt 2-amp wall-mounted transformer
Miscellaneous: PC boards, fuse clip, IC sockets, 20-pin header for SO1, 5-watt heat sink for IC28, suitable case, wire, connectors and cables for your computer and printer

The following are available from Alpha *Electronics*, PO Box 1005, Merritt Is., FL. 32952 (305-453-3534). A complete kit of parts—including main PC board, memory PC board, cable, case—for printer conversion (does not include memory IC's): $129 plus $6 postage; complete kit for *Electronic* conversion (does not include memory PC board or memory IC's): $119 plus $6 postage; 2K × 8 static RAM IC's, $6.50 each postpaid; 13941 PROM, $25; memory PC board (PC1832) $13 postpaid; main PC board, (PC1831), $18 postpaid; ABS plastic case, $12. Florida residents please add 5% tax. Canadian orders please add $2 per order in addition to U.S. postage. Other countries please add $6 per order in addition to U.S. postage.

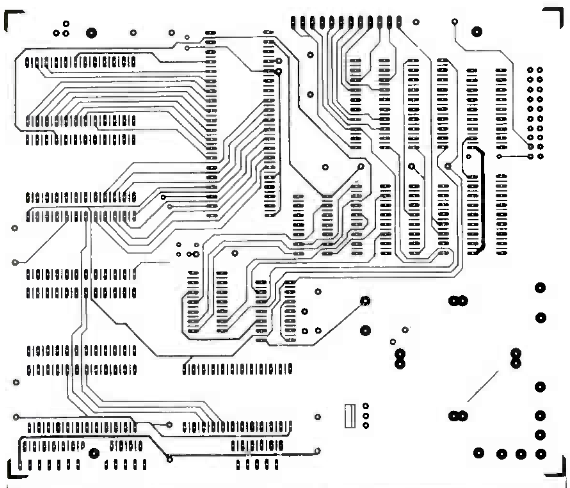

FIG. 5—THE FOIL PATTERN of the component side of the main board is shown here half-size

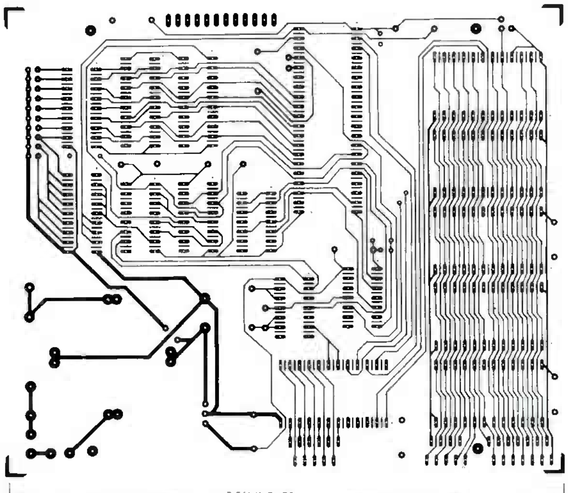

FIG. 6—THE FOIL PATTERN for the reverse side of the main board shown here half size.

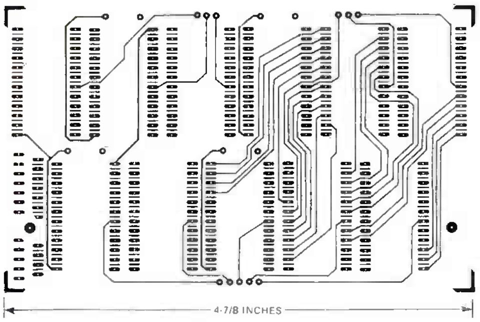

FIG. 7—THE FOIL PATTERN for the component side of the memory board is shown here half size.

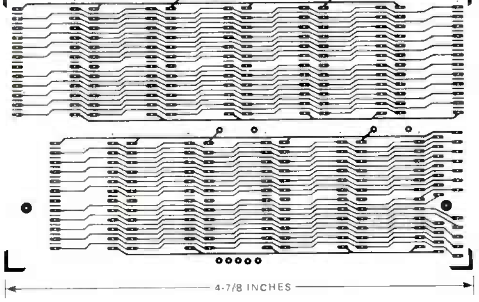

FIG. 8—THE FOIL PATTERN for the reverse side of the memory board is shown here half size.

you are not using the interface to connect to a *Selectric*, then the main board is all that is required. The foil diagrams for that double-sided board are shown half-size in Figs. 5 and 6.

If you do need more than 8K, a PC board that can hold up to an additional 22K RAM is used. We'll call that the memory board. The foil diagrams for that double-sided board are shown half-size in Figs. 7 and 8.

Three additional boards are needed for adapting a *Selectric* typewriter. But we'll get to those in the "*Selectric* Installation" section.

If you make your own double-sided PC boards, be aware that you will have to solder the components on *both* sides of the board. Also, there are two pads for feedthroughs near and to the left of pins 18 and 19 of IC1. Inst short wires—cut resistor leads work fine—in those two pads and solder on both sides of the board. (The PC boards available from the supplier named in the parts list have plated-

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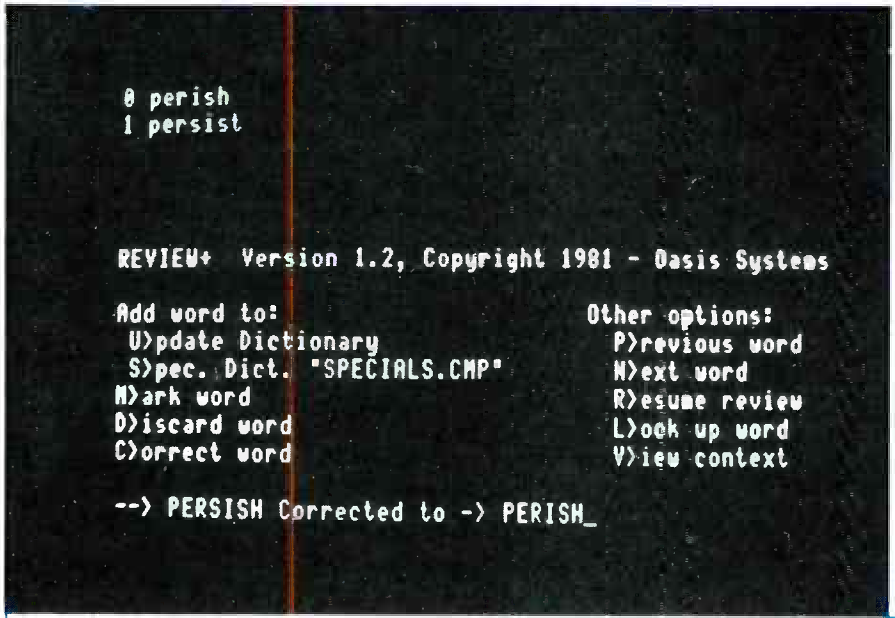
Radio-Electronics YOUR OWN Software

Spell Checkers



Spelling and style checkers are making it harder to make a mistake—but not when buying your program. Here we'll look at some features that you should be familiar with.

Spell Checkers

HERB FRIEDMAN

WORD PROCESSING HAS NOT ONLY MADE THE PREPARATION OF documents easier, it has made documents longer. Words and phrases are polished to perfection and, before one knows it, a short memo has turned into several thousand words.

According to Murphy's Law, however, the more words you type, the greater the chance for error: A greater percentage of words are misspelled; a greater percentage have typographical errors (typos); a greater number of words will be repeated, and phrasing becomes trite, repetitive, and riddled with cliches.

While you could muck your way through a word-processor-prepared document to correct spelling errors, typos, and style (phrasing and punctuation), a far easier way to polish a document is with an electronic spelling checker—which is sometimes improperly called an electronic dictionary—and/or one of the punctuation-and-style processors.

The electronic spelling checker is an independent program that processes a partial or completed document for spelling errors. All spelling checkers work on more or less the same basic premise; they compare the words in your document against a previously prepared list of correctly-spelled words (a dictionary). That list can either be complete unto itself, or it can be expanded, upgraded, or "enhanced" by the user. If there is no match for a word in your document with those in the dictionary the word is flagged. The flag means the word does not exist in the dictionary. The reason a word doesn't exist in the dictionary is because either the word is simply not listed (even though it is spelled correctly) or the correct spelling is in the dictionary but the spelling of the word in the document is incorrect. A modern spelling checker with 99% to 100% accuracy requires a precise match between the word in the document and those in its dictionary. If the match isn't found, it flags the word. (Many early spelling checkers used space-compression techniques that did not require a precise match. Hence, their accuracy ranged between 80% and 100%).

The number of words in the dictionary is determined primarily by the disk system. It's approximately 25,000 words for single density, 50,000 to 100,000 words for double-density. More than 100,000 words can be stored on 8-inch disk drives, but since most **Radio-Electronics** readers have 5¼-inch disk systems, comments will pertain only to software that fits on 5¼-inch disk systems.

The manner in which the program tells you a word is incorrect or unrecognized varies from program to program, though many start the analysis in more or less the same way. The earliest of the spelling checkers were based on the procedures used for many dedicated word processors. The spelling-checker program would read the document, compile a list of the individual words, and then check the word list against the words in its dictionary. The document words that did not match a dictionary entry were flagged. The list of flagged words was scrolled on the screen and the user could indicate whether the words was to be skipped (accepted as correct), or marked with some form of symbol indicating the spelling was to be corrected. At the end of the list the software recorded a disk file that was identical to the original document except that "incorrectly spelled" words were marked. The user could then run the marked file through the word processor, search for the marking symbol, and then correct the document. Finally, when all errors were corrected, the document was printed.

Spellguard—one of the earliest and most famous of the spelling checkers for personal computers—uses the marking method. With *Spellguard* (Sorcim Corp., 2310 Lundy Ave, San Jose, CA 95131), the marking is done by changing the last letter of the marked word to a marking character, for example, a left bracket. To correct the words, the user can either scroll through the entire document correcting each marked word as it appears, or the user could use the word processor's search function to locate the bracket marking the words, and then correct the marked words.

The major difficulty with a marking-type spelling checker is that while it quickly locates the misspelled words, the actual process of making the corrections can take up a lot of time.

Among the earliest spelling checkers for microcomputers that didn't use the marking system was *Hexspell* (from Hexagon Systems, Box 397, Station A, Vancouver, B.C., Canada V6C 2N2) for the Radio Shack *Model I* and *Model III* computers. *Hexspell* scrolls the document at a moderate reading speed so the viewer can see the entire document as it is checked for spelling. When it locates an unmatched word the scroll stops, the word is highlighted and the user can either accept the spelling, correct the spelling, or store the word in the dictionary at the touch of a single key. Regardless what decision is made, the scroll resumes. In this way the user sees each word in context, and gets a chance to spot other mistakes—such as duplicated words—that had gone unnoticed on the final read-through. When *Hexspell* has finished reading the document it asks if you want any dictionary words deleted (in case you had inadvertently keyed in an incorrect spelling). It then records the corrected version of the document in place of the old disk file, and then records a second corrected version under a file name you had selected when first starting *Hexspell*.

An unusual feature of *Hexspell* is that it learns your vocabulary—both the words you add to the dictionary and those you use most frequently. They "float" to the top of the list so they are checked more rapidly than words used infrequently.

Typical of much so-called "improved" software, the new "improved" version of *Hexspell* is not as convenient in certain important respects as the older version. The new version does not permit a phrase (two or more words) to be substituted for a single "misspelled" word. Also, the new version does not run under *Model III* TRSDOS (for reasons having nothing to do with *Hexspell*); it runs under NEWDOS, DOSPLUS and LDOS.

Radio Shack's own spelling checker for the *Model I* and *Model III* computers works very similar to the type that compiles a word list, checks all the unique words, and then displays the unmatched word in context. It provides a fully corrected version of the document. It is, however, considerably slower than the average "word compiler" spelling checker.

The heavyweights

For those who have no need to scroll the document, the heavyweights in spelling correction are best represented by *The Random House ProofReader* by Aspen Software (Box 339-B, Tijeras, NM 87095), and *The Word Plus*, by Oasis Systems (2765 Reynard Way, San Diego, CA 92103). Both are similar in concept, but with substantially different applications. Both, however, represent the most efficient way to correct spelling errors on non-Radio Shack computers. Both programs determine all the unusual words in a document and then compile a list of unmatched words. While it is doing the compilation it keeps the user entertained with a screen full of almost useless information. The number of words checked is flashed on the screen, the number of unusual words is flashed, the *ProofReader* even does a countdown on the alphabet. All this stuff is fluff to entertain the user until the program is ready. Once the software has determined the unmatched words, it displays them on the screen one at a time. The user can then accept the word, correct it, add it to the dictionary system for permanent reference, or accept it as a "correct" reference only for the document being processed. (The *ProofReader* has that feature).

The software immediately updates the document by replacing the misspelled words with the correct spelling. *The Word Plus* and the *ProofReader* will even provide marking in addition to actual spelling correction if the correction will change the width of the word; which is important, for *WordStar*, because it does not automatically reformat.

It is in the correction process that these two correction systems really shine. First, in both systems the user can call for a viewing that displays the word in context—a line or so of text which includes the unmatched word is printed on the screen. Also, the user can call for a dictionary search (a lookup) if he or she doesn't know the actual spelling of the word. The *ProofReader* will fill the screen with words which generally approximate the spelling of the unmatched word. The correct spelling can be selected from the display and typed in. *The Word Plus* does it somewhat differently. It displays fewer words, those more closely approximating the unmatched word. Adjacent to each word is a number or symbol. If any of the displayed words is wanted as a substitute for the unmatched word, simply pressing the key that corresponds to the symbol will enter it in the document.

At the conclusion of the processing both programs record a fully corrected disk file in place of the original document. If used with a CP/M computer, the original document, with all its errors, automatically becomes the backup disk file.

From here on out the two programs differ markedly, particularly in price. The *ProofReader* is about $50, *The Word Plus* is $150. The *ProofReader* constructs an auxiliary dictionary of words assembled as an ASCII file with a word processor, or keyed in during the processing of a document. The auxiliary dictionary must be added to the main dictionary periodically for the auxiliary words to be available during a lookup. If it isn't, the auxiliary words are used only for the start-up span.

The Word Plus is actually a system of several programs; the spelling checker is only one part of the system. It has a main dictionary and an update dictionary, but words keyed in during updating become part of the start-up dictionary system. *The Word Plus* also allows the user to construct specialized dictionaries, such as for law, medicine, or science. At start up, the user can call specifically for the use of the specialized dictionary(ies).

All of *The Word Plus'* routines can be called up as separate programs, such as when working on a document, or even while doing a crossword puzzle. The dictionary itself is accessed through a program called "SPELL." Then there's one for automatic hyphenation that can even be used on-line. There's "LOOKUP," which can also be used on-line to look up the correct spelling of a word, there's an anagram program used for unscrambling "jumble" puzzles, and a "homonym helper" that will untangle soundalike words such as "capital" and "capitol."

Other spelling checkers, dictionaries, or whatever they are called, are more or less similar to the ones we have covered. As a general rule of thumb, you have no idea how they will work for you until you try them. There are some users who rave over the marking system used by *Spellguard*. Others prefer the screen full of words displayed by the *ProofReader*. Some, such as I, prefer the slow-scroll spelling checker, so defects other than misspellings can be found. Still others think the keyed lookup and instantaneous word replacement of *The Word Plus* to be the ultimate in spelling correcting. Your best bet—as with any purchase for a microcomputer—is to try a few before you buy.

Grammar checkers

Finally, we come to punctuation and style, represented by *Grammatik* from Aspen Software, and *Punctuation & Style* from Oasis Systems. Both do the more or less the same thing. They check for proper punctuation, such as a period in front of the closing quotation mark rather than after, for cliched, muddy and awkward phrasing, for duplicate words, etc. *Grammatik* will also check for sexist words (gender specific), and the number of times a particular word was used. It is really difficult to precisely describe what each does. *Punctuation & Style* is essentially into phrasing, *Grammatik* is into punctuation. Both tend to make copy bland, taking the individual writer out of the document. For example, they turn one of the classic lines of the Gettysburg address, "...that that nation...," into just another phrase by just another politician. The processed documents are clear, but they could have been written by anyone.

But if you have no idea how to punctuate either for correct use or ease of reading, or you are submitting your prose to the New York *Times*, or you don't care if your stuff reads as if written by any of a thousand other authors, then let a computer check and correct your writing style. (Just imagine what a computer would do with this paragraph.) **R-E**

How to Design Analog Filter Circuits

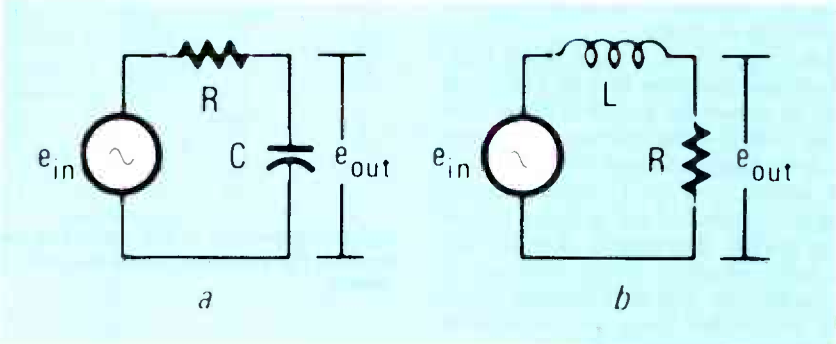


FIG. 1—TWO LOWPASS FILTERS. Even though the filters use different components, they perform in a similiar fashion.

MANNIE HOROWITZ

Because almost every analog circuit contains some filters, understanding how to work with them is important. Here we'll discuss the basics of both active and passive types.

THE MAIN PURPOSE OF AN ANALOG FILTER circuit is to either pass or reject signals based on their frequency. There are many types of frequency-selective filter circuits; their action can usually be determined from their names. For example, a band-rejection filter will pass all frequencies except those in a specific band. Consider what happens if a parallel resonant circuit is connected in series with a signal source. It lets all frequencies pass freely, with the exception of those in a small band of frequencies around the circuit's *resonant frequency*. (At its resonant frequency, the parallel circuit theoretically acts as an infinite impedance. That impedance is greatly reduced at off-resonant frequencies.)

On the other hand, should the parallel L-C circuit be placed across (in parallel with) the signal source, only the narrow band previously rejected would be allowed to pass from the source to the amplifier. Thus, we have just described a *bandpass* filter.

In addition to bandpass and band-rejection filters, circuits can be designed to only pass frequencies that are either above or below a certain *cutoff* frequency. If the circuit passes only frequencies that are below the cutoff, the circuit is called a *lowpass* filter, while a circuit that passes those frequencies above the cutoff is a *highpass* filter.

All of the different filters fall into one of two categories: active or passive. *Passive* filters are composed of passive components such as resistors, capacitors, and inductors. Inductors, however, are undesirable at some frequencies because of their size and/or practical performance. (At low frequencies, a real inductor's properties vary considerably from those of an ideal inductor.) *Active* filters consist of passive elements along with an active element such as a transistor or an integrated-circuit op-amp. Active filters are usually designed without using inductors. Therefore they have the advantage of being less expensive on the average (because inductors can be expensive and hard to find); they are generally easier to tune; they can provide gain (and thus they do not necessarily have any insertion loss); they have a high input impedance, and have a low output impedance.

A filter can be in a circuit with active devices and still not be an active filter. For example, if a resonant circuit is connected in series with two active devices (such as transistors) it is called a passive filter. But, if the same resonant circuit is part of a feedback loop, it is then called an active filter. We saw an example of such an active filter when we discussed a tape-player preamplifer during our discussion of feedback (see the July 1983 issue of **Radio-Electronics**).

Basic filters

A rudimentary passive filter consists of an R-C network or an R-L network. Those networks can be found in many different types of electronic equipment performing different roles. For example, in power supplies, such circuits are used to filter undesirable ripple. In audio amplifiers, different R-C networks are used in tone-control, scratch-filter, and rumble-filter circuits.

Let's take a look at some actual filter circuits and determine the effect they will have on signals that are fed to them. Two filter circuits—that perform the same function using different components—are shown in Fig. 1. When a low-frequency signal is fed to either one of those circuits, the output is identical with the input. However, as the frequency is increased, the output is reduced—thus they are lowpass filters. The output rolls off at the rate shown by the curve in Fig. 2. The important frequency to note is f_o.

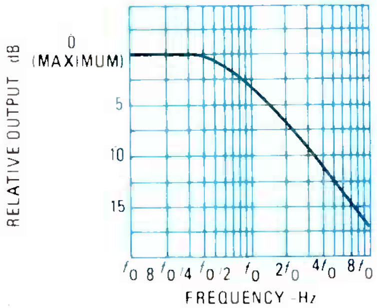


FIG. 2—THE OUTPUT OF THE LOWPASS filters shown in Fig. 1 decreases as the frequency increases.

That's the frequency where the output has dropped 3 dB from its maximum value (0.707 of the maximum). That *corner frequency* (also called the half-power point) can be determined from the values of the components in the circuit. For the R-C circuit in Fig. 1-a:

$$f_o = 1/2\pi RC. \qquad (1)$$

For the R-L circuit in Fig. 1B:

$$f_o = R/2\pi L. \qquad (2)$$

Figure 3 shows two circuits, either of which can be used to attenuate the *low* frequencies (thereby creating a highpass filter). Note that the curve shown in Fig. 4, when compared to Fig. 2, is symmetric about the y-axis. In Fig. 2, the output drops in the linear portion of the curve by 6-dB every time the frequency is doubled. In Fig. 4, the output drops by 6-dB every time the frequency is halved. The important point is that in the linear portion of each curve, the slope is the same—6-dB-per-octave.

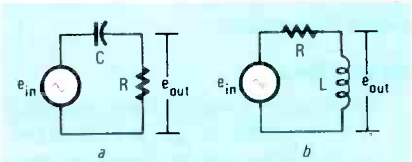


FIG. 3—TWO HIGHPASS FILTERS that use different components but perform similiarly.

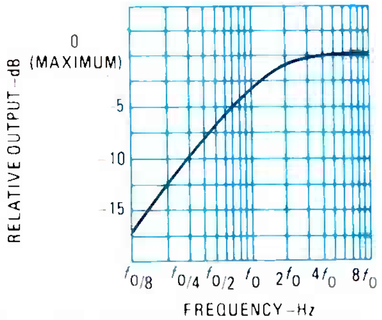


FIG. 4—THE OUTPUT OF THE HIGHPASS filters shown in Fig. 3 decreases as the frequency decreases.

Any of these filter circuits can be placed between two amplifier stages. If that's done, the corner frequency, f_o, is still as predicted by equation 1—presuming that the impedance of the circuit feeding the filter is zero and the input impedance of the circuit at the output of the filter is infinite. Otherwise, resistors in series with the input to the filter and in parallel with the output from the filter, must be considered when determining f_o.

For example, assume that the circuit in Fig. 3-a is connected between two transistors, as shown in Fig. 5-a. Figure 5-b is the equivalent circuit involving the filter and transistors. (The function of coupling capacitor C1 is to DC-isolate the transistor from the filter. That capacitor is usually of such magnitude that it can be treated as a short for all signal voltages.) It can be simplified by determining the equivalent resistance, R_Q, of all resistances at the output. The final circuit is shown in Fig. 5-c. Equation 1 applies there also.

The analysis of this circuit—as well as more complex filter circuits that have more than one corner frequency—can be accomplished in two simple steps. First, short the input, e_{in}, and note the total resistance across the capacitor. In this case it is 2.7K + R_Q. Using equation 1, we determine that $f_o = 1/2\pi(2.7K + R_Q)C$. The frequency at which the rolloff starts is f_o, as shown in Fig. 4.

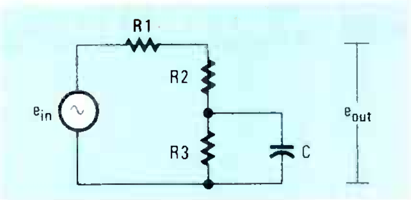


FIG. 6—A MORE COMPLEX filter circuit. This filter has more than one corner frequency.

The next step is to place a short across the output and leave e_{in} open. There is no parallel R-C combination in the circuit when that is done; the only frequency indicated in the response calculations of the filter is f_o and its curve in Fig. 4.

Now let's look at a more complex filter circuit—one in which there will be more than one corner frequency. We will use the procedure noted above to analyze the circuit in Fig. 6 and find those corner frequencies. One f_o corner frequency is the beginning of the rolloff characteristic curve and a second f_o corner frequency is on a curve with rising characteristics. The two resulting curves are then added to provide a curve illustrating the overall response of the circuit as shown in Fig. 7. First, we short e_{in} and note the total resistance across C—R3 in parallel with the sum of R1 and R2. Substituting this information into equation 1, we find that one of the corner frequencies, where the high-frequency roll off starts, is:

$$f_{o1} = 1/2\pi\,((R1 + R2)\|R3)C.$$

We continue by leaving e_{in} open and shorting e_{out}. Then, R2 is across both R3 and C. By inserting those values into equation 1 we find for the second corner frequency:

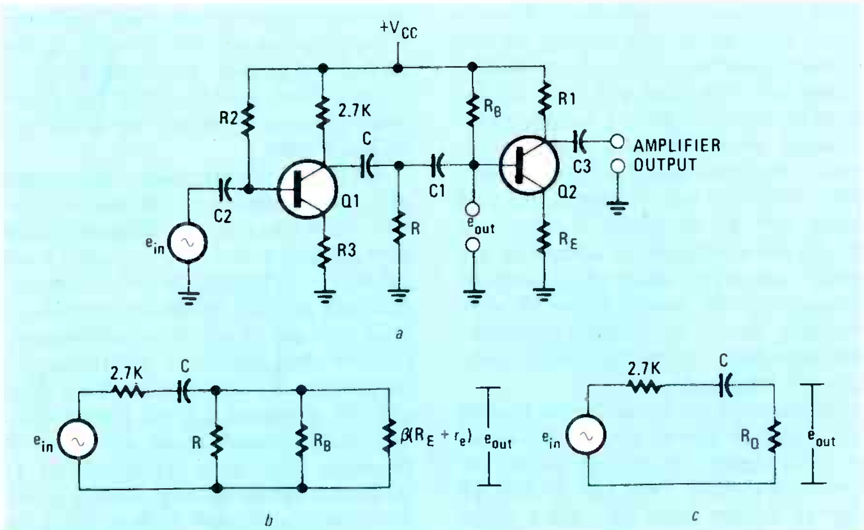


FIG. 5—TO WORK WITH a filter between two transistor circuits, you must first find the simplified equivalent circuit.

$$f_{o2} = 1/2\pi(R2 \| R3)C$$

The curves add as shown in Fig. 7. The total curve indicates the overall response of the filter. The two equations differ only by the resistance factors. Because R2||R3 is smaller than (R1 + R2)||R3, f_{o2} is higher in frequency than is f_{o1}. A similar procedure may be used to determine the frequency response of other complex arrangements.

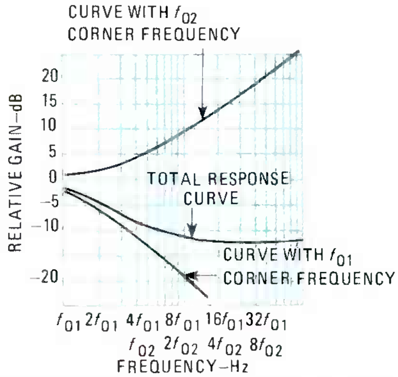


FIG. 7—FREQUENCY RESPONSE curve of the circuit shown in Fig. 6.

Sharpening the rolloff

Rolloff using but one R-C or one R-L network, cannot exceed a 6 dB-per-octave rolloff rate. However, a faster rolloff rate can be achieved by using more than one filter in a circuit. An arrangement using two lowpass filters connected in series is in Fig. 8. There, R1-C1 is one network with a corner frequency at f_{o1}.

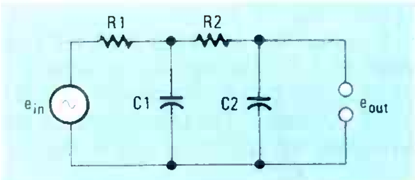


FIG. 8—TO INCREASE THE ROLLOFF RATE, you can use more than one filter in a circuit.

The combination of R2 and C2 is a second filter network, with a corner frequency at f_{o2}. Those corner frequencies are determined through use of equation 1 for each R-C combination. Curves with those corner frequencies are shown in Fig. 9. Each curve illustrates a rolloff at the rate of 6 dB-per-octave. Adding the two curves results in a characteristic with an eventual rolloff of 12 dB-per-octave.

If more resistors and capacitors are added to a circuit of the type shown in Fig. 8, a procedure similar to that used with the circuit in Fig. 6 may also be used. But this time, the circuit must be split into two portions with each containing the individual filter sections, and each section is analyzed as if the other section does not exist. The effects on the frequency response of each of the two sections are then added to determine the circuit's overall response.

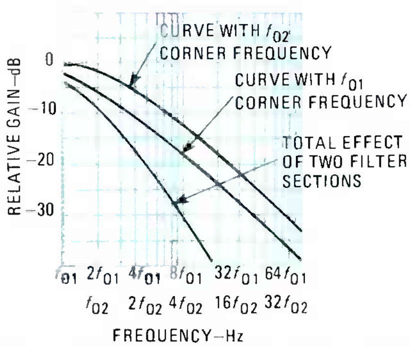


FIG. 9—THIS FREQUENCY-RESPONSE CURVE shows how the rolloff is sharpened by using more than one filter.

Other two-section filters (two R-C networks) can be combined to generate a bandpass filter circuit. That is illustrated in Fig. 10. There is low frequency rolloff due to the C1-R1 section of the filter and high frequency rolloff due to the R2-C2 filter. The corner

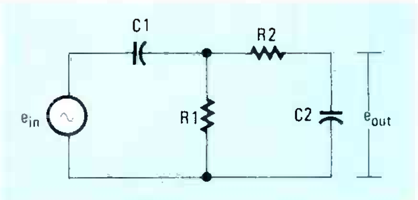


FIG. 10—BANDPASS FILTER USING two R-C networks.

frequencies, f_{o1} and f_{o2}, are determined for the R1-C1 combination and the R2-C2 combination, respectively. When f_{o1} is substantially less than f_{o2}, the response curve for the circuit is as shown in Fig. 11-a. Should f_{o1} be higher in frequency than f_{o2}, the curve in Fig. 11-b applies.

In the circuits drawn in Figs. 8 and 10, the R2-C2 combinations probably have some effect on f_{o2}. (The responses of those filters are shown in Figs. 9 and 11.) To minimize their interrelated effects, components should be chosen so that the R2-C2 circuit has a minor shunting effect on R1 and C1 and that the R1-C1 combination has only a minor affect on loading the R2-C2 combination. It is best if the two circuits were completely isolated from each other by placing each R-C filter between different transistors in a three-transistor amplifier circuit.

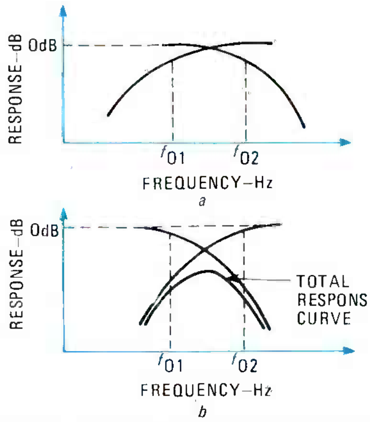


FIG. 11—FREQUENCY-RESPONSE CURVES. **The response when f_{o1} is less than f_{o2} is shown in *a*. It is equal to that of the two original curves below the 0-dB level. Shown in *b* is the response when f_{o2} is less than f_{o1}.**

Active filters

An active filter involving bipolar transistors, is shown in Fig. 12. Here we assume that R_E is much greater than r_e, the internal emitter resistance of Q2. Capacitor C1, along with the output impedance of Q1 and the input impedance of Q2, form one high pass filter. The corner frequency, f_{o1}, due to those components is

$$f_{o1} = 1/2\pi C1(R_c + \beta R_E \| R_B)$$

if we assume that the impedance of C2 is much higher than R_F at f_o Hz. Here, R_C is the impedance at the input of the filter, βR_E is the impedance reflected from the emitter circuit of Q2 into its base circuit, and $\beta R_E \| R_B$, the equivalent resistance of R_B in parallel with βR_E, is the resistance at the output of the filter. Due to those resistances, the output rolls off at frequencies below f_{o1}.

A second corner frequency, f_{o2}, is caused by the presence of C2 and R_F in the emitter circuit. Because C2 shunts a portion (R_F) of the total resistance in the emitter circuit, feedback due to the presence of this resistor is reduced as the frequency increases. Hence beginning at f_{o2}, the output increases with the applied frequency. It is equal to $1/2\pi C2R_F$.

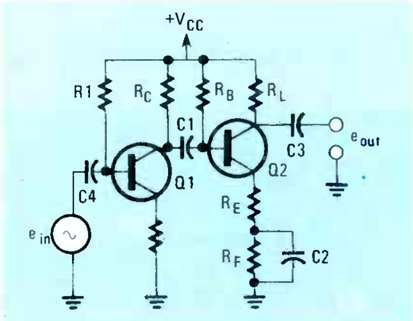


FIG. 12—ACTIVE TRANSISTOR FILTER has three corner frequencies.

Next consider the total resistance in the emitter circuit not shunted by C2. It is $R_T = R_E + R_B/\beta$ where R_B/β is the resistance reflected from the base circuit into the emitter circuit. A corner frequency due to the action of those resistances along with the $C2$-R_F combination is $f_{o3} = 1/2\pi C2(R_F R_T/(R_F + R_T))$. Voltage begins to roll off at that frequency.

It is obvious that f_{o3} is at a higher frequency than is f_{o2} because the resistance

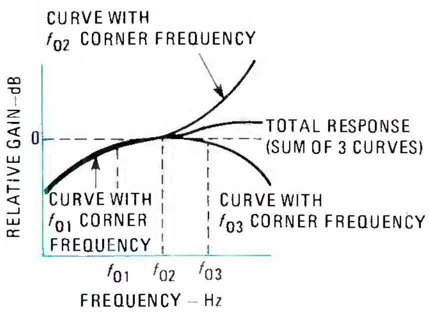


FIG. 13—CURVE SHOWING THE THREE corner frequencies and how they add to provide the overall circuit response.

in the denominator of the equation for f_{03} is lower than that for f_{02}. Usually, f_{01} is lower than either f_{02} or f_{03} because the capacitance of C1 and the input and output resistors in the circuit, are all large. The value of R_F is seldom negligible when considering the factors in equation for f_{01} because C2 can frequently be considered as an open circuit at f_{01} Hz.

Four curves are shown in Fig. 13. Three of these represent the response of individual filter sections in the circuit, with rolloff or amplitude increases starting at the three corner frequencies. The total curve shows the overall effect on the response of the combination of the three.

Using op-amps

Now we'll look at an active filter that is designed around an op-amp. In the circuit shown in Fig. 14-a, the capacitor in the feedback loop attenuates the high frequencies, therefore, the circuit behaves as a lowpass filter. The frequency at which the output has been attenuated 3 dB can be approximated from equation 1 when R and C are identical in both filter sections. If they should differ, then

$$f_o = 1/2\pi\sqrt{(R1C1)(R2C2)} \quad (3)$$

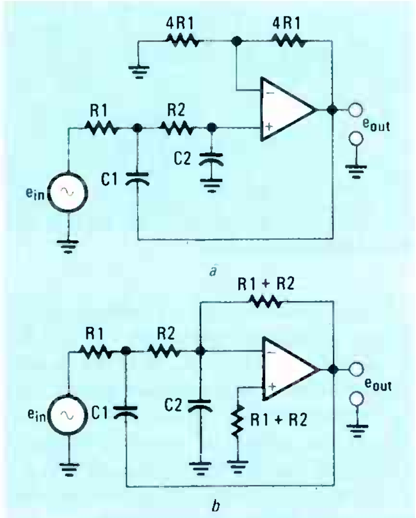


FIG. 14—ACTIVE LOWPASS FILTER. The signal is fed to the non-inverting op-amp input in *a*, and to the inverting input in *b*.

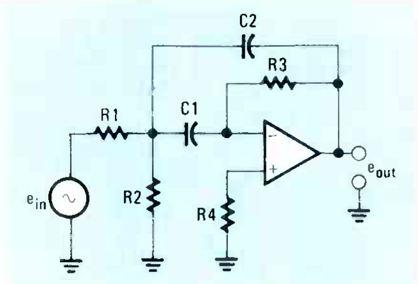


FIG. 15—ACTIVE BANDPASS FILTER using an op-amp.

where R1 and C1 are the components in one of the R-C networks and R2 and C2 are the components in the second R-C network. An inverting circuit could just as well have been used here. Figure 14-b shows shuch an arrangement. Equation 3 still applies. Negative feedback is applied through C1—high frequencies are fed through C1 back to the input, to increase the rolloff rate. In both lowpass-filter circuits, R1 and R2 are usually made equal—about 10,000 ohms.

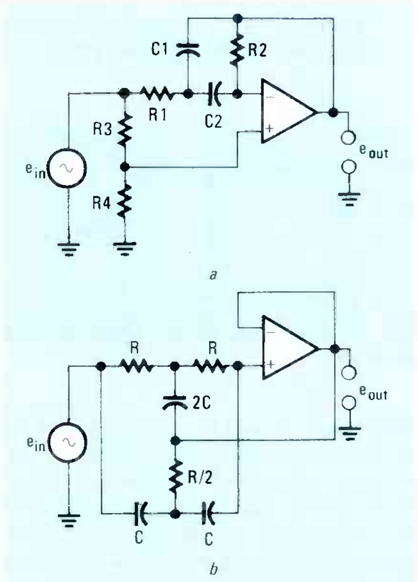


FIG. 16—ACTIVE BAND-REJECTION filters using op-amps. The filter shown in *b* uses a twin-T circuit.

Highpass filters can be formed using circuits identical to those drawn in Fig. 14. All that's necessary is to interchange the locations of components in the R1-C1 filter as well as components in the R2-C2 filter. As before, equation 3 applies.

In the article on high frequency circuits (see the August 1983 issue of **Radio-Electronics**), the Q of an L-C circuit was defined. That same definition also applies to bandpass and band-rejection types of R-C circuits. As you recall, the Q of a bandpass circuit is equal to $f_o/(f_H\text{-}f_L)$ where f_o is the center or resonant frequency. f_H is the frequency above resonance where the gain has dropped 3-dB from what it is at resonance, and f_L is the frequency below resonance with the 3-dB gain reduction.

We will now be looking at some more active filters and we will present a number of different equations for determining the various C's and R's that are needed. We will not derive the equations; the filters will be presented in "cookbook" form. You'll achieve good performance if the given relationships are observed. Rolloff will approach the ideals of 40 dB-per-octave for the circuits we'll discuss.

A typical bandpass filter circuit using resistors and capacitors is shown in Fig. 15. Before you determine what components you use, you must calculate just what Q must be. Let us say you want a peak response at 1000 Hz and that the gain should be down 3 dB at 900 Hz and 1100 Hz. Q must then be 1000/(1100 − 900) = 5.

Continue the design by letting C1 be equal to C2. Calculate R1 by setting it equal to 100,000/Q. Because Q = 5, R1 = 20,000 ohms. The relationship for determining R2 is 5250/Q, so in this ex-

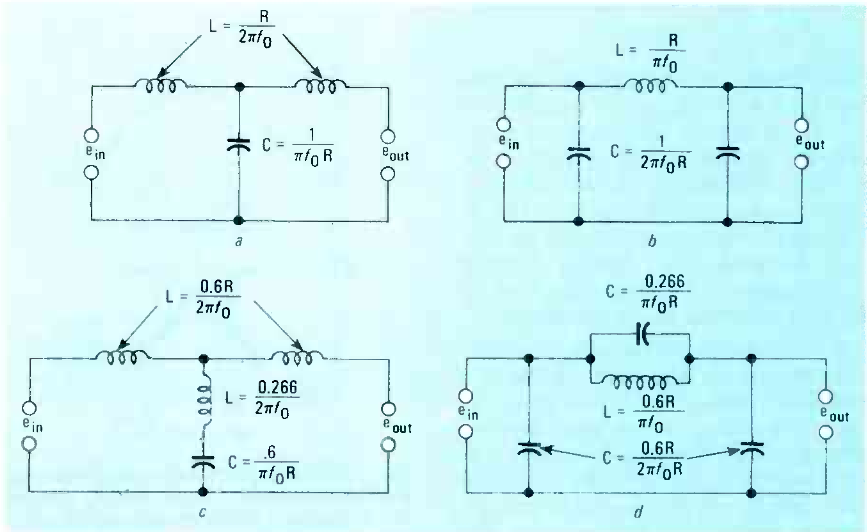


FIG. 17—LOWPASS FILTERS. The circuit shown in *a* is a constant-K T-section filter; *b* shows a constant-K π-section; *c* shows an M-derived T-section, and *d* shows an M-derived π-section filter.

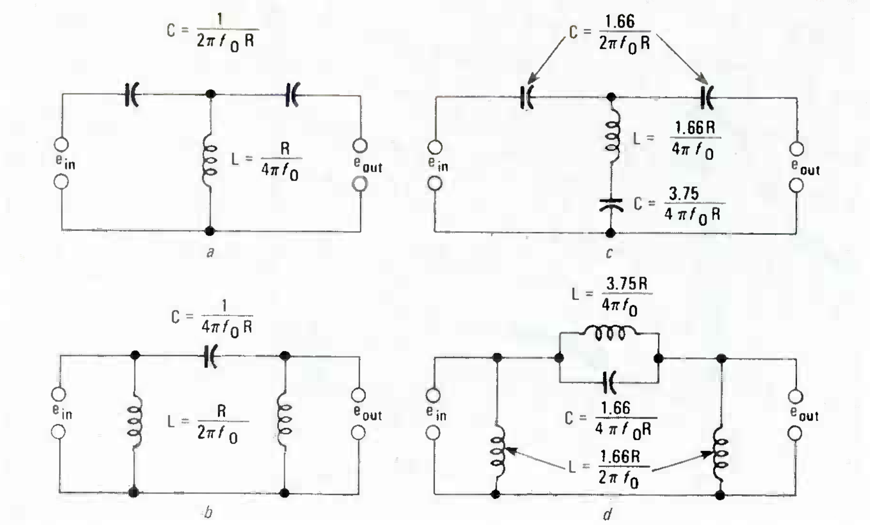


FIG. 18—HIGHPASS FILTERS. The circuit shown in *a* is a constant-K T-section filter; *b* shows a constant-K π-section; *c* shows an M-derived T-section, and *d* shows an M-derived π-section filter.

ample, R2 should be set equal to 1050 ohms. The value of R3 is equal to the product of 20,000 ohms and Q. For this problem, R3 = 100,000 ohms.

For the circuit in Fig. 15

$$f_o = 1/2\pi\sqrt{C1C2R3(R1 \| R2)} \qquad (4)$$

Because C1 is identical to C2, the product of the two capacitances is C^2. To determine C, equation 4 becomes

$$C = 1/2\pi f_o\sqrt{R3(R1 \| R2)}. \qquad (5)$$

Substituting f_o = 1000, R3 = 1000,000, and R1||R2 = 998 into equation 5 yields the fact that C = 0.016 µf. If you follow the results, you can obtain a capable filtering circuit.

A band rejection or notch filter is in Fig. 16-a. Here, Q is determined as before. Capacitor C1 is usually made equal to C2 and the resonant frequency, as indicated in equation 3, is:

$$f_o = 1/2\pi\sqrt{R1R2C1C2}.$$

Once Q has been determined, the ratio of R2 to R1 in the circuit can be set equal to $4Q^2$. Make R1 equal to about 100,000/Q, R3 equal to about 5250/Q and R4 equal to about 50 × R3. Using this information, calculate the C's for the circuit through use of equation 3.

Another type of notch filter (often called the twin-T arrangement) built around an op-amp is shown in Fig. 16-b. In that circuit, f_o can be determined using equation 1. Because Q can be very high, the rolloff is sharp.

Constant-k and m-derived filters

Constant-k filters get their name from the fact that the product of the capacitive and inductance reactances ($X_C \times X_L$) is constant at all frequencies. They exhibit reasonably sharp rolloff with a smooth passband. However, sharpness of rolloff can be improved considerably by using an m-derived filter.

An m-derived filter can be recognized by the parallel-resonant or series-resonant circuit in series or across the line respectively. They produce essentially infinite attenuation of the frequency to which they are tuned (thus zero transmission of that frequency along the line).

Schematics of both constant-k and m-derived filters are shown in Figs. 17 through 19.

Component values in the circuits depend on the resistance at the input to the filter circuit as well as the resistance at its output. In this discussion, we assume them to be equal—that is the usual case. We denote that resistance by the letter R. If input and output resistances differ, let R equal the average value of the resistance at the input and output. Rolloff will be affected by that mismatch. But resistance can be adjusted to the ideal by merely adding the proper transistor circuits at the input and output of the filter.

In the bandpass circuits, the Q of the coils do affect the sharpness of rolloff, but only to a minor degree. Rolloff at the low end of the pass band starts at f_L while rolloff at the high end of the passband starts at f_H. (f_L and f_H were defined above). For these circuits the resonant frequency is equal to $\sqrt{f_L f_H}$.

The various filter circuits shown include equations to indicate the approximate values of the components to be used in the circuits. Using those, you should be able to design a practical circuit.

Several constant-k or m-derived filter sections may be combined to sharpen rolloff and increase attenuation at different frequencies, if required. Input and output impedance matching will not be disturbed by such combinations.

Next time we'll look at another aspect of solid-state devices—how they can be used in switching applications. **R-E**

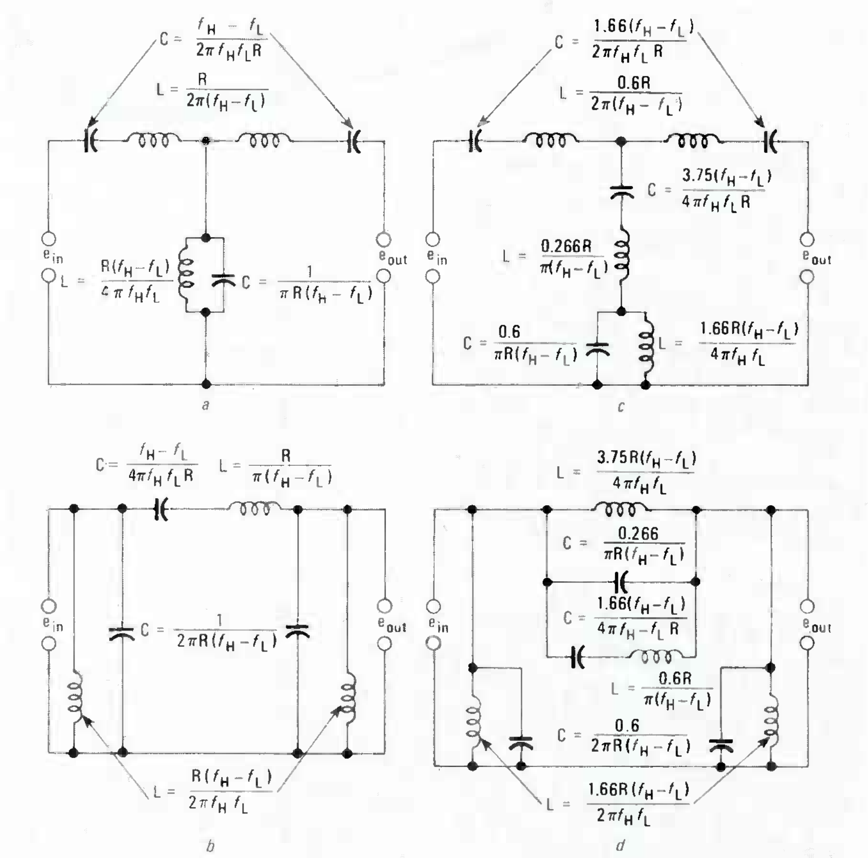
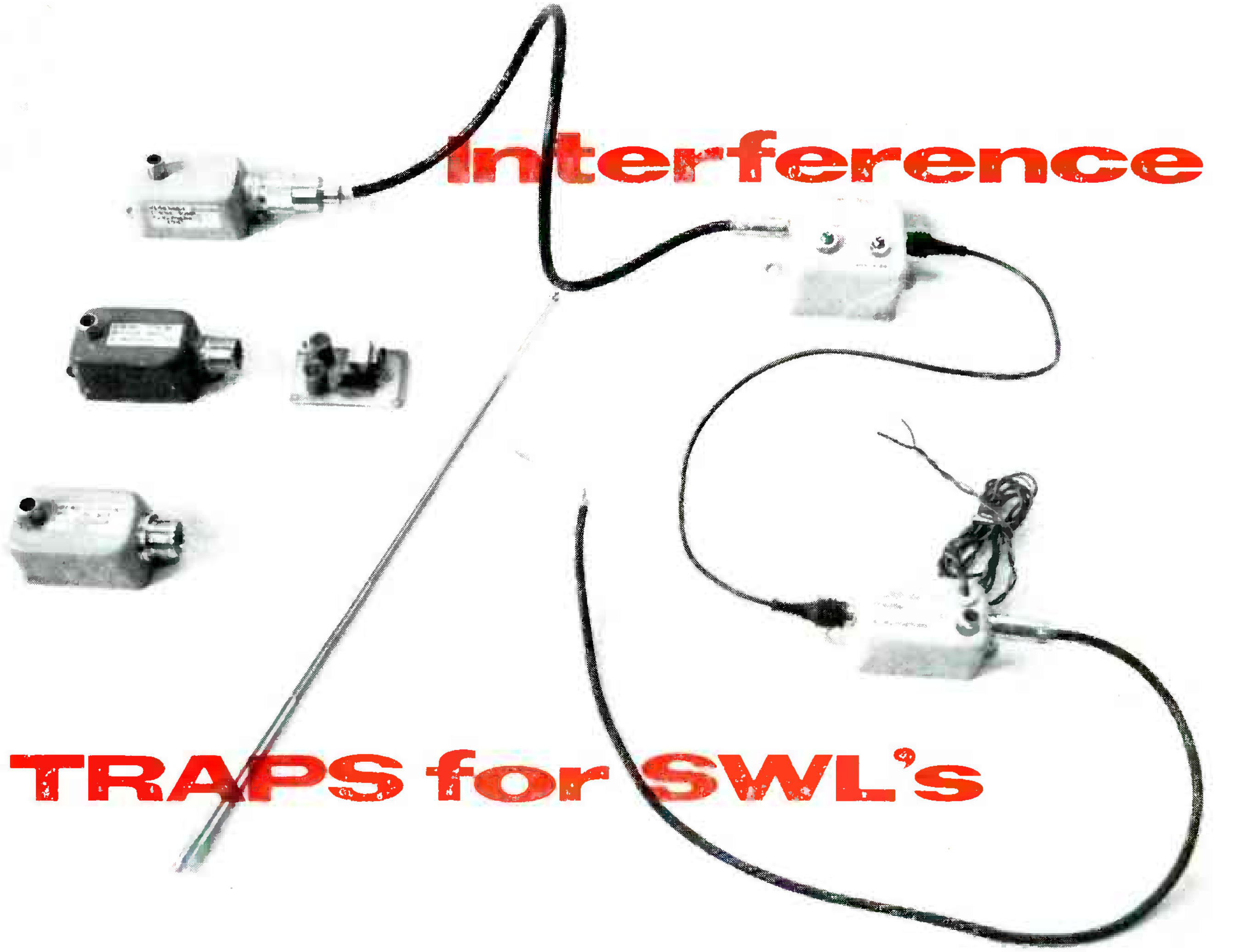


FIG. 19—BANDPASS FILTERS. The circuit shown in *a* is a constant-K T-section filter; *b* shows a constant-K π-section; *c* shows an M-derived T-section, and *d* shows an M-derived π-section filter.

Interference TRAPS for SWL's



Interference from AM (broadcast-band signals can often be a source of irritation for shortwave listeners and longwave enthusiasts. Here's one way to eliminate the offending signals.

R.W. BURHANS

SHORTWAVE AND LONGWAVE RADIO listeners are often plagued with interference from strong, local, broadcast-band (BCB) stations. The interference often results in intermodulation distortion in the receiver. Antenna tuners or RF preselectors are often used to reduce the problem. Sometimes, traps made up of parallel-tuned L-C circuits are simply connected in series with the receiver's antenna-input cable. However, a more effective trap—one that we will discuss—is the T-notch circuit. The T-notch trap also consists of a parallel L-C circuit—but the capacitor has a center tap that is fed to ground through an adjustable resistor. Figure 1 shows a dual T-notch circuit that is used to attenuate interference from two local broadcast-band stations. (In our case, each station is located about one mile from the test sight.) Of course, a single T-notch trap can be used if you have a single-station interference problem.

The T-notch trap operates as a delay-and-add network. The tunable, parallel L-C circuit provides a 180° phase shift from input to output. The delayed signal is then added to the original (with a multiplying constant). The variable resistor—by letting you adjust the phase and how much of the original signal will be added to the delayed signal—provides a way to adjust the circuit for a sharp null.

Circuit design

Let's consider a single T-notch trap. For a 50-ohm antenna system, the trap's inductor, L, is chosen such that its reactance (X_L) is in the range of 30 to 100 ohms. At the band of frequencies we're interested in (600–1600 kHz), that requires an inductance in the range of 7 μH to 12 μH with a fairly large parallel capacitance. (Two capacitors, connected

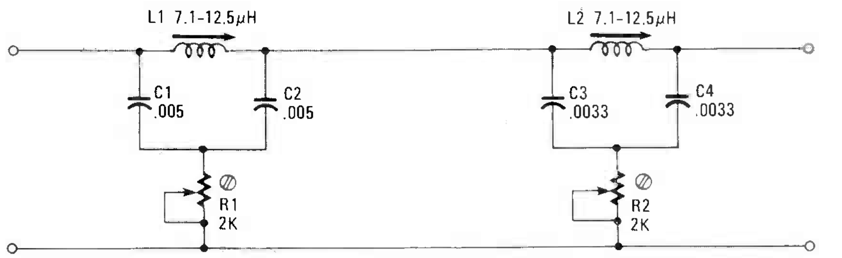


FIG. 1—T-NOTCH TRAP. Our trap was set to reduce interference at 970 kHz and 1340 kHz. Coils L1 and L2 were set to 10.5 and 8.5 μH respectively.

TABLE 1—Capacitor Selection

Capacitor value	Trap frequency for L = 12.5 μH	Trap frequency for L = 7.1 μH	Midband X_L
.01μF	625 kHz	810 kHz	40 Ω
.0068 μF	770 kHz	1000 kHz	50 Ω
.005 μF	860 kHz	1200 kHz	65 Ω
.0033 μF	1100 kHz	1480 kHz	72 Ω
.0022 μF	1360 kHz	1800 kHz	100 Ω

PARTS LIST

R1, R2—2000 ohms, trimmer potentiometer
C1–C4—polystyrene capacitors (values depend on the interfering frequencies—see text and Table 1)
L1, L2—7.1–12.5μH slug-tuned coil (Mouser 542-23A105RPC or equivalent)

in series, are required for each trap. Don't forget that the value of each will be double that required for an equivalent single-capacitor parallel L-C resonant circuit.) Table 1 shows a selection of capacitors designed to cover the AM band. (The capacitance values shown are for each capacitor—not the equivalent of the two capacitors in series.) The inductor is a 7.1-to-12.5 μH slug-tuned, adjustable RF coil with a Q greater than fifty. We mentioned one possible source for that coil in the parts list. In addition, we have also used many surplus adjustable inductors on older-style ceramic forms with considerable success.

Trap performance

While the trap will work best when driven from a 50-ohm source and terminated in a 50-ohm receiver load, it can also be used with 500-ohm receiver input-terminals. However, its null will not be as deep. Figure 2 is a graph that shows the typical response of a T-notch trap circuit when it is connected in series with a 50-ohm active antenna system that covers the range of 10 kHz to 30MHz. (Such active antenna systems were discussed in the February through April 1983 issues of **Radio-Electronics**.) We should note that this trap circuit does not present any problems when it is used in series with active antenna systems where DC power flows in the connecting cable between an antenna preamplifier and receiver coupler. The reason that that is the case is because there is a direct, low-resistance DC path from input to output and no DC ground.

When used at frequencies above 3 MHz or below 500 kHz, this T-notch trap is very effective at removing interference from broadcast-band stations—as seen in Fig. 2, the trap's −3-dB skirts start at 500 kHz and extend to 3 MHz. In our test setting, we achieved nulls of at least −40 dB at the two selected local-interference frequencies. You should find it possible to tune the trap for an even deeper null of −60 dB—but that requires very careful adjustment of the inductor and adding-resistor. At the deepest null point there will be a pronounced 2nd-harmonic effect, but at a very low level. That effect (where you see a signal of twice the frequency of the interfering signal) is a result of the addition of the delayed and original signal.

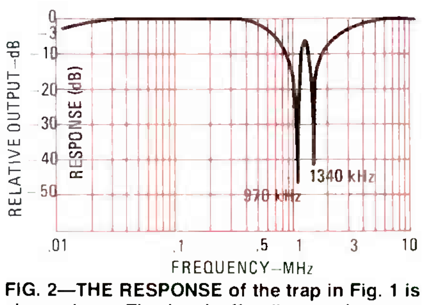


FIG. 2—THE RESPONSE of the trap in Fig. 1 is shown here. The local offending stations are WATH (970 kHz) and WOUB (1340 kHz). While the power of neither station is above 1 KW, they produced considerable interference.

Tuning the trap

To be of use, the trap has to be tuned to the particular offending stations in your area. The method of adjusting the traps is rather simple: First, tune your receiver to the interfering station. Next, adjust the inductor to reduce the signal and then adjust the resistor for a sharper null. We mentioned previously that the resistor is used to trim the circuit and obtain a sharp null point. That null is deepest when $R = QX_L/4$ (where Q is the unloaded Q of the inductor). It is usually necessary to go back and forth over those adjustments—that's particularly true when two traps are used (because of the interaction between the circuits.)

Applications

The T-notch trap is not limited to reducing broadcast-band interference. We have used similar traps for Loran-C receiver input circuits to remove 88-kHz and 115-kHz signals that were causing interference in the desired 90–110 kHz Loran-C range. If you are designing a trap circuit that uses use similar inductor values for traps for two different frequencies, it is often best to place the lower-frequency trap first (toward the antenna) with the higher-frequency trap toward the receiver.

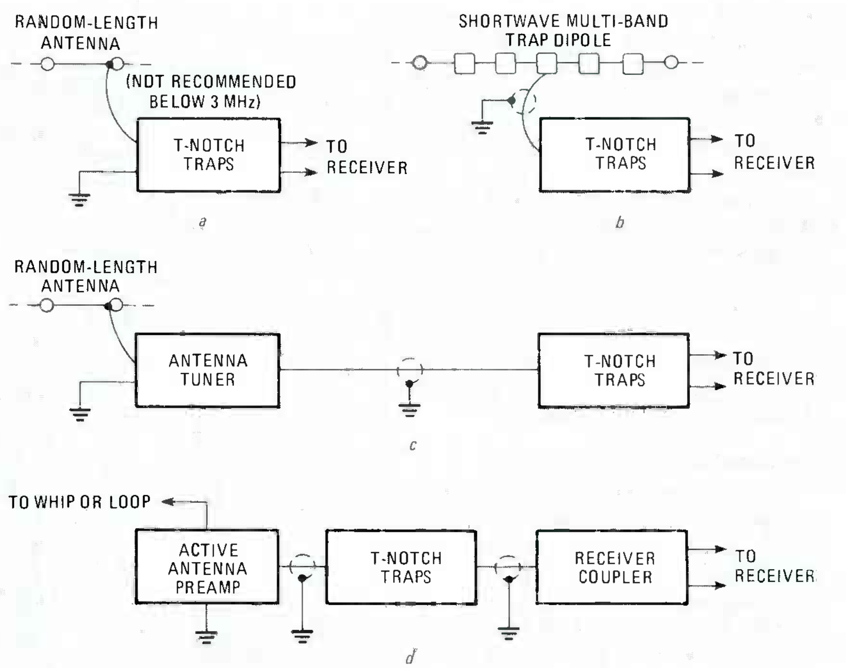


FIG. 3—THE T-NOTCH TRAPS can be used with various antennas.

Figure 3 shows ways of using T-notch traps with various receiving antennas. If a short random wire is directly connected to the trap input at frequencies below about 3 MHz, the trap shunt capacitance will effectively short the antenna or act like a large attenuator. Thus, this low-impedance trap is most useful at a 50–500-ohm impedance level when inserted between a receiver and a tuned antenna, antenna tuner, or active-antenna system. **R-E**

THE DRAWING BOARD

Solving the reset problem

ROBERT GROSSBLATT

THE MOST IMPORTANT THING WE LEARNED from last month's discussion of counters in general and the 4017 in particular is this: you get what you pay for. Using the 4017 to get nice cheap frequency division was like a lot of things in life—it seemed like a good idea at the time but when we put the IC to work we only got half of what we expected. The circuit was certainly cheap enough but the results were a far cry from nice. Two major problems showed up that really limited the usefulness of the circuit. The first, asynchronous reset, introduced some unpredictability in the output. The second problem was that the output duty cycle would change as we changed the number we were dividing by. Now, for some applications those may not be important but for others, they can be a real problem.

Not only that, but it's a good rule of thumb in design to limit the times you're willing to shrug your shoulders and compromise. After all, one of the main reasons you're designing something from scratch is to have the circuit do exactly what you want it to do. There are already more than enough times in life when you have to meet something halfway.

The reset problem

Let's tackle the reset problem first. In a nutshell, asynchronous reset means that the IC will reset itself whenever the reset pin is brought high. Not only is the operation independent of the input clock but you also have no control of the time the RESET pin remains high. Fortunately, that problem can be licked with a little bit of imaginative gating.

The trick to adding synchronous reset to the 4017 is being able to control the RESET pin. We need some sort of gating arrangement that will make it go high when we want; and more important, make it go low when we want. We also need some way of making sure that latter signal comes when RESET is completed. Remember that the 4017 is disabled as long as the RESET pin is held high.

Let's digress for a bit. What we're talking about here is a gating arrangement that has two independent inputs and whose output will change state when triggers are applied to each of the inputs. So, as you've probably guessed by now, we need a flip-flop. Now, you can use some standard-type flip-flop such as the 4043 or 4044; but in line with the established traditions of this column, let's see what we can do with a bunch of simple gates.

Figure 1 shows how we could build a simple flip-flop. It's made from two inverters and is mechanically triggered. If we connect the R switch to ground the Q output will be positive and the Q̄ output will be negative. In fact, triggering either of the outputs will produce entirely predictable results and obviously stable outputs. The only thing we can't do is connect both the R and S inputs to the same polarity—if we did, the whole thing would obviously go up in smoke. Since we all know that if something bad can happen it *will* happen, we'd better look further for our needed flip-flop.

In Fig. 2, we've done the same sort of thing with a pair of NAND gates. The operation of the circuit is more interesting and, ultimately, more useful. Let's assume the R input is connected to +V and see what happens as we switch the S input between +V and ground.

If we connect the S input to ground, the Q̄ output will be high because a NAND gate has a high output if one or more of its

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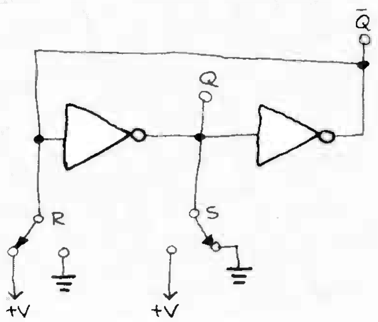

FIG. 1

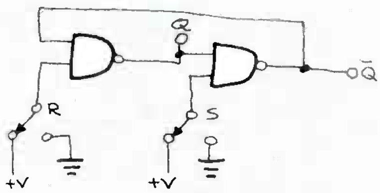

FIG. 2

FLIP-FLOP TRUTH TABLE

R	S	Q	Q̄
LOW	LOW	No Change	
LOW	HIGH	HIGH	LOW
HIGH	LOW	LOW	HIGH
HIGH	HIGH	Not Allowed*	

*See text

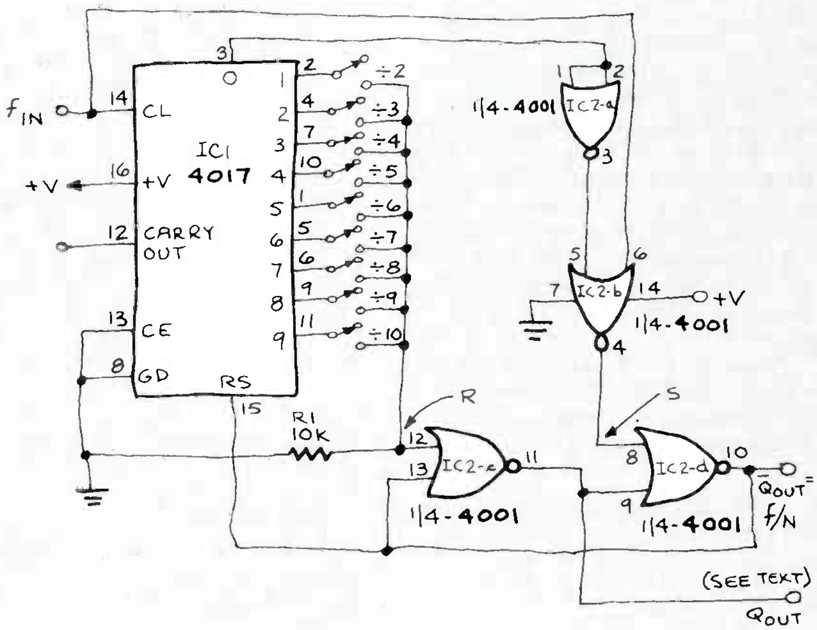

FIG. 3

DRAWING BOARD

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inputs are grounded. Since the $\bar{Q}$ output is also connected to one of the legs of the first NAND gate we have two highs there and the Q output will be low. If we switch the S input to +V, the output of the second NAND gate won't change because the other leg is still being held low. Suppose we now connect the R input to ground while the S input is switched to +V. With one leg grounded, the Q output will go high and the two highs at the inputs of the second NAND gate will make the $\bar{Q}$ output low. As you could predict, that flip-flop only responds to negative triggering because of the basic operation of the NAND gate.

The only thing to watch out for when you're using this flip-flop is to make sure that the S and R inputs aren't grounded at the same time. If that does happen, both outputs will be high and the circuit will be unstable. In practice, the last input to be grounded will decide the ultimate state of the flip-flop. But don't believe us—build it and try it yourself.

We can build the same sort of circuit with NOR gates and the flip-flop will respond to positive triggering. Use the previous discussion as a guide and trace through the operation of the NOR gate flip-flop so you understand how it works.

Now let's get back to our original problem. The circuit in Fig. 3 uses a NOR gate flip-flop to control the operation of the reset pin on the 4017. We're using NOR gates because they respond to positive triggering and the outputs of the 4017 are active high. The truth table for the flip-flop is shown in Table 1. The not-allowed state with NOR gates is having both the flip-flop inputs high. This isn't a problem, since the internal gating of the 4017 guarantees that only one output can be high at any one time.

As long as none of the switches are closed, R1 holds the input of the flip-flop low. That means that the $\bar{Q}$ output will be low regardless of what is happening at the S input. The reset pin of the 4017 is also held low and the chip is enabled. Now let's close one of the switches and see how the circuit works.

When the selected output goes high, the R input of the flip-flop goes high and a high appears at the $\bar{Q}$ output. This resets the 4017, the selected output goes low, and the 0 output, pin 3, goes high. Remember that the 4017 outputs go high in turn and whatever output you select will be low immediately following a reset pulse. That makes the R input low and control of the flip-flop moves over to the S input. You can see from the truth table in Table 1 that we need a positive pulse there to make the flip-flop change state and put a low at the $\bar{Q}$ output to release the 4017's RESET pin.

The Ø output of the 4017 is inverted by NOR gate IC2-a and presents a low to one leg of NOR gate IC2-b. The other leg of the gate is connected to the input clock and when a low appears there, IC2-b goes high and resets the flip-flop. That releases the RESET pin and enables the 4017. If you keep the switch closed at the keyboard, the circuit will reset over and over at the same point. The result will be a series of pulses at the $\bar{Q}$ output equal to the input frequency divided by whatever number you chose.

That circuit gives the 4017 a reset operation that is both synchronous and locked to the input clock. By following everything carefully you should have no trouble understanding how we did it. Remember that the reset operation starts on the positive half of the incoming clock cycle and is ended on the negative half of the same clock cycle. Since the input clock will be running faster than the pulses at any of the 4017 outputs, we don't have to worry about glitching in the count.

A side advantage of that approach is that the Q output of the flip-flop will give us an output wave that is equal in frequency to the $\bar{Q}$ output but opposite in sign. That can come in handy for some things and is especially nice since we're getting it for free.

If you want to cascade several 4017's together to increase the range of division, you won't be able to use the carry output, pin 12. Since that pin is high for the first half of the 4017's full count and low for the second half, frequency division of less than six will mean that the carry pin never goes low. The 0 output will, however, always go through a full cycle no matter what division you're doing, so you can take your signal from there.

The duty cycle problem

Now that we've solved the reset problem, let's look at the duty-cycle problem. In case you forgot what it is, we discovered that the duty cycle of the output would change every time we divided by a different number. It would follow the form 1/N where N is the number you're dividing by. More specifically, the high time would be equal to the period of the incoming clock, and the low time would be equal to N − 1 times the period.

If you're dividing by an even number, some simple gating would let you get an output with a nice 50% duty cycle but trying to do the same thing with an odd number would be—well, odd.

One of the basic rules of design is that there's a better way to do everything and that's true here. When simple problems generate overly complex solutions, it's time to scrap your whole approach and start over with a different color paper. In this case, squaring up the duty cycle not only calls for a different approach, it calls for a different IC—a different kind of counter. We'll examine that—and other mysteries—in next month's column. **R-E**

NEW LIT

COMPONENTS catalog, 68 pages, 5½ × 8¼ inches, lists semiconductors, integrated circuits, microcomputer boards, microprocessor and support circuits, transistors, diodes, capacitors, resistors, potentiometers, multimeters, connectors, sockets, PC boards, plastic enclosures, soldering aids, data and reference books, and much more. Free upon request.—**Active Electronics,** PO Box 8000, Westborough, MA 01581.

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COMPUTERS, *Di$count America Guide* (Directory of Discount Computer Suppliers) is 31 pages 8½ × 11 inches and contains data on books and periodicals, cable, calculators, components, diskettes, games, hardware, insurance, mainframes, minicomputers, paper, ribbons, software, supplies, tape, typesetting, typewriter conversion, and used equipment. There is a "Computer Comparison Chart" that will aid the reader in figuring the real costs of purchasing computer systems. It is available at $3.50 postpaid from **Di$count America Publications,** 51 East 42nd St., Room 417P, New York, NY 10017. **R-E**

SELECTRIC INTERFACE

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PARTS LIST—SELECTRIC ADAPTER

All parts mentioned in the Parts List for the *Electronic* and Printer versions, plus:
IC10, IC11—ULN2813A or ULN2803A high-voltage/current darlington transistor array, (Sprague)
D2 – D4—1N5400
SOL1 – SOL10—Solenoid, 12-volts DC
Miscellaneous: PC boards, No. 6 hardware: (two 1 × ¼ inch male/female threaded round spacers, two ⅜-inch flathead screws, two ⅛-inch pan-head screws, hex nut), music wire (12 inches, .031-inch diameter), plastic-covered stainless steel cable (27 inches, .020-inch diameter) 18 crimp sleeves (.040-inch diameter), wire ties, ribbon cable, etc.

A complete kit of all parts for *Selectric* conversion, including main PC board, case, cable for typewriter, solenoids, etc. (not including memory board or memory IC's) is available from *ALPHA* Electronics, PO Box 1005, Merritt Is., FL. 32952 (305-453-3534) for $169 plus $6 postage. The mechanical adapter alone (solenoid boards and solenoids) is available for $90 plus $5 postage. The ULN2813A or ULN2803A IC's can be purchased for $3 each postpaid. Florida residents please add 5% sales tax. Canadian orders please add $2 additional to US postage; other foreign orders please add $6 additional to US postage.

through holes, so those procedures are not necessary.)

That's all we have room for now, but we still have a lot to do. That includes assembling the boards, and connecting them between your computer and typewriter (or printer). We'll begin that next time when we continue this article. **R-E**

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

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EST. 1974

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#Ni-Cad-70S	internal Ni-Cad battery pack	25.

MODEL LFM:1110 Low frequency multiplier. A frequency counter accessory enabling tone frequencies to be counted faster and more accurately. Has low pass filter for off-the-air. Tone-squelch measurements. BNC input/output.

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MODEL 7010-S 10 Hz to 600 MHz counter. 50 Ohm & 1 megohm inputs via BNC type connectors on rear panel. ±1 PPM TCXO standard ±0.1 PPM TCXO time base optional for greater accuracy. 10 mV average sensitivity. Very compact 8 1/2 digit counter: Size 2" H x 4" W x 5" D, 1 lb.

#7010-S	600 MHz counter 115 V AC/12 V DC	$235.
#TCXO-80	±0.1 PPM TCXO time base	75.
#Ni-Cad-76	Internal Ni-Cad Battery Pack	25.

MODELS 8007-S, 8010-S, 8013-S Deluxe series with frequency ranges of 10 Hz to 700 MHz, 1 GHz and 1.3 GHz. Standard features include: external clock input/output, excellent sensitivity, sealed ±1 PPM 10 MHz TCXO time base, 4 gate times, 9 digit resolution to 175 MHz, front panel power jack for optional Broadband Preamp accessory, 115 V AC or 12 V DC operation, high quality compact construction housed in rugged aluminum cabinet. Optional features: internal Ni-Cad rechargeable battery operation, precision ±0.1 PPM TCXO or ±0.05 PPM proportional oven (OCXO) time base. All time base oscillators, including the standard TCXO, have 10 turn calibration adjustment accessible from rear panel. Size 3" H x 7 1/2" W x 6 1/2 D. 2 3/4 lbs.

#8007-S	700 MHz counter	$350.
#8010-S	1 GHz counter	425.
#8013-S	1.3 GHz counter	495.

OPTIONS:

#TCXO-80	±0.1 PPM TCXO time base	75.
#OCXO-80	±0.05 PPM (prop. oven) OCXO time base	125.
#Ni-Cad-86	Internal Ni-Cad battery pack	60.

MODEL AP-8015-A Broadband Preamp with 25 dB nominal gain from 1 MHz to 1 GHz, 10 dB gain at 1.3 GHz. Noise Figure less than 5.5 dB. supplied with AC adaptor or may be powered from power jack on 80XX-S series counters.

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K-7000-AC	550 MHz	5.24288	±1 PPM-RTXO	15 mV -24 DBM	N/A	(2) .1, 1 SEC	10 Hz			100 Hz		No	No	Yes	No
7010-S	600 MHz	10.0 MHz	±1 PPM-TCXO *±0.1 PPM-TCXO	10 mV -27 DBM	20 mV -21 DBM	(3) .1, 1, 10 SEC	.1 Hz	1 Hz		10 Hz		Yes	No	Yes	No
8007-S	700 MHz	10.0 MHz	±1 PPM-TCXO *±0.1 PPM-TCXO *±0.05 PPM-OCXO	10 mV -27 DBM	20 mV -21 DBM	(4) .01, .1, 1, 10 SEC	.1 Hz		1 Hz		10 Hz	Yes	Yes	Yes	Yes
8010-S	1 GHz														
8013-S	1.3 GHz														

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OUR PRICE **$119.95**

Contains five units in one, stabilizer (video guard remover); image enhancer, video to RF converter, video fader; and dual output distribution amplifier.
Stabilizer Will correct entire range of copy guard distortion such as jitter, vertical roll or black bar travelling through picture.
Enhancer Attain best picture for your preference.
RF Converter Allows your TV set to receive video and audio signals from your image enhancer, guard stabilizer, video camera, computer, VCR, etc. The direct video signal from any video component can be fed into the V-1880 and converted to a usable RF signal that can go to your TV antenna terminals.
Video Fader Used to produce fade ins and outs.

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Easily connects to any TV and Stereo Amplifier or simulated stereo sound. Makes taping TV Audio simple – TV can be located any distance from stereo. Delivers two channels of simulated stereo. With noise eliminator and special output level controls. Frequency response: 50 Hz - 15,00 KHz.

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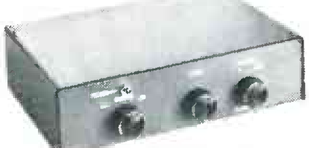
BP VIDEO GUARD STABILIZER
MODEL V-1875



OUR PRICE **$39.95**

Has self contained A&B and bypass switch. Many movies, concerts and special programs for sale or rental are copy guarded. This removes copy guard and allows you to make copies. Many TV sets will not play prerecorded tapes because copy guard causes picture to roll and jitter, turn to snow or disappear. Video Guard Stabilizer removes copy guard from signal.

BP RF CONVERTER/MODULATOR
MODEL V-1885

OUR PRICE **$39.95**

Allows your TV to receive video and audio signals from image enhancer, guard stabilizer, video camera, computer, VCR, etc. The outputs of many video components cannot be directly hooked up to the VHF antenna terminals on your TV set. This problem is solved by using the Model V-1885 RF Converter. Converts video signal from any video component to adjustable RF signal at antenna terminals. Allows your VCR output to feed two TV sets at the same time, with virtually no signal loss.

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Use as an RF Converter only. Used in conjunction with your TV, you can feed direct audio and video signals from any video device such as video camera, computer, portable VCR, etc.

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HOBBY CORNER

This and that

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH WE ARE GOING TO TAKE ANother dip into our mailbag. One of our readers, Gareth Ridout, is having a bit of trouble with a project he is working on. The schematic diagram for the device he is building calls for a 4016 CMOS switch. That IC contains four SPST switches like the one shown in Fig. 1-a.

The contacts of that switch are between pins 1 and 2. The control voltage is applied to pin 13. When 13 is made high, the contacts are closed.

The problem is caused by the fact that the schematic itself shows the switches as *SPDT* devices. That would mean that the IC is probably a 4053, which contains three SPDT switches (one is shown in Fig. 1-b).

Unfortunately, the text is of no help in determining which is correct. Well,

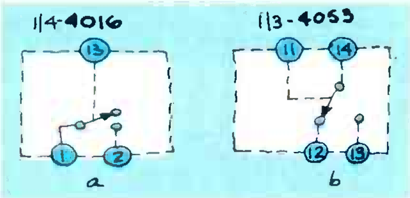

FIG. 1

Gareth, we have found that it is the schematic that is usually correct when there is a discrepancy between what it shows and the parts list accompanying it. In this case, we would use the 4053 IC.

Gareth also asks whether or not a 4066 IC can be substituted for a 4016. The answer is that it is even better than the 4016 in most uses. The 4066 is an improved version that has a lower closed resistance. On the other hand, the 4016 has lower leakage and should be used in a circuit when that characteristic is most important.

Receiver drift

A receiver that drifts in frequency is a real pain—you must tune and re-tune as you attempt to listen to a station. The problem can be especially bad when you are on a shortwave band and is made even worse as you make the bandpass narrower to eliminate interference from adjacent stations.

Richard Fry has asked how to "remedy the most irksome problem" of drift in older tube-type communication receivers. Indeed, drifting can be quite frustrating and the problem is not limited to tube receivers nor to old ones. Even new transistor receivers can be plagued with drift

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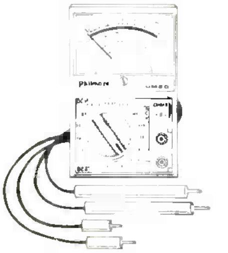

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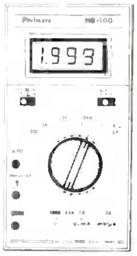

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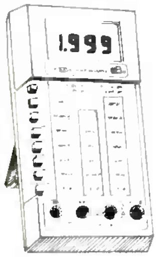

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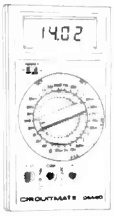

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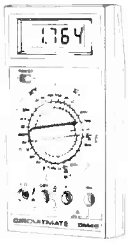

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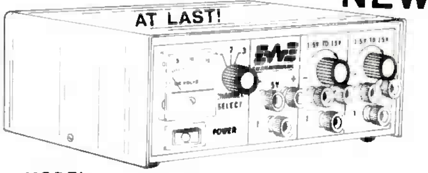

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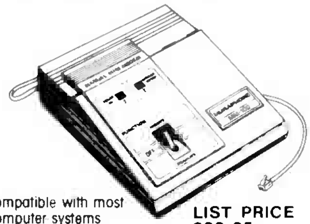

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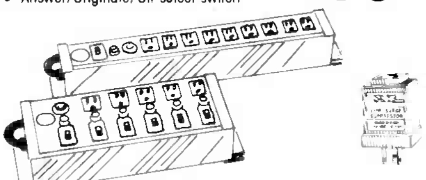

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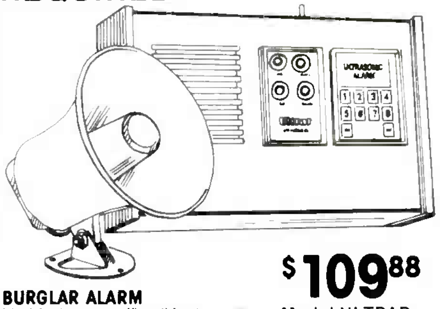

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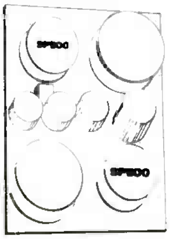

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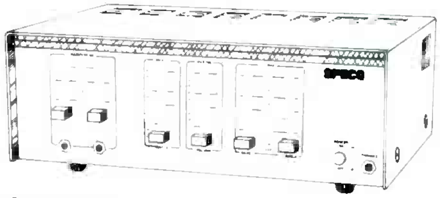

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but older tube devices are better—if that's the word—at it.

Space won't permit going into much detail, Richard, but we can point you in several directions that may help. We figure that your's is just one of thousands of such receivers that could stand some sprucing up.

One of the first things you should do to an old receiver of any kind is to take a hard look at the capacitors inside of it. You may even find some old paper capacitors in there! They are the worst offenders but others can change value and develop excess leakage with age, too. The thing to do, of course, is to replace them with new, modern units (tantalum, poly, etc.). You could test the old ones but the cost of replacement is low and it's quicker just to clip the old ones and solder in new ones. If you replace just one real loser, you will be amazed at the obvious improvement.

Most often, drift originates in the oscillator circuits of a receiver. Temperature changes can run the frequencies all over the map. As the set warms up to operating temperature, drift is at its worst. One way to avoid that is to leave the receiver on all the time. That way, it stays at operating temperature (and the cost of electricity is not significant).

Assuming that your set has the filaments ("heaters") wired in parallel (not series), there is an old trick that is almost as good as leaving it on all the time. It may do just as well, depending on the construction of the receiver. Old-timers frequently installed a small filament transformer that did not turn on and off with the main switch. That was connected to the filaments of the oscillator tubes (or sometimes all of the filaments in the set). Thus, those tubes stayed at operating temperature as long as the line cord remained connected to the wall socket.

Believe it or not, but some sensitive receivers can be affected by drafts in the air. In such cases, it will help to place it in locations where air from a radiator or hot air vent will not blow over it. And don't back it up to a window where winter drafts can reach it. The last suggestion is to stabilize the voltages, especially those on the oscillators and mixers. You can use old voltage regulator tubes if you can find them, and find space to mount them, but solid state regulators or Zeners are a better solution.

By the way, did you know that audio-power output transistors can function as Zeners? Only one junction is used, of course, so even some "blown" transistors can be used. You must test them for their knee voltages, which you will find often to be in the range around 100 volts, but they work great and are much cheaper than the "bought" variety.

Well, Richard, that should give you a good start. We hope you get that old unit in top shape.

Circuit analysis

Frequently, we receive a letter describing a circuit or device that a reader has built. The question usually is why it doesn't work or why it works in the way that it does. Sometimes, we can offer a suggestion or two, but we surely can't if the schematic is not included with the inquiry.

Just the other day, we received another such letter. The reader gave a fine word-description of the circuit and the problem but there was no schematic. The problem might have been caused by at least a dozen things. Without a schematic we have no way to narrow down the possibilities so we can't help.

The moral of that story is that you should send us a schematic whenever you ask about a specific circuit. We still may be unable to point out your difficulty, but without that schematic, there is *no* chance of help from here.

Surge filter

Larry Zimmerman wrote to find out how he could protect his Timex/Sinclair *1000* from troublesome and dangerous powerline surges without spending more than he spent on the computer itself. By this time, Larry, you most likely have seen the great multi-purpose powerline-filter construction article on page 57 in the September issue of **Radio-Electronics**.

That should take care of your problem provided, of course, that it is caused by surges. We presume that you are aware of the heat problem in the *1000*. The voltage regulator in the computer sometimes cuts out because of overheating. When the regulator cools a bit, the machine can be operated once again.

The solution to overheating is to drill a few ventilation holes in the case and/or replace the regulator heat sink with a larger one.

More on cassette machine speed

We recently received a nice letter from Ronald Gronsky about changing the speed of cassette recorder/players. He says that he has not had success with decreasing the size of the capstan and when making a pulley smaller, he prefers to use a small lathe-like tool to shave it, rather than a file.

Even more interesting: Ronald had dissected some of the shunt motors from inexpensive cassette machines. By removing the outer motor covering you can see two small centrifugal switches in a slot in the case. Turning the armature will reveal two screws for each switch—a larger mounting screw and a smaller adjusting screw.

The smaller screws can be turned to change the speed of the motor. Counterclockwise slows the motor and clockwise speeds it up. You should try to turn both screws the same amount in order to keep the motor in balance.

Thanks for sharing that useful information with us, Ronald.

Your questions and topics

Don't forget to send us any questions or suggestions for topics you would like to have covered in this column. Those of the greatest general interest will appear here in the future. Now, what was it you wanted to know? **R-E**

AN INVITATION

To better meet your needs, "Hobby Corner" has undergone a change in direction. It has been changed to a question-and-answer form. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in ""Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

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SERVICE CLINIC

More on opening your own shop

JACK DARR, SERVICE EDITOR

WE STARTED TO TALK ABOUT WHAT IT takes to open your own service shop back in the September issue of **Radio-Electronics.** This seems like a good time to look at that topic a little further.

Pay attention to what we're about to say because it is important. When talking about opening your own business, the key word is *business*: to survive, you've got to run your business like a business. You're the whole crew: technician, bookkeeper, parts man, collector, and janitor. So, if you don't do a job, it won't get done! Here are some helpful ideas.

First of all, know what it costs you to do business. That is how you figure your prices. Add up all your monthly expenses: light, heat, phone, delivery costs, rent, taxes—everything. Get those figures, then divide that by the number of weeks, then the number of days (5 or 6) you work. Divide that by 8 hours in a day and you've got your costs for every hour. Add your profit to that (without a profit you would starve pretty quickly) and you've got your basic service charge per hour. Stick to it. If you don't, you're losing money.

Secondly, keep your books up to date. It's a good idea to use a set of the special TV-service forms; you can get those at your TV-parts supply house. Those forms have an original and a duplicate. Give the customer the original and the duplicate serves as your job-record. Also, it's a good idea to enter each job in a "Day Book" under the customer's name. That makes it easy to run up your totals at the end of each month, for tax purposes and sales tax (don't forget to collect that; it can add up in only a month). You have to make those tax reports, so make it as easy as you can. Do that every day or you'll wind up way behind.

Finally, keep the shop clean. When you finish a job, check it out, then clean up the bench. Put tools back, and above all put your service data back in the file. Never leave it lying around in heaps. If you do, you will waste about $3.00 worth of time hunting for it! You sell your time, so don't waste it!

The new man in town

When you come into a new town/city, you need to get out and meet the people. After you get set up, go out and ring a few doorbells. Tell the people you're a new TV technician in the town/neighborhood, and you want to meet them. Give them a card with your name and phone number on it. You may get a few doors slammed in your face, but keep on. That technique worked years ago, and, given a chance, it still works today.

It's also a good idea to visit the other TV shops in your neighborhood. Introduce yourself, and be sure to tell them you're not going to cut prices! If you're careful, you can find out what they're charging. Set your prices at about the same level. If they have been there for a while, they know what it takes. Above all, make friends with them; that can be handy as most shops swap parts at intervals.

Credit

There's one thing to watch out for—credit! In all areas, there will be a few deadbeats that have already exhausted their credit with the other TV shops. When a new shop opens up, they flock to it thinking you don't know them yet. Put up a big sign "Cash On Delivery Only" and then stick to it. No reasonable customer will object to that. Cash is always good to have. It pays your bills on time, which is a nice thing to do, and makes your suppliers like you a lot.

Finally, thanks to a reader, Robert E. Taber, who's a Navy radio-man. He started all this by asking for advice on the subject! Several others have also asked the same question, so we hope that this will help them out. Good luck and much success to all of you just starting. **R-E**

VCR REPAIRS

continued from page 68

The current applied to the brake coil is increased if rotational speed exceeds 1800 rpm, and vice versa, to maintain the scanner speed at precisely 1800 rpm.

As shown in Fig. 11, the CTL control signal recorded on tape becomes the standard reference signal during playback. The CTL signal is compared with the 30 PG signal of the rotating heads, and any difference or error signal is amplified. Again, the amplifier output is used to control operation of the brake (and thus control speed of the rotating heads), so the heads trace the appropriate tracks, and playback is synchronized with record.

The system shown in Figs. 10 and 11 is a form of drum servo. There is also a capstan servo used in many VCR's. Most of the advanced servo systems used in present-day VCR's not only control speed, but also control the phase relationship between drum and capstan servos, producing even more precise synchronization.

Now that we have a basic understanding of how a VCR works, it is time to turn our attention to some more practical matters, such as the tools and procedures used in servicing those devices. We'll start by taking a look at the tools you need next time when we continue this article. **R-E**

STATE OF SOLID STATE

High-voltage transistors

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

EVEN THOUGH WE ALL KNOW THAT HIGH-voltage transistors are available, many of us still think of the transistor as a low-voltage device. And we would be hard-pressed to draw a circuit illustrating a simple application of a high-voltage transistor. That's not true of STI (Semiconductor Technology Inc., (STI, 3131 S.E. Jay street, PO Box 474, Stuart, FL 33494), one of the industry leaders in high-voltage-transistor technology. They manufacture a broad line of silicon high-voltage types. The low- and high-power devices have ratings ranging from 30 mW to 200 watts and voltage ratings up to 2 kV V_{CBO} (collector-base breakdown voltage with open emitter). Many of those are direct replacements for discontinued types that were made by Delco and Texas Instruments.

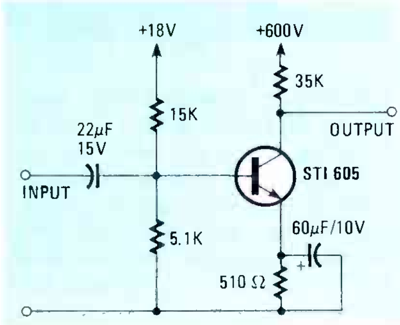

FIG. 1

The circuits in Figs. 1, 2, and 3 (from an STI application note) illustrate the development of a high-voltage wide-band deflection amplifier for the CRT in an oscilloscope. Figure 1 is the circuit of a basic Class-A amplifier. It has a low input impedance and a voltage gain of over 300. A disadvantage of this circuit is that the Miller effect multiplies the collector-to-base or feedback capacitance by about the value of the gain. That very high effective input-capacitance loads the input circuit, reduces the high-frequency response, and increases the effective input-to-output coupling. The collector voltage is 300 volts with an idling or quiescent current of 10 mA, and the output voltage swing is 600 volts peak-to-peak.

Figure 2 shows how—through the addition of a low-voltage, high beta, NPN silicon transistor such as the 2N2219—we can improve performance by greatly minimizing the Miller effect and almost completely eliminating input circuit loading. The transistors are stacked in what is often called a cascode configuration with the

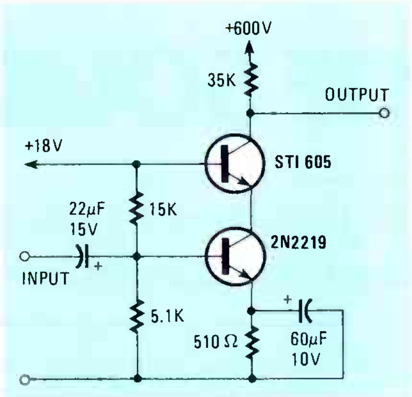

FIG. 2

2N2219 as a common-emitter amplifier driving the emitter of the STI 605 that is operating in the grounded-base mode. The input signal is fed to the base of the 2N2219. The STI 605 provides the necessary voltage gain while the 2N2219 provides current gain. The collector of the 2N2219 sees only a 1-volt peak-to-peak swing.

One of the advantages that is offered by this arrangement is that the STI 605 is operating under conditions that minimize the effects of beta changes and leakage currents, so the stability factor approaches one. That's accomplished by biasing the base of the STI 605 base with a constant voltage while emitter is biased by the 2N2219, which acts as a constant-current source.

Figure 3 shows how two stages of the

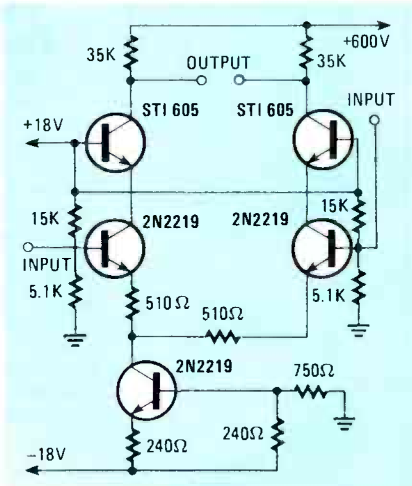

FIG. 3

circuit just described can be arranged as a differential amplifier delivering approximately 1200 volts peak-to-peak. The circuit can be used as a wide-band deflection amplifier in a scope. The third 2N2219 is a constant-current source for the differential amplifier.

Taking a quick look at the characteristics of the STI 605, we see that its power dissipation at 25°C is 2 watts; V_{CBO} is 600 volts; I_{CBO} (the collector-base cutoff current) at 450 volts is 4 μA; h_{FE} (the DC current gain in the common-emitter configuration) at $I_C = 25$ mA is 30; and

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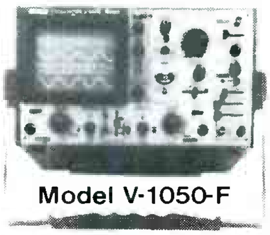

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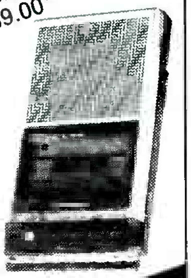

V_{CEsat} (the collector-emitter saturation voltage) when $I_C = 25$ mA is 1.5 volts.

DRAM control application manual

A 42-page booklet, *TMS4500 Dynamic RAM Controller User's Manual* (SCG690A) describes the operation of the Texas Instruments TMS4500 dynamic memory controller and illustrates its applications in a microprocessor system. The device provides address multiplexing, cycle timing, and refreshing for DRAM's (*D*ynamic *R*andom-*A*ccess *M*emories). Chapter headings are "Functional Description," "Typical Implementation," "Design Criteria," and "Application Examples." The last chapter discusses uses of the TMS4500A with the 8085A, Z80, TMS-9900, MC68000, 8086, Z8001, and TMS-9995 microprocessors. It's a handy guide if you are designing or updating a small computer or microprocessor-based equipment.—**Texas Instruments**, PO Box 3640, Dallas, TX 75285.

BiFET op-amp

The AD547 is a monolithic, FET-input op-amp from Analog Devices. It offers the low-input-bias-current (typically 25 pA) advantage of the BiFET with the low-offset-voltage and low-drift characteristics usually associated with high-quality bipolar devices. Input offset voltage and offset-voltage drift are 1 mV, ±5 μV/°C for the AD547J; 0.5 mV, ±2μV/°C for the -K; 0.5 mV, ±1 μV/°C for the -L, and 0.5 mV, ±5μVmu/°C for devices with the SH suffix.

The low noise, high open-loop gain, and outstanding offset performance make the AD547 ideal for use as a precision instrumentation amplifier for signal conditioning and analog computations. The device is available in three commercial grades. The J, K, and L grades operate in the 0° to +70°C range. The SH grade (military version) operates from −55°C to +125°C. All grades are in TO-99 hermetically sealed cans. —**Analog Devices**, PO Box 280, Norwood, MA 02062.

Dedicated IC catalog

Microelectronics Product Guide assists the reader in selecting the dedicated IC best suited to his needs. Devices are catalogued according to category under such headings as "ROM's," "Keyboard Encoders," "Character Generators," "EEPROM's/EAROM's," "Microcomputers and Microcomputer Development Systems," "Speech Synthesis," "TV Games," and "Radio and TV Control." Devices in each category are listed in a tabular form. In addition to part numbers, there are column headings for function, description, package type, supply voltage, and special features.—**General Instrument**, Microelectronics

continued on page 110

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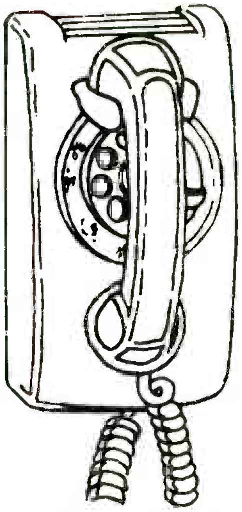

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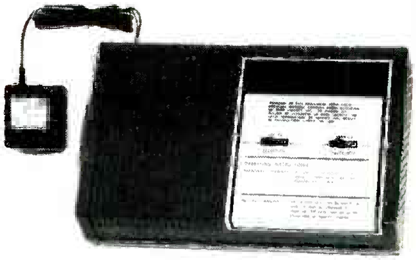

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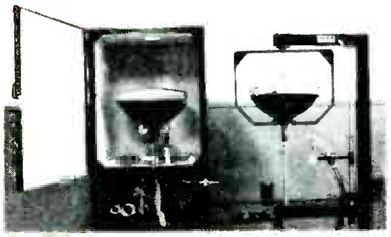

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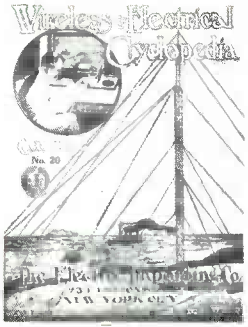

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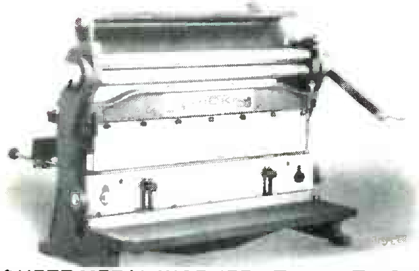

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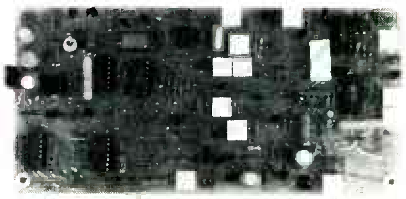

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STATE OF SOLID STATE

continued from page 106

Div., 600 W. John St., Hicksville, NY 11802

Power semiconductor data manual

Semiconductor Product Digest—1982-1983 (Catalog SPD-1) is a 25-page short-form listing of the characteristics of International Rectifier's power semiconductor devices. Devices are listed by construction and purpose so they can be quickly located. Groupings include *HEXFET* Power MOSFET's, Power Schottky Rectifiers, Bipolar Power Transistors and Darlingtons, Thyristors; General-Purpose, Fast-Recovery, and High-Voltage Silicon Rectifiers; Diode Bridges, Protective Devices, and Opto-electronic Devices. An alphanumeric listing greatly simplifies finding the location of a particular device in the manual.—**International Rectifier**, 233 Kansas St., El Segundo, CA 90245. **R-E**

PORTABLE VIDEO

continued from page 74

the system at the same time, there now appears to be considerable disagreement as to the timing of the introduction, and some even want to go back to the drawing board to develop an even more advanced system. Thus, rather than a single standard, we could yet wind up with two incompatible 8-mm formats, or perhaps none at all.

We've already touched upon one major area of disagreement—the method of video recording. Several manufacturers want to bring everything back into committee and develop a standard based on something similar to Thomson's "Timeplex" baseband proposal. There has even been feeling that everything should be put on hold to await further advancements or developments in the field, perhaps even for the advent of digital TV.

Others are pushing for delaying introduction of the new standard until at least the end of 1984. Among the arguments for the delay are the desire to see how the new *Betamovie* fares, the lack of a ready library of tapes for the new standard, and the feeling that the new tape heads and metal tapes need more development.

The real reason, however, might be some manufacturer's fears of what the new standard could do to their existing ½-inch business. If the system lives up to the high expectations many have for it, extended play-time cassettes and home machines are sure to follow, making 8-mm video a home as well as portable standard. If that happens, it could relegate both VHS and Beta to the scrap heap before very long. In any event, it appears that the future of 8-mm video may depend more on politics than on any other factor. **R-E**

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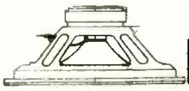

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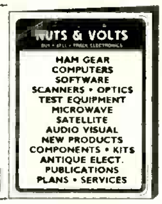

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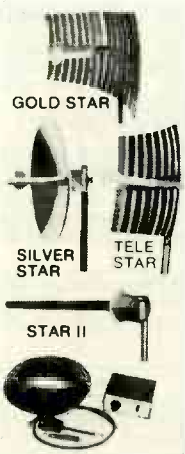

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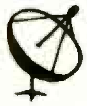

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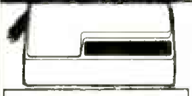

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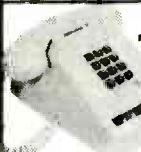

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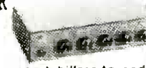

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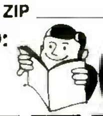

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74S32	.50	74S158	1.25	74S280	1.75
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		74S163	1.40	74S374	1.75

TTL IC SERIES

7400	.30	7474	.50	74164	.80
7401	.30	7475	.50	74165	.80
7402	.30	7476	.45	74166	.90
7403	.30	7480	.45	74170	1.60
7404	.30	7483	.50	74173	.75
7405	.30	7485	.70	74174	.65
7408	.30	7486	.55	74175	.70
7409	.30	7490	.50	74176	.75
7410	.30	7491	.55	74180	1.90
7411	.30	7492	.55	74181	1.90
7412	.30	7493	.55	74182	.90
7413	.45	7494	.60	74190	.80
7414	.60	7495	.55	74191	.80
7416	.75	7496	.60	74192	.80
7417	.75	74107	.50	74193	.79
7420	.30	74116	1.50	74194	.85
7425	.30	74121	.45	74195	.45
7426	.30	74122	.50	74196	.75
7427	.30	74123	.55	74221	1.00
7430	.30	74125	.60	74273	.85
7432	.40	74126	.45	74279	.60
7437	.50	74145	.60	74298	.65
7438	.90	74148	1.10	74365	.80
7440	.30	74150	1.10	74367	.80
7441	.75	74151	.60	74390	.90
7442	.60	74153	.60	75325	1.50
7445	.80	74154	1.60	75492	1.05
7446	.80	74155	.60	9601	.75
7447	.80	74157	.60	9602	.75
7448	.80	74160	.85	8T26	1.40
7450	.30	74161	.65	8T28	1.40
7472	.40	74162	.70	8T97	1.10
7473	.45	74163	.70	8T98	1.10

LINEAR CIRCUITS

DAQ08EQ — 3.75	LM370 — 1.60	LM1310 — 1.60
TL062 CP — .95	LM377 — 1.60	1456 — .80
TL064 CN — 1.50	LM380 — 1.20	1458 — .50
LM201 — .75	LM384 — 1.60	LM1808 — 1.75
LM301/748 — .30	LM386 — 1.20	LM2901 — .95
LM307 — .30	LM387 — 1.25	CA3018 — 1.95
LM308 — .65	LM393 — .75	CA3078AT — 1.50
LM310 — 1.10	LM555 — .50	CA3086 — .75
LM311 — .50	LM556 — .90	CA3089E — 1.75
LM318 — .95	558 — 3.50	AD2700LD — 4.95
LM319 — 1.30	565 — 1.25	CA3140 — 1.00
LM324 — .55	566 — 1.25	3900 — .50
LM339 — .90	567 — 2.50	LM3909 — .80
LM348 — .90	709C — .35	4136 — .85
LF351 — .55	LM710 — .60	N5596A — 1.50
LF355 — .90	711CH — .40	D6303B — 1.75
LF356 — 1.00	733 — .95	8038CC — 3.90
LM358 — .50	741CV — .40	LM13080 — .95
LM361 — 1.75	747 — .50	8700CJ — 5.95
	CA758 — 1.75	

2N3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG. UJT	$ .65

DISC CAPACITORS

.1UF 16V	10/$1.00	100/$8.00
.01UF 35V	16/$1.00	100/$5.00

PRINTED CIRCUIT BOARD
4" x 6" DOUBLE SIDED EPOXY BOARDED 1/16" THICK $.60 ea. ..... 5/$2.60

TOGGLE SWITCHES
108D — SPDT — 1.00
206D — DPDT — 1.40
206P — DPDT — CENTER OFF 1.80

IN4148 (IN914) 15/1.00

L1411-IR DETECTOR	3/$1.00
FP 100 PHOTO TRANS	$ .50
RED LED's .2"	8/$1.00
YEL, GREEN or AMBER LARGE LED's .2"	6/$1.00
RED-GREEN BIPOLAR LED	$ .90
RED-YELLOW BIPOLAR LED	$ .90
MLED92 IR LED	$ .40
MRD14B PHOTO DARL. XTOR	$ .50
MCT2 OPTO ISOLATORS	$ .60
4N26 OPTO ISOLATOR	$ .40
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V	6/$1.00

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12V DC RELAYS TTL SIZE
S.P. 1200 ohm coil .75
D.P. 400 ohm coil .95

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.05	.14	.35	.90	5.00	6.00
200	.06	.17	.50	1.30	7.00	9.00
400	.09	.25	.65	1.50	10.00	12.00
600	.11	.30	.80	2.00	13.00	15.00
800	.13	.35	1.00	2.50	16.00	18.00
1000	20	.45	1.25	3.00	20.00	26.00

74LS SERIES

74LS00	.40	74LS109	.55	74LS221	1.50
74LS01	.40	74LS112	.50	74LS240	1.50
74LS02	.40	74LS113	.60	74LS241	1.50
74LS03	.40	74LS114	.65	74LS242	1.50
74LS04	.50	74LS123	.85	74LS243	1.50
74LS05	.50	74LS125	1.00	74LS244	2.25
74LS08	.50	74LS126	.60	74LS245	3.25
74LS09	.50	74LS132	.75	74LS246	.95
74LS10	.40	74LS136	.55	74LS247	1.50
74LS11	.40	74LS137	.85	74LS248	1.50
74LS12	.40	74LS138	1.25	74LS251	.70
74LS13	.55	74LS139	1.49	74LS253	.70
74LS14	.70	74LS147	1.95	74LS257	.70
74LS15	.50	74LS151	.70	74LS258	.80
74LS20	.40	74LS153	.70	74LS259	1.00
74LS21	.40	74LS154	2.40	74LS266	.70
74LS22	.40	74LS155	.80	74LS273	1.60
74LS26	.55	74LS156	.80	74LS279	.60
74LS27	.40	74LS157	.80	74LS280	1.80
74LS28	.50	74LS158	.80	74LS283	.80
74LS30	.40	74LS160	.90	74LS290	.90
74LS32	.75	74LS161	.90	74LS293	.90
74LS37	.50	74LS162	.90	74LS298	1.20
74LS38	.50	74LS163	.90	74LS320	2.00
74LS40	.40	74LS164	.90	74LS323	3.50
74LS42	.55	74LS165	.90	74LS365	.90
74LS47	.80	74LS166	1.90	74LS366	.90
74LS51	.40	74LS169	2.50	74LS367	1.25
74LS54	.40	74LS170	1.90	74LS368	.90
74LS73	.55	74LS173	.90	74LS373	2.00
74LS74	1.00	74LS174	.90	74LS374	2.00
74LS75	1.25	74LS175	.90	74LS377	1.50
74LS76	.55	74LS181	1.95	74LS386	.60
74LS83	.80	74LS190	.90	74LS390	1.10
74LS85	.90	74LS191	.90	74LS393	1.10
74LS86	.60	74LS192	.90	74LS398	2.50
74LS90	.80	74LS193	.90	74LS625	1.75
74LS92	.70	74LS194	.90	74LS668	1.50
74LS93	.70	74LS195	.90	74LS670	1.20
74LS96	.80	74LS196	.90	81LS97	1.50
74LS107	.55	74LS197	.90	81LS98	1.50

REGULATORS

LM338K	$5.75	323K (LA1405)	$1.75
LM317T	$1.35	LM305G	$ .75
78L05, 78L12	$ .40	340T-5, 6, 8, 9, 12, 15, 18 or 24V	$ .75
723	$ .50	LAS1412 + 12V 3A	$3.95
320T 5, 12, 15 or 24	$ .85		
LM 337T	$1.95		

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CTS 206-7	7 POSITION	.95
CTS 206-8	8 POSITION	.95
CTS 206-10	10 POSITION	1.25

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8 PIN	.10	20 PIN	.25
14 PIN	.15	22 PIN	.25
16 PIN	.18	24 PIN	.25
18 PIN	.20	28 PIN	.35
		40 PIN	.40

WIRE WRAP SOCKETS

14 PIN —	.45
16 PIN —	.50
18 PIN —	.65
20 PIN —	.90
24 PIN —	1.10
28 PIN —	1.25
40 PIN —	1.80

20KV DIODES 250 ma. $1.95

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DB9P -	$2.00	DB25P -	$2.40
DB9S -	3.00	DB25S -	3.20
HOODS-	1.10	HOODS-	1.10

TANTALUM CAPACITORS

.22UF 35V	5/$1.00	15UF 16V	3/$1.00
.47UF 35V	5/$1.00	30UF 6V	5/$1.00
.68UF 35V	5/$1.00	33UF 15V	$ .50
1UF 20V	5/$1.00	47UF 20V	$ .85
2.2UF 20V	5/$1.00	68UF 16V	$1.00
3.3UF 20V	4/$1.00	120UF 6V	$ .75
4.7UF 35V	4/$1.00	200UF 20V	$1.75
6.8UF 20V	4/$1.00	150UF 16V	$1.30
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22UF 10V	— $ .30		

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1358	1 25	10 00
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1496	1 50	13 20

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7818	95	7 90
7824	75	6 90
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5 VOLT 6 AMP

• IC Regulated
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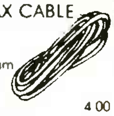

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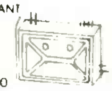

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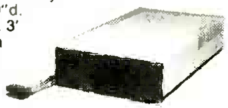

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MONITOR (12")

- Orange amber screen
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- High resolution graphics

Composite video 1/O 75/10K ohm impedance. A phenomenal quality monitor for your computer. 110 VAC.

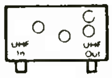
MON-1 .... $119.95

SOLID STATE STEREO GRAPHIC EQUALIZER PRE AMP KIT TA-2500

Specifications: • Total Harmonic Distortion: Less than 0.05% • Intermodulation Distortion: (70Hz: 7KHz = 4:1 SMPTE Method) Less than 0.03% • Frequency Response: Overall 10Hz ~ 100KHz +0.5db.—1dB. • RIAA Curve Deviation: (Phono) +0.2dB.—0.2dB (30Hz ~ 15KHz) • Channel separation (at rated output 1 KHz) • Phono. Tuner. Aux and Tape Monitor better than 70dB. • Input sensitivity and impedance (1KHz for rated output)
Phono: 2MV 47K ohms **Aux:** 130MV 50K ohms. **Tuner:** 130MV 50K ohms **Tape:** 130MV 50K ohms. **Graphic Equalizer control:** 10 Band Slide Control. **Frequency Bands:** 31 5Hz: G3Hz: 125Hz: 250Hz: 500Hz:1Khz: 2KHz: 4KHz: 8KHz: 16KHz also with on panel selector for Phono. Tuner. Aux 1 and Aux 2. **Power Supply:** 117 VAC
Kit comes with all electronic components, transformer, instructions and a 19" rack mount type metal cabinet.

MODEL TA-2500
$119.00 PER KIT

UHF TV PREAMP



Features:
- 25 dB gain!
- Kit

Your reception will dramatically improve! This unit will enable you to pull in signals you never knew were there!
For both indoor and outdoor use. Input and output impedance 75 ohm. No adjustment! Easy assembly.

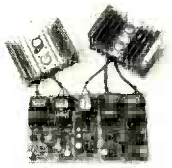
JH-0 Kit $23.95

TA-802 160 WATT TOTAL 80W + 80W STEREO AMP KIT

This is a solid state all transistor circuitry on board stereo amplifier. Power output employs 2 pairs of matching Darlington transistors. T.H.D. less than .05% between DC to 200 KHz. Pwr supply requires 30 VCT 2 amp × FMR.

TA-802 $39.95

Transformer (optional) $9.95 ea.



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80 column card	$109.95
16 Ram card	$44.50
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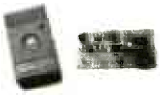
R.F. MODULATOR

Combine both audio and video output onto channel 3 or 4 of your T.V. set.
Single J.C. chip (MC 1374) makes for quick and easy assembly. Single adjustment control! A must for every video recording or computer enthusiast.

VH-0 Kit $19.95

INFRA-RED REMOTE CONTROL SWITCH KIT



Infra-red Remote Control switch can be used to control appliances up to 500 W. The TK-41 has effective control up to 10 meters. No antenna needed. Features latest IC controller which excludes interferences from light or AC pulse signal.

TK-41 Kit $24.95

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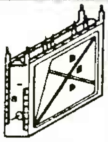
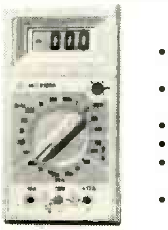
PHILIPS VARACTOR TUNER



Comes with adaptor board to directly replace Mitsuimi tuner! Can use this with any board drilled for Mitsuimi! High gain and phenomenal picture quality.
SPECIFICATIONS: • Freq. Range: 470-899 mHz • Output: Channel: 3 • Input: 75 ohm • Gain: 18 dB

ELC 1045 .... $23.95

DIGITAL MULTIMETER



- 3½ digit LCD meter
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- DCA up to 10 amps
- Leads and battery included

MIC-3300A $59.95
Carrying Case .... $ 9.95

TTL/CMOS LOGIC PROBE

- 4 LED states
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- Supply Voltage 3 ~ 18 VDC
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LOGIC PULSAR PROBE

- Easily repair logic circuits
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- External Sync Input
- Supply Voltage 3 ~ 18 VDC

L201A $34.95

LOW TIM DC STEREO PRE-AMP KIT TA 2800

Incorporates state of D.C. design that gives a frequency response from OHz-100KHz ± .5dB. • Features tone defeat switch, loudness, treble, midrange, bass, balance. • TA-2800 contains quad BiFet op-amp to develop T.H.D. of .005% at rated output • Input sensitivity: phone 2.5 MV tuner, aux, tape play 100MV/100K • Power supply ± 15 volt DC at .2A. Kit comes with regulated power supply, all you need is a 15-20 VCT .2 amp. XFMR.

Only $44.50

XFMR $4.50 ea.

AMATEUR MICROWAVE RECEIVER KIT 1.9-2.5 GHZ

PS-1 Assembled 32 element antenna	$19.95
PS-2 20 dB gain microwave receiver kit with variable power supply kit	$50.00
PS-3 Complete package PS-1 & 2	$65.00

MOUNTING HARDWARE INCLUDED

MICROWAVE PREAMP! NEW KIT

Use with PS-3 Kit. Adds 20-25 dB gain to boost reception distance.
- Low Noise
- High Gain
- Can be used with all existing stop sign board receivers!
- 1.9-2.5 gHZ freq. range

PS-4 (Kit) $34.95

SOLID STATE STEREO REVERBERATION AMPLIFIER

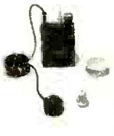
Specifications:
- Total harmonic distortion less than .05%
- Frequency response 10 Hz to 50KHz ±ldB
- S/N Ration 90dB
- Reverberation time 1 to 3 sec
- Input 150MV/50K ohm
- Max. input 2V
- Accepts input from tape, phono, or aux.

Includes an LED Reverb Level display. Kit comes with all electronic components, transformer and instructions, and 19" rack mount cabinet.

Model TA-2400 .... $89.95

SPY EAR!

A very popular device designed to listen to sounds & voices through rooms or 3 ft. thick concrete walls. Place listening sensor against wall and earphone in ear. Adjust volume control! Hear clearly to things you might not want to!

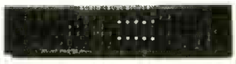


CM-8 .... $89.95

TY-45 20 STEP LED POWER LEVEL INDICATOR KIT

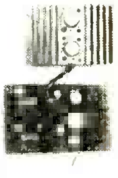
This new stereo level indicator kit consists of 40 3-color LED's to indicate sound level output of your amplifier from -57 dB to 0 dB. Comes with an attractive silk screen printed panel. Has selector switch to allow floating or gradual output indicating.
Kit includes all parts, Front panel and power supply.

TY-45 KIT $34.95



MICRO COMPUTER POWER SUPPLY TR-626

The TR-626 is a power regulator for use with popular microcomputer circuits. Features:
- ±5V 6A
- -5V .5A
- +12V 1.5A
- -12V .5A



Each unit contains current limit protect circuit and two Darlington power transistor on a heatsink. Transformers included.

$39.95 each

Minimum order $15.00. Add 10% shipping on orders under $35.00. Orders over $35.00, add 5%.
Catalog - $1.00. Visa & Mastercharge acceptable.

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80 column x 24 lines
64K RAM
Compatible with Apple IIe Software

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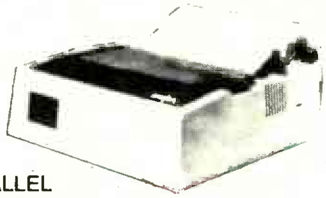

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- Extreme Low Power Dissapation (<500mA Typical
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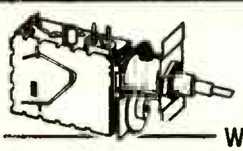
CIRCLE 88 ON FREE INFORMATION CARD

MORE GAIN
Than a Varactor UHF Tuner



$15.00 **SATISFACTION GUARANTEED**
Frequency Range 470-899 MHz Channels 14-83. Output Channel 3. Ch 2 or 4 Avail.

PART #B20 .... **$15.00**

WHAT'S IN IT?

To make a regular UHF tuner into a **GILCO HIGH GAIN TUNER**, each and every one of the following steps is painstakingly taken by a certified technician:

1. The first thing GILCO does is change the standard diode to a **hot carrier diode**.
2. The tuner's output is then measured on our JERROLD field strength meter and compared to a computer derived chart from which we determine the correct value coil to add across the IF output for *maximum pre-peaked gain*.
3. The tuner is then fed a standard 10db 300 ohm antenna input and while monitoring the output on our HEWLETT PACKARD spectrum analyzer, the tuner is tuned to the desired channel and its oscillator is offset for the desired output frequency as follows:

Channel 2: 58 Mhz, Channel 3: 63 Mhz, Channel 4: 68 Hhz

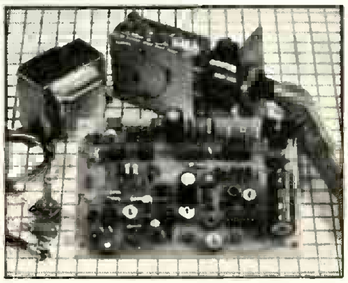
We call this step peaking because the tuner's output looks like a peak on our spectrum analyzer and the highest point of that peak is actually adjusted for the desired output.

4. The last step is one more measurement on the field strength meter which is again compared to our performance chart to calculate the correct value of the second coil which is added to the tuners internal connections.

This procedure was developed by GILCO and it is our computer derived performance charts that make our tuner better, that's because *almost every tuner gets a different value coil* before it's peaked and again a different value coil after it's peaked. The combinations are endless and *the way we determine the values is our secret...*

GILCO PARTS KIT & PRINTED CIRCUIT BOARD

- **Use with GILCO High Gain Tuner**
- **Requires NO Modification to Your Television**
- ***Individually Packaged and Labeled Parts Save Guesswork***
- The only tools required for assembly are: screwdriver, soldering iron, voltmeter. No drilling is required to the P/C board.
- This kit was designed to take advantage of the GILCO high gain tuner which means its circuitry is *simpler and more efficient* than those circuits that require inferior varactor tuners.



Pre-drilled, pre-screened, plated through the holes P/C board. All hardware, connectors, 22 page illustrated instruction manual, & Gilco Hy-Gain tuner. Kit assembles in just 4 hours.

FREE 22 Page Instruction Book included with each P/C Board or Parts Kit. This instruction book will guide the builder through every step of the assembly. *Nearly every page is illustrated.* With this Instruction Book, estimated assembly time is 4 hours.

HERE'S WHAT YOU GET FROM GILCO

Part No. B21 Printed Circuit Board **$17.00**

1. This Printed Circuit Board uses *only one jumper, others use nine.*
2. *The component layout is screen printed* on the component side of the P/C board.
3. The solder side of the P/C board is covered with high temperature solder resist. This prevents solder bridges.
4. *Newest Addition:* **the P/C board is plated through the holes**. This allows for easier and more positive soldered contact between the parts and the P/C board.

Part No. B22 Complete Electronic Parts Kit **$80.00**

All resistors (30), Potentiometers (1-5K, 3-10K), Panel Mount Potentiometer (10K), Electrolytic Capacitors (6), Ceramic and Mylar Disc Capacitors (35), Variable Capacitors (4), All Integrated Circuits (7), Voltage Regulator, Heat Sink, Diodes (4), IC Sockets (4-8 pin, 3-14 pin), Power Transformer (24V, 1A), Coil Kit with No. 26 wire (4), Speaker (4", 3oz.), Standoffs, Coaxial Cable, All Miscellaneous Harware, Etc. All parts are individually packaged and labeled.

All components including the Wire, Hardware, Coaxial Cable and Heat Sinks are included in the parts kit. This means your assembly time from start to finish is just 4 hours.

GILCO ACCESSORIES & AMPLIFIER KITS

#A02 New 2 stage, low noise, 28db gain, RF Amplifier Kit .... **Kit $18.00**
#A03 New 1 stage, low noise, 14db gain, RF Amplifier Kit .... **Kit $10.50**

GILCO ORDER FORM

#B20 GILCO Hy-Gain Modified Tuner	$15.00	______
#B21 GILCO Predrilled, Screen Printed, Circuit Board	$17.00	______
#B22 GILCO Parts Kit (Less P/C Board)	$80.00	______
#B20, B21, B22 Complete P/C Board and Parts Kit (all three)	$110.00	______
#A02 Two stage, 28 db gain, Amplifier Kit	$18.50	______
#A03 One stage, 14db gain, Amplifier Kit	$10.50	______
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153	.40	276	6.95	529	13.75
154	.60	291	.95	712	1.25

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TESTED AND OPERATIONAL!

I/O Selectric ..... **$329.00 ea.**

Type Element .... **$21.00ea.** Add $20 for Packaging and Handling · Pay shipping on Delivery

SAVE!!! Untested version of the above, otherwise whole & complete. May require some service .... **$279.00 ea.**

Diablo Daisy Printer

- Pre-owned, TESTED & Operational!
- Uses Xerox Metal Wheels or Plastic Wheels
- Original OEM Interface (Diablo Interface)
- Requires ±15V @5A & 5VDC @5A
- Positional access to 1/120 "Horiz." 1/48 "Vertical"
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- Heavy Duty Printwheel Motor and 15" Frame

1355-WP Word Processing Daisy Printer

These fabulous daisy printers feature 35-40cps, 10 & 12 pitch as well as proportional space, and plotter capability. Only a power supply and interface are required for full printer capability. Fully tested and operational, ready to configure for the interface of your choice. Platen and I/O data included

Forms tractor for the above .... **$ 99.00**
Spare P.C. Board Set (6 P.C. Cards) **$279.00**
Spare Printwheel carrier assembly **$329.00**
Serial & Parallel Interface for Above **$295.00**
Power Supply .... **$ 79.00**

Just $549.00
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120 volt primaries

5.6 VOLTS at 750 MA	$3.00
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16.5 V. at 3 AMPS	$6.50
18 V at 650 MA	$3.50
18 VOLTS at 1 AMP	$4.50
18 V.C.T. at 2 AMP	$5.50
24 VOLTS at 250 MA	$2.50
24 VCT at 1 AMP	$4.50
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WILL HOLD P.C BOARD OR OTHER SMALL ITEMS AND ALLOW BOTH YOUR HANDS FREEDOM TO WORK.
$6.50 EACH

LIGHTS
GRAIN OF WHEAT
T1 SIZE
.125" DIA. (3.15mm)

3 to 6 VOLTS 3 for $1.00
Rated: 55ma @ 5 VOLTS

6 to 12 VOLTS 3 for $1.00
Rated: 55ma @ 8 VOLTS

12 to 24 VOLTS 3 for $1.00
Rated: 45ma @ 14 VOLTS

SOLDERING IRON STAND
SPRING STEEL IRON HOLDER ON WEIGHTED BASE
$5.00 EACH

DC WALL TRANSFORMER
ALL ARE 115 VAC PLUG IN

4 VDC at 70 MA	$2.50
9 VDC at 225 MA	$3.00
16.5 VAC at 10 VA	$3.50
17 VAC at 500 MA	$4.00

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3 STATION NON-INTERLOCKING
3 - 2PDT SWITCHES. EACH OPERATES INDEPENDENTLY.
1¾" BETWEEN MOUNTING CENTERS.
$1.75 EACH

5 STATION INTERLOCKING
MADE BY ALPS. 3 - 2PDT AND 2 - 6PDT SWITCHES ON FULLY INTERLOCKING ASSEMBLY. 3¼" BETWEEN MOUNTING CENTERS.
$2.50 EACH

5 STATION NON-INTERLOCKING
SAME AS ABOVE, EXCEPT EACH SWITCH OPERATES INDEPENDENTLY.
$2.50 EACH

MIKE CONNECTOR
5 CONDUCTOR IN-LINE PLUG AND CHASSIS MOUNT JACK. TWIST LOCK STYLE, SAME AS SWITCHCRAFT 12CL5M.
$2.50 PER SET

T1 SIZE WITH WIRE LEADS
3 to 6 VOLTS 2 for $1.00
Rated: 55ma @ 5 VOLTS

6 to 12 VOLTS 2 for $1.00
Rated: 55ma @ 8 VOLTS

12 to 24 VOLTS 2 for $1.00
Rated: 45ma @ 14 VOLTS

12 VOLT A.C. POWER UNIT
THIS UNIT CONSISTS OF A 12 VOLT 2 AMP TRANSFORMER, 1 AMP CIRCUIT BREAKER, 4 PRONG CINCH JONES SOCKET AND A 3 WIRE A.C. CORD ALL MOUNTED IN AN ATTRACTIVE 4½" x 5½" x 3" CHASSIS BOX. GOOD FOR PARTS OR A NICE START FOR D.C. POWER SUPPLY.
$8.50 PER UNIT

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0 - 15 V.D.C.
THIS 2-1/4" SQUARE METER MEASURES 0-15 VDC.
$4.50 EACH

2K 10 TURN
MULTI-TURN POT
SPECTROL #MOD 534-7161
$5.00 EACH

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.163" DIA. (4.14mm)

3 to 6 VOLTS 2 for $1.00
Rated: 45ma @ 6 VOLTS

6 to 12 VOLTS 2 for $1.00
Rated: 55ma @ 8 VOLTS

12 to 24 VOLTS 2 for $1.00
Rated: 45ma @ 14 VOLTS

EDGE CONNECTORS
ALL ARE .156" SPACING

15 PIN GOLD
SOLDER EYELET $1.75 EACH

15/30 GOLD
SOLDER EYELET $2.00 EACH

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35¢ EACH
10 FOR $3.25
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SPECIFY COLOR: RED, BLACK, WHITE, GREEN, YELLOW.

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S.P.S.T. 4 AMPS @ 125 VAC KEY REMOVES BOTH POSITIONS
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"POWER" PRINTED ON FACE. MOUNTS IN 7/8" SQUARE HOLE.
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CONTROL: 3-32VDC
LOAD: 10 AMP 140 VAC
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DB-15 PLUG	$2.75
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CONTAINS 5 SINGLE-POLE NORMALLY OPEN SWITCHES. MEASURES 3 3/4" LONG

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ENERGIZE COIL TO OPEN CONTACT . . .
COIL: 13 VDC 650 OHMS
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ALL ARE RATED 5 AMPS @ 125 VAC

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75¢ EACH
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1" × 5/8" DIA.
45¢ EACH . . .
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12 AMP
SCR
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WOWIE!! AN INTERCOM, BUGGING DEVICE, & PA SYSTEM ALL ON A 3-1/2 X 1-1/4" PC BOARD! RUNS ON 9V, HAS 1-SN16923N AUDIO AMP IC, 8 Ω SPEAKER, PLUS AN ELECTRET MICROPHONE - 3/8" DIA X 1/2" LONG.

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FOR LSI-11 COMPUTERS * FLOPPY DISK REPLACEMENTS *
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BMA-2 EXTRA BUBBLE MEMORY BOARD $150.00
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BMA-4 MANUAL WITH SCHEMATICS $15.00
WT 8 LB

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74LS93	4 BIT BINARY CTR	.15
7497	RATE MULTIPLIER	12¢
74141	BCD-DECIMAL DECODER	15¢
74LS151	1 OF 8 MULTIPLEXER	15¢
74LS163	4 BIT BINARY CTR	12
74LS164	8 BIT SHIFT REG	.15
75183	DUAL LINE RCVR	15¢

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Po = 5.5 w
THD = .25%
BW = 450 KHz
Av = 34 db
Vcc = 28 VDC MAX
14 PIN DIP 39¢
STOCK UP NOW!
DATA SHEET 25¢

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$1.95
WT 0.2 LB
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THIS BABY PRODUCES STRANGER TUNES THAN A COCKATIEL IN HEAT!!
RUNS ON 9V

EPROMS
PRIME 1st QUALITY 450 NS
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2764 $7.95

X-1085 $15.95
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WT 3 LB
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BRAND NEW PRODUCTION AEL UNIT TAKES THE 'HIDDEN CHANNELS' ON MIDBAND AND MOVES THEM TO CHANNELS 7-13. SWITCH SELECTS 'NORMAL' OR 'MIDBAND'. JUST PUT IN LINE WITH YOUR CABLE AND SWITCH BACK & FORTH. 115 VAC WITH OUTLET FOR YOUR TV. ONLY TWO CONNECTIONS IN & OUT. OVERALL SIZE IS 6 X 4-5/8 X 2" HIGH.

9,000 MFD
25 v
COMPUTER GRADE
$1.50
NEW SPRAGUE POWERLYTIC ONLY 3-1/4 X 1-3/8

Ammonium Persulfate ETCHANT $1.95 LB
FAST & EASY TO USE. JUST ADD WATER & ETCH. TURNS BLUE WHEN FULL OF COPPER. 1 LB MAKES 2 GALLONS.
H-2240 10 LBS/17.50

DB 9P
GOLD PINS
MFD BY CANNON
POPULAR PLUG FOR JOYSTICKS, EXPANSION AND COMMUNICATION PORTS. THESE ARE TOP QUALITY CANNON UNITS
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PP-28	2"	PLAY 28 TRK

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Receive all the EXTRA CABLE TV "MIDBAND" & SUPERBAND CHANNELS on your UHF DIAL.
Eliminates the need for renting or leasing. This system takes the "midband" and "superband" channels your TV, VCR or projector can't receive and converts them to standard UHF channels that any set can tune in.
Use of this unit may be subject to rules by your local cable TV Co.
A MUST FOR VIDEO-TAPING FROM CABLE TV!
The system allows you to program both pay (pay TV decoder required) and standard cable channels for taping on any VCR — while you are watching a different channel on your TV.
Simple to install and operate on any make of TV with UHF.
Now $28.95 ea. PLUS POSTAGE
NOW AVAILABLE
NEW TUNEABLE DELUXE MODEL CVU-1000 $34.95 ea.

UHF TUNERS
45 MHz Output
Click Stop Detent Tune model. Excellent for replacement use or experimental work building UHF receivers for ham or TV.
WHILE THEY LAST
$3.95 ea.
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POPULAR IC's
TOP QUALITY
NO SECONDS

TYPE	DESCRIPTION	1-9	10-UP
LM-380N	2 watt Audio Power Amp	$1.49	$ .89
LM-386N-3	Low Voltage Audio Amp	1.59	1.19
LM-565N	Phase Locked Loop	1.49	.99
LM-733N	Video Amp	1.69	98
MC-1330	Video Detector	2.29	1.69
MC-1349	Video If Amp	2.08	1.55
MC-1350	Video If Amp	1.75	1.19
MC-1352	Video If Amp AGC	2.69	2.09
MC-1358	Audio If Amp	1.95	1.64
MC-1374P	R.F. Modulator	3.19	2.39
MC-1458	Dual Comp. Op Amp	88	.59
MC-1496N	Balanced Mod/Demodulator	1.79	1.34
LM-1889	Video Modulator	2.79	1.95
	LINEAR VOLTAGE REGULATORS		
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LM-7808	8 Volt Positive Volt. Reg.	1.19	.89
LM-7812	12 Volt Positive Volt. Reg.	1.19	89
LM-7815	15 Volt Positive Volt. Reg.	1.19	89
LM-7818	18 Volt Positive Volt. Reg.	1.19	.89
LM-7824	24 Volt Positive Volt. Reg.	1.19	.89

NE-564 New Plug-in Replacement now in stock - $5.75 ea or $3.50 each with every $50.00 purchase of other parts.

WINEGARD
75 OHM UHF YAGI ANTENNAS
12 db GAIN
Specify Channel
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8 OR MORE $6.95 EA.
OPTIONAL Winegard UHF Antenna Preamp 18db Gain NF - 1.8db $39.95 ea.

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SANYO UHF VARACTOR TUNERS
75 Ohm Input - 45 MHz Output
For Channels 14 - 83
MODEL 115-B-403A $19.95 EACH
All units are brand new from Sanyo
Call for Quantity Price

AC LINE CORDS
18 gauge wire
6 ft. long cable
Prestripped and tinned ends for easy installation.
49¢ ea.
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Popular speaker cabinets for those famous homebrew TV circuits. Speakers included.
Dimensions: 7¾" wide x 9½" high x 5½" deep. Removable 1/8" thick back cover.
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This handsome contemporary telephone is Touch-tone, making it ideal for MCI or Sprint service, or banking by phone. Deluxe two piece design allows for wall or desk mount. Also on-off ringer switch. Almond in color.
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2N6603 (formerly MRF-902)	11.98

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This box is 11¾"W - 4½"H - 6½"D with a removable aluminum U-shaped chassis 11"W - 3½"H - 6"D inside.
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These tuners receive all channels 2-83, plus midband cable channels and are perfect for home-brew TV circuits etc. Output Freq. 45 MHz. Hookup data included. Name Brand.
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With Schematic
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Specify Pushbutton or lever type
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CIRCLE 8 ON FREE INFORMATION CARD

ramsey the first name in Counters !

9 DIGITS 600 MHz $129.95 WIRED

PRICES

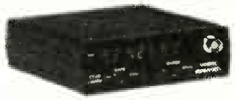
CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack +AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

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

SPECIFICATIONS:

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

7 DIGITS 525 MHz $99.95 WIRED



SPECIFICATIONS:

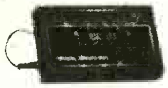
Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

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

PRICES:

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

7 DIGITS 500 MHz $79.95 WIRED



PRICES:

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

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

SPECIFICATIONS:

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

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

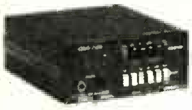
Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

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

PRICES:

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

DIGITAL MULTIMETER $99.95 WIRED



PRICES:

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

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

SPECIFICATIONS:

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

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

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

$29.95 Kit $39.95 Wired

ACCESSORIES

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

COUNTER PREAMP

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

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

$34.95 Kit $44.95 Wired

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2.5 Mhz

Z80-CPU	3.90
Z80-CTC	4.45
Z80-DART	9.95
Z80-DMA	13.95
Z80-PIO	4.45
Z80-SIO/0	15.95
Z80-SIO/1	15.95
Z80-SIO/2	15.95
Z80-SIO/9	15.95

4.0 Mhz

Z80A-CPU	4.90
Z80A-CTC	4.90
Z80A-DART	10.95
Z80A-DMA	15.95
Z80A-PIO	4.90
Z80A-SIO/0	15.95
Z80A-SIO/1	15.95
Z80A-SIO/2	15.95
Z80A-SIO/9	15.95

6.0 Mhz

Z80B-CPU	12.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	18.95

ZILOG

Z6132	33.95
Z8671	38.95

DISC CONTROLLERS

1771	15.95
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8272	38.95
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MB8876	28.95
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UARTS

AY3-1014	6.90
AY5-1013	3.90
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2651	8.90
TMS6011	5.90
IM6402	7.90
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INS8250	9.95

INTERFACE

8T26	1.54
8T28	1.84
8T95	.88
8T96	.88
8T97	.88
8T98	.88
DM8131	2.90
DP8304	2.24
DS8835	1.94
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VOLTAGE REGULATORS

7805T	.74	7905T	.84
78M05C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

C,T = TO-220 K = TO-3 L = TO-92

DIP SWITCHES

4 POSITION	.84
5 POSITION	.89
6 POSITION	.89
7 POSITION	.94
8 POSITION	.94

IC SOCKETS

	1-99	100
8 pin ST	.12	.10
14 pin ST	.14	.11
16 pin ST	.16	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call
ST = SOLDERTAIL		
8 pin WW	.58	.48
14 pin WW	.68	.51
16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75
WW = WIREWRAP		
16 pin ZIF	6.70	call
24 pin ZIF	9.90	call
28 pin ZIF	9.95	call

ZIF = TEXTOOL (Zero Insertion Force)

CRYSTALS

32.768khz	1.90
1.0 mhz	4.90
1.8432	4.90
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2.4576	3.90
3.2768	3.90
3.579535	3.90
4.0	3.90
5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
18.0	3.90
18.432	3.90
20.0	3.90
22.1184	3.90
32.0	3.90

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS.	1.25
100 PCS.	2.00
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80 Column Card	129.95
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Fan	38.95
Power Supply	84.95
RF Mod	24.95
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Paddles Apple	9.95
Z80 Card	129.95
SCRG Switch-A-Slot	19.95
Paddle Adapple	24.95
Extend-A Slot	19.95
Disk Drive	224.95
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ATHANA OR NASHUA

SSSD	18.95
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- Simple to use — No configuring required
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- Battery recharges automatically

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- Expandable from 16K to 64K

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The Flip Sort™

The new Flip Sort™ has all the fine qualities of the original Flip Sort™, with some added benefits. Along with a new design, capacity has increased 50%, to hold 75 diskettes and the price is more reasonable than ever. **$19.95 ea.**

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4164 64K DYNAMIC 200 NS $5.95

TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4 (450ns)	1.95
5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	.99
2102L-2	1024 x 1 (250ns) (LP)	1.49
2111	256 x 4 (450ns)	2.49
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/9.95
2114-25	1024 x 4 (250ns)	8/10.95
2114L-4	1024 x 4 (450ns) (LP)	8/12.95
2114L-3	1024 x 4 (300ns) (LP)	8/13.45
2114L-2	1024 x 4 (200ns) (LP)	8/13.95
2147	4096 x 1 (55ns)	4.95
TMS4044-4	4096 x 1 (450ns)	3.49
TMS4044-3	4096 x 1 (300ns)	3.99
TMS4044-2	4096 x 1 (200ns)	4.49
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	4.15
TMM2016-150	2048 x 8 (150ns)	4.95
TMM2016-100	2048 x 8 (100ns)	6.15
HM6116-4	2048 x 8 (200ns) (cmos)	4.75
HM6116-3	2048 x 8 (150ns) (cmos)	4.95
HM6116-2	2048 x 8 (120ns) (cmos)	8.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8 (300ns) (Qstat)	34.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.99
UPD411	4096 x 1 (300ns)	3.00
MM5280	4096 x 1 (300ns)	3.00
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.85
4116-300	16384 x 1 (300ns)	8/11.75
4116-250	16384 x 1 (250ns)	8/11.95
4116-200	16384 x 1 (200ns)	8/12.95
4116-150	16384 x 1 (150ns)	8/14.95
4116-120	16384 x 1 (120ns)	8/29.95
2118	16384 x 1 (150ns) (5v)	4.95
4164-200	65536 x 1 (200ns) (5v)	5.95
4164-150	65536 x 1 (150ns) (5v)	6.95

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.50
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	5.95
TMS2516	2048 x 8 (450ns) (5v)	5.50
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	5.95
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	8.95
2732-200	4096 x 8 (200ns) (5v)	11.95
2764	8192 x 8 (450ns) (5v)	9.95
2764-250	8192 x 8 (250ns) (5v)	14.95
2764-200	8192 x 8 (200ns) (5v)	24.95
TMS2564	8192 x 8 (450ns) (5v)	17.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	39.95
27128	16384x8 Call	Call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95

6.0 Mhz

Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95

ZILOG

Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
AY5-3600 PRO	11.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	24.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	39.95
8748	24.95
8755	24.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	49.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	7.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	14.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

FUNCTION

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	1.90
74LS125	.49	74LS386	.45
74LS126	.49	74LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS399	1.49
74LS137	.99	74LS424	2.95
74LS138	.55	74LS447	.37
74LS139	.55	74LS490	1.95
74LS145	1.20	74LS624	3.99
74LS147	2.49	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS668	1.69
74LS153	.55	74LS669	1.89
74LS154	1.90	74LS670	1.49
74LS155	.69	74LS674	9.65
74LS156	.69	74LS682	3.20
74LS157	.65	74LS683	3.20
74LS158	.59	74LS684	3.20
74LS160	.69	74LS685	3.20
74LS161	.65	74LS688	2.40
74LS162	.69	74LS689	3.20
74LS163	.65	74LS783	24.95
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

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7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74190	1.15
7453	.23	74191	1.15
7454	.23	74192	.79
7460	.23	74193	.79
7470	.35	74194	.85
7472	.29	74195	.85
7473	.34	74196	.79
7474	.33	74197	.75
7475	.45	74198	1.35
7476	.35	74199	1.35
7480	.59	74221	1.35
7481	1.10	74246	1.35
7482	.95	74247	1.25
7483	.50	74248	1.85
7485	.59	74249	1.95
7486	.35	74251	.75
7489	2.15	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.35	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.75	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.49	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
74128	.55	74490	2.55

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1800	2.37
LM301H	.79	LM348	.99	LM567	.89	LM1812	8.25
LM307	.45	LM350K	4.95	NE570	3.95	LM1830	3.50
LM308	.69	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308H	1.15	LM358	.69	NE592	2.75	LM1872	5.49
LM309H	1.95	LM359	1.79	LM709	.59	LM1877	3.25
LM309K	1.25	LM376	3.75	LM710	.75	LM1889	1.95
LM310	1.75	LM377	1.95	LM711	.79	LM1896	1.75
LM311	.64	LM378	2.50	LM723	.49	ULN2003	2.49
LM311H	.89	LM379	4.50	LM723H	.55	LM2877	2.05
LM312H	1.75	LM380	.89	LM733	.98	LM2878	2.25
LM317K	3.95	LM380N-8	1.10	LM741	.35	LM2900	.85
LM317T	1.19	LM381	1.60	LM741N-14	.35	LM2901	1.00
LM318	1.49	LM382	1.60	LM741H	.40	LM3900	.59
LM318H	1.59	LM383	1.95	LM747	.69	LM3905	1.25
LM319H	1.90	LM384	1.95	LM748	.59	LM3909	.98
LM319	1.25	LM386	.89	LM1014	1.19	LM3911	2.25
LM320 (see 7900)		LM387	1.40	LM1303	1.95	LM3914	3.95
LM322	1.65	LM389	1.35	LM1310	1.49	LM3915	3.95
LM323K	4.95	LM390	1.95	MC1330	1.69	LM3916	3.95
LM324	.59	LM392	.69	MC1349	1.89	MC4024	3.95
LM329	.65	LM394H	4.60	MC1350	1.19	MC4044	4.50
LM331	3.95	LM399H	5.00	MC1358	1.69	RC4136	1.25
LM334	1.19	NE531	2.95	MC1372	6.95	RC4151	3.95
LM335	1.40	NE555	.34	LM1414	1.59	LM4250	1.75
LM336	1.75	NE556	.65	LM1458	.59	LM4500	3.25
LM337K	3.95	NE558	1.50	LM1488	.69	RC4558	.69
LM337T	1.95	NE561	24.95	LM1489	.69	LM13080	1.29
LM338K	6.95	NE564	2.95	LM1496	.85	LM13600	1.49
LM339	.99	LM565	.99	LM1558H	3.10	LM13700	1.49

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

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
		74C929	19.95

74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
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74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call

ZIF = TEXTOOL (Zero Insertion Force)

VOLTAGE REGULATORS

7805T	.75	7905T	.85
78M05C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49
78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79
78H05K	9.95	LM323K	4.95
78H12K	9.95	UA78S40	1.95

C, T = TO-220   K = TO-3   L = TO-92

LED LAMPS

	1-99	100-up
Red	.10	.09
Green	.18	.15
Yellow	.18	.15

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

INTERFACE

8T26	1.59
8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

ULN2003	2.49
3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49

CLOCK CIRCUITS

MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

9000

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

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XR 2206	3.75
XR 2207	3.75
XR 2208	3.75
XR 2211	5.25
XR 2240	3.25

DATA ACQUISITION

ADC0800	15.55	DAC0808	2.95
ADC0804	3.49	DAC1020	8.25
ADC0809	4.49	DAC1022	5.95
ADC0817	9.95	MC1408L6	1.95
DAC0800	4.95	MC1408L8	2.95

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- ★ INCLUDES MOUNTING HARDWARE AND FEET

CABINET #2 $79.00

- ★ COMPLETE WITH POWER SUPPLY, SWITCH, LINE CORD, FUSE & STANDARD POWER CONNECTOR
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- ★ +5V @ 1 AMP, +12V @ 1.5 AMP
- ★ FITS STANDARD 5¼" DRIVES
- ★ PLEASE **SPECIFY** GRAY OR TAN

NOTE: Please include sufficient amount for shipping on above items.

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RS232 FEMALE	3.25
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95
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44 pin WW	4.95
72 pin SE	3.95

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2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.70	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

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TM100-2 5¼" (FOR IBM) DS/DD	295.00

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SA 400L 5¼" (40 TRACK) SS/DD	199.95
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100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

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4N27	1.10
4N28	.69
4N33	1.75
4N35	1.25
4N37	1.25
MCT-2	1.00
MCT-6	1.50
MCA-7	4.25
MCA-255	1.75
IL-1	1.25
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1N759	12.0 volt zener	.25
1N4148	(1N914) switching	25/1.00
1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5amp bridge	.45
KBP04	400PIV 1.5amp bridge	.55
VM48	Dip-Bridge	.35

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP		RIGHT ANGLE PC SOLDER		IDC RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	—	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

CALL FOR MOUNTING HARDWARE

RIBBON CABLE

CONTACTS	SINGLE COLOR		COLOR CODED	
	1'	10'	1'	10'
10	.50	4.40	.83	7.30
16	.55	4.80	1.00	8.80
20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH10SR.

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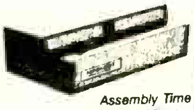

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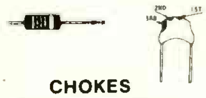
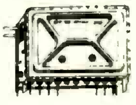
MC 1330	1.25
MC 1350	1.15
MC 1358	1.25
MC 1458	.49
MC 1496	1.50
LM 1889	2.50
7805	.80
7808	.80
7812	.80
7815	.80
7818	.80
MV 2109	.69
2N2222	.30
MC1349	1.79



CHOKES
.33 uh — 33 uh
.47 uh — 100 uh
15 uh — 10 mh
18 uh — 69¢ each

VARI CAPS
10 - 60 pf 79¢ each
30 - 90 pf 79¢ each



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UES A55F
VARACTOR TUNER
CHAN. 14-83
300 ohm INPUT **$17.95**

DELUXE PARTS ASSORTMENTS

#1 Resistors & Trimpots
68 ¼ watt, 5% resistors & 5 PT-15 10K trimpots. 1 each - 51, 75, 100, 470, 1.5K, 3.6K, 51K, 470K. 13-1.2K, 2-220, 3-100K, 6-330, 6-12K, 7-910, 9-3.3K, & 14-4.7K.
$5.25 each

#2 Capacitor "A"
Monolythics - 1-560pf, 7-.1 mfd, & 1-.22 mfd. Silver Micas - 2-10pf, & 1 each of 43pf, 110pf, 560pf, 1200pf, 3000 or 3300pf.
$5.95 each

#3 Capacitor "B"
Mylars 4-.001, 2-.047, 29-.01. Radial lytics 3-10 mfd 16V, 1-1000 mfd 50V, 1-2200 mfd 35V. Disc Caps 1 each of 5, 12, 27, 36, 110, 330pf, 2-120pf, 3-39pf, 3-220pf, and 1 Vari Cap 5-35pf.
$7.50 each

#4 Coil & Chokes
1 each of 15, 33, and 100 (uh) micro henries chokes. 1-variable RF coil (same as #49A537MPC)
$3.25 each

#5 IC's, Sockets, & Semi's
1 each of: LM565, MC1330, MC1350, MC1496, LM1889, 7812, 7818, 2N2222A, MV2109, heat sink 2-MC1458, 4-1N4002, 4-8 pin, 2-14 pin, 1-16, & 1-18 pin socket. (564 not included)
$11.95 each

#6 Misc. Hardware
LED & holder, fuse & holder, line cord, grommet, SPST switch, DPDT switch, 2-F61 conn. & lugs, knob, 4-spacers, 6-screws & nuts, 2'-RG-174, matching transformer w/nut.
$5.95 each

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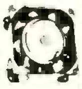
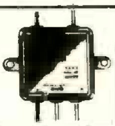
25 db gain stripline PC board using (2) BFR-90's
$10.95
power supply for above **$3.49**

MINI FAN 3.125" SQ.



40 CMF
115VAC-60hz
REMOVED FROM NEW EQUIP.
TESTED **$6.95**

RFI FILTER



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Wire wrap—gold plated **4.95 ea.**

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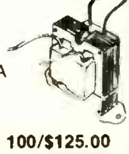

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3A 400 PIV $1.00

THUMBWHEEL SWITCH
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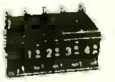
(EACH DIGIT ILLUMINATED W/LED)



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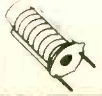
Special 99¢ ea.

RF COIL



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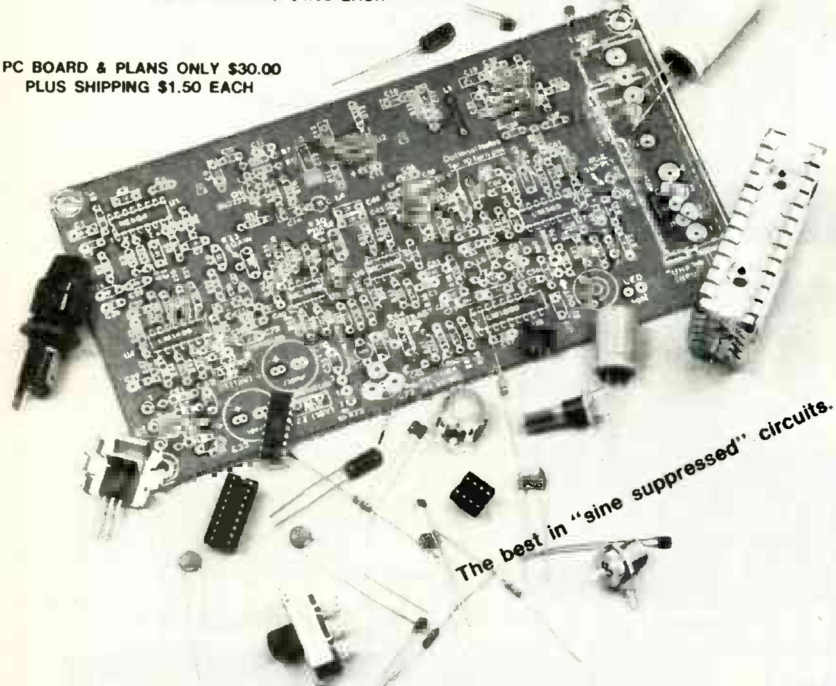

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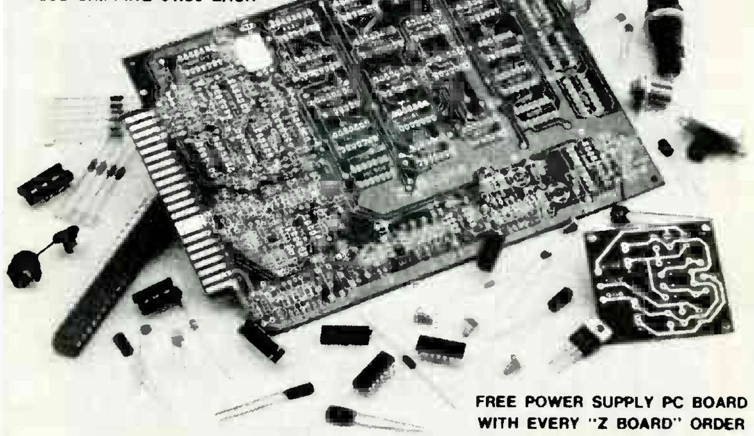

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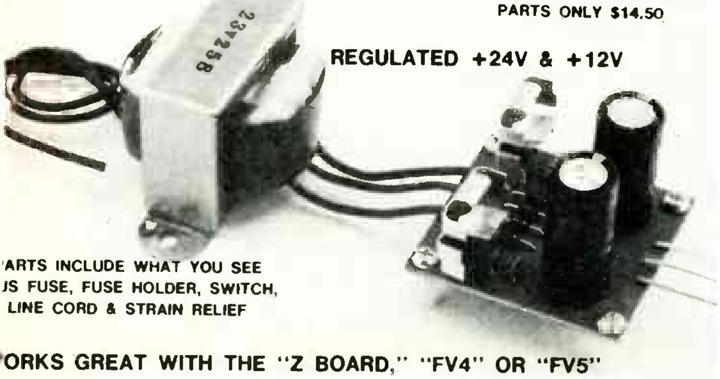

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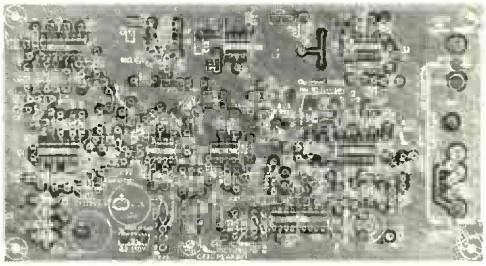
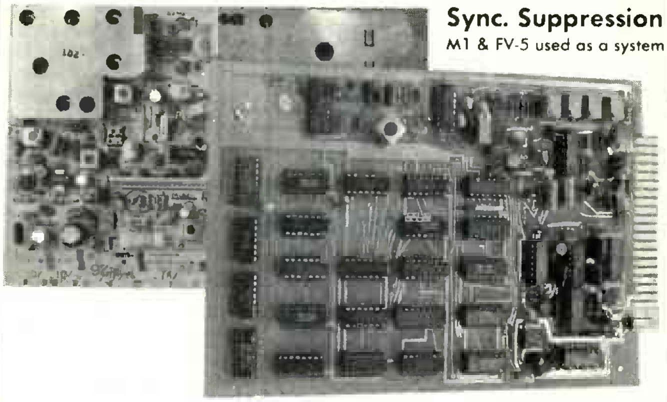


State of the art technology brings you this superior Sinewave Superboard. It has no internal connection to TV, RF modulator built on the board, AGC for stability and tunes the entire band with a varactor tuner and multi-turn pot. A high quality plated-thru circuit board with silk-screened parts layout, easy to follow, fully illustrated instructions and quality parts make this kit easy to assemble. The beautifully finished cabinet will add a touch of class to the many hours of enjoyment you will receive building and using this kit.

ZENITH M1 09-151-03 FV-5

Phase Video Sync. Suppression

M1 & FV-5 used as a system



- ☐ **KZM 2083** M1 FV-5 Kit **$199.95** + $6.95 S/H
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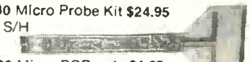

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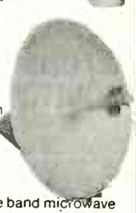
- ☐ **MPD 2000** Micro 20" Dish **$14.95** + $5.95 S/H



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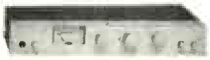

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- ★ Crystal Controlled Video Modulator
- ★ Detent Channel Tuning with Fine Tune
- ★ Scan Mode on Front
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- ★ Antenna Mounted Image Reject Mixer (Down Converter)

OMNI

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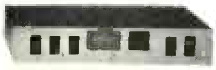

FEATURES

- ★ Signal Strength Carrier Level Meter
- ★ Crystal Controlled Video Modulator
- ★ Detent Channel Tuning with Fine Tune
- ★ Scan Mode on Front
- ★ Polarity Selector on Front
- ★ Decoder Output—5 Pin DIN
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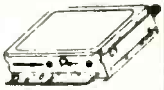

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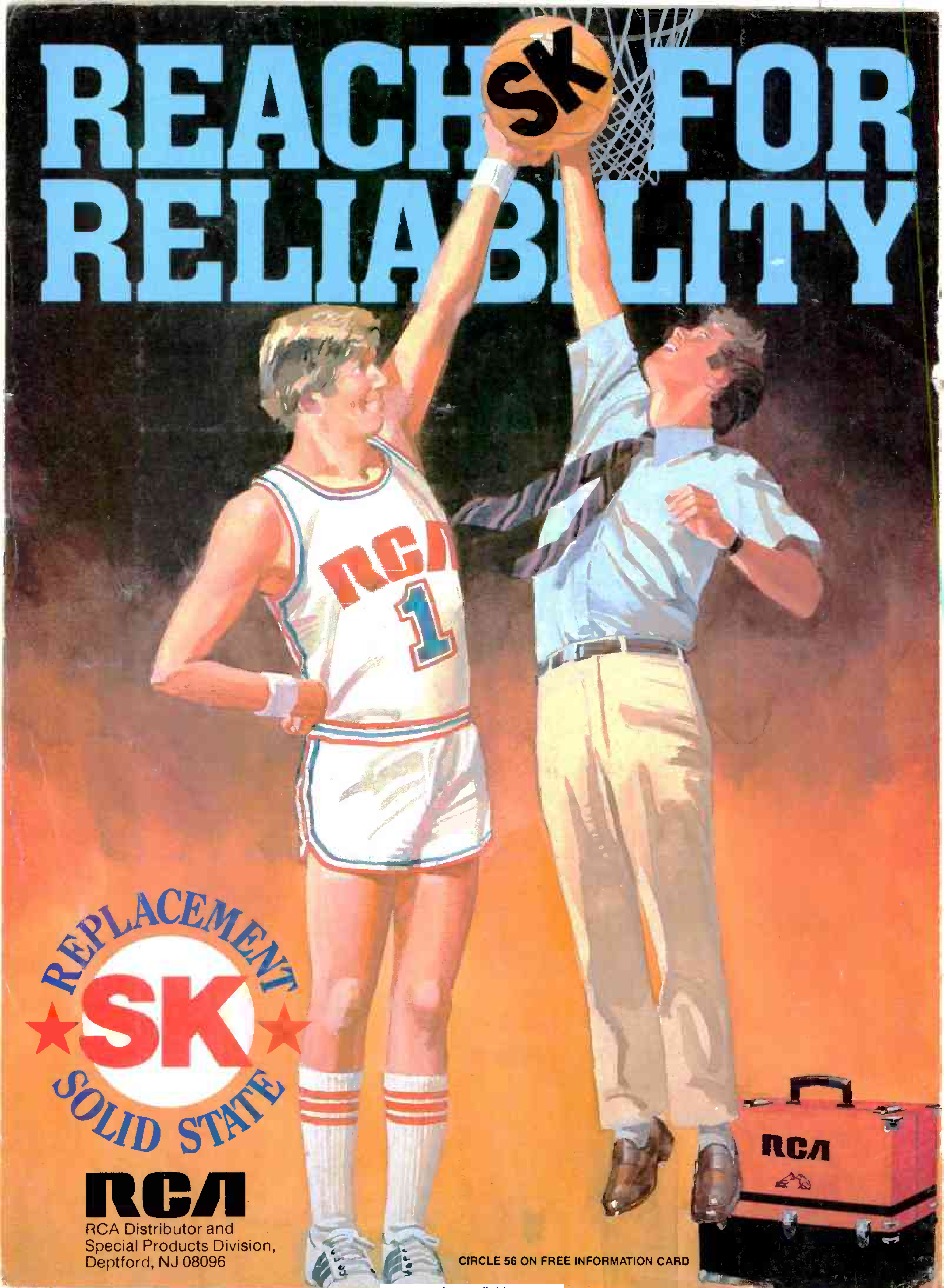
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