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CSC's Model LM-3 Logic Monitor. It's a new breed of test instrument. Here in a single compact package are *forty* high-speed high-impedance precision-threshold logic state indicators with triggerable latching modes.

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40 logic channels. Triggerable memory. And more. At $585*, it's probably underpriced. Call now and get the full story.

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CIRCLE 26 ON FREE INFORMATION CARD

NEW PRODUCT

Sports Radar

T.M.

Here's how an exciting new micro-electronic breakthrough will make your children heros and improve your tennis game.

Just point the gun and read the results.

When Roger started pitching for his little league team, he was just another player. And his arm was no better than anybody elses.

Two months later a small miracle took place. Roger was the best pitcher on the team and had a fast ball that was the most powerful in his league—and all thanks to his father.

Roger's success came from a radar gun—the same type device used by police to catch speeding motorists.

SCRAMBLED EGGS

The minute Roger's father was able to clock his son's pitching speed, Roger was subconsciously given a daily challenge of pitching harder and faster to beat his previous speed. The more he practiced, the better he got.

Roger's father paid $2,000 for the radar gun. But in his upper class neighborhood, it wasn't too unusual for a father to spend that kind of money to help his son.

SPEEDING CITATION

A large manufacturer of radar-type security devices saw what Roger's father had done and felt that there was a definite need to produce a low cost radar unit designed exclusively for the sports market.

The company, Solfan Systems, developed the Sports Radar gun—a major breakthrough in projectile speed detection as well as electronic radar circuitry.

Using the doppler effect of radar and phased-lock-loop circuits, Solfan has developed the Sports Radar gun that compares to even the most sophisticated of police radar units that cost $2,000.

OVERLAND EXPRESS

The Sports Radar gun is held in your hand and pointed toward the pitcher. You turn it on, press the ready button, and point the gun. The gun will ignore the moving arm of the pitcher but will lock in on the moving ball. The radar unit would then follow the ball for approximately ten milliseconds and the built in computer measures and computes the speed and flashes the reading on the display. The gun registers the speed to the exact mileage within one-half miles per hour.

The gun can be mounted on a tripod so that the person taking the measurements can also catch the ball.

In tennis, the speed of the serve can be measured by aiming the gun at the person serving. You can also use the unit by yourself by setting the unit on a tripod and measuring the speed from behind.

WORKING AND PLAYING

Aside from its extreme accuracy and advanced electronics, the unit is priced to meet the budget of every sports-minded athlete or parent. It's only $149.95 complete.

You can measure the speed of baseballs, soccer balls, tennis balls, golf balls, hockey pucks, downhill skiers, radio controlled model airplanes or anything that moves—even automobiles.

The speed is flashed on the large LED display and is shown in miles per hour.

The unit accepts two commercially available 6-volt lantern batteries which you can purchase locally or from JS&A for only $2 each. The batteries will last for weeks with normal use.

SUCCESS AND GOOD THINGS

The unit comes in a sports blue color and weighs 38.4 ounces, exclusive of batteries. It's rugged, well built and designed to endure the typical use and abuse it would normally receive.

We urge you to test this exciting new product during our 30-day free trial. Order the Sports Radar gun. When you receive it, measure your child's pitching speed. Test it on your own tennis serve. See how knowing your speed will actually improve it as you try to out perform your previous record fast pitch or serve. Then decide if the Sports Radar gun doesn't make a very exciting addition to your sports equipment.

ONE FOR THE MONEY

If you are not convinced that the Sports Radar gun is something that you'll use constantly to help improve your game, return it for a prompt and courteous refund, including your $3.50 postage and handling. You can't lose—and chances are your son will at least have the most popular new product in the neighborhood.

To order one for your test, simply send your check for **$149.95** plus $3.50 for postage and handling to JS&A Group, Inc., at the address shown below. (Illinois residents please add 5% sales tax.) Credit card buyers may call our toll-free number below. If you wish to buy a set of two six-volt batteries, simply add $4.00 to your order.

We'll then send your unit, the batteries (if you order them from us), a 90-day limited warranty and complete easy-to-understand instructions.

Radar electronics for the sports enthusiast is now a reality. Watch your game improve by ordering your Sports Radar gun at no obligation, today.

JS&A PRODUCTS THAT THINK®

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Northbrook, Ill. 60062 (312) 564-7000
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Sabtronics gives you DMM and Frequency Counter kits with more features, better performance and incredibly lower prices

Model 2010A Bench/Portable DMM: $69.95 kit

Features: 3½ digit LED display • 31 measurement ranges 6-Functions • 0.1% Basic DCV accuracy • Touch-and-hold capability • Hi-Lo Ohms • 40 Hz to 40 kHz frequency response • Auto Zero, Auto Polarity • Overload protected • Overrange indication • Single chip LSI logic • Laser-trimmer resistor network and ultra-stable band-gap reference for better long term accuracy • Built-in NiCd battery charging circuit.

Brief Specifications: DC Volts 100μV to 1000V in 5 ranges; AC Volts 100μV to 1000V in 5 ranges; DC Current 0.1μA to 10A in 6 ranges; AC Current 0.1μA to 10A in 6 ranges; Resistance 0.1Ω to 20MΩ in 6 ranges; Diode Test Current 0.1μA to 1mA in 3 ranges; Input impedance, 10MΩ on AC and DC volts; Power requirement, 4.5 to 6.5 VDC (4 "C" cells) or optional AC adapter/charger.

$69.95

Model 2015A Bench/Portable DMM: $89.95 kit

Same features and specifications as Model 2010A except with large, 0.5" LCD 3½ digit display.

Optional Accessories:
#AC-115, AC adapter/charger $7.95
#THP-20, Touch and Hold Probe $19.95
#NB-120 NiCd Battery Set **$18.75**

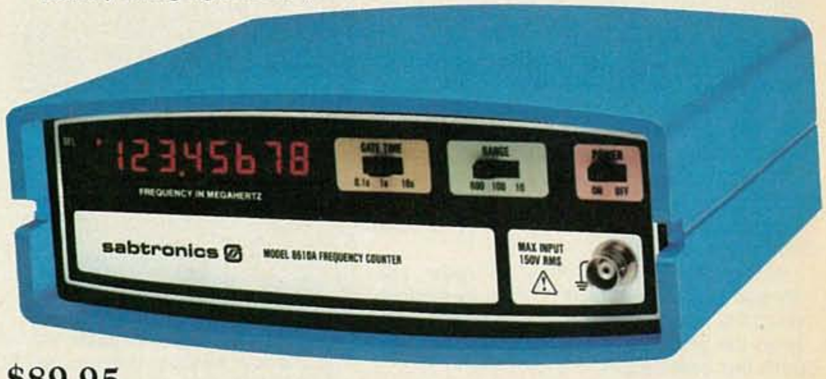
$89.95

Model 8610A Frequency Counter: $89.95 kit

Features: 8-digit LED display • 10 Hz to 600 MHz guaranteed frequency range (5 Hz to 750 MHz typical) • 3 Gate times • 10 MHz TCXO Time base • Auto decimal point • Overflow indicator • Leading zero blanking • Resolution to 0.1 Hz • Built-in charging circuit for NiCd batteries.

Brief Specifications: Freauency Range, switch selectable, 10 MHz, 100 MHz, 600 MHz • Sensitivity, $\pm$ 10mV RMS to 100 MHz, $\pm$50mV RMS, 100 MHz to 450 MHz; 90mV RMS 450 MHz to 600 MHz • Impedance, 1 MΩ, 10 MHz and 100 MHz ranges; 50Ω, 600 MHz range • Gate time (switch selectable) 0.1 sec, 1 sec, 10 sec • Temperature stability, 0.1 ppm/°C • Ageing rate $< \pm 5$ ppm/yr • Accuracy, 1 ppm or 0.0001% • Input protection, 150V RMS to 10 kHz (declining with frequency) • Power Requirement, 4.5 to 6.5V DC @ 300mA (4 "C" cells) or optional AC adapter/charger (7.5 to 9V DC @ 300mA).

Also available Model 8110A, same as 8610A except maximum frequency is 100MHz and without battery charging circuit: $59.95 kit



$89.95

Ordering Information

USA — Add $5.00 per kit for shipping & handling. Personal checks have to clear before goods are shipped (allow 2-3 weeks). For faster delivery send cahsiers check or money order. 10% deposit for C.O.D. orders. **Florida residents and sales tax.**
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Radio-Electronics®
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

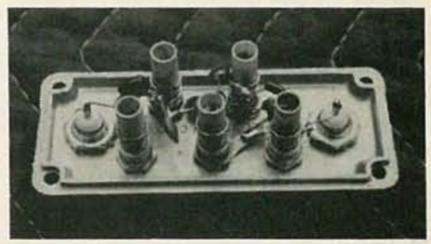
Electronics publishers since 1908

APRIL 1980 Vol. 51 No. 4

ON THE COVER

Even though it costs less than $125 to build, the triggered oscilloscope contains some rather nifty features. For example, a reference display of the zero volt DC level. To find out more and to get started building your own, turn to page 39.

MULTI-LINGUAL VOICE SYSTEM from Votrax can talk to you in seven languages. To find out what other speech synthesizer equipment is available, turn to page 44.



IF BANDPASS FILTER provides satellite TV receiver with the required selectivity. To find out the other missing components of the receiver, turn to page 47.

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looking ahead

Videodiscs heat up: A traditional rivalry has been buried in the interest of videodisc standardization. CBS and RCA, traditional rivals in the battles over color-TV systems, phonograph record speeds, and bitter competitors in broadcasting and records, have finally gotten together on something. CBS has taken out a license to press discs for the RCA *SelectaVision* grooved capacitance disc system, which is scheduled to go into nationwide marketing early in 1981 (See **Radio-Electronics,** March 1980). CBS's pressing operation is scheduled to be on stream in 1982. In the meantime, RCA will custom-press videodiscs for CBS.

And from Japan: Mighty Matsushita Electric finally got moving on videodiscs, too, after more than a year of indecision. Matsushita scrapped its own mechanical Visc-O-Pac system to officially embrace the grooveless capacitance VHD (video high density) system developed by its subsidiary Japan Victor Corporation. Matsushita said both companies would produce players and seek to have VHD established as the Japanese and world standard. Although both VHD and *SelectaVision* operate by reading variations in capacitance, they are incompatible. Not only is one grooveless and the other grooved, they use different modulation systems and RCA's revolves at 450 rpm while JVC's spins at 900 rpm.

Following the Philips-MCA optical system, now on the market, and RCA's announcement, VHD becomes the third "standard" to be announced for the consumer market. All three companies are wooing other TV receiver and record manufacturers as licensees for their respective systems. In the U.S., Zenith—the largest TV manufacturer—is getting the most attention. There's a feeling that if it opts for the RCA system, the battle is over. If it chooses either of the others, the consumer market will be saddled with multi-standards.

And another VCR: If you think that videodisc standards are muddled, how about those for videocassette recorders? In addition to fast-, medium- and slow-speed Beta and VHS formats, BASF is about to introduce its LVR (Linear Video Recorder), using 8-mm tape. Toshiba says it will market its own LVR (Longitudinal Video Recorder) using ½-inch endless-loop tape. Now along comes another—a neat-looking little seven-pound attache-case portable VCR that uses quarter-inch cassettes resembling audio cassettes. Playing time per cassette currently is 30 minutes, but is scheduled to be stepped up to a full hour. The unit is made in Japan by Funai Electric, and is expected to be imported into the U.S. by Technicolor as both a consumer and educational-institutional product. Price in the U.S. is targeted at "under $1,000," double the prospective price of Toshiba's LVR.

Andean color: Nearly 20 years of lobbying effort by the U.S. Commerce Department and the American television industry have finally paid off in South America, as the NTSC color system makes a clean sweep of the six Andean countries. Colombia was the last country in the group to opt for the American-developed system, following Venezuela's choice of the system. Just before Venezuela's commitment, Ecuador chose the American system. The other countries are Bolivia, Chile, and Peru. Some of them won't be colorcasting for quite a while. But South America's two biggest countries are lost to NTSC. Brazil colorcasts in the German-developed PAL color on a 525-line television system. Argentina, which has not officially chosen a color system, probably will add PAL to its 625-line system, largely as a result of its extensive imports of German color equipment for last year's World Cup soccer matches. Argentina's neighbors Paraguay and Uruguay are still uncommitted.

Subscription TV: First it was pay cable. Now over-the-air subscription TV is beginning to make the kind of impact its proponents have forecast for 35 years. Although there are only six stations broadcasting the special no-commercial service, and they had a total of 400,000 subscribers at the start of this year (as compared with nearly 6,000,000 pay-cable subscribers), rapid growth is seen, and manufacturers are hurrying to set up plants to build decoders. Some familiar names are getting into the act: Magnavox and Zenith are preparing to make the units, along with Canada's Electrohome, and CTS Knights, Oak, and Blonder-Tongue, the latter three already in production, as well as Consumer Technology. Up to a million decoders are expected to be installed this year, at $125 and up. The simplest decoders merely unscramble the pay picture and are rented for a fixed monthly fee.

Dishes and captions: The old-line catalog and retail chain, Sears Roebuck, is gradually coming into the forefront of consumer-electronics technology. This month, Sears is scheduled to begin marketing captioning decoders for TV viewers with impaired hearing; they're manufactured by Sears affiliate Sanyo Manufacturing Co. ABC and NBC each is scheduled to offer five hours of programming with captions encoded in the vertical interval; PBS will provide 10 hours. Captioning will be handled by the new National Captioning Institute, which will get a royalty on each decoder and special TV decoding receiver sold. Decoders initially will be priced at $250. The IC's for the decoders are being made by Texas Instruments. Sears, meanwhile, is holding talks with Comsat about possibly handling subscriptions and providing receiving installations for its proposed direct-to-home pay-TV system, which Comsat hopes to propose formally to the FCC this month.

Talking IC's: What's the hottest thing on the drawing boards in the semiconductor industry? Probably voice-synthesis and voice-recognition IC's. Everybody's working on special IC's to recognize and answer commands. One of the most interesting—and probably one of the first in the consumer field—is expected to be the talking automobile dashboard, considered a potential safety device. An imaginary conversation between driver and dashboard: "How's the gasoline?" "You've got about two gallons, enough to get 40 miles." "What about the oil pressure?" "It's OK." "Tune the radio to 96.2 and mute the commercials." "Yes, sir—and, by, the way, you're exceeding the speed limit by five miles per hour."

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

APRIL NEWS AROUND THE WORLD

FIBER SONICS

Warszaw———Polish scientists, following research designed to produce an inexpensive equivalent to fiber optics for use in the audio ranges, have announced the discovery of *fiber sonics*. They have discovered that certain tubular materials, consisting of interiors transparent to sound and skins opaque to sound, can actually transfer sound from one end to another over lengths of several dozen meters through a series of internal reflections. Research group head Tomski Edisinski completed his successful first trial using a garden hose and two funnels, following over 800 unsuccessful trials using such lavish materials as sausage casings stuffed with cheese, prune-whip filled soda straws, and 10-meter-long filter cigarettes.

FIBER PHONICS

Moscow———Russian scientists, claiming they had discovered "fiber sonics" years ago, but abandoned it due to a shortage of garden hose, today responded to the Polish announcement of fiber sonics with their own announcement of *fiber phonics*. Fiber phonics, instead of relying on the internal reflections of a carrier medium, takes advantage of the transmission capabilities of a suitably stressed elastic fiber. Initial tests involving two tin cans and a string were expanded to four tin cans and two strings for stereo; work on six tin cans and three strings has been delayed pending advances by Soviet medical technologists in grafting together the heads of one-and-a-half dogs.

NOPE SCOPE

Eugene———Oregon oscilloscope manufacturer Whobet-Packers today announced a major breakthrough in low-price oscilloscopes. Their surprising new no-trace oscilloscope offers response and bandwidth specifications reaching into the several Gigahertz region. Offering a 5-inch undergraduated display with illuminated ridicule, this new scope is slated to sell in the "under-$100" area (just outside Enid, Oklahoma). Compared to single-trace, dual trace and multiple-trace scope, a company spokesman described this new no-trace scope as the ultimate in simplicity. "There's not a trace of confusion" sez he.

SOLDERLESS CAKE

No Haven———Solderless breadboard manufacturer Condimental Special Tease has again denied rumors of the development of solderless raisin, rye, and whole-wheat breadboards, while announcing plans to create an international breadboard shortage, resulting in a breadboard crisis, mandatory rationing, and wholesale price increases to an unaffordable level. Warned that price increases might dampen sales because of inflationary influences on available discretionary dollars, a company spokeswoman said "The peasants have no bread? Let them eat cake!" This announcement was quickly followed by the firing of the spokeswoman, abandonment of the planned price increases, new contracts for workers at the company's Bastille plant, and the announcement of a new line of inexpensive solderless cake boards.

PICO COMPUTERS

Austin———Taxless Instruments has announced a new level of miniaturization resulting in an under-three-hundred-dollar home computer, complete with keyboard and voice synthesis capabilities, small enough to fit on the head of a pin. Company miniaturization director V. Pryss, wearing a cloth over his head, explained to newsmen that only two problems remain before the new computer can be introduced to the public. First, keyboard entry seems to be a problem with the tiny, quarter-pinhead size keyboard. Second, they can't remember which pinhead they left it on. Meanwhile, several newsmen in the garden reported hearing a small voice crying "Help me! Help me!"

BUS STRUCTURES

Rainyvale———The California District Federal Court has ruled on the level of integration in integrated circuits, found it inadequate, and will enforce mandatory bussing beginning immediately. The judge in the case denied taking payoffs from wealthy IEEE Bus Company executive Carmen Getitt, claiming they were campaign contributions only.

ONE-CHANNEL STEREO

Parma———Ohio inventor Emma R. T. Sullivania has announced *stereo for one ear*. The new advance is said to require only one amplifier, one speaker, and is compatible with everything from current television audio to old 78-RPM records. Called *Emma Naural* after its inventor, the new advance is not expected to be commercially available in Parma until sometime in the next millenium.

CALCULATOR POCKET

Salerno———Fashion-designer Coochy has attacked what he finds as a major disadvantage to the pocket calculator. "Putta the dumma thing inna yor pocketta anna you no see what she says," complains Coochy. The answer is in his new line of shirts with transparent calculator pockets, including cutouts for keyboard access. The fashion world has acknowledged this as another Coochy coup.

MARTIN BRADLEY WEINSTEIN

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

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

satellite tv news

International bird watching

A high percentage of the mail generated by the current series of articles on satellite TV in **Radio-Electronics** asks about receiving direct satellite-relayed reception from Europe, South America, and so on. It is possible. It is no more difficult than receiving the U.S. or Canadian domestic satellites, provided that you make a few minor adjustments to your equipment, and are ready to accept slightly inferior pictures.

One of the most interesting targets is the Russian Statsionar-4 satellite positioned over the Atlantic at 14° west (longitude). Statsionar-4 has at least six operating transponders: 3,695 MHz, 3,745 MHz, 3,795 MHz, 3,845 MHz, 3,895 MHz, and 3,945 MHz. The polarization is horizontal and audio is carried on a 7.5 MHz subcarrier. The apparent footprint-signal level is in the 19 dBw region on a global beam, which means that this satellite is receiveable throughout all of Europe and Africa and west to an imaginary line drawn north by south from Chicago to New Orleans. All of South America is included in that coverage.

RUSSIA'S STATSIONAR-4 SATELLITE located at 14° west can be received well even on an 8-foot dish with a 150° Kelvin LNA as this photo shows. The edge of visibility (i.e., where the horizon cuts off for the satellite) in the U.S. is roughly along a line drawn from Chicago to New Orleans. Statsionar 8, to be located at 25 degrees west, will push the western edge of visibility to the eastern slope of the Rockies. If you go fishing for this one, remember the time-zone difference; Moscow signs off at around 10 PM their time most nights (although test patterns continue to be broadcast).

Within that coverage region a ten-foot dish, 150° Kelvin LNA and a tuneable receiver with a 11-13 dB noise figure should insure high-quality reception. It won't be in color however, because Russia employs the SECAM color system. That satellite is but one of approximately ten the Russians expect to have operational before this year is out, so that they can relay television worldwide by the start of 1981 using their own network of geostationary satellites.

Can American (or Canadian) DOMSAT's (domestic satellites) be received outside of North America? Yes, in some cases. Canadian ANIK satellites have sculptured antenna patterns favoring Canada; but reception south of the Mason-Dixon line without big antennas (20 feet in diameter or bigger) is poor. U.S. DOMSAT's have a bigger area to cover (Alaska to Puerto Rico, Maine to Hawaii) so there is more spillover than with ANIK birds. Bermuda, the central and western Caribbean, virtually all of Central America, and the shoreline regions of South America bordering on the Caribbean are all capable of receiving U.S. DOMSAT's. But along with those coverage edges big antennas (20 to 30 feet in size) are required and with bigger antennas comes added expense.

The same people who refuse to grant private terminals permission to view their signals are quick to point out that, under international law, the U.S. (and Canadian) DOMSAT's are only licensed to serve their respective countries and that legally you are not supposed to set up a terminal in Caracas or Bogota in order to pirate U.S. satellite signals outside U.S. borders.

ROBERT B. COOPER, Jr.

Cable TV companies selling homesat

Scientific-Atlanta has shifted its marketing strategy for the Homesat subsidiary it created last year. Now cable-TV companies will be selling the small TVRO earth stations to individual families within certain geographical regions. Originally, Homesat sold directly out of Scientific-Atlanta's home office. The first major cable-TV firm to hook into the deal is Tele-Communications Inc., which will sell Homesat equipment in the western states area, where that company operates many cable-TV systems. Meanwhile the increasing number of competing firms that sell earth-station equipment to families (such as Gardiner Communications' StarScan, Avcomm, Channel One) continue to work out their own distribution means.

Satellite news notes

KRON-TV, an NBC-TV affiliate in San Francisco, is the first Bay Area TV station to set up its own Washington D.C. news bureau. The staff there beams news reports affecting Californians back home each evening via satellite, thus giving the newscast a Washington report with a local touch. **WOR-TV** New York Channel 9—with its hefty line-up of sporting events and movies—is now a round-the-clock superstation via Eastern Microwave which sends the signal around the country aboard RCA Satcom on Transponder 17.

C-SPAN (*C*able-*S*atellite *P*ublic *A*ffairs *N*etwork), which carries live coverage of debates from the House of Representatives, is adding other Capitol Hill and political features. C-SPAN recently transmitted highlights of a Republican political caucus in Texas; and starting this year, there's an arrangement with Close-Up Foundation that will involve the presentation of high-schoolers interviewing Washington figures during the traditional school excursions to the Nation's Capitol. Those interviews will be beamed to schools around the country to be used as supplements in social studies, government, and civics classes.

Sony, which makes equipment for the Japanese direct-to-home-satellite experiment, is looking at the U.S. and could introduce components or entire systems when direct-broadcasting satellites arrive here. Currently the 12-GHz experiment in Japan involves earth terminals costing about $350 each.

Political commercials via satellite! It's a possibility for this fall's campaign if a plan by John Blair & Co. materializes. Blair, a leading media company, has been experimenting with sending commercials directly to local TV stations via satellite links and hopes to have a system in place nationwide by this Autumn so that quickly up-dated commericals could be sent out. One obvious kind of commercials are the paid political announcements that are now usually air-freighted to TV stations; the satellite process could speed up their timeliness by a day or more.

GARY H. ARLEN

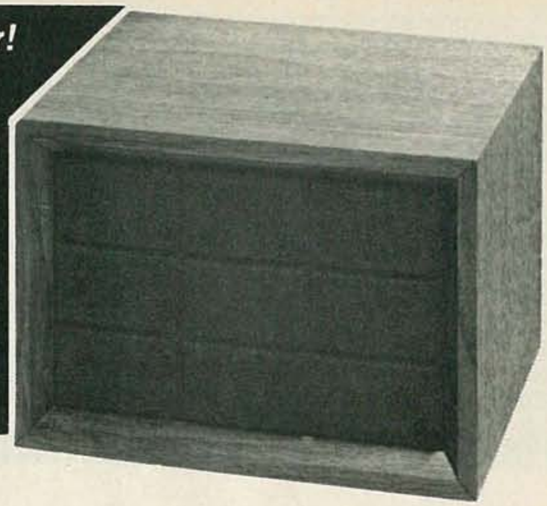
Not Just Another Limited Area Motion Detector!

guardex™

Protects Every Square Inch Of Your Building

Turns On Lights Automatically

Powerful Electronic Siren



The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6¾" × 9¾" × 8") and weighs less than 6½ pounds.

Low Cost Computerized Burglar Alarm System Home - Office - Business

NO INSTALLATION

Just plug the Guardex 8000 alarm system in, make several simple control adjustments to suit your particular building and it works! There are no other wires to run. This totally self-contained burglar alarm can completely seal off every square inch of the surface of your building. It protects doors, windows, and what most alarms miss... your roof, walls and floors.

HOW CAN ONE SMALL COMPUTER PROTECT MY WHOLE BUILDING?

Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

TURNS ON LIGHTS AUTOMATICALLY

When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected, (it can be only a second or two after the first break-in sound) the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.

The rear control panel contains two standard AC plug receptacles for a table lamp, spot lights, radio, etc.; terminals for connecting optional outside siren and back-up battery (not included); entry delay time control and sensitity control.

EXIT AND ENTRY DELAY

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

BATTERY BACK-UP

Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

THE BURGLARY PROBLEM

The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from the main alarm, they are available with 50 feet of wire for $24.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

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CIRCLE 48 ON FREE INFORMATION CARD

editorial

The BIG show

It was electronics time in Las Vegas. The 1980 Winter Consumer Electronics show had arrived and more than 65,000 retailers and distributors jammed the convention center to capacity, while previewing the products that will soon be available to us. Much of what was shown was conventional—those everyday products that are the staples of the consumer electronics industry. But here and there, the spotlight shone on the exceptional.

I'd like to take just a few moments of your time for a look at these exciting products.

A flat-screen TV prototype from Sinclair. It will not be available this year, but the unit demonstrated was a working model. It fortells a whole new world of television. I believe the prototype unit I saw may finally introduce those large-screen, hang-on-the-wall color sets that have been so consistently predicted over the years and have, to date, not appeared.

"The Source" is the name of a time-shared computer service. Connect your home computer to your phone via a modem and with a local phone call you can now dial up all kinds of advanced programs, daily news, and wire-service features that you can select with key words of your choice. It makes your terminal a part of a nationwide communications network that will permit you to talk or send mail to any other terminal for as little as $2.75 per hour. It provides a buying service that lets you order merchandise, charge it to your credit card, and have it delivered to your door. It's an information service with endless possibilities. And there's much, much more; but that will be the subject of a complete article in a future issue.

Quasar presented a talking microwave oven. Again it's a prototype, but obviously represents the start of a whole wave of talking appliances, from wristwatches and calculators to you name it.

And then there are the TV's you talk to—actually command. "Tell" it to switch on and it will. Tell it to change channel and it will. And it's custom-tailored to your voice—no one else can operate the remote. Panasonic and Toshiba showed these.

How about a Sharp TV that lets you watch nine channels at the same time on a single 25-inch color screen. Oh, you can snatch frames too. And Toshiba showed a four-channel-on-one-screen set too. Of course, it will probably be less expensive to buy multiple individual sets, but what a beautiful example of technology.

Satellite TV? Out in the parking lot, and not officially a part of the show, was a $7500 earth station for satellite TV reception. In a truck with the antenna on the tailgate it was available for sale. The owner got his idea from the satellite-TV series currently running in **Radio-Electronics.**

Last, but not least, was Kenwood's FM stereo receiver. It has a CRT display that shows you every station on the air in your area; displays call signs and frequencies; measures signal strength, multipath distortion, and just about everything else you could possibly want. It is several years away from production, but if there had been one piece of equipment that I would have been allowed to cart out of the show, that FM tuner would have been my choice.

The next CES show is in Chicago in June and I just can't wait to get a look at that one.

Larry Steckler

LARRY STECKLER
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letters

AC OUTLET CHECKER

The AC outlet checker described by William D. Kraengel, Jr., in the August 1979 issue has a serious shortcoming which may lull its users into a false sense of security. All neon-lamp outlet testers of that type will indicate whether the neutral and grounding conductors are at the same potential, but none of them will measure the actual *quality* of the ground.

It is imperative that the grounding (green or bare wire) conductor be able to carry the full fault current, which would be 15 or 20 amperes in a residential receptacle. To do that, the resistance to ground must be less than 8 ohms on a 15-ampere circuit, or 6 ohms on a 20-ampere circuit. Mr. Kraengel's tester will indicate a satisfactory ground connection even if the ground resistance is up on the kilohm range.

I recommend that all users of the simple neon-lamp receptacle testers perform a simple added check: De-energize the circuit, and measure the resistance between the ground*ed* (wider slot) terminal and the ground*ing* (round hole) terminal on a receptacle that has passed the neon-lamp test. That resistance should be less than 10 ohms. It would be a good idea to measure the resistance between the grounding terminal on the receptacle and a known good ground, such as a water pipe or a ground rod; that resistance should be a few ohms at most.

One last word about ground quality: Some ground clamps that are sold in handyman and department stores are of inferior quality, being made of aluminum with a copper or brass plating. Don't use them! The safest, most durable grounding system uses copper ground rods (or a buried copper water-pipe network) with copper ground clamps and copper wire. I have discovered many faulty grounding systems where the clamp used to connect the load center's ground wire to the ground rod was made of aluminum, and had been eaten away completely by galvanic corrosion.

ERIC LEMMON
Lompoc, CA

VIDEODISC SYSTEMS

I have been reading your articles on the two major videodisc systems, as well as updates and letters from other readers. I myself have managed to order a Magnavision optical system machine through the aid of a friend.

My concern is that a potentially beneficial invention, such as this, may be totally lost in the shuffle, or be greatly delayed in production, because of the useless haggling over different and entirely incompatible systems.

Many articles have stated: "Let the public decide." I would certainly agree with that. The problem is that the various companies are stacking the decks so that the public's decision will not be based upon the merits of a particular system but on the software available. Magnavision/MCA has Paramount, Universal, and Warner Brothers films, for example, while RCA has MGM and 20th Century Fox. Isn't that familiar—or have we forgotten about the quad situation when Columbia and RCA were incompatible? Everyone lost, including the consumer—perhaps especially the consumer!

Perhaps we could learn a better lesson from the videocassette "war" now going

continued on page 22

Whoever said, "The best things in life are free," was writing a song, not living a life. Life is not just a bowl of cherries, and we all know it.

You fight for what you get. You get what you fight for. If you want a thorough, practical, working knowledge of electronics, come to CIE.

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Pattern shown on oscilloscope screen is simulated.

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LETTERS

continued from page 16

on. True—there are different systems, but when software is made available it's produced in both formats: Beta and VHS. That way, the buyer can select a recorder for its recording abilities rather than being penalized because of which pre-recorded material he wants.

Along those lines, I see no reason why the two videodisc systems can't exist side by side. Those who want only movies, and a less expensive machine, can buy an RCA system. Those who want (or need) the extra features that Magnavision/Philips provides (such as freeze frame, lectures, art gallery tours, etc.) can buy that format, and would be willing to pay extra for the extra features. But the movies and other entertainment items should be available for both systems. A buyer could then truly decide upon which system he needs. As things stack up now, I would have to buy one player to see *Jaws* and a different one to see *Star Wars.*

Should this become a software war, rather than a hardware one, the public has shown, in the way it has ignored quad, that it will throw up its hands and bypass the whole thing. And that would be a shame.

WILLIAM RADFORD-BENNETT
Washington, D.C.

TEXTRONIC TEST EQUIPMENT

Off and on in your magazine, I have noticed requests for technical data for Textronic and related test equipment. I have located the Air Force technical order numbers for some of the more common oscilloscopes and preamps on the surplus market, and have listed them below. To obtain those, individuals should write to the Government Printing Office, Washington, D.C. for information on price and availability.

Oscilloscopes:

Tex. RM35 .... T.O. No. 33A1-13-76
Tex. RM35A.. T.O. No. 33A1-13-177
Tex. 535........ T.O. No. 33A1-13-76
Tex. 535A ..... T.O. No. 33A1-13-241
Tex. 545........ T.O. No. 33A1-13-73
Tex. 545A ..... T.O. No. 33A1-13-247
Tex. 585........ T.O. No. 33A1-13-173
Hickock 1805,
1805A................ No. 33A1-13-66

Preamps:

Tex. type B ... T.O. No. 33A1-13-115
Tex. type CA......... No. 33A1-13-116
Tex. type K ... T.O. No. 33A1-13-113
Tex. type 53/54A.. No. 33A1-13-114
Tex. type 53/54B.. No. 33A1-13-115
Tex. type 53/54C.. No. 33A1-13-409
Tex. type 53/54CA No. 33A1-13-116
Tex. type 53/54G . No. 33A1-13-118
Tex. type 53/54K.. No. 33A1-13-113

CHARLES BROWN

EINSTEINIAN IMPOSSIBILITIES

Having made a list of extensive impossibilities in Einstein's special theory of relativity, I notice that Dr. Howard Mark's letter (October 1979 issue) mentioned an Einsteinian notion that is one of my evidences: relativity of simultaneity.

Mark states: ". . . events simultaneous to one observer cannot be simultaneous to (a moving) observer." By "events" he means, for instance, flash-emissions of light at two spots (A′ and B′) in the moving reference system and equidistant from the "moving" and "rest" observers (M′ and M respectively).

Resulting flash-beams are *received* simultaneously by M but non-simultaneously by M′ because M′ moves closer to one (from B′) and farther from the other (from A′). Einstein could not explain how the beams could be received nonsimultaneously by M′ in his reference system (say a train) because that would mean the beams had unequal or variable velocities coming from each direction along the train. So he assumed that the *emissions* occurred "nonsimultaneously" *in the train.* Purporting that one flash (at A′) occurred later than the other (at B′) he could insist that the beams had equal or constant velocities.

Inspect Einstein's logic closely: As M and M′ coincide, M judges that the flash at A′ occurs (with the flash at B′). It did not yet occur according to M′ but occurs later, after M′ moves farther to the right of M. Meanwhile, according to M, the beam has *already* passed A′, having traveled along the train to some spot to the right of A′; observers in the same train with M′, stationed between A′ and that spot cannot have helped notice! Einstein's logic proves to be a physically impossible self-contradiction. Relativity of simultaneity is physically impossible.

ANTHONY HANS KLOTZ
Long Island, NY

OUTBOARD CONVERTERS

Can you tell me something about the availability of "outboard converters" as mentioned in the review of the Electra BC-220 scanner on page 35 of the September 1979 **Radio Electronics?** Any information about the purchase or construction of such converters would be greatly appreciated. Also, any information about improving reception on the Aircraft Band (118-136 MHz) would also be very helpful.

Your magazine is the finest in its field. Keep up the good work!

J. P. MAGUIRE
Wappingers Falls, NY

Converters are available both as kits and factory-wired units from several domestic manufacturers:

Hamtronics, Inc., 65 Moul Rd., Hilton, NY 14468;

Vanguard Electronic Labs, 196-23 Jamaica Ave., Hollis, NY 11423;

VHF Engineering, 320 Water St., Binghamton, NY 13901;

Hermes Research and Development Co., 3997 Elkcam Blvd SE., St. Petersburg, FL 33705;

Janel Laboratories, 33890 Eastgate Circle, Corvallis, OR 97330;

Advanced Receiver Research, Box 1212, Burlington, CT 06013.

We have been advised by the Electra Company (Cumberland, IN 46229) that the BC-220 aircraft performance has been improved since our evaluation sample was tested. They assure us that customers should find no trouble receiving stations in the 118-136 MHz frequency range. In any case, sensitivity on weak signal reception may be improved with the addition of a preamplifier available from virtually all of the converter manufacturers above.—Robert B. Grove **R-E**

Our 130 DMM gives you 0.5% DCV accuracy, a 10A range, a bigger display, easier controls, and lighter weight.

With all the hand-held DMMs around these days, it can be tough to pick the one that's best for you. Some are just too basic; others have a lot of high-priced frills that you may not want. Our Model 130 Digital Multimeter makes that choice a lot easier because it was designed with your needs in mind.

Accurate. The 130 is five times more accurate than many comparably priced analog VOMs, and it also compares favorably with other, more expensive hand-held DMMs. Its basic 0.5% DCV accuracy is probably as much as you'll need outside of lab situations, so you don't have to pay for more than you want. That's long term accuracy—only one calibration adjustment is required, once a year.

Rugged. We built the 130 to be tough enough to take it in real-world situations. The case is 2.5mm (.100") thick and made of high strength, impact resistant plastic. The LCD window is tough, scratch-resistant polycarbonate. The handsome faceplate is designed for maximum legibility and ease of use—all ranges and functions are color-coded and clearly marked. And all components are on a single PC board that's mounted to the faceplate, permitting the vital electronics to "float" free of the backing and protecting them from jolts. Yet the whole unit weighs a mere 283g (10 oz.) —one of the lightest units around.

Easy to use. Our 15mm (0.6") LCD display is 60% larger than that of many other pocket DMMs. Both range and function are easily selected with one hand—no complicated pushbuttons. And a rear panel mounting screw lets you use the 130 while it's mounted to a stand or special holder, even without taking it out of its optional carrying case.

And that's no fluke.

Keithley quality. Like all Keithley products, precision components and user-oriented design are built right in to the 130. Full overload protection, a 10A current range, auto zero and auto polarity round out the list of standard features. And a full line of accessories expands its capabilities to 40kV, 200A and 700MHz. But the real measure of Keithley value is how we give you all this performance at a sensible price.

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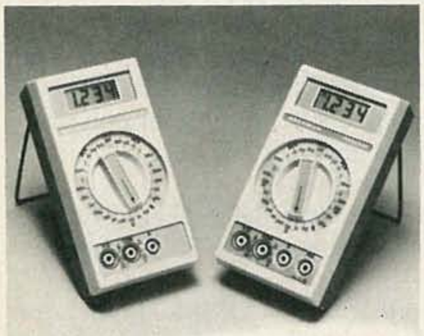
equipment reports

Beckman Instruments Models Tech 300 and 310 Digital Multimeters



CIRCLE 101 ON FREE INFORMATION CARD

BECKMAN INSTRUMENTS, INC. (2500 HARBOR Blvd, Fullerton CA 92634) has been making test instruments and precision components of many kinds for a long time. They're now making a complete line of digital multimeters. One pair of almost twin meters are designed and priced especially for electronic technicians and hobbyists in all fields. These are the models *Tech-300* and *Tech-310*. A 10-ampere current range and a built-in continuity function are provided on the 310, but otherwise they're almost identical. The readout is a highly legible 3.5 digit liquid crystal display.

The Tech-300 has a total of 27 ranges for seven functions, while the Tech-310 has 27 ranges, plus an additional 10-ampere current range. The functions and ranges are selected using the function/range switch. (You can't say "controls" because there is only one.)

Each function and range is very plainly marked, and the knob is recessed to avoid accidental damage. So are the special banana jacks along the bottom. Those are of the protected type, so that no bare metal is exposed when the test-leads are plugged in. The test leads, by the way, are very rugged-looking and the probes have protective collars on the end to keep fingers out of things.

Both meters measure DC volts on 5 ranges from 200 mV up to 1500 V with an accuracy of 0.25% for the *Tech-310* and 0.5% for the *Tech-300*. AC volts are measured on the same ranges except for the top one which is 1,000 volts RMS. The accuracy of the AC voltage measurements is 0.75% for the *Tech-310* and 1.5% for the *Tech-300*. Alternating and direct current are measured in 5 ranges (6 ranges on the *Tech-310*) from 200 microamps to 2 amps with the *Tech-300* and 10 amps with the *Tech-310*. There are 5 resistance ranges, from 200 ohms to 20 megohms. All are low-power ohms with a maximum in-range voltage of 250 mV.

For diode/transistor testing, a special range is used, marked with a diode symbol. That applies up to 2.0 volts across the junction. If the junction is reverse-biased, OL appears on the display indicating circuit condition. Reverse the test leads and if the junction is good, you'll read the actual voltage drop across the junction on the 2-volt scale with a resolution of 0.1 mV. The current flowing is limited to 5 mA by a constant-current source. That protects transistors from damage. Junctions may be tested in-circuit with as little as 200 ohms shunt resistance.

A special continuity test that Beckman calls *Insta-Ohms* is used in the *Tech-310* on all ohms ranges. Continuity tests have been difficult on conventional DMM's. With this new feature, if you touch the test leads to a circuit and the resistance is anything less than twice the range chosen, an ohms (omega) symbol will appear instantly in the upper left corner of the display. It tells you that the circuit does have continuity. A fraction of a second later (1/4 second to be exact) the circuit resistance will appear. (If you're on the 200-ohm scale, you'll see the reading if there's anything below 400 ohms.) If it's more than range, OL appears and you switch to a higher range. The OL is also overrange readout for all other ranges and functions.

Another feature that should also be popular is the battery life. The meters use only a single 9-volt rectangular battery and an average life of 1600 hours or 2 years is claimed for a common zinc-carbon battery (with an alkaline battery, up to 2,000 hours). The low battery indication is a blinking decimal point. When that appears, there is approximately 200 hours of battery life left.

Practically all of the circuitry is contained on a custom-CMOS LSI IC. The CMOS technology accounts for the long battery life. By using the LSI IC, the total count of electronic parts is reduced to less than 40. Each instrument is given a 100-hour burn-in test and complete calibration tests. A one-year warranty is given, which includes calibration.

The high accuracy of those two meters is obtained by the use of special thin-film IC-type voltage divider networks. They are used on all functions. All of the inputs are protected against overload including the resistance ranges, which can withstand up to 300 VDC or RMS AC. The current inputs are protected against overload by a 2-ampere fuse, except for the 10-ampere range on the *Tech-310*. That input will withstand up to 20 amps for 30 seconds (which should give you plenty of time to "get out of there!")

Accessory probes are available for reading up to 50 kV DC, 200 MHz AC currents up to 1000 amps, with a current-clamp-type probe. Also available are a set of deluxe test leads and two carrying cases. The meter case itself is a tough plastic that is claimed to withstand a drop of 6 feet to a hard surface. It has a retractable bail that is used for a bench-rest, or can be flipped around to make a carrying handle.

The price is quite reasonable for instruments of this quality: $110.00 for the *Tech-300* and $140.00 for the *Tech-310*. The Beckman company has a wide reputation for making quality instruments and precision components and their technology has been put to good use in designing and building these two meters.

We checked our meters out on TV sets and assorted semiconductors, and found them very easy to use and to read in dark places with no problems. Quite a pair of instruments! **R-E**

JVC HR-6700U Video Cassette Recorder

CIRCLE 102 ON FREE INFORMATION CARD

THE FIRST BLOW TO THE MOTION PICTURE INdustry was the widespread profileration of home television: Box-office receipts plummeted. Then Hollywood discovered that, rather than a threat, TV was a logical medium to exploit with the made-for-television movies. Now, a new threat appears to have emerged: the home video recorder.

The home video machines are available in two hotly-contested formats: Beta and VHS. At the present time, there seems to be an indication that VHS is winning. We decided to have a look at one of the better VHS machines, the *6700U* video cassette recorder from JVC. In addition, JVC offers a matching *Vidstar* color camera that can turn the video cassette recorder into an instant home movie camera. . . . but more about that later.

The *HR-6700U* VCR weighs in at 31 pounds, and is a videophile's delight! Handsome in appearance and flexible in performance, the recorder touts a variety of features, many controlled by six microprocessor memories.

Selectable tape speeds provide up to six hours of recording from a standard two-hour T-120 video cassette. Slow motion at 1/15 to 1/3 normal speed shows no degradation or noise on the signal; and even still playback is available for "freeze-frame" fans!

The secret behind the quality of slow-speed video recording is the recording-head complement. Most competitive recorders use the same heads for recording a variety of speeds. Because of that tradeoff, non-standard speeds suffer distortion. The *HR-6700U* features six separate recording heads, providing a much higher density of information. Both picture and sound are enhanced using that technique at both slow and normal speeds.

Crosstalk distortion is also minimized by an advanced H-aligned format that allows noiseless double-speed playback in the normal (two-

continued on page 32

CIRCLE 21 ON FREE INFORMATION CARD

PRB-1 DIGITAL LOGIC PROBE

- DC to > 50 MHZ
- 10 Nsec. pulse response
- 120 K Ω impedance
- Automatic pulse stretching to 50 Msec.
- Automatic resetting memory
- Open circuit detection
- Automatic threshold resetting
- Compatible with all logic families 4-15 VDC
- Range extended to 15-25 VDC with optional PA-1 adapter
- Supply O.V.P. to ± 70 VDC
- No switches/no calibration

PRB-1	DIGITAL LOGIC PROBE	$36.95

PROTOTYPE BOARD CM-100

TERMINALS: 1,020 TEST POINTS. 188 separate 5 point terminals, plus 2 horizontal bus lines of 40 common test points each.

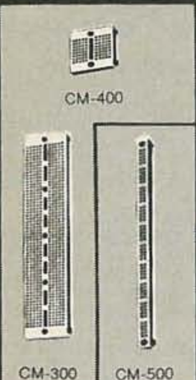
SIZE: 6½" Wide, 5" Long.

CM-100	MODULAR PROTOTYPE BOARD	$25.95

PROTOTYPE BOARD CM-200

TERMINALS: 630 TEST POINTS. 94 separate 5 point terminals, plus 4 bus lines of 40 common test points each. SIZE: 6" Wide, 3½" Long.

CM-200	MODULAR PROTOTYPE BOARD	$16.45



PROTOTYPE BOARD CM-300, CM-400

CM-300 and CM-400 have two separated rows of five interconnected contacts each. Each pin of a DIP inserted in the strip will have four additional tie-points per pin to insert connecting wires. They accept leads and components up to .032 in. diameter. Interconnections are readily made with RW-50 Jumper Wire. All contact sockets are on a .100 in. square grid (1⁵⁄₁₆ in. wide).

CM-300	MODULAR PROTOTYPE BOARD	$9.95
CM-400	MODULAR PROTOTYPE BOARD	$2.45

MODULAR BUS STRIP

CM-500 is a bus strip to be used in conjunction with CM-300 and CM-400 for distribution of power and common signed lines. Two separate rows of common terminals, grouped into clusters of five. All contact sockets are on a .100 in. square grid.

CM-500	MODULAR BUS STRIP	$1.95

JUMPER WIRES

50 Preformed wires, from 1½ to 4 inches, 20 AWG solid wire, white insulation.

RW-50	JUMPER WIRES	$2.98

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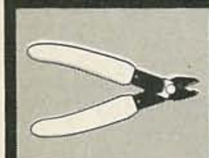
For cutting and stripping 1 in. insulation from 30 AWG wire.

CAS-130	CLIP AND STRIP	$1.98

THE ABOVE CUT AND STRIP TOOL IS NOT APPLICABLE FOR MYLENE OR TEFLON INSULATION



MINI SHEAR

MS-10	MINI-SHEAR	$4.95

MINI SHEAR WITH SAFETY CLIP

MS-20	MINI-SHEAR WITH CLIP	$5.95

VACUUM VISE

ABS construction, 1½ in. wide jaws.

VV-1	VACUUM VISE	$3.49

WIRE WRAPPING KITS WK-2, WK-3, WK-4

WK-2-B	WIRE-WRAPPING KIT (BLUE)	$12.95
WK-2-Y	WIRE-WRAPPING KIT(YELLOW)	$12.95
WK-2-W	WIRE-WRAPPING KIT (WHITE)	$12.95
WK-2-R	WIRE-WRAPPING KIT (RED)	$12.95
WK-3B (BLUE)	WIRE-WRAPPING KIT	$16.95
WK-4B (BLUE)	WIRE-WRAPPING KIT	$25.99

WIRE WRAPPING KIT WK-5

BW-630, WSU-30M, CON-1, EX-1, INS-1416, TRS-2, MS-20, 14, 16, 24 and 40 DIP sockets, WWT-1, WD-30-TR1, H-PCB-1.

WK-5	WIRE-WRAPPING KIT	$74.95

PC BOARD

4 x 4.5 x ¹⁄₁₆ in. board, glass coated EPOXY laminate, solder coated 1 oz. copper pads. The board has provision for a 22/44 two sided edge connector. .156 in. spacing. Edge contacts are non-dedicated for maximum flexibility.

The board contains a matrix of .040 in. diameter holes on .100 in. centers. Component side contains 76 two-hole pads.

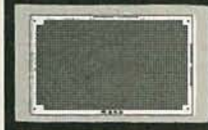
Two independent bus systems are provided for voltage and ground on both sides of the board.

H-PCB-1	HOBBY BOARD	$4.99

TERMINAL BOARD

.062 thick glass coated epoxy laminate. Outside dimensions 6.3 in. x 3.94 in. Not plated.

A-PC-01	TERMINAL BOARD	$3.45



PC BOARD

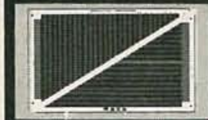
Same specifications as A-PC-01 except matrix pattern is copper plated and solder coated on one side.

A-PC-02	PRINTED CIRCUIT BOARD	$5.95

PC BOARD

Same specifications as A-PC-01. Each line of holes is connected with copper plated and solder coated parallel strips on one side.

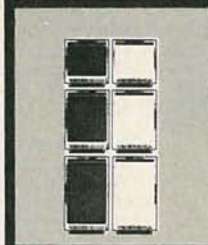
A-PC-03	PRINTED CIRCUIT BOARD	$5.95



PC BOARD

Same specifications as A-PC-01. One side has horizontal copper strips, solder coated. Second side has vertical parallel bars.

A-PC-04	PRINTED CIRCUIT BOARD	$7.95



PC BOARD

The A-PC-05 features numbered contacts for easy reference along with a numbered matrix for easy hole locations. Made of .062 in. thick epoxy laminate. 4.5 in. x 5 in. Edge Connector Board.

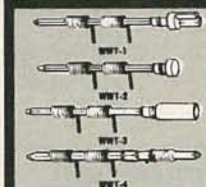
A-PC-05	PRINTED CIRCUIT BOARD	$5.45

Same as A-PC-05 except outside dimensions are 4.5 in. x 6.5 in. Edge Connector Board.

A-PC-06	PRINTED CIRCUIT BOARD	$6.95

Same as A-PC-05 except outside dimensions are 4.5 in. x 7 in. Edge Connector Board.

A-PC-07	PRINTED CIRCUIT BOARD	$8.95



TERMINALS

WWT-1	SLOTTED TERMINAL	$4.98
WWT-2	SINGLE SIDED TERMINAL	$2.98
WWT-3	IC SOCKET TERMINAL	$4.98
WWT-4	DOUBLE SIDED TERMINAL	$1.98

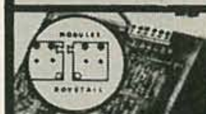
TERMINAL INSERTING TOOL

For inserting WWT-1, -2, -3 and -4 terminals.

INS-1	INSERTING TOOL	$2.49

P.C.B. TERMINAL STRIPS

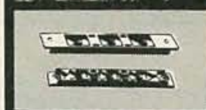
TS-4	4-POLE	$1.39
TS-8	8-POLE	$2.19
TS-12	12-POLE	$2.99



MODULAR TERMINAL STRIPS

TS-6MD	2-POLE	$1.79

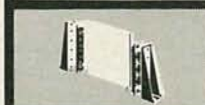
(3 per Package)



PC CARD GUIDES

TR-1	CARD GUIDES	$1.89

QUANTITY — ONE PAIR (2 PCS.)



PC CARD GUIDES & BRACKETS

TRS-2	GUIDES & BRACKETS	$3.79

QUANTITY — ONE SET (4 PCS.)

PC EDGE CONNECTOR

44 pin, dual read-out, .156 in. spacing, wire-wrapping.

CON-1	P.C. EDGE CONNECTOR	$3.49

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CIRCLE 22 ON FREE INFORMATION CARD

An introductory Electronics

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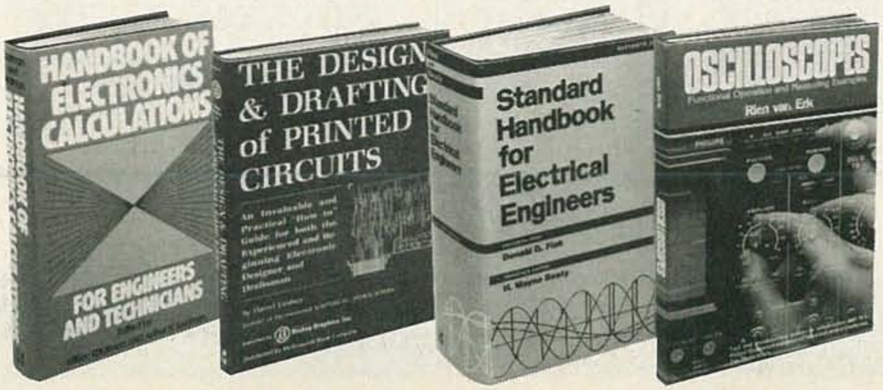

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786/755 Pub. Pr., $35.00 Club Pr., $26.50

EQUIPMENT REPORTS

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hour) mode as well as triple-speed playback in the six-hour mode.

Picture stability has always been a problem in video recording; as speed fluctuates, so does the synchronization signal. The new JVC recorder incorporates a microcomputer-controlled timer that works in conjunction with a fast-response capstan servomechanism to lock on to those synchronizing signals; that prevents the annoying flopover so frequently associated with home recorders.

For recording off the air, a built-in VHF/UHF solid-state tuner is operated manually or by microprocessor memories. Unattended, the machine will record six programs on different channels up to a week in advance; or at the same time every day—or at different times on different days! Now that's flexibility!

A dual-mode auto-search counter allows the user to program the recorder to stop at "0000" in rewind, or to stop where the recording began—whether in fast forward or rewind.

A remote-control accessory allows the operator to shift speeds from the comfort of his viewing position. But to use the convenience of the many automatic features, he may allow the machine to do his speed thinking for him. The *HR-6700U* senses the speed format of the tape that has been loaded and automatically switches to the correct speed.

When the owner desires to watch TV, he merely switches off his recorder; the antenna will be automatically connected to the television receiver. The tuner portion of the recorder is a presettable 12-channel VHF/UHF tuner with channel-lock provision. Input impedance is nominally 75 ohms on VHF, and 200 ohms on UHF.

Video signal-to-noise ratio is better than 45 dB, and horizontal resolution is at least 240 lines; the audio-frequency response is 50-10,000 Hz.

The optional matching color camera is compact and lightweight, slightly over three pounds, depending upon zoom lens.

The original engineering philosophy was to provide a camera that is as small and lightweight as a standard 8 mm home movie camera—and as easy to operate. A tall order, but JVC seems to have done it! In our test, the video camera came through with flying colors. Focus was sharp; persistence was fast (very little smear from rapid movement), and the camera was not fatiguing to hold and operate.

The operation of the camera couldn't have been simpler: Point and shoot! Zoom and focus are no more awkward than on a quality photographic camera. For the home-movie addict who wants to move up into the electronic age, this is the way to go.

The camera is built around a 0.66-inch vidicon with either a 3× or 6× zoom lens available. It features automatic iris control and through-the-lens viewfinder. Color correction (temperature or white balance) is accomplished electronically without the need of optical filters. Exposure indicators in the viewfinder alert the user whenever there are improper lighting conditions.

A built-in high-sensitivity condenser microphone features a wind screen. While a ten-foot cable is provided, extensions up to 60 feet from the recorder are allowable.

A pistol-trigger switch activates the camera and recorder. A tripod and spotlight accessory may be purchased separately if desired, to be used with the camera.

The specifications for the camera show it to be a 3.6-MHz single-carrier frequency multiplex system with 525 lines, 2:1 interlaced. Color temperatures are switch selectable among 3000, 4800, or 6000° K. Video output is 1 volt P-P with 250 line resolution.

We found the new JVC video cassette system with matching camera an impressive performer. It is full-featured, innovatively-engineered, and realistically-priced.

The suggested retail list price for the *GX-66U* Color Video Camera is $850 and the *HR-6700U* Vidstar Color Video Cassette Recorder is $1350. For more information, write to: JVC, 58-75 Queens Midtown Expressway, Maspeth, NY 11378. **R-E**

Hitachi Model V-302 Dual-Trace Scope

CIRCLE 103 ON FREE INFORMATION CARD

JUST A FEW YEARS AGO A 10-MHz OSCILLOSCOPE would have sufficed for all but the most critical applications. Today's sophisticated technology is rapidly making the 10-MHz scope as obsolete as the older 5-MHz units. Even the well-equipped TV service bench of today is required to have a scope capable of at least 30 MHz, especially if that service center is expecting to become a VCR service agency for most of the popular brands of units on the market.

With the above facts in mind, Hitachi Denshi, Ltd., Tokyo, Japan, has introduced a unit that seems to fill the requirements of the TV service industry and at the same time is perfectly at home in the other fields of industry such as the computer field.

The Hitachi model *V-302* dual-trace scope is very neat-appearing and professional-looking with a brushed-metal rim surrounding the entire front panel. The panel itself is composed of three colors, and the colors are arranged to indicate to the user the location of all controls that are related to each other. For instance, the silver area contains the power switch, INTENSITY control, FOCUS control, and the LED pilot light.

The inputs and controls that are related to the horizontal (X) and vertical (Y) display functions will be found in the gray-colored sections. The third color is brown and it contains the trigger MODE and SOURCE switches, trigger LEVEL, and external TRIG INPUT. That multi-colored panel adds a quality look to the overall appearance as well as serving a very useful purpose for the operator. When shipped, the panel has a protective plastic film covering its entire surface. The protective shield may be removed or allowed to remain to prevent the front panel from becoming soiled from fingerprints, etc.

The unit supplied came equipped with two test probes, each containing a convenient built-in thumb hook that adds to the ease of handling the probe, especially when hooking onto a circuit point. The probe itself is of a convenient size for the state-of-the-art units the present-day technician is required to troubleshoot. The "clip-on" hook portion may be removed and a miniature-sized needle-tipped test probe is available for point-to-point testing. The normal probes (as supplied) are × 10 low-capacitance types.

The gray-shaded portion of the panel contains the horizontal-display controls. The TIME/DIV rotary switch dominates that section with 19 positions that select sweep speeds ranging from 0.2μs-per-division to 0.2 seconds-per-division in a 1–2–5 sequence. When this switch is placed in the fully clockwise position, the scope is set to operate in the X-Y mode. In that case, the input signal to Channel 1 is displayed on the X axis and Channel 2 signals are presented on the Y axis. To the right of the TIME/DIV switch is the variable sweep control for the timebase settings that are not covered by the preset times on the main switch. When the control is adjusted to the extreme clockwise position, the unit is in the calibrated mode. The horizontal-positioning (centering) control is also in this section. In addition, if the control is pulled outward, the scope is set for a ×10 magnification of the horizontal trace.

The vertical sensitivity is selectable in ten steps over the range of 5mV-per-division to 5 volts-per-division. These ranges are also continuously variable when the vertical gain control is turned from the calibrated position. In addition, by pulling the vertical position knob to the outward position, the gain of the vertical (Y) amplifier is multipled by a factor of 5. Of course, being a dual-trace unit, there are duplicate controls for the second channel. The vertical input has an impedance of 1 megohm

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shunted by 30 pF. A switch selects AC or DC input, as well as acting as a grounding switch for the input circuitry.

Other features are located in the brown-shaded area at the upper right hand corner and the extreme bottom center. The latter is the MODE switch that determines which input signals will be displayed. Aside from the normal Channel-1 or Channel-2 signals being displayed alone or simultaneously, the switch will also algebraically add or subtract the input signals. That feature is particularly useful when comparing phase and voltage relationships of the two input signals, among many other important tests.

The center right-hand portion of the front panel is related to the triggering of the timebase. In that section will be found the LEVEL control; the MODE switch, which selects whether the scope will be triggered automatically, in the normal manner, or if it is to be used with composite signals such as a TV signal. In fact, like most better scopes today, the MODE switch has positions for TV(+) and TV(−) signals. There is also a SOURCE switch that obtains the trigger pulse from the Channel-1 or Channel-2 inputs, the 60 Hz line, or the external TRIG INPUT jack. The latter is a BNC type.

For calibration purposes there is a 0.5V P-P squarewave signal available on the front panel. It is located at the upper right-hand side of the unit. The amplitude is accurate to within 3% and the frequency is 1 kHz ±10%.

Another control that is often not found on many scopes is a TRACE ROTATION control. It is useful in eliminating the effects of external magnetic fields and could be called a tilt control as that is the effect of misadjustment.

SPECIFICATIONS

Bandwidth	DC to 30 MHz DC to 5 MHz (using × 5 gain)
Rise time	12 nanoseconds
Max input voltage	600 volts P-P, 300V (DC+AC peak)
Timebase	0.2 μs to 0.2 s-per-div . . . 19 steps, 1-2-5 sequence
Magnification ...	×10 (max speed, 100 ns-per-div.)
Sensitivity	Y Axis: 5 mV to 5 V-per-div.) X Axis: same as above
Bandwith	X Axis: DC to 500 kHz
X-Y phase	Less than 3-degrees at 10kHz
Trigger sensitivity	20 Hz to 5 MHz; 0.5 div internal, 200 mV external 5 MHz to 30 MHz 1.5 div internal 800 mV external

The rear panel contains an external blanking input jack, a 2-amp fuse (for 90-132V operation) and the AC line cord.

All input connectors with the exception of a common ground jack on the front panel are of the BNC type that allows for quick connection and disconnection of cables and probes. The ground jack is the banana-plug type.

Using this Hitachi scope on the bench is enjoyable. After the short period of time that is needed to become familiar with the location and function of the various controls, the ease of operation was quite noticeable. The patterns displayed were steady, sharp, and showed no signs of blooming. A composite video waveform was used to test the usefulness of the scope. The *V-302* came through with flying colors. If your use for an oscilloscope is in the TV and video industry, then you are sure to appreciate the *V-302's* ability to display a composite waveform.

The operating manual supplied with the scope tested was complete and contained all the material necessary to help you become adept at the operation of the *V-302*. All controls, input jacks, and adjustments are outlined within the three dozen pages in the manual. In addition, there is a wealth of information and theories that outline the manner-in which the scope can be used to its fullest extent—including the measurement of frequency and time, amplitude, and voltage. Other uses include phase measurements and delays. Some internal operator-adjusted adjustments are also outlined in the manual.

Although many owners of such exotic equipment may be in the habit of making most of their own repairs, one thing lacking from the manual is almost anything relating to service. There is no schematic or any internal layout charts to assist in even minor servicing. While we do not doubt that such informaiton is available, we feel that such equipment should be shipped with a simple service manual at the very least. There is, however, a list of Hitachi Denshi Ltd. offices throughout the world and

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EQUIPMENT REPORTS

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assistance would most likely be available from one of them. The *V-302* is also covered by a 2 year warranty.

The lack of storage space for the line cord hampers the portability of the unit somewhat. Although not a serious problem, it could be solved easily by extending the length of the four bumpers on the rear of the cabinet and winding the cord around them.

In addition, the unit (supplied) had a handle on the top of the cabinet that is centered well and provides a well-balanced grip. One minor problem was noticeable on the bench . . . . one that could be solved by the use of a bail-type handle. When the unit sat flat on the test bench, it was difficult to view the screen because of the low-profile of the Hitachi *V-302*. By tilting the scope upward, the visibility and ease of operation improved dramatically. A bail-type handle could be added, which would also serve as a prop or stand to elevate the front of the unit and therefore add to the operating comfort.

Even though the graticule was not illuminated, the divisions were found to be easy to read and as pointed out earlier, the ease of operation was outstanding.

The V-302 is designed to operate from an AC supply of 100/120/220/240V. The size is listed as 190 × 275 × 400mm (7.5 × 10.8 × 15.7 inches) and weights 8.5 kg (18.7 lbs.) Standard equipment supplied include two probes and the operation manual. Price $945.

One final observation: the miniature-sized probes are extremely handy and do add to the ease of servicing on printed-circuit boards and IC's. There's no doubt that these probes are becoming standard equipment as they make more sense than the older large-sized units. **R-E**

The BASIC Programmer's Toolkit for PET Computers

CIRCLE 104 ON FREE INFORMATION CARD

OWNERS OF PET PERSONAL COMPUTERS HAVE been known to collect software from numerous sources. Among this software are utility programs that assist the programmer in writing BASIC language programs. The best utility programs are written in machine language to minimize conflict with the user's program and to execute rapidly. Normally stored on tape, utility programs must be loaded each time they are used. If your computer system goes down for any reason, you must reload the utility program and usually carry out an inconvenient initialization procedure. To have two or more tape-resident utility programs in memory at the same time, you may have to relocate one or more so they don't overwrite each other. The *BASIC Programmer's Toolkit* is a firmware system that provides a real solution to the PET utility muddle.

The *Toolkit* is a collection of the most useful utilities programmed into a read-only memory that is always ready to use. The complete set of programs are initialized with a simple SYS command after the PET computer is turned on. The command must be given only once for each time the power is applied. If your system bombs out, or the power goes out temporarily, the *Toolkit* utilities can be called back into service in seconds. A very handy feature to incorporate into your computer.

The *Toolkit* has a ten-command repertoire.

Its unique design adds the *Toolkit* commands to the PET's own BASIC-command list. Once the system is initialized, you can't tell where the PET leaves off and the *Toolkit* takes over, except that the added commands cannot be written into program statements. The command list consists of: AUTO, DELETE, RENUMBER, APPEND, DUMP, TRACE, STEP, OFF, FIND, and HELP.

The AUTO command automatically prints statement-line numbers, starting at any legal number and increasing by any increment. DELETE erases a specified line or block of lines. RENUMBER spreads your line numbers apart after you have inserted too many lines to allow further additions. RENUMBER updates all jump destinations in GOTO statements etc.

The APPEND command combines two programs without the gyrations required by most other methods. You load the first program conventionally and then append the second. The only requirement is that the line numbers be in proper sequence. Of course, you can use the RENUMBER command to prepare programs for the append operation.

The DUMP command lists all the variables except arrays, following program execution. As a program runs, the TRACE facility displays the line numbers of the last six statements executed. STEP is a variation of TRACE that executes one statement at a time. OFF disables the TRACE and STEP functions.

The FIND command searches all program lines or a goup of lines for a specified character sequence. It is very useful when you want to find a particular line that has been moved because of renumbering. It also helps determine if a particular variable name has already been used. FIND displays all lines that include the specified reference.

Finally, The HELP command makes short work of careless program errors. When the PET displays an error message, typing HELP will cause the computer to display the line in which the error occurred, and, in addition, display the end of the last completed statement in reverse-video.

A well-written instruction manual includes a section that contains a more detailed explanation of how the system and its commands work. All the programs function extremely well and the examples in the instruction manual demonstrate how seemingly strange things can crop up.

The *Toolkit* is available in several versions that match the various PET configurations. All involve the connection of a ROM into the "B" (11×4096) block of memory. Early PET's were not wired with empty ROM sockets, so the corresponding *Toolkit* version consists of a board that interfaces to the memory-expansion connector and to the second cassette port. Newer PET's have the extra sockets, so the applicable kits consists only of a ROM—no additional memory decoding is required. There are also versions for Expandamem and Skyles memory boards, so the *Toolkit* can be added without hooking into the memory connector already used to interface with the memory-expansion board.

The BASIC Programmer's Toolkit is a product of Palo Alto IC's and is available only at local PET dealers. Chip-only versions sell for \$49.95, and the completely-assembled versions for 8K Pets, Skyles or Expandamem boards are \$79.95. The Toolkit is an exceptional, professionally designed PET add-on. Any PET owner who is serious about BASIC programming would do well to put it at the top of his shopping list. **R-E**

BUILD THIS

TRIGGERED OSCILLOSCOPE

This easy-to-follow design lets you keep cost low by using a CRT of your choice. Its operational feature is a continuous zero baseline.

DANIEL METZGER and DENNIS PERRY

ONCE A TECHNICIAN HAS EXPERIENCED troubleshooting with a calibrated DC lab scope, he'll probably want to keep that scope probe close at hand most of the time he's at the service bench. Transistor base-emitter voltages, collector saturation voltages, and IC logic levels can be checked as easily as power-supply lines while the operating signals are present. No other instrument provides that simultaneous readout of bias and signal conditions.

Two factors have conspired to keep that scope probe out of the hands of most experimenters. The first is cost, which approaches $200—even for a kit. That problem is easily solved by simplified design. The scope described here can be built from standard parts for $100, and considerably less if the junk box is well stocked. Yet it boasts a 2-MHz bandwidth and 10 mV-per-division vertical sensitivity.

The second factor is the annoyingly frequent need to lay down the probe, reach over to the scope, throw the input switch from DC to GROUND, check the position of the zero-volt baseline, and throw the switch back to DC. That problem is handled by incorporating a circuit that provides a continuous display of the DC ground level at a brightness level lower than that of the signal display.

How it works

The operation of the scope as a whole is best understood from the block diagram, Fig. 1. The vertical attenuator and amplifier provide a replica of the input signal, both AC and DC, at the approximately 100-volt level needed at the deflection plates of the CRT. The electronic baseline switch interrupts the signal and grounds the amplifier input for approximately 3 ms each 15 ms, thus providing a 1/5 duty-cycle baseline display at a rate of about 60 Hz—too fast for the eye to perceive the flicker.

A separate trigger amplifier is fed from a point ahead of the electronic baseline switch to preserve continuity of sweep triggering. A Schmitt trigger produces squarewaves in sync with the input signal, and a differentiator produces sharp spikes from the edges of the squarewaves. The negative spikes initiate a linear ramp that always starts at the same selected point on the input AC wave-

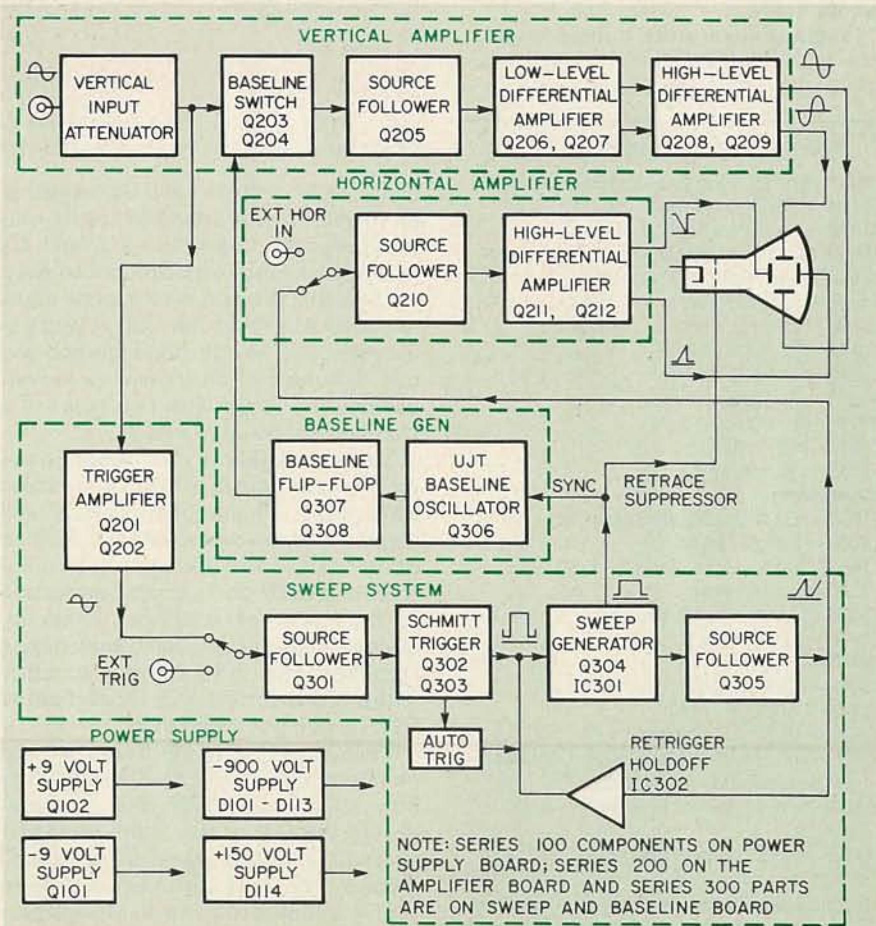


FIG. 1—BLOCK DIAGRAM of the zero-baseline scope. Operation is somewhat similar to a dual-trace scope with the baseline considered as the second trace.

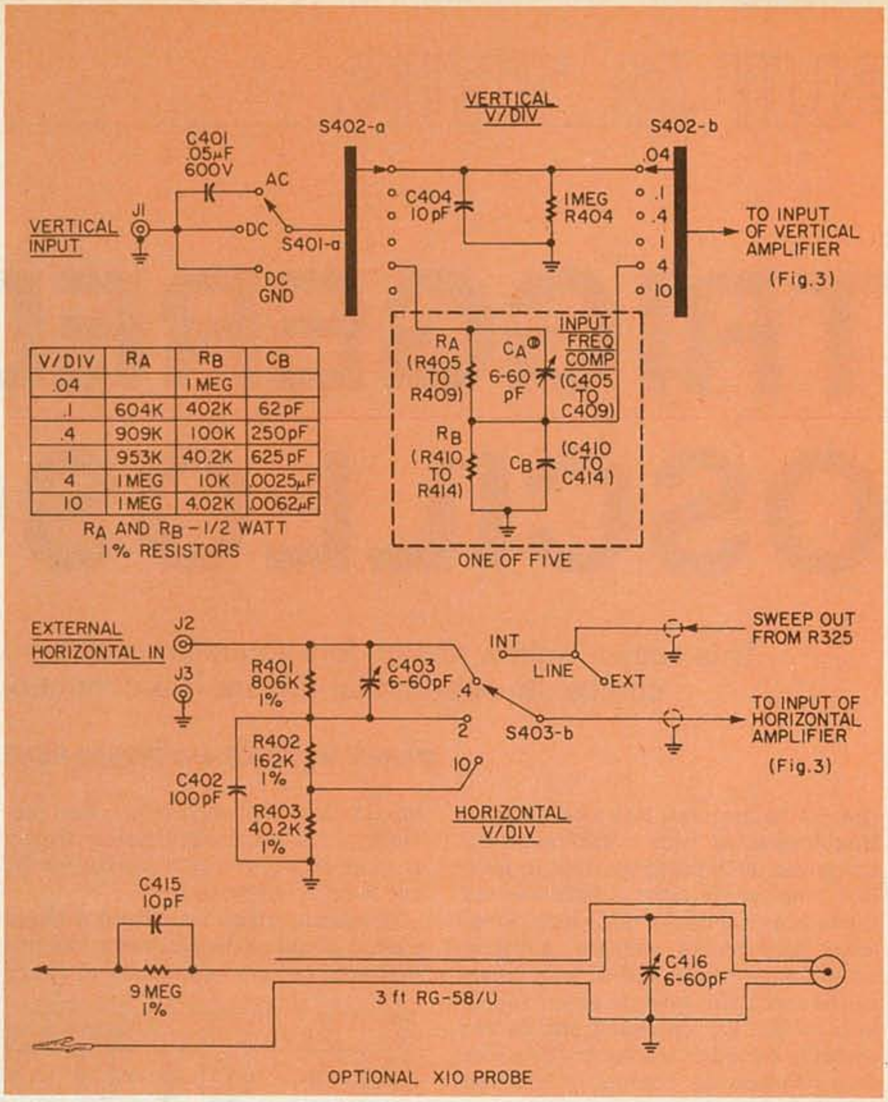
form. That ramp is applied to the horizontal amplifier to produce the calibrated time sweep. A source-follower provides a low output impedance for the ramp, and an op-amp comparator holds off further triggering signals until the ramp voltage returns to zero.

An auto-trigger circuit senses when the Schmitt trigger is not switching and immediately applies a voltage to the ramp genrator commanding continuous ramps, thus providing sweeps for the display of DC voltages.

A UJT baseline oscillator running at approximately 60 Hz is synchronized to the sweep generator to insure that the switching from signal to baseline will always occur during a retrace of the sweep. The baseline flip-flop drives the baseline-switching FET's at the input of the vertical amplifier.

The CRT cathode is operated at −900 volts to accelerate the electron beam toward the CRT face. Deflection sensitivity and hence calibration depend upon that voltage, so it is regulated by a string of 180-volt Zener diodes. Vertical and horizontal position and sweep time depend upon the 9-volt supplies, so they are transistor-regulated. The +150-volt supply serves only differential amplifiers, and their inherent common-mode rejection makes regulation of that supply unnecessary. We shall now proceed to a detailed description of each functional block.

Vertical attenuator: Voltage dividers R_A and R_B (Fig. 2) reduce the input signal to a maximum of 0.32 volt (8 divisions at 0.04 volt-per-division) or a minimum of 0.01 volt (1 division at 0.01 volt-per-division). Capacitors C_A and C_B swamp out stray capacitances to keep the reactive division ratio exactly equal to the resistive division ratio at high frequencies. A 1—4—10 step-sequence permits coverage of the 10-mV to 10-volt-per-division range with two poles of a standard six-position switch.



V/DIV	R_A	R_B	C_B
.04		1MEG	
.1	604K	402K	62pF
.4	909K	100K	250pF
1	953K	40.2K	625pF
4	1MEG	10K	.0025µF
10	1MEG	4.02K	.0062µF

R_A AND R_B – 1/2 WATT 1% RESISTORS

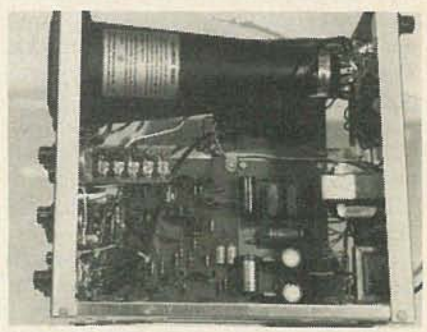
FIG. 2.—THE ATTENUATORS. Components for the vertical attenuator are mounted on a special circuit board. Also shown in the diagram of the optional multiplier probe.

PARTS LIST (Attenuators, Fig. 2)

Resistors 1% tolerance or better, ½ watt
R401—806,000 ohms
R402—162,000 ohms
R403, R412—40,200 ohms
R404, R408, R409—1 megohm
R405—604,000 ohms
R406—909,000 ohms
R407—953,000 ohms
R410—402,000 ohms
R411—100,000 ohms
R413—10,000 ohms
R414—4,020 ohms
R415*—9 megohms
Capacitors
C401—.05 µF, 600 volts, ceramic
C402—100 pF, Mylar
C403, C405—C414, C416*—6-60 pF ceramic trimmer
C404, C415*—10 pF, ceramic
C410—62 pF, mica
C411—250 pF, mica
C412—620 pF, mica
C413—.0022 µF, Mylar
C414—.0062 µF, Mylar
S401—miniature double-pole 3-position toggle switch (Alco MST205T)
S402—3-pole, 6-position rotary wafer switch
R403—2-pole, 6-position rotary wafer switch
Miscellaneous: printed circuit board
*Note: Components required for optional ×10 probe

Vertical amplifier: The overall gain of the vertical amplifier (Fig. 3) is about 2000 in the full-gain (÷4) position, and about 500 in the calibrated (×1) position of the vertical variable control. Resistor R201 and D201 provide input protection in the event of accidental overload. Source-follower Q201 and common-base amplifier Q202 form a trigger amplifier with a non-inverting AC gain of about 40 and a high input impedance.

Transistors Q203 and Q204 are switched on alternately by the zero-baseline flip-flop (Q307 and Q308, Fig. 4), connecting the base of source-follower Q205 alternately to the signal input and to ground. The stray capacitance of these FET's amounts to about 10 pF, and produces switching transients of about 10 µS duration on the 1-megohm input line.



TOP VIEW of the scope. The amplifier board is beneath the CRT. The power-supply board is at the rear near the transformers mounted on the back panel. The sweep board is up front near the controls. The attenuator board, with its five trimmers, is on a bracket held by the vertical-sensitivity control. Astigmatism control is on rear panel near base of the CRT.

The switching frequency must therefore be held below a few hundred hertz to prevent those transients from being frequent enough to be seen on the CRT display.

Transistors Q206 and Q207 are wired as a variable-gain differential amplifier. Potentiometer R213 is the 10-mV calibrator and sets the gain to four times the indicated vertical sensitivity with R214

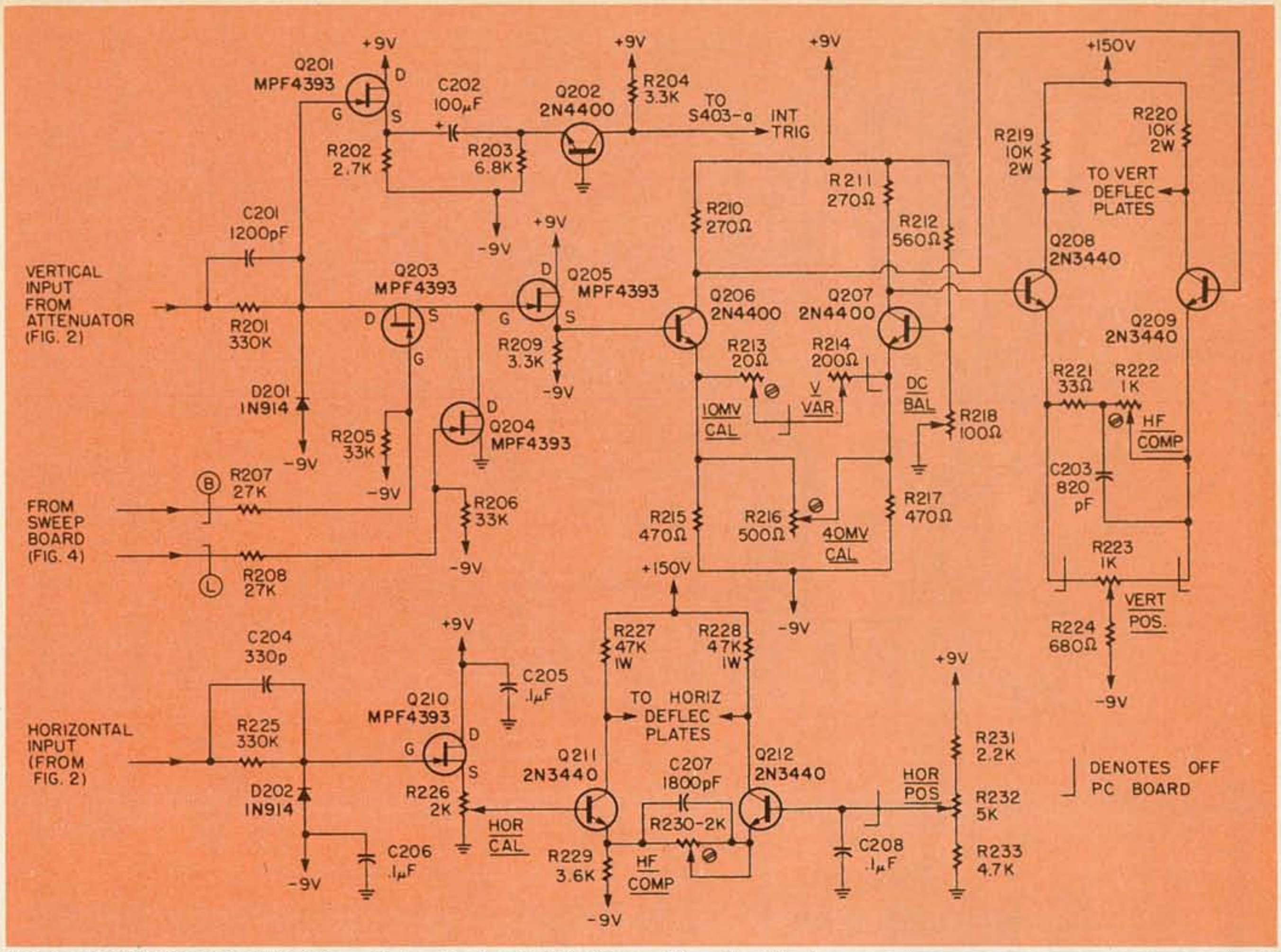
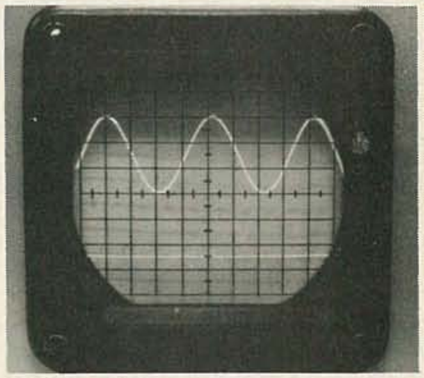


FIG. 3—SCHEMATIC DIAGRAMS of the vertical and horizontal deflection amplifiers. The latter is comparatively simple because its response is limited to the sweep frequencies.

at minimum resistance. Pot R216 is the 40-mV calibrator. It adjusts the indicated sensitivity with R214 at maximum resistance. Pot R218 is the DC balance control; it sets zero voltage between the two emitters at zero input in order that the gain control will not shift the vertical position.

Transistors Q208 and Q209 provide a second stage of amplification, producing a maximum differential output of about 180 volts P-P. Capacitor C203 lowers the impedance between the emitters to track the decrease in impedance between the collectors caused by CRT plate capacitance at high frequencies. Since gain is essentially the ratio of those impedances, C203 tends to preserve a constant gain as frequency increases. Because an 820-pF trimmer would be large and unstable, we adjust the associated resistor (R202) to suit the capacitor, instead of vice-versa. Capacitor C203 thus determines the stage gain, and should be altered if necessary to produce a stage gain of about 50.

Horizontal amplifier: This amplifier (Fig. 3) is similar to the vertical amplifier except that the low-voltage differential stage is omitted and the entire gain (about 70) is achieved in the high-voltage stage. The differential output voltage required is about 250 volts P−P because the second (less sensitive) set of CRT deflection plates is used. Bandwidth is about 500 kHz.



ZERO-BASELINE DISPLAY permits reading the DC component of this waveform. Scale factor is 1 V/div and the sinewave is 3 volts peak-to-peak riding on a 4-volt DC level.

PARTS LIST (Amplifiers, Fig. 3)

Resistors ½ watt, 10%, carbon composition, unless otherwise noted
R201, R225—330,000 ohms
R202—2700 ohms
R203—6800 ohms
R204, R209—3300 ohms
R205, R206—33,000 ohms
R207, R208—27,000 ohms
R210, R211—270 ohms
R212—560 ohms
R213—20 ohms, trimmer, vertical mount
R214—200 ohms, potentiometer
R215, R217—470 ohms
R216—500 ohms, trimmer, vertical mount
R218—100 ohms, trimmer, vertical mount
R219, R220—10,000 ohms, 2 watts
R221—33 ohms
R222—1000 ohms, trimmer, vertical mount
R223—1000 ohms, potentiometer
R224—680 ohms
R226, R230—2000 ohms, trimmer, vertical mount
R227, R228—47,000 ohms, 1 watt
R229—3600 ohms
R231—2200 ohms
R232—5000 ohms, potentiometer
R233—4700 ohms

Capacitors
C201—1200 pF, Mylar
C202—100 μF, 15 volts, radial-lead electrolytic
C203—820 pF, mica
C204—330 pF, mica
C205, C206, C208—0.1 μF, ceramic disc
C207, 1800 pF, Mylar

Semiconductors
D201, D202—1N914 or similar silicon diode
Q201, Q203, Q204, Q205, Q210—MPF4393 or similar N-channel FET (Motorola)
Q202—2N4402 or similar
Q206, Q207—2N4400 or similar
Q208, Q209, Q211, Q212—2N3440 or similar

Miscellaneous: PC or perforated circuit board, hookup wire, mounting hardware, transistor sockets, etc.

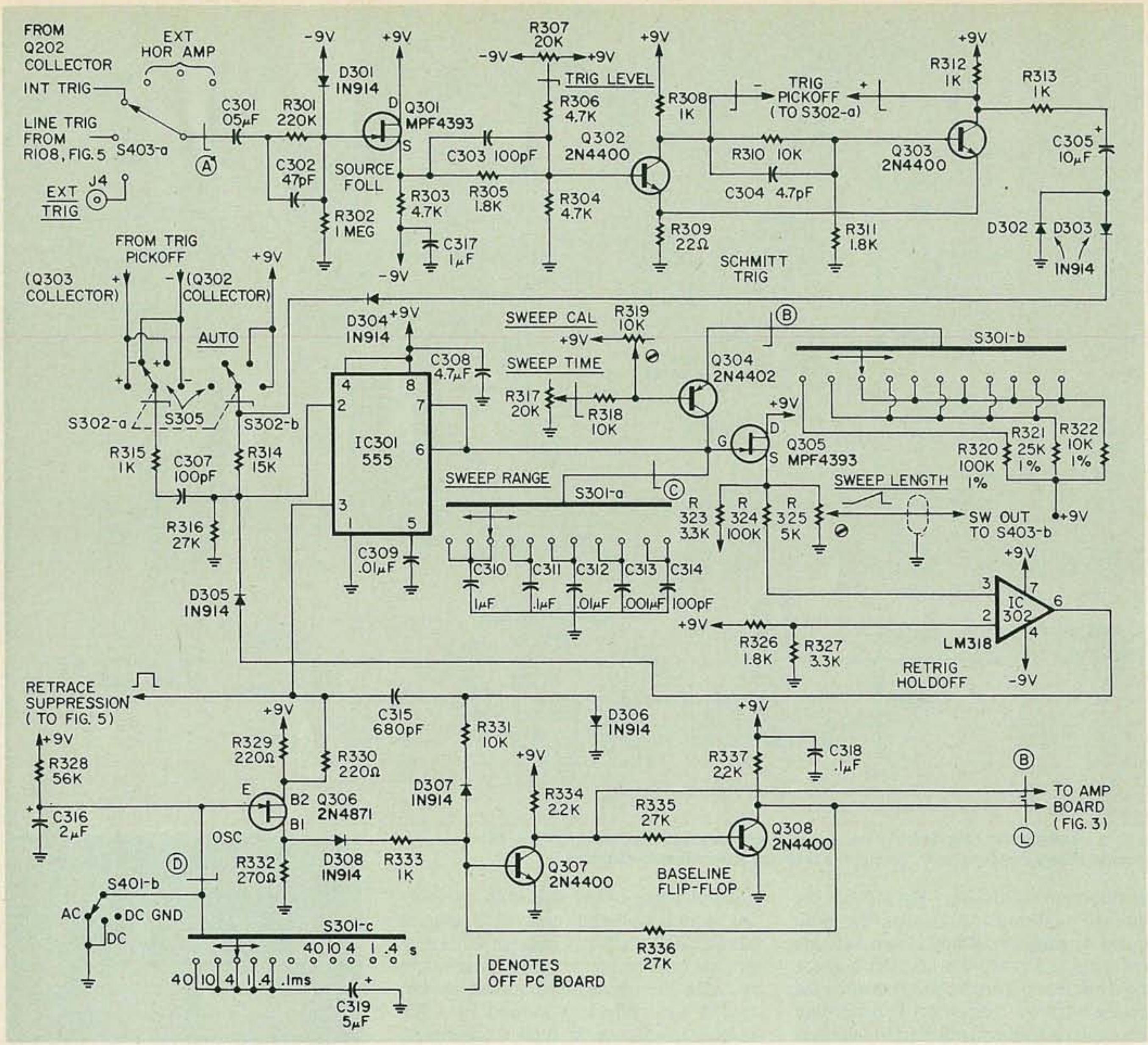


FIG. 4—THE SWEEP and zero-baseline generator circuits comprise the most complex sections of the instrument.

PARTS LIST (Sweep and zero-baseline generators, Fig. 4)

Resistors ½ watt, 10% unless otherwise noted
R301—220,000 ohms
R302—1 megohm
R303, R304, R306—4700 ohms
R305, R311—1800 ohms
R307, R317—20,000 ohms, potentiometer
R308, R312, R313, R315, R333—1000 ohms
R309—22 ohms
R310, R318, R331—10,000 ohms
R314—15,000 ohms
R316, R335, R336—27,000 ohms
R319—10,000 ohms, trimmer, vertical mount
R320—100,000 ohms, 1%
R321—25,000 ohms, 1%
R322—10,000 ohms, 1%
R323, R327—3300 ohms
R324—100,000 ohms
R325—5000 ohms, trimmer, vertical mount
R326—18,000 ohms
R328—56,000 ohms
R329, R330—220 ohms
R332—270 ohms
R334, R337—2000 ohms

Capacitors
C301—.05 μF, 600 volts, ceramic disc
C302, C304—47 pF, ceramic disc
C303, C307—100 pF, ceramic disc
C305, C306—10 μF, 25 volts, axial-lead electrolytic
C308—4.7 μF, 25 volts, axial-lead electrolytic
C309—.01 μF, ceramic disc
C310*—1 μF, Mylar
C311*—0.1 μF, Mylar
C312*—.01 μF, Mylar
C313*—.001 μF, Mylar
C314**—100 pF, ceramic trimmer
C315—680 pF, ceramic disc
C316—2 μF, 25 volts, axial-lead electrolytic
C317, C318—0.1 μF, ceamic disc
C319—5 μF, 25 volts, axial-lead electrolytic
*Note: select to keep ratios within ± 1%
**Note: In prototype, C314 was made by connecting a 47-pF disc in parallel with a 6-60-pF ceramic trimmer

Semiconductors
D301-D308—1N914 or similar silicon diode
IC301—555 timer
IC302—LM318 op-amp (National)
Q301, Q305—MPF4393 or similar N-channel FET (Motorola)
Q302, Q303, Q307, Q308—2N4400 or similar
Q304—2N4402 or similar
Q306—2N4871 or similar unijunction transistor
S401, S403—see attenuator parts list
S301—3-pole, 11-position rotary wafer switch (Centralab PA-10009 or equal)
S302—2-pole, 4-position rotary switch

Miscellaneous: PC or perforated circuit board, shielded cable, transistor and IC sockets, mounting hardware, knobs, etc.

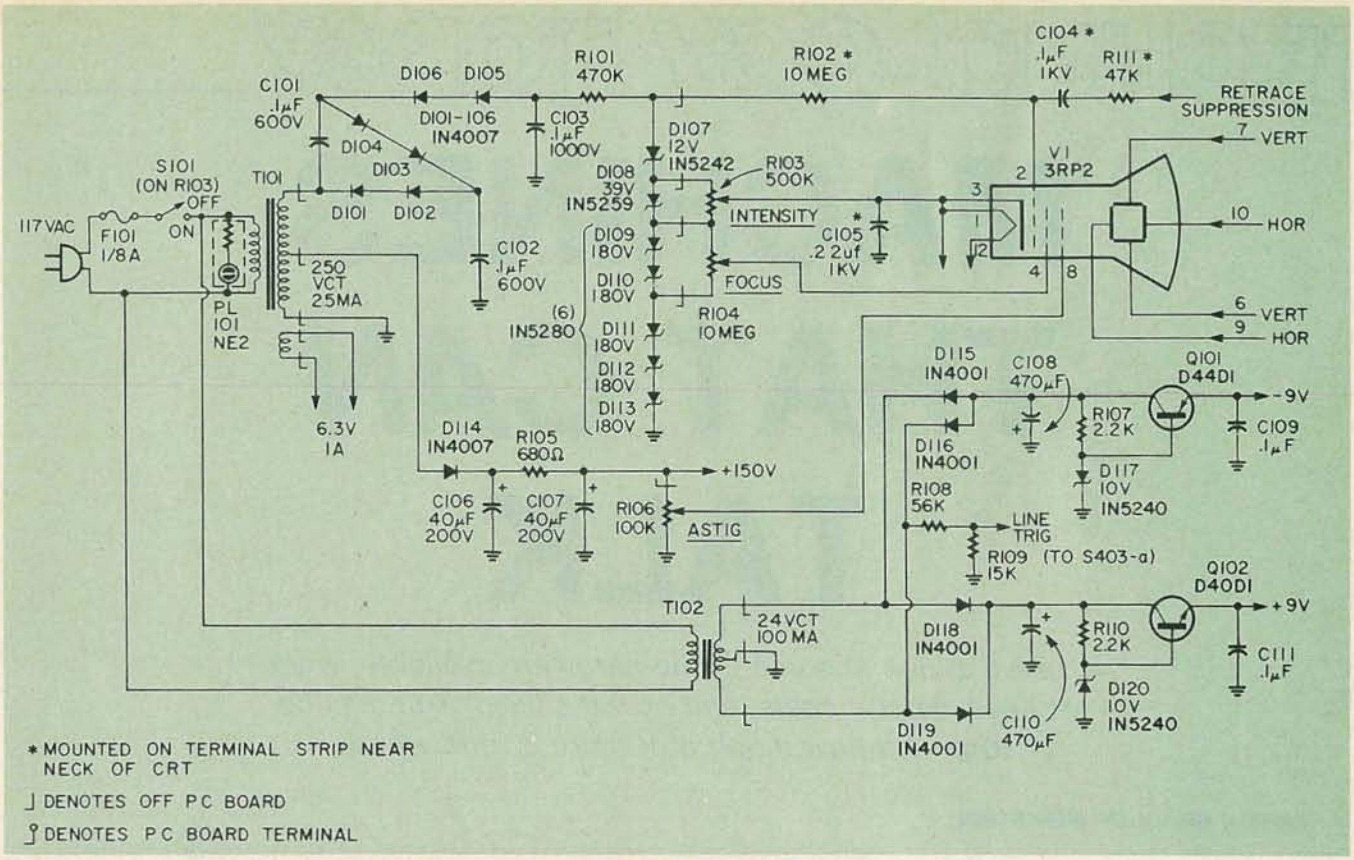


FIG. 5—THE POWER SUPPLY is simple and inexpensive to build. The voltage-tripler replaces the expensive and dangerous high-voltage power transformer used in many scopes. The string of Zener diodes replaces a high-resistance voltage-divider string.

Trigger circuits: Source-follower Q301 (Fig. 4) provides the high input impedance required during external triggering, and the low driving impedance necessary for good sensitivity of the Schmitt trigger, Q302 and Q303. The trigger will operate with 0.1 volt P-P input, and trigger up to 5 MHz with 0.3-volt P-P input. The edges of the Schmitt-trigger output (inverted or non-inverted) are coupled through switch S302-a capacitor and C307 to the trigger input of the NE555, IC 301; that is where the negative edges are used to initiate the sweep ramps.

In the DRIVEN mode, the trigger input is held high by the +9-volt supply through R314 and triggering occurs only by negative pulses from C307. In the AUTO mode, AC detectors D302, D303, and C306 furnish the positive supply as long as the Schmitt trigger is switching. However, if the trigger remains inoperative for longer than about 150 ms, C306 discharges and R316 pulls the trigger input low, resulting in automatic triggering with no input signal.

Sweep circuit: Transistor Q304 is a variable-current source that charges the selected timing capacitor (C310 through C314) at a linear rate depending on the sweep variable control and the selected timing resistor (R320 through R322). Pin 7 of the NE555 automatically discharges the capacitor whenever pin 6 rises to +6 volts. A source-follower Q305 buffers the ramp since any current drawn from it would destroy its linearity. Pot R325 reduces the ramp to 4.4 volts, thus providing 11 divisions of sweep to the 0.4 volt-per-division horizontal amplifier.

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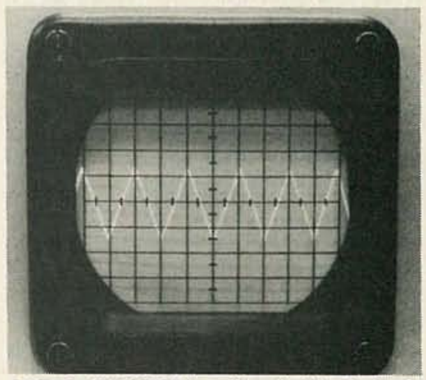


SWEEP LINEARITY is evident in this photo of a 500-kHz triangle waveform at 1 mV/div.

PARTS LIST (Power supplies, Fig. 5)

Resistors ½ watt, 10% carbon composition unless otherwise noted
R101—470,000 ohms
R102—10 megohms
R103—500,000 ohms potentiometer with SPST switch
R104—10 megohms, potentiometer
R105—680 ohms
R106—100,000 ohms, potentiometer
R107, R110—2200 ohms
R108—56,000 ohms
R109—22,000 ohms
R111—47,000 ohms

Capacitors
C101, C102—0.1 uF, 600 volts, tubular
C103, C104—0.1 uF, 1000 volts, tubular
C105—.22 uF, 1000 volts, tubular
C106, C107—40 uF, 200 volts, axial-lead electrolytic
C108, C110—470 uF, 25 volts, radial-lead electrolytic
C109, C111—0.1 uF ceramic disc
V1—CRT, 3RP2 was used in prototype. 3EP1, 3RP1, 3BP1 and 3ACP11 can be used. See text.

Semiconductors
D101–D106, D114—1N4007
D107—1N5242 Zener diode, 12 volts, 500 mW
D108—1N5259 Zener diode, 39 volts, 500 mW
D109–D113—1N5280 Zener diode, 180 volts, 500 mW
D115, D116, D118, D119—1N4001
D117, D120—1N5240 Zener diode, 10 volts, 500 mW
Q101—D41D1 (GE) or similar PNP silicon transistor
Q102—D40D1 (GE) or similar NPN silicon transistor
F101—1/8-amp fuse
PL101—neon pilot-light assembly (NE-2 lamp with 68K resistor)
S101—SPST switch (part of R103)
T101—power transformer, 250 volts center-tapped, 25 mA; 6.3 volts, 1 amp. (Stancor PS-8416 or equivalent)
T102—power transformer, 24 volts center-tapped, 100 mA (Stancor P-8395 or equivalent)

Miscellaneous: Fuse holder, line cord, PC or perforated circuit board, hookup wire, terminal strip, MuMetal shield for CRT, CRT socket, transistor sockets, etc.

TECHNOLOGY TODAY

MACHINES THAT CAN TALK

Here's a look at some of the hardware available; what it does, what it costs, and how it's used. You may be surprised how much of it there is, and where.

MARTIN BRADLEY WEINSTEIN

LAST TIME WE LOOKED AT THE PROBLEM of how a human voice might be synthesized, from the simplest digitized recording media to the sleeker new equipment (**Radio-Electronics,** March 1980).

The block diagram (Fig. 1) boils it all down into the most common areas of circuitry (by function) found in the more sophisticated general vocabulary synthesizers. How each function is handled varies widely from manufacturer to manufacturer, and often from product to product. But in some form or another, those elements almost always occur.

Somehow, having actual equipment to look at and talk about (eventually, to listen to) tends to make things easier to understand. So here's a brief review of the equipment available today, plus a peek at early tomorrow.

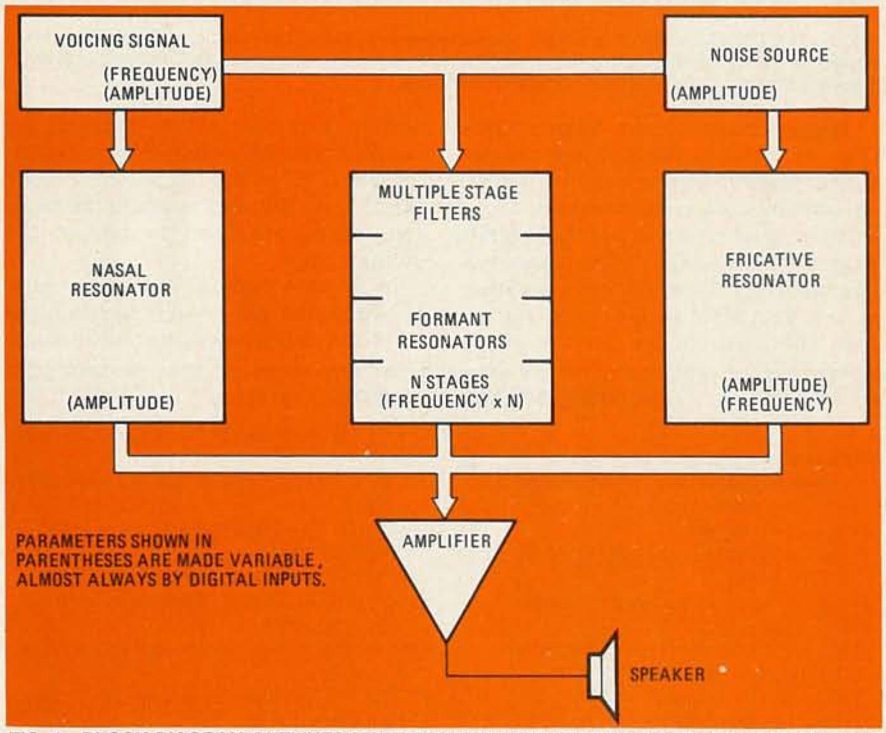
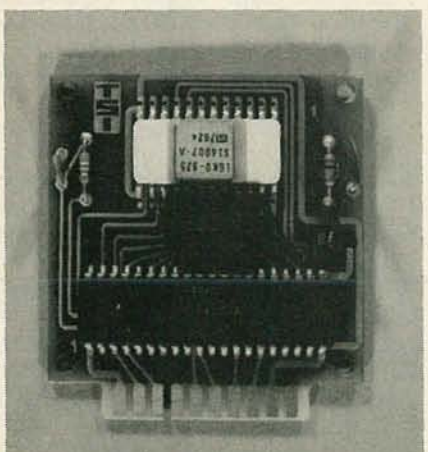


FIG. 1—BLOCK DIAGRAM OUTLINES MOST COMMON CIRCUITRY (by function) found in the more sophisticated general-vocabulary speech synthesizers.



A TALKING CALCULATOR, the TSI Speech + is a most-handy device.

Telesensory Systems, Inc.

Speech +™ is a talking calculator designed for the blind and vision-impaired. In addition to operating as any normal calculator might, it offers the option of having its calculations announced by a built-in, 24-word-vocabulary speech snythesizer.

Telesensory Systems, Inc. (TSI, 3408 Hillview Avenue, P.O. Box 10099, Palo Alto, CA 94304), the manufacturer of Speech +, offers the board—in English —for $150. The same vocabulary is available in a small printed-circuit board module (less filters, amplifier, speaker) −in English, French or German—for $95. And for $179, two 64-word modules are available: one designed for announcing key hits on typewriter-style keyboards, the other for announcing electronic instrumentation readings.

Those modules contain little more than a custom MOS microprocessor

TELESENSORY SYSTEMS model Speech +

built for TSI by General Instruments, and a ROM or two. Custom vocabularies are available to OEM's interested in large-volume purchases, and to those of us willing to invest $200 per word for custom coding.

TSI has also announced a two-chip set of custom LSI IC's that can be applied to speech synthesis, as well as other tasks, but details are still a few months away.

Just now out from TSI is a special $1500 speech snythesizer designed for elevators. ("Penthouse, going up.") The Elevator Voice Module includes circuitry that interfaces with the elevator controls, a speech synthesizer with custom elevator vocabulary, and the audio amplifier and speaker.

Votrax Division

Votrax Division of Federal Screw Works, (500 Stephenson Highway, Troy, MI 48084) manufactures what may be the broadest line of voice synthesizers available today.

Starting at the top of the pile, the *LVM-70 Business Communicator* is a fixed-vocabulary computer peripheral designed to tie into from 4 to 64 telephone lines. It offers up to 128 seconds of speech, translatable into as many as 256 individually-addressable variable-length messages. Voice quality is excellent. That is the kind of voice/speech synthesizer often used with banks, telephone services, and "talking" computer services. Prices vary from under $10,000 to over $50,000, depending upon capabilities.

Working our way down the price stream, we find a generalized-vocabulary phonetic (phoneme-based) speech synthesizer capable of speaking English, German, Spanish, Italian, Japanese, French, and Farci. The key to that flexibility is an un-minimized phoneme set, including 122 selectable phonemes; in addition, each 12-bit command word permits 8 levels of inflection, or *pitch*, and 4 phoneme rates, or *duration*... yes, you *can* program it to speak with a

BUSINESS COMMUNICATOR model LVM-70 is a fixed vocabulary computer peripherial from Votrax.

drawl. The *ML-1 Multi-Lingual Voice System* doesn't come cheap (except, perhaps, comparatively, in terms of value received), with prices between roughly $6000 and $8000, depending on configuration, plus $1500 for the companion keyboard and more for every

MULTI-LINGUAL VOICE SYSTEM, model ML-1, also from Votrax, speaks in seven languages, including Farci.

language after English (standard). It's well worth it, though, where multilingual capabilities are needed in conjunction with a computer, as evidenced by the success of the *ML-1* in schools.

In the $3500 to $5000 range, the Votrax *VS-6 Electronic Voice System* uses 8-bit command words to select 61 phonemes and four levels of inflection; one *VS-6* user has reportedly developed a vocabulary of over 300,000 words for it. While priced well beyond most hobby budgets, the *VS-6* performs admirably in a number of fascinating applications, including military flight simulators,

AS MANY AS 300,000 WORDS have been developed by one user of the Votrax VS-6 Electronic Voice System.

talking instrumentation, handicapped aids, and talking OCR (optical character recognition) printed copy readers.

Votrax also manufactures the Radio Shack *TRS-80 Voice Synthesizer*, and includes with it software for a talking blackjack game. The user hears cards shuffling and the banter of a "wise guy" dealer.

RADIO-SHACK SPEECH SYNTHESIZER is a part of their TRS-80 personal computer system and is available as an option.

HC Electronics, Inc.

That division of American Hospital Supply Corporation (HC Electronics, Inc., 250 Camino Alto, Mill Valley, CA 94941) manufactures and distributes products for language and speech therapy. Their two speech snythesizers, *Phonic Mirror® HandiVoice™* models *HC110* and *HC120*, are actually manufactured for them by Votrax.

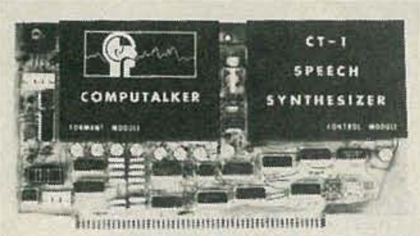
The *HC110* is a lap-size, flat device designed for young children, the handicapped, or developmentally disabled persons with speech impairments or disabilities. Most of its surface is covered by its 128-key keyboard, itself covered with one of three overlays—words, graphics, or symbols. It is preprogrammed with 373 words, 45 phonemes, 26 letters (the English alphabet), 13 morphemes (standard word prefixes and suffixes), and 16 short phrases like "My name is...", "How are you?", "Would you come here?".

HANDIVOICE HC120 is a portable device for language and speech-therapy applications.

The *HC120*, by comparison, is a physically smaller unit that offers all the capabilities of the *HC110*, plus an additional 520 words, accessed by a 4×4 keyboard and a 3-digit control code.

Computalker Consultants

One of the least expensive, though highly capable, speech synthesizers available that is based on phonemes, yet capable of direct parameter control, is the *CT-1 Speech Synthesizer* by Computalker Consultants (P.O. Box 1951, Santa Monica, CA 90406).



HIGH-CAPABILITY CT-1 SPEECH SYNTHESIZER from Computalker is available for the TRS-80, Apple II and S-100 computer systems.

The CT-1 is in the $425 to $550 range, depending on software options, and plugs into the S-100 bus. Pre-packaged AC-powered versions for Apple II *(CT-1A)* and the TRS-80 *(CT-1T)* are available for $595.

In the *Direct Parameter Control Mode*, signals modeled after previously-decoded words are used to recreate them. That is obviously a limited-vocabulary approach, but the naturalness of speech is especially high; even the mannerisms of the original speaker are preserved.

The *Phonetic Mode*, by comparison, is phoneme-based, but with a twist. Target values for each phoneme parameter are first located, then a smooothing-calculation performed to calculate parabolic trajectories between them. The result is less mechanical-sounding speech.

The computer hobbyist interested in experimenting with speech snythesis is strongly urged to investigate Computalker.

Also, about a year from now, expect news from Computalker about a totally digital system, replacing their current analog approach. Much of the cost of their current hardware is attributable to precision tuning and calibration of the many analog-circuit sections, a cost that the all-digital approach promises to all but eliminate.

Texas Instruments

While the TI approach to speech synthesis leads inevitably to fixed vocabulary products (for the time being, at least), their expertise with high-density memories and the economies of high-volume production has yielded a group of products affordable and useful at a general-consumer level.

Speak & Spell™ (mine cost about $55), was introduced a couple of years ago. It conducts spelling bees and plays word games, primarily for children. (My wife and I both get a kick out of ours, though we have no children.)

New ROM modules to expand the vocabulary of Speak & Spell have now been introduced. Vowel Power™ (recommended resale $15) adds 140 words to help children master vowel sounds in four categories. Two new Super Stumpers modules (also $15 each) for grades 4–6 and 7–8 add word lists to cover such problems as silent letters, irregular spellings, double consonants, and homonymous spellings.

TEXAS INSTRUMENTS' NEW HOME COMPUTER has a speech-synthesizer accessory available. They also use synthesizers in other products.

The heart of the Texas Instruments approach to speech synthesis is multiple-stage digital filtering and Linear Predictive Coding—a mathematical approach to modeling, analyzing, and synthesizing the human voice. While TI is producing 40,000 to 60,000 synthesizers-on-a-chip each month, their entire production output is currently going into TI products.

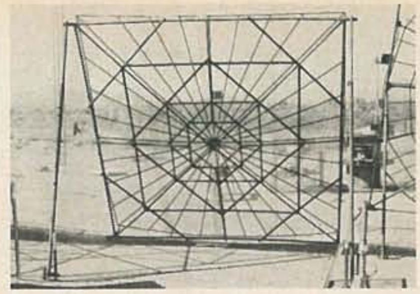
Two of those products are their talking Language Translator (about $300, with $60 modules to translate English, French, Spanish, German, Chinese, and Japanese) and their new Home Computer. The Solid State Speech TM peripheral (suggested resale $150) synthesizes a 200-word vocabulary.

Who else?

Lexicon, Craig, Matsushita, and others have all admitted to "looking at" talking products. National Semiconductor has announced a one-chip synthesizer, about which little has reached us. Ohio Scientific offers a speech synthesizer of some description for their Challenger computers, but repeated calls to the company have resulted in no information to date.

Stay tuned. There's no telling who will speak up next. **R-E**

BUILD THIS



BACKYARD SATELLITE TV RECEIVER

Conclusion of Bob Cooper's series on operational satellites that are relaying television programs and how we can receive their signals. This story describes receiver-system hardware and how it goes together.

ROBERT B. COOPER, JR.

IN THE PREVIOUS SIX PARTS OF THIS ARticle series, appearing in the August through October 1979 issues and the January through March 1980 issues, we have developed the background for the presently operational domestic and INTELSAT satellite systems that are transmitting television via satellite relay to virtually every portion of the globe. In the January and February issues, we have looked closely at the construction that is required to build your own low-cost home satellite television receiving terminal using a special spherical antenna design (February 1980 issue of **Radio-Electronics**), a single conversion 4-GHz-to-70-MHz GAAS-FET LNS plus active mixer package (March 1980 issue of **Radio-Electronics**) with an accompanying 24-channel frequency-agile tuning system.

In this seventh and final part, we will describe the 70-MHz IF-to-baseband system, and show you how to reconvert the baseband video and audio signals back to a standard NTSC-format RF carrier that can then be tuned in on your standard television receiver.

Gain at 70 MHz

In part six of this series we determined the amount of gain required between the 4-GHz feedhorn antenna receiving energy from the spherical reflector surface, and the baseband demodulator operating at 70 MHz. We determined that between 70 and 90 dB of voltage gain is required and that around 20 to 25 dB of that gain should be provided by the GAAS-FET LNA (two stages). The amplified signal from the LNA should then drive a similar GAAS-FET active mixer converting our 4-GHz signal down to a more manageable (and comfortable!) 70-MHz IF. The balance of the gain should then be provided by the 70-MHz circuitry.

Getting gain at 70 MHz is so simple that it almost becomes a waste of space here to tell you how to get it. Here are several suggestions:

1. You need 50 dB of gain here.
2. How you get it is relatively unimportant although if you can keep the noise figure of the IF amplifier at or below 8 dB you will be much better off. (Too high a noise figure here will degrade the carefully created low noise figure from the 4-GHz to 70-MHz mixer.)
3. You may *not* need to build this IF amplifier; it may be lying over in the corner of your shop or down the street.

Virtually all of the pre-1970 era microwave equipment employed a 70-MHz IF strip, usually made up of six to ten tubes operated in cascade or cascode. Typical IF strings have 50 to 90 dB of gain (much more than you need and you'll have to cut it back) and such gear is around in surplus outlets (usually without power supply) for around $10 an IF strip. Another source for 70-MHz IF gain is a CATV or MATV line amplifier. Typical line amps (the boards are available at local CATV firms, where they are taken out and discarded or sold as junk) have 25 to 30 dB of gain maximum and it will take a pair to get the gain you require.

However, the easiest—and perhaps for the most cheapest—way to get 50 or so dB of IF gain at 70 MHz is to investigate the Motorola AWT-120, a three-lead device that operates from near DC to around 300 MHz with 14 dB of gain with an acceptable noise figure. Four of those in series will give you 56 dB of voltage gain at 70 MHz. The AWT-120 is easy to make operate. Of the three leads, there is a ground pin, an input pin, and an output pin. The operating voltage (12 volts regulated) feeds into the output pin through a 330-ohm resistor. You couple into and out of the device through a .01 disc capacitor. Just pop four in a row on a piece of G-10 *double sided* board and you are in business. The AWT-120 costs around $6 per device; for $30 or so you have the full 50+ dB-gain IF strip.

Note however that our gain is spread from near DC to 300 MHz. And all we really want is the 30-MHz-wide spectrum between 55 MHz and 85MHz, centered on 70 MHz. Obviously we need some bandpass filtering in here someplace.

There are sound arguments for placing the 70-MHz bandpass filter *ahead* of the IF strip, and for placing it *after* the IF gain string. Some builders compromise and place it in the center of the string, or between the first and second AWT-120 devices. Briefly, if you place the bandpass filter ahead of the IF gain string, you run the risk of permitting a mistuned (or improperly built) 70-MHz bandpass filter to degrade the noise figure of the system. The bandpass filter will have some loss and that loss be-

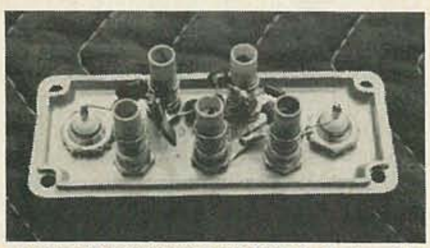
FIG. 1—BLOCK DIAGRAM shows how the 70-MHz signal from the mixer is converted to an NTSC RF output suitable for connection to the antenna terminals of your TV receiver.

comes part of the total system signal-to-noise equation. We'll describe a nearly foolproof 70-MHz bandpass filter for you shortly.

If you place the bandpass filter after the IF gain string, you run the risk of amplifying in the IF string undesirable heterodyne-produced products that may sum the desired signals coming out of the 4-GHz-to-70-MHz IF port on the mixer and causing the AWT-120 (or whatever) IF string to go into saturation. One solution is to run the AWT-120 first stage immediately after the 70-MHz IF output from the mixer, then stick in your bandpass filter, and proceed thereafter to amplify the 70-MHz signal in another three stages. We'll leave the final decision to you, noting only that we have placed the 70-MHz bandpass filter at the end of the IF string in the block diagram shown in Fig. 1.

Bandpass filter construction

There is no way we can suggest in good conscience that you will be able to construct and tune up this bandpass filter by eye or meter. You will need to run down a good CATV-type sweep generator and marker system to show you where in the spectrum you are tuning, and a detector and display. The sweep system should span the 50-to-100-MHz region as a minimum to align the bandpass filter properly.



70-MHZ IF BANDPASS FILTER is designed to pass a 30-MHz-wide spectrum centered on 70 MHz to provide the satellite-TV receiver with the selectivity required to separate adjacent satellite transponders.

Building the bandpass filter, shown in Figs. 2-a and 2-b, is not complicated, and if you follow the layout shown and mount the device in the Bud box recommended you won't have any problems. The coil forms, wire size, and capacitors (all are 5% dipped micas; don't substitute!) are important. If you change anything in the parts called for, you have just entered the R and D business and you'll have to recompensate other part valves accordingly. Properly constructed, and aligned, the passband of the IF filter will be from 55 to 85 MHz, ± 3 dB at the very edges, with less than 1.5-dB insertion loss and a passband ripple of less than ± 0.5 dB from 60 through 80 MHz.

70 MHz to baseband

The utter simplicity of recovering good quality satellite TV video and audio becomes apparent as you study Fig. 3 (for the video) and Fig. 4 (for the audio). The secret is that you are coming into the field "late;" all of the dozen-transistor circuits worked out initially, some three or more years ago, have fallen by the wayside since clever design people such as Taylor Howard of Stanford tackled the project with an eye to reducing every section of the system to its basic required parts.

The 70-MHz IF input, following the 70-MHz IF gain-string, plugs into the input side (left hand side) of Fig. 3. The NE564 phase-locked loop makes a dandy video demodulator for this application, although note that there is this 5% warning:

The 564 is operating at the upper end

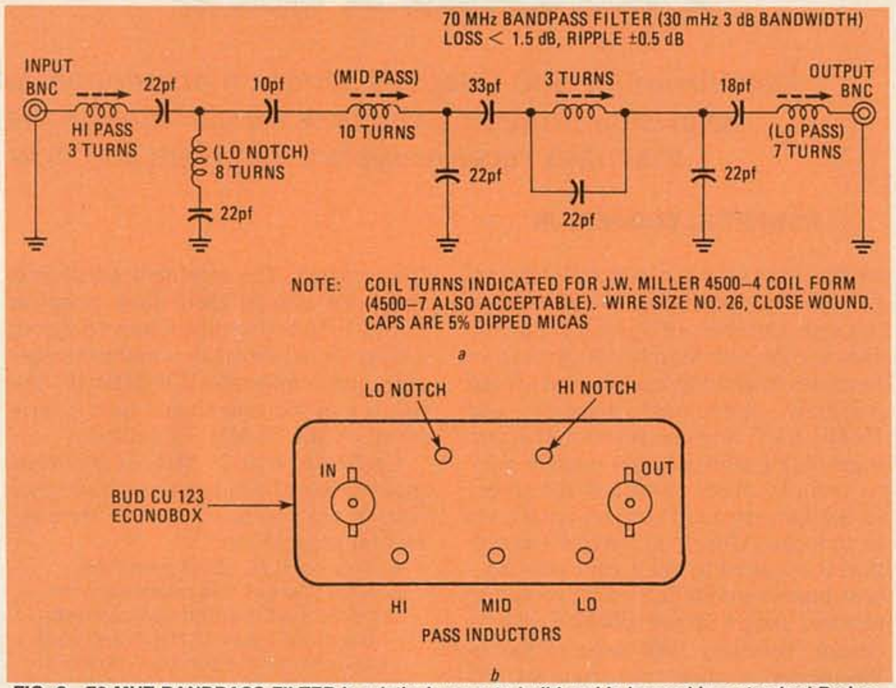


FIG. 2—70-MHZ BANDPASS FILTER is relatively easy to build and is housed in a standard Bud enclosure.

PARTS LIST (70 MHz to baseband, video/audio)

Resistors ¼ watt, 10% unless otherwise specified
R1—2200 ohms
R2—27,000 ohms
R3, R7; R27—1000 ohms
R4—200 ohms
R5, R17, R23, R28, R29—10,000 ohms
R6—3900 ohms
R8–R10, R12—147 ohms
R11—41 ohms
R13; R19—22,000 ohms
R14–470 ohms
R15, R16, R18–560 ohms
R20, R21—10,000 ohms, potentiometer
R22—270 ohms
R24–R26—100,000 ohms
R30—510 ohms

Capacitors
C1, C4, C6, C15, C19—.01 μF ceramic disc
C2—1 μF, 15 volts, electrolytic
C3—100 μF, 20 volts, electrolytic
C5—.001 μF ceramic disc
C7—1.5 to 8 pF trimmer
C8, C9—3 pF dipped silver mica
C10—330 pF
C11—4400 pF
C12—91 pF
C13—300 pF
C14—100 μF, 10 volts, electrolytic
C16—1 μF, 20 volts, electrolytic
C17—15 μF, 15 volts, electrolytic
C18—300 μF, 16 volts, electrolytic
C20—22 μF, 6 volts, electrolytic
IC1—7812 voltage regulator, +12 volts
IC2—NE564 phase-locked loop
IC3—NE592 video amplifier
Q1–Q3—2N2222
D1—HP5082/2800 Schottky diode (Hewlett-Packard)
D2—1N5248 Zener diode, 12 volts
RFC1—100 μH
RFC2—2.7 μH
RFC3—4.7 μH

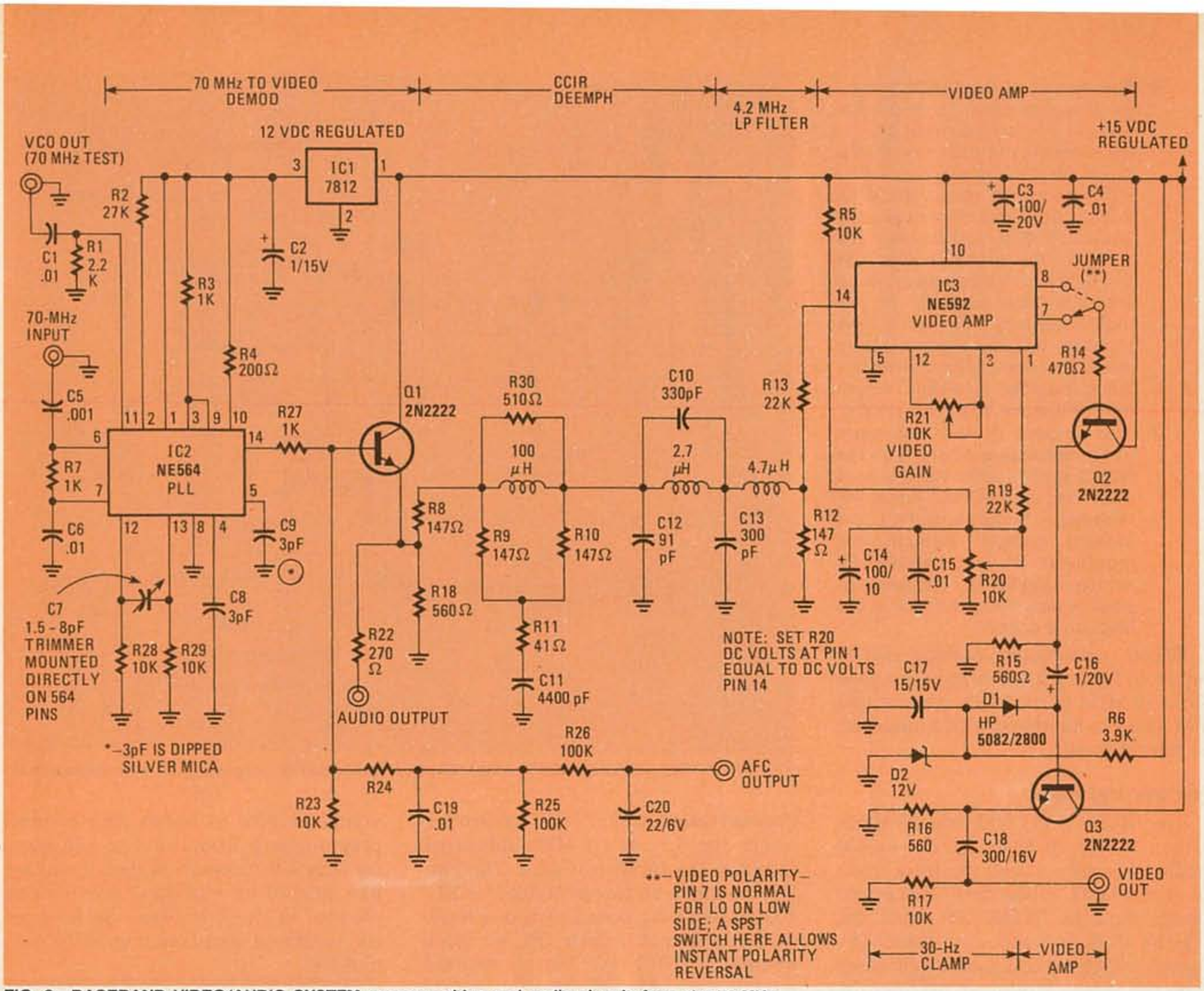


FIG. 3—BASEBAND VIDEO/AUDIO SYSTEM recovers video and audio signals from the 70-MHz output of the IF strip.

of its frequency range in this application, and you may find that some small percentage of the 564's around will not demodulate properly the video from the 70-MHz carrier. On the other hand (here's the good news), some 564's function to nearly 100 MHz. They are not touchy; several of the newer commercial receivers use the same device for this purpose and thousands of home-brewed receivers have been built using this approach.

The 564 provides video input that is amplified by a garden-variety 2N2222. Note that the audio-subcarrier comes off the emitter of the 2N2222 through a 270-ohm resistor. We'll talk about recovering the audio shortly.

Following the 2N2222 is a CCIR de-emphasis network. That's a collection of passive devices designed to establish the proper video baseband curve that matches the pre-emphasis networks used by the satellite TV transmitter on the uplink end. Without that network in place you'll get something less than true colors and will experience other video problems. Following the CCIR de-emphasis network is a 4.2-MHz low-pass filter network. This is in place to insure that the 6.2-, 6.8,- or 7.4-MHz audio subcarrier does not get on into the balance of the video circuits. Frequencies above 4.2 MHz in the baseband region do not contribute to the video quality and in fact, if left in, will create high-frequency video noise on your baseband video signal.

Between the second 2N2222 (following the NE592) and the third such stage is a harmless-looking Schottky diode-the HP 5082/2800. That is a clamp diode. You may recall from previous sections that the uplink signals transmitted to the satellites are "frequency dithered" at a 30-Hz rate as a means of dispersing the energy waveform over a relatively wide band (36 MHz if you follow out to the 1% energy levels). That dispersal action was motivated by designers of early INTELSAT systems, who feared they might cause interference to terrestrial microwave circuits operating in the same 3.7-to-4.2-GHz region. Spreading the waveform energy out with the 30-Hz waveform reduces the probability that any appreciable amount of satellite TV downlink energy will get into any terrestrial system. To get rid of the 30-Hz waveform we shove the video into a hard clamp. The Schottky diode is fast and it clamps the 30-Hz waveform to ground by as much as 40 dB or more. That either eliminates the 30-Hz flicker in the picture or reduces it to the point where it cannot be seen.

There are these caveats and cautions about this portion of the system:

1. Use only double-sided board; good quality G-10 board will do.
2. Mount the finished board in a container, grounding all the way around on both sides of the board. Place the 15 VDC regulated line on the backside of the board along with power supply bypasses and the 7812 regulator.
3. The 70-MHz VCO output test jack is for setting the operating frequency of the PLL to 70 MHz. Adjust the 1.5-to-8 pF trimmer (C7) for 70 MHz (a counter is handy but you could do it with the TV monitor tuning for best picture).
4. Adjust pot R20 off pin 1 of the NE592 for the same voltage on pin 1 as you have on pin 14 of the same device.
5. The AFC output shown is not totally applicable to the system you are *presently* building. As you get more sophisticated in using your home terminal you may wish to add an AFC system later on (as many have) and that brings it out so it is available when you wish to add the feature.

6. The output of the NE592 (pins 7 or 8) is selectable for good reason. As long as your local oscillator is driving the 4-GHz-to-70-MHz mixer on the low side (i.e. 4 GHz input frequency minus the VTO-8360 local-oscillator source equals 70 MHz) you will find the video in the proper polarity on pin 8. If you mistune and end up with the local oscillator on the high-frequency side, you'll have to swap the video output lead to pin 7 to re-establish the proper video polarity. A simple switch here will make changing simple.
7. The purpose of 10K video-gain pot between pins 12 and 3 on the NE592 is to set your video output level into your NTSC format RF modulator. Simply tune it for best looking picture, through the modulator, on your standard TV set (typically in the 1 volt peak-to-peak region if you can look at the level on a scope.)

There is absolutely nothing else to adjust or fiddle with! You have just gone from 70 MHz to relatively complicated FM video to baseband with a minimum of harrassment.

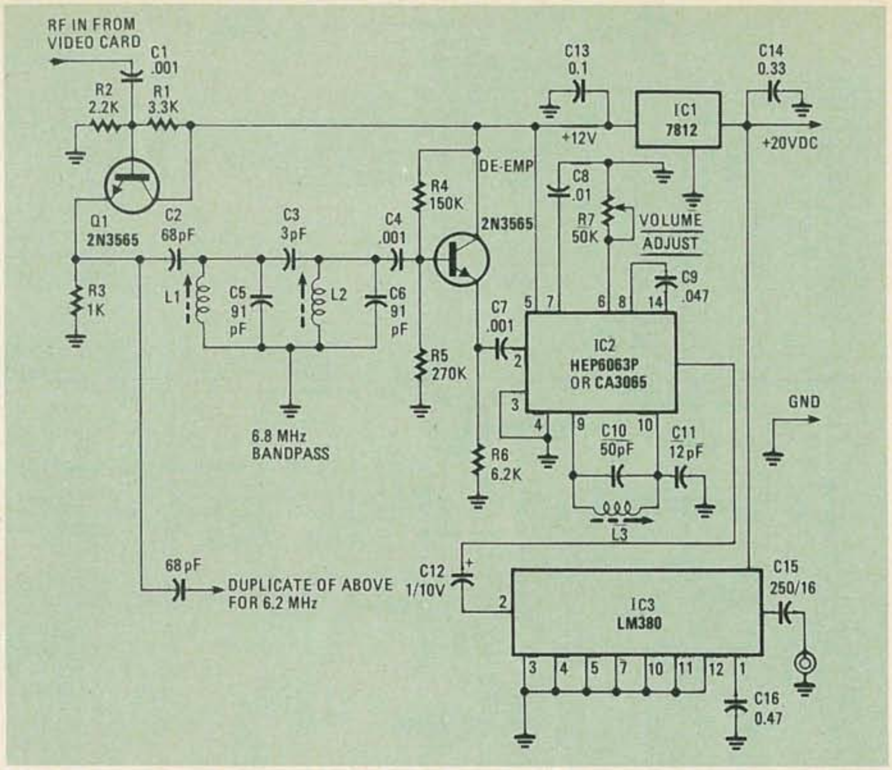


FIG. 4—6.8-MHZ AUDIO DEMODULATOR. Circuit is duplicated for recovering 6.2-MHz audio signal.

Recovering Audio

The RCA SATCOM and Western Union WESTAR birds carry their FM audio on either 6.2 or the more common 6.8-MHz subcarriers. When you demodulate the 70-MHz IF signal, the NE564 PLL recovers that higher-frequency baseband component right along with the video. We take it off after the first 2N2222 baseband amplifier and send it on to a second demodulator which is L-C tuned to the 6.2- or 6.8-MHz subcarrier frequency.

Two methods of recovering the audio are presented here. In Fig. 4 we have the basic (Taylor Howard developed) audio demodulator that uses a 2N3565 amplifier, a tuned network designed for either 6.8- or 6.2-MHz, a second 2N3565 amplifier, a (Motorola) HEP6063P demodulator (or RCA CA3065), and finally an audio amplifier. That system has seen thousands of duplications by home builders and it works just fine.

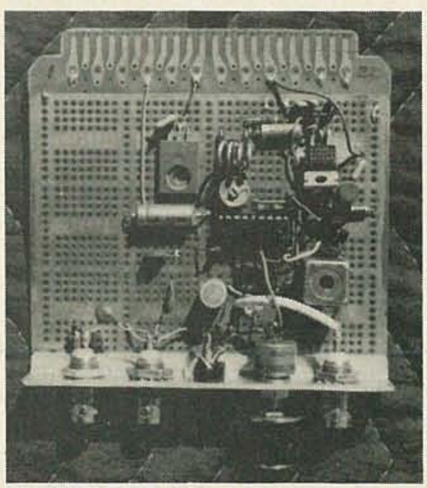
Simply tune L1 and L2 for the desired frequency (6.8- or 6.2-MHz) and then tune L3 for recovery of the audio on that frequency by simply listening on some suitable audio-display system. There is a 50K volume-control pot and those are the only adjustments that are in the system.

Figure 5 shows how to do the same thing for about $12 for each audio subcarrier desired and perhaps 15 minutes of your time. Several satellite TV enthusiasts in the Indianapolis area, where RCA has a production facility, discovered that the RCA XL-100 audio demodulator (model PM-200) can be field-modified with a pair of capacitors to tune not the usual 4.5-MHz subcarrier channel found in the NTSC system but rather the 6.2- or 6.8-MHz subcarrier found in the satellite system. The PM-200 is a stock replacement item for XL-100 chassis; it is a complete module ready to hook up and operate (RCA's stock number is 130-753). You go into the module and add capacitors C1 and C2 (both 33 pF to hit 6.8-MHz) as shown. Input is through pin 3. As noted, the cost of this module (new, through an RCA parts house) is in the $12 range.

Once again, recovering the satellite audio is not much of a trick.

Modulating to NTSC

Now that you have the baseband video and audio displayed on a color-video monitor and audio system, it would be nice to watch your favorite programming from satellite programs on your TV receiver. In fact, if you are like most of us, you don't own a video monitor in the first place. So let's get the baseband signal back to NTSC format RF.



RF MODULATOR construction followed by do-it-yourself satellite-TV enthusiasts. This module is the RF modulator described in the text using the LM1889 IC device.

PARTS LIST
(Audio demodulator, Fig. 4)

Resistors ¼ watt, 10% unless otherwise noted
R1—3300 ohms
R2—2200 ohms
R3—1000 ohms
R4—150,000 ohms
R5—270,000 ohms
R6—6200 ohms
R7—50,000 ohms potentiometer
Capacitors
C1, C4, C7—.001 μF
C2—68 pF dipped mica
C3—3 pF dipped mica
C5, C6—91 pF dipped mica
C8—.01 μF
C9—.047 μF
C10—50 pF dipped mica
C11—12 pF dipped mica
C12—1 μF 10 volts, electrolytic
C13—0.1 μF
C14—.33 μF
C15—250 μF, 16 volts, electrolytic
C16—.47 μF
Q1, Q2—2N3565
IC1—7812 voltage regulator, +12 volts
IC2*—HEP6063P or CA3065
IC3*—LM380
L1, L2—adjustable RF coil, 3—7 μH (J.W. Miller No. 9051)
L3—adjustable RF coil, 7—14 μH (J.W. Miller No. 9052)
***Note: The RCA CA3134GM can replace the CA3065/LM380 combination**

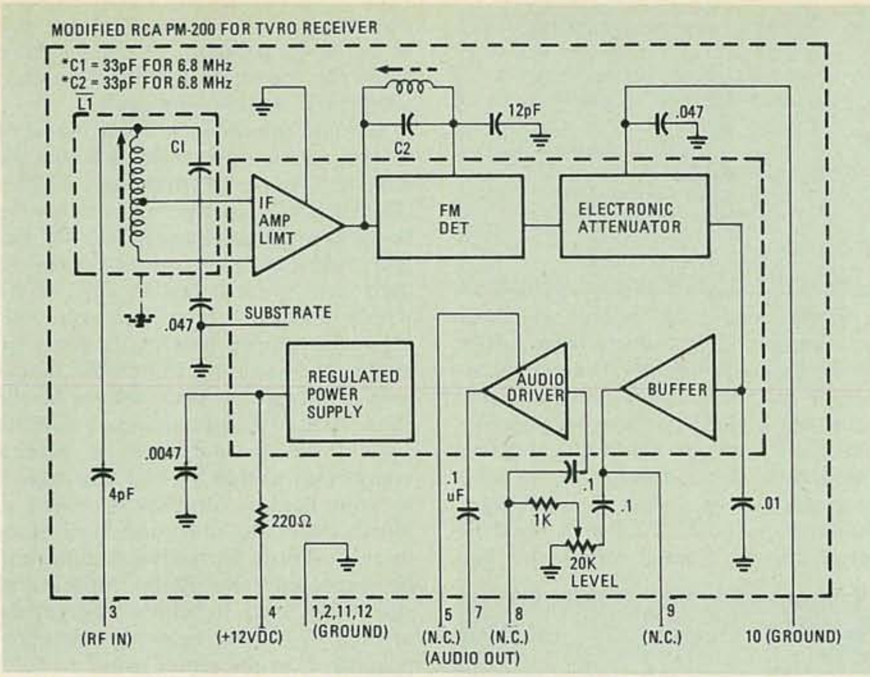


FIG. 5—ALTERNATE APPROACH to subcarrier audio detection uses a standard module from an RC TV receiver.

If you own a video-tape recorder, you already have a modulator. Simply connect the video output of the satellite receiver to the video input jack on the VCR, the AUDIO OUT to the AUDIO IN, and switch the VCR to CAMERA INPUT. Now run a piece of RG-59/U coaxial cable from the output of the VCR to your TV receiver(s). And the satellite signals will appear on the modulated channel determined by the VCR modulator switch (typically Channel 3 or 4).

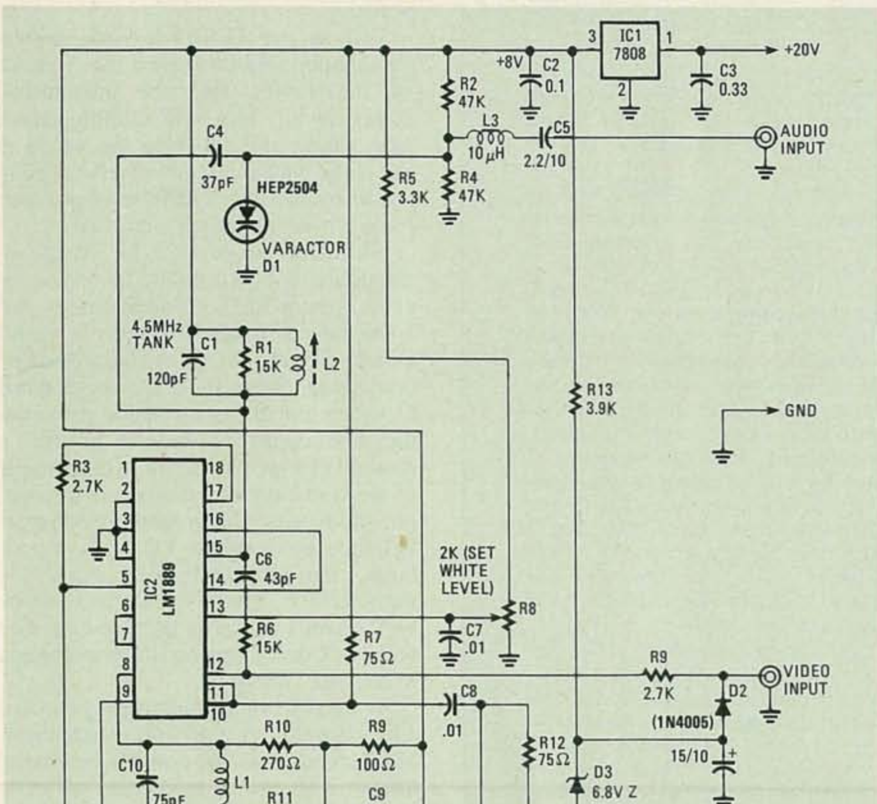


FIG. 6—NTSC RF MODULATOR for Channel 3, 4, or 5.

If you don't have a VCR, you'll need to build, or buy, your own video RF modulator. The most common RF modulator used by satellite TV enthusiasts is shown in Fig. 6. This system uses the LM1889 IC that is really a miniature TV transmitter disguised as an IC. The LM1889 device (or something very similar) is found in dozens of TV games, VCR modulators, computer modulators, and so on. The 1889 is available from firms such as Poly-Pak, usually for under $5.00. A complete modulator kit, using the LM1889 is available (model PXP-4500) for around $25 (ATV Research, 13-B Boardway, Dakota City, NB 68731).

The schematic in Fig. 6 shows what is involved. Coil L2 establishes the 4.5-MHz sub-carrier for the audio in a tuned network and a 2K pot connected to pin two of the 1889 establishes the saturated white level for the video. Although the schematic establishes tuning procedures (off pins 8 and 9 of the 1889) for Channel 3 or 4, many people have also found that the system will function on VHF TV Channel 5 as well, by adjusting the tank circuit accordingly.

A modulator such as this is capable of putting out around 10,000 microvolts of maxium signal (3,000 is more typical). That is more than enough RF voltage to drive through several hundred feet of RG-59/U coaxial cable into, perhaps, as many as a half dozen TV receivers con-

PARTS LIST (RF-modulator, Fig. 6)

Resistors ¼-watt, 10% unless otherwise specified.

R1, R6—15,000 ohms
R2, R4—47,000 ohms
R3, R9—2700 ohms
R5—3300 ohms
R7, R12—75 ohms
R8—2000 ohms potentiometer
R9—100 ohms
R10, R11—270 ohms
R13—3000 ohms

Capacitors

C1—120 pF dipped mica
C2—0.1 μF ceramic disc
C3—.33 μF ceramic disc
C4—37 pF dipped mica
C5—2.2 μF, 10 volts, electrolytic
C6—43 pF dipped mica
C7—C9—.01μF ceramic disc
C10—75 pF dipped mica
C11—15 μF, 10 volts, electrolytic
C12—1 μF, 10 volts, electroytic
C13—20 μF, 20 volts, electrolytic
IC1—7808 voltage regulator, +8 volts
IC2—LM1889 TV video modulator
IC3—7908 voltage regulator, −8 volts
D1—HEP2504 varactor diode (Motorola)
D2—1N4005 diode
D3—Zener diode, 6.3 volts
L1—tank coil, .08μH (3 turns No. 16 wire air-wound ¼" ID, ⅜" long)
L2—adjustable RF coil, 7—14 μH (J. W. Miller type 9052)
L3—10 μH molded RF choke

nected to the system through appropriate 75-ohm splitters and taps.

Power supply

There is little to be said about the system powering that is not obvious in the schematics. The total power drain will be in the ½-ampere range at the master supply level of 20 volts. Regulation, where noted, is very important. Pure DC, well filtered, is very important. Protection of the satellite TV receiver, from line glitches is also very important. If you live in an area where you have erratic AC line service, invest a few dollars in some fast-acting devices so that AC line spikes and surges don't eat up your relatively delicate 4-GHz parts. Saving $10 on the master power supply may cost you a $100 GAAS-FET, so use a good, stiff, regulated supply.

Satellite television has been called the new frontier of electronics. There is little doubt that a proliferation of communication satellites in the geostationary orbit will change the way we perceive ourselves and our world neighbors in the decade ahead. Heretofore we have been able to keep control of our individual nationalistic goals through a flood of programming created largely by our own countrymen. What we have seen of Brazil, for example, or Zambia, have been the views of our own program producers, writers, and actors.

Satellite television is changing all of that: a trickle now, a flood within the next ten years. International satellites (INTELSAT) already in operation are beaming programs from Brazil, Zambia, and dozens of other nations not only to their own citizens but to 40% of the whole globe at a time. Regional satellites with shaped antenna patterns are spilling the programs from India, for example, throughout Africa and the Middle East. A Russian geostationary satellite system called Statsionar is nearing completion so that by 1981 you may sit in your home—virtually any place in North America—and tune in Moscow directly. Those Statsionar satellites can be expected, like Radio Moscow of shortwave fame, to become instruments of their operators, beaming video propaganda over the entire globe.

Satellite receiving hardware is a new, business still struggling between the first $50,000 INTELSAT receivers and what will become ultimately (perhaps soon) $1,000 receivers sold through electronic emporiums. By 1990, satellite television will be a household word and $250 receiving *systems* will proliferate into every book corner of the world.

Just as our U.S. television system has shaped and re-shaped the America of the 1940's into the present-day America, so, too, will satellite television shape and re-shape the world of the early 1980's into an entirely different world by the year 2,000; some say perhaps ten years sooner than that.

Until October of 1979, for private individuals to own satellite television receivers here in the United States was something of a misdemeanor. It wasn't clearly illegal, but wasn't approved by law either. Since the FCC decided last October that private satellite terminals did not require a federal license, a marked change has begun in the attitude of electronic hardware suppliers throughout the world. Suddenly there *is* a marketplace for satellite TV gear—a very large, national and even worldwide marketplace. That FCC decision alone will result in dozens of receiving-system packages entering the marketplace in the year ahead.

As an electronics enthusiast you have a leg up on the rest of your countrymen. You have a head start on this new technology and, for a few years at least, your expertise in that area will make you a special person with special knowledge—and the opportunity either to enjoy it to the fullest, or cash in on a very attractive business opportunity.

Never before in electronics has the sky been the limit. Never before have we had satellite television available. **R-E**

LEARNING MORE ABOUT SATELLITE TV

If you are fascinated by the rapid development of satellite television as a worldwide video communications system, some of the following reference materials may be of interest to you:

Satellite Study Package—A thorough study of how the satellite system works, what the individual elements of a successful satellite TV receiving system are, how they work, and what they do. Includes a 72-page book written by Bob Cooper that explains in lay terms just what the satellite TV revolution is all about. Includes reference section with dozens of other study materials sourced. Also includes 22 × 35-inch four-color, two-sided wall chart depicting the presently operating international network of geostationary communication satellites, where they are, and what their operational parameters are. Price is $15 for first class mail delivery in U.S. and Canada, $20 (in U.S. funds) elsewhere from: Satellite Television Technology, P.O. Box 2476, Napa, CA 94558.

Satellite Seminar—The third in a series of *Satellite Private Terminal Seminars;* scheduled for mid-June in the San Francisco Bay Area of California. Three days of lectures; classroom instruction taught by leading designers of low-cost satellite TV systems. A combination of "how to do it yourself" featuring the latest state-of-the-art technology and "entering the satellite TV business" sessions. Two early seminars (Oklahoma in August, 1979, Miami, Florida this past February) were total sell outs, so advance registration is a must. For complete details contact: SPTS '80/California, P.O. Box G, Arcadia, Oklahoma 73007.

Construction Manuals—A series of three manuals describing the construction of (1) the *Swan spherical TVRO* multi-satellite antenna, (2) *Coleman TD-2 conversion Satellite TV Terminal*, and (3) *Howard Terminal Receiver*. Swan's manual takes you into the satellite TV antenna world for less than $300-cost for a very effective 10 × 10 foot antenna that features the unique ability to receive up to 9 separate satellites with one antenna in a fixed position. The *Coleman TD-2* manual covers conversion of surplus (inexpensive) microwave equipment to satellite TV reception, plus illustrates new low-cost microwave technology for home builders. The *Howard Terminal Receiver* manual describes 24-channel frequency-agile, double conversion receiver, LNA and feed antenna system that can be duplicated for under $800. Price per manual is $30, all three for $80 (U.S. funds) from Satellite Television Technology, P.O. Box G, Arcadia, Ok. 73007.

Monthly Publication—A "nuts and bolts" monthly publication aimed squarely at explaining the construction of low-cost terminals, satellite operations, and the business of selling and installing private satellite TV terminals. Price for *Coop's Satellite Digest* is $50 per year in U.S. and Canada, $75 (in U.S. funds) elsewhere via first class mail from: Coop's Satellite Digest, P.O. Box G, Arcadia, Ok. 73007.

Circuit Boards—A series of circuit boards are available for virtually all portions of the satellite TV receiver described in this series. Circuit board *IF-70A* provides the circuit necessary to create your own 70-MHz IF strip as described here, using the Motorola ART-120 device. Circuit board *DEMOD-TVRO* provides the layout for the 70-MHz-to-baseboard demodulator circuits described in this issue. For price and delivery contact: Robert M. Coleman, RFD 3, Box 58-A, Travelers Rest, SC 29690.

PORTABLE ELECTRONIC ORGAN

If you don't play a keyboard instrument but would like to learn, you might consider starting out on one of the two simple easy-to-build organs described here. One plays melody; the other also plays chords.

I. QUEEN

MUSIC IS A POPULAR AND SATISFYING HOBby, judging by the continuing sales of hi-fi equipment, FM receivers, tapes and discs. Listening to music is a pleasure, but playing your own instrument can be doubly satisfying and challenging. After experimenting with several types of audio oscillators and construction plans, I completed a simple organ that measures $14 \times 4\frac{1}{2} \times 1\frac{1}{2}$ inches and plays $2\frac{1}{2}$ octaves. It uses a single oscillator and can play any melody. This instrument was so successful that I then constructed a more sophisticated model that can play *chords* as well as the melody. This one covers 3 octaves. We'll take a look at how to build both models.

Playing an organ

It is amazing how quickly one can learn to play an organ, especially with the help of books written for piano beginners. First, we will give some simple music theory for those readers who are not familiar with it.

The human ear is a sensitive detector of frequency ratios. For example, it easily recognizes a ratio of 2:1. The higher frequency is said to be one *octave* above the other. Since piano and organ keyboards cover an extensive range of frequencies, let's use an octave as a convenient interval of sound. Each octave is divided into 12 equal geometric steps, each step representing a change of about 6%.

The keyboard is arranged so that a musician can distinguish and identify a particular key out of the 12 in each octave. The keys are arranged in 2 rows: one with seven white keys, the other with five black keys forming a pair and a trio (See Fig. 1). A letter of the alphabet, from A to G, is assigned to each of the seven white keys. The word "sharp" (written as ♯) may be applied to a black key to indicate one step *higher*. For example, F♯ is one step above F. Sometimes it is more convenient to use the word "flat" (shown as ♭) to indicate a black key that is one step *lower*. For example, B♭ is one step below B. Obviously, A♯ and B♭ refer to the same black key.

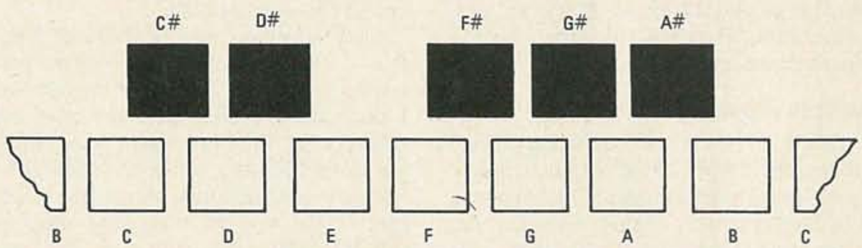


FIG. 1—HOW KEYS ARE ARRANGED on the home-built organ. You can salvage individual keys from an old electronic calculator or purchase them from a surplus parts dealer.

An inexpensive keyboard can be constructed with individual calculator keys, approximately $\frac{3}{4}$-inch square, that you can take from an old calculator, or purchase from a surplus parts dealer.

Poly Paks for instance has carried switches that are easy to operate, and have low resistance. They come in sets of 4 switches, one of which is a dummy switch without leads. You can remove the inoperative switch and substitute a good one from another set. A set of 4 switches can also be sawed apart to make a group of 2 or 3, which are needed for the black keys. Key caps are sold that mate with the key switches.

Radio Shack has sold individual calculator keys, and some stores may still stock them. They are fairly good and can be cemented down on any flat surface.

(Neither of the switches we used are currently available from Poly-Paks or Radio Shack but you are sure to find suitable substitutes if you keep an eye on ads and catalogs from surplus parts dealers. Any SPST pushbutton switch can be used provided it is large enough to be comfortably used in a keyboard. Simply modify the switch mountings and organ housing to match the switches you use.—*Editor*)

Building the organ

The top and bottom of the organ are made of three-ply wood, held in place by aluminum supports at the front and rear, as shown in Fig. 2. Two L-shaped lengths of aluminum that are held together with machine screws form each U-shaped support. The aluminum comes in 6-foot lengths and measures 1 inch on each side. It is readily available in hardware stores.

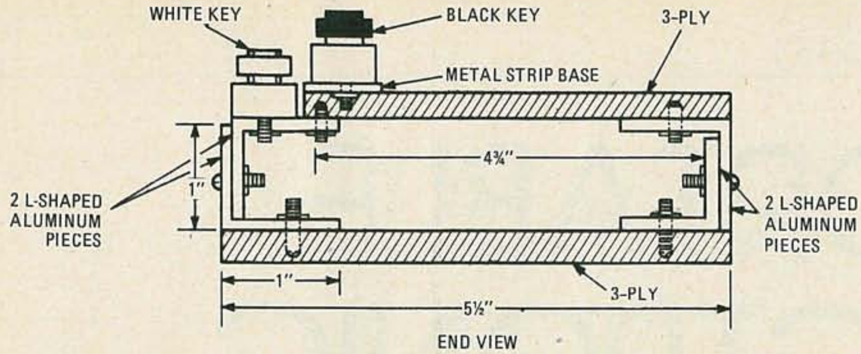


FIG. 2—PUTTING THE ORGAN TOGETHER. Drawing shows mechanical cross-section. Keys are mounted so the black ones are higher and farther back than the white ones; as on a piano keyboard.

TABLE 1

C♯	139	Hz	G	196	Hz
D	147	Hz	G♯	208	Hz
D♯	156	Hz	A	220	Hz
E	165	Hz	A♯	233	Hz
F	175	Hz	B	247	Hz
F♯	185	Hz	C	262	Hz

See Fig. 6 for higher tones. Frequencies in Hz.

For a 3-octave range, the length of the organ should be about 18 inches.

Note that the top of the organ is narrower than the bottom. This allows you to use a convenient metal base to mount the white keys right in front. The black keys should be slightly behind and somewhat higher than the white ones. Some types of keys have a flat bottom and are made to be cemented onto any flat surface. The Poly Paks key sets came with No. 2-56 screws extending from the bottom. With No. 2-56 hex nuts, I mounted the sets on a metal strip, since the screws are not long enough to pass through the plywood. Then, the metal strip was mounted on the plywood, with the aid of machine screws. Use a strip about three inches long to hold 3 black keys, and another strip about 2¼ inches long for 2 black keys.

Below each key, drill holes for the leads to pass through to the terminals.

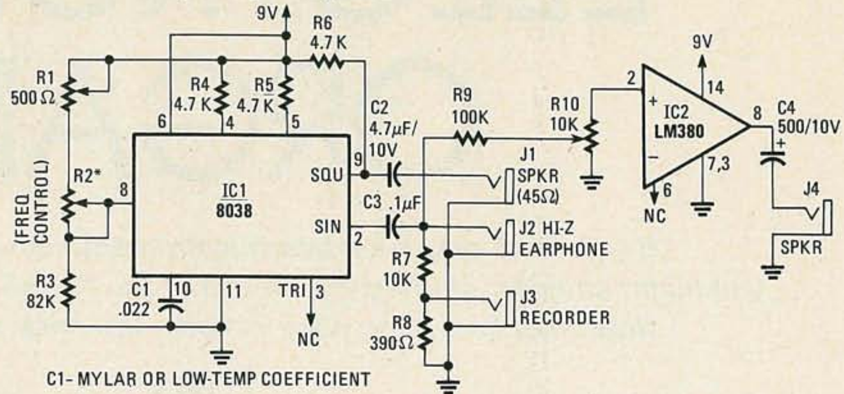
Mount the power and the output jacks, as well as the volume control, on the rear metal panel.

To build either organ model, you must have a frequency meter that can measure to about 100 Hz. It is suggested that you construct the simpler organ first to get the feel of playing music. If you are still enthusiastic about playing, then go for the more difficult organ.

Melody organ

In Fig. 3, IC1 is a VCO (*V*oltage-*C*ontrolled *O*scillator) whose output frequency varies with the voltage applied to pin 8. The frequency is minimum when the pin is connected *directly* to the positive (+) terminal of the power supply. As R2 increases, so does the frequency. With a 9-volt supply, the minimum frequency is about 130 Hz.

Oscillator IC1 generates three output waveforms: a sinewave (pin 2), a squarewave (pin 9) and a triangular wave (pin 3). (The latter waveform is not used.) The squarewave output is sufficient to drive a 45-ohm speaker directly at J1. The sinewave has a pleasing tone, and can drive a high-impedance earphone at J2 or drive an external amplifier. An internal amplifier, IC2, is provided however. The output at J3 is greatly attenuated for a tape-recorder.



*ACTUALLY, R2 IS VARIED IN STEPS AS SHOWN IN FIG. 4 TO CONTROL FREQUENCY

FIG. 3—SIMPLE MONOPHONIC ORGAN plays melodies—one note at a time. Circuit is based on IC1, a voltage-controlled oscillator tuned by the value of resistor R2.

Actually, R2 must be varied in steps for organ music, as shown in Fig. 4. Each resistor is selected to tune to the required frequency when the corresponding switch is closed.

To calibrate the organ, let IC1 warm up and connect a frequency meter at J2. Set R_A for the lowest tone to be played when S_A is closed. In the instrument I built, it is the key of F (175 Hz). Now, select R_B to play the next higher tone when S_B is closed, and so on up the scale. Table 1 lists the frequencies at the low end of the musical scale.

Each resistance in the series, R_B, R_C, R_D . . . increases gradually over the preceding resistance. The first four resistors I used are 82 ohms each, the next five resistors are 100 ohms each. Then, there are three 120-ohm resistors, followed by four 150-ohm resistors, etc. At the upper end of the musical scale, the resistors should be about 300 ohms each. Try for a frequency accuracy of about 0.5% or better. If your resistors are in smaller increments—such as 82, 91, 100, 110, etc.—you can achieve higher accuracy. To reach a desired value, you can connect two resistors in series. Use terminal strips to hold resistors, or solder them directly to each other and to the keys. Hook the ends of resistors to hold them more securely.

Oscillator IC1 is very sensitive to changes in voltage. You must use either a regulated power supply or batteries. If required, R_A can be used to retune the organ to some extent. The socket of IC1 can easily be mounted on a socket adapter

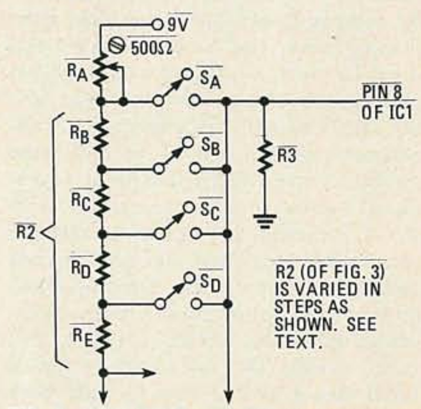


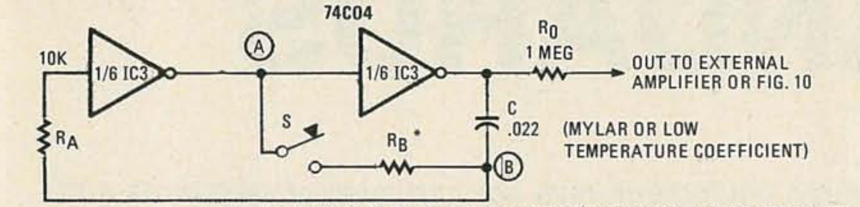
FIG. 4—HOW KEYS ARE WIRED to switch in different resistors to tune the VCO.

PARTS LIST FOR MELODY ORGAN

Resistors are ¼ watt, 5%
R1—500 ohms, potentiometer
R2—calibrating resistors (see text and Fig. 4)
R3—82,000 ohms
R4-R6—4700 ohms
R7—10,000 ohms
R8—390 ohms
R9—100,000 ohms
R10—10,000-ohm potentiometer
C1—.022 μF, Mylar or low-temperature coefficient
C2—4.7 μF, 10 volts, electrolytic
C3—0.1 μF, disc
C4—500 μF, 10 volts, electrolytic
IC1—8038, voltage-controlled oscillator
IC2—LM380 audio amplifier
J1-J4—miniature jacks
Misc.—sockets for audio amplifier, keys (12 per octave), plywood, aluminum supports, hardware (see Fig. 2).

Table 2
(Frequency mHz)

	Oscillator 1	2	3	4	5	6
1st octave	B 247 C 262	C# 277 D 294	D# 311 E 330	F 349 F# 370	G 392 G# 415	A 440 A# 466
2nd octave	B 494 C 523	C# 554 D 588	D# 622 E 660	F 698 F# 740	G 784 G# 830	A 880 A# 932
3rd octave	B 988 C 1046	C# 1108 D 1176	D# 1244 E 1320	F 1397 F# 1480	G 1568 G# 1661	A 1760 A# 1865



*R_B IS SHOWN IN MORE DETAIL IN FIG. 6 AS A SERIES OF 6 FIXED RESISTORS.

FIG. 5—ONE OF SIX OSCILLATORS based on a pair of CMOS inverters. The instantaneous frequency is determined by the value of resistor R_B.

WHAT IS A CHORD?

It is a combination of 3 or more simultaneous tones that harmonize and enhance the playing of a melody. The ear is a sensitive frequency ratio detector. The octave (2:1) was mentioned earlier. If you call *any* note of an organ, 1, and count half-steps upwards, you can show that the pair, 1 and 3, bear the ratio 9:8. Other pairs (and ratios) are: 1 and 4 (6:5), 1 and 5 (5:4), 1 and 6 (4:3), 1 and 8 (3:2). If the 4 notes; 1, 4, 6, 10, are played, it is called a "seventh chord" and combines the following pairs: 1 and 4, 1 and 6, 1 and 3, 1 and 5. The pair, 4 and 6, plays the same frequency ratio as, 1 and 3, since both have the same interval of 2 half-steps. A "major chord" is played, 1, 6, 10. Many other chords, and variations of them, are played in organ and piano music.

PARTS LIST FOR MELODY AND CHORD ORGAN

Resistors are ¼ watt, 5%

R_A—10K (6 resistors, 1 for each oscillator)
RB—Calibrating resistors, selected by trial (see Fig. 6 and text)
R_O—1 MEG (6 resistors, 1 for each oscillator)
C—.022 μF Mylar (6 capacitors, 1 for each oscillator)
Misc.—pair of 74C04 CMOS hex inverters (for building 6 oscillators as in Fig. 5); sockets for inverters; terminal strips for resistors; and plywood, aluminum, hardware, keys, as for organ 1.

(Radio Shack 276-024). I used a small piece of PC board to hold the socket of IC2.

Chord and melody organ

This organ is superior in several ways: It not only plays the melody but also plays chords and contains 3 octaves. It is more stable with respect to frequency and voltage. The IC's consume less power and are less expensive. A disadvantage is that the calibrating resistors vary over a wide range of values, and so are more difficult to select. You may need two or three resistors in series to achieve a desired value. An accurate calibration is desirable since errors are more noticeable when you play chords.

To play chords and melody over three octaves, it at first would appear that we need 36 oscillators, and this thought is unbearable! However, we can simplify. Each oscillator is responsible for two adjacent musical tones (called half-steps), as for example A and A#. Half-steps are seldom, if ever, played together. This cuts the required number of oscillators by half. Another simplification is to make each oscillator responsible for its own half-steps in *all* octaves. You cannot play the same note in more than one octave.

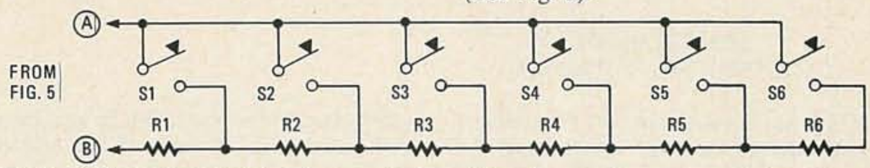


FIG. 6—THE CHORD ORGAN has six monophonic oscillators to cover three octaves. Each oscillator is tuned to six notes selected by the key arrangement shown.

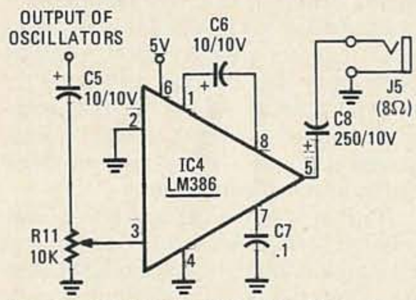


FIG. 7—SCHEMATIC DIAGRAM of the simple power amplifier used in the chord organ.

PARTS LIST FOR AMPLIFIER

R11—10,000 ohms, potentiometer, ¼ watt, 5%
C5, C6—10 μF, 10 volts, electrolytic
C7—0.1 μF, 10 volts, disc
C8—250 μF, 10 volts, electrolytic
J5—miniature jack
IC4—LM386

Table 2 shows how six oscillators cover three octaves.

A typical oscillator is shown in Fig. 5. This oscillator is very stable with respect to voltage and temperature. It uses a pair of CMOS inverters operating at 5 volts. One hex inverter such as the 74C 04 can be used to make three oscillators. With R_A and C fixed, the frequency depends only on R_B. A larger R_B means a lower frequency. Of course, the voltage applied to the inverter must remain constant. This oscillator can generate only one frequency at a time. For six different frequencies, you must provide six different values of R_B, each with its own switch (See Fig. 6).

Calibration

To calibrate the organ, begin with the oscillator 6. Referring to Table 2, select R1 for 1865 Hz when S1 is closed. Then, select a value for R2 to play 1760 Hz when S2 is closed. Next, select R3 to play 932 Hz when S3 is closed, and so on. Similarly, proceed with oscillator 5 and the remainder, observing the frequency meter for correct frequencies. Don't try for an exact frequency in each case, but accuracy should be well within 0.5%. You may need two or even three resistors in series to reach the desired value. Here are the approximate values for the resistors shown in Fig. 6:

Resistor R1 is about 10,000 ohms for oscillator 6; about 12,000 ohms for oscillator 5; 14,000 ohms for oscillator 4, etc. After selecting the value of R1 for any oscillator, the other values in the same series will be approximately as follows:

R2 = .06 R1
R3 = R1
R4 = 2 R2
R5 = 2 R3
R6 = 2 R4

All the output leads (three leads from each oscillator) are tied together, and the signal is amplified. The simple output stage shown in Fig. 7 can be operated from the same power supply as the organ—either a regulated supply or batteries.

The more complex organ obviously requires more patience and time for proper calibration than does the simpler organ. However, it is well worth the extra effort. **R-E**

CAR STEREO STANDARDS

Until now, makers of car stereo equipment have not had a set of standards and specifications that were meaningful to the consumer. Recently twenty-two manufacturers agreed on these new standards. Others are expected to follow.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IF YOU ARE A HIGH-FIDELITY ENTHUSIAST who has considered duplicating the good sound you enjoy at home in your car, truck, or van, you already know that until now there has been virtual chaos in the car stereo marketplace. Twenty watts of power in a car stereo amplifier or complete receiver is, in most instances, not even remotely related to 20 watts of audio power in a home hi-fi system. And a tuner sensitivity of 2.0-μV in a car radio (if quoted at all by the manufacturer) has usually meant sensitivity that is only one fourth as good as that of a home tuner boasting the same 2.0-μV sensitivity. As for tape-playing equipment in automobiles, frequency response, if quoted at all, has provided the prospective purchaser with little or no information as to the fidelity of the product being considered for installation in his or her vehicle.

We can now hope that the situation is about to change. As of this writing, 22 leading car stereo equipment manufacturers have agreed to publish specifications and measurements about their products that will be meaningful and helpful to consumers who want good sound on the road. What follows is some of the background that led to the creation of those new standards and a summary of the standard measurements themselves. Particular thanks are due to Marshall Mack Brown of Craig Corporation, who was in charge of the standards meetings that led to the creation of the new standards, along with Jim Twerdahl of Jensen Sound Laboratories and Don Coleman of Clarion Corporation.

It took more than 30 years for the home audio component industry to reach its present level. But in less than five years annual sales of car stereo equipment have actually equalled or surpassed those of home audio equipment. Unfortunately, the rapid growth of car stereo has resulted in many practices that are contrary to high-fidelity philosophy and concepts. Perhaps the most flagrant abuse has been the artificially inflated "power ratings" of car stereo products. (We all remember that battle in home equipment.)

Back in 1974 the Federal Trade Commission formulated a rule that requires all manufacturers of home audio equipment to state the power output of audio amplifiers on the basis of continuous power, with extremes of frequencies at which the rated power can be delivered for a given level of harmonic distortion and into a specified load impedance. Note, however, that the FTC rule applies *only* to "home" audio equipment. In 1974, car-stereo equipment sales were not significant, and the FTC did not include that category in its rule. Given that loophole, many car-stereo manufacturers began to exaggerate power ratings, omit references to distortion levels, and so forth and so forth. Serious and conscientious audio-equipment makers were caught up in the specification race as well, and were often forced to publish unrealistic figures for their own products, if only to survive in a highly competitive marketplace.

Discouraged, but by no means defeated, those manufacturers (including many in the U.S., and several importers of equipment from abroad) did not give up. More than a year ago, they formed an Ad Hoc Committee of Car Stereo Manufacturers and set about to write and publish their own measurement standards. Seventeen well-known manufacturers and importers participated in the deliberations. Their work has now been completed and, in a letter to all car-stereo manufacturers, they have invited all to endorse and use the specifications as presented. By endorsing the new standards, participating companies agree that by June 1, 1980, all of their printed catalogs, specifications sheets, advertisements, and other literature will present product specifications in accordance with the new standards.

Amplifier measurements standards

The new car-stereo standards are divided into three sections. Section I deals with audio power amplifiers (whether supplied as separate components or as part of a car radio) and parallels many of the standards developed for home audio amplifiers by the IHF (Institute of High Fidelity). Six specifications must be presented by a manufacturer in standard format. The format for specifying power output must read: *"Power Output: ___ watts per channel minimum continuous average power into ___ ohms, both channels driven, from ___ Hz to ___ Hz with no more than ___% total harmonic distortion."* While that method of presentation corresponds almost exactly to that required for home-audio equipment, the committee had to address itself to one important additional matter. The nominal 12-volt supply in most cars may vary from 11 to 16 volts under driving conditions. Figure 1 shows what happens to the power output of a nominally-rated 10-watt-per-channel amplifier over those

SHMEGG ELECTRONICS
MODEL 6OA

extremes of supply voltage. With only 11 volts of supply voltage, clipping distortion is reached with only 8 watts delivered, while with 16 volts of battery supply, power output increases to more than 12 watts per channel. The new standards call for a standard DC voltage of 14.4 volts to be used when measuring power output of a car amplifier.

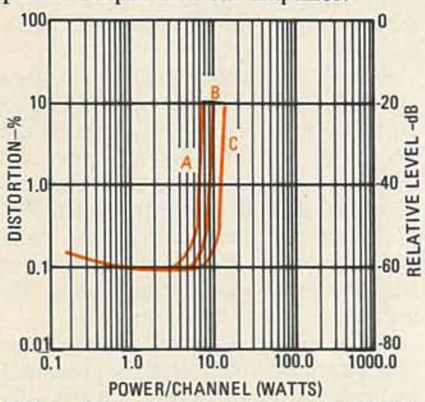


FIG. 1—HOW POWER OUTPUT VARIES with supply voltage. Curve A is for 11-volt supply, B is for 14.4 volts and C for 16.0 volts.

Frequency response for a car amplifier must be stated as follows: *Frequency Response: ___ Hz, to ___ Hz, ± ___ dB*. Measurements must be made at a 1-watt output level with the amplifier terminated in its rated load impedance. For complete car radios (where the amplifier is inaccessible as a separate entity) the "input" maybe considered to be at the input of the volume control of the receiver.

For signal-to-noise measurements, an "A"-weighting network is to be used (that weighting is also called for in the IHF Amplifier Measurement Standards) and the S/N ratio must be quoted with respect to 1-watt output, with an input voltage of 0.5 volts.

Input Sensitivity must be referenced to 1-watt of power output and should be expressed in volts. Here, an option is provided, wherein an additional sensitivity specification may be given for the input voltage required to produce rated output.

A minimum input-impedance specification is called for in the new standards, but that spec is applicable to separate component amplifiers only and is intended to establish compatibility of interfacing between models and brands. It would be stated, simply, in ohms.

The last required amplifier specification is Tone Control Action and the format will be: *Tone (Equalizer) Action: ± ___ dB at ___ Hz and ___ Hz*. In the case of bass and treble controls, the recommended test frequencies are 100 Hz and 10,000 Hz. For multiband equalizers, the appropriate center frequencies should be used in making the measurements. Curves, such as those shown in Fig. 2, may also be presented as an option, but those will most likely be used only for multiband equalizers.

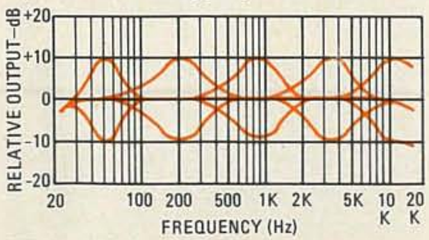


FIG. 2—TONE-CONTROL CURVES can be shown in specs. These curves are typical of those for a five-section equalizer.

Standards for FM tuners

The second section of the new standards is concerned with FM-tuner specifications, or the tuner section of a complete radio receiver. Nine separate disclosures are called for. The first of those is Monophonic Usable Sensitivity. It is to be stated in dBf. There has been wide variation in practice in measuring and stating the sensitivity of an FM receiver or tuner. Although it has been common practice to state sensitivity either in dB re: 1 μV, or directly in volts (or microvolts), the modern practice of stating the sensitivity in terms of relative power level (expressed in dBf) eliminates ambiguity and enables the consumer to make direct comparisons between products. The ambiguities have been particularly prevalent when it comes to car stereo FM receivers, largely because their antenna input impedance is usually 75-ohms as opposed to the more common 300-ohm input impedance found on home FM equipment.

Figure 3 shows how 2 μV, applied to a 75-ohm antenna input impedance, is actually four times as much *power* delivered to the first stage of the receiver as the same 2 μV would be if connected to a 300-ohm impedance. Looking at it another way, a tuner that boasts a 2-μV

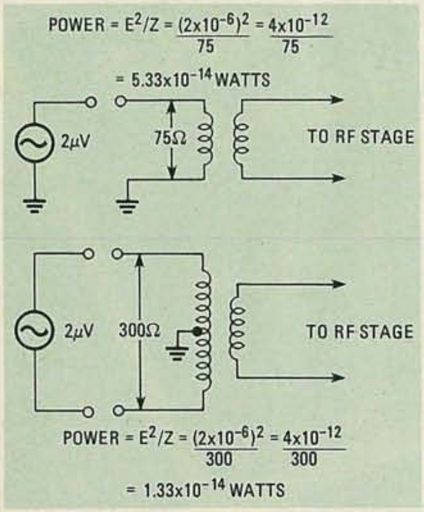


FIG. 2—RECEIVER SENSITIVITY depends on the input impedance of the first RF stage. Equations show relationships.

sensitivity (and fails to mention the fact that this figure applies to 75-ohm inputs) is really only one fourth as sensitive as one which has a 2-μV sensitivity but has a 300-ohm input.

Another indicator of tuner sensitivity that must be stated by manufacturers adhering to the new Car Stereo Standard is 50-dB Quieting Sensitivity, in mono. A signal-to-noise capability of 50 dB is generally considered to be the least amount of noise (with respect to signal peaks) that can be tolerated in high-fidelity equipment, whereas the 30-dB S/N figure, often used by car-stereo equipment manufacturers, really amounts to "barely usable" performance. The signal strength required for producing 50 dB of S/N is also to be quoted in terms of power, or dBf.

Frequency response of the tuner section is to be quoted over the range from 30 Hz to 15,000 Hz (the frequency limits of FM broadcasting) with a "plus and minus" dB tolerance required in the reporting format.

Such less familiar tuner characteristics as Capture Ratio (the ability of a tuner to zero in on the stronger of two stations broadcasting at the same frequency), Alternate Channel Selectivity (the ability of the tuner to reject signals that are removed in frequency from the desired station frequency by 400 kHz), Image Response Ratio (the ability of the tuner to reject incoming signals that are above 10.7 MHz the local oscillator frequency), and IF Response Ratio (ability of the tuner to reject incoming radio signals that are broadcast at the tuner's 10.7-MHz IF) are all called for in the new standard and are generally to be measured and reported in a manner consistent with the universally used IHF/IEEE Tuner Measurement Standard which has been formalized since 1975 (IHF-T-200, 1975).

One additional tuner measurement standard called for in the new Car Stereo standards is actually borrowed from the IHF Amplifier Standard, and is called Maximum Output Voltage. It is to be reported in *Volts, from* ____ *Hz to* ____ *Hz, with* ____ *ohms load*. That specification is applicable to tuners, decks, and integrated units provided with line output terminals and is intended to establish compatibility of interfacing between models and brands. The minimum recommended load impedance must also be stated.

The third and final section of the new Car Stereo Standards deals with tape players. Since IHF standards for tape decks have not as yet been established, here the committee had to develop its own interim standards. Six required measurements and specifications are called for.

The first of those is playback frequency response. Tape playback frequency response has probably been one of the most flagrantly exaggerated specifications relating to car stereo tape equipment. As illustrated in Fig. 4, the frequency response shown in curve "A" for one typical tape deck and that shown in curve "B" for an inferior product could both be reported as extending from "30 Hz to 15,000 Hz"—providing that no tolerance in dB accompanies the published statement.

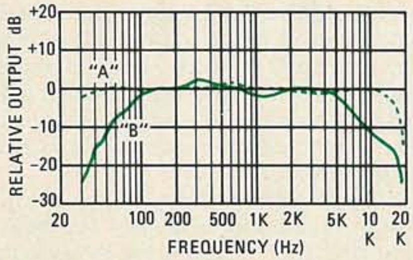


FIG. 4—PLAYBACK FREQUENCY RESPONSE curves for two tape recorders. The one producing curve A is clearly superior.

Clearly, the tape deck represented by the response curve of "B" *is* able to deliver some output at 30 Hz and some output at 15,000 Hz. That output, however, is some 15 dB *lower* than the reference level measured at 1 kHz and is therefore all but useless. For that reason, the format for stating tape playback frequency response must be: *Frequency Response:* ____ *Hz to* ____ *Hz, ± dB*. The specification must be referred to 1000 Hz as zero reference level and a ±3-dB tolerance is recommended (but not required) in the standard. Units having selectable equalization (e.g. for ferric oxide and chrome or chrome-equivalent tapes) should have frequency response stated for all conditions.

IN-DASH AM/FM/MPX CAR RADIO that includes an 8-track tape player. This model is the RCA AutoSound 12R711.

Wow-and-flutter performance of the tape equipment is to be measured using an rms-responding meter with weighted response. The meter is read for random 10-second periods at the beginning, middle, and end of the tape cassette or cartridge, noting the average of the peak readings, but excluding random peaks which do not occur more than twice in any 30-second period. Wow and flutter is reported as a percentage, followed by the notation "wrms" (weighted rms).

To measure stereo separation of car tape equipment, a reference level of 250 nWb/meter tone at 1 kHz is used, recorded on one channel. The opposite channel is played back through a narrow-band filter that includes 1 kHz, and the residual signal is measured. The purpose of the filter is to minimize the masking effect of tape noise, since interchannel leakage (crosstalk) may actually be lower in level than the noise and still be more objectionable.

"A"-weighted signal-to-noise ratio is also to be specified for tape playback devices intended for car use and is to be measured with respect to a 1-kHz recorded signal at a level of 250 nWb/meter, using a 20 Hz to 20,000-Hz band-pass filter.

Finally, the maximum output voltage of the tape deck is to be specified in volts, over the relevant frequency band and with a minimum recommended load also stated. Again, that specification is intended to establish compatibility of interfacing between models and brands, particularly where separate car stereo components (as opposed to all-in-one car stereo units) are used.

While there are certainly many more specifications which might be measured and published for mobile audio products in those three categories of amplifiers, tuner/receivers, and tape players (or combinations of them), it is significant that a group of audio-equipment manufacturers were able to get together, without any government prompting or pressure, to produce meaningful measurement standards. The result of their efforts can only benefit the audio consumer who wishes to have good high-fidelity sound while traveling in a vehicle.

The proposed standards have been printed, and readers wanting to learn more about them may write to Marshall Mack Brown, Chairman of the Ad Hoc Standards Committee of Car Stereo Manufacturers, at Craig Corporation, 921 West Artesia Blvd., Compton, California 90220. **R-E**

1

CIRCLE 106 ON FREE INFORMATION CARD

Nikko Audio EQ-11 Graphic Equalizer

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

GRAPHIC EQUALIZERS HAVE BECOME ONE OF the most popular add-on products in a high-fidelity stereo system. By dividing the audio-frequency spectrum into several segments, a graphic equalizer permits the user to tailor tonal response of the entire system more precisely than would be possible using ordinary bass and treble controls or even bass, midrange and treble controls. Until now, most of the equalizers we have seen featured either five bands or ten bands per channel, with a few offering even more frequency segmentation.

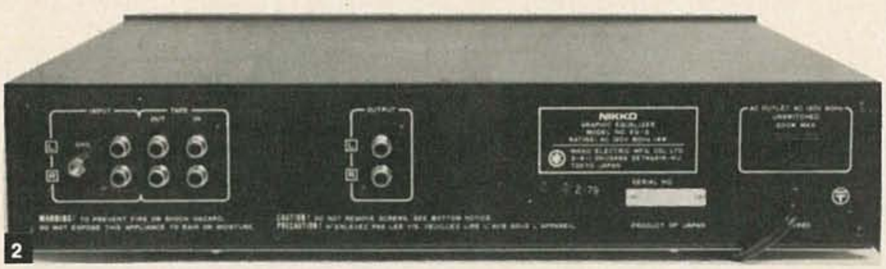
Now Nikko has come up with a graphic equalizer, model *EQ-II* shown in Fig. 1, that offers six bands of frequency-per-channel, thereby providing a bit more flexibility than that offered by five-band units without increasing the retail price to that of most ten-band units.

The all-black front panel of the *EQ-II* features a POWER on/off switch at the left-hand side, above which is a small, red indicator light that turns on when power is applied to the unit. Nearby, along the lower edge of the panel, are a pair of pushbutton switches. One of these is used to bypass the equalizer when its functions are not required, or for making instant audible comparisons between equalized and unequalized sound. The other switch introduces a tape-monitor circuit that can be used to connect a tape deck, since the tape out/tape in jacks on any associated receiver or amplifier will have been used up by installation of the equalizer.

RADIO-ELECTRONICS AUDIO LAB
R.E.A.L. SOUND
RATES

NIKKO AUDIO EQ-II
GRAPHIC EQUALIZER

EXCELLENT



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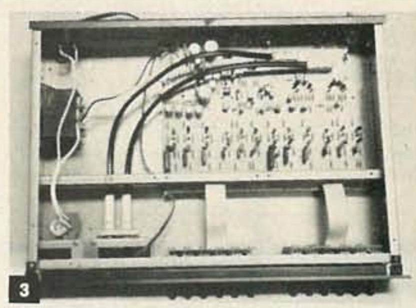

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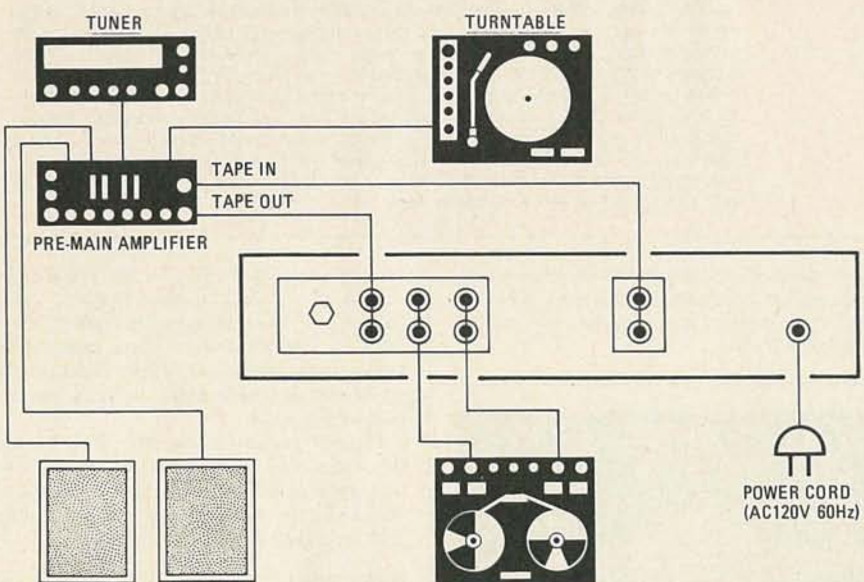
The wiring of the tape-monitor circuit is such that only preequalized signals can be fed to the line inputs of the connected tape deck. In other words, you cannot use the *EQ-II* to equalize signals being recorded; only to equalize signals being played back via the tape deck or your other program sources. Above the equalization in/out switch is a small green light that turns on when the *EQ-II* is "in circuit".

Nikko has chosen to separate the left and right channel slider controls that occupy the rest of the front panel into two separate groups. The alternative approach is to position left and right sliders that have the same center



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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Control Frequencies: 40 Hz, 125 Hz, 400 Hz, 1.25 kHz, 4 kHz, 12.5 kHz. **Control Range:** ± 12 dB at center frequencies. **Rated Output Level:** 1.0 volt. **Maximum Output Level:** 4.0 volts. **Total Harmonic Distortion:** 0.01%. **Signal-to-Noise Ratio:** IHF "A"-Weighted; 100 dB. **Frequency Response:** 10 Hz to 30 kHz, ± 1.0 dB. **Input Impedance:** 80K ohms. **Power Requirement:** 120 volts 60Hz, 14 Watts. **Dimensions:** 16½ W × 3⅝ H × 13-inches D. **Net Weight:** 10.8 lbs. **Suggested Retail Price:** $200.00

frequencies in adjacent pairs. Each approach, of course, has its advantages and disadvantages. With all the controls of one channel grouped together, if the user finds that both channels require the same degree of equalization the arrangement on the *EQ-II* requires that each channel be adjusted separately. When similar center frequencies are paired together, (as on some other equalizers we have tested), the user can adjust left and right sliders with a single finger motion. On the other hand, in most practical situations, with speaker systems placed at different positions in the listening room, in non-identical environments, the likelihood is that the left-channel equalization requirements will differ from those of the right channel, and individual adjustment would be required in any case.

The center frequencies chosen by Nikko for this six-band equalizer are 40 Hz, 125 Hz, 400 Hz, 1.25 kHz, 4 kHz and 12.5 kHz. Spacing is therefore something more than one octave and less than two octaves. The slider controls used to adjust response at each of these center frequencies have well defined detents with approximately a 2-dB step per detent. Sliders are calibrated from 0 (center position) to 10 in both the boost and cut directions of the slider. Those calibration points have no direct correlation to dB of boost or cut, however, since maximum boost or cut is 12 dB.

The rear panel of the *EQ-II*, shown in Fig. 2, is equipped with a pair of INPUT jacks at the left, a pair of OUTPUT jacks at the center and the previously mentioned TAPE-OUT and TAPE-IN jacks in between. An unswitched AC convenience outlet, rated at 200 watts, is located at the extreme right of the rear panel above the power cord. There are no externally-replaceable fuses on the rear panel.

Figure 3 shows the inside of the chassis of the unit. Note that the single circuit board at the right rear contains no inductors, as such. Instead, gyrator circuits using op-amps with feedback networks are used to create the necessary individual filter circuits required. The entire circuit is well shielded from any induced hum via the front panel and from the small power transformer mounted at the extreme left of the chassis. That careful layout accounts in part for the excellent signal-to-noise ratio that we found. Figure 4 shows how to connect the *EQ-11* into a hi-fi system.

RADIO ELECTRONICS PRODUCT TEST REPORT

TABLE 1

Manufacturer: **Nikko** Model: **EQ-II Equalizer**

GRAPHIC EQUALIZER PERFORMANCE MEASUREMENTS

Specification	R-E Measurement	R-E Evaluation
Control range (±dB)	12	Very Good
Center frequencies (Hz)	40,125,1.25K,4K,12.5K	Good
Maximum output level (V)	4.5	Very Good
Harmonic distortion, 1kHz (%)	0.003	Excellent
Harmonic distortion, 20 Hz (%)	0.008	Excellent
Harmonic distortion, 20kHz (%)	0.005	Excellent
S/N ratio, "A"-weighted (dB)	99	Very Good
Frequency response, Hz-kHz, ± 1dB	10-25	Very Good
MATCHING CHARACTERISTICS		
Rated output (V)	1.0	
Input impedance (ohms)	80 K	
Power consumption (W)	12	

RADIO-ELECTRONICS PRODUCT TEST REPORT

TABLE 2

Manufacturer: **Nikko Audio** Model: **EQ-II Equalizer**

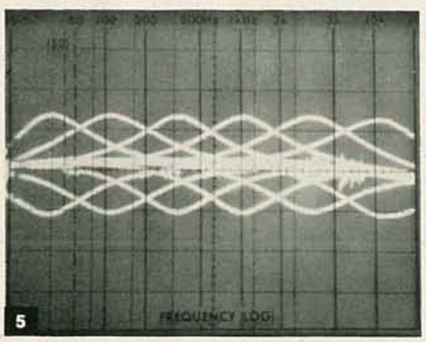
OVERALL PRODUCT ANALYSIS

Retail price	**$200.00**
Price category	**Medium**
Price/performance ratio	**Very good**
Styling and appearance	**Excellent**
Sound quality	**Excellent**
Mechanical performance	**Very good**

Comments: Many audio enthusiasts find that a 10-band (octave-by-octave) graphic equalizer is a bit too much to cope with while some of the low-cost 5-band equalizers don't offer as much control as they feel they need. Nikko Audio has apparently tried to solve that problem by coming up with a six-band graphic equalizer that provides just a bit more control flexibility than do the five-band models available. By resorting to gyrator circuitry, Nikko has managed to keep hum and noise levels as low as those found in much more expensive equalizers; distortion contributed by the device is almost at the vanishing level. The multi-detented settings of each slider control make preferred settings easily repeatable. The incorporation of a tape-monitor circuit means that those owning a receiver with only one tape circuit will not lose that function when connecting the *EQ-II*. It would have been nice (and not expensive) if Nikko had enabled the user to equalize signals *ahead* of the tape out circuit instead of only during playback. An overall level control would also have been useful, especially when extreme settings of the sliders are called for. But, all in all, the *EQ-II* offers good basic equalization facilities at a moderate price.

Lab measurements

Table I summarizes the laboratory measurements made on our sample unit. The exceedingly low distortion levels, measured at mid-frequencies as well as at the audio frequency extremes, were measured with an input signal level of 1.0 volt, which corresponds to the rated output level of the unit (the *EQ-II* has 0 dB or unity gain, as an equalizer should). Even as one approaches maximum output level, however, distortion remains almost as low until output exceeds 4.0 volts.



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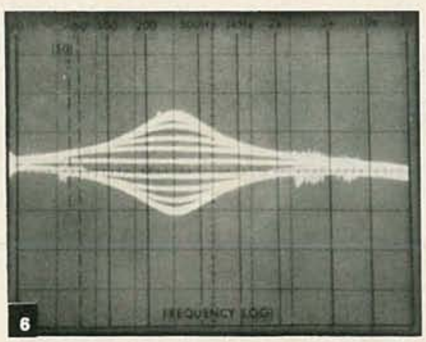

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Figure 5 shows the response of the *EQ-II* with each of its frequency levers alternately moved to the maximum boost and cut positions. Vertical sensitivity for the presentation was 10 dB-per-division while frequency, plotted from left to right, extended from 20 Hz to 20 kHz, logarithmically. Thus, spacings between center frequencies of the various bands are almost precisely equal, between one and two octaves apart.

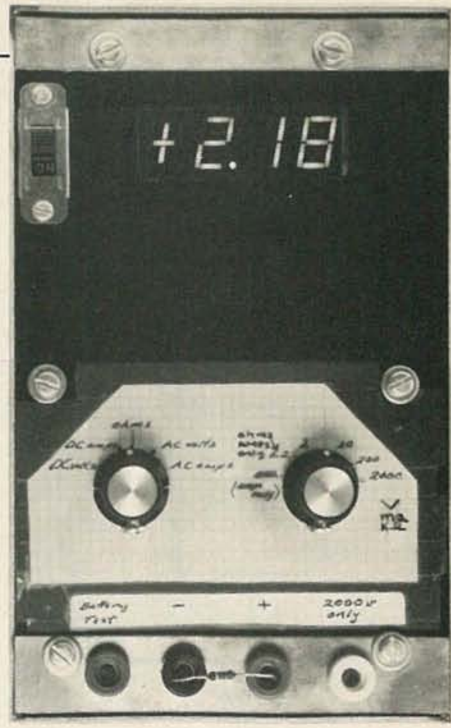
Figure 6 presents a sequential plot of one of the slider controls (the one having a center frequency of 400 Hz) for each of its eleven detented steps and while the boost and cut for each step, they are very nearly equal.

Summary

At its price, the Nikko *EQ-II* offers a good deal of tonal control flexibility. In listening tests, the unit introduced no noticeable sound coloration when the controls were set to their mid-positions and the EQ light was on. Neither was their any noticeable increase in distortion or noise level when the equalizer was switched into the rest of our test stereo component system. More detailed summary comments, together with our overall product evaluation, will be found in Table II. **R-E**

BUILD THIS

3½ Digit DMM



Want to design and build your own DMM? If so, this developmental prototype is a good place to start. You can add features and select an enclosure and layout to meet your needs.

CARSON CHEN*

HERE'S HOW AN ACCURATE, INEXPENSIVE 3½ digit DMM can be built. The DMM is designed around a single 3½ digit DVM IC that performs the analog-to-digital conversion function. The specifications of the DMM are shown in Table 1.

Referring to the schematic in Fig. 1, (see page 62) the basic building block of the multimeter is the ADD3501 analog-to-digital converter using a pulse-modulation technique. A 2-volt reference voltage tapped off the LM336 2.5-volt precision reference diode allows for a 1mV resolution. Additional ADD3501 support circuitry consists of an NSB5388 LED display, a DS75492 digit driver, an RA08 resistor array and an LM340 to regulate the V_{CC} supply voltage.

DC voltage measurement: Depending upon the range selected, the positive or negative DC voltage to be measured is applied to the + and − meter probes and, where applicable, attenuated so that the maximum voltage per range equates to 2 volts full-scale and applied across the ADD3501 $V_{IN}+$ $V_{IN}-$ pins (pins 13 and 12 respectively). The ADD3501 then performs a pulse-modulation analog-to-digital conversion and digitally displays the numerical equivalent of the analog input voltage.

DC current measurement: In the DC current mode, the meter probes are placed in series with the current to be measured. On any range, the DMM places a known resistance in series with the current to develop a 2-volt full-scale voltage drop. (This voltage drop may be reduced to 200 mV; refer to the last section of this article). The equivalent drop across the current measuring resistor is then converted and displayed by the ADD3501.

Resistance Measurement: As in all multimeters, a current source develops a voltage drop across the unknown resistor being measured. In this case the resistor to be measured is placed across the + and − meter probes and, depending upon the range selected, a constant current is forced through the resistor developing, at maximum, 2 volts full-scale. This voltage is applied to the $V_{IN}+$ and $V_{IN}-$ pins of the ADD3501 and converted to its proper digital equivalent displayed as ohms. The current source is designed around two of the op-amps in the LM346 (IC2-a and IC2-b) and transistors Q1 and Q2.

Isolating the current source and analyzing the circuit in Fig. 2, we see that resistor R_X sets the desired current for a chosen resistance measurement range. It is essential to note that varying resistor values placed at R_X must not alter the constant current through R_X. If this occurs, erroneous resistance readings will be displayed. To eliminate any non-constant current conditions, op-amp IC2-b and transistor Q2 function as follows:

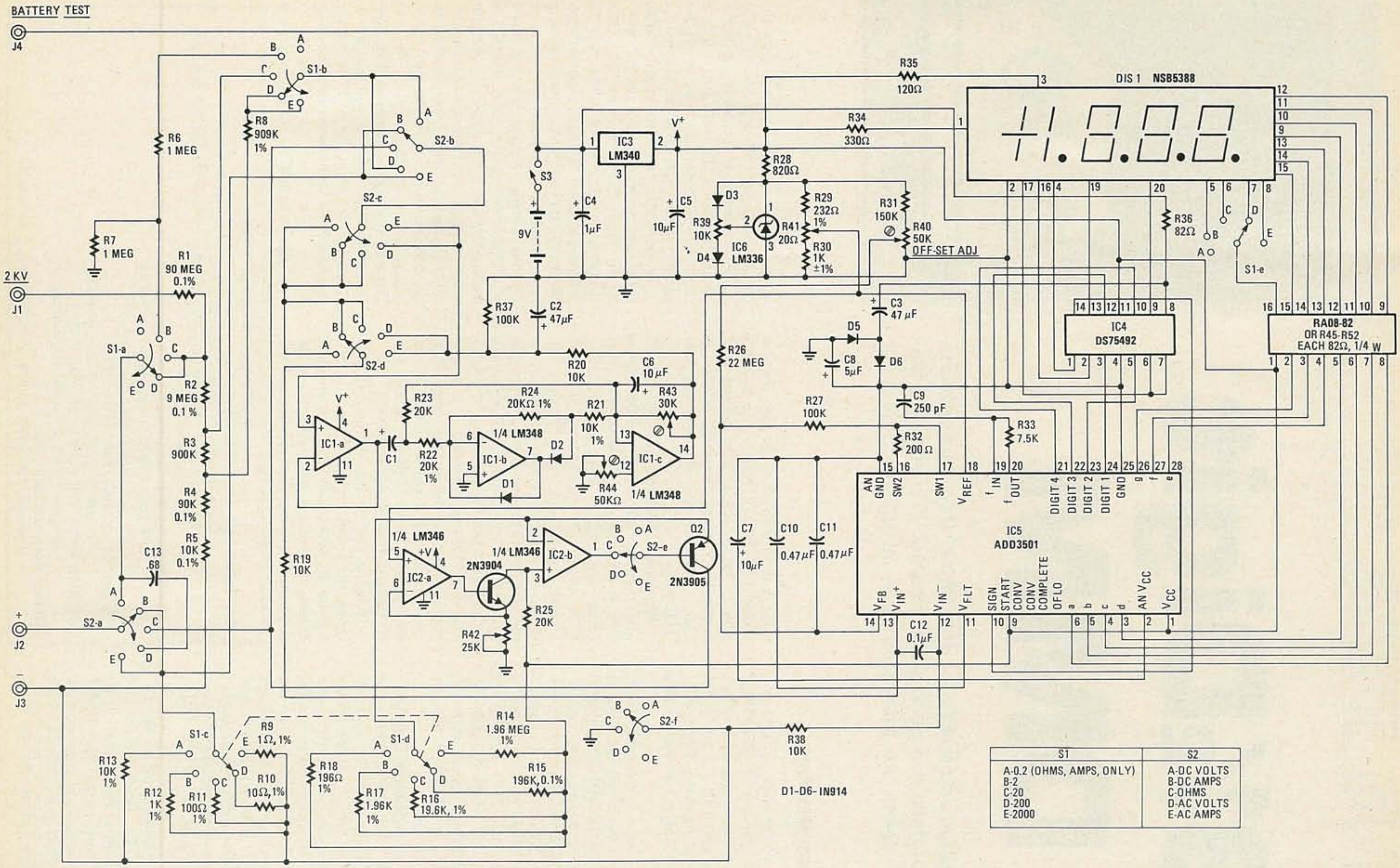
To establish a constant-current source, a constant voltage drop must be maintained across load resistor, R_L. The closed-loop operation of IC2-b trys to maintain a zero differential input voltage. With V_A applied to the non-inverting input, point A is forced to V_A+V_{BE} so that the voltage of point B would equal V_A. Thus a constant voltage potential is maintained across R_L. With V_A constant at point B, the current source remains constant, and varying R_X has no effect on the current source, provided that $R_X \times I_{SOURCE}$ is not greater than V_A-V_{BE}, so that transistor Q2 is saturated. This non-linear condition however will not be noticed since $R_X \times I_{SOURCE} \geq 2V$ will force the ADD3501 to display +OFL. (See Fig. 3.)

A change in the V_{CC} supply voltage is

TABLE 1—SPECIFICATIONS

DC Volts:	Accuracy better than ±1%
	Ranges: 2 volts, 20 volts, 200 volts, 2 kV.
	Input impedance: greater than 10 megohms on 2-volt range; 10 megohms on 20-volt to 2-kV ranges.
AC RMS Volts:	Accuracy better than ±1%
	Ranges: 2 volts, 20 volts, 200 volts, 2kV (40 Hz to 8 kHz, sinewave)
DC Amps:	Accuracy better than ±1%
	Ranges: 200 μA, 2 mA, 20 mA, 2 amps
AC RMS Amps:	Accuracy better than ±1%
	Ranges: 20 μA, 2 mA, 20 mA, 2 amps
Ohms:	Accuracy better than ±1%
	Ranges: 200, 2000, 20,000, 200,000 ohms, 2 megohms

*Senior Applications Engineer, National Semiconductor



S1	S2
A-0.2 (OHMS, AMPS, ONLY)	A-DC VOLTS
B-2	B-DC AMPS
C-20	C-OHMS
D-200	D-AC VOLTS
E-2000	E-AC AMPS

FIG. 1—SCHEMATIC of the low-cost digital multimeter. The component-count is low for an instrument of its versatility.

PARTS LIST

Resistors ¼ watt, 5% unless otherwise specified

R1—90 megohms, 0.1%
R2—9 megohms, 0.1%
R3—900,000 ohms, 0.1%
R4—90,000 ohms, 0.1%
R5—10,000 ohms, 0.1%
R6, R7—1 megohms
R8—909,000 ohms, 1%
R9—1.0 ohms, 1%
R10—10 ohms, 1%
R11—100 ohms, 1%
R12—1000 ohms, 1%
R13—10,000 ohms, 1%
R14—1.96 megohm, 1%
R15, 196,000 ohms, 1%
R16—19,600 ohms, 1%
R17—1960 ohms, 1%
R18—196 ohms, 1%
R19, R20, R38—10,000 ohms
R21—10,000 ohms, 1%
R22, R23, R24—20,000 ohms, 1%
R25—20,000 ohms
R26—22 megohms,
R27, R37—100,000 ohms
R28—820 ohms
R29—232 ohms, 1%
R30-1000 ohms
R31—150,000 ohms
R32—200 ohms
R33—7500 ohms
R34—330 ohms
R35—120 ohms
R36—82 ohms
R39—10,000 Ohms, 10-turn trimmer pot
R40, R44—50,000 Ohms, 10-turn trimmer pot
R41—20,000 ohms, 10-turn trimmer pot
R42—25,000 ohms, 10-turn trimmer pot
R43—30,000 ohms, 10-turn trimmer pot
R45—R52—RA08-82 resistor array (National) or eight—82 ohms, ¼ watt

Capacitors

C1, C2, C3—47 μF, 15 volts, electrolytic
C4—1 μF
C5, C6, C6—10 μf, 15 volts, electrolytic
C8—5 μF, 15 volts, electrolytic
C9—250 pF
C10, C11—0.47 μF
C12—0.1 μF

Semiconductors

D1—D6—1N914
Q1—2N3904
Q2—2N3905
DIS1—NSB5388 3½-digit LED display
IC1—LM346 quad op-amp
IC2—LM348 quad op-amp
IC3—LM340 5-volt regulator
IC4—DS75492 (National) MOS to LED hex-digit driver
IC5—ADD3501 3½-digit digital voltmeter
IC6—LM336 2.5-volt Zener reference source
S1—rotary switch, 5 circuits, 5 positions
S2—rotary switch, 6 circuits, 5 positions
S3—SPST miniature slide switch
Miscellaneous hardware including case, stand-off bushings, hookup wire, IC sockets, etc.

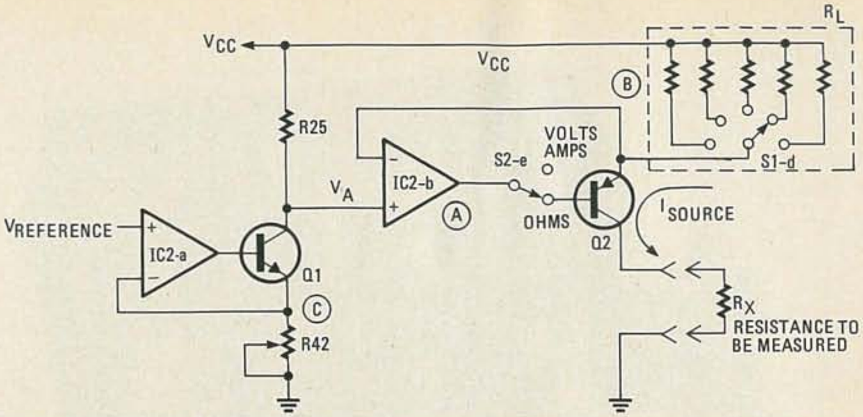


FIG. 2—FUNCTIONAL DIAGRAM of the constant-current source. The op-amps are part of a quad device.

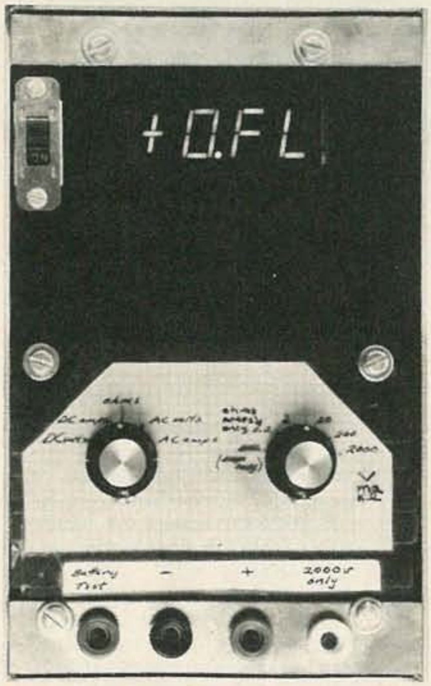


FIG. 3—THIS DISPLAY on the readout can not be mistaken for anything other than overflow.

another condition that may affect the constant-current source and must be corrected for within the circuit. A constant-current sink is established when amplifier IC2-a forces point C to the non-inverting input voltage V_{ref}. With V_{ref} held constant at point C, the current through R25 is roughly equal to the current through R42. (See equation 1.) This allows V_A to vary directly proportional to any fluctuations in supply voltage.

$$V_A = V_{CC} - [(V_{ref}/R42)\alpha]R25 \qquad (1)$$

If V_{CC} drops by V_X, V_A drops by V_X and sustains the desired voltage across R_L. Reference voltage V_{ref} is taken from the LM336 and remains constant throughout the ADD3501 supply voltage range. Note that the base of Q2 must be left connected to IC2-b during the AC current or voltage measurements. In these modes the R_X terminals (and the collector–ground) are open circuited. This allows the Q2 emitterbase junction to act as a forward-biased diode pulling the V− supply to ground through IC2-b. This problem is eliminated by the opening switch (S2-e) connecting Q2 to IC2-b.

AC voltage measurement: The AC voltage is measured using the AC-to-DC converter shown in Fig. 4. The voltage attenuator has a source impedence on any range of 1 megohm. Amplifier IC1-a is connected as a voltage-follower lowering the source impedence driving IC1-b to a few hundred ohms. The small DC offset voltage is decoupled through C1.

The AC/DC converter, IC1-b and IC1-c, can best be understood by following the signal path for negative and then for positive inputs. For negative signals, the output of IC1-b is clamped to +0.7 volt by diode D1 and disconnected from the summing point of IC1-c by D2. Amplifier IC1-c then functions as a simple unity-gain inverter with input resistor R23 and feedback resistor R43 giving a positive-going output.

For positive inputs, IC1-b operates as a normal amplifier connected to the summing point of IC1-c through resistor R21. Amplifier IC1-b then acts as a simple unity gain inverter with input resistor R22 and feedback resistor R24. The gain accuracy of IC1-b is not affected by diode D2 since it is inside the feedback loop. Positive current enters the summing point of IC1-c through R23 and negative current is drawn from the summing point through R21. Since the voltage across R23 and R21 are equal and

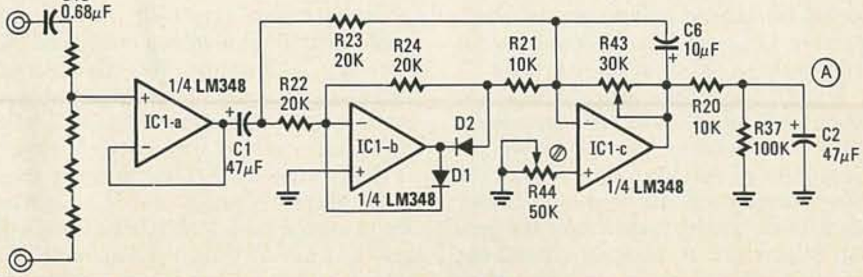


FIG. 4—THE AC/DC CONVERTER is designed around three op-amps and a few other components.

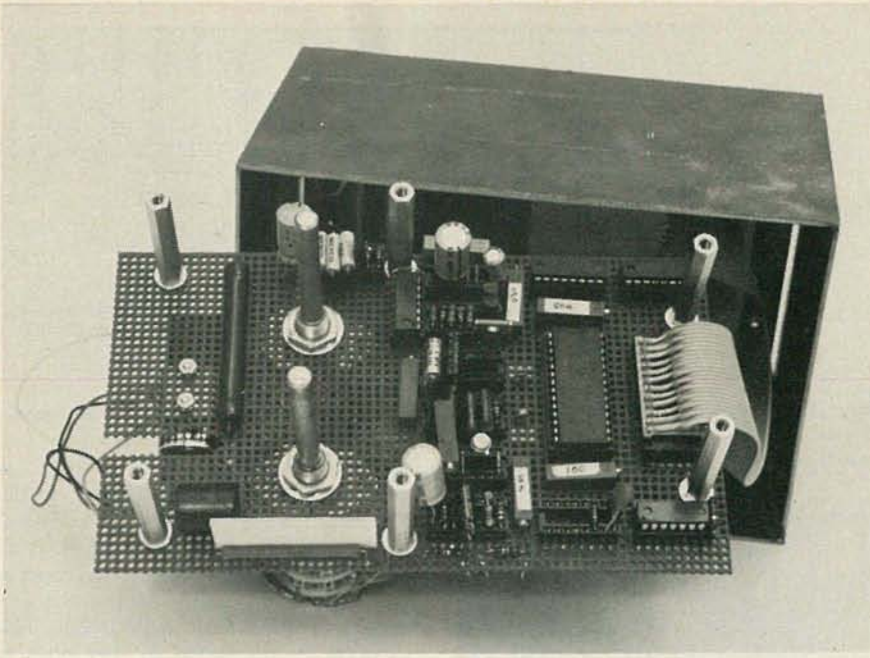


FIG. 5—INTERIOR VIEW of the DMM. Perforated board is used for the chassis. Wiring is point-to-point. Precision resistors in the voltage divider, current shunts and ohmmeter circuits are plugged into IC sockets.

opposite, and R21 is one-half the value of R23, the net input current at the summing point is equal to and opposite from the current through R23. Thus amplifier IC1-c operates as a summing inverter with unity gain, again giving a positive output. The circuit then becomes an averaging filter with C6 connected across R43. Trimmer resistor R44 is used to minimize output errors due to input offset currents.

AC current measurement: To measure AC current, the meter circuit is configured as in the DC current measurement setup. Again, IC1-a through IC1-c (see Fig. 4) performs the AC to DC conversion with the final DC voltage at point A being fed to and converted by the ADD3501.

Construction

The digital multimeter described here was developed as a prototype to prove the suitability of the ADD3501 for use in an inexpensive electronic test instrument. The circuit is simple and the component-count relatively low so point-to-point wiring or wirewrap on perforated board can be used. An interior view is in Fig. 5. Note that all V_{CC} connections should be made to a single point and all grounds should be made to a single ground point. Be sure to connect an 0.1-μF capacitor from each V_{CC} IC terminal to ground.

It cannot be overly stressed as to the importance of maintaining single-point ground connections for the amplifiers. Ground-loop resistances coupled with the offset currents and AC response can play absolute havoc with system linearity, gain and display flicker. Similarly, flickering occurs if precautions are not taken when considering the layout of analog, high-switching-current and digital ground-loop paths of the ADD3501.

Calibration

Calibration of the digital multimeter is performed as follows:

1. Adjust R40 until the cathode of the precision zener reference diode (LM336) equals 2.49-volts. This adjusts the diode's temperature coefficient.
2. Set the meter to measure 2 volts DC. Short the + and − probe inputs of the meter and adjust R45 until the display reads 0000.
3. Now, apply 1.995 volts DC across the + and − probe inputs and adjust R41 until the display reads 1.995.
4. Set up the meter for resistance on the 2-megohm range. Select a precision resistor whose value is a little lower than 2 megohms and adjust R42 until the appropriate value is displayed.
5. Apply a known 1.995-volt RMS sinewave signal to the meter and adjust R43 until the display reads the same.

(Calibrating the DMM to three decimal places will be difficult for many readers. You can do it if you have access to a 4½- digit DMM. A friendly TV service technician or a lab technician in a local electronics plant may help you with the calibration. If, at first, you don't need the accuracy offered by this instrument, there are a couple of schemes that you can use to get all the precision you'll need for ordinary servicing and experiments.

Calibration on the DC range is relatively simple. A rough calibration can be made using a fresh flashlight cell that will give 1.54 to 1.55 volts. For a more precise reference, you can use a 1.35-volt mercury cell. Most of these supply 1.354 volts ± 2 mV. Note that 1.4 volt mercury cells are available but they are not suitable for use as voltage standards. Among the several 1.35-volt mercury cells that are available are Mallory RM12R, Burgess HG12R and Eveready E12N. The "N" and "R" suffixes indicate types suitable for instrument voltage references and high-temperature applications. If the type 12 is not available, try to get a 42, 400, 401 or 625 with the "N" or "R" suffix.

(If your scope has AC/DC coupling you can use it and your DC reference to arrive at a reasonably accurate AC reference source. Connect the DC reference cell across the vertical input and adjust the vertical attenuator for deflection to a convenient reference point above the zero reference line. Without changing the attenuator setting, switch the scope to AC and connect an adjustable AC source to the scope input. Adjust the applied voltage so its uppermost peak rests on the same reference line as the DC voltage.

(The effective or RMS value of the AC voltage equals 0.707 times the peak value indicated on the scope. For example, when a 1.35-volt cell is the DC reference, the equivalent RMS voltage giving the same deflection is 1.35 × 0.707 or 0.954 volt.—*Editor*).

Final note

The digital multimeter described here was specifically developed with accuracy and minimal cost in mind. For a more elaborate multimeter, improvements to the basic circuit of Fig. 1 can be made in the following areas.

1. Increase the volts mode to include a 200 mV full-scale range. (Refer to the ADD3501 data sheet).
2. Decrease the full-scale current measurement load voltage from 2 volts to 200 mV.
3. Provide true-RMS mesurement capability.

The first two categories may be satisfied by dividing down the ADD3501 feedback loop by a ratio of 10 to 1, thus scaling down the full-scale 2-volt input requirement to 200 millivolts. This not only allows 200 mV impressed across the $V_{IN}+$ and $V_{IN}-$ inputs to display a full-scale reading but also implies that the maximum voltage dropped across the current-measuring resistance is also 200 millivolts.

Note, of course, that the values of the current-measurement resistor array must be scaled down by a factor of 10 to 1. Also note that a 200 mV full-scale input implies a resolution of 100μV. At these low input levels, offset currents may effect linearity and gain of the AC/DC converter and some clever circuitry may be required to eliminate such problems. A true RMS meter can be made by replacing the AC to DC converter with LH0091, a true RMS-to-DC converter, and appropriate interface circuitry. **R-E**

TROUBLESHOOTING BETA TRANSPORT MECHANISMS

Threading video tape from a cassette into the transport mechanism blends a mixture of mechanics and electronics that seems simple—after you understand it.

FOREST BELT

IN MOST OF TODAY'S BETA-FORMAT home video recorders, one direct-current (DC) motor drives the entire tape-loading mechanism. (Sony, Toshiba and Zenith are the main Beta-system brands.) In one exception, a drive belt supplies the force from a main AC motor. Yet the mechanics of actual tape-threading remain the same whatever the driving force.

The DC motor drives a large *threading ring*. Running counterclockwise, the ring draws the video tape out of the cassette and wraps it in a giant semicircle around the video-head drum and assorted guides and sensors.

The DC motor reverses, too. Running clockwise, the threading ring unwraps the tape; the takeup reel in the cassette winds the tape slack back into the cassette.

Of course, that explanation oversimplifies. Yet, it describes the basic mechanical operation by which video tape from a Beta-format cassette is loaded or threaded into the recording/playing mechanism, and then withdrawn (unloaded or unthreaded). You can build from this fundamental view to a more detailed understanding of how a VCR works. The loading/unloading operation involves both mechanics and electronics. For best comprehension, the mechanics of a VCR may be the place for you to begin your study. That's where you generally should begin troubleshooting any Beta machine's loading/unloading faults.

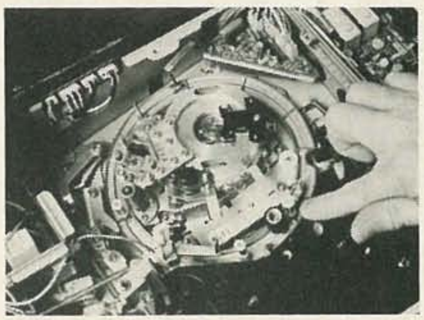
Threading-ring drive

You can follow the action of tape-threading best with a video cassette recorder in front of you. To watch all that happen, you need to remove the cover from the machine—an easy matter.

While you can derive a fair notion of the actions from the photo in this article, the better your familiarity with how specific operations proceed, the easier you can spot malfunctions.

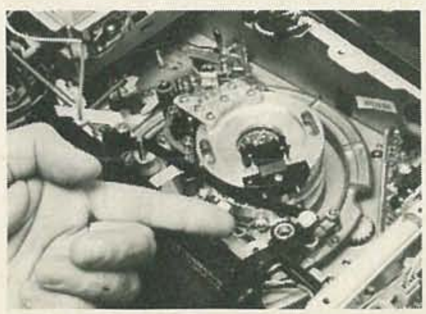
To load a Beta cassette onto the machine, first depress the EJECT button. That raises a compartment called the *cassette-lift assembly*. Insert the video cassette, and then press the cassette compartment down until it clicks. The cassette fits down over the front edge of the *threading ring* in such a way that a lead or No. 1 guidepost fits up behind the tape itself, more or less inside the cassette. Simultaneously, the downward motion lifts a cover on the front of the cassette, exposing the tape.

Proper switching takes place automatically when you push the cassette-lift compartment down until it latches. The cassette encounters a *cassette-in switch*. A DC motor (located inside the main chassis in the rear left corner) turns on. The motor's pulley-belt drives a worm gear that rotates a threading-

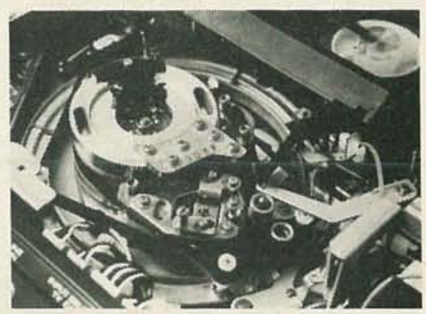


THREADING THE TAPE begins when the threading ring revolves counter clockwise.

THE THREADING RING continues to revolve wrapping the tape closely around the face of the video-head drum.



AS THE THREADING RING revolves, the lead guide post catches the tape.



A STOPPER TAB ends threading ring travel when threading is completed.

drive shaft. On its upper end, the shaft has another gear that engages the large-diameter threading ring.

The threading ring revolves counterclockwise (as you look down at it). The *lead guidepost* encounters the tape as the rotation brings the post outward and then begins pulling the tape out of the cassette.

The tape coming out of the cassette travels around the video-head drum. At first, the tape being pulled out by the lead post is doubled. But, at intervals, three additional guideposts on the circumference of the threading ring enter the tape loop. These posts hold the outer side of the tape loop away from the video-head drum. The inner side of the loop, however, wraps very closely around the face of the video-head drum. Behind the drum, two fixed guideposts also shape the outside dimensions of the tape loop.

Meanwhile, on the left-hand side of the cassette, a lever—with a guidepost that is also inside the cassette similar to the lead guidepost—has filled out a *tape-tension arm*. That post has also drawn some tape from the supply reel of the cassette.

Near the end of the threading-ring travel, a cam-follower lever moves the tape-tension arm solidly outward. That completes the tape-wrapping procedure around the video-head drum. As shown in the photo, this action also positions the tape so that it can pass the audio-control head properly.

A stopper tab ends the threading-ring travel. Microswitches open the circuit to the DC threading motor. Toggle levers hold the ring firmly against the stopper. The tape is now in position for any of the RUN modes: PLAY, RECORD, FAST FORWARD, or REWIND.

Unthreading or unloading

When the EJECT button is down, the voltage at the DC motor reverses and starts the threading ring revolving clockwise. A few degrees of rotation toggles the cam-follower lever and loosens the tape-tension arm.

Tape could suddenly go slack and create a "spill," but a lever lifts the brake from the takeup-reel turntable. The direction of the reel rotation winds up any slack in the tape as it occurs.

Continuing clockwise, the threading ring unwraps the tape from the video-head drum—exactly the reverse of how it operates in threading the machine. Finally, at the end of the unthreading operation, the cassette-lift mechanism raises the compartment. The cover at the front of the cassette closes, and the cassette can be removed.

Tape-loading electronics

Unless you know what happens electronically during the threading sequence, you cannot always determine for certain whether a defect is a mechanical or an electronic fault. Once you are familiar with both sides, troubleshooting can proceed directly.

Several electronic functions must be taken into account during tape loading. Many are safety interlocks that prevent damage to the machine. The basic threading circuits are shown in Fig. 1.

A CASSETTE-IN microswitch operates from a plunger that is activated when the cassette is in the lift compartment *and* the assembly has been pushed down to latch it. The switch applies 12 volts of regulated DC to the loading-circuit board.

A LOADING-STOP microswitch connects as an interlock between pin 2 of connector CN4001 and pin 3 of CN4002. This switch is located beside the threading ring. It stays closed at all times except when the threading ring reaches its limit (when the tape is loaded). Thus, at the start of tape loading, the switch carries 12 volts from the CASSETTE-IN switch to the threading-control circuits.

With both microswitches closed, 12 volts goes to a *standby-lamp* stage (the circuits are not shown in Fig. 1). An illuminated standby lamp warns the operator to wait until loading is finished before pressing one of the RUN-mode buttons. Some Beta-format machines omit this warning light.

Forward-biased diode D4016 carries 12 volts DC to a charge-up circuit that consists of R4011, R4055 and C4009. This capacitor holds a 12-volt charge even after the voltage is removed; which is what happens when the threading-stop switch opens. The purpose is to keep the threading motor turning an extra moment or so until the threading ring reaches its mechanical-stop pin. That assures complete loading.

Diode D4015, which is also forward-biased, places 12 volts on pin 19 of the threading-logic IC. (In digital logic, that constitutes a logic *high* on pin 19.) As long as the other input of gate AND-2 sees a logic high, the output is a logic high. Two logic-high inputs to gate AND-3 gives another logic-high output, that inverts in the gate immediately following it.

The logic low from IC pin 21 cuts off transistor Q4003, placing a logic high on the base of Q4010. Because it is an emitter-follower (noninverting), Q4010 delivers a logic high through switch segment S4004-1 to one side of the DC threading motor. Switch-segment S4004-2 grounds the other side of the motor. The threading motor runs.

Now, let's review some of the ramifications of various circuit elements you have encountered along the way. Some of them can, for one reason or another, inhibit the operation of the threading motor.

First, let's start with gate AND-2. To deliver a logic-high output, both gate inputs must be high. However, if certain things malfunction elsewhere in the machine, an automatic-stop system switches a logic-low signal onto this line. A logic-low signal would inhibit gate AND-2, and this would force a logic high at IC pin 21, and, ultimately, a logic high at IC pin 21, and, ultimately,

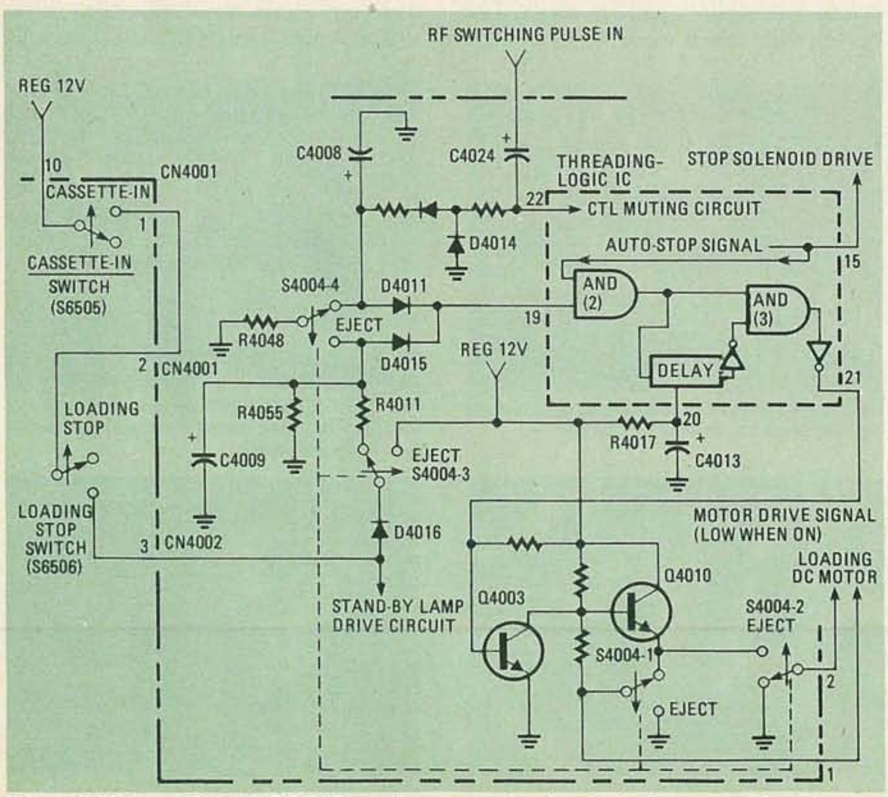


FIG. 1—BASIC THREADING CIRCUIT contains many safety interlocks that prevent damage to the machine during the tape loading process. A microswitch detects when the cassette is in place.

a logic low at the emitter of Q4010. Thus, the threading motor would stop.

Let's look at the delay-logic circuit block shown in Fig. 1. The delay circuit acts as a switch that keeps IC pin 20 normally grounded. This in turn sends a logic low to the delay gate and a normal logic high to gate AND-3.

However, when gate AND-2 applies a logic high to the delay input, it effectively lifts the ground from IC pin 20. Capacitor C4013 begins charging through R4017. If the threading finishes in the usual two or three seconds, the threading-stop switch opens, the output of gate AND-2 goes low and IC pin 20 reverts to ground or zero.

But if something goes wrong and threading has not been completed in ten seconds, capacitor C4013 attains nearly full charge. The delay gate inverts the developed logic-high output from the delay amplifier, sending a logic-low input signal to gate AND-3. A logic-high output thus appears on IC pin 21, which shuts off the threading motor, thus averting excessive tape stress or breakage.

Eject or unload

Eject mode is another term for unthreading the tape, returning it to the cassette and raising the cassette-lift mechanism to remove the cassette.

Basically, unthreading can proceed whenever the EJECT button is depressed. Figure 1 shows that Main Eject switch S4004 has four segments. Switch segments S4004-1 and S4004-2 reverse the DC voltage that is applied to the threading motor from Q4010. The motor runs in the opposite direction, and the gearing system now drives the threading ring back clockwise toward the tape-unloaded position.

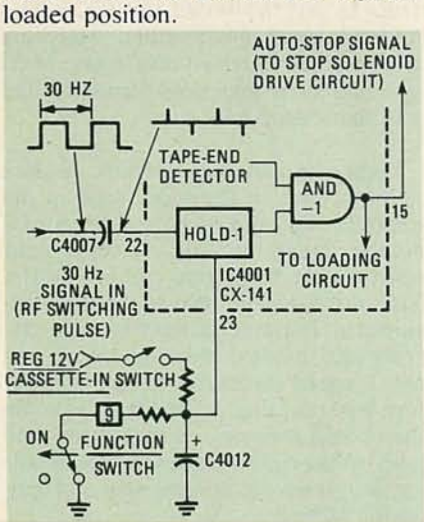


FIG. 2—THREADING LOGIC IC uses 30-Hz signal to verify that the video head drum is rotating.

Switch segment S4004-3 opens the voltage path from switches S6505 and S6506. Switch segment S4004-4 moves to its Eject position and discharges any voltage stored across capacitor C4009.

The turn-on logic for unthreading comes from a safety system. It is important that the takeup reel is operational when the threading ring begins unwinding tape from around the video-head drum. If not, the tape could wad up in the mechanism. Slack tape must be drawn back quickly into the cassette. The takeup turntable depends on the AC motor for its drive, so threading should not begin unless the AC motor is definitely running.

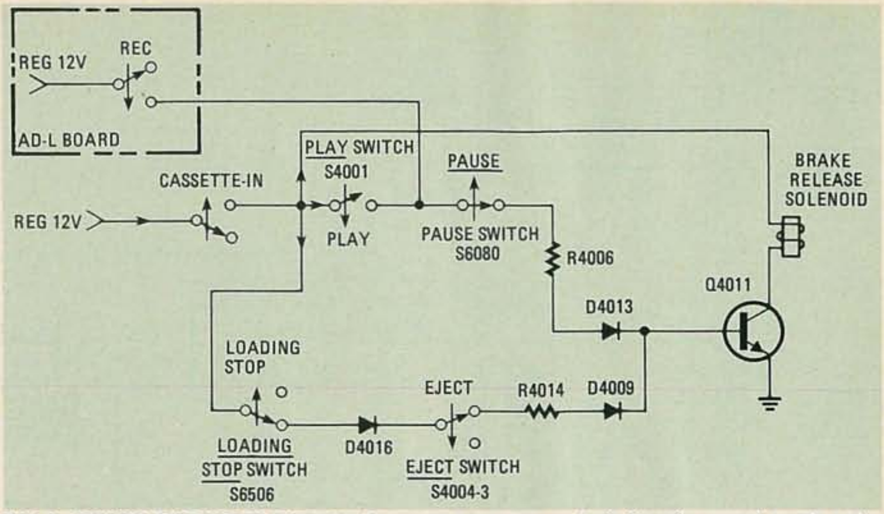


FIG. 3—BRAKE RELEASE ELECTRONICS control the brakes on both the take-up and supply reels. Brakes are released when solenoid is energized.

The turn-on voltage (logic) for the unthreading operation comes from this relation-sensing system. The head-switching pulse signal depends on the rotation of the head drum, which is belt-driven by the AC motor. Capacitor C4024, shown in Fig. 1, couples a sample of the switching signal into the threading-logic system.

Doubler diodes D4012 and D4014 rectify the signal. Positive DC develops across C4008, forward-biases D4011, and feeds a logic high to pin 19 of the IC. You have already traced through the remainder of the logic that activates the threading motor. Remember, though, that the motor is now turning backwards to unthread the tape.

One type of VCR uses circuits inside the threading-logic IC to verify the video-head drum rotation. See Fig. 2.

Capacitor C4007 couples a sample of the 30-Hz pulse-generator signal to a sample-and-hold stage in the IC. Capacitor C4012 is the charge-holding capacitor. As long as the signal is present, the logic output of the sample-and-hold stage stays high. When this logic-high output is fed to inhibit gate AND-1, it keeps the gate operative and feeding a logic high to gate AND-2 (Fig. 1) through threading IC pin 19.

When the signal ceases, indicating that the AC motor has stopped, C4012 discharges—leaving a logic low at pin 23. The sample-and-hold output goes low. Gate AND-1 inhibits gate AND-2, stopping any threading action. The same logic-low indication appears on the auto-stop signal line, and also triggers a STOP solenoid into action.

Figure 2 shows that other safety shutoffs work through IC4001 and duplicate those shown in Fig. 1.

In Fig. 1, the delay system works for the unthreading operation just as for threading. If the unthreading is not finished in less than 10 seconds, the delay system shuts off the threading motor.

Brake-release electronics

During the loading or threading operations, the brakes on both the takeup and supply-reel turntables must be freed. In some VCR's a solenoid controls the brakes; in others, a mechanical link-up provides control. (In the rewind and unthreading modes, individual links manipulate the turntable brakes one at a time.)

Figure 3 shows the brake-release solenoid electronics. When the solenoid is at rest, the brakes are spring-applied to both takeup and supply-reel turntables. When activated, the solenoid releases both brakes. Inserting the cassette and dropping the lift compartment to its latched position turns on the cassette-in switch. This action applies 12-volts DC directly to the solenoid.

The bottom of the solenoid goes to ground through Q4011, but only when the transistor turns on. Figure 3 shows that there are two paths to the base of Q4011. One is via PLAY switch S4001, PAUSE switch S6080, R4006, and D4013. This path turns Q4011 on only when the PLAY pushbutton is down.

The other signal path goes through LOADING-STOP switch S6506, D4016, EJECT switch S4004-3, R4014 and D4009. Inserting a cassette applies DC to this *enable* path to Q4011. Therefore the transistor turns on and the brakes are released.

At the end of threading, switch S6506 opens and the brakes are set again. The same procedure occurs if the EJECT mode is selected; the mechanical linkages control the takeup brake.

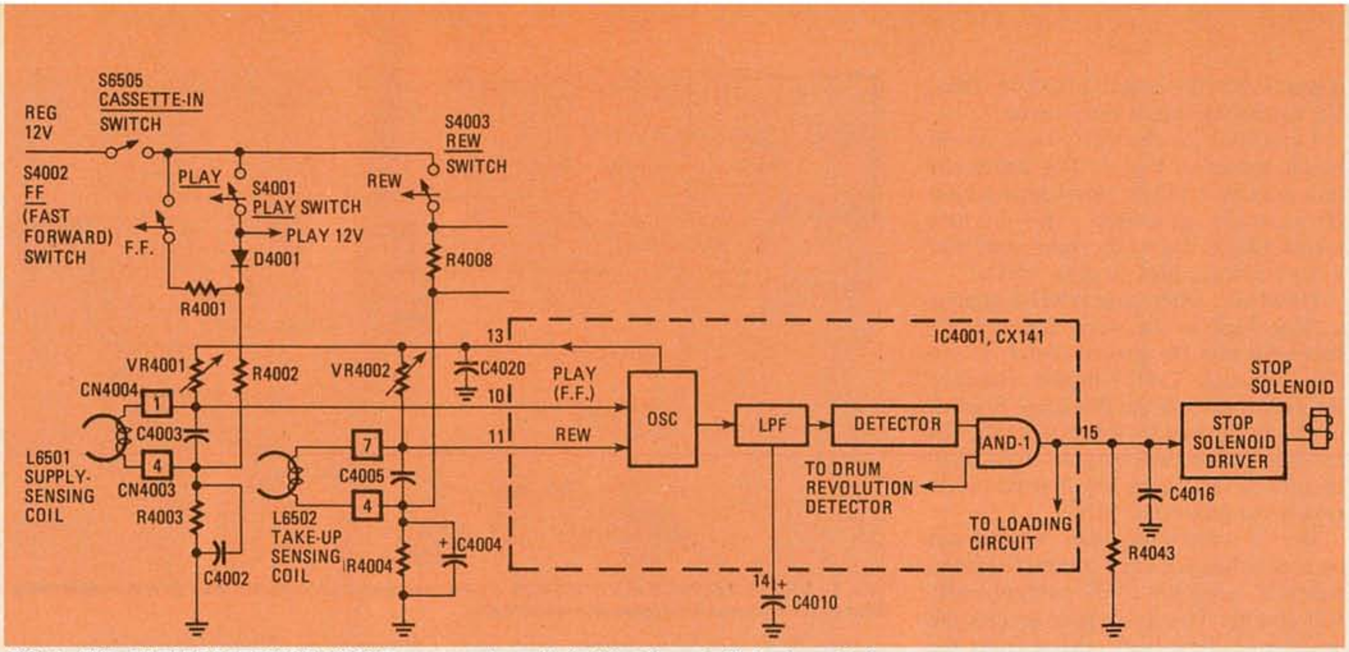
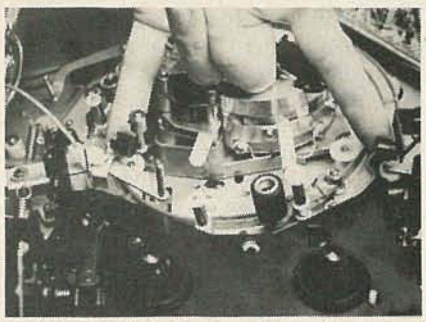


FIG. 4—END-OF-TAPE DETECTOR CIRCUIT uses sensing coils to detect the metallic leaders at both ends of the magnetic tape.

Once the tape has been threaded, both brakes can be released simultaneously by pressing either the RECORD or PLAY buttons (they're labelled FORWARD on some machines).

The braking system is simple, but you must remain aware of it. If a malfunction leaves the brakes set during the threading operation, the machine will shut down when the ten-second safety delay expires. That's because turntable brakes prevent the tape from being pulled out of the cassette.


SENSING COILS detect metallic leaders at both ends of tape to provide an end-of-tape indication that is used to trigger automatic shutoff.

Automatic stop signals

As you already know, due to the load-inhibit operation of gate AND-2 an automatic-stop signal from any stage in the machine can prevent loading or bring it to a halt. Hence, when you set out to troubleshoot a loading problem, you may track the fault to some faraway stage or section.

Now, refer again to Fig. 1. If you're familiar with digital-logic diagnosis and tracing, you know there are two ways to check out inhibit operation of the AND-2 gate.

You can check the top input with a logic probe (or voltmeter). If the input measures logic low, the warning must be coming from elsewhere in the machine, and you troubleshoot there for the fault. If the inhibit input measures a logic high, the auto-stop signal line is OK, and the fault must lie inside the threading-logic system.

A less-desirable approach can be used: Disconnect the auto-stop line and feed a logic-high input to the inhibit side of gate AND-2. If all is well in the threading system, loading or unloading will start again. (Warning: Do *not* let the loading continue. The fault located "elsewhere" might cause damage, which is the reason for including the inhibit gate. Track down the trouble that is causing the auto-stop signal (a logic low).

Automatic-stop signals comprise part of the system control network. The threading/unthreading system you just studied is part of the system control, as are the brake release system and all mode pushbuttons. Here are other stages you must investigate when you detect a logic-low signal on the automatic-stop line.

Tape-end detector—Metallic leaders at both ends of the video tape in the cassette indicate end-of-tape. Two coils do the supply sensing. A supply-end sensing arm holds one coil beside the left-side tape path, next to the tape-tension arm. In the PLAY, RECORD, or FAST-FORWARD modes, this *supply-sensing coil* triggers automatic shutoff just before tape runs out. A fixed bracket holds the *takeup-sensing coil* next to the tape path on the right side beside the threading ring. It works the same way, but only during REWIND.

Figure 4 shows the switching that connects the sensing coils. DC from one of the forward-mode switches couples supply-sensing coil L6501 into the feedback loop of an oscillator. The signal from the oscillator is rectified and filtered in the detector, and then

continued on page 91

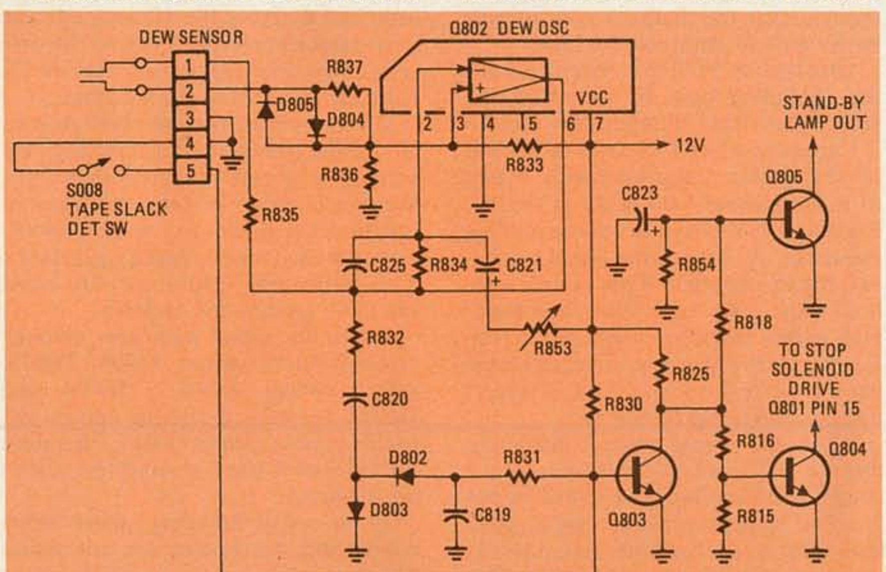


FIG. 5—DEW SENSOR CIRCUIT prevents operation if moisture condenses in the tape transport mechanism. Moisture can seriously damage tape.

AFFORDABLE NTSC COLOR-BAR GENERATOR

A precision color-bar generator is desirable when servicing the color circuits of TV receivers and all types of video recorders. This new instrument brings TV-station accuracy to the shop at service-bench prices.

JACK DARR
SERVICE EDITOR

UP TO NOW, THERE HAVE BEEN TWO KINDS of TV test equipment: One kind is expensive, accurate and designed for use in TV stations and studios. The other kind is inexpensive, less accurate and made for TV service work. Now, the B&K-Precision Product Group of Dynascan Corp., 6460 W. Cortland St., Chicago, IL 60635 has come out with an instrument that is accurate enough for use in TV stations and studios and, at the same time, versatile and inexpensive enough to be valuable in the better TV service shops. In fact, the price is a real breakthrough at $795.

Their new model 1250 NTSC (*N*ational *T*elevision *S*ystems *C*ommittee) Color-Bar Generator will generate the same color-bar patterns used in TV stations with the same accuracy. It will also make four stock convergence patterns and all three color rasters (or any mix of the three). The RF output is on Channel 3 or Channel 4 and is crystal controlled. There is an IF output at 45.75 MHz, also crystal controlled. The sound subcarrier is at 4.5 MHz and may be frequency modulated with either a 1 kHz or 3 kHz audio signal that is generated internally. The audio signal is also available at a jack labelled *AUDIO OUT* for testing audio equipment, and there is a jack for an external audio input signal.

There is a composite video output that can be calibrated to the standard 1.0 volt P-P negative modulation, or can be varied up to 1.5 volts P-P. This is another standard signal for making many tests on video tape recorders, whether the big studio types or the home units. The video can be modulated by any of the standard patterns. A very accurate 3.579545-MHz color subcarrier signal is available. All RF and video output impedances are 75 ohms and are equipped with BNC connectors. Audio inputs and outputs are phono jacks.

NTSC

Now, just what *is* an "NTSC color Signal?" Back in the early 1950's there was quite a hassle over two different color-TV systems. One was approved by the FCC and tried out: That was the CBS system which used a color wheel. The other, developed by RCA, was the all-electronic color system, with all of the matrixing done inside the picture tube. Eventually, that was the system chosen.

A national committee was appointed to study the RCA and other systems, and came up with a set of standards for transmitters and receivers. (That committee was the National Television Systems Committee.) In 1953, after some years of testing, deliberation and probably quite a bit of arguing, they selected what are now the NTSC Standards. The color TV systems now in use in Europe—PAL, and the French SECAM—were considered, tested and not chosen.

The NTSC system has worked very well so far; there have been no major alterations since its adoption. One of the headaches was coming up with a system that was fully compatible with black-and-white TV.

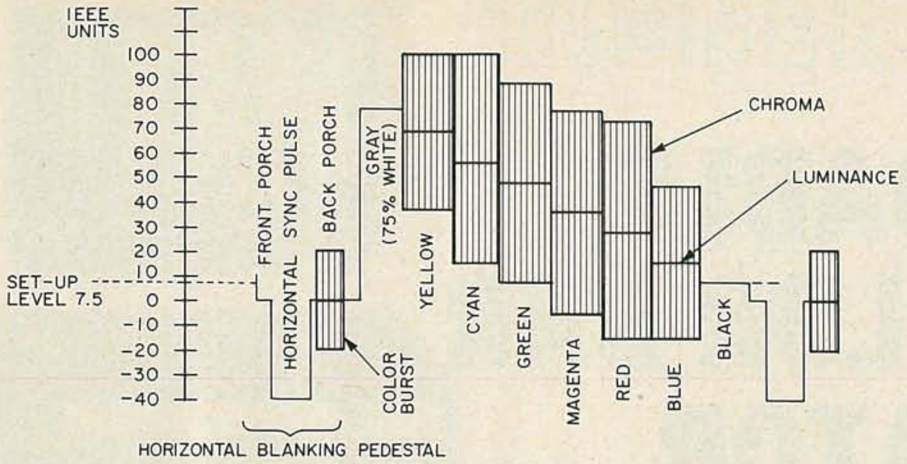
The NTSC Standards cover everything—the TV signal transmitted from the station, color modulation, and you name it. Thus, TV station engineers now had a set of standards to go by in setting up their equipment; and receiver designers used those standards for making color TV receivers.

Now we come to the nitty-gritty: They also specified an NTSC Standard color-bar pattern that could be used in setting up TV cameras, monitors, and color TV receivers as well. There are several of these patterns, intended for use in checking the ability of TV equipment to reproduce the transmitted signal exactly.

At first, only TV stations had generators capable of producing the NTSC pattern. They were big and expensive, so only very few (if any) TV shops had them. Now, we have an NTSC generator that is not only accurate enough for a TV station but also can be afforded by a service shop. Somewhat simpler and less accurate types had been developed for the service shop, but they had some disadvantages, especially if you wanted precision.

The NTSC color bars

Let's go into the NTSC color-bar pattern a little more; there's more to it than meets the eye. Figure 1 shows the waveform of one line of the NTSC color-bar pattern. On the screen it looks like an ordinary color-bar pattern, with colors in a different place than we're used to. The first bar is pure white; next, in a logical progression comes yellow, which is nearest to a white. Then comes cyan (blue-green), green, magenta (blue-red), red, blue, and finally a black bar. It progresses from the brightest color, nearest to white, to the darkest, blue, which is nearest to black. The color signals are carefully controlled both in phase *and* in amplitude. Each of the colors is fully saturated; that is the difference between the NTSC sig-



LUMINANCE	0	-40	0	77	69	56	48	36	28	15	7.5
CHROMA AMPLITUDE	–	–	40	–	62	88	82	82	88	62	–
VECTOR (FROM B-Y)	–	–	180°	–	167°	284°	241°	61°	104°	347°	–

Fig. 1—NTSC COLOR BAR waveform for one horizontal line. The waveform is 1 volt P-P and is divided into 140 IEEE units. Note the difference in luminance levels of the different colors and the staircase pattern.

nal and that of lower-priced generators. With lower-priced generators, the color bars are all at the same amplitude, and some are over-saturated.

The NTSC composite video signal is exactly 1.0 volt peak-to-peak. It is divided into 140 equal units, called "IEEF units." At first they were "IRE units" from *I*nstitute of *R*adio *E*ngineers, but when this was changed to IEEE (*I*nstitute of *E*lectrical and *E*lectronic *E*ngineers), the name of the units was also changed. Note, in Fig. 1, that the zero-reference for the composite video signal is the blanking level—the porches of the horizontal sync pedestal. The tips of the horizontal sync pulses are at −40 IEEE units; the sync pulse is approximately 0.3 volt. Note that the black level is at +7.5 units. That is called the setup level and is the black reference for the picture. Levels of luminance between 7.5 and 100 units produce various shades of gray. The brightest white is 100 units, or 100% and it is equivalent to zero modulation of the composite RF signal. The sync tips are at −40 units, which corresponds to maximum modulation of the RF carrier—hence the strongest signal. The advantage is that the weakest signal—where interference can cause snow—is in the white parts of the picture where snow isn't so easy to see.

Now, we come to the really different part: Note that each color is at a different luminance level. Note also that there is a difference between some colors. That was done so that each color will have precisely the right amplitude (of the chroma carrier) to give it full saturation—no more and no less. Note that the luminance has a "staircase" effect. That is a very important part of it. The staircase is another standard NTSC signal.

As previously mentioned, on the screen it looks like a color-bar signal. On the scope it doesn't! Therein lies a major advantage. For example, when you feed the NTSC signal into the antenna you should see an exact duplicate at the video detector output. (Set the scope to display it at exactly 1.0 volt P-P). Feed in a video signal from the model 1250 to the upper channel of a dual-trace scope. (All RF, IF and video outputs may be used at the same time.) If there is any difference between the two waveforms, you have problems in the RF or IF circuits of the receiver. In fact, you can superimpose the two waveforms to make comparison easier. The model 1250 also provides scope trigger signals at vertical and horizontal frequencies, so that the patterns will be steady. Any distortion or poor frequency response, etc, will make the waveforms look different.

The −IWQ signal.

If you've ever seen a network color-bar signal (usually switched in by accident!) you've probably seen black and white bars across the bottom. That is another NTSC standard signal, called the "−IWQ." It's composed of equal parts of the signal

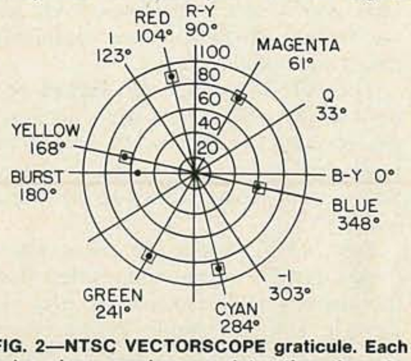


FIG. 2—NTSC VECTORSCOPE graticule. Each color phase produces a dot rather than the familiar "petal."

called −I (which is chroma at a phase angle of 303° from burst), a fully saturated 100 units white bar and the Q signal (which is chroma at 33° from burst). Both the I and Q signals are at a level of 40 units. The last bar you see at the right is a black signal at the 7.5 unit reference level.

The IWQ signal is used mainly in studio phase measurements, in video processors, amplifiers, and similar items. For an eyeball test, the first quarter of the pattern should be black, then you see pure white, then black again for the rest. Transitions between black and white should be sharp.

The NTSC color-bar pattern can also be used for vectorscope analysis. That is the method used in TV stations. The pattern is basically similar to the familiar "flower" pattern, but it has no petals; each color makes a single *dot* on a vectorscope. Fig. 2 shows a vectorscope ratio graticule for use with the NTSC color-bar pattern. Note the small boxes for each color or combination of colors; each color must fall within its box. If it isn't in the box, there's an incorrect phase.

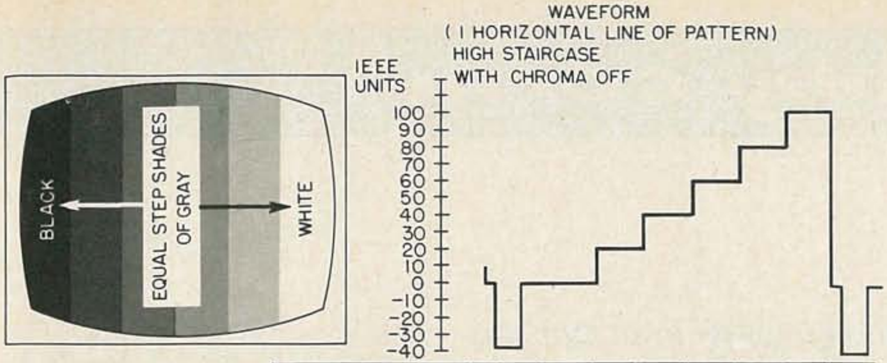
One novel test is possible with this graticule and the model 1250. The model 1250 will make a pix raster of each primary color—red, blue, or green. You can also use two colors at once to make combinations such as cyan. On the vectorscope only the dots for the color in use will be seen. Very small phase shifts can be detected by this method. Note that the colors, burst, I, Q, etc., are all marked on the graticule.

The Staircase

Another NTSC standard pattern that is available with the model 1250 is the "staircase." The reason for the name should be obvious from the waveform. There are actually three different staircase patterns available, each with a different purpose. They are shown in Fig. 3. The pattern in Fig. 3-a is just 5 steps of video luminance without modulation. The screen will show a pattern of vertical bars, starting at left with black and going to white. The steps are 20 IEEE units each. These bars can be used to check for luminance response and linearity. It's the same procedure as with the color bars: Use a comparison pattern on one channel of the scope. All steps in the signal at the video detector must be exactly the same amplitude as the signal from the model 1250. Turn the CHROMA switch on the front panel of the model 1250 off to get this signal.

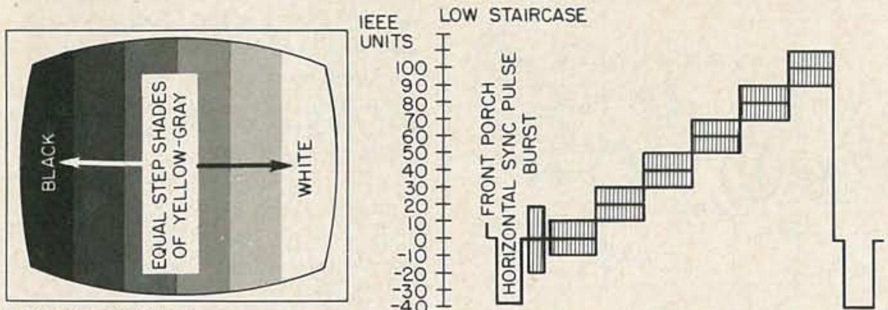
Figure 3-b shows one of the two modulated staircase patterns. Each step is modulated 20 IEEE units with chroma at burst phase. To get this signal, push the LOW STAIRCASE button. Figure 3-c shows the high staircase—identical but modulated at 40 IEEE units.

What can you do with these two unmodulated staircase signals? You can make



LUMINANCE	0	-40	0	0	20	40	60	80	100
CHROMA AMPLITUDE	–	–	–	–	–	–	–	–	–
VECTOR (FROM B-Y)	–	–	–	–	–	–	–	–	–

a.

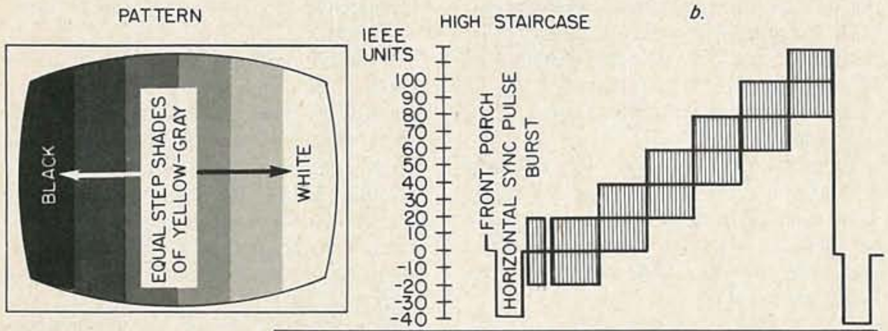


(LESS YELLOW THAN HIGH STAIRCASE)

LUMINANCE	0	-40	0	0	20	40	60	80	100
CHROMA AMPLITUDE	–	–	40	20	20	20	20	20	20
VECTOR (FROM B-Y)	–	–	+180°	180°	180°	180°	180°	180°	180°

b.

PATTERN



LUMINANCE	0	-40	0	0	20	40	60	80	100
CHROMA AMPLITUDE	–	–	40	40	40	40	40	40	40
VECTOR (FROM B-Y)	–	–	180°	180°	180°	180°	180°	180°	180°

c.

FIG. 3—NTSC STAIRCASE waveforms. The waveform shown in *a* contains only luminance and produces a series of bars on the picture screen from black to white. The low staircase waveform shown in *b* contains 20 IEEE unit chroma modulation. The high stairc.ise waveform shown in *c* contains 40 IEEE unit chroma modulation. The waveforms shown in *b* and *c* are used to measure differential gain.

tests that up to now have been very difficult. They are for differential gain and differential phase. Either of these can cause color distortion. The TV studios use these two signals for checking video processing equipment of all kinds—video monitors, VTR's, etc. Now, with these two waveforms, you can check for these parameters.

Differential gain means that the chroma amplitude should not *vary* as the luminance is varied. That is done for you automatically; the staircase steps the luminance from zero to maximum; the amplitude of the chroma signal must remain the same as the input. Any variation means that something is wrong in the equipment. The two modulation levels let you check so you can be sure there is no difference between low and high modulation levels.

The chrome phase must not shift as the luminance is varied from 0 to 100%. If it does, you have differential phase-shift problems. To check that, the staircase pattern is displayed on a vectorscope with chroma modulation. If there is any differential phase shift as the luminance steps up, it will show up as an angular shift of the dot on the graticule. Use both low and high modulation to make sure.

On the bench

The model 1250 can be a fast and accurate aid to any kind of service work: color TV sets, VTR's, VCR's, or you name it. The front panel of the unit is laid out so that switching can be very easy. There are 15 pushbutton switches that are functionally divided into three groups. The NTSC patterns are all selected by the right-hand group, along with the FULL BURST, TOP BURST (that one turns off the burst for only the top fourth of the screen on the color bars and raster patterns: it's used to check the sync), CHROMA, −IWQ, LOW STAIRCASE and HIGH STAIRCASE pushbutton switches.

The next group, from right to left, are the four convergence pattern switches: DOTS, CROSSHATCH, DOTHATCH, and CENTER CROSS. Those are mechanically interlocked with the NTSC switches; if any of those is turned on the other patterns are turned off. Because of interlaced scanning, you may see a small vertical jitter in the convergence patterns. That is normal and won't affect convergence adjustments. It does *not* indicate any problems in vertical sync.

Last, but definitely not least, are the RASTER switches: one for each primary color and a raster ON-OFF switch. The raster ON-OFF switch is interlocked so that it turns off the NTSC or convergence switches that are on. There are three color raster buttons; you can make *eight* different color rasters with them. All switches off produces black at the 7.5 unit reference level. This is used for adjusting the receiver brightness control. Pure red, green, or blue rasters are for purity adjustments. Red was used in many older sets and some new ones. In some sets with in-line pix tubes, the green raster is for purity. By pushing any two at once you can get the combination of the two colors. Red and green give yellow, and so on. The three pure colors could be handy for checking the guns of a picture tube for equal emission. Pushing all three primaries at once gives you a pure white raster at a 75-unit level.

The IF output can be used for tuner substitution. It has a level of 10 mV with no load, which is ample.

If you use all possible combinations of switching, you can get a total of 28 different patterns! The manual lists them.

For TV and VTR testing, the composite video signal is available through a jack on the front panel. It has a gain control that will vary the level from 0 to 1.5 volts P-P. Turning the control fully counter clockwise until a click is heard sets the output at the standard level of 1.0 volt P-P with the sync negative going. That is the standard video input used for many VTR tests. Any of the patterns can be used to modulate the video signal. You can feed the NTSC color bar signal into a VTR, record it, then play it back to make sure it comes out the same as it went in. If you have sound problems in the VTR, you can feed an RF signal into its tuner, with either of the two audio frequencies as modulation.

continued on page 93

hobby corner

An inexpensive wide bandwidth preamplifier in kit form that has many applications on your workbench.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

A WHILE BACK I WAS WORKING WITH SOME low-level RF circuits and discovered that my frequency counter would not pick up those feeble signals. Needing that information, I had two choices. One was to rebuild the counter-input stage to provide more gain. That seemed to be too much trouble so I chose to add a preamplifier.

International Crystal (10 North Lee St. Oklahoma City, OK 73102) has a little two-stage, broadband-amplifier kit that looked good for this application. The BAX-1 has 30 dB to 6 dB gain over a range of 20 Hz to 150 MHz—that was just what my counter needed. I put it together in about ten minutes and temporarily inserted it between the RF circuit and the counter.

The setup worked so well that I started taking the counter cabinet apart to stick the amplifier inside. Fortunately, I decided to try a few more things before wiring it in. Here is what happened.

With the BAX-1 in the input line, my AC voltmeter was much more sensitive. Of course, all measurements were relative instead of absolute but those really weak ones were in there.

The BAX on the output of a little crystal oscillator made an excellent low-power transmitter. Placed between the antenna and a shortwave receiver, it amplified the incoming signals and thus enabled the receiver to pick up weaker signals.

That's just for starters. There is no reason why the BAX can't be used to increase the sensitivity of a microphone. I want to try it on my TV antenna and on the FM in the car. The BAX is quite versatile and, in some applications, should be even better with a tuned circuit or filter before and/or after it. Needless to say, mine hasn't gotten into the counter cabinet yet and probably won't, at least for a good long while.

The BAX-1 ($6.67 including postage in U.S.A.) contains a circuit board, all parts, and mounting hardware. You can get the kit or build your own from scratch. With International's permission, the circuit is shown in Fig. 1. There is nothing critical about its construction.

In a couple of applications I found that some method was needed to vary the gain (there was too much). Of course, that can be done in several ways; for example: a pot used as a voltage divider at the input, or by varying the bias on a transistor. The easiest way for me was to vary the applied voltage. The BAX-1 specifies 9 to 15 volts but it works fine at much lower voltages, too.

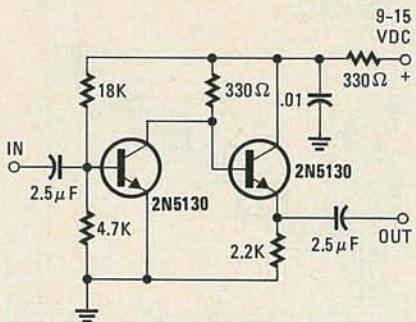


FIG. 1

By the way, International has several other interesting little kits that I really want to investigate. If you have used any of them in unusual applications, how about sharing your experiences with me and other readers?

Technical training

In past columns I have mentioned from time to time the need for the serious hobbyist to learn more than just tinkering will provide. The real pleasure of electronics is found *beyond* the stage of following "cookbook" building plans (though that is a good place to begin). The satisfaction that comes from experimenting, modifying and, ultimately, designing is hard to beat.

Going beyond the simple matter of just following instructions requires a basic knowledge. Several suggestions have been made for acquiring that base. Among the suggestions was independent study—a method probably most suited to a majority of the hobbyists.

One of the problems with independent study has been finding the right materials. I have told you about study materials from the Heath Company and the American Radio Relay League, among others. Recently, I have discovered some excellent materials from the McGraw-Hill Book Company.

McGraw-Hill publishes textbooks on a wide range of technical subjects. In the electricity and electronics area, the list goes on and on from servicing to applied mathematics. Of particular interest at this point are a couple of texts that I have had an opportunity to examine quite thoroughly. They are: *Electronics: Principles and Applications* by C. A. Schuler, with its Activities Manual ($16.00 and $7.50, respectively) and *Digital Electronics* by R. L. Tokheim, with its Activities Manual ($8.50 and $5.75).

As a professional educator, I have examined many textbooks over the years. Those two are near if not at the top in instructional quality. Both are unusually well-written and well-presented. Organization of content, clarity of circuit diagrams, and explanatory text are outstanding. Best of all, from our standpoint, is that those textbooks are as well suited to independent study as they are to classroom use.

I recommend either or both of those books, depending upon your interests and needs, for building that base of knowledge which will enable you to get the most from your hobby. If you choose to go that route, I also recommend that you get the corresponding Activities Manual(s). They are not necessary to an understanding of the texts but they will be an additional help.

The Manuals contain specific lab-type activities to illustrate and "nail down" the concepts in the texts. Components that may be needed to carry out the activities are readily available and inexpensive. (You probably have most of them in your junk box.)

It is unlikely that you can find those books and manuals locally. Exact prices and ordering information can be secured from Gordon Rockmaker, Editor in Chief, Electricity/Electronics, Gregg Division, McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020.

Again, I urge those of you who have not done so to do some studying and enjoy your "work" more!

Photo timer

J. D. Miner of Lima, OH has written about adapting a clock module for photographic use. Color processing, as you know, requires several sequential timed steps. Of course you can do that, J.D. It will start at zero and read elapsed minutes and seconds.

Most, if not all, modules have a *reset* capability. Take the National 5316 as an example: Activate the seconds display (pin 32) and then *both* the slow (pin 33) and fast (pin 34) set. The clock resets to midnight and the display, showing minutes and seconds, starts at zero.

As a matter of fact, the off-the-shelf commerical clocks that I have seen do exactly the same thing. You might make it a little more convenient as a timer by wiring the slow and fast pins to one double-pole switch.

But, J.D., let me pass along another way you may like. Some 25 years ago, when I was deep into photography, I ran across an article in one of the photography magazines about using a tape recorder to time color processing. What I did was to make a tape recording of some favorite music and, at appropriate times, faded to instructions; e.g., "in 30 seconds do thus-and-so. . . . now." Not only did the tape do the timing and free me from watching the clock, but it provided instructions and music to "agitate" by! R-E

computer corner

Here's a look at the various ways you can interface a microprocessor to a 7 segment LED display.

J. TITUS, P. RONY, D. LARSEN and C. TITUS

REGARDLESS OF THEIR APPLICATION, MOST microcomputers need peripheral I/O devices for the input and output of data. The more common output devices include 7-segment displays, 5 × 7 dot-matrix displays, printers and CRT displays.

This month, we'll look at several methods that can be used to interface 7-segment displays, as well as different programs to "drive" such displays that are widely used in electronic games, calculators, point-of-sale (POS) terminals, gasoline pumps, children's toys and taxicab meters.

One of the simplest methods for interfacing a 7-segment display to a microcomputer consists of latching the appropriate data values from the data bus under software control (see Fig. 1). The latch's inputs (7475) are wired to the computer's bidirectional data bus, and the latch's outputs are wired to a 7-segment decoder/driver (7447). The decoder's outputs (current-sinking) are wired to the 7-segment display with 220-ohm current-limiting resistors. When an

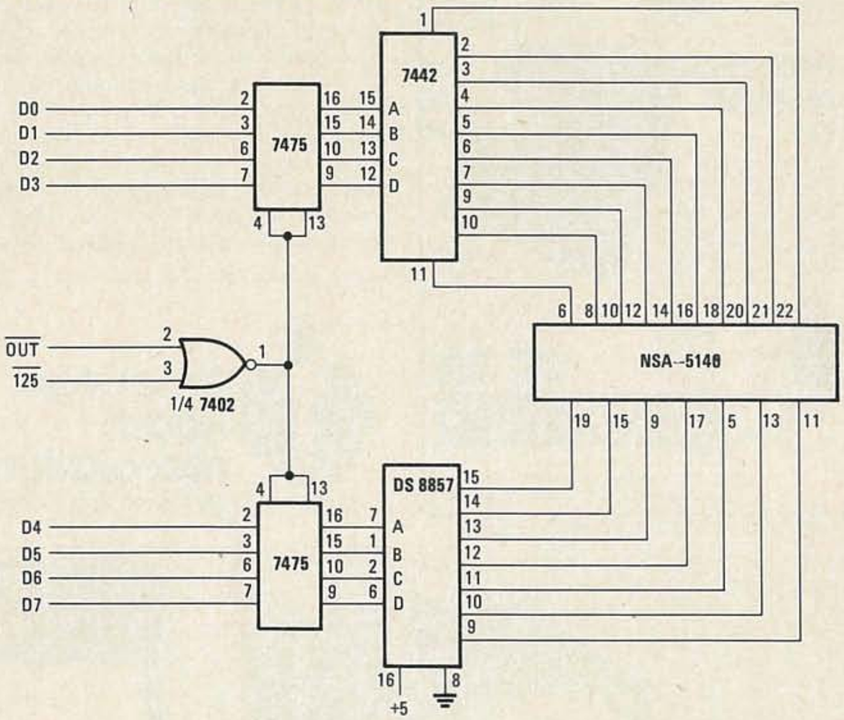


Fig. 2

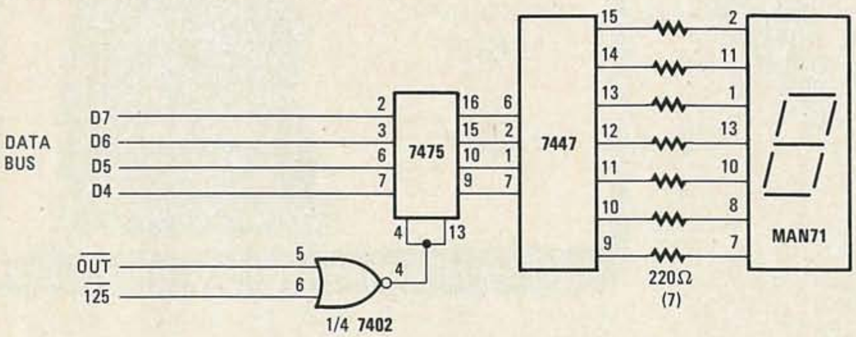


Fig. 1

TABLE 1—DISPLAYING A 39 on the two-digit display

```
/THIS SECTION OF A PROGRAM OUTPUTS THE
/BIT PATTERN 00111001 (OCTAL 071, HEX 39)
/TO AN OUTPUT PORT EQUIPPED WITH TWO
/SEVEN-SEGMENT DISPLAYS.

      •
      •
MVIA        /LOAD A WITH THE FOLLOWING IMMEDIATE
071         /DATA BYTE (HEX 39, BINARY 00111001)
OUT         /OUTPUT IT TO THE TWO SEVEN-SEGMENT
125         /DISPLAYS EQUIPPED WITH LATCHES
      •     /CONTINUE WITH THE REMAINDER OF THE
      •     /PROGRAM
```

OUT125 instruction is executed, the content of the 8080's A register is latched by the display interface, and the two BCD numbers represented by D7–D4 and D3–D0 are illuminated on the two displays. The instructions listed in Table 1 cause a "39" to be displayed.

To display a 10-digit number using this method, 10 latches, 10 decoder/drivers, 70 resistors and 10 seven-segment displays will be required. One method of reducing the "parts count" for this interface is to use a device such as the 8255 Programmable Peripheral Interface (PPI) integrated circuit. This device can be used as three independent 8-bit output ports, so it is the equivalent of six 7475 latches. Therefore, two 8255 PPI IC's, along with 10 decoder/drivers, 70 resistors and 10 seven-segment displays would be required in the interface. An obvious disadvantage of this method is the large number of IC's required. However, one advantage is that the software needed to drive this interface is relatively simple. Also, the microcomputer only has to output this information once to the interface for the information to be continuously displayed. This, of course, is due to the latches or the 8255 IC's in the interface. Thus, the microcomputer can output numeric information once and then go on to perform any other required operations.

Another interfacing method is digit *multiplexing*. Multiplexing reduces the display-interface electronics (number of parts) to a minimum; however, at the expense of longer and more complex display-driver software. Multiplexing a display consists of enabling or turning on one particular digit with a *digit-enable code* and providing the BCD numeric information for that digit to a multidigit display interface. In this way each digit is turned on, one at a time, as the actual BCD data for each digit is provided. Multiplexing is usually only used with multidigit displays.

As an example, let's suppose the number "237" is to be displayed on a 3-digit multiplexed display. To display this number the BCD value for the digit "7" would be output to the interface along with the digit-enable code for the right-hand display. After a short period (1 μs to 10 μs) the BCD value for number "3" would be output along with the digit-enable code for the middle digit. Again, after a short delay, the BCD value for the number "2" and the digit-enable code for the left-hand display would be output to the interface. By performing this sequence 50 or more times every second, each digit in the display *appears* to be on *all the time*. This display method is used in hand-held calculators. Even though the digits are being turned on and off, it happens too fast for the eye to see. The interface for a 10-digit multiplexed display is shown in Fig. 2.

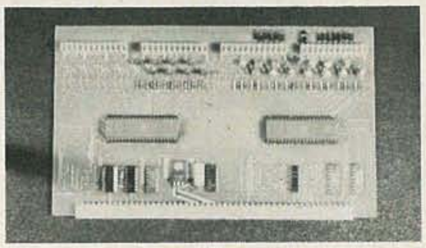
When an OUT125 instruction is executed, bits D3–D0 of register A determines which one of the 10 digits in the display will be enabled (turned on). Therefore, these 4 bits constitute the digit-enable code. Bits D3–D0 are latched (7475) and are decoded with a one-of-10 decoder (7442). The decoded outputs of the 7442 are wired to the common cathodes of the individual digits in the display. Bits D7–D4 provide the BCD code of the value to be displayed (0–9). These bits are also latched (7475) and are decoded by a 7-segment decoder/driver (DS8857, manufactured by National Semiconductor, Santa Clara, CA):

An additional display method involves the use of an external display controller IC to control the multiplexed display. The Intel Corporation manufactures some of these IC's that are compatible with the 4004/4040, 8080 and 8085; these IC's are the 4269, 8279 and 8279-5. National Semiconductor Corporation also has developed two display controller IC's that can be used with 6-digit displays. One of the devices (the MM74C912) can be used to display 0–9 and the other (the MM74C917) can be used to display hexadecimal numbers. **R-E**

computer products

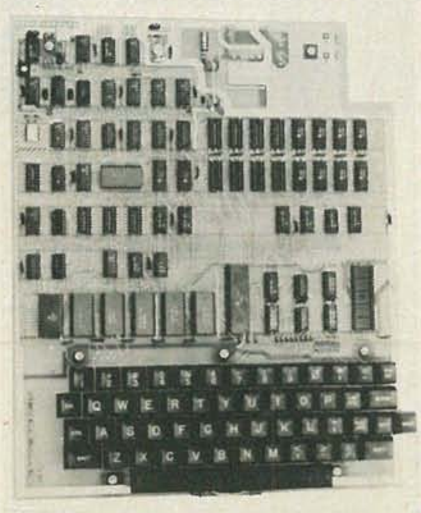
More information on computer products is available. Use the Free Information Card inside the back cover.

PARALLEL INTERFACE, *model VPI-1,* is an SS-50 bus-compatible board providing four I/O ports to interface keyboard, printers, etc., with CPU's. Two MC6820 peripheral interface adapters, two MC6522 versatile interface adapters or a combination of both give a total of 40 I/O lines (36 of them for input/output, 4 for input only) to hookup to IC power drivers and buffers. The MC6522 has two programmable timers that provide for real-time interrupts and waveform generation. Address selection and port selection are DIP-switch or jumper-selectable. Prices: *model VPI-1* board, \$32.50, plus \$2.50 per order shipping and handling; documentation, \$5 ppd. Ohio residents add state and local taxes where applicable.—**F & D Associates,** 1210 Todd Rd., New Plymouth, OH 45654.



CIRCLE 121 ON FREE INFORMATION CARD

SINGLE-BOARD COMPUTER SYSTEM, *Superboard II,* is a complete personal computing system on one board. It provides 8K BASIC in ROM; 8K RAM; 6502 microprocessor; user-programmable 53-key keyboard; video display interface, audio cassette interface; machine-code monitor; and I/O ports. Video display provides upper/lower case, graphics and game characters for up to 156 × 256-point resolution. Available options include expander board with 24K RAM, dual mini-floppy disc; port adapter for printer or modem; and 48-line expansion interface. Also available are an assembler/editor, extended machine-code monitor and complete software library. System is powered by +5-VDC 3-amp supply (not included), and is also available as *Challenger 1P* complete with case and on-board power supply. Suggested retail prices: *Superboard II,* \$279; *Challenger 1P,* \$349.—**Ohio Scientific, Inc.,** 1333 S. Chillicothe Rd., Aurora, OH 44202.



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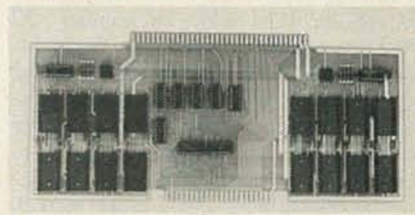
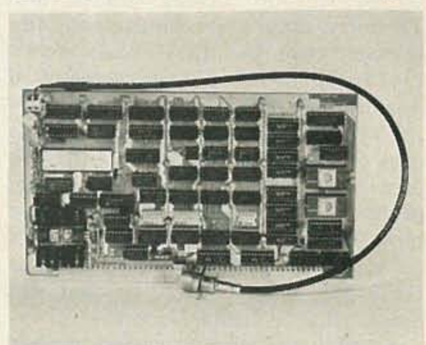
16K EPROM BOARD uses 2708 16K memories compatible with Digital Group 2708 systems. Features 8K or 16K selectability with each 8K memory block jumper to any 8K boundary and fully buffered address and data lines. The board comes assembled and ready for EPROM insertion. Price per board, \$99.50; 2708 EPROM's, \$12.50 each.—**PEC,** 21720 Alcazar Ave., Cupertino, CA 95014.



CIRCLE 123 ON FREE INFORMATION CARD

SS-50 BUS VIDEO BOARD has an 80 × 24 format with hardware scrolling, X-Y addressable cursor and multiple-character generators that allow user-programmable character sets. The board contains a 2716 EPROM with 128 upper and lower case ASCII character set, plus a TMS 2716 socket for optional 128-character set; plus 2K RAM. User can create own graphics for storage on PROM, disc or tape. The board can be used to display up to 256 characters simultaneously, either in inverse or normal mode, at half or full intensity. The board is addressable to any 2K boundary; addressing allows multiple boards at the same address. Available software includes *GMXBUG* video-based 3K ROM monitor, separate driver routines and a program that lets you create your own characters. Price: \$458.76.–**Gimix, Inc.,** 1337 W. 37th Pl., Chicago, IL 60609. **R-E**



CIRCLE 124 ON FREE INFORMATION CARD

new ideas

RELAY MULTIVIBRATOR

AMONG THE EARLIER MULTIVIBRATORS, one of the simpler models was a device using two relays and one or more capacitors and resistors to control the timing cycle and operating frequency. When it comes to small size and speed, all is in favor of the solid-state electronic multivibrator.

current activates relay RY1 and causes its normally closed contacts (RY1-1) to open. When the C1 charging current falls below the hold-in rating of RY1, the relay releases and closes contact RY1-1.

At that moment, the coil of RY2 is connected across C1. The capacitor starts to discharge and the discharge current energizes RY2 and causes contact RY2-1 to open. When the discharge current drops below RY2's hold-in current rat-

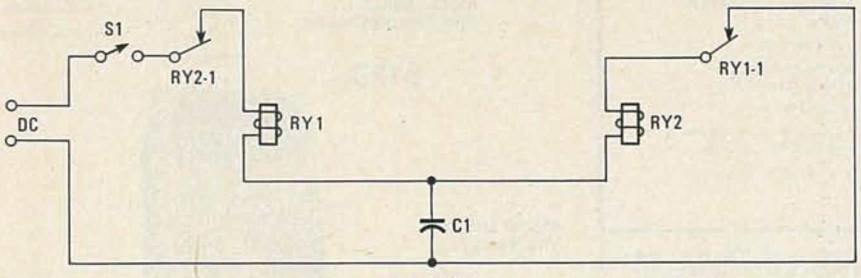


FIG. 1

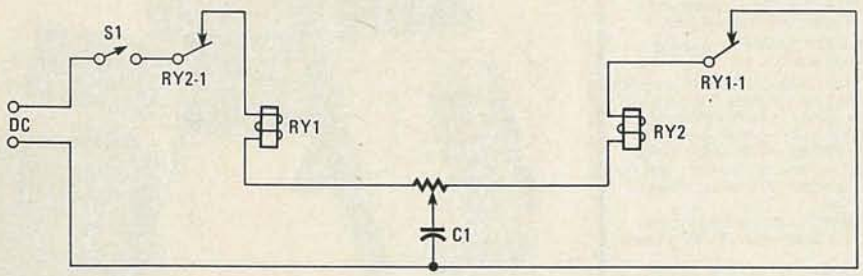


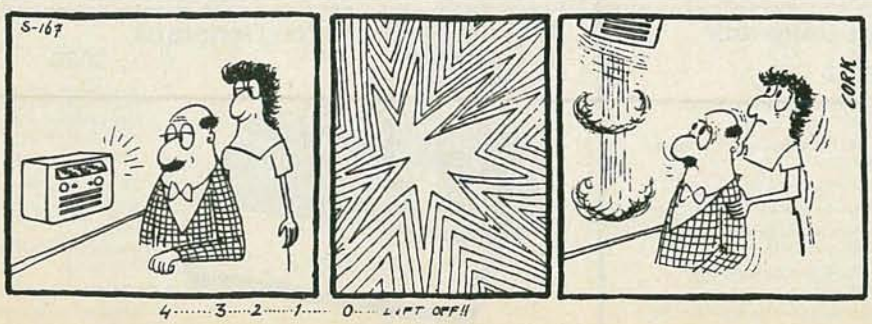
FIG. 2

However, from time to time we may need the simplicity of the relay multivibrator. Most circuits shown in literature use the charging of a capacitor to control the timing and one or more resistors to limit the discharge current so it won't damage the relay contacts. The circuit in Fig. 1 was developed around two relays and a single capacitor to perform the same tasks as the more elaborate circuits.

Circuit operation is as follows: When switch S1 is first closed, the C1 charging

ing, contact RY2-1 closes to start the cycle anew. The multivibrator will switch back and forth between the relays at a frequency governed by the capacitance of C1, the resistance of the relay coils, the applied voltage, and the hold-in current of the relays. As the relays cycle, switching operations can be carried out as needed by auxiliary contacts on either or both relays.

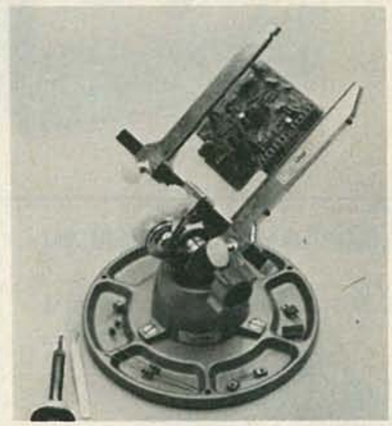
A potentiometer can be inserted between the relays as in Fig. 2 so you can vary the cycling.—*J. Ofer*



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 plus a Circuit Board Holder, Standard Base and Tray Base Mount from Panavise Products, Inc. (See photo below.) Selections will be made at the sole discretion of the editorial staff of **Radio-Electronics.**



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ADVANCE ELECTRONICS

OSCILLOSCOPE

continued from page 43

The LM318 op-amp (IC302) is used as a voltage comparator, holding the trigger input of the 555 positive until the timing capacitor has completely discharged. Premature triggering during retrace is thus prevented. The 555 provides a squarewave output at pin 3 that goes to +9 volts while the ramp is rising and drops to ground during retrace and hold-off. That line is capacitively coupled to the CRT grid to suppress the beam except during the sweep.

Baseline generator: The retrace-suppression line is used via R330 to synchronize the zero-baseline oscillator Q306, insuring that the switch from baseline to signal display will always occur at the start of a retrace when the beam is suppressed. For the lower sweep speeds, synchronization requires a slower oscillator, and for that C319 is switched in.

Each time unijunction transistor Q306 fires, C316 discharges through R332, setting flip-flop Q307–Q308 through D308 and initiating a baseline sweep. After the baseline sweep (or several sweeps if C316 is not discharged after the first one) pin 3 of the 555 goes low, bringing the base of Q307 low through C315 and D307, thus resetting the flip-flop for a series of signal displays.

Power supplies: The power supplies (Fig. 5) are entirely conventional except for the −900-volt tripler. Diodes D105 and D106 charge C102 to the peak negative voltage of the transformer secondary on the negative half cycle. On the positive half-cycle, C102 and the secondary appear in series to charge C101 to twice the peak secondary voltage (negative on top), through D103 and D104. On the next negative half-cycle, C101 and the secondary appear in series to charge C103 to three times the peak secondary voltage through D101 and D102. The drain on that supply is about 200 uA, so the 0.1 μF Mylar filters are quite adequate. Some of those capacitors are used at 20% or so above their rated voltage, but many have been tested at four times rated voltage with no breakdowns. Any string of five to ten Zener diodes adding up to about 900 volts will do for D109 through D113 if 180-volt Zener diodes are hard to find. Capacitor C105 filters out the 60-Hz noise picked up from the power transformer by the CRT heater winding.

We must breakoff our discussion of the oscilloscope's power supplies now and will conclude it next month when we will also go into construction, checkout and calibration. **R-E**

radio products

More information on radio products is available. Use the Free Information Card inside the back cover.

AMPLIFIED MICROPHONE, *model T^2M,* has integral touch-pad encoder, 12-key keyboard and LED display. Other features include preamplified electret element, digital integrated tone genera-

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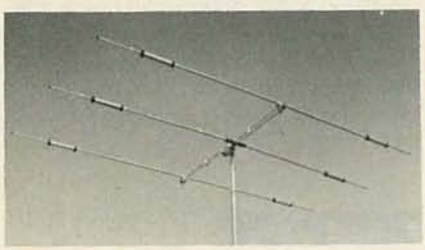
tor with 3.5795 crystal, and a mixer amplifier with up to 15-dB gain. Power is supplied by 6-0.16-volt DC sources. Mike is housed in rugged shielded plastic, and an 8-foot, 3-conductor cable is included. Suggested retail price; \$105—**The Astatic Corp.** Conneaut, OH 44030.

THREE-BAND ANTENNA, *System Three,* is a lightweight antenna designed for 10-15-20 meters, and features low SWR across the entire bandwidth, and a 14-foot × 4-inch boom length.



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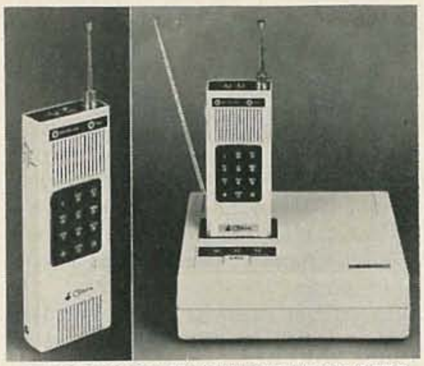
The antenna can survive up 100-mph winds. Direct feed with 52-ohm coax cable or a balun and has a power-handling capability of 2000 watts. Suggested retail price: \$179.95.—**Wilson Electronics,** P.O. Box 19000, Las Vegas, NV 89119.

CORDLESS REMOTE TELEPHONES, *models CP-100S* and *CP-200S,* contain full duplex circuitry and have an effective range of 300 feet. Features include pushbutton number entry, automatic redialing of the last number called, and rechargeable nickel cadmium batteries. *Model*



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CP-100S is portable style and *CP-200S* is phone handset style. Suggested retail price \$269.95.—**Cobra Communications,** Dynascan Corp., 6460 W. Cortland St., Chicago, IL 60635.

MORSE CODE READER, *Morse-A-Word,* assembled or kit, is designed for SWL's and amateur radio operators. Accepts audio signals from communications receivers and displays 8 digital characters sequentially. Other features are a 5- to 35-

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word-per-minute code speed, a built-in oscillator and monitor speaker for code practice. The unit measures 7.735 W × 5.75 D × 3.375 inches H, and weighs 4 lb. Suggested retail prices: kit, \$169.95; assembled, \$249.95.—**Microcraft Corp.,** Box 513, Theinsville, WI 53092.

CB RADIO, *model PC-100,* has a wide range of control functions including volume/squelch, RF microphone gain, clarifier, tone control and ANL. A panel switch provides instant shift to Channel 9.

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Performance is monitored by a meter reading signal strength and power output, a TX modulation indicator and an RX lamp. Operation is from 13.8 VDC, positive or negative ground. Suggested retail price \$119.95.—**NDI,** 22125½ S. Vermont, Torrance, CA 90502.

service clinic

How to locate faults in the all-electronic tuners

JACK DARR, SERVICE EDITOR

THE ALL-ELECTRONIC TUNER HAS BEEN with us for a while. Now they are beginning to show up on our service benches, too. As with all of the other innovations, we have to devise a method of attack for the problems that are showing up.

The problems are complicated. However, there is an old saying: "All complex circuits are nothing but a lot of simple circuits tied together."

If we look at the schematic of the electronic tuner *functionally* and rationally, we can get a much better idea of what is wrong and where. Most of the troubles will be the same as in the older mechanical tuners—snow, wrong channels, and so on. Translation: What does the thing do? It tunes in, converts and amplifies the RF TV signal, and makes the IF out of it.

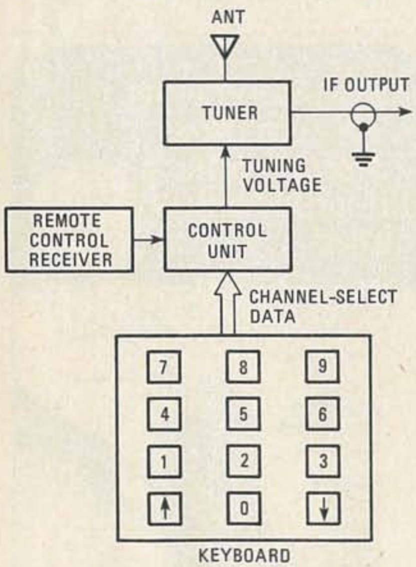


FIG. 1

The all-electronic tuners are composed of two major parts—the tuner itself and another unit that controls it. Figure 1 shows a block diagram. The tuner contains no moving parts. The only things that "move" when you change channels are *voltages*. The control circuit can be fairly simple, ranging from a couple of IC's to generate the voltages, all the way up to the frequency-synthesizer and microprocessor-controlled types. The purpose of the control circuit is to generate the tuning voltage in response to signals from the keyboard.

Understanding that gives us our first handle on the problem. Look at the TV set. What is it doing? If the answer is "nothing", providing just a plain or snowy white screen, then we may have a tuner problem. To make sure, use the old test: Feed the output of a tuner subber into the IF input and see if the rest of the set works. If so, the problem is definitely in the tuner and we've eliminated a whole lot of things.

The tuner will have the standard stages: an RF amplifier, usually a dual-gate FET, a mixer, another mixer, and the oscillator. All tuning will be done with varactor diodes that are controlled by the tuning voltage from the control unit. If the TV set tunes to a wrong channel, or refuses to change channels, the first thing you need to check is that tuning voltage.

Sams, and others, provide us with the other necessity: very complete service data and pinouts on the various circuits. Among that service data is a table of the tuning voltages you should get for the various channels. For example, let's look at the tuner in an RCA CTC-92A chassis. You should read +1.8 volts for Channel 2, +19 volts for Channel 6, +8.5 volts for Channel 7, and +14.6 volts for Channel 11. Punch in the various channels on the keyboard and make sure these voltages are correct; there is a small tolerance. If the tuning voltage is OK but the tuner still doesn't work, then the fault should be in the tuner itself and not in the control unit.

Bandswitching is also done by voltages and switching-diodes. Those voltages are also given in table form in the service data. If they prove not to be correct, you have a control-unit problem. Same principle goes for the tuning voltages. If the voltages are correct, the trouble lies in the tuner circuitry.

Since these *are* tuners, we can use signal-tracing tests to find out which stage is bad, just as we did with the mechanical tuners. Inject a signal into the mixer input. If that produces some kind of picture or at least a reaction, move to the RF input. Easy way: you do not have to make contact with the circuit. For safety's sake, connect a short piece of insulated wire to either lead of an antenna, or to the RF output of a bar-dot generator. Just holding the insulated end of the wire *near* the input of a stage should radiate enough signal into it to get some reaction.

Many of those units are modular. At first, you would probably be better off simply to replace the suspected module. However, when you're more familiar with them, you could try to locate and replace bad parts since the modules are pretty good-sized with "room to work" and make tests.

A lot of set-makers have come out with very detailed descriptions on how those circuits work, along with servicing hints and check-points—Magnavox, RCA, Sylvania and others among them. Get hold of those descriptions and read up on them. They provide a very valuable source of reference and familiarization material. Service data is absolutely necessary so that you'll know where the test points are for the voltages, etc.

So, I don't see why the new tuners should be any more difficult to service than some of the impossibly-crowded old ones. In many cases, they should be a lot easier! (For our sake let's hope so.) If you use a calm "functional approach:" Look at it and see what it's doing, then look at the service data and see what could make it do that, the new tuners should be much simpler than you'd think at first glance.

New service center

I've just gotten a notice that PTS Electronics, Inc., has opened a new service center at 1289 Madison Ave., P.O. Box 41043, Memphis, TN 38104. They rebuild tuners, modules, and quite a few other things. That should improve service for people in the Mid-America area. John Postlewaite, General Manager, invites all technicians to visit the new facility and get a first-hand look at the many things they can provide to help us out. **R-E**

service questions

VERTICAL RASTER LINES

I'm having a problem with a Zenith model 20X1C38. The set has bright vertical lines in the raster. So far nothing that I've checked or changed has had any effect! Any help would be appreciated—O.B.G., Albuquerque, NM.

continued on page 84

SERVICE QUESTIONS
continued from page 82

This one has a vaguely familiar look. Quite a while back, I had a similar problem, also in a Zenith of about this vintage. After "checking and changing everything we could think of," I noted that with a probe held near the high-voltage cage the stray pickup waveform showed something odd. If you turn the gain up until you can only see the horizontal part of the waveform (the spike is up and off-screen), note if there are small vertical spikes on it. This is the *scan* part of the waveform. After some nail-biting, we tried changing the flyback and that fixed it!

I've still got the original flyback in a box and to this day I have no idea at all what the defect is! My only guess is that it could be some kind of oddball ringing in one of the windings.

ARCING PROBLEM

When I turn the brightness up on this Admiral model 4H12 chassis, light and dark horizontal streaks show up in the picture. I've checked quite a few things with no luck. Any ideas?—S.L., Massapequa Park, NY.

(I suggested that he do a few things, and check the high-voltage rectifier tube, etc.) Later he wrote:

"I checked all the things you mentioned. While I was working, I happened to touch the degaussing coil socket and it bit me! I disconnected it, and the arcing disappeared. A new degaussing coil fixed it. Thanks!"

Glad to hear he found the trouble. Degaussing coils can do some fantastically funny things.

MYSTERY STEREO IDENTIFIED

I can't identify this AM/FM stereo that's labeled "2S2," and is made in Taiwan. One source told me it was an Admiral model ST-1000, but Admiral says no. Both the output transistors are shorted, and a diode in one transistor base has exploded. The PC board schematic shows a diode as being a "KB-162" and something else is shown as a 15-ohm resistor. The KB-162 in the working channel tests as a diode, but the 15-ohm resistor looks more like a glass diode. It checks out as a glass diode too, but if it is it's leaky! It has a low front-to-back ratio. Any help will be much appreciated.—J.P., Lewistown, MT.

Without much hope, I looked in my Admiral file and found a 2S2 listed that certainly looks like the minischematic you sent! (Sams Photofact Folder No. 1443-2 shows it.) The output transistors are a complementary-symmetry pair. An RCA SK-3083 replaces the 2SA699A(Q),PNP, and an SK-3054 replaces the 2SC1266A(Q). The bias diode is an SK-3087.

Both the Sams and Admiral schematics show *two* diodes in series in this stage. If the "something" you have checks as a diode, I'd say that it is one. (Just to double-check on the leakage, lift one end of the transistor and repeat your tests.) Since it has 0.7 volt across it, it is probably a silicon diode. Perhaps an Si and a Ge diode were used in series to obtain the required bias voltage. I once had an amplifier that had one Si and one Ge transistor in the output stages. I replaced them with two Si's; this resulted in quite a lot of distortion. I finally checked and found out what was going on.

TRANSISTOR SUBS WANTED

I need replacement transistors for a Dynaco model 120 power amplifier. I can't seem to locate them anywhere. I understand Dynaco is out of business. Can you help?—H.K., Akron, OH.

Yes, apparently Dynaco has gone out of business. Sams lists the name but not the address and no Photofacts schematics! However, the RCA SPG-202X *Transistor Guide* shows the 2N3053 as an SK-3024, NPN silicon, TO-39 case; the 2N4037 is an SK-3262, NPN silicon, TO-39 case. The voltage for each is about 90. That should do it.

TEXTBOOK ON PICTURE TUBES?

I'm looking for a textbook on picture tubes that tells how to test and handle them, what instruments to use, etc. Can you give me the name of such a book?—J.O., Richmond, IN.

I'm afraid not. This information is all available from set manufacturers (in their service data), and from picture tube manufacturers such as RCA, GE, Sylvania, etc. The "picture tube characteristics" books show a great deal of data on basing, voltage ratings, specs, etc. You should be able to obtain these books from your local radio-TV supplier.

In order to test picture tubes, you need a picture tube tester! These are manufactured by several companies. The instruction manuals give all the necessary data on how to use them. Suggestion: Try to obtain a Heathkit manual that describes one of this company's better picture tube testers. This manual will usually have a full circuit description and a very well-written explanation.

WORKS ON JIG, NOT IN SET

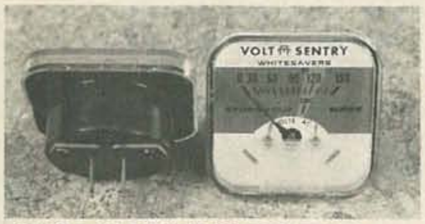
This RCA CTC-46 works on a test jig. Put it back in the cabinet and the vertical output transistors blew out! However, the yoke resistance checks out OK.—J.S., Lakewood, CO.

Well, the vertical output used here is a complementary-symmetry circuit, as used in audio amplifiers. It will withstand an open but a short will damage it. So, you have a short somewhere in the vertical yoke or in the pincushion circuitry. If the yoke resistance seems to be OK, check the pincushion corrector circuitry, looking for possible shorts to ground or to boost. It's bound to be in there somewhere! **R-E**

new products

More information on new products is available. Use the Free Information Card inside the back cover.

VOLTAGE METER, the *Volt Sentry*, is designed to identify faulty outlets and circuits. It can be plugged into the common outlet to indicate the voltage level. The scale is divided into Normal,



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Brown-Out and Surge. The meter also shows the actual voltage being fed to an appliance plugged into the same outlet. Measures 2½ × 2½ × 1½ inches. Price is $14.95.—**Whitesavers Co.,** 71 E. 13th St., Huntington Station, NY 11746.

SOLAR POWERED RADIO, 3 solar cells operate this 8 oz., 1.5 volt AM radio during daylight hours. By means of a selector switch, the radio can also

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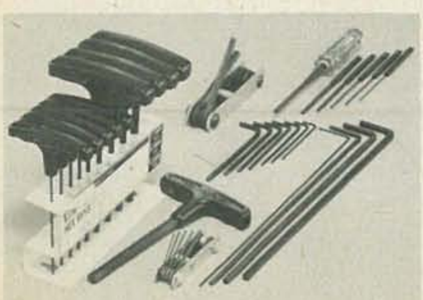
run during darkness from a battery contained in the case. Suggested retail price $39.95.—**Solec International, Inc.,** 12533 Chadron Ave., Hawthorne, CA 90250.

HEX KEYS AND WRENCHES, offers 4 new sizes of short-series standard right-angle hex keys, sizes ½", 5/16", 3/8" and ¾", and two new long-series, sizes 8mm and 10mm. Featured are pouched sets *No. LM12* with 12 metric-sized keys and *No. SLK17* with 17 short-series keys. The



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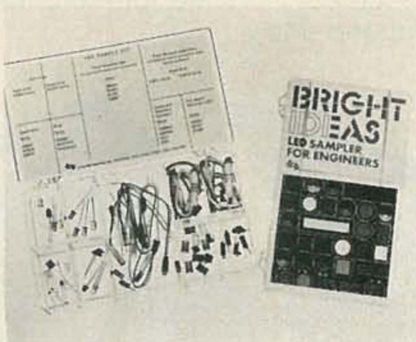
wrench line is available in short, long, extra and foot-long series, and includes a wrench that can drive at angles up to 40° with full torque. These products are made of steel, are corrosion resistant and are heat treated for added strength.—**Vaco Products Co.,** 1510 Skokie Blvd., Northbrook, IL 60062.

LED SAMPLER KIT, *model EK-2*, contains samples of LED indicator lights that can be used in breadboarding or building working prototypes. The kit consists of 28 different LED's and assem-



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blies in 21 styles and 3 colors, including plain, panel-mounted, and PC-board-mounted LED's, and complete assemblies that include current-limiting resistors and protective diodes. Price is $10 postpaid with check or money order.—**Industrial Devices, Inc.,** 7 Hudson Ave., Edgewater, NJ 07020

AC VOLT/AMMETER, *model 30, The Grabber*, is a clamp-on handheld instrument designed for fast accurate service checks on electronic equipment. The unit has a one-inch jaw opening, a sin-

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gle range switch, a lock switch for holding readings and an easy-to-read, large dial face. AC ranges are 0-300 amperes in six ranges and 0-

continued on page 90

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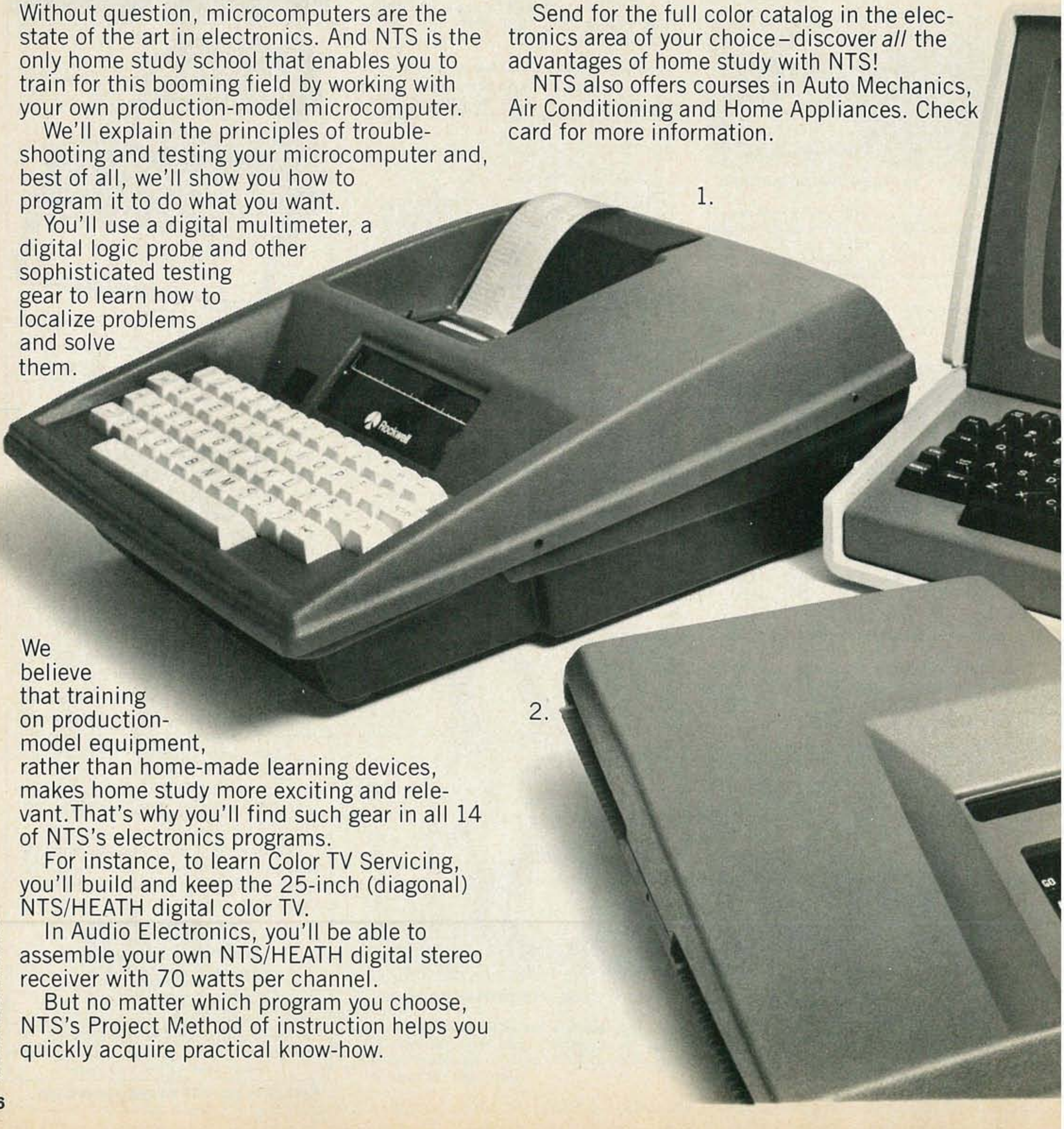

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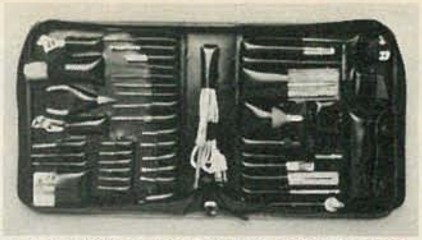
NEW PRODUCTS

continued from page 85

600 volts in three ranges. Insulated test leads are disconnected when model 30 is set for AC current ranges. Optional accessories include a 0-1000 ohms plug-in adapter that is required for measuring resistance. The model can withstand momentary overloads and has an accuracy of 3% in all ranges. Frequency response of voltmeter is flat ± 1% of full scale from 20 to 5000 Hz. Price is $65.—**Triplett Corp.**, Dept. PR, 286 Harmon Rd., Bluffton, OH 45817.

TOOL KIT, *model JTK-24,* is a miniature and subminiature tool kit designed for servicing, repair and assembly of precision electronic equipment. It contains more than 120 tools including screwdrivers, nutdrivers, pliers, wrenches, drills, hex keys and many more. These tools are useful for repair of many types of equipment such optical,



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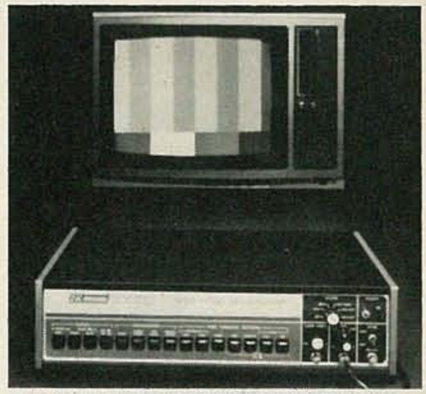
photographic, sound, broadcast and test equipment. Tools come in a 10½ × 12½-inch zippered case. Price is $315.—**Jensen Tools, Inc.,** 1230 South Priest Dr., Tempe, AZ 85281.

COLOR PATTERN GENERATOR, *model 1250,* is designed as a test signal source for station CATV as well as for maintenance and troubleshooting of video equipment. It generates the NTSC bar pattern with a −IWQ signal plus a full-screen color bar pattern. Other patterns include a staircase with selectable chroma levels, plus dot, crosshatch, center cross and color raster.



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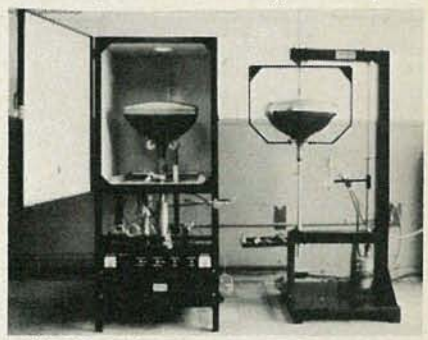
Model 1250 also produces a 4.5 MHz sound carrier or an external audio signal, and generates RF outputs on either Channel 3, 4, or the standard TV IF frequency. Operating manual is included. Price is $795.—**B & K—Precision,** 6460 W. Cortland St., Chicago, IL 60635.

PICTURE TUBE MACHINE, the latest in research and development, enables anyone to rebuild any CRT—color, black and white, 20 mm, foreign or domestic picture tube, in approximately two



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hours. Complete information and literature available.—**Lakeside Industries,** 4071 N. Elston Ave., Chicago, IL 60618.

DIGITAL PANEL METER, *model B500,* is a 3½-digit meter containing 13 parts—one IC, 7 passive components and a display. The unit is bipolar, differential and features auto-zero. The input

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range is from 50mV to 1000V. Requires either a 5VDC source or a 115/230 VAC, 47-400 Hz source. It consumes 200-800 mW and its accuracy is ±0.05% ±1 digit. The red LED display is 5 inches high. Price is $49.00.—**International Microtronics Corp.,** 4016 E. Tennessee St., Tucson, AZ 85714. **R-E**

TROUBLESHOOTING
continued from page 68

fed as a DC logic high to gate AND-1. (The other input of gate AND-1 is fed by the drum-rotation detector stage shown in Fig. 2.) A logic-high output goes to IC pin 15 when both detectors are working.

Near the end of the tape, the metallic strip severely loads down the Q of the supply-sensing coil. Oscillation stops, and the detector no longer sends a logic-high signal to the input of gate AND-1. A logic low goes to the auto-stop signal line and to gate AND-2 shown in Fig. 1.

Besides inhibiting any threading motion, the auto-stop signal triggers a driver stage that activates a STOP solenoid. The result is the same as you get from pressing the STOP pushbutton—tape transport ceases.

Rewind switching connects takeup-sensing coil L6502 into the oscillator-feedback loop. Again, as long as regular tape moves past the coil, the oscillator supplies a signal to the detector and (thus) a DC logic signal to gate AND-1. But when the metallic leader moves alongside the coil, the oscillation is loaded down and stops. A logic low at the input of gate AND-1 places a logic low on the auto-stop signal line.

You have already seen how the drum-rotation detector works. If the video-head drum stops spinning, the pulse generator that is a part of the drum immediately stops generating a signal. The sensing stages no longer produce logic high for gate AND-1. Again, a logic low on the auto-sto signal line triggers the STOP solenoid and also (through gate AND-2) inhibits any threading (or unthreading) activity.

Dew sensor—Not all Beta machines include this protective system. It keeps the mechanism from operating if moisture has condensed in the works (that could damage tape seriously). Figure 5 is the diagram of the dew-sensing stage used in one Toshiba model.

The sensor itself is a resistance that decreases in value (generally to below 500,000 ohms) when moisture forms on its probes. The sensor is part of the feedback circuit in a dew-oscillator stage. No oscillation takes place as long as the sensor resistance is high. As the resistance lowers, the feedback becomes sufficient to start the oscillator.

Network R832-C820 feeds the oscillator-output signal to rectifiers D802-D803. Filter capacitor C819 charges to a negative DC value (note the orientation of the diodes). This negative voltage "bucks" to zero the normal logic high that is fed to the base of Q803 through R830.

A logic low at the base of Q803 creates a logic high at the collector, and then again a logic low at the collector of Q804. We know that a logic low on the auto-stop line to the STOP-solenoid driver causes the solenoid to activate. The same logic low from Q804 goes to gate AND-2 and inhibits the threading system.

In the Toshiba model, the reed switch on the tape-slack detector arm is also connected at the base of Q803. Any slack in the tape closes the switch and plunges the Q803 base to a logic low. Transistor Q803 generates a logic high and transistor Q804 generates a logic low. The STOP solenoid is activated, and threading is inhibited too.

Now that we've examined the electronics, we'll break off this issue in order to give you time to digest what you have learned. Next time we'll take a close look at the electromechanical systems. **R-E**

stereo products

More information on stereo products is available. Use the Free Information Card inside the back cover.

PHONO CARTRIDGE, *model M95HE,* is a top-of-the-line phono cartridge incorporating a hyperelliptical nude diamond-tip stylus (*model N95HE*) that provides up to 25% reduction in distortion, and is also used with the *model V15 Type*

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IV cartridge. The *model M95HE* features an ultra-flat frequency response, light trackability and tracks at between ¾ and 1½ grams. Suggested retail prices: *M95HE,* \$89.50; *N95HE* stylus, \$34.—**Shure Brothers, Inc.,** 222 Hartrey Ave., Evanston, IL 60204.

GRAPHIC EQUALIZER, *model GEM-1,* is a five-band-per-channel instrument featuring center-

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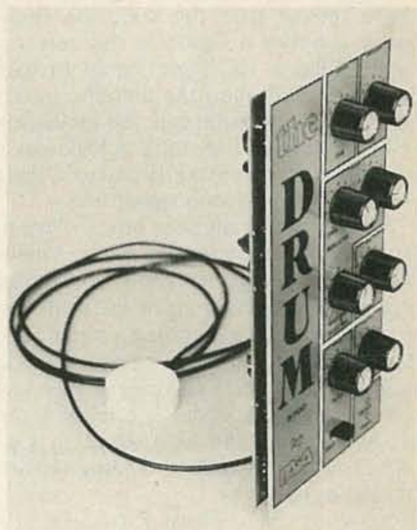
detented linear controls, three tape-deck switches for record equalization, playback equalization and tape monitor, and a separate power supply for low noise. *Model GEM-1* also uses a system in which the user contours cards for a specific equalization setting. When a card is moved up the faceplate of the unit, all the frequency controls are automatically positioned. Another feature is narrow-bandwidth circuitry for minimum adjacent band interaction. All components are mounted on a single glass epoxy PC board. Frequency response is 10 Hz to 150 KHz ±0.5 dB. Suggested retail price is \$89.95.—**Superex Electronics Corp.,** 151 Ludlow St., Yonkers, NY 10705.

PERCUSSION SYNTHESIZER, the *Drum 5700,* is a versatile instrument that uses continuously variable controls for pitch modulation—up or down, oscillator waveform mix, noise filter frequency, and oscillator/noise mix. It features modular construction which allows it to configure any size drum set, and numerous rear panel patching and control points which allow multiple cards to be cascaded for a wide range of effects.

Other features include an encapsulated sensor that can be mounted permanently or temporarily to a drum set, and an optional cancel switch that



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disables the synthesizer when not in use. Price is \$59.95 for a kit; assembled units are also available.—**PAIA Electronics, Inc.,** 1020 Wilshire Blvd., Oklahoma City, OK 73116.

DIRECT-DRIVE TURNTABLE, *model 650 RC,* is an automatic single-play turntable that can be operated in automatic, semiautomatic and manual modes, and has remote-control capability (optional). The turntable features a high-torque DC motor, an ultra-low-mass (ULM) tonearm (with optional ULM cartridge), gimbal suspension, pitch control, cue control, antiskating control and

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an aluminum platter. The turntable comes complete with cover and base, and sells for a suggested retail price of under $400. Optional cartridge, *model 55E*, $110; and infra-red remote control, *model RC 152*, $79.95.—**United Audio Products**, 120 So. Columbus Ave., Mt. Vernon, NY 10553.

SPEAKER SYSTEMS, a line of four speakers feature a unique total motor system that results in a higher than normal efficiency for acoustic suspension speakers. The 8-inch 2-way system, *model 94-1200*, is a lightweight compact speaker rated at 25 watts RMS with a frequency response of 45 to 20,000 Hz. The 10-inch 2-way system, *model 94-1300*, features a 10-inch woofer and

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wide dispersion and is rated at 35 watts RMS. The 10-inch 3-way system, *model 94-1350* (shown), handles a power of 40 watts RMS; the 12-inch 3-way system, *model 94-1400*, has a 12-inch woofer, 4½-inch midrange, is rated at 45 watts RMS and has a frequency response of 35 to 20,000 Hz. Prices range from $59.95 to $99.95.—**GC Electronics**, 400 So. Wyman St., Rockford, IL 61101. **R-E**

COLOR-BAR GENERATOR

continued from page 71

Even video cameras may be tested with the model 1250. You can switch to an external video input signal by just pulling out the center knob of the RF switch. Feed the camera output signal into the EXT VIDEO IN on the rear panel and you can see the results on a video monitor or color TV set.

Also on the rear panel is a BNC output jack for the 3.579545 subcarrier. A frequency counter can be connected there to check the frequency, or the signal can be used for synchronizing other circuits. The signal is at the 1.0 volt level with no load and is matched for a 75 ohm input impedance.

The model 1250 is an accurate and very versatile piece of electronic equipment for any serious video engineer, technician, or anyone else in the field. It can be used for many tests in CATV and MATV systems, and also for closed-circuit TV systems. Up to now, equipment of such accuracy has been far too expensive for the average TV shop, and also too big to fit comfortably on the service bench.

The model 1250 is only a bit more than 4 inches tall and 17.5 inches wide. The jacks that you will use most often are on the front panel. All of the controls are conveniently arranged, which makes the model 1250 a very easy instrument to operate quickly.

All of the RF and IF signals are crystal controlled for greater accuracy. Each one has its own crystal oscillator for maximum stability. The sync-generator circuitry uses the latest LSI circuit design. A single integrated circuit generates all of the sync signals, again to strict NTSC standards. Even the newer TV receivers, which use a count-down IC to develop the sync signals will work here. Every one of the outputs of the model 1250 may be used at the same time. You could drive a video monitor with the video output and at the same time feed RF signals to a color TV set!

There's one other thing you can do with it, too. If you run into the hypercritical customer who insists that a problem *is* in his TV set (and you are almost sure that it is either a network goof or a local TV station goof!), you can show him that his set will indeed make the standard patterns and tell him that this is the kind of equipment that the TV station *ought* to be using! **R-E**

books

RADIO OPERATOR'S LICENSE Q&A MANUAL (Revised Ninth Edition), by Milton Kaufman. Hayden Book Company, Inc., 50 Essex Street, Rochelle Park, NJ 07662. 646 pp. 5⅛ × 8⅛ in. Softcover $8.95; cloth $13.95.

The latest revision of this manual, which has been appearing regularly since 1949, is in complete accordance with the latest FCC Study Guides, the Supplements to the Study Guides, and the latest FCC Rules and Regulations. It's designed to prepare the student to take the radiotelephone examination for Third-Class, Second-Class, and First-Class licenses and for the Radar Endorsement. It contains all the information a student will need to take an examination for *any* class of radiotelephone operator's license.

The questions in each section are exactly the type of questions to be found in the official examinations, and at various stages sample FCC tests are printed. Questions are followed by clear, concise answers, and in many cases by a discussion of the matter at hand. It is the detailed discussions, accompanied by many diagrams, that make this single volume self-sufficient for the student.

In addition to the elements, there is an extensive section on troubleshooting, which will give the student practice in solving the kind of problems that will be posed in FCC examinations.

THE DESIGN & DRAFTING OF PRINTED CIRCUITS, By Darryl Lindsey. Bishop Graphics, Inc., 5388 Sterling Center Drive, PO Box 5007, Westlake Village, CA 91359. 196 pp. 8¾ × 11 in. Hardcover; $24.95.

This sturdily-bound book is designed for use in the workshop as well as the library and will remain open at any page to which you turn. Bishop is the world's largest manufacturer of printed circuit design products, and the present volume is an answer to many requests received for a comprehensive single volume on understanding, designing, and creating PC artwork. Both those who are experienced and the beginning electronic designer and draftsperson will find it a valuable "how to" guide.

The author, Darryl Lindsey, is the founder of the Masters PC Design

School in San Francisco, and has spent over 17 years as a printed circuit draftsman, designer, and PC supervisor in the commercial and military electronics field.

The book includes chapters on schematics, PC board layout ground rules, discrete components layout, mounting components, IC grouping, digital layout, multi-layer PC boards, production considerations, artmaster tape-up, ground planes, familiarization with fabrication and assembly drawings, silkscreen drawings and artmasters, the manufacturing process of PC boards, and logic as it relates to PC design reference materials. There are over a hundred clear "how to" diagrams and charts.

OSCILLOSCOPE APPLICATIONS & EXPERIMENTS, by Edward M. Noll. Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46268. 223pp. 5¼ × 8⅜ in. Softcover. $8.95.

For both the neophyte and the advanced technician, this book covers the entire range of oscilloscope application fundamentals and technics. After a chapter on basics there are two chapters dealing with oscilloscope applications in audio, AM/FM receivers, and TV receivers. The fourth chapter emphasizes two-way radio applications, particularly in reference to modulation checks and waveform analysis. The last two chapters go into the dual-trace oscilloscope and applications in digital electronic circuits. Each chapter in the book includes suggested learning experiments. They will aid in developing new skills necessary to make the most effective use of the modern oscilloscope.

HANDBOOK OF ELECTRONICS CALCULATIONS FOR ENGINEERS AND TECHNICIANS, Edited by Milton Kaufman and Arthur H. Seidman. McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020. 668pp. 6 × 9 in. Hardcover; $24.50.

Each of the 24 chapters in this handbook is written by an expert in its particular area, and the volume as a whole covers around 500 worked-out problems ranging from microprocessors to thick-film technology. There are over 700 illustrations.

The subjects covered are: Technical math review, DC circuit analysis, AC circuit analysis, Selecting *R*, *L*, and *C* components. Selecting semiconductor devices, audio amplifiers, tuned amplifiers, feedback, oscillators, power supplies, batteries and special skills, op amp applications, digital logic, computer-aided circuit design, analog-to-digital conversion, video amplifiers, microprocessors, transmission lines, filters, antennas, microwaves, communications systems, measurements, and thick-film technology. There are also 23 pages of appendices, and an index. The publishers state that the present volume is the first fully comprehensive electronics handbook that can help you solve the day-to-day problems of electronics engineers and technicians in a practical way. R-E

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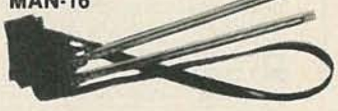

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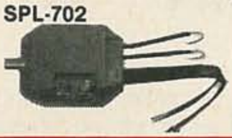

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DIGITAL MULTIMETER

$99.95 WIRED

Low cost, high performance, that's the DM-700. Unlike some of the hobby grade DMMs available, the DM-700 offers professional quality performance and appearance at a hobbyist price. It features 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 high LED display, with automatic decimal placement, automatic polarity, and overrange indication. You can depend upon the DM-700, state-of-the-art components such as a precision laser trimmed resistor array, semiconductor band gap reference, and reliable LSI circuitry insure lab quality performance for years to come. Basic DC volts and ohms accuracy is 0.1%, and you can measure voltage all the way from 100 µv to 1000 volts, current from 0.1 µa to 2.0 amps and resistance from 0.1 ohms to 20 megohms. Overload protection is inherent in the design of the DM-700, 1250 volts, AC or DC on all ranges, making it virtually goof proof. Power is supplied by four 'C' size cells, making the DM-700 portable, and, as options, a nicad battery pack and AC adapter are available. The DM-700 features a handsome, jet black, rugged ABS case with convenient retractable tilt bail. All factory wired units are covered by a one year limited warranty and kits have a 90 day parts warranty.

Order a DM-700, examine it for 10 days, and if you're not satisifed in every way, return it in original form for a prompt refund.

Specifications

DC and AC volts:	100 µV to 1000 Volts, 5 ranges
DC and AC current:	0.1 µA to 2.0 Amps, 5 ranges
Resistance:	0.1Ω to 20 megohms, 6 ranges
Input protection:	1250 volts AC/DC all ranges fuse protected for overcurrent
Input impedance:	10 megohms, DC/AC volts
Display:	3½ digits, 0.5 inch LED
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells, optional nicad pack, or AC adapter
Size:	6"W x 3"H x 6"D
Weight:	2 lbs with batteries

Prices

DM-700 wired + tested	$99.95
DM-700 kit form	79.95
AC adapter/charger	4.95
Nicad battery pack	16.95
Probe kit	3.95

TERMS: Satisfaction guaranteed or money refunded. COD, add $1.50. Minimum order $6.00. Orders under $10.00, add $.75. Add 5% for postage, insurance, handling. Overseas, add 15%. NY residents, add 7% tax.

master charge THE INTERBANK CARD

BANKAMERICARD VISA

600 mHz COUNTER

$99.95 WIRED

The CT-70 breaks the price barrier on lab quality frequency counters. No longer do you have to settle for a kit, half-kit or poor performance, the CT-70 is completely wired and tested, features professional quality construction and specifications, plus is covered by a one year warranty. Power for the CT-70 is provided by four 'AA' size batteries or 12 volts, AC or DC, available as options are a nicad battery pack, and AC adapter. Three selectable frequency ranges, each with its own pre-amp, enable you to make accurate measurements from less than 10 Hz to greater than 600 mHz. All switches are conveniently located on the front panel for ease of operation, and a single input jack eliminates the need to change cables as different ranges are selected. Accurate readings are insured by the use of a large 0.4 inch seven digit LED display, a 1.0 ppm TCXO time base and a handy LED gate light indicator.

The CT-70 is the answer to all your measurement needs, in the field, in the lab, or in the ham shack. Order yours today, examine it for 10 days, if you're not completely satisfied, return the unit for a prompt and courteous refund.

Specifications

Frequency range:	10 Hz to over 600 mHz
Sensitivity:	less than 25 mv to 150 mHz less than 150 mv to 600 mHz
Stability:	1.0 ppm, 20-40°C; 0.05 ppm/°C TCXO crystal time base
Display:	7 digits, LED, 0.4 inch height
Input protection:	50 VAC to 60 mHz, 10 VAC to 600 mHz
Input impedance:	1 megohm, 6 and 60 mHz ranges 50 ohms, 600 mHz range
Power:	4 'AA' cells, 12 V AC/DC
Gate:	0.1 sec and 1.0 sec LED gate light
Decimal point:	Automatic, all ranges
Size:	5"W x 1½"H x 5½"D
Weight:	1 lb with batteries

Prices

CT-70 wired + tested	$99.95
AC adapter	4.95
Nicad pack with AC adapter/charger	9.95
Telescopic whip antenna, BNC plug	7.95
Tilt bail assembly	3.95
CT-70 Kit Form	75.95

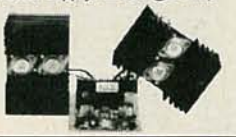
ramsey electronics

BOX 4072, ROCHESTER, N.Y. 14610
PHONE ORDERS CALL
(716) 271-6487

100W CLASS A POWER AMP KIT

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

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



TA-1000 KIT $51.95
Power transformer $15.00 each

PROFESSIONAL 10 OCTAVE STEREO GRAPHIC EQUALIZER!!

Graphic equalizer have been used for years in sound studios and concert arenas but were too expensive to be considered for home use. Now we offer you the facility at an affordable price. This unit can extend your control of your Hi-Fi system by minimizing the non-linearities of the combined speaker/room system. Fantastic features as follows:
- 10 double slide controls for two channels
- Cut out rumble, surface noise and hiss
- Minimizes speaker/room non-linearities
- Frequency response from 30Hz to 16KHz
- 10 tone controls plus defeat, monitor and tape selector.
- Control range ± 12dB in 10 octaves (30Hz, 60Hz, 120Hz, 240Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz.)
- Operating voltage 117V 50/60Hz.

FACTORY ASSEMBLED UNIT, NOT A KIT
SPECIAL PRICE **$117.00** ea

SUB MINI SIZE FET CONDENSER MICROPHONE

Specification:
Sensitivity: — 65dB ± 3db
FEQ. Response: 50 Hz 8 KHz
Output Impedance: 1K ohm max.
Polar Pattern: Omni-directional
Power Supply: 1.5V 10V D.C.
Sound Pressure Level: Max. 120dB
EM4RP **$2.50** ea. or **2** for **$4.50**

NEW MARK III
9 Steps 4 Colors
LED VU

Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large, from —30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $18.50

MARK II SOUND ACTIVATED SWITCH KIT

A new designed circuit employed 2 I.C., a DPDT relay with a led indicator. A condensor microphone comes with the kit. The relay can handle up to 200 watts contact to allow to control most things. Just click the finger, the relay will close, the second click will release it. Sensitivity can be adjusted by an on board trim-pot. Operating voltage 9V D.C.
TY-18
$8.50 PER KIT

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

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

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

MARK IV KIT **$31.50**

30W+30W STEREO HYBRID AMPLIFIER KIT

It works in 12V DC as well! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz.

$32.50 PER KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R FEATURES

- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern.

$10.50 EA

STEREO AMPLIFIER

60 W + 60 W

COMPLETED UNIT — NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit. Assembled **$49.50 ea.**
Power transformer **$ 8.50 ea.**

5W AUDIO AMP KIT

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

PROFESSIONAL PANEL METERS

Type MU-52E

A.	0-50UA	8.50 ea.
B.	0-30VDC	8.50 ea.
C.	0-50VDC	8.50 ea.
D.	0-3ADC	9.00 ea.
E.	0-100VDC	9.00 ea.

All meters white face with black scales. Plastic cover.

SPECIAL 0.5" LED SALE ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!

Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.

ONLY **$7.00 EACH**
SPECIAL TRANSFORMER FOR CLOCK
(FREE)

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!

SPECIAL $19.95

- proximity triggered
- voltage triggered
- mechanically triggered

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm. **3-WAY PROTECTION!**

All units factory assembled and tested — Not a kit!

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

This series covers a wide range of level indication uses, output and input voltage, time related change, temperature, light measurement and sound level. The problem of uneven brilliance often encountered with LED arrangements as well as design problems caused by using several units of varying size are substantially reduced. 12 LEDs in one bar:

LED ARRAY	
GL-112R3 Red, Red, Red	**$5.50**
GL-112N3 Green, Yellow, Red	**$6.50**
GL-112M2 Green, Green, Red	**$6.50**
GL-112G3 Green, Green, Green	**$6.50**

0.27"
2.28"

LED DRIVERS

1R 2406G is an I.C. specially designed to drive. 12 LED. The number of LED is lineally illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. **$5.35 EACH**

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6¼" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

$16.50

FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor neded. Pulse rate 3Hz @ 5V 20mA.

2 for $2 .20

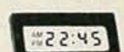
BIPOLAR LED RED/GREEN

2 colors in one LED, green and red, changes color when reverse voltage supply. Amazing!
2 FOR $1.60

LCD CLOCK MODULE!

• 0.5" LCD 4 digits display • X'tal controlled circuits • D.C. powered (1.5V battery) • 12 hr. or 24 hr. display • 24 hr. alarm set • 60 min. countdown timer • On board dual back-up lights • Dual time zone display • Stop watch function.

NIC1200 (12 hr) $24.50 EA.
NIC2400 (24 hr) $26.50 EA.



MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!
Receives all AM stations.
Batteries and ear phones included.

Only $10.50

12 DC MINI RELAY

6V	SPDT	2 AMP	**1.30**
12V	SPDT	3 AMP	**1.60**
12V	DPDT	2 AMP	**2.50**
12V	4PDT	3 AMP	**3.50**

LINEAR SLIDE POT

500Ω SINGLE
Metal Case 3" Long
2 FOR $1.20

CIRCLE 24 ON FREE INFORMATION CARD

CIRCLE 25 ON FREE INFORMATION CARD

4500v 9Watt DC SUPPLY "ZOW!" L-450 BACK AGAIN

WE HAVE ACQUIRED A FEW HUNDRED MORE OF THESE FINE HIGH VOLTAGE SUPPLIES. USE FOR CRT SUPPLIES, HI VOLTAGE EXPERIMENTS, BUG ZAPPERS, ION GENERATORS. COMMERCIAL QUALITY, 115V AC IN, 4500 V DC AT 2 MA OUT. OVERALL SIZE 3.7" x 4.2" x 2.5" HIGH.

WE ALSO HAVE ACQUIRED A SMALL QUANTITY OF 6KV AND 12KV NEW GE SUPPLIES.

$7.95 ea PLEASE WRITE FOR INFO.

+$1.75 SHIPPING

4.5-20 pF CERAMIC TRIMMER T-3251

HIGH-Q SILVER ON CERAMIC TRIMMER IS 1/4" DIA BY 1/4" HIGH, 510 MIG CENTERS.

2/$1 · 10/$4.50 · 100/$40

600 V 15A TRIAC

RCA TYPE 40804

FULL PRIME STUD MOUNT TRIAC IN A HARD-TO-FIND VOLTAGE, AND PRICED RIGHT!

$1.95 EA · 10/$17.50 · 100/$155

5 TURN 100K LINEAR POT

UNUSUAL 5 TURN POT IS A CARBON UNIT FITTED WITH A BALL BEARING REDUCTION (SMOOTH). LINEAR TAPER. LOTS OF USES. B-3954

60¢ EA · 10/5.50 · 100/$50

Clock/Radio Timers D-2000

BRAND NEW, MFD BY GENERAL TIME. 115vac 60 Hz, WITH 4A SWITCHED OUTPUT, SWEEP SECONDS, 3-5/8 x 2 x 2. NO HANDS SUPPLIED.

49¢ EA · 10/$4.50 · 100/$40

18v 85MA WALL TRANSFORMERS

USE FOR CLOCKS, CALCS, OR WHATSITS. UL APPROVED, OUTPUT IS SCREW TERMINALS. T-1408

$1.75 EA · 10/$15

MOLDED TO-3 SOCKETS

HIGHEST QUALITY WITH RAISED SHOULDERS, TAPPED 6-32, AT THE PRICE OF CHEAP WAFER TYPES. B-2150

3/$1 · 10/$2.75 · 100/$25

9 VOLT BATTERY CLIPS

FIT STANDARD 9 VOLT "TRANSISTOR" BATTERY 4" LEADS, HANDY TO HAVE AROUND. B-5900

10/$1 · 100/$9

120 VAC 10 AMP Hash Filter

NEW, MFD BY CDE. UNITS HAVE 3 WIRE LINE CORD & PLUG IN, WIRE LEADS OUT. REMOVES NOISE FROM LINE.

$2.98 · 10/$25

SINGLE TURN PC TRIMMERS APPROX 5/8" DIA B-1550

VERTICAL MT.: ☐ 250Ω ☐ 1K ☐ 25K ☐ 100K

HORIZONTAL MT.: ☐ 100Ω ☐ 500Ω ☐ 1K ☐ 10K ☐ 25K ☐ 100K ☐ 1MEG

5/$1 · 50/$9

1 MEG AUDIO TAPER W/SWITCH L-1011 6/$1 · 100/$15

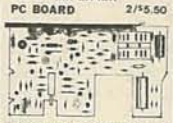
1-12pf CERAMIC TRIMMER MULTI TURN C-3450 49¢

ICL7107 3½ DIGIT VOLTMETER »on-a-chip« $11.95 WITH DATA

RHYTHM GENERATOR ROM $1.75 · 10/$15 · 100/$120

PRE PROGRAMMED ROM HAS SEVERAL RHYTHM PATTERNS STORED THAT ARE "WALKED OUT" WITH A COUNTER(ie, 555 & CD4024) CHANGE PATTERNS WITH A SWITCH. WITH DATA, FUN TO PLAY WITH!!! D-6304

—HOBBYIST'S DELIGHT— TAPE AMPLIFIER PC BOARD $2.98 · 2/$5.50



12vac Power in · 5W Audio out. Tape head, mic, aux inputs. Sold as-is, Complete & New.

«FIRE SALE»

· ASSEMBLED & TESTED
· PHOTOELECTRIC TYPE
· 117vac – NO BATTERY TO BUY !
· 4A 400v SCR OUTPUT

SMOKE ALARM S-1012

$1.79 ea · 2/$3

"HOT" DEAL ON THE GUTS (LESS BELL) FROM A POP US MFR. OF SMOKE ALARMS. BOARD CAN BE EASILY PUT INTO SERVICE AS A SENSITIVE SMOKE DETECTOR, OR USED FOR A NUMBER OF LIGHT SENSITIVE GADGETS SUCH AS BURGLAR ALARMS, LIGHT RELAYS, EVEN FLASHERS! TO USE, CONNECT 117VAC DIRECTLY TO BOARD (CURRENT DRAIN IS ONLY 10MA), AND ATTACH A LOAD (BELL, BUZZER, LAMP, ETC., UP TO 4 AMPS) TO THE OUTPUT. AS LONG AS A SMALL AMOUNT OF LIGHT IS ALLOWED TO FALL ON THE PHOTOTRANSISTOR, THE UNIT REMAINS "OFF". AS SOON AS THE LIGHT DROPS BELOW A MINIMUM LEVEL, THE OUTPUT BEGINS TO CYCLE ON & OFF AT A 1 HZ RATE!(UNIT CAN BE CHANGED TO CAUSE OUTPUT TO REMAIN ON INSTEAD OF PULSING). ALARM FEATURES ZENER REGULATION, SENSITIVE FET, SCR OUTPUT, PHOTOTRANSISTOR, ASSEMBLED & TESTED. WITH SCHEMATIC.

8 'AA' CELL (12 VOLT) BATTERY HOLDERS 2-1/4" SQ x 1-1/8"

50¢ ea · 10/$4.50 · 100/$40 — STD 9V OUTPUT TERMINAL. G-1509

PHOTOTRANSISTOR FPT-100 .49

N-CHANNEL J-FET SIM TO MPF 102 39¢

ANTENNA PLUG & JACK -SET- A-5411

AS USED ON AUTO RADIOS. GOOD ABOVE 150 MHz.

39¢/SET · 10 Sets $3.00 · 100 Sets $25

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Garland TX 75040

NPN HIGH VOLTAGE 2.00

VCEO = 450 VDC IC = 3A (5A Peak)

FOR TV HORIZONTAL SECTIONS; HIGH VOLTAGE REGULATORS
REPLACES: 2N5076, 2N5077, 2N5838, 2N5665, BDY94, BU126, 2SC2121, 2N5840, 2SC1046, 2N5466, TIP556 AND MANY OTHERS.

HOUSE #

LM3046	(CA3046) Transistor Array	.75
RCA 40430	400V 6A TRIAC TO-66	.75
CA3086	RCA Transistor Array	.80
MC1438R	Power Op Amp/Driver	.50
1N4148	Prime, Full Lead	100/2.50
LM3302	Quad Comparator	.89
2SC1849	High Freq NPN TO-92	6/1.00
MPS A20	NPN GEN PUR	8/1.00

AY3-8910 PROGRAMMABLE SOUND GENERATOR

The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

$14.95 W/Basic Spec Sheet (4 pages)
60 page manual with S-100 interface instructions and several programming examples, **$3.00 extra**.

A HOT NUMBER, AY3-1350

TUNES SYNTHESIZER

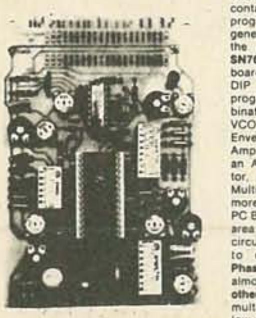
The AY3-1350 is a MOS microcomputer synthesizer of pre-programmed tunes for applications in toys, music boxes, and door chimes. The standard device has a set of 25 different popular and classical tunes. In addition there are 3 chimes making a total of 25 tunes.

FEATURES

* Minimal external components
* Automatic switch-off signal at end of tune for power saving
* Envelope control to give organ or piano quality
* Sequential tune mode
* 4 door capability when used as door chime
* Operation with tunes in external PROM if required (2708)
* Single supply (+5V) Operation
* Tunes include: **STAR WARS, BEETHOVEN'S 9th & 5th, JINGLE BELLS, YANKEE DOODLE, STAR SPANGLED BANNER, CLEMENTINE, GOD SAVE THE QUEEN, O SOLE MIO, WEST MINISTER** AND **DESCENDING OCTAVE CHIME** PLUS MANY MORE!

$14.50 WITH DETAILED SPECS AND INSTRUCTIONS

SE 01 Sound Effects Kit 17.50



The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip,** the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of **other sounds.** The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included)

* **76477 CHIP IS INCLUDED.** EXTRA CHIPS **$2.95** EACH
* **$17.50** LESS SPEAKER & BATTERY

1/2W RESISTOR ASSORTMENT

A good mix of 5% and 10% values in both full lead and PC lead devices. All new, first quality.

(Asst.) 200 pieces/**2.00**

POTENTIOMETER ASSORTMENT

A mix of new, panel mount 3/8" bushing pots in various values. Some dual, **some with switches.**

10/**2.00**

SLIDE SWITCH ASSORTMENT

An outstanding bargain. Includes miniature and standard sizes and multi-position units. All new first quality, name brand switches. Try one pack and you'll reorder more: *SPECIAL — 12 for $1.20* (Assortment)

XAN SUPER DIGITS

.6" JUMBO LED
7 SEGMENT
RED

99¢

6920 COMMON CATHODE
6640 COMMON ANODE

NOW A SUPER READOUT AT A SUPER BUY! These are **factory fresh prime** LED readouts, not seconds or rejects as sold by others. Compare our price and send for yours today, but hurry, the supply is limited! **SPECIFY: COMMON ANODE OR COMMON CATHODE**

7 WATT AUDIO AMP KIT

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT. **$5.95**

ULTRASONIC RELAY KIT

INVISIBLE BEAM WORKS LIKE A PHOTO ELECTRIC EYE. USE UP TO 25 FT. APART. COMPLETE KIT. ALL PARTS & PC BOARDS. **$21.50**

From T.I.: **TL490 BAR/DOT DRIVER IC.** Drives 10 LED's with adjustable analog steps. Units are cascadable up to 10 (100 steps). Drives LED's directly. Great for **voltage, current,** or **audio displays.** Similar in features to LM3914 with specs and circuit notes.

2.95

* NO C.O.D.'s
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TEST EQUIPMENT, TOOLS, TELEPHONE DEVICES, AUTO STEREO PRODUCTS

FREE 8 pc. Tool Set (value $14.95) with $200.00 purchase of merchandise from this ad

DIGITAL MULTIMETERS

Sinclair PDM 35
Reg. $69.95
$49.95

Hickok LX 303
$69.50

Beckman TECH 310
- 22 MΩ input resistance - 10 Amp AC/DC - 1500V Overload - 6KV Transient Protection - 2 year battery life

$130.

Simpson 461
Complete with nickel-cadmium batteries, AC charger/adapter, test leads
$149.95

Logic Probe
- Compact circuit powered - Detects pulses as short as 50 μsec - DTL/TTL/HTL/CMOS compatibility

$44.95
Model LP-1

CONTINENTAL SPECIALTIES CORPORATION
CSC

Function Generator
Model 2001
Reg. $185.95
$157.95
- Sine-, square-, triangle- and separate TTL square wave output

100 MHz 8-Digit Counter
- 20 Hz to 100 MHz range - LED display - Fully automatic

Model MAX100 Reg. $150.00 $127.50

Preassembled Proto Boards
Model PB-104
$49.95
Fully assembled breadboard contains four QT-59S sockets, seven QT-59B bus strips and four 5-way binding posts

Proto Board with Built-in Power Supplies
- Regulated
- Short-proof

Reg. $154.95
$129.95 Model PB-203A

3½-Digit 0.1% Digital Capacitance Meter
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- 9 ranges from 1999 pF to 199.9 μF - 0.1% of reading accuracy - Auto over and under range indication

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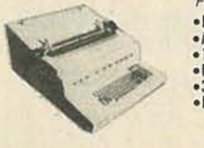

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7430	.17	74122	.39	74194	.85
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DELUXE ULTRASONIC CONSOLE

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STEREO GRAPHIC EQUALIZER & PREAMP
Octave-Band 50 hz to 12,800 18 CTS Slide controls

Assembled & tested $109.15
No additional components necessary
for 12 VDC operation
- American made
- Glass epoxy Double sided p.t.h. circuit board
- ALLEN BRADLEY Type M conductive plastic volume control
- Adjustable input sensitivity: .3V to 3V RMS (Bourns MFT Dual trimmer)
- BIFET II Op amps: low noise, 13V/uS (TL074)
- Bourns 2% Resistor networks
- 1% Metal film resistors
- Instrument-type min. toggle switch (on-off-22 db mute)
- 2 accurate clipping lights: one on preamp stage, one on EQ stage
- All 3 LED's are Hi-brightness types (8mcd at 20mA DIFFUSED)
- Wiring & mtg. info included

80 WATT STEREO POWER AMPLIFIER
Assembled & tested circuit board.
American made $67.89 (Class B $61.90)
Ready to mount to heat sinks. Requires 27V split supply, 125W.
- 40W/ch 8 ohm Class AB • .08% THD at 20 khz, full power (.2% Class B)
- Slew Rate 33V/uS, low TIM • VI limiting

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Includes 125W xfmr, filter caps, rect, schemo $33.00
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ALLEN BRADLEY type M cond. plastic dual Aud. taper 100K, 1 cm cube 3mm (1/8") shaft w/mtg. hdw $3.75
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Z-80 * $12.50

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7474	.35	74LS122	.50	MC14528BCP	1.00
74181	1.55	74LS175	.95	NE555	.28
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74LS03	.24	74LS386	.80	LM3900	.58
74LS08	.32	74LS393	1.95	SG3083	1.25
74LS09	.35	74S05	.45	C2416	3.99
74LS20	.30	74S51	.50	N2431	1.99

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LOWEST IN PRICE—HIGHEST IN PERFORMANCE
*Compact Size
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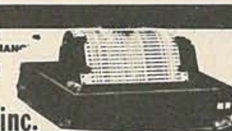

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MEMORY ADD-ON FOR THE TRS-80™ OR APPLE II™
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8216 $1.99 BUS DRIVER

T.I./M.M.I.
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LIMIT 10 EACH
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2716 16K EPROM $27.95
450ns single+5V
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WITH DOCUMENTATION AND DETAILED INSTRUCTION BOOK. $28.95

MH0026CJ DUAL CLOCK DRIVER $1.00

74S373
74S374
$3.25

2114L 1024×4 Static RAM $4.75
450 ns

16K STATIC RAM

S-100 MEMORY ADD-ON
** FULLY STATIC OPERATION
** USES 2114 TYPE STATIC RAMSMS
** +8 VDC INPUT AT LESS THAN 2 AMPS
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** LED INDICATORS FOR BOARD/BANK
** SOLDER MASK ON BOTH SIDES OF BOARD
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California Computer Systems

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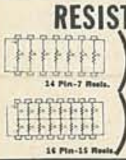

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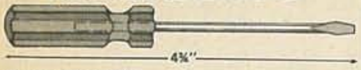

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1000's OF USES – 1/8" TIP .... 2/$1.00

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Picks up elusive metal parts or tools in hard-to-reach places.

EXTENDS TO 26¾" – ROTATES 360°
STRONG, LIFETIME MAGNET

MRT-2281 .... $3.95

CSC CONTINENTAL SPECIALTIES

LOGIC PROBE KIT

SPECIFICATIONS

Input Impedance: 300,000 Ohms.
Thresholds: "Lo" 30%Vcc – "Hi" 70%Vcc
Maximum Speed: 300 nsec., 1.5MHz
Input Protection: ±50VDC continuous 117VAC for 15 sec.
Power: 30mA @5V – 40mA @ 15V – 25V max. reverse voltage protected; 36" cable with color coded clips included.
Operating Temp.: 0-50°C.
Dimensions: 5.8L x 1.0W x 0.7D in. (147 x 25 x 18mm)
Weight: 30 oz. (85 gm)

LPK-1 .... $21.95/Kit

Proto Clips

14-PIN CLIP	PC-14	$ 4.50
16-PIN CLIP	PC-16	$ 4.75
24-PIN CLIP	PC-24	$10.00
40-PIN CLIP	PC-40	$16.00

Proto Boards

PB-6	$17.95
PB-100	19.95
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PB-102	26.95
PB-103	44.95
PB-104	55.95
PB-203	99.95
PB-203A	155.00
PB-203A-Kit	131.00

Jumbo 6-Digit Clock Kit

* Four .630"ht. and two .300"ht. common anode displays
* Uses MM5314 clock chip
* Switches for hours, minutes and hold functions
* Hours easily viewable to 30 feet
* Simulated walnut case
* 115 VAC operation
* 12 or 24 hour operation
* Includes all components, case and wall transformer
* Size: 6¾ x 3⅛ x 1¾

JE747 .... $29.95

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 .... $14.95

ADAPTER BOARD
–Adapts to JE200–
±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... $12.95

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8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
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MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$13.95
Z80A(780-1)	CPU	15.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$ .50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49
UART'S		
A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS		
M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
ROM'S		
2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
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2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
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UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516	16K*	EPROM	39.95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages, –5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT

FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 .... $59.95
Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 .... $39.95

62-Key ASCII Encoded Keyboard Kit

The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10mA for operation.

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 ..... $79.95
62-Key Keyboard only . . $34.95

HICKOK LX303 Portable LCD Digital Multimeter

• Big ½ inch high, 3½ Digit Liquid Crystal Display • Over 200 Hours of operation with a 9V battery • Automatic zero, polarity and overrange indication • 100mV DC F.S. sensitivity • 1% basic accuracy • 19 ranges and functions • Rugged Cycolac® case and removable cover, stores test lead set. • Full one year warranty

SPECIFICATIONS: DC volts (5 ranges): [illegible]
AC Volts: [illegible]
Resistance (6 Low Power Ranges): [illegible]
DC Current (6 ranges): [illegible]
Dimensions and Weight: [illegible] POWER: 9V battery [illegible] Hickok AC adapter. READ RATE: [illegible]

LX303 Digital Multimeter $74.95

PART NO.	DESCRIPTION	PRICE
RC-3	115V AC ADAPTER	7.50
CC-3	PADDED CARRYING CASE	7.50
VP-10	X10 DC PROBE ADAPTER (Up to 10K)	14.95
VP-40	40kV DC PROBE	35.00
CS-1	10 Amp DC Current Shunt	14.95

$10.00 Min. Order – U.S. Funds Only
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4-80

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without cribical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark
Receive Sensitivity	–46 dbm accoustically coupled
Transmit Level	–15 dbm nominal. Adjustable from –6 dbm to –20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
* 8 each UPD416-1 (16K Dynamic Rams) 250NS
* Documentation for conversion

TRS-16K $75.00

ok JUST WRAP™

- 30 AWG wire
- Daisy chain or point-to-point
- No stripping or slitting required—just wrap
- .025" square posts
- Built-in cut off
- Includes 50 ft. wire

Part No.	Wire Color	Price
JW-1-B	Blue	$14.95
JW-1-W	White	14.95
JW-1-Y	Yellow	14.95
JW-1-R	Red	14.95

JUST WRAP™ Replacement Wire

Part No.	Color		Price
R-JW-B	Blue	50 ft. roll	$2.98
R-JW-W	White	50 ft. roll	2.98
R-JW-Y	Yellow	50 ft. roll	2.98
R-JW-R	Red	50 ft. roll	2.98

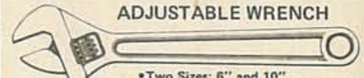
JUST WRAP™ Unwrap Tool $3.49

ok Vacuum Vise

Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws, 1¾" travel. Can be permanently installed.

VV-1 ...... $3.49

ADJUSTABLE WRENCH



- Two Sizes: 6" and 10"
- Professional Quality
- Chrome Vanadium Steel

6" – AW-6 . . $4.95   10" – AW-10 . . $6.95

JOYSTICK VIDEO CONTROLLER

- IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS
- SMALL CASE SIZE: 1-1/2"H x 2-3/8"W x 4-5/16"L
- 2 MINIATURE POTENTIOMETERS – 40K OHM EACH
- SPST PUSH BUTTON CONTROL
- 5-WIRE CONNECTION CABLE – 5 FEET LONG
- RUGGED PLASTIC CASE

JVC-40 ...... $4.95 each

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2SA 473	.45	.55	.60
2SA 483	2.00	2.20	2.50
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2SA 485	1.40	1.60	1.80
2SA 489	1.10	1.25	1.40
2SA 490	.70	.80	.90
2SA 493	.45	.53	.59
2SA 495	.30	.35	.40
2SA 496	.50	.64	.70
2SA 497	1.00	1.20	1.30
2SA 505	.50	.64	.70
2SA 509	.30	.35	.40
2SA 525	.50	.64	.70
2SA 530	1.50	1.70	1.90
2SA 537A	1.50	1.70	1.90
2SA 539	.40	.45	.50
2SA 545	.45	.53	.59
2SA 561	.30	.35	.40
2SA 562	.30	.35	.40
2SA 564A	.20	.27	.30
2SA 565	.70	.80	.90
2SA 566	2.50	2.70	3.00
2SA 606	1.00	1.20	1.30
2SA 607	1.10	1.25	1.40
2SA 624	.70	.80	.90
2SA 627	3.10	3.30	3.60
2SA 628	.30	.35	.40
2SA 634	.40	.45	.50
2SA 640	.30	.35	.40
2SA 642	.30	.35	.40
2SA 643	.30	.40	.45
2SA 653	1.90	2.10	2.40
2SA 659	.35	.40	.45
2SA 661	.50	.64	.70
2SA 663	3.65	3.80	4.20
2SA 666	.35	.40	.45
2SA 671	.80	.90	1.00
2SA 672	.30	.35	.40
2SA 673	.35	.40	.45
2SA 678	.35	.40	.45
2SA 679	4.20	4.40	4.90
2SA 680	4.20	4.40	4.90
2SA 682	.80	.90	1.00
2SA 683	.30	.35	.40
2SA 684	.35	.40	.45
2SA 695	.40	.53	.59
2SA 697	.40	.53	.59
2SA 699A	.50	.64	.70
2SA 705	.40	.53	.59
2SA 706	.85	1.00	1.10
2SA 715	.60	.70	.80
2SA 719	.30	.35	.40
2SA 720	.30	.35	.40
2SA 721	.30	.35	.40
2SA 725	.30	.35	.40
2SA 726	.30	.35	.40
2SA 733	.20	.27	.30
2SA 738	.40	.53	.59
2SA 740	1.50	1.70	1.90
2SA 743A	.85	1.00	1.10
2SA 744	4.20	4.40	4.90
2SA 745R	3.80	4.00	4.40
2SA 747	4.20	4.40	4.90
2SA 748	.70	.80	.90
2SA 750	.35	.40	.45
2SA 755	.80	.90	1.00
2SA 756	2.30	2.40	2.65
2SA 758	3.40	3.55	3.90
2SA 764	3.80	4.00	4.40
2SA 765	3.10	3.30	3.60
2SA 774	.40	.45	.50
2SA 777	.50	.64	.70
2SA 794A	.60	.70	.80
2SA 798	.50	.55	.60
2SA 814	.70	.80	.90
2SA 815	.60	.70	.80
2SA 816	.50	.64	.70
2SA 818	.70	.80	.90
2SA 837R	2.50	2.70	2.90
2SA 839T	1.30	1.45	1.60
2SA 908	8.60	8.80	9.80
2SA 913	.70	.80	.90
2SB 22	.30	.35	.40
2SB 54	.20	.27	.30
2SB 55	.40	.53	.59
2SB 75	.35	.40	.45
2SB 77	.35	.40	.45
2SB 173	.30	.35	.40
2SB 175	.20	.27	.30
2SB 176	.30	.35	.40
2SB 178	.35	.40	.45
2SB 186	.20	.27	.30
2SB 187	.20	.27	.30
2SB 202	1.10	1.20	1.30
2SB 220	.90	1.10	1.20
2SB 303	.30	.35	.40
2SB 324	.30	.35	.40
2SB 337	1.40	1.60	1.80
2SB 346	.30	.35	.40
2SB 367	1.10	1.25	1.40
2SB 368B	1.80	2.00	2.25
2SB 379	.70	.80	.90
2SB 381	.30	.35	.40
2SB 400	.30	.35	.40
2SB 405	.30	.35	.40
2SB 407	.80	.90	1.00
2SB 415	.30	.35	.40
2SB 434	.80	.90	1.00
2SB 435	.90	1.10	1.20
2SB 440	.40	.53	.59
2SB 449	1.30	1.45	1.60
2SB 461	.90	1.10	1.20
2SB 463	.90	1.10	1.20
2SB 471	1.10	1.25	1.40
2SB 472	2.10	2.50	2.80
2SB 473	.80	.90	1.00
2SB 474	.70	.80	.90
2SB 481	.90	1.10	1.20
2SB 492	.60	.70	.80
2SB 507	.80	.90	1.00
2SB 509	1.10	1.20	1.30
2SB 511	.70	.80	.90
2SB 514	.70	.80	.90
2SB 523	.70	.80	.90
2SB 526C	.70	.80	.90
2SB 527	.90	1.10	1.20
2SB 528D	.70	.80	.90
2SB 529	.70	.80	.90
2SB 530	3.20	3.40	3.70
2SB 531	1.80	2.00	2.25
2SB 536	1.00	1.20	1.30
2SB 537	1.00	1.20	1.30
2SB 539	3.20	3.40	3.70
2SB 541	3.20	3.40	3.70
2SB 554	5.00	6.00	6.60
2SB 556	3.20	3.40	3.70
2SB 557	2.10	2.50	2.80
2SB 561B	.35	.40	.45
2SB 564	.40	.53	.59
2SB 595	1.10	1.40	1.50
2SB 596	1.10	1.40	1.50
2SB 600	5.00	6.00	6.60
2SC 183	.40	.53	.59
2SC 184	.40	.53	.59
2SC 281	.30	.35	.40
2SC 283	.40	.53	.59
2SC 284	.80	.90	1.00
2SC 317	.40	.53	.59
2SC 352A	2.00	2.20	2.50
2SC 353A	1.40	1.60	1.80
2SC 367	.60	.70	.80
2SC 369	.30	.35	.40
2SC 370	.20	.27	.30
2SC 371	.30	.35	.40
2SC 372	.20	.27	.30
2SC 373	.20	.27	.30
2SC 374	.30	.35	.40
2SC 375	.30	.35	.40
2SC 377	.30	.35	.40
2SC 380	.20	.27	.30
2SC 381	.35	.40	.45
2SC 382	.35	.40	.45
2SC 383	.35	.40	.45
2SC 387A	.35	.40	.45
2SC 388A	.40	.53	.59
2SC 394	.20	.27	.30
2SC 403	.30	.35	.40
2SC 430	.50	.64	.70
2SC 454	.30	.35	.40
2SC 456	.20	.27	.30
2SC 460	.35	.40	.45
2SC 461	.35	.40	.45
2SC 478	.60	.70	.80
2SC 481	1.30	1.40	1.50
2SC 482	1.10	1.25	1.40
2SC 484	1.30	1.40	1.50
2SC 485	1.30	1.40	1.50
2SC 486	1.30	1.40	1.50
2SC 493	3.00	3.20	3.40
2SC 495	.45	.55	.60
2SC 496	.45	.55	.60
2SC 497	1.10	1.25	1.40
2SC 509	.35	.40	.45
2SC 510	1.30	1.40	1.50
2SC 515A	.80	.90	1.00
2SC 517	2.50	2.70	3.00
2SC 535	.30	.35	.40
2SC 536	.30	.35	.40
2SC 537	.30	.35	.40
2SC 627	1.30	1.45	1.60
2SC 631	.35	.40	.45
2SC 632A	.35	.40	.45
2SC 634A	.35	.40	.45
2SC 680	1.90	2.10	2.40
2SC 681A	3.00	3.25	3.50
2SC 684	.80	.90	1.00
2SC 693F	.20	.27	.30
2SC 696	1.00	1.20	1.30
2SC 708	1.30	1.45	1.60
2SC 710	.20	.27	.30
2SC 711	.20	.27	.30
2SC 712	.20	.27	.30
2SC 715	.30	.35	.40
2SC 717	.35	.40	.45
2SC 727	1.00	1.20	1.30
2SC 730	3.00	3.20	3.40
2SC 731	2.50	2.70	2.90
2SC 732	.20	.27	.30
2SC 733	.20	.27	.30
2SC 734	.20	.27	.30
2SC 735	.20	.27	.30
2SC 738	.20	.27	.30
2SC 756	1.50	1.80	2.00
2SC 756A	1.50	1.80	2.00
2SC 763	.35	.40	.45
2SC 772	.30	.35	.40
2SC 773	.35	.40	.45
2SC 774	1.00	1.20	1.30
2SC 775	1.40	1.60	1.80
2SC 776	2.00	2.20	2.50
2SC 777	3.00	3.25	3.50
2SC 778	2.90	3.20	3.40
2SC 781	1.90	2.10	2.40
2SC 783	2.10	2.50	2.80
2SC 784	.30	.35	.40
2SC 785	.35	.40	.45
2SC 789	.80	.90	1.00
2SC 790	.80	.90	1.00
2SC 793	2.00	2.20	2.50
2SC 799	2.00	2.20	2.50
2SC 828	.20	.27	.30
2SC 829	.20	.27	.30
2SC 830H	2.50	2.70	3.00
2SC 838	.35	.40	.45
2SC 839	.30	.35	.40
2SC 853	.70	.80	.90
2SC 867	4.20	4.40	4.90
2SC 867A	4.20	4.40	4.90
2SC 870	.35	.40	.45
2SC 871	.35	.40	.45
2SC 895	4.20	4.40	4.90
2SC 897	2.00	2.20	2.50
2SC 898	2.50	2.70	3.00
2SC 900	.20	.27	.30
2SC 923	.20	.27	.30
2SC 929	.20	.27	.30
2SC 930	.20	.27	.30
2SC 941	.20	.27	.30
2SC 943	.35	.40	.45
2SC 945	.20	.27	.30
2SC 959	1.00	1.20	1.30
2SC 971	.70	.80	.90
2SC 982	.70	.80	.90
2SC 983	.50	.64	.70
2SC 1000	.35	.40	.45
2SC 1012	1.20	1.40	1.50
2SC 1013	.50	.64	.70
2SC 1014	.50	.64	.70
2SC 1017	.80	.90	1.00
2SC 1018	.60	.70	.80
2SC 1030	1.80	2.10	2.40
2SC 1047	.35	.40	.45
2SC 1051	3.40	3.55	3.90
2SC 1060	.70	.80	.90
2SC 1061	.70	.80	.90
2SC 1076	30.00	35.00	39.00
2SC 1079	3.40	3.55	3.90
2SC 1080	3.40	3.55	3.90
2SC 1096	.45	.55	.60
2SC 1098	.50	.64	.70
2SC 1111	2.10	2.50	2.80
2SC 1114	4.20	4.40	4.90
2SC 1115	2.50	2.70	3.00
2SC 1116	3.20	3.40	3.70
2SC 1116A	3.40	3.55	3.90
2SC 1124	.80	.90	1.00
2SC 1127	.80	.90	1.00
2SC 1161	1.30	1.45	1.60
2SC 1162	.70	.80	.90
2SC 1166	.20	.27	.30
2SC 1167	3.80	4.00	4.40
2SC 1170B	3.80	4.00	4.40
2SC 1172B	3.20	3.60	3.95
2SC 1173	.50	.55	.60
2SC 1175	.35	.40	.45
2SC 1177	11.00	12.60	14.00
2SC 1189	1.00	1.10	1.20
2SC 1209	.30	.35	.40
2SC 1211D	.30	.35	.40
2SC 1212A	.80	.90	1.00
2SC 1213	.30	.35	.40
2SC 1215	.35	.40	.45
2SC 1222	.20	.27	.30
2SC 1226	.50	.55	.60
2SC 1226A	.50	.55	.60
2SC 1237	1.80	2.00	2.25
2SC 1239	2.20	2.70	2.90
2SC 1279	.50	.55	.60
2SC 1306	1.30	1.45	1.60
2SC 1307	1.90	2.10	2.40
2SC 1310	.20	.27	.30
2SC 1312	.20	.27	.30
2SC 1313G	.20	.27	.30
2SC 1316	4.20	4.40	4.90
2SC 1317	.20	.27	.30
2SC 1318	.35	.40	.45
2SC 1325A	6.50	6.90	7.60
2SC 1327	.20	.27	.30
2SC 1330	.50	.55	.60
2SC 1335	.50	.55	.60
2SC 1342	.45	.53	.59
2SC 1344	.45	.53	.59
2SC 1358	4.20	4.40	4.90
2SC 1359	.30	.35	.40
2SC 1360	.50	.55	.60
2SC 1362	.35	.40	.45
2SC 1364	.35	.40	.45
2SC 1377	3.20	3.40	3.70
2SC 1383	.30	.35	.40
2SC 1384	.35	.40	.45
2SC 1396	.45	.53	.59
2SC 1398	.70	.80	.90
2SC 1400	.35	.40	.45
2SC 1402	3.00	3.20	3.40
2SC 1403	3.20	3.40	3.70
2SC 1407	.50	.55	.60
2SC 1419	.60	.70	.80
2SC 1444	1.60	1.80	2.00
2SC 1445	2.50	2.70	2.90
2SC 1447	.60	.70	.80
2SC 1448	.70	.80	.90
2SC 1449	.60	.70	.80
2SC 1451	1.00	1.10	1.20
2SC 1454	3.20	3.40	3.70
2SC 1475	.80	.90	1.00
2SC 1478	.50	.55	.60
2SC 1509	.50	.55	.60
2SC 1567	.60	.70	.80
2SC 1567A	.60	.70	.80
2SC 1584	6.00	6.30	7.00
2SC 1586	6.50	6.90	7.60
2SC 1624	.60	.70	.80
2SC 1626	.60	.70	.80
2SC 1628	.60	.70	.80
2SC 1647	.70	.80	.90
2SC 1667	3.00	3.20	3.40
2SC 1669	.90	1.00	1.10
2SC 1674	.30	.35	.40
2SC 1675	.20	.27	.30
2SC 1678	1.10	1.25	1.40
2SC 1679	3.00	3.20	3.40
2SC 1681	.30	.35	.40
2SC 1682	.30	.35	.40
2SC 1684	.30	.35	.40
2SC 1687	.40	.45	.50
2SC 1688	.35	.40	.45
2SC 1708	.30	.35	.40
2SC 1728	.70	.80	.90
2SC 1730	.45	.53	.59
2SC 1756	.50	.55	.60
2SC 1760	.70	.80	.90
2SC 1816	1.50	1.75	1.95
2SC 1856	.45	.53	.59
2SC 1885	.45	.53	.59
2SC 1908	.30	.35	.40
2SC 1909	1.80	2.00	2.25
2SC 1945	4.50	5.00	5.60
2SC 1957	.60	.70	.80
2SC 1969	3.60	4.00	4.40
2SC 1973	.70	.80	.90
2SC 1975	1.30	1.70	1.90
2SC 1978	5.40	6.00	6.60
2SC 2028	.50	.64	.70
2SC 2029	1.50	1.80	2.00
2SC 2074	.80	.90	1.00
2SC 2076	.50	.64	.70
2SC 2091	.90	1.10	1.20
2SC 2092	1.80	2.00	2.25
2SC 2098	3.20	3.40	3.70
2SC 2166	1.40	1.60	1.80
2SD 72	.50	.64	.70
2SD 77	.35	.40	.45
2SD 90	1.30	1.45	1.60
2SD 91	1.30	1.45	1.60
2SD 92	1.30	1.45	1.60
2SD 93	1.60	1.80	2.00
2SD 118	2.90	3.20	3.40
2SD 130	1.10	1.25	1.40
2SD 187	.35	.40	.45
2SD 201	2.30	2.40	2.65
2SD 202	3.40	3.55	3.90
2SD 218	2.50	2.70	3.00
2SD 234	.60	.70	.80
2SD 235	.60	.70	.80
2SD 261	.35	.40	.45
2SD 287	2.50	2.70	2.90
2SD 300	4.50	5.00	5.60
2SD 313	.60	.70	.80
2SD 315	.60	.70	.80
2SD 325	.60	.70	.80
2SD 330	.60	.70	.80
2SD 350	3.80	4.00	4.40
2SD 380	5.20	5.40	5.95
2SD 381	.85	1.00	1.10
2SD 424	3.80	4.00	4.40
2SD 425	2.90	3.20	3.40
2SD 426	3.10	3.30	3.60
2SD 427	1.80	2.00	2.25
2SD 525	.90	1.10	1.20
2SD 526	.60	.70	.80
2SK 19BL	.50	.55	.60
3SK 22Y	1.40	1.60	1.80
3SK 39	.90	1.10	1.20
3SK 40	.90	1.10	1.20
3SK 41	1.30	1.45	1.60
3SK 45	1.30	1.45	1.60
AN 203	1.40	1.60	1.80
AN 214Q	1.50	1.70	1.90
AN 239	4.20	4.40	4.90
AN 247	2.50	2.70	3.00
AN 274	1.50	1.75	1.95
AN 313	3.00	3.20	3.40
AN 315	1.80	2.00	2.25
BA 511A	1.80	2.00	2.25
BA 521	1.90	2.10	2.40
HA 1151	1.50	1.75	1.95
HA 1156W	1.60	1.80	2.00
HA 1306W	2.00	2.20	2.50
HA 1339	2.50	2.70	3.00
HA 1339A	2.50	2.70	3.00
HA 1342A	2.50	2.70	3.00
HA 1366W	2.50	2.70	3.00
HA 1366WR	2.50	2.70	3.00
LA 4031P	1.80	2.00	2.25
LA 4032P	1.80	2.00	2.25
LA 4051P	1.80	2.00	2.25
LA 4400	1.90	2.10	2.40
LA 4400Y	2.00	2.20	2.50
LA 4420	2.00	2.20	2.50
LD 3001	2.00	2.20	2.50
M5 1513L	2.00	2.20	2.50
STK 011	3.80	4.00	4.40
STK 013	7.60	8.00	8.80
STK 015	4.20	4.40	4.90
STK 435	4.50	5.00	5.60
STK 439	7.90	8.00	8.80
TA 7045M	2.00	2.20	2.50
TA 7055P	2.00	2.20	2.50
TA 7061AP	.90	1.10	1.20
TA 7062P	1.10	1.25	1.40
TA 7203P	2.50	2.70	2.90
TA 7204P	2.00	2.20	2.50
TA 7205P	1.60	1.80	2.00
TA 7222P	3.40	3.55	3.90
TA 7310P	1.30	1.45	1.60
TBA 810SH	1.90	2.10	2.40
TC 5080P	5.00	5.20	5.80
TC 5081P	3.00	3.20	3.40
TC 5082P	3.40	3.55	3.90
UHIC 001	4.20	4.40	4.90
UHIC 002	4.20	4.40	4.90
UHIC 003	4.20	4.40	4.90
UHIC 004	4.20	4.40	4.90
UHIC 005	4.20	4.40	4.90
uPC 20C	2.10	2.50	2.80
uPC 563	1.90	2.10	2.40
uPC 575C2	1.30	1.45	1.60
uPC 576	1.90	2.10	2.40
uPC 592H	.70	.80	.90
uPC 1001H	1.90	2.10	2.40
uPC 1008C	4.20	4.40	4.90
uPC 1020H	1.90	2.10	2.40
uPC 1025	1.90	2.10	2.40
uPC 1154	2.00	2.20	2.50
uPC 1155	2.00	2.20	2.50
uPC 1156	1.90	2.10	2.40
uPD 861	8.00	8.40	9.50
uPD 857	8.00	8.40	9.50
uPD 858	6.00	6.30	7.00
PLL 0IA	3.00	4.20	4.60
PLL 02A	5.00	5.20	5.90
PLL 03A	7.60	8.00	8.80
C-3001	1.30	1.45	1.60
2SC F8	2.20	2.70	2.90
4004	1.90	2.10	2.40
4005	2.00	2.20	2.50
SG 613	5.90	6.50	6.90
78L05	.90	1.00	1.10
MPS U31	1.50	1.70	1.90
SN 7400	.15	.17	.19

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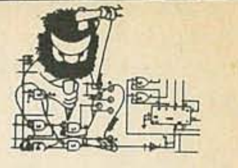

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27003	SBC-100 Single Board Computer Kit	295
27004	Z80 Starter Kit	340
27007	ExpandoPROM Kit	175
27010	Add-on RAM (16K Devices) 4116 (250nsec)(package of eight devices	165
27011	VDB-8024 Video Display Board Kit	370
27012	ExpandoRAM II Expandable RAM Board Kit (16K RAM)	460
27013	Versafloppy II Flexible Disk Drive Controller Kit	350
27014	PROM-100 PROM Programmer Board Kit	200
27015	MPB-100 Z80 Central Processing Unit Board Kit	250
27017	Add-on RAM (16K devices) 4116 (200nsec)	250
27018	SBC-200 Single Board Computer Kit	320
27024	ExpandoRAM II Expandable RAM Board Kit (No RAMs)	230

SD Systems	ASSEMBLED	
38001	ExpandoRAM (16K of on-board RAM)	$ 480
38002	ExpandoRAM (32K of on-board RAM)	620
38003	ExpandoRAM (48K of on-board RAM)	760
38004	ExpandoRAM (64K of on-board RAM)	900
38005	Versafloppy Flexable Disk Drive Controller	335
38006	SBC-100 Single Board Computer	350
38007	Z80 Starter System	450
38010	ExpandoPROM	245
38011	Cable for 8" Disk Drives	80
38013	VDB-8024 Video Display Board	470
38016	Cable, 6ft., 26 Pin Edge Connector (one end)	50
38017	Cable for SD-100/SD-200 Interface to Texas Instruments 810 Printer	80
38018	Cable, same as above (Internal)	120
38019	Cable, same as above (External)	80
38020	ExpandoRAM II (16K Population)	610
38021	ExpandoRAM II (32K Population)	840
38022	ExpandoRAM II (48K Population)	1070
38023	ExpandoRAM II (64K Population)	1300
38024	Versafloppy II Double Density Flexible Disk Drive Controller	430
38025	PROM-100 PROM Programmer	265
38026	MPB-100 Z80 Microprocessor Board	325
38028	SBC-200 Single Board Computer	400

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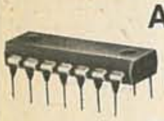

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- *Flip Open Cover*
- *High Impact Plastic*

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This deluxe molded case is ideal for many projects. Easy-to-work reversible inner panel accepts switches, meter or readouts. Hinged lid has snap-lock closure. 5½x3⅜x2". **270-290** **2.99**

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Storage Box Included!

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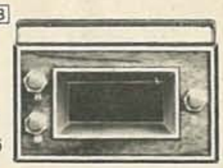

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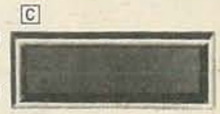

C

[A] **Digital Display Case.** Ideal for clocks, counters, testers. Mounts up to four 0.6" or eight 0.3" readouts. **270-285.** Reg. 3.95 .... **Sale 2.95**

[B] **Auto Project Case.** Mounts in or on dash. Companion enclosure to MA1003 Auto Clock Module. Accepts 3 push switches (not included). Blue lens. 3½x2 1/16x2" **270-303.** Reg. 5.95 .... **Sale 3.95**

[C] **Bezel With Lens.** High contrast lens, ideal for LED displays. 3 9/16x1" lens opening. With hardware. **270-301.** Reg. 3.95 .... **Sale 2.95**

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When quality counts

Do not be fooled by the low prices, these brand new lab quality frequency counters have important advantages over instruments costing much more. The models 7010 and 8010 are not old counters repackaged but 100% new designs using the latest LSI state-of-the-art circuitry. With only 4 IC's, our new 7010 offers a host of features including 10 Hz to 600 MHz operation, 9 digit display, 3 gate times and more. This outperforms units using 10-15 IC's at several times the size and power consumption. The older designs using many more parts increase the possiblity of failure and complexity of troubleshooting. Look closely at our impressive specifications and note you can buy these lab quality counters for similar or less money than hobby quality units with TV xtal time bases and plastic cases!

Both the new 7010 and 8010 have new amplifier circuits with amazingly flat frequency response and improved dynamic range. Sensitivity is excellent and charted below for all frequencies covered by the instruments.

Both counters use a modern, no warm up, 10 MHz TCXO [temperature compensated xtal oscillator] time base with external clock capability - no economical 3.579545 MHz TV xtal.

Quality metal cases with machine screws and heavy guage black anodized aluminum provide RF shielding, light weight and are rugged and attractive - not economical plastic.

For improved resolution there are 3 gate times on the 7010 and 8 gate times on the 8010 with rapid display update. For example, the 10 second gate time on either model will update the continuous display every 10.2 seconds. Some competitive counters offering a 10 second gate time may require 20 seconds between display updates.

The 7010 and 8010 carry a 100% parts and labor guarantee for a full year. No "limited" guarantee here! Fast service when you need it too, 90% of all serviced instruments are on the way back to the user within two business days.

We have earned a reputation for state-of-the-art designs, quality products, fast service and honest advertising. All of our products are manufactured and shipped from our modern 13,000 square foot facility in Ft. Lauderdale, Florida.

When quality counts...count on Optoelectronics.

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MODEL 8010 1 GHz

MODEL 7010 600 MHz

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- 100% PARTS & LABOR YEAR GUARANTEE
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- 9 RED LED DIGITS .4" HIGH
- .1 Hz RESOLUTION
- 0.1 PPM 10 MHz TCXO TIME BASE
- LAB/PORTABLE-AC ADAPTER INCLUDED
- 1 MEGOHM & 50 OHM INPUTS
- STATE-OF-THE-ART LSI DESIGNS
- COMPREHENSIVE USER MANUAL PROVIDED
- COMPACT SIZES—7010- 1-¾" Hx4-¼" Wx5-¼"D 8010- 3" Hx7-½" Wx6-½"D

MODEL	$ PRICE	RANGE 10Hz to	LED DIGITS	SENSITIVITY 50 OHM INPUT 25-250 MHz	SENSITIVITY 50 OHM INPUT 250-450 MHz	SENSITIVITY 50 OHM INPUT 450 MHz-1GHz	SENSITIVITY HI-Z INPUT 10Hz - 60 MHz	GATE TIMES	RESOLUTION 12 MHz	RESOLUTION 60 MHz	RESOLUTION MAX. FREQ.	TCXO TIME BASE 20°-40°C	TCXO TIME BASE FREQ.	EXT CLOCK INPUT	NI-CAD BATT PACK
7010 *7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-30 mV	20-40 mV to 600 MHz	1-10 mV	[3] .1,1,10 SEC	.1Hz	1 Hz	10 Hz 600 MHz	1 PPM 0.1 PPM	10 MHz	YES OPTION $25.	YES OPTION $15.
8010 *8010.1	325.00 405.00	1 GHz	9	1-10 mV	5-20 mV	10-25 mV	1-10 mV	[8] .01-20 SEC	.1 Hz	1 Hz	10 Hz 1 GHz	1 PPM 0.1 PPM	10 MHz	YES STD	YES OPTION $39.

* Has precision 0.1 PPM TCXO time base.

MODEL 7010

#7010 600 MHz Counter - 1 PPM TCXO $145.00
#7010.1 600 MHz Counter - 0.1 PPM TCXO $225.00

OPTIONS

#Ni-Cad-701 Ni-Cad Battery Pack & charging circuitry Installs inside unit $ 15.00
#EC-70 External Clock input, 10 MHz $ 25.00
#CC-70 Carry Case, Padded Black Vinyl $ 8.95

MODEL 8010

#8010 1 GHz Counter - 1 PPM TCXO $325.00
#8010.1 1 GHz Counter - 0.1 PPM TCXO $405.00
#8010.1-13 1.3 GHz Counter - 0.1 PPM TCXO $495.00

OPTIONS

#Ni-Cad-801 Ni-Cad Battery Pack & charging circuitry Installs inside unit $ 39.00
#CC-80 Carry Case, Padded Black Vinyl $ 9.95

ACCESSORIES

#TA-100 Telescope Ant with Right Angle BNC $ 9.95
#P-100 Probe, 50 ohm, 1x $13.95
#P-101 Probe, Lo-Pass, Audio Usage $16.95
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In one year our K40™ antenna has become the largest selling CB antenna in the world!

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And when you pay more, you expect more!

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MORE FLEXIBILITY: You can fit your K40 to any mounting surface. It will fit any vehicle you'll ever own! That includes choppers, dune buggies, gutters, mirror mounts, luggage racks, trunks, hatchbacks, through roofs, semis, pick ups and RV's.

MORE QUALITY: It's not imported. It's not made in Taiwan, Korea or Japan. It's American made in an American town. It's made with better materials that cost more and by professional people we pay more. And we designed it right here in the U.S.A.

*Including optional mounts at extra cost.

2. It's made better...

3. It's proven best!

...Here's what the leading CB publications said.

CB TIMES: "... it's not often that a product bursts onto the market scene, dominates and improves CB'ing for everyone. American Antenna and the K40 are doing it—repeated tests showed the K40 could out-perform the major competitive brands."

RADIO-ELECTRONICS: "The results of our tests showed that, in three different positions of the monitoring receiver, the *model K40* equaled or out-performed the competitive antenna. Apparently, American Antenna's advertising is not merely Madison Avenue showmanship."

PERSONAL COMMUNICATIONS: ". . . an impressive 95% of the trials, the K40 out-performed the existing mobile antennas. We had to try one for ourselves.
". . . in every case, the K40 either equaled or out-performed its competitor.
"No ifs, ands, or buts! The K40 Antenna from American Antenna would have to be just about the best antenna around.

CB MAGAZINE: "Introduced in October, 1977, the K40 quickly became the top seller and in mid 1978, became the number one selling antenna in the nation."

...Here's what CB'ers all across the country said.

ANTENNA SPECIALISTS: ". . . truck driver and CB'er for 10 years . . . 50% further than my M410 'Big Momma'."
—J.H. Collett, 207 McFee, Bastrop, LA

AVANTI: "I'm an electronic technician with a Second Class FCC license . . . I was able to transmit 70% further and tune the SWR 75% lower than my Avanti."
—H.R. Castro, VRB, Monserrante D-67, Salinas, Puerto Rico

PAL: ". . . 20% better in transmission and reception than my 5/8 wave Pal Firestik."
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SHAKESPEARE: ". . . I've been a CB'er for three years and the K40 is the best I've ever had. Better in reception and transmission than my Shakespeare."
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—Jerome R. Brown, 7800 S. Linder, Burbank, IL

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Our K40 Dealers will be happy to sell you any of the older style and less expensive antennas that are great bargains for any beginning CB'er.

K40 POWER!

...This Antenna is so DYNAMITE you receive a...

DOUBLE GUARANTEE

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