HOW WE TEST HI-FI GEAR

75¢ ■ JUNE 1975

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

NEW WAYS TO USE YOUR SCOPE
Special 4-Part Story

MAKE YOUR OWN
Reading Computer

VIDEO DISCS
Today And Tomorrow

PHONO CARTRIDGES FOR CD-4
See How They Work

A GERNSBACK PUBLICATION

DIGITAL SCOPE MEMORY
Add It To Your Scope Now

PLUS

...nic

R-E's Replacement Transistor Directory

Jim is one of the busiest antenna installers in Pennsylvania. He does work for 17 major appliance dealers. But the bulk of his antenna sales come from his own advertising, yellow page listings and word-of-mouth recommendations from satisfied customers.

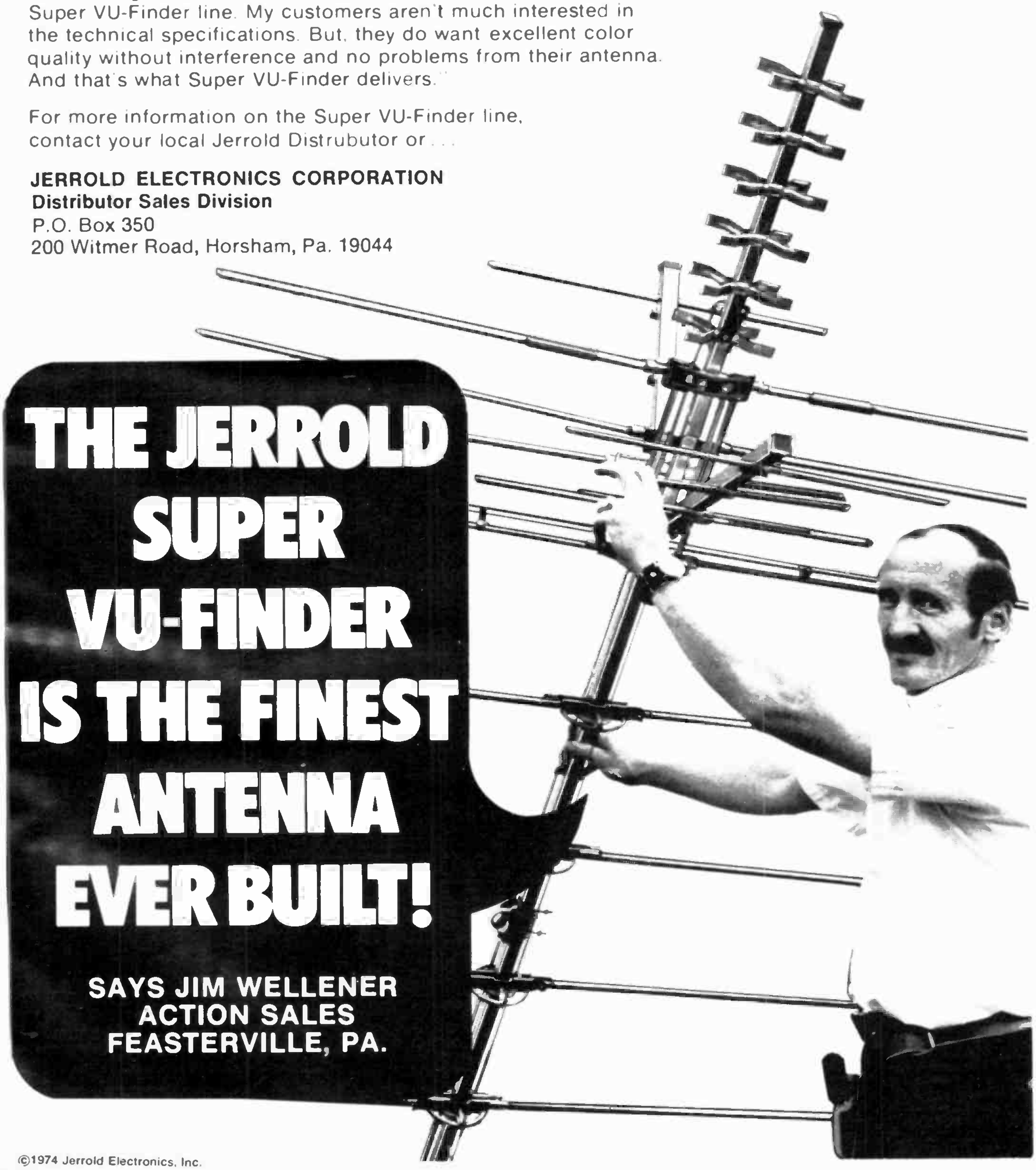
JERROLD
a GENERAL INSTRUMENT company

Jim doesn't try to be the cheapest — only the best. He stresses quality of workmanship plus quality of materials. With this philosophy and a lot of hard work, Action Sales has doubled sales volume each of the four years since Jim started the business.

"My reputation means everything to me," says Jim. "That's why I'm so delighted with the performance and durability of the Jerrold Super VU-Finder line. My customers aren't much interested in the technical specifications. But, they do want excellent color quality without interference and no problems from their antenna. And that's what Super VU-Finder delivers."

For more information on the Super VU-Finder line, contact your local Jerrold Distrubutor or . . .

JERROLD ELECTRONICS CORPORATION
Distributor Sales Division
P.O. Box 350
200 Witmer Road, Horsham, Pa. 19044



Circle 2 on reader service card

Introducing

a TV set only a TV technician could love.

Ultra-portable CK3000 Test Jig. Under 25 lbs.—easy to tote from job to job. The handle's not just for show!

Ready to use. Fully pre-tested. A complete unit including 13V in-line slotted-mask CRT with x-ray inhibiting glass.

30kV and more. A must for today's sets. Anode meter's big 50μA movement makes it easy to monitor voltages to 35kV—more than in any TV set you'll meet.

Accessories included: Two 70° adapters; two 90° extensions; six yoke-programmer plugs; audio leads; four convergence ballast plugs; Set-Up and Instruction Manuals.

Patented yoke programmers let you match CK3000's yoke to six different deflection outputs. Three for tube and hybrid, two for transistor sweep, one for SCR sweep.

The big book. CK3000 Set-Up Manual lists over 7000 models, 49 brands. And we're constantly updating it. Just mail the registration card.

Dual focus connections. Built-in alternate focus supply for testing both 4.5kV and the new Black-Matrix 7.1kV.

Adapters. You can buy kits for the seven most popular brands and discrete adapters for 42 more. Many old adapters can be used, too—don't throw them away!

See the CK3000 Test Jig at your Sylvania distributor's now!

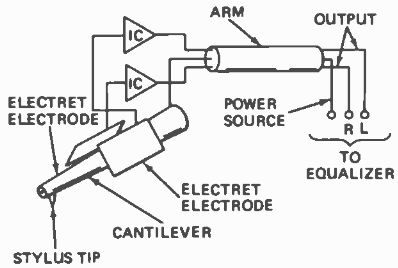
GTE SYLVANIA

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

JUNE 1975 Vol. 46 No. 6



CD-4 PHONO CARTRIDGES are complicated. **To see how they work turn to page 46.**

Cover photo courtesy Walter Herstatt
Cover design by Louis G. Rubsamen

Radio Electronics is a member of the *Institute of High Fidelity* and is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature.*

Radio-Electronics, Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Phone: 212-777-6400. Second-class postage paid at New York, NY and additional mailing offices. One-year subscription rate: U.S.A., U.S. possessions and Canada, $8.75. Pan-American countries, $10.25. Other countries, $10.75. Single copies 75c.

Printed in U.S.A.

Subscription Service: Mail all subscription orders, changes, correspondence and Postmaster Notices of undelivered copies (Form 3579) to Radio-Electronics Subscription Service, Boulder, CO 80302.

looking ahead

Videodisc battle

The war of the videodiscs has gone public — with a potential prize of hundreds of millions of dollars to the winner. The battle is between the proponents of the laser-optical scanned system (Philips and MCA Inc.) and the capacitance system. Both were recently demonstrated to the press and the battle-lines drawn.

The Philips/MCA system is the result of a compatibility agreement between two companies which had been working along virtually identical lines simultaneously and independently. The collaboration of the two firms has resulted in specifications for that which can be played by attachments developed by either firm. The Philips discs are rigid, the MCA discs flexible, but the recently demonstrated Philips-built player can accommodate them both. MCA, the parent company of Universal Pictures, has developed mastering and replication equipment and plans to offer a huge library of feature films, instructional and cultural programs.

Magnavox, now a subsidiary of North American Philips, announced it would produce and sell the Philips/MCA player in the U.S., with regional test-marketing to begin in fall 1976, expanding to nationwide distribution by the end of 1977. The player is targeted at $500 list price, disc programs at two to ten dollars each.

The Philips/MCA proponents are emphasizing the characteristics of the optical systems with which the capacitance system can't compete: Stop-action, infinitely variable slow motion, forward or reverse. At the push of a button a digital readout is super-imposed on the TV screen so that any individual frame of the 54,000 frames on a 30-minute disc may be selected at will. Also stressed is the fact that the laser read-out system brings no stylus into contact with the record, thereby eliminating record wear as well as the need to replace a stylus.

RCA, too, is emphasizing the unique advantages of its system. It can be built almost entirely from off-the-shelf parts, to sell at around $400. It requires no such esoteric special parts as lasers or servos, which RCA people imply will lift the actual price of the optical player well above the $500 price class. The capacitance disc spins along at a relatively lazy 450 rpm, as compared with the 1,800 of the optical system.

RCA concedes its system can't provide slow or stop motion or reverse, but doesn't believe these features are needed on a consumer device. It says its discs have been played 500 hours before signs of signal degradation and that the easily replaceable snap-in sapphire stylus cartridge will last for 300 to 500 hours. Both RCA and the Philips/MCA systems can provide 30 minutes of recorded material on one side of a 12-inch disc. RCA is building 75 prototype players this year for field-testing next year, and its marketing targets dates are about the same as Magnavox's.

The proponents of both systems are making their major efforts now in the hope of persuading other television set manufacturers to adopt their systems. If the videodisc is truly the next major home electronic product, with a potential greater than any product since color TV — as the proponents believe it is — the stakes are high indeed. And nobody wants to see the battle of the standards fought out in the marketplace by two incompatible systems.

Meanwhile, in Germany, the long-delayed TeD videodisc system was finally put on the market by Telefunken. The TeD system uses a flexible eight-inch disc, giving 10 minutes playing time. The disc is read out by a "pressure stylus" which translates hills and dales on the disc to voltages. Most American manufacturers feel TeD's playing time is too short for serious consideration. The single-play player is priced in Germany at $650, programs at about $4.30 to $11.

For the complete home video player story see Bob Gerson's article elsewhere in this issue.

Rural TV

About a million American homes are beyond range of acceptable TV pictures and 6 million receive fewer than three channels. The President's Office of Telecommunications Policy has been concerned with ways to bring multi-channel service to those areas which are too remote or low in population to make such service profitable, and commissioned the Denver Research Institute to look into the situation. OTP's report, based on DRI's findings, says a combination of cable TV and low-power translator stations would be able to reach all except 150,000 American households in the short run, but doesn't rule out direct satellite reception over the long term. The report suggests that cable systems should serve villages, translators rural areas, both types of facilities sharing the same signal reception and processing facilities, as well as maintenance crews and offices. To bring three-channel reception to the entire country, OTP estimates it would cost between $272 and $336 million, presumably to be supported both through taxes and private cable services.

More X-Ray recalls

Following on the heels of a government-ordered recall of some 400,000 sets made by Matsushita for Panasonic, W. T. Grant and J. C. Penney, new recall programs have been started for some 19,200 sets sold by Panasonic, Quasar and Toshiba. In all cases, the sets have been found capable of emitting radiation in excess of the permitted amount in certain cases of component failure. There is no reason to believe any of them is currently radiating beyond the government-prescribed limit.

Reports of the recalls in the news media tend to stress that a set is "leaking radiation" or "could cause dangerous radiation." In none of the cases has there actually been potential for dangerous radiation, even with component failure. In each case, though, under certain conditions the set might exceed the extremely conservative limits set by law.

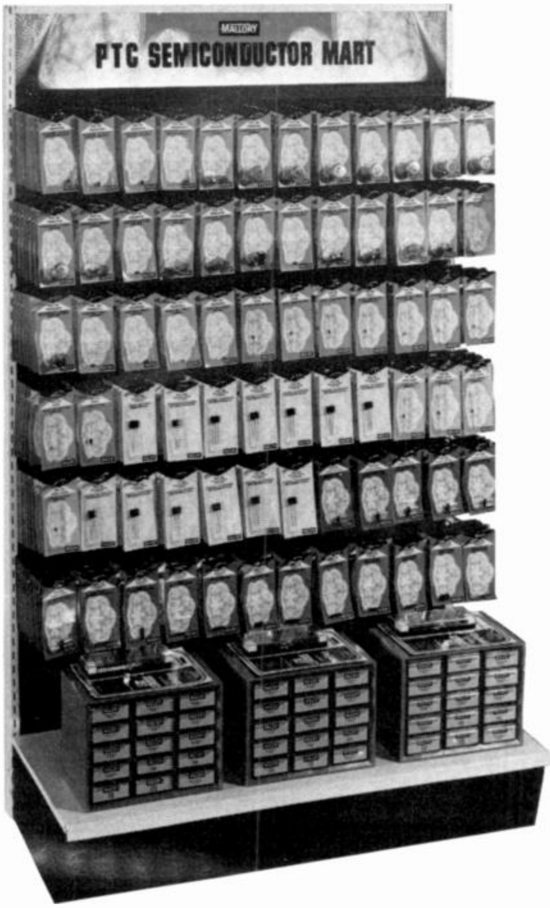
In Panasonic's massive recall, the company is sending repair teams to five market areas at a time, where they service sets for about a week before moving on to other areas. Owners of the defective sets are notified to bring them in for modification or to call for home service. Under the Radiation Control Act, all names of TV set purchasers must be filed against the possibility of such recalls.

Solid-state sweep

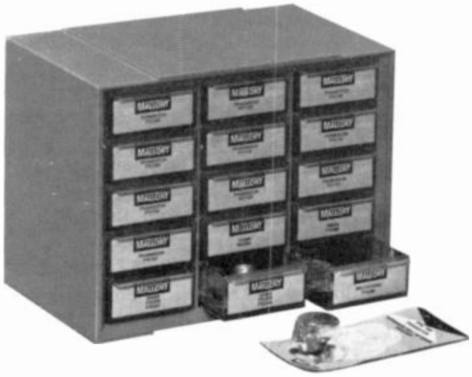
The results for 1974 are in, and all-solid-state circuitry accounted for 72.6% of all color TV sets produced or imported, up from 51.1% in 1973. Of black-and-white sets, 39.1% were all-solid-state, as opposed to 20.3% the year before. The most popular color screen size was 19 inches, taking over from the 25, while in black-and-white, the best-seller was the 12-incher. Some 15% of color sets and 68% of monochrome were imported.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Look for the PTC Semiconductor Mart at your Mallory Distributor's.



THE SEMICONDUCTOR MART. Here's the quick, easy way to get the replacements you need. It's the best assortment of the hottest semiconductors around. Transistors, diodes, multiple diode packages, zener diodes and integrated circuits included.



THE FAMOUS MALLOBIN® WAREHOUSE.
With the semiconductors most needed by service technicians.

FREE copies of the very latest cross-referenced Semiconductor Product Guide.

Clear, concise product data on the packages makes your choice easy. And Mallory quality, versatility, and dependability make every choice a good one.

You know what you need. Now you know where to find it.

MALLORY

MALLORY DISTRIBUTOR PRODUCTS COMPANY
a division of P. R. MALLORY & CO. INC.
Box 1284, Indianapolis, Indiana 46206; Telephone: 317-856-3731

Batteries • Capacitors • Controls • Security Products • DURATAPE® • Resistors • Semiconductors • SONALERT® • Switches • Timing Devices and Motors

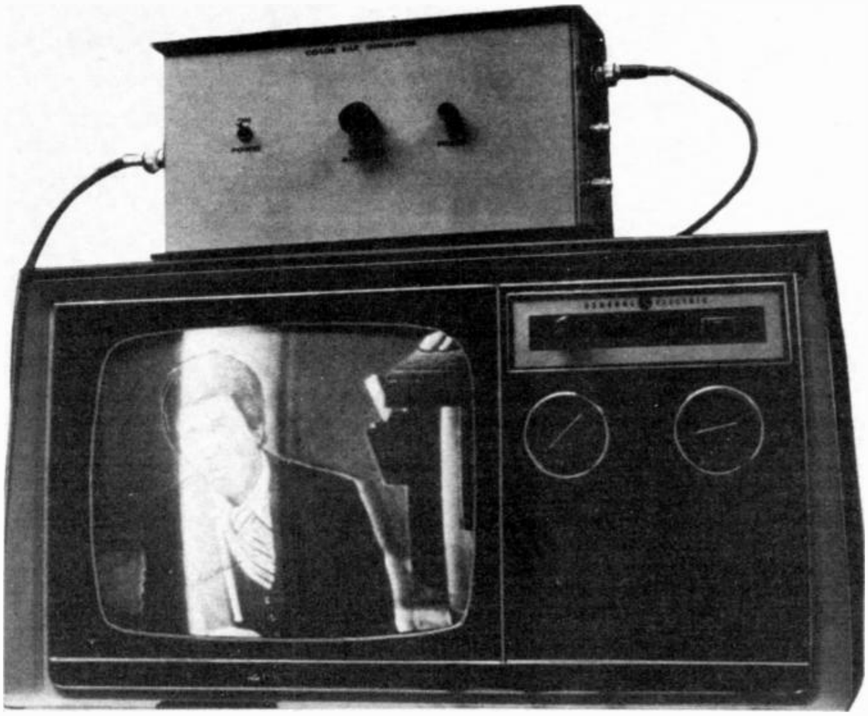
MALLOBIN® is a registered trademark of P. R. Mallory & Co. Inc.

Circle 3 on reader service card

new & timely

Frequency calibration service cuts labor, increases accuracy

The National Bureau of Standards (NBS) has developed a new service and hardware that uses automatically controlled oscillator signals from the major television networks for fast, accurate, and NBS-traceable oscillator callibration. Accuracy of a few parts in 10^{11} within minutes, the Bureau says, represents a quantum jump in low-cost frequency measurement. Calibration with low-frequency radio broadcasts can match this accuracy only after a day or more of averaging. Further, the system is directly traceable to the NBS standard clock.



THE NBS COLOR BAR COMPARATOR reaches an accuracy on one part in 10^9 in about five minutes and can be built for $25.

To encourage use of the system, NBS will offer complete circuit and hardware details for two basic types of instruments to interested individuals and manufacturers. The technique is based on the fact that he ABC, CBS and NBC networks all use rubidium-controlled oscillators to form the color-burst signals required for color TV. NBS monitors these signals, compares them with the NBS atomic frequency standard, and publishes the average fractional frequency offset in the NBS Time & Frequency Services Bulletin. Thus, anyone with a color TV set has access to a number of atomic oscillator signals and—with the precise offset data from NBS—can make frequency calibrations that are directly traceable to NBS.

Two basic types of instruments have been developed. Differing in accuracy, complexity and cost, each offers a non-labor-intensive calibration method.

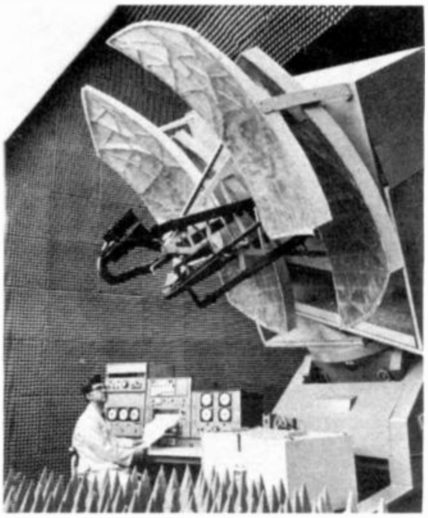
The simplest circuit — the color-bar generator — produces a "rainbow" bar on any standard color TV. It has been constructed for about $25 in parts and will be accurate to one part in 10^9 in about five minutes. Signals of the oscillator to be calibrated are inserted either through the antenna or the set's color circuits. The beat of the oscillator with the network signal forms a vertical bar, which changes colors at a rate corresponding to the frequency difference between the oscillator being calibrated and the network rubidium.

To use the color bar system, the user times the color changes with a stop watch. The oscillator is calibrated by adjusting its frequency until the time for a color change to occur corresponds to the data from the NBS bulletin.

For users who require higher accuracies, a second version, the 358 Frequency Measurement Computer (FMC) has been designed. It automatically computes and displays the calibrations on the TV screen, showing numbers that represent the frequency offset between the oscillator being calibrated and the color subcarrier. By referring to the netwok data published by NBS, the user can calibrate his oscillator to better than one part in 10^{10} in less than five minutes.

It is estimated that the FMC unit can be manufactured and marketed for $1,500 to $2,000, including the color TV set. NBS has applied for patents on both circuits and is encouraging discussions regarding manufacturing rights.

ANTENNA TEST IN ANECHOIC CHAMBER



ANTENNA for the RCA Satcom satellite is being tested in the chamber to assure absorption of any extraneous radio energy that might otherwise interfere with the test. Satcom will be launched in late 1975, and will cover the contiguous United States, Alaska and Hawaii.

World's largest IC is sensor of 525-line TV camera

A new type of television camera, demonstrated by RCA, uses as its image sensor a charge-coupled silicon imaging device instead of a camera tube. The device is a flat pack that measures 1 in. × 1½ in., containing 163,840 separate storage sites. About half of the surface of the device is the imaging area (12.2 mm diagonal). The rest is used for storage and for outputting the television signal.

The SID51232, as it is called, is the largest integrated circuit ever produced —100 times greater in area than the standard IC. It consists of 512 rows of 320 light-sensitive electrodes, positioned above the surface of a wafer of P-type

(continued on page 12)

Vaco.

"V" is for Vaco. And value, too. A good sign in times like these.

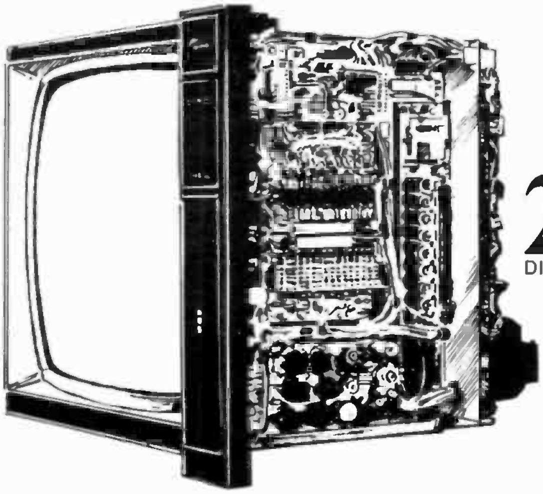
But that's the Vaco way. From Screw Holding and Magnetic Drivers to a complete line of electronic pliers. Even a complete line of electrical testers. They're quality tools to solve your problems. Professionally. And they're all unconditionally guaranteed.

You'll find these and all the other fine Vaco tools, along with problem solving aids, in our new *free* "Answer Book". From your tool distributor. Or write direct:

Vaco Products Co., 510 N. Dearborn St., Chicago, Illinois 60610.

And remember the sign of the "V". Value . . . variety . . . Vaco!

Circle 4 on reader service card



You get the same 25" DIAGONAL hobby-kit color TV from three different schools.

You get this designed-for-learning 25" DIAGONAL color TV only with NRI training.

No other home-study school gives you a TV like the one you build with NRI's Master Course in Color TV/Audio servicing. Some schools give you three or four plug-in sub-assemblies off the production line to put together a commercial set. Others give you a hobby-kit bought from outside sources. And because neither type was originally designed to train people for TV servicing, lessons and experiments must be "retro-fitted" to the set as it comes.

That's why we went to the trouble to engineer our own, exclusive solid-state TV. It's the only way a student can (1) get the feel of typical commercial circuitry, (2) learn bench techniques while building a complete set from the "ground" up, (3) perform over 25 "in-set" experiments during construction, and (4) end up with a 25" diagonal solid-state color TV with console cabinet and all the modern features you'll find on sets you'll service. Nobody else can give you this combination of advantages because nobody else invested the time and money to design a set with learning in mind.

More know-how per dollar

That's what it all boils down to, the quality of training you get for the money you spend. In our 60-year history, more than a million students have come to NRI and we're fully approved for career study under the G.I. Bill. We must be teaching something right.

Some of those "right" things are bite-size lessons to ease understanding and speed learning . . . personal grading of all tests, with comments or explanations where needed . . . a full-time staff of engineer/instructors to help if you need it . . . plenty of "real-life" kits and experiments to give you hands-on training . . . and fully professional programs oriented to full- or part-time career needs.

NRI passes the savings on to you

You don't pay a big premium to get this unique TV as part of your training, because NRI engineering eliminates the cost of buying from an outside source. And we pay no saleman's commission. We enroll students by mail only. We pass the savings along to you in the form of low tuition fees, extras like a cabinet for the TV, a solid-state radio you learn on as you build, and actual instrument kits for servicing TVs . . . triggered sweep oscilloscope, integrated circuit TV pattern generator, and 3½ digit digital multimeter. You can pay hundreds of dollars more for a similar course and not get a nickel's worth more in training and equipment.

Widest choice of career opportunities

NRI offers not one, but five excellent TV/Audio servicing courses so you can tailor your training to your budget. Or, you can study other opportunity fields like Computer Electronics, Communications, Aircraft or Marine Electronics, Mobile Radio, and more. Free catalog describes them all, showing lesson plans, equipment and kits, and career opportunities. There's no obligation and no salesman will ever call, so send for your copy today. See for yourself why NRI experience, selection, and exclusives give you something no other school can.

If card is missing, write to:

NRI McGraw-Hill

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue,
Washington, D.C. 20016

new & timely *(continued from page 6)*

THE CHARGE-COUPLED IMAGE SENSOR of the new solid-state television camera is the largest and highest resolution device of its kind yet made. Production in sample quantities is scheduled for the second quarter of 1975.

silicon and separated from it by an insulating silicon dioxide layer.

In the silicon imaging device of the new television camera, the scene being photographed is focused on the imaging area. Each element develops a charge corresponding to the amount of light falling on it.

The camera using the new sensor is designed to produce standard broadcast signals, with 3-MHz bandwidth and the regular 2-to-1 interlace. It weighs 2.5 pounds, is 3¾ inches high, 4½ inches wide at its widest point and, including the lens, 7¾ inches long. It is available in two options, the higher-priced one at about $3800 (of which $2300 is for the silicon imaging device).

Newest digital voltmeter gives readings by voice

A recenlty developed digital voltmeter reads out the voltages in a loud, clear voice. Billed by its manufacturer — Master Specialties Co. of Costa Mesa, CA—as a boon to blind engineers, it can be equally valuable to technicians who sometimes find it hard to hold the prods on the right points while twisting half-way round to read the meter.

The voltmeter's readout system uses whole words, digitized and stored in read-only memories. By storing whole words instead of synthesizing them from individual phonemes, the voice output is natural sounding with all the qualities of a genuine human voice.

The regular model is supplied with the numbers zero to nine, but additional words (such as "plus" or "minus", or "point") can be added if specified by the purchaser.

Plasma panel is used in new flat-screen video transmitter

A commercially available plasma panel display has been modified by Bell Labs scientists to make an experimental flat-screen video system that transmits handwriting, reproduces pictures and can be used to communicate directly with a computer.

Plasma panels are made up of thousands of tiny neon-gas cells arranged in vertical and horizontal rows. Applying voltages to the correct terminals can cause any one or all of them to glow.

Two panels may be connected by telephone lines, and when one panel is written on with a "light pen," the writing is reproduced on the other panel. A novel feature of this video transmitter is that gray tones may be produced by varying the density of the cells turned on or off in a given area of the flat-screen plasma panel.

FLAT PLASMA SCREEN VIDEO DEVICE demonstrated by developers Eugene Sampiere and Peter Ngo, can not only transmit handwriting, but other forms of graphic display, and enables the user to "talk to the computer."

THESE MODERNISTIC CANISTERS will house seven bi-directional transmitter and receiver systems, plus a standby, together with antennas and interconnecting equipment.

Radio Shack® "Range Busters" SSB/AM CB at its Best!

You can't beat the extra power and extra reliability of SSB when you're using CB 2-way radio. And if you're in a heavy-CB-usage area, SSB really multiples the chance of getting through. It's added insurance when you need it. You can get immediate delivery on both these great Realistic® SSB sets. There's only one place you can find them . . . Radio Shack!

329⁹⁵

BASE/MOBILE TRC-46

The one with everything! 12-watts P.E.P. output, combined with Range-Boost circuit, for the ultimate in power. Total 69-channel capability—46 on SSB, 23 on AM—and you get crisp, clear performance on them all. A "clarifier" to shift both the transmitter and receiver for Net operation. A PA switch that lets you use the set as a public address amplifier and still receive incoming CB calls. Even an extra, remote volume control on the mike—a real convenience for mobile use. With all crystals, mobile mounting bracket, AC and DC power cables. U.L. listed. FCC Type Accepted. #21-146

TRC-47—OUR FINEST MOBILE TRANSCEIVER

Linear sideband circuitry gets through when AM won't—and the dual conversion receiver captures the faintest signals. 12-watts P.E.P. output, 69 channel capability, clarifier and RF gain controls, superb specs. With all crystals, mobile mounting bracket, power cables. FCC Type Accepted. #21-147.

249⁹⁵

FREE New 1975 Radio Shack Catalog

OVER 2000 PRODUCTS
EXCLUSIVES ON EVERY PAGE
BEAUTIFUL FULL COLOR

**Stereo • Quadraphonic • Phonographs
TV Antennas • Radios • Citizens Band
Kits • Recorders • Tape • Tools
Auto Tune-Up • Electronic Parts
Test Instruments • More!**

164 pages of the finest in home and hobby electronics. Respected brand names like Realistic, Micronta, Archer, Science Fair — and they're available only at Radio Shack stores and dealers nationwide! See what's *really* new in electronics by getting this catalog now.

**SEND FOR YOURS TODAY!
FILL OUT COUPON BELOW**

1975 Catalog — **Mail to Radio Shack, P. O. Box 1052, Ft. Worth, Texas 76101. (Please print.)** 526

Name ______________________ Apt. No. ________

Street ______________________

City ______________________

State ______________ ZIP ☐☐☐☐☐

BankAmericard at participating stores

Radio Shack®
A TANDY CORPORATION COMPANY
OVER 3000 STORES • 50 STATES • 7 COUNTRIES
Retail prices may vary at individual stores.

Circle 5 on reader service card

The Quadiophile's

Features and specs, like money, aren't everything, but they can help a lot. Take a look at the comparison chart on the opposite page. You will find there many reasons why Sansui 4-channel technology is superior and why every Sansui 4-channel receiver is the best buy in its category. Of course, only a demonstration can really show you Sansui's ingenuity and what the famous Sansui sense of sound can do for you and your musical enjoyment. Only a Sansui 4-channel receiver with vario-matrix* can give you outstanding 4-channel separation, a clear sense of location and full musicality.

A Sansui 4-channel receiver can synthesize any of your favorite stereo records or tapes into fascinating quadraphonic sound. And they also contain the Sansui universal decoding system which permits decoding from any 4-channel source, including SQ and CD-4. Of course, the best way is to listen to 4-channel from 4-channel records or QS broadcasts.

Look carefully at the chart on the opposite page and then go to your nearest Sansui franchised dealer and listen to a demonstration. Prove to yourself what Sansui can do for you. Or write today for the brochure "What you should know about 4-Channel Sound."

* vario-matrix is the only 4-channel technology which offers highest interchannel separation, full frequency response, wide dynamic range, low distortion.

The Sansui QRX-3000

The Sansui QRX-3500

The Sansui QRX-6001

The Sansui QRX-7001

Sansui

SANSUI ELECTRONICS CORP.
Woodside, New York 11377
Gardena, California 90247
SANSUI ELECTRIC CO. LTD. Tokyo, Japan
SANSUI AUDIO EUROPE S.A. Antwerp, Belgium
ELECTRONIC DISTRIBUTORS (Canada) B.C.

Circle 6 on reader service card

Comparison Chart

Power Range: 9-15 Watts

MANUFACTURER MODEL	SANSUI QRX-3000	Fisher 334	Kenwood KR-6340	Pioneer QX-646	Sony SQR-4750	Technics SA-8000X
QS DECODING	Built-in VARIO-MATRIX	—	Simple RM	Simple RM	—	Adjust-able RM
SQ DECODING	Built-in VARIO-MATRIX	Simple SQ	Simple SQ	Simple SQ	Full logic SQ	—
SYNTHESIZING SURROUND	Built-in VARIO-MATRIX	—	—	—	—	—
SYNTHESIZING HALL-AMBIENCE	Built-in VARIO-MATRIX	—	—	—	Simple Matrix	—
CD-4 DEMODULATING	Adaptor	Built-in	Adaptor	Built-in	Adaptor	Built-in

Power Range: 16-24 Watts

MANUFACTURER MODEL	SANSUI QRX-3500	Fisher 534	Harman Kardon 800+	Marantz 4240	Pioneer QX-747	Sony SQR-6750
QS DECODING	Built-in VARIO-MATRIX	—	Simple RM	Adjustable RM	Simple RM	—
SQ DECODING	Built-in VARIO-MATRIX	Full Logic SQ	Simple SQ	—	Simple SQ	Full Logic SQ
SYNTHESIZING SURROUND	Built-in VARIO-MATRIX	—	—	—	—	—
SYNTHESIZING HALL-AMBIENCE	Built-in VARIO-MATRIX	Matrix	—	—	—	Simple Matrix
CD-4 DEMODULATING	Adaptor	Built-in	Built-in	Adaptor	Built-in	Adaptor

Power Range: 25-34 Watts

MANUFACTURER MODEL	SANSUI QRX-6001	Harmon Kardon 900+	Kenwood KR-8340	Marantz 4270	Sony SQR-8750	Technics 8500
QS DECODING	Built-in VARIO-MATRIX	Simple RM	Simple RM	Adjustable RM	—	Simple RM
SQ DECODING	Built-in VARIO-MATRIX	Simple SQ	Simple SQ	—	Full Logic SQ	—
SYNTHESIZING SURROUND	Built-in VARIO-MATRIX	—	—	—	—	—
SYNTHESIZING HALL-AMBIENCE	Built-in VARIO-MATRIX	—	—	—	Simple Matrix	Simple Matrix
CD-4 DEMODULATING	Built-in	Built-in	Adaptor	Adaptor	Adaptor	Built-in

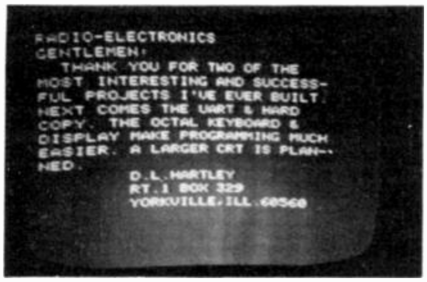
Power Range: 35-45 Watts

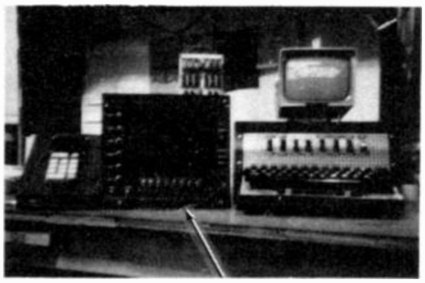
MANUFACTURER MODEL	SANSUI QRX-7001	Fisher 634	Kenwood KR-8840	Marantz 4300	Pioneer QX949	Sylvania RQ-3747
QS DECODING	Built-in VARIO-MATRIX	—	Simple RM	Adjustable RM	Simple RM	—
SQ DECODING	Built-in VARIO-MATRIX	Full Logic SQ	Full Logic SQ	—	Simple SQ	Simple SQ
SYNTHESIZING SURROUND	Built-in VARIO-MATRIX	—	—	—	—	—
SYNTHESIZING HALL-AMBIENCE	Built-in VARIO-MATRIX	Simple Matrix	—	—	—	—
CD-4 DEMODULATING	Built-in	Built-in	Built-in	Adaptor	Built-in	Adaptor

SQ tm – CBS Inc. CD-4 tm – JVC Inc. QS tm – Sansui Electric Co., Ltd.

letters

MARK-8 AND TVT





Thanks for the photos Mr. Hartley
—Editor

WANT'S TO TRADE

I've been looking forward to every issue of **Radio-Electronics** for many years. As a serious electronics experimenter, I am especially interested in your more complex projects, e.g. the TV Typewriter and the Mark-8 minicomputer. These projects are, however, far too complicated if I cannot get the PC's or in some cases, very special parts.

So far I didn't even try to order those parts for PC's by mail as correspondence across the ocean does take its time and as postage rates are complicated or even changed without my knowledge. Also, getting a money order every time is tiring and mailing it isn't too secure these days.

So my question is: is there any way to make an arrangement with you (I'm not too sure about that myself!) or perhaps with some reader of yours? I would, of course, readily agree to help my "partners" in case they should need some help with European parts or technical publications, etc.

If this shouldn't be possible; do you know if there is a uniform practice with a kit manufacturing people as far as mailing to Europe is concerned?

Many thanks in advance for your reply to a problem which I think many readers here in Europe have.

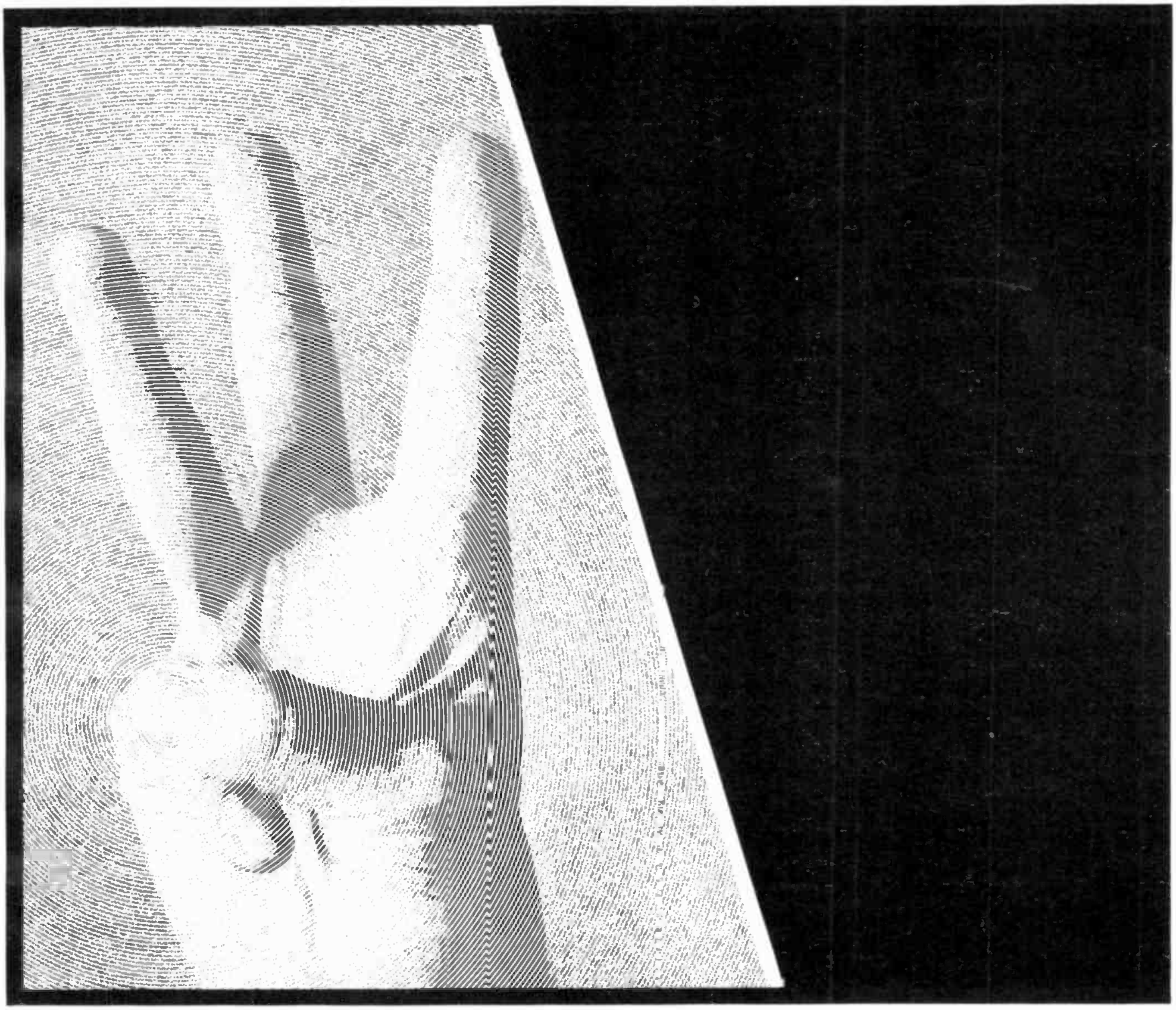
ROBERT BRINER
Feldeggstr. 82
CH-8008 Zurich
Switzerland

Sorry Bob, but there is no standard policy. You'll have to write and ask. But perhaps one of our U.S. readers would like to work something out with you—OK men, if you're interested, why don't you drop Bob a line?—Editor

TVT PARTS

I've been building the TV Typewriter described in **Radio-Electronics** and I've been following the letters that have been published in **Radio-Electronics** concerning where to buy Signetics IC's, both MOS and TTL. I recently found a

(continued on page 22)



program which gives you in electronic circuit design

only CREI offers you a complete college-level Electronic Design Laboratory to speed your learning

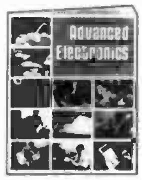
Electronic circuit design—source of all new development in the application of electronics to new products and services. Without this skill, we would be unable to monitor the heartbeat of men in space. Without it, the computer revolution would never have occurred. And we would have yet to see our first TV show. *Yet, only CREI teaches electronic circuit design at home.*

ELECTRONIC CIRCUIT DESIGN
A key skill which paces our nation's progress in countless fields—from pollution control to satellite tracking to modern medicine to exploring the ocean's depths. And beyond. A skill which *you* must have to move to the top in advanced electronics.

CREI programs open up new worlds of opportunity for you.

In addition to electronic circuit design, CREI provides you with a full advanced electronics education in any of thirteen fields of specialization you choose. Communications, computers, space operations, television, nuclear power, industrial electronics—to mention just a few of the career fields for which CREI training is qualifying. With such preparation, you will have the background for a career which can take you to the frontiers of the nation's most exciting new developments. And around the world.

This free book can change your life. Send for it.

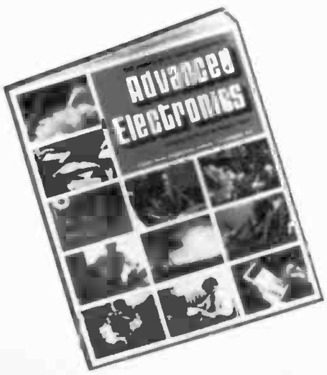


If you are a high-school graduate (or equivalent) and have previous training or experience in electronics, then you are qualified to enroll in a CREI program to move you ahead in advanced electronics.

Send now for our full-color, eighty page book on careers in advanced electronics. In it, you will find full facts on the exciting kinds of work which CREI programs open up to you. And full facts on the comprehensive courses of instruction, the strong *personal* help, and the professional laboratory equipment which CREI makes available to you. All at a surprisingly low tuition cost.

And when you have it, talk with your employer about it.
Tell him you're considering enrolling with CREI. He'll undoubtedly be happy to know you are planning to increase your value to him. *And he may offer to pay all or part of your tuition cost.* Hundreds of employers and government agencies do. Large and small. Including some of the giants in electronics. *If they are willing to pay for CREI training for their employees, you know it must be good.*

Send for Advanced Electronics today. You'll be glad you did.



CREI Dept. E-1406F
3939 Wisconsin Avenue
Washington, D.C. 20016

Rush me your FREE book describing my opportunities in advanced electronics. I am a high school graduate.

Name ______________________ Age ________
Address ______________________
City ______________ State ________ ZIP ________
If you have previous training in electronics, check here ☐
Employed by ______________________
Type of Present Work ______________________
Veterans and servicemen, check here for G. I. Bill information ☐

CREI
CAPITOL RADIO ENGINEERING INSTITUTE
WASHINGTON, D.C. 20016

LETTERS

(continued from page 16)

source that stocks them besides Signetics. The company is in San Diego, California; Liberty Electronics, phone is 714-565-9171.

Thank you for your article, just returning the favor.

J. MANNING
Carlsbad, CA

SEQUERRA TUNER

As a state-of-the-art achievement, Mr. Sequerra's FM tuner probably is worth every penny. That is, of course, if the state-of-the-art of FM programming is totally disregarded. Here we have a beautiful black box into which we pour garbage. After passing through hundreds of components (all working at optimum from 93 adjustments), out comes the garbage, pure and undistorted but in a louder and more disturbing form.

Because nothing has been done to rescue the FM spectrum from the fate that has befallen it, designing superior tuners has become simply an end in itself. Without more justification than this, the outcome can be self-defeating. Who will pay $2500 for a tuner which will bring in, with unrivaled clarity, that "vast wasteland" of junk which FM has taken over from TV and AM; news, advertising, local announcements, advertising, commentary, advertising, talk shows, advertising and practically no decent music?

If the engineers want to make some money and do the public a favor, let them design tuners that will exclude everything except music and thereby cure this national earache.

CLEM PORTMAN
San Clemente, CA

I think there is too much emphasis on the quality of the tuner and not enough effort is going into improving the transmission end. The $2500 tuner is great, but my $200 tuner receives the same unlistenable jungle music as does the more expensive version. My equipment stands dormant until such time when the powers decide, once again, to put Mozart, Beethoven, etc., back on.

Thank you.

FRED HARTMAN
Paterson, NJ

MARK-8 MEMORY CHECK

I have just completed building the Mark-8 and was thoroughly gratified with the results. **Radio-Electronics** is to be commended for its policy of providing satisfying projects for the more experienced experimenter as well as offering excellent projects for those who are beginning.

One area not covered deeply in the instruction manual concerns the fact that, while relatively inexpensive, MOS memory chips do have a fair failure rate. To adequately check boards from 1K to 4K by the random method suggested is so tedious that the check-out isn't likely to be thorough. But it is essential that it be thorough if the programmer is to know that whatever problems may be in his programs are not related to hardware failures.

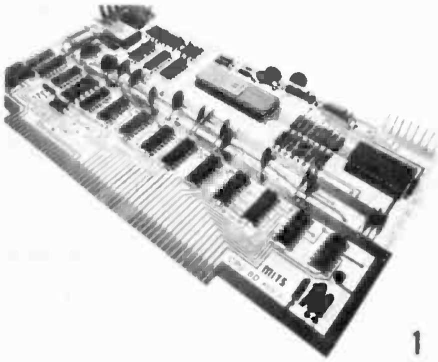
The following is a program that will dynamically check memory. It follows the same operating instructions outlined in the manual. If all of memory is okay, the program will run in a circle until halted. If a location is bad, the computer will halt on the first bad location found. High address of the failure location will be in memory location (octal) 045. Low address of the failure location will be in the Port 0 register.

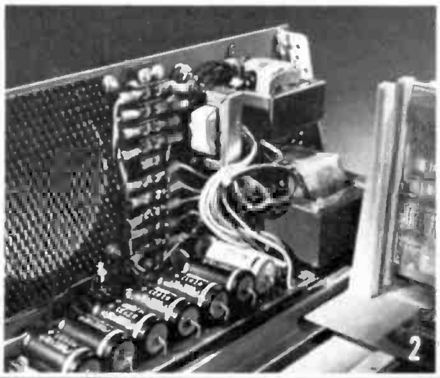
Location	Data	Explanation
000	066	Load L with 046
001	046	
002	056	Load H with 000
003	000	
004	006	Load A with 046
005	046	
006	370	Store A in memory location
007	277	Compare A with memory location
010	150	If =, halt & display error location
011	023	
012	000	
013	121	Output A to Port 0
014	305	Move H to A
015	066	Load L with 45
016	045	
017	056	Load H with 0
020	000	
021	370	Store A in memory
022	377	Halt
023	060	Increment L
024	004	Add 1 to A
025	001	
026	100	If no carry, loop
027	006	
030	000	
031	050	Increment H
032	305	Move H to A
033	074	Compare for octal 004 (This represents decimal 1,025 and location 034 must be changed for larger memories.)
034	004	
035	150	If =, go to program beginning
036	000	
037	000	
040	006	Clear A
041	000	
042	104	Loop
043	006	
044	000	
045	000	Data storage word

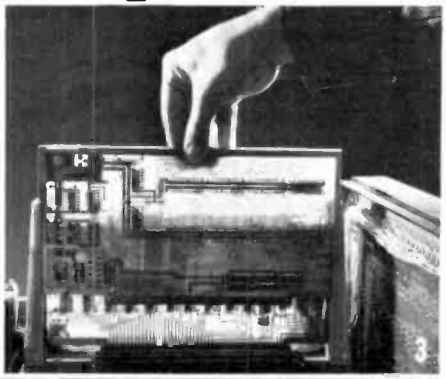
If a bad memory IC is found, it is suggested that it not be removed. Almost surely the board will be ruined by the inexperienced person. Cut the leads of the malfunctioning IC close to the body of the IC after having soldered the back side of each one to the board. Then straighten them out and use them as supports and solder the new IC to them with a low wattage iron.

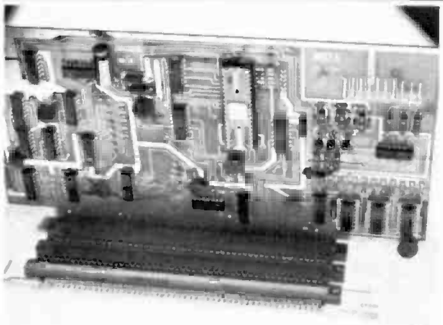
JAMES E. BARHAM
Arlington, VA

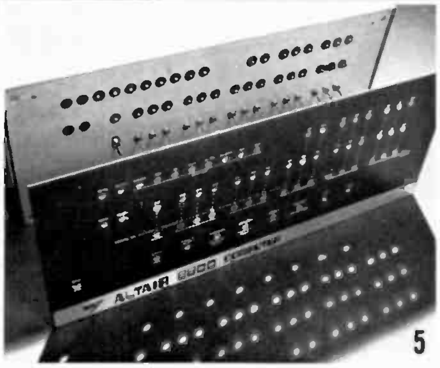
INSIDE the Altair Computer

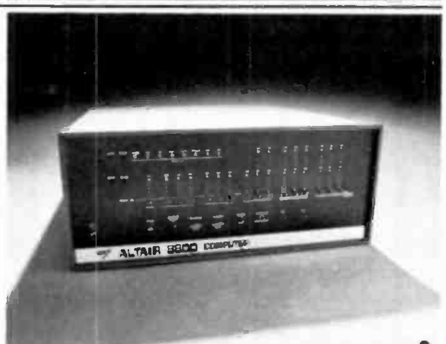

1


2


3


4


5


6

1. Central Processing Unit (CPU) Board. This double-sided board is the heart of the Altair. It was designed around the powerful Intel 8080 microprocessor—a complete central processing unit on a single LSI chip using n-channel silicon gate MOS technology. The CPU Board also contains the Altair System Clock—a standard TTL oscillator with a 2.000 MHz crystal as the feedback element.

2. Power Supply. The Altair Power Supply provides two +8, a +16 and a −16 volts. These voltages are unregulated until they reach the individual boards (CPU, Front Panel, Memory, I/O, etc.). Each board has all the necessary regulation for its own operation.

The Altair Power Supply allows you to expand your computer by adding up to 16 boards inside the main case. Provisions for the addition of a cooling fan are part of the Altair design.

3. Expandability and custom designing. The Altair has been designed to be easily expanded and easily adapted to thousands of applications. The basic Altair comes with one expander board capable of holding four vertical boards. Three additional expander boards can be added inside the main case.

4. Altair Options. Memory boards now available include a 256 word memory board (expandable to 1024 words), a complete 1024 word memory board, and a 4,096 word memory board. Interface boards include a parallel board and 3 serial boards (RS232, TTL and teletype). Interface boards allow you to connect the Altair Computer to computer terminals, teletypes, line printers, plotters, and other devices.

Other Altair Options include additional expander boards, computer terminals, audio-cassette interface board, line printers, ASCII keyboards, floppy disc system, alpha-numeric display and more.

5. All aluminum case and dress panel. The Altair Computer has been designed both for the hobbyist and for industrial use. It comes in an all aluminum case complete with sub-panel and dress panel.

6. It all adds up to one fantastic computer. The Altair is comparable to mini-computers costing 10-20 thousand dollars. It can be connected to 256 input/output devices and can directly address up to 65,000 words of memory. It has over 200 machine instructions and a cycle time of 2 microseconds.

You can order the Altair Computer by simply filling out the coupon in this ad or by calling us at 505/265-7553. Or you can ask for free technical consultation or for one of our free Altair System Catalogues.

PRICES:

Altair Computer kit with complete assembly instructions $439.00
Assembled and tested Altair Computer $621.00
1,024 word memory board $176.00 kit and $209.00 assembled.
4,096 word memory board $264.00 kit and $338.00 assembled.
Full Parallel Interface board $92.00 kit and $114.00 assembled.
Serial Interface board (RS232) $119.00 kit and $138.00 assembled.
Serial Interface board (TTL or teletype) $124.00 kit and $146.00 assembled
Expander Boards $43.00 kit and $57.00 assembled.

SPECIAL: Altair Computer plus 256 words of memory (save $45.00) Only $497.00*

NOTE: Altair Computers come with complete documentation and operating instructions. Altair customers receive software and general computer information through free membership to the Altair User's Club. Software now available includes a resident assembler, system monitor, text editor and BASIC language.

*In quantities of one per customer only.
Offer expires June 30, 1975.

MITS/6328 Linn NE, Albuquerque, NM, 87108 505/265-7553

MITS INC.
"Creative Electronics"

Prices and specifications subject to change without notice. Warranty: 90 days on parts for kits and 90 days on parts and labor for assembled units.

MAIL THIS COUPON TODAY!

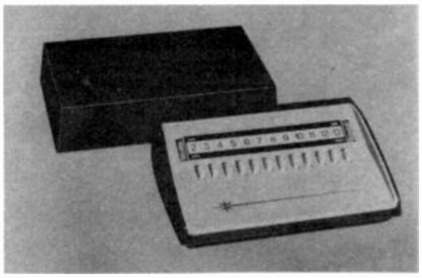
☐ Enclosed is check for $________
☐ BankAmericard #________
☐ or Master Charge #________
☐ Credit Card Expiration Date ________
☐ Altair Computer ☐ Kit ☐ Assembled
☐ Options (list on separate sheet)
Include $8.00 for postage and handling.
☐ **PLEASE SEND FREE ALTAIR SYSTEM CATALOGUE**

NAME________
ADDRESS ________
CITY________ STATE & ZIP________
MITS/6328 Linn NE, Albuquerque, NM, 87108
505/265-7553

Circle 10 on reader service card

equipment reports

Jerrold TRC-12 Television Remote Controller



Circle 101 on reader service card

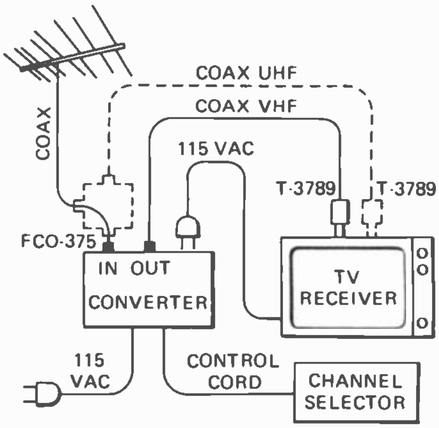
DO YOU OWN A TELEVISION RECEIVER THAT doesn't have remote control? Wish you did? Well, about all you could do up till now was to either live with your misery and curse the TV set each time you had to get up to change a channel or purchase a new TV set with the remote control feature built-in. That was till now, because Jerrold has come up with an answer; their new Television Remote Controller model TRC-12.

With the TRC-12, you can select any one of 12 VHF channels, fine tune the selected channel and turn the receiver on and off. But the really good news is that the device can be connected to *any* TV receiver within a matter of minutes, and once connected it can be removed and connected to a different receiver just as quickly.

The TRC-12 consists of two units, the Remote Control Channel Selector and the RF Converter. The two units are connected together by a 25-ft. cord. The RF Converter is placed next to and electrically connected to the television receiver. The Remote Control Channel Selector is placed in any convenient location; ie., near your armchair, bed, etc. The 25-ft. cord can be run underneath the carpet, around the baseboard of the room or any way that is convenient.

It's easy to connect the RF Converter to the television receiver. Two type "F" coaxial cable connectors are provided on the rear panel. One is labeled INPUT, the other OUTPUT. Both are for 75-ohm coaxial antenna lines, So if you are presently using 75-ohm lead-in, it's really simple. Just cut the lead-in somewhere near the receiver and equip each end with the associated connector supplied with the unit. Then screw on the antenna lead-in to the INPUT terminal and the other cable to the OUTPUT terminal.

This cable can go directly to the receiver if it is equipped with a 75-ohm input. If not, you will have to go through a 75/300-ohm matching transformer first, which you probably already own since the orignal antenna system was also 75-ohms. Then plug the AC line cord from the receiver into the switched AC convenience outlet in the rear panel of the RF Converter and the power cord into any 117V 60-Hz. outlet.



The RF Converter is factory tuned to either channel 2 or 3, so set the receiver to the proper channel. With the Remote Control Channel Selector placed near your favorite viewing spot, just sit back and relax.

With the television receiver warmed-up, you can select any one of 12 VHF stations by using the 12 push-buttons on the front panel. With this set up, you can select any channel in a random fashion. If the TRC-12 is tuned to channel 2 and you want channel 7; all you do is press the button marked 7 and presto, channel 7 appears.

If the station you selected is not tuned properly, use the fine tuning control. It's a thumbwheel control located on the front panel of the Remote Control Channel Selector.

For those readers who like specs, I'll give them to you. These specs come from the instruction sheet.

The bandwidth of the output channel is 6 MHz ± 1-dB flatness. Gain is 4.5-dB minimum and 11-dB maximum. The noise figure is 13-dB nominal, 14-dB maximum. Carrier-to-noise ratio is 46-dB at 0-dBmV input level. The fine tuning range is ± 1.5 MHz. Second order distortion is −66-dB at +15-dBmV input level. The local oscillator level at the input connector is 0-dBmV maximum. Re-

(continued on page 26)

(continued from page 24)

mote control switching capacity is 500W max. Power consumption is 8W at 115V, 60 Hz.

The unit performs exactly as its supposed to, which is about the best comment I can make about any piece of equipment. I've been using it for approximately 3 months and nothing has failed. I have the unit hooked up to a portable B-W TV and there's no noticeable deterioration of the receiver's performance. The channel selection push-buttons operate smoothly and give a reassuring click. Hook-up took about 15 minutes. **R-E**

Wahl Thermal-Spot Tester

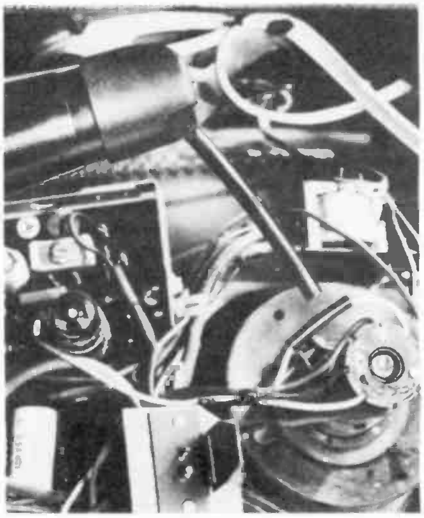
WE'VE USED AEROSOL COOLANTS FOR A long time, to help locate thermal intermittents. The reverse is also very handy. However, in order to get heat we've had to hold the tip of a soldering iron on the body of a component. This has drawbacks. Now, we can heat up components in perfect safety, with the Wahl "Thermal-Spot" model 5800 tester. It's fast, handy and completely safe.

It is a hand-sized blower with a heater. It blows a strong stream of hot air through a nozzle. Temperatures up to 260°F (125°C.) can be reached. This is the normal maximum operating temperature for many silicon transistors and similar parts. The long tapered case is plastic and the nozzle is a 3-in. length of

Circle 102 on reader service card

plastic tubing about ⅜-in. in diameter. This completely eliminates any chance of an accidental short. This tubing is small enough so that you can heat up transistors, resistors, etc., one at a time to make a definite identification of the bad one.

The Thermal Spot has several other uses around the shop. It will get hot enough to shrink any of the popular types of plastic "shrink-tubing" into place. The stream of hot air can be used to speed up drying of epoxies and other cements. For another one, it can be used to dry out tuners after spray-cleaning and for



drying out any kind of equipment that has been wet.

The case is about 10 inches long and tapers enough so that you can get it into the numerous tight places we run into. Hot air can also be blown through a slotted vent on the tip of the case, if needed. The heater is protected by a safety thermostat. If the air intake is accidentally blocked or if it's left on too long, this will open and shut the unit off. After it has cooled to safe temperatures, it recloses and you're ready to go again.

This should fill a long-felt need in the service shop for a safe way of heating things up. **R-E**

Circle 11 on reader service card

Circle 12 on reader service card

Portable Digital Multimeter at an Analog Price

ONLY

$99.95

less batteries and optional AC adapter/charger

MODEL 280

Shown actual size

9 reasons why our new meter should be your next:

1. **ANALOG PRICE**
2. **RELIABLE**
   Fully overload protected
   Built-in battery check
   Impact-resistant Cycolac® case
3. **EASY TO READ**
   Large 3-digit LED readout
   Automatic polarity, decimal point and out-of-range indication
4. **COMPLETELY PORTABLE; USE IT ANYWHERE**
   Only 4.38 x 6.38 x 2" deep
   Operates from 4 ordinary "C" cells or AC with optional adapter/charger
5. **HIGH-LOW POWER OHMS**
   Measures accurately in solid state circuitry
6. **HIGH RESOLUTION**
   1mV, 1μA, 0.1 ohm
7. **DIGITAL ACCURACY**
   DC volts typically ±1% F.S.; AC volts and ohms typically ±2% F.S. except ±2.5% on highest range
8. **RANGES**
   DC and AC volts, 0-1, 10, 100, 1000V;
   DC and AC current, 0-1, 10, 100, 1000mA;
   Ohms, 0-100, 1K, 10K, 1 meg, 10 megs.
   10 meg industry standard input impedance
9. **IN STOCK AT YOUR DISTRIBUTOR**

B+K PRECISION

PRODUCTS OF DYNASCAN

1801 W. Belle Plaine Ave. Chicago, IL 60613

Circle 13 on reader service card

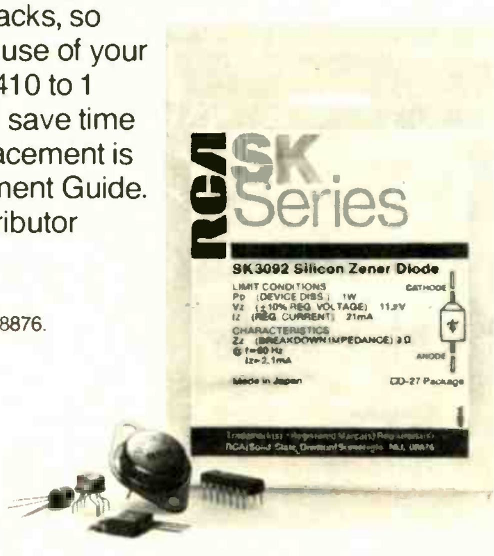
RCA

SK Series

Fix it with SK.
The RCA quality replacement.

Count on top quality in SK replacement semiconductors. Because they carry the name RCA, a top manufacturer of OEM devices. Same strict AQL standards, same strict Director of Quality Assurance. That's how we protect you from callbacks, so you can make more profitable use of your time. RCA's higher-than-ever 410 to 1 replacement ratio will help you save time too. Your key to fast, easy replacement is RCA's new 1975 SK Replacement Guide. Get your copy at the RCA distributor where you buy SK parts.

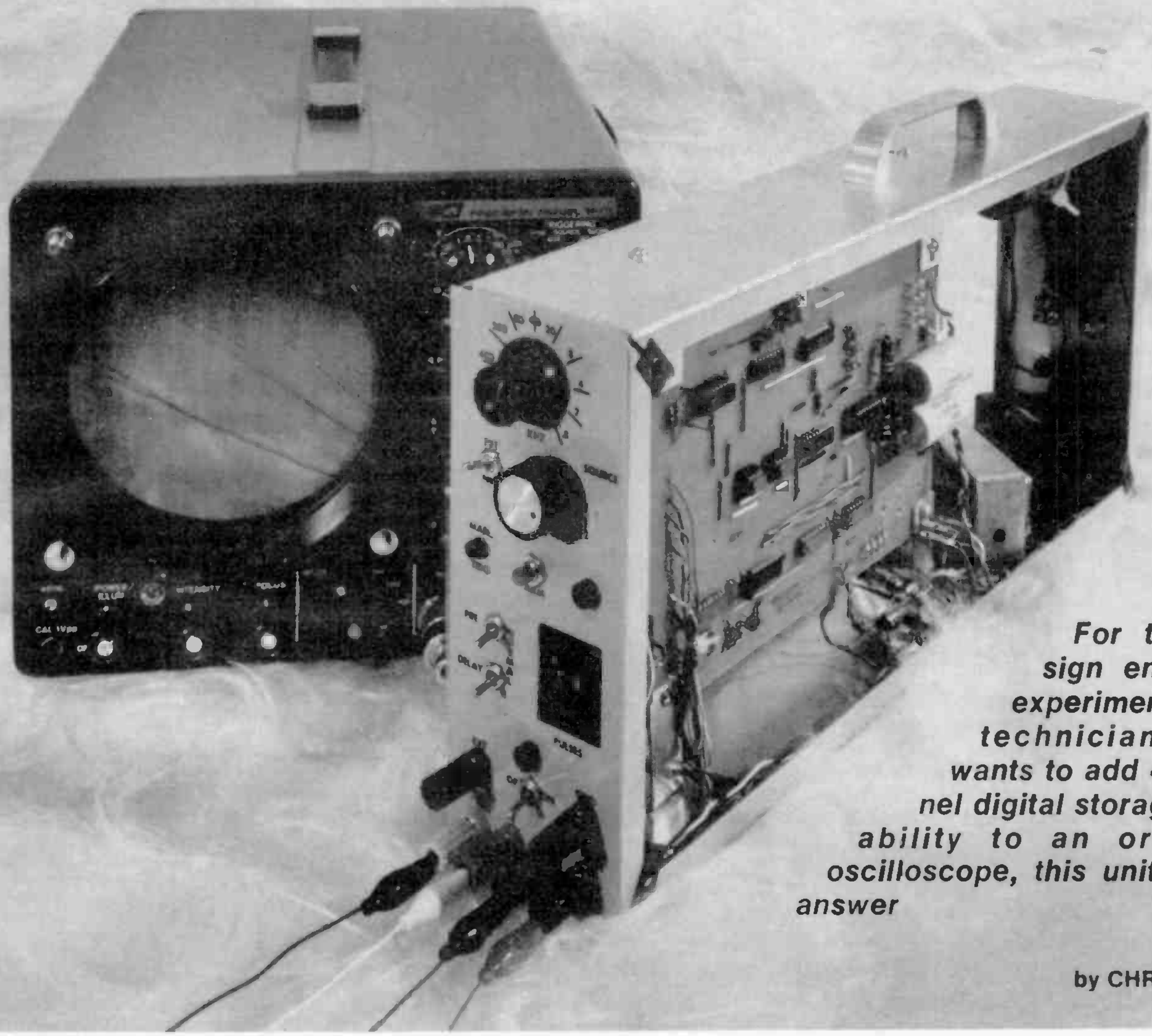
RCA Solid State, Box 3200, Somerville, N.J. 08876.



It's OK if it's sk

Circle 14 on reader service card

BUILD THIS Digital Scope Memory



For the design engineer, experimenter or technician who wants to add 4-channel digital storage capability to an ordinary oscilloscope, this unit is the answer

by CHRIS TITUS

THE DIGITAL STORAGE SCOPE CONTROLLER (DSSC) is an extremely versatile and powerful accessory that can be used with any oscilloscope with X-Y capabilities. This accessory permits the professional digital designer, technician or amateur to monitor the time relationships between four TTL signals originating from a breadboard, printed circuit board or single integrated circuit! Unlike a conventional storage scope that has a long-persistence phosphor on the CRT face, the DSSC "stores" the four TTL pulse trains in an MOS memory. Once the memory has been filled, the data is continuously fed to the oscilloscope fast enough to produce four distinct, static, flicker-free traces on the screen.

The DSSC consists of a memory, an X and Y axis controller, a time base and a main control section. The time base (see Fig. 1) is a crystal clock and a series of divide-by-ten counters. At the highest frequency of 2 MHz, 4 bits of TTL data are stored in the memory every 500 ns. At the lowest frequency of 800 Hz, the sample interval would be 1.25 ms. Within this range of frequencies, we can diagnose problems in such projects as the Mark 8 Minicomputer or the TV Typewriter. We can also test flip-flops, shift registers, counter-decoder circuits or even another DSSC!

The DSSC has four digital storage channels, each one 256 bits long. The data is stored in two N2527V IC's, IC13 and IC14 (see Fig. 2). Each contain two, 256-bit shift registers and recirculate logic (see **Radio-Electronics** December, 1974). At a data acquisition frequency (sample interval) of 2 MHz, we can acquire one bit of information every 500 ns until we have accumulated our maximum capacity of 256 bits. This would give us a total monitoring time of 128 ms. At 800 Hz (clock frequency), maximum acquisition time is 320 ms.

The X-axis controller is a sawtooth wave generator that provides separate but simultaneous positive and negative ramps. The sawtooth wave provides the X-axis scope deflection for the digital data as it is fed to the Y-axis, providing the complete display. The 2 different ramps are available because some scopes require a positive ramp and others a negative ramp to sweep the electron beam from left to right. Determination of the type of ramp your scope will require is described in the Construction section.

The Y-axis controller is designed around a two-bit Digital-to-Analog converter (DAC). The four data outputs of the shift registers go into a 4:1 multiplexer and the A and B select pins of the multiplexer are driven by a 2 bit counter. The same two-bit counter drives the DAC inputs. The counter is pulsed once each time the shift registers have been clocked 256 times. The output of the multiplexer would then consist of data from one of the other four shift registers *and* the DAC would produce a new offset voltage. The different analog voltage output steps of the DAC are then summed with the digital output of the 4:1 multiplexer to provide the 4 separate traces. Therefore, during the display of the stored data, we have 4 separate traces on the CRT face, each composed of 256 bits of TTL data.

The control section (Fig. 3) permits the user to operate the DSSC in the PRE-TRIGGER, NORMAL and DELAY record modes. In the PRE-TRIGGER mode, the DSSC is continuously acquiring data, once the DSSC is armed. The data is shifted from one memory location to another until it is shifted out of the last location and lost. When a valid trigger pulse occurs, the memory contains the last 256 "samples" that entered the memory before the trigger pulse occurred. We continue to acquire data until the number of data "samples" is equal to a number established by internal user-selectable jumpers. Assume that we had decided to use 100 of the 256 memory locations to store pre-trigger data. This would mean that after a trigger pulse occurred, we would acquire 156 additional points (we would add binary jumpers until they added up to 156—128 + 16 + 8 + 4) before the shift registers began to recirculate the data and the display began. The displayed data would be about 2/5 (100/256) pre-trigger data and about 3/5 (156/256) post-trigger data. The data would be displayed from left to right with the earliest pre-trigger data on the left of the screen.

We can also delay data acquisition by setting two thumbwheel switches (TWS) to any number between 0 and 99. When the ARM pushbutton is activated, the number set on the TWS is entered into a series of programmable down counters. Only after these counters have counted down to 0, one count per trigger pulse, will the next pulse be permitted to trigger the DSSC. Thus, if we set 46 on the TWS, we will need 47 pulses to trigger the DSSC.

Where do valid trigger pulses come from? Ideally, we should be able to monitor any one of the 4 data inputs for either a positive-to-negative (1 to 0–NET) or a negative-to-positive (0 to 1–PET) transition and use this to trigger the DSSC. The CHANNEL SELECT switch permits us to choose any one of 6 trigger sources. Four of these are the 4 data input lines, the other two being a MANUAL TRIGGER pushbutton and a separate EXTERNAL TRIGGER binding post. The EXTERNAL TRIGGER position permits us to monitor a signal for triggering purposes only. In this manner, one of the four traces will not be wasted storing the trigger pulse. With the PET/NET switch, we can also determine which edge (positive or negative—PET or NET) will be used to trigger the DSSC.

The DELAY mode of operation is very useful for diagnosing faults in logic that only become apparent after a particular number of pulses have occurred. If your logic becomes unsynchronized or halts after it has been pulsed 32 times, we could enter 27 on the TWS and store only the data present at the four inputs after the 28th (or 1 more than the number set on the TWS) pulse. This way the display will be composed of data present before, during and after the 32nd pulse had occurred!

Construction

Use care in soldering all components to the PC boards, using a low wattage (25-35W) soldering iron. If you are soldering the IC's directly to the PC boards, make sure that they are *completely functional* (test them yourself to be sure). When you make the jumpers, use insulated wire. This not only makes the project more attractive, but prevents the possibility of a short-circuit during the construction and testing. Once you've soldered the components to the PC boards, you can remove the flux with denatured alcohol or rubbing alcohol. Make sure that the polarity of all diodes and the orientation of all IC's is correct before soldering. *Note* that in this section, a capitalized word or abbreviation represents a pad on one of the two PC boards that a wire will be soldered to.

Time base board

Build the power supplies on the mem-

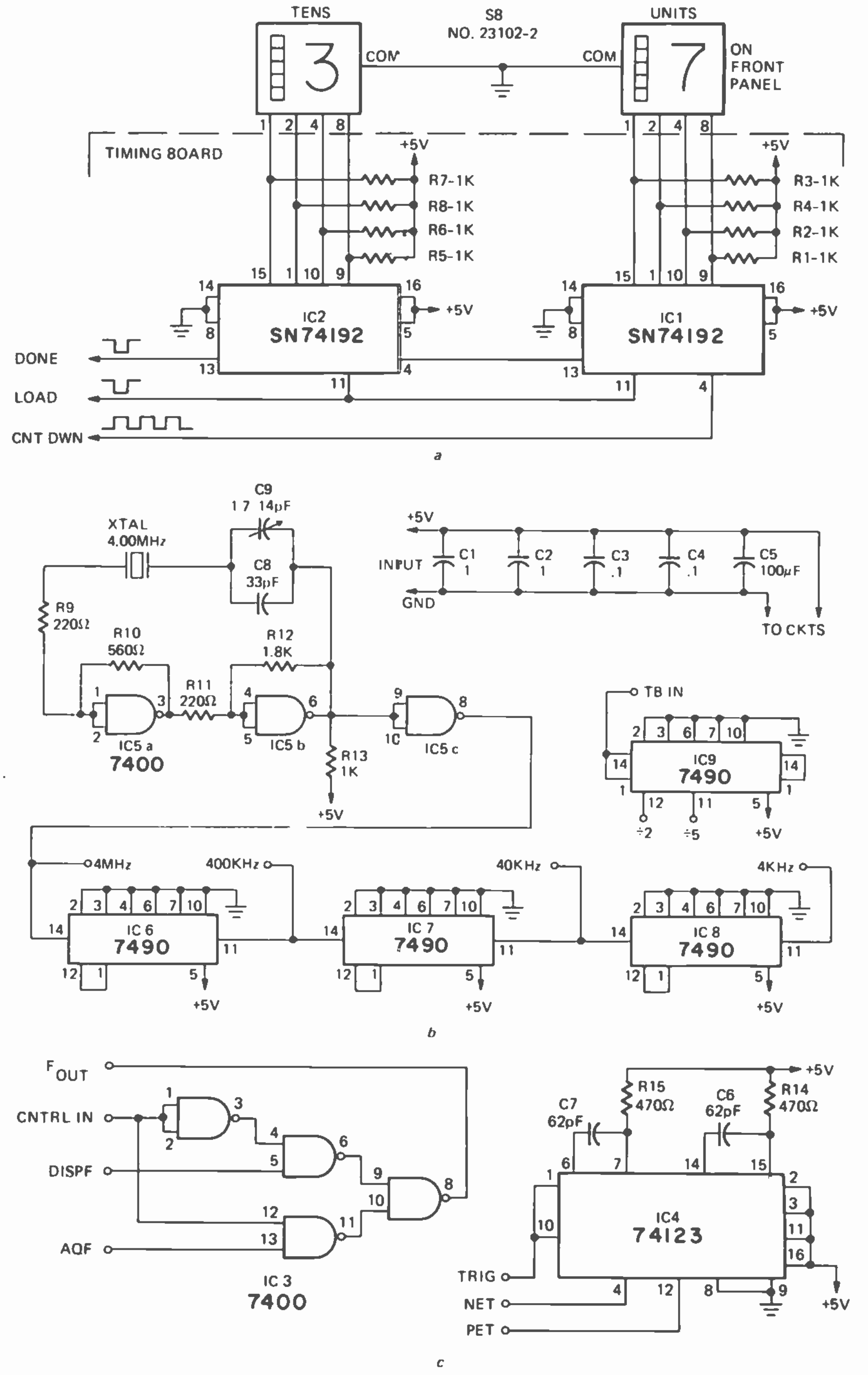


FIG. 1—THE TIME-BASE BOARD CONTAINS THREE SETS OF CIRCUITRY. As you can see they do not interconnect with each other. They do connect to either the memory board or the controls on the instrument.

ory board (Fig. 4). Note the orientation of the diodes and capacitors. The 10,000-μF capacitor and Q3 should be connected to the board with 10-inch jumpers. These components will eventually be mounted on the chassis. Check the output voltages of the supplies, making sure you have +5, +12 and −12.

Wire all the components and jumpers to the time-base board. Don't forget to add a +5V and ground jumper between the memory and time base boards. Adjust trimmer capacitor C9 so that ½ of the adjustable portion is meshed with ½ of the fixed portion. Observe the 4-KHz signal from the 4-KHz pad on the time base board or from pin 11, IC8. If there is no signal, move back up the chain of 7490 decade counters, IC8, IC7 and IC6 until the problem is located. Wire a jumper from any one of the time base outputs to TB IN, near IC9. Verify the functionality of the divide-by-2 and divide-by-5 circuits. IC9, a decade counter, has been wired to perform both the divide-by-2 and divide-by-5 functions.

Wire the thumbwheel switches using 10-inch jumpers. Be sure to connect the commons of both sections (terminals marked COM) to the ground located between IC2 and IC3. Set the thumbwheel switches to any number between 10 and 20 and momentarily ground LOAD. Verify that pulsing CNT DWN with a positive going pulse one more time than the number set on the switches produces a negative going pulse on DONE. The pulsing *MUST* be done with a debounced switch or a TTL oscillator.

Jumper any two frequencies from crystal clock section of the Time base board to the AQF and DISPF inputs (1 to each input) near IC3. Put CNTRL IN to +5V and then ground making sure that both frequencies are available at FOUT depending on the voltage level at CNTRL IN.

Memory board

Add all the remaining components to the memory board except the MOS shift registers, IC13 and IC14. Wire a jumper between the 40-KHz output of the time base and the SWEEP input between IC19 and IC20. Connect YOUT to your scope and observe the four-step staircase, going down from left to right. If you only have two steps, check the Q outputs of IC16, pins 11 and 15. They should be changing, one twice as fast as the other.

Connect XOUT to the scope and observe the sawtooth, doing the same for -XOUT. One output should be a positive ramp and the other a negative ramp. If there is no sawtooth, make sure pin 3 of IC11 is being clocked and that the resulting output, pin 6 of IC11 is a short positive-going pulse. Also check the orientation of the

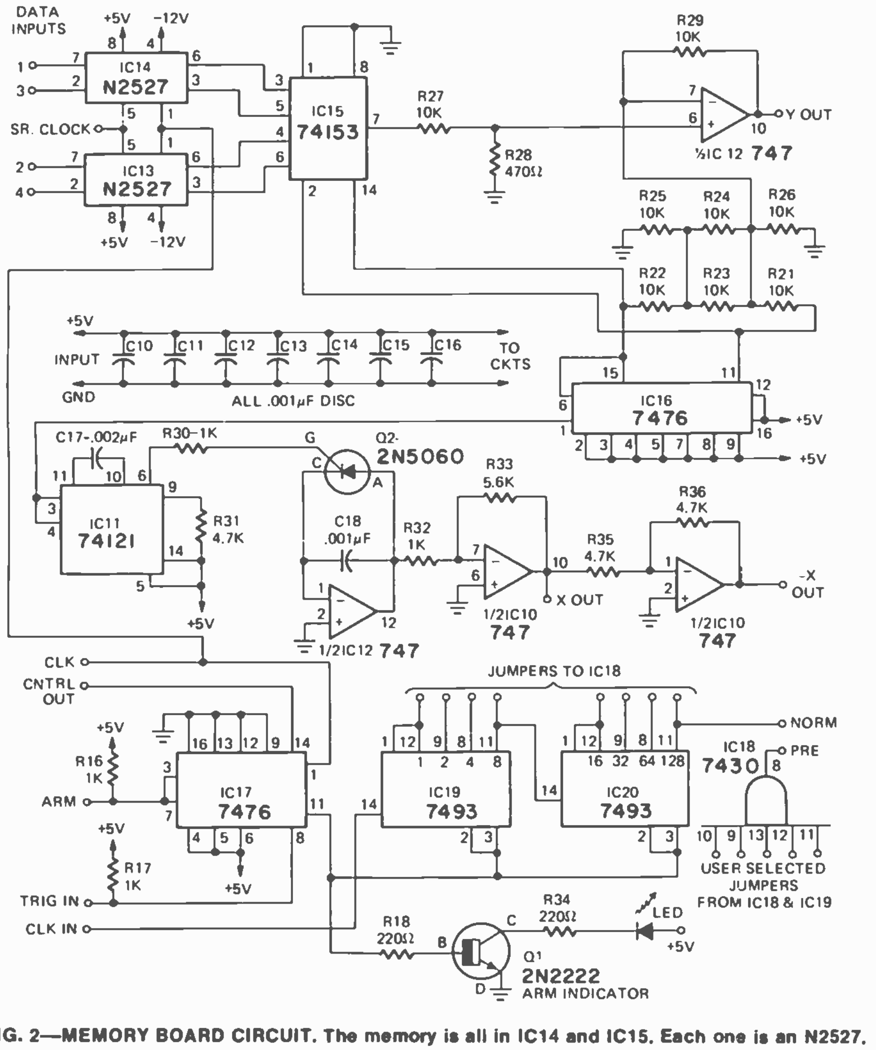


FIG. 2—MEMORY BOARD CIRCUIT. The memory is all in IC14 and IC15. Each one is an N2527.

PARTS LIST

All resistors are ¼ W, 10% unless otherwise noted

R1-R8, R13, R16, R17, R30, R32—1000 ohms
R9, R11, R18, R34—220 ohms
R10—560 ohms
R12—1800 ohms
R14, R15, R28—470 ohms
R19—47 ohms, 1W
R20—220 ohms, ½W
R21-R26, R27, R29—10,000 ohms
R31, R35, R36—4700 ohms
R33—5600 ohms
C1-C4, C10-C16—.1-μF ceramic disc
C5—100-μF 6V electrolytic
C6, C7—62-pF ceramic disc
C8—33-pF ceramic disc
C9—1.7—14-pF trimmer; Johnson 189-505-5 or equal
C18—.001-μF polystyrene
C17—.002-μF ceramic disc
C19, C20—500-μF 25V electrolytic
C21—10,000-μF 10V electrolytic
Q1—2N2222 general purpose NPN
Q2—2N5060 SCR
D1-D8—IN4001 or equal
D9, D10—12V, 1W Zener, 1N4742 or equal
IC1, IC2—74192 synchronous decade up/down counter—TTL
IC3, IC5—7400 quad nand gate—TTL
IC4—74123 monostable multivibrator—TTL
IC6, IC7, IC8, IC9—7490 decade counter—TTL
IC11—74121 monostable multivibrator—TTL
IC10, IC12—747 dual operational amplifier
IC13, IC14—N2527V dual 256 bit static shift register (Signetics)—MOS
IC15—74153 dual four-to-one multiplexer—TTL
IC16, IC17—7476 dual J-K flip-flop—TTL
IC18—7430 8-Input positive nand gate—TTL
IC19, IC20—7493 4-bit binary counter—TTL
Q3—LM309K or equal
T1—24VCT ½A power transformer
T2—6.3V 1A power transformer
LED—MV 5020 or equal
XTAL—4.0000 MHz crystal available from International Crystal, 10 North Lee, Oklahoma City, OK 73102
Order as: 4,000 KHz EX series crystal $3.95
S1—2 pole, 11 position, 2 deck rotary switch, NON-SHORTING (1 pole/deck)
S2—1 pole, 6 position rotary switch, NON-SHORTING
S3, S4, S5, S9—SPDT miniature toggle switch
S6, S7—SPST normally open, momentary pushbuttons
S8—Digitran 23102-2; 2 module thumbwheel switch, BCD complement with one common

Misc.

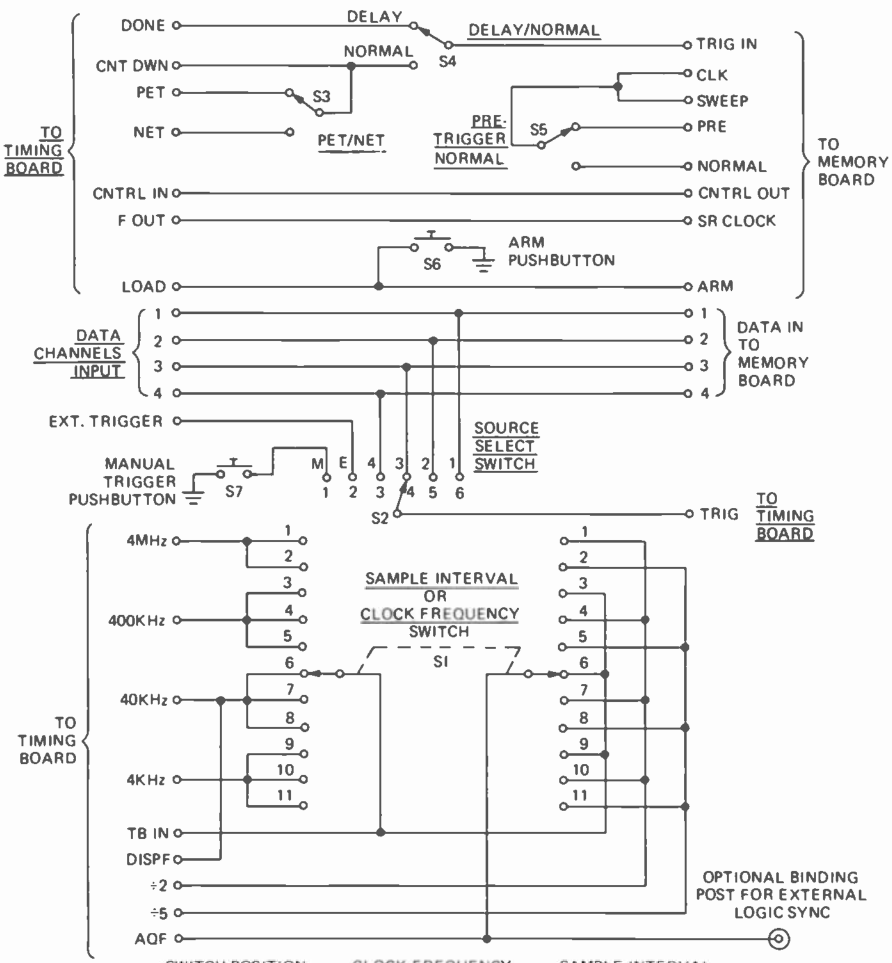
Mounting hardware, fuseholder, line cord, fuse, power (110 VAC) switch, 6-5 way binding posts. 2 BNC connectors for the X and Y signals, pilot light, rubber feet, Bud chassis AC 412 and bottom plate BPA 1520.

The Johnson 189-505-5 is available from:
Circuit Specialists Co., Box 3047
Scottsdale, AZ 85257

— or —

Bursten Applebee, 3199 Mercier St.
Kansas City, MO 64111

Both the memory and time base Glass Epoxy printed circuit boards, drilled, cut to size and ready for component insertion is available for $12.95 postpaid from Techniques Inc., 235 Jackson Street, Englewood, NJ 07631. New Jersey resident should add 5% sales tax.



SWITCH POSITION	CLOCK FREQUENCY	SAMPLE INTERVAL
1	2 MHz	500 ns
2	800 kHz	1.25 μs
3	400 kHz	2.50 μs
4	200 kHz	5 μs
5	80 kHz	12.5 μs
6	40 kHz	25 μs
7	20 kHz	50 μs
8	8 kHz	125 μs
9	4 kHz	250 μs
10	2 kHz	500 μs
11	800 Hz	1.25 ms

FIG. 3—FRONT PANEL CONTROLS ARE SHOWN IN THIS DIAGRAM. They connect to both the memory and time-base circuit boards. Foil patterns for these boards will be published with the second part of this article.

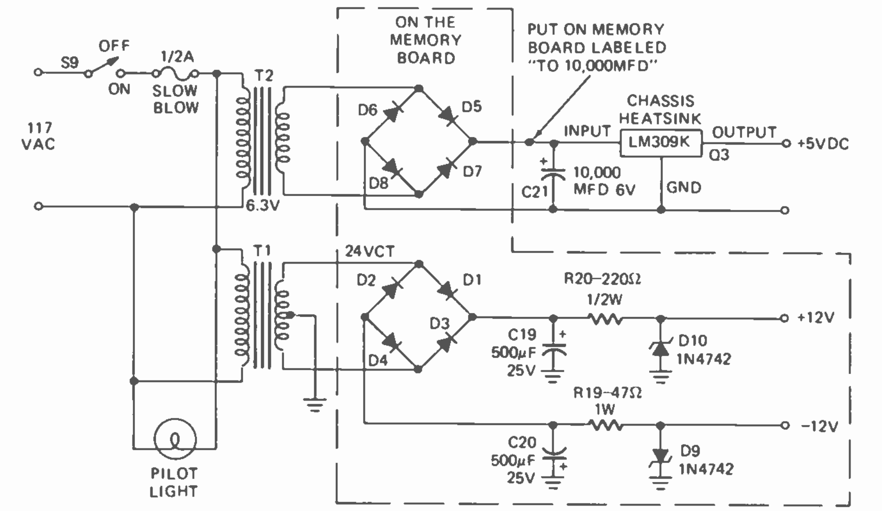


FIG. 4—POWER SUPPLY FOR THE SCOPE MEMORY. Note that the circuitry inside the dashed lines is on the memory board. Don't build it twice.

SCR and Q2 making sure that the gate of the SCR is being pulsed.

Move the 40-KHz jumper to SR CLOCK near IC13, and note the 156-Hz output on NORM, near IC20. If there is no pulsing output, go back up the chain of the divide-by-2 circuitry until the problem is located, IC19 and/or IC20.

Add your light-emitting-diode (LED) ARM indicator. Wire one end to the LED terminal between IC17 and IC18 and the other end to +5V. Momentarily ground ARM and the LED should turn on. If not, check pin 11 of IC17 for a logic 1 (+5V). Make sure that the polarity of the LED is correct. Also check pin 14 of IC17 for a logic 1. Momentarily ground TRIG IN, the LED should go out, but pin 14 of IC17 should still be a logic 1. By grounding CLK pin 14, IC17 should go to a logic 0 (ground).

Since the shift registers are reasonably expensive, use sockets or Molex strips for these two IC's. Add the shift registers, IC13 and IC14. Momentarily ground ARM and then individually ground or connect to +5V the four DATA INPUT pads. Grounding or connecting to +5V, one input pad at a time should only effect one input, pins 3, 4, 5 and 6, of IC15. Check these pins with a VTVM, VOM, scope or logic probe, while connecting the DATA INPUT pads to ground and +5V. If you don't observe any changes, the shift registers are bad. Don't forget, at 40 KHz, the data will take 6.4 ms to "percolate" through the shift registers before appearing at the input pins of IC15.

Wire up all the SPDT and rotary switches with 12" jumpers and connect them to the appropriate pads on the PC boards. Add the jumpers between IC18 and IC19 and IC18 and IC20. There should be no jumpers between IC19 and IC20. If you want 50 pre-trigger data points, add jumpers until they add up to 206 (128 + 64 + 8 + 4 + 2). Remember, the jumpers represent the number of data points to be stored *after* a trigger pulse occurs, when the DSSC is in the PRE-TRIGGER mode.

We will complete this article next month and present foil patterns and parts layout overlays for the scope memory.

(to be continued)

"Yes, I am an authority on Test Patterns, *but I'm afraid your History Exam is your own problem."*

COMING SOON home videoplayers

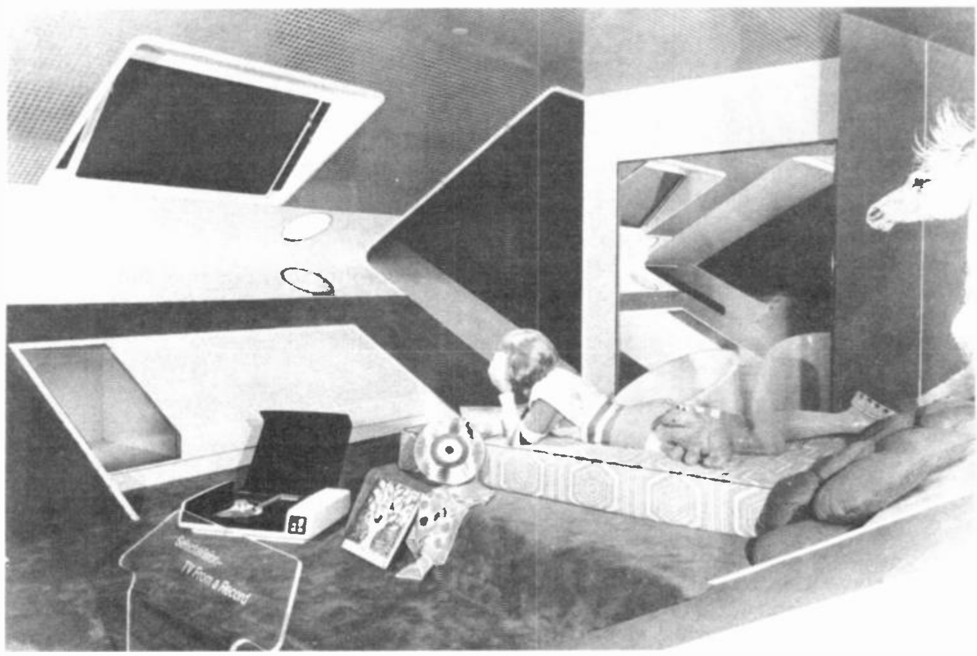
by ROBERT E. GERSON

Here's a rundown of the current status of the various home videoplayer manufacturers

A YEAR AGO LAST JANUARY IT LOOKED like the era of the home videoplayer-recorder was about to burst upon us. Research and development laboratories on three continents were feverishly at work perfecting the devices that would let the consumers of the world "see what they want to see when they want to see it." By the end of 1973 we had all heard of, or seen demonstrated, a dozen or so gadgets employing nearly as many different technologies, all with the potential of becoming the in-home videoplayer standard of the world.

But now, a full year passed and, in the United States, we appear to be as far away from the home videoplayer as we were last year—that is about two years from availability. What happened to set the industry back from its point of greatest promise? It was a combination of factors, some economic, some technological, while others were simply practical marketing considerations.

Here's a run down on the current status starting with video disc systems, of the devices that were considered to have the most potential:



VIEW OF THE FUTURE is offered tourists at Florida's Disney World in RCA's Space Mountain exhibit that features the Selecta-Vision videodisc system. This display will be the first look at videodiscs for thousands of American consumers this year.

TeD

The first of the play-only videodisc systems, Ted, named for developers Telefunken of West Germany and England's Decca, may have made its marketing debut in Europe by the time this article appears in print. The latest test market date, Spring 1975, is the third in as many years. This mechanical disc system has been plagued with engineering problems, and its acceptance by other manufacturers has been hindered because the playing time offered is just 10 minutes per disc. TeD uses a sled runner-shaped stylus to read audio and color video information embossed on ridges which extend out from the center of the disc. TeD appeared to have scored a major coup last summer with the announcement that Sanyo of Japan had become a hardware licensee and that a group of Japanese companies would provide software, thus making TeD the first internationally accepted system. But since then Sanyo's interest appears to have waned, and early this year TeD proponents were in Japan trying to revive enthusiasm.

Disco-Vision and VLP

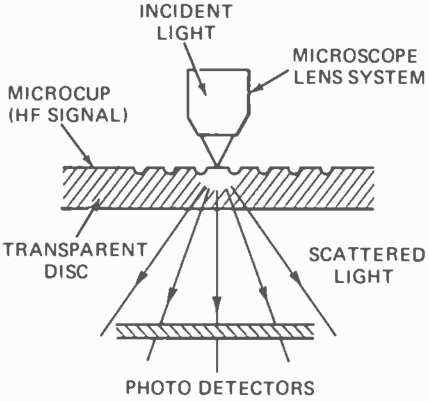
About three years ago the first demonstrations were held of the essentially similar MCA Disco-Vision and Dutch Philips VLP videodisc systems. Both use a laser etching process in which the video and audio information is recorded in the form of microscopic pits on a master disc. Both also use relatively standard stamping or printing techniques to make duplicates and employ lasers for playback. They were expected to be on the market this year. But last fall MCA and Philips got together to announce they had joined forces, and would eventually introduce a single system in a joint-manufacturing-marketing effort. Last March, they held their first joint demonstration. While they plan to have players and discs on the market late next year, 1977 seems a more likely time. Present plans call for MCA, parent of Universal Pictures, to play the role of software supplier, while Philips, along with its American subsidiary, Magnavox, provides players.

Zenith-Thomson

For the past two years Zenith of the U.S. and Thomson-CSF of France have worked on the development of yet another optical laser videodisc system. This one uses an air cushioned, transparent floppy disc, and unlike the similar MCA and Philips systems in which the read-out laser beam is reflected off the surface of the disc, Zenith and Thompson has the laser pass right through. This makes it possible, by focusing the laser, to read both sides of the disc without turning it over. Zenith and Thomson have started compatability talks with MCA-Philips, creating the possibility of a four-company standard, which certainly would help its chances of acceptance. But such an agreement could easily force a further market introduction delay.

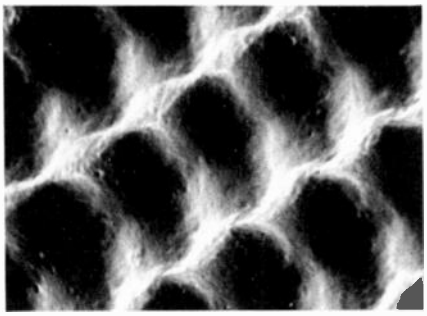
RCA SelectaVision Disc

After nearly 10 years of secrecy, RCA has at last taken the wraps off its capacitance disc system. The RCA disc is a plastic-metal-plastic sandwich with grooves like a phonograph record. The program material is recorded in the grooves in the form of transverse slots, and is read out by a sapphire stylus containing a metal electrode. The stylus rides in the grooves, while the electrode detects the signal by the changes in the capacitance between its tip and the distance to the disc's metallic layer. RCA plans a 12-inch disc providing 30 minutes of playing time per side. The disc revolves at 450 RPM. The recorded information is in



THE TRANSMISSION-TYPE READING SYSTEM

THOMSON-CSF optical reading system. The reading-head is not in contact with the disc and wear is virtually non-existent.



SECTION OF TELEFUNKEN/DECCA MOLDED DISC photographed with a raster-scanning electron microscope. Enlargement is 20,000 times.

a 2.44-inch band containing 13,500 grooves, with four frames recorded on each groove. RCA claims that disc deterioration doesn't begin until after 500 plays, and that stylus life is in the 300-500 hour range.

i/o Metrics

There are several other disc systems, all optical, that were talked about last year as having promise in the field. Of those only one, i/o Metrics Corp.'s has been publically shown in the past 12 months. That demonstration, at New York's Lincoln Center, indicated the company has not been able to produce even a satisfactory monochrome picture from its laser-recorder photographic film systems.

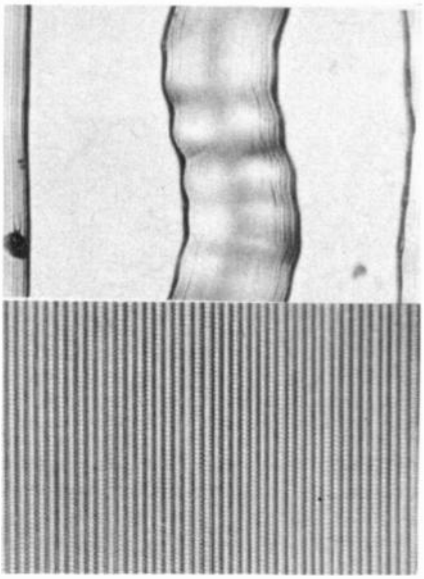
In the field of home video tape recordings, the disappointments have, if possible, exceeded even those created by the failure of video discs to come to market. Here's the status of those considered to be the most viable:

Cartrivision

This half-inch, skip-field system counted such industry leaders as Avco, ABC, Admiral, Montgomery Ward, Sears, and Teledyne Packard Bell among its supporters. But later deliveries of hardware and software, plus mechanical problems with the transport spelled its doom, even though some VTRs were actually purchased by consumers. Late last year, after filing for bankruptcy, Cartridge Television Inc., the developer of Cartrivision, was liquidated, wiping out an investment estimated at more than $100 million, not counting the sums spent by consumers.

RCA MagTape

The only American developed video tape recording system for the home, MagTape was given a market test in Indianapolis IN, RCA's home town. The test results showed consumers would be interested in buying a color home VTR providing it had a built-in timer and a tuner for off-the-air recording. The consumers said they would like to have a camera for home recording too. But they indicated that



PHOTOMICROGRAPH COMPARISONS of a standard lateral-cut phono groove (top) and the grooves in the TeD videodisc (bottom).

the $800 price for Mag Tape was a bit steep. In any event, RCA has put a hold on this ¾-inch cartridge system. While continuing to revive MagTape, the company says there now is no full-scale marketing date. However RCA says it's still interested in the product.

Sony Home VTR

In Japan, Sony has developed a half-inch cartridge recorder with hopes of having it become the consumer market VTR standard, in much the same way its ¾-inch U-matic system has dominated the industrial VTR market. Believed to use a high-density recording technique, the Sony system was designed to use less tape to provide 30 minutes of record-play time than machines using the EIA-Japan Type One half-inch standard cartridge format. The Sony unit has never been demonstrated publically, and, it's understood, Sony cancelled marketing plans following a determination that a one hour cartridge would be needed for a successful consumer VTR.

V-Cord

The first home VTR system introduced in 1975 was V-cord, jointly developed in Japan by Tokyo Shibaura Electric (Toshiba) and Sanyo. While utilizing a unique single reel ½-inch tape cartridge, V-cord is virtually identical in operation to the EIA-Japan Type One standard, except VTRs in this format are capable of either full speed or half-speed recording. While half-speed record-playback provides lower picture quality, the result is good enough for home use. Units to be marketed in Japan are expected to be priced in the $1,000 range. One advantage to the V-cord is that the vast library of tapes now avail-

VLP DISCS ARE TRANSPARENT RIGID PLASTIC with a thin reflective metal layer. Duplication is by stamping from glass master.

VIDEOPLAYER developed by Philips to play its VLP (Video Long Play) discs. Signal is fed to set's antenna terminals.

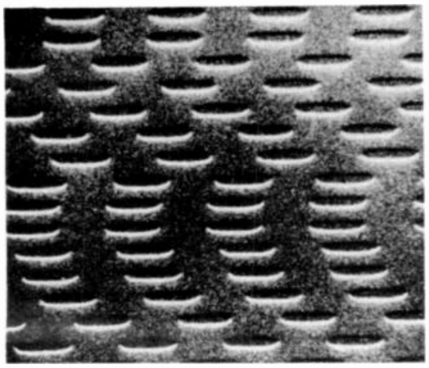
able for the EIA-Japan standard can be made available for rental to consumers. Expected to help V-cord's acceptance is the development by Matsushita Electric of the first high-speed tape duplicator for half-inch tape. Now being offered for sale both in the United States and Japan, the duplicator, priced at about $15,000, can turn out a copy of a 30-minute tape recorded in the standard format, or a 60-minute V-cord copy, in three minutes. The duplicator uses a direct contact magnetic transfer process requiring use of a mirror-image tape master. Master recorders, like the duplicators, are priced at $15,000 each.

BASF LVR

Demonstrated in West Germany last fall was the LVR (for Longitudinal Video Recorder) system developed by BASF. This unit uses a ½-inch tape with 28 parallel tracks traveling at 120 IPS. At the end of each track the tape reverses, and starts playing in the opposite direction. The reversal process takes an almost unnoticeable 80 milliseconds. A playing time of up to 2 hours per cartridge is possible, BASF says. Cartridges, containing chromium dioxide tape, of up to 90 minutes (1,900 feet) have been shown. No introduction date or price has been set.

American Videonetics

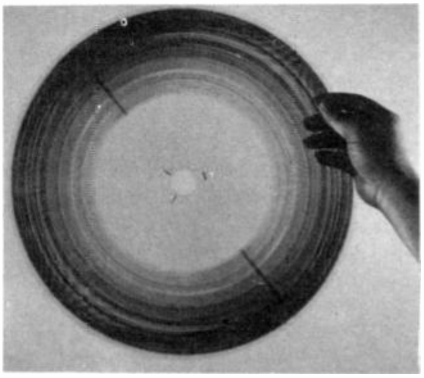
A completely different approach to home video recorder is being taken by American Videonetics which has a prototype recorder using a cartridge



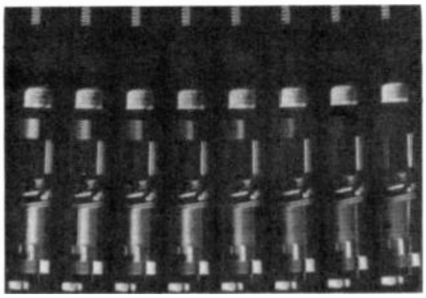
PITS STAMPED IN VLP DISC contain audio and video information. This is a photomicrograph of a section of the disc surface.

of ¾-inch tape traveling at just 2.88 IPS. Signals are recorded and played back by a bottle-cap sized 8-head assembly rotating at 7,200 RPM. The video information is recorded in nearly vertical segments across the width of the tape, much like they are on four-head broadcast quality VTRs, rather than in the long slants laid down by the more common helical-scan units. An hour-long tape can be housed in a 3½-inch diameter, single reel cartridge. The company feels that 1977 is the earliest it can bring a product to market.

While the future of the home VTR seems assured, if only as a hobbiest gadget, the success of the video disc is still up in the air. The difference between the two can be expressed in a single word — programming. The



RECORDED DISC used with i/o Metrics system is 12 inches in diameter. The disc is capable of carrying in excess of one hour of video programming with a quadriphonic sound track.



TRACKS MAGNIFIED TWENTY TIMES show data spacing and density of encoded video program in i/o Metrics photographically reproduced disc.

availability of a camera and broadcast television ensures a limitless supply of suitable material for the taping by the home VTR. But the home videodisc player, which is just that, a player only, demands the creation of a vast library of inexpensive prerecorded programming.

The discs themselves present no major production or duplicating problems. The materials used cost only a few cents per disc, and duplication is, in all cases, a conventional process. But while the developers have spent millions of dollars perfecting and promoting their systems, none have demonstrated a full picture of what material will be offered in disc form.

RCA, for example, has a software acquisition program, but has never been willing to discuss what it's doing. Philips and MCA talk about the thousands of motion pictures in the library of Universal Pictures, and now Warner and 20th Century believe they lead now, but are unwilling to talk frankly about how much a consumer would actually have to pay to own a 90-minute feature film. TeD plans on going to market with a lot of short educational and children's shows.

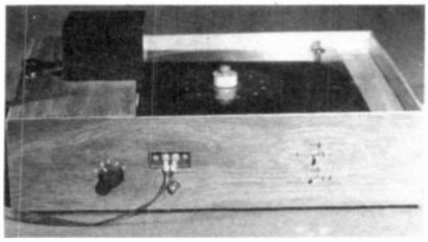
It seems fairly obvious that with audio-only phonograph records retailing at about $6 each, a full-length feature film would have to retail for at least double and probably more like three times that price. This of course raises the question of how

ANALYSIS OF LEADING VIDEODISC SYSTEMS

	MCA-Philips	RCA	TeD
Type	Optical	Mechanical	Mechanical
Readout	Laser	Metal Sapphire Stylus	Ceramic Stylus
Disc Size	12"	12"	12"
Speed (rpm)	1,800	450	1,500
Playing time	30-min. (one side only)	60-min. (both sides)	10-min. (one side only)
Disc life	infinite	500 + plays	1,000 + plays
Slow motion capability			
Freeze frame capability	yes	no	yes
Introduction	late 1976	1977	1975
Player price	$500 (approx.)	$400 (approx.)	$650
Disc price	$2 to $10 for albums	$3 to $8	n. a.

many people would be willing to pay $12, $18 or more to own a film they may watch once or twice a year at home. And let's not forget that free broadcast TV won't disappear with the coming of the home videodisc. The consumer will still have the option of watching a dozen or so feature films a week at no extra cost at all—if you forget about commercial interruptions.

From talks with officials of presently uncommitted companies such as



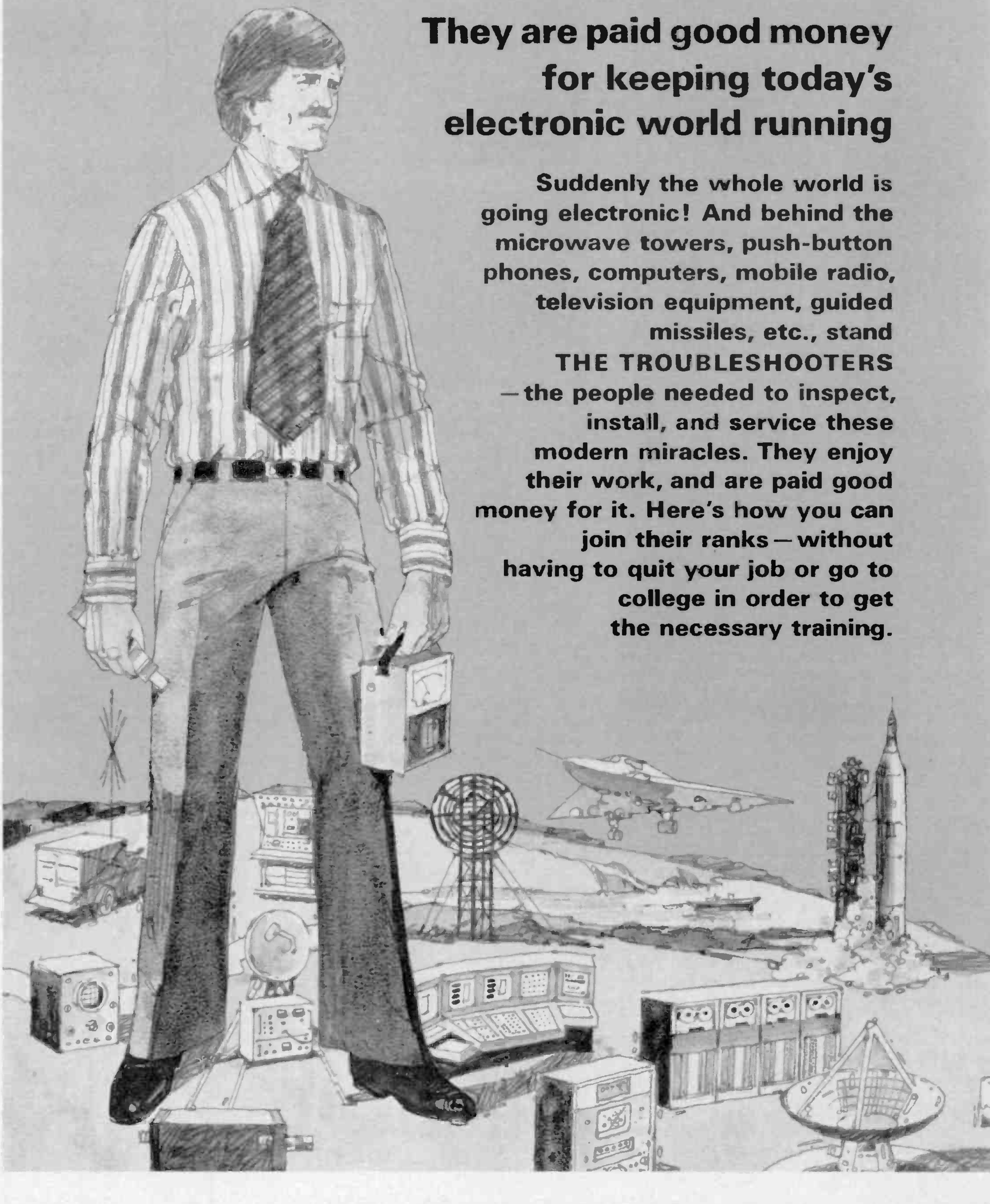
PLAYBACK DEVICE for i/o Metrics videodisc playback system. The playback device weighs under 30 pounds and occupies less than one cubic foot of space.

CBS and Warner Communications, who specialized in recorded entertainment, it appears that a new generation of entertainment programming will be needed for videodiscs. While special interest material, such as how-to-do-it, travelogues, art tours, etc., will appear and succeed in this new medium, the mass market potential will be tapped only when entertainment material particularly suited for videodisc presentation is developed. At present, prospective videodisc producers have their eye on securing videodisc rights for live concert and night spot performances, plays, and other events with short lives. Original videodisc programming appears to lie off in the future when the videoplayer population can support discs whose program production costs run upwards of $100,000 per hour. **R-E**

Join "THE TROUBLESHOOTERS"

They are paid good money for keeping today's electronic world running

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS—the people needed to inspect, install, and service these modern miracles. They enjoy their work, and are paid good money for it. Here's how you can join their ranks—without having to quit your job or go to college in order to get the necessary training.



Just think how much in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter . . . keep a whole assembly line moving by fixing automated production controls . . . prevent a bank, an airline, or your government from making serious mistakes by servicing a computer.

Today, whole industries depend on Electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians — The Troubleshooters.

The troubleshooters have many names. In radio or TV, they're the Broadcast Engineers. In other industries, their titles may be Technical Representative or Customer Engineer.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college degree, but you don't. What you need is know-how — the kind a good service technician has — only lots more.

Learn at Home . . . In Your Spare Time

As one of The Troubleshooters, you'll have to be ready to tackle a wide variety of electronic problems. You may not be able to dismantle what you're working on — so you must be able to take it apart "in your head." You'll have to know enough Electronics to understand the engineering specs, read the wiring diagrams, and calculate how the circuits should test at any given point.

Surprisingly, you'll find that you can learn the tech skills you have to know without setting foot in a classroom . . . without giving up your present job and its steady income.

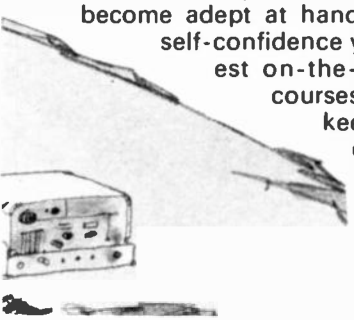
For more than 40 years, CIE — Cleveland Institute of Electronics has **specialized** in teaching Electronics at home. We've developed independent home-study techniques that make it possible for you to learn Career Electronics even if you have had no previous electronics experience. Our Auto-Programmed® Lessons help you build a thorough knowledge of Electronics just as you would build a wall . . . building block by building block . . . moving ahead at your own pace, in your spare time, until you have reached your goal.

You mail your lesson exams to CIE where our Instruction Department checks your thinking, grades your work and refers any questions to the instructor best suited by experience to help you. That way, you benefit from the combined knowledge of the entire specialized CIE instruction staff.

Exams received any weekday before noon will be graded and mailed back to you the same day. Then you can review the CIE staff comments while the work is still fresh in your memory.

You learn by doing

With CIE you can learn by doing . . . two ways: with your head and with your hands. In some CIE courses, you learn by doing "hands on" projects with actual components to solve "real world" problems . . . working with CIE's Experimental Electronics Laboratory. You'll become adept at handling components, pick up the self-confidence you'll need to handle the toughest on-the-job challenges. In other CIE courses, you'll go on to build . . . and keep . . . a big screen, solid-state color TV. After assembling the set, you'll learn the troubleshooting techniques of a TV technician with emphasis on digital electronics. The "learn by doing" method is so effective, some leading companies use CIE courses to train their own employees.



Get an FCC License

For troubleshooting jobs in broadcasting . . . television, AM or FM radio . . . or even in the repair and maintenance of mobile, two-way communication systems, federal law requires a Government FCC License. A number of CIE career courses include preparation for the FCC License exam. If that is your goal, we are confident that you can successfully earn your license because the vast majority of CIE graduates have. In fact, in continuing surveys, close to 9 out of 10 CIE graduates have passed their FCC exams. So we know our courses work.

That's why we offer this Warranty: when you successfully complete any CIE career course which includes FCC License preparation, you will be able to pass the Government FCC Examination for the License for which the course prepared you or you will be entitled to a full refund of an amount equal to the cash price of tuition for CIE's Course No. 3, "First Class FCC License," in effect at the time you enrolled. This warranty is good from the date you enroll until the last date allowed for completion of your course.

Send for FREE school catalog

Discover the opportunities open to people with electronics training. **Learn** how CIE career courses can help you build new skills and knowledge and prepare you for a meaningful, rewarding career. We have courses for the beginner, for the hobbyist, for the electronics technician, and for the electronics engineer. Whether you are just starting out in Electronics or are a college-trained engineer in need of updating, (or anywhere in between), CIE has a course designed for **you.**

Send today for our FREE school catalog and complete package of career information. For your convenience, we will try to have a representative call to assist in course selection Mail reply card or coupon to CIE . . . or write: Cleveland Institute of Electronics, Inc., 1776 East 17th Street, Cleveland, Ohio 44114. Do it TODAY.

Approved Under G.I. Bill

All CIE career courses are approved for educational benefits under the G.I. Bill. If you are a veteran or in service now, check box for G.I. Bill information.

CIE **Cleveland Institute of Electronics, Inc.**

1776 East 17th Street, Cleveland, Ohio 44114

Accredited Member National Home Study Council

Please rush me your FREE school catalog and career information package today.

I am especially interested in:

- ☐ Electronics Technology
- ☐ FCC License Preparation
- ☐ Color TV Maintenance
- ☐ Mobile Communications
- ☐ Industrial Electronics
- ☐ Electronics Engineering
- ☐ Other ________

Print Name ________

Address ________ Apt. ____

City ________

State ________ Zip ____ Age ____

Check box for G.I. Bill information.

☐ Veteran ☐ On Active Duty

RE-55

Circle 15 on reader service card

Radio-Electronics® Tests HI-FI Gear

by LEN FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

STARTING NEXT MONTH, **RADIO-ELECTRONICS** is introducing a new feature—testing high-fidelity equipment. The component high-fidelity industry has grown tremendously over the past several years. Today there are thousands of hi-fi components available. Manufacturers of receivers, tuners, amplifiers, record playing equipment, tape decks, phono cartridges and speakers introduce new models each year—and sometimes twice a year. There are annual publications, and even some quarterly ones that attempt to tabulate the current models, constantly updating their listings as best they can. But these publications limit themselves to, at best, a listing of the manufacturer's own published specifications, as copied from available advertising literature.

Other respected publications do provide in-depth product test reports that attempt to evaluate a product's performance through instrument testing and a minimum of actual listening and subjective evaluation. Still others present wholly subjective evaluations of new equipment, based solely upon use and listening tests. Most of these publications cater exclusively to the so-called audiophile who also expects to find record and tape reviews in the same periodicals.

Radio-Electronics has long recognized that the interest in high-fidelity is a broad one, and one that particularly interests our readers, who are involved professionally in other areas of electronics. Therefore, we plan to strike a balance between "test-equipment" measurement of high fidelity performance and listening tests as well as "hands on" use tests. We recognize, too, that our readership is extremely diverse. We have readers who would like us to delve into the circuitry of the latest tuner we test and even provide circuit diagrams, with suitable explanatory material. Others would simply like to know

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, Mono: (μV)		
Sensitivity, Stereo (μV)		
50 dB quieting signal, Mono (μV)		
50 dB quieting signal, Stereo (μV)		
Maximum S/N ratio, Mono (dB)		
Maximum S/N ratio, Stereo (dB)		
Capture ratio (dB)		
AM suppression (dB)		
Image rejection (dB)		
IF rejection (dB)		
Spurious rejection (dB)		
Alternate channel selectivity (dB)		
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)		
Harmonic distortion, 1 kHz, Mono (%)		
Harmonic distortion, 1 kHz, Stereo (%)		
Harmonic distortion, 100 Hz, Mono (%)		
Harmonic distortion, 100 Hz, Stereo (%)		
Harmonic distortion, 6 kHz, Mono (%)		
Harmonic distortion, 6 kHz, Stereo (%)		
Distortion at 50-dB quieting, Mono (%)		
Distortion at 50-dB quieting, Stereo (%)		
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV)		
Separation, 1 kHz (dB)		
Separation, 100 Hz (dB)		
Separation, 10 kHz (dB)		
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV)		
Dial calibration accuracy (±kHz @ MHz)		
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		
Ease of tuning		
Accuracy of meters or other tuning aids		
Usefulness of other controls		
Construction and internal layout		
Ease of servicing		
Evaluation of extra features, if any		
OVERALL FM PERFORMANCE RATING		

We're introducing a new, additional, editorial feature to Radio-Electronics—laboratory tests of the latest high-fidelity components. Our approach to testing is quite different from anything that has been done by other publications and is designed to be more informative. In this article we describe how our tests are performed, what we measure, how we rate our findings, and how we report them. In all future issues, at least two high-fidelity components will be tested and detailed reports presented

FIG. 1. FM PERFORMANCE MEASUREMENTS

IHF SENSITIVITY: While still listed as the "primary" performance specification for FM sets, this number, stated in microvolts, tells relatively little about FM quality. It is simply the number of microvolts needed to produce an audio signal at the tuner output that contains no more than 3% combined noise and distortion. Numbers range from about 1.6 microvolts (the lowest or best) upwards, but most modern products measure around the 2.0-μV range. Sensitivity in stereo will always measure higher (poorer) since greater signal strength is required in stereo to produce noise-free, distortion-free results.

50 dB QUIETING: When noise has been suppressed to this degree, audio programming can be enjoyed and will be considered of "hi-fi" quality. Again, the number of microvolts of signal required to achieve this condition will be greater in stereo than in mono.

MAXIMUM S/N RATIO: When strong signals are received, the tuner achieves its best signal to noise ratio, expressed in dB. Figures in hi-fi equipment range from 60 dB upwards, with top sets exceeding 70 dB.

CAPTURE RATIO, SELECTIVITY: Both terms describe a tuner's ability to receive desired signals while rejecting undesired ones. In the case of CAPTURE RATIO, two signals (one weaker, the other stronger) are at the same broadcast frequency. Capture ratio is expressed in dB and the lower the number the better. About 1.0 dB is the best achieved to date. When we speak of a capture ratio of 1 dB we mean that a tuner will reject the weaker of two signals transmitting at the same frequency when that weaker signal is only 1 dB lower in signal strength than the desired signal. Degree of rejection will be 30 dB.

SELECTIVITY, also measured in dB, should be as high as possible and describes the ability of the tuner to reject signals located 400 kHz away from the desired station frequency. Typically, numbers range from about 50 dB to 100 dB.

AM SUPPRESSION: An FM set should respond only to frequency modulation and not to amplitude modulation. Ability to reject the latter is expressed in dB, and the higher the number the better. Numbers above 45 dB may be expected in hi-fi component equipment.

IMAGE, IF, AND SPURIOUS REJECTION: All relate to a tuner's ability to reject ambiguous signals which sometimes appear at various points on the FM tuner dial. Higher numbers (expressed in dB) are desirable and may reach 100 dB or better for all three specifications in top-rated products.

FREQUENCY RESPONSE: Though top audio frequencies broadcast in FM are limited to 15 kHz, this is high enough to be considered true high fidelity. Variations from "flat response" over this range are expressed in ± dB, and the less the variation the better.

HARMONIC DISTORTION: Tends to be a bit higher in stereo than in mono, but should be below 1.0% for mid-frequencies in a well designed product. Typical low, mid and high frequency distortion values are measured by **Radio-Electronics** for both mono and stereo performance. Since the 50 dB quieting point is considered "listenable" from the point of view of residual noise, distortion is also measured at signal levels required to reach that quieting level.

STEREO THRESHOLD: The signal level at which circuitry switches over to stereo reception in the presence of a stereo broadcast. If set too high, certain weak-signal stereo broadcasts will only be heard monophonically. This may be desirable, if noise in stereo would be too annoying.

SEPARATION: While high channel separation figures (over 30 dB at mid-frequencies, somewhat less at frequency extremes) are now easily attainable, the importance of high separation may be overemphasized by manufacturers, since separation is also limited by phono cartridges (used at the broadcast station) and other factors.

MUTING THRESHOLD: Sometimes adjustable, sometimes fixed. If too high may prevent reception of weak signals. Defeat switch is usually provided. With muting on, interstation noise is eliminated.

what we think of a given piece of equipment and how we would rate it verbally (acceptable, good, very good, excellent, superb, etc.). Still others want to know how our measurements compare with a manufacturers published claims and—in some cases—what measurements we have come up with that are not even mentioned in the advertising literature. Styling and control layout are important, too. Is the product easy to use? How much trouble will a service technician have getting into the equipment if and when it ever requires repair? What about the quality of the parts used in its construction? And, perhaps most important of all, how does the unit *sound* when assembled with suitable associated components?

Quite an order! But **Radio-Electronics** intends to answer all of these questions in forthcoming test reports covering a variety of high fidelity components.

Test equipment we will use

A list of the test equipment needed to perform the myriad tests involved in checking high-fidelity component performance would be several pages long. There are a few items on that list that should be described, since they are crucial in any attempt to obtain accurate and meaningful performance measurements.

The key item in measuring FM performance is the FM generator used. It is the Sound Technology Model 1000A and with it we can measure signal strength, sensitivity and other related parameters down to 0.5 microvolts with great accuracy. This same generator enables us to produce composite mono and stereo FM signals with audio distortions of less than 0.1%. Stereo separation measurements can be made up to 50 dB, considerably better than the separation capability of most products we will be testing.

For those measurements which require the use of two generators, we will use a Boonton 202-H FM/AM generator. Such measurements include Capture Ratio, Selectivity and AM Suppression.

Many of our audio amplifier measurements, such as power output, distortion at various levels, frequency response and the like will be made using a McAdam Audio Analyzer, Model 2000A. Audio frequencies produced by this device have an inherent harmonic distortion of less than 0.02%, and a variety of accurate output readings can be made across built-in resistive load impedances of 4, 8 or 16 ohms, as well as 600 ohms or open circuit conditions.

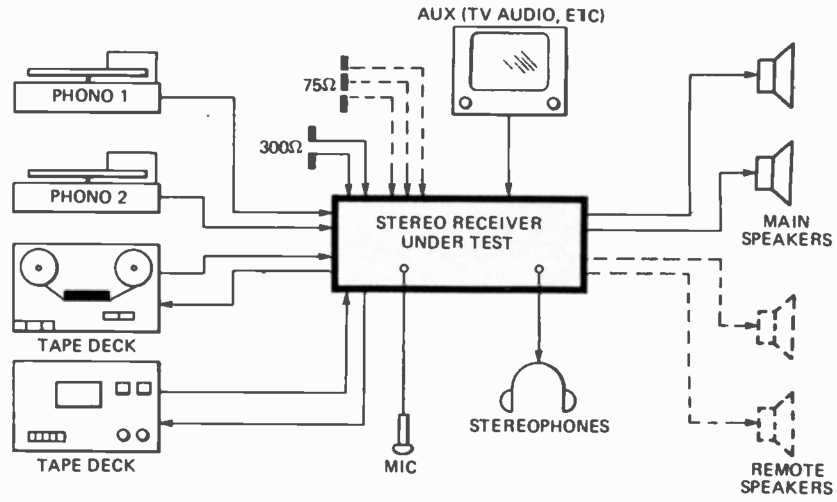
We will be using a variety of test records from such sources as CBS, RCA and Bruel & Kjaer in connection with our record player and phono cartridge testing, as well as such specialized devices as a cartridge analyzer developed by Shure Bros., strip chart recorders, dual-trace oscilloscopes by Hewlett-Packard, sound level meters from Scott Laboratories and much more.

All of the measurements we make would be fairly meaningless unless we can present them in a way which gives readers an immediate and easy-to-understand idea of how good the unit performs with respect to each particular measurement. Which brings us to the use of our newly developed Test Report Rating Charts.

A sample of our FM Performance Chart is in Fig. 1. Notice that as with all our charts, we have arranged sets of measurements in particular categories or families. Thus, all the measurements relating to fidelity and distortion are grouped together, as are stereo performance measurements, etc. After each measurement, **Radio-Electronics** will assign a verbal rating for the result, based upon the price classification of the particular equipment and upon a comparison of how that measurement compares with the same measurement made on comparably priced gear.

For example, a 1% harmonic distortion reading obtained at 1 kHz in mono might earn a barely acceptable rating in an expensive stereo receiver selling for over $400.00. The same measurement, obtained from an under-$100 tuner might merit a "good" rating. The non-technical reader will find useful information in the chart even if he is not familiar with all the specifications we list thanks to our verbal rating system.

In addition, evaluations of control features and product flexibility, quality of construction and layout will be given purely verbal ratings, since these things are not subject to numerical test results. Finally, an overall product rating (in this case FM performance) will be assigned.



2

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	______	______
RMS power/channel, 8-ohms, 20 Hz (watts)	______	______
RMS power/channel, 8-ohms, 20 kHz (watts)	______	______
RMS power/channel, 4-ohms, 1 kHz (watts)	______	______
RMS power/channel, 4-ohms, 20 Hz (watts)	______	______
RMS power/channel, 4-ohms, 20 kHz (watts)	______	______
Frequency limits for rated output (Hz-kHz)	______	______
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	______	______
Intermodulation distortion, rated output (%)	______	______
Harmonic distortion at 1-watt output, 1 kHz (%)	______	______
Intermodulation distortion at 1-watt output (%)	______	______
DAMPING FACTOR, AT 8 OHMS		
PHONO PREAMPLIFIER MEASUREMENTS	______	______
Frequency response (RIAA ± ___ dB)	______	______
Maximum input before overload (mV)	______	______
Hum/noise referred to full output	______	______
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± ___ dB)	______	______
Hum/noise referred to full output (dB)	______	______
Residual hum/noise (Minimum Volume) (dB)	______	______
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. ___	______
Action of secondary tone controls	See Fig. ___	______
Action of low frequency filter(s)	See Fig. ___	______
Action of high frequency filter(s)	See Fig. ___	______
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, Phono 1/Phono 2 (mV)	______	
Input sensitivity, Auxiliary input(s) (mV)	______	
Input sensitivity, Tape input(s) (mV)	______	
Output level, Tape output(s) (mV)	______	
Output level, Headphone jack(s) (V or mW)	______	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		______
Adequacy of input facilities		______
Arrangement of controls (Panel Layout)		______
Action of controls and switches		______
Design and construction		______
Ease of servicing		______
OVERALL AMPLIFIER PERFORMANCE RATING		______

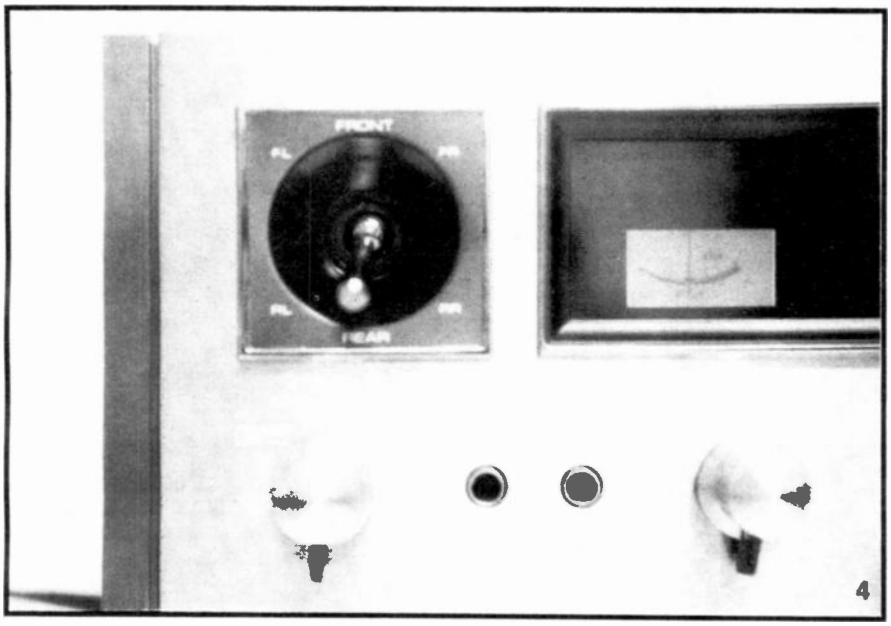


FIG. 3. AMPLIFIER PERFORMANCE MEASUREMENTS

POWER OUTPUT CAPABILITY: All **Radio-Electronics** power output measurements will be made on the basis of continuous (RMS) power and will include readings at low, mid and high frequencies for both 4-ohm and 8-ohm load conditions. Readings should then be compared with manufacturer's claims which appear at the beginning of each report. Range of frequencies over which full power can be obtained at or below rated harmonic distortion will also be noted. *All power measurements will be made with all channels operating and delivering equal power, after pre-conditioning tests (as required by the FTC rules governing power output claims for audio products).*

HARMONIC AND IM DISTORTION: Measured at manufacturer's stated power output level and at 1 watt. The lower the results the better, but figures listed should be compared with manufacturer's claims, since some base power ratings are on higher rated distortion levels than others.

DAMPING FACTOR: Higher damping factors restrain speaker's motion when audio signal stops abruptly. Damping factor should be at least 15, and numbers higher than 50 or so offer little audible improvement and are generally wasted because the resistance of speaker wires (unless heavy gauge cable is used) effectively subtracts from the high values of damping factor available at the amplifier's output terminals.

PHONO PREAMP CHARACTERISTICS: Include frequency response which should conform closely to the standard RIAA (Record Industry Association of America) playback curve. We show maximum deviation from this response in dB, and the lower the figure the better. With today's records containing great dynamic range (difference between softest and loudest musical passages) it is important that phono inputs be able to handle high inputs before distortion in these low level stages occurs. If distortion occurs at the preamp stage, no amount of volume control reduction will help the problem, since the distortion has now become part of the signal being controlled. Therefore, a high overload number (in mV) is better and should be at least 20 or 30 times the nominal input sensitivity listed later in the chart. Our hum and noise measurements are always referred to input sensitivity, rather than to some arbitrary number of millivolts. For this reason, we may read "poorer" (lower) numbers than manufacturers claim, but main text will always describe hum level in qualitative terms as well.

All RMS measurements are for *rated* distortion. Phono hum measurements are in dB. The input capacitance of most preamp circuits is insignificant compared to audio cable and tonearm wiring. Hum and noise are referred to **INPUT SENSITIVITY,** which *results* in full output. In other words, if input sensitivity is 2.0 mV, that value will produce full power output with all level controls full up and that's the way hum will be measured. As for high level input hum measurements, these will be made with all level controls full up, and therefore dB readings will be "below full output" based on maximum input sensitivity. The minimum volume hum measurement is also referred to the previously determined "full output" level and is given mostly to provide some indication of hum level of the main amplifier section alone.

HIGH-LEVEL INPUT MEASUREMENTS: Include frequency response (which should have the least deviation over the useful range from 20 Hz to 20 kHz), hum and noise (which should have the highest number of dB's as possible) and residual amplifier noise, in which, again higher dB numbers are better.

TONAL COMPENSATION MEASUREMENTS: In addition to stating range of bass, treble (and such other tone controls as appear) controls, test reports will include graphs showing tone control action. Too much range here is not necessarily a virtue, since overuse of tone controls can cause distortion and overdriving of amplifiers. Pivot frequencies and the way in which the tone controls behave is more important than absolute total range of control—hence the more definitive graphs. High and low filter circuits, designed to reduce scratch and rumble, will also be plotted in graphic form, since many accomplish little more than the tone controls while some provide useful scratch and rumble attenuation with a minimum sacrifice in musical content.

COMPONENT MATCHING MEASUREMENTS: These are given for reference and to enable you to choose matching component properly, rather than as a qualitative listing. For example, one should not choose a 2.0 mV phono cartridge to use with an amplifier having a nominal phono input sensitivity of 4.0 mV, etc.

How the component fits into a total system

If a picture is worth a thousand words, so is a simple diagram, especially if it can show at a glance how a given high-fidelity component can be used in an entire system. Figure 2 is typical of those we will include with each product test report. It would take several paragraphs to detail everything in that diagram. At one glance we see what additional components can be connected to the receiver, how many phonograph input facilities there are, how many tape machines can be used at one time and much more. We also learn from the diagram just where the component under discussion fits into the entire high fidelity scheme of things.

Incidentally, we will use the same Rating Chart for FM performance whether the FM circuitry is part of a separate FM tuner or part of an overall integrated receiver. The same thing applies to amplifier performance measurements and the Rating Chart shown in Fig. 3. Conversely, if we were testing a basic power amplifier (one with no controls or preamplifier circuitry), those items relating to preamplifier and control performance in Fig. 3 would not appear, but the same chart format will be used. Readers unfamiliar with some of the terms used in measuring these electronic components will find brief explanations in the text appearing below Figs. 1 and 3.

Where we encounter a novel or worthwhile feature on the control panel of a given product, we will try to present a close-up view of that feature for greater clarity. It has been our feeling that the overall product photos accompanying most test reports in the past have been so reduced in size (in the interest of conserving space) that readers cannot hope to inspect the details of the front panels from such pictures. Our close-ups, where applicable, should help. (See example, in Fig. 4).

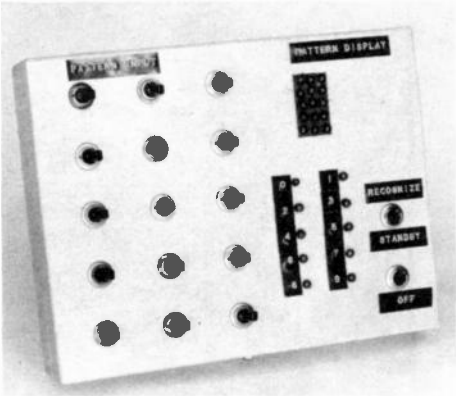
An overall amplifier performance rating will appear at the conclusion of the amplifier performance measurement rating chart even if the amplifier is part of an all-in-one receiver. In that way, the reader can easily separate tuner section and amplifier section performance, since very often these two major sections of a stereo or 4-channel receiver do not measure up equally.

Similar performance rating charts have been created for the evaluation of such other high fidelity component products as open-reel tape decks, cassette tape decks, phonograph cartridges and record playing equipment. The notes accompanying each of these charts will help acquaint you with the relative importance of the measurements we make.

(continued on page 72)

make your own reading computer

This device demonstrates how a computer recognizes characters. It can recognize and identify the numerals 1 through 9



by JOSEPH BRAUNBECK

THE ABILITY TO RECOGNIZE PATTERNS is one of the most impressive features of modern electronic computers. While their ancestors had to get every bit of data via punched card or tape, modern computer systems are able to read numbers and letters, printed or even handwritten. They can recognize star patterns for navigation or search acres of aerial reconnaissance film for the deadly patterns of tanks and rockets. How is this done? Usually a special peripheral unit, called a reading computer, is attached to the central processor of a large computing system. The following description shows how to build a demonstration model of such a reading computer. The relation of this model to a reading computer capable of reading about 3000 characters-per-second is about the same as that of a July-4-fireworks rocket to a Saturn V. Nevertheless this little box containing 17 toggle switches and 25 lamps gives a good idea of what is meant by the term "artificial intelligence."

A practical reading computer

To make this a simple device, I limited the number of patterns to be recognized to the shapes of the numerals 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.

There is a fairly large number of reading computers, so called "document readers," which are also specialized in reading numerals. For example, magnetic ink inscriptions on checks consist of numbers and a few special symbols only.

A reading computer for practical use has a rather complicated mechanism to transport the paper or film to be scanned towards and away from the scanner at high speed. The scanner locates the shapes to be recognized and converts them into electrical signals.

To keep the investment in money and work within the experimenter's reach, I omitted the mechanical transport as well as the scanner and prefer

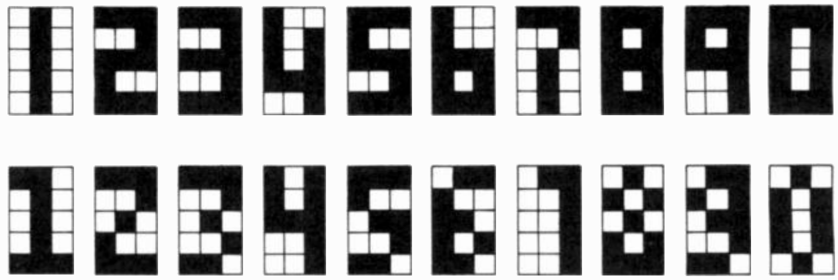


FIG. 1—A FEW RECOGNIZABLE NUMBERS that can be generated with a 15-dot matrix.

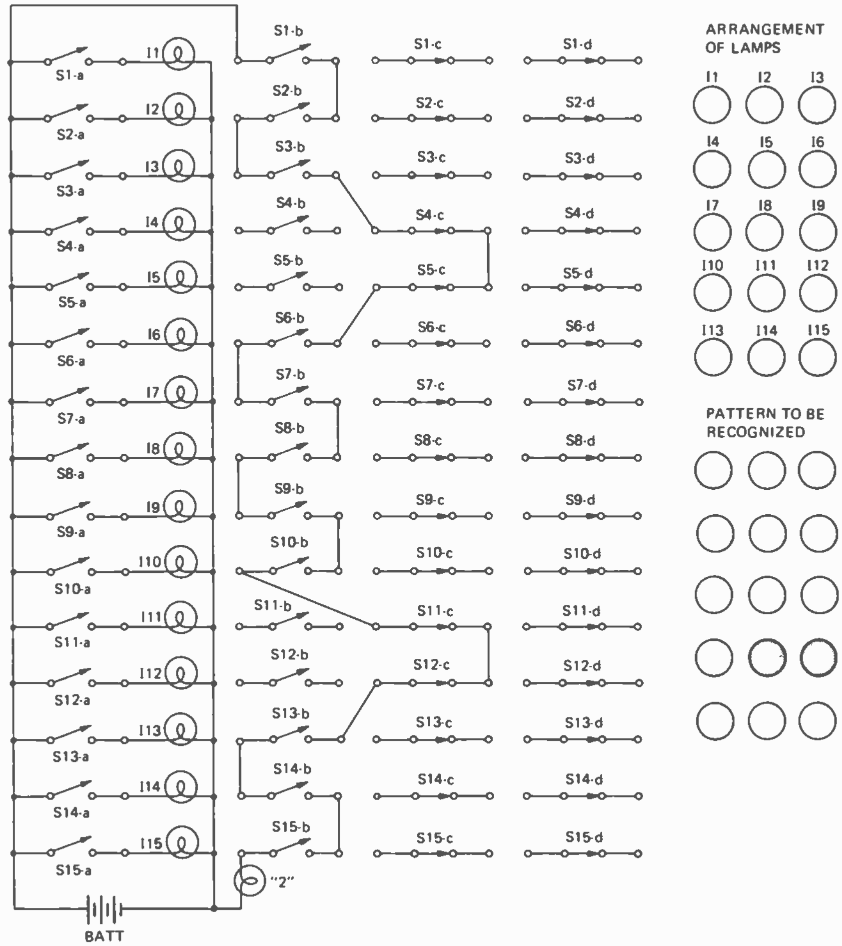
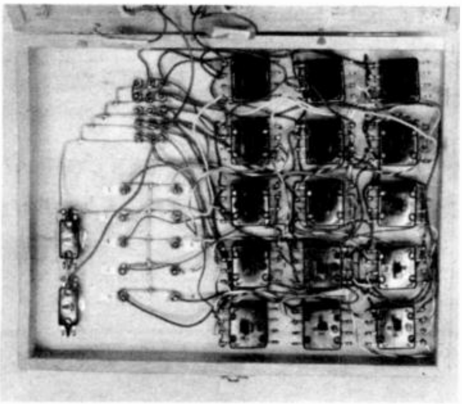


FIG. 2—THIS CIRCUIT WILL ONLY RECOGNIZE the pattern "2". It is an impractical circuit due to the number of switches that would be necessary to recognize all ten numbers.

PARTS LIST

S1 thru S15—4PDT toggle switches (see text)
S16, S17—SPST toggle switches
I1 thru I25 — sub-miniature lamps 6V, 40mA (Hudson #1730, Sylvania #342, GE #1730D or equiv.—see text)
BATT—6V, 800mA (see text)



pattern input by hand.

In each reading computer, the pattern to be recognized is checked against a number of stored patterns. The stored pattern most similar to the incoming one, is then transmitted to the central processor unit of the computing system. Sometimes, for greater flexibility, the reading computer does not store the complete patterns, but only the characteristic features. We will duplicate this part of the reading computer using the cheapest logic circuit elements available— switches.

As the average experimenter does not own a computer, our demonstration model has no computer output interface. If a pattern is recognized, the device shows its meaning by lighting one of ten lamps.

As mentioned earlier, pattern input is done by hand. That means that the pattern is composed of a number of lamps, that are switched on and off individually. Again, we have to think of our budget.

What is the minimum number of dots to form the shapes of the numeric characters 0-9? Experience shows, that you need at least 15 dots, 5 lines of 3 dots each. Believe it or not, you can compose 32,768 different patterns by choosing each of the dots to be black or white. Figure 1 shows a few numbers composed of 15 dots.

The circuit for realizing a 15 dot pattern input is shown in the left side of Fig. 2.

Fifteen switches are connected to 15 miniature lamps I1 through I15. For the sake of convenience, the switches are arranged physically in the same manner as the miniature lamps. Now, by switching the lamps on and off, any of the 32,768 patterns can be realized and is promptly displayed by the lamps. But how can it be recognized? The answer is to use switches with more than one contact. This device uses double-throw switches that close two contact pairs in one position, and two in the other position. So switch S1 has two contact pairs labelled S1-a and S1-b in the circuit that close when lamp I1 is switched on. And also has two contact pairs labelled S1-c and S1-d that close when lamp I1 is switched off. If such switches are used, there is a total of 60 contact pairs available. Figure 2 now shows a very straightforward approach to pattern recognition. While 15 contact pairs are used to display the pattern by means of lamps, there are 15 more contact pairs wired in such a manner, that the lamp labelled "2" is only energized if the display lamps I1 to I15 form the pattern of a "2" like that shown beside the circuit.

This straightforward approach has two disadvantages. The first is, that we have already used 30 of 60 contacts for recognizing only one shape. We would run into difficulties if we tried to wire all 10 numerals into the 15 switches. The second disadvantage is, that the device still is extremely stupid. If, for example, lamp I3 is extinguished, a human observer would still consider the pattern to be a "2". The machine, wired as in Fig. 2, would not be able to recognize it.

Both difficulties may be overcome if we do not store complete patterns but only essential features of numeric characters. For example, a "2" is sufficiently described if we say that lamps I4, I5 and I12 have to be switched off in any pattern in order to make it look like a "2", while I1 and I15 have to be switched on. Then, with only 60 contact pairs at our disposal, we cannot afford the luxury of using contact pairs only to switch display lamps. Furthermore, the wiring may take into account features common to two different characters. This too, saves contacts.

A circuit based on these principles is shown in Fig. 3. This device is able to recognize a variety of shapes by lighting the appropriate lamp. It does not use all the contact pairs that are available, so that there is enough room left to incorporate additional ideas.

Beside the on/off switch, there is another one labelled STANDBY/RECOGNIZE. This switch, which simply switches the bank of output lamps, adds much to the impressive perform-

(continued on page 78)

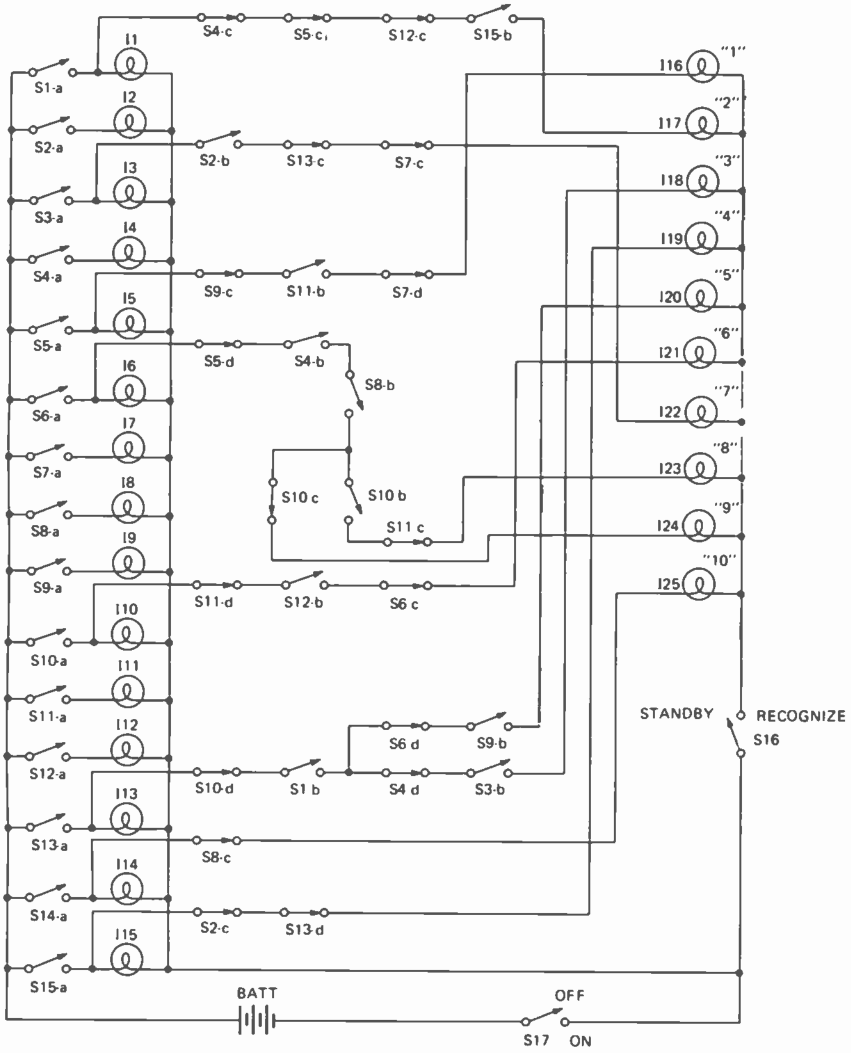


FIG. 3—PRACTICAL CIRCUIT that will recognize all ten numbers. This circuit reduces the number of switch contacts by recognizing only the essential features of numeric characters.

All About CD-4

Present day CD-4 cartridge technology has gone in technology. Here's a look at several manufacturers

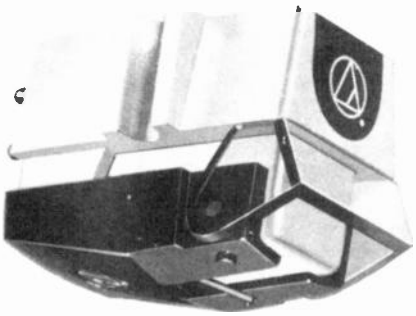
THE DEVELOPMENT OF THE COMPATIBLE Discrete 4-channel (CD-4) quadriphonic system placed demands on the phonograph cartridge that were unheard of a little more than five years ago. In the stereo recording system, developed in the late 1950's, each of the walls carries one of the two stereo program channels. The major requirement of the stereo cartridge is that its stylus follow faithfully the undulations in the groove walls and develop output signals that are replicas of the signals recorded in the wall grooves. The stylus/cartridge assembly is designed for faithful reproduction of signals from about 20 Hz to 20 kHz.

The CD-4 recording and playback system is similar in some respects to FM multiplex stereo broadcast and reception. Each wall of the record groove carries a single channel of information—left-front plus left-rear on the inner wall and right-front plus right-rear on the outer wall of the groove. In addition, each groove wall carries a 30-kHz FM subcarrier that is modulated by the front-minus-back difference signals that are needed to decode or demodulate the quadriphonic signal into four discrete channels. This is illustrated in Fig. 1. Thus, the signal on each groove wall consists of the 20-15,000-Hz front-plus-rear sum signal with the piggyback 30-kHz subcarrier modulated by the front-minus-rear difference signal. From this discussion and Fig. 1, we see that a CD-4 cartridge and stylus assembly must respond accurately to signals as high as 45 kHz—the 30-kHz subcarrier frequency plus a maximum deviation of 15 kHz. Optimum design for a CD-4 cartridge aims at a response out to 50 kHz.

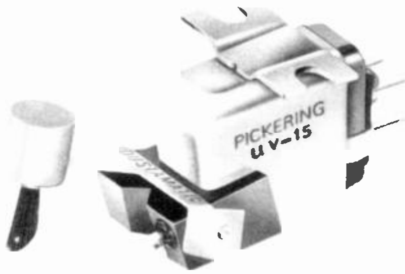
A new stylus is needed

Conventionally, the standard stereo stylus has a spherical tip with a radius of 0.7 mil (0.0007 inch) radius. But, this is too large for accurate tracking of high frequencies, particularly in the grooves near the center of the record.

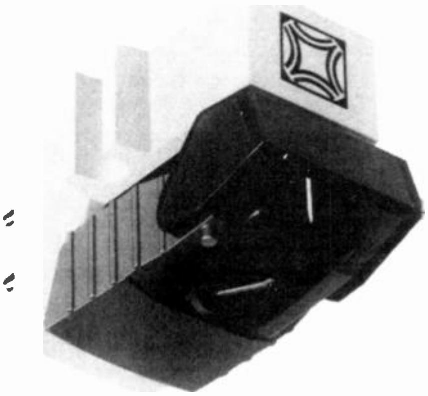
Reducing the tip radius to, say, 0.5 mil, improves high-frequency response at the cost of groove deformation and in-



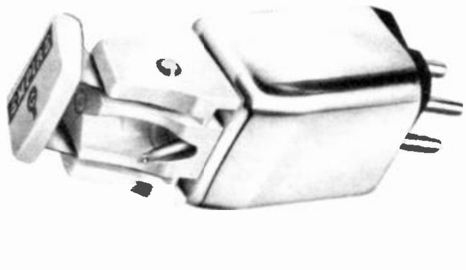
AUDIO TECHNICA AT15S and AT20SL



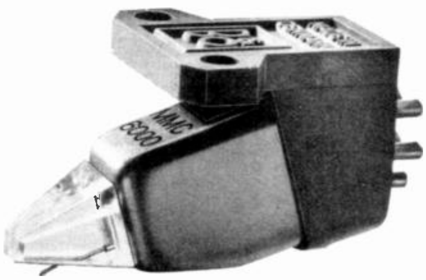
PICKERING UV-15



JVC 4MD-20X



EMPIRE 4000D series.



BANG & OLUFSEN MMC-6000

creased record wear. The reasoning behind this is simple. With smaller stylus tip radius, the weight of the cartridge assembly is now concentrated in a smaller area of the groove and the damage (wear) is greater. So, a few years ago, cartridge manufacturers developed an eliptical stylus for stereo cartridges with a radius of around 0.7 mil across the groove and about 0.2 mil in the direction of the groove. A comparison of spherical and elliptical stylii in record grooves is shown in Fig. 2.

The elliptical stylus does not track the 30-kHz subcarrier very well and a further reduction in tip radius would result in increased record wear—particularly in the area of the subcarrier modulations.

The solution to this problem has been the development of the Shibata (and Shibata-type) stylus—a concept in which the tip radius is reduced to 0.2 to 0.3 mil while the area of the stylus in contact with the record groove is increased over

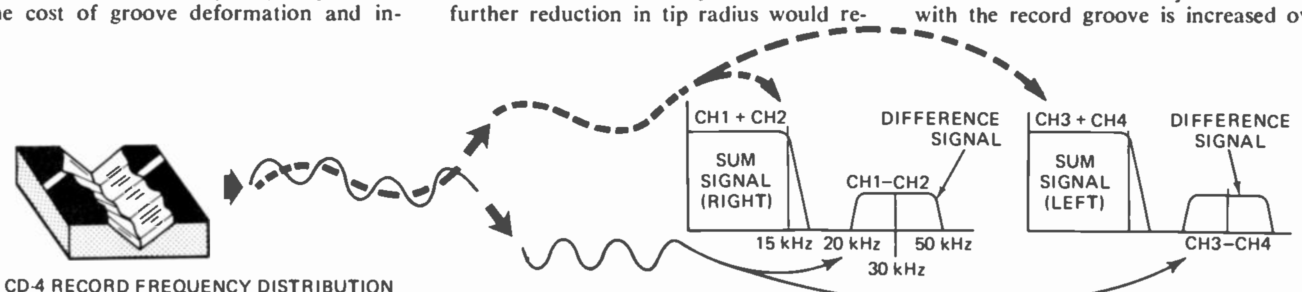
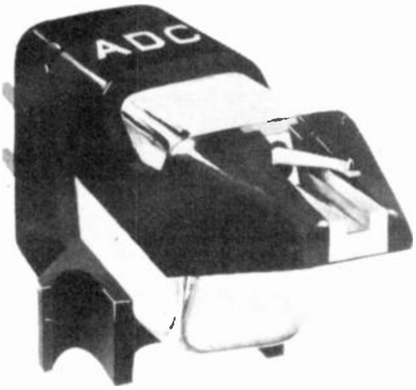


FIG 1—HOW SIGNAL FREQUENCIES ARE DISTRIBUTED on a CD-4 disc. The pickup must have response out to 45 kHz so it can respond to the full deviation of the 30-kHz frequency-modulated subcarrier.

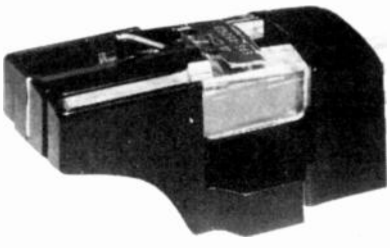
Phono Cartridges

many different directions, as did stereo cartridge and their approach to producing a CD-4 cartridge.

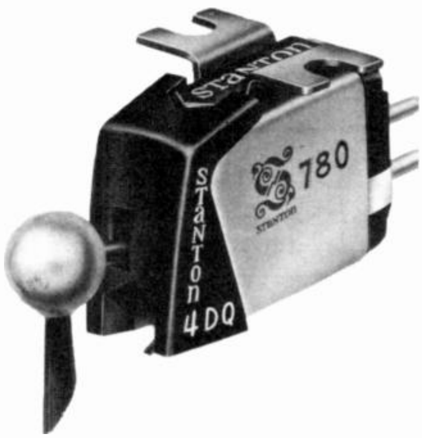
by ROBERT F. SCOTT
TECHNICAL EDITOR



AUDIO DYNAMICS ADC-XLM and ADC-VLM



TECHNICS EPC-450C-II



STANTON 780/4DQ

MICRO-ACOUSTICS QDC-1

four times. This reduces pressure at the point of contact and is said to not only provide faithful tracking out to 45 kHz but also reduce record wear and prolong stylus life.

What about the cartridge?

When the CD-4 record hit the market, there were several high-quality stereo cartridges with claimed response out to 30 kHz. The CD-4 cartridges available today are generally top-of-the-line stereo cartridges with mechanical innovations

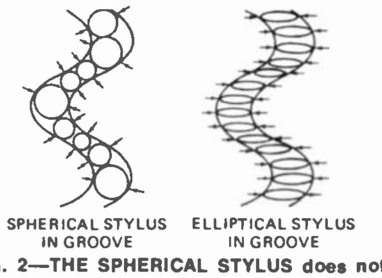


FIG. 2—THE SPHERICAL STYLUS does not track well at high frequencies unless its tip radius is reduced to about 0.5 mil. This increases record wear. An elliptical stylus gives excellent tracking at high frequencies with minimum deformation and wear on the record grooves.

made to improve (1) high-frequency response, (2) smoothness at the extremely high frequencies to insure distortion-free recovery of the subcarrier and (3) high-frequency channel separation—poor channel separation results in FM beat distortion between channels rather than linear crosstalk as is common in matrix-type quadriphonic systems.

(Basically, these improvements are the result of reducing the mass of the mechanical or moving elements in the system. The lower the mass, the higher the resonant frequency and increasing the resonant frequency improves both the high-frequency response and high-frequency separation.)

What about cartridge construction?

Modern cartridges develop output voltages that are either proportional to the *amplitude* or *velocity* of stylus motion. Amplitude-proportional cartridges include crystal and ceramic (piezoelectric), strain-gauge (piezoresistive) and electret (electrostatic capacitor and voltage-variable) types.

Velocity-proportional cartridges develop output voltages proportional to the *product of amplitude and frequency*. In a constant-amplitude groove, the output voltage is proportional to frequency. The various forms of magnetic cartridges (moving-iron, moving-magnet, moving-coil, induced-magnet and variable-reluctance) are all velocity-proportional types. The output voltage developed by magnetic cartridges is generated by varying the strength of a magnetic field surrounding a coil or by varying the position of the coil in a fixed magnetic field. The construction of some of these amplitude-proportional and magnetic cartridges will now be covered in more detail.

Electret cartridges

The electret can be considered as a permanent electrostatic equivalent of a permanent magnet. It is a permanently polarized dielectric device. Two different design approaches are used in the Micro-Acoustics QDC-1 and Toshiba C-404X cartridges.

Figure 3 shows the basic structure of

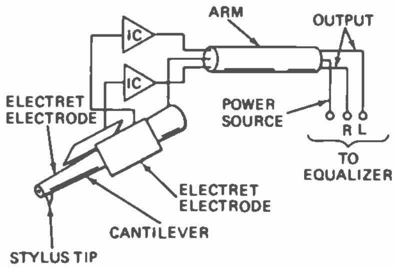


FIG. 3—THE ELECTRET CARTRIDGE by Toshiba uses two electrets as fixed plates of two capacitors. Movement of the stylus cantilever develops varying electrostatic voltages that are amplified by IC's built into the cartridge.

the Toshiba electret capacitor cartridge. The tapered cantilever that holds the stylus tip is the movable element of two charged capacitors—one in each channel. It is positioned between two electret electrodes mounted at a 90° angle so they are perpendicular to the walls of the record groove. As the stylus moves, the capacitance between the cantilever and each electrode varies, developing an electrostatic voltage that is amplified by two IC's built into the cartridge.

The Toshiba C-404X—to be marketed in June—will be supplied with an equalizer/preamp that provides flat frequency response so it works through a CD-4 demodulator into the AUX inputs of a 4-channel receiver or amplifier. The preamp/equalizer also reverses the phase of one of the channels.

The circuit in Fig. 4 is the equalizer/preamp for the Toshiba C-410C stereo cartridge. The equalizer/preamp for the C-404X will probably include a CD-4 decoder circuit or will be designed to work into one.

Micro-Acoustics QDC-1

Figures 5, 6 and 7 illustrate the construction and operation of the QDC-1 electret cartridge by Micro-Acoustics. Basically, stylus motion varies the instantaneous pressure on the two electret transducers—one for each channel. The transducers are suspended from damping blocks mounted at the top of the cartridge assembly. When the electret is flexed, there is a change in the standing polarizing voltage between two opposing surfaces. The output voltage is the exact analog of the mechanical vibrations coupled to the electret by the stylus. A passive network converts the output to the characteristics of a typical magnetic cartridge so the QDC-1 can be used as a direct replacement.

Figure 6 shows how the cantilever or stylus bar connects to the resolver or coupling device at a pivot point common to the vertical and horizontal axis. The coupler has four points of force transmission equidistant from the pivot point. Two are the two elastomer members fastened to the base of the cartridge. The two top resolver force points are on the two electrets.

Motion imparted to the stylus bar by right-channel modulations causes the resolver to rotate about the "L" axis, so pressure is applied to the right transducer. Conversely, only the left transducer is excited when only the left channel of the record groove is modulated.

When both channels are modulated out-of-phase, stylus motion is vertical and both transducers are excited by equal pressures developed around the X-X axis. When both channels are modulated by in-phase signals, the resultant action is lateral around the Y-Y axis—resulting in alternately increasing and decreasing pressure on the transducers. The action of the resolver on the transducers during other groove-modulation conditions can be determined by studying Fig. 7.

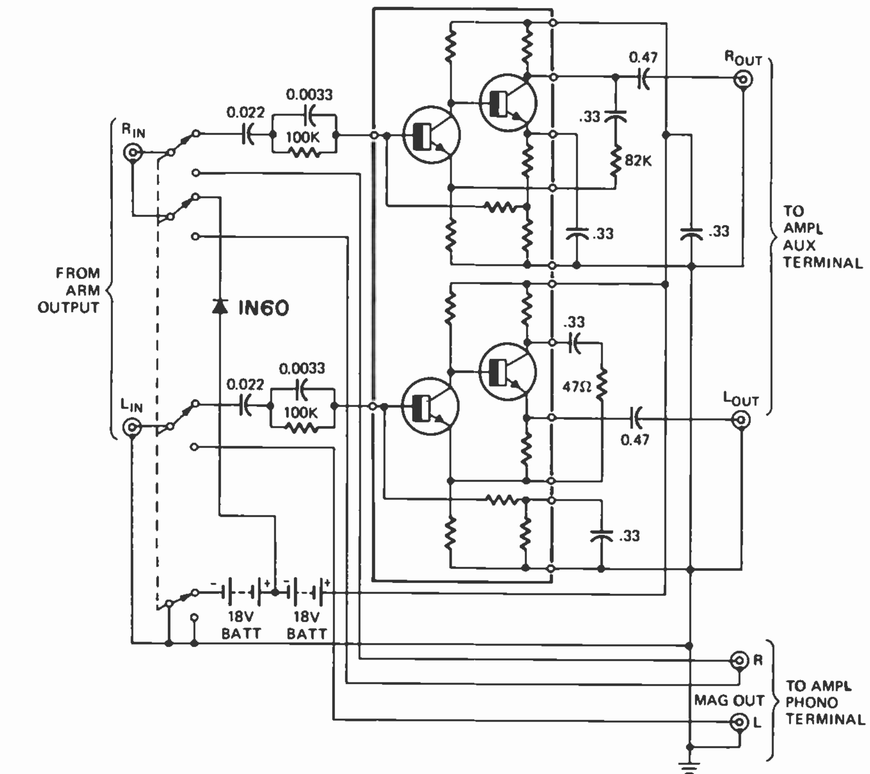


FIG. 4—EQUALIZER/PREAMP for Toshiba C-410C electret stero cartridge. A CD-4 decoder will probably be included in a similar unit made especially for the Toshiba C-404X cartridge.

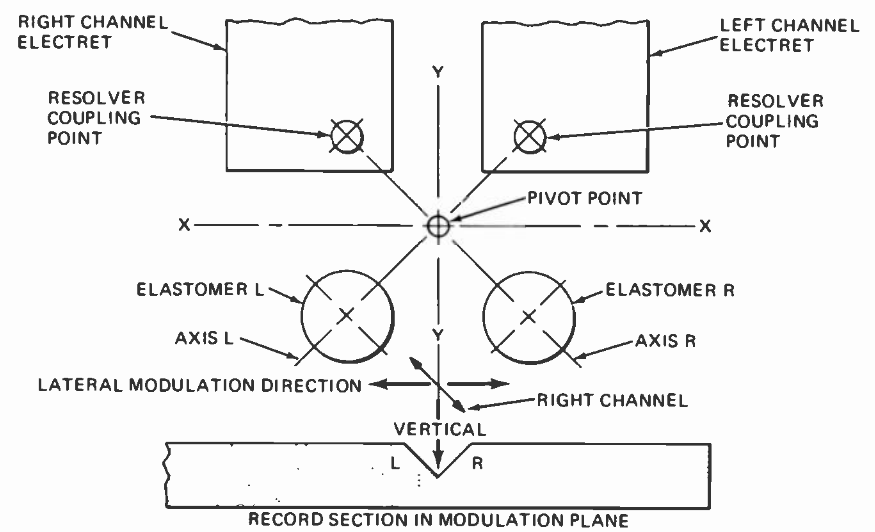


FIG. 6—RESOLVER GEOMETRY illustrates how resolver exerts varying pressures on the electrets in response to record groove modulation in the QDC-1 cartridge.

The strain-gauge cartridge

The EPC-450C-II is Panasonic's 4-channel version of an earlier *piezoresistive* semiconductor stereo cartridge. Its construction is shown in Fig. 8. The cartridge operates like a strain-gauge—a resistive measuring device that converts pressure or tension into an electrical signal. As the stylus swings, the Micro-Coupler (resolver) presses alternately against the two piezoresistive silicon transducers so their resistance changes with pressure. Resistance change alone is not enough to develop an output signal so about 4 volts DC bias is supplied to each transducer by the CD-4 demodulator. Normal current through the strain-gauge sensors is about 3.5 mA with swings to 7 mA with maximum groove modulation.

The EPC-450C-II works directly into the model SH-405-II CD-4 demodulator or into any Technics quadriphonic receiver that has a built-in CD-4 demodulator. Since the cartridge does not generate a signal within itself, the output cables are not frequency sensitive and there is no high-frequency loss due to cable capacitance as is the case with most magnetic cartridges.

(Most CD-4 cartridges work into fairly high impedances so ordinary shielded audio cables have enough stray capacitance to seriously attenuate frequencies above around 20 kHz. This causes carrier drop-out, resulting in noise and poor separation. Special low-capacitance audio cables to run from the cartridge to the demodulator input are available from most cartridge makers.)

Figure 9 shows the basics of the input circuits in the Technics CD-4 demodulator. The outputs of the two cartridge channels are out of phase and cannot be changed by exchanging connections to the + and − cartridge terminals. There-

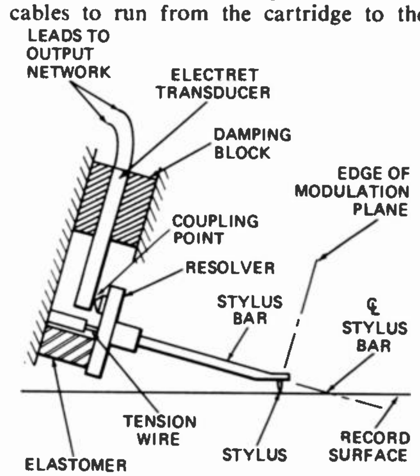


FIG. 5—SIDE VIEW showing basic construction of the QDC-1 electret cartridge by Micro-Acoustics. Stylus bar exerts pressure on two electret elements through resolver bar.

Manufacturer	Model Number	Type of Operation (see code)	Frequency Response (Hz)	Separation (dB @ 1 kHz)	Separation (dB @ 30 kHz)	Stylus Type (see code)	Tracking Force (Grams)	Weight (Grams)	Output (mV)	Recommended Load Resistance	Price
Audio Dynamics Corp. Pickett District Rd., New Milford, CT 06776	Supex XLM-MkII	IM	15—50,000[4]	28	25	S	0.75—1.5	5.75	0.6[5]	47K/200pF	$125.00
Audio Technica U.S. 33 Shiawassee Ave. Fairlawn, OH 44313	AT—12S	DMM	15—45,000	25	15	S	1.0—2.0	6.9	0.54	47K—100K	$ 64.95
	AT—14S	DMM	5—45,000	25	15	S	1.0—2.0	6.7	0.54	47K—100K	$ 75.00
	AT—15S	DMM	5—45,000	25 (min.)	15 (min.)	S	1.0—2.0	8.5	0.54	47K—100K	$100.00
	AT—20SL	DMM	5—50,000	25 (min.)	15 (min.)	S	1.0—2.0	8.5	0.54	47K—100K	$175.00
Bang & Olufsen of America 2271 Devon Ave., Elk Grove Village, IL 60007	MMC 6000	MI	20—45,000	25 (min.)	15 (min.)	O[1]	1.0	5.5	0.6	100K/100pF	$ 85.00
Benjamin Electronic Sound Co. 40 Smith St., Farmingdale, NY 11735	ELAC STS-655-D4	MM	10—50,000	26	20	S	1.0—2.0	6.0	0.8	47K—100K	$100.00
Empire Scientific Corp. 1055 Stewart Ave., Garden City, NY 11530	4000D/I	MI	5—50,000	27	20	O	1.0	7.0	3.0[3]	100K	$ 89.95
	4000D/II	MI	5—50,000	30	23	O	1.0	7.0	3.0[3]	100K	$124.95
	4000D/III	MI	5—50,000	35	25	O	1.0	7.0	3.0[3]	100K	$149.95
Hitachi Sales Corp. of America 401 W. Arista Blvd., Compton, CA 90220	MT-14F[8]	DMM	20—45,000	NA	NA	S	2.0	NA	1.5—2.5[9]	NA	$350.00[8]
JVC America 50-35 56th Road, Maspeth, NY 11378	4MD-20X	MM	20—60,000	30 (min.)	20 (min.)	S	1.5—2.0	4.0	25.[4]	47K—100K	$ 49.95
Micro-Acoustics Corp. 8 Westchester Plaza, Elmsford, NY 10523	QDC-1q	EC	5—50,000	30	15	O	1.0—2.0	7.0	3.0[6]	47K	$120.00
Panasonic 200 Park Ave., New York, NY 10017	EPC-450C-II	SG	0—50,000	20	15	S	1.5—2.5	3.8	NA[7]	100K	$ 64.95
	EPC-451	SG	0—50,000	20	15	O	2.0—3.0	3.8	NA[7]	100K	$ 50.00 (app.)
Pickering & Co. 101 Sunnyside Blvd., Plainview, NY 11803	UV-15/2400Q	MI	10—50,000	35	20	O	1.5—2.5	6.0	0.6	100K/100pF	$124.95
	UV-15/2000Q	MI	10—45,000	30	20	O	1.5—2.5	6.0	0.6	100K/100pF	$ 69.90
Stanton Magnetics, Inc. Terminal Drive, Plainview, NY 11803	780/4DQ	MI	10—50,000	35	20	O	1.5—2.5	6.0	0.6	100K/100pF	$125.00
	780/Q	MI	10—45,000	30	20	O	1.5—2.5	6.0	0.6	100K/100pF	$ 75.00
Toshiba America, Inc. 280 Park Ave., New York, NY 10017	C-404X	EC	20—50,000	25	15	O	1.0—2.0	6.5	10	NA	NA
U.S. Pioneer Electronics Corp. 75 Oxford Drive, Moonachie, NJ 07074	PC-Q1	IM	10—50,000	25	20	O	1.0—2.1	5.5	0.4	100K	$ 69.95

Codes:
DMM—dual moving magnet
EC—electret capacitor
IM—induced magnet
MC—moving coil
MI—moving iron
MM—moving magnet

NA—data not available or not applicable
SG—Strain gauge
O—multi-radial stylus, similar to Shibata type
S—Shibata stylus

1—Cartridge must be returned to manufacturer for stylus replacement.
2—@ ±2.5dB
3—@ 3.54 cm/sec.
4—@ ±5dB
5—@ 1 cm/sec.
6—@ 5 cm/sec.
7—Requires external DC source
8—Cartridge not sold separately. Available only as a part of the PS-14 turntable and CD-4 demodulator combination
9—@ 1kHz; 1.5—3.5 mV at 30 kHz

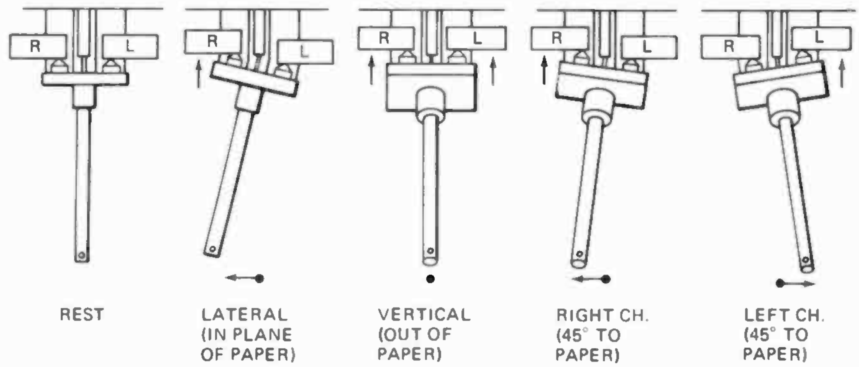


FIG. 7—STYLUS BAR MOVEMENT is transmitted through resolver in response to lateral and vertical movement of the stylus tip.

fore, the phase of one channel is reversed by a phase inverter included in one of the demodulator input channels as shown. Frequency response is 0 to 50 kHz with RIAA equalization. The demodulator has a switch that removes the bias voltage so it can also be used with any magnetic cartridge.

Magnetic cartridges

The induced-magnet cartridge system (the Pioneer PC-Q1, Fig. 10, for example) is similar to a moving-iron type in construction and operation. The induced magnet is a small slug of magnetic material placed between the pole pieces of magnets and driven by stylus motion. Stylus movement distorts magnetic coupling between the pole pieces and causes corresponding voltages to be generated in the pickup coils.

The classic moving-magnet system has a single magnet with two coil systems, each responsive to magnet movement in a single plane. Generally, the design requires a relatively large and heavy magnet structure that results in limted high-frequency tracking ability and reduced separation above around 10 kHz.

Audio-Technica's approach—employed in the AT20SL, AT15S and similar cartridges—is to use two small, light-weight magnets for reduced mass and extended high-frequency performance. The basic design of this cartridge series is shown in Fig. 11.

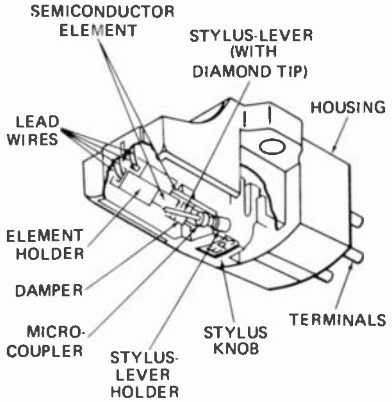


FIG. 8—A PIEZORESISTIVE SEMICONDUCTOR element is the heart of Panasonic's EPC-450C-II strain-gauge cartridge. Motion at the stylus tip varies the resistance of the transducers. A fixed bias voltage develops a current that varies with groove modulation.

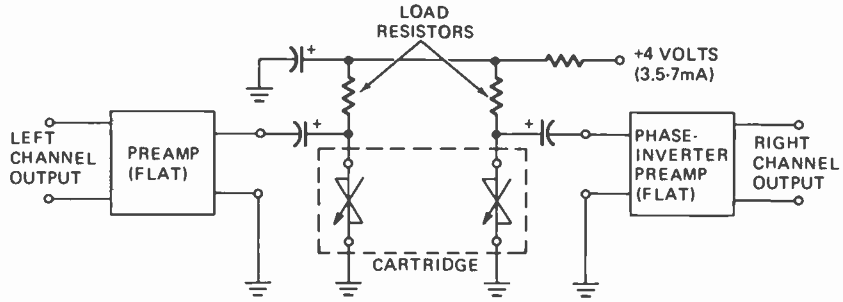
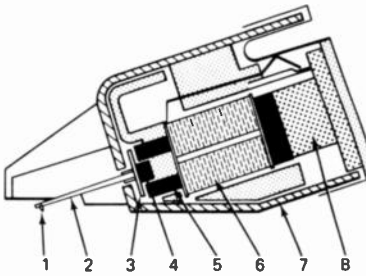


FIG. 9—PREAMPLIFIER for strain-gauge cartridge. Photoresistive elements are across preamplifier inputs and in series with load resistors and a bias supply. Two flat preamplifiers and a phase inverter feed signals to CD-4 demodulator circuits.

FIG. 12 (right)—CROSS-SECTION of the B&O MCC 6000 integrated CD-4 cartridge. The unit must be returned to the manufacturer for stylus replacement.



KEY

1. NUDE PRAMANIK (SHIBATA-TYPE) DIAMOND
2. LOW-MASS BERYLLIUM CANTILEVER
3. MOVING MICRO CROSS
4. BLOCK SUSPENSION
5. POLE PIECES (4)
6. INDUCTION COILS (4)
7. MU-METAL SCREEN
8. HYCOMAX MAGNET

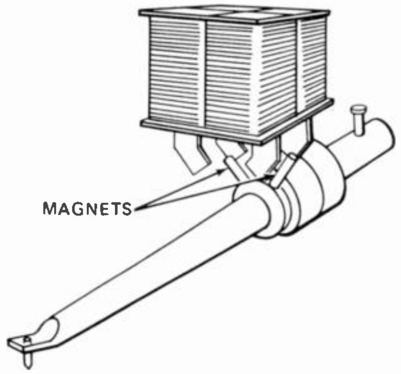


FIG. 11 (above)—DUAL MAGNETS driven by the stylus are features of the Audio-Technica cartridges.

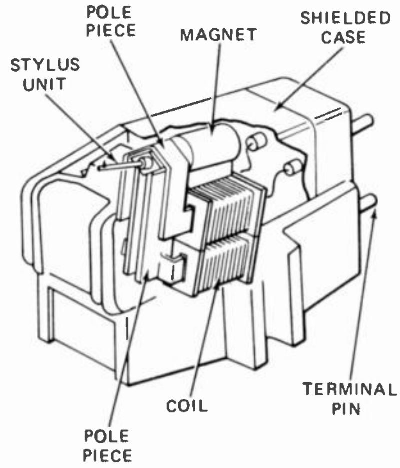


FIG. 10 (left)—BASIC CONSTRUCTION of the Pioneer PC-Q1 induced-magnet cartridge.

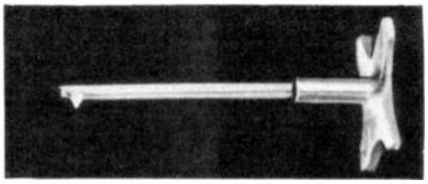


FIG. 13 (above)—STYLUS ASSEMBLY for the B & O cartridge. The "X" shaped element is the moving-iron armature that the maker calls the "Moving Micro Cross."

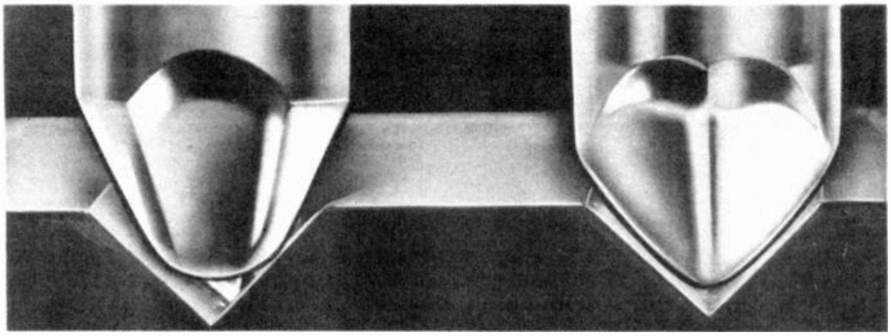


FIG. 14 (left)—MODELS OF TYPICAL STYLI contrast the contact areas of elliptical and multi-radial tip contours. The multi-radial type shown (right) is the Pramanik diamond used by Bang & Olufsen.

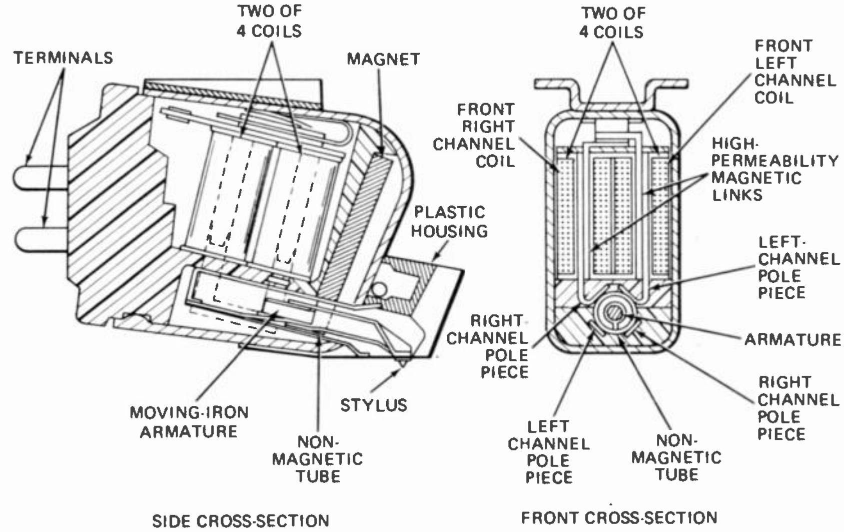


FIG. 15 (bottom left)—BASIC CONSTRUCTION of the Stanton and Pickering cartridges for stereo and CD-4 reproduction. The moving-iron armature is magnetized by its proximity to the permanent magnet fixed to the front of the cartridge housing. Armature motion induces signal voltages in the pairs of coils for the right and left channels.

The Bang & Olufsen MMC-6000 integrated CD-4 cartridge uses a moving-iron concept that B & O calls "Moving Micro Cross." The construction of the cartridge is shown in Fig. 12. The "X"-shaped armature and stylus assembly is shown in the photo in Fig. 13. In the original version of the Moving Micro Cross concept, introduced in 1958, the armature and stylus assembly weighed 2.6 mg. The assembly in the photo weighs only 0.22 mg.

The photo in Fig. 14 compares an elliptical stylus and the multi-radial Pramanik (Shibata-type) diamond stylus used by B & O in the MMC-6000.

(continued on page 94)

All About OSCILLOSCOPES

A new series of articles that presents oscilloscope fundamentals, examines specifications and features, and develops a series of applications

by CHARLES GILMORE*

THE OSCILLOSCOPE IS OFTEN LABELED the most valuable tool in the field of electronic measurement. While this may be an overstatement, it is so close to accurate that it is surprising to find many people using oscillocopes everyday without understanding the basic principles. Consequently, they fail to operate this instrument effectively.

Perhaps one of the reasons for this is that the price of high-performance oscilloscopes has been decreasing dramatically. The result of this change has been the virtual elimination of the sub $100 oscilloscope and the entrance of the high performance oscilloscope in the under $1,000 classification. For example, yesterday's television service technician either made do without an oscilloscope or, more likely, made do with a 3-5-MHz oscilloscope with recurrent sweep. The cost of this oscilloscope was probably between $50 and $250. Today, for slightly over $200, the service technician can purchase a 10-MHz triggered oscilloscope incorporating a calibrated vertical-attenuator and time base. Suddenly this technician is face to face with such items as sweep magnifiers, auto and normal triggering, trigger level controls, and a host of other specialized functions which did not exist on the simple 3-MHz recurrent-sweep oscilloscope.

Why make such a necessary tool so complicated? The answer lies in the oscilloscope's versatility, versatility brought about the complexity of controls.

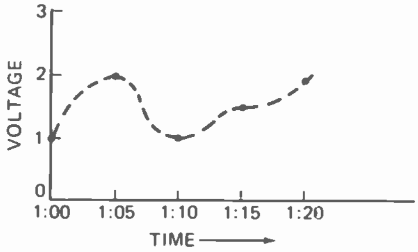
In this series of articles, I will review the fundamentals of an oscilloscope, examine specifications and features in detail, review operation of basic oscilloscope sections, and then develop a series of applications for oscilloscopes.

It is not within the scope of this article to discuss all the various types of oscilloscopes available today. The discussion is confined to instruments in the sub $1,000 class, mostly service instruments. Such items as specialized plug-ins, spectrum analyzers, and time-domain reflectometers, are not discussed.

*Design Engineer Heath Company, Benton Harbor, Mich.

Fundamentals

The often used phrase "A picture is worth ten thousand words," is directly applicable to the oscilloscope. This is especially true when we, as technically oriented people, realize that the graph is our most important picture. The oscilloscope presents a graphical display that, in its normal mode of operation, shows how a particular voltage changes with respect to time. For the simplest oscilloscope, not only must this voltage change in time, but it must also repeat these changes regularly in time. In other words, be periodic. Fortunately, the vast majority of signals within the electronic world do vary periodically. Of course a graph can be made by making the voltage measurements with some other instrument, say a digital voltmeter, and then plotting these numbers. A reading can be taken at 1:00 o'clock, 1:10, 1:15 and 1:20, and these can be plotted on a graph as shown in Fig. 1. This technique is tedious and is not easily applicable to rapidly changing signals. The oscilloscope provides this same graph with much greater speed and with much less tedium.



TIME	VOLTAGE
1:00	1.0
1:05	2.0
1:10	1.0
1:15	1.5
1:20	1.8
DATA	

FIG. 1—MEASUREMENTS CAN BE MADE without the aid of an oscilloscope by plotting measurements that were taken at predetermined points in time.

Figure 2 is a block diagram of a basic oscilloscope. The basic oscilloscope consists of a cathode ray tube (CRT), a vertical amplifier, a horizontal amplifier, and sweep circuits. Power supplies are used, but they are not shown in this elementary diagram.

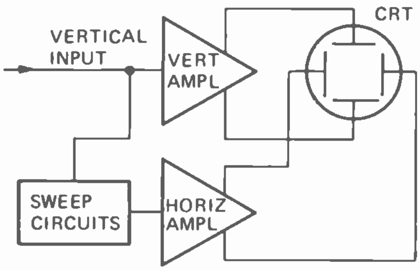


FIG. 2—BASIC OSCILLOSCOPE CONSISTS OF a vertical amplifier, sweep crciuits and horizontal amplifier driving a cathode-ray tube.

The amplifiers

The vertical and horizontal amplifiers increase small electrical signals sufficiently to deflect the electron beam either vertically or horizontally across the CRT. Typically, a CRT will require a voltage differential between its vertical plates of 100 volts if the beam is to be deflected across the tube. Input levels which will cause such a deflection will be more like 100-mV, thus requiring a gain of 1000 from the amplifier.

Sweep circuits

Sweep circuits are used to convert time to horizontal displacement on the face of the CRT. The sweep circuit generates a waveform which rises linearly

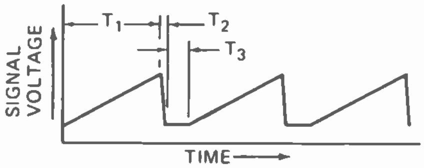


FIG. 3—SAWTOOTH OR RAMP WAVEFORM commonly used by the sweep circuits to provide horizontal displacement of the CRT beam.

with respect to time (Fig. 3–T_1) and then suddenly drops to its initial value (Fig. 3–T_2). It then waits for a period of time (Fig. 3–T_3) and begins to rise linearly again. This waveform is commonly called a sawtooth or ramp signal.

Generating a time base

When the sawtooth waveform is used to drive the horizontal amplifier, the initial beam position will be the left edge of the CRT. As the sweep circuit output voltage increases, the beam is driven to the right on the CRT. When the peak of the ramp is reached, the beam is at the right edge of the CRT. At this point the beam rapidly returns to the initial starting point as the sweep voltage returns to zero. When the horizontal amplifier of the oscilloscope is driven with this type of a sweep signal, horizontal displacement of the beam may be equated to time. This gives the oscilloscope a time base. For example, if the ramp charging time (Fig. 3–T_1) is 1 second, the center of the CRT represents ½ second later in time with respect to the left edge of the CRT. In order to successfully use the sweep circuits, the ramp must be synchronized to the vertical input signal. In other words, it must always start at the same point on the input waveform. If this did not happen, the displayed waveform would start randomly, and a display such as that in Fig. 4 would exist. Figure 4 shows this condition when displaying a sinusoidal waveform.

Recurrent sweep

To prevent the condition shown in Fig. 4, synchronization or triggering circuits are employed. In the simplest of oscilloscopes, the sweep-generator consists of a free-running oscillator which generates the ramp waveform. The free-running oscillator is synchronized to the vertical signal by adjusting the sweep generator until its frequency is identical to, or a submultiple of, the frequency of the signal in the vertical amplifier. With the oscillator and the vertical amplifier signals approximately the same frequency, a small amount of the vertical signal is injected into the sweep oscillator. The sweep generator will lock or synchronize, tending to assume the frequency and phase of the vertical signal. Obviously, this method of synchronization is somewhat crude; however, until recently, it has provided the lowest cost method of deriving a synchronized horizontal time base. For some forms of work this is entirely satisfactory. This elementary time base, called recurrent sweep, has some rather severe limitations: it can only synchronize an integral number of vertical cycles; it is virtually impossible to change the point at which the triggering starts; and unless some separate form of time measurement is available, the period of the sweep signal is unknown.

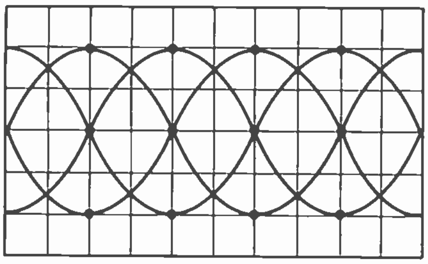


FIG. 4—RANDOM DISPLAY of a sinusoidal signal occurs when a free-running oscillator is used in the time base circuit.

Triggered sweep

All these problems may be solved through the use of a calibrated, triggered sweep. In an oscilloscope employing triggered sweep, the sweep generator is converted from a free-running oscillator to a single-shot generator; that is, the oscillator will produce one signal ramp of a known period when the appropriate trigger signal is applied. With this time-base, the user may select the exact period of sweep and through various amplification and comparing circuits, the exact point on the input signal at which he desires the sweep to start. Given a time base of this sophistication, there are many applications for the oscilloscope which were simply not available with recurrent sweep.

Blanking

The rapid retrace of the beam from the right side of the CRT to the left can cause undesirable traces on the display. To eliminate this effect a special signal is developed just before the end of each sweep signal. This signal turns off the beam in the CRT. The blanking signal prevents the undesirable retrace signals from appearing on the face of the CRT. Normally, the trace is not unblanked until a new sweep has partially started. Waiting until after sweep starts permits the ramp to become fully linear, which may not be the case in the first few percent of the ramp.

Some oscilloscopes have provisions for external inputs to the blanking circuits so that the blanking may be controlled externally for special purpose applications.

Dual beam

On the simple oscilloscope (Fig. 2), the vertical movement of the beam is governed by the signal present in the vertical amplifier. Such an oscilloscope is called a signal trace oscilloscope. This simply means all vertical deflection is a function of one input.

Frequently, when working with electronic circuits, it is desirable to determine cause and effect. That is, to look at the input of a circuit with a certain signal applied and compare the signal at the output of the circuit to that signal on the input. This may be done with a single-trace oscilloscope by first observing the input signal then moving the probe to the output and observing the output signal. Obviously, this process is somewhat tiresome. As neither trace remains on the screen permanently, one has to remember each small variation of each waveform to compare them. One method of overcoming this is shown in Fig. 5.

This configuration is known as a dual-beam oscilloscope. The dual-beam oscilloscope employs a special CRT which has two sets of vertical deflection plates and two electron guns, but only a single set of horizontal deflection plates. Both electron beams are simultaneously deflected from left to right by the horizontal amplifier and therefore, by the sweep signal. However, one of the beams will respond vertically to the signal applied to vertical amplifier number 1 and the other will respond to the signal applied to vertical amplifier number 2. The dual-beam oscilloscope overcomes the problem of moving the probe from input to output. As could be expected,

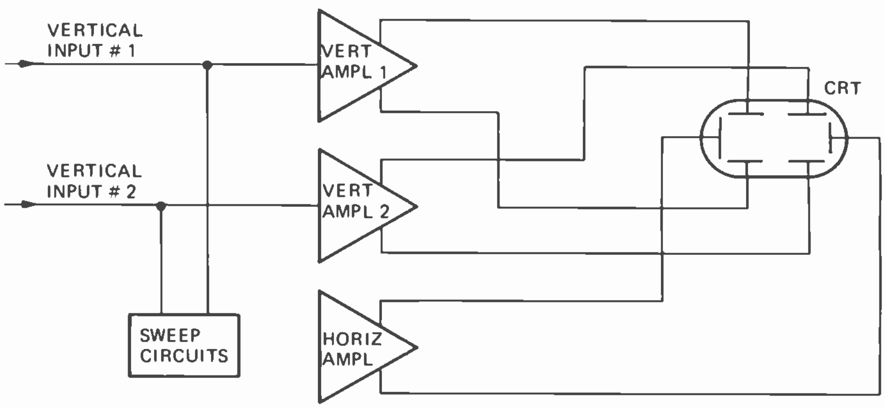


FIG. 5—DUAL-BEAM uses two sets of vertical deflection circuits to present two input signals independantly.

the dual-beam oscilloscope costs additional money. Dual-beam oscilloscopes have been quite popular in Europe and several are available, some even below $1,000.

Dual trace

This problem has been more popularly solved in the United States with the dual-trace oscilloscope. A simple block diagram of the dual-trace oscilloscope is shown in Fig. 6.

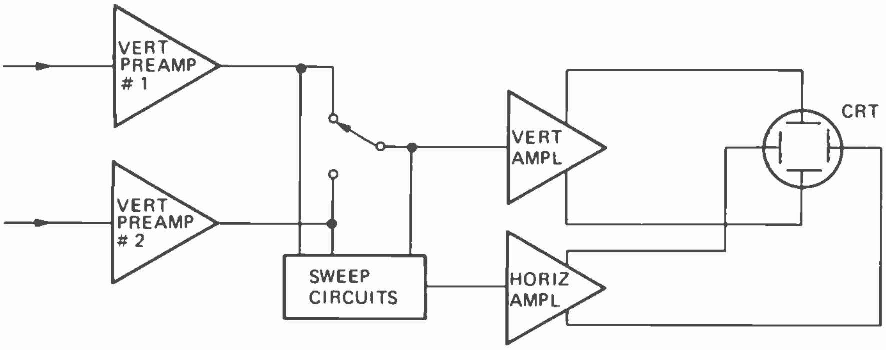


FIG. 6—DUAL-TRACE OSCILLOSCOPE uses one set of deflection circuits and a special switch to present two input signals.

This oscilloscope is similar to the original single-trace oscilloscope; however, two vertical preamplifiers are employed and a switch connects the main vertical amplifier to either INPUT 1 or INPUT 2. This switch is controlled by the time base circuitry or an internal oscillator. The switch operates in one of two modes.

In the alternate mode, the switch is changed from one input to the other following each horizontal sweep. On the first sweep, INPUT 1 is displayed; on the second sweep, INPUT 2 is displayed. On the third sweep, INPUT 1 is again displayed, etc. This method is rapid enough to keep the trace presented by one input from fading during the time the other input is writing.

At sweep rates of sufficiently long duration to cause a flickering problem, a different mode of dual-trace display is employed. In this second mode, called chopped mode, the switch is no longer operated by successive cycles of the time base, but is alternated by a high frequency oscillator, generally in the 50-200 kHz region. This produces a trace by the technique illustrated in Fig. 7. The time intervals in Fig. 7 are considerably exaggerated. In actual practice, even at quite short time base periods, one must carefully scrutinize the trace to observe the chopping effect.

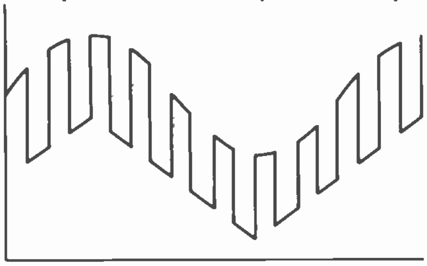


FIG. 7—CHOPPED MODE is used by a dual-trace oscilloscope when the time base frequency is too slow to use the alternate mode.

The dual-trace configuration is popular because it does not require a special purpose, and therefore expensive, CRT. The dual-trace technique offers an additional advantage over the dual-beam in that it may be expanded to more than two channels, whereas the dual beam requires a third set of deflection plates and a third electron gun assembly within the cathode-ray tube.

Trigger selection

With either the dual-trace or the dual-beam oscilloscope, a question presents itself: Where should the trigger signal be taken from? Most oscilloscopes utilizing dual vertical-channels have a switch permitting the user to select either INPUT 1 or INPUT 2. In some products, the user is often offered a third option of triggering on the combined signal after the switch.

The electronic switch

The simple signal-trace oscilloscope may be converted to a dual-trace oscilloscope by means of an external electronic switch available for this purpose. These electronic switches have not been too popular as they tend to limit the portability of the oscilloscope, and the cost of single versus dual trace on a high-performance oscilloscope is generally low.

The electronic switch provides separate input attenuators for each channel to be observed, some amplification, and separate position controls for each channel to permit the control of the vertical separation between the traces. Electronic switches are available in two-and four-channel configurations.

Delay lines

In a situation where the triggered oscilloscope is used with very short periods of horizontal sweep (generally under 10 microseconds or so) and the user desires to observe either the leading or trailing edge of a pulse in some detail, there is a new problem. Most trigger circuits are incapable of responding and producing sweep before the first few hundred nanoseconds of the vertical signal has actually arrived at the vertical deflection plates. Therefore, the signal that caused the triggering, say the leading edge of a fast pulse, generally reaches the deflection plates a few hundred nanoseconds before the sweep actually starts. When this occurs, the initial 200 ns of the signal is completely lost. In order to avoid this situation, the signal in the vertical amplifier must be delayed. The most common technique is to use some form of transmission line to slow the signal. The signal in the vertical amplifier must be delayed enough to permit the trigger and then the sweep circuits to respond. In order to achieve these considerably long delays without limiting the frequency response of the vertical amplifier, rather specialized transmission lines are employed. Delay lines certainly add to the oscilloscope's performance and obviously add to its cost.

X-Y oscilloscopes

Occasionally it is desirable to make certain measurements by comparing two external signals, one of them on the Y or vertical axis and the other on the X or horizontal axis. When the oscilloscope is used on this mode, the sweep circuits are no longer employed. With the simple oscilloscope, this is done by applying one signal to the vertical axis and the other signal to the external input connection of the horizontal amplifer. Horizontal amplifiers do not usually have calibrated attenuators nor will they accept a wide range of input signal levels. When the oscilloscope is either a dual trace or dual beam, two identical vertical amplifiers are available. Such oscilloscopes often have a mode called X-Y, in which one of the vertical input amplifiers remains connected to the vertical deflection plate and the other vertical input amplifier is connected to the horizontal plates. This provides the user with two wide-range inputs with calibrated attenuators.

Sampling oscilloscopes

The oscilloscopes discussed above will generally be sufficient for most service work. However, there are certain types of measurement work which require very high frequency oscilloscopes. The bandwidth of the vertical amplifier limits the ability of the oscilloscope to observe high-frequency signals. To overcome this prob-

(continued on page 85)

The better the training the better you'll

(Simulated TV Reception)

As an NTS student you'll acquire the know-how that comes with first-hand training on NTS professional equipment. **Equipment you'll build and keep.** Our courses include equipment like the **NTS/Heath Digital GR-2000 Solid State color TV** with first-ever features like silent varactor diode tuning; digital channel selection, (with optional digital clock), and big 315 sq. in. ultra-rectangular screen.

Also pictured above are other units — 5" solid state oscilloscope, vector monitor scope, solid-state stereo AM-FM receiver with twin speakers, digital multimeter, and more. It's the kind of better equipment that gets you better equipped for the electronics industry.

This electronic gear is not only designed for training; it's field-type — like you'll meet on the job, or when you're making service calls. And with NTS easy-to-read, profusely illustrated lessons you learn the theory behind these tools of the trade.

Choose from 12 NTS courses covering a wide range of fields in electronics, each complete with equipment, lessons, and manuals to make your training more practical and interesting.

Compare our training; compare our lower tuition. We employ no salesmen, pay no commissions. You receive all home-study information by mail only. All Kits, lessons, and experiments are described in full color. Most liberal refund policy and cancella-

and the equipment be equipped.

tion privileges spelled out. Make your own comparisons, your own decision. Mail card today, or clip coupon if card is missing.

NO OBLIGATION. NO SALESMAN WILL CALL

APPROVED FOR VETERAN TRAINING

Get facts on new 2-year extension

NATIONAL TECHNICAL SCHOOLS

TECHNICAL-TRADE TRAINING SINCE 1905
Resident and Home-Study Schools
4000 So. Figueroa St., Los Angeles, Calif. 90037

NATIONAL TECHNICAL SCHOOLS — Dept. 206-065
4000 South Figueroa St., Los Angeles, Calif. 90037
Please send FREE Color Catalog and Sample Lesson.
NO OBLIGATION. NO SALESMAN WILL CALL.

- ☐ Color TV Servicing
- ☐ B & W TV and Radio Servicing
- ☐ Electronic Communications
- ☐ FCC License Course
- ☐ Electronics Technology
- ☐ Computer Electronics
- ☐ Basic Electronics
- ☐ Audio Electronics Servicing

NAME ________ AGE ____

ADDRESS ________ APT # ____

CITY ________ STATE ____

Please fill in Zip Code for fast service ________

☐ Check if interested in G.I. Bill information.

☐ Check if interested ONLY in classroom training in Los Angeles.

State of SOLID STATE

This month we will take an in depth look at a new monolithic IC analog-to-digital converter set from Siliconix

by KARL SAVON
SEMICONDUCTOR EDITOR

FIRST HYBRID AND NOW MONOLITHIC IC analog to digital converters in single and dual-chip versions are replacing expensive and complicated discrete circuitry. The A/D converter is the backbone of most digital-readout measurement equipment. Already digital readouts have replaced meter movements in many professional electronic instruments where rapid, accurate and error free readings are vital. Digital readouts are cropping up where there were no meters at all in the past. Today there are oscilloscopes that have built-in digital voltmeters, frequency counters and time-period meters. In some models, the readout is viewed on the CRT screen and there are no LED indicators. It seems that the only place where the meter movement will stay put are inexpensive voltmeters and in those applications where up and down trends are important.

An on-the-chip AC to DC converter and resistance measurement system would be a nice addition to the A/D complement. Even though the technology and circuits are here today, manufacturers have plenty of things to do and what seems like a good idea to us may not be one that brings the most, or for that matter even any profits to them. Operational amplifiers and hybrids handle these secondary functions well, so the AC/OHM chip may be a little while off.

Nevertheless, the monolithic A/D converter is a new powerful tool for the engineer, technician, and experimenter. I'm sure the usual ingenuity of the nonprofessional technical society, applied to this previously out of reach technique will lead to some intriguing contrivances.

Siliconix 3½-digit A/D converter

By adding some external components to Siliconix's (2201 Laurelwood Rd., Santa Clara, CA 95054) LD110-LD111 IC team, a 3½-digit 0 to ±200-mV or 0 to ±2-volt digital voltmeter can be easily constructed. Frequency, temperature, AC voltage and other variables of interest can be measured by putting the corresponding variable-to-DC converter in front of the analog-to-digital converter set.

The LD110 is a PMOS *p*-channel *m*etal-*o*xide *s*emiconductor synchronous digital processor, and the LD111 is an analog processor made with combined bipolar-PMOS technology. Fig. 1 is a block diagram that shows the internal partitioning of the 2-chip system. Fig. 2 details the hook up for the ±2-volt DVM.

As with many A/D conversion techniques, this system uses a comparator to balance the input voltage against an analog voltage derived from the system's digital output. In other words, there is a digital-to-analog converter in a feedback

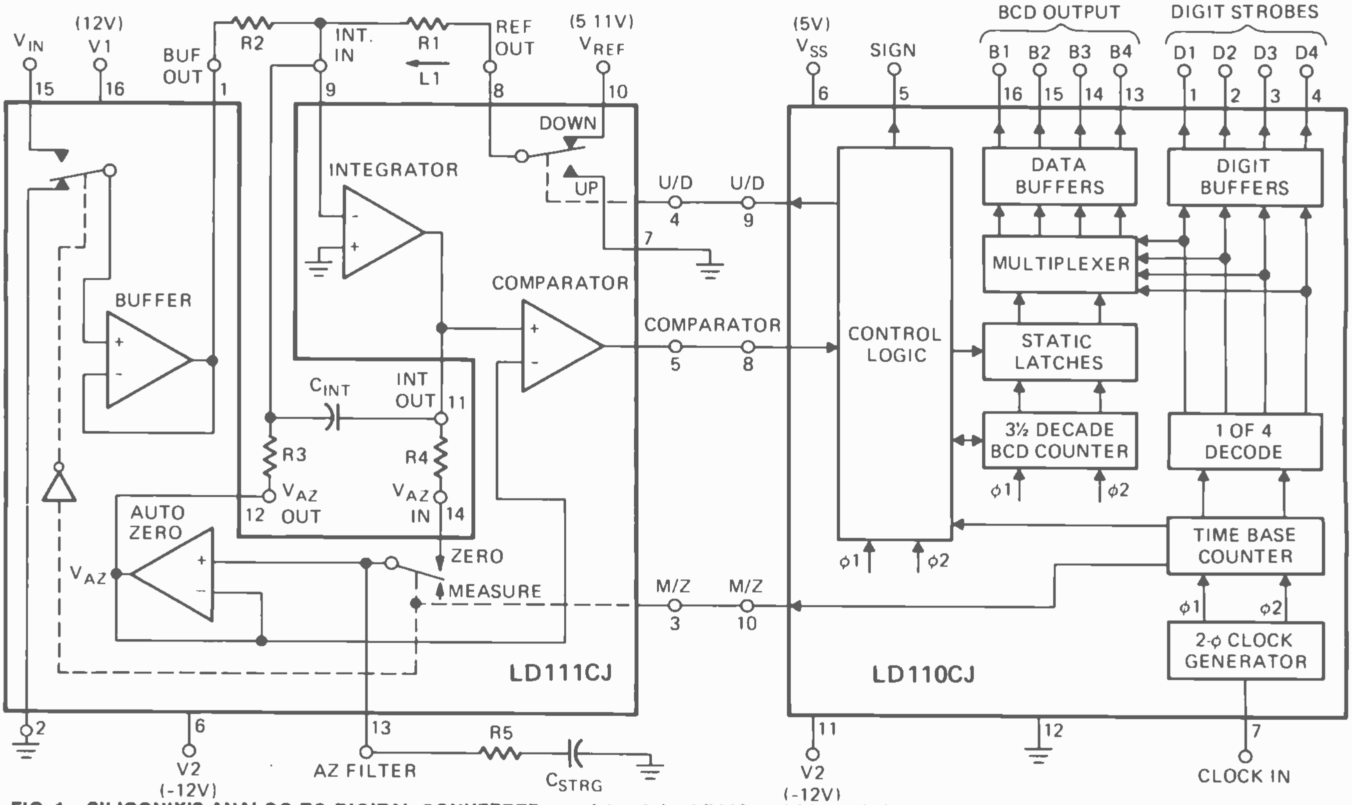


FIG. 1—SILICONIX'S ANALOG-TO-DIGITAL CONVERTER consists of the LD110 and LD111 IC's.

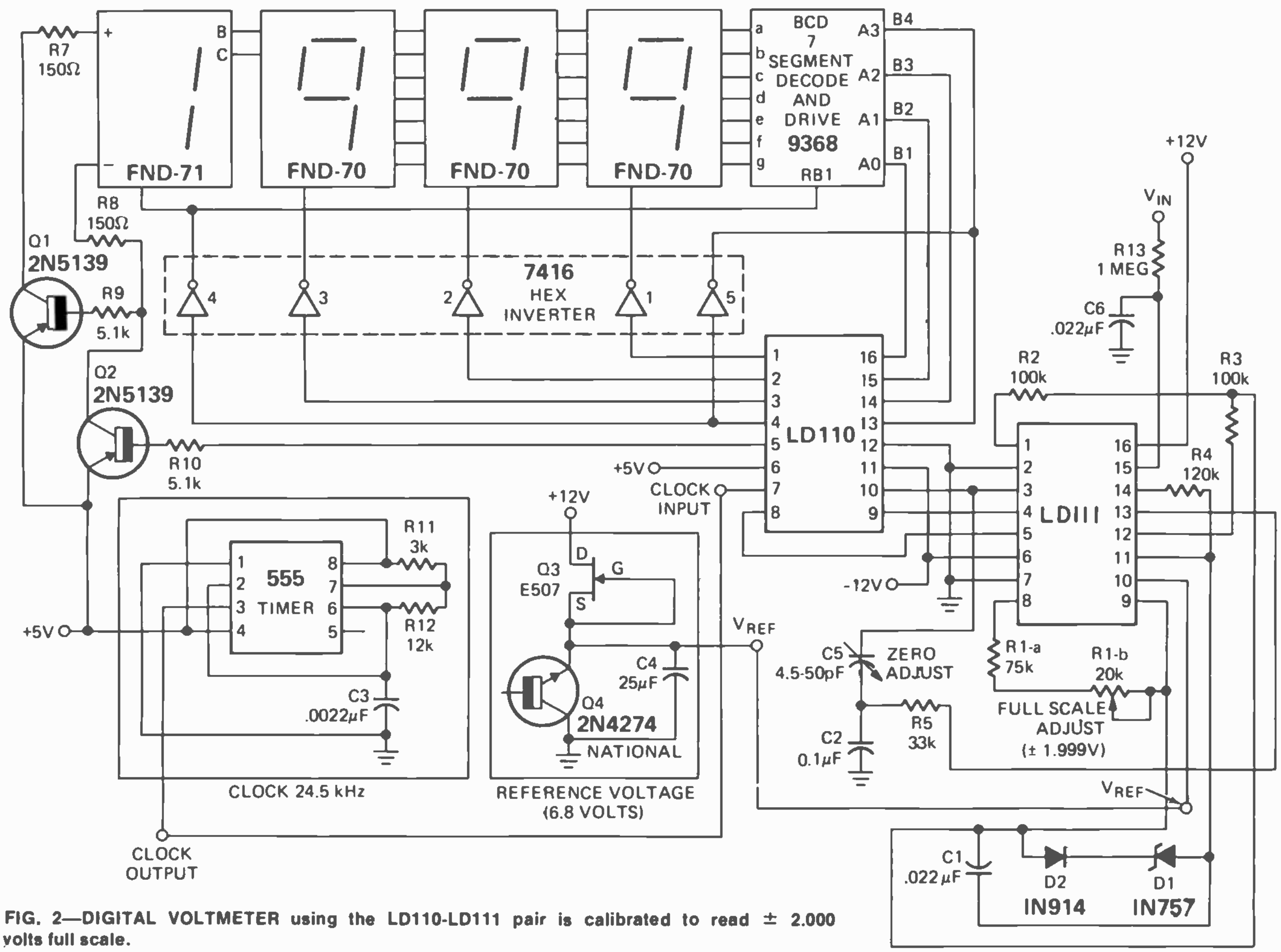


FIG. 2—DIGITAL VOLTMETER using the LD110-LD111 pair is calibrated to read ± 2.000 volts full scale.

path of the A/D converter. In the LD110-LD111 *charge-balancing* scheme, an up-down counter is controlled by a comparator to step in one direction or the other depending on whether the input is higher or lower than the accumulated number in a BCD counter. The D/A conversion is done by adding or depleting charge on an integrating capacitor. When the system stabilizes, the net count on the 3½-digit decade counter is stored in binary latches and multiplexed or sequentially sampled to drive a binary-to-7-segment decoder to operate the LED display segments.

A buffer amplifier gives the LD111 its high input impedance at pin 15. At room temperature the input bias current is specified as 4 picoamperes typical. With the system set up for 2 volts full scale, the smallest input voltage of interest would be 100 mV. Dividing voltage by current $0.1/4 \times 10^{-12} = 25 \times 10^{9}$ ohms. At 70°C the input current increases an order of magnitude to 40 pA, but 25×10^{8} ohms is still a formidable number, 2500 megohms. High input impedance is essential to maintain accuracy because of loading on the input attenuator and series filter resistance.

The output of the buffer feeds the integrator through R2 to pin 9. This circuit is an operational integrator with a negative feedback path between the input and output of the high-gain amplifier through C_{INT}. Like all operational amplifiers, the feedback keeps the amplifier's differential input stage very close to balance. This means that the positive and negative inputs are very nearly the same voltage. The positive input is grounded so the negative input is forced to stay close to 0 volts. Current into the negative input terminal is stored by the capacitor. Held at a virtual ground the pin 9 side of the capacitor cannot change potential, so the pin 11 side, the integrator output, changes potential as charge flows in and out of the capacitor. Three inputs feed the virtual ground integrator input: the buffered input voltage through R2, the up-down counter switched reference voltage through R1, and the auto-zero amplifier output V_{AZ} through R3.

Before looking at the details of the measurement process, let's see how the auto-zero system works to cancel the effects of offset along with temperature and component drifts. The analog-to-digital conversion set operates synchronously. All processing is timed in relation to an externally supplied clock frequency between 2 and 76 kHz. A complete measurement and auto-zero sequence is made up of 6144 clock cycles. Dividing 30,720 Hz by 6144 tells us that this particular choice of clock frequency results in 5 measurements per second. The 6144 cycles are subdivided into 4096 cycles for the measurement, and half this count or 2048 is for the automatic zeroing process. Selecting the clock frequency so its period is an integral multiple of the AC line period gives the meter its best 60-Hz rejection. For example, 24.576 Hz gives a sampling frequency of 4 per second or a period of ¼ second. One third of this time, the shorter of the two intervals spent in the auto-zero mode, is 1/12 second. This is five times the 1/60-second power line period and the rejection condition is satisfied.

When the LD110 control logic initiates the auto-zero interval, the input of the buffer amplifier is grounded through LD111 pin 2, and the MEASURE/ZERO mode switch is changed to the ZERO position. One other change takes place in this system configuration; after a short initial interval which corrects for an error discussed later, the UP/DOWN switch in the analog processor is toggled with a 50% duty cycle. For 4 clock pulses the switch is in the UP position and for 4 counts it is in the DOWN position. The three switches in the LD111 are PMOS enhancement devices. The comparator performs no useful function during the zeroing process and the up-down counter is reset. There is a feedback path paralleling C_{INT} by the connection of the auto-zero amplifier through the MEASURE/ZERO switch.

Starting at the output of the integrator, the path is traced through the auto-zero amplifier and through R3 to the integrator input node. The auto-zero loop self-adjusts so the net integrator input current is zero towards the end of the interval. The current through R3 is $V_{AZ}/$

R3 and must equal the current through R1. R1 is connected to the 50% duty cycle waveform that has an average value of $V_{REF}/2$. Therefore $-V_{AZ}/R3 = V_{REF}/2R1$, or $I_3 = V_{AZ}/R3 = -V_{REF}/2R1$. An approximation sign is used because an input offset error in the buffer amplifier produces an off-zero buffer output voltage and adds another current through R2.

Offset errors in the integrator cause it to seek equilibrium at some slightly off-zero potential. V_{AZ} holds a small component on top of its V_{REF} component that compensates for these errors through the following measurement interval. Any error drifts between any two successive sampling times are corrected during the next auto-zero interval. In effect, an extremely high dc gain negative feedback loop reduces the errors to a miniscule value. V_{AZ} is held by C_{STRG} retaining the voltage when the MEASURE/ZERO switch disconnects the capacitor from R4.

At the 2048th clock count, the system switches to the measurement mode and the comparator takes over control of the up-down counter. Counting up when the comparator output is low, the UP/DOWN switch is up for seven clock pulses and down for one and the inverted output of the comparator ramps downward. The duty cycle is reversed for a high comparator output, seven cycles down and one up, and the comparator output ramps upward. Don't be confused by the labeling of the UP-DOWN switch that is connected to the reference supply in the DOWN state and to ground in the UP state. Integration of the net six counts, up or down, by the current through R1 is the mechanism of the digital-to-analog conversion mentioned earlier.

It is now possible to calculate what the digital output will read to figure out what relationship between R1 and R2 must be satisfied to calibrate the converter. Once again, the net current at the input node of the integrator must be zero at equilibrium, after the system reacts to a possibly changed input and then settles down. The current in R1 is $V_{IN}/R2$ and the current in R3 was already calculated to be $V_{REF}/2R1$. R1 conducts an average current dependent on the net count. If the up and down counts are equal or NETCOUNT = UPCOUNT − DOWNCOUNT = O, the UP-DOWN switch will be in one position for the same time as in the other position so the average current is one-half the peak $V_{REF}/R1$ or $V_{REF}/2R1$. Some deduction leads to the expression:

$$I_1 = \frac{V_{REF}}{2R1}\left(1 - \frac{\text{NETCOUNT}}{4096}\right)$$

The expression is tested by setting the net count to its top extreme. If it were possible for the switch to be UP, switched to ground for the full 4096 possible counts, I_1 should be zero and the equation agrees. Equating the sum of the currents during the measurement period to zero gives:

$$\frac{V_{IN}}{R2} - \frac{V_{REF}}{2R1} + \left(1 - \frac{\text{NETCOUNT}}{4096}\right) = 0 \text{ and}$$

$$\text{NETCOUNT} = 8192 \times R1/R2 \times V_{IN}/V_{REF}.$$

Picking $V_{REF} = 6.8$ volts as in Fig. 2 and choosing a full-scale reading of 2000 for an input $V_{IN} = 2$ volts:

$2000 = 8192 \times R1/R2 \times 2/6.8$ and $R1/R2 = 6.8/2 \times 2000/8192 = 0.83$.

Significantly, the frequency of the oscillator does not enter the calculation so conversion accuracy does not depend on its stability! The accuracy specified by Siliconix is 0.05% ± 1 count. After the system settles down, the integrator current hunts above and below the comparator reference voltage V_{STRG} because the integrator must charge and discharge with the discrete net 6 count stimulus of the UP/DOWN switch. The error is predictable and is compensated for by the short override period at the start of the auto-zero process. Input polarity is sensed by whether the system is counting up or down when its net count passes through zero.

The digital voltmeter in Fig. 2 is calibrated to read ±2.000 volts fullscale. R1 composed of the fixed part R1-a and potentiometer R1-b is adjustable between 75 and 95K, and R2 is a 100K resistor. The R1/R2 combination can be varied from 0.75 to 0.95 straddling the 0.83 number calculated. These resistors are picked to be temperature and time stable since they determine the instrument's calibration.

Common-cathode type LED's are used in the design and their cathodes are driven from 4 of the sections of a 7416 hex inverter. Exceeding 1.999 volts at the input triggers an over-range alarm by blinking the display at the sampling rate—4 times a second. To conserve IC terminals, reduce the number of necessary decoders to one, and increase the efficiency of the LED emission; the display is multiplexed or scanned one digit at a time in an interlaced 1-3-2-4 pattern. An FET constant-current source biases the 6.8-volt reference Zener and a 555 timer IC generates the 24.5-kHz clock waveform.

Over-range and under-range conditions are coded on the 3rd and 4th bits of the LD110 BCD output during the 4th digit strobe time. Under-range, predetermined as 5% of full scale, is indicated by a 1 in the bit 3 position. Over-range is detected by sensing all four digits in a zero state. Not used in the illustrated DVM, this feature is useful in building automatic ranging voltmeters.

One last point: the A/D converter is capable of operating beyond the 2000 count to 3100. Each 7 up and 1 down count or the reverse situation requires 6 of the 8 pulses. The useable number of clock cycles is then ¾ of 4096 or about 3100 leading to the maximum useable count. An erroneous display shows up in the fourth digit place when an extended count is allowed unless bit 3 and 4 inputs to the BCD to 7-segment decoder are grounded during the digit strobe time.

Class E citizen band transistors

Motorola Semiconductor Products has two new transistors, the MRF225 and MRF226, which have maximum RF output powers of 1.5 and 13 watts respectively at 225 MHz. Both transistors have a minimum 9 dB power gain. The coordinates of the cross mark on Fig. 3 are 1.3 watts in, 13 watts out. Power gain calculates as $10 \log \frac{13}{1.3} = 10 \log 10 = 10$ dB gain.

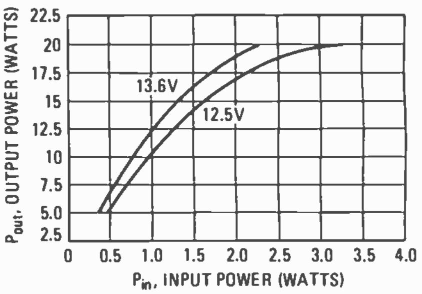


FIG. 3—OUTPUT POWER vs. INPUT POWER for Motorola's MRF-226 Citizen Band RF power transistors.

The driver-output pair sell for \$2.50 for the MRF225 and \$11.70 for the MRF226 in small quantities. **R-E**

R-E's Substitution guide for replacement transistors

PART XXVII

by ROBERT & ELIZABETH SCOTT

ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores, Allied Radio Shack, 2725 W. 7th St., Ft. Worth, Texas 76107

DM—D. M. Semiconductor Co., P.O. Box 131, Melrose, Mass. 02176

G-E—General Electric Co., Tube Product Div., Owensboro, Ky. 42301

ICC—International Components, 10 Daniel Street, Farmingdale, N.Y. 11735

IR—International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245

MAL—Mallory Distributor Products Co., 4760 Kentucky Ave., Indianapolis, Ind. 46241

MOT—Motorola Semiconductors, Box 2963, Phoenix, Ariz. 85036

RCA—RCA Electronic Components, Harrison, N.J. 07029

SPR—Sprague Products Co., 65 Marshall St., North Adams, Mass. 01247

SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154

WOR—Workman Electronic Products, Inc., Box 3828, Sarasota, Fla. 33578

ZEN—Zenith Sales Co., 5600 W. Jarvis Ave., Chicago, Ill. 60648

Radio-Electronics has done its utmost to insure that the listings in this directory are as accurate and reliable as possible; however, no responsibility is assumed by Radio-Electronics for its use. We have used the latest manufacturers material available to us and have asked each manufacturer covered in the listing to check its accuracy. Where we have been supplied with corrections, we have updated the listing to include them. The first part of this Guide appeared in March 1973.

	ARCH	DM	GE	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N6181	NA	TS-5006	NA	ICC-S5006	NA	NA	HEP-S5006	SK 3025	RT-149	NA	NA	NA
2N6182	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6183	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6184	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6185	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6186	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6187	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6188	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6189	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6190	NA	TS-3003	NA	ICC-S0003	NA	NA	HEP-S0003	NA	NA	NA	NA	NA
2N6191	NA	TS-3003	NA	ICC-S0003	NA	NA	HEP-S0003	NA	NA	NA	NA	NA
2N6206	NA	NA	NA	ICC-S0005	NA	NA	HEP-S0005	NA	NA	NA	NA	NA
2N6207	NA	NA	NA	ICC-S0007	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N6208	NA	NA	NA	ICC-S0007	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N6226	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	NA	NA
2N6229	NA	TS-5005	NA	ICC-S5005	NA	PTC 149	HEP-S5005	NA	NA	NA	NA	NA
2N6238	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5421	NA	NA
2N6237	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5422	NA	NA
2N6238	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5423	NA	NA
2N6246	NA	TS-7001	NA	ICC-S7001	NA	PTC 149	HEP-S7001	SK 3167	RT-148	ECG 219	WEP-S7001	NA
2N6247	NA	TS-7001	NA	ICC-S7001	NA	PTC 149	HEP-S7001	NA	RT-148	ECG 219	WEP-S7001	NA
2N6248	NA	TS-7001	NA	ICC-S7001	NA	PTC 149	HEP-S7001	NA	RT-148	NA	NA	NA
2N6249	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	SK 3167	NA	NA	NA	ZEN 204
2N6250	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	NA	NA	ZEN 204
2N6251	NA	T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZEN 204
2N6253	NA	T-704	NA	ICC-704	NA	PTC 119	HEP-707	SK 3027	RT-131	ECG 130	WEP-247	NA
2N6254	NA	T-704	NA	ICC-704	NA	PTC 149	HEP-707	SK 3511	NA	NA	NA	NA
2N6255	NA	NA	NA	NA	NA	PTC 143	NA	NA	NA	NA	NA	NA
2N6257	NA	TS-7000	NA	ICC-S7000	NA	NA	HEP-S7000	SK 3036	RT-154	ECG 181	WEP-S7000	NA
2N6258	NA	TS-7000	NA	ICC-S7000	NA	PTC 139	HEP-S7000	SK 3036	RT-149	ECG 181	WEP-S7000	NA
2N6260	NA	T-703	GE-66	ICC-703	NA	PTC 137	HEP-703	SK 3026	RT-154	ECG 175	WEP-241	NA
2N6261	NA	T-703	NA	ICC-703	NA	PTC 154	HEP-703	SK 3026	RT-154	ECG 175	WEP-241	NA
2N6262	NA	T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZEN 204
2N6263	NA	T-241	NA	ICC-241	NA	PTC 104	HEP-241	NA	NA	ECG 175	WEP-241	NA
2N6264	NA	T-241	NA	ICC-241	NA	PTC 148	HEP-241	NA	NA	NA	NA	NA
2N6270	NA	TS-7000	NA	ICC-C7000	NA	PTC 159	HEP-S7000	NA	RT-148	NA	NA	NA
2N6271	NA	TS-7000	NA	ICC-S7000	NA	PTC 159	HEP-S7000	NA	RT-149	NA	NA	NA
2N6288	NA	TS-5001	NA	PTC 137	NA	NA	HEP-S5001	SK 3054	NA	NA	NA	ZEN 209
2N6289	NA	TS-5001	NA	ICC-S5001	NA	PTC 137	HEP-S5001	SK 3054	NA	NA	NA	ZEN 209
2N6290	NA	TS-5001	NA	ICC-S5001	NA	PTC 137	HEP-S5001	SK 3054	NA	NA	NA	ZEN 209
2N6291	NA	TS-5001	NA	ICC-S5001	NA	PTC 137	HEP-S5001	SK 3054	NA	NA	NA	ZEN 209
2N6292	NA	TS-5004	NA	ICC-S5004	NA	PTC 154	HEP-S5004	SK 3054	NA	NA	NA	NA
2N6293	NA	TS-5004	NA	ICC-S5004	NA	PTC 154	HEP-S5004	SK 3054	NA	NA	NA	NA
2N6296	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 218	WEP-S5007	NA
2N6297	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 218	WEP-S5007	NA
2N6306	NA	T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZEN 204
2N6307	NA	T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZEN 204
2N6308	NA	T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZEN 204
2N6329	NA	NA	NA	NA	NA	PTC 159	NA	NA	RT-148	ECG 180	WEP-S7001	NA
2N6338	NA	TS-7000	NA	ICC-S7000	NA	PTC 159	HEP-S7000	NA	RT-149	NA	NA	NA

This concludes the listing of American (E.I.A. registered) semiconductors. Following your suggestions, we will now begin the listing of universal replacements for discrete Japanese semiconductors. Later, if you wish, we will list replacements for European semiconductors.

REPLACEMENTS FOR JAPANESE SEMICONDUCTORS

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2NJ5A	NA	NA	GE-2	NA	TR-05	PTC 102	NA	SK 3005	RT-118	ECG 100	WEP-254	NA
2NJ5D	NA	NA	GE-2	NA	TR-05	PTC 102	NA	SK 3123	NA	NA	NA	NA
2NJ8A	RS-276-2004	T-253	GE-2	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	WEP-254	ZEN 304
2NJ9A	RS276-2005	T-254	GE-52	ICC-254	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2NJ9D	NA	T-254	GE-52	ICC-254	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2NJ50	RS276-2005	T-636	GE-51	ICC-636	TR-17	PTC 107	HEP-638	SK 3007	NA	ECG 126	WEP-635	ZEN 312
2NJ51	RS276-2004	T-253	GE-1	ICC-253	IRTR-17	PTC 109	HEP-253	SK 3007	NA	ECG 126	WEP-635	ZEN 304
2NJ52	RS276-2004	T-253	GE-1	ICC-253	IRTR-17	PTC 109	HEP-253	SK 3006	NA	ECG 126	WEP-635	ZEN 304
2NJ53	RS276-2005	T-254	GE-1	ICC-254	IRTR-17	PTC 109	HEP-254	SK 3006	NA	ECG 126	WEP-635	ZEN 305
2NJ59D	NA	NA	GE-1	NA	TR-85	PTC 109	NA	NA	NA	NA	NA	NA
2NL48	NA	NA	GE-63	NA	TR-25	PTC 144	NA	NA	NA	NA	NA	NA
2NS31	NA	NA	NA	NA	TR-85	PTC 102	NA	NA	RT-120	ECG 102	WEP-631	NA
2NS32	NA	NA	NA	NA	TR-85	PTC 102	NA	SK 3004	RT-120	ECG 102	WEP-631	NA
2NS121	NA	NA	NA	NA	TR-85	PTC 102	NA	SK 3004	RT-120	ECG 102	WEP-631	NA
2NU/9	NA	NA	NA	NA	NA	NA	NA	SK 3123	NA	NA	NA	NA
20A90	NA	D-135	NA	NA	NA	NA	HEP-135	SK 3087	NA	NA	NA	NA
20C72	NA	T-253	NA	NA	TR-84	NA	HEP-253	SK 3004	NA	ECG 158	WEP-238	ZEN 304
2PB187	NA	NA	NA	NA	TR-85	PTC 135	NA	SK 3004	NA	ECG 120A	WEP-250	NA

NA=NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2R9.1	NA	RZ-2513	NA	ICC-Z2513	Z1512	NA	HEP-Z2513	NA	NA	ECG 5124	NA	NA
2R10	NA	RZ-2514	NA	ICC-Z2514	NA	NA	HEP-Z2514	NA	NA	ECG 5125	NA	NA
2R11	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5126	NA	NA
2R12	NA	RZ-2516	NA	ICC-Z2516	Z1516	NA	HEP-Z2516	NA	NA	ECG 5127	NA	NA
2R13	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5128	NA	NA
2R15	NA	RZ-2519	NA	ICC-Z2519	NA	NA	HEP-Z2519	NA	NA	ECG 5130	NA	NA
2R16	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5131	NA	NA
2R18	NA	RZ-2522	NA	ICC-Z2522	Z1520	NA	HEP-Z2522	NA	NA	ECG 5133	NA	NA
2R20	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5135	NA	NA
2R22	NA	RZ-2525	NA	ICC-Z2525	Z1522	NA	HEP-Z2525	NA	NA	ECG 5136	NA	NA
2R24	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5137	NA	NA
2R27	NA	RZ-2528	NA	ICC-Z2528	NA	NA	HEP-Z2528	NA	NA	NA	NA	NA
2R30	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5141	NA	NA
2R33	NA	RZ-2531	NA	ICC-Z2531	Z1526	NA	HEP-Z2531	NA	NA	ECG 5142	NA	NA
2R36	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5143	NA	NA
2R39	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5144	NA	NA
2R43	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5145	NA	NA
2R47	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5146	NA	NA
2R51	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5147	NA	NA
2R56	NA	RZ-2537	NA	ICC-Z2537	NA	NA	HEP-Z2537	NA	NA	ECG 5148	NA	NA
2R68	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5151	NA	NA
2R75	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5152	NA	NA
2R91	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5155	NA	NA
2R100	NA	RZ-2545	NA	ICC-Z2545	NA	NA	HEP-Z2545	NA	NA	ECG 5156	NA	NA
2R110	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5157	NA	NA
2R120	NA	RZ-2547	NA	ICC-Z2547	NA	NA	HEP-Z2547	NA	NA	ECG 5158	NA	NA
2R130	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5159	NA	NA
2R140	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5160	NA	NA
2R150	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5161	NA	NA
2R160	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5162	NA	NA
2R180	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5164	NA	NA
2R200	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5166	NA	NA
2S001	NA	T-51	NA	NA	TR-86	PTC 132	NA	SK 3124	RT-100	ECG 123	WEP-53	NA
2S002	NA	T-51	NA	NA	TR-86	PTC 132	NA	SK 3124	RT-100	ECG 123	WEP-53	NA
2S003	NA	T-53	NA	NA	TR-86	PTC 132	NA	SK 3124	RT-100	ECG 123	WEP-53	NA
2S004	NA	NA	NA	NA	TR-86	PTC 132	NA	SK 3124	RT-100	ECG 123	WEP-53	NA
2S005	NA	T-51NA	NA	NA	TR-21	PTC 132	NA	SK 3124	RT-102	ECG 123A	WEP-736	NA
2S006	NA	T-51	NA	NA	TR-95	PTC 121	NA	SK 3039	RT-113	ECG 108	WEP-56	NA
2S014	NA	T-243	NA	NA	TR-87	PTC 132	NA	SK 3020	RT-114	ECG 128	WEP-243	NA
2S017	NA	NA	NA	NA	TR-87	PTC 144	NA	SK 3024	ER-114	ECG 128	WEP-243	NA
2S018	NA	NA	NA	NA	TR-87	PTC 144	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2S019	NA	T-243	NA	NA	TR-87	PTC 144	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2S020	NA	NA	NA	NA	TR-87	PTC 144	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2S021	NA	NA	NA	NA	TR-87	NA	NA	SK 3025	RT-115	ECG 129	WEP-242	NA
2S022	NA	T-52	NA	NA	TR-86	NA	NA	SK 3025	RT-115	ECG 129	WEP-242	NA
2S023	NA	T-52	NA	NA	TR-86	NA	NA	SK 3025	RT-115	ECG 129	WEP-242	NA
2S033	NA	NA	NA	NA	TR-59	PTC 110	NA	SK 3027	RT-131	ECG 130	WEP-247	NA
2S034	NA	NA	NA	NA	TR-59	PTC 110	NA	SK 3027	RT-131	ECG 130	WEP-247	NA
2S035	NA	NA	NA	NA	TR-67	NA	NA	NA	NA	ECG 162	WEP-707	NA
2S036	NA	NA	NA	NA	TR-67	NA	NA	NA	NA	ECG 162	WEP-707	NA
2S095	NA	NA	NA	NA	NA	PTC 136	NA	NA	NA	NA	NA	NA
2S0226	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2S0371	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2S0460	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2S12	NA	NA	GE-2	NA	TR-05	PTC 102	NA	SK 3005	RT-118	ECG 100	WEP-254	NA
2S13	NA	T-254	GE-2	ICC-254	TR-05	PTC 102	HEP-254	SK 3005	RT-118	ECG 100	WEP-254	ZEN 305
2S14	RS276-2005	T-254	GE-52	NA	TR-05	PTC 102	NA	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S15 .	RS276-2005	T-254	GE-52	ICC-254	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S16E	NA	NA	NA	ICC-R0050	806	NA	HEP-R0050	SK 3016	RT-215	ECG 116	WEP-158	NA
2S22	RS276-2005	T-254	GE-52	ICC-254	806	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S24	NA	NA	GE-52	NA	TR-05	PTC 102	NA	SK 3004	RT-120	ECG 102	WEP-631	NA
2S25	NA	NA	GE-2	NA	TR-05	PTC 102	NA	SK 3005	RT-118	ECG 100	WEP-254	NA
2S26	NA	NA	GE-16	NA	TR-01	PTC 105	NA	SK 3009	RT-127	ECG 121	WEP-232	NA
2S30	RS276-2005	T-636	GE-1	ICC-636	IRTR-85	PTC 109	HEP-636	SK 3005	RT-118	ECG 100	WEP-254	ZEN 312
2S31	RS276-2004	T-253	GE-1	ICC-253	IRTR-05	PTC 109	HEP-253	SK 3005	RT-118	ECG 100	WEP-254	ZEN 304
2S32	RS276-2004	T-253	GE-1	ICC-253	IRTR-05	PTC 109	HEP-253	SK 3004	RT-120	ECG 102	WEP-631	ZEN 304
2S33	RS276-2005	T-254	GE-1	ICC-254	IRTR-85	PTC 109	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S34	RS2276-2005	T-254	GE-254	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305	
2S35	NA	T-2	GE-50	ICC-2	TR-17	PTC 107	HEP-2	SK 3008	NA	ECG 126	WEP-635	ZEN 300
2S36	NA	T-2	GE-50	ICC-2	TR-17	PTC 107	HEP-2	SK 3008	NA	ECG 126	WEP-635	ZEN 300
2S37	RS276-2005	T-254	GE-52	ICC-254	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S38	RS276-2005	T-254	GE-2	ICC-254	TR-05	PTC 135	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S39	RS276-2005	T-254	GE-52	ICC-254	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S40	RS276-2005	T-254	GE-2	ICC-254	TR-05	PTC 135	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2S41	RS276-2006	T-230/232	GE-3	ICC-230/232	TR-01	PTC 114	HEP-230/232	SK 3009	RT-124	ECG 104	WEP-230	ZEN 325/326

*Indicates a dual transistor for high-speed switching, diff amplifier etc. Likely to be a matched pair. Use two of the type specified, matching when necessary, on a curve traver or lab-type transistor checker.

NA=NOT AVAILABLE

(continued next month)

R-E's Service Clinic

High-voltage hold-down circuits

Part II: These circuits can produce some strange reactions

by JACK DARR
SERVICE EDITOR

In the all-solid state chassis, such as late production CTC 46, and all of the CTC 54's, the hold-down circuitry has been added to the original solid-state sweep circuits. Fig. 3 shows this one. The high-voltage, output-sweep stage is the same SCR-type used in earlier chassis. Q401 is the (high-voltage) regulator. A sensing pulse for this comes from the high-voltage transformer. An extra stage, Q402, marked "hold-down" does a bit more.

This is a plain error-amplifier. It picks up a signal from the regulator stage and the high-voltage transformer. If regulator failure occurs, this stage throws the horizontal oscillator completely out of sync! Following the circuitry, you can see that the horizontal oscillator transistor collector is supplied from the collector of Q402. So this transistor acts as a series regulator. If Q402 itself should fail, you'll lose horizontal sync, and the oscillator will probably stop. An open Q402 would kill the oscillator, and a shorted transistor here would throw it far out of sync. In addition to the stock symptoms of narrow, dim raster, the picture will be completely out of sync, and the controls won't bring it back.

If you can't adjust the HORIZONTAL HOLD and HOLD LIMIT controls and lock the picture, ground test point TP-2, which is the base circuit of Q402. If you can get a locked picture now, it's not an oscillator problem, but a regulator trouble. If this makes no difference, *then* you check the horizontal oscillator circuit.

After finishing repairs, check the hold-down circuit. Short test points TP-1 and TP-2 together. The picture *must* fall out of sync when this is done.

VDR in regulator circuitry

Zenith, RCA, and several others use Voltage Dependent Resistors (VDR's) in the control circuits. Conventional diodes are also used ,of course. However, with a *non-sinusoidal* waveform, a VDR can be

(continued on page 68)

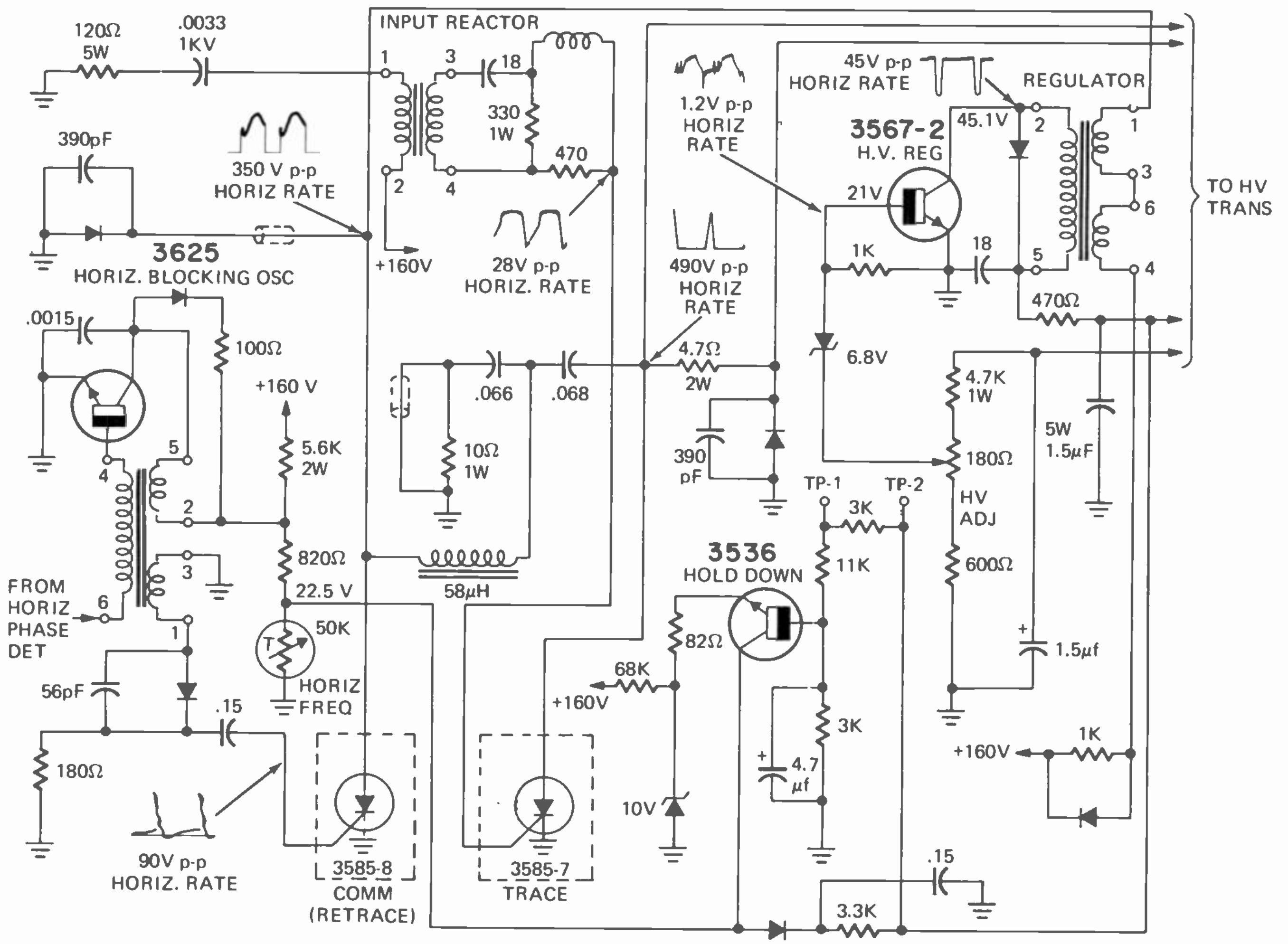


FIG. 3—A SOLID-STATE VERSION—the hold-down circuitry used in RCA's CTC54.

Bell & Howell Schools invites you to

BREAK INTO 4-C

Pick up new professional skills in this exciting field as you build Bell & Howell's new quadraphonic audio center. It's the very first learn-at-home program of its kind!

You've probably heard a lot about 4-channel sound by now. It's the most talked about and impressive technical advancement in sound in years. Separately recorded channels literally wrap a room in sound for a totally new listening experience.

And the excitement doesn't stop there. Thanks to Bell & Howell Schools' brand new learning program, now you can explore quad sound for yourself—from the inside out—and master the technology behind this important advancement right in your own home!

It's your opportunity to break away from the everyday routine and learn new occupational skills that could lead you in exciting new directions. Mail the attached card, postage free, to get the facts today!

Take hold of opportunity with both hands now!

The world around you is changing every day. Forging ahead. The man who keeps pace is the man who continues to learn and grow. He's in the mainstream of life. Interested in what's going on. And he's much more interesting, too.

Bell & Howell Schools' new 4-channel audio program was designed to help you learn and grow. To put you in the mainstream of audio electronics technology. Where you can delve into fascinating electronics principles. Solve challenging problems and get actual hands-on, build-it-yourself experience.

And where you can acquire a sense of satisfaction and accomplishment you may not currently be getting.

Completely different from the typical kind of school you grew up with.

Learning all about quad sound with Bell & Howell Schools is a lot more interesting and convenient than "school" used to be. First of all, we know you can't afford to quit your job. So we set up a program that lets you work at home in your spare time.

There are no classes to attend. No dry lectures to sit through. Everything comes to you in the mail. Lesson by lesson. Exciting package after package. And you work at a flexible pace in the relaxed atmosphere of your workshop—or wherever your favorite spot may be.

Sure, books are important. But they're only the beginning.

With this fascinating learn-at-home program, you do a lot more than just read about electronics. You'll conduct dozens of experiments . . . build your own laboratory equipment for testing out electronics principles . . . and also as part of this program you put together a 4-channel amplifier and FM/FM stereo tuner as you delve into advanced audio technology.

We try to make learning so interesting you look forward to receiving each new lesson. And enthusiastically dive into each new project we send you.

We'll start you off on the right foot.

You may be thinking, "I don't have any training in electronics . . . I might be getting in over my head."

Well, you can stop worrying about that. You don't need previous experience. You'll begin with the basics and acquire a thorough understanding of the fundamentals before moving on.

And remember, it's not just reading. With your very first lesson you get our LAB STARTER KIT, consisting of a simple voltmeter and electronics "breadboard" you can experiment with right away.

Of course, if you're already into electronics, you might be thinking, "I already know the basics . . . I want to get into the advanced stuff right away!"

For you there's an advanced standing program that lets you skip the beginning lessons.

Next you build the exclusive Electro-Lab® electronics training system.

Once you've mastered the basics, we'll send you everything you need to put together these three important testing instruments:

The design console. You use it to set up and examine various kinds of circuits. It's completely modular . . . no soldering!

The digital multimeter. Use it to measure voltage, current and resistance. Displays data accurately in big, clear numbers—just like on a digital clock.

The solid-state "triggered-sweep" oscilloscope. Use it to analyze modern,

HANNEL AUDIO!

state-of-the-art integrated circuits. Triggered-sweep feature locks in signals for easier observation.

These three superb testing instruments are the basis of your own home electronics laboratory. You'll use them throughout the program as you move into more advanced electronics principles and work into audio technology.

Bell & Howell's high performance 4-channel audio center you actually build and experiment with yourself!

You need practical experience with high caliber equipment to develop professional skills and understand the ins and outs of today's audio technology.

So we came up with a system that Bell & Howell is proud to have its name on:

First, there's the sophisticated outstanding 4-channel amplifier with SQ full-logic decoding and front to back separation. As you build and experiment with this remarkable piece of equipment, you'll learn about matrix 4-channel and discrete—including CD-4 when processed through an external demodulator.

And with it you'll have the advanced circuitry you need to get into signal tracing low level circuits . . . troubleshooting high power amplifier stages . . . and checking the operation of tone control circuits.

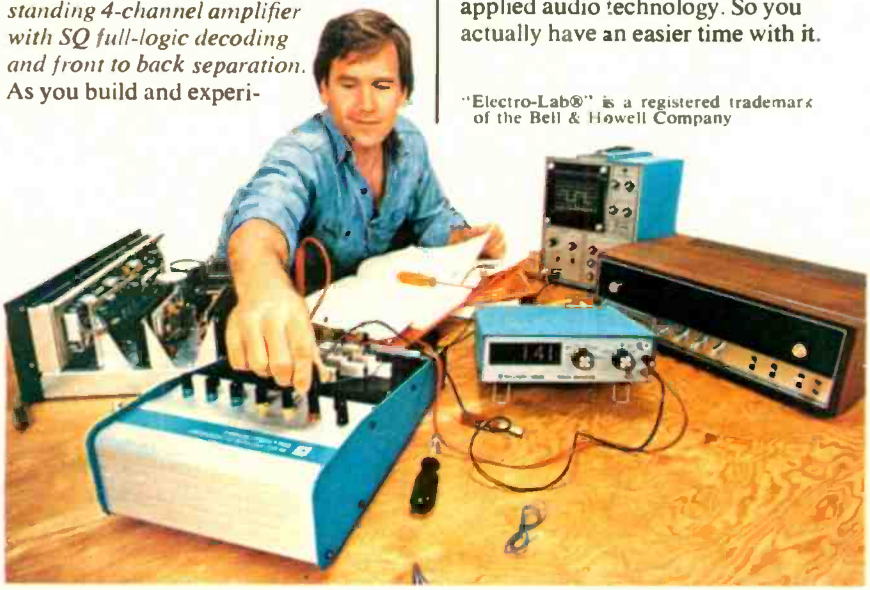
Next, the advanced FM-FM stereo tuner. As you build this superb stereo tuner, you'll come to fully understand how the advanced, "state-of-the-art" features lead to such high performance specs.* You'll learn about all solid-state construction, FET front end for superior sensitivity, crystal IF filters for wide bandwidth and the superior multiplex circuit that produces such excellent stereo separation.

A wealth of knowledge in digestible chunks.

O.K.! So now you might be thinking, "It sounds really interesting . . . but kind of complicated." And you're right. But that is why we use the "hands on" teaching approach.

We've taken all the material and broken it down into short, simple-to-grasp lessons, so you can master one thing at a time before moving on. And we take you through it step by step. From the basics to advanced theory to applied audio technology. So you actually have an easier time with it.

"Electro-Lab®" is a registered trademark of the Bell & Howell Company



Special learning opportunities give you extra help and attention.

In case you do run into a problem or two, we're ready to give you more help and personal attention than you'd expect from most learn-at-home programs.

For example, many home study schools ask you to mail in your questions. Bell & Howell Schools gives you a toll-free number to call for answers you need right away.

Few home study schools offer personal contact with instructors. Bell & Howell Schools organizes "help sessions" in 50 major cities at various times during the year—where you can discuss problems with fellow students and instructors in person.

And when you're done, you'll know a lot more than just 4-channel sound!

You'll have covered the complete spectrum of electronics principles, leading to a full understanding of audio technology.

And while no school can promise you a job or income opportunity, you will have occupational skills necessary to become a full-service technician. With the ability to work on the entire range of audio equipment. Such as tape recorders, cassette players, FM antennas and commercial sound systems. You'll know audio technology from the inside out. And you'll be proud of it.

Plus you will have the basic skills that apply to the entire electronics field, including television technology and repair.

For more details, mail card today!

Here's your chance to break out of the mold. And break into 4-channel audio with Bell & Howell Schools. Why not look into it today. Mail the attached postage-paid card now. There's no obligation!

Taken for vocational purposes, this program is approved by the state approval agency for Veterans' Benefits.

Wood cabinets available at extra cost.

*35 watts per channel—Min. RMS into 8 ohms at less than 0.25% total harmonic distortion from 20-20,000 Hz, all channels fully driven.

If card has been removed, write:

An Electronics Home Study School

DEVRY INSTITUTE OF TECHNOLOGY 766

ONE OF THE

BELL & HOWELL SCHOOLS

4141 Belmont, Chicago, Illinois 60641

SERVICE CLINIC

(continued from page 63)

made to work as a rectifier. Fig. 4 shows how.

Figure 4-a is the typical circuit used in

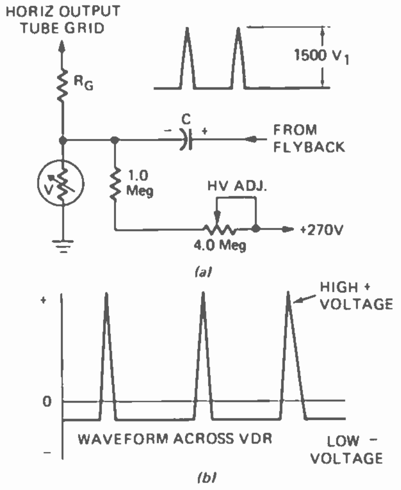


FIG 4—HOW A VDR can be a rectifier.

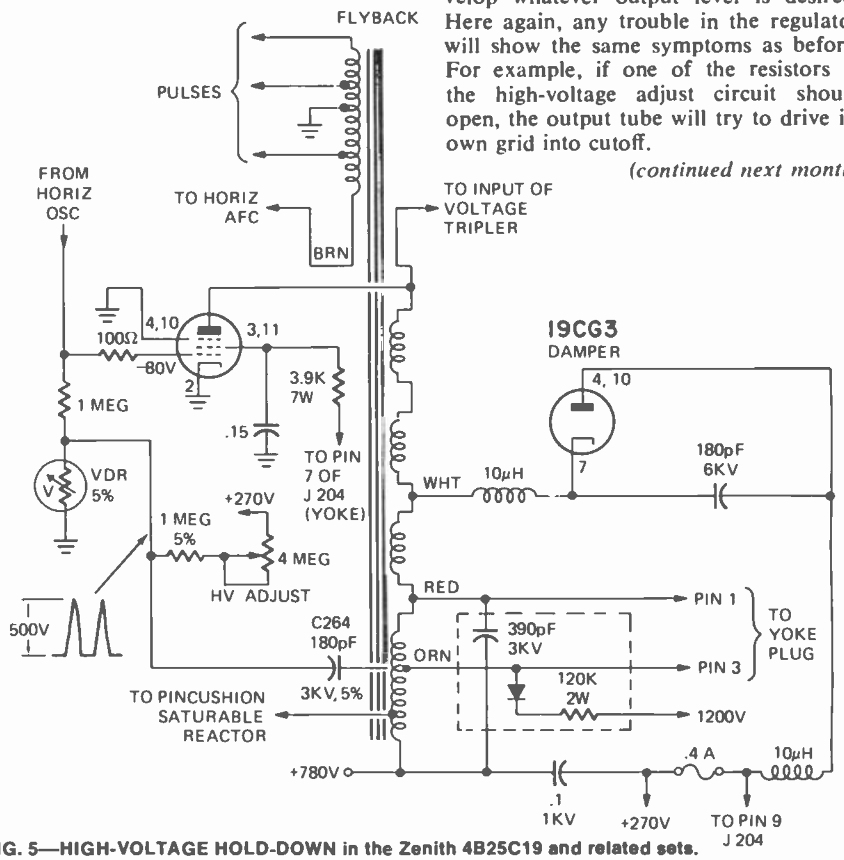


FIG. 5—HIGH-VOLTAGE HOLD-DOWN in the Zenith 4B25C19 and related sets.

Zeniths, such as 4B25C19 and others. During the high positive portion of the pike waveform (Fig. 4-b), the VDR's resistance will be much lower, and it will conduct heavily. During the low-voltage portion, the resistance will be greater. Coming through a capacitor, the waveform will automatically assume a "zero-line", as shown.

During the high-conduction parts of the spike, capacitor C charges up. The higher resistance of the VDR during the low-voltage part of the waveform won't let it discharge. So, a high negative voltage is developed and applied to the bottom end of the horizontal output tube's grid resistor. (For an interesting comparison, check this, and then look back at a similar circuit described last month. In that version, the pulse comes *through* the VDR, charging the grounded capacitor; in Fig. 4, the pulse comes through the capacitor and the VDR is grounded. Yet both circuits work the same way.)

Figure 5 is a partial circuit of the Zenith 4B25C19 chassis, using this type of regulation. It works like this: If the pulse voltage rises, meaning more output from the flyback, and greater high-voltage, this pulse also rises across the VDR. So, the charge on capacitor C264 increases (more negative), which biases the horizontal output tube to lower conduction, reducing the output. I'm talking about these reactions as if they took about 5 minutes; actually, they're practically instantaneous!

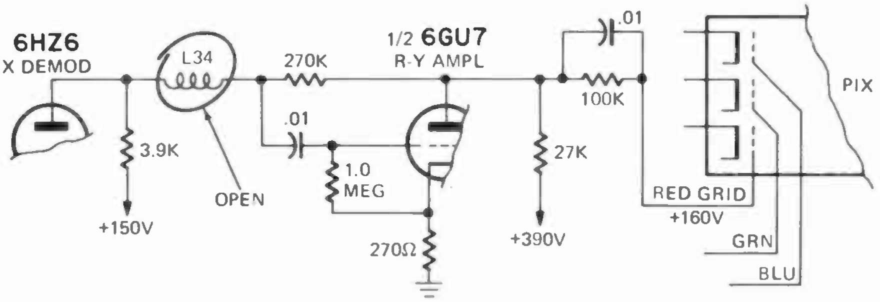
For a means of adjusting the high-voltage, a bias control is connected from the bottom of the grid resistor back to +270 volts. By varying this control, the positive bucking voltage can be set to develop whatever output level is desired. Here again, any trouble in the regulator will show the same symptoms as before. For example, if one of the resistors in the high-voltage adjust circuit should open, the output tube will try to drive its own grid into cutoff.

(continued next month)

reader questions

NO RED

Everything else works, but I can't get any red in the picture on this RCA CTC-16XL. As you said, I checked all of the DC voltages. The blue and green grids on the pic-



ture tube are OK at +160 volts, but the red grid is down to +82 volts. The 6GU7 is OK, and the plate resistors (27,000 ohms) is OK. Only +82 volts on the plate of the R–Y amplifier. What goes now?—F.C. Augusta GA.

Old saying: if plate voltage is low, tube and plate load resistor OK, then check cathode and grid circuits. (You're losing the red because the red gun of the picture tube is plain old cut off. A "drop" in bias from +160V to +82V is enough to stop this gun from conducting.)

Cathode circuit of all three difference-amplifier tubes is common, but check it anyhow. Also check the grid circuit. I think you may find that little choke, L34, is open. This would upset the bias on this section of the 6GU7, which upsets the picture tube grid bias. (Feedback: that *was* it!)

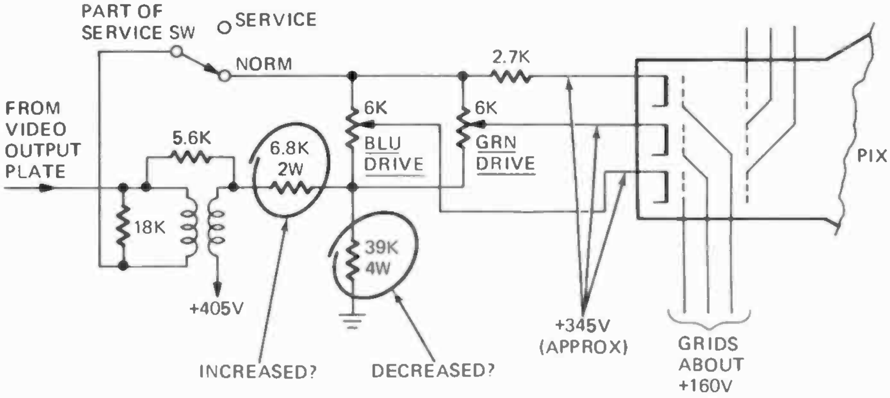
NO BRIGHTNESS CONTROL

I can't turn the brightness off in this Olympic CC3340. Even the kine bias switch has no effect. Picture tube OK, other tubes OK. I'd like a schematic on this, too; can't find one in Canada.—J.F., Montreal, Canada.

This particular model of Olympic uses an RCA CTC-15 chassis. You can use this, or write to Olympic International Ltd., 88-89 Union Turnpike, Ellendale, NY 11227.

Brightness control: Check the grey-scale adjustments, especially the setting of the screen controls on the picture tube. If someone has turned all three of these full up, you might not be able to turn the raster off.

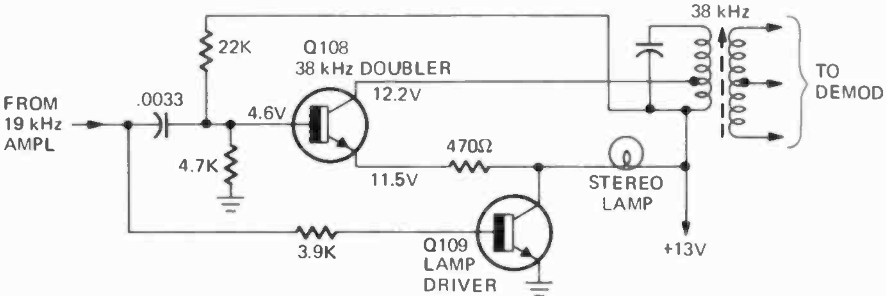
If these are OK, then you have a *bias* problem. Read the cathode and grid voltages on the picture tube. Cath-



odes should be about +345 volts, grids about +160 volts. If the grids are "too positive" (high), or the cathodes "too negative" (low), the picture tube will be near to "zero-bias", and the control won't work.

NO STEREO FM, MONO OK

I fixed one trouble in this Lafayette LR-1000TA radio receiver, by replacing an IC in the IF. Now it is working on AM and FM, but I can't get any FM multiplex, and the stereo light won't go on. Lamp driver transistor Q109 checks OK, as does lamp itself. DC voltages around the 38-kHz doubler are as shown.



Can I signal-trace through this circuit, and if so, how? C.W., VA.

You can. The 19-kHz and 38-kHz pilot signals are well within the range of even a narrow-band scope. You should see a sinewave through there. Check amplitude of the signal, and the frequency. By setting the horizontal scope sweep to display about 3 cycles of the 19-kHz signal, you can tell if the 38-kHz circuit is doubling; you'll see 6 cycles.

Those voltages around Q108 look very peculiar, especially the collector and emitter. I believe this transistor has a collector-emitter short. If so, it won't let the lamp-driver work. Bias looks suspicious, too.

Follow the 19-kHz signal through the two preamplifiers (not shown in diagram and check for amplitude. The 38-kHz doubler stage won't show a gain in amplitude, but should show a doubling of the frequency.

NO HV, NO BOOST

This GE M213CWD has an odd problem. I get no boosted boost on the picture tube screens, and no HV. Everything around the flyback seems to check out; no shorts, etc. in the boost-boost circuits, etc. Cathode current of the horizontal output tube is only a little high.—V.A., Honolulu, HI.

Check the picture tube bias voltages. This sounds a good deal like the cases where something is pulling the high-voltage away down because of excessive load. A shorted 1AD2 high-voltage rectifier will do the same thing, by the way. Any short in the boost circuits, etc. will make the cathode current of the output tube run very high. Shorts in the high-voltage will often raise it only a little.

NO RASTER

The problem in this Singer HE8015 TV is no raster, good sound. Voltages of DC power supply OK, horizontal output tube OK. I get +240 volts on the grid of the 6BK4, and +240 volts on the cathode. Is this normal?—S.C., Santa Fe, NM.

Nope. Your 6BK4 is running at *zero-bias*. Quick check for this; lift the 6BK4 plate cap. If the raster comes back, that's it. One common cause of this is a short in that .0033-μF capacitor connected between grid and cathode of the 6BK4. Quick check; clip one lead. Be sure to use a high-voltage capacitor here, and space the leads exactly as they were; this acts as an arc-gap. **R-E**

HOW R-E TESTS HI-FI GEAR

(continued from page 43)

OPEN-REEL TAPE DECK MEASUREMENTS

	R-E Measurement	R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS		
Standard Tape		
Frequency response @ 15 ips (Hz-kHz ± — dB)		
Frequency response @ 7½ ips (Hz-kHz ± — dB)		
Frequency response @ 3¾ ips (Hz-kHz ± — dB)		
CrO_2 Tape		
Frequency response @ 15 ips (Hz-kHz, ± — dB)		
Frequency response @ 7½ ips (Hz-kHz, ± — dB)		
Frequency response @ 3¾ ips (Hz-kHz ± — dB)		
	See Figs. —	
DISTORTION MEASUREMENTS (RECORD/PLAY)		
Harmonic distortion @ −10 VU (highest speed) (%)		
Harmonic distortion @ −3 VU (highest speed) (%)		
Harmonic distortion @ 0 VU (highest speed) (%)		
Harmonic distortion @ +3 VU (highest speed) (%)		
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Best S/N ratio, standard tape (dB)		
Best S/N ratio, CrO_2 tape (dB)		
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow-and-flutter @ 15 ips (% WRMS)		
Wow-and flutter @ 7½ ips (% WRMS)		
Wow-and-flutter @ 3¾ ips (% WRMS)		
Rewind time, 1200' tape (seconds)		
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)		
Line output sensitivity (mV)		
Line output level (mV)		
Phone output level (mV or mW)		
Bias frequency (kHz)		
TRANSPORT MECHANISM MEASUREMENTS		
Action of transport controls		
Tape guidance system		
Absence of mechanical noise		
Tape head accessibility		
Construction and internal layout		
Evaluation of extra features, if any		
OVERALL TAPE DECK PERFORMANCE RATING		

FIG. 5. OPEN-REEL TAPE DECK MEASUREMENTS

FREQUENCY RESPONSE MEASUREMENTS of an open reel tape deck are linked to speed of tape travel, bias adjustment of the machine, distortion which the user is willing to tolerate, and to the choice of tape (which should correspond, if possible, to manufacturer's recommendations). We will list response for all available speeds using one standard type of tape and one suggested CrO_2 type, but, since it is important to know at what frequencies maximum departure from flat response occurs, we will also include graphic plots of frequency response in each report covering an open-reel tape product. Measurements will be made at a −10 dB VU meter reading. Manufacturers use a variety of record and playback equalization curves (NAB, CCIR, etc.). Therefore, using one special prerecorded tape is meaningless. The important thing for the user is the "closed loop" frequency response, through the record and playback cycle. A prerecorded tape done to NAB will not reproduce flat response when played on a machine equalized per DIN or CCIR. Cross talk measurements are of little significance on open reel machines. Readings are usually much better than one needs for acceptable or even excellent stereo.

DISTORTION MEASUREMENTS at various recording levels will be noted, so that users can choose maximum indicated recording level on meters supplied to correspond with greatest percentage of distortion they are willing to tolerate. While lower recording level results in lower harmonic distortion, the penalty paid in underrecording is poorer signal to noise ratio, since "hiss" or noise level is constant.

SIGNAL-TO-NOISE RATIO MEASUREMENTS made using the same two types of tape used in frequency response measurements are stated in dB, and referred to a "O VU" reading on the equipment's own meters. The higher the measured figure, the better. From this single reference, users can easily determine what the S/N ratio will be if they must record at lower VU readings to obtain better distortion figures or extended high frequency response.

MECHANICAL PERFORMANCE MEASUREMENTS in tape equipment involve wow-and flutter measurements which simply mean slow or fast variations from true speed, and are analogous to the same measurement made for phono turntables. The lower the figure (given in percent) the better. WRMS means weighted root-mean-square and is an "averaged" sort of measurement that also takes into account human response to variations in pitch. We are less conscious of slow cyclical variations in speed or pitch than we are to more rapid variations. Fast rewind time, while not truly indicative of a tape deck's quality or performance, is nevertheless of interest to some readers and will therefore be measured and tabulated for standard 1200 foot reels of tape.

COMPONENT MATCHING CHARACTERISTICS are supplied for informational purposes once more, and not as an indication of quality of performance. A tape deck whose line output for 0 VU is 0.3 volts (300 mV) would not be able to drive an amplifier to full output if that amplifier had a high level input sensitivity of, say, .5 V (500 mV). Similarly, some headphones, though directly connectable to phone jacks on the tape deck, may not be sensitive enough (require more drive) to provide adequate monitoring levels when used this way.

CASSETTE TAPE DECK MEASUREMENTS

	R-E Measurement	R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS		
Frequency response, standard tape (Hz-kHz ± ___ dB)		
Frequency response, CrO_2 tape (Hz-kHz ± ___ dB)		
Frequency response, other (see text) (Hz-kHz ± ___ dB)		
	See Figs. ___	
DISTORTION MEASUREMENTS (RECORD/PLAY)		
Harmonic distortion @ −10 VU (1 kHz) (%)		
Harmonic distortion @ −3 VU (1 kHz) (%)		
Harmonic distortion @ 0 VU (1 kHz) (%)		
Harmonic distortion @ +3 VU (1 kHz) (%)		
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Standard tape, "Dolby" off (dB)		
Standard tape, "Dolby" on (dB)		
CrO_2 tape, "Dolby" off (dB)		
CrO_2 tape, "Dolby" on (dB)		
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow and flutter (%, WRMS)		
Fast wind and rewind time, C-60 (seconds)		
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)		
Line input sensitivity (mV)		
Line output level (mV)		
Phone output level (mV)		
Bias Frequency (kHz)		
TRANSPORT MECHANISM EVALUATION		
Action of Transport controls		
Absence of Mechanical Noise		
Tape head accessibility		
Construction and internal layout		
Evaluation of extra features, if any		
CONTROL EVALUATION		
Level indicator(s)		
Level control action		
Adequacy of controls		
Evaluation of extra controls		
OVERALL TAPE DECK PERFORMANCE RATING		

FIG. 6. CASSETTE TAPE DECK MEASUREMENTS

FREQUENCY RESPONSE MEASUREMENTS. Since cassette decks operate only at one speed (1⅞ IPS), response measurements will be confined to the use of two or more types of cassette tapes, based on manufacturer's recommendations. Cassette decks generally do not offer as extended high frequency response as do open-reel machines, but better cassette units used with top quality tape can maintain flat response to above 15 kHz with a minimum of variation in dB.

DISTORTION MEASUREMENTS: The same interrelationships that apply to open reel machines exist in the case of cassette recording. Distortion increases with recording level, and we tabulate harmonic distortion readings for a wide range of meter levels for each machine we test.

SIGNAL-TO-NOISE RATIO MEASUREMENTS: Dolby noise reduction circuitry is now considered a virtual necessity with better cassette decks intended for high fidelity applications. Properly calibrated and used, Dolby can improve S/N ratios by as much as 10 dB at high frequencies where tape hiss is most prominently heard. Readings of noise will be presented with two types of tape, with and without Dolby circuitry switched on. Most modern high quality decks will offer in excess of 45 dB without Dolby, better than 55 dB with Dolby in use, but variations will occur depending upon quality of the tape cassette itself.

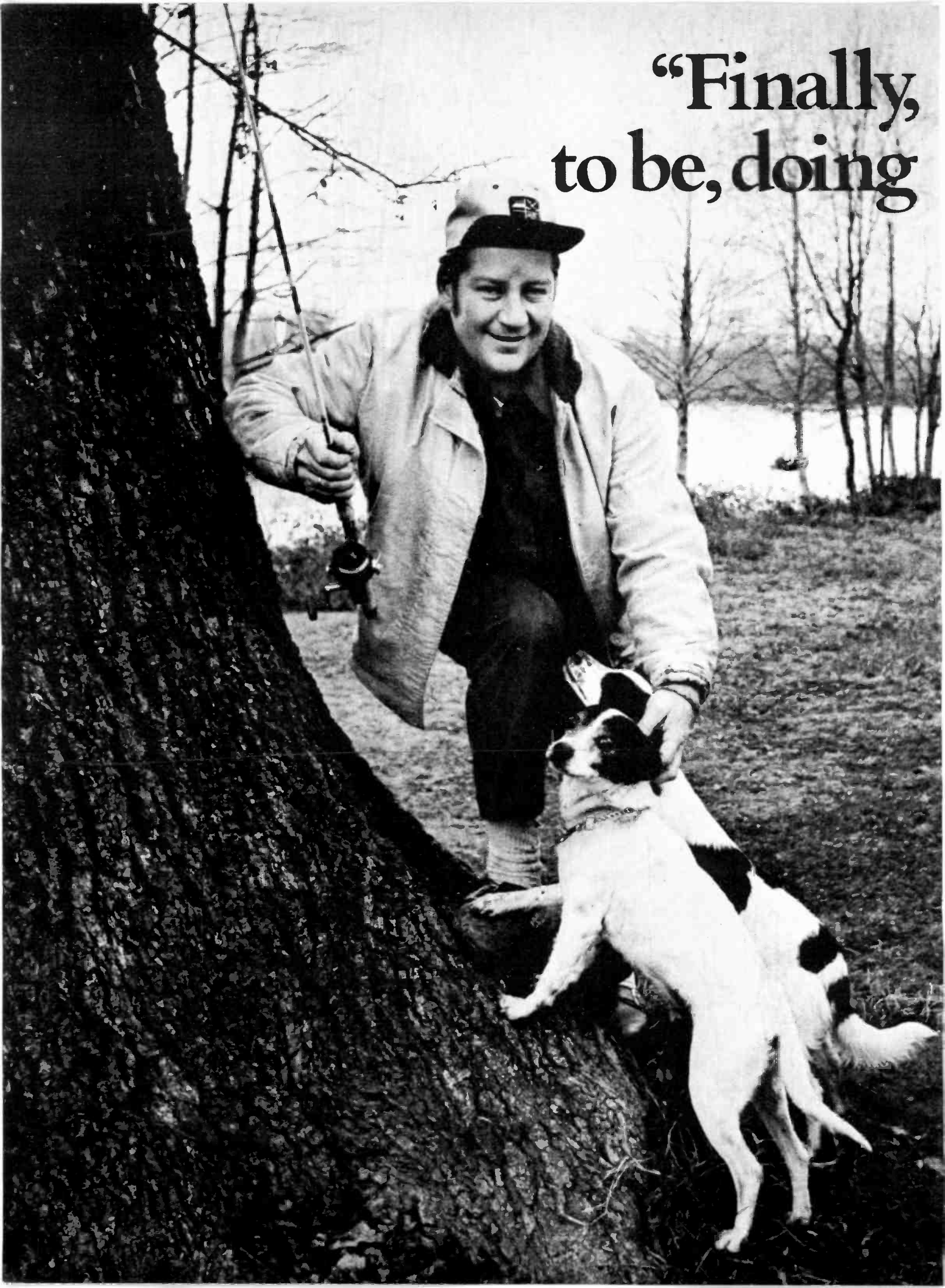
MECHANICAL PERFORMANCE CHARACTERISTICS: Because of the much lower speed of cassette tape, and because of limitations in the cassette itself, wow-and-flutter readings observed for cassette decks are seldom as good as those observed for open-reel machines of better quality. Nevertheless, wow and flutter in top-quality cassette decks can be as little as 0.1% or even lower. As in the case of open reel units, we will also report on fast rewind time (for a 60 minute—30 minute per side—cassette) for informational purposes.

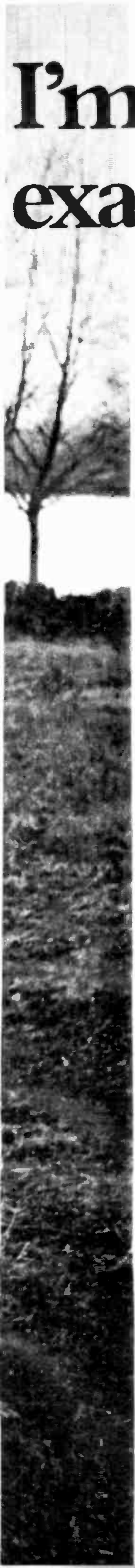
COMPONENT MATCHING CHARACTERISTICS. These observations are intended to enable the reader to select the right microphone for use with the machine and also to insure a good match between tape-output level of amplifier or receiver and the deck, and between the deck and the tape input circuitry or associated playback equipment. Bias frequency should be high enough (above 75 kHz or 80 kHz) to insure freedom from audible "beats" when attempting to record stereo FM programs off the air onto a cassette. Stereo FM composite signals contain frequencies up to about 53 kHz which might interact with low tape bias frequencies, yielding "difference frequencies" which might be permanently recorded onto, and audible from the cassette.

AM performance measurements

While we recognize that most tuners and receivers sold for high fidelity component systems include an AM tuner section, we have not included a separate AM Performance Measurement chart in our test report format. For one thing, the number of significant measurements that can be made with respect to AM performance are rather limited. Most manufacturers, in fact, list no more than a half dozen or fewer performance "specs" regarding the AM section of their tuners or receivers. While AM buffs may argue about the potential high fidelity capabil-

(continued on page 84)


"Finally,
to be, doing



"I'm right where I want exactly what I want to do."

(A TRUE STORY)

"Judy, start packing. We're moving out."

Bill Alfring was so fed up with the hassles of living in Los Angeles, he quit his job on the police force and moved his family up north to logging country.

Bill put a down-payment on a wooded home site along the salmon-filled Sacramento River. He got a job as a car salesman. Then, he started to think what he could do for a living that would give him more freedom.

A business of his own

"Judy, I've always wanted to know how a TV set works," he told his wife. "If I knew that, I could have my own TV shop. And as this town grows, my business would grow too."

So, Bill enrolled in the ICS TV program, kept selling cars, and studied his TV lessons whenever he had free time.

Two years later, Bill Alfring opened the doors of Shasta TV—right in the center of Anderson, California. Business grew rapidly. The shop needed to be enlarged. Today, Bill has two repairmen working for him.

Standing in front of his shop, Bill looks south to San Francisco and L.A. "That's where the people are coming from. It'll take time. But when they get here, my business could be worth ten times as much. I'll just sell out and find a better place to fish."

The right combination for success

Bill Alfring has the right combination for success. He's in a growing field. And he has good training for it. You could, too.

Especially if you're interested in one of the fast-growing careers where ICS concentrates its training. Like TV Repair & Servicing. Electrician. Engineering. Automotive Mechanic. Drafting. Air Conditioning. Accounting. Business Management. (Check your choice on attached card.)

Ideal way to learn

As an ICS student, you study at home, on your own schedule. You waste no time traveling to and from class. And you never have to miss a paycheck.

But you're never alone. Skilled instructors are always ready to help you.

If you ever have doubts or problems or just want to talk to an instructor, you can call ICS from anywhere. Toll-free.

ICS training works

More than 8,500,000 men and women have turned to ICS for career training in the past 80 years.

Government agencies, unions and some of America's top corporations (including Ford, U.S. Steel, Mobil, Alcoa, GE, Motorola and RCA) use ICS courses in their own training programs.

Free demonstration lesson

If you want your job to give you more (more money, more day-to-day satisfaction, and more future), send for our career guide booklet and free demonstration lesson.

It's your life. Make the most of it.

Bill Alfring often quits work early to catch a salmon in the Sacramento River that runs through his back yard. (see left) (Photo: Charles Weckler)

READING COMPUTER

(continued from page 45)

ance of the device. The 15-dot pattern is composed with the switch in the STANDBY position. Then the switch position is changed to RECOGNIZE, and on this command the output lamp lights up. Sometimes there are ambiguous patterns, which might be for example either a defective "2" or an incomplete "3". In this case, the output lamps labelled "2" and "3" will light up simultaneously. Most of these ambiguities, however, appear so also to the human eye.

As this is a digital circuit, the question of voltage ratings and power consumption is of secondary importance. The lamps may be any voltage or power, provided they do not impose excessive load on the switches. The battery, which may be replaced by a suitable transformer, has to be capable of bearing the full load of 15 display lamps and at least two output lamps. If it is desired, display and output lamps may be replaced by neon lamps to conserve power. However, the suitable supply voltage for neon lamps is 75-80 volts AC or 105-125 volts DC. Therefore, a suitable supply must be used.

Construction

The reading computer was built into a wooden case originally designed for 2 by 2 inch color slides. The case contains four flashlight cells in its lower compartment for power. Pattern input and other switches, pattern display lamps and output lamps, are all mounted on the lid of the case. The result is a very handy device suitable to be taken along to lectures, demonstrations, science fairs etc. However, any case that is large enough to accommodate all the components and a power supply can be used.

Switches S1 through S15 are 4PST types with two contact pairs open and two contact pairs closed. A schematic diagram of these switches is shown in Fig. 4-a. However, these switches may

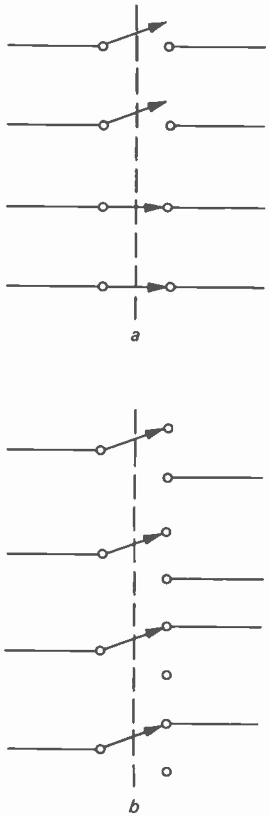
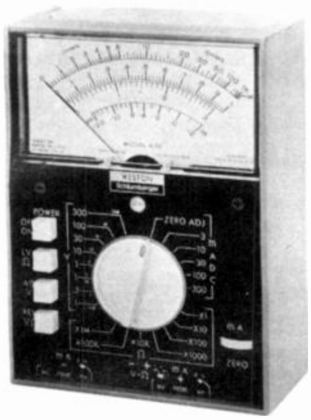


FIG. 4—ORIGINAL SWITCHES used for S1 through S15 were 4PST types with two contact pairs open and two contact pairs closed and are shown in a. In their place, 4PDT switches can be used if they are wired as shown in b.

be difficult to obtain. In their place, 4PDT switches can be used if they are connected as shown in Fig. 4-b. Though this device is extremely simple, it should provide many hours of entertainment in construction and use. **R-E**

IN THIS ISSUE
Radio-Electronics tests hi-fi equipment. Don't miss the introductory article describing how the tests will be done.

Weston Model 670 In-Circuit Tester



Circle 106 on reader service card

THE "TYPICAL" FET VOM CAN DO TRICKS that were unbelievable only a few years ago. Now, by combining linear IC technology and the FET VOM, they can work wonders. The Weston Model 670 In-Circuit Tester FET VOM is a good example of this new generation.

The model 670 is a portable, self-contained analog multimeter, powered from either 115 or 230 volts AC, at 60 Hz. It reads DC voltages on 8 ranges, from 0.1 volt to 300 volts, full-scale. Polarity is automatic; the meter reads upscale at all times and it displays the polarity on LED's. The AC voltage readings are read on the same scales, as is the current. These all use the handy "1-3" calibration, which makes them easier to read.

The ohmmeter section has both standard and low-voltage functions. On the standard ranges, 1.5 volts appears across the prods. On the low-voltage ohms setting, only 85 millivolts; this will not turn on transistor junctions.

Conventional DC current readings are made in the usual way, from 3.0 to 300 mA, full-scale. Normally, the circuit must be opened to make a current measurement. This is called the "two-terminal" current reading. Now, we get to the really novel feature of the Model 670. With it, you can read DC current in any circuit, on the same ranges, but *without* opening the circuit. No unsoldering of wires or cutting of PC board conductors! Current readings are thus made just as easy as DC voltage readings were; just a quick jab of the test probes.

In operation, it's simple. The circuit itself isn't. The basic metering circuit uses an FET op-amp that feeds a bridge, and the meter itself. A precision resistor network determines the voltage applied to the op-amp, by the setting of the range switch. For two-terminal current readings, the op-amp monitors the voltage drop across the precision shunts, and this is read out as current values. The circuit must be opened.

To use the four-terminal method, two special probes are plugged in. Although they look like ordinary pro'es, they're not. Each one has two leads, and special concentric probe tips. These have a sharp, spring-loaded inner tip and an

(continued on page 88)

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

TV TUNER AEROSOL, *model CLD-4* cleans tuner contacts thoroughly, then leaves a protective film of silicone lubricant to assure smooth detent action. Blister-packed for

pegboard display; safe for plastics; will not detune; non-flammable. 4-oz. spray can $1.35.—**Chemtronics Inc.**, 1260 Ralph Avenue, Brooklyn, NY 11236.

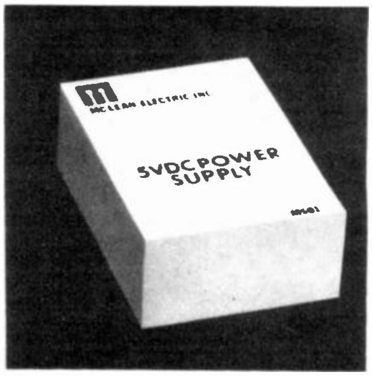
Circle 31 on reader service card

POWER SUPPLY, *model 1040.* Multipurpose solid-state power supply enables you to enjoy automotive stereo tape player, CB rig, etc. at home. Converts 115 VAÇ house current to 12 volt DC power. The *1040* makes it possible to check out equipment on the

test bench before actually installing it in your car or on your boat. It can also be used as a battery charger for 12 volt batteries. Input: 120 VAC, 50-60 Hz; output: 12 VDC at 4 amps continuous. $19.95 (factory wired only).—**EICO Electronic Instrument Co.**, 283 Malta Street, Brooklyn, NY 11207.

Circle 32 on reader service card

POWER SUPPLY MODULE, *model M501* provides 5 VDC (@ 1000 MA and 0.05% line and load regulation) to digital IC's and asociated circuitry. Useful for industrial and laboratory applications. Designed for printed circuit



card mounting and can be supplied with voltage from 1.0 VDC to 28VDC. Input: 105 VRMS to 125 VRMS, 50-400 Hz; temperature range: 0-71°C. 2.5 × 3.5 × 1.25 in.; $12.00 each (1-9 quantity).—**McLean Electric Inc.**, 48 Highland Avenue, Bergenfield, NJ 07621.

Circle 33 on reader service card

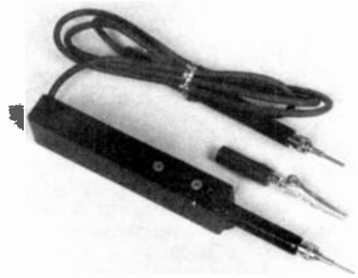
TV SERVICE TABLE, *model 10J108.* Roll-around utility table is 35 in. tall—to match the heights of most service benches. Its top shelf—constructed of 20 gauge sheet metal and insuated with a ⅛-in. tempered masonite panel—offers nearly four square feet of work surface. Convertible bottom shelf can be installed with a flat surface or inverted

for use with its 1¾ in. lip to prevent small parts and tools from falling off.

Constructed of 20 gauge rustproofed steel, the table is coated with blue enamel paint, baked on for years of hard usage. Two of its four 3-in. plastic casters are equipped with pushdown brakes to prevent rolling. Although shipped dismantled, it can be easily assembled; only tool required is a screwdriver since all nuts are spot welded in place.—**RCA Parts & Accessories,** Box 100, Deptford, NJ 08096.

Circle 34 on reader service card

PROBE IV, *Cat. No. 5104.* 4-function tester allows you to check digital logic, continuity, voltage and polarity with one instrument. Easy-to-use pocket-size tester operates on 2 AAA batteries. Features solid-state circuitry,

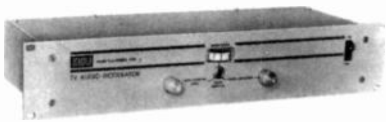


3 to 600 volt AC-DC operation, voltage indicating LED and a 48-in. insulated wire lead with test probe and alligator clip adapter. Safe to use; comes with its own self-protective vinyl carrying pouch.—**GC Electronics,** 400 South Wyman, Rockford, IL 61101.

Circle 35 on reader service card

AUDIO MODULATOR, *model ATS Audio-Trol.* Solid-state audio modulator for MATV acsepts any audio source and distributes it over an unused TV channel frequency. Actually generates a complete TV channel that includes both audio and video carriers. Audio carrier is modulated by audio input source and video carrier is left blank.

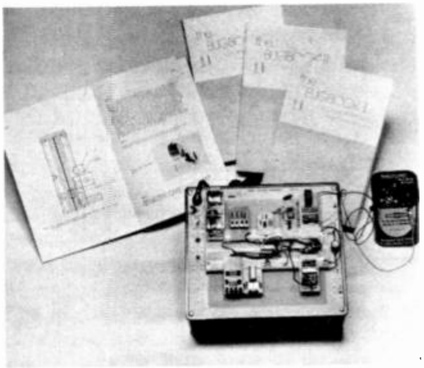
Any TV receiver connected to an MATV system which includes *Audio-Trol.* can be tuned to that channel to reproduce the



sound. If a background music channel were required in an apartment system, this unit could be fed by the background music source and then into the MATV system head end. Tenants could then hear the background music on their TV receivers. Can also be used to make announcements. Accepts a minimum of 50 mV RMS of audio input. Maximum output level is 53 dBmV audio carrier and 53 dBmV video carrier that is crystal controlled. Audio carrier is modulated with 25 kHz maximum deviation. Modulation distortion is less than 2%. Spurious output signal is down at least 60 dB on high band units. Takes up 3½ in. of space; mounts in standard 19 in. rack; 7 in. deep. Audio impedance is 600 ohms unbalanced. RF in and out mixing terminals are 75 ohms. Available for each VHF channel.—**Jerrold Electronics Corp.,** 200 Witmer Road, Horsham, PA 19044.

Circle 36 on reader service card

DIGITAL ELECTRONIC TEACHING SYSTEM, *LR Innovator Series* includes modular hardware called Outboards that plug directly into the SK-10 solderless breadboarding socket that allows the student to learn and experiment with different components of digital logic. Software is comprised of over 750 pages and 90 experiments that can be incorporated into an existing program or used by the student for self-programmed instruction. Modularity of this system means that as there are new developments in digital

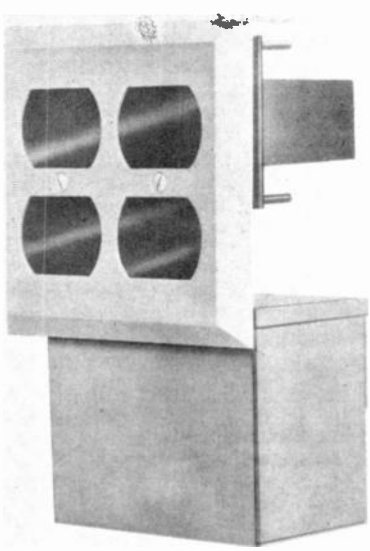


electronics, the company will be able to provide new modules that cover these areas. —**E & L Instruments, Inc.,** 61 First Street, Derby, CT 06418.

Circle 37 on reader service card

PHOTOELECTRIC SYSTEM, *No. 1355* is pulsed beam system that looks like two double-gang electrical wall outlets when installed. Features a single-ended design. Instead of having a separate transmitter and receiver that fit at opposite sides of the protected span, this model has a 2-part transceiver that fits into a 3¾- x 4-in. hole in the wall. All supervisory and power wiring is brought to just one side of the protected span, cutting installation time in half.

Contains pulse modulated solid-state light source whose life rating is in excess of 25 years; light source projects a beam up to 75 feet. Beam is aimed at a bounce back reflector that looks like a wall outlet. This reflector, without any kind of adjustment, bounces the invisible beam from the transmitter back to the receiver. A patented drop-pack houses all supervisory circuitry as well as the power supply. Transceiver and drop-pack can be recessed together in any plaster, sheet rock

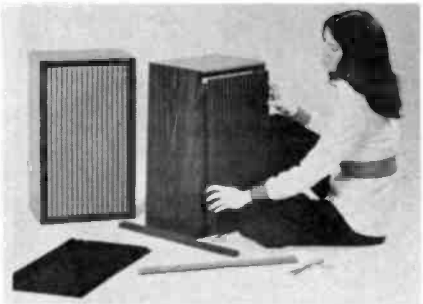


or panelled wall as long as it is at least 3⅝ in. deep.—**Alarm Device Manufacturing Co.,** 165 Eileen Way, Syosset, NY 11791.

Circle 38 on reader service card

FOAM SPEAKER GRILLE KITS. *Do-it-yourself kits* feature sculptured-foam speaker grilles for replacement of conventional grille cloth on stereo and hi-fi speakers. Unlike grille cloth, sculptured-foam doesn't distort sound, even in higher frequency ranges. Flexible urethane foam is acoustically transparent which permits sound to pass through as though there were no grille at all.

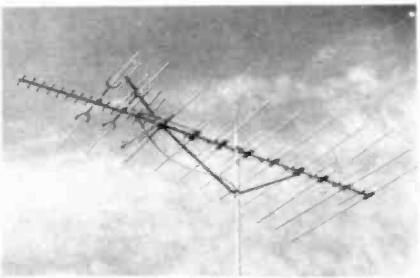
Each kit contains sculptured foam grille, self-sticking attachment material and instructions for installation. Available in 15x8 in.



and 14x24 in. sizes; foam grille can be cut with household shears to fit smaller speakers.—**Republic Systems Corp.**, 9160 South Green Street, Chicago, IL 60620.

Circle 39 on reader service card

ANTENNAS, *Ultra-Hi Crossfire*. VHF-UHF antennas incorporate colinear elements and a corner reflector. UHF section is engineered to



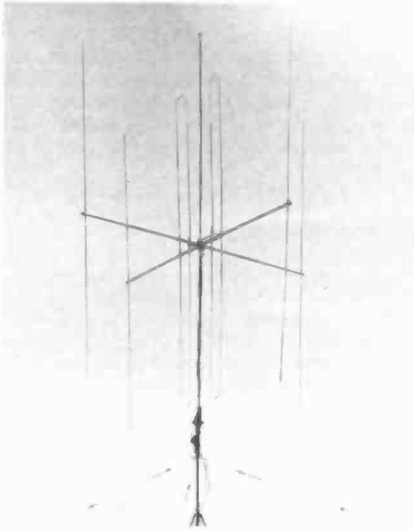
avoid interference with the rest of antenna. As a result, antennas deliver very high UHF gain where it is needed most without diminishing performance of original VHF antenna. These antennas replace previous VHF-UHF *Crossfires* model for model. In addition, there are two special models designed for areas that require only moderate VHF gain but very high UHF gain.

Antenna has a single set of terminals. Comes with a band splitter that uses separate VHF and UHF circuits — affording complete electrical isolation between outputs. 8 models—$30.25 to $98.50.—**Channel Master**, Ellenville, NY 12428.

Circle 40 on reader service card

MOBILE ANTENNAS, *Signal Kicker Antennas* are computer-designed and use a twin-folded dipole center element; balanced-fed configuration completely eliminates most current problems.

Base Kicker is omni-directional and can be raised to new 60-ft. legal height. Delivers full 3 dB gain: $79.95. *Tri Kicker* is 3-element directional and provides solid 9.3 dBi gain;



$119.95. *Ultra Kicker* allows both omni and directional capabilities. Remote electronic switching to eight different directions instantaneously. Eliminates need for a rotor and provides precise directional capabilities; provides 8.3 dBi in the directional modes and 3 dBi in its omni mode; $239.95.—**Con-rac Corp., Turner Div.**, 909 17th Street, NE, Cedar Rapids, IA 52402.

Circle 41 on reader service card

"I've gotta admit you have the color coming in pretty good — considering that's a black and white set."

new lit

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free. Use the Reader Service Card inside the back cover.

HI-FI BROCHURE. 8-page, 4-color brochure describes and illustrates the company's hi-fi amplifiers, preamplifiers, speaker systems, control centers and tape recorders. Contains many photographs and specifications.—**Crown International,** 1718 Mishawaka Road, Elkhart, IN 46514.

Circle 42 on reader service card

TAPE QUESTIONS—TAPE ANSWERS. 126-page book has chapters that include: selecting the right tape, compact cassettes or spool tape recorders?, selecting the appropriate compact cassette equipment, selecting the right spool tape recorder, which trick equipment for what purpose, which sound mixing for what purpose, which microphone for what purpose, recording with microphones, how to record direct, editing and splicing of magnetic tape, endless tape loops, how is a tape library arranged?, tape and recorder maintenance, exchange of recorded tapes, exchange of recorded cassettes, how is sound added to slides?, how to add sound to 8-mm films. Many diagrams. **BASF Systems,** 460 Colfax Avenue, Clifton, NJ 07013.

Circle 43 on reader service card

UNDERSTANDING QS 4-CHANNEL SYSTEM. 52-page guide for electronic engineers contains the following sections: QS 4-channel encoder technical data, QS coding system and new technique to improve interchannel separation characteristic, improving encode-decode system for matrix 4-channel reproduction, additional functions of QS decoder and specifications of QS vario-matrix integrated circuits. Each section is sub-divided and there are many diagrams and schematics.—**Sansui Electronics Corp.,** 55-11 Queens Blvd., Woodside, NY 11377.

Circle 44 on reader service card

TEST INSTRUMENTS CATALOG. 24-page catalog describes oscilloscopes, digital multimeter, solid-state video color signal source, color bar pattern generators, DC power supply, sweep/marker generators, signal generator, sine/square wave generator, FM multiplex/stereo generator, electronic switch, curve tracer and much more. Includes photographs, specifications and prices.—**Leader Instruments Corp.,** 151 Dupont Street, Plainview, NY 11803.

Circle 30 on reader service card

Circle 61 on reader service card

HOW R-E TESTS HI-FI GEAR

(continued from page 73)

PHONOGRAPH CARTRIDGE MEASUREMENTS

	R-E Measurement	R-E Evaluation
FREQUENCY RESPONSE (Hz-kHz, ± ___ dB)	See Fig. ___	___
STEREO SEPARATION		
Separation, 1 kHz (dB)	___	___
Separation, 10 kHz (dB)	___	___
Separation, 30 kHz (dB)	___	___
CHANNEL BALANCE, 1 kHz (dB)	___	___
TRACKABILITY MEASUREMENTS		
Stylus velocity at 1 kHz (CM/Sec.)	___	___
Stylus velocity at 10 kHz (CM/Sec.)	___	___
COMPONENT MATCHING CHARACTERISTICS		
Output level, 1 kHz, 3.54 CM/Sec. (mV)	___	
Optimum load impedance (ohms)	___	
Tracking force range (___ to ___ grams)	___	
Cartridge weight (grams)	___	
OVERALL PHONO CARTRIDGE RATING		___

FIG. 7. PHONOGRAPH CARTRIDGE MEASUREMENTS

FREQUENCY RESPONSE: As with all elements of a high fidelity system, frequency response of a phonograph cartridge should be as uniform as possible over the entire audible range. A cartridge, like a loudspeaker or headphone, is an electro-mechanical device rather than a purely electronic component, which makes it more difficult for the phono cartridge to maintain perfectly uniform response. Mechanical resonances at a given frequency can upset uniformity of response, as can the physical limitations of the sylus assembly as it attempts to follow tiny groove modulations in the recorded disc. Special test records are used to measure cartridge response. These contain specific frequencies recorded at a precisely maintained level. Slow sweeping frequencies, which start at the low bass end and sweep evenly up to 20 kHz may be used, synchronized with an automatic strip-chart recorder so that a permanent record of the response of each channel is plotted automatically. That is the system used in our tests. Newer CD-4 (4-channel) records may contain frequencies up to 45 kHz and cartridges intended for playback of these new quadraphonic records must respond with reasonable uniformity up to such high frequencies. In addition to our tabulated statement of response, our tests reports will show graphs of overall frequency response so that readers may not at what frequencies maximum departure from flat response occurs.

STEREO SEPARATION, or the ability to maintain isolation of left and right channel signals from each other, is measured in dB and the higher the reading the better. As was true of stereo FM, separation capability tends to decrease at higher frequencies, and our tests will report separation at mid-frequencies, 10 kHz and 30 kHz (the center frequency of the super-audible carrier used in CD-4 records) where applicable.

TRACKABILITY MEASUREMENTS give good indication of the compliance of a phono pickup stylus assembly. The stylus must move freely and be able to follow large excursions or modulations in the groove of a record. The greater the undulations in the groove, at a given frequency, the greater the velocity of the stylus (measured in centimeters per second), and so a higher number indicates better "trackability" or stylus assembly compliance. The text will specify the tracking force used to achieve maximum velocity tracking under the two frequencies shown. Of course, if that tracking exceeds recommended range given by manufacturer, suitable comment will have to be made in the text.

COMPONENT MATCHING CHARACTERISTICS are presented to enable the reader to choose the right cartridge to match other components, such as preamplifier, amplifier or receiver and record turntable system. The tone arms on low-cost record changers, for example, may require several grams of downward force on the part of the cartridge stylus. It would be unwise in such instances to purchase a top-grade cartridge that should be adjusted at about 1 gram of tracking force and try to use it in such inferior record playing products. Most stereo cartridges work best when connected to a 47,000 ohm load (common in most preamplifier circuits) while newer, CD-4 type cartridges work best when operating into 100 Kohm loads. Manufacturers of preamplifiers, amplifiers and receivers will supply this information regarding the phono input circuits as part of their published specification literature. Few, if any, cartridge manufacturers specify capacitive loading and since this will affect overall frequency response, the best we can do is measure with a "typical" 40" cable of medium pF per foot and report response accordingly. Further capacitance loading can alter the high end response but cannot hold the consumer to a given capacitive loading, so there's no point in specifying it.

ity of AM, they will surely admit that *most* AM broadcasting in this country is definitely of the "low-fi" variety. Accordingly, *most* high fidelity component manufacturers do not bother to build in hi-fi potential to the AM section of their products. There are exceptions, and these will be noted as we encounter them in the months ahead. Normally, however, we will simply evaluate AM performance in a paragraph or two in our narrative description of the product under test.

Capsule summaries regarding products tested will appear both in abbreviated chart form (See Fig. 9) and in brief narrative form. These summaries should enable the reader who does not wish to explore the detailed reports in depth to gain a quick insight as to our overall reaction to, and evaluation of the product under discussion.

(continued on page 86)

SCOPES

(continued from page 53)

lem, a specialized oscilloscope has been developed for viewing periodic waveforms of extremely high frequency. This technique is called sampling. The sampling oscilloscope takes a small sample of high-frequency waveform each time a horizontal sweep occurs. After a number of horizontal sweeps, the point of sampling is moved slightly and sampling occurs again. The result of this technique is an output from the sampling gate which is a replica of the high-frequency waveform, but whose frequency is much much lower. Figure 8

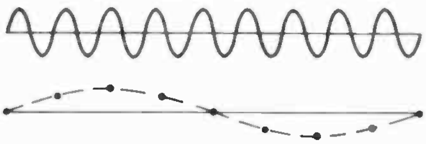


FIG. 8—SAMPLING OSCILLOSCOPES display high-frequency signals by sampling the input signal at discreet intervals of itme.

shows an exaggerated display from a sampling oscilloscope. Sampling oscilloscopes are very specialized instruments. They tend to be quite expensive and difficult to operate. However, when a waveform must be observed and its frequency exceeds the capabilities of any real-time (non-sampling) oscilloscope, they are the instrument to use.

Storage oscilloscope

At the opposite end of the spectrum are the signals that occur either too slowly or too infrequently to be recorded by the rapidly fading phosphors of a conventional cathode ray tube. The solution to this problem is again a specialized version of the oscilloscope—the storage oscilloscope. The storage oscilloscope is either built around a specialized cathode-ray tube or digital-storage circuitry. In the first case, once the signal has been recorded on the CRT, it will remain permanently on the face of the CRT until erased. With the digital-storage technique, the signal is applied to an analog-to-digital converter, and the digitized waveform is stored in memory. The memory is then cycled in step with the time base of a conventional oscilloscope. The output of the memory is applied to a digital-to-analog converter whose output is connected to the vertical deflection plates of the oscilloscope. This results in slowly varying signals being sped up considerably and signals only occurring once being displayed over and over again. At present, the storage oscilloscope employing the storage

(continued on page 87)

HOW R-E TESTS HI-FI GEAR

(continued from page 84)

TURNTABLE SYSTEM MEASUREMENTS

PERFORMANCE CHARACTERISTICS	R-E Measurement	R-E Evaluation
Wow-and-flutter (% WRMS)	______	______
Rumble, unweighted (dB)	______	______
Rumble, (din weighted "B") (dB)	______	______
Speed accuracy (%)	______	______
Speed adjustment range (± __ %)	______	______
Speed build-up time (rotations)	______	______
COMPONENT MATCHING CHARACTERISTICS		
Tracking force range (__ to __ grams)	______	
Anti-skating force range (__ to __ grams)	______	
Available speeds (rpm)	______	
Drive system	______	
Motor type	______	
Power requirements	______	
Pick-up arm wiring capacitance (per channel) (pF)	______	
MISCELLANEOUS EVALUATIONS		
Adequacy of controls		______
Automatic features, performance		______
Speed stability		______
Vertical tone arm friction		______
Lateral tone arm friction		______
Quality of construction		______
OVERALL TURNTABLE SYSTEM RATING		______

FIG. 8. TURNTABLE SYSTEM MEASUREMENTS

PERFORMANCE CHARACTERISTICS. It has been said that all a turntable system has to do is rotate the platter at constant, unwavering speed, silently. Wow and flutter of a turntable are a function of the drive system used to rotate that turntable and are measured in percent. The lower the better, and figures well under 0.1% are not uncommon these days. Again, the weighted root-mean-square measurement will be used, since it corresponds closely with the audible effect of these speed variations. Vibration in a turntable is transmitted up into the phono pickup and results in audible "rumble" of very low frequencies. While some rumble content may be lower in frequency than humans can hear, even such low frequencies (fed to an amplifier which also goes down in response to sub-audible frequencies) may cause large excursions in speaker cones which, in their distended positions, can then impart audible distortion to the music you are attempting to reproduce. Our unweighted rumble measurement takes all vibration frequencies into account and will ordinarily show up as a "poorer" (lower dB) reading than the "weighted" DIN B reading which more nearly represents the audible effects of rumble content, favoring higher frequencies in the measurement and ignoring the sub-audible content. DIN stands for Deutsche Industrie Normen, a series of measurement standards developed in Germany and widely used throughout the world in the measurement and evaluation of audio equipment. The DIN B rumble measurement uses a filter network in series with the output of the cartridge. The filter has a roll-off characteristic below the mid-frequency range which takes into account the fact that human hearing responds less to absolute amplitudes of lower frequencies than it does to mid- and higher frequencies. Thus, the DIN B rating attempts to evaluate rumble in terms of its audible effects upon the listener, with less emphasis placed on absolute readings caused by low and sub-sonic frequencies.

SPEED ACCURACY is important for maintaining proper musical pitch, though some turntable systems have a range of adjustment, which we will also note in our reports. Speed build-up time is important only if you are using the system as a professional "disc jockey," though it does provide some measure of the quality of the drive system, its torque, etc.

COMPONENT MATCHING CHARACTERISTICS. These are supplied for informational purposes and to aid in the choice of such associated equipment as phono cartridges, and records which can be played on the machine. Most latter day systems have dropped the 78 rpm speed and the 16⅔ rpm speed since no records are presently recorded at those speeds. If you own a collection of old "78's," availability of that speed may be more important than some other performance specifications. Some systems adapt easily to 50 Hz power line operation (50 Hz is standard in many overseas countries, as opposed to the 60 Hz house voltage supplied in the U.S. The use of 220-240 volts is also quite common overseas, as opposed to the 110-120 volts commonly available in the U.S.).

While multiple-play turntable systems still represent the majority of record players in this country, many high fidelity enthusiasts prefer single-play systems, either manually operated or with automatic features such as arm-return, automatic shut-off after record play, and push-button actuation of the cycle. These differences will be discussed in individual test reports, but measurements of performance will be made in the same way regardless of the basic type of turntable system being investigated.

OVERALL PRODUCT ANALYSIS

Manufacturer ______________________ Model # ____________

Retail Price	______
Price Category	______
Price/Performance Ratio	______
Styling and Appearance	______
Sound Quality	______
Mechanical Performance	______

Comments:

It is our hope that the combination of performance measurements, graphs, partial circuit analysis and graphics will provide readers with a meaningful and useful series of test reports that will serve as an aid in purchasing and assembling a fine high fidelity component system in whatever price category they choose. We would be very interested in receiving your comments after you have had an opportunity to read the first few reports to appear in future months. High fidelity is admittedly a complex field, but enjoying the benefits of a good hi-fi system need not and should not be complicated. We recognize that in the past, audiophiles (and that includes product reviewers) have tended to overemphasize the technological aspects of hi-fi and to de-emphasize what is after all the most important attribute of any hi-fi system—how well it reproduces music in the home. We will try not to fall into that trap! **R-E**

SCOPES

(continued from page 85)

tube has the highest frequency capabilities, which is important in transient (single occurrence) measurements, whereas the digital-storage oscilloscope has the advantage of indefinite storage and a simple display mechanism. Both are reserved for specialized applications and are high cost.

Television oscilloscopes

The television industry consistently deals with complex high-frequency waveforms. These video signals can not be analyzed easily with any other instruments but the oscilloscope.

The television waveform monitor, or A-scope, is simply a conventional oscilloscope with limited time-bases. Time-base periods are limited to those needed to display one or two TV lines and one or two TV fields. Such oscilloscopes are usually mounted in a specific location to monitor the quality of video waveforms from a camera, network, film chain, transmitter, etc.

The vector monitor or vector-scope is an oscilloscope without sweep circuits. Red chroma minus luminance signals are connected to the vertical deflection system and blue chroma minus luminance signal are connected to the horizontal deflection system. Patterns displayed on the face of the CRT reveal information concerning the phase and amplitude characteristics of the chroma signals. The vectorscope is used both by the television transmitting and by the service industry.

Developed from these generalized oscilloscopes are all forms of dedicated oscilloscopes. Dedicated oscilloscopes have their vertical amplifiers, horizontal amplifiers, and time bases customized to a particular situation.

(to be continued)

HANDBOOK OF MODERN SOLID-STATE AMPLIFIERS, by John D. Lenk. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 414 pp. 9¼ x 6 in. Hardcover $15.00.

Here is a detailed treatment of both the theory and practice of modern electronic amplifiers. It is perhaps the most comprehensive handbook available today on circuit theory and analysis at the technician level featuring simplified guidelines for practical design, complete test procedures and practical troubleshooting techniques. The book describes all types of amplifiers in common use—audio, rf, direct-coupled, differential, compounds and op-amps. It also covers both discrete amplifier circuits and selected IC's. It is well suited to a broad readership—students, designers, technicians and anyone else who would like to have a source of up-to-date information on solid-state amplifiers.

ELECTRONIC TECHNIQUES: SHOP PRACTICES AND CONSTRUCTION, by Robert S. Vilanucci, Alexander W. Avtgis & William F. Megow. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 569 pp. 9½ x 7 in. Hardcover $14.95.

Here is a practical and realistic approach to help the reader develop skills in the planning, layout and construction of electronic equipment. The clear and concise coverage of all aspects of fabrication techniques provides a solid background of needed information. A quick rundown of the chapter subject areas starts off with design factors for packaging, preparing detailed drawings, shearing, chassis layout techniques and goes on through printed circuit board materials, printed circuit board processing, chassis hardware and assembly, harness and cable fabrication. **R-E**

EQUIPMENT REPORTS
(continued from page 79)

insulated outer shell. To take a current reading, the probes are simply touched to any conductor on the PC board, and pushed down until both inner and outer tips are making contact.

The special circuitry used for this includes a very high gain, high common-mode-rejection differential amplifier. The outer terminals of the probes read the DC voltage drop across the part of the conductor between their tips. The differential amplifier senses this minute voltage drop, and develops a bucking voltage that exactly cancels it. This bucking or feedback current flows through the regular precision shunt as before. So, it is read out as a given amount of current. The bucking current is exactly equal and opposite to the current flowing in the conductor.

The sensitivity of this is amazing. The meter will read current, at its rated accuracy (±5% full-scale) with as little as 100 *microvolts* of differential between the probe terminals. This allows the Model 670 to do tricks such as reading the current flowing in an IC by putting both probes on the same pin, top and bottom, or about ⅛ of an inch from each other.

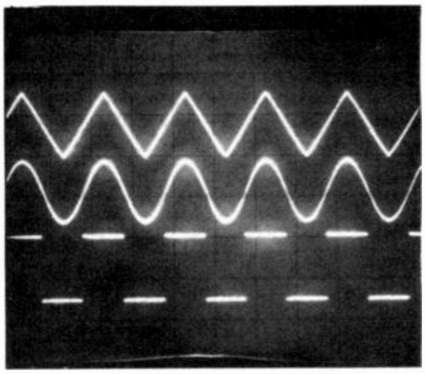
A pair of special "Kelvin Clips" may be used. These look like large alligator clips but the two jaws are insulated from each other. With these clips, current can be measured in a connecting wire, for example, by putting one clip on each end of the wire.

The circuit also detects the polarity of the current being read. If the + LED is lit, this means that current is flowing from the red probe toward the black probe.

There are only a few don'ts for using this instrument. For example, always select the longest piece of conductor that you can. This minimizes the effects of thermal EMF's and other unbalances. The farther the probes can be spaced, the less gain needed in the internal amplifier and the better the accuracy. If you are probing a circuit node or junction, the probes must be set so that they're measuring only one of the branches. When using the concentric-tip probes very close together, they should be tilted toward each other; this gets the voltage and current points as close as possible.

This should be very useful for doing such work as servicing modules, and the sensitivity should make it handy for work with TTL and other low-voltage logic circuits. Quite an instrument for any application. **R-E**

Heathkit IG-1271 Function Generator



Circle 100 on reader service card

LABORATORY GRADE FUNCTION GENERATORS are priced from around $400 to over $1000. They're a bit beyond the reach of most of us. Yet the technician could well use the versatility of having square, triangle, and sine waves conveniently at hand in one compact package. He rarely needs the voltage-controlled oscillator capability and the extremely low distortion and linearity deviation the lab instrument affords. The Heathkit IG-1271 is a basic instrument minus the frills, priced at a much more reasonable $99.95 in kit form. Factory assembled it sells for $140.

A matched set of Mylar capacitors guarantees close frequency tracking between ranges. Switching to the next higher range sets the output ten times higher in frequency within a fraction of a percent. Frequency is continuously variable over a 100 to 1 span by a front panel vernier control. The basic output of the function generator is a triangular wave. Square waves are produced by feeding a voltage comparator with the triangular waveform. Sine waves are

(continued on page 90)

new books

HI-FI STEREO SERVICING GUIDE, Second Edition, by Robert G. Middleton. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268. 104 pp. 11 x 8¼ in. Softcover $4.50 (in Canada $5.40).

The book will acquaint the reader with hi-fi circuitry and troubleshooting procedures, the use of audio test and measurement equipment and the basic principles of acoustics. The following topics each receive extensive treatment: AM tuner troubles, FM tuner troubles, stereo multiplex troubleshooting, introduction to audio amplification, servicing audio amplifiers, installing hi-fi speakers, system evaluation and trouble localization. This latest edition has been brought up-to-date by the addition of such topics as the use of integrated circuits, digital tuning indicators, digital frequency synthesizers and quadriphonic sound.

The text is generously illustrated with appropriate schematics and diagrams. Each chapter concludes with an analysis of common trouble symptoms for that particular section of the stereo system.

WORLD RADIO/TV HANDBOOK, 1975. Edited by J. M. Frost. O. Lund Johansen, Hvidovre, Denmark. 440 pp., 6 x 9 in. (Available in U.S. through Gilfer Associates, Inc., P.O. Box 239, Park Ridge, NJ 07656.) World Radio/TV Handbook is still, by far, the greatest aid to the ardent short-wave listener (SWL) and broadcast DX'er since the invention of the vacuum tube. Many of us still have fond memories of the long-gone White's Radio Log—which, upon reflection, was never like this.

To those of you who are familiar with WRTVH, it is sufficient to say that the 1975 edition is now available. For the newcomer to broadcast and short-wave DX'ing, the handbook is a complete directory of international radio and television stations and programming ranging from Afars and Afghanistan to Zaire and Zambia. The Handbook is divided into roughly three sections; a country-by-country listing of short-wave, medium-wave and FM broadcasting activity in 220 countries, a country-by-country listing of TV stations with technical details on systems and frequencies, and a tabular listing of worldwide broadcasting by frequency from 115 kHz to 21.745 MHz. Included in each station entry are address, personnel, station announcements, time zone, AC power voltage and frequency, geographical location, etc.

And of particular importance to the serious listener are the musical interval signals—those sections of musical selections played at sign-on, sign-off and often between programs. The musical interval signals are described literally. Examples are "Extract from Ballet Music from Rosamunde" by Franz Schubert and "Hymn to Freedom" by Gretchaninoff. In addition, the handbook carries the musical score of the interval signal so you need not be familiar with the selection if you read music.

In addition to all you need to know to locate and identify any station, you will find the handbook crammed with other information vital to your enjoyment short-wave listening or DX'ing. The following listing of a few articles from the table of contents will give you an idea of what you'll find in your copy of World Radio/TV Handbook: Broadcasts in English, DX Programs on the Air, Broadcast Reception in 1975, How To Use the WRTVH, Shortwave Reception Today, International Organizations, International Regulations, Most Suitable Bands in 1975, Recorded Music Libraries, Religious Broadcasting, Set Count by Country, Solar Activity in 1975, Standard Frequency Stations, World Television, World Time Chart & Tables, World Broadcasting Maps.

ABC'S OF HYDRAULIC CIRCUITS, by Harry L. Stewart & John M. Storer. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268. 160 pp. 8¼ x 5¼ in. Softcover $4.50 (in Canada $5.40).

This book will familiarize the reader with basic hydraulic circuit building techniques, beginning wth the fundamental explanation of the symbols and symbology. The control circuits in this book range from the simple to the complex—from single motion control to multiple interlocks and from individual manual actuations to automatic sequencing and programming.

Many specific circuits designed to perform particular tasks are depicted. By concentrating on explanation and orientation to specific applications, the end product is a wide variety of performance-tested circuits. R-E

EQUIPMENT REPORTS

(continued from page 88)

synthesized by a 12-diode non-linear shaping circuit. Half of the diodes take care of positive signal excursions and the other six shape the negative going portion. More and more diodes turn on as the triangle signal increases around zero in both the positive and negative directions. The low-distortion sinewave is the third output of the function generator. Slight slope discontinuities at the sinewave peaks are visible on a single cycle scope display. These points correspond to the sharp slope changes in the triangle wave.

The output of the function generator is routed through a 0 to 50-dB 50-ohm calibrated attenuator made from 1% resistors. Step accuracy of the attenuator is better than ± 1 dB. Power output is about ¼ watt into a matched 50-ohm load.

Calibration steps are reached about 7 hours after opening the carton. Two calibration procedures are detailed in the Heath manual. Both depend on a triggered oscilloscope to adjust the waveform symmetry. The preferred method uses a frequency counter to calibrate the IG-1271's frequency dial. The second method calibrates the dial against the scope's time base which is a less precise way of doing things. Sine-wave distortion is minimized by adjusting positive and negative sine distortion pots in the sine shaper circuit. How do you optimize this adjustment without a distortion analyzer? You make one! Included with the generator kit are three resistors and three capacitors that are assembled into a 1-kHz twin-T notch filter. The filter is inserted between the generator output and the input to either an oscilloscope with 100 mV/division sensitivity or an audio voltmeter. The fundamental 1 kHz signal is filtered out and the higher harmonic distortion components feed through. The two distortion adjustment pots are then adjusted for minimum output. Heath's method is completely satisfactory and a professional distortion analyzer gave the same results.

I verified that all Heathkit specifications were met or surpassed and here is a comparison of the specified and measured values:

Parameter	Specification	Measured Value
Frequency accuracy	±3% of full dial scale	+2, −1%
Triangle non-linearity	5% maximum	4%
Triangle and Square Wave Symmetry	within 10% of 50% duty cycle	40/60 duty cycle below 1 MHz 51/49 duty cycle below 100 kHz
Sinewave Distortion	3% maximum 5 Hz to 100 kHz	THD less than 1.1% 5 Hz to 100 kHz 5.8% at 1 MHz
Output Level	20 volts p/p open circuit	21.5 volts p/p
Flatness	±1.5 dB 0.1 Hz to 1 MHz	+0, −1 dB

Enclosed in a 8⅞-in. deep by 7¼-in. wide by 3-in. high cabinet, the IG-1271 weighs 4.2 pounds. This is the same package Heath uses for their DVM and coun-

(continued on page 92)

DOLLAR VALUE

FREE $1 BUY WITH EVERY 10 YOU ORDER
Only applies to "$1" Buys

FREE GIFT WITH EVERY ORDER
CANADIANS: Ordering is easy—we do the paperwork—try a small order

SHANNON MYLAR RECORDING TAPE

3"	— 225'	.19
3¼"	— 600'	.78
5"	— 600'	.82
5"	— 900'	.90
5"	— 1200'	1.49
5"	— 1800'	1.89
7"	— 1200'	.97
7"	— 1800'	1.32
7"	— 2400'	1.99
7"	— 3600'	3.49

CASSETTE C-60	.59
CASSETTE C-90	1.19
CASSETTE C-120	1.97
8-Track — 64 Min.	1.29
8-Track — 80 Min.	1.59
8-Track — Cleaner	1.49
3" TAPE REEL	.09
3¼" TAPE REEL	.12
5" TAPE REEL	.29
7" TAPE REEL	.35

RCA 110° FLYBACK TRANSFORMER

We scooped the Market. Latest type — standard for all 110° TV's (Blk. & Wht.). RCA's design of large Coil produces 18KV—assuring adequate width Incl. Schematic Diagram application for any TV. List price $13.90 Your price 3.95. 10% off in lots of 3.

WESTINGHOUSE ALL TRANSISTOR HOME/OFFICE MESSAGE CENTER

Leaves messages for other for replay . . . Built in speaker/microphone for talk-into convenience . . . Records up to 3 minutes of messages . . . Illuminated signal shows when a message is waiting. Control adjusts playback volume without affecting recording volume . . . Capstan Drive: BRAND NEW SOLD AS IS 7.95

KNOB SPECIAL

- ☐ 100—Assorted RADIO KNOBS All standard types $20 value 1.00
- ☐ 50—TV KNOBS—POPULAR TYPES Mostly Selector & Fine Tuning 1.00
- ☐ 20—Vertical Linearity KNOBS Long shank . . . Front mount assortment 1.00
- ☐ 20—Vertical Linearity KNOBS Side mount . . . Standard sizes 1.00
- ☐ 25—Knurled Shaft KNOBS Hard to get. Best selection 1.00
- ☐ 25—Clock & Radio KNOBS most popular types 1.00

ANY 6 KITS FOR $5

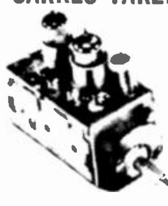
- ☐ TRANSISTOR RADIO asst type good, bad, broken, as-is, potluck 1.50
- ☐ TAPE RECORDER assorted types good, bad broken, as-is, potluck 4.00
- ☐ 200 ASST. ½ W RESISTORS Top Brands, Short Leads, Excellent Selection 1.00
- ☐ 75—ASST ¼ WATT RESISTORS stand. choice ohmages, some in 5% 1.00
- ☐ 100—ASST ½ WATT RESISTORS stand. choice ohmages, some in 5% 1.00
- ☐ 70—ASST 1 WATT RESISTORS stand. choice ohmages, some in 5% 1.00
- ☐ 35—ASST 2 WATT RESISTORS stand. choice ohmages, some in 5% 1.00
- ☐ 50—PRECISION RESISTORS asst. list-price $50 less 98% 1.00
- ☐ 20—ASSORTED WIREWOUND RESISTORS, 5, 10, 20 watt 1.00
- ☐ 10—ASST SLIDE SWITCHES SPST, SPDT, DPDT, etc. 1.00
- ☐ 25—SYLVANIA HEAT SINKS For Transistors 1.00
- ☐ 20—ASSORTED TV COILS I.F. VIDEO, sound radio, etc. 1.00
- ☐ 1—ELECTROLYTIC COND. 200/300/100/100 MFD—25V 1.00
- ☐ 1—ELECTROLYTIC COND 100 MFD—300V 1.00
- ☐ 3—ELECTROLYTIC COND 20/20 MFD-450V 1.00
- ☐ 40—ASST. TUBE CARTONS Most popular types 1.00
- ☐ 2—ELECTROLYTIC Condensers 300 mfd-200V, 300/60 mfd-150V 1.00
- ☐ 4—ELECTROLYTIC COND 75/30mfd—150V 1.00
- ☐ ELECTROLYTIC CONDENSERS 200/200 mfd.—200V 1.00
- ☐ 2—ELECTROLYTIC COND 1000 mfd.—25V 1.00
- ☐ 250—ASST SOLDERING LUGS best types and sizes 1.00
- ☐ 250—ASST WOOD SCREWS finest popular selection 1.00
- ☐ 250—Asst Self Tapping SCREWS #6, #8, etc. 1.00
- ☐ 100—ASST 6/32 SCREWS and 100—6/32 HEX NUTS 1.00
- ☐ 100—ASST 8/32 SCREWS and 100—8/32 HEX NUTS 1.00
- ☐ 100—ASST 2/56 SCREWS and 100—2/56 HEX NUTS 1.00
- ☐ 100—ASST 4/40 SCREWS and 100—4/40 HEX NUTS 1.00
- ☐ 100—ASST 5/40 SCREWS and 100—5/40 HEX NUTS 1.00
- ☐ 500—ASSORTED RIVETS most useful selected sizes 1.00
- ☐ 300 ASSORTED WASHERS most useful selected sizes 1.00
- ☐ 100—ASST RUBBER BUMPERS for cabinet bottoms—other uses 1.00
- ☐ 100—Asst RUBBER GROMMETS best sizes 1.00
- ☐ 15—DIPPED MYLAR CAP. .01—600V 1.00
- ☐ 15—DIPPED MYLAR CAP. .033—600V 1.00
- ☐ 15—DIPPED MYLAR CAP. .0033—1000V 1.00
- ☐ 15—DIPPED MYLAR CAP. .047—400V 1.00
- ☐ 15—Molded Tubular Capacitors .056—400V 1.00
- ☐ 15—DIPPED MYLER Condensers .0039 400V 1.00

MARKET SCOOP COLUMN

- ☐ KANDU—Printed Circuit Kit Trace & Etch your own circuits easy to use instructions 9.95
- ☐ IC4 and IC3 Integrated Circuit Used in Scott—Fisher etc. 1.00
- ☐ 15—ASSORTED IC'S For Experimenters 1.00
- ☐ Silicon NPN HV TRANSISTOR RCA—SK-3021—Hep-240 RCA—SK-3026—Hep-241 1.00 ea.
- ☐ Transistor Specials—Your Choice SK3006, SK3018, SK3020 SK3122, SK3124 1.00 ea.
- ☐ Transistor Specials—Your Choice SK3009, SK3024, SK3040 1.98
- ☐ TACHOMETER 2¼" Sq. Panel Meter 1-VDC, full scale 33 Ohm coil resistance 0-6000 R.P.M. 2.00
- ☐ 1—CASSETTE type dynamic Mike with universal plugs—200 Ohms 2.99
- ☐ VU 1" PANEL METER 0-20 db Scale 1.29
- ☐ 100' GREY SPEAKER WIRE 2 Cond. mini zip. 101 uses 2.00
- ☐ WAHL-CORDLESS SOLDER IRON Complete with Auto Charger - Fast Heating - Compact 19.95
- ☐ 5—Audio Output TRANSFORM Sub-min for Trans Radios 1.00
- ☐ 5—I.F. Coil TRANSFORMERS 456-kc for Transistor Radios 1.00
- ☐ 6" UNIVERSAL SPEAKER Top quality Special buy EA. 1.59
- ☐ 12" UNIVERSAL SPEAKER Top Quality . . . Large Magnet 5.89
- ☐ 10" PHILCO SPEAKER Top Quality . . . Large Magnet 3.95
- ☐ 8" UNIVERSAL SPEAKER—Large Magnet—Special Buy 2.99
- ☐ 3" UNIVERSAL TWEETER 1 oz. Magnet 1.29
- ☐ 2½"x4" SPEAKER Special Buy 10 for $5 EA. 69¢
- ☐ 4"x6" "QUAM" 16 OHM SPK. Large magnet . . . Special BUY (10 for $15.00) 1.79
- ☐ UTAH 8"—HEAVY DUTY 10 OZ. SPEAKER Ceramic Type—8 Ohm 4.50
- ☐ 1—6"x9" Heavy Duty 10 oz. Speaker Ceramic Type . . . 8 Ohm 4.50
- ☐ 1—5"x7" UNIVERSAL SPK. (10-20-40 OHM Imped.) 2.95
- ☐ 3 SPEAKER—7 WAY SELECTOR SWITCH Wall Mount 1.00
- ☐ STEREO MICROPHONES FL 1979/01 Made in Holland SET 6.50
- ☐ STANCOR POWER TRANSFORMER 117V—50—60 Cycle—Pri. Sec. 12.6 Cent. Tap 2 Amp. 3.29
- ☐ POWER TRANSFORMER (PT-48)—110V Pri.—12V Sec. Used in many transistor Power supplys 2.29
- ☐ COMPLETE CONVERGENCE ASSY.—Inc. Yoke, Board & Plug Conn. Adaptable to most 90° sets 3.95
- ☐ COLOR DELAY LINE—Used in most color sets 1.69
- ☐ 7—ASSORTED VOLUME CONTROLS with switch 1.00
- ☐ 10—ASSORTED VOLUME CONTROLS less switch 1.00
- ☐ 15—ASST. ROTARY SWITCHES All popular types—$20 value 1.00
- ☐ DELUXE PILLOW SPEAKERS With plug & volume control 2.49
- ☐ 2—12BH7 RCA TUBES 1.00
- ☐ 10—ASST DIODE CRYSTALS 1N34, 1N48, 1N60, 1N64, etc. 1.00
- ☐ TUBE & CONTINUITY CKR. Model FT425 (Tests fuses, heaters, lamps, Etc.) 1.98
- ☐ VARCO Stereo Cartridge-CN-72 With mounting bracket, flipover needle 2.95
- ☐ RONETTE Stereo Cartridge latest dual sapphire flipover type 2.00
- ☐ Stereo Headphones Hi-Fi Quality . . . Complete with Stereo plug 5.95
- ☐ 10—STANDARD TRANSISTORS NPN & PNP 2N404, 2N414, etc. 1.00
- ☐ 25' Shielded MIKE CABLE Grey 25/1 1.89

- ☐ 110° TV DEFLECTION YOKE for all types TV's incl schematic 4.95
- ☐ "COMBINATION SPECIAL" RCA 10° FLYBACK plus 110° DEFLECTION YOKE 6.95
- ☐ 90° FLYBACK TRANSFORMER for all type TV's (Blk. & Wht.) 2.95
- ☐ 90° TV DEFLECTION YOKE for all type TV's (Blk. & Wht.) 3.95
- ☐ 70° FLYBACK TRANSFORMER for all type TV's (Blk. & Wht.) 2.00
- ☐ 70° TV DEFLECTION YOKE for all type TV's (Blk. & Wht.) 2.00
- ☐ OLYMPIC & SHARP FLY-BACK Part #SFT592 Equiv. Stancor #HO-408—Thordarson #Fly339 2.95
- ☐ 90° COLOR YOKE For all Rectangular 19 to 25" Color CRT's 7.95
- ☐ 70 COLOR YOKE For all round color CRT's 8.95
- ☐ DELMONICO NIVICO COLOR FLYBACK Part #A20411-B 7.95

SARKES TARZIAN TUNER 41mc



Latest Compact Model good for all 41 mc TV's. BRAND NEW —

Best TUNER "SARKES TARZIAN" ever made — last word for stability, definition & smoothness of operation. An opportunity—to improve and bring your TV Receiver up-to-date. Complete with Tubes 7.95

- ☐ WESTINGHOUSE FM TUNER #476-V-015D0 1 Transistor 3.99
- ☐ WESTINGHOUSE FM TUNER (12DT8 Tube) 1.00
- ☐ UHF TUNER—Transistor Type Used in all TV sets 3.95
- ☐ G.E. UHF TUNER—TRANSISTOR TYPE Model #8X4 3.95
- ☐ ADMIRAL TV TUNER Model #94C393-1 (2HA5-4LJ8) Model #T94C441-3 (Transistor) 7.95
- ☐ WELLS GARDNER TUNER Part #7A 120-1 (4GS7-2HA7 Tube) 7.95
- ☐ G.E.—TV TUNER (2GK5-4LJ8) Model #EP 86x11 7.95
- ☐ PHILCO UHF/VHF TUNER Transistorized 9.95
- ☐ GE TV TUNER ET 86x196, (6GK5-6BL8) 5.95
- ☐ UNIVERSAL TV Antenna Back of set mounting . . . 5 section rods 2.99
- ☐ BLUE LATERAL Magnet Assy. Replacement for most color TV's 1.79
- ☐ 5—10K—2 WATT BIAS POTS Used in solid state application 1.00
- ☐ COLOR CONVERGENCE Assy. Universal type—good for most sets 2.49
- ☐ COLOR-TV RECTIFIER—Used in most color sets—6500 kv 3 for 1.95
- ☐ 2 COLOR-TV CRT SOCKETS Wired leads, for all color TV's 1.00
- ☐ 3—RCA 110° CRT SOCKETS Wired leads, for all TV's 1.00
- ☐ RMS—9 ELEMENT COLOR OUTDOOR ANTENNA Model HA-9 VHF/UHF 8.95
- ☐ 4—Polarized CHEATER CORD Grey 1.00
- ☐ 70° COLOR TUBE BRIGHTNER 3.95
- ☐ 90° COLOR TUBE BRIGHTNER 4.95
- ☐ 2—Colorburst Quartz-Crystal For most color TV sets 3579.545 KC 1.89
- ☐ 5 ASST GLOBAR VARISTOR Popular replacements for most COLOR TV 1.00
- ☐ UHF or VHF Matching Trans. Simple Fool-proof installation 1.00

Test Equip. Special Discount Prices

B&K · EICO · Leader · SENCORE

- ☐ MERCURY COMPACT TUBE TESTER Model #990 Miniature-sized Specs Saver Full sized in performance 49.95
- ☐ TELMATIC Tuner-Mate KT-730 Portable "Substi-Tuner"—Instant Tuner Check 42.50
- ☐ TELEMATIC Test Jig Model—EJ-190—Master Rigs—Combo Rigs—Econo Rigs 49.95

KLEPS "CLEVER" TEST PRODS

"Third-hand" test prods, reach into out of way places - Insulated - cannot slip - accommodates bare wire or banana plug—no soldering.

- ☐ PRUF 10—Versatile Test Probe 89¢
- ☐ KLEPS 10—Boathook Clamp 4¾" long 1.39
- ☐ KLEPS 20—Boathook Clamp 7" long 1.49
- ☐ KLEPS 30—flexible-forked Tongue 6" long 1.79
- ☐ KLEPS 40 FLEXIBLE-PC Board Terminals 6¼" long 2.59
- ☐ KLEPS 1-ECONOMY Kleps for Light Work 99¢

- ☐ 4 — TV ALIGNMENT TOOLS most useful assortment #1 1.00
- ☐ 4 — TV ALIGNMENT TOOLS For Color TV #2 1.49
- ☐ 6 — TV COLOR ALIGNMENT TOOLS Most popular type 2.79
- ☐ TV TWIN LEAD-IN 300 ohm 500'—$7 100'—$1.50, 50' 1.00
- ☐ CO-AX CABLE RG59U (Black) 250'—$10, 100'—$4.50, 50' 2.69
- ☐ 5—DUAL DIODE—MOST POPULAR TYPES Common cathode or Series connected 2.50
- ☐ CONVERGENCE RECTIFIER—For COLOR TV 4 Cell—Used in RCA—Philco, etc. 1.00
- ☐ TV DAMPER DIODE Single—Replace RCA part #120818 $2.29; Dual—RCA part #135932 $3.95
- ☐ COLOR POWER TRANS. —Good for most sets 26R150 List Price—$36.75 6.95
- ☐ 6—Top Brand Silicon RECT. 1 amp., 1000 PIV 1.00
- ☐ 5—PNP TRANSISTOR general purpose, TO-5 case 1.00
- ☐ 5—NPN TRANSISTORS general purpose, TO-5 case 1.00
- ☐ 25—ASSORTED TRANSISTORS big factory scoop—sold as-is 1.00
- ☐ 5—9 VOLT MOTORS Excellent for hobbyist 1.00
- ☐ 2—ELECTROLYTIC CONDENSERS Axial leads—500—25V 1.00
- ☐ ELECTROLYTIC CONDENSER 300 mfd.—200V 1.00
- ☐ 2—ELECTROLYTIC CONDENSERS 80/100/60 MFD—160V 1.00
- ☐ 2—ELECTROLYTIC COND 200/30/4—mfd—350V 1.00
- ☐ 3—ELECTROLYTIC COND 100 mfd.—100V, 50 mfd.—75V 1.00
- ☐ 2—ELECTROLYTIC COND 40 mfd—500V, 40 mfd—400V 1.00
- ☐ 5—AC LINE CORDS Approved 6' 1.00
- ☐ 4-50' HANKS Hook-Up Wire assorted colors 1.00
- ☐ 10—SETS PHONO PLUGS & PIN JACKS RCA type 1.00
- ☐ 8—MINI PILOT BULBS With 8" Leads—6.3V 30MA (5000 Hrs) 1.00
- ☐ 8—MINI PILOT BULBS With 12" Leads—6.3V, 150MA (5000 Hrs.) 1.00
- ☐ 32'—TEST PROD WIRE DELUXE QUALITY red & black 1.00
- ☐ 10—MINI ELECTROLYTIC Cond For Transistor & miniature work 1.00

IMMEDIATE DELIVERY . . . Scientific light packing for safe delivery at minimum cost.
HANDY WAY TO ORDER . . . Send check or money order, add extra for shipping. Lists of new offers will be returned in your order.
Minimum Order $5.00
Please specify refund on shipping overpayment desired: ☐ CHECK ☐ POSTAGE STAMPS ☐ MERCHANDISE (our choice) with advantage to customer

BROOKS RADIO & TV CORP., 487 Columbus Ave., New York, N.Y. 10024 TELEPHONE 212-874 5600

Circle 72 on reader service card

EQUIPMENT REPORT

(continued from page 90)

ters and they can be neatly stacked. Mechanical appearance is attractive because of a smart white plastic front panel. Control markings stand out well against the white background. The generator emulates its higher class lab cousins with a swing handle-support. As usual, the construction manual and parts supplied are superb. Particularly appealing are the printed circuit rotary switches that eliminate the dullest part of kit building, those terrible wafer switch wires. And believe it or not the 28 transistor, 23 diode, 2 IC kit worked perfectly the first time over its entire 0.1 Hz to 1 MHz range. **R-E**

Archerkit 50,000 Ohms-Per-Volt VOM Kit

Circle 107 on reader service card

THIS HANDY LITTLE VOM KIT WOULD BE A great help for anybody in need of a good quality, low cost multimeter. It is well worth its low retail cost of $19.95. It has several features that give it the versatility usually unavailable in an instrument in this price category.

The meter has five jacks:—(COMMON), +, DC + 12 AMPS, DC + 1.2 KV(insulated), and OUTPUT. A set of test leads is supplied.

The meter has 43 ranges, made possible by a VA/2 switch that cuts voltage and current ranges in half without impairing accuracy (it does, however, cut input impedances in half, reducing the DC impedance from 50K ohms-per-volt to a still adequate 25K ohms-per-volt and the AC impedance from 5K ohms-per-volt to 2.5K ohms-per-volt.) Thus, if you wanted to check, say, a 5-volt battery, and you wanted a more accurate reading than the 12-volt range could provide, you would merely flip the switch and read off the 0-60 DC scale (in this case representing 0-6 volts).

The VOM's ranges go like this: DC voltage–12 ranges from 300 millivolts (suitable for many of today's extreme low-voltage circuits) all the way up to 1200 volts; AC voltage–9 ranges from 3 volts to 1200 volts; DC current–10 ranges from 30 microamps to 12 amps (using the DC + 12 AMP jack); Output voltage–

7 ranges from 3 volts to 300 volts; Resistance-multiplication ranges ×1, ×100, ×1000, and ×10,000; and dB from −10 to +17.

It has a stated accuracy of ±3% on DC and ±4% on AC. The meter movement is diode-protected.

Construction of the meter did not pose any serious problems. All resistors are 1% precision, and all circuit components are secured to clearly marked cards for easy identification. Be very careful when wiring the switch wafer, as it is easy to let excess solder run down where it isn't wanted and cause a short or a bump that may later cause mechanical problems. Except for the switch wafer, most components are mounted on a printed circuit board that fastens directly to the meter terminals. The instruction manual is easy to follow and well illustrated, with many helpful hints on construction. It contains excellent instructions and safety rules for operation of the VOM, including how to use Ohm's Law to calculate AC currents.

The meter case measures a compact 2¼-in. × 4-in. × 6-in. It is grey plastic with a brushed aluminum faceplate. All functions are well defined for easy use. The meter scales also are uncrowded and easy to read.

All in all, this meter provides good all-around performance at a low cost. For the average hobbyist, experimenter, or anyone in need of a general-purpose multitester, this VOM should be given serious consideration. It is available at Radio Shack stores as catalog number 29-3986. From what I have seen of the low-cost multitester market, one would have to go up quite a ways in price to match the versatility of this one. R-E

X-ray waveguide devised with sapphire, boron nitride

An experimental thin-film device that can guide X-rays is reported by two IBM scientists, Eberhard Spiller and Armin Segmulled. It has not been possible to guide X-rays in the past because potential waveguide materials absorbed practically all the energy directed on them, reflecting little or nothing.

The experimental waveguides were constructed by sandwiching a layer of boron nitride, 300 to 500 angstroms thick, between a substrate and cover layer of sapphire.

X-rays are directed at the cover layer at such an angle that most of the beam is reflected, but that a portion of the energy penetrates into the boron nitride layer, where—due to the difference in the refractive index of boron nitride and sapphire—it zig-zags back and forth to the other end of the guide, reflected at the boundary layer between the two materials much like visible light in an optical fiber (and for the same reason).

The waves sent through the new waveguide are only 1.54 angstroms long. (The length of a wave of ordinary red light is about 7,000 angstroms.) So far the longest waveguide made by the scientists is 0.3 millimeter, though the inventors believe that the length may be increased by at least a factor of ten by using other materials.

CD-4 CARTRIDGES

(continued from page 50)

The moving-iron concept is used in the Pickering and Stanton cartridges whose basic construction can be seen in the drawings in Fig. 15. Four coils are used in the cartridge assembly. As viewed from above, the right-channel coils are in the front-left and rear-right corners. Similarly, the coils for the left channel are in the rear-left and front-right corners. Two "Z-shaped" straps of high-permeability material complete the magnetic circuits through the pairs of coils for the right and left channels. These core straps enter the coil cores from the top and are in intimate contact with the legs of the pole pieces that extend into the coil cores from the bottom. The lower ends of the pole pieces form a cluster into which the stylus armature is inserted.

The stylus assembly consists of a tubular non-magnetic casing carried by a plastic housing that mates with the front of the main casing. A moving-iron armature is mounted lengthwise in the non-magnetic casing and is connected to the stylus by a stylus tube made of a light, non-magnetic metal. A damping collar and spacer, fastened around the front end of the armature, engage the tubular casing so the moving assembly, consisting of the stylus, stylus tube and moving-iron armature are free to oscillate in response to stylus movement in the record grooves. The damping collar also insures that the relative positions of the armature and magnet remain constant so the degree of magnetization of the armature does not change as the armature swings in response to stylus motion.

As the stylus tip moves in the record groove, the magnetized armature moves inside the quadrangular pole-piece cluster. The motion of the stylus in response to the right-channel signal causes the armature to move along a path between the right-channel pole pieces. This produces a change in the flux linking the right-channel coils; thereby inducing a voltage in these coils. Similarly, a left-channel signal on the record causes the armature to move to and fro along a path between the left-channel pole pieces so a corresponding signal voltage is induced in the left-channel coils. R-E

next month

JULY 1975

■ **Build A Color TV Camera**
Special techniques make this unit possible. It's a 2-color camera that reproduces full-color pictures on the screen of a conventional TV set. It's a bargain too—costs about $400 to build.

■ **More Ways To Use Your Scope**
You'll discover scope techniques and applications that you may never have seen before.

■ **R-E Tests The Sansui QRX-6001 Receiver**
Our first test report on hi-fi gear. It tells you more about the equipment than any other report published by any other magazine.

Radio-Electronics is published by Gernsback Publications, Inc. 200 Park Ave. S. New York, NY 10003 (212) 777-6400

President: M. Harvey Gernsback

Secretary: Bertina Baer

ADVERTISING SALES

EAST

Stanley Levitan, Sales Manager
Radio-Electronics
200 Park Ave. South
New York, NY 10003
(212) 777-6400

MIDWEST/Texas/Arkansas/Okla.

Ralph Bergen
The Ralph Bergen Co.
6319 N. Central Ave.
Chicago, IL 60646
(312) 792-3646

PACIFIC COAST/Mountain States

Jay Eisenberg
J.E. Publishers Representative Co.,
8732 Sunset Blvd.,
4th Floor,
Los Angeles, CA 90069
(213) 659-3810

Sales Mart Building
1485 Bayshore Blvd., Box 140
San Francisco, CA 94124
(415) 467-0125

THIS MONTH IN R-E NEW 4-PART SERIES ON SCOPES STARTS ON PAGE 51

SUPER BUYS!

FAMOUS MAKE, NEW JOBBER-BOXED TUBES 80% OFF LIST

☐ 1B3	5 for $5.00	☐ 6HA5	5 for $4.80
☐ 1V2	5 for $3.00	☐ 6HB7	5 for $4.85
☐ 2AV2	5 for $3.95	☐ 6HQ5	5 for $6.35
☐ 3A3	5 for $5.05	☐ 6HV5	5 for $11.80
☐ 3AT2	5 for $4.90	☐ 6JC6	5 for $5.65
☐ 3GK5	5 for $4.85	☐ 6JE6	5 for $11.15
☐ 3HA5	5 for $4.80	☐ 6JS6	5 for $9.30
☐ 3HM5	5 for $4.80	☐ 6JU8	5 for $5.55
☐ 4BZ6	5 for $4.70	☐ 6KA8	5 for $6.15
☐ 5GH8	5 for $5.90	☐ 6KE8	5 for $7.65
☐ 6AX4	5 for $5.05	☐ 6KM6	5 for $11.25
☐ 6AY3	5 for $5.05	☐ 6KN6	5 for $9.85
☐ 6BK4	5 for $9.35	☐ 6KT8	5 for $6.85
☐ 6CG3	5 for $4.95	☐ 6KZ6	5 for $5.15
☐ 6CG8	5 for $5.40	☐ 6LB6	5 for $10.75
☐ 6CJ3	5 for $4.70	☐ 6LQ6	5 for $11.15
☐ 6DQ6	5 for $6.75	☐ 8FQ7	5 for $3.75
☐ 6DW4	5 for $4.70	☐ 12BY7	5 for $4.50
☐ 6EA8	5 for $4.95	☐ 12GN7	5 for $7.00
☐ 6EH7	5 for $4.80	☐ 17JZ8	5 for $4.50
☐ 6EJ7	5 for $4.50	☐ 21GY5	5 for $6.30
☐ 6FQ7	5 for $3.75	☐ 23Z9	5 for $6.00
☐ 6GF7	5 for $6.65	☐ 31LQ6	5 for $10.15
☐ 6GH8	5 for $3.95	☐ 33GY7	5 for $8.05
☐ 6GJ7	5 for $3.40	☐ 36MC6	5 for $11.40
☐ 6GM6	5 for $5.25	☐ 38HE7	5 for $9.20
☐ 6GU7	5 for $5.25	☐ 38HK7	5 for $9.00
☐ 6GY6	5 for $4.35	☐ 42KNG	5 for $9.15

DIODES—SEMI CONOUCTORS
100—2.5 Amp. 1000 PIV (IR) $11.95
20—2.5 Amp. 1000 PIV (IR) $3.00
4—6500 PIV FOCUS RECT. $2.00
5—13.5 KV FOCUS RECT. $3.00
5—COLOR BOOST RECT. $2.00
RCA DAMPER DIODES—120818 ..... Ea. $1.50

SPEAKERS—SPEAKERS
4" Square .... Ea. $ .89
6x9" .... Ea. $2.99
6" Round .... Ea. $1.79
8" Round Whizzer .... Ea. $2.59

RESISTORS—CONTROLS
100 Asst'd Carbon Res. $1.69
50 Asst'd W.W. Resistors $2.59
50 Asst'd Controls (MALLORY) $2.59
3 On/Off V.C. Short Shaft $1.19
10—8 Ohm-5 Watt Resistors $1.19

TUNERS—NEW WITH TUBES-TRANSISTORS
3 Asst'd Trans. Tuners $11.00
3 Asst'd Tube Tuners $11.00
G.I. PAR. TUNER—6GS7—6HA5 ..... Ea. $2.75

CONDENSERS
47 Mfd. 350 Volts Axial .... 6 for $1.98
100 Mfd. 15 Volts Axial .... 10 for $1.98
25 Asst'd Condensers Axial $3.96
200—80 Mfd. 350 Volts Cans ..... 3 for $1.79
500 Mfd. 25 Volts—(P.C.) .... 5 for $1.00
25 Asst'd Filters (CANS) $3.95

ANT. EQUIPMENT SPECIAL SALE
2 Set Coupler .... Ea. $1.50
4 Set Coupler .... Ea. $1.98
VHF-UHF Splitter 300 Ohms .... Ea. $1.49
VHF-UHF-FM Splitter 300 Ohms ..... Ea. $1.98
6 Antenna Clothespins $1.19

AUDIO EQUIPMENT
5 Assorted STEREO CART. $5.95
SONOTONE—8T (BULK) .... Ea. $1.25
BSR TC8S—(BULK) .... Ea. $1.25
BSR SC5MD—EV5540D (BULK) ...... Ea. $1.25
VM 45 Adapt. FLAT .... Ea. $ .59
10 RCA Phono Plugs $1.00
100 Assorted Springs $1.59
HV ANODE LEADS LARGE CUP ...... 3 for $1.19
DELAY LINES .... 2 for $1.19
10 Asst'd Slide Switches $1.00
20 Asst'd Tube Sockets $1.00
25 Assorted Plate Caps Leads $1.19
25 Assorted Terminal Strips $1.00
SHUNT REG HOODS (6BK4 etc.) .... 2 for $1.19
10 Asst'd Aligning Tools $1.98
BLUE LAT. MAG. W/Purity Ring .... 2 for $2.98
Color CRT Harness .... 5 for$1.29
Focus Sockets (1V2-2AV2) .... 6 for$1.19

SEND FOR FREE CATALOG
TUBES UP TO 80% OFF
MINIMUM ORDER $15.00
SEND CHECK OR M.O.

TV TECH SPECIALS
P.O. BOX 603
KINGS PARK, L.I., NEW YORK 11754
PHONE 516-269-0805

Circle 86 on reader service card

market center

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). **$1.40 per word** . . . minimum 15 words.

NONCOMMERCIAL RATE (for individuals who want to buy or sell personal items) **85c per word** . . . no minimum.

FIRST WORD AND NAME set in bold caps at no extra charge. Additional bold face at 10c per word. Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. All copy subject to publisher's approval. Advertisements using P.O. Box address will not be accepted until advertiser supplies publisher with permanent address and phone number. Copy to be in our hands on the 26th of the third month preceding the date of the issue (i.e. August issue closes May 26). When normal closing date falls on Saturday, Sunday or a holiday, issue closes on preceding working day.

WANTED

COMPUTER printed circuit boards and equipment. Send list now! **FLATIRON ENTERPRIZES**, 4654 Harwich St., Boulder, CO 80301

QUICK cash . . . for electronic equipment, components, unused tubes. Send list now! **BARRY**, 512 Broadway, New York, NY 10012, 212 Walker 5-7000

EDUCATION & INSTRUCTION

UNLOCK your future. Become professional locksmith by spare time homestudy. $13 in an hour possible. All tools, equipment included. Facts free. Send name. **LOCKSMITHING INSTITUTE** (homestudy), Dept. 1339-065, Little Falls, NJ 07424

LEARN design techniques. Electronics Design Newsletter. Digital, linear construction projects, design theory and procedures. Annual subscription $6.00, sample copy $1.00. **VALLEY WEST**, Box 2119-A, Sunnyvale, CA 94087

SELF-STUDY CB radio repair course. There's money to be made repairing CB radios. This easy-to-learn course can prepare you for a career in electronics enabling you to earn as much as $16.00 an hour in your spare time. For more information write: **CB RADIO REPAIR COURSE**, Dept. RE-065, 531 North Ann Arbor, Oklahoma City, OK 73127

FREE educational electronics catalog. Home study courses. Write to: **EDUKITS WORKSHOP**, Department 268G, Hewlett, NY 11557

BE A LOCKSMITH

"Have seen other Locksmith courses but none compared to yours. Have a successful mobile service of my own ...earn $2000-$3000 per month." Keith Hamill, Toronto

You'll enjoy your work as a Locksmith because it is more fascinating than a hobby—and highly paid besides! You'll go on enjoying the fascinating work, year after year, in good times or bad because you'll be the man in demand in an evergrowing field offering big pay jobs, big profits as your own boss. What more could you ask!

Train at Home – Earn Extra $$$$ Right Away!

LOCKSMITHING INSTITUTE
Div. Technical Home Study Schools
Dept. 1479-065, Little Falls, N. J. 07424

Name ________ (Please Print)
Address ________
City/State/Zip ________
☐ Check here if Eligible for Veteran Training

PLANS & KITS

DIGITAL clock calendar kit. (7001 IC, transistors, resistors, diodes, capacitors, xformer, PC boards, .33" displays, switches, etc.) $27.95. **Giant Clock display kit. 2" digits.** (75 selected red LED's, PC board). $27.95. **Super value—clock calendar with giant display.** $47.95. All components new—first quality. Enclose 10% postage & handling. **SIL-TECH**, 3630 South Kenwood Lane, Tempe, AZ 85282

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans $2.00. **SANDERS**, Dept. A-25, Box 92102, Houston, TX 77010

NEW organ kit builders guide $3.00. Circuits, block diagrams, details on diode keyed IC divider and independent oscillator designs. Many new kits and models. Keyboards also for synthesizers. Manual cost refundable with purchase. **DEVTRONIX ORGAN PRODUCTS**, Dept. B, 5872 Amapola Dr., San Jose, CA 95129

EM synthesizer concept-features universal compatibility, modular construction. For complete information send SASE or 25c to: **CFR ASSOCIATES**, POB F, Newton, NH 03858

ALTAIR 8800 USERS!

Get your system going with our memory and I/O cards. All are fully 8800 compatible, with doublesided plated thru epoxy boards. Each comes with all necessary parts and full documentation. **100% GUARANTEED!**

2KRA up to 2048x8 static RAM, 500 nsec access time. Run your 8800 top speed!
w/ 1Kx8 KIT = $85.
2Kx8 = $125.

2KRO Card accepts up to 8 Intel 1702A or National 5203 eraseable PROMs, has all addressing logic but NO PROMs.
KIT = $45.

3P+S Three parallel input & 3 output ports plus one serial I/O using a UART. One parallel I/O can be used for UART control. Full handshaking and jumperable interrupt outputs are provided.
KIT = $120.

Orders over $250 subtract 10%. Send for our **FREE** flyer or order now from:
PROCESSOR TECHNOLOGY CO.
2465 Fourth Street
Berkeley, Calif. 94710
(415) 549-0857

SPECTACULAR music patterns on color television from your amplifier. Easy. Won't affect TV. "TV color organ." Plans $5. **MALVERN ELECTRONICS**, Box 338R, Malvern, OH 44644

Here is what Poly Paks is Famous for...

Fabulous POLY PAKS BARREL SALE

For the first time anywhere, Poly Pak merchandisers introduce a new way in buying the economical way. Raw stock from the "barrel". Remember the "good ole days"? They're back again. The same way merchandisers throughout the United States buy from various factories . . . their over-runs in barrels. Poly Pak has done the same. Therefore you are getting the same type of material as the RE-TESTERS DO!

25 BARRELS PURCHASED FOR THIS SALE! BUY 'EM FROM THE "BARREL" AND SAVE!

Your choice of any kit $1.98

BARREL KIT #1 SN7400 DIP IC'S 75 for $1.98
Marked 14 and/or with 16 pin dips, may include gates, registers, flip flops, counters. Who knows!

BARREL KIT #2 LINEAR OP AMPS. 75 for $1.98
May include 709's, 741's, 703's, 560 series, 555 includes marked and unmarked. DIPS

BARREL KIT #3 1N4148/914 SWITCHING DIODES 100 for $1.98
You never saw this before. Imagine famous switching diodes at these prices!

BARREL KIT #4 "4000" RECTIFIERS 100 for $1.98
1N4000 series. May include 25, 50, 100, 200, 400, 600, 800 and 1000 v

BARREL KIT #5 SCRS, TRIACS, QUADRACS 40 for $1.98
All the famous plastic power tab type. Raw factory stock! All the 10 amp types.

BARREL KIT #6 RELAYS! RELAYS! 30 for $1.98
Raw fallout stock, marked and unmarked stock. Babcock, Leach, etc. All types.

BARREL KIT #7 VOLUME CONTROL 40 for $1.98
Singles, duals, variety of values, styles, big ones — small ones.

BARREL KIT #8 SUBMINI IF TRANSFORMERS 40 for $1.98
Amazing, includes 455kcs, osc, antenna, who knows? From transistor radio man-

BARREL KIT #9 SCRS, TRIACS 30 for $1.98
All stud types, asst, amperages and voltages.

BARREL KIT #10 ROMS-REGISTERS 40 for $1.98
28 to 40 pin devices, marked, internal factory numbers, etc

BARREL KIT #11 POWER TAB TRANSISTORS 40 for $1.98
NPN, plastic TO220 type. Assorted 2N numbers.

BARREL KIT #12 POWER TAB TRANSISTORS 40 for $1.98
PNP, plastic TO220 type. Assorted 2N numbers.

BARREL KIT #13 RESISTOR NETWORKS 40 for $1.98
By Corning Glass, in 14-pin dip paks.

BARREL KIT #14 PRECISION RESISYORS 200 for $1.98
Marked and unmarked ¼, ½, 2 watts.

TEST 'EM YOURSELF AND SAVE!

BARREL KIT #15 MOSFET TRANSISTORS 30 for $1.98
All 4 leaders TO-18 case. Includes UHF transistors too!

BARREL KIT #16 DISC CAPACITORS 100 for $1.98
Marked and unmarked. Red case type asst. values.

BARREL KIT #17 LINEAR & 7400 DIPS 100 for $1.98
Marked and unmarked, internal numbers of raw factory stock.

BARREL KIT #18 ZENER-RECTIFIER MIX 100 for $1.98
Subminiature, DO7's, includes asst. zeners and rectifiers. It's mixed

Every kit carries money back guarantee.

4-pc. COUNTING "COMBO" KITS!

Your Choice **$4.44** ☐ *With Diagrams!*

Combo No. 1 SN7441 ☐ & SN7475 NIXIE SN7490
Combo No. 2 SN7447 ☐ & SN7475 NIXIE SN7490
Combo No. 3 SN7448 ☐ & SN7475 NIXIE SN7490

"GIANT DIGIT" READOUTS

- 7-SEGMENT
- Reflective bar
- 25 mils per seg
- TTL compatible

3 for $12. ☐ $4.50 each

Mfgr	Type	Color	Size
☐ Opcoa	SLA-3	Green	0.7
☐ Opcoa	SLA-3	Yellow	0.7
☐ "M"	MAN-6*	Red	0.6
☐ Litronix	747	Red	0.6
☐ Litronix	746**	Red	0.6

*All LED, fits standard 14-pin socket
**Plus or Minus 1

SLA-3 MAN-6

RAYTHEON-RCA NATIONAL SIGNETICS LINEAR IC'S

Buy 3 — Take 10%

CODE
State 1st, 2nd, 3rd Choices of Case Styles
*State Voltages 5 thru 24
(D) = Duals; (Q) = Quads

Type	Sale	Type	Sale
☐ LM300	$ .69	☐ LM566	2.65
☐ LM301	.29	☐ LM567	2.85
☐ LM302	.69	☐ LM702	.49
☐ LM304	.79	☐ LM703	.41
☐ LM305	.89	☐ LM703M	.41
☐ LM307	.31	☐ LM709	.25
☐ LM308	1.05	☐ LM710	.29
☐ LM309H	1.05	☐ LM711	.29
☐ LM309K	1.50	☐ LM723	.61
☐ LM310	1.10	☐ LM733	1.75
☐ LM311	.99	☐ LM741	.31
☐ LM318	1.75	☐ LM741CV	.31
☐ LM319	1.19	☐ LM747(D)	.69
☐ LM320*	1.25	☐ LM748	.35
☐ LM322	1.75	☐ LM753	1.79
☐ LM324 (Q)	1.85	☐ LM1303	.79
☐ LM339 (Q)	1.45	☐ LM1304	1.00
☐ LM340*	2.50	☐ LM1307	.79
☐ LM341-T*	1.75	☐ LM1458(D)	.69
☐ LM350	.69	☐ LM1496	.99
☐ LM370	1.05	☐ LM1800	3.50
☐ LM371	1.05	☐ RC2556(D)	2.25
☐ LM373	1.95	☐ CA3028	.59
☐ LM374	1.95	☐ CA3045	.59
☐ LM376	.49	☐ CA3054	.59
☐ LM377	2.50	☐ CA3065	.59
☐ LM380-8	1.10	☐ CA3082	.59
☐ LM380	1.39	☐ LM3900	.49
☐ LM381	1.69	☐ RC4136(Q)	1.95
☐ LM382	1.69	☐ RC4195	2.50
☐ LM531	1.95	☐ LM4250C	2.10
☐ LM532	1.95	☐ LM7520	.59
☐ LM533	1.95	☐ LM7521	.59
☐ LM536	2.39	☐ LM7522	.59
☐ LM540	2.95	☐ LM7523	.59
☐ LM555	.88	☐ LM7524	.59
☐ LM558(D)	.69	☐ LM7525	.59
☐ LM560	2.50	☐ LM7528	.59
☐ LM561	2.50	☐ LM7529	.59
☐ LM562	2.50	☐ LM7535	.59
☐ LM565	2.50		

INDUSTRIAL SPEED CONTROL ☐ $4.95

A $30 item from G.E. Model 533A (made for Xerox) that controls home, shop and industrial lighting too! A very elaborate circuit for controlling many electrical and electronic devices. Easily controls speeds of electric drills, brush type motors, etc. 115vac, rated at 1100 watts. With variable speed or dimming control in heavy-duty aluminum case. 3 x 2¾ x 2. With diagram and hookups.

8008 "THE COMPUTER ON THE CHIP" Only $44.

Usually called "Microprocessor" — it is a p Channel Si gate MOS 8-bit Parallel Central Processor. A CPU Central Processing Unit on a chip. Features complete instruction decoding and control. Capability to address 16K x 8 bits of memory (RAM, ROM, SR). Build a micro-computer system when interfacing with other chips, such as 1101, 1103, 2102 (RAMS), etc. With spec sheets. 16-pin dip package. $44

2102 1000-bit 'static' Ram for above. $6.50

WRISTWATCH LIQUID CRYSTAL DISPLAY ☐ $8.88

3½ digit, 7-segment — only 1 1/16 x 11/16 x 1/4". Includes readout, socket, "slide-in-place chrome slide face plate". Same display as found in $200. units.

GAS DISCHARGE DISPLAY POWER SUPPLIES

Only ☐ $4.95

3 x 3" pc board power supply with brightness control for the NDP or any gas discharge tubes. Completely wired. As extra feature has calculator clock circuit. The transformer is the new Toroidal transformer itself worth our asking price. Only ½ x ½". Electrical specs 110 vac input, output. With spec sheet.

LED MITY DIGIT "DCM'S"

Buy 3 — Take 10% ☐ Only $8.88

"Digital Counting Modules" outperform any other DCM on the market today. More features than ever before! Not gaseous, not incandescents, not nixie but the modern LED. Choose from such famous manufacturers as Monsanto's MAN-1, MAN-4, Litronics 707 and 704, Opcoa's SLA-1 (the last 4 having character heights of 0.33 at no extra charge). Each kit includes 3x2" p.c board with fingers for a FREE edge connector, side-mounting dip socket, LED readout of your choice, resistors, 3 IC's, and Molex connectors (this ELIMINATES SOLDERING YOUR IC's) and booklet. **INCLUDES P.C. EDGE CONNECTOR — FREE!**

READOUT	Char.	Maker
☐ MAN-1	.27 h.	Monsanto
☐ MAN-4	.19 h.	Monsanto
☐ 707*	.33 h.	Litronics
☐ 704**	.33 h.	Litronics
☐ SLA-1*	.33 h.	Opcoa
☐ MAN64	.4 h.	Monsanto

* Pin-for-pin MAN-1. ** Pin-for-pin MAN-4, elec. char.

☐ Same as above except uses MAN-6....$9.95
Character Size: 0.6

☐ 555 Timer OR ☐ 558 Dual 741

2 for $1
Sale good till July 15, 1975

TOUCH TONE $4.95 KEYBOARD KIT

Kit includes 4 x 2½" G-10 glass etched pc board, with 10 OAK "smooth touch" white keys with black numerals, plus diagram on "touch tone encoder". Makes many "keyboard systems" readily available. *0-to-9*

XENON FLASH STROBE TUBE ☐ $1.95

Epoxy SILICON BRIDGE RECTIFIERS

Full Wave

PIV	2 Amp	6 Amp	10 AMP
50	☐ $ .69	☐ $ .88	☐ $1.49
100	☐ .79	☐ .99	☐ 1.69
200	☐ .95	☐ 1.25	☐ 1.89
400	☐ 1.19	☐ 1.50	☐ 2.09
600	☐ 1.35	☐ 1.75	
800	☐ 1.59	☐ 1.95	
1000	☐ 1.79	☐ 2.25	

Code: 2 amp TO-5 case
6 Amp 1/2 x 1/2 x 3/16 sq.

"ALL LED" MONSANTO READOUTS

MAN-1 MAN-3
*35 LED matrix

MONSANTO TYPE	CHAR. HT.	SALE EACH	Quantity Discounts
☐ MAN-1	.27	$2.95	3 for $ 7.
☐ MAN-2	.32*	4.95	3 for $14.
☐ MAN-3	.12	1.00	3 for $2.50
☐ MAN-4	.19	2.95	3 for $6

BIGGEST MAN-7 SALE

3 for $2.50 ☐ $1

THAT'S RIGHT! MAN-7's at the readout sale of the century! The MAN-7 is a 7-segment "reflective bar" version of the famous MAN-1. The optimum in light efficiency and construction. Looks like, acts like, the MAN-1. Pin connections same. Wide angle viewing. 0.27" character height, color red.

MAN-5 as MAN-7 except green ☐ 1.49
MAN-8 as MAN-7 except yellow ☐ 1.49

"BLASTAWAY" ON 1N4000 RECTIFIER PRICES

Type	PIV	Sale
☐ 1N4001	50	10 for 45c
☐ 1N4002	100	10 for 55c
☐ 1N4003	200	10 for 65c
☐ 1N4004	400	10 for 75c
☐ 1N4005	600	10 for 85c
☐ 1N4006	800	10 for 99c
☐ 1N4007	1000	10 for 1.29

BUY 10 IC'S TAKE 15% — BUY 100 TAKE 25%

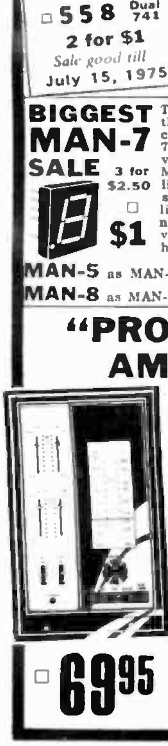
Inflation-Fighting ECONOMY IC PRICES

Brand New
Order by type number! Spec sheets on request "ONLY" • Factory Marked

Type	Sale	Type	Sale	Type	Sale	Type	Sale	Type	Sale
☐ SN7400	$ .22	☐ SN7438	.49	☐ SN7481	1.25	☐ SN74141	1.19	☐ SN74191	1.49
☐ SN7401	.22	☐ SN7440	.19	☐ SN7482	.99	☐ SN74145	1.19	☐ SN74192	1.59
☐ SN7402	.22	☐ SN7441	1.00	☐ SN7483	1.19	☐ SN74148	2.95	☐ SN74193	1.59
☐ SN7403	.22	☐ SN7442	1.00	☐ SN7486	.49	☐ SN74150	1.19	☐ SN74195	1.10
☐ SN7404	.27	☐ SN7443	1.00	☐ SN7489	2.95	☐ SN74151	.99	☐ SN74197	1.10
☐ SN7405	.24	☐ SN7444	1.00	☐ SN7490	1.81	☐ SN74153	1.39	☐ SN74198	2.45
☐ SN7406	.79	☐ SN7445	1.00	☐ SN7491	1.35	☐ SN74154	1.69	☐ SN74199	2.45
☐ SN7408	.27	☐ SN7446	1.10	☐ SN7493	.99	☐ SN74155	1.29	☐ SN74200	7.50
☐ SN7409	.27	☐ SN7447	1.10	☐ SN7495	.99	☐ SN74156	1.45		
☐ SN7410	.19	☐ SN7448	1.45	☐ SN7496	.99	☐ SN74157	1.45		
☐ SN7411	.31	☐ SN7450	.27	☐ SN74100	1.55	☐ SN74158	1.45		
☐ SN7413	.89	☐ SN7451	.28	☐ SN74104	1.25	☐ SN74161	1.59		
☐ SN7414	2.25	☐ SN7453	.28	☐ SN74105	.95	☐ SN74163	1.75		
☐ SN7415	.45	☐ SN7455	.28	☐ SN74106	.95	☐ SN74164	2.85		
☐ SN7416	.45	☐ SN7462	.39	☐ SN74107	.49	☐ SN74165	2.85		
☐ SN7417	.50	☐ SN7464	.39	☐ SN74108	.95	☐ SN74166	1.85		
☐ SN7420	.22	☐ SN7465	.39	☐ SN74112	.95	☐ SN74173	1.85		
☐ SN7422	.29	☐ SN7471	.55	☐ SN74113	.95	☐ SN74174	2.25		
☐ SN7423	.32	☐ SN7472	.42	☐ SN74114	.95	☐ SN74175	1.99		
☐ SN7425	.35	☐ SN7473	.52	☐ SN74121	.49	☐ SN74176	1.25		
☐ SN7426	.31	☐ SN7474	.39	☐ SN74122	.55	☐ SN74177	1.25		
☐ SN7427	.35	☐ SN7475	.91	☐ SN74123	1.09	☐ SN74180	1.10		
☐ SN7430	.24	☐ SN7476	.52	☐ SN74125	.65	☐ SN74181	3.95		
☐ SN7432	.28	☐ SN7478	.79	☐ SN74126	.89	☐ SN74182	1.05		
☐ SN7437	.45	☐ SN7480	.59	☐ SN74140	2.50	☐ SN74190	1.49		

Money-Back GUARANTEE on all Items

"PROFESSIONAL" 60 WATT AM-FM MUX TUNER AMP



The finest built 60 watt tuner amp we've had for years. We call it THE AUDIOPHILE BUY OF THE YEAR! It compares to Fisher and H H Scott quality. Crisp hi's, organ type quality for the lows. Fine linear response using a pair of 35 watt style matched power tab transistors for each channel. Built-in preamp for using magnetic cartridges, black and chrome-silver look molded panel with glass already attached to tuner. It's made to JUST SLIDE INTO CABINET! Push-button features for phono, am, fm, fm stereo, tape. Red "FM and TAPE" show on glass. You can't see dial plate behind glass til you press any of the above push buttons, and then the scale illuminates. Two separate rocker switches for POWER ON-OFF and AFC Controls. Modern slide volume, balance, bass and treble controls. With knobs for these and a black chrome trimmed 2" round for tuning. Balance controls indicate left and right speakers. Jack on panel for standard stereo headphones. Built-in AM and FM antennas. REAR CONNECTIONS: has two separate cables to plug into stereo, phono system. AC cable for interconnect power to turn-table, cable to connect to phono system for automatic shut-off. Separate bakelite panel that you can add an additional FM antenna for "souping up" signals, stereo jacks for playback and record for external tape decks. 4-WAY SPEAKER SYSTEM with switch to any channel individually for testing. Wt. 5 lbs.

☐ **69.95**

7-SEGMENT OPCOA SLA-1 REFLECTIVE LED READOUT

3 for $6. **$2.50**
☐ Red ☐ Yellow ☐ Green

Litronix 704 ☐ Red $2.50
Litronix 707 ☐ Red $2.50

Terms: add postage Rated: net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

☐ 20c CATALOG Fiber Optics, 'ICs', Semi's, Parts

MINIMUM ORDER — $4.00

POLY PAKS
P.O. BOX 942R, LYNNFIELD, MASS. 01940

Circle 87 on reader service card

FREE catalog. Most unusual electronic kits available. Music accessories, surf, wind synthesizers, wind chimes, many others. **PAIA ELECTRONICS**, Box B14359, Oklahoma City, OK 73114

F.C.C. EXAM MANUAL

PASS FCC EXAMS! Memorize, study—Tests-Answers for FCC 1st and 2nd class Radio-telephone licenses. Newly revised multiple choice questions and diagrams cover all areas tested in FCC exams, plus Self-Study Ability Test. $9.95 postpaid. Money-back guarantee.

COMMAND PRODUCTIONS P.O. BOX 26348 E
RADIO ENGINEERING DIV. SAN FRANCISCO, CAL. 94126

PRACTICAL and easy to understand guide on how to build any ± regulated and current limited power supply: $4.25 **TV ping pong** game. Plays through your set's antenna terminals: Plans $3.25. **ARS SYSTEMS**, Box 1922C, Sunnyvale, CA 94088

FOR SALE

LIQUID crystal. 3½ digit wristwatch display. New, with instructions for building wristwatch. Final close-out. Less than original, factory wholesale price. $5.50 each. Two for $10. **TRICOUNTY WINSLOW**, Inc., Box 5885, Grand Central Station, New York, NY 10017

DYNACO-A-R, transistors, repairs-boards-& units, speaker service. Send for prices & details: BEAR ELECTRONICS, 117-R, Hillcrest Road, Mt. Vernon, NY 10552

ELECTRONIC Ignition: Capacitor, transistor, pointless. Auburn sparkplugs. Information 10c. **ANDERSON ENGINEERING**, Epsom, NH 03234

QUICK cash for your used Altair 8800, TV Typewriter, interfaces, software, etc. Contact us for service, parts, and free applications information. **ALCOVE**, 230 Main, North Reading, MA 01864 (617) 664-4271

INTEL 8008 8 BIT MICRO PROCESSING CHIP (with data book) $64.50
2102-2 1024 BIT RAM .... $ 6.95
1702A UV PROM $24.00
MM5203 UV PROM $24.00

MINIATURE TRIM POTS
5K, 10K, 25K, 100K
$.75 ea. .... 3/$2.00

MULTI-TURN TRIM POTS
Similar to Bourns 3010 style, 3/16" x 5/8" x 1-1/4"; 50, 100, 2000, 5000, 10,000 ohms. $1.50

LIGHT ACTIVATED SCR's
TO-18, 200V 1A $1.75

PRINTED CIRCUIT BOARD
4-1/2" x 6-1/2" single sided epoxy board, 1/16" thick, unetched
$50 ea. .... 5/$2.20

MC14435 & MC1405L
A two piece 3-1/2 digit A/D converter system for panel meters and with schematics DVM's $39.95

TIS 73 N FET .... $.50
2N4891 UJT .... $.50
ER900 TRIGGER DIODES .... 4/$1.00
2N6028 PROG. UJT .... $.75

VERIPAX PC BOARD
This board is 1/16" single sided paper epoxy board, 4½" x 6½", DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16 or LSI DIP IC's with busses for power supply connector. $5.25

FCD 811 OPTAL COUPLER $1.20
RED/GREEN BIPOLAR $1.30
MT-2 PHOTO TRANS .... $.60
GREEN GAP OSL-16 LED .... $.40
RED GAP OSL-3LED .... $.30
14 PIN DIP SOCKETS .... $.40
16 PIN DIP SOCKETS .... $.50

10 WATT ZENERS
3.9, 4.7 OR 18V .... $.75 EA.
1. WATT ZENERS 5.6
10, 12, 15, 18, OR 22V .... $.40 EA.

Silicon Power Rectifiers

PRV	1A	3A	12A	50A
100	.06	.14	.30	.80
200	.07	.20	.35	1.15
400	.09	.25	.50	1.40
600	.11	.30	.70	1.80
800	.15	.35	.90	2.20
1000	.20	.45	1.10	2.75

REGULATED MODULAR POWER SUPPLIES
+ − 15VDC AT 100ma
115VAC INPUT $24.95
5VDC AT 1A, 115VAC INPUT $19.95
12V .6A $24.95

IN 4148 (IN914) .... 14/$1.00

1103 1024 bit RAM $4.75
NEC 6003 2048 bit RAM $9.50
1101 256 bit RAM $1.75
5260 RAM $4.50
7489 RAM $2.75

Terms: FOB Cambridge, Mass. Send Check or Money Order. Include Postage. Minimum Order $5.00.

TRANSISTOR SPECIALS
2N4898 PNP TO-66 .... $.60
2N404 PNP GE TO-5 .... 4/$1.00
2N3919 NPN Si TO-3 RF $1.50
MPSA13 NPN Si TO-92 .... 3/$1.00
2N256 PNP GE TO-3 .... $.40
2N3767 NPN Si TO-66 .... $.70
2N2222 NPN Si TO-18 .... 5/$1.00
2N3055 NPN Si TO-3 .... $1.00
2N3904 NPN Si TO-92 .... 4/$1.00
2N3906 PNP Si TO-92 .... 4/$1.00
2N5296 NPN Si TO-220 .... $.50
2N6109 PNP Si TO-220 .... $.55
2N3866 NPN Si TO-5 Si RF POW .... $.75
MJ2252 NPN Si TO-66 .... $.90
2N3638 NPN Si TO-5 .... 5/$1.00
2N2218A NPN Si TO-5 .... 4/$1.00

C/MOS (DIODE CLAMPED)

74C02	$ .55	CD4019	$ .95
74C10	$ .60	CD4022	$2.10
74C157	$2.15	CD4023	$ .48
74C165	$3.50	CD4024	$1.80
CD4001	$ .48	CD4025	$ .48
CD4002	$ .48	CD4026	$5.00
CD4006	$3.50	CD4027	$1.20
CD4007	$ .48	CD4028	$2.20
CD4009	$ .80	CD4029	$4.00
CD4010	$ .65	CD4030	$ .53
CD4011	$ .48	CD4035	$2.30
CD4012	$ .48	CD4042	$2.75
CD4013	$ .90	CD4046	$3.75
CD4015	$2.80	CD4047	$3.10
CD4016	$1.05	CD4050	$1.05
CD4017	$2.60	CD4055	$2.70

CAPACITORS
35V at 6.8 UF TANT. .... 3/$1.00
26V at 200 UF TANT .... $.40
6V 30 UF TANT .... 5/$1.00
12V 200 UF ELECT .... $.30
200V 4.7 UF ELECT .... $.30
10 UF 12V ELECT .... 5/$1.00

MAN-1, Red or Yellow LED READOUT $2.50
MAN-3 READOUT $1.75
MAN-4 READOUT $2.00
SLA 3 .... $4.50

Full Wave Bridges

PRV	2A	6A	25A
200	.95	1.25	$3.00
400	1.15	1.50	$4.00
600	1.35	1.75	$5.00

100x100 IMAGE SENSOR CHARGED COUPLE DEVICES USED IN SOLID STATE CAMERAS, WITH APPLICATIONS $198.00
MM5203-2048 BIT ERASABLE PROM $24.00
8223 PROM .... $ 4.75

2516—64x6x8 STATIC CHARACTER GEN $9.95

FPA 711-7 LEVEL Diode Array Optical Tape Readers $5.95
CD110 LINEAR 256 XI BIT Self Scanning Charged Coupled Divise, With Data $150.00

Conductive Elastometer low profile calculator keyboard. A 2⅞" X 3¼" X ½" flex key. 19SK-C keyboard having 0.9, •, +, −, X, ÷, =, K+C buttons with off, on switch. $6.00

SANKEN AUDIO POWER AMPS
Si 1010 G 10 WATTS .... $ 6.40
Si 1020 E 20 WATTS $13.95
Si 1050 E 50 WATTS $24.95

TTL IC SERIES

74L00	.30	7476	.45
7400	.17	7480	.61
7401	.17	7483	.99
7402	.17	7485	1.30
7403	.17	7486	.48
7404	.21	7490	.71
7405	.21	7491	1.10
7406	.37	7492	.75
7407	.37	7493	.71
7408	.23	7495	.85
7410	.17	7496	.85
7411	.27	8267	1.95
7412	.45	74107	.45
7413	.73	74121	.55
7416	.37	74123	.91
7417	.37	74125	.65
7420	.17	74126	.70
7425	.37	74150	.99
7426	.27	74151	.85
7427	.31	74153	1.05
7430	.17	74154	1.49
7432	.27	74155	1.05
7437	.41	74157	1.19
7438	.35	74163	1.49
7440	.17	74164	1.79
7441	.95	74165	1.79
7442	.95	74173	1.55
7445	1.05	74175	1.80
7446	1.10	74177	1.50
7447	1.10	74181	3.50
7448	1.10	74192	1.45
7472	.33	74193	1.30
7473	.41	74195	.89
7474	.41	75324	1.75
7475	.71	75491	1.10

LINEAR CIRCUITS
LM 309K 5V 1A REGULATOR $1.50
723 −40 +40V REGULATOR .... $ .58
301/748 Hi Per. Op. Amp. .... $ .30
LM 320 −5 or −15V REGULATOR $1.75
LM 376 −V to 37V POS REG. .... $ .58
741A or 741C OP. AMP. .... $ .31
709C OPER AMP. .... $ .25
340T-5, 12, 15, 18, 24V
POS. REG. TO-220 .... $1.75
101 OPER. AMP., HI PERFORM. .... $ .75
LM 308 OPER. AMP., LOW POWER. $1.05
747—DUAL 741 .... $ .75
711 COMPARATOR .... $ .31
537- PRECISION OP. AMP. $2.60
LM 3900—QUAD OP. AMP. .... $ .49
LM 324—QUAD 741 .... $2.20
560—PHASE LOCK LOOP $2.50
561—PHASE LOCK LOOP $2.50
565—PHASE LOCK LOOP $2.50
567—TONE DECODER $2.85
703—RF IF AMP. .... $ .41
LM 370—AGC SQUELCH AMP. $1.15
555—2 μs — 2 HR. TIMER. .... $ .88
FCD 810 OPTO—ISOLATOR $1.35
1456 OPER. AMP. .... $ .95
LM 380—2W AUDIO AMP. $1.39
LM 377—2W STERO AUDIO AMP. $2.50
LM 381—STEREO PREAMP $1.69
LM 382—DUAL AUDIO PREAMP $1.69
LM 311—HI PER. COMPARATOR. .... $ .95
LM 319—DUAL HI SPEED COMP. $1.15
LM 339—QUAD COMPARATOR. $1.45

8038C IC VOLT CONT. OSC. $4.95

5311 — CLOCK CHIP 6 DIGIT BCD HOLD COUNT, OUTPUT STROBE $6.75
5314 — CLOCK CHIP 6 DIGIT HOLD COUNT, OUTPUT STROBE $6.75
5316 — ALARM CLOCK CHIP $6.75

PRV	TRIACS 1A	TRIACS 10A	TRIACS 25A	SCR'S 1.5A	SCR'S 6A	SCR'S 35A
100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
600	1.70	2.30	3.00			3.00

Send 20c for our catalog featuring Transistors and Rectifiers; 145 Hampshire St., Cambridge, Mass.

SOLID STATE SALES
P O BOX 740
SOMERVILLE, MASS 02143 TEL 617 547 4005

WE SHIP OVER 95% OF OUR ORDERS THE DAY WE RECEIVE THEM

JAPANESE transistors, wholesale prices, free catalog. **WEST PACIFIC ELECTRONICS**, Box 25837, W. Los Angeles, CA 90025

RECONDITIONED test equipment. $0.50 for catalog. **WALTER**, 2697 Nickel, San Pablo, CA 94806

FREE bargain catalog. Ultrasonic devices, LED's, transistors, IC's, keyboards, Xtals, unique components. **CHANEY'S**, Box 15431, Lakewood, CO 80215

CATALOG
GOVERNMENT SURPLUS ELECTRONIC EQUIPMENT
For 1975
FREE UPON REQUEST! Write for Copy of Catalog WS-75 Now!
Address: Attention Dept. RE

FAIR RADIO SALES
1016 E. EUREKA • Box 1105 • LIMA, OHIO • 45802

COMPLETE construction plans-Telephone: answering device, automatic dialer, "black boxes", call diverter, call limiter, conference bridge, central dial exchange, melodic ringing generator, recorder-actuator, remote control, schematics, speakerphone, Telelink burglar alarm, voice scrambler, $3.00 each. **Electronic**-Biofeedback conditioner, horticulture stimulator, multifrequency encoder network (Speeds telephone dialing 500%!). $5.00 each. **One year subscription:** Telephone electronics line (Tel) $6.00. Legal aspects of interconnection book $29.95. **All of the construction plans above plus a years subscription to tel and catalog: 29.95. TELETRONICS COMPANY OF AMERICA**, 220 35 Burbank Blvd., Woodland Hills, CA 91364, U.S.A.

QUALITY military and industrial surplus electronics. Send 25c for last 3 of our monthly picture flyers. It's different! U.S. only. **STARTRONICS**, Box 17127, Portland, OR 97217

Saxitone's Bicentennial Tape Shoppe
CASSETTE LABELS

Plain white cassette labels. Norelco cassette cleaners, famous brand cassettes. Metal 10" reels. Send for open reel and cassette discount catalog.

	1-9	10-99	100	1000	10M
Cassette Labels (Multiples of 10)		.02	.015	.01	.006
Norelco Cassette Cleaner	.65	.60	.55	.50	.45
*Scotch Cassette SC90HE	3.25	3.10	2.95	2.80	2.75
10½" Metal, NAB REEL, Used	1.00	1.00	.90	.80	.75

*Buy 10, SC90HE, get 5 free.
Plus Postage by Weight and Zone. **Minimum Order $5.00**

OPEN REEL STEREO TAPE BUYERS!
At last! An open reel catalog, including titles, songs, etc. of 95 long play, 2-3 hour albums by American Airlines or Ampex 4 track stereo tapes. Send $1.00—and we will also mail you a 140-page Harrison stereo tape guide—so you'll get both for $1.00—and this $1.00 is refundable on your first $10.00 purchase of open reel stereo tapes at our 30% discount.
We've Got the "Spirit" The Prices And The Address To Prove It
SAXITONE TAPES 1776 Columbia Rd., N.W., Wash. D.C. 20009

PRINTED CIRCUIT
EPOXY GLASS CIRCUIT BOARD STOCK; CARBIDE DRILL BITS; TAPE RESIST; ARTWORK; BUBBLE ETCHERS
SEND S.A.S.E. FOR FLYER
TRUMBULL
833 BALRA DR., EL CERRITO, CA 94530

BURGLAR alarm police dialing unit automatically calls police. $29.95. Free literature. **S & S SUPPLY**, Box 12375G, North Kansas City, MO 64116

MULTIPLE restrike ignition. Repetitive spark improves combustion efficiency. Free brochure. **LABTRONICS**, 3635-B Hillside, Ypsilanti, MI 48197

HOLD-IT! A new precision electronic product. Details free. **INNOVATIVE CONCEPTS**, 4018 Clarke, Ft. Worth, TX 76107

TUNER TORNADO = 9,95 for AM

AM TUNER
WITH BUILT-IN AMP

- Slide-Rule Dial Covers
- (10-watts Peak Power)
- ALL SOLID STATE!!!

□ **$9.95** For the Audiophiles who are seeking an economy hi-fi AM only at our give-away price! Never advertised before. Same quality and construction as our 20W to 60W units. Features: 4 controls; Tuning, Tone, ON/OFF Volume, Circuit Switch (AM-phono). 2-Speaker stereo effect system. 6-ft. power cord. Phono cables, with hookups. 115 VAC, 60 cycles. No escutcheon. Size: 10⅝ x 5⅝ x 3½" deep. Wt. 3 lbs.

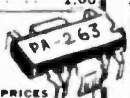
AM □ FM $19.95 Never before have we ever seen such a combination of AM and FM with built-in high quality at such a low price. A "natural" for the economy-minded Audiophile. Features: Tuning Tone, ON/OFF Volume, Balance, Circuit Switch (AM, FM, FM-AFC, phono). 2-Speaker stereo effect system. 6-ft. power cord. Phono cables, with hook-ups. 115 VAC, 60 cycles. No escutcheon. Size: 13 x 7 x 3½" deep. Wt. 3 lbs.

GIANT SALE ON LED'S
LIGHT EMITTING DIODE GaAs INDICATORS

- □ 3-MV2, TO-18, dome, green, visible 1.00
- □ 3-MV2, green small dome, green diff. lite 1.00
- □ 3-MV3, micro-mini 'pin head' dome, TO-18, green lite 1.00
- □ 3-MV3, visible, "coax pin pak", red, mini dome lens 1.00
- □ 5-MV10B, visible, red, clear dome lens TO-18 .... 1.00
- □ 5-MV10C, visible, red, diffused, dome lens, TO-18 .... 1.00
- □ 8-MV50, axial leads, micro-mini dome, clear, red, TO-18 .... 1.00
- □ 3-MV52, micro-mini, axial green lens, green lite 1.00
- □ 3-MV53, micro-mini, axial yellow lens, yellow lite 1.00
- □ 5-MV54, micro-mini, axial leads, red lens, red lite 1.00
- □ 5-MV5012, red small dome lens, red lite, TO-18 .... 1.00
- □ 5-MV5013, sm. dome, 2 hi red dome, soft red diff. lite, TO-18 .... 1.00
- □ 5-MV5021, jumbo diffused dome, visible, red, TO-18 .... 1.00
- □ 5-MV5054, red jumbo dome lens, TO-18 red lite, upright 1.00
- □ 5-MV5080, TO-18, micro-mini red dome, red lite 1.00
- □ 5-MV5080, TO-18, micro-mini flat clear lens, red lite 1.00
- □ 1-MV5094, red bi-polar, solid state lamp V to 110-115VAC-DC 1.98
- □ 5-MV5222, green jumbo dome, green lite, panel snap-in 1.00
- □ 5-MV5282, micro-mini, green lens TO-18, green lite 1.00
- □ 5-MV5322, yellow jumbo dome, yellow lite, panel snap-in 1.00
- □ 2-MT2, photo transistor, light sensor, TO-18 .... 1.00

COUPLERS
- □ 2-MCT2, 1500V isolation photo transistor 1.00
- □ 2-MCD2, 1500V isolation photo diode 1.00

GENERAL ELECTRIC 3-WATT AUDIO AMP □ $1.49



Delivers 3 watts continuous, 10 watts peak. With heat sinks; micro-mini size: ¾x½x½". 9 to 30V supply. High sensitivity. 8 to 16 ohms. For mono and stereo phonos, tape, FM, AM, TV, servo. **3 for $3** BRAND NEW LOWEST PRICES

WORLD FAMOUS SEMI-KON Dollar Stretchers

- □ 50 – SILICON, glass rectifiers, computer, axial leads .... $1.
- □ 50 – GERMANIUM, glass rectifiers, signal, axial leads* .... $1.
- □ 6 – 1-AMP 1000 PIV, epoxy, submini, silicon rectifiers .... $1.
- □ 50 – 1-W ZENERS, axial 4, 6, 9, 10, 12V rectifiers, etc .... $1.
- □ 4 – 2N3055, HOBBY, 40W npn silicon transistors, TO-3 .... $1.
- □ 40 – 3-AMP RECTIFIERS, silicon, epoxy, assorted V. axial* .... $1.
- □ 10-1N82 GERMANIUM UHF diode, clip-in type* .... $1.
- □ 2-EPOXY 2-AMP SILICON BRIDGE RECT. 1000 V "comb. type" .. $1.
- □ 10-MOS FETS, 3N187, 3N200, 3N128, TO-18, Fairchild* .... $1.
- □ 5-SCRS & TRIACS up to 25 amps. 6-12-24 prv, studs too .... $1.
- □ 2 – 2N3819, Texas, N channel, 6500 umho TO-18 .... $1.
- □ 2 – 2N2646 UNIJUNCTIONS, plastic transistors, Texas .... $1.
- □ 5 – ER900 TRIGGER DIODES for SCRs & Triacs .... $1.
- □ 2 – FET'S 2N5457 N channel 5000 umhos, TO-92 plastic .... $1.
- □ 10 – 1N914 fast switch diodes, silicon, 4 nanoseconds .... $1.
- □ 2-Sylvania 18,000V Matchstik TV rectifier, 4" x ⅛ with leads $1.
- □ 50 – ITT MICRO MINI RECTIFIERS silicon porcelain to 1KV* .... $1.
- □ 50 – WORLD'S SMALLEST RECT. & zeners, 1W, assorted volts* $1.
- □ 10-6000 PIV 50 mil epoxy rectifiers, axial leads* .... $1.
- □ 10 – BENDIX 25 WATT "pellet" power transistors, silicon* .... $1.
- □ 3-DARLINGTON, powers, plastic, HFE up to 60K, 6W, 30V .... $1.
- □ 10 POWER TABS, plastic includes Darlingtons. HI AMP, HI V .. $1.
- □ 2 – 2N5655 200 hfe, 250 vceo. power tab .... $1.
- □ 4 – 2N5296 HOBBY, 35 watts, plastic powers, NPN .... $1.
- □ 4 – 2N6109 HOBBY, 40 watts, plastic powers, PNP .... $1.
- □ 5 – PLASTIC 35W powers, npn, silicon, hobby 2N6121 .... $1.
- □ 5 – PLASTIC 35W powers, pnp, silicon, hobby 2N6124 .... $1.
- □ 2 – MOS FETS, N channel 10K umos 3N128, TO-18, RCA .... $1.
- □ 2 – MOS FETS, DUAL GATE, N chan. 3N187, TO-18, RCA .... $1.
- □ 2 – MOS FETS, DUAL GATE, N chan. 3N140, TO-18, RCA .... $1.
- □ 4 – RCA 2N3600 NPN, UHF transistors, tv-fm, TO-18, 1000mc .. $1.

- □ 1 — PHOTO TRANSISTOR, with darlington amp filter $1
- □ 2 — PHOTO TRANSISTORS, with darlington amp, 2N5777, GE .. $1

- □ 4-5316 CLOCK CHIP, hobby $1
- □ 2-5005 MEMORY CALCULATOR CHIPS, 28-pin HOBBY $1
- □ 5-555 TIMERS, mini DIP, hobby $1
- □ 10-741 OP AMPS, mini DIP HOBBY $1

I.C. & LED HOBBY-ONICS

- □ 5 – HOBBY MEMORY CELLS, SN7481, up to 16-cell, DIP* .... $1.
- □ 5-MOS REGISTERS, 501 to 5017, TO-5, Mini-DIP's* .... $1.
- □ 10-"C" MOS IC's, 74C and CD4000 series, DIP pak* .... $1.
- □ 10-MINI DIPS, OP AMPS, 709, 741, 301, 307, hobby* .... $1.
- □ 10-SIGNETIC OP AMP, 531, 533, 536, 550, 550, DIPs, TO-5* $1.
- □ 1 -5311-14 CLOCK ON A CHIP, 4-or-6 digit, 24-or-28-pin* .. $1.
- □ 10 – LINEAR AMPS, 709, 710, 711, 741, TO-5 .... $1.
- □ 10-TO-5 Case 536, 540, 555, 567, 741* .... $1.
- □ 4 – PHASE LOCK LOOPS, hobby 535, 560, 561* .... $1.
- □ 4—MM5736 6-Digit Calculator on a Chip, hobby .... $1.
- □ 2-AM RADIO-ON-A-CHIP, by Sprague, DIP, u test 'em .... $1.
- □ 4-DUAL 2-WATT "Stereo-Amp-On-A-Chip", fallout Sprague, u test $1.
- □ 2-OPCOA SLA-11*, like MAN-5, green, 1-or-more segs gone. $1.
- □ 2-OPCOA SLA-3H*, 0.7 charac. readout, 1-or-more segs missing $1.
- □ 5-MONSANTO opto isolators, no test, 1500V .... $1.
- □ 10-LED HOBBY SURPRIZE, asst. types, factory rejects, no test $1.
- □ 3-OPCOA SLA-1*, MAN-1, red, .33" charac. 1-or-more segs gon $1.
- □ 4-MONSANTO MAN-4, .19" charac. 1-or-more segs missing, red $1.
- □ 8-MONSANTO MAN-3, .12" charac. red. 1 or more segs missing. $1.
- □ 2 — 3-DIGIT NATIONAL READOUTS, some digits good .... $1.
- □ 10-SPRAGUE DIPS, LINEAR OP AMPS, 2111 series, 2120 series $1.
- □ 4-NATIONAL 6-Digit readout, segs missing .... $1.
- □ 3- National 8-Digit READOUTS, segs missing, red .... $1.

* UNTESTED GUARANTEED SATISFACTION

IT'S NEW! NEVER OFFERED BEFORE!

9-FUNCTION, 8-DIGIT MEMORY CALCULATOR KIT

It's the easiest multi-function kit today!

- DOUBLE MEMORY Percent, Constant, Display Restore
- 4-Function Arithmetic
- 22 KEYS!

Only □ **$26.95**

EASY TO PUT TOGETHER! You bet it is . . . imagine no resistors, capacitors, but it ONLY REQUIRES 2 CHIPS and a READOUT! How's that for simplicity? The 2 Memory keys are MS Memory Storage and MR Memory Recall (requires very little soldering). The display restore key is to conserve battery life. Your display on panel shuts off 25 seconds after the last operation. By depressing "D" key, the display is restored! Uses 6 N cell batteries. Red decimal appears on left to show when batteries need replacement or charging. Has Decimal, Clear, Constant, Percent, and arithmetic key red, white and blue colors. Lightweight, pocket size 5¼ x 3 x (2" at back side) x 1¼" front side of angular display panel black case. Nifty unit for business, school, home, and for the youngsters. Slips into any pocket, briefcase with ease. Easy-to-understand pictoral instruction booklet and how-to-use-book.

AC/DC too!

KIT INCLUDES: case, 22-key keyboard kit, ON-OFF switch (part of keyboard) PC board, driver and memory calculator chips, 9-digit "bubble" magnifier LED array, array cable, AC adapter jack & wires, battery case, 6 battery card display, instruction and pictoral step-by-step construction booklet.

□ AC ADAPTER FOR ABOVE $2.95

6-FUNCTION Calculator Kits $22.50 □ Same as above

6 & 8 DIGIT MINI CALCULATOR BASICS
"The key parts kits"
- *So small fits in 'ur palm!
- *Easiest basics around!
- *Requires approx. 6 more parts.

KIT NO. 5030 — 6 functions. Includes mini case, with lens, HP nine digit readouts with multiplex pc board, main pc board, mini keyboard (with two switches, percent and constant), ac adapter jack, 2- SN75491 drivers, CT5030 calculator chip with diagram. 8-Digits. □ $16.95

KIT NO. 5031 — 4 function, same as 5030 except uses CT5031 chip. 8-Digits. □ $16.95

KIT NO. 5736 — 4 function, like 5031. Uses National MM5736 6-Digits. □ $12.95

ACOUSTIC RESEARCH AR-2 MID-AND-HIGH RANGE SPEAKER

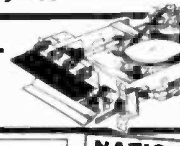
One of the finest and well-built mid-range (1200 cycles) to high range (14000 cycles) "tweeter" speakers on the market today. Built by the finest . . . ACOUSTIC RESEARCH! Used in their expensive multi-speaker high fidelity systems. Size: 4½ x ¼". Use it with any system 60 watts up for beste efficiency (it's excellent with our own models). Has metal grille, expoxied over protective cone material. Ceramic magnet With mtg. holes. Wt. 2 lbs.

SALE □ **$4.95**

- High Compliance
- 1200 to 14000 cycles

8-Track tape transport with complete stereo play-back system less audio amplifier. Operates off 12 VDC Wow & flutter proof. Use 739 preamp & ready to go. Uses 8-track tape. Wt. 3-lbs.

8-TRACK CAR RADIO STEREO
TAPE TRANSPORT FOR HOME USE □ $16.95



Low Prices On Calculator CHIPS

□ CT 5001	12-Digits, 40 pin	$3.95	3 for $9.
□ CT 5002	9-Volt version of 5001	3.95	3 for $9
□ CT 5005	12-Digits, 28-pin, with 3-function memory	3.95	3 for $9
□ CT 5030	4-Function with %	6.50	3 for $18.
□ CT 5031	4-Function Only	6.50	3 for $18.
□ TMS-0128	4-Function by Texas	3.50	3 for $9
□ MM 5725	8-Digits, 4-funct. LED	3.50	3 for $9.
□ MM 5736	6-Digits, 28-pin, 9V	3.50	3 for $9
□ MM 5738	8-Digits, memory	6.50	3 for $8

NATIONAL LM-340T VR's
- TO-220 Case • 1 Amp
- POSITIVE VOLTAGE

$1.75 Each Buy 3 — Take 10%

Type	Volts
□ LM-340-05T	5 v
□ LM-340-06T	6 v
□ LM-340-08T	8 v
□ LM-340-12T	12 v
□ LM-340-15T	15 v
□ LM-340-18T	18 v
□ LM-340-24T	24 v

"MEMORY LANE"

Buy Any 3 — Take 10%

□ 2513	Character Generator	$12.50
□ 1101	256 Bit RAM MOS	$1.50
□ 1103	1024 Bit RAM MOS	4.50
□ 7489	64 Bit RAM TTL	2.95
□ 8223	Programmable ROM	4.50
□ MM5220	Pre-Programmable ROM	2.95
□ MM5260	1024 Bit RAM	6.50
□ MM5262	2048 Bit RAM	9.95
□ MM5203	Eraceable PROM	24.50

"C" MOS IC'S

Type	Sale	Type	Sale	Type	Sale
□ CD4000AE	$.53	□ CD4020AE	3.19	□ CD4044AE	2.75
□ CD4001AE	.53	□ CD4021AE	3.45	□ CD4047AE	3.45
□ CD4002AE	.53	□ CD4022AE	3.45	□ CD4049AE	.95
□ CD4006AE	3.50	□ CD4023AE	.53	□ CD4050AE	.95
□ CD4007AE	.53	□ CD4024AE	1.85	□ CD4051AE	3.50
□ CD4008AE	3.25	□ CD4025AE	.53	□ CD4052AE	3.50
□ CD4009AE	.75	□ CD4026AE	6.95	□ CD4053AE	3.50
□ CD4010AE	.53	□ CD4027AE	1.17	□ CD4060AE	4.50
□ CD4011AE	.51	□ CD4028AE	2.61	□ CD4066AE	2.71
□ CD4012AE	.53	□ CD4029AE	4.25	□ CD4069AE	.57
□ CD4013AE	.95	□ CD4030AE	.85	□ CD4071AE	.57
□ CD4014AE	3.19	□ CD4033AE	3.25	□ CD4072AE	.57
□ CD4015AE	3.50	□ CD4034AE	9.95	□ CD4073AE	.57
□ CD4016AE	.90	□ CD4035AE	2.65	□ CD4075AE	.57
□ CD4017AE	2.50	□ CD4040AE	4.10	□ CD4082AE	.57
□ CD4018AE	2.50	□ CD4041AE	1.15	□ CD4518AE	2.95
□ CD4019AE	1.10	□ CD4042AE	2.75	□ CD4520AE	2.95
		□ CD4043AE	2.75		

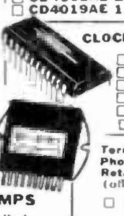
'BEEPER" AND "DATER' CLOCK ON THE CHIPS

□ MK50250 BEEPER $ 8.50

Imagine a chip (MK50250) "Beepin" and audible alarm! All others are external. It also features internal brightness control. The CT7001 requires external triggering of alarm, date of the month and direct drive to LED readouts. Both require minimum current drain and voltages, for either 4 to 6 LED readouts. 12 or 24 hours. AM and PM.

□ CT7001 Alarm and Date $6.95

CLOCK CHIPS ON A "DIP" WITH DATA SHEETS



□ MM5311	6-digit	28-Pin	$5.50
□ MM5312	4-digit	24-Pin	5.50
□ MM5313	6-digit	28-Pin	5.50
□ MM5314	6-digit	24-Pin	5.50
□ MM5316	4-digit	40-Pin, alarm	5.50
□ MM5316-A	no alarm		2.95

Sanken	Watts	Sale
SI-1010G	10	$ 8.88
SI-1020G	20	14.95
SI-1030G	30	18.88
SI-1050G	50	29.95

SANKEN HYBRID AUDIO POWER AMPS

All amplifiers, flat within ½ db from hz to 100,000. Each unit properly heat-sinked, with heavy-duty connecting tie lug connections. Single-ended pushpull output. Power supply required 24VDC. Output to 8 ohms. Order by Stock No.

Terms: add postage Rated: net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

□ 20c CATALOG on Fiber Optics, 'ICs', Semi's, Parts
MINIMUM ORDER — $4.00

POLY PAKS
P.O. BOX 942R, LYNNFIELD, MASS. 01940

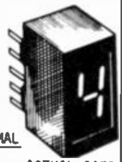
Circle 87 on reader service card

2102-2 MOS 1024 BIT MEMORY

FULLY DECODED STATIC RANDOM ACCESS MEMORY
DIRECTLY TTL COMPATIBLE INPUTS AND OUTPUT
SINGLE 5V SUPPLY - - NO CLOCKS OR REFRESH
NEW

$6.95 EA. (DIP) 8 FOR $49.95

Numeric Display
¼" Single Digit
GaAsP LED



COMMON CATHODE WITH RH DECIMAL

ACTUAL SIZE

Compact–10 digits in 3" panel width
Highly legible– bright red 1/4" character easily read within 10 feet over a wide viewing angle
125 mW per digit at typical brightness

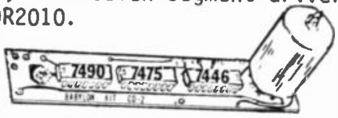
SUPER SPECIAL $.75
TEN for $5.95

SPECIAL
8223
PROM

8 BIT
32 WORD
MEMORY
$3.00 EA.
10 - $29
WE PROGRAM
FOR $5 EACH

CD-2 COUNTER KIT

Unit includes board, 7490, 7475, quad latch, 7447 seven-segment driver, and RCA DR2010.



COMPLETE KIT only $11.95; FULLY-ASSEMBLED $15.00; boards can be supplied separately at $2.50 per digit.

RCA 2010

Numitron Digital Display Tube, incandescent 5-volt 7-segment:
.6" High numeral visible from 30 ft
Standard 9-pin base (solderable)
Left-hand decimal point
EACH $5.00 5 FOR $20.00

CMOS

		CD4016	1.00
CD4000	$.55	CD4019	1.00
CD4001	.45	CD4023	.45
CD4002	.45	CD4024	1.60
CD4007	1.00	CD4025	.45
CD4008	3.25	CD4027	1.00
CD4009	.75	CD4030	1.00
CD4010	.75	74C20	.65
CD4011	.45	74C42	2.00
CD4012	.45	74C157	2.50
CD4013	1.00	74C161	3.00
CD4015	3.00	74C195	2.00

TRANSISTOR SPECIAL

2N3568-HEP736
TO92 PLASTIC
NPN 300MW
60V 40-120B
EACH $.15
TEN 1.00
100 9.00
1000 80.00

NEW-TELEDYNE MARKED T3568

POTTER BRUMFIELD

Type KHP Relay
4 PDT 3A Contacts
24 VDC (650 coil) $1.50 EA.
120 VAC (10.5 MA coil) $1.75 EA.

TTL DIP

7400	.20
74H00	.25
7401	.20
74H01	.25
7402	.25
7403	.25
7404	.25
74H04	.30
7405	.30
7406	.40
7408	.30
7400	.20
7410	.20
7413	.75
7417	.40
7420	.20
74L20	.30
74H20	.30
74H22	.30
7430	.20
74H30	.30
74L30	.30
7440	.20
74H40	.30
7442	1.00
7447	1.50
7450	.20
74H50	.30
7451	.20
74H51	.25
7453	.20
7454	.20
74L54	.25
74L55	.25
7460	.16
74L71	.25
7472	.40
74L72	.60
7473	.35
74L73	.75
7474	.45
74H74	.75
7475	.80
7476	.55
74L78	.70
7480	.50
7483	.70
7489	3.00
7490	1.00
7492	.65
7493	1.00
7495	.65
74L95	1.00
74107	.50
74145	1.25
74180	1.00
74193	1.50
74195	.80

SEND FOR FREE FLYER!

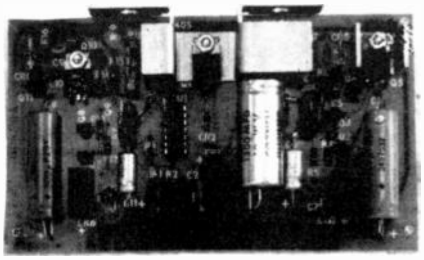
C.O.D. PHONE ORDERS ACCEPTED--$10 MINIMUM

All IC's new and fully tested, leads plated with gold or solder. Orders for $5.00 or more are shipped prepaid, smaller orders--add 55¢. California residents add Sales Tax......IC's shipped within 24 hours.

BABYLON ELECTRONICS
P.O. BOX 41727
SACRAMENTO, CA
95841 . . . .
916 334 2161

Circle 88 on reader service card

TRIPLE REGULATOR BOARD

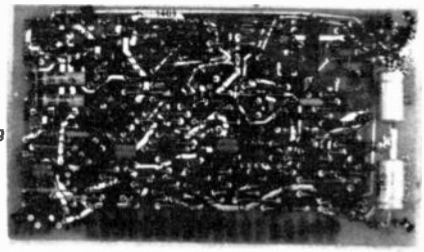


This board has 3 regulators, ±12 volts @ 200 ma., and a tracking regulator, 0 to 5 volts @ 500 ma. Regulation is 0.5% for all regulators. We supply circuit diagram and data sheet
5¾"x3¼"

STOCK NO.R9013 Triple voltage regulator, $5.95 ea. 2/10.00

SOPHISTICATED PARTS BOARD

This board is loaded with exotic parts. 6 741 op amps., 4 dipped tantalum caps., multi turn trimpot, 20 transistors, including complimentary 2N3904 &2N3906, plus about 100 ¼ watt resistors, diodes and zeners.



STOCK NO.R9327 Sophisticated parts board $2.00 ea. 3/5.00

POWER TRANSFORMERS

90V @ 2A.ct., 6.3V@ 1.5A	8½lb.	Stk. R9315	9.95	2/19.00
70V @ 1.5A ct., 6V @ .5A	5½lb.	Stk.R9314	6.50	2/12.00
36V @ 1A.ct., 6.3V @ .2A	3Lb.	Stk.R9313	3.50	2/6.00

Enclose sufficient postage. Excess will be refunded. Send for our new catalog 14. 64 pages of electronic bargains.

DELTA ELECTRONICS CO.
BOX 1, LYNN, MASSACHUSETTS 01903
Phone (617) 388-4705

Circle 89 on reader service card

LIQUID CRYSTAL CALCULATOR
$10.00

Rejects and require repairs but most easily repaired. Desk top models. We furnish 32 page instruction and trouble shooting. 8 digit 4 function. Two models available.
AC model #SP102A
$10 each; 3 for $26.50
Btry. model #SP102B
$11 each; 3 for $30.00

PANAPLEX 12 DIGIT DISPLAY

12 digit neon (180 volts) display. Genuine Burroughs Panaplex II cold cathode gas discharge 7 segments. Unused and we include the special socket. Measures 3⅝ x ⅞ (pic shown is full size). Data sheet included. Good for clocks, timers, counters, any type of digital readout use. Readability at 15 feet.
#PANAPLEX $6.00

HI-VOLTAGE (NEON) DRIVER PACKAGE

Package of 3 IC units for interfacing of high voltage neon type displays with low voltage calculator chips. This set of three IC's consists of Cathode Driver IC, Anode Driver IC, and Level Shifter IC. We include data for use. Good with Panaplex displays, Sperry displays, Anaplex displays, etc. From what we can see, no one seems to have them and this is the first time offered at surplus prices. They are first line devices, surplus due to a manufacturer of keyboard displays going out of business.
#OION $6.00

MOS ASCII ENCODER CHIP

With all the interest in keyboard encoders, TV readouts, etc. this single chip ASCII encoder should be welcome news. And the price...unbelievable at $9.95. 40 pin DIP, made by MOS Technology. Data sheets enclosed with each order.
#SP-105 $9.95; 3 for $25

Please add shipping cost on above.

Meshna
P.O. Box 62
SURPLUS ELECTRONIC MATERIAL
19 ALLERTON ST., E. LYNN, MASS. 01904

Circle 90 on reader service card

LISTEN TO

Spectacular

4-Channel Sound!

Latest High-Quality Quadraphonic Performance with the Vista SQ-3 Decoder

EXCLUSIVE CBS LICENSED CIRCUITY, SUPERB RESPONSE AND CHANNEL SEPARATION

FULL LOGIC, WAVE MATCHING AND VARIABLE BLEND

KIT SQ-3
$55.00

ALL NECESSARY PARTS EXCEPT CASE AND +20V 75mA POWER SUPPLY

Shipped prepaid in USA *NY State add Tax*
$2.00 additional for CANADA

PHOTOLUME CORPORATION
118 East 28th STREET, New York, N.Y. 10016

Circle 91 on reader service card

SEVERAL hundred tubes, receiving & misc. types, new and used. Write **CHRIS HAYES**, Box 650, St. Michaels, AZ 86511

SURPRISE! Build inexpensively, the most unusual test instruments, futuristic gadgets using numerical readouts! Catalogue free! **GBS**, Box 100B, Greenbank, WV 24944

NEW Canadian Magazine, "Electronics Workshop", $5.00 yearly, sample $1.00. **ETHCO**, Box 741 "A", Montreal

TV Dot C.H. Generator

3 pencells power this TTL module. Produces 2 patterns to antenna (RF) & guar. lyr. Delivery from stock Postpaid
Model 43A Modnle shown 29.95
Model 42 Kit of above 24.95
Model 44 In cabinet 39.95

Litek Inc. 2143-1 Wyandotte St Mt View CA 94043

BUILD YOUR OWN TV CAMERA!
— Ideal for home & business —

THE ECONOMICAL ANSWER TO HOME MONITORING OF NURSERIES, ENTRANCES, DRIVEWAYS...BUSINESS and INDUSTRIAL SURVEILLANCE...ITV...AMATEUR TV PLUS HUNDREDS OF OTHER APPLICATIONS. MODEL XT-1A, SERIES D - KIT FORM $185; ASSEMBLED $275. SOLID-STATE. WORKS ON ANY TV SET. OPTIONAL SOUND KIT $28.95.
PHONE or WRITE for catalog. Dial 402-987-3771

BOX 453-RE **ATV Research** DAKOTA CITY, NE 68731

DIGITAL/analog multimeters, logic probes—guaranteed lowest prices. Free catalog. **ELECTRO INDUSTRIES**, 4201 Irving Park, Chicago, IL 60641

FREE giant bargain electronic catalog listing thousands of components, tubes, transistors, IC's, kits, test equipment. **EDLIE'S** 2700-RB Hempstead Tpke., Levittown, NY 11756

DIGITAL electronics! Complete schematics, parts lists, theories—Discrete Component Digital Clock, $3.00. Increase technical competence, hobby skills—Complete course in Digital Electronics is highly effective, $10.00. Free literature. **DYNASIGN**, Box 60R2, Wayland, MA 01778

JUNE SPECIALS
Japanese Transistors

ALL TRANSISTORS ORIGINAL FACTORY MADE

2SA12	$ .50	2SB187	$ .55	2SC732	$ .70
2SA15	.55	2SB303	.55	2SC733	.70
2SA102	.60	*2SB324	.80	2SC734	.70
2SA221	.50	*2SB337	1.95	2SC735	.65
2SA234	.70	2SB367	1.55	2SC799	4.50
2SA341	.90	2SB370	1.00	*2SC828	.70
2SA342	.95	2SB400	.65	2SC828A	.75
2SA350	.70	*2SB405	.90	*2SC829	.70
2SA435	1.05	*2SB415	.95	2SC830	1.80
2SA440A	.80	2SB439	.85	2SC859	.60
2SA545	1.05	2SB463	1.60	2SC945	.50
2SA546	2.95	2SB473	1.60	2SC959	1.75
2SA564A	.70	*2SB474	1.60	2SC960	2.05
2SA606	2.15	2SB475	.65	2SC1000	.75
2SA607	2.20	2SB481	1.85	*2SC1030	3.05
*2SA634	1.35	*2SB492	1.15	2SC1060	1.65
2SA636	1.75	2SC281	.70	2SC1061	1.65
2SA640	.65	2SC367	1.10	*2SC1096	1.10
2SA641	.60	2SC369	1.05	2SC1098	1.10
*2SA643	.85	2SC371	.65	2SC1173	1.20
2SA670	1.75	2SC372	.65	*2SC1226A	1.25
2SA671	1.75	2SC373	.65	2SC1237	1.85
*2SA683	.80	2SC374	.65	2SC1306	5.50
*2SA699A	1.40	2SC381	.65	2SC1307	6.50
2SB22	.60	2SC394	.70	2SC1318	.75
2SB54	.60	2SC454	.65	2SC1377	6.50
2SB56	.60	*2SC458	.60	*2SC1383	.70
2SB73	.65	*2SC460	.60	2SC1384	.70
2SB75	.65	2SC461	.70	2SD24	1.70
2SB77	.65	2SC491	2.25	*2SD72	.95
2SB156	.80	2SC535	.80	2SD77	1.00
2SB171	.50	*2SC536	.60	2SD178	1.75
2SB172	.50	*2SC537	.60	2SD186	.70
2SB173	.50	2SC644	.60	2SD218	4.15
2SB175	.50	2SC693	.70	2SD234	1.50
2SB178	.90	2SC694	.65	2SD235	1.25
2SB185	.55	*2SC710	.60	*2SD261	.75
2SB186	.55	*2SC711	.60	2SK19	1.95

- Transistor Kit TR24 $22.10
  Kit Contains 24 *Mark Transistors. You Save 10%.

ALL TRANSISTORS 100% TESTED. ORDERS LESS THAN $5.00 ADD 40c; $5.01 to $10.00 ADD 50c—OTHERS POSTPAID. CALIF. RESIDENTS PLEASE ADD SALES TAX.

Write for Free Catalog—Over 500 Types Available

SEND ORDER AND MAKE CHECK OR MONEY ORDER TO:

West Pacific Electronics
P.O. BOX 25837
W. LOS ANGELES, CALIF. 90025

Circle 92 on reader service card

JUNE INVENTORY SPECIAL!

Replacement Semiconductors

MOTOROLA

HEP No.		HEP No.	
1	.89	233	4 20
2	1.25	234	3.25
3	1.25	235	4.50
50	79	236	5.70
51	1.29	237	9.75
52	.95	238	4 70
53	1.15	239	6.50
54	1.08	244	2 15
55	1 20	248	6.49
56	1.44	250	.79
57	1.20	253	1.20
75	2.95	553	4.10
76	4 95	554	2 70
101	95	556	3.87
102	1.20	558	4.39
103	1.20	570	2 10
104	1.20	571	2 10
105	1.20	600	1 11
134	.26	601	1 11
151	1.90	602	1 84
156	.41	603	1 84
160	.75	604	1 84
165	.62	605	1.84
166	.60	606	1 84
170	.82	607	1 84
176	2.05	608	1.84
177	2.25	609	2 49
178	3.05	610	2.49
231	1.99	611	2.49
232	2.34	623	2.20

GENERAL ELECTRIC

G.E No		G.E No	
1	1 20	54	3 00
2	1 02	55	3 05
3	1 78	56	4 25
4	2.94	57	1 95
5	1 68	58	2 20
6	1 83	59	1 26
7	1 77	60	1 20
8	1 29	61	1 32
9	1 26	62	81
10	1 20	63	1 80
11	1.53	64	96
12	2.34	66	2 49
13MP	3 56	67	1 80
14	3 51	69	2 76
15MP	7 02	72	4 15
16	3 15	73	11 00
17	1 42	74	8 10
18	1 46	75	7 20
19	3 06		
20	1 10		
21	1 12		
22	1 03		
23	2 52		
24MP	5 04		
25	7 50		
26	3 10		
27	2 18		
28	2 15		
29	2 40		
30	2 20		
31MP	4.40		
32	2.79		
35	7.95		
36	10 75		
37	8 10		
38	12 00		
50	1 29		
51	1 14		
52	1 02		
53	1 02		

International Rectifier

CD05F	80
CD07F	90
CD09F	1 00
CY-1F	2 55
CY-2F	3 35
E-075L-C	81
E-150L-C	1 00
E-150L-F	1 00
E-500L-F	1.61
EX39-X	5 34
EX42-X	3 33
EX46-X	6 15
EX62-X	3 33
EX76-X	54
EX85B-X	1 65
EX89-X	1 62
EX215-X	5 85
EX499-X	84
TR23-C	2 90
TR30-C	1 80
TR53-C	1 05
TR57-C	2 75
TR59-C	3.35
TR65-C	4.00
TR67-C	11 30
Z1012-C	50
Z1106-C	85
Z1306-C	2 05
Z1312-C	2 05
Z1314-C	2 05
Z1318-C	2.05
Z1322-C	2 05
Z1328-C	2.05
Z1334-C	2.05
Z3305-C	3 50
Z3314-C	3.50
Z3320-C	3 50
Z3325-C	3 50

RCA

SK3003	99
SK3004	1 14
SK3005	1.17
SK3006	1 41
SK3007	1 26
SK3008	1.23
SK3009	2 34
SK3010	1 26
SK3012	2 88
SK3015	6 30
SK3019	1 47
SK3020	1 32
SK3021	1 95
SK3025	2 70
SK3026	1 80
SK3027	3 15
SK3050	3 78
SK3052	2 35
SK3053	4 68
SK3067	3 15
SK3078	7 00
SK3079	4.95
SK3082	2 34
SK3083	2 52
SK3084	2.88

20% off on Replacement orders of 25.00 or more. Above is partial list of current stock available at drastic reductions. Send for complete list!

ALL PARTS GUARANTEED AND TESTED ON PREMISES.
WRITE FOR FREE CATALOG AND LG. QUANTITY DISCOUNTS.

TRANSISTOR SPECIALS
Power Units Similar to Jedec Nos. Hardware Included.

2N441	To-36	2 1 00
2N458A	To 3	4 1 00
2N538	Mt-36	3 1 00
2N1015	Mt-1	1 00
2N1725	To-61	2 1 50
2N2288	To-3	2 1 00
2N3054	To-66	5 1 00
2N3055	To 3	4 1 00
2N5002	To-59	3 2 00
2N5296 Tip31	To-220	7 1 00

OEM SPECIALS

	METAL	EPOXY		METAL	EPOXY
2N718	27	15	2N2222A	35	22
2N918	55	25	2N2369	18	13
2N930	25	18	2N2484	75	35
2N1420	25	15	2N2904	50	20
2N1613	65	30	2N2905	50	20
2N1711	65	30	2N2905A	85	35
2N2218	50	22	2N2906	40	20
2N2219	50	22	2N2907	40	20
2N2219A	75	30	2N3053	20	16
2N2221	25	17	2N3251	75	35
2N2222	23	17	2N4036	75	35

Motorola MK-20 Power Transistor Mounting Kit .75

Integrated Circuits

UA703C	40
CA3066	4 00
CA3068	6 50
MC1305	1 50

Replacement for Zenith 221-36 221-37 221 39 3 50

World's Smallest Transistor! Now Available! Limited Time Only!
Case Size 04 x 04 x 03 in PNP 3 00 NPN 3 00

Transistor Grab Bag - Germanium and Silicon small sigs and power transistors 95% yield 30 1 00

Prime 10 watt Zeners, anode and cathode case, up to 180 volts, Do 4 1.75

CITIZEN BAND APPLICATION
NPN Silicon 27 MH Band RF Power Transistors

2SC781	3 25
2SC799	4 75
2SC1306	5 75
2SC1307	6 75
2SC517	4 75
MRF8004	3 00
2SC1678	5 75
2SC1679	5 75
2SC1449	3 50
2SC773	65

POWER TRANSISTORS
High Voltage TV Transistors

BU204	1300v	4 00
BU205	1500v	4 75
BU206	1700v	5 80
BU207	1300v	5 50
BU208	1500v	6 75
BU209	1700v	8 25
2SC1170	1100v	4 00
2SC1172B	1100v	4 50
2SC1308	1100v	5 00
2SD350	1100v	6 00

RECTIFIERS

	10	100
1N4001	90	7 00
1N4002	1 00	8 00
1N4003	1 10	9 00
1N4004	1 20	10 00
1N4005	1 30	11 00
1N4006	1 40	12 00
1N4007	1 50	13 00

12 Line Cords 2 25 ea

Experimenter-Hobbyist Parts

GE-X1	2.60	GE-X11	1.80
GE-X2A	2.80	GE-X12	4.50
GE-X3	4.00	GE-X13	1.60
GE-X4	1.60	GE-X14	1.15
GE-X5	2.30	GE-X15	5.50
GE-X6	1 40	GE-X16	3.45
GE-X8	70	GE-X17	1.20
GE-X9	70	GE-X18	1 50
GE-X10	1.35	GE-X19	1 10

SILICON UNIJUNCTIONS

2N2646	To-18	50
2N2647	To-18	65
2N6027 PUT	To-92	55
2N6028 PUT	To-92	75
2N1671	To-5	1 00
D5E37	To-18	4 1 00

BRIDGES

PRV	2 AMP	PRV	2 AMP
200	95	600	1 25
400	1 10	1000	1 75

CMOS

SS4001AE	55	SS4025AE	55
SS4002AE	65	SS4027AE	1 35
SS4011AE	55	SS4028AE	2 80
SS4012AE	55	SS4030AE	65
SS4013AE	1 30	SS4049AE	1 35
SS4015AE	3 00	SS4050AE	1 35
SS4023AE	55		

CHECK OR MONEY ORDER
NO CODS INCLUDE 10% FOR POSTAGE AND HANDLING
MINIMUM ORDER 5 00

New-Tone Electronics
P.O. BOX 1738 A
BLOOMFIELD, N.J. 07003 • 201-762-9020

Circle 93 on reader service card

Circle 94 on reader service card

Circle 95 on reader service card

Circle 96 on reader service card

INTERNATIONAL ELECTRONICS UNLIMITED

10% Off on orders over $25.00
15% Off on orders over $100.00
20% Off on orders over $250.00

TTL

7400	$ .19	7450	$ .24	74151	$ .89
7401	.19	7451	.27	74153	1.29
7402	.19	7453	.27	74154	1.25
7403	.19	7454	.29	74155	1.19
7404	.22	7460	.19	74156	1.29
7405	.22	7464	.39	74157	1.29
7406	.39	7465	.39	74160	1.58
7407	.39	7470	.49	74161	1.39
7408	.25	7472	.36	74163	1.59
7409	.25	7473	.39	74164	1.89
7410	.19	7474	.39	74165	1.89
7411	.29	7475	.40	74166	1.65
7413	.49	7476	1.11	74170	2.95
7415	.39	7483	1.11	74173	1.65
7416	.39	7485	1.10	74174	1.80
7417	.39	7486	.44	74175	1.85
7420	.19	7489	2.75	74176	.85
7422	.29	7490	.69	74177	.85
7423	.32	7491	1.00	74180	1.00
7425	.27	7492	.79	74181	3.65
7426	.29	7493	.79	74182	.89
7427	.32	7494	.89	74184	2.30
7430	.22	7495	.89	74185	2.19
7432	.26	7496	.89	74187	5.95
7437	.39	74100	1.50	74190	1.50
7438	.39	74105	.49	74191	1.50
7440	.19	74107	.49	74192	1.25
7441	1.09	74121	.47	74193	1.25
7442	.89	74122	.47	74194	1.39
7443	.89	74123	.99	74195	.99
7444	.89	74125	.60	74196	1.25
7445	.99	74126	.79	74197	.99
7446	.99	74141	1.15	74198	2.19
7447	.89	74145	1.15	74199	2.19
7448	1.15	74150	.95	74200	7.95

LOW POWER TTL

74L00	$ .25	74L51	$ .29	74L90	$1.49
74L02	.25	74L55	.33	74L91	1.45
74L03	.25	74L71	.25	74L93	1.69
74L04	.25	74L72	.39	74L95	1.69
74L06	.25	74L73	.49	74L98	2.79
74L10	.25	74L74	.49	74L164	2.79
74L20	.33	74L78	.79	74L165	2.79
74L30	.33	74L85	1.25		
74L42	1.49	74L86	.69		

HIGH SPEED TTL

74H00	$ .25	74H21	$ .25	74H55	$ .25
74H01	.25	74H22	.25	74H60	.25
74H04	.25	74H30	.25	74H61	.25
74H08	.25	74H40	.25	74H62	.25
74H10	.25	74H50	.25	74H72	.39
74H11	.25	74H52	.25	74H74	.39
74H20	.25	74H53	.25	74H76	.49

8000 SERIES TTL

8091	.59	8214	1.69	8811	.69
8092	.59	8220	1.69	8812	1.10
8095	1.39	8230	2.59	8822	2.59
8121	.89	8520	1.29	8830	2.59
8123	1.59	8551	1.65	8831	2.59
8130	2.19	8552	2.49	8836	.29
8200	2.59	8554	2.49	8880	1.33
8210	3.49	8810	.79		

9000 SERIES TTL

9002	.39	9309	.89	9601	.99
9301	1.14	9312	.89	9602	.89

Data sheets supplied on request
Add $.50 ea. for items less than $1.00

JUNE SPECIALS

SPECIAL PURCHASE LED DISPLAY MAN 3M

$.25 ea. 5/$1.00 8/$1.50

NINE DIGIT LED ARRAY

FAIRCHILD 37 .2" DIGITS
with clear magnifying lens .... **$5.95 ea.**

NINE DIGIT SPERRY GAS DISCHARGE DISPLAY

HI VOLTAGE .... $1.99 ea.

8038 FUNCTION GENERATOR

Voltage Controlled Oscillator Sine, Square, Triangular Output 16 Pin Dip **$4.95**

POCKET CALCULATOR KIT

5 function plus constant — addressable memory with individual recall — 8 digit display plus overflow — battery saver — uses standard or rechargeable batteries — all necessary parts in ready to assemble form — instructions included. 3" x 5¼" **$24.95**
ASSEMBLED **$29.95**

2101 MEMORY

1024 bit N-chan. Static Ram **$5.95**

5262 MEMORY

2048 bit Ram **$5.95**

MEMORIES

1101	256 bit RAM MOS	$1.75
1103	1024 bit RAM MOS	3.95
2101	1024 bit static RAM	6.95
5203	2048 bit UV eras PROM	19.95
5260	1024 bit RAM	2.95
5261	1024 bit RAM	2.95
5262	2048 bit RAM	7.95
7489	64 bit ROM TTL	2.75
8223	Programmable ROM	3.95
74200	256 bit RAM tri-state	7.95

CALCULATOR & CLOCK CHIPS

5001	12 DIG 4 funct fix dec	3.95
5002	Same as 5001 exc btry pwr	4.95
5005	12 DIG 4 funct w/mem	5.95
MM5725	8 DIG 4 funct chain & dec	2.25
MM5736	18 pin 6 DIG 4 funct	4.95
MM5738	8 DIG 5 funct K & Mem	5.95
MM5739	9 DIG 4 funct (btry sur)	5.95
MM5311	28 pin BCD 6 dig mux	4.95
MM5312	24 pin 1 pps BCD 4 dig mux	4.45
MM5313	28 pin 1 pps BCD 6 dig mux	4.95
MM5314	24 pin 6 dig mux	4.95
MM5316	40 pin alarm 4 dig	5.95

LED's

MV10B	Red TO 18	$ .25
MV50	Axial leads	.20
MV5020	Jumbo Vis. Red (Red Dome)	.25
	Jumbo Vis. Red (Clear Dome)	.25
ME4	Infra red diff. dome	.60
MAN1	Red 7 seg. .270"	2.50
MAN2	Red alpha num .32"	4.95
MAN4	Red 7 seg. .190"	2.15
MAN5	Green 7 seg. .270"	2.95
MAN6	.6" high solid seg.	4.95
MAN7	Red 7 seg. .270"	1.35
MAN8	Yellow 7 seg. .270"	3.95
MAN64	.4" high solid seg.	3.50
MAN66	.6" high spaced seg.	4.65
DL707	Red 7 seg. .3"	2.15
MCT2	Opto-iso transistor	.69

SHIFT REGISTERS

MM 5013	1024 bit accum. dynamic	mDIP	$1.95
MM 5016	500/512 bit dynamic	mDIP	1.75
MM 5058	1024 bit static	DIP	3.95
SL 5-4025	Dual 64 bit static	DIP	1.50

LINEAR CIRCUITS

300	Pos V Reg (super 723)	TO-5	$ .79
301	Hi Perf Op Amp	mDIP TO-5	.32
302	Volt follower	TO-5	.59
304	Neg V Reg	TO-5	.89
305	Pos V Reg	TO-5	.79
307	Op AMP (super 741)	mDIP TO-5	.29
308	Micro Pwr Op Amp	mDIP TO-5	.99
309K	5V 1A regulator	TO-3	1.50
310	V Follower Op Amp	TO-5 mDIP	1.19
311	Hi perf V Comp	mDIP TO-5	1.05
319	Hi Speed Dual Comp	DIP	1.29
320	Neg Reg 5.2, 12, 15	TO-3	1.25
322	Precision Timer	DIP	1.15
324	Quad Op Amp	DIP	1.89
339	Quad Comparator	DIP	1.69
340T	Pos Volt Reg (5V-6V 8V-12V-15V-18V-24V)	TO-220	1.75
370	AGC/Squelch AMPL	TO-5 or DIP	1.15
372	AF-IF Strip detector	DIP	.79
373	AM/FM/SSB Strip	DIP	3.25
376	Pos. V. Reg	mDIP	.59
377	2w Stereo amp	DIP	2.69
380	2w Audio Amp	DIP	1.29
380-8	.6w Audio Amp	mDIP	1.25
381	Lo Noise Dual preamp	DIP	1.69
382	Lo Noise Dual preamp	DIP	1.69
550	Prec V Reg	DIP	.79
555	Timer	mDIP	.99
560	Phase Locked Loop	DIP	2.75
562	Phase Locked Loop	DIP	2.75
565	Phase Locked Loop	DIP TO-5	2.65
566	Function Gen	mDIP TO-5	2.50
567	Tone Decoder	mDIP	2.95
709	Operational AMPL	TO-5 or DIP	.29
710	Hi Speed Volt Comp	DIP	.39
711	Dual Difference Compar	DIP	.29
723	V Reg	DIP	.69
739	Dual Hi Perf Op Amp	DIP	1.19
741	Comp Op AMP	mDIP TO-5	.35
747	Dual 741 Op Amp	DIP or TO-5	.79
748	Freq Adj 741	mDIP	.39
1304	FM Mulpx Stereo Demod	DIP	1.19
1307	FM Mulpx Stereo Demod	DIP	.82
1458	Dual Comp Op Amp	mDIP	.69
1800	Stereo multiplexer	DIP	2.75
LH2111	Dual LM 211 V Comp	DIP	1.89
3065	TV-FM Sound System	DIP	.69
3075	FM Det-LMTR & Audio preamp	DIP	.79
3900	Quad Amplifier	DIP	.39
7524	Core Mem Sense AMPL	DIP	.79
7534	Core Mem Sense Amp	DIP	.79
8864	9 DIG Led Cath Drvr	DIP	2.50
75451	Dual Perepheral Driver	mDIP	.39
75452	Dual Peripheral Driver	mDIP	.39
75453	(351) Dual Perlph. Driver	mDIP	.39
75491	Quad Seq Driver for LED	DIP	.79
75492	Hex Digit Driver	DIP	.89
MCT2	OPTO-ISO TRANS	mDIP	.69

CMOS

4000 AE	$ .40	4019 AE	$2.10	4066 AE	$1.05	4014 AE	2.10	4049 AE	.90	4528 AE	1.60
4001 AE	.40	4020 AE	2.20	4068 AE	.40	4015 AE	2.10	4050 AE	.90	4585 AE	2.40
4002 AE	.40	4021 AE	2.05	4069 AE	.40	74C00	$ .24	74C74	$1.15	74C162	3.25
4006 AE	1.75	4023 AE	.40	4071 AE	.40	74C02	.29	74C76	1.49	74C163	2.95
4007 AE	.40	4024 AE	1.45	4072 AE	.40	74C04	.49	74C107	1.25	74C164	2.95
4008 AE	2.45	4025 AE	.40	4073 AE	.40	74C08	.75	74C151	2.90	74C173	2.90
4009 AE	.80	4027 AE	1.20	4075 AE	.40	74C10	.39	74C154	3.50	74C195	2.95
4010 AE	.80	4028 AE	1.75	4078 AE	.40	74C20	.39	74C157	1.95	80C95	1.50
4011 AE	.40	4030 AE	.85	4081 AE	.40	74C42	1.79	74C160	2.75	80C97	1.25
4013 AE	.80	4042 AE	1.90	4082 AE	.40	74C73	1.15	74C161	3.25		

DTL

930	$ .17	937	$ .17	949	$ .17
932	.17	944	.17	962	.17
936	.17	946	.17	963	.17

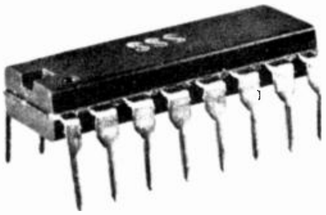
Shipment will be made via first class mail — postage paid in U.S., Canada and Mexico — within three days from receipt of order. Minimum order — $5.00. California residents add sales tax.

master charge — THE INTERBANK CARD
Your BANKAMERICARD welcome here

INTERNATIONAL ELECTRONICS UNLIMITED

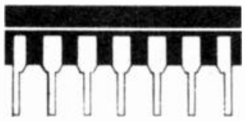
P.O. BOX 1708 / MONTEREY, CA. 93940 USA
PHONE (408) 659-3171

C/MOS



CD4000AE	$ .29	CD4033AE	$3.95
4001AE	.29	4035AE	1.85
4002AE	.29	4040AE	2.45
4006AE	2.50	4041AE	1.90
4007AE	.29	4042AE	1.90
4008AE	1.98	4043AE	1.50
4009AE	.59	4044AE	1.50
4010AE	.59	4049AE	.79
4011AE	.29	4050AE	.79
4012AE	.29	4051AE	2.98
4013AE	.69	4052AE	2.98
4014AE	1.98	4053AE	2.98
4015AE	1.98	4055AE	2.75
4016AE	.69	4056AE	2.50
4017AE	1.75	4060AE	3.25
4018AE	1.98	4066AE	1.75
4019AE	.69	4069AE	.45
4020AE	1.98	4071AE	.45
4021AE	1.98	4076AE	2.85
4022AE	1.70	4081AE	.45
4023AE	.29	4507AE	1.35
4024AE	1.50	4510AE	2.95
4025AE	.34	4511AE	2.95
4026AE	3.95	4512AE	3.25
4027AE	.85	4516AE	2.70
4028AE	1.65	4518AE	3.10
4029AE	2.90	4520AE	3.10
4030AE	.65	4528AE	2.50

TTL



SN7400	$ .16	SN7447	$ .99	SN74116	$1.98	SN74173	$1.45
7401	.16	7448	.99	74118	1.35	74174	1.39
7402	.16	7450	.16	74120	1.40	74175	1.30
7403	.16	7451	.17	74121	.49	74176	1.20
7404	.19	7453	.17	74122	.48	74177	1.20
7405	.19	7454	.17	74123	.85	74178	1.98
7406	.35	7460	.17	74125	.59	74179	1.98
7407	.35	7470	.29	74126	.59	74180	.95
7408	.19	7472	.29	74128	.95	74181	2.98
7409	.19	7473	.36	74132	1.75	74182	.74
7410	.16	7474	.36	74136	.75	74184	1.98
7411	.25	7475	.59	74141	1.10	74185	1.98
7412	.30	7476	.39	74142	3.98	74186	14.95
7413	.59	7480	.52	74143	4.50	74188	5.90
7414	1.65	7481	.99	74144	4.50	74190	1.40
7416	.34	7482	.89	74145	1.05	74191	1.40
7417	.34	7484	1.95	74147	2.50	74192	1.25
7420	.16	7483A	1.25	74148	2.25	74193	1.25
7421	.45	7485	1.25	74150	.98	74194	1.20
7423	.29	7486	.37	74151	.75	74195	.85
7425	.29	7489	2.45	74153	.90	74196	1.80
7426	.25	7490	.59	74154	1.35	74197	.90
7427	.29	7491	1.10	74155	.95	74198	1.75
7428	.40	7492	.59	74156	.95	74199	1.75
7430	.16	7493	.59	74157	.95	74251	1.40
7432	.25	7494	.95	74159	3.98	74265	.95
7433	.49	7495	.79	74160	1.35	74278	2.70
7437	.34	7496	.79	74161	1.25	74279	.99
7438	.34	74100	1.40	74162	1.35	74283	1.95
7440	.16	74104	.44	74163	1.35	74284	6.98
7442	.70	74105	.44	74164	1.50	74285	6.98
7443	1.25	74107	.44	74165	1.50	74290	.95
7444	1.25	74109	.75	74166	1.50	74293	.89
7445	.89	74110	.55	74170	2.30	74298	2.25
7446	1.15	74111	.75	74172	9.80	74948	1.75

DTL

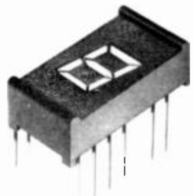
DTL930N	$ .29
932N	.29
933N	.29
935N	.39
936N	.35
937N	.35
944N	.29
945N	.45
946N	.29
949N	.29
951N	.99
952N/SN158099N	.58
953N/SN158093N	.58
955N/SN158097N	.58
956N/SN158094N	.58
958N	.29
961N	.29
962N	.29
963N	.29

I.C. SOCKETS

8 PIN DIL	$ .19
14 PIN DIL	.23
16 PIN DIL	.27
24 PIN DIL	.68

ALL NEW CURRENT PRODUCTION MATERIAL FROM THE MAJOR MANUFACTURERS

LED's & OPTO-ISOLATORS



DL707	$1.98
DL747	2.45
ILCA2-30	2.50
RL2	.25
TIL209	.19
TIL111	1.25

LINEAR I.C.'s

LM300H (metal can)	$ .75
LM301AH (metal can)	.55
LM304H (metal can)	.85
LM305H (metal can)	.85
LM307H (metal can)	.29
LM307 (mini dip)	.29
LM309H (metal can)	1.00
LM309K (TO-3)	1.45
LM310H (metal can)	1.25
NE555V (mini dip)	.68
LM723CH (metal can)	.90
LM741CH (metal can)	.29
LM741 (mini dip)	.29
LM747CH (metal can)	.65
LM1458H (dual 741)	.65
LM3046N	.90

PLASTIC TRANSISTORS

2N3702	$ .17	2N3905	$ .15
2N3703	.17	2N3906	.15
2N3704	.17	2N4058	.17
2N3705	.17	2N4059	.17
2N3706	.17	2N4060	.17
2N3707	.17	2N4061	.17
2N3708	.17	2N4062	.17
2N3709	.17	2N4123	.15
2N3710	.17	2N4124	.15
2N3711	.17	2N4125	.15
2N3819	.29	2N4126	.15
2N3820	.35	2N5447	.16
2N3903	.15	2N5449	.16
2N3904	.15	TIS43	.39

SCR's

C106B1	$ .55	2N5063	$ .32
C106D1	.85	2N5064	.34
2N5060	.26	TIC45	.34
2N5061	.28	TIC47	.38
2N5062	.30		

PLASTIC POWER TRANSISTORS

TIP29A	$ .45	TIP41A	$ .65
TIP30A	.49	TIP42A	.75
TIP31A	.52	TIP2955	.89
TIP32A	.55	TIP3055	.85

Active Electronic Sales Corp.

P.O. BOX 1035 FRAMINGHAM, MASSACHUSETTS 01701

Telephone Orders (617) 879-0077

MINIMUM ORDER $10.00 ADD $1.00 TO COVER POSTAGE & HANDLING

Circle 98 on reader service card

LINEAR INTEGRATED CIRCUITS

		1-24	25-99	100 up
GENERAL PURPOSE AMPLIFIERS				
SL201B	GP amplifier	4.01	3 51	3 01
SL201C	GP amplifier	1 87	1 64	1 40
MATCHED NPN TRANSISTORS				
SL301A	Matched pair	2 72	2 46	1 40
SL301B	Matched pair	2 30	2 01	1 72
SL303A	Matched triplet	5 47	4 78	4 09
SL303B	Matched triplet	3 93	3 43	2 93
SL305B	Dual matched pairs	7 37	6 44	5 52
SL312B	Matched pair w/tail	2 85	2 56	2 27
SL354B	Matched quad	4 22	3 70	3 17
SL360C	2 5GHz matched pr	10 93	9 56	8 18
SL362C	2 5GHz low noise pr	16 26	14 20	12 14
SL3045C	Transistor array	2 77	2 43	2 09
SL3145C	2 5GHz trans array	14 78	12 94	11 09
AUDIO CIRCUITS				
SL414A	3W audio amplifier	4 22	3 70	3 17
SL415A	5W audio amplifier	5.49	4 81	4 12
POWER CONTROL CIRCUITS				
SL440	Power control circuit	5 49	4 81	4 12
TRANSISTOR ARRAYS				
SL3046	Five transistor array	1 85	1 61	1 37
LINEAR RF AMPLIFIERS				
SL501A	RF amplifier	19 25	16 84	14 44
SL501B	RF amplifier	5 91	5 17	4 44
SL502A	RF amplifier	14 55	13 04	11 54
SL502B	RF amplifier	3 88	3 49	3 09
SL503A	RF amplifier	16 50	14 78	13 07
SL503B	RF amplifier	4 12	3 70	3 27
SL551A	RF amplifier	18 82	16 87	14 92
SL551B	RF amplifier	5 89	5 28	4 67
SL552A	RF amplifier	18 82	16 87	14 92
SL552B	RF amplifier	5 89	5 28	4 67
SL553A	RF amplifier	21 09	18 90	16 71
SL553B	RF amplifier	6 28	5 62	4 96
SL510C	RF det & video amp	25 34	22 18	19 00
SL511C	RF det & video amp	25 34	22 18	19 00
LIMITING WIDEBAND AMPLIFIERS				
SL521A	Limiting RF amp	27 72	24 26	20 80
SL521B	Limiting RF amp	17 58	15 58	13 57
SL521C	Limiting RF amp	10 59	9 27	7 95
SL571A	Limiting RF amp	37 80	33 08	28 35
SL571B	Limiting RF amp	23 39	20 46	17 53
SL571C	Limiting RF amp	17 48	15 29	13 09
SL525C	Wideband amplifier	5 80	5 20	4.60
SL530C	Logarithmic amp	17 58	15 58	13 57
SL550C	200MHz widebd amp	26 19	21 81	18 16
SL1030C	200MHz widebd amp	29 57	25 87	22 18
RADIO COMMUNICATIONS CIRCUITS				
SL610C	RF amplifier	4 07	3 56	3 06
SL611C	RF amplifier	4 07	3 56	3 06
SL612C	IF amplifier	4 07	3 56	3.06
SL613C	Limiting amp/det	8 66	7 58	6 49
SL620C	VOGAD	6 15	5 39	4 62
SL621C	AGC generator	6 15	5 39	4 62
SL622C	AF amp/VOGAD sidetone amplifier	15 21	13 31	11 41

PLESSEY SEMICONDUCTORS

		1-24	25-99	100 up
SL623C	AM det /AGC amp,/ SSB demod	11 19	9 79	8 40
SL624C	Multimode det AF amp	5 70	5 00	4 28
SL630C	AF amplifier	3 85	3 38	2 90
SL640C	Dbl bal modulator	7 55	6 60	5 65
SL641C	Receiver mixer	7 55	6 60	5 65
SL645C	Square law device	7 55	6 60	5 65
SL650B	Mod /phase loc loop	10 86	9 31	7 76
SL650C	Mod /phase loc loop	6 80	5 83	4 86
SL6518	Mod /phase loc loop	12 06	10 34	8 62
SL651C	Mod /phase loc loop	7 56	6 84	5 40
OPERATIONAL AMPLIFIERS				
SL701B	Op amplifier	7 13	6 23	5 39
SL701C	Op amplifier	3 56	3 12	2 67
SL702B	Op amplifier	7 13	6 23	5 39
SL702C	Op amplifier	3 56	3 12	2 67
SL717A	Dual comparator	10 35	9 06	7 76
SL717C	Dual comparator	6 57	5 76	4 94
SL751B	Op amplifier	8 37	7 50	6 63
SL751C	Op amplifier	4 81	4 30	3 80
TELECOMMUNICATIONS CIRCUIT				
SL1001A	Linear mod/demod	3 22	2 83	2 43
SL1001B	Linear mod/demod	3 22	2 83	2 43
SL1020A	Lin amp remote DC control	7 15	6 26	5 36
TELEVISION CIRCUITS				
SAA570	Limit IF amp/FM det	4 22	4 22	3 30
SAA661	Limit IF amp/FM det	4 73	4 73	3 70
SAA700	Signal processor	10 14	10 14	7 92
SBA550	Signal processor	10 14	10 14	7 92
SBA750	Limit IF amp/FM det	4 73	4 73	3 70
SL432	Limit IF amp/FM det	4 73	4 73	3 70
SL437C	IF & AGC for PNP tuners	13 52	13 52	10 56
SL437D	IF & AGC for NPN tuners	13 52	13 52	10 56
SL442	Switch mode power supply control	9 24	7 92	6 60
SL450	Power sup & Syn sep	11 09	9 50	7 92
SL456A	TV IF system	7 39	6 34	5 28
SL456B	TV IF system	7 39	6 34	5 28
SL457A	TV IF system	7 39	6 34	5 28
SL457B	TV IF system	7 39	6 34	5 28
SL901	Color demodulator	10 14	10 14	7 92
SL917	Color decoder	13 52	13 52	10 56

DIGITAL INTEGRATED CIRCUITS

	Description	1-24	25-99	100 up
PROCESS CONTROL CIRCUITS				
SP520	Gray code counter	13 94	12 49	11 04
SP521	Binary rate multip	13 94	12 49	11 04
SP522	Phase loc,div & com	13 94	12 49	11 04
PECL II – SP1000 SERIES				
SP1004B	Dual 4 I/P OR/NOR gate	1 71	1 48	1 25
SP1005B	Dual 4 I/P OR/NOR gate	1 71	1 48	1 25
SP1006B	Dual 4 I/P OR/NOR gate	1 71	1 48	1 25
SP1007B	Triple 3 I/P NOR gate	1 71	1 48	1 25
SP1008B	Triple 3 I/P NOR gate	1 71	1 48	1 25
SP1009B	Triple 3 I/P NOR gate	1 71	1 48	1 25
SP1010B	Quad 2 I/P NOR gate	1 71	1 48	1 25
SP1011B	Quad 2 I/P NOR gate	1 71	1 48	1 25
SP1012B	Quad 2 I/P NOR gate	1 71	1 48	1 25
SP1023B	Dual 4 I/P clock driv	2 80	2 40	2 00
SP1039B	PECL to sat logic trans	6 07	5 20	4.33
SP1204B	Dual 4 I/P OR/NOR gate	2 17	1 86	1 55
SP1205B	Dual 4 I/P OR/NOR gate	2 17	1 86	1 55
SP1206B	Dual 4 I/P OR/NOR gate	2 17	1 86	1 55
SP1207B	Triple 3 I/P NOR gate	2 17	1 86	1 55
SP1208B	Triple 3 I/P NOR gate	2 17	1.86	1.55
SP1209B	Triple 3 I/P NOR gate	2 17	1 86	1.55
SP1211B	Quad 2 I/P NOR gate	2 17	1 86	1.55
SP1223B	Quad 4 I/P clock driv	3 50	3 00	2 50
SP1239B	PECL to sat logic trans	7 60	6 51	5 42
PECL III – SP1600 SERIES				
SP1660B	Dual 4 I/P gate Hi Z	15 00	12 00	10 00
SP1662B	Quad 2 I/P NOR gate Hi Z	16 50	13 20	11 00
SP1664B	Quad 2 I/P OR gate Hi Z	16 50	13 20	11 00
SP1670B	Single D F/F Hi Z	27 00	21 60	18 00
SP8000 SERIES HIGH SPEED DIVIDERS				
SP8600A	÷ 4 at 250MHz	25 20	21 60	18 00
SP8600B	÷ 4 at 250MHz	11 06	9 48	7 90
SP8601A	÷ 4 at 150MHz	15 96	13 68	11 40
SP8601B	÷ 4 at 150MHz	10 08	8 64	7 20
SP8602A	÷ 2 at 500MHz	95 00	81 43	67 86
SP8602B	÷ 2 at 500MHz	26 82	22 99	19 16
SP8603A	÷ 2 at 400MHz	71 68	61 44	51 20
SP8603B	÷ 2 at 400MHz	20 29	13 39	14 49
SP8604A	÷ 2 at 300MHz	34 58	29 64	24 70
SP8604B	÷ 2 at 300MHz	15 40	13 20	11 00
SP8607B	÷ 2 at 600MHz	40 99	35 14	29 28
SP8613B	÷ 4 at 700MHz	49 00	42 00	35 00
SP8614B	÷ 4 at 800MHz	56 00	48 00	40 00
SP8615B	÷ 4 at 900MHz	67 20	57 60	48 00
SP8616B	÷ 4 at 1GHz	81 20	69 60	58.00
SP8616D	÷ 4 at 950MHz	74 20	63 60	53 00
SP8620B	÷ 5 at 400MHz	45 92	39 36	32 80
SP8621B	÷ 5 at 300MHz	31 78	27 24	22 70
SP8622B	÷ 5 at 200MHz	25 13	21 54	17 95
SP8630B	÷ 10 at 600MHz	69 82	59 84	49.87
SP8630D	÷ 10 at 550MHz	58 83	50 40	42 00
SP8631B	÷ 10 at 500MHz	53 20	45 60	38 00
SP8632B	÷ 10 at 400MHz	42 00	36 00	30 00
SP8634B	÷ 10 (BCD) at 700MHz	81 20	69 60	58.00
SP8635B	÷ 10 (BCD) at 600MHz	70.00	60 00	50.00
SP8636B	÷ 10 (BCD) at 500MHz	60 20	51 60	43 00
SP8637B	÷ 10 (BCD) at 400MHz	50 40	43 20	36.00
SP8640A	÷ 10/11 (ECL) at 200MHz	28 00	24 00	20 00
SP8640B	÷ 10/11 (ECL) at 200MHz	12 99	11 14	9 28
SP8641A	÷ 10/11 (ECL) at 250MHz	32 20	27 60	23 00
SP8641B	÷ 10/11 (ECL) at 250MHz	19 04	16 32	13 60
SP8642A	÷ 10/11 (ECL) at 300MHz	58 80	50 40	42 00
SP8642B	÷ 10/11 (ECL) at 300MHz	25 20	21 60	18 00
SP8643B	÷ 10/11 (ECL) at 350MHz	35 00	30 00	25 00
SP8650B	÷ 16 at 600MHz	70 00	60 00	50.00
SP8651B	÷ 16 at 500MHz	53 20	45 60	38 00
SP8652B	÷ 16 at 400MHz	42 00	36 00	30.00
SP8655A	÷ 32 at 100MHz	63 00	54 00	45.00
SP8655B	÷ 32 at 100MHz	21 00	18 00	15 00
SP8657A	÷ 20 at 100MHz	63 00	54 00	45 00
SP8657B	÷ 20 at 100MHz	21 00	18 00	15 00
SP8659A	÷ 16 at 100MHz	53 20	45 60	38 00
SP8659B	÷ 16 at 100MHz	18 90	16 20	13 50
SP8665B	÷ 10 at 1 0GHz	98 00	84 00	70 00
SP8666B	÷ 10 at 1 1GHz	107 80	92 40	77 00
SP8667B	÷ 10 at 1 2GHz	119 00	102 00	85 00
SP8670B	÷ 8 at 600MHz	63 00	54 00	45 00
SP8671B	÷ 8 at 500MHz	49 00	42 00	35 00
SP8672B	÷ 8 at 400MHz	37 80	32 40	27 00
SP8685A	÷ 10/11 at 500MHz	116 20	99 60	83.00
SP8685B	÷ 10/11 at 500MHz	35 00	30 00	25 00
SP8690A	÷ 10/11 at 100MHz	63 00	54 00	45 00
SP8690B	÷ 10/11 at 100MHz	19 60	16 80	14 00
MNOS NON-VOLATILE MEMORY ELEMENTS				
NOM201C	Single MNOS trans	4 44	3.80	3 17
NOM202C	MNOS transistor pr	7 39	6 34	5 28
NOM204C	Quad MNOS trans	12 94	11 09	9.24
NOM401C	8x8 MNOS array	33.26	28.51	23 76
INTERFACE CIRCUITS				
SP701A	MOS analog switch drv	14 15	12 38	10.61
SP701B	MOS analog switch drv	10 56	9 24	7 92
SP702A	MOS logic driver	14 15	12 38	10 61
SP702B	MOS logic driver	10 56	9 24	7 92
SP703A	MOS logic & clock driv	14 15	12.38	10 61
SP703A	MOS logic & clock driv	18 32	16.03	13 73
SP703B	MOS logic & clock driv	10 56	9 24	7 92
SP703B	MOS logic & clock driv	14 78	12 94	11 09
SP704A	MOS logic & clock driv	14 15	12 38	10 61
SP704A	MOS logic & clock driv	18 32	16 03	13 73
SP704B	MOS logic & clock driv	10 56	9 24	7 92
SP704B	MOS logic & clock driv	14 78	12 94	11 09
SP721B	Balanced line driver	8 26	7 23	6 20
SP721B	Balanced line driver	12 67	11 09	9.50
SP722B	TTL driver	8 26	7 23	6 20
SP722B	TTL driver	12 67	11 09	9 50
SP723B	TTL driver	9 40	8 24	7.05
SP723B	TTL driver	13 73	12 01	10 30
SP724B	Dual TTL driver	11 83	10.35	8 87
SP724B	Dual TTL driver	16 47	14 41	12 36
SP740B	Current comparator	30 41	26 61	22.81
SP740B	Current comparator	37 83	33 11	28 38
SP741B	Current comparator	30 41	26.61	22.81
SP741B	Current comparator	37 83	33 11	28 38
SP751A	MOS analog switch drv	18 32	16 03	13 73
SP751B	MOS analog switch drv	14 78	12 94	11 09

EXAR ICs

		1-9	10 up	100 up
XR 100K	XR chip cust IC des kit	$80 00	$80 00	$80 00
XR B101	NPN trans array, sm sig	3 50	3 50	3 50
XR B102	PNP array	3 50	3 50	3 50
XR C101	NPN array, sm sig	3 50	3 50	3 50
XR C102	PNP array, lat & subs	3 50	3 50	3 50
XR C103	NPN array, pwr & schottky	3 50	3 50	3 50
XR C104	Diffused resistor array	3 50	3 50	3 50
XR C105	Diffused & pinch resis array	3 50	3 50	3 50
XR C106	Bal mod & NPN,PNP cur source	3 50	3 50	3 50
XR S200	Multifunction IC	28 00	23 00	21 00
XR 205	Waveform gen IC	8 40	7 35	6 30
XR 205K	Waveform gen kit	25 00	25 00	25 00
XR 210	FSK mod demod	5 20	4 55	3 90
XR 210M	FSK mod demod	10 40	9 10	7 80
XR 215	Gen purpose PLL	6 56	5 74	4 92
XR 320	Timing circuit	1 52	1 33	1 14
XR 555CP	Timing circuit	1 07	94	80
XR 556M	Dual timing circuit	10 56	9 24	7 92
XR 556CN	Dual timing circuit	2 88	2 52	2 16
XR 556CP	Dual timing circuit	1 82	1 60	1 37
XR 567M	Tone decoder	12 96	11 34	9 72
XR 567CN	Tone decoder	1 84	1 61	1 38
XR 567CP	Tone decoder	1 68	1 47	1 26
XR 1310P	Stereo demod	3 20	2 80	2 40
XR 1310EP	Stereo demod	3 20	2 80	2 40
XR 1468CN	±5V tracking VR	3 84	3 36	2 88
XR 1468CP	±5V tracking VR	2 54	2 23	1 91
XR 1488N	Quad line driver	5 76	5 04	4 32
XR 1488P	Quad line driver	5 20	4 55	3 90
XR 1489AN	Quad line rec	4 80	4 20	3 60
XR 1489AP	Quad line rec	4 32	3 78	3 24
XR 1568M	±15V track VR	14 32	12 53	10 74
XR 1568N	±15V track VR	7 20	6 30	5 40
XR 1800P	Stereo decoder	3 20	2 80	2 40
XR 2206N	Monolithic funct gen	$11 20	9 80	8 40
XR 2206P	Monolithic funct gen	10 24	8 96	7 68
XR 2206CN	Monolithic funct gen	6 16	5 39	4 62
XR 2206CP	Monolithic funct gen	5 12	4 48	3 84
XR 2207M	VCO	15 44	13 51	11 58
XR 2207N	VCO	7 76	6 79	5 82
XR 2207P	VCO	6 72	5 88	5 04
XR 2207CN	VCO	4 80	4 20	3 60
XR 2207CP	VCO	3 84	3.36	2 88
XR 2208M	Op multiplier	17 76	15 54	13 32
XR 2208N	Op multiplier	8 88	7 77	6 66
XR 2208P	Op multiplier	7 92	6 93	5 94
XR 2208CN	Op multiplier	5 60	4 90	4 20
XR 2208CP	Op multiplier	5 20	4 55	3 90
XR 2211CN	FSK demod /tone decoder	7 57	6 62	5.68
XR 2211CP	FSK demod /tone decoder	6 88	6 02	5 16
XR 2240M	Prog timer/ctr	19 52	17 08	14 64
XR 2240N	Prog timer/ctr	8 80	7 70	6 60
XR 2240P	Prog timer/ctr	7 20	6 30	5 40
XR 2240CN	Prog timer/ctr	6 24	5 46	4 68
XR 2240CP	Prog timer/ctr	4 80	4 20	3 60
XR 2556M	Dual 555 timer	10 56	9 24	7 92
XR 2556CN	Dual 555 timer	3 52	3 08	2 64
XR 2556CP	Dual 555 timer	3 20	2 80	2 40
XR 2567M	Dual 567 tone decoder	16 94	14 83	12 71
XR 2567CN	Dual 567 tone decoder	7 90	6 92	5 93
XR 2567CP	Dual 567 tone decoder	5 18	4 54	3 89

The Function Generator Kit features sine, triangle and square wave, THD 0 5% typ AM/FM capability

XR-2206KA FUNCTION GENERATOR KIT $18.95
Includes monolithic function generator IC, PC board, and assembly instruction manual

XR-2206KB FUNCTION GENERATOR KIT $28.95
Same as XR 2206KA above and includes external components for PC board

STANDARD MICROSYSTEMS

		1-9	10 up	100 up
COM2502	Universal asynchronous receiver transmitter	$13 20	$10 60	$ 8 80
COM2502P		8 00	6 85	5 95
COM2017		13 20	10 60	8 80
COM2017P		8 00	6 85	5 95
COM2502H		25 00	20 00	16 00
COM2017H		25 00	20 00	16 00
COM2601	Univ sync rec /trans	30 00	24 00	20 50
COM5016	Dual baud rate gen prog div	12 00	9 60	8 00
	Keyboard encoder ROM			
KR2376 ST	Keyboard encoder ROM	20 00	17 50	15 00
KR3600 ST	10 channel multiplexer	20 00	17 50	15 00
NMX5010	10 channel multiplexer	12 00	9 60	8 00
CAL1022	12 digit print cal sgl chip MOS/LSI circuit	60 00	52 00	45 00

ELECTRONIC ARRAYS

1024 BIT READ/WRITE RANDOM ACCESS MEMORY N-CHANNEL, SILICON GATE

	1-24	25 up	100 up
EA 1500AJ	$21 00	$16 80	$14 00
EA 1500ASJ	16 00	14 40	12 00

PREMIUM QUALITY TRANSISTORS

2N173	2 15	2N877	2 50	2N1921	3 00	2N2600	7 10
2N178	1.00	2N894	2.00	2N1924	1 30	2N2604	1 80
2N293	.60	2N918	.40	2N1934	9.40	2N2605	.50
2N293B	65	2N956	.40	2N1990	80	2N2646	70
2N321	.50	2N960	50	2N2060	2 10	2N2648	4 00
2N327A	1 40	2N962	50	2N2065A	1.80	2N2658	7 00
2N334	1 40	2N967	50	2N2080	5.00	2N2708	25
2N336	1 00	2N981	2 00	2N2081A	2 50	2N2712	30
2N338A	1.25	2N984	1 00	2N2100	3.00	2N2713	15
2N389	9 00	2N1015B	16.00	2N2102	50	2N2714	18
2N393	2.70	2N1016B	18.00	2N2148	70	2N2716	18
2N398B	1.00	2N1026	1 50	2N2192A	.66	2N2754	95 00
2N404	.20	2N1035	2.00	2N2193	45	2N2802	9 80
2N417	.50	2N1136	2.00	2N2193A	90	2N2808	9 00
2N420	1.20	2N1137A	2.00	2N2218	26	2N2833	4 00
2N424	9 00	2N1142	2.20	2N2218A	.30	2N2880	11.00
2N439	1 00	2N1143	2.00	2N2219	30	2N2890	4 60
2N443	1.15	2N1168	75	2N2219A	.38	2N2892	6 70
2N456	1 30	2N1204	1.50	2N2221	.25	2N2893	9 80
2N497	1 40	2N1234	15 00	2N2221A	26	2N2894	50
2N501A	4 00	2N1302	.30	2N2222	24	2N2895	1 00
2N508A	40	2N1305	.35	2N2222A	.30	2N2903	4 00
2N512B	2 90	2N1377	1 50	2N2259	1 10	2N2904	30
2N555	50	2N1404	50	2N2270	.40	2N2904A	36
2N586	1 00	2N1408	60	2N2289	3 70	2N2905	32
2N594	1.50	2N1420	50	2N2290	6 00	2N2905A	34
2N630	3 50	2N1483	1.20	2N2297	1.00	2N2906	18
2N652A	1 00	2N1485	1.60	2N2322	1 80	2N2906A	20
2N677C	5 50	2N1523	5 00	2N2323	1 90	2N2907	.20
2N681	2.00	2N1534	1 00	2N2324	2 40	2N2907A	30
2N682	2.50	2N1540	1.10	2N2325	2 60	2N2913	90
2N683	2 70	2N1543	3 50	2N2326	3.40	2N2914	1 40
2N685	3.40	2N1544	.90	2N2327	4.60	2N2916A	4 05
2N686	4.00	2N1549	1.35	2N2328	5.00	2N2925	20
2N689	7.00	2N1551	4.00	2N2329	7.00	2N2926	15
2N697	.25	2N1552	4 00	2N2356	6.00	2N2947	14.50
2N700	4.00	2N1554	2.00	2N2356A	7.00	2N2949	6 00
2N705	.60	2N1557	1 70	2N2359	16.00	2N2950	6.50
2N706	.20	2N1560	3.30	2N2368	30	2N2969	31 00
2N706B	.40	2N1595	1.50	2N2369	.20		
2N711	40	2N1596	1 60	2N2382	4 50		
2N711B	60	2N1597	2.20	2N2440	3.50		
2N718A	30	2N1598	2.00	2N2453	3.00		
2N720A	50	2N1599	2.30	2N2465	7.50		
2N741	1.50	2N1605	45	2N2475	.60		
2N744	.35	2N1613	.50	2N2476	80		
2N759	1.00	2N1671	2.00	2N2484	.25		
2N759A	1.00	2N1693	15.00	2N2511	1 50		
2N760	.50	2N1711	.50	2N2518	6 00		
2N760A	1.70	2N1715	.70	2N2526	4.50		
2N829	3.00	2N1720	5.00	2N2527	5.50		
2N834	.35	2N1899	69.00	2N2537	1.30		
2N859	5.00	2N1907	5.00	2N2538	2.50		

2N3019	1 50	2N3502	1 40	2N3693	.21
2N3022	18.00	2N3503	1 60	2N3694	.22
2N3053	35	2N3506	7 50	2N3702	18
2N3054	80	2N3544	4 00	2N3705	25
2N3055	.95	2N3548	2 80	2N3707	17
2N3060	3.00	2N3549	3.00	2N3710	20
2N3066A	1 20	2N3553	1.80	2N3711	18
2N3070	1 30	2N3563	15	2N3725	.36
2N3107	80	2N3564	14	2N3730	1 50
2N3109	.75	2N3565	18	2N3731	2.00
2N3117	1.00	2N3567	.19	2N3740	1.20
2N3130	5.00	2N3568	.30	2N3763	5 00
2N3133	80	2N3569	17	2N3771	2 20
2N3202	16.00	2N3584	1 80	2N3772	2 30
2N3209	90	2N3599	38 00	2N3773	2.40
2N3227	2.40	2N3614	1 10	2N3789	3.00
2N3239	3.00	2N3616	1.25	2N3793	25
2N3247	3 90	2N3617	2.50	2N3796	3 00
2N3250	.50	2N3634	8.00	2N3799	3.20
2N3371	4.00	2N3638	.18	2N3805	10.50
2N3375	5.50	2N3642	19	2N3807	4.80
2N3390	50	2N3643	14	2N3819	30
2N3393	.20	2N3645	15	2N3823	70
2N3398	25	2N3646	10	2N3843	30
2N3442	2 20	2N3656	8 60	2N3856	25
2N3445	5.00	2N3657	9.00	2N3865	7 00
2N3467	1.50	2N3680	6.00	2N3866	1 10
2N3468	1.90	2N3684	1.25	2N3903	.20
2N3500	4 00	2N3685A	1.50	2N3904	22
2N3501	6.50	2N3692	.20	2N3905	.20

2N3906	22	2N4303	30	2N4890	.90	2N5407	29 00
2N3909	80	2N4341	1 35	2N4898	1 10	2N5409	32 00
2N3924	3 50	2N4347	1.60	2N4905	2 00	2N5414	6 50
2N3925	4.80	2N4348	2.00	2N4922	1 00	2N5449	.25
2N3945	.90	2N4352	2.00	2N5016	12.80	2N5453	5 40
2N3954	5 00	2N4356	30	2N5036	1 18	2N5457	40
2N3954A	5 50	2N4395	1 30	2N5061	32	2N5458	40
2N3955	2.70	2N4399	6 40	2N5064	48	2N5467	32.00
2N3955A	3 20	2N4400	30	2N5086	30	2N5562	12.50
2N3957	1 60	2N4401	32	2N5088	40	2N5563	9 00
2N3958	1 40	2N4402	34	2N5089	46	2N5636	13 50
2N3964	1 10	2N4403	40	2N5105	3 10	2N5637	27.00
2N3971	1 00	2N4416	90	2N5127	16	2N5655	.85
2N3972	1.40	2N4429	6.00	2N5130	20	2N5657	1 20
2N4012	10.50	2N4430	8 60	2N5133	16	2N5679	1 40
2N4037	70	2N4441	95	2N5138	16	2N5742	41.00
2N4045	1.95	2N4442	1 10	2N5154	7 10	2N5778	55
2N4093	1 05	2N4443	1 40	2N5157	9 90	2N5923	12.80
2N4120	3 90	2N4852	80	2N5198	4 30	2N6027	50
2N4124	.20	2N4858	1 10	2N5202	2.20	2N6028	.65
2N4126	26	2N4859	1 20	2N5294	.70	2N6076	.20
2N4141	26	2N4863	5 50	2N5306	27	2N6099	95
2N4142	17	2N4870	60	2N5354	30	2N6101	85
2N4143	16	2N4878	3.90	2N5369	.25	2N6103	.90
2N4208	2 05			2N5397	2 90	2N6155	1.50
2N4220A	1 00						
2N4225	3 80						
2N4226	3.95						
2N4227	.35						
2N4228	50						
2N4234	1 50						
2N4235	1 90						
2N4248	17						
2N4249	18						
2N4250	22						
2N4258	34						
2N4291	.35						
2N4293	50						

IF YOU DON'T SEE WHAT YOU NEED, LOOK FOR OUR ADDITIONAL FULL PAGE AD IN THIS ISSUE

FREE
"Store Opening Special"
Audio Amplifier
LM354A (2.80W)

Bring this coupon to our new electronic parts outlet for your Free Audio Amplifier. Limit one per coupon (Not redeemable by mail) Offer good until 7/1/75 Ancrona Corporation, 11080 Jefferson Blvd, Culver City, CA

MINIMUM ORDER $10.00
Add $1 00 to cover postage and handling
SEND CHECK OR MONEY ORDER (NO C.O.D.) TO:
California residents add 6% sales tax.

ANCRONA CORP.

P.O. BOX 2208R, Culver City, CA 90230

SPECIFICATIONS SHEETS $ 25 EACH

Circle 103 on reader service card

ADVERTISING INDEX

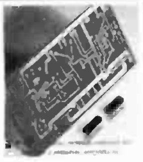
RADIO-ELECTRONICS does not assume responsibility for any errors which may appear in the index below.

MARKET CENTER

Circle 105 on reader service card

C-MOS

	1-9	10up
4000AE	.44	.38
4001AE	.44	.38
4002AE	.44	.38
4004AE	5.84	5.84
4006AE	3.49	3.29
4007AE	.44	.38
4008AE	2.89	2.69
4009AE	.44	.38
4010AE	.54	.53
4011AE	.47	.44
4012AE	.44	.38
4013AE	.44	.38
4014AE	2.79	2.49
4015AE	2.79	2.49
4016AE	.89	.74
4017AE	1.79	1.69
4018AE	2.79	2.59
4019AE	.84	.59
4020AE	2.79	2.59
4021AE	2.19	1.89
4022AE	1.79	1.59
4023AE	.47	.44
4024AE	1.59	1.39
4025AE	.44	.31
4026AE	8.39	7.89
4027AE	.89	.79
4028AE	1.69	1.49
4029AE	2.19	1.99
4030AE	.79	.59
4033AE	3.39	2.89
4035AE	1.99	1.79
4040AE	2.19	1.99
4041AE	1.19	.89
4042AE	1.19	.99
4043AE	1.19	.99
4044AE	1.19	.99
4047AE	3.09	2.99
4048AE	1.44	1.34
4049AE	.99	.79
4050AE	.99	.79
4051AE	3.34	2.89
4052AE	2.14	2.04
4053AE	2.89	2.79
4055AE	2.69	2.59
4056AE	3.44	3.40
4060AE	3.29	2.99
4066AE	1.19	.99
4069AE	.79	.69
4071AE	.44	.37
4076AE	1.69	1.49
4081AE	.44	.38
4510AE	1.99	1.79
4516AE	2.89	2.79
4518AE	3.29	2.99
4520AE	1.89	1.69
4901AE	.44	.37
4911AE	.44	.37



WAVEFORM GENERATOR

XR205K **KIT** Only $25.00

Here's a highly versatile lab instrument at a fraction of the cost of conventional unit. Kit includes two XR205 IC's, data & applications, PC board (etched & drilled, ready for assembly) and detailed instructions.

DUAL LOW NOISE OP AMP

LM331N:
V_{io} = 6mV
I_{io} = 1000 nA
I_b = 2000 nA
Noise = 1.5dB
$2.20

7400N TTL

7400N	$.14	7444N	$1.05	7496N	$.85	74161N	1.28
7401N	.17	7445N	1.04	74100N	1.30	74162N	1.50
7402N	.14	7446N	1.10	74104N	1.25	74163N	1.48
7403N	.17	7447N	1.00	74105N	.45	74164N	1.70
7404N	.20	7448N	1.00	74107N	.40	74165N	1.78
7405N	.20	7450N	.15	74109N	.92	74166N	1.50
7406N	.35	7451N	.20	74110N	.72	74170N	2.60
7407N	.45	7453N	.20	74111N	.92	74173N	1.55
7408N	.18	7454N	.26	74114N	.92	74174N	1.20
7409N	.23	7455N	.37	74115N	.92	74175N	1.60
7410N	.18	7460N	.25	74118N	1.51	74176N	1.30
7411N	.27	7462N	.37	74121N	.50	74177N	1.50
7412N	.52	7464N	.37	74122N	.50	74180N	1.05
7413N	.65	7465N	.37	74123N	.90	74181N	3.20
7414N	1.80	7470N	.30	74125N	.60	74182N	.75
7415N	.37	7471N	.49	74126N	.64	74184N	2.90
7416N	.36	7472N	.33	74128N	.95	74185N	2.29
7417N	.37	7473N	.38	74132N	1.80	74188N	4.90
7420N	.17	7474N	.35	74136N	.92	74190N	1.49
7421N	.60	7475N	.60	74140N	2.50	74191N	1.49
7422N	.27	7476N	.45	74141N	1.19	74192N	1.40
7423N	.48	7478N	.55	74145N	1.08	74193N	1.29
7425N	.34	7480N	.60	74147N	2.90	74194N	1.35
7426N	.27	7481N	1.19	74148N	2.20	74195N	.80
7427N	.31	7482N	.90	74150N	.99	74196N	1.90
7428N	.52	7483N	.80	74151N	.84	74197N	.80
7430N	.22	7484N	3.02	74152N	1.50	74198N	2.00
7432N	.27	7485N	2.50	74153N	1.05	74199N	2.09
7433N	.62	7486N	.40	74154N	1.48	74200N	5.90
7437N	.36	7489N	2.40	74155N	1.08	74221N	1.75
7438N	.35	7490N	.60	74156N	1.18	74251N	1.75
7439N	.90	7491N	1.00	74157N	1.18	74278N	2.95
7440N	.16	7492N	.84	74158N	1.44	74279N	1.10
7441N	.95	7493N	.60	74160N	1.50	74293N	.95
7442N	.78	7494N	1.20			74298N	2.55
7443N	.95	7495N	.80				

DISPLAYS

OPCOA		
SLA1	Red	2.25
SLA11	Green	3.50
SLA21	Yellow	3.50
SLA7	Red	1.60
LITRONIX		
DL80	Red	6.00
DL81	Red	6.00
DL10	Red	6.00
DL10A	Red	4.00
DL101	Red	4.90
DL57	Red	9.90
DL61	Red	12.00
DL33	Red	4.00
DL44	Red	6.00
DL402	Red	4.00
DL701	Red	3.40
DL704	Red	2.25
DL707	Red	2.35
DL747	Red	3.50
XCITON		
XAN72	Red	2.00
XAN52	Green	2.00

EP 9125
9-DIGIT DISPLAY
$7.90

- 1/8" character height
- compact, thin PC package
- wide viewing angle

OPTOISOLATORS

MONSANTO	
MCT2	1.35
LITRONIX	
IL1	1.30
IL12	1.40
IL16	1.80
IL74	1.35
ILD74	1.75
ILQ74	3.40

LEDs

.125" dia.		
209	Red	$.25
209	Yellow	.35
209	Green	.35
.160" dia.		
216	Red	.25
216	Yellow	.30
216	Green	.30
.200" dia.		
220	Red	.25
220	Yellow	.30
220	Green	.30
LOW PROFILE		
226	Red	$.25
226	Yellow	.30
226	Green	.30
226	Orange	.30
5053	Red	.35
5053	Yellow	.40
5053	Green	.40
5053	Orange	.40

216 = MV5024
5053 = MV5053

MV50 Red $.30

CALCULATORS (Limited Qty.) $19.00

1024-BIT N-Channel RAM

2601-1	11.40
2601-21	11.40
2602B	8.00
2602-1B	8.00
2602-2B	8.00
MK4102P	11.40
7552-1CPE	8.00
7552-2CPE	8.00

74LS

		74LS76	.92
74LS00	.58	74LS78	.92
74LS01	.58	74LS107	.92
74LS02	.58	74LS109	.92
74LS03	.58	74LS112	.92
74LS04	.63	74LS113	.92
74LS05	.63	74LS114	.92
74LS08	.58	74LS138	2.38
74LS09	.58	74LS139	2.38
74LS10	.58	74LS151	2.10
74LS11	.58	74LS153	2.38
74LS15	.58	74LS157	2.10
74LS20	.58	74LS158	2.40
74LS21	.58	74LS160	2.70
74LS22	.58	74LS161	2.70
74LS27	.64	74LS170	5.92
74LS30	.58	74LS174	3.02
74LS32	.64	74LS175	2.90
74LS51	.58	74LS181	3.72
74LS54	.58	74LS251	2.55
74LS55	.58	74LS253	3.05
74LS73	.92	74LS260	.58
74LS74	.92		

9300 SERIES

9300PC	1.00
9301PC	1.20
9304PC	1.50
9306PC	6.90
9308PC	2.50
9309PC	1.60
9310PC	1.50
9311PC	2.30
9312PC	1.20
9314PC	1.30
9316PC	1.50
9318PC	2.30
9321PC	1.20
9322PC	1.30
9324PC	2.00
9328PC	2.50
9334PC	2.95
9338PC	3.30
9340PC	5.00
9341PC	4.10
9342PC	1.15
9360PC	1.75
9366PC	1.75

1-AMP RECTIFIERS

	10	100	1000
1N4001	1.00	7.00	60.00
1N4002	1.10	8.00	70.00
1N4003	1.20	9.00	80.00
1N4004	1.30	10.00	90.00
1N4005	1.40	11.00	100.00
1N4006	1.50	12.00	110.00
1N4007	1.60	13.00	120.00

PHASE-LOCKED LOOPS

LM567CM Mini-dip 1.80

DECODED READ/WRITE RAM

P1103 $6.20

PREMIUM QUALITY COMPONENTS

We've been buying and selling top quality components for nearly ten years. Our annual volume exceeds $3 million. We handle only original parts, from the world's leading manufacturers and our customers include some of the largest and most quality-conscious companies. Now you can take advantage of our component buying skills and power and select from a broad range of advanced circuits.

FIRST QUALITY ONLY

INTERFACE MODULES

CY1010	Instr. Amp., Bipolar Input	29.00
CY1011A	Instr. Amp., Bipolar Input	49.00
CY1020	Instr. Amp., FET Input	34.00
CY1021	Instr. Amp., FET Input	49.00
CY1021A	Instr. Amp., FET Input	59.00
CY2137	DAC, 10 Bit, Low Drift	39.00
CY2218	DAC, 12 Bit, 2 Quad Multiplying	149.00
CY2237	DAC, 12 Bit, Low Drift	69.00
CY2735	DAC, 4 Digit BCD, Low Cost	79.00
CY3035	ADC, 8 Bit, Sect. Counting, Low Cost	89.00
CY3635	ADC, 3 Digit BCD, Sect. Count, Low Cost	119.00

SCHOTTKY TTL

				74S158N	2.40
				74S160N	4.70
74S00N	.45	74S74N	1.30	74S161N	4.70
74S02N	.80	74S85N	6.10	74S174N	3.30
74S03N	.75	74S86N	2.70	74S175N	3.30
74S04N	.75	74S112N	2.20	74S181N	10.20
74S08N	.80	74S113N	1.50	74S189N	5.10
74S10N	.75	74S132N	3.60	74S194N	3.30
74S11N	.65	74S133N	.90	74S195N	3.30
74S20N	.80	74S138N	2.40	74S251N	2.40
74S30N	.80	74S139N	2.40	74S253N	2.40
74S32N	.80	74S140N	.90	74S257N	2.40
74S40N	.80	74S151N	2.40	74S258N	2.40
74S51N	.80	74S153N	2.40	74S260N	.90
74S64N	.80	74S157N	2.40	74S280N	5.70

LOW POWER TTL

74L00N	.34
74L02N	.34
74L03N	.39
74L04N	.39
74L10N	.34
74L20N	.39
74L42N	1.62
74L51N	.34
74L73N	.74
74L74N	.89
74L90N	1.62
74L93N	1.74
74L95N	1.62
93L00	1.50
93L01	1.60
93L08	3.20
93L09	1.80
93L10	2.80
93L11	4.20
93L12	1.80
93L14	1.70
93L16	3.20
93L18	3.50
93L21	1.50
93L22	1.80
93L24	2.80
93L28	3.70
93L34	4.00
93L38	4.20
93L40	6.50
93L41	6.50
93L60	3.00
93L66	2.70

HIGH SPEED TTL

74H00N	.34	74H53N	.36
74H01N	.34	74H54N	.36
74H04N	.38	74H55N	.36
74H05N	.37	74H60N	.36
74H08N	.40	74H61N	.36
74H10N	.36	74H62N	.36
74H11N	.36	74H71N	.80
74H20N	.36	74H72N	.74
74H21N	.36	74H73N	.90
74H22N	.36	74H74N	.87
74H30N	.36	74H76N	.90
74H40N	.36	74H101N	.80
74H50N	.36	74H102N	.80
74H51N	.36	74H103N	1.10
74H52N	.36	74H106N	.95

AUDIO AMPS

Type	V	W	Ω	Price
LM352	6-15	1.15	8	1.60
LM354A	6-27	2.80	8	2.50
TAA611B12	6-15	1.15	8	1.60
TAA621A12	6-27	1.40	8	2.00
TBA641B11	6-18	2.20	4	3.00
TBA800	5-30	4.70	8	2.20
TBA810AS	4-20	2.50	4	3.00
TBA820	3-16	0.75	4	1.70
TCA830	5-20	2.00	4	2.20
TCA940	6-24	6.50	8	4.40

IC SOCKETS

SOLDER - TIN	
8 pin DIL	.22
14 pin DIL	.26
16 pin DIL	.29
24 pin DIL	.75
28 pin DIL	1.10
36 pin DIL	1.70
40 pin DIL	1.90
WIRE WRAP-GOLD	
14 pin DIL	.40
16 pin DIL	.45
SOLDER - GOLD	
14 pin DIL	.35
16 pin DIL	.40
TEFLON	
3 pin TO-5	.55
4 pin TO-5	.65
6 pin TO-5	.90
8 pin TO-5	1.10
10 pin TO-5	1.40

75107

75107BN	2.60
75108BN	2.30
75109N	2.20
75110N	2.20
75115N	2.25
75138N	2.95
75150N	3.10
75154N	4.10
75208N	2.70
75234N	2.50
75450N	1.25
75451N	1.00
75452N	1.00
75453N	1.00

7520 SERIES SENSE AMPS

7520N	4.00
7521N	2.00
7522N	4.25
7523N	1.75
7524N	2.00
7525N	4.50

LINEAR ICs

H=TO5 N=DIP M=MINI-DIP D=CER-DIP K=TO3

LM114H	3.00	LM311H	1.70	LM711CN	.90
LM300H	1.20	LM311D	1.90	LM715CH	4.30
LM300N	1.20	LM311M	1.75	LM715CD	4.60
LM301AH	.90	LM311N	2.00	LM723CH	.90
LM301AM	.80	LM312H	2.70	LM723CN	.75
LM301AN	1.10	LM318H	2.60	LM725CH	5.00
LM301M	.90	LM324N	1.90	LM725CD	5.20
LM301H	.90	LM331N	2.20	LM733CH	1.40
LM302D	3.50	LM339N	3.20	LM733CD	3.50
LM302N	1.30	LM320-5K	2.90	LM733CN	1.30
LM302H	1.50	LM320-5T	2.50	LM741CH	.45
LM304H	1.50	LM320-12K	2.90	LM741CD	1.25
LM305H	1.05	LM320-12T	2.50	LM741CM	.44
LM305AH	1.05	LM340-05K	2.60	LM741CN	.70
LM305N	1.00	LM340-06K	2.60	LM747CH	1.70
LM306H	.95	LM340-08K	2.60	LM747CN	.90
LM307H	.75	LM340-12K	2.60	LM747CD	2.50
LM307M	.95	LM340-15K	2.60	LM748CM	.55
LM307N	1.50	LM340-18K	2.60	LM748CN	.55
LM308H	1.20	LM340-24K	2.60	LM777CH	2.15
LM308AH	5.00	LM555CM	.90	LM777CM	2.10
LM308D	2.00	LM556CN	1.30	LM3046CN	.95
LM308M	1.20	LM709CH	.45	LM3054CN	1.50
LM309H	1.75	LM709CN	.45	SG4501T	2.20
LM309K	1.95	LM710CH	.90	SG4501N	2.20
LM310H	1.60	LM710CN	.90	LM5000K	7.50
LM310M	1.80	LM711CH	.90		

2524V
Recirculating 512 Bit Dynamic Shift Register
1—24: $3.90 25 up: $3.80

BIPOLAR MEMORY

C3101	6.50
P3101	4.90
C3101A	7.30
P3101A	5.80
IM5501CDE	7.30
IM5501CPE	5.80
MM5560D	7.30
MM5560N	5.80
DM8599N	5.80
93403PC	5.80

MOS-LSI

P1101A	6.90	C2102-2	8.00
P1101A1	8.50	P2102-2	6.00
1402AN	5.40	2505K	3.30
1403AH	8.00	2512K	5.50
1403AN	5.40	2521V	4.00
1404AH	8.00	2524V	3.90
1404AN	5.40	2525V	5.30
1405A	4.10	2533V	8.50
1506	4.00	3341PC	8.20
1507	4.00	MM5025N	20.00
1602	33.00	MM5026N	20.00
1702	33.00	MM5027N	20.00
C2102	8.00	MM5055N	5.50
P2102	6.00	MM5056N	5.50
C2102-1	8.00	MM5057N	5.50
P2102-1	6.00	MM5058N	5.50

FM STEREO DEMODULATOR

XR1310 $3.20

MM

MM404H	12.00
MM405H	23.00
MM406H	6.50
MM407H	6.50
MM451H	11.40
MM454F	18.00
MM500H	2.00
MM506H	3.20
MM507H	3.20
MM550H	5.90
MM551H	5.60
MM555H	5.60

HYBRID Power AMPLIFIERS

SI-1010G	10W	$6.90
SI-1020G	20W	9.90
SI-1030G	30W	18.70
SI-1050G	50W	25.90

IC POWER REGULATORS

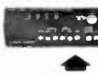
LM335K:	5V,	600mA	2.40
LM336K:	12V,	500mA	2.90
LM337K:	15V,	450mA	2.90

TWO-PHASE MOS CLOCK DRIVER

MH0026CN $5.50

COMPUTER INTERFACE

DM8820N	2.40
DM8820AN	6.90
DM8830N	2.40
DM8831N	5.20
DM8832N	6.00
N8T26B	4.40
9600PC	1.30
9601PC	1.20
9602PC	2.10
9614PC	2.30
9615PC	2.40
9616DC	5.00
9617PC	3.50
9620PC	4.00
9621PC	4.00



A PORTABLE 4½ DIGIT MULTIMETER FOR $299.
A 10 MHZ COUNTER OPTION FOR $50.

INTERSIL 8038 PRECISION WAVEFORM GENERATOR & VCO

For simultaneous sine, square and triangular waveforms <.001 Hz to 1MHz.

Part No.	1-9	10 up
8038CCPD	$4.50	$3.70

XR 215 PHASE-LOCKED LOOP

For FM or FSK demodulation, freq. synthesis and tracking filter applications. 5 to 26V from 0.5Hz to 35MHz. Accepts analog signals 300mV to 3V. Interfaces with DTL, TTL & ECL

1-24	25 up
$15.00	$12.50

POWER TRANSISTORS

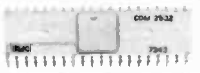
BU204	3A	1300V	$4.14
BU205	3A	1500V	4.95
BU206	3A	1700V	5.94
BU207	6A	1300V	5.85
BU208	6A	1500V	6.93
BU209	6A	1700V	8.64

COM2601 USRT

UNIVERSAL SYNCHRONOUS RECEIVER/TRANSMITTER from Standard Microsystems

STR, BSC, bi-sync and interleaved bi-sync modes of operation ● fully programmable ● full or half duplex operation ● fully double buffered ● directly TTL compatible ● high speed operation ● low power

PRICE:	1-9	10 up
	$30.00	$24.00



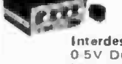
COM2502 UART

UNIVERSAL ASYNCHRONOUS RECEIVER/TRANSMITTER from Standard Microsystems

Direct TTL compatibility ● full or half duplex operation ● fully double buffered ● fully programmable ● high speed operation ● tri-state outputs

PRICE:	1-9	10 up
	$13.20	$10.60

SPECIFICATION SHEETS: $.25 ea.



PULSE GENERATOR

Interdesign 1101: 0.1Hz-2MHz, 0-5V Output, var. width, line or battery operation. $159.00

MINIMUM ORDER: $10.00
Add $1.00 to cover postage and handling
SEND CHECK OR MONEY ORDER (NO C.O.D.) TO:
California residents add 6% sales tax.

ANCRONA CORP.

P.O. BOX 2208R, Culver City, CA 90230

Circle 104 on reader service card

LIVE IN THE WORLD OF TOMORROW . . . TODAY!

And our FREE 180 PAGE CATALOG is packed with exciting and unusual values in electronic, hobby and science items — plus 4,500 finds for fun, study or profit . . . for every member of the family.

A BETTER LIFE STARTS HERE

WHEN YOU COME TO PHILADELPHIA BE SURE TO SEE
FREE BICENTENNIAL LIGHT SHOW
IN BARRINGTON, N.J. ONLY 10 MINUTES AWAY AT
EDMUND FACTORY STORE

3-CHANNEL COLOR ORGAN KIT

Easy to build low-cost kit needs no technical knowledge. Completed unit has 3 bands of audio frequencies to modulate 3 independent strings of colored lamps (i.e. "lows"-reds, "middles"-greens, "highs"-blues. Just connect hi-fi, radio, power lamp etc. & plug ea. lamp string into own channel (max. 300w ea.) Kit features 3 neon indicators, color intensity controls, controlled individ SCR circuits; isolation transformer; custom plastic housing; instructions.
Stock No. 41,831 EH .... $18.95 Ppd.

AM RADIO FITS IN/ON YOUR EAR!

Wear it inconspicuously everywhere. Listen as you work (lawn, yard, office), watch (game, beach) or wait. Instant music, news, sports. No gimmick, our 6/10 oz. Technological wonder has integrated circuit. 11 transistors, patented ferrite antenna/tuner/volume dial. Uses normal silver oxide hearing aid batt. (incl) for approx. 100 hrs. playing. New batt. to slip in avail. at drug stores (about 50c). No lengthy wires, bulky cases, or power-packs!
Stock No. 42,275 EH .... $14.95 Ppd.

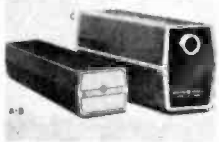
PRO ELECTRONIC SOUND CATCHER

Parabolic mike w/ 18¾" reflecting shield & 2 I.C.'s in amplifier magnifies signals 100X that of omni-directional mikes. Catch a songbird ½ mile off; QB's huddle strategy; sounds never before heard. Super directivity gives highest signal to noise ratio poss. Safe: auto. cuts off ear damaging noises. Earphones, tape recorder output, tripod socket. Req. two 9v trans. batt. (not incl).
No. 1649 EH (5½ LB.) .... $299.00 Ppd.
BIG EAR "TOY" MODEL #80,176 EH .... $32.25 Ppd.

WHICH ARE YOUR CRITICAL DAYS?

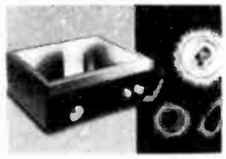
Can Bio-rhythm tell you? We're not sure, but we're told that vast mood shifts are caused by your body's Internal Time Clock whose rhythms can be charted ahead to possibly warn you of "critical" days. Some are great, some blah. Maybe it's your physical, emotional & intellectual rhythms converging at the right or wrong time. Compute your cycles with our Bio-rhythm kit and judge for yourself. Incls Charting kit, metal Dialgraft Calc. instrs.
Stock No. 71,949 .... $11.50 Ppd.
1 YR. PERSONALIZED REPORT — BY COMPUTER
Stock No. 19,200 (Send Birthdate) .... $15.95 Ppd.

He-Ne LASERS . . . $115.00 up!



Top quality lasers feature TEMoo mode, internal mirror plasma tubes w/10,000 hr. life, self-starting cold aluminum cathodes, low noise & ripple, guaranteed output power stability and more for demanding lab work. 18-mo. mfr. wty. 115v AC
(A) 0.5mW . . . 0.86 Beam Dia., 1 mRad Diverg.
#79,070 EH (2.6x8.5x14.8") .... $115.00 Ppd.
(B) 1.0mW . . . (as above) #79,073 EH .... $150.00 Ppd.
(C) 4.0mW . . . 0.8 Beam Dia., 1.1 mRad Diverg.
#79,079 EH (3.9x5.5x15.6") .... $485.00 Ppd.

TOTAL KIRLIAN PHOTOGRAPHY SET

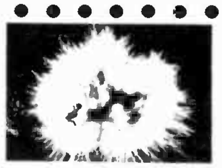


Explore "aura" photography w/ superb new self-contained Kirlian Electrophotography Research Unit. Terrific value — introduced at $99.95 ($140 in Sept.)! Has everything but vinyl photo changing bag. Ideal for color or b&w 35mm, sheet or Polaroid film for photos up to 5x7" all without camera or lens. Variable voltage 12v to 32kv. Ultimate safety design—fully encased in plastic; patented electronics. Instrs.
No. 72,104 EH (3x5⅞x7⅞") .... $99.95 Ppd.
No. 42,240 EH (CHANGING BAG) .... $6.50 Ppd.

LOW COST 7X INFRA-RED VIEWER

For Infra-red crime detection surveillance, security system alignment, I.R. Detection, laser checking, nite wildlife study, any work req. I.R. detection & conv. to visible spectrum. Self cont. scope w/everything incl. I.R. light source. 6v or 12v power, 6032 I.R. converter tube, f/4.5 objective lens, adjust. triplet eyepiece. Focuses from 10' to infinity.
No. 1659 EH (11x14¼x3") .... $275.00 Ppd.
WITHOUT LIGHT SOURCE
No. 1648 EH .... $225.00 Ppd.

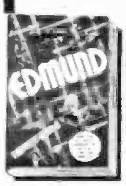
NEW! KIRLIAN PHOTOGRAPHY KIT!



Experiment in the fascinating new field of "Kirlian electrophotography" —images obtained on film without camera or lens by direct recording of electric charge transmitted by animate & inanimate objects. Each "aura" differs—animate aura said to change corresponding to physical changes. Kit incls portable darkroom, double transformer isolated from power source; instructions.
No. 71,938 EH .... $49.95 Ppd.
"HIGH VOLTAGE PHOTOGRAPHY" by H. S. Oakin
No. 9129 EH (60-PG.) PPBK BK.) .... $5.00 Ppd.
DELUXE KIRLIAN PHOTOGRAPHY SET
NO. 72,053 EH .... $399.00 Ppd.

KNOW YOUR ALPHA FROM THETA!

For greater relaxation, concentration, listen to your Alpha-Theta brainwaves. Ultra-sensitive electrode headband slips on/off in seconds—eliminates need for messy creams, etc. Atch'd to amplifier, filters brainwaves, signals beep for ea. Alpha or Theta wave passed. Monitoring button simulates Alpha sound; audio & visual (L.E.D.) feedback. Reliable, easy-to-use unit—comparable to costlier models. Completely safe. Comprehensive instruction booklet.
No. 1635 EH (8x3x4"; 24 oz.) .... $134.50 Ppd.
LOW COST "STARTER" UNIT
No. 71,809 EH .... $55.00 Ppd.
DELUXE "ON" TIME MONITOR MEASURES & RECORDS %
No. 1652 EH .... $349.50 Ppd.



MAIL COUPON FOR GIANT FREE CATALOG!

180 PAGES • MORE THAN **4500** UNUSUAL BARGAINS

Completely new 1975 edition. New items, categories, illustrations. Dozens of electrical and electromagnetic parts, accessories. Enormous selection of Astronomical Telescopes. Unique lighting and ecological items. Microscopes, Binoculars, Magnifiers, Magnets, Lenses, Prisms. Hard-to-get surplus bargains. Ingenious scientific tools. 1000's of components.

EDMUND SCIENTIFIC CO.
300 Edscorp Building, Barrington, N.J. 08007
Please rush Free Giant Catalog "EH".

Name ____
Address ____
City ____ State ____ Zip ____

COMPLETE AND MAIL WITH CHECK, M. O. OR CHARGE NO.

EDMUND SCIENTIFIC CO. 300 Edscorp Building, Barrington, N.J. 08007

☐ PLEASE SEND GIANT FREE CATALOG "EH"

How Many	Stock No.	Description	Price Each	Total
		Add Handling Chg.: $1.00, Orders Under $5.00, 50¢, Orders Over $5.00		
		I enclose ☐check ☐money order for TOTAL $		

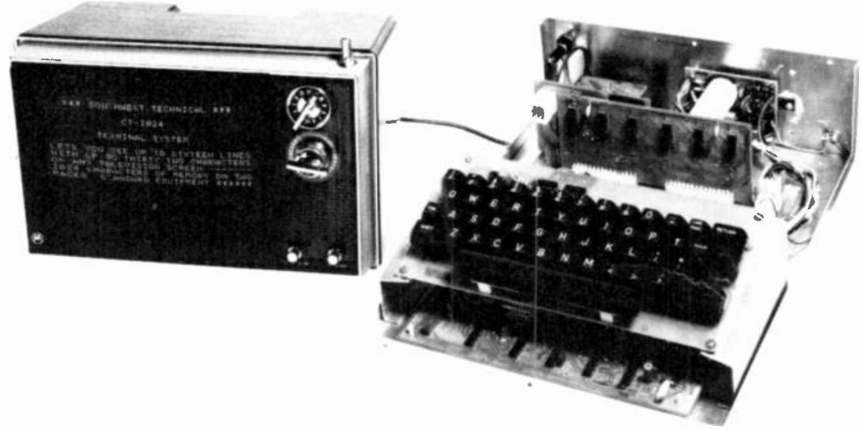
☐ Charge my BankAmericard *
☐ Charge my Master Charge *
Interbank No. ____
My Card No. Is ____
Signature ____
Card Expiration Date ____

30-DAY MONEY-BACK GUARANTEE. You must be satisfied or return any purchase in 30 days for full refund.
*$15.00 minimum

Name ____
Address ____
City ____ State ____ Zip ____

Circle 83 on reader service card

SWTPC



CT-1024 TERMINAL SYSTEM

When we designed the CT-1024 we knew that there were many applications for an inexpensive TV display terminal system. Even so, we have been surprised at the many additional uses that have been suggested by our customer in the last four months since we introduced this kit.

The basic kit, consisting of the character generator, sync and timing circuits, cursor and 1024 byte memory gives you everything you need to put a sixteen line message on the screen of any TV monitor, or standard set with a video input jack added to it. Input information to the CT-1024 may be any ASCII coded source having TTL logic levels. Two pages of memory for a total of up to one thousand and twenty four characters may be stored at a time. The CT-1024 automatically switches from page one to page two and back when you reach the bottom of the screen. A manual page selector switch is also provided. The main board is 9½ x 12 inches. It has space provided to allow up to four accessory circuits to be plugged in. If you want a display for advertising, a teaching aid, or a communication system then our basic kit and a suitable power supply is all you will need.

CT-1 TERMINAL SYSTEM with MEMORY KIT........................ $175.00 ppd

Power supply kit to provide + 5 Volts @ 2.0 Amps and - 5 Volts, -12 Volts @ 100 Ma. required by the CT-1 basic display system.

CT-P POWER SUPPLY KIT........$15.50 ppd

A very nice convenience feature at a very reasonable cost is our manual cursor control plug-in circuit. The basic kit allows you to erase a frame and to bring the cursor to the upper left corner (home up). By adding this plug-in, you can get Up, Down, Left, Right, Erase to End of Line and Erase to End of Frame functions. These may be operated by pushbutton switches, or uncommitted keyswitches on your keyboard. Although not essential to terminal operation, these features can be very helpful in some applications.

CT-M MANUAL CURSOR CONTROL KIT..$11.50 ppd

If you plan to use your terminal with a telephone line modem, or any other system that requries a serial data output; you will need our serial interface (UART) plug-in circuit. This circuit converts the ASCII code from a parallel to a serial form and adds "Start" and "Stop" bits to each character. The standard transmission rate for this circuit is 110 Baud, but optional rates of 150, 300, 600 and 1200 Baud may be obtained by adding additional parts to the board. The output of this circuit is an RS-232 type interface and may be used to drive any type modem, or coupler system using this standard interface.

CT-S SERIAL INTERFACE (UART) KIT..$39.95 ppd

If you are using the CT-1024 as an IO (input - output) device on your own computer system, you will probably want to connect it to the computer with a parallel interface system. A direct parallel interface allows for much faster data transmission and reception and is basically a simpler device than a serial interface system. Our parallel interface circuit contains the necessary tristate buffers to drive either a separate transmitt and receive bus system, or a bidirectional data bus system. TTL logic levels are standard on this interface. Switch selection of either full, or half duplex operation is provided. The terminal may write directly to the screen, or the computer may "echo" the message and write to the screen.

CT-L PARALLEL INTERFACE KIT..$22.95 ppd

We would be happy to send you a complete data package describing the CT-1024 and a achematic. If you want this additional information, circle our number shown below on your reader information service card. The CT-1024 kit has complete assembly instructions with parts location diagrams and step-by-step wiring instructions. If you would like to check the instruction manual before you purchase the kit, please return the coupon with $1.00 and we will rush you the manual and the additional data mentioned above.

MAIL THIS COUPON TODAY

☐ Enclosed is $________________ ☐ or Master Charge #________________

☐ or BankAmericard #________________ Card Expiration Date________________

☐ CT-1024 Kit ☐ CT-M Cursor Control Kit

☐ CT-S Serial Interface Kit ☐ CT-L Parallel Interface Kit

NAME ________________________________

ADDRESS________________________________

CITY________________STATE__________ZIP__________

☐ $1.00 Enclosed send manual and data package

Southwest Technical Products Corp., Box 32040, San Antonio, Texas 78284

Circle 84 on reader service card