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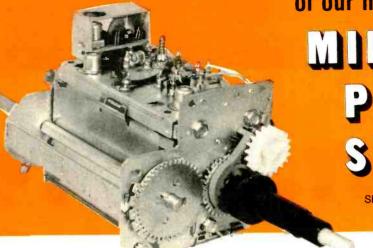
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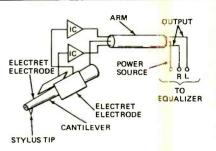
JUNE 1975 Vol. 46 No. 6

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- How R-E Tests Hi-Fi Gear Radio-Electronics is going to test hi-fi gear. Here's the story on how it is going to be done. by Len Feldman
- How CD-4 Phono Cartridges Work Inside those new CD-4 cartridges. See how they work. by Robert F. Scott

# **BUILD ONE OF THESE**

- Add-On 4-Channel Digital Scope Memory Turns any scope into a storage scope. Costs about \$125 to build, by Chris Titus
- **Build Your Own Reading Computer** Discover how a computer identifies written letters. by Joseph Braunbeck



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

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# 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 Phillips, announced it would produce and sell the Phillips/ 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 compatible systems.

Meanwhile, in Germany, the long-delayed TeD video-disc 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 "pres-

sure 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.

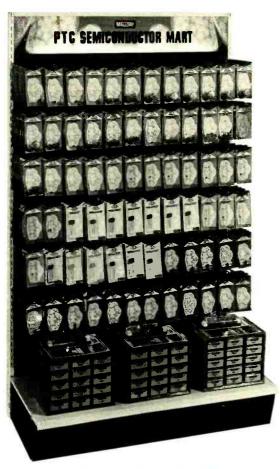
In Panasonic's massive recall, the company is sending repair teams to five market areas at a time, where they service sets for about a week before moving on to other areas. Owners of the defective sets are notified to bring them in for modification or to call for home service. Under the Radiation Control 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-andwhite, 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.

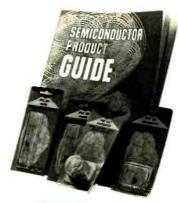


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# new & timely

## 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" 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.

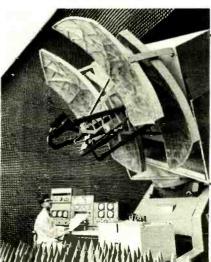
-with the precise offset data from NBS-can make frequency calibrations that are directly traceable to NBS.

Two basic types of instruments have been developed. Differing in accuracy, complexity and cost, each offers a nonlabor-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° 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. bers 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 1010 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**



sorption 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

# ANTENNA for the RCA Satcom satellite is being tested in the chamber to assure ab-

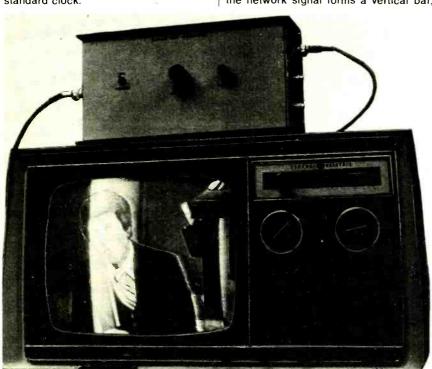
and Hawaii.

## 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.  $\times$  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)



THE NBS COLOR BAR COMPARATOR reaches an accuracy on one part in 10° 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

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.

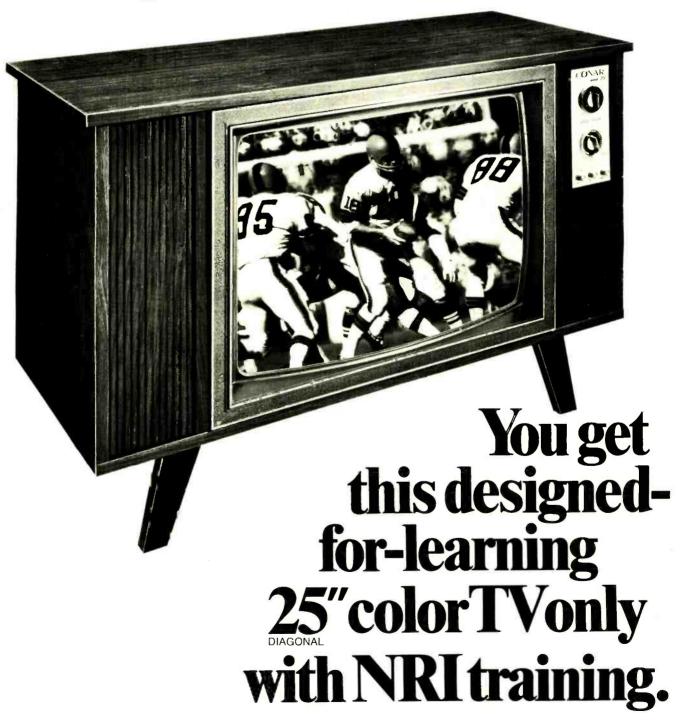
For users who require higher accuracies, a second version, the 358 Computer Frequency Measurement (FMC) has been designed. It automatically computes and displays the calibrations on the TV screen, showing num-



Circle 4 on reader service card



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



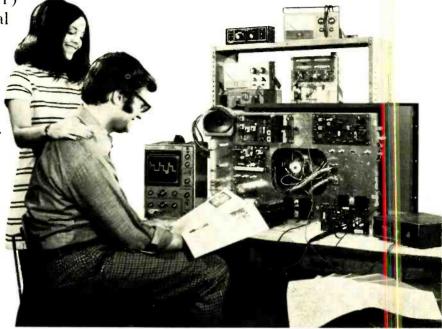
No other home-study school gives you a TV like the one you build with NRI's Master Course in Color TV/Audio servicing. Some schools give you three or four plug-in sub-assemblies off the production line to put together a commercial set. Others give you a hobby-kit bought from outside sources. And because 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.

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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.

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# 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 33/4 inches high, 41/2 inches wide at its widest point and, including the lens, 73/4 inches long. It is available in two options, the higherpriced one at about \$3800 (of which \$2300 is for the silicon imaging device).

## Newest digital voltmeter gives readings by voice

A recenity 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

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



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.'

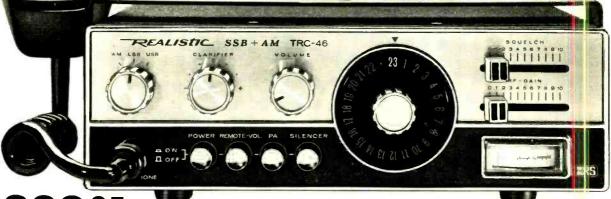
varying the density of the cells turned on or off in a given area of the flatscreen plasma panel.



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

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# 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.



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.

# The Sansui QRX-3000



# The Sansui QRX-3500



# The Sansui QRX-6001



# The Sansui QRX-7001



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-500CX
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 Matik
CD-4 DEMODULATING	Adaptor	Bullt-in	Bullt-in	Adaptor	Built-in	Adaplo:
Power Range	: 25-34 Watts	10/4				
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		Simpe
SQ DECODING	Built-in	Simple	Cimania			RM
DECODING	VARIO-MATRIX	SQ SIMPLE	Simple SQ		Full Logic SQ	RM
SYNTHESIZING SURROUND	VARIO-MATRIX Bullt-in VARIO-MATRIX					RM
SYNTHESIZING	Built-in					Simple
SYNTHESIZING SURROUND SYNTHESIZING	Bullt-in VARIO-MATRIX Bullt-in			Adaptor	Simple	Simple
SYNTHESIZING SURROUND SYNTHESIZING HALL-AMBIENCE CD-4	Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in	SQ —	SQ '	Adaptor	Simple Maint	Simple
SYNTHESIZING SURROUND SYNTHESIZING HALL-AMBIENCE CD-4 DEMODULATING	Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in	SQ —	SQ '	Adaptor  Marantz 4300	Simple Maint	Simple
SYNTHESIZING SURROUND SYNTHESIZING HALL-AMBIENCE CD-4 DEMODULATING POWER Range MANUFACTURER	Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in  : 35-45 Watts SANSUI	SQ Built-in	Adaptor  Kenwood	Marantz	Simple Matrix Adaptor	Simple Maria Maria Built-in
SYNTHESIZING SURROUND SYNTHESIZING HALL-AMBIENCE CD-4 DEMODULATING  Power Range MANU-ACTURER MODEL QS	Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in  : 35-45 Watts  SANSUI QRX-7001 Built-in	SQ Built-in	Adaptor  Kenwood KR-8840 Simple	Marantz 4300 Adjustable	Simple Matrix Adaptor  Ploneer QX949 Simple	Simple Maria Maria Built-in
SYNTHESIZING SURROUND SYNTHESIZING HALL-AMBIENCE CD-4 DEMODULATING  Power Range MANU-ACTURER MODEL QS DECODING SQ	Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in  35-45 Watts  SANSUI QRX-7001 Built-in VARIO-MATRIX Built-in	Built-in  Fisher 634  Full Logic	Adaptor  Kenwood KR-8840  Simple RM  Full Logic	Marantz 4300 Adjustable	Simple Matrix Adaptor  Ploneer QX949 Simple RM Simple	Simple Maria Built-in  Sylvania RQ-3747  Simple
SYNTHESIZING SURROUND SYNTHESIZING HALL-AMBIENCE CD-4 DEMODULATING  Power Range  MANU-ACTURER MODEL QS DECODING SQ DECODING SYNTHESIZING	Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in  35-45 Watts  SANSUI QRX-7001 Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in VARIO-MATRIX Built-in	Built-in  Fisher 634  Full Logic SQ	Kenwood KR-8840 Simple RM Full Logic SQ	Marantz 4300 Adjustable	Simple Matrix Adaptor  Pioneer QX949 Simple RM Simple SQ	Simple Maria Built-in  Sylvania RQ-3747  Simple

SQ - CBS Inc.

CD-4 - JVC Inc.

es – Sansui Electric Co., Ltd.

## **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)

# RCA's versatile WO-535A... DC to 10 MHz response for only \$349.\*

- 1. Operates in either triggered or recurrent sweep mode.
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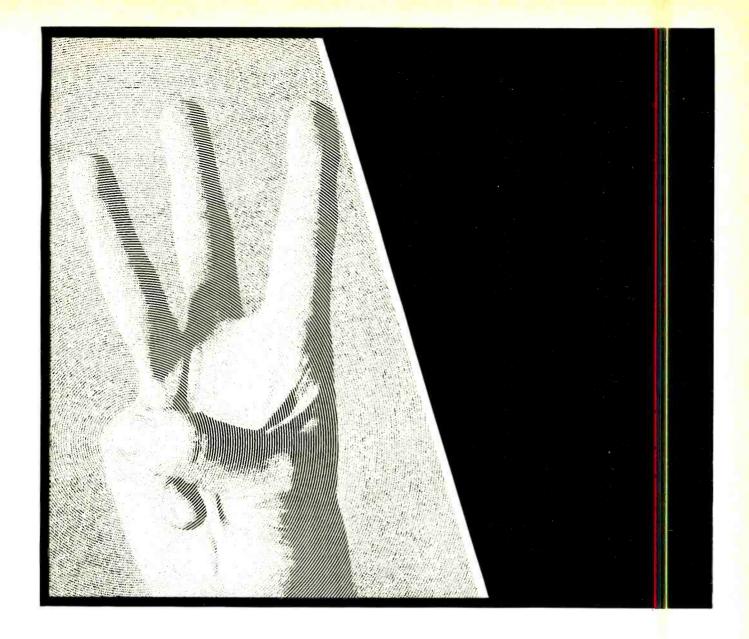
For complete information and fast delivery on the versatile WO-535A, Dual Mode Oscilloscope, contact any one of the more than 1,000 RCA Distributors worldwide. Or write: RCA Electronic Instruments Headquarters, Harrison, N.J. 07029.

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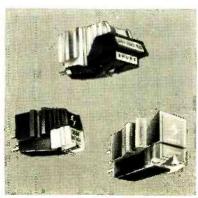


Circle 7 on reader service card

16



# Best. best. best buys.



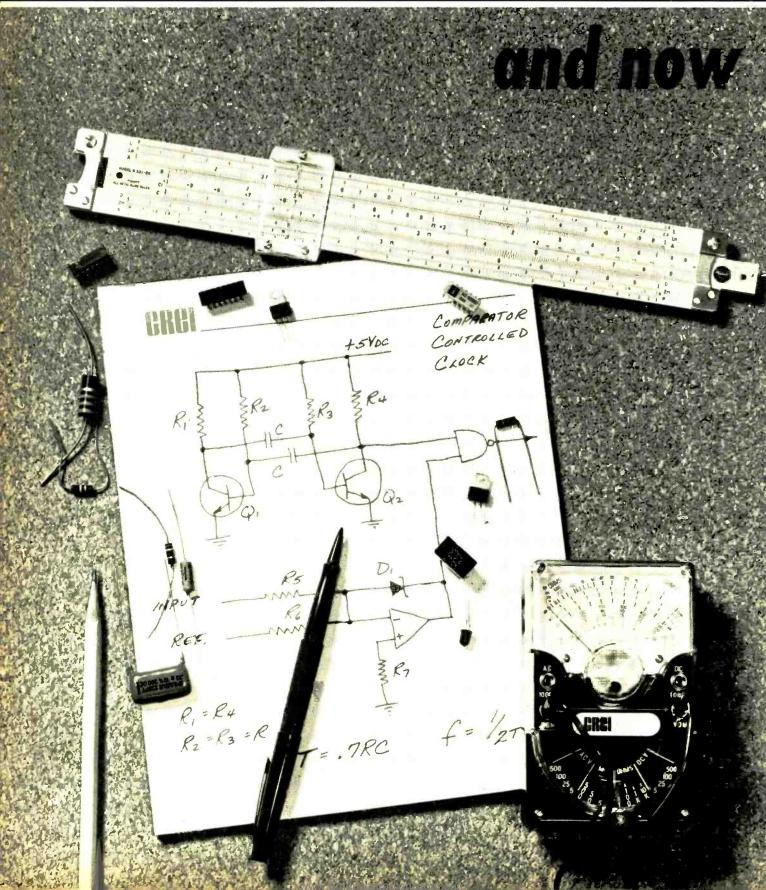
Fact: the lowest cost way to improve your whole high fidelity system is simply to upgrade the source of sound—the cartridge! If you're ort a temporary austerity program, the Shure M44E can make a significant difference in sound over the cartridges supplied with many budget component systems. If your budget is a trifle more flexible, an M91ED can bring you into the area of high trackability (with performance second only to the V-15 Type III). And for those who can be satisfied with nothing less than state-of-the-cart play-back perfection, Shure offers the widely acclaimed V-15 Type III, the recognized number one cartridge in the industry, which, in truth, costs less than a single middle-of-the-road loudspeaker. To read about what a Shure cartridge could do for your system, write:

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source that stocks them besides Sig-

netics. 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.

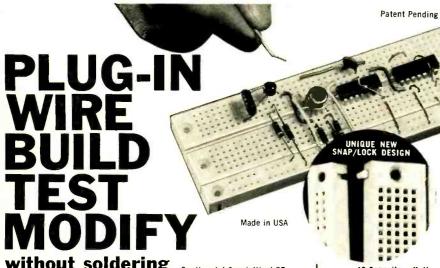
Location Data Explanation

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	location
012	000	
013	121	Output A to Port 0
013	305	Move H to A
015	066	Load L with 45
016	045	Load E With 43
017	056	Load H with 0
020	000	Load II willi o
021		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 dec-
		imal 1,025 and loca-
		tion 034 must be
		changed for larger
004	004	memories.)
034	004	16
035	150	<pre>If =, go to program   beginning</pre>
036	000	
037	000	
040	006	Clear A
041	000	
042	104	Loop
043	006	
044	000	Data standard under

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

000 Data storage word

045



without soldering for as little as

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QT-47S	6	10.00
QT-47B	_	2.25
QT-35S	5	8.50
QT-35B	_	2.00
QT-18S	2	4.75
QT-12S	1	3.75
QT- 8S	1	3.25
QT- 7S	1	3.00

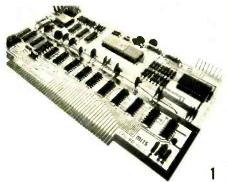
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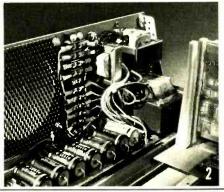
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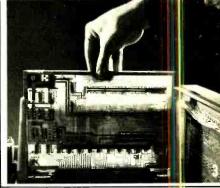
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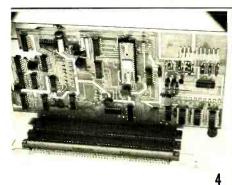
Circle 9 on reader service card

# INSIDE the Altair Computer













- 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  $\pm 8$ , a  $\pm 16$  and a  $\pm 16$  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 canask for free technical consultation or for one of our free Altair System Catalogues. PRICES:

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NOTE: Altair Computers come with complete documentation and operating instructions tair 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 inditor and BASIC language

> \*In quantities of one per customer ally. Offer expires June 30, 1975

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Circle 10 on reader service card

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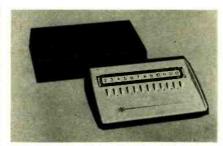
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GENERAL & ELECTRIC

# equipment reports

# Jerrold TRC-12 Television Remote Controller



Circle 101 on reader service card

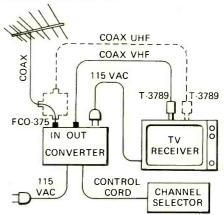
DO YOU OWN A TELEVISION RECEIVER THAT doesn't have remote control? Wish you did? Well, about all you could do up till now was to either live with your misery and curse the TV set each time you had to get up to change a channel or purchase a new TV set with the remote control feature built-in. That was 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 original antenna system was also 75ohms. 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 warmedup, 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-

# Now Heathkit digital-design Color TV comes in two screen sizes



21" 5995\* less cab.

Now you can enjoy what Popular Electronics editors call "the color TV of the future" in either of two sizes, the original GR-2000 with 25" picture tube or the new GR-2050 with 21" tube. They have identical technology and features...just choose the picture size you prefer.



On-screen electronic digital channel numbers — big, bright, and easiest to read.

On-screen electronic digital clock time—low cost insurance against missed programs.

Silent, electronic, touch-tuning, thanks to the combination VHF-UHF varactor tuner. No knobs to turn, no contacts to clean, no noisy turrets, no humming motors, nothing to wear out.

Just touch a button to tune.

Programmable Digital Counter/Channel Selector — a computer-like programming board for you to pre-program any 16 stations, UHF or VHF, or both, in any order, even repeating if you choose, so there is never any need to have unused channels again. When

activated by touching the tune button or remote control, the counter silently sweeps up or down through the 16 programmed channels; release the button and the selected channel is locked in. And you can change the programming any time you wish, such as when new stations come on the air, or you move to a new locality...just slide out the Service drawer and re-program.

HEATHKIT ELECTRONIC CENTERS — Units of Schlumberger Products Corporation Retail prices slightly higher.

ARIZ.: Phoenix; CALIF.: Anaheim, El Cerrito, Los Angeles, Pomona, Redwood City, San Diego (La Mesa), Woodland Hills; COLO.: Denver; CONN.: Hartford (Avon); FLA.: Miami (Hialeah), Tampa; GA.: Atlanta; ILL.: Chicago, Downers Grove; IND.: Indianapolis; KANSAS: Kansas City (Mission); KY.: Louisville; LA.: New Orleans (Kenner); MD.: Baltimore, Rockville; MASS.: Boston (Wellesley); MICH.: Detroit; MINN.: Minneapolis (Hopkins); MO.: St. Louis (Bridgeton); NEB.: Omaha; N.J.: Fair Lawn; N.Y.: Buffalo (Amherst), New York City, Jericho (L.I.), Rochester. White Plains; OHIO: Cincinnati (Woodlawn), Cleveland, Columbus, Toledo; PA.: Philadelphia, Pittsburgh; R.I.: Providence (Warwick); TEXAS: Dallas, Houston; VA.: Norfolk (Va. Beach); WASH.: Seattle; WIS.: Milwaukee.



25" 66995\* less cab.

Exclusive Heathkit fixed ten-section LC bandpass filter — does away with critically adjusted traps yet elimi-

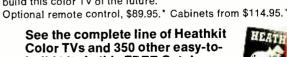
nates adjacent-channel and in-thannel carrier beats to give you truly superior color reception in multiple-transmitter urban areas or where multi-channel cable service is available. And it will never need periodic instrument alignment — it's abjusted

and sealed at the factory so you have better pictures longer.

100% solid-state — more ICs than any other set in the world — 33 in all with remote control and clock — for greater reliability, less interference, truer colors, more precise tints, improved sersitivity, and better picture interlace for remarkable definition. Both sizes of picture tubes are black (negative) matrix types with full illuminated dots and black "surround" for brighter, more vivid pic-

Easier to build, easier to service. Built-in digital-design dot generator, check-out meter, and easy-access adjustments for service you can do yourself. Modular circuit boards, wiring harnesses, and fewer

chassis-mounted parts make it easier to build this color TV of the future.



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(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.

# Wahl Thermal-Spot Tester

WE'VE USED AFROSOL 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.

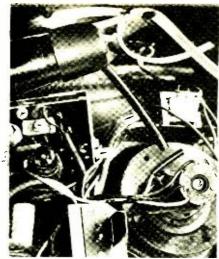
It is a hand-sized blower with a heater. It blows a strong stream of hot air through a nozzle. Temperatures up to 260°F (125°C.) can be reached. This is the normal maximum operating temperature for many silicon transistors and similar parts. The long tapered case is plastic and the nozzle is a 3-in.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



Circle 102 on reader service card

plastic tubing about %-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

# Affordable frequency counter for jobs that have always needed one



With a good autoranging frequency counter you can watch oscillator adjustments, monitor RF and audio frequencies precisely, do fast production testing, check critical countdown chains, calibrate signal generators, pull-in range of AFT circuits and CB frequencies accurately. The 1801 is good because its accuracy is typically better than 10PPM; it typically reads 10Hz-60MHz and is guaranteed to read 20Hz-40MHz. It's automatic—there's just one control and gate times, decimal points and scalings are automatically selected for best speed and accuracy. And it's fast—the display is refreshed up to 5 times per second.

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Circle 11 on reader service card

# Color Generator doubles as portable Analyst



## MODEL 1248 \$175

Now you can localize TV problems at the customer's location without bench equipment! Service CCTV and Videotape too! The 1248 is a rocksteady nine-pattern IC color generator—with RF, IF, video, sync and sound outputs that let you substitute signals to find the problem. Digitally generated patterns. Crystal-controlled IF and RF outputs. With carrying case; dependable AC operation

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Circle 12 on reader service card

# Portable Digital Multimeter at an Analog Price ONLY

\$9995

less batteries and optional AC adapter/charger

# 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 stand<mark>ard</mark> input impedance

9. IN STOCK AT YOUR DISTRIBUTOR



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# 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.

where you buy 5K parts.

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

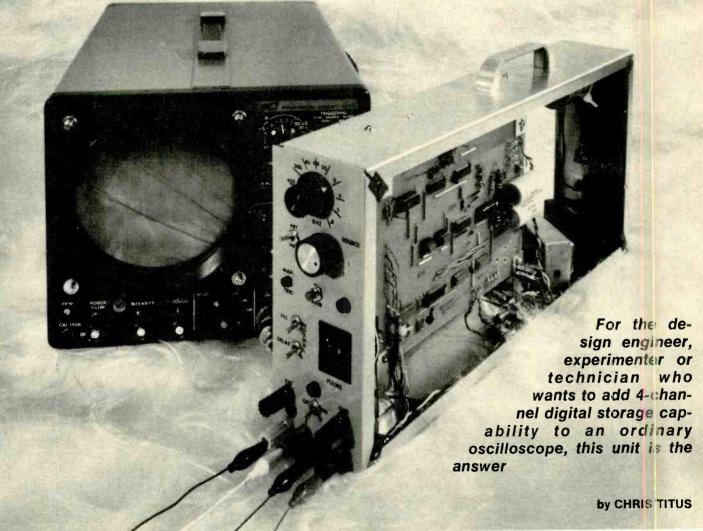


It's OK if it's Sk

AADIO-ELECTRONIC

# **JUNE 1975**





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 longpersistence 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 as 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.

mum 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 cesigned around a two-bit Digital-to-Analog converter (DAC). The four data ou puts 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 userselectable 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 Ex-TERNAL 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-

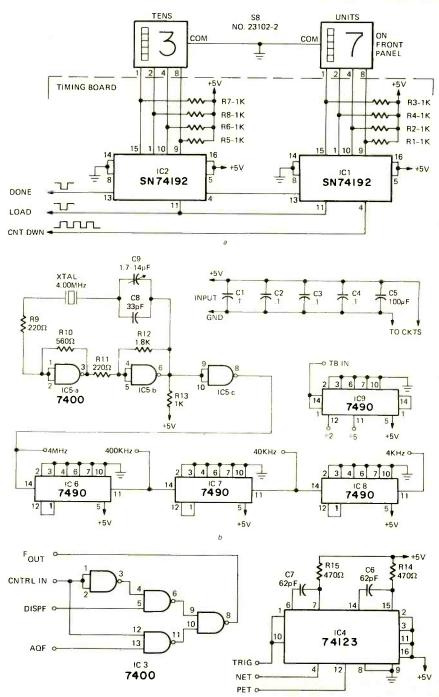


FIG. 1—THE TIME-BASE BOARD CONTAINS THREE SETS OF CIRCUITRY. As you can see they do not interconnect with each other. They do connect to either the memory board or the controls on the instrument.

ory board (Fig. 4). Note the orientation of the diodes and capacitors. The 10,000μF 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 1/2 of the adjustable portion is meshed with 1/2 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 go-

ing 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

### 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 Your 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

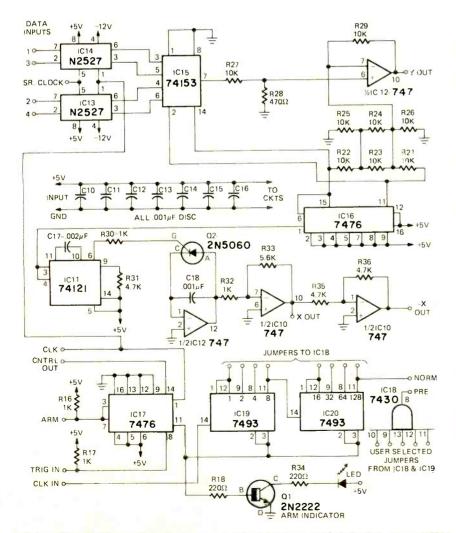


FIG. 2—MEMORY BOARD CIRCUIT. The memory is all in IC14 and IC15. Each one is an N2527.

### PARTS LIST

All resistors are 1/4 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, 1/2 W R21-R26, R27, R29-10,000 ohms R31, R35, R36-4700 ohms R33-5600 ohms C1-C4, C10-C16-1-4F 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-#F ceramic disc C19, C20-500-#F 25V electrolytic C21-10 000-#F 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 1C16, 1C17-7476 dual J-K flip-flop---TTL IC18—7430 8-Input positive nand gate—TTL IC19, IC20-7493 4-bit binary counte -TTL 23-LM309K or equal

F1-24VGT 1/2 A power transformer 12-6.3v 1A power transformer LED--MY 5020 or equal

XTAL -4.0000 MHz crystal available from International Crystal, 10 North Lee, Oklanoma 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/cleck)

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 teet, Bud chassis AC 412 and bottom plate EPA 1520.

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

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

Both the memory and time battle 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.

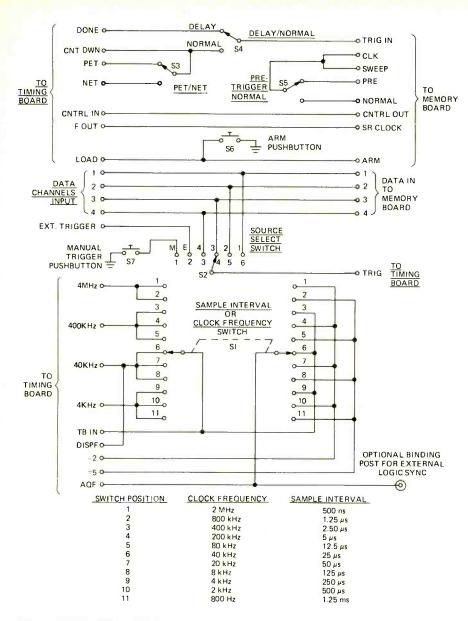


FIG. 3—FRONT PANEL CONTROLS ARE SHOWN IN THIS DIAGRAM. They connect to both the memory and time-base circuit boards. Foil patterns for these boards will be published with the second part of this article.

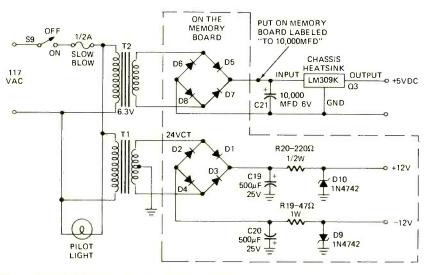


FIG. 4—POWER SUPPLY FOR THE SCOPE MEMORY. Note that the circuitry inside the dashed lines is on the memory board. Don't build it twice.

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."

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:

### 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.

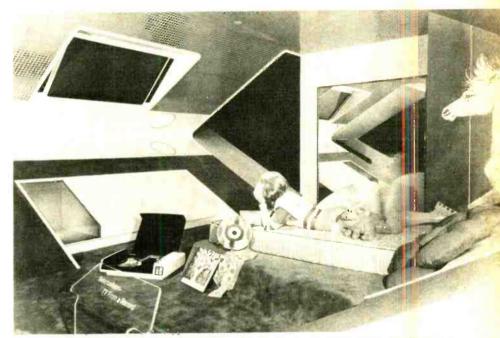
# Disco-Vision and VLP

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 em-

# COMING SOON home videoplayers

by ROBERT E. GERSON

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



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.

ploy 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

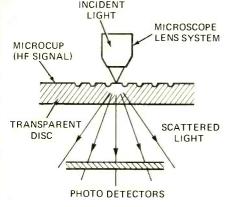
For the past two years Zenith of the U.S. and Thomson-CSF of France have worked on the development of yet another optical laser videodisc system. This one uses an air cushioned, transparent floppy disc, and unlike the

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 MOLD-ED 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.

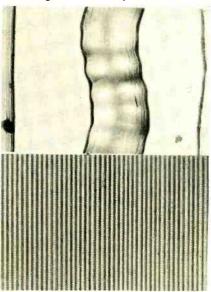
In the field of home video tape recordings, the disappointments have, if possible, exceeded even those created by the failure of video discs to come to market. Here's the status of those considered to be the most viable:

### 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 1/2-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.

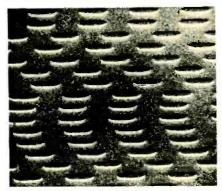
able for the EIA-Japan standard can be made available for rental to consumers. Expected to help V-cord's acceptance is the development by Matsushita Electric of the first highspeed tape duplicator for half-inch tape. Now being offered for sale both in the United States and Japan, the duplicator, priced 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 1/2-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



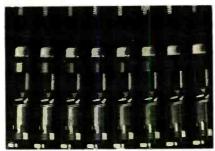
PITS STAMPED IN VLP DISC contain audio and video information. This is a photomicrograph of a section of the disc surface.

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.

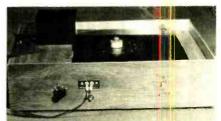
It seems fairly obvious that with audio-only phonograph records retailing at about \$6 each, a full-length feature film would have to retail for at least double and probably more like three times that price. This of course raises the question of how

# ANALYSIS OF LEADING VIDEODISC SYSTEMS

	MCA-Philips	RCA	TeD
Type	Optical	Mechanica	Mechanical €
Readout	Laser	Metal Sapphire Stylus	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. (on≥ side only)
Disc life	infinite	500 +	1,000 +
Slow motion capability		plays	plays
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	ń. 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.

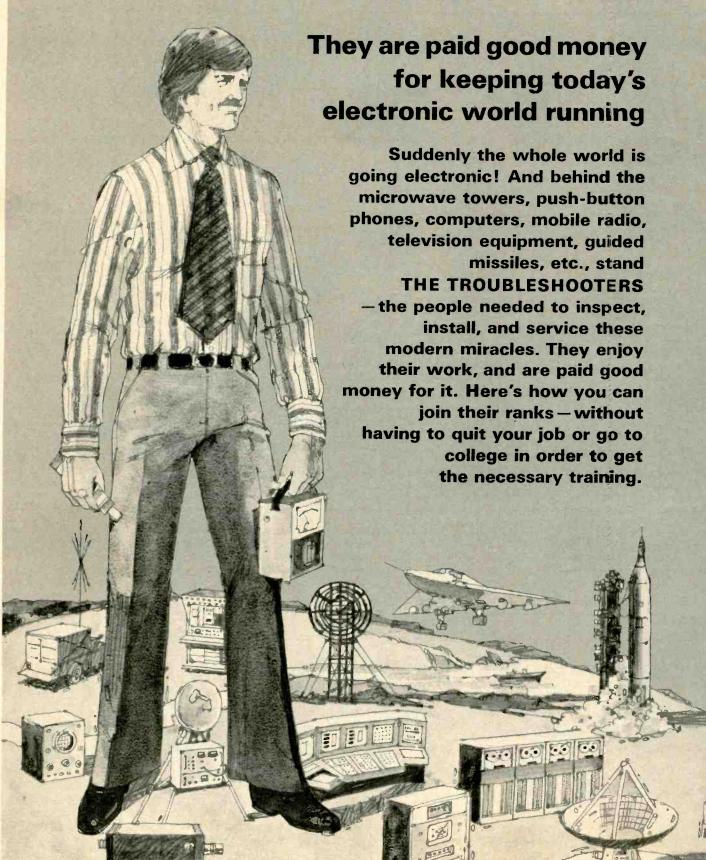
From talks with officials of presently uncommitted companies such as



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 howto-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

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39

# ADIO-ELECTRONIC

# Radio-Electronics® Tests HI-FI Gear

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE

by LEN FELDMAN CONTRIBUTING HIGH-FIDELITY EDITOR

R-E

STARTING NEXT MONTH, RADIO-ELEC-TRONICS 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.

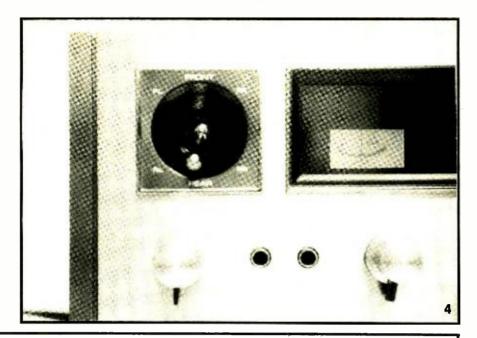
views in the same periodicals.

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**

	Measurement	Evaluation
IHF sensitivity, Mono: (μV)		
Sensitivity, Stereo (µV)	25.00	
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)	- 6	
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, 100 Hz, Stereo (%)		
Harmonic distortion, 6 kHz, Stereo (%)		
Distortion at 50-dB quieting, Mono (%)		
Distortion at 50-dB quieting, Stereo (%)	N.m	
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (µV)		
Separation, 1 kHz (dB)		
Separation, 100 Hz (dB)		
Separation, 10 kHz (dB)		
Separation, 10 km2 (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		( <del></del>
Usefulness of other controls		
Construction and internal layout		
Ease of servicing		
Evaluation of extra features, if any		
CVERALL ENGINEERING PARTIES		
OVERALL FM 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 giver highfidelity component can be used in an entire system. Figure 2 is typical o 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 additiona 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 fis into the entire high fidelity scheme of things.

Incidentally, we will use the same Rating Chart for FM performance whether the FM circuitry is par of a separate FM tuner or part of an >verall 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 ppear, 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 worth-while feature on the control pan-1 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).

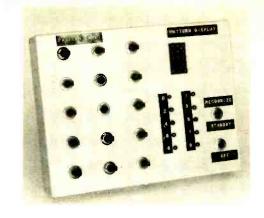
An overall amplifier performance rating will appear at the conclusion of the amplifier performance measurement rating chart even if the amplifier is part of an all-in-one receiver. In that way, the reader can easily separate tuner section and amplifier section performance, since very often these two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

Similar performance rating char's have been created for the evaluation of such other high fidelity component products as open-reel tape decks, cassett: tape decks, phonograph cartridges and record playing equipment. The notes accompanying each of these charts will help a quaint 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

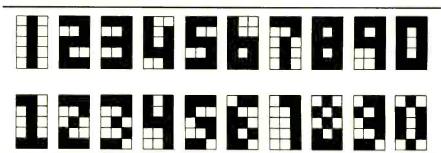


FIG. 1—A FEW RECOGNIZABLE NUMBERS that can be generated with a 15-dot matrix.

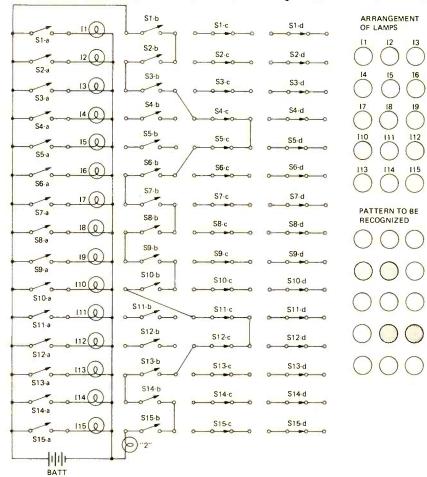


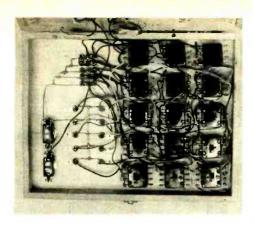
FIG. 2—THIS CIRCUIT WILL ONLY RECOGNIZE the pattern "2". It is an impractical circuit due to the number of switches that would be necessary to recognize all ten numbers.

#### PARTS LIST

S1 thru S15—4PDT toggle switches (see text) S16, S17—SPST toggle switches

11 thru 125 — 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 11 through 115.

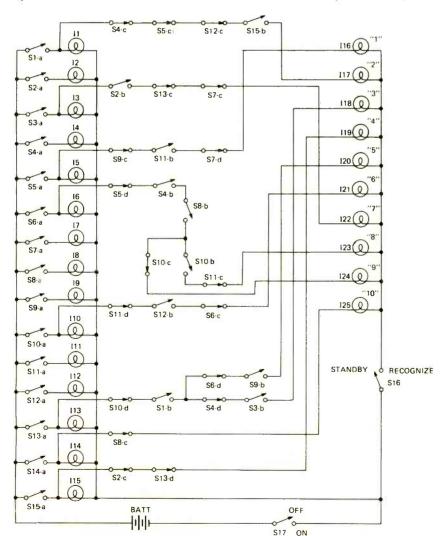


FIG. 3—PRACTICAL CIRCUIT that will recognize all ten numbers. This circuit reduces the number of switch contacts by recognizing only the essential features of numeric characters.

For the sake of convenience, the switches are arranged physically in the same manner as the mniature 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 lotal 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 13 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 rumeric 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)

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

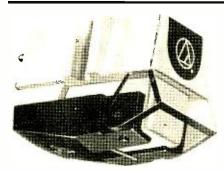
THE DEVELOPMENT OF THE COMPATIBLE Discrete 4-channel (CD-4) quadriphonic system placed demands on the phonograph cartridge that were unheard of a little more than five years ago. In the stereo recording system, developed in the late 1950's, each of the walls carries one of the two stereo program channels. 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 rightfront 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.

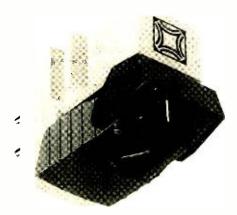
Reducing the tip radius to, say, 0.5 mil, improves high-frequency response at the cost of groove deformation and in-



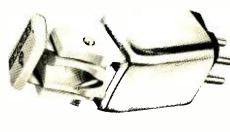
**AUDIO TECHNICA AT15S and AT20SL** 



**PICKERING UV-15** 



JVC 4MD-20X



EMPIRE 4000D series.

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 re-



BANG & OLUFSEN MMC-6000

sult 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

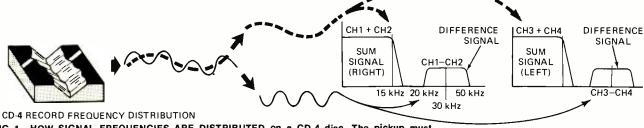


FIG 1—HOW SIGNAL FREQUENCIES ARE DISTRIBUTED on a CD-4 disc. The pickup must have response out to 45 kHz so it can respond to the full deviation of the 30-kHz frequency-modulated subcarrier.

46

## **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



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

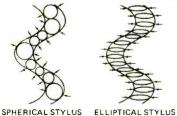


FIG. 2—THE SPHERICAL STYLUS does not track well at high frequencies unless its tip radius is reduced to about 0.5 mil. This increases record wear. An elliptical stylus gives excellent tracking at high frequencies with minimum deformation and wear on the record grooves.

IN GROOVE

IN GROOVE



**TECHNICS EPC-450C-II** 



STANTON 780/4DQ

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-proportiona types. The output voltage developed by magnetic cartridges is generated by rarying 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

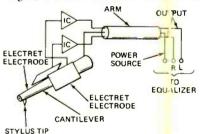


FIG. 3—THE ELECTRET CARTRICGE by Toshiba uses two electrets as fixed plates of two capacitors. Movement of the stylus cantilever develops varying electrostatic voltages that are amplified by IC's built into the cartridge.

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 wills of the record groove. As the stylus moves, the capacitance between the cartilever 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 CI-4 demodulator into the AUX inputs of a 4-channel receiver or amplifier. The preamp/equalizer also reverses the plase 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 con-

struction 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

of the resolver on the transducers during other groove-modulation conditions can be determined by studying Fig. 7.

#### 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

0.47 ROUT 16 0.0033 0.022 + 100K ₹82K TO AMPL 木.33 33 AUX TERMINAL FROM ARM **IN60** 0.0033 47Ω 16 LOUT LIN 0 0 .33 18V 18V BATT **⊕** R TO AMPL MAG OUT PHONO TERMINAL (O) L

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.

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

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

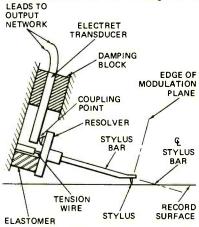


FIG. 5—SIDE VIEW showing basic construction of the QDC-1 electret cartridge by Micro-Acoustics. Stylus bar exerts pressure on two electret elements through resolver bar.

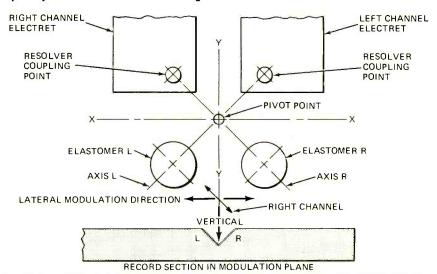


FIG. 6—RESOLVER GEOMETRY illustrates how resolver exerts varying pressures on the electrets in response to record groove modulation in the QDC-1 cartridge.

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

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-

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—50,0004	28	<b>2</b> 5	S	0.75—1.5	5.75	0.65	47K/200pF	\$12	,00
Audio Technica U.S. 33 Shiawassee Ave. Fairlawn, OH 44313	AT—12S AT—14S AT—15S AT—20SL	DMM DMM DMM	15—45,000 5—45,000 5—45,000 5—50,000	25 25 25 (min.) 25 (min.)	15 15 15 (min.) 15 (min.)	S S S	1.0—2.0 1.0—2.0 1.0—2.0 1.0—2.0	6.9 6.7 8.5 8.5	0.54 0.54 0.54 0.54	47K—100K 47K—100K 47K—100K 47K—100K	5 75 5100	95 00 .00
Bang & Olufsen of America 2271 Devon Ave., Elk Grove Village, IL 60007	MMC 6000	MI	20—45,000	25 (min.)	15 (min.)	01	1.0	<b>5</b> .5	0.6	100K/100pF	<b>3</b> 8!	.00
Benjamin Electronic Sound Co. 40 Smith St., Farmingdale, NY 11735	ELAC STS-655-D4	MM	1050,000	26	20	S	1.0—2.0	6.0	0.8	47K—100K	2 00	.00
Empire Scientifc Corp. 1055 Stewart Ave., Garden City, NY 11530	4000D/I 4000D/II 4000D/III	MI MI	5—50,000 5—50,000 5—50,000	27 30 35	20 23 25	0 0	1.0 1.0 1.0	7.0 7.0 7.0	3.0 <sup>3</sup> 3.0 <sup>3</sup> 3.0 <sup>3</sup>	100K 100K 100K	\$ 89 \$124 \$149	.95
Hitachi Sales Corp. of America 401 W. Arista Blvd., Compton, CA 90220	MT-14F®	DMM	20—45,000	NA	NA NA	S	2.0	NA	1.5—2.59	NA	\$350	00°
JVC America 50-35 56th Road, Maspeth, NY 11378	4MD-20X	мм	20—60,000	30 (min.)	20 (min.)	S	1.5—2.0	4.0	25.6	47K—100K	5 4	.95
Micro-Acoustics Corp. 8 Westchester Plaza, Elmsford, NY 10523	QDC-1q	EC	550,000	30	15	0	1.0-2.0	7.0	3.04	47K	5 26	00
Panasonic 200 Park Ave., New York, NY 10017	EPC-450C-II EPC-451	SG SG	050,000 050,000	<b>20</b> 20	15 15	S O	1.5—2. <b>5</b> 2. <b>0—3</b> .0	3.8	NA <sup>7</sup>	100K 100K	\$ 64 \$ 50	95 00 (arr
Pickering & Co. 101 Sunnyside Blvd., Plainview, NY 11803	UV-15/2400Q UV-15/2000Q	MI MI	10—50,000 10—45,000	<b>35</b> 30	20 20	0	1.5—2.5 1.5—2.5	6.0 6.0	0.6 0.6	100K/100pF 100K/100pF	\$ 225 \$ 65	95 90
Stanton Magnetics, Inc. Terminal Drive, Plainview, NY 11803	780/4DQ 780/Q	MI MI	1050,000 1045,000	35 30	20	0	1.5—2.5 1.5—2.5	6.0 6.0	0.6 0.6	100K/100pF 100K/100pF	512E 5 7E	
Toshiba America, Inc. 280 Park Ave., New York, NY 10017	C-404X	EC	2050,000	25	15	0	1. <b>0—</b> 2.0	6.5	10	NA	N	
U.S. Pioneer Electronics Corp. 75 Oxford Drive, Moonachie, NJ 07074	PC-Q1	IM	10—50,000	25	20	0	1.02.1	5.5	0,4	100K	1 68	95
Codes: DMM—dual moving mag EC—electret capacitor IM—induced magnet MC—moving coil MI—moving iron MM—moving magnet	SG-	or not a —Strain g -multi-rad	ial stylus, Shibata type		1—Cartridge to manuf replacem 2—@ ±2.5d 3—@ 3.54 c 4—@ ±5dB 5—@ 1 cm/	acturer nent. IB m/sec.	oe returned for stylus		8—Cartric Availa the PS demod	m/sec. res external DC dge not sold sep ble only as a pa -14 turntable ar dulator combina z; 1.5—3.5 mV	arate of of od CE tion	ily. :-4

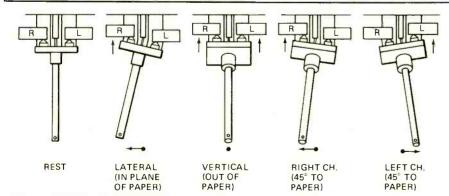


FIG. 7—STYLUS BAR MOVEMENT is transmitted through resolver in response to lateral and vertical movement of the stylus tip.

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 notion. 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 coll systems, each responsive to magnet movement in a single plane. Generally, the design requires a relatively large and heavy magnet structure that results in limited highfrequency 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.

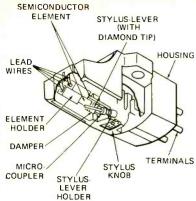
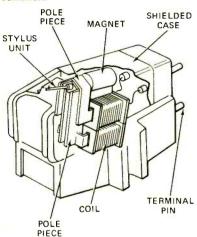


FIG. 8-A PIEZORESISTIVE SEMICONDUC-TOR element is the heart of Panasonic's EPC-450C-II strain-gauge cartridge, Motion at the stylus tip varies the resistance of the transducers. A fixed bias voltage develops a current that varies with groove modulation.



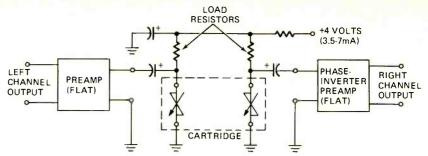


FIG. 9-PREAMPLIFIER for strain-gauge cartridge. Photoresistive elements are across preamplifier inputs and in series with load resistors and a bias supply. Two flat preamplifiers and a phase inverter feed signals to CD-4 demodulator circuits.

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.

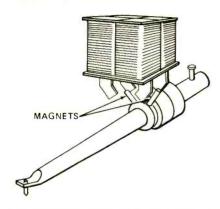
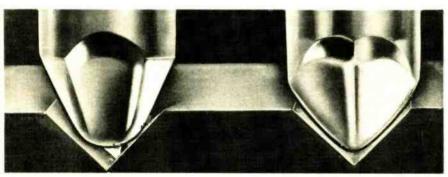
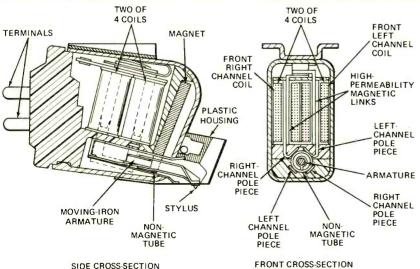


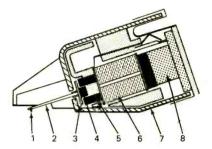
FIG. 11 (above)—DUAL MAGNETS driven by the stylus are features of the Audio-Technica cartridges.

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





SIDE CROSS-SECTION



KEY

- NUDE PRAMANIK
- (SHIBATA-TYPE) DIAMOND
- LOW-MASS BERYLLIUM CANTILEVER
- MOVING MICRO CROSS
- BLOCK SUSPENSION POLE PIECES (4)
- INDUCTION COILS (4) MU-METAL SCREEN
- HYCOMAX MAGNET



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 CONSTRUC-TION 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 movingiron 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)

# JUNE 1978

# 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 every-day 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 oscil-

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

\*Design Engineer Heath Company, Benton Harbor, Mich.

in the sub \$1,000 class, mostly service instruments. Such items as specialized plug-ins, spectrum analyzers, and time-domain reflectometers, are not discussed.

#### **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

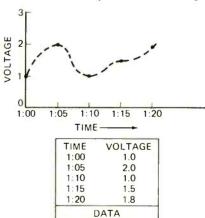


FIG. 1—MEASUREMENTS CAN BE MADE without the aid of an oscilloscope by plotting measurements that were taken at predetermined points in time.

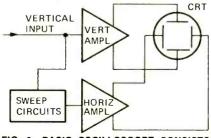


FIG. 2—BASIC OSCILLOSCOPE CONSISTS OF a vertical amplifier, sweep crciuits and horizontal amplifier driving a cathode-ray tube.

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 p'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.

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.

#### 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

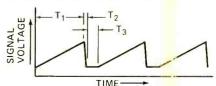


FIG. 3—SAWTOOTH OR RAMP WAVE-FORM commonly used by the sweet circuits to provide horizontal displacement of the CRT beam,

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

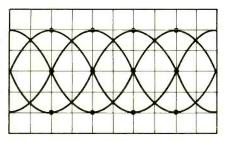


FIG. 4—RANDOM DISPLAY of a sinusoidal signal occurs when a free-running oscillator is used in the time base circuit.

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 oscil-

lator. 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.

#### **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 freerunning 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 parti-

ally 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 dualbeam 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,

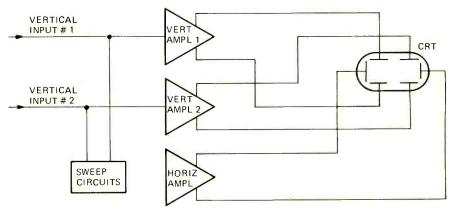


FIG. 5—DUAL-BEAM uses two sets of vertical deflection circuits to present two input signals independently.

JUNE 1975

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.

time base periods, one must carefully scrutinize the trace to observe the chopping effect.

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 ex-

illustrated in Fig. 7. The time intervals

in Fig. 7 are considerably exaggerated.

In actual practice, even at quite short

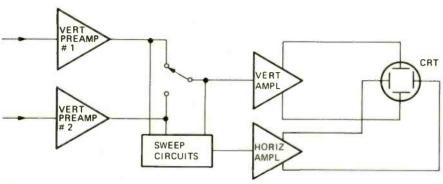


FIG. 6—DUAL-TRACE OSCILLOSCOPE uses one set of deflection circuits and a special switch to present two input signals.

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 I 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, hut is alternated by a high frequency oscillator, generally in the 50-200 kHz region. This produces a trace by the technique

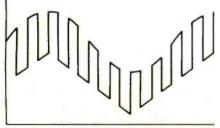


FIG. 7—CHOPPED MODE is used by a dual-trace oscilloscope when the time base frequency is too slow to use the alternate mode.

panded 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 hetween 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 perfermance 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 or page 85)



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## 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 non-professional 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 metal-oxide semiconductor 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

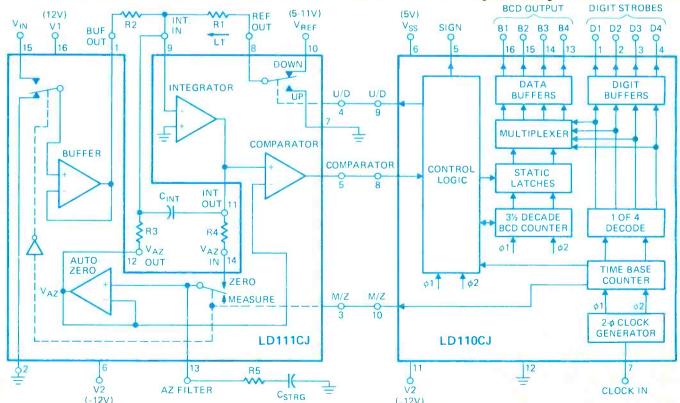
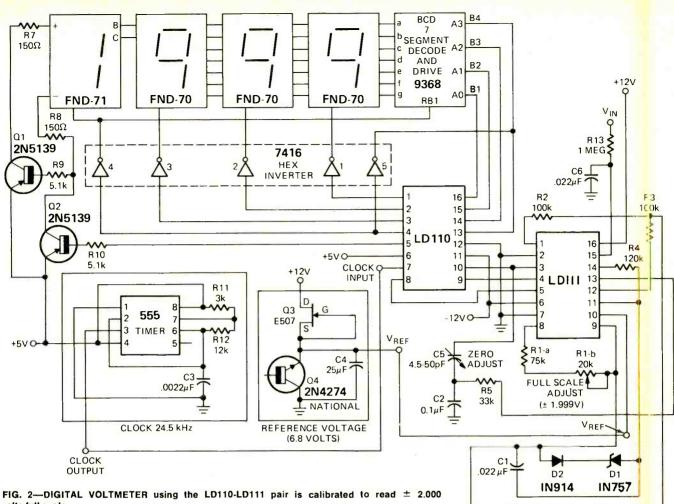


FIG. 1—SILICONIX'S ANALOG-TO-DIGITAL CONVERTER consists of the LD110 and LD111 IC's.



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 31/2-digit decade counter is stored in binary latches and multiplexed or sequentially sampled to drive a binary-to-7segment 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 x 108 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 CINT. Like all operational amplifiers, the feedback keeps the am-

plifier'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 huffered input voltage through R2, the up-down counter switched reference voltage through R1, and the auto-zero amplifier output V<sub>AZ</sub> 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-todigital 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 1/4 second. One third of this time, the shorter of the two intervals spent in the autozero 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 huffer 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 updown counter is reset. There is a feedback path paralleling C<sub>INT</sub> 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 selfadjusts so the net integrator input current is zero towards the end of the interval. The current through R3 is VAZ/

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  $I_3 = V_{AZ}/R3 = -V_{REF}/2R$ 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 offzero potential.  $V_{\scriptscriptstyle AN}$  holds a small component on top of its  $V_{\scriptscriptstyle \rm REF}$  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. VAZ is held by CSTRG 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 RI 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<sub>IN</sub>/R2 and the current in R3 was already calculated to be VREF/ 2R1. R1 conducts an average current dependent on the net count. If the up and down counts are equal or NET-COUNT = UPCOUNT - DOWN-COUNT = 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<sub>REE</sub>/R1 or V<sub>REF</sub>/2R1. Some deduction leads to the

$$I_{\scriptscriptstyle 3} = \frac{V_{\scriptscriptstyle \rm REF}}{2R1} \, (1 - \frac{NETCOUNT}{4096})$$

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, should be zero and the equation agrees. Equating the sum of the currents during the measurement period to zero gives:

$$\frac{V_{IN}}{R2} - \frac{V_{RRF}}{2RI} + \frac{NETCOUNT}{400C} = 0 \text{ and}$$

NETCOUNT =  $8192 \times R1/R2 \times V_{1N}/$ 

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  $0.05\% \pm 1$  count. After the system settles down, the integrator current hunts above and below the comparator reference voltage V<sub>STRG</sub> 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  $\pm 2.000$  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 34 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 calcu-

lates as 10  $\log \frac{13}{1.3} = 10 \log 10 = 10$ dB gain.

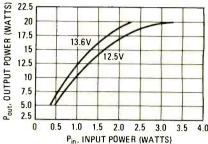


FIG. 3-OUTPUT POWER vs. INPUT POWER for Motorola's MRF-226 Citizen Band RF power transistors.

The driver-output pair sell for \$2,50 for the MRF225 and \$11.70 for the MRF226 in small quantities.

#### R-E's Substitution quide 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, III. 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
2N6236	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 TC 7001	NA	NA NA	NA	NA	NA	NA	NA	ECG 5423	NA	NA
2N6246		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 2N6250	NA NA	T-707 T-707	NA	ICC-707	NA	PTC 118	HEP-707	SK 3167	NA	NA	NA	ZIEN 204
			NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	NA	NA	ZIEN 204
2N6251	NA	T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZIEN 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 TO 7000	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 2N6262	NA	T-703	NA	ICC-703	NA	PTC 154	HEP-703	SK 3026	RT-154	ECG 175	WEP-241	NA
2N6262	NA NA	T-707 T-241	NA	ICC-707	NA	NA DTO 404	HEP-707	NA	NA	NA FOO 175	NA	ZIEN 204
			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 2N6289	NA NA	TS-5001 TS-5001	NA	PTC 137	NA	NA DTO 107	HEP-S5001	SK 3054	NA	NA	NA	ZEN 209
			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		HEP-S5001	SK 3054	NA	NA	NA	ZEN 209
2N6292	NA	TS-5004	NA	ICC-S5004	NA		HEP-S5004	SK 3054	NA	NA	NA	NA
2N6293 2N6296	NA	TS-5004	NA	ICC-S5004	NA			SK 3054	NA	NA	NA	NA
	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 2N6307	NA	T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZEN 204
2N6307 2N6308	NA NA	T-707 T-707	NA	ICC-707	NA	NA	HEP-707	NA	NA	NA	NA	ZIEN 204
2N6329	NA NA	NA	NA NA	ICC-707	NA	NA DTC 150	HEP-707	NA	NA DT 149	NA FCC 190	NA WED 87001	ZEN 204
2N6338	NA	TS-7000	NA	NA ICC-\$7000	NA NA	PTC 159 PTC 159	NA HEP-S7000	NA	RT-148	ECG 180 NA	WEP-\$7001	NA NA
2110000	11/	13-7000	IVA	100-37000	INA	FIC 159	HEP-3/000	NA	RT-149	INA	NA	INA

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

NA=NOT AVAILABLE

(tt.m page)

	ARCH	DM	G-E	ICC	IR	MAL	мот	RCA	SPR	SYL	WOR	ZEN
2R9.1 2R10 2R11 2R12 2R13	NA NA NA NA	RZ-2513 RZ-2514 NA RZ-2516 NA	NA NA NA NA	ICC-Z2513 ICC-Z2514 NA ICC-Z2516 NA	Z1512 NA NA Z1516 NA	NA NA NA NA	HEP-Z2513 HEP-Z2514 NA HEP-Z2516 NA	NA NA NA NA	NA NA NA NA	ECG 5124 ECG 5125 ECG 5126 ECG 5127 ECG 5128	NA NA NA NA	NA NA NA NA
2R15 2R16 2R18 2R20 2R22	NA NA NA NA	RZ-2519 NA RZ-2522 NA RZ-2525	NA NA NA NA	ICC-Z2519 NA ICC-Z2522 NA ICC-Z2525	NA NA Z1520 NA Z1522	NA NA NA NA	HEP-Z2519 NA HEP-Z2522 NA HEP-Z2525	NA NA NA NA	NA NA NA NA	ECG 5130 ECG 5131 ECG 5133 ECG 5135 ECG 5136	NA NA NA NA	NA NA NA NA
2R24 2R27 2R30 2R33 2R36	NA NA NA NA	NA RZ-2528 NA RZ-2531 NA	NA NA NA NA	NA ICC-Z2528 NA ICC-Z2531 NA	NA NA NA Z1526 NA	NA NA NA NA	NA HEP-Z2528 NA HEP-Z2531 NA	NA NA NA NA	NA NA NA NA	ECG 5137 NA ECG 5141 ECG 5142 ECG 5143	NA NA NA NA	NA NA NA NA
2R39 2R43 2R47 2R51 2R56	NA NA NA NA	NA NA NA NA RZ-2537	NA NA NA NA NA	NA NA NA NA ICC-Z2537	NA NA NA NA	NA NA NA NA	NA NA NA NA HEP-Z2537	NA NA NA NA	NA NA NA NA	ECG 5144 ECG 5145 ECG 5146 ECG 5147 ECG 5148	NA NA NA NA	NA NA NA NA
2R68 2R75 2R91 2R100 2R110	NA NA NA NA	NA NA NA RZ-2545 NA	NA NA NA NA	NA NA NA ICC-Z2545 NA	NA NA NA NA	NA NA NA NA	NA NA NA HEP-Z2545 NA	NA NA NA NA	NA NA NA NA	ECG 5151 ECG 5152 ECG 5155 ECG 5156 ECG 5157	NA NA NA NA	NA NA NA NA
2R120 2R130 2R140 2R150 2R160	NA NA NA NA	RZ-2547 NA NA NA NA NA	NA NA NA NA	ICC-Z2547 NA NA NA NA	NA NA NA NA	NA NA NA NA	HEP-Z2547 NA NA NA NA	NA NA NA NA	NA NA NA NA	ECG 5158 ECG 5159 ECG 5160 ECG 5161 ECG 5162	NA NA NA NA	NA NA NA NA
2R180 2R200 2S001 2S002 2S003	NA NA NA NA	NA NA T-51 T-51 T-53	NA NA NA NA	NA NA NA NA	NA NA TR-86 TR-86 TR-86	NA NA PTC 132 PTC 132 PTC 132	NA NA NA NA	NA NA SK 3124 SK 3124 SK 3124	NA NA RT-100 RT-100 RT-100	ECG 5164 ECG 5166 ECG 123 ECG 123 ECG 123	NA NA WEP-53 WEP-53	NA NA NA NA
2S004 2S005 2S006 2S014 2S017	NA NA NA NA	NA T-51NA T-51 T-243 NA	NA NA NA NA	NA NA NA NA	TR-86 TR-21 TR-95 TR-87 TR-87	PTC 132 PTC 132 PTC 121 PTC 132 PTC 144	NA NA NA NA	SK 3124 SK 3124 SK 3039 SK 3020 SK 3024	RT-100 RT-102 RT-113 RT-114 ER-114	ECG 123 ECG 123A ECG 108 ECG 128 ECG 128	WEP-53 WEP-736 WEP-56 WEP-243 WEP-243	NA NA NA NA
2S018 2S019 2S020 2S021 2S022	NA NA NA NA	NA T-243 NA NA T-52	NA NA NA NA	NA NA NA NA	TR-87 TR-87 TR-87 TR-87 TR-86	PTC 144 PTC 144 PTC 144 NA NA	NA NA NA NA	SK 3024 SK 3024 SK 3024 SK 3025 SK 3025	RT-114 RT-114 RT-115 RT-115	ECG 128 ECG 128 ECG 128 ECG 129 ECG 129	WEP-243 WEP-243 WEP-242 WEP-242	NA NA NA NA
2S023 2S033 2S034 2S035 2S036	NA NA NA NA	T-52 NA NA NA NA	NA NA NA NA	NA NA NA NA	TR-86 TR-59 TR-59 TR-67 TR-67	NA PTC 110 PTC 110 NA NA	NA NA NA NA	SK 3025 SK 3027 SK 3027 NA NA	RT-115 RT-131 RT-131 NA NA	ECG 129 ECG 130 ECG 130 ECG 162 ECG 162	WEP-242 WEP-247 WEP-247 WEP-707	NA NA NA NA
2S095 2S0226 2S0371 2S0460 2S12	NA NA NA NA	NA NA NA NA	NA NA NA NA GE-2	NA NA NA NA	NA NA NA NA TR-05	PTC 136 NA NA NA PTC 102	NA NA NA NA	NA NA NA NA SK 3005	NA NA NA NA RT-118	NA NA NA NA ECG 100	NA NA NA NA WEP-254	NA NA NA NA
2S13 2S14 2S15 2S16E 2S22	NA RS276-2005 RS276-2005 NA RS276-2005	T-254 T-254 T-254 NA T-254	GE-2 GE-52 GE-52 NA GE-52	ICC-254 NA ICC-254 ICC-R0050 ICC-254	TR-05 TR-05 TR-05 806 806	PTC 102 PTC 102 PTC 102 NA PTC 102	HEP-254 NA HEP-254 HEP-R0050 HEP-254	SK 3005 SK 3004 SK 3004 SK 3016 SK 3004	RT-118 RT-120 RT-120 RT-215 RT-120	ECG 100 ECG 102 ECG 102 ECG 116 ECG 102	WEP-254 WEP-631 WEP-158 WEP-631	ZEN 305 ZEN 305 ZEN 305 NA ZEN 305
2S24 2S25 2S26 2S30 2S31	NA NA NA RS276-2005 RS276-2004	NA NA NA T-636 T-253	GE-52 GE-2 GE-16 GE-1 GE-1	NA NA NA ICC-636 ICC-253	TR-05 TR-05 TR-01 IRTR-85 IRTR-05	PTC 102 PTC 102 PTC 105 PTC 109 PTC 109	NA NA NA HEP-636 HEP-253	SK 3004 SK 3005 SK 3009 SK 3005 SK 3005	RT-120 RT-118 RT-127 RT-118 RT-118	ECG 102 ECG 100 ECG 121 ECG 100 ECG 100	WEP-631 WEP-254 WEP-232 WEP-254 WEP-254	NA NA NA ZEN 312 ZEN 304
2\$32 2\$33 2\$34 2\$35 2\$36	RS276-2004 RS276-2005 RS2276-2005 NA NA	T-253 T-254 T-254 T-2 T-2	GE-1 GE-1 GE-254 GE-50 GE-50	ICC-253 ICC-254 TR-05 ICC-2 ICC-2	IRTR-05 IRTR-85 PTC 102 TR-17 TR-17	PTC 109 PTC 109 HEP-254 PTC 107 PTC 107	HEP-253 HEP-254 SK 3004 HEP-2 HEP-2	SK 3004 SK 3004 RT-120 SK 3008 SK 3008	RT-120 RT-120 ECG 102 NA NA	ECG 102 ECG 102 WEP-631 ECG 126 ECG 126	WEP-631 WEP-631 ZEN 305 WEP-635 WEP-635	ZEN 304 ZEN 305 ZEN 300 ZEN 300
2S37 2S38 2S39 2S40 2S41	RS276-2005 RS276-2005 RS276-2005 RS276-2005 RS276-2006	T-254 T-254 T-254 T-254 T-230/232	GE-52 GE-2 GE-52 GE-2 GE-3	ICC-254 ICC-254 ICC-254 ICC-254 ICC-230/232	TR-05 TR-05 TR-05 TR-05 TR-01	PTC 102 PTC 135 PTC 102 PTC 135 PTC 114	HEP-254 HEP-254 HEP-254 HEP-230/232	SK 3004 SK 3004 SK 3004 SK 3004 SK 3009	RT-120 RT-120 RT-120 RT-120 RT-124	ECG 102 ECG 102 ECG 102 ECG 102 ECG 104	WEP-631 WEP-631 WEP-631 WEP-230	ZEN 305 ZEN 305 ZEN 305 ZEN 305 ZEN 325/326

<sup>\*</sup>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

## **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 transition of the stopping of the stop

sistor 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 HOFIZONTAL 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 VDF can be (continued on page 68)

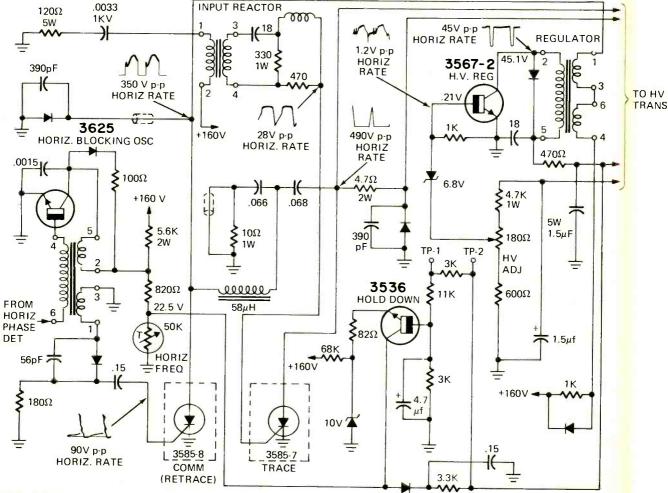


FIG. 3—A SOLID-STATE VERSION—the hold-down circuitry used in RCA's CTC54.

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ment with this remarkable piece of equipment, you'll learn about matrix 4-channel and discrete-including CD-4 when processed through an external demodulator.

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Circle 16 on reader service card

(continued from page 63)

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

Figure 4-a is the typical circuit used in

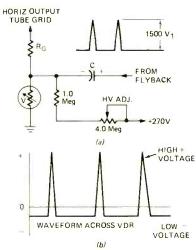


FIG 4—HOW A VDR can be a rectifier.

itor; 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

age is developed and applied to the bot-

tom 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 capac-

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

FLYBACK PULSES open, the output tube will try to drive its own grid into cutoff. (continued next month) FROM TO INPUT OF HORIZ TO HORIZ VOLTAGE OSC AFC TRIPLER BRN 19CG3 100Ω DAMPER 3.9K **≸** 7W 1 MEG 180pF TO PIN 6KV VDR 10µH 7 OF WHT J 204 +270V 1 MEG (YOKE) RED HV ADJUST то C264 390pF YOKE 180pF 3KV ORN PLUG TO PINCUSHION 3K V, 5% SATURABLE 1200V REACTOR 10uH +780V o QQQQ 1KV TO PIN 9 +270V

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.

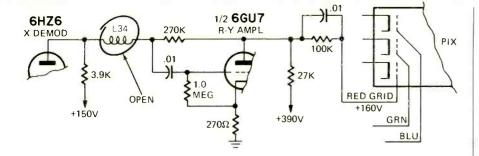
During the high-conduction parts of the spike, capacitor C charges up. The higher resistance of the VDR during the low-voltage part of the waveform won't let it discharge. So, a high negative volt-

# 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-

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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 greyscale 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-

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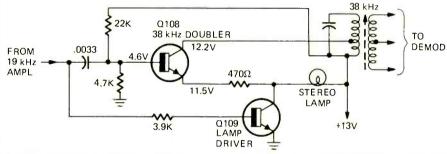
SERVICE SW O SERVICE PART OF 2 7K NORM FROM 6K 6K VIDEO BLU GRN OUTPUT PIX DRIVE DRIVE PLATE 2W 18K 39K 4W +405V +345V GRIDS (APPROX) AROUT INCREASED? DECREASED? +160V odes should be about +345 volts,

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 highvoltage 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.



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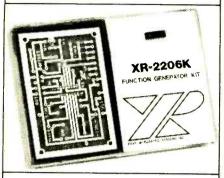


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#### **HOW R-E TESTS HI-FI GEAR**

(continued from page 43)

#### **OPEN-REEL TAPE DECK MEASUREMENTS**

FREQUENCY RESPONSE MEASUREMENTS Standard Tape	R-E Measurement	R-E Evaluation
Frequency response @ 15 ips (Hz-kHz ± dB)		Lvalaation
Frequency response @ 7½ ips (Hz-kHz ± dB)		
Frequency response @ 3¾ ips (Hz-kHz ± — dB)		
CRO₂ 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<sub>2</sub> 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<sub>2</sub> 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.

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CASSETTE TAPE DECK MEASU	JREMENTS	
FREQUENCY RESPONSE MEASUREMENTS	R-E Measurement	R-E Evaluation
Frequency response, standard tape (Hz-kHz ± dB)	Wicasarcinicit	Lvaldation
Frequency response, CRO <sub>2</sub> tape (Hz-kHz ± dB)		
Frequency response, other (see text) (Hz-kHz ± dB)		
Trequency response, other (see text) (the time	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)		
CRO₂ tape, "Dolby" off (dB)		
CRO₂ 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 (1½ 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.

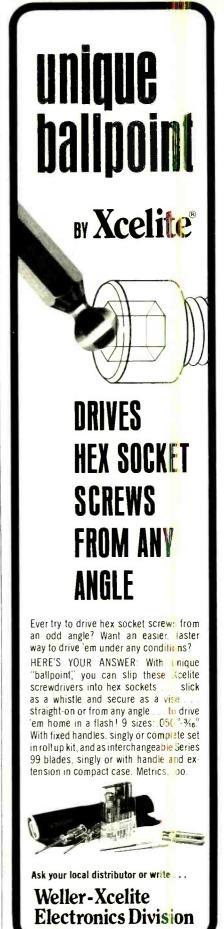
COMPONENT MATCHING CHARACTERISTICS. These observations are intended to enable the reader to select the right microphone for use with the machine and also to insure a good match between tape-output level of amplifier or receiver and the deck, and between the deck and the tape input circuitry or associated 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)



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"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."

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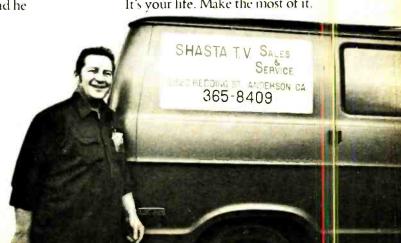
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It's your life. Make the most of it.

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)

If card is missing, write for free career booklet to: International Correspondence Schools, Scranton, Pa. 18515. ©1974 ICS.



(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

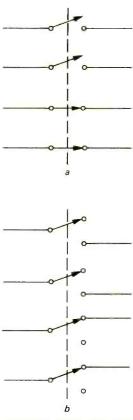


FIG. 4—ORIGINAL SWITCHES used for S1 through S15 were 4PST types with two contact pairs open and two contact pairs closed and are shown in a. In their place, 4PDT switches can be used if they are wired as shown in b.

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.



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RADIO-ELECTRONICS

## equipment reports

#### 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

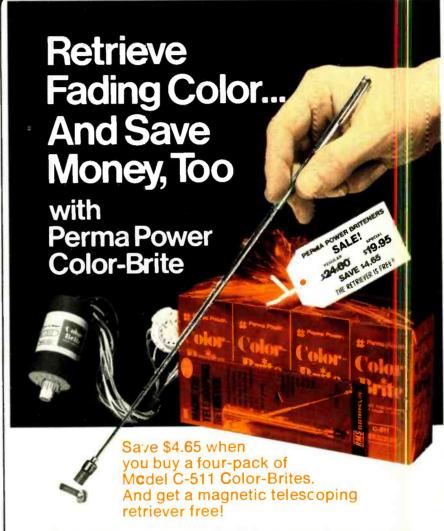
The ohmmeter section has both standard and low-voltage functions. On the standard ranges, 1.5 volts appears across the prods. On the low-voltage ohms setting, only 85 millivolts; this will not turn on transistor junctions.

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 probes, they're not. Each one has two leads, and special concentric probe tips. These tave a sharp, spring-loaded inner tip and an (continued on page 88)



Ever dropped a nut or screw and had it bounce away from you, out of reach? With this magnetic telescoping retriever, it's easy pickings! The 5" long retriever clips to your pocket, so it's handy whenever you need to retrieve a part as far as 19 inches away.

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Circle 27 on reader service card

## 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.

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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 VAC 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 associated 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.  $2.5\times3.5\times1.25$  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 ½-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 134 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. Al-

though shipped dismantled, it can be easily assembled; only tool required is a screw-driver 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

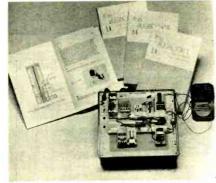


sound. If a background music channel were required in an apartment system, this unit could be fed by the background music source and then into the MATV system head end. Tenants could then hear the background music on their TV receivers. Can also be used to make announcements. Accepts a minimum of 50 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 31/2 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 in-

struction. 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.

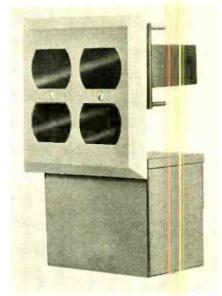
—E & L Instruments, Inc., 61 First Street, Derby, CT 06418.

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 3% in. deep.—Alarm Device Manufacturing Co., 165 Eileen Way, Syosset, NY 11791.

Circle 38 on reader service card

FOAM SPEAKER GRILLE KITS. Do-it-your-self 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.

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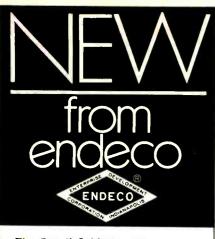
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   Desoldering Kits
  - Soldering Kits
     Soldering/Desoldering Kits

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Circle 29 on reader service card

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

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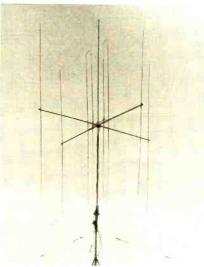
gain where it is needed most without diminishing performance of original VHF antenna. These antennas replace previous VHF-UHF Crossfires model for model. In addition, there are two special models designed for areas that require only moderate VHF gain but very high UHF gain.

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.—Conrac 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."

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. 126page 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 cas-

settes, how is sound added to slides?, how to add sound to 8-mm films. Many diagrams. BASF Systems, 460 Colfax Avenue, Clifton, NJ 07013.

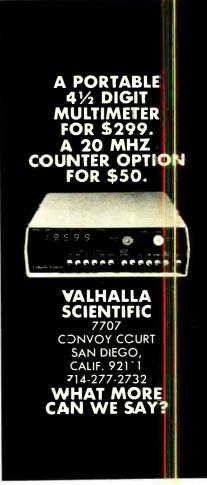
Circle 43 on reader service card

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 encodedecode 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.





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.M341P-XX	(0.5A		1.45	LF311H	5.50	LM381AN	3.70
M342P-XX			.99	LM306H	5.95	LM386N	1.35
Note:	(0.27			LM311N	1.95	LM387N	1.65
	5.2.6.0	, 8, 12, 15, 1	8. 24V	LM311H	2.95	LM703LN	.85
_M345K		-5.2V)	6.75	LM339N	2.35	LM733CN	1.35
_M323K	(3A.	+5.0V)	6.25	LM360N-8	3.39	LM1303N	1.60
_M309K	(1A,	+5V)	2.75	LM361N	1.95	LM1310N	2.40
M325AN		,±15V, 1%)	3.45	LM710CN	.60	LM1351N	1.10
_M325N		(,±15V, 5%)	2.60	LM2901N	1.95	LM1800N	2.25
LM326		(±12V, 5%)	2.95	LM3302N	1.50		
LM327N		1 <u>.</u> + 5V. – 12V.		TIME PIECE	CIRCUI	TS	
LM723CN		Reg.	.79	SCL5411AT		SCL5440F	38.00
LM304H		Reg.	3.25	SCL5420F	21.00	SCL5441F	28.00
LM305H		Reg.	2.00	SCL5424F	29.00	SCL5442F	39.00
LM376N		Reg.	1.50	SCL5425F	12.00	SCL5443F	21.00
TIMERS, OF				SCL5427F	12.00	SCL5447F	20.00
LM555CN	.79	LH0032CG	26.50	SCL5437F	12.00		
LM565CN	1.75	LM301AN	.67	C1103	F 00	2526B	16.00
LM565CH	3.50	LM308AD	11.50	P2102-2	5.00 7.95	2527V	5.00
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LH0042CH	11.00	LM318H	3.25	2519B	3.75	MM5056N	3.95
LH0042CH	5.25	LM318N	2.95	2521V	3.50	MM5057N	3.95
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LH0043CG	27.50	LM324N	2.50	2525V	5.00		

IMERS, OP	. AMPS	PLL'S C	ont.	CMOS					
M343H	6.00	LM322N	2.50	4000	.47	4023	.47	4053	3.35
M358N	1.65	LM3905N	1.50	4001	. 47	4024	2.10	4060	4.62
M725CN	3.00	LM371H	2.10	4002	.47	4025	.47	4066	.79
_M741CH	.55	LM375H	3.00	4006	2.66	4026	4.15	4069	.47
M747CN	1.55	LM377N	2.75	4007	.39	4028	2.60	4071	.47
_M1458N	1.28	LM378N	3.25	4008	2.70	4029	4_79	4072	.47
_M3900N	.89	LM379M		4009	1.20	403C	1 19	4073	.47
M2902N		LM380N	1.25	4010	1.30	4033	4.27	4081	.47
M4250CN	3.65	LM381N	1.85	4011	.47	4034	9.99	4082	47
F311H	5.50	LM381AN	3.70	4012	.47	4035	3.20	4502	2.35
-M306H	5.95	LM386N	1.35	4013	1.12	4040	3.79	4510	5.55
-M311N	1.95	LM387N	1.65	4014	2.99	4041	2 64	4511	79
_M311H	2.95	LM703LN	.85	4015	.99	4042	2 92	4514	7.70
M339N	2.35	LM733CN	1.35	4016 4017	2.93	4044	2.92	4515	7.70
_M360N-8 _M361N	1.95	LM1303N LM1310N	2.40	4017	3.36	4046	3.43	4516	5.40
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M2901N	1.95	LM1800N	2.25	4020	3.19	4050	120	4527	4.63
M3302N	1.50	LIVITOUUN	2.23	4021	2.89	4051	3.35	4528	3.33
IME PIECE		re		4022	2.79	4052	3 35		
SCL5411AT	6.00	SCL5440F	38.00	TOLL		,,,,,			
SCL5411A1	21.00	SCL5441F	28.00						
SCL5424F	29.00	SCL5442F	39.00						
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#### **HOW R-E TESTS HI-FI GEAR**

**OVERALL PHONO CARTRIDGE RATING** 

(continued from page 73)

#### PHONOGRAPH CARTRIDGE MEASUREMENTS

EDECUTION DESCRIPTION OF THE PROPERTY OF THE P	R-E Measurement	R-E Evaluation
FREQUENCY RESPONSE (Hz-kHz, ± dB)	-	
STEREO SEPARATION	See Fig.	
Separation, 1 kHz (dB)		
Separation, 10 kHz (dB)		
Separation, 30 kHz (dB)		
CHANNEL BALANCE, 1 kHz (dB)	2	
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)		

#### 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 hifi 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)

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

-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)



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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 e ased. With the digital-storage technique, the signal is applied to an analog-to-ligital 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 sorage (continued on page 87)

### (C293) SEVEN SEGMENT SURPLUS TUBES All guaranteed for H. LED's \$1.00 1 full year. 14 pin DIP guar. ANY 3 FOR \$1.25 ☐ (C175) 70 1/2 w CARBON Acquired from U.S. Defense depots RESISTORS or removed from equipment (new and used). These are laboratory tested and guaranteed for one full year, Most are of such standard makers as RCA, GE, etc. Asst. values, Some 5%. C154) 150 CUT LEAD RESISTORS Carbon, all leads long enough for soldering. 6AQ5 6DE4 6DR7 6AQ7 6AT6 GRADE CAPACITORS \$1.00 **3RN6** 6DW4 6EA8 1 AE, 1 AL5 1 AL11 1 AT7 1 AU7 1 AV6 PAE 7 \$1.00 HIGHEST QUALITY 6AV11 6AX4 6AX5 C253) 7 AMP POWER TRAN-**3KT6** 6F 17 3Q4 4BC5 SISTOR \$1.49 3E6 **4BN6** 6AY3 Si NPN. Similar to SK3054. 90v, 90w. 6AY11 6BA6 IZ8 W6 KQ6 4BZ7 4CY5 6RG6 6GN8 C (C132) 20 DUAL POTENTIOMETERS 4HA5 6GU7 ONLY NEW 5V6 5Y3 6AC7 6AF4 \$1.00 **6BQ6** 6K11 **PRODUCTS 6BZ6** Asst. ohmages 6CB6 6CG7 6LB6 6SN7 EH5 ☐(C131) 13 ELECTROLYTIC 25 4M3 CONDENSERS 6AG5 6AG7 6AL5 6AL7 3 IAM 5 IA5 5 IL6 6CL6 6CM7 618 (C128) 13 MINIATURE ELECTROLYTIC CAPACITORS \$1.00 Axial & upright, popular values. FP types, tubulars, some multi-ple sections. 6DA4 ☐ (C138) 10 SLIDE (C150) 15 HI-FI KNOBS \$1.00 SWITCHES \$1.00 (C182) 2 TUNING METERS Every one superb! Purchased from Harmon Kardon, Fisher, All types: DPDT, SPST, etc. \$1.00 ☐ (C134) 8 ROTARY Misc., miniature. SWITCHES \$1.00 ☐ (C427) 12" HEAVY DUTY (C153) CHASSIS Some multiple gang. WOOFER \$17.95 20 oz. ceramic magnet, 75 W RMS MYSTERY (C125) 4 TRANS-Take a chance! Could be a FORMERS \$1.00 C124) 3 TRANSISTOR EARPIECES With plug. recorder, radio, walkie talkie, Some power, filament, output, worth up to \$10 each. \$1.00 ☐ (C156) 60 DISC (C102) CALCULATOR KEYBOARD (C144) TRANSISTOR CAPACITORS \$3.95 REPAIR KIT Asst. from .0001 to .1, 600v, Z5U, NPO, N750, etc. Wild Rover C-1380. Can te used with CT5001. 4 function clear, clear entry and constant. Various parts used to repair transistorized devices. ☐ (C147) 4 lb. GRAB BAG (C137) 10 INSTRUMENT SPECIAL \$1.00 Full of exotic and exciting elec-SPECIAL (C222) 20 DIODES 1A 50PIV. Epoxy, guar. KNOBS \$1.00 Made by Ratheon, etc. With set tronics parts. ☐ (C417) 4" X-air SPEAKER \$6.95 15 watts, high compliance, re-sponse 35-16,000Hz. (C140) TAPE RECORDER SPARE PARTS KIT \$2.95 Parts for repairing most tape recorders: capacitors, meter, ☐ (C143) 20 RUBBER FEET \$1.00 For bottom of cabinets (C412) OUR FAMOUS 8 pilot lamp, jacks, and MUCH MORE. (C164) 4 ROLLS OF WIRE \$1.00 SPEAKER \$5.95 Approx. 25 ft, per roll, 20-28ga. Full Range, whizzer core, 30-20,000Hz, 30 watts. (C148) 4 ROCKER SWITCHES ☐ (C155) TUBE BONANZA! \$1.00 \$1.00 Assorted. (C126) 10 HUM BALANCERS 20 asst. popular tubes, untested. (C141) 6 RCA JACK STRIPS \$1.00 ☐ (C223) 10 ASST. LED's \$1.00 From 2-6 per strip. \$1.00 (C575) BATTERY CLIPS \$ .15 For stand. 9v battery. (C142) 50 PRECISION ☐ (C178) 2 BATTERY RESISTORS (C1094) DISPENSER PACK MOTORS Misc. \$1.00 All 1%, 1/2w and 1w, low and SOLDER .59 \$ .59 60/40 Rosin Core, .04" 1 110". high ohmages. ☐ (C242) 3 LED's Yellow or green (specify) guar. C(174) 20 SCREW TERMINAL BOARDS Speaker type, from 2-8 term. MONEY BACK GUARANTEE ☐ (C001) 5 RED LED's Terms: Minimum order \$4.00. Include postage. Either full payment with order or 20% deposit, balance C.O.D. guaranteed \$1.00 (CLSS32) 10 ZENER ☐ (C136) 50 RADIO KNOBS \$1.00 DIODES \$1.19 1w, 3-30v, under 1v forward characteristic. Asst. shapes, sizes, colors. ☐ (C181) 8 NE2 NEON WRITE FOR FREE LAMPS (C167) 10 MINIATURE POTENTIOMETERS VALUE PACKED CATALOG With pigtail leads. POTENTIOMETERS \$1.00 For transistor applications. C377) SMALL PHONO ARM BONUS

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### **HOW R-E TESTS HI-FI GEAR**

**OVERALL TURNTABLE SYSTEM RATING** 

(continued from page 84)

TURNTABLE SYSTEM MEASU	REMENTS	
	R-E	R-E
PERFORMANCE CHARACTERISTICS	<b>Measurement</b>	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		

### 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 subaudible 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

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  $16\frac{2}{3}$  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 PRODUC	CT 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 systemhow well it reproduces music in the home. We will try not to fall into that trap!

### 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 hy 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. 91/4 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 readershipstudents, designers, technicians and anyone else who would like to have a source of upto-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., Englawood 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 Crawings, shearing, chassis layout techniques and goes on through printed circuit board maerials, printed circuit board processing, chassis hardware and assembly, harness and cable fabrication.



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in most every electronic area . . . the L80-502 is also a vectorscope. Basic specifications include: Automatic and Triggered sweep from  $1\mu$  sec/cm to 0.5sec/cm, 17 steps calibration: magnification is 5X, max sweep  $0.2\mu$ sec/cm; vertical sensitivity is from 10mVp-p/cm to 20Vp-p/cm; bandwidth is DC to 15MHz; rise time is 35 nanoseconds. Compact, lightweight, complete with probe, adapter and leads.

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### **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 commonmode-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 1/8 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,

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for example, by putting one clip on each end of the wire.

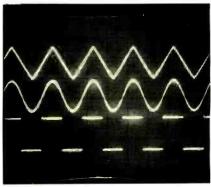
The circuit also detects the polarity of

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.

### Heathkit IG-1271 Function Generator



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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 mus 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)

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RADIO-ELECTRONICS

# 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 81/4 in. Softcover \$4.50 (in Canada \$5.40).

The book will acquaint the reader with hi-fi circuitry and trouble-shooting 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 signon, 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. 81/4 x 51/4 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.

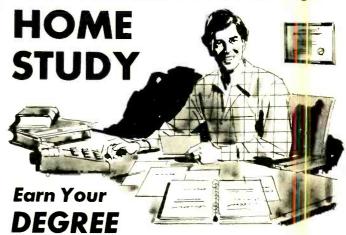
Many specific circuits designed to perform particular tasks are depicted. By concentrating on explanation and orientation to specific applications, the end product is a wide variety of performance-tested circuits.

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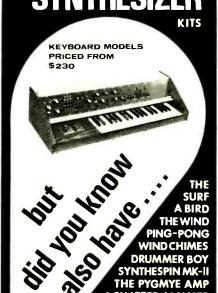
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meet your unique requirements, it combines the SK-10 socket with the UMP-01 universal panel and gives the designer an instrument in

**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 1/4 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 1kHz 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 meas-

ured values:		
Parameter Frequency	Specification	Measured Value
accuracy	dial scale	<b>+2</b> , <b>−1%</b>
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 voits p/p
Flatness	±1.5 dB 0.1 Hz to 1 MHz	+0, −1 dB

Enclosed in a 81/8-in. deep by 71/4-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)



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25—Knurled Shaft KNOBS Hard to get, Best selection 25—Clock & Radio KNOBS 100	Transistor Specials—Your Choice	70° TV DEFLECTION YOKE 900	in performance
25—Clock & Radio KNOBS 100	SK3006. SK3018. SK3020 100 SK3122 SK3124 16a.	for all type TV's (Blk. & Wht.)	Portable "Substi-Tuner"— A 750
Most popular types  ANY 6 KITS FOR \$5	SK3122. SK3124 Lea. Transistor Specials—Your Choice 198	BACK Part #8FT592 Equiv.	Portable "Substi-Tuner"— 4250 Instant Tuner Check
TRANSISTOR RADIO	SK3009. SK3024, SK3040	Stancor #HO-408— 295 Thordarson #Fly339	TELEMATIC Test Jig Model EJ-190—Master Rigs—
asst type good, bad, broken, 150	TACHOMETER 21/4" Sq. Panel Meter 1-VDC, full scale 33 Ohm 200	90° COLOR YOKE For all	Combo Rigs—Econo Rigs 4995
as-is, potluck	coil resistance 0-6000 R.P.M.	Rectangular 19 to 25" Color CRT's	KLEPS "CLEVER" TEST PHODS
TAPE RECORDER assorted types good, bad	I—CASSETTE type dynamic Mike 299	70 COLORE YOKE Q95	"Third-hand" test prods, reach into
proken, as-is, poetuck	VUI PANEL MEIER 29	For all round color CRT's O DELMONICO NIVICO COLOR 795	out of way places - Insulated cannot slip - accommodates bare wire or
200 ASST. ½ W RESISTORS Top Brands, Short Leads,	0-20 db Scale	FLYBACK Part #A20411-B	hanana blug—no soldering.
Excellent Selection	2 Cond. mini zip, 101 uses	CARVEO TARRIAN TUMER	PRUF 10— 89°
75-ASST 1/4 WATT RESISTORS 100	WAHL-CORDLESS SOLDER	SARKES TARZIAN TUNER	
stand, choice ohmages, some in 5% 100—ASST 1/2 WATT RESISTORS 100	IRON Complete with Auto tharger - Fast Heating - Compact 1995 5—Audio Output TRANSFORM 100	41mc	Boathook Clamp 43/4" lone 1
stand, choice ohmages, some in 5%	5—Audio Output TRANSFORM 100	TIMO	Boathook Clamp 7" long 149
70—ASST I WATT RESISTORS 100 stand, choice changes, some in 5%	5-1.F. Coil TRANSFORMERS 100	Latest Compact	KLEPS 30- 179
35-ASST 2 WATT RESISTORS 100	456-kc for Transistor Radios	Model good for	flexible-forked Tongue 6" ling 1
stand, choice chinages, some in 5% 100—PRECISION RESISTORS 100	6" UNIVERSAL SPEAKER Top quality Special buy EA. 159	all 41 mc TV's.	Board Terminals 61/4" long 259
asst. list-price \$50 less 98%	12" UNIVERSAL SPEAKER 589	BRAND NEW —	KLEPS I-ECONOMY QQ:
RESISTORS, 5, 10, 20 watt	Top Quality Large Magnet 10" PHILCO SPEAKER 395	1122	
10-ASST SLIDE SWITCHES 100			# TV ALIGNMENT TOOLS 100
SPST, SPDT, DPDT, etc. 100	8" UNIVERSAL SPEAKER— 299 Large Magnet—Special Buy 299		4 — TV ALIGNMENT T)OLS 149
For Transistors	3" UNIVERSAL TWEETER 129	Best TUNER "SARKES TARZIAN" ever made — last word for stability,	For Color TV #2
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- I-ELECTROLYTIC COND. 100	Special Buy 10 for \$5 EA. UJ	An opportunity—to improve and bring	TV TWIN LEAD-IN 100
☐ 200/300/100/100 MFD—25V ☐ 1—ELECTROLYTIC COND 100	4"X6" "QUAM" IO UHM SPK.	795	☐ 300 ohm 500'—\$7 100'—\$1,50 50' ☐ CO-AX CABLE RG59U (Black) 769
100 14 1773 20017	(10 for \$15.00)	Complete with Tubes	250'—\$10, 100'—\$4.50, 50'
3-ELECTROLYTIC COND 100	UTAH 8"-HEAVY DUTY 10 DZ. 150	WESTINGHOUSE FM TUNER 399	250'—\$10, 100'—\$4.50, 50' 5—DUAL DIODE—MOST
20/20 MFD-450V 40—ASST. TUBE CARTONS 100	SPEAKER Ceramic Type—8 Ohm 1—6"x9" Heavy Duty 10 oz. Speaker 150	# 4.6-V-015D0 1 Transistor	cathode or Series connected 250
Most popular types 2—ELECTROLYTIC Condensers	Ceramic Type 8 Ohm	(12DT8 Tube)	CONVERGENCE RECTIFICA-
300 mfd-200V, 100		UHF TUNER—Transistor Type Used in all TV sets	For COLOR TV 4 Cell— Used in RCA—Philco, etc.
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□ 75/30mfd-150V 1	STEREO MICROPHONES C50	TOR TYPE Model #85X4 J	Dual—RCA part # 135932 \$3.95
ELECTROLYTIC CONDENSERS 100	FL 1979/01 Made in Holland SET O	Model #94C393-1 (2HA5-4LJ8) 795	COLOR POWER TRANS.  Good for most sets 26R150  Lint Pring \$26.75
2—ELECTROLYTIC COND 100	TRANSFORMER	Model #T94C441-3 (Transistor) WELLS GARDNER TUNER Part 795	List File \$30.13
1000 mfd.—25V 250—ASST SOLDERING LUGS 100	117V-50-60 Cycle—Pri, Sec. 12.6 Cent. Tap 2 Amp. 329	#7A 120-1 (4GS7-2HA7 Tubes)	100 1 amp., 1000 PIV
best types and sizes	POWER TRANSFORMER	G.E.—TV TUNER (2GK5-4LJ8) 795 Model #EP 86x11	5-PNP TRANSISTOR 100
250—ASST WOOD SCREWS 100	Used in many transistor Power sumplys  29	PHILOU UHF/VHF TUNER 995	☐ general purpose, TO-5 case  ■
250—Asst Self Tapping SCREWS 100	Power supplys COMPLETE CONVERGENCE	Translation of the contract of	5-NPN TRANSISTORS general purpose, TO-5 case
#6, #8, etc. 100—ASST 6/32 SCREWS 100	ASSY.—Inc. Yoke, Board &	ET 86x196, (6GK5-6BL8)	25—ASSORTED TRANSISTORS 100
☐ and 100—6/32 HEX NUTS ☐ ■	Plug Conn. Adaptable to most 90° sets 395	UNIVERSAL TV Antenna Back of 299 set mounting 5 section rods 299	□ big factory scoop—sold as-is ■
100—ASST 8/32 SCREWS 100—8/32 HEX NUTS	COLOR DELAY LINE—Used 169	BLUE LATERAL Magnet Assy. 179	Excellent for hobbyist 100
100-ASST 2/56 SCREWS 100	7-ASSORTED VOLUME 100	Replacement for most color TV's	2-ELECTROLYTIC CON- 100
and 100—2/56 HEX NUTS 100—ASST 4/40 SCREWS 100		Food in walid A 40 11 41	DENSERS Axiat leads 500 25V L ELECTROLYTIC CONDENSER 100
and 100—4/40 HEX NUTS	CONTPOLS less switch	COLOR CONVERGENCE Assy. 249 Universal type—good for most sets 2	□ 300 mfd.—200V
100—ASST 5/40 SCREWS and 100—5/40 HEX NUTS	15—ASST. ROTARY SWITCHES 100	COLOR-TV RECTIFIER—Used 195	ERS 80/100/60 MFD-160V
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best sizes	Model FT425 198	Model HA-9 VHF/UHF 0 4—Polarized CHEATER CORD 100	Approved 6'
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□ .0033—1000V	RONETTE Steren Cartridge 200 latest dual sapphire flipover type	BRIGHTNER 2—Colorburst Quartz-Crystal 189	8-MINI PILOT BULBS With 8" Leads-6.3V 30MA (5001 Hrs)
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Circle 73 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-



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Circle 76 on reader service card

RADIO-ELECTRONICS

It has a stated accuracy of  $\pm 3\%$  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 21/4-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 allaround 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 lowcost multitester market, one would have to go up quite a ways in price to match the versatility of this one.

### 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.

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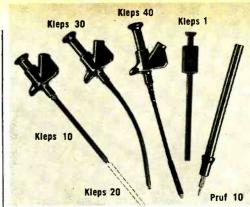
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Kleps 40. Completely flexible. 3-segment automatic collet firmly grips wire ends, PC-board terminals, connector pins.

Kleps 1. Economy Kleps for light line work (not lab quality).

Meshing claws. 4½" long.

Pruf 10. Versatile test prod. Solder connection. Molded phenolic. Doubles as scribing tool. "Bunch" pin fits banana jack. Phone tip. 5½" long.

1. Solder constant and solder connection.

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Circle 77 on reader service card





21 million Americans have high blood pressure. But 50 percent of those who have it, don't know it.

When blood pressure goes higher than it should, and stays high, it sets the stage for heart attack or stroke Most cases of high blood pressure can be controlled with drugs and other advances in treatment. That's why you should see your doctor reg-ularly. Only he can tell if you need



Now you can get all the benefits of a VTVM (laboratory accuracy, stability and wide range) but with its drawbacks gone: no plugging into an AC outlet, no waiting for warm-up, no bulkiness. New Field Effect Transistor (FET) design makes possible low loading, instant-on battery-operation and small size. Excellent for both bench and field work.

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4DB ranges: -24 to +56DB.
Sensitive easy-to-read 4½' 200 microamp meter. Zero center position available. Comprises FET transistor, 4 silicon transistors, 2 diodes. Meter and transistors protected against burnout. Etched panel for durability. High-impact bakelite case with handle useable as instrument stand. Kit has simplified step-by-step assembly instructions. Both kit and factory-wired versions shipped complete with batteries and test leads. 5¼'H x 6¾'W x 2%'D. 3 lbs.



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Circle 78 on reader service card

### **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 highpermeability 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 nonmagnetic 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 movingiron 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.



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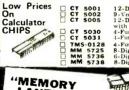
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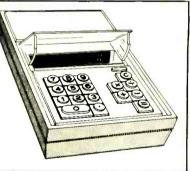
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55	1.20	248	6.49	19	3.06	CD05F	.80	SK3006	1.41
56	1.44	250	.79	20	1.10	CD07F	.90	SK3007	1.26
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57	1.20	253	1.20	21	1.12	CY-1F	2.55	SK3008	1.23
75	2.95	553	4.10	22	1.03	CY-2F	3.35	SK3009	2.34
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			2N718 2N918	27 55	.15	2N2222A 2N2369	35
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N1015 N1725	Mt-1 To-61	1 00 2 1.50	2N1711 2N2218	.65	30 22	2N2905A 2N2906	35
N2288	10-3	2 1.00	2N2219	.50	.22	2N2907	40
N3054	To-66	5 1 00	2N2219A	.75	.30	2N3053	20
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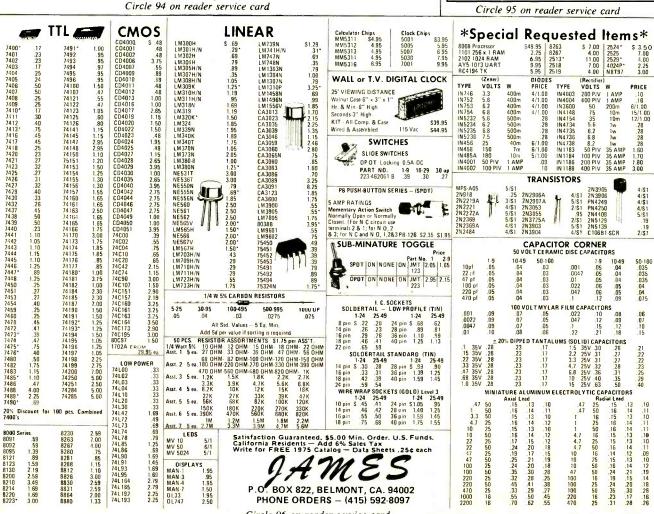
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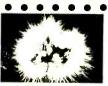
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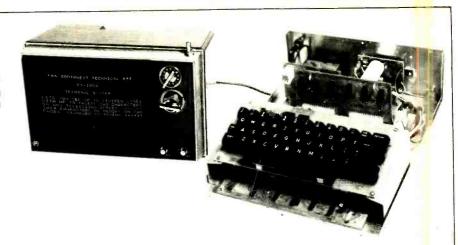
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# CT-1024 TERMINAL SYSTEM



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 91/2 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 basis 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

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 in erface. 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 stepby-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.

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